Accelerating Large-scale Adoption of Low Carbon Cleaner Production Development in Asian Developing Countries

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Accelerating Large-scale Adoption of Low Carbon Cleaner Production Development in Asian Developing Countries

Snellere adoptie van low carbon schone productie in Aziatische ontwikkelingslanden

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
AIT	Asian Institute of Technology
APO	Asia Productivity Organization
APEC	Asia-Pacific Economic Council Co-operation
APRCP	Asia-Pacific Roundtable for Cleaner Production
APRSCP	Asia-Pacific Roundtable for Sustainable Consumption and Production
ASEAN	Association of Southeast Asian Nations
ASEAN-EIP	ASEAN Environmental Improvement Program
AEEAP	ASEAN Environmental Education Action Plan
BOD	biological oxygen demand
CBO	community-based organization
CER	Certified Emission Reduction
CDM	Clean Development Mechanism
CIF	Climate Investment Funds
CII	collaborative impact initiatives
CNCPC	Chinese National Cleaner Production Center
COP	Conference of Parties
CP	cleaner production
CPIE	Cleaner Production for Industrial Efficiency
CSIRO	Commonwealth Scientific and Industrial Research Organization
CSO	civil society organizations
CT	clean technology
CTEM	Clean Technology and Environmental Management
CTF	Clean Technology Fund
CVM	contingent valuation method
DAC	Development Assistance Committee
DENR	Department of Environment and Natural Resources
DESIRE	Demonstration in Small Industries for Reducing Waste
DO	dissolved oxygen
EBRD	European Bank for Reconstruction and Development
EMS	environmental management systems
EOP	end of pipe
ESCO	energy service companies
ETS	European Trading Scheme
EU	European Union
FDI	foreign direct investment
FI	financial intermediary
G8	Group of Eight
GAIA	Global Alliance for Incinerator Alternatives
GAVI	Global Alliance for Vaccinations and Immunizations
GCF	Green Climate Fund
GCPC	Gujarat Cleaner Production Center
GDP	gross domestic product
GEF	Global Environment Facility
GGGI	Global Green Growth Institute
GHa	global hectare
GHG	greenhouse gases
Global Fund	Global Fund to Fight AIDS, Tuberculosis and Malaria
GPG	global public goods
GSCM	green supply chain management
HDI	Human Development Index
IEAT	Industrial Estate Authority of Thailand
IAA	international assistance agency
IDG	International Development Goals
IFC	International Finance Corporation
IFFIm	International Finance Facility for Immunization
INDC	Intended Nationally Determined Contributions

IPEN	International POPs Elimination Network
ISO	International Standards Organization
ITPO	Investment and Technology Promotion Office
JBIC	Japan Bank for International Cooperation
JICA	Japan International Cooperation Agency
LCA	lifecycle assessment
MA	Millennium Ecosystems Assessment
MDB	multilateral development banks
MDG	Millennium Development Goals
MOI	Ministry of industry
MOSTE	Ministry of Science, Technology and Environment
MSME	micro, small, and medium-sized enterprises
MVA	manufacturing value added
NAMA	Nationally Appropriate Mitigation Actions
NAPCC	National Action Plan for Climate Change
NCCAP	National Climate Change Action Plan
NCPC	National Cleaner Production Center
NDC	Nationally Determined Contributions
NDRC	NATIONAL DEVELOPMENT AND REFORM COMMISSION
NEASEC	Northeast Asian Sub Regional Program Of Environmental Cooperation
NFSCC	National Framework Strategy On Climate Change
NGO	nongovernment organization
NPO	National Productivity Organization
OECD	Organization For Economic Cooperation And Development
PCB	polychlorinated biphenyl
PMR	Partnership For Market Readiness
POP	persistent organic pollutant
PPAH	Pollution Prevention And Abatement Handbook
PPP	polluter pays principle
PPPs	public-private partnerships
PROPER	Public Disclosure Of Industrial Pollution Program For Pollution Control Evaluation And Rating
SAICM	Strategic Approach To International Chemicals Management
SCP	sustainable consumption and production
SD	sustainable development
SDG	Sustainable Development Goals
SEPA	State Environmental Protection Administration
SME	small and medium-sized enterprise
SOE	state owned enterprise
SPARC	Subsidy Phase Out And Reform Catalyst
TA	technical assistance
TBIRD	Thai Business Initiative In Rural Development
TEI	Thailand Environmental Institute
TM	transition management
TNEC	Thai Network Of Eco-Efficiency And Cleaner Production
TVE	town and village enterprise
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UN ESCAP	United Nations Economic And Social Commission For Asia And Pacific
UNFCCC	United Nations Framework Convention On Climate Change
UNIDO	United Nations Industrial Development Organization
USAEP	US-Asia Environmental Partnership
USAID	United States Agency For International Development
WCMC	World Conservation Monitoring Centre
WDR	World Development Report
WEC	World Environment Center
WHO	World Health Organization
WTO	World Trade Organization
WTP	willingness to pay

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The journey behind this thesis began in 1995. I had the remarkable opportunity to be engaged with a number of Asian developing countries in supporting their efforts to use some of their newfound wealth to invest in waste management systems intended to not only improve sanitation/public health but also improve ecological health and productivity. The focus of the countries was on end-of-the-pipe solutions- the concept of Cleaner Production (CP) was just emerging but was not seen as an integral element of national environmental or industrial development policy. I was inspired by the work of Professor Donald Huisingh who was stimulating a growing awareness of the potential economic and environmental benefits of CP at the global level and I wish to acknowledge the important role he played in convincing me that CP was not an option but rather a necessity for sustainability in developing Asia. Professor Huisingh also convinced me to take the journey I have been on over the last twenty years for this thesis- a long journey indeed.

In the early stages of this journey I was the beneficiary of guidance and support from a number of individuals within the Erasmus program, but want to particularly thank, in addition to Prof. Huisingh, Prof. Wim Hafkamp, Dr. Leo Baas, and Dr. Frank Boons; and particular appreciation to Prof. Hafkamp and Prof. Huisingh for their patience. I was also greatly encouraged and supported by colleagues in Thailand and The Philippines who worked with me on the thesis case studies. Ms. Wanida Srichai, Dr. Olivia Castillo, Dr. Chaiyud Bunyagidj, and Dr. Anthony Chiu- each have continued to be champions for cleaner production and sustainable consumption in the region. I also acknowledge the leadership and support of Dr. Pakit Kirivanich, who as Director General of the Thai Pollution Control Department, recognized the need for large-scale adoption of CP and hosted the first Asia-Pacific Roundtable for Cleaner Production. There were also a number of international experts supporting Asian developing countries to include CP as an integral element of the development process with whom I worked closely and benefited from their energy and knowledge- most notable was Dr. Richard Stevenson, an intellectual leader for CP before his untimely passing.

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SUMMARY

Work on this thesis was initiated in 1995. Its focus is on Asian developing countries, particularly rapidly industrializing and urbanizing countries since they represent a large portion of current and future global economic growth, consumption and waste emissions including greenhouse gases (GHGs). The research presents a relatively long-term perspective of the evolution of cleaner production (CP) and shorter-term perspective on low carbon development in developing Asia. Understanding this history- stakeholders, barriers, and drivers of change- provides a basis for conceptualizing a transformational shift to large-scale adoption of CP as an integral element of reaching the Sustainable Development Goals and low carbon development.

In the mid-1990s, the rapidly industrializing Asian developing countries- China, India, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam- initiated CP programs, with considerable international financial and technical assistance, in order to reduce waste and to improve industrial efficiency. These countries established CP policies and supporting networks and training/education programs. However, environmental quality has deteriorated for most indicators. The implementation of CP, whether as an element of environmental or industrial development policy, has not significantly improved environmental quality.

This thesis author, based on about twenty year's experience working on environmental management challenges in Asian developing countries when the research was conceptualized, hypothesized that a framework for establishing CP as a core development principle, with sufficient technical and financial assistance, could help to effectively improve Asian countries' environmental quality and productivity by large-scale adoption of CP in all development sectors. Over time this hypothesis evolved to reflect (i) the dramatic growth of urban/industrial complexes across Asia, (ii) the recognition that climate change threatens poverty and development gains of the last twenty years, and (iii) the transformational potential of integrating low carbon and CP development.

The overarching question addressed in this thesis is:

How can Asian developing countries shift to low carbon CP development to optimize local environmental and social benefits while achieving global climate objectives?

Related questions are:

How can initiatives to shift to low carbon development be built build upon CP concepts?

How can international and national financial mechanisms help Asian developing countries to implement prevention-oriented climate actions that are based upon societal implementation of CP and related concepts?

What are the key development policy and institutional reforms and other measures needed for developing countries to take advantage of opportunities to optimize climate actions and finance by integrating CP concepts?

With these questions addressed, it was possible to explore how a framework might be designed to assist countries to transition to low carbon CP development paths.

The methodological approach included extensive review of twenty years of relevant literature review to identify and analyze the determining factors of successes and failures in CP and low carbon development programs; case studies supported by surveys to assess alternative CP program frameworks within local and national governments and industrial organizations.

A triangulation of information from literature and case studies documented that:

(i) Barriers identified in the 1990s and early 2000s continue to inhibit the adoption of CP at scale in Asian developing countries;
(ii) Those barriers can be typified as policy/legal/regulatory, behavioral, knowledge, or financial and that types of barriers overlap and interact;
(iii) Some barriers are particularly important at the firm-level, community-level, city-level, national-level and international-level but they overlap and measures to overcome them generally require actions at different hierarchical levels and by several stakeholders;
(iv) many of the barriers to CP are also being experienced in efforts to mainstream low carbon development in the development process;
(v) Efforts to scale-up CP and low carbon development have a generally common set of stakeholders.

The key stakeholders for both CP, CSP and low carbon development include national (i) governments, (ii) local governments and communities, (iii) national and local financial institutions, (iv) policy, technology and other research and training support centers including academic and research institutions, (v) civil society, (vi) industry associations, (vii) business and industry, (viii) and international organizations.

Understanding the interactions among these stakeholders and the various barriers and drivers for change are essential, whether seeking to initiate or expand to large scale CP or low carbon development.

The thesis research documented that a new regional or global low carbon CP transformation framework is urgently needed to support the transitions to low carbon CP development. Such a transformation is needed in all countries but this thesis focused on rapidly industrializing Asian developing countries. The international successes of the Paris Agreement and SDGs in 2015 set the stage for such a transformation but it will require effective international and national leadership. The analyses performed for this thesis revealed that initiatives for transformation should:

- Be framed around a cohesive international framework agreement and national policy frameworks fully integrating low carbon climate and CP and CSP policies and programs.

- Provide innovative financing mechanisms that capitalize on climate finance for supporting integrated low carbon CP action. Much of this financing will need to be from developing country domestic resources.
- Generate a new kind of multi-stakeholder collaborative partnership(s) to support long-term action, built on the transition management approach which among other important structural components provides for horizontal and vertical participation, learning and feedback loops to guide future actions.
- Focus on the urban industrial complex level.

Initially a core group of like-minded parties should agree on a general approach to the transformation framework and then engage a broad range of international stakeholders from the UN, governments, private sector, CSO's, and philanthropies to discuss how a transformative regional low carbon CP development partnership might evolve. Most international assistance organizations are revisiting their respective climate strategies and action plans in light of the 2015 Paris Agreement. Thus the timing is opportune to influence their respective approaches to integrating climate and SDG support to be more holistic with long-term transformational objectives. Once partners agree on a lead institution and governance arrangements a core transition management team and national transition management teams would support national low carbon and CP policy integration and urban-industrial low carbon CP actions.

Two major research initiatives are identified that would support the construction and implementation of a regional framework partnership for low carbon CP. The first is to prepare an analysis and proposal for forming a collective impact initiative partnership to plan and operationalize integration of the UNFCCC Paris Agreement and CP-related elements of the SDGs. The second major area of research required relates to supporting national low carbon and CP policy integration, including analytical work to clarify countries' Nationally Determined Commitments and improve methodologies for reporting/measuring the intentions. Once the research clarifies a country's intentions and priorities for low carbon development, a review of the relevant policy framework for CP would be undertaken to establish linkages, duplications and gaps. This will enable the researcher to propose specific country-level policy integration and related institutional, regulatory, and financing requirements for implementing the integrated policies.

SAMENVATTING

Het onderzoek voor dit proefschrift ging in 1995 van start. De focus was gericht op ontwikkelingslanden in Azië, in het bijzonder de landen met snel industrialisatie en verstedelijking. Dat zijn immers de landen waar veel van de huidige en toekomstige groei verwacht wordt; Niet alleen de economische groei, maar ook de groei in het energieverbruik en de uitstoot van broeikasgassen. Dit onderzoek geeft een relatief lange-termijn perspectief op de ontwikkeling van schone productie (CP) en een meer korte-termijn perspectief op een koolstofarme groei in Azië. Daarmee wordt tevens een basis gelegd voor het conceptualiseren van een transformatie naar schoon produceren (CP) als een integraal onderdeel van de doelstellingen op het gebied van duurzame ontwikkeling.

In het midden van de jaren negentig initieerden Aziatische landen (o.a. China, India, Indonesië, Maleisië, De Filippijnen, Thailand en Vietnam) programma's op het gebied van schoner produceren (CP) met aanzienlijke internationale financiële en technische ondersteuning. Dat alles met als doel het terugdringen van industriële afvalstoffen en emissies, en het vergroten van de efficiency in de industrie. Deze landen introduceerden CP-beleid en ondersteunende netwerken, alsmede onderwijs- en trainingsprogramma's. Niettemin is de milieukwaliteit verslechterd op de meeste indicatoren.

De auteur van dit proefschrift heeft meer dan twintig jaar ervaring met uitdagingen op het gebied van milieumanagement in Azië. Hij ging er aanvankelijk van uit dat een raamwerk voor CP, met voldoende technische en financiële ondersteuning kon bijdragen tot een effectieve verbetering van de milieukwaliteit en economische productiviteit. Het raamwerk zou dan de basis kunnen zijn voor grootschalige adoptie van CP in alle sectoren. In de loop van de tijd ontwikkelde dit uitgangspunt zich onder invloed van (i) de snelle groei van stedelijke en industriële complexen overal in Azië, (ii) het inzicht dat klimaatverandering de winst op het gebied van ontwikkeling teniet doet, en gaat leiden tot meer armoede, en (iii) het inzicht dat het integreren van koolstofarme otwikkeling in CP geweldige kansen biedt.

De alomvattende onderzoeksvraag in dit proefschrift luidt:
Hoe kunnen ontwikkelingslanden in Azië omschakelen naar een koolstofarme, schoner producerende ontwikkeling om de locale kosten en sociale baten te optimaliseren en tegelijkertijd mondiale klimaatdoelstellingen te behalen?

Bij deze hoofdvraag zijn de volgende subvragen geformuleerd:

Hoe kunnen initiatieven om over te gaan op een koolstofarme ontwikkelen in gebouwd worden in schoner produceren (CP)?

Hoe kunnen (inter)nationale financiële instrumenten Aziatische landen helpen om preventieve klimaatacties uit te voeren die gebaseerd zijn op maatschappelijke implementatie van CP en daaraan geralteerde concepten?

Welke hervormingen zijn nodig op het gebied van ontwikkelingssamenwerking, en met welke institutionele hervormingen en welke aanvullende maatregelen kunnen ontwikkelingslanden klimaatacties en CP-concepten integreren en optimaliseren?
Met het antwoord op deze vragen was het mogelijk een raamwerk te ontwerpen dat geschikt is voor landen die de overgang willen maken naar een koolstofarme, schoner producerende ontwikkeling.

In het onderzoek werd onder andere een uitgebreide review gedaan van de relevante literatuur over een periode van twintig jaar. Daarbij werd gepoogd de succes- en faalfactoren van CP- en CO2-reductieprogramma's te identificeren, en hun invloed te analyseren. Daarnaast werden cases studies uitgevoerd, en enquetes gehouden bij locale en nationale overheden en organisaties in het bedrijfsleven.

Trianulatie van de informatie uit de literatuur en case studies liet zien dat:

(i) De belemmeringen die in de jaren negentig en het eerste decennium deze eeuw in Azië bestonden nog steeds de adoptie van CP op grotere schaal belemmeren.

(ii) Deze belemmeringen zijn van uiteenlopende aard: beleid, wet- en regelgeving; gedrag en kennis; financieel. De verschillende belemmeringen beïnvloeden elkaar.

(iii) Sommige belemmeringen zijn vooral belangrijk op het niveau bedrijven, gemeenschappen, steden, landen en internationale organisaties, maar ze overlappen elkaar; en maatregelen om ze te overwinnen vereisen in het algemeen acties van verschillende actoren op verschillende hiërarchische niveaus.

(iv) Veel belemmeringen voor CP worden ook ervaren bij pogingen om een koolstofarme ontwikkeling van de economie te bevorderen.

(v) Voor het opschalen van CP zijn over het algemeen dezelfde actoren nodig als voor het bevorderen van een koostofarme ontwikkeling.

De belangrijkste stakeholders voor CP en koolstofarme ontwikkeling zijn (i) nationale overheden, (ii) locale overheden en gemeenschappen, (iii) nationale en locale financiële instellingen, (v) civil society, (vi) organisaties in het bedrijfsleven, (vii) het bedrfijsleven zelf, en (viii) internationale organisaties. Bij het initiëren en versterken van programma's op het gebied van CP en koolstofarme ontwikkeling is het van cruciaal belang de interacties tussen deze stakeholders, en de belemmeringen en stimulerende factoren te begrijpen.

Dit proefschrift laat zien dat een nieuwe regionale of mondiale koolstofarme CP-transformatie hard nodig is voor de transitie naar een koolstofarme economie. Zo'n transformatie is nodig in alle landen, maar in dit proefschrift gaat staan de snel industrialiserende landen in Azië centraal. Het internationale succes van de Paris Agreement, en de Strategic Development Goals die de VN in 2015 vast stelde zetten de toon voor zo'n transformatie. Er zal echter effectief nationaal en internationaal leiderschap nodig zijn. De analyses die voor dit proefschrift zijn uitgevoerd laten zien dat initiatieven voor transformatie een aantal kenmerken moeten hebben:

. Geformuleerd rond een internationale raamovereenkomst met nationale beleidslijnen voor een volledige integratie van koolstofarme, klimaatneutrale en CP ontwikkeling

. Met innovatieve financieringsmechanismen die klimaatfinanciering benutten om geintegreerde koolstofarme/CP-acties uit te voeren. Een groot deel van de financiering zal uit de ontwikkelingslanden in Azië zelf moeten komen.

. Nieuwe multi-stakeholder samenwerking, voor transitiemanagement, gericht op horizontale en verticale samenwerking, leerprocessen en terugkoppeling naar toekomstige acties.

. Focus op stedelijke industriële complexen.

Aanvankelijk zal een kerngroep van gelijkgestemde partijen tot overeenstemming moeten komen over de aanpak van de transformatie en vervolgens een brede range aan international stakeholders in het process betrekken, van de VN, nationale overheden, het bedrijfsleven tot CSO's en filantropen. Ze zullen met elkaar moeten bespreken hoe een transformationele koolstofarme CP-ontwikkeling zou kunnen verlopen. De meeste organisaties voor ontwikkelingssamenwerking herzien momenteel hun klimaataanpak en actieplannen in het licht van de Paris Agreement van 2015. De tijd is rijp voor een transformationele aanpak. Het gaat erom deze organisaties ertoe te brengen dat ze tot een zelfde integratie komen van klimaat, de Strategic Development Goals, en de meer lange-termijndoelen van zo'n transformatie. Zodra de partijen een leidende instelling hebben gekozen, en een vorm van governance hebben uitgewerkt voor de samenwerking, kan er een kernteam voor transition management ingesteld worden. Dat zou dan moeten gaan samenwerken met nationale transitiemanagement teams om te komen tot integratie van koolstof- en CP-beleid, en stedelijk-industriële koolstof/CP acties.

Er zijn twee forse onderzoeksinitiatieven geformuleerd voor het tot stand komen van een regionaal samenwerkingsverband voor koolstofarme CP. Het eeste is om een analyse uit te voeren en een voorstel uit te werken voor de vorming van een *collective impact partnership* voor de operationele integratie van de UNFCC Overeenkomst in Parijs en de Strategic Development Goals van de VN (met name waar ze CP raken). Het tweede onderwerp waar onderzoek nodig is betreft de ondersteuning van de integratie van het beleid gericht op CP en koolstofarme ontwikkeling op nationaal niveau. Dat zou zich ook moeten richten het verhelderen van de nationale ambities, en de methoden om te rapporteren over intenties en resultaten op beide gebieden. Daarmee kunnen dan verbanden, overlappingen en gaten in kaart gebracht worden, waarna voor landen afzonderlijk specifieke voorstellen gedaan kunnen worden op institutioneel gebied, en op het gebied van wet- en regelgeving, en financiële instrumenten.

1. INTRODUCTION

1.1 Setting the Stage- Asian Developing Countries Driving the Global Economy

Economic growth in several Asian developing countries[1] in 1995, largely driven by expansion of export-oriented manufacturing, was unprecedented. It was that rapid economic and industrial development that stimulated work on this thesis. Since then, economic growth rates as measured by gross domestic product (GDP) in Asian emerging economies have been the highest in the world. The region has also experienced dramatic drops in poverty. In1995 about 40 percent or 700 million East Asians were impoverished (living on $1.90/day based on 2011 purchasing power parity). By 2012 poverty rates dropped to about 7.2 percent of the population (147 million people). South Asia experience was similar with a drop in poverty rates from 43 percent or 550 million people in 1995 to about 19 percent or about 309 million people in 2012. The growth and poverty reduction trajectories were in part a response to rapid urbanization across the region, increasing from 0.94 billion urbanites in 1995 to 1.63 billion in 2015. (UN, 2015; ESCAP, 2016)

During this time there were many ups and downs and adverse side effects of this very rapid growth. The financial crisis in 1997/1998 hit several Asian developing countries particularly hard with GDP growth rates in countries like Indonesia and Thailand dropping from seven percent to negative thirteen percent and six percent to negative seven percent, respectively. The financial crisis of 2008 also reversed economic growth across Asia, but not as severely as in 1997 or as compared to the impact in much of the rest of the developed and developing world.

The costs of environmental and natural resource degradation have also been a casualty of lack of attention to environmental sustainability of the industrial-driven economic growth across Asia in the 1990s. If such casts are internalized in the calculation of GDP, then the growth rates would be recognized as being much lower than those reported. As described in Chapters three and four, the rapid rates of industrialization and resulting environmental degradation and loss of critical ecosystems and ecosystem services was a major stimulus for cleaner production (CP) in several Asian developing countries in the mid- to late-1990s. As countries gained experience and capacity, including improved ability to monitor and report on industrial efficiency and waste, several have undertaken substantial policy reforms and deployed cleaner technologies leading to a new eco-industrial development pattern. More recently, many stakeholders, governments, businesses, communities, and households, are paying increasing attention to not only production but also to consumption. This new eco-industrial development pattern is critically important for achieving sustainable development at both the local and global levels. (Geng et. al., 2016)

[1] For purposes of this thesis, Asian developing countries are comprised of East Asia and South Asia countries. The thesis focus is on the rapidly industrializing countries and emerging economies which include China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Viet Nam.

While this thesis research was started in 1995, it is this thesis author's view that a long-term outlook must be taken to drive a transformative process towards real sustainability. The changes that will take place between now and 2030 or 2050, particularly in the emerging economies of Asia, driven by further population growth and urbanization and climate change, demand that a long-term vision be applied. International agreements and processes have
taken place in last twenty years that have brought attention to the need for and are guiding a reimagining of what the future may become in the context of climate changes and consequent geo-political dynamics with their potentials and risks (see Section 1.2).

Research that projects or proposes future long-term scenarios is critically important for reimagining the future. Understanding how to bridge the gap between disciplines and between theory, practice and policy, scenario and envisioning methodologies is not a well-developed research methodology. (Mont et.al., 2014) Nevertheless, this thesis author attempted to gain an understanding of the long-term perspectives and steps needed to help Asian developing countries transform the development process from its historic and current unsustainable path to one of eco-industrial sustainability.

1.2 Global Attention to Sustainability of Growth in Developing Countries

This thesis author considers that five major developments during the last twenty years have been instrumental in strengthening the international resolve to take the serious actions needed for societies to make progress toward sustainable development. These include: (i) the Millennium Development Goals, (ii) the Millennium Ecosystem Assessment, (iii) the intensification of the climate change dialogue, (iv) the green growth agenda, and (v) the Sustainable Development Goals.

The adoption in 2000 of the 2015 Millennium Development Goals (MDGs) placed “environment” in a new context: good environmental quality promotes poverty reduction and bad environmental quality exacerbates poverty. The poor bear the brunt of failed development policies in urban and rural areas and suffer even more when these failures perpetuate the process of environmental degradation. Urban environmental degradation, through lack of, or inappropriate, waste management and sanitation, and industrial and transport-related pollution, adversely impacts on air and water quality, which disproportionately impairs the health of the urban poor. This, in turn, decreases opportunities for steady employment and schooling, diminishes productivity, and perpetuates poverty. The linkages among environment, poverty, and economic development are clear. Thus, new policy initiatives are needed, which can generate pro-poor economic gains while achieving environmental objectives (UN Millennium Project, 2005; UN, 2015).

The Millennium Ecosystems Assessment (MA) played a critically important role in elevating the understanding of the inter-linkages of ecosystems and the importance of ecosystem services for poverty reduction and economic growth. The results of the MA provided a wake-up call regarding the severely poor state of ecosystem health and the widespread prevalence of mismanagement. While ecosystem services are of global importance, the MA highlighted their importance at the local, national and regional levels for sustainable societal development that is more ecologically, ethically and sociologically sound.

Much of the future economic and social welfare of developing countries relies on having healthy and productive ecosystems to provide such services as delivery of good quality water for agricultural, urban and industrial uses: stable and sustainable agricultural and fisheries productivity; flood mitigation; raw materials for industry, energy, and shelter; and protection of coastal resources. The MA highlighted the need for better protection of these natural assets by (i) coordinated efforts of governments, businesses and international institutions and (ii) wise policy choices on investment, trade, subsidy, regulation and taxation (Millennium Ecosystem Assessment, 2005 (a)).

The third and perhaps most dramatic development has been the elevation of climate change as one of the most politically charged development challenges. Increased scientific knowledge and awareness of the potentially devastating impacts of climate change in developing and developed countries has been a key factor in furthering the debate on who should do what and when. The impacts of climate change are being experienced at a much faster pace than expected, consequently, the likely extreme heat waves, declining global food stocks, loss of ecosystems, and sea level rises and storm surges are going to have unprecedented impacts globally, but will particularly hurt the poorest, least resilient countries and sub regions (IPPC, 2014; World Bank, 2012 (a), World Bank, 2013 (a)).

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and entered into force in 1994 with 196 parties. But it wasn't until the implementation of the Kyoto Protocol in February 2005 and promulgation of the European Trading Scheme (ETS) spawning a thriving carbon market, that there was an elevated awareness of the potential importance of carbon trade for developing countries. The adoption by the "G-8 plus 5" at the G-8 Summit in Gleneagles, Scotland in July 2005 of climate change as a priority issue resulted in a dramatic scaling-up of climate change related work by the World Bank and by other multilateral development banks (MDBs) (Evans, 2015). Of particular concern to the G-8 and MDBs at that time was reducing the carbon footprint of rapid growth- particularly from fossil-fueled energy, transport and industrial expansion and increasing access to cleaner technologies. (World Bank, 2006 (a))

The Stern Review (2006), the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007), and the movie, "An Inconvenient Truth" (Gore, 2006) all served to heighten attention to climate change. During 2009, a concerted effort was exerted by the international community to achieve a strong outcome at the Copenhagen Conference of Parties (COP) to enhance implementation of the UNFCCC, based on the elements of the Bali Action Plan.

While the UNFCCC negotiations process has continued to be the leading forum, several other processes and fora, at the global and regional level, have stepped in to add weight and support for climate action. New stakeholders have begun taking action outside UN climate negotiation process- some have been government led such as the establishment of the $8 billion Climate Investment Funds (CIFs) implemented by MDBs. But others have brought together like-minded parties including governments, civil society organizations (CSOs), UN, MDBs, and the private sector, in partnerships with highly focused actions such as the Reduced Emissions from Deforestation and Forest Degradation plus partnership (REDD+). Initiatives to understand and address the climate change challenge are increasingly engaging a cross-section of stakeholders, such as parliamentarians, city mayors, community leaders, private sector executives, academics, non-government organizations (NGOs) and civil society.

The Copenhagen COP highlighted the complexity of the issues and challenges in seeking to facilitate global action and in working to clearly articulate the needs and views of developing countries. While not resulting in a legally binding agreement or many of its other objectives, the Copenhagen COP did achieve scaled-up, near-term financing for low-carbon and adaptation initiatives with $30 billion new and additional funds pledged for "fast-start finance," and strengthened the societal resolve to establish a long-term financing framework with commitments of $100 billion per year climate finance by 2020 (IISD, 2009). The extent to which the $30 billion fast-start pledge was met is contested because there was no agreement among parties on what funding would count, and many donors simply reoriented existing development assistance funding (Ciplet et al, 2012). The OECD and Climate Policy Institute (2015) estimate that $62 billion in climate finance was provided by donor countries in 2014 and concluded that there has been significant progress towards the $100 billion commitment.

The lack of success in Copenhagen and subsequent annual negotiating sessions placed in question the timing and level of effort that countries will take in collective action to reduce GHG emissions. The late-2015 Paris COP was viewed as a make-or-break negotiation. Fortunately, the Paris COP achieved significant progress in that most developed and developing countries made emission reduction and adaptation commitments in the form of Intended Nationally Determined Contributions (INDCs). In addition, among other accomplishments, the parties (negotiating countries) agreed on a new sustainable development mechanism, which will strengthen the linkage of climate action with the achievement of the Sustainable Development Goals (SDGs).

However, the Paris COP of 2016, was not successful in securing adequate, long-term financial support for climate action. Nor are the INDC GHG reduction commitments sufficient to meet the agreed 2°C maximum target increase in mean temperature above pre-industrial levels. Nevertheless, potential progress in this regard is significant in that business-as-usual emissions would lead to a 4°C to 5°C increase by 2100, while the current INDC emission-reduction pledges would lead to a 2.7° to 3.7°C increase by 2100 (UNEP, 2015; Reilly et al, 2015). The new commitments are sufficient to bend the curve of emissions growth but will not reverse it.

The fourth and fifth, more recent, global initiatives are indicative of an evolving dialogue on the sustainability challenge. The Green Economy (or green growth) initiative was launched at the Rio+10 sustainable development summit in 2012. A new set of Sustainable Development Goals (SDGs) was agreed to replace the MDGs at the September 2015 UN General Assembly.

The 2008 financial crisis presented an opportunity to promote "Green Economy" or "Green Growth" concepts and approaches. Several institutions and partnerships have adopted their own versions of definitions of green growth (at least 13) and green economy (at least eight). But the Green Growth definition by the Global Green Growth Institute (GGGI) and Green Economy definition by UNEP are generally representative of the range of definitions. UNEP defines a green economy as "one that results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. It is low carbon, resource efficient, and socially inclusive." The GGGI defines green growth as "the new revolutionary development paradigm that sustains economic growth while at the same time ensuring climatic and environmental sustainability. It focuses on addressing the root causes of these challenges while ensuring the creation of the necessary channels for resource distribution and access to basic commodities for the impoverished." (UNEP, 2011; OECD, 2009; World Bank, 2012 (b)).

The increasingly evident limitations of natural ecosystems and their services to fulfill the growing global consumption demands, the prospects of more severe constraints due to climate change, together with a global human population projected to be 9 billion by 2050, make it very clear that countries can no longer: (i) count on an unlimited supply of cheap natural resources, (ii) continue resource-intensive consumption practices, or (iii) meet the consumption demands with inefficient and high carbon production practices. This reality has led to the Green Economy initiative initiated by the United Nations Environment Programme (UNEP). The Green Economy is a more holistic approach than many of the global initiatives that have emerged during the last twenty years to transform development and growth to achieve long-term environmental, social and economic sustainability.

The objective of the new green economy initiative is to demonstrate that greening of the economy across a range of sectors can drive economic recovery and growth and lead to future prosperity and job creation, while at the same time addressing social inequalities and environmental challenges. Essentially the approach is to establish an open architecture partnership whereby, those concerned can engage in a range of research and implementation programs, and policy dialogues to refine the knowledge on the financial support required and the key policy tools and supporting infrastructure needed to influence investment and consumption decisions. The global effort is expected to effectively make the case for and to demonstrate feasibility of the sustainable use of natural, human and economic capital, thereby, facilitating actions by governments to transition to a Green Economy (UNEP, 2011; ESCAP/ADB/ UNEP, 2012).

The stalemate on achieving consensus through the UN COPs stimulated greater attention to the decade's major global event on sustainability, the Rio+20 summit held in June 2012. This was the second decadal follow-up to the 1992 Rio Summit on Sustainable Development. The UN and many other stakeholders attempted to use the Rio+20 summit to bring the global sustainability issues together under a Green Economy banner. Thus the primary focus of the preparations for Rio+20, was on the integration of relevant issues and global, national and local initiatives to achieve a more holistic green economy. The entire UN system explored how they can assist in achieving such a transformation. The World Bank and many other development finance institutions independently initiated internal strategic planning processes to understand how they can most effectively assist developing countries to achieve such a transformation at the national and local levels (World Bank, 2012 (c)). The intent was to build on the UNEP Green Economy Initiative to help countries reform policies that drive investments in economic and social development by integrating green objectives such as supporting clean(er) technologies, renewable energy, smart urban growth, sustainable agriculture, and minimizing generation of and improving 'cradle-to-cradle' management of wastes, into development policies and programs. An interesting lesson from the policy integration efforts of several countries was that success was more dependent on pragmatism, timing and careful planning than upon the scale of resources committed. (Hamdouch and Depret, 2010)

A major outcome of the Rio+20 summit was the decision to initiate negotiations on SDGs, designed to be implemented at the expiration of MDGs in 2015. The SDGs retain a strong poverty reduction focus but unlike the Environmental Sustainability goal in the MDGs, the SDGs are clearer and the ability to measure progress is stronger too (UN, 2014).

Given the diversity of Asian countries, the impact of these international developments has been variable across the region. However, there is little question that these five developments have strengthened the resolve of most Asian industrializing countries toward sustainable development (for example, the concept of green growth was launched in 2005 at a meeting of Asian ministers of environment).

The Green Economy and SDG initiatives could significantly improve the likelihood that efforts by developing countries to adopt CP policies and strategies, integrated with efforts to shift to low-carbon development paths, can contribute to stronger sustainable growth in Asia and throughout the world. A joint analysis by the United Nations Economic and Social Commission for Asia and Pacific (UN ESCAP), UNEP, and the Asian Development Bank (ADB) concluded that "*Action for sustainable development is now more economically and politically feasible than ever before, and governments and stakeholders in the region are searching for ways to rise to the challenges*" (ESCAP/ADB/UNEP, 2012). In other words, the time is right for countries to capture the opportunities and to benefit from a rapid shift to a CP development framework.

This thesis was built on the premise that CP is indeed a "win-win" approach to reducing environmental degradation without inhibiting growth- that CP is a key element of achieving sustainable growth. There is good reason to be optimistic that Asian developing countries' governments and their private sectors will reorient themselves towards environmentally sound development, based upon CP principles. Several developing countries demonstrated the ability to make dramatic changes in that direction in the 1980s and 1990s, which resulted in the remarkable economic boom in Asia (Smith and Jalal, 2000). Such energies and innovation can be applied to changing development patterns towards environmental and social sustainability. But they need to be guided by an appropriate development policy framework. Such a development framework is perhaps most appropriate for rapidly industrializing countries such as is found across Asia. However, if tailored to economic, environmental and social conditions, the development framework should be as effective in supporting sustainability in less-developed countries such as in Sub-Saharan Africa as in rapidly industrializing middle-income countries.

1.3 The Need and Opportunity to Co-Adopt Cleaner Production, Low Carbon Growth, and the Green Economy in Asian Developing Countries

The wide-scale adoption of CP principles, including low carbon growth, by governments and existing and future industries in Asia's developing countries is an immediate need and a formidable challenge. The coming decades are expected to bring ever-increasing environmental risks to Asian countries associated with unsustainable economic growth. Asia has emerged from the economic turbulence of 1997-1998 and 2008-2009 to embark on what will be the largest urban and industrial expansion ever witnessed.

The current global population of 7.1 billion will increase to 8 billion by 2030 (NIC, 2012) and 9 billion by 2050 (OECD, 2008; OECD 2012). More than 97 percent of the increase will occur in developing countries, especially within Asia (World Bank, 2007(a)). The output of the global economy is projected to increase from $35 trillion in 2005 to $72 trillion (at constant market exchange rates and prices) by 2030. Developing Asia's GDP growth in 2015 was about 6.3 percent (ADB, 2016) compared to the global average of 3.1 percent (IMF, 2016). Asian economic expansions were achieved in spite of the food and fuel crises in the mid-point of the 2001 - 2010 decade. However, as discussed in Section 3.4, the environmental degradation and related public health costs and loss of ecological productivity and services exacted by this rapid and poorly managed growth have been severe.

The 2008 global financial crisis quickly transformed into an economic crisis for almost all countries of the world. The crisis affected developing countries with dwindling capital flows; huge withdrawals of capital, leading to losses in equity markets and skyrocketing interest rates. Like climate change, the financial crisis was a result of market and regulatory failures in developed countries. Nevertheless, while poorer countries have been hit hardest, major Asian economies recovered from the 2008 financial crisis faster than other major economies (IMF, 2009; Foxley, 2009). The long-term outlook to 2030 projects that East Asian developing countries will lead with average GDP growth rates of 4.0 percent and South Asia will have 4.7 percent compared to 2.4 percent for high-income countries. This will result in dramatic increases in consumption and increases in negative environmental and social impacts on already over-stressed eco-systems and urban-systems (McKinsey, 2012).

Asia's population is anticipated to increase by 50 percent within the next generation. Most importantly, there is expected to be a continuation of the tidal shift of population from rural to urban areas and from agriculture to manufacturing and service industries. In the 1950s, an estimated 232 million people, or 17 per cent of the population, lived in urban areas in Asia. During the subsequent 55 years to 2005, the urban population grew nearly sevenfold to over 1.5 billion, 40 per cent of the total population. Asia's urban population is expected to reach 2.2 billion by 2020, making it the largest urban population in the world. This population includes an estimated 70 percent of the global poor. By 2030, it is estimated that 2.7 billion people, about 55 percent of the population in the Asia region, will live in urban areas (ADB, 2006 (a)).

About 600 million new consumers living in 440 cities in emerging markets will generate almost 50 percent of global GDP growth between 2010 and 2025 (McKinsey, 2012). This increase in per capital disposable income will increase consumption of energy and water and generation of wastes. Demand for food is expected to rise by 35 percent and energy by 50 percent over the next 15 to 20 years (NIC, 2012). Demographic changes, such as higher levels of urbanization and changes in household size and composition, also contribute to changes in lifestyle, consumption patterns and dietary preferences (animal products, oils and fats, processed food, etc.). *(*OECD, 2008; OECD, 2012*)* The economic and population/urban growth in Asia will present daunting challenges for environmental and natural resource managers. They will cause increased consumption of natural resources that are being extracted from ecosystems that are already over-taxed when it comes to ecosystem services (Millennium Ecosystem Assessment, 2005(b)) and to massive increases in energy and other infrastructure support systems (ADB, JICA, World Bank, 2005). When the impacts of climate change overlay the future scenarios of population, urbanization, and production/consumption, it is reasonable to assume that ecosystem services will become a serious constraint to the projected economic and social growth of all countries (Perrings, 2010).

At the same time, the economic development prospects present an exciting opportunity to shift to much more sustainable pathways. The vast majority of the capital stocks of factories, machinery and infrastructure needed to fuel this growth between now and 2030 in Asian developing countries have not yet been built. For example, the Chinese Ministry of Construction stated that by 2020 an additional 180 million people will reside in urban areas, and about 13 billion square meters more residential floor space will be constructed in the next two decades. This is equivalent to the total floor area of all existing residential buildings in the European Union (EU) countries. The environmental impacts of buildings constructed today will continue for years to come. There is considerable potential to reduce the sector's environmental impacts, particularly with energy efficient buildings. (OECD, 2008)

A key part of the challenge is to create a policy and regulatory environment that will provide incentives for the adoption of CP practices and low carbon emitting technologies in the next phase of urban and industrial investment. This, in turn, requires an equally fundamental shift towards the integration of development and environment policy to ensure sustainability. Tinkering around the edges will not work; only fundamental and dramatic changes in approaches will achieve the level of success required. Most Asian developing countries have not effectively implemented successful pollution control programs (ADB, 2001(a)), let alone made the essential shift from 'end-of-pipe' mitigation of pollution to the up-front pollution prevention approaches to eliminate or substantially reduce the pollution problems at their sources (Evans and Stevenson, 2001).

Building the foundation for such changes, in addition to the policy and regulatory frameworks, must include making fundamental changes in management, product design, process optimization, changes in technology and life cycle, supply chain management of products and services to ensure the implementation of CP to help make substantial progress toward sustainable regional development. Cleaner Production is a broadly endorsed concept in Asia's emerging economies, but as of the turn of the century, had achieved a limited impact in comparison to its potential (UNEP, 2001).

As was the case in 1997, the 2008 financial crisis caused several developing countries to shift attention and resources away from efforts to address environmental sustainability and climate change (IFC, 2010; Thavasi and Ramakrishna, 2010). But the financial crisis, combined with a looming food crisis and the memories of fuel crises, underscore the potential of environmental degradation and climate change to further aggravate the economic impacts of financial crises, particularly on the poor and vulnerable in developing countries given their lack of resources, capacity and resilience. In spite of the difficult economic times, a number of Asian developing countries have taken action to shift to low carbon growth paths (UNFCCC, 2009). China and India, two of the world's largest and most rapidly developing economies, have undertaken large-scale, low carbon development programs. Indonesia, Philippines, Thailand, and Viet Nam, the next tier of developing economies, have also initiated low carbon development programs. (CIF, 2009) The opportunity to build upon these programs in a structured way to broaden the mandate and impact to effect local as well as global environmental quality through CP is emerging. A global push for CP, as per the SDGs, needs to be taken as an integral element of the low carbon development path.

Clearly, there is an urgent need and opportunity to shift to a cleaner, lower-carbon, more sustainable development and production regime in Asia and elsewhere throughout the world. The actions by several governments to shift towards low-carbon development are promising. However, one must also question why CP has not yet been widely adopted. After all, during the last two decades, extensive efforts by bilateral and international assistance agencies have been made to assist Asian developing countries to put in place effective environment management regimes and institutions in support of CP. These countries have responded with the promulgation of numerous policies and laws, institutions and pilots intended to stimulate adoption of CP. Despite these efforts, as this thesis author described, in Chapter 3, how Asia's environmental quality is continuing on a downward spiral.

Demonstrations of real commitments to take the necessary actions for protecting the environment are limited. It is noteworthy that during periods of rapid economic growth in Asia, governments' increases in investments for improving environmental quality were not substantial, as compared to other forms of public and private expenditures. In the mid-1990s, among the topics with "lots of talk but little action" was CP. Since the financial crisis of 1998, there was be much less emphasis on guiding clean industrial growth in many developing countries and by many international development institutions (World Bank, 2009 (a)). Serious attempts to implement 'polluter-pays policies,' officially adopted by many developing countries, and to recover costs of water supplied to and solid wastes taken away from industries, would have encouraged greater efficiency in industrial production and reduced waste loads and resource depletion rates, and would have facilitated private sector participation in delivery of environmental services. All of these ideas were known, but perhaps not well understood and certainly not well implemented by decision-makers, politicians and industrialists.

What is required to stimulate developing country's governments and the private sector to remedy the policy deficiencies that have undermined sustainable development in the past? The answers were embedded in the recommendations resulting from the work on the MDGs, SDGs, ecosystems and climate change, as well as in much of the literature regarding sustainability of growth, which emphasizes the need for improved policies and governance along with stronger institutions, transparency and accountability. This author built his thesis upon the premise that large-scale application of CP is financially, environmentally, and technologically feasible, but only likely to be realized if critical policy, governance, institutional, industrial awareness and educational barriers are overcome.

1.4 The Research Questions

The primary objective of this thesis author was to develop a framework to assist developing country governments to optimize local and global benefits for integrating and implementing low carbon development and broader national CP policies and programs. The challenges and opportunities described in this Chapter lay the foundation for the main research questions that were addressed to achieve this objective. While there were numerous sub-questions that emerged, the higher level questions addressed in this thesis are:

- How can initiatives by Asian developing countries to shift to low carbon development build upon CP concepts, thereby, increasing local environmental and social benefits while achieving global climate objectives?
- How can international and national financial mechanisms be designed and implemented to help Asian developing countries to implement prevention-oriented climate actions that are based upon societal implementation of CP and related concepts?
- What are the key development policy and institutional reforms and other measures such as improved planning, regulations, and education, that can help developing countries to take advantage of opportunities to optimize climate actions and finance by integrating CP concepts?
- How could a framework designed to integrate global climate action with local CP initiatives serve as a useful tool to assist international mechanisms and developing countries generate and optimize the co-benefits of addressing global climate change and local sustainability?

1.5 Summary of the Research Process and Methodology

The initial methodological approach to this thesis, conceptualized over the period 1995 to 1996, relied largely on a combination of literature analyses with descriptive case studies supported by structured surveys. While that continued to be the fundamental approach for this thesis, as described in Chapter 2, the element of longitudinal studies and historical events were built upon in the overall analytical approach. The theory and hypotheses formulated twenty years ago drove the methodological approach. But the theory and hypotheses have evolved and have been refined based upon lessons learned. In particular, the growing recognition in the last decade that climate change and its risks is one of the world's greatest challenges, and the limited awareness that CP approaches to development implemented at a massive scale can achieve local (environmental and economic) and global (reduced greenhouse gas emissions and resource efficiency) benefits, have resulted in the thesis author redesigning the overall research approach to focus on potentials for achieving these dual benefits. Thus, the data generated and analyzed have a different relevance to the overall study and recommendations than was originally envisioned.

As described in detail in sections 2.2 and 2.3, this thesis author applied a mixture of research methodologies, combining quantitative and qualitative approaches. Surveys, case studies, and secondary research were the major research tools, with the analytical base covering a relatively long (though unintended) timeline. From a theoretical vantage point, Ragin (1987) emphasized that the type of process of scientific research is more the norm than otherwise (though maybe with less of an extreme time lapse) and that in practice there is not an intentional "gulf between hypothesis or concept formation and data analysis" but that "most hypotheses and concepts were refined, and often reformulated after the data were collected and analyzed. Initial examinations of the data usually exposed the inadequacy of the initial theoretical formulations, and a dialogue evolved between the investigator's conceptual tools for understanding the data and the data analysis. The interplay between concept formation and data analysis led to progressively more refined concepts and hypotheses. The preliminary theoretical ideas continued to serve as guides, but they were refined or altered, sometimes fundamentally, in the course of data analyses." This was certainly the case for the research and writing of this thesis.

The initial research design focused on use of field surveys to develop a case study approach; focusing on two of the Asia's most rapidly industrializing countries at the time the research was initiated- Thailand and the Philippines. Both countries initiated national programs for promoting the adoption of CP practices in the manufacturing sectors in the mid-1990s, and were keen to scale up such initiatives. Thus the objective was to understand the barriers and drivers for successful incentives at the firm level and at the national level for scaling up CP. Those initial thesis surveys were supplemented by similar surveys in China, India, Indonesia, and Sri Lanka, undertaken by ADB consultants as elements of technical assistance projects at least in part supervised by this thesis author.

Thailand and Philippines were significantly impacted by financial crises in 1997 and 2008 and their national CP initiatives suffered major setbacks as a result. Thus the research design had to be significantly adjusted to rely on secondary research as a major tool. Since the objective of the research was to propose approaches to transformative, large-scale adoption of CP, much of the secondary research focus was on the largest economies in the region-China and India. Both of these countries have initiated large-scale climate action programs and CP programs, though they are not effectively linked.

When looking at achieving transformation, that is broad-scale behavioral change with large-scale and sustainable impacts, a key challenge that emerged during the research was how to work with the multilayered and complex elements that must come together. Thus, as noted in section 2.4, this thesis author identified and characterized the most critical elements of such transformation and their inter-linkages by using a relatively new tool, 'transition management' (TM). Since TM is a relatively new tool, which did not exist when the research was initiated and it is still very much in the research stage, the research process for this thesis evolved to seek to use TM concepts to describe the inter-linkages of actions and roles of various actors that are essential for achieving the intended transformation.

1.6 Thesis Overview

Work on this thesis was started in 1995, at a time when there was substantial economic growth throughout much of Asia, including a growing middle class that was paying increasing attention to environmental quality. There was great hope that these countries might leapfrog the "pollute now and cleanup later" syndrome of developed countries. The potential for adopting CP seemed to be high, with extensive international support and national commitment in several rapidly industrializing countries. It is now 2016. As noted in sections 1.2 and 1.3, a number of global and regional events have impacted the decisions and actions of countries, and this thesis author's hope to see a transformation in how Asian developing countries manage their environmental assets has not been realized. The intention of this thesis author, including its structure, was to describe (i) the conditions that led to the efforts to adopt CP in the mid-1990s, (ii) the successes and failures of those efforts and their sustainability and evolution over twenty years, and (iii) how these experiences and evolving external factors might be built upon to achieve large-scale adoption of CP as an integral objective of economic development.

Chapter 2 explains the research methodologies applied over the life of the thesis research, including the reasons for the mixture of methodologies and how they are mutually supportive in addressing the thesis questions. This Chapter also directs the reader to the more detailed descriptions of the case study methodology and the approach taken to apply transition management theory.

Chapter 3 contains a snapshot of the ‘state-of-the-environment,’ and the major issues and challenges that stimulated efforts to adopt CP in the 1990s and that Asian developing countries continue to face in seeking to achieve environmental sustainability while reducing poverty and maintaining social, environmental and economic sustainability.

Asian developing countries, largely supported by bilateral and multilateral donor programs, undertook a number of CP demonstration and pilot projects, capacity development and training programs, CP roundtables, workshops and related activities to promote CP in Asia. The regional and sub-regional programs and the lessons learned are summarized in **Chapter 4.**

Perhaps, the most interesting recent developments related to the objectives of this thesis are the decisions several Asian and other emerging economies have taken to shift to low(er) fossil carbon energy, transport, industrial and urban development options. In most cases, the implementation of these decisions is conditional on having adequate financial support to offset technological costs. These efforts are described in **Chapter 5**, along with an assessment of the linkages, or lack thereof, to the same countries’ strategies for implementation of CP.

Asia’s two largest economies, China and India, have each undertaken policy, regulatory, and investment programs in support of CP and low fossil carbon development. The relevant experiences of these two countries are reviewed and evaluated in **Chapter 6** in order to further substantiate the lessons and to derive recommendations for how to catalyze CP implementation at a scale that has a large-scale impact on environmental quality and productivity.

Chapter 7 summarizes case studies used for this thesis in the Philippines and Thailand. The detailed case studies included surveys undertaken in Samut Prakarn Province of Thailand and in MetroManila, Philippines urban-industrial region in order to assess alternative CP program frameworks within local and national governments and industrial organizations. These case studies also addressed the identification of approaches that effectively encourage SMEs to adopt CP practices and to identify incentives and disincentives required by SMEs to make the shift to CP.

Review of experiences in both CP and low(er) fossil carbon development, both positive and negative, provided valuable insights into the barriers, driving forces, and potential solutions to wide-scale adoption of CP are described in **Chapter 8**. **Chapter 9** builds on the analyses of barriers and drivers from Chapter 8 to assess approaches to scale-up CP in tandem with low carbon development. This thesis author used the TM approach to structure the key barriers and other variables, actions and actors and their inter-linkages and actions required to drive the desired large-scale transformation to a cohesive low carbon CP development future. This presentation facilitates an improved understanding of priorities possible, in terms of addressing barriers, providing incentives for innovation, establishing policy frameworks that support diffusion and embedding- all with short- medium- and long-term outlooks. Further, the short- and medium-term can be cast in a collaborative, operational approach designed to achieve collective impact and enhance opportunities for sustainability and further co-evolution.

Finally, **Chapter 10** discusses the next steps for achieving the desired transformation in developing countries in Asia including the kinds of additional research required to strengthen the case and support the actions needed.

2. RESEARCH METHODOLOGY

2.1 Evolution of the Research Goal and Relationship to Research Approach and Methodologies

In 1995, when this research was initiated, there was very limited experience in Asian developing countries in terms of following a strategic approach to the wide-scale adoption of CP. Several countries had initiated CP projects in various manufacturing sectors but none of the Asian developing countries had embarked on a broader effort to maximize the benefits of pollution prevention by embedding CP in national development policy and developing strategies for its implementation. In fact, in 1995, most Asian developing countries were just beginning to invest in end-of-pipe (EOP) waste management systems in response to rapidly deteriorating environmental quality.

This thesis author was an active participant in a growing community of development professionals and academicians interested in exploring how to incorporate CP in the development process across the Asia region in the mid-1990s. As a development professional responsible for promoting environmental sustainability through economic and social development, this thesis author was curious why CP was not being adopted more rapidly and at a broader scale given its demonstrated economic and environmental benefits at the factory, community, and, potentially, subnational and national levels. The challenge, in this thesis author's view in 1995, was how to convince and support developing countries to transition to wide-scale CP in order to achieve the combined benefits of improved economic and financial return and reduced environmental degradation. The initial goal of this thesis author was to perform research to enable testing of the proposition of a framework approach to achieving such a rapid transition at the scale required to generate substantial environmental benefits.

In developing countries the dissemination of CP has been shown to be a complex and dynamic process (van Hoof, 2014). The selection of the thesis research methodology needed to take into consideration this complexity and dynamism. A research strategy utilizing a combination of complimentary methodologies, combining quantitative and qualitative approaches, was determined to be appropriate. The thesis research strategy relies extensively on literature review. Literature and targeted surveys were used to construct case studies. Yin (1984) argued that a case study approach is the preferred research strategy when the researcher is trying to answer or better understand "how" or "why" questions and has little control over related events. This situation certainly applied to this thesis.

At the time the thesis research design was conceptualized, the two Asian developing countries showing the most potential for adopting strategic approaches, policies, and programs for CP at the national level were Thailand and the Philippines. Thus much of the initial research effort reported in this thesis is on the experience in these two countries- including the surveys and case studies undertaken, in part, for purposes of answering the initial research questions.

The review of relevant literature was initiated at the outset of the research to draw upon key experiences related to the implementation of CP, This process was a critically important element of this research. Experience in developed countries was reasonably well documented and to a large extent the lessons learned from their implementation of CP appeared applicable to developing countries. The most critical references at the outset of the research, though limited, were experience-based reports on policy and technical barriers to adoption of CP in several Asian developing countries at the project and program levels.

Over the years since the thesis research was initiated, the thesis author's professional engagement in climate change and climate finance in particular, resulted in a transition in focus of the research to a broader objective. Given the global attention to climate change and positive response from several Asian developing countries in terms of policy and regulatory reform and emerging shifts in investments towards low carbon and climate resilient development, should not the objectives of such climate action and its financial mechanisms be designed to optimize local and national economic, social and environmental benefits by merging CP and climate action?

The research questions, approach and methodology were adapted to address this new objective and form the basis for the thesis as depicted in Table 2.1. The resulting research was an iterative process to:

(i) Perform extensive literature review and interviews to identify and analyze the determining factors of successes and failures in CP programs;
(ii) Perform detailed case studies in several Asian countries to assess alternative CP program frameworks within local and national governments and industrial organizations;
(iii) Perform analyses of low carbon development policies and strategies and to investigate the linkages and complementarities to CP policies and strategies in representative developing countries;
(iv) Identify, analyze and propose policy, regulatory and financial frameworks including incentives and disincentives at the global and national levels that will effectively encourage large-scale adoption of CP practices concurrent with transition to achieving low(er) fossil carbon development;
(v) Develop and validate a framework, particularly for development of economic instruments as incentives and disincentives for the promotion of implementation of CP;
(vi) Evaluate options for (1) strengthening international climate finance agreements to provide incentives for integrating national climate mitigation and CP programs, and (2) national approaches to achieving such integration including policy, regulatory, financing, and institutional incentives and disincentives and supported by strengthened participatory approaches, knowledge management, education, and research and development.

The key research elements are shown in Figure 2.1 and Figure 2.2. In that context, Figure 2.1 shows the linkages of climate actions and CP policies and programs at the regional and national levels as critical for overcoming the barriers that have limited the ability of countries to successfully implement large-scale CP initiatives. Figure 2.2 outlines the key elements of the thesis.

Table 2.1: The Thesis Research Objectives and Questions Determine the Conceptual Design and Methodology.

Objective and Research Questions		Concept	Methodology
Develop a framework to facilitate large-scale and rapid implementation of fully integrated low carbon and CP development in Asian developing countries.	How to build on CP experience to integrate low carbon, climate resilient development with CP?	Assess what has and has not worked in CP initiatives and the relationship to climate action.	Literature review with applied triangulation to validate Surveys with statistical comparitive analysis Case studies (Chapters 3-7)
	How to utilize international and national climate and other development finance mechanisms in Asian developing countries for prevention-oriented climate actions that are based upon CP and related concepts?	Assess the potential to link climate finance with broader CP objectives including achieving related international SDGs.	Literature review Applied policy integration theory (Chapters 4, 5 and 8)
	What are the key development policy and institutional reforms and other measures needed optimize collective impact of climate and CP actions?	Understand the complexity of stakeholders and their respective potential roles, and the barriers and drivers for scaled-up action.	Literature review and Case study analysis of barriers and drivers with applied triangulation to validate (Chapters 5-8)
	Can a framework be designed to integrate global climate action with local CP initiatives to assist international mechanisms and developing countries generate and optimize the co-benefits of addressing global climate change and local sustainability?	Prioritize governance and institutional actions that would need to be taken by key stakeholders at local, national and international levels.	Applied policy integration theory Applied transition management theory (Chapters 9 -10)

Figure 2.1 The Thesis Research Focal Areas Include Cleaner Production Actions and Climate Actions in Asian Developing Countries, their Common Barriers and Potentials for Integration Leading to Scaled-up Application of CP.

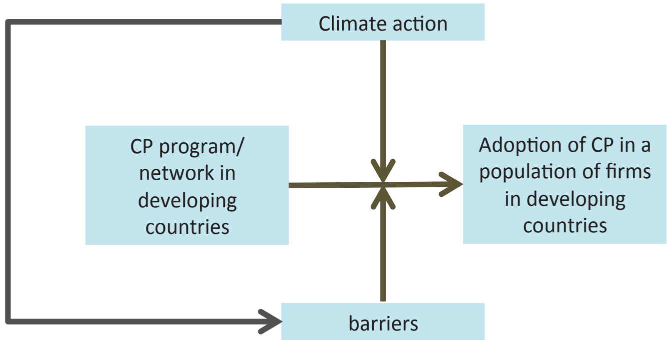
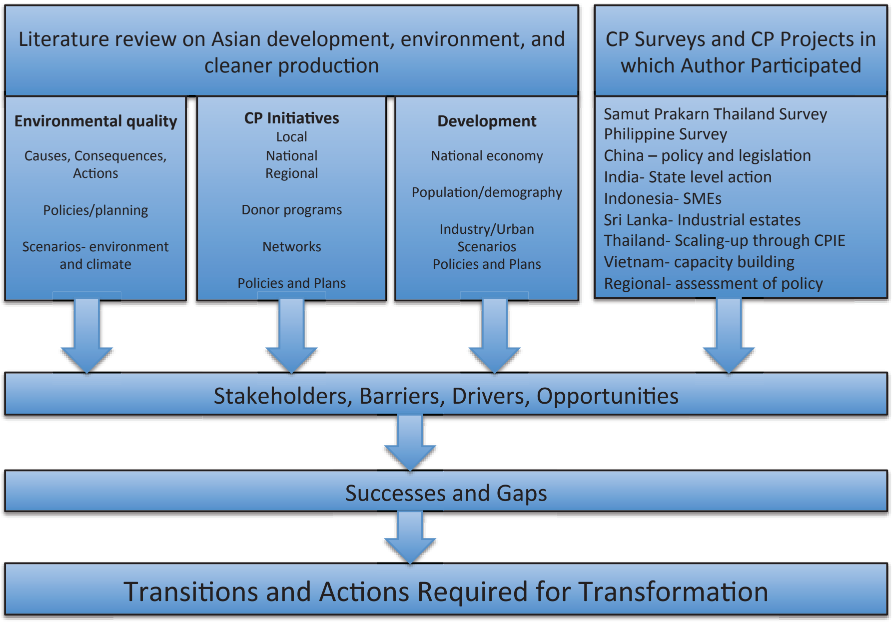


Figure 2.2 Key Elements of this Thesis Workflow include Literature Review, Case Studies and Applied Transition Management Theory.



2.2 Literature Review

A significant challenge at the time that the research was initiated was the lack of relevant literature on application of CP in developing countries. There was considerable literature emerging from industrialized countries but the literature on developing countries was largely limited to reports on donor-supported demonstration projects and UN-supported programs. This situation has dramatically improved over the years so that there is now a considerable quantity and quality of peer-reviewed and grey literature[2] relating to the opportunities and challenges for adopting CP in the development process.

In addition to literature on methodologies relevant to the research, this thesis author relied upon CP and climate change research and project reports from international and bilateral development organizations such as the United States Agency for International Development (USAID), World Bank, ADB, and UNEP; peer reviewed journal articles; and related academic publications. Publications describing (i) economic and environmental conditions in developing countries and (ii) the development process and experiences, are particularly dominated by development finance institutions and UN agencies and tend to fall in the grey literature category.

The references can be typified as follows:

(i) The historic and current economic, social and environmental conditions in the focal study area, industrializing Asia, and the critical global, regional, and national events over the past several years that interacted to influence decision-making and actions relevant to shifting to a more sustainable development path;

(ii) Projected regional and national economic, social, and environmental scenarios including industrial growth and limiting factors such as climate change;

(iii) CP experiences in industrialized and developing countries;

(iv) Industry-specific technologies for CP demonstrating the feasibility to leapfrog from ‘end-of-pipe’ pollution control approaches to new CP technologies in developing countries;

(v) The psychology of industry and how to convince industry to make a shift from traditional approaches of production to CP. This literature is also relevant for the application of basic theories on paradigm shifts, innovation diffusion, fostering of creativity, and so on, for policy formulation to stimulate a transformation to CP and to a lower fossil carbon societal development.

(vi) Command-and-control approaches to industrial pollution control vs. the more integrative, holistic, proactive framework of CP-oriented approaches.

(vii) Financing environmental investments- references discussing financing of CP are limited but there are relevant references on financing public environmental infrastructure. The last decade’s experiences with carbon markets and the climate finance, provide interesting lessons for applying market-based mechanisms and public sector finance initiatives to stimulate adoption of cleaner technologies;

(viii) The various stakeholders for CP, their respective roles, as well as their perceptions of barriers and drivers for achieving a CP transformation; and

[2] Grey literature is the term used for materials and research produced by organizations outside of traditional academic publishing.

(ix) Theoretical and proven approaches to achieving transformative change such as policy integration and transition management.

The reader will find that some of the descriptive literature cited in Chapters 3 through 7 may appear to be out of date. However, the objective of presenting this information and data was to assist the reader to understand the economic and environmental conditions in Asian developing countries in the 1990s and 2000s that led to government CP actions and policies (positive or negative). In addition, the reader will note inconsistency in descriptions of environmental conditions. The reality is that data on environmental quality in the 1990s was often spotty with inconsistent reporting.

2.3 Surveys and Case Studies

In the early stages of the work on this thesis, based on the thesis author's professional experience and the knowledge drawn from the literature, it appeared that the most important and immediate question regarding overcoming barriers to scaling up CP dissemination and implementation in Asian developing countries was: What triggers adoption of CP by management and operations at the firm and local government levels? A case study approach was selected to generate detailed information to answer this question. This was deemed to be appropriate given experience in similar market conditions where policy, behavioral and structural changes were involved (Westgren and Zering, 1998).

A key methodological question was "what type of case study approach is most relevant for obtaining answers to this thesis author's research questions?" The fundamental choice was whether to focus on a variable oriented strategy or on a more holistic case-oriented comparative method. A case-oriented comparative study enables the investigator to take into account that the causal significance of a condition often varies by context and in some situations a variable may be relevant to a given outcome but in others it may be unimportant. In other situations the absence of a variable may be causally significant to the outcomes (Ragin, 1987). Comparative cases have also been useful for policy integration assessments (Nilsson and Persson, 2003) which is an important element of this thesis.

The challenge for this thesis author was to identify and to understand the variables and their relative importance under a range of conditions and by diverse stakeholders in order to generate an effective policy framework. Thus, it was essential to compare and contrast the different case results in a holistic manner. According to Ragin (1987) the case-oriented comparative methods provide the latitude to achieve this in that they allow (i) a focus on divergence and causal heterogeneity, (ii) causal complexity, and (iii) an accounting of the differences in outcomes from different scenarios, thereby, enabling a better understanding of "when a cause should enable the ranking of priorities of inputs or actions to secure the desired change."

However, case-oriented approaches have limits with regard to the number of cases that can be compared in contrast with the variable-oriented approach since it can readily embed key assumptions into statistical models. These assumptions, however, discourage consideration of causal complexity, and the research dialogue is fundamentally altered as a result. The case-oriented approach, by contrast, allows investigators to comprehend diversity and, as noted in Chapter 7, helped this thesis author to address causal complexity. By considering cases as wholes, it was possible to examine causal processes more directly and to evaluate them in context. The research dialogue was therefore, centered on intersections of causal conditions.

Given the variability of stakeholders, a d*escriptive* case-oriented comparative study approach was adopted so that corporate and individual behavioral patterns based on iterative, cause-effect dynamics could be established and compared (Tellis, 1997; Yin, 2014). Thailand and Philippines were selected as cases because they were the two countries with the most active CP programs with participation by large numbers of diverse stakeholders with whom this thesis author had the best access in 1995 when work on this thesis was initiated.

Particular attention was given to construct and select cases that would generate valid and replicable information, taking into account potential investigator subjectivity. The approach taken was to utilize multiple sources and to seek external validity to establish if the results could be used to generalize or if they were only applicable to the immediate case (Yin, 1994). Further, a multiple, case-oriented comparative study approach was selected to help this thesis author to understand the combinations of conditions of causes and effects among the diverse set of stakeholders. Each case was compared and contrasted with other relevant cases found in the literature in order to generate an understanding of divergence and causal heterogeneity. This approach was based upon the knowledge that the problem is not based upon a single cause-effect relationship, but rather is related to a range of different cause and effect scenarios, which can be described by comparable cases. Thus, it was important to design a case methodology that made allowances for causal complexity, especially multiple, conjunctural causations. This approach allowed this thesis author to not only focus upon the importance of a cause but, more importantly, to understand the different scenarios in which a “cause” has an impact. (Ragin, 1987)

Prior to data collection, a case study protocol was developed based upon the survey instrument, including procedures and general rules followed in using the survey instrument. The protocol included an overview of the case study objectives, issues, and topics being investigated; field procedures including credentials and access to sites, and sources of information; and case study questions (specific questions that the investigator had to keep in mind during data collection). The face-to-face interview based upon a structured questionnaire, was the primary approach used to gather case study information. The survey questionnaire was structured but the interviews, while focused, were open-ended so that respondents could comment on issues of concern to them and thereby corroborate or disagree with evidence from other sources. The potential shortcomings of this approach, namely response bias, incomplete recollection and reflexivity, (interviewee response is what he/she thinks the interviewer wants to hear) were minimized by using survey teams (a minimum of two researchers) and large sample sizes. The interviews were supplemented, in many instances, by direct observations during the field visits by the surveyors. (Strauss and Corbin, 1990)

Two surveys were undertaken. The Samut Prakarn, Thailand survey (see section 7.3) was designed to accomplish two objectives. The first was to assess readiness of factories to participate in a CP initiative and the second was to determine willingness-to-pay for connections to a newly proposed central (regional) wastewater collection and treatment facility and for reducing waste management costs by adopting pollution prevention measures or avoid pollution charges/penalties. The survey used the contingent valuation method (CVM) to assess willingness-to-pay. This approach has several important advantages over indirect methods. It can be used to value services that are impossible to assess with indirect approaches. For example, it can be used to evaluate the benefits of increased availability of financing for factory improvements, or the reaction of industries to pollution charges or penalties which have not been enforced in the past but are about to be invoked, or the reaction of industries to alternative approaches to technical or managerial support related to a CP program. (Mitchell and Carson, 1989)

The second survey, the MetroManila, Philippines survey (see section 7.5), was also designed for assessing readiness of factories to adopt CP management and practices, but also focused on potentials to green the supply chain.

The survey variables from the Philippines and Thailand surveys were compared using quantitative statistical analyses in order to test the validity of the conclusions drawn on commonality of responses. The Thai and Philippine survey instruments were designed with the intention of building on the experience so that the survey could be improved and replicated in other countries. Subsequent surveys undertaken as part of ADB technical assistance in China, India, and Sri Lanka were adapted from the Thai and Philippine surveys. The conclusions from the various surveys were compared with each other, and similar information on barriers and drivers for CP and climate action from academic and grey literature also compared to the survey results (see sections 7.2 and 7.3) to ensure validity of the conclusions drawn from the surveys.

2.4 Applying Policy Integration and Transition Management Theories

This thesis is focused on the changes required to transform societies and economies in Asian developing countries to become more environmentally and socially sustainable. What is meant by “transformational”? There is no common understanding of the meaning of this term- depending on the perspective there can be several different elements considered as key to transformational change. In the context of this thesis, it is a collective of actions at a scale required to result in a significant shift in development pathways and production processes leading to a measurable change in the long-term availability, quality of public goods and resources and avoidance or reduction of public “bads” such as greenhouse gases. Driving such a transformational change requires a combination of policy shifts and reforms, political leadership and capacity, appropriate financing mechanisms, business models and production modes adapted to better focus on long-term cycles, improved management of uncertainty, innovation and new technologies, and fundamental societal behavioral changes led by government, private sector and civil society (TSU/GCF, 2011).

A fundamental challenge for this thesis author was establishing a “theoretical thread” through the elements of this research to improve the likelihood that the resulting conclusions and recommendations would be operationally relevant to key stakeholders. The subject of this thesis is essentially how to effect "change." How can individuals, companies, communities, cities, countries and regions achieve transformational change in their production and consumption to lead to ecological and environmental sustainability? This question is effectively addressed in the ecological modernization (EM) theory (Mol and Sparargaren, 2000) which served as a foundation for conceptualizing the policy and institutional reforms required to shift unsustainable to sustainable development. This is achieved by internalizing environmental values, not just direct costs of actions, but the full environmental values of ecosystems and their services, as opposed to the currently common practice of viewing environmental values as externalities. In order to effectively internalize environmental values, structural reform (technological, institutional, and social actions) must be undertaken to address structural faults that cause environmental degradation and loss of ecosystem productivity.

Since elements of society are interconnected through constantly evolving networks, correction of structural faults that EM demands is not static but must reflect, or be embedded in the interactive processes between and within different elements of society. Thus, the concept of social embeddedness also provided an important theoretical foundation for this thesis.

Embeddedness, in the context of this thesis research, is the understanding of the relationships with and dependence on, the various networks of key CP stakeholders. According to Boons and Grenville (2009), because of these network interlinkages, diffusion of transformational actions is not so much a technological function, even though much of the work on CP has focused on the technological aspects, but is rather a social function.

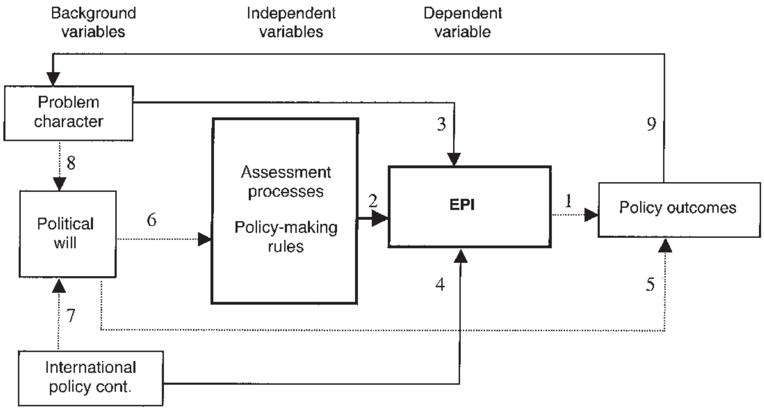
The numerous efforts to transition in this direction, including adoption of the principles and approaches of CP, have not been durable or reached the scale required to achieve transformation needed to improve the Asia region's environmental quality or productivity. Some countries' efforts to shift to low(er) fossil-carbon development approach are promising. The real question is: Can a new developmental framework that is built on the theory of EM, with sound environmental principles and practices thoroughly embedded and diffused, be adopted and thereby, help to secure true environmental sustainability? The theories of EM, embeddedness, and diffusion are intertwined as the basis of environmentally sustainable development and were therefore, fundamental to the fabric of this thesis and were revisited throughout the development of this thesis.

The transformation towards sustainability will be an evolutionary (or co-evolutionary) process. The process will be affected by numerous political and economic considerations and actions, which are impossible to predict or plan. Further, as noted in section 8.1, to achieve this transformation will require a complex array of stakeholders to collaborate over a long period of time. Is it possible to lay out a plan, intervene and steer management of radical actions that can achieve the needed changes in socio-technological structure and societal values? Modern environmental sustainability challenges require a fresh approach capable of dealing with the complexities of multiple domains and recognizing the uncertainties that are unavoidable when multiple actors are engaged in transition over a relatively long period of time (Shove and Walker, 2007). The case study approach used in this thesis research has also been shown to offer cross domain tools for integrative research addressing multi-scale, multi-actor and long-term transitions (Manring, 2014).

A common theme throughout the various assessments of barriers to CP is the complexity and often duplication of policies and regulations governing CP and resulting ambiguities of responsibilities and accountabilities of various stakeholders-particularly from government, but also research and academic institutions and other stakeholders. Governmental agencies, corporate departments, and research and academic institutes are typically set up according to discrete sectors and disciplines, each with its own interests (and interest groups), virtually ensuring policy segregation. The need to address the challenge of breaking down the silo effects of segregated policies and institutions was one of the key messages in the World Commission on Environment and Development (1987) Brundtland Report: “The ability to choose policy paths that are sustainable requires that the ecological dimensions of policy be considered at the same time as the economic, trade, energy, agricultural, industrial, and other dimensions on the same agendas and in the same national and international institutions. That is the chief institutional challenge of the 1990s.”

The EU agreed with the Brundtland Commission’s conclusion and, after several years of testing different approaches, adopted a comprehensive system for applying environmental policy integration in 2002 in order to integrate environmental aspects and policy objectives into various sector policies. Persson (2004) concluded that experience of applying policy integration theory in Europe was mixed. Understanding what “policy” means in a given setting and then the mechanisms and sequence of actions are essential starting ingredients for policy integration analysis. (Jiao and Boons, 2014) Variables and measures for environmental policy integration were found to fall into three broad, inter-related categories: normative (eg. political leadership, overall policy framework, change of policy-making culture); organizational (eg. Integrated government departments, change of budget process); and procedural (eg. policy integration strategies and action plans, systematic impact assessment procedures). (Nilsson and Persson, 2003) Governance arrangements and the structure of institutional arrangements and institutions have been key determinants for impacts of policy integration.(Atkinson and Klausen, 2013; Jacob and Volkery, 2004) Figure 2.3, which outlined an approach to environmental policy integration that helped this thesis author to understand the complex mechanisms that shape policy making and assess the level of embeddedness of policy integration in terms of generating real change. (Nilsson and Persson, 2003)

Figure 2.3 Achieving policy integration requires political will as well as a structured understanding of its objectives (problem character), variables, and processes.



source: Nilsson and Persson, 2003

The review of barriers and drivers to transitioning to low carbon CP development discussed in Chapters 8 and 9 showed that policy segregation continues to plague the effective coordination and lowers efficiency and effectiveness of both CP and climate actions. Thus, this thesis author in Chapters 9 and 10 applied policy integration theory as a core element for a transformational framework. However, there remains an analytical challenge - how to frame the transitions required to achieve transformation. Transition Management was designed to meet the challenges that transformational sustainable development presents. The TM approach is a relatively new practice, very much in the testing and development phase. (Van der Brugge; Loorbach et al, 2015)

Based on the following "definition" from Geels and Schot (2007), the TM theoretical framework is a good fit for the challenge of understanding the broad complexities and facilitates the identification of gaps of a transformational shift in policy or behavior. They described TM as:

1. *"Transitions are co-evolution processes that require multiple changes in socio-technical systems or configurations. Transitions involve both the development of technical innovations (generation of novelties through new knowledge, science, artifacts, and industries) and their use (selection, adoption) in societal application domains. This use includes the immediate adoption and selection by consumers (markets and integration into user practices), as well as the broader process of societal embedding of (new) technologies (e.g. regulations, markets, infrastructures, and cultural symbols).*
2. *Transitions are multi-actor processes, which entail interactions among social groups such as businesses or firms, different types of user groups, scientific communities, policymakers, social movements, and special interest groups.*
3. *Transitions are radical shifts from one system or configuration to another. The term "radical" refers to the scope of change, not to its speed. Radical innovations may be sudden and lead to creative destruction, but they can also be slow or proceed in a step-wise fashion.*

4. *Transitions are long-term processes (40-50 years); while breakthroughs may be relatively fast (e.g. 10 years), the preceding innovation journeys through which new socio-technical systems gradually emerged usually took much longer (20-30 years).*
5. *Transitions are macroscopic. The level of analysis is that of organizational fields."*

The transition approach recognizes that current top-down modes of governance, whether at the global, regional, national or city/community level, require deep connections with bottom-up initiatives as well as horizontal interactions in order to support for shifts toward inclusive sustainable development (Nevens et al, 2013; Frantzeskaki et al, 2012) Transitions are complex and non-linear, multi-level, and multi-actor (Loorbach 2007). The transition approach facilitates connections between structures, cultures, and practices of different societal actors with several (conflicting) public and private interests to cross-span multiple levels, domains, and terms (van Eindhoven, Frantzeskaki, and Loorbach, 2013). It is intended to generate reflexive analytical frameworks in recognition of uncertainties and complexities inherent in transformation (Loorbach and N. Frantzeskaki, 2012). Thus, the TM approach is well suited to the challenge of CP transformation planning and is applied in Chapters 9 and 10 in order to conceptualize a transformation framework.

2.5 Validating through Triangulation

Cooper (1984) identified a threat to validity of integrative research as a misinterpretation of review-based evidence as supporting statements about causality. This thesis was built on a highly integrative approach from literature, surveys and case studies to determine causality, and the risk of misinterpretation of any single analysis is clear.

While the availability of peer-reviewed journal articles on CP in developing countries has dramatically improved, much of the literature most relevant to this thesis continues to be dominated by grey literature- analyses and reports of programs implemented in developing countries with support from multilateral development banks (MDBs) such as the World Bank and Asian Development Bank, bilateral donors and UN agencies. Thus the reader will find a predominance of citations relating to CP experience in Asian developing countries, particularly as relates to applied development policy and finance, is from the grey literature. This leads to the question of validation of conclusions drawn from such literature, as well as to the author's experience-based conclusions and recommendations. This risk of misinterpretation of individual data points is elevated in this case because of the substantial reliance of this thesis author on personal professional experience and the grey literature.

The common focus of multiple sources of grey literature and journal articles reviewed and this thesis author's own experience of over twenty-five years in supporting CP as a development objective have enabled this thesis author to validate conclusions through a triangulation process (Yin, 2014; Berg, 2001). Yin (2014) defines triangulation as "*the convergence of data collected from different sources, to determine the consistency of a finding*". Triangulation means that the data points on particular geographies and issues, drawn from this thesis author's experience, the grey and academic literature, and other sources such as surveys and case studies, are sufficiently consistent to assure validity.

Triangulation research methodology recognizes that every method is a different line of sight directed toward the same point, but that the convergence of data from the various methods enables analysis of consistency of a finding. By combining several lines of sight the research generated a clearer picture of reality. Developing a convergence of evidence from multiple sources to corroborate the same finding strengthens the confidence that the findings from a case study or from surveys or the literature are valid (Yen, 2014; Berg, 2001). Use of multiple sources of evidence required multiple data collection approaches.

3. SUSTAINABILITY IN DEVELOPING ASIA: THE REALITIES OF ECONOMIC GROWTH AND ENVIRONMENTAL DEGRADATION

3.1 Introduction

Asia's developing countries are in a state of rapid change and great dynamism. This dynamism creates the possibility for altering the trajectory of development in more environmentally-sound directions. Smith and Jalal (2000) emphasized the risks in any generalization about Asia, considering the diversity of ecological situations, cultures, political systems, and economies. However, it was possible to characterize Asia, for purposes of this thesis, in terms of CP policy and strategy formulation while recognizing the need to apply detailed analyses of specific country or even to sub-national situations in furthering the design of policies, procedures and tools to address local situations.

The extent of environmental degradation in most Asian developing countries has been severe, including pollution of air, water and soils to levels that threaten public health and reduce the productivity and viability of the region's natural resource base. The loss of ecosystem productivity and services further impacts the ability to develop in a sustainable manner, particularly impacting the poorer segments of societies. This chapter summarized the numerous stresses, resulting levels and shifts over the last two decades of environmental degradation in developing Asia. Many of the examples are from the 1990s to give the reader an understanding of the emerging, unsustainable growth-induced environmental challenges that countries were facing and a key reason many decided to include CP in the solution toolkit.

Understanding the drivers and consequences of environmental degradation is required in order to understand why Asian developing countries have committed to both low carbon and CP as development objectives. This understanding then sets the stage for subsequent review of the extent to which low carbon and CP initiatives have been successful in meeting local and/or global environmental objectives (research question 1).

3.2 Economic and Social Development

Asia experienced remarkable economic and social development during the last 50 years. The GDP in East Asia grew from an average of 5.5 percent from 1960 to 1980 to 8.5 percent from 1980 to 2000 and was around 9 percent until the 2008 financial crisis, and over 6 percent since then. Developing Asia's GDP growth is expected to exceed GDP growth in developed countries. (Table 3.1) (World Bank, 2007(a); World Bank, 2015(a)). In particular, newly industrializing economies of Asia such as China, India, Indonesia, Malaysia, Philippines, Thailand, and Viet Nam took advantage of their wealth in both labor and natural capital (agriculture, forests, minerals), and employed the technological advancements of industrialized countries and capital surpluses to stimulate phenomenal industrial growth. Initially, priority was given to labor productivity and little attention was provided to ways of increasing resource productivity. This pattern was reversed in the early 1990s and manufacturing has been the major driver of overall economic growth of Asian developing countries in the last twenty years. During this period, while the GDP of developing countries nearly doubled, manufacturing value added grew by 2.25 times (UNIDO, 2013).

The late 1990s financial crisis essentially stopped the growth for a few years, but in the longer run the decline in growth was but a minor artifact in an overall upward trajectory of economic expansion in the region (ADB, 2000 (a)). Following the financial crisis of 1997, East Asia's GDP almost doubled, reaching $4 trillion in current dollar terms by 2005. Other indicators of performance in East Asia are equally impressive, producing 20 percent of the world exports valued at over $2 trillion per year. Business-friendly reforms have progressed, thereby, helping to make Asia the most attractive region for foreign direct investment (FDI). China has become the biggest development story in the world, and is now the major economic presence in the region, representing about one-half of developing East Asia's GDP and one-third of its exports, surpassing Japan as having the largest foreign reserve in 2006 and the region's largest economy (second in the world only to the USA) in 2010 (Cohen and Chiu, 2014).

Most Asian middle-income countries weathered the 2008 global financial crises better than many developing countries, experiencing only limited drops in GDP growth rates and largely they recovered by 2010 (Foxley, 2009). In fact China and India maintained high growth rates during the most recent financial crisis. As a result, China climbed to the second position in the world, after the United States, as top ten world manufacturers (UNIDO, 2013). In terms of manufacturing competitiveness, China is ranked first and India fourth (behind Germany and USA) (Deloitte and US Council on Competitiveness, 2013). This trend is expected to continue into the foreseeable future as shown in Figure 3.1 and Table 3.1.

While GDP is one indicator of a country's economic growth, it is often misleading when it comes to the status or change in social well-being of populations. To address this shortcoming, the United Nations Development Programme (UNDP) developed the Human Development Index in 1995, which is used as an indicator of socio-economic progress and human well-being based on life expectancy, education and GDP (UNDP, 1995).

The social and human welfare benefits of Asia's relatively recent development, indicated by the Human Development Index (HDI), are demonstrated in Table 3.2. From a poverty reduction perspective, most Asian countries have achieved substantial improvements. The world met its first MDG – to reduce the 1990 poverty rate by half by 2015- by 2010. As shown in Figure 3.2, several of Asia's countries have made dramatic improvements in reducing poverty and providing the types of goods and services needed for an improved quality of life. East Asia saw the most dramatic reduction in extreme poverty. South Asia also made tremendous progress. There are 300 million fewer people living in poverty in China today than there were in 1998. (World Bank, 2015 (b))

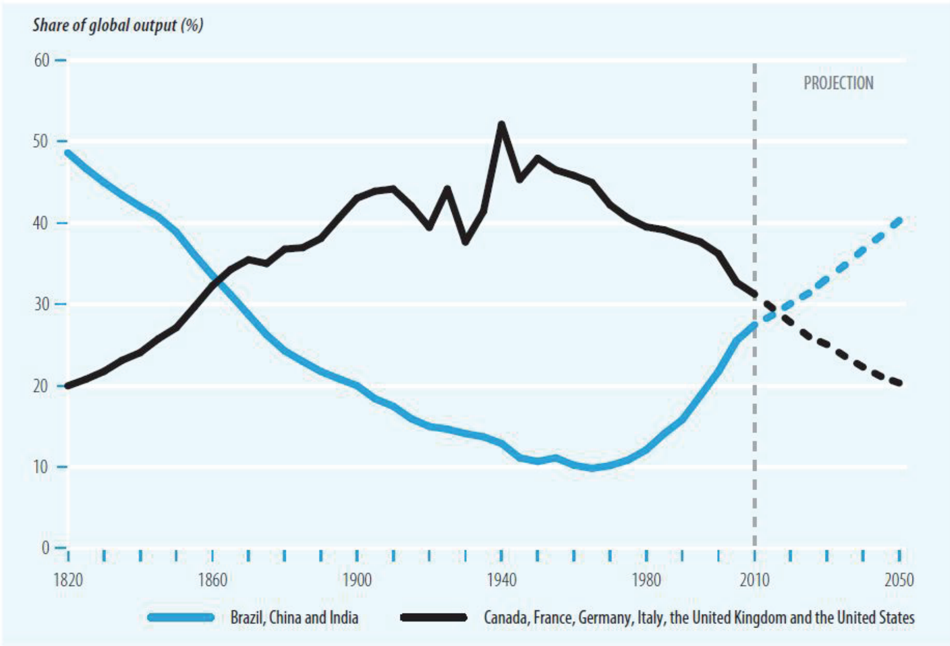
However, poverty continues to be a pervasive problem. Today, half of the poorest tenth of the world population lives in Asia with about 78 percent of the extremely poor still living in South Asia; by 2030, Asia's share in the lower tenth will be reduced to one-fifth (UNDP, 2009; World Bank, 2015 (b)). In addition, equity varies dramatically and the experiences of the economic downturns in 1997 and 2008 have shown how fragile the progress was due to the lack of resilience of many of the countries' economies.

The rate of population growth throughout most of the Region has declined from the 1980s, reflecting the sharp downturn in fertility rates. In South Asia, the annual rate of population growth declined from 3.7 percent in the 1980s to 2.1 percent in the 1990s to 1.36 percent in 2014. In East Asia the decline was from 2.6 percent to 1.5 percent to 0.73 percent per year for the 1980s, 1990s and 2014, respectively. Nevertheless, fertility rates are still above replacement levels and the population of Asia is projected to increase from 3.9 billion in 2011 to 5 billion by 2025.

Table 3.1 GDP growth in industrializing Asian developing countries outpaced global growth (1996-2014).

	1996	1997	1998	1999	2000	2005	2007	2009	2010	2011	2012	2013	2014
China	9.9	9.2	7.9	7.6	8.4	11.4	14.2	9.2	10.6	9.5	7.8	7.7	7.3
India	7.5	4.0	6.2	8.8	3.8	9.3	9.8	8.5	10.3	6.6	5.1	6.9	7.3
Malaysia	10.0	7.3	-7.4	6.1	8.9	5.3	6.3	-1.5	7.4	5.3	5.5	4.7	6.0
Philippines	5.8	5.2	-0.6	3.1	4.4	4.8	6.6	1.1	7.6	3.7	6.7	7.1	6.1
Indonesia	7.6	4.7	-13.1	0.8	4.9	5.7	6.3	4.6	6.2	6.2	6.0	5.6	5.0
Thailand	5.7	-2.8	-7.6	4.6	4.5	4.2	5.4	-0.7	7.5	0.8	7.3	2.8	0.9
Vietnam	9.3	8.2	5.8	4.8	6.8	7.5	7.1	5.4	6.4	6.2	5.2	5.4	6.0
East Asia (developing only)	9.0	7.1	2.2	6.2	7.5	9.7	12.2	7.6	9.8	8.5	7.5	7.2	6.7
South Asia	6.9	3.8	5.6	7.8	4.1	8.8	9.0	7.6	9.1	6.3	5.2	6.5	6.9
World	3.3	3.7	2.6	3.4	4.3	3.6	3.9	-2.1	4.1	2.8	2.3	2.4	2.5

Figure 3.1 Comparison of Global Output Shows that Major Developing Countries are overtaking and will continue to outpace major developed countries.



Note: Output is measured in 1990 purchasing power parity dollars.
Source: HDRO interpolation of historical data from Maddison (2010) and projections based on Pardee Center for International Futures (2013).

Source: World Development Indicators, 02/17/2016 update

Successful poverty reduction together with rapid urbanization (see Table 3.2 and Table 3.3) has led to a middle "consuming" class. The median East Asian is already a citizen of a middle-income country since China, Indonesia, the Philippines, Thailand, and Malaysia all have per capita incomes between $1,000 and $10,000 and Viet Nam will soon join this group (UNDP, 2013). The current eight million Indian households that can afford discretionary spending will increase to about 94 million by 2025. China's middle class (defined as households with annual incomes of ranging from $6,000 to $25,000) of around 87 million in 2005 reached over 300 million in 2014 and is expected to be about 630 million by 2022. The demand for goods and services from these and other growing middle classes is already changing the face of these developing countries. For example, the demand for food in Asia is projected to increase by 40 percent from 2000 to 2050. (Evans, 2014; UN, 2014)

Unfortunately, the net effect of this rapid growth has generated a pattern of resource exploitation, environmental and human health degradation and urbanization that are not sustainable, by nearly anyone's definition of the term. The demographics and economic boom described in the previous paragraphs guarantees an immense increase in the need for resources and in the generation of wastes and pollutants of all types. Concurrently, tremendous increases in unsustainable stresses on the ecosystems upon which the entire world's population is interdependent will accelerate (World Bank, 2011(a)).

Table 3.2 The Human Development Indices in Asian Developing Countries have generally improved above global averages (1990-2014).

Country	HDI Value	HDI Value	HDI Value	HDI Value	HDI rank	Average annual HDI growth %	Average annual HDI growth %	Average annual HDI growth %	Average annual HDI growth %
	1990	2000	2010	2014	2014	1990–2000	2000–2010	2010–2014	1990–2014
Malaysia	0.64	0.72	0.77	0.78	62	1.21	0.62	0.32	0.82
China	0.50	0.59	0.70	0.73	90	1.62	1.74	1.02	1.57
Thailand	0.57	0.65	0.72	0.73	93	1.25	1.00	0.35	1.00
Indonesia	0.53	0.61	0.66	0.68	110	1.34	0.92	0.71	1.06
Philippines	0.59	0.62	0.65	0.67	115	0.61	0.50	0.52	0.55
Viet Nam	0.48	0.57	0.65	0.67	116	1.92	1.29	0.47	1.41
India	0.43	0.50	0.59	0.61	130	1.49	1.67	0.97	1.48
East Asia	0.52	0.59	0.69	0.71	—	1.39	1.48	0.87	1.34
South Asia	0.44	0.50	0.59	0.61	—	1.42	1.55	0.86	1.38
Developing countries	0.51	0.57	0.64	0.66	—	1.02	1.23	0.70	1.06
OECD	0.78	0.83	0.87	0.88	—	0.61	0.44	0.24	0.48
World	0.60	0.64	0.70	0.71	—	0.71	0.85	0.47	0.73

Source: UNDP 2015

3.3 Urban Growth

Asian cities are experiencing the largest rural-to-urban shift in population in human history. Unfortunately, the development of associated services and infrastructure facilities is not keeping pace with population growth resulting in already under-infrastructured and serviced cities being increasingly less capable of meeting urbanites needs. Similar to much of the rest of the world's urban transformation, sustainability is generally not built into urban development policies, and even if it is, sustainability drivers are not sufficient. Forward looking policies and practices are currently insufficient to transform urban growth to achieve its potential in terms of sustainable, low carbon development. (Bayulkan and Huisingh, 2015; Olazabal and Pascual, 2015)

Urban population in East Asia is projected to grow from 780 million to 2.1 billion from 2010 to 2025, a 173 percent increase, and over the same period South Asia will grow from 430 million to 1.9 billion, a 355 percent increase (McKinsey, 2012). India will add about 404 million and China about 292 million urban dwellers by 2050. (UN, 2014)

Table 3.3 Asian developing country population growth is leveling off but urban population growth will continue to increase (1990-2050).

	Population	1990	1995	2000	2005	2010	2015	2020	2030	2050
China	total (millions)	1,135	1,204	1,262	1,303	1,337	1,371	1,398	1,413	1,337
	Urban (millions)	300	373	453	554	658	762	853	971	1,014
	Urban (% of total)	26	31	36	43	49	56	61	69	76
India	total (millions)	870	960	1,053	1,144	1,231	1,312	1,389	1,528	1,705
	Urban (millions)	222	256	291	335	381	429	483	603	857
	Urban (% of total)	26	27	28	29	31	33	35	39	50
Indonesia	total (millions)	181	197	212	226	245	256	272	295	322
	Urban (millions)	55	71	89	104	121	138	156	186	228
	Urban (% of total)	31	36	42	46	50	54	57	63	71
Malaysia	total (millions)	18	21	23	26	28	30	32	36	41
	Urban (millions)	9	12	15	17	20	23	25	30	35
	Urban (% of total)	50	56	62	67	71	75	78	82	86
Philippines	total (millions)	61	70	78	86	93	101	108	124	148
	Urban (millions)	30	34	37	40	42	45	48	57	83
	Urban (% of total)	49	48	48	47	45	44	44	46	56
Thailand	total (millions)	56	59	63	66	67	68	69	68	62
	Urban (millions)	16	18	20	25	29	34	38	44	45
	Urban (% of total)	29	30	31	38	44	50	56	64	72
Vietnam	total (millions)	66	72	28	82	87	92	95	99	100
	Urban (millions)	13	16	19	22	26	31	35	43	54
	Urban (% of total)	20	22	24	27	30	34	37	43	54
World	total (millions)	5,282	5,706	6,116	6,515	6,924	7,345	7,750	8,489	9,683
	Urban (millions)	2,258	2,540	2,835	3,179	3,552	3,940	4,324	5,054	6,373
	Urban (% of total)	43	45	47	49	51	54	56	60	66

Data from database: Health Nutrition and Population Statistics:
Population estimates and projections
Last Updated: 01/05/2016

About 35 to 40 percent of the people in developing Asia's cities live in slums – many without access to basic services. The stress on urban services and related issues of poverty, crime, and degraded environmental quality are already evident in practically every city; these cities will have to provide employment, housing, water, energy, health care, transport, education and other urban services for an additional two million people every month for the next fifteen to twenty years. Table 3.3 shows the urban growth trends in several Asian developing countries.

The bulk of Asian countries' economic activity is urban-based. In East Asia, urban/industrial complexes are estimated to generate about three-quarters of the annual national economic output, and between one-half and two-thirds of the exports. In several countries, a single city is the primary economic center. For example, Bangkok has 40 percent of Thailand’s GDP, Manila has 30 percent of the Philippine’s GDP, Ho Chi Minh City has 20 percent of Viet Nam’s GDP; and Shanghai has 11 percent of China’s GDP.

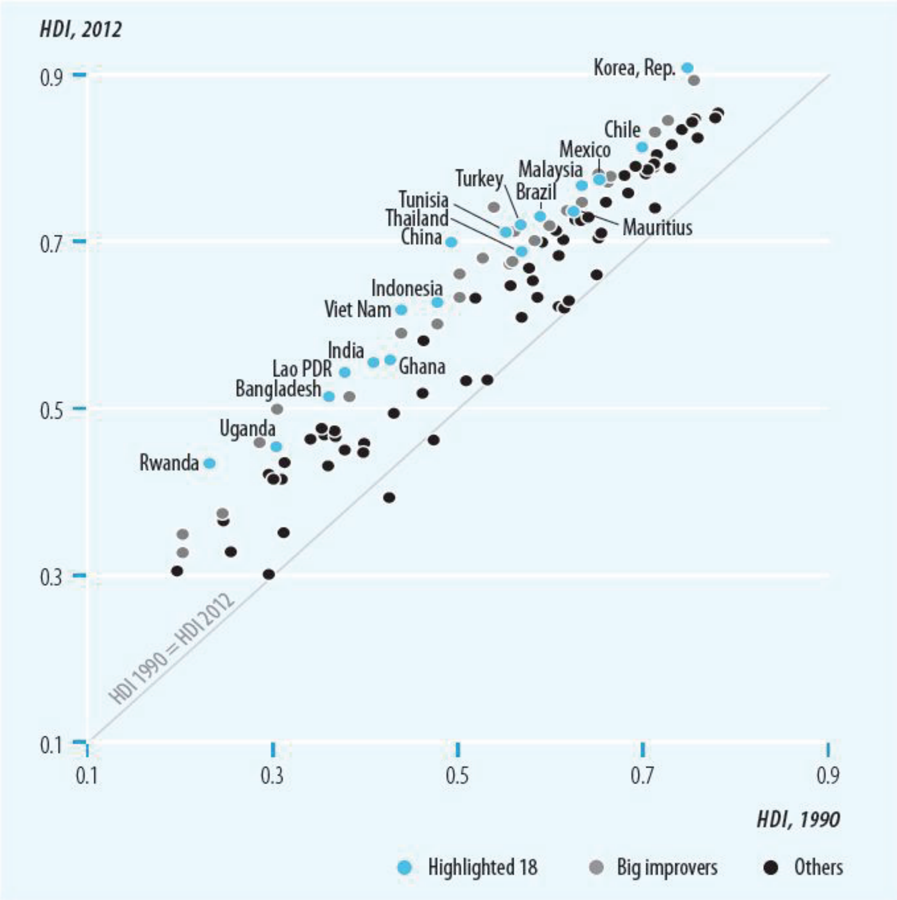
Per capita incomes in cities exceed national averages; the average urbanite consumes almost twice as much as the average rural inhabitant. It is not surprising that industry is drawn to cities, which in turn draw rural migrants – cities have the labor and services needed by industry. Small, medium, large, or mega-cities are at the center of specialization, innovation, trade, and growth. For example, while only 30 percent of Viet Nam’s population resides in its cities, 70 percent of the national GDP is urban-based. In China, productivity of firms is highest in the 120 cities that together account for three-quarters of total national output (World Bank, 2006(b)).

By 2025, 18 out of 30 mega-cities (populations over 14 million) globally will be in Asia. Another 300 million inhabitants will live in 45 cities with populations over five million people (ADB, 2001(a)). China has the most pronounced urban growth where the total number of cities increased from 190 in 1978 to 663 in 2000. (World Bank, 2006(b)).

This urban growth boom has generated unprecedented demands for housing and infrastructure (ADB, 2006(a)). The far-reaching effects of Asia’s urban growth at a global level – on climate change, water, energy, biodiversity, chemicals, wastes, trans-boundary air and river pollution, and pollution of coastal areas – is already being felt. The growing economies are generating demand for increased mobility, which is stimulating remarkable increases in the use of private automobiles and is resulting in high levels of air pollution in many cities with adverse consequences for human health. China is forecast to experience 590,000 premature deaths per year from 2001-2020 due to urban air pollution primarily arising from the transportation and power sectors, this is nearly 30 times higher than is experienced in western European countries and in the U.S. and Canada (World Bank, 2006(b)). Urban activities generate close to 80 percent of all carbon dioxide (CO2) emissions as well as significant amounts of other greenhouse gases.

Key indicators of quality of life in some key Asian cities in the 1990s are presented in Table 3.4. These were the prevailing conditions at the time this thesis work was initiated. In general, access to water, sanitation and solid waste management and education has improved over the last twenty years in these cities, but air and water quality have remained poor and in many cases worsened.

Figure 3. 2: The Human Development Index in Selected Countries shows the progress in reducing poverty in many Asian countries 1990 – 2012 (UNDP, 2013)



Note: Countries above the 45 degree line had a higher HDI value in 2012 than in 1990. Blue and grey markers indicate countries with significantly larger than predicted increases in HDI value between 1990 and 2012 given their HDI value in 1990. These countries were identified based on residuals obtained from a regression of the change in log of HDI between 2012 and 1990 on the log of HDI in 1990. Countries that are labelled are a selected group of rapid HDI improvers that are discussed in greater detail in chapter 3 of the full Report.
Source: HDRO calculations.

Table 3.4: The Quality of Life Indicators in Selected, Present and Future Megacities Demonstrate Variability in the Poverty Levels and Urban Services in the them during the 1990s.

Indicator	Bkk	Ccu	Dha	Jkt	Khi	Mnl	Sel	Sha
Poverty								
Poverty incidence (Percent of population)	15	33	50	34	30	15	n.a.	n.a.
Percentage of income spent on food	36	60	63	43	43	38	12	14
Environment								
Floor space/person (m²)	16	n.a.	3.7	10	7	12	13	n.a.
House price to income ratio	4.1	n.a.	6.3	3.5	1.9	2.6	9.3	n.a.
Air pollution; average number of days over acceptable level								
(a) Suspended particulates	97	268	n.a.	173	n.a.	n.a.	n.a.	133
(b) Sulfur dioxide	–	25	n.a.	n.a.	n.a.	24	87	16
Percent of water service coverage	75	64	65	40	83	75	100	100
Hours of water supply/day	24	10	6	19	4	16	24	24
Sanitary sewerage (% population served)	10	3.2	28	–	83	16	90	–
Percentage of solid wastes collected	95	60	50	70	36	82	90	65
Social								
Infant deaths per 1,000 live births	27	46	108	45	65	36	12	14
Percentage of children in secondary school	71	49	37	77	65	67	90	94
Telephones/1,000 population	12	2	2	3	2	9	22	4

Source: Westfall and de Villa, 2001

N.A. – Data not available, Bkk-Bangkok, Ccu- Calcutta, Dha-Dhaka, Jkt-Jakarta, Khi-Karachi, Mnl-Manila, Sel-Seoul, Sha-Shanghai

3.4 Industrial Development and Resource Consumption

Thirty Asian countries rely on industrial production for at least 20 percent of their GDP. In 1992, about seven percent of global manufacturing value added (MVA) was from Asia. By 2012 it was about 24 percent. China alone is responsible for about 17% of global MVA. But the region's industrializing developing countries all enjoyed substantial growth in manufacturing (se Table 3.5). (UNIDO, 2013) About 70 percent of global developing country MVA was from Asia, an almost 70 percent increase in less than ten years, from 1995 to 2003. This rapid industrial expansion occured in the absence of a strong corporate, social and environmental responsibility ethic or governmental regulations in most countries (ESCAP, 2005).

The increases in economic and population growth and household wealth have generated a surge in the demand and use of energy, raw materials and consumer products. (Angel et al, 1999) For example, Chinese car ownership increased from 1.1 million to 6 million from 1990 to 2000, a 445 percent increase- by 2012 China was home to over 240 million cars (Myers and Kent, 2003; Bloomberg, 2013). Many of the most rapidly growing industrial subsectors, such as production of chemicals, transport equipment, crude steel, petroleum, rubber and plastic products, are major consumers of energy and water. By the beginning of the 21st century, Asia had become the world's largest resource user, consuming 35 billion tonnes of metal ores, industrial minerals, fossil fuels, construction minerals, and biomass per year by 2005, 58 percent of the global resource use (ESCAP/UNEP/ADB, 2012). Rates of increased domestic material consumption doubled from 2000 to 2005.

Table 3.5 The Growth of Manufacturing Output in Asian Industrializing Developing Countries is an Important Contributor to GDP Growth.

	Manufacturing output US$ billion		Share of manufacturing value added- % GDP		Share world manufac- turing value added (%)	
	2006	2011	2006	2011	2006	2011
China	3,642	11,275	32.62	34.15	10.44	16.42
India	509	1,164	14.78	14.89	1.70	2.25
Indonesia	141	299	27.17	25.30	1.03	1.17
Malaysia	194	294	29.84	26.73	0.55	0.55
Philippines	59	77	23.79	22.40	0.32	0.35
Thailand	193	291	34.96	36.66	0.82	0.88
Vietnam	64	na	21.43	23.57	0.15	0.21

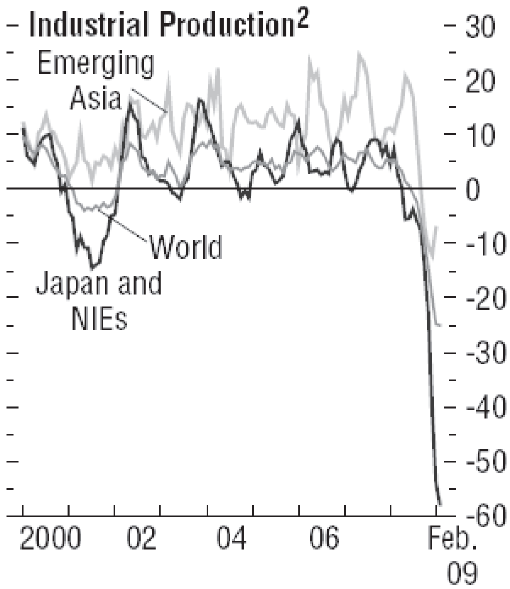
Figure 3.3 and Table 3.6 compared the changes in industrial development (manufacturing, mining and construction) of Asian developing countries to some developed countries and the world. Both show a higher rate of growth in Asian developing countries with China and India, in particular, being key drivers in the global economy. But they also demonstrate that the Asian economies were highly vulnerable to the 2008 financial crisis because of their heavy reliance on export demand, particularly for manufactured goods (Nissanke, 2010).

Table 3.6: The Percentage Change in Industrial Growth Rate in Some Industrializing Asian Countries Compared to the EU and the World.

Country	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
China	8.8	10		12.6	30.4	17.1	29.5	22.9	13.4	9.3	9.9	11
India	6	7.5		6	6.5	7.4	7.9	7.5	8.5	4.8	9.3	9.7
Philippines	1.7	4			-0.1	5	2.2	4.8	7.1	5	-0.9	12.1
Thailand	12.6	3			12.3	8.5	9.1	6	5.4	3.4	-4.2	14.5
Japan	-0.1	5.3		-1.4	3.3	6.6	1.5	3.3	1.3	-2	-17	15.5
Netherlands	3	3.2		0	-2.1	0.8	-1.4	2.3	3.1	2.9	-7.2	3.2
United States	2.4	5.6	-3.7	-0.4	0.3	4.4	3.2	4.2	-1.7	-2	-5.5	3.3
European Union						2.4	1.3	3.2		10.8		4.1
World		6		3	3				5	3.2	-2.7	4.6

Source: CIA World Factbook, 2011

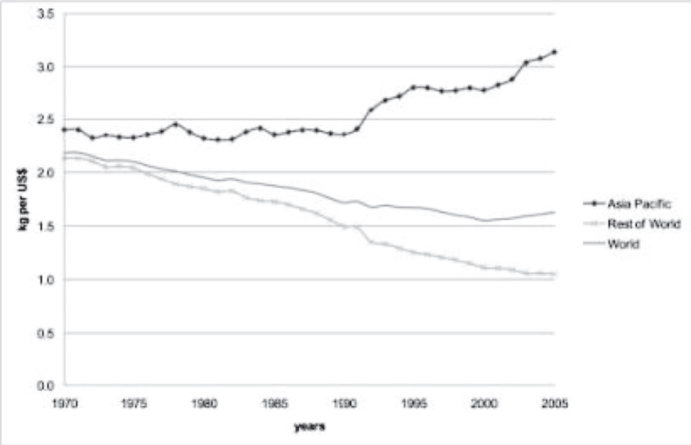
Figure 3.3: The Percentage Changes in Industrial Production of Asian Developing Countries Compared to the World



Source: Nissanke, 2010.
(note- Asian newly industrialized economies (NIEs) include South Korea, Singapore and Taiwan)

The Commonwealth Scientific and Industrial Research Organization (CSIRO) of Australia, working with UNEP, established a database for material and resource use for 1970 to 2005. The online database provides information on primary material flows that will be highly relevant for tackling the difficult policy, regulatory and institutional challenges the Region must address in moving towards a low carbon, green economy. In addition to documenting trends in use, the database enabled an analysis of resource intensity; a measure of efficiency of resource use. If resource intensity is increasing then the likelihood of depletion is increased. Of course, increased efficiency is not the panacea: even if a country achieves a reduction in resource intensity the total resource demand will increase over time as a result of increasing population and buying power. Figure 3.4 showed that resource intensity generally increased in Asian developing countries between 1995 and 2005. Domestic material consumption intensities dropped in some countries, with significant improvement in Philippines and India. However, China, Malaysia, and Viet Nam which are experiencing dramatic increases in buying power and consumption demand did not improve their resource intensity (UNEP and CSIRO, 2013).

Figure 3.4: Material Intensity For The Asia-Pacific Region Has Generally Increased In Comparison With The World, 1970–2005.



Source: UNEP and CSIRO, 2013

Most Asian middle-income countries have reduced the energy intensities of their economies over time (Figure 3.5), at rates higher than their respective GDP growth. Indonesia, Malaysia and Thailand showed significant improvement. However, in China and Viet Nam, early signs of improvement slowed relative to economic growth during 2000-2005. Industry uses about one-third of the total global energy produced, excluding transport of raw materials and products, and produces about 22 percent of global CO_2 emissions. The iron and steel industry generates about 26 percent of these emissions, non-metallic minerals extraction and processing produces about 25 percent, and petrochemicals about 18 percent. Many emerging, cleaner, more energy efficient technologies are being developed, demonstrated and adapted in the industrial sector. Compared to today's state-of-the-art processes, such new technologies could bring long-term energy efficiency improvements of 35 percent in steel production and 75 to 90 percent improvements in the paper production industry. Similar potential improvements can be achieved in most other industrial sectors.

Oil, natural gas and coal, in roughly equal proportions, comprise 70 percent of the industrial energy used. Most industrial energy consumption is accounted for by industries that produce raw materials: chemical and petrochemicals, iron and steel, non-metallic minerals, paper and pulp, and non-ferrous metals. The chemical and petrochemical industries account for 30 percent of industrial energy use. Energy efficiency tends to be lower in regions with low energy prices. To some extent, regional differences in efficiency can be attributed to labor cost differences, outdated production equipment, energy subsidies, natural resource endowment and policies designed to limit imports (IEA, 2006).

No other major economy is as industry-driven as China where manufacturing capacity has grown rapidly - from 37 percent to 44 percent of GDP between 1990 and 2002. Unfortunately, the manufacturing sector continues to be relatively inefficient. For example, China's basic materials industries, most of them the largest in the world, use 20 to 120 percent more energy per unit physical output compared to international best practices (World Bank, 2006(a)). Much of Chinese production capacity is in small-scale plants, including paper and pulp, cement, aluminum and iron and steel. In 2004, a quarter of China's coke production came from primitive beehive ovens. Thirty percent of the energy China uses for coking could be saved, and even large-scale Chinese ovens use about 20 percent more energy than similar ovens in other countries (IEA, 2006). Another example is in cement production. Whereas, in much of the world, optimal energy efficiency has been reached in the cement industry, China has 50 percent lower efficiency levels (World Bank, 2006(a)) (see Table 3.7). The largest potential for energy-efficiency improvements lies in industry, but that must be coupled with changes in the economic structure (World Bank, 2010(a)).

Table 3.7: Energy Use Per Unit Output, China vs. International Best Practice

	Steel	***Cement***	***Fertilizer***	***Paper***	***Electric Motors***	***Coal-fired Boilers***	***Heavy Trucks***	***Coal-fired Power***
International Best Practice	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
China Good Practice	1.21	1.45	1.31	2.20	1.11	1.15	2.25	1.19

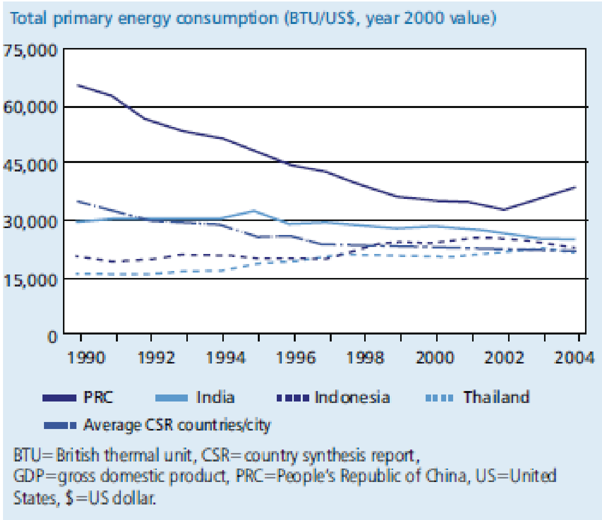
Source: Xu, Y. 2012

A similar situation exists in India’s steel industry. Pig iron is produced in coke-fired mini blast furnaces and is then sold to manufacturers, which have to re-melt the pig iron in electric-arc furnaces, adding 10 percent to 20 percent energy consumption per ton of product than would be required if these processes were integrated at the original factory. Similarly, in India, coal-based sponge iron kilns discharge about 40 percent of the energy with the kiln waste gases in the form of heat. The International Energy Agency (2006) estimates that 400 to 500 kWh of electrical energy could be produced per ton of iron by exploiting the heat content of the kiln waste gases and, if that energy was then used for melting sponge iron, energy use in electric arc furnaces or in induction furnaces could be reduced by 50 percent.

It is estimated that the energy intensity of key chemicals (ammonia and petrochemicals) can be reduced by at least 20 percent if current state-of-the-art technologies were used. A good example is the ammonia industry. Most of the growth in ammonia production is in Asia, where heavy oil based processes are used, which are 30 percent less energy efficient than gas processes, or are based upon coal-based processes, which are 70 percent less energy efficient than gas-based processes. Tremendous potentials for energy savings are also present in China and India’s paper industry, which is largely reliant on second-hand equipment and upon the use of coal for steam generation (IEA, 2006)

While water is increasingly a scarce resource in many countries (see Section 3.4.2, below), there has been little attention to the intensity of industrial water consumption and waste. Investments in industrial estates have increased but there is insufficient evidence that they have significantly reduced waste production or improved waste management by providing common waste management facilities at lower costs than those usually incurred at the factory level (ESCAP, 2013; ADB, 2013(a))

Figure 3.5: The Energy Intensities in Asia's Largest Developing Economies is Improving (1995 and 2007).



Source: Energy Information Administration. 2006. www.eia.doe.gov/emeu/international/contents.html

Over 81 percent of water extracted in Asia is for agriculture. The second highest demand is by industry (Table 3.8). Water intensity has increased, which means that productivity per unit of water extracted has decreased (UNEP, 2011).

Table 3.8: The Agriculture Sector is the Primary Consumer of Water (ESCAP 2005)

Subregion	Agriculture (GL)	Percentage of total withdrawals	Industry (GL)	Percentage of total withdrawals	Municipal (GL)	Percentage of total withdrawals	Total withdrawals (GL)
Australia and NZ	18,900	72.6%	2,600	10.0%	4,540	17.4%	26,040
Central Asia	127,450	91.0%	8,040	5.7%	4,540	3.2%	140,030
North-East Asia	503,120	66.7%	183,240	24.3%	67,370	8.9%	753,760
South Asia	925,510	899%	40,575	3.9%	63,580	6.2%	1,029,675
South-East Asia	273,010	85.6%	24,890	7.8%	21,180	6.6%	319,080
The Pacific	51	36.2%	40	28.4%	50	35.5%	141
Asia-Pacific	1,848,041	81.5%	259,385	11.4%	161,260	7.1%	2,268,726

3.5 Environmental Quality

Asia is one of the world's richest regions in terms of diversity of human cultures and ecosystems. At the same time, Asia is the most polluted and environmentally degraded part of the world. The range of environmental problems is huge. In addition to the loss of habitat for biodiversity, surface and ground waters with high concentrations of organic and inorganic pollutants and pathogens, air with high concentrations of fine particulates and toxics, and soils contaminated by hazardous chemicals, are serious threats to people's health, their quality of life, and productivity throughout Asia – particularly in urban/industrial zones. Compared to industrialized countries, environmental factors contribute disproportionately more to the burden of human disease in developing countries (World Bank, 2006(c)). Asians are increasingly concerned about environmental impacts on their health and well-being (Globescan, 2004).

The economic benefits of addressing environmental problems often far outweigh the costs. In Thailand, for example, the total annual cost of implementing air pollution controls was estimated to be about $400 million in 2000, $660 million in 2005, and projected at $1.5 billion in 2020, while the benefits of investing in pollution control were estimated at about $2 billion, $4.7 billion, and $25 billion for those years (World Bank, 2006(b)). In China, water pollution and shortages are inhibiting development activities and the cleanup challenge is huge. The cost of water shortages from pollution ranges from 1 to 3 percent of local GDP in water scarce areas (World Bank and SEPA, 2007).

In spite of huge FDI (Table 3.9) and economic growth throughout Asia in the 1990s, few countries invested proportionately in the environmental software (institutions, management capacity and regulatory governance) and hardware (infrastructure, technologies) required to reduce environmental costs. FDI stimulated growth in several polluting and extractive industries such as mining, chemicals, and transport equipment. There is good evidence that FDI introduced an increase in cleaner manufacturing practices; however, by expanding the scale of industrial production, the regional impact of FDI was, overall, negative in environmental terms. One of the reasons is that there is limited recognition of the true costs of development. The cost of environmental degradation and loss of natural capital are not accounted for when measuring growth (Box 1). Also the cost of human health degradation is not adequately factored into most of these assessment systems.

Table 3.9: Foreign Direct Investment Stock as a Percentage of GDP Throughout the World

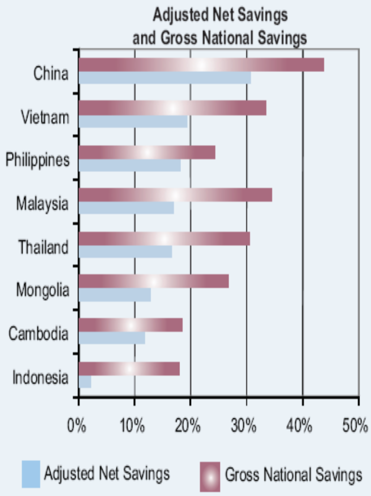
	1980	1990	*1999*
South-East Asia	23.4	18.4	34.4
Asia and the Pacific	2.9	15.5	30.2
Developing countries	4.3	13.4	28.0
World	6.0	9.2	17.3
China	3.1	7.0	30.9
India	0.7	0.6	3.6
Indonesia	14.2	34.0	46.2
Republic of Korea	1.8	2.0	7.9
Malaysia	21.1	24.1	65.3
Philippines	3.9	7.4	14.9
Singapore	52.9	76.3	97.5
Thailand	3.0	9.6	17.5

Source: ESCAP (2001).

Box 1: Adjusted Net Savings with Natural Capital

It has been long recognized that traditional indicators of economic growth do not measure the long-term sustainability of development. The World Bank publishes adjusted or "genuine" net saving (ANS) rates that account for changes in all assets (physical, natural, human). This is done by measuring how much national income is not consumed (gross saving), then adding/subtracting the accumulation and depreciation of produced, natural and human capital, i.e. the net accumulation of wealth in a given year.

When a country draws down its total assets through over-consumption or resource depletion, its future welfare is reduced, i.e. negative saving rates indicate that the country is on an unsustainable development path. In the EAP region, large gaps between gross and net savings indicate that wealth accumulation is much slower than commonly understood, particularly in countries with significant depletion of natural resources and those experiencing high pollution levels. Empirical evidence also indicates a positive relationship between net adjusted savings and economic growth.



Note: Figures show data for 2002.
Source: World Development Indicators (2004).

Source: World Bank, 2010(b).

3.5.1 Ecosystems and Ecosystem Services

The greatest stress on ecosystems is agricultural expansion. New crop varieties with higher yields and improved agricultural practices have not been sufficient to offset the need to cultivate new land. The land under cultivation has increased nearly everywhere in Asia, with the expansion coming at the expense of natural ecosystems, particularly forests.

Most of the new land brought into cultivation is of lower quality and hence it is more susceptible to degradation. In 1992, Asia had only 0.3 hectares of agricultural land per person, compared to 1.6 hectares in the rest of the developing world and 1.4 hectares in OECD countries. Around 130 million hectares of Asian cropland, particularly in China, India and Pakistan, are affected by salinity and waterlogging because of poor irrigation practices. Desertification is also an increasing problem with as many as 63 million hectares of rain-fed land and 16 million hectares of irrigated land, already lost to desertification (Kaosard and Reckasem, 1999; Rosengrant and Hazell, 2000).

Six of the seventeen mega-diversity nations that have two-thirds of the planet's biological resources are in developing countries in Asia and the Pacific. As much as 80 percent of the world's endangered species are found in this Region. Six of 25 conservation "hotspot"- areas of extraordinary biodiversity, which are also under intense human pressure, are in developing Asian nations. (Squires, 2014) The demand for agricultural land and the growing demand for commercial forest products caused the loss of more than six percent of the forested area in Asia from 1985 to 1995. Deforestation rates throughout Asia, but particularly in Southeast Asia, have continued to increase largely due to high population densities and increased consumption with demand from local and global markets. (Juffe-Bignoli etal, 2014; UNEP-WCMC, 2016)

Asia's coastal and marine fisheries and mangrove and coral reef systems are among the most diverse in the world. Two-thirds of the world's coral reefs are in Asia. Bleaching and mass mortality of corals has increased over the last 25 years due to rising temperatures. This in turn is reducing fisheries productivity and tourism values. (UN, 2016) More than half of Asia's wetlands have been lost, and more than half of the mangroves in the Indo-Malayan region have been cleared. (CEPF, 2012) Further, the oceans, seas, lakes and rivers are losing aquatic biodiversity at all levels of the food chains due to excessive nitrogen, phosphorous, toxic substances and over-exploitation. (UNEP-WCMC, 2016)

The degradation of ecosystems has resulted in increased desertification, soil erosion and flooding, as well as extensive biodiversity losses across Asia's landscapes and seascapes. Increased attention has been given to the important economic role of these ecosystems and their services in the last 10 years, culminating in the Rio +20 launch of the of the "50-50 campaign" at Rio+20 in 2012 with commitments from 62 countries, the European Commission and 90 private companies to join forces to factor the value of natural assets into business decision-making and country systems of national accounting. If the alarming loss of habitat and ecosystems in the world is to be checked, then this natural capital has to be properly valued and tools must be developed and utilized to help to ensure that finance, planning and other ministries have the full economic picture of what all their country's assets are worth and what is being wasted by what types of activities. Then, they will be more likely to begin to see the value of preserving versus one-off exploitation of natural resources and recognize the long-term cost of degradation and destruction for short-term gains. Ecosystem services include (i) provisioning services such as food and water, (ii) regulating services such as filtration of pollutants by wetlands, climate regulation through carbon storage, pollination, and buffering impacts of natural disasters, (iii) cultural services, and (iv) supporting services such as nutrient cycling. (WAVES Partnership, 2015)

The recent work on 'The Economics of Ecosystems and Biodiversity' (Sukhdev et al, 2010) and Wealth Accounting and Valuation of Ecosystems Services (WAVES Partnership, 2015) has begun to raise awareness and has demonstrated some procedures that governments can use to change the ways they measure, monitor and manage their eco-system assets. For example, several countries currently value their forests for their commercial timber value but do not yet account for the carbon sink value, the value of non-timber forest products, or the value of hydrological services to downstream users such as agriculture, fisheries and municipal water authorities.

Once natural capital is valued as assets, in order to have significant impact on policy and planning decisions at the scale required, national accounts need to more fully reflect the role of the environment in the economy and the impact of the economy on the environment. The national accounts are designed to record market transactions, but many environmental services do not have market prices, so they are not accounted for. At the same time, they are essential to support critical sectors, like agriculture, fisheries, medicinal sources, and eco-tourism. There would be no agriculture without pollination services, water services, and soil maintenance.

Greening of the national accounts means bringing these values explicitly into the national accounts. At the same time, countries do not fully take into account human impacts on the environment—impacts that affect the ability of the environment to support long-term survival. In the private sector, if a company raises revenue by selling off assets, the gain in its income statement is offset by a loss in the company's total assets. But that kind of accounting does not exist for national economies—a country can liquidate its natural capital without accounting for it, at least in the short-run! Depletion of top and subsoil assets, natural forests and fisheries are not measured in the national accounts. Similarly, countries do not account for damage to human health from air and water pollution (World Bank, 2012(d)).

3.5.2 Water Resources and Pollution

From 1985 to 2000, total water withdrawals increased by about 25 percent across the region. Water withdrawals from surface and groundwater sources are growing faster than the GDPs of several countries (ADB, 1997; World Bank, 2016). Increased demand for water in the 1990s-2000s of about 130 percent for agriculture, 150 percent for industry, and 180 percent for domestic consumption has left many water sources, including trans-regional sources, overstressed (UNEP, 2011).

Water withdrawals in South Asia were about 48 percent of available water resources, indicating high water stress. Water resources per capita in South Asia have declined by as much as 70 percent since 1950. India withdrew about 53 percent of its freshwater resources in 2013, Thailand about 25 percent, China about 20 percent, and Philippines about 17 percent (World Bank 2016). These indicators of water stress reflect not only population growth, but, more significantly, they also reflect gross inefficiencies in water use in irrigation, manufacturing and urban water supply (ADB, 2001(b)).

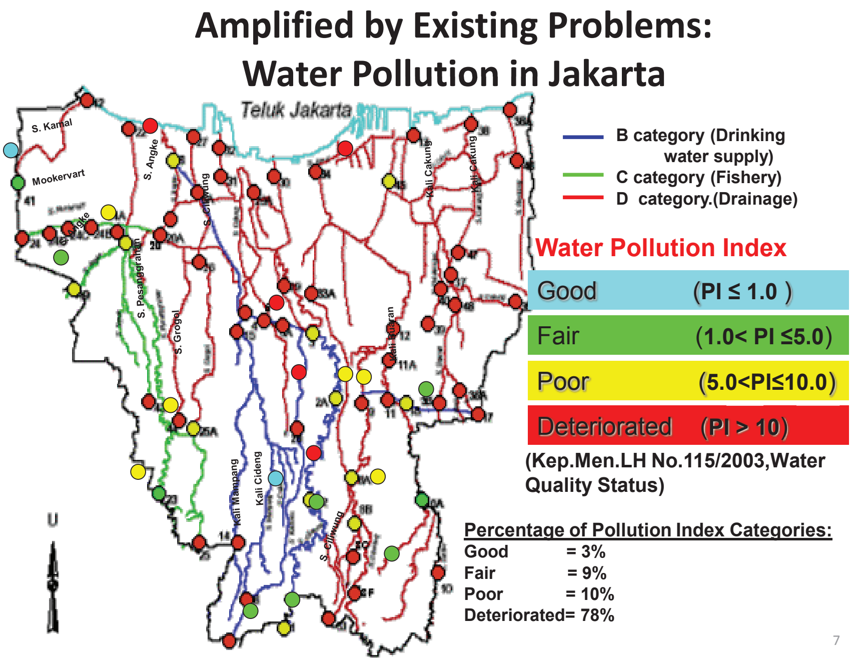
Asia's rivers are far more polluted than those in the rest of the world. Water quality has deteriorated, particularly in the vicinity of urban areas, due to increasing and uncontrolled discharges from municipal and industrial sources. Countries in the region have made significant progress in improving access to safe water. However inadequate sanitation and wastewater management continue be major sources of public health risks and water quality degradation, compounded by increased urbanization, population growth, and per capita resource consumption.

The example shown for water quality degradation in Jakarta is typical for practically every major city across Asia (Figure 3.6). Almost all of the major waterways in the city area of Jakarta are degraded to the point at which the water cannot be used without extensive pre-treatment. In 2004, only 28 percent of monitored river water in Asian urban zones was suitable for use as raw public water supply, while 31 percent was in categories limited to agriculture and landscape or was "essentially useless". (ESCAP, 2005) These conditions have severe public health impacts on the poor who often rely on these as direct water sources. It also has significantly increased the financial burden on delivering urban and industrial water supply as many cities have had to relocate water intakes and to dramatically increase water treatment capacity.

As shown in Figure 3.7, countries like China and India experienced substantial increases in organic pollution loads from industry in the 1990s when this thesis work was initiated. The median fecal coliform levels in Asian rivers, a key indicator of health risk, were three times the world average and 50 times higher than the level recommended by the World Health Organization (WHO). Levels of suspended solids quadrupled from the 1970s to 2000. According to the Asian Development Bank (ADB, 2001(a)), biological oxygen demand (BOD), an important indicator of overall water quality, is about 40 percent higher than recommended by the Organization for Economic Co-operation and Development (OECD). These conditions were important as the stimulus for Asia's industrializing countries' actions on CP in the 1990s and early 2000s.

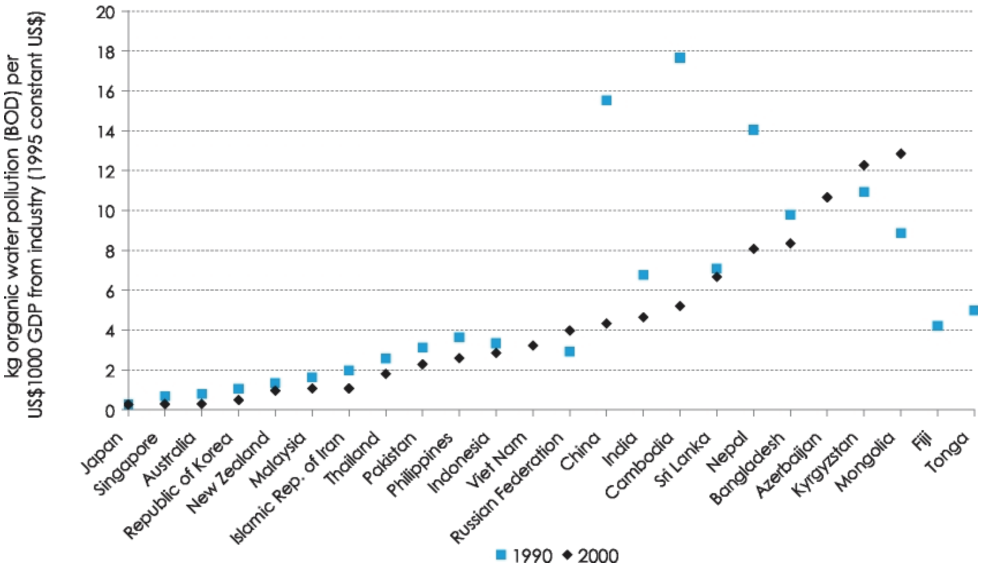
Historically, industrial pollution was the main contributor to the increased pollution load. Measures to encourage industries to meet wastewater regulation standards in China led to a 25 percent reduction in emissions (from 28 to 21 billion tons) between 1990 and 2004. The most important sectors in terms of total wastewater discharge volumes in China are paper and chemicals; both release over three billion tons annually (World Bank, 2006(d)). The cost of water pollution to China's national economy has been estimated at about 1.22 percent of GDP (Minjun and Guaxia, 2011).

Figure 3.6: Water Quality Degradation in Jakarta is Severe.



Source: Fulazzaky, 2005

Figure 3.7: Industrial Organic Water Pollution in Asian Countries



Source: ESCAP, 2000

3.5.3 Air Pollution

The air in Asian cities is three times dirtier than in cities worldwide. The levels of ambient particulates—smoke particles and dust—are generally twice the world's average. The ambient level of sulfur dioxide is 50 percent higher in Asia than in either Africa or Latin America. They are most severe in China, where air pollution from fuel combustion has been estimated to cause the equivalent of three to six million life-years lost annually (World Bank, 2010(a)). Minjun and Guaxia (2011) estimate the cost of air pollution to the Chinese economy at about 1.19 percent of GDP.

In the early 1990s, industrial emissions in large urban/industrial complexes were 40–70 percent of urban air pollution. These sources combined with use of inefficient vehicles caused average levels of particulates to increase five times higher than in OECD countries and to twice the world average levels (Kato, 1996). Industrial air pollution in most Asian developing countries has become much less of a cause of the accelerated air quality degradation in the 2010s than urban transport, power supply, heating, and construction (SEI, 2008). In fact, industrial air pollution control has been a success in many countries relative to industrial water and toxics pollution (OECD, 2012).

3.5.4 Solid Wastes

Much of the material that feeds the production and consumption of goods eventually ends up as solid waste. Industrial growth and urban expansion in Asia have greatly increased the generation and accumulation of solid wastes, including hazardous wastes. In 1999 average daily waste generation in Asia's developing countries was estimated at about 760,000 tons. East Asia is projected to generate about 1.9 million tons of solid waste per day by 2025. South Asia will add 0.6 million tons per day. (Hornweg and Thomas, 1999; Hoornweg and Bhoda-Tata, 2012).

Asia's municipal managers and leaders are already struggling to reuse, treat, and/or dispose of sold wastes. Municipal authorities in Asian cities, on average, spend between 50 and 70 percent of their revenues on municipal waste management. Despite this, only a small fraction of urban residents, receive any service. As a result, dumping of solid wastes into lakes and rivers is a common practice in the slums of large Asian cities (Chatham-Stephens et al, 2013).

3.5.5 Toxic and Hazardous Wastes

The very rapid export-oriented industrial growth in the 1970s through 1990s in several Asian developing countries resulted in large volumes of highly toxic and hazardous industrial wastes being discharged directly to the local receiving environment. The quantity of heavy metals accumulating per year in Indonesia increased by almost a factor of ten, with similar increases in the Philippines and Thailand. Production in highly toxicity-intensive sectors, such as the chemical sector, crude steel and ingot production, production of transport equipment, petroleum, rubber, plastic, basic metals and fabricated metal products, expanded rapidly.

Asian developing countries had limited capacity to monitor, let alone manage industrial hazardous wastes, even though most had a reasonable regulatory framework within their environmental pollution control policies and laws. Many of the regulatory frameworks were stimulated by the Bhopal gas tragedy of 1984 in India. Governments in the region established rules regarding handling, storage, transportation and treatment of hazardous materials and wastes. But these countries had very limited regulatory or technological capacity to meet the regulations. Industries lacked the capital needed to invest in in-house waste treatment systems and support was only beginning to be available to replace old equipment with clean technologies that reduce the need for or volumes for of toxic and hazardous materials and processes. Governments had not invested in or provided sufficient incentives for the private sector to invest in centralized hazardous waste management facilities which could be used by industries instead of investing in their own facilities.

As awareness grew of the existing damages and potential risks of hazardous wastes in many of the countries, regulatory efforts were stepped up and industries generally were responsive. But even though hazardous wastes collection improved, disposal generally involved combining industrial hazardous wastes with domestic garbage in open dumps. Some countries improved open dumps to sanitary landfills, which were also used for landfilling hazardous wastes (ADB, 2005; UNEP and ASEAN, 2002; Mugdal et.al., 2007).

By the late 1990s and into the 2000's several countries set up hazardous waste management programs for key industries including centralized facilities for hazardous waste recovery and disposal. The use of integrated hazardous waste treatment facilities and recycling facilities has now become more commonplace across the region. (UNEP, 2002) Environmental awareness and the global waste trade are creating a growing hazardous waste industry. (Chin, 2011) For example, in China a number of initiatives for eco-industrial parks and other approaches to achieve industrial symbiosis are demonstrating success in reducing use of industrial toxic and hazardous materials and reducing or reusing wastes. By 2014 there were 85 national level eco-industrial parks and numerous other provincial and municipal eco-industrial parks. Integrated solid waste management is being used to optimize resource efficiency and to minimize the amount of waste produced and disposed of in many of the high technology industries. (Ngoc and Schnitzer, 2009; Shi, 2010; Qu et.al, 2015)

But major gaps remain and hazardous waste treatment facilities and regulatory enforcement continue to fall short of meeting the countries' needs. Cities such as Manila and Jakarta, each generate about eight million metric tons of hazardous toxic waste each year from hospitals, industrial and commercial establishments. About 60 to 65 percent of these hazardous wastes are put into dumpsites or landfills, five to ten percent are dumped in the ocean and the remainder is incinerated or is chemically treated. In most cases, proper safeguards are absent or are largely ineffective (Chatham-Stephens et al, 2013). By 2016, China will create 70 million tons of hazardous waste, and the annual utilization and disposal volume will reach 49 million tons. However, in 2013, Chinese licensed companies could only treat 50 to 60 percent of hazardous waste. (MRM, 2014)

The hazardous waste management industry is not yet applying latest technologies and capacity continues to be relatively weak. In particular, in China and India the challenges of e-waste imports much of which is recent recycled illegally causing significant environmental and human health impacts. Asian hazardous waste management companies do not provide much disclosure on environmental sustainability practices other than stating that they adhere to local regulations and emissions standards. Environmental monitoring continues to be inadequate for high-risk operations of hazardous waste. (Chin, 2011; Sepulveda et.al., 2009)

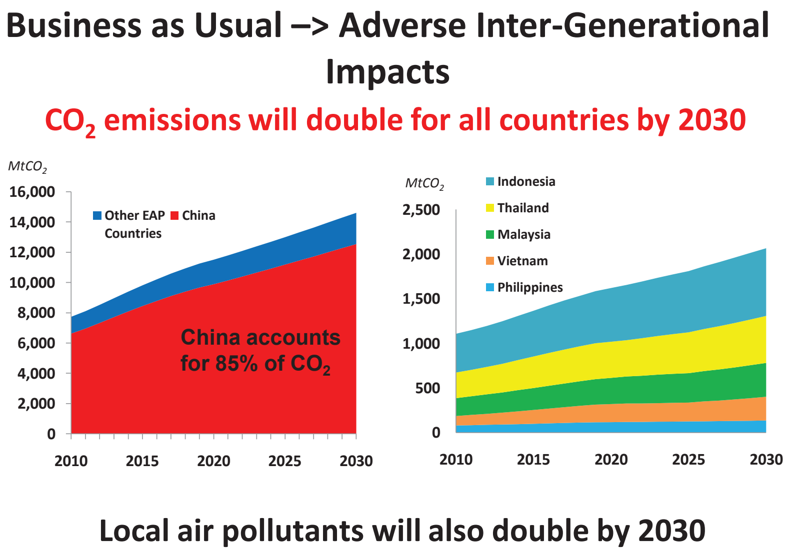
3.5.6 Global Pollution

While the environmental degradation in Asia's developing countries justifies urgent attention because of local health effects and loss of ecosystem services, the global significance cannot be understated. An estimated 34 million tons of sulfur dioxide were emitted in Asia in 1990, over 40 percent more than in North America. Negative impacts on crop yields and forestry growth have already been documented in China, India, Korea, and elsewhere in Asia (Smith and Jalal, 2000).

But the "elephant in the room" is carbon dioxide and other greenhouse gases (GHG). As presented in Figure 3.8, GHG emissions from the region are expected to double by 2030 (World Bank and AusAID, 2010). Since two of Asia's giant economies—China and India—rely heavily on coal, Asia's share of GHG emissions is dramatically and rapidly increasing. On a per capita basis, industrial nations still emit far more GHGs relative to developing nations and most of the anthropogenic carbon dioxide in the atmosphere was placed there by industrial nations. But Asia's developing countries also contribute significantly to total emissions today. China emits the largest volume of GHGs from fossil fuel use and cement production, India is fourth globally. Annual increases are about 7 percent in China and 5 percent in India. (PBL and EC, 2014).

China, the source of most of Asia's GHG emissions, has dramatically increased the efficiency of coal-fired power plants by 15 percent in the 2000s to an average of 34 percent (Biello, 2010). Like China, India heavily relies on coal to meet 53 percent of its energy demand. While the efficiency of coal-fired power plants in India has improved in recent years, the average is still low at 29 percent, and nearly all the coal-fired plants are subcritical. GHG emissions are dominated by heavy industry. The rampant growth in energy-intensive industries has been the main driver behind the sharp increase in GHG emissions since 2000 with around one-third of the emissions in 2005 from manufacturing goods for export (World Bank, 2010(a)).

Figure 3.8: Carbon Dioxide Emissions From East Asian Countries Will Double By 2030.



Source: World Bank and AusAID, 2010

3.6 Summary

This Chapter has broadly outlined the titanic environmental and natural resource management challenge facing Asian developing countries. The degradation is accelerating. Efforts to strengthen environmental management and protection have not kept pace with urban, industrial and agricultural expansion. The policy-base for such efforts is not appropriately embedded; similarly, the principles and practices are not properly diffused in poverty reduction and development programs as demonstrated by the loss of momentum and, in some countries, reversals of progress when economies falter. Addressing this challenge will take a political commitment and a multi-pronged, well-financed effort, which has, to date, not existed on a sustained basis. But a number of examples of significant steps in this direction are given. Many of these are CP initiatives undertaken in response to the severe environmental and natural resource costs of the rapid development of the 1990s and 2000s and other, more recent initiatives are indicative of countries' interests and internal and external incentives for shifting to a low-carbon development path as a means to address climate change. Such efforts are discussed in detail in Chapters 4 and 5, respectively.

4. CLEANER PRODUCTION (CP) PROGRAMS AND EXPERIENCES IN ASIAN DEVELOPING COUNTRIES

4.1 Introduction

Chapter 3 outlined the "local" and "global" environmental crises that Asian developing countries and the rest of the world face. The trends and projections make it clear that a substantial change in the development process must take place. Approaches to deal with these challenges have not been adequate or sustained; for sure they have not led to environmental transformation. The challenge is to fully diffuse necessary actions across all segments of society so that the principles, policies, and actions that are resilient to local and global shocks are embedded in the development processes.

In the mid-1990s, recognizing the rapid environmental deterioration accompanying rapid industrial growth, several Asian developing countries, many with assistance from bilateral and multilateral assistance agencies, established CP programs intended to reduce industrial waste and improve resource efficiency. Much attention was given to shifting technologies and managerial practices at the factory-level. Some attention was given to national CP policy and regulatory development and even less to education.

The scope and outcome of some of these assistance programs, which have been undertaken in Asian developing countries, are described in this chapter. A more detailed analysis that focuses on country efforts as opposed to those of bilateral and international assistance agencies is presented in Chapters 6 and 7. In addition, some of the major global initiatives are reviewed to learn from the experiences, to build upon the successes and to avoid the mistakes in guiding the preparation of a transition framework for accelerating wide-scale implementation of CP. The purpose is to understand the experiences, what worked and what did not, what was sustained after external assistance declined and what was not. This review includes review of some of the earliest financing initiatives targeting CP. By doing so, these lessons can guide future actions at the national and international levels (research questions 1 and 2).

4.2 The Emergence of Cleaner Production in Asia

The ways in which the developing economies of Asia and the global community have responded and are responding to the environmental imperatives will have far-reaching and long-lasting impacts on local, regional and global quality of life and the sustainability of social and economic development. There is no single approach to solving challenges as diverse, and taking place as rapidly and in such uncontrolled ways as Asia's urban and industrial growth, resource depletion, pollution, and climate change.

Most Asian developing countries followed a western model when establishing laws and institutions charged with environmental protection, controlling wastes and reducing their impacts through regulation (Ludwig et al, 1988). In industrialized countries, this approach has been largely successful in terms of improving ambient environmental quality and meeting environmental standards, but at enormous cost to both industry and government. It has been much less successful in developing countries that lack the human and financial resources, and often also lack the political will, to enforce regulations. (ADB, 2005; UN, 2012; ADB, 2011)

In industrialized countries and in some developing countries, as the marginal cost of collection and treatment of wastes increased, both to the firms and to the governments that must monitor and regulate, there has been increased attention to more cost effective and sustainable solutions. In many countries the increasing costs of input production by public utilities and waste management stimulated attention to demand-side management, by pricing and other incentives and disincentives to reduce the inefficient use of raw materials and unnecessary generation of wastes (ADB, 2000 (b)).

The solution widely selected involves basic concepts of pollution prevention or waste minimization. In retrospect, even those countries with successful regulatory regimes recognized that they could have accomplished more, faster with a combination of regulations and incentives to induce voluntary pollution prevention and better environmental management. Unlike the treatment and disposal of wastes, pollution prevention and its evolution, cleaner or sustainable production, cost less per unit of impact reduction and are more cost-effective the more intensively they are integrated into the operations of all industrial sectors as well as within the service sectors and within domestic contexts. Asian industrializing countries were attracted to these proactive, prevention-oriented approaches, both because of the lower economic, environmental and human health costs and because it is less politically demanding (WEC, 1994).

Early efforts to introduce CP in developing countries are well summarized by Baas (2005). He gave significant credit to UNEP and to UNIDO whose staff initiated CP pilot projects in China and India in the early 1990's. The definition of CP used by these two organizations is:

"Cleaner production is the continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment. The three classes of objectives CP seeks to achieve are:

Production processes: conserving raw materials and energy, eliminating toxic raw materials and reducing the quantity and toxicity of all emissions and wastes.

Products: reducing negative impacts along the life cycle of a product, from raw materials extraction to its ultimate disposal.

Services: incorporating environmental concerns into designing and delivering services." (UNEP, 1994)

The initial demonstration projects followed by broader technical assistance projects and programs on CP by UNEP and UNIDO led to the establishment of several National Cleaner Production Centers (NCPCs) starting in 1993. These centers were intended to promote CP at the national level by in-plant demonstrations and various training programs for governments and industry to show CP at work, and by analyzing the policy framework for CP, and acting as a focal point of CP through information collection, analysis and dissemination activities. The first set of NCPCs were established in Brazil, China, the Czech Republic, Hungary, India, Mexico, the Slovak Republic, Tanzania, Tunisia and Zimbabwe. By 2008 there were a total of 45

NCPCs in developing countries (Table 4.1) (UNEP/UNIDO/SECO, 2008) and by 2015 there are 58 NCPCs.

Early bilateral initiatives by Norway in Central and Eastern Europe; Denmark in India, South Africa, Thailand and Zimbabwe; and the USA in a range of countries across the globe helped stimulate national CP programs (Baas, 2005). Many of these programs were started as industry-sector specific, demonstration programs and evolved into broader training initiatives, undertaken by national institutes with bilateral support. Most focused on technology transfer and diffusion while some evolved into support networks, and to develop national CP policies and regulations.

Table 4.1: National and Sub-national Cleaner Production Centers (NCPCs) were established in many developing countries with international and bilateral assistance

Region	Number of CP Centers/Countries
Africa and Middle East	Cape Verde, Egypt, Ethiopia, Ghana, Kenya, Lebanon. Morocco, Mozambique, Rwanda, Senegal, South Africa, Tunisia, Uganda, Tanzania, Zimbabwe
Asia and Pacific	Cambodia, China, Gujarat(India), India, Indonesia, Laos, Republic of Korea, Sri Lanka, Vietnam
Europe and Central Asia	Armenia, Albania, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Georgia, Hungary, Montenegro, Moldova, Romania, Russia, Serbia, Slovakia, The Former Yugoslav Republic of Macedonia, Ukraine, Uzbekistan
Latin America	Bolivia, Brazil, Columbia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Peru
Total	**58**

Source: Luken et al, 2015.

Globalization and the global focus on climate change reinforced the interests of several countries to strengthen CP (ADB, 2005). Further, there is hope that evolution of new initiatives in “green growth” (UNEP, 2011; OECD, 2009; World Bank, 2012(b)) to link the various sectors which provide goods and services will help to improve the sustainability of current and future economic growth. A number of studies have demonstrated that increased access by developing countries to cleaner technologies, combined with the adoption of CP policies and practices, resulting in the production of goods and services that substantially reduce the environmental footprint should enhance access to global markets for their products and could lead to greater profits by using fewer resources and generating less waste within ecologically sound systems (ADB, 2000(b); WB, 2010(a); UNEP, 2011). This is what CP is all about.

4.3 Overview of Asian Regional, Sub-regional and National Programs

The aforementioned efforts of the early 1990s to introduce pollution prevention and the use of cleaner technology resulted in a wide range of related initiatives by the mid-1990s in Asian developing countries. These programs were initially designed to test market-based instruments for achieving environmental quality improvements, to improve information disclosure and public participation, and to stimulate diffusion and implementation of cleaner technologies for prevention of the production of pollutants rather than focusing solely upon end-of-pipe pollution control approaches.

In particular, a number of CP-like programs were developed with support from international and bilateral organizations with the objective of demonstrating how countries can reduce the energy, water, materials, pollution and waste intensity of urban-industrial economic activities (Evans and Stevenson, 2001). Different names have been used to introduce the concepts of CP in Asian developing countries since the mid-1990s. Pollution prevention, waste minimization, cleaner technologies, environmental management systems, green productivity, increased market competitiveness, natural resource conservation, clean production, eco-efficiency, cradle-to-cradle, industrial ecology, industrial symbiosis, and others, all of which are fundamentally similar, in many ways to CP.

Different donor countries and international organizations promoted a particular brand for different reasons and often through different institutions and mechanisms (Stevenson, 2001). For example, the USA-supported programs had the "pollution prevention" brand, worked primarily with ministries of environment, and supported pollution prevention roundtables in some Asian countries. The Asian Productivity Organization promoted "green productivity" and worked through its network of developing country organizations; this was the APO brand (APO, 1995). The UN and multilateral development community tended to use the CP brand in its assistance, which was often aimed at ministries of industry and environment. The Asia Pacific Roundtable for Cleaner Production (APRCP), was initiated by the Thai Government with support from the Asian Development Bank (ADB) and UNEP (Evans and Hamner, 2004).

In general, regardless of the branding, the programs adopted by Asian developing country governments have focused on the triple objectives of sustainable economy, environment and society and have tended to become more harmonized under the CP concept. Many of the programs demonstrated how CP can lead to more sustainable production approaches that can effectively, and positively impact up and down-stream of the production processes to include consideration of the environmental consequences of the design of the product, selection, extraction and processing of production inputs, and the distribution, use and ultimate end-of-life management of the products. They also demonstrated that effective leadership and management is as, or more, critical than technology in most cases. The programs also demonstrated the numerous reasons for countries and firms to adopt principles of CP on their own initiative. Early national efforts focused on integrating CP into efforts to reduce growing pollution levels and in support of demand-side energy policies. Early firm-level initiatives were promoted because of the potential win-win benefits such as reduced operating costs and greater profitability through greater production efficiency, improved public image as being environmentally responsible, better access to certain types of financing, reduced business risk from worker accidents, decreased risks from faulty regulatory enforcement, and increasingly a stronger and even preferential competitive position, especially in international trade.

A review by Stevenson (2000) documented that as the initial demonstration projects evolved into investment and national policy and capacity development programs, they moved from a largely manufacturing focus and were adapted to many other development sectors such as energy, transportation, extractive industries, agriculture, forestry, tourism, health care, universities and other service sectors. The experiences showed that CP has the potential to transform development when it is implemented as a strategic development principle using multiple stakeholders – the multiple layers of government and utilities as well as education, financial and professional organizations, civil society and community-based organizations. This approach was conceptually very different from the simple concept of pollution prevention at the firm level, it was a sustainable development concept that offered a substantial resolution of the conflict traditionally seen between achieving economic growth and preserving the environment. Based on experience from the 1990s in Asia, it was clear that CP has the potential to stimulate more sustainable economic growth by increasing the efficiency of production, enabling more wealth creation from the same resource base, while reducing the impact of that growth on the environment and human health and the depletion of natural resources. Further, a sustainable approach to economic development based on CP brings together the parties concerned with growth and environmental protection so that they can work together to ensure that national development policies and environmental policies are mutually supportive (Stevenson and Evans, 2004).

Given these broad, and positive outcomes of Asian CP initiatives, the question continues to be, why governments, sectors, firms, regional governments and others have not more effectively adopted CP principles and practices as central to their developmental policies and programs and at the scale necessary to achieve significant positive impacts upon ambient environmental quality and resource management. More importantly, of course, is the need to understand what is necessary to achieve such system-wide transformation. In order to gain the necessary insights, it is important to assess the successes and failures of various initiatives; in other words, we need to find out what worked and why and what did not work and why. This is the objective of the remainder of this chapter.

A regional technical assistance program undertaken by ADB and UNEP in 2001 supported a survey of various CP programs in Asia. The objective was to understand the extent and nature of actions being taken in Asia by the many international organizations concerned with promoting the adoption of principles and techniques of CP. The results of the survey showed that over fifty organizations with international operations were spending many millions of dollars annually to promote CP and its related approaches in Asia, and most national governments were funding their own national CP promotion programs. The increasing concern over the impact of industry and other economic activities on human health and the sustainability of the environment and natural resources was evident from the breadth of involved organizations. There also appeared to be a consensus based on the number of programs specifically promoting CP that, together with innovative and enforceable environmental standards and regulations, it was a key means to reduce pollution, to conserve natural resources and to thereby, help to ensure progress toward more sustainable societal systems (ADB, 2001).

In spite of this important progress, the survey and subsequent discussions at the 2002 APRCP showed that CP practices were not spreading rapidly or at the scale required to significantly improve ambient environmental quality. The pollution and resource consumption intensities per unit of production were not falling as rapidly as increases in total production. Given the substantial investments by donors and governments, the question of effectiveness of the CP approaches had to be raised (Evans, 1999). At a minimum it was clear from the survey of who was doing what with regard to promoting CP that improved coordination and focus of the considerable resources and skills available was needed to bring about more rapid changes in the perspectives and behavior of businesses and organizational decision-makers in Asia who could influence the environmental future of the region.

The review of various programs showed that three fundamental principles had been generally recognized in designing Asia's CP programs:

a. Firstly, the environmental challenges of the 1990s to the present that are challenging Asia's industrializing economies were qualitatively different from the concerns that underlay the emergence of the environmental regulatory systems within OECD economies during the 1960s and 1970s. There were both greater understanding of the long-term threats to sustainability from development, and greater opportunities for the developing countries to employ environmentally sustainable technology and practices given their rapid turnover in capital stock. Understanding this context is critical to successful policy intervention. Accordingly, policy development must begin by identifying the economic, political and social conditions that constitute the structure of the environmental challenges and the attendant opportunities for change.

b. Secondly, given that continued growth will result in continuing shifts from agriculture into industry, and from rural areas into cities, the key policy focus must be on reducing the energy, water, materials, pollution and waste intensity of urban-industrial activities. Reductions in these intensities must continuously offset rapid growth in both industrial and urban activity. This will undoubtedly require improvements that generally exceed the improvements that can feasibly be achieved through existing environmental regulatory approaches since conventional standard setting in developing countries was usually not based on absorptive capacity of receiving environments but rather on industrialized country experiences.

c. Thirdly, a focus on CP, reducing intensity and toxicity of pollutants and resource use, stimulated new economic development prospects. Redefining the environmental problems discussed in Chapter 3, as an industrial challenge, expanded the range of drivers and points of entry that can be harnessed to achieve the goal of wide-spread implementation of CP. The array of possible drivers is wide, ranging from industrial and environmental extension, to supplier relations, and to contributions from the education and health sectors (discussed in detail in Chapter 8). From a national development policy perspective, this implied that the policy domain is not limited to environment or even environment and industry, but was as much an issue of energy, health, science and technology, transportation, tourism, trade and urban development policy as it was of environmental and industrial development policy. Furthermore, with an emphasis upon sustainable regional development, elements of ethical, social and long-term futures, it became increasingly important in governmental policies, industrial stakeholder responsiveness and in university curricular and research programs.

While there was diversity among the programs described in this chapter, in general there was a common policy objective whereby, governments used CP concepts and approaches to help to redirect environmental behavior of industry with the following types of instruments:

- Regulations: such as when the permit of a firm to operate depends on meeting environmental standards, and failure to do so incurs financial or criminal penalties;
- Voluntary Programs: such as regulators engaged in an interactive dialogue with firms with an emphasis on sharing and dissemination of information and expertise;
- Market-Based Instruments: such as in the use of taxes, tariffs, subsidies and other such methods to shift the financial calculations of firms toward environmentally beneficial decisions; and
- Transparency: through which public awareness of the dangers of pollutants plus ready access to required reporting by firms on their discharges creates public pressure on the firms to reduce their discharges.

The shortcoming of most of these measures was that they were not effectively integrated into the broader environmental and pollution control regulations. Consequently, the priority of many regulatory agencies and the responses of industry were to focus on end-of-the-pipe, pollution control approaches instead of improved material efficiency, pollution prevention and toxics use reduction approaches (Evans and Stevenson, 2001).

4.4 The Role of International Assistance in Promoting CP in Asia

Many Asian developing country governments requested and received financial and technical assistance for designing and implementing regional, national, and local, as well as industry-specific, CP programs. The primary supporters have been multilateral development banks, in particular the ADB and the World Bank; United Nations organizations such as UNDP, UNEP, and UNIDO; and bilateral programs, particularly Denmark, Japan, Norway, Sweden, Germany, Switzerland, Canada the U.K., Australia and the USA; several multinational companies (particularly the chemicals industry (WEC, 1995) and NGOs such as Greenpeace and the World Environment Center (WEC). By 2003 there were over fifty international organizations, national donors and non-profit organizations funding CP-like programs in Asia with many millions of dollars annually to promote CP.

UNEP and UNIDO initiated the first major CP activities in the Asia and Pacific region (Van Berkel et al, 1994). The UNEP Industry and Environment's Cleaner Production Programme was key to the establishment of multi-country networks for the promotion of CP. Its activities included awareness and capacity building, documenting successful cases in different industries, and effective information dissemination. UNEP's CP Working Groups supported identification and supply of technical expertise, provide advice and develop and disseminate CP-related information. Their focal areas initially included: leather production, textile production, food industry, biotechnology for CP, metal finishing, pulp and paper production, sustainable product development, and Education and Training for CP and Sustainable Development. Under UNEP's CP program, the *International Declaration of Cleaner Production* was launched in 1998. The Declaration was a multi-stakeholder partnership aimed at increasing awareness and demand for CP and renewing the commitment of CP practitioners. By late 1999, over 1800 corporate leaders, government officials, academic experts and NGO representatives had signed the Declaration compared with less than 100 signatories during the launch in

Korea. Like many similar environmental declarations, it is not really clear that this made a substantive impact, but it was an important message.

Some of the first UNIDO/UNEP NCPCs were in Asia. They were intended to facilitate the transfer of technical information and technology to industrial enterprises and environmental management agencies and build CP capacity at the national level. The focus was on in-plant demonstrations, CP practitioner training, information collection and dissemination, and provision of assistance to policy makers in identifying CP barriers through policy studies and recommendations.

Major donor-assisted CP projects and programs were undertaken across Asia in the late 1990's as indicated in Table 4.2. The countries, which benefited the most in terms of assistance received (not necessarily in terms of resulting impact) were China, India, Philippines, Sri Lanka, and Thailand. Several of these programs and projects are summarized in the following sections.

Table 4. 2: Examples of Types of Activities in Donor Supported CP Programs in Asia

Type of Activity	Organization	Project Name	Country Coverage
Capacity Building	DANIDA DANCED		Nepal Thailand, Malaysia
Demonstration	UN, UNEP, UNIDO AIT	CP Financing Project	Vietnam India, Sri Lanka, China, Philippines, Vietnam
Environmental Management	DANIDA		Nepal
Guideline/ Manual Preparation	JICA Asia Foundation	 NGO-Business Environmental Partnership Program	
Networking/ Information Exchange	ASEAN Asian and Pacific Centre for the Transfer of Technology (ESCAP) Asia Society for Environmental Protection Asia Pacific Roundtable for CP	Regional Centre for Promotion of Environmentally Sound Technology INET Asia	ASEAN member countries INET Pakistan, China, CIS, Europe-India Southeast and East Asia
Planning and Policy	JICA APEC USEPA	Master Plan Study for Industrial Prevention in Vietnam APEC Industrial Science and Technology, CP Working Group Pollution Prevention	Vietnam China
CP Promotion	Asia Productivity Organization EC SEPA	Green Productivity Asia-Eco Best SEMA	Indonesia, Malaysia, Philippines, Thailand, Vietnam Vietnam

Type of Activity	Organization	Project Name	Country Coverage
	DANIDA		Nepal
	Asia Foundation	NGO-Business Environmental Partnership Program	
	DANCED		Thailand, Malaysia
Renewable Energy, Pollution Control Projects	AusAID		Philippines, ASEAN, China, Indonesia
Research and Survey	JICA	Mining and Industry Development Study	Philippines, Malaysia, Thailand, China
	AIM		Survey for Philippines, Indonesia, Malaysia, Thailand
Standards for Environmental Management	ISO	ISO 14000 etc.	
Technology Transfer	UN, UNEP, UNIDO	International Declaration on CP	
		National Cleaner Technology Strategies	
		National CP Centres in Asia	China, India, Vietnam
	Asian and Pacific Centre for the Transfer of Technology (ESCAP)	APCTT	
Training	AIT		
	DANCED		Malaysia
	Asia Foundation	NGO-Business Environmental Partnership Program	
	ISO	ISO 14000 etc.	
	CDG		China
	Asia Society for Environmental Protection		Southeast and East Asia
	AIM		
	RIET		

Compiled by author

Large-scale financing in the region has come primarily from multilateral development banks (MDBs). During the 1990's, the ADB was one of the primary sources of finance and technical assistance for CP, primarily at the national-level, but also at the regional-level. A summary of major CP activities undertaken by ADB is presented in Table 4.3. Until 1995, pollution prevention projects funded by the ADB were piece-meal with little inter-relation with succeeding or previous projects funded by ADB or by other funding agencies. In some cases, ADB assistance had "leap-frogged" immediately to direct provision of investments for retrofitting or for upgrading of firms using clean and/or energy efficient technologies in a subsector of an industry, instead of focusing initially on awareness promotion, or upon establishment of the required institutional, regulatory and legal framework and information systems, and promotion and building of technical capacity. Piece-meal identification of projects through *ad hoc* programming produced beneficial results that lasted only for as long as the consultants were present to provide help.

In 1995 ADB performed in-house evaluations of the barriers to widespread adoption of CP in its developing member countries. The conclusions were consistent with other analyses, which concluded that a strategic approach must begin with an evaluation of the capacity of developing countries to take advantage of the potential offered by clean(er) technologies from the developed world. On the basis of this analysis, ADB determined that its comparative advantages for assisting recipient countries to undertake CP programs were in development of policy dialogue and finance. It also recognized that many factory-specific demonstration projects were leading to limited extension of CP, and that perhaps ADB could use its TA grant funds to provide value added to the more technical demonstrations by supporting CP policy development, capacity building and networking. Initially, ADB provided two TAs for these purposes- one to China and one to Thailand. In addition, at the request of several Asian developing countries and in collaboration with several other donors, ADB provided regional technical assistance to support the aforementioned APRCP[3].

The World Bank has also been a key source of project and policy work, backed up by an extensive research program, aimed at identifying means to integrate CP and other environmental objectives effectively into World Bank operations. A critical review of the World Bank's industrial pollution operations in 2001 considered that, while the World Bank had taken some initiatives on CP in some projects and program, it was "losing ground" in supporting CP because it had mainly abandoned general lending to industry and had not made serious efforts to coordinate with and to complement the efforts of other international and bilateral agencies, which were focusing on the issues of industrial pollution and CP. (Williams and Warford, 2001)

The International Finance Corporation (IFC), the private sector wing of the World Bank Group is closer to a private investment bank than to being an aid agency, offering medium to long-term loans with equity positions in some of its clients' projects, and also it arranges syndications whereby, a number of investors are brought together to mobilize resources and expertise required for major investment projects. As part of this mandate it has recently emphasized assistance to small and medium-sized enterprises (SMEs) and non-profit corporations. The IFC's initial experience relevant for CP was dominated by its efforts to support energy efficiency. An early, innovative initiative was a $21 million (with GEF grant funding) to make loans to SMEs, both non-profit and private sector in addressing the environmental problems of climate change and bio-diversity. The IFC then established a "Sustainability Business Innovator" initiative, which undertook more than 220 projects from 2006 to 2011 and for which one of the six priority themes was CP. In 2007 the IFC scaled up its support for CP-related programs with the "Cleaner Production Lending pilot" to help demonstrate financial viability and environmental improvements. A $20 million lending pilot facility was established to provide from $250,000 to $5,000,000 loan per project using an accelerated lending process.

Based on these experiences, in early 2011 the IFC initiated a major new program called the 'Sustainable Business Advisory,' services. Under this program the IFC

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[3] The concept for the APRCP was first developed by Dr. Donald Huisingh who recognized the need for sharing of experiences in a similar forum as the European Roundtable for Cleaner Production.

works with individual firms as well as at the sector level to address market barriers, which are preventing the broad deployment of business practices and decisions that would lead to profitable commercial outcomes while creating environmental or social value. The Sustainable Business Advisory services include a strong focus on global supply chains and standards to create access to markets for developing country firms that adopt sound sustainability practices such as CP. Technical assistance will target SMEs to help them adopt and deploy internationally recognized environmental, social, and trade standards. (IFC, 2011)

The European Bank for Reconstruction and Development (EBRD) operates in the countries of Central and Eastern Europe and the Former Soviet Union, including Central Asia and Mongolia. A substantial amount of the EBRD's financing is directed to industry and energy facilities, both directly through loans and equity, and indirectly through financial intermediaries (FIs) in its borrowing countries. Most FI funds assist SMEs. Much of the EBRD's work involves re-structuring and privatizing state-owned enterprises (SOEs), many of which use old, outdated technologies and also invests in remediation of polluted sites. Probably more closely related to the IFC experience than to that of the ADB or World Bank, much of EBRD's financing for industrial environmental projects is through local financial intermediary banks (FIs). A key challenge identified by the EBRD based on their experience to date is due to the weak capability of the staff in intermediary banks to assist SMEs with suitable proposals on environmental (including CP) projects, and to appraise them.

4.5 Regional and Sub-regional CP Programs

The governments of many Asian developing countries have initiated programs for the promotion of CP by industries and utilities as an integral component of their national economic, social and environment development programs. In particular, the governments of China, India, Indonesia, Malaysia, Philippines, Sri Lanka, Thailand and Viet Nam have undertaken initiatives, in concert with many enlightened industries, to implement CP programs. India and China are discussed in detail in Chapter 6 Philippines and Thailand in Chapter 7. Many of the Pacific Island developing countries have incorporated CP as part of their national environmental management strategies. Countries such as Bangladesh and Nepal, which have less mature national environment policies and programs, have also explored the possible integration of CP in their industrial development programs. In order to stimulate the development and implementation of national CP programs, a number of regional, sub-regional and national initiatives have been undertaken, most with some form of international and/or bilateral assistance.

Table 4. 3: ADB-Funded Technical Assistance Projects with Cleaner Production Objectives/Components (compiled by this thesis author)

Country	**Year**	**Project Title**	Amount (US$'000)
Bangladesh	1992	Industrial Pollution Control Management	600.0
	1993	Energy Conservation in the Industrial Sector	250.0
India	1994	Toxic and Hazardous Waste Management (Tamil Nadu)	500.0
		Energy and Environmental Management of the Industrial Development Bank of India	585.0

Indonesia	1993	Industrial Technology and Human Resource Development	99.5
Kyrgyz Rep.	1995	Strengthening Environmental Institutions and Improving Procedures for EIA	556.0
Malaysia	1990	Small and Medium Industry Technology Development	430.0
	1991	Energy Conservation Study	400.0
		Study on Industrial Technology Contract Management	325.0
	1995	Strengthening the Institutional Framework for Sustainable Development	142.0
	1997	Industrial Pollution Control Management	588.0
Mongolia	1995	Energy Conservation	100.0
Pakistan	1996	Power Efficiency Project	850.0
Philippines	1996	Evaluation of Environmental Standards for Selected Industry Subsectors	400.0
	1997	Metro Manila Air Quality Improvement	150.0
China	1992	Management of Energy Conservation Program	600.0
	1994	Second Industrial Energy Conservation and Environmental Improvement	393.0
		Anhui Industrial Pollution Abatement	450.0
	1995	Improving Coal Efficiency and Reducing Environmental Pollution	570.0
		Establishing a Center for the Transfer of Environmentally Sound Technology	550.0
		Strengthening the Environmental Standards and Enforcement Policies	600.0
	1997	Study on Clean Coal Integrated Gasification Combined Cycle Technology	500.0
		Improvement of Environmental Management in Shaanxi Province	935.0
		Capacity Building for Energy Conservation	78.0
		Financing Mechanism for Energy Efficiency Investment	150.0
		Promotion of Market-Based Instruments for Environmental Management	697.0
	1998	Hai River Basin Wastewater Management and Pollution Control	570.0
		TA Cluster to the PRC for the Promotion of Clean Technology	3,500.0
		Power Rehabilitation and Environmental Improvement	1,000.0
Sri Lanka	2001	Integrating Cleaner Production into Industrial Development	800.0
Thailand	1992	Institution Building for Energy Conservation	100.0
		Environmental Rehabilitation	350.0
		Drafting Implementation of the Energy Conservation Promotion Act	200.0
	1993	Wastewater Management and Pollution Control in	600.0

		Samut Prakarn	
	1995	Bangkok Metropolitan Region Wastewater Management	600.0
		Solid Waste Management Sector Plan	400.0
		Strengthening National Financing and Cost Recovery Policies for the Wastewater Management Sector	600.0
	1997	Capacity Building for Waste Management Program Administration	300.0
	1998	Promotion of Market-Based Instruments for Environmental	605.0
Regional TA	1998	Management	600.0
		Promotion of Cleaner Production Policies and	
	2001	Practices in Selected DMCs	5,000.0
		Promotion of Renewable Energy, Energy Efficiency and Greenhouse Gas Abatement	

The Asia Productivity Organization (APO), established in 1961 as a regional intergovernmental organization, launched its Green Productivity Program in 1994. Under this program, APO has carried out some of the early, comprehensive surveys of country-level and firm-level participation in environmentally sound industrial production. Its 1995 publication, Cleaner Production for Green Productivity (APO, 1995) was the first field-based analysis of barriers to wide scale adoption of CP in Asian developing countries. Since then the APO has supported a number of research studies, publications and international conferences intended to raise consciousness of their Green Productivity concepts and applications and serve as a clearinghouse on Green Productivity. APO works through its National Productivity Organizations (NPOs) to support capacity development and lead research and demonstration projects. APO has a primary focus on SMEs and since 1996 has implemented fourteen CP demonstration projects (APO and SPSB, 2000).

UNEP initiated "Strategies and Mechanisms for Promoting Cleaner Production Investments in Developing Countries", a CP project undertaken from 1998 to 2001, which focused on financing CP investments in developing countries. Its objectives were to demonstrate how to initiate and facilitate the financing of CP investments through case studies in five developing countries (Guatemala, Nicaragua, Tanzania, Zimbabwe and Viet Nam); develop financing instruments for effectively promoting CP investments; design enabling strategies for supporting public and private financial institutions and industries in adopting CP financing instruments; and motivate decision makers to pursue CP investments. The Norwegian government funded the Project, with an estimated investment of $4.9 million (UNEP 2011).

The Asia Pacific Economic Cooperation (APEC) identifies best practices, provides technical cooperation, develops websites, provides information and training, and collaborates with other organizations on CP. From 1998 to 2000 APEC's Working Group on Industrial Science and Technology led an initiative called *International Cooperative for Cleaner Production*, which was intended to help establish CP databases in government, industry and NGO sectors, and make this information available to users.

The US Asia Environmental Partnership (US-AEP) was a public-private initiative operating from 1992 until 2004 to promote environmentally sustainable development in Asia. Its Clean Technology and Environmental Management (CTEM) component supported market pressures and private initiatives to promote industrial environmental performance. CTEM activities were undertaken from about 1995 to 2002 and included: corporate environmental management promoting the adoption of environmental management systems specifically ISO 14001 in targeted countries (India, Indonesia, Malaysia, Philippines, Singapore, Thailand, and Viet Nam), voluntary business standards, greening the supply chain, industrial extensions for the environment, and environmental due diligence.

Northeast Asian Sub-regional Programme of Environmental Cooperation (NEASPEC) is an UN-supported partnership established in 1993 with six country members- China, Japan, Democratic People's Republic of Korea, Mongolia, Republic of Korea, and Russia. NEASPEC has initiated several CP projects including training for sulfur dioxide reduction in coal-fired power plants and a demonstration of the best available technology in each country for reducing pollution.

The Association of Southeast Asian Nations (ASEAN) strategic action plan specifically sites the development of a system for the promotion of environmentally sound technologies (Strategy 8). This included CP efforts particularly regional efforts for linking with clearinghouses and disseminating research and development efforts. The ASEAN Environmental Improvement Project (ASEAN-EIP) was initiated in partnership with the USAID in 1992 at US$17.5 million to run for six years. It had the overall objective of introducing concepts and practices of waste minimization and environmental management to industry in the (then) six countries of ASEAN. The intent of the ASEAN-EIP was that the demonstration firms would serve as examples and sources of technical information to other firms in the industry. It was expected that the national industry associations would be the primary conduits of such information, and that other mechanisms such as a CTEM information center would augment these channels. The ASEAN-EIP also worked with government agencies to develop the financial and financial analysis on which to justify market-based instruments that would encourage adoption of waste minimization practices by firms, creating a demand for the information offered for dissemination.

In recognition of the heightened interest of Asian developing countries in attempting to integrate CP into their development process, the resulting influx of international assistance in support of this, and the potential to accelerate adoption of CP through coordinated, regional initiatives, UNEP and ADB jointly developed a regional technical assistance grant, funded by ADB, for the promotion of CP policies and practices in 1998. The goal of this project was to accelerate in Asia the development of national policies and action plans for the adoption of CP. To achieve this goal the project-focused support to Philippines, Indonesia, Vietnam, India and Thailand to develop the policy framework, integrated action plans and institutional capabilities they need for rapid and efficient adoption of CP. The project was designed to achieve an impact broader than in the directly participating countries by providing training on subjects such as policy development, CP planning and emerging areas for CP applications to a larger audience of Asian nations. It used the experience of participating countries to develop generic guidelines for national policy development and strategic planning, and built mechanisms to facilitate regional networking, cooperation and coordination among assistance agencies and other interested parties in Asia. It included a study of CP financing around the world and developed a mechanism for improving the financing of CP in Asia. A key product of the regional initiative was the preparation of the ADB's Guidelines for Policy Integration and

Action Planning for the Promotion of Cleaner Production launched at the third annual meeting of the Asia Pacific Roundtable on Cleaner Production (Evans and Hamner, 2001).

4.6 Roundtables and Cleaner Production Centers

The Asia Pacific Roundtable for Cleaner Production (APRCP) was launched in Bangkok, Thailand in November 1997. This was an important stimulant for regional CP efforts. The APRCP initiated networking and experience sharing among CP experts and organizations from the region. Since 1997, the partnership has matured and now includes public and private sector members from twenty-five Asian and Pacific countries. In 2003 the name was changed to Asia Pacific Roundtable for Sustainable Consumption and Production (APRCSP) and a charter was adopted, reflecting a broader orientation than originally envisioned. A secretariat was established to enhance information flow and human resource development and to strengthen public/private partnerships.

The *Asia Pacific Cleaner Production Network,* established by the Thai Environmental Institute (TEI) in 1997 was the foundation for regional networking activities. The network is a focal point for facilitating on-going discussions on CP related topics of regional relevance, sharing experiences and barriers and CP activities and for enhancing CP community networking. In 2003, the Board of APRCP decided to take a stronger focus on consumption issues and transformed the roundtable to become the APRSCP. There have been a total of twelve major regional APRCP/APRSCP conferences held since the initial one in 1997.

National CP "Roundtables" also emerged in the Asian region in the late 1990's, largely supported by the USA and Canada which relied largely on subnational-level pollution prevention roundtables bringing together public and private sector actors for network building; collaborating on ideas, resources, and research; sharing practical experience; and learning from others. The Pollution Prevention World Information Network (2009) reported that they have seventeen network partners. Within Asia, in addition to APRSCP, China, India, Indonesia, and Philippines have national Pollution Prevention Roundtables. These roundtables, regardless of their sustainability in terms of maintaining effective networks for sharing lessons (which is mixed) were important for raising awareness. For example, the first Indonesian roundtable in 1997 had 200 attendees. Subsequent roundtables focused on issues such as using CP for environmental sustainability and increased profit and included site visits and training sessions. The first Philippine Pollution Prevention Roundtable, also in 1997, effectively engaged business and industry, government, communities and other sectors to agree on the need to adopt CP in operations and address the growing pollution problems of the country. It focused on increased awareness of the need for and benefits of CP rather than end-of-pipe solutions, and provision of a venue for negotiated and shared objectives among stakeholders. The Philippines has held eight national CP Roundtables, the most recent one was focused upon climate change.

As noted in Table 4.1, UNEP/UNIDO-supported NCPCs have been established in eight Asia-Pacific countries, namely Cambodia, China, India, Indonesia, Laos, Republic of Korea, Sri Lanka, and Vietnam. Their primary objective is to help these countries build indigenous CP capacity through technology and CP management transfer. National officers who understand the local conditions staff each national center; therefore, they are especially insightful with regard to appropriate approaches for relevant technology transfer. The centers have a multi-stakeholder target audience of different levels of industry, government, academia and the financial sector. The global network of NCPCs comprise a valuable resource of practitioners who can share lessons learned, thereby fostering dialogue between industry and government and enhancing investments for transfer and application of environmentally sound technologies in their companies and supply chains.

4.7 Lessons Learned from CP Initiatives in the Asian Region

The first substantial review of impacts of CP projects in Asia, carried out by the APO in 1995 (APO, 1995), provided early, valuable guidance to enhance understanding of some of the barriers to adoption of CP at the firm level as well as how to improve the design of demonstration projects, which were the predominant form of CP assistance at the time. Subsequently, a number of relevant critical reviews were undertaken, which helped to define technical, regulatory and institutional barriers and responses, as well as they helped us to refine the understanding of the roles of various stakeholders in the development and implementation of CP programs.

4.7.1 The Asia Productivity Organization Review

In 1995, APO reviewed numerous demonstration projects in several countries (Hong Kong, India, Indonesia, Japan, Mongolia, Nepal, Singapore, South Korea, and Taiwan) in order to "(i) clarify positive impacts of CP on local enterprises and communities; (ii) examine the background of and driving force for the development and use of CP technologies as well as the barriers to them; and (iii) explore specific policies, strategies, and instruments for promoting CP in local enterprises to help advance productivity, enhance industrial hygiene, improve the local environment, and strengthen the local economy" (APO, 1995). The comparative research was particularly focused on SMEs. The study was benchmarked against the Japanese situation since Japanese industry was one the most advanced in terms of adoption of cleaner technologies at the time of the study.

The objective was to determine to what extent the Japanese experiences could guide work with SMEs in other Asian countries. According to the APO report, Japanese experiences were that the most important factor for the promotion of CP in SMEs was the stringent enforcement of environmental regulations. Regulatory enforcement has stimulated Japanese SMEs to try to achieve the required environmental goals in a cost-effective manner, which in many cases has meant the development and use of CP measures. The Japanese experiences showed that incorporation of cleaner processes into production could be easily achieved at the time new plants were being built or during plant/process renovations.

The Japanese experiences documented that in economies undergoing rapid transition involving the accelerated construction of new plants and plant/process renovation, technologies, decisions promoting CP were relatively easy and inexpensive to adopt. Difficulties frequently encountered in the use of CP in SMEs included the lack of expertise and financial resources. In Japan, these difficulties were overcome, to some extent, by the existence of specialized supporting industries and financial schemes for SMEs. The possibility of space economization also contributed greatly to the use of CP because Japanese SMEs usually suffer from severe shortages of space.

APO generally concluded that Japanese approaches for the greening of SMEs, which depended on carrot-and-stick policies of the government sector and responsiveness of the private sector, were also relevant to newly industrializing economies such as Korea, Taiwan, Hong Kong, and Singapore. However, in the case of the other country programs they reviewed (India, Indonesia, Nepal and Mongolia), neither stringent enforcement of environmental regulations nor technical and financial assistance to the private sector were considered to be easily achievable, making the adoption of carrot-and-stick policies difficult. In addition, the responsiveness of SMEs to such policies is limited. APO identified capacity building of both the public and private sector as a prerequisite of SME greening and proposed the following conclusions based on the study results:

(i) "Low-cost, simple improvement measures should be introduced prior to sophisticated measures. Good housekeeping is the starting point for CP, and simple measures can yield substantial savings of energy and materials and reductions in waste. The payback period for such measures is often less than one year.

(ii) Cleaner processes should be incorporated into production processes when new plants are built and when old plants and processes are renovated. In economies that are undergoing rapid transition involving accelerated plant establishment and plant/process renovation, it is relatively easy and inexpensive to make technological decisions that promote CP.

(iii) A National Standing Committee for CP Promotion should be established to formulate, implement, and monitor a CP promotion action plan, and an existing institution that could work as the national CP center and as the secretariat of the standing committee should be identified. The chairpersonship of the standing committee should be shared among the agencies responsible for industrial development and environmental management.

(iv) Water and energy pricing systems (full cost recovery and a progressive charging system) should be rationalized with a credible timetable for introduction.

(v) Domestic and international markets should be created in which the "polluter pays principle" (PPP) is applied to the greatest possible extent. The improved internalization of the cost of environmental pollution will encourage pioneer firms that try to develop and deploy CP technologies. The behavior of multinational corporations may also favor such pioneer firms. Generally speaking, they are eager to protect their corporate image as environmentally friendly companies. They will therefore, try to weed out "dirty" suppliers. "Cleaner" suppliers will improve their competitiveness in international markets.

(vi) Favorable markets should be created for environmentally friendly products and services through measures that include Eco-labeling and preferential procurement by governments and multinational corporations. The OECD and other international organizations should take the lead in encouraging Eco-consumerism and Eco-auditing in industrialized countries as a means of expanding markets for environmentally friendly products and services from developing countries. In this regard, actions to be taken by the WTO on the issue of trade and the environment and the moves of the International Standards Organization (ISO) in the field of environmental management systems deserve special attention.

(vii) Strategic industries should be identified from the viewpoint of GDP contribution, job creation, and pollution loads. This should be followed by consultation and negotiation with target industries regarding why, how, and when their pollution output should be reduced. Incentives for CP development and deployment (information services, technical advice, financial assistance, etc.), procedures to monitor compliance with regulations, and penalties for non-compliance should also be studied and negotiated.

(viii) A pollution control manager system should be established. All firms above a certain size and with certain processes should be required to have pollution control managers. These people should be trained in CP and life cycle assessment (LCA), as well as environmental regulations. They should be responsible for plant control and environmental auditing and subject to severe punishing in cases of environmental noncompliance.

(ix) External aid possibilities should be explored for the transfer of CP promotion measures and CP technologies. CP promotion includes the establishment of CP committees and CP centers and the introduction of the pollution control manager system.

(x) Concepts and approaches of CP should be incorporated into the directives of the OECD Development Assistance Committee (DAC). Pollution control experts in governments and industries have been heavily exposed to end-of-pipe (EOP) technologies and tend to think that EOP is more dependable than CP in terms of meeting media-specific discharge standards. In some cases, they completely forget the potential for CP approaches. A business alliance of pollution control specialists in developed countries, manufacturers of EOP pollution control facilities, and multilateral and bilateral aid agencies, usually, therefore, tends to only promote EOP methods in developing countries. This alliance should be blocked, since it is working against sustainable industrial development in developing countries. The DAC will be asked to correct this tendency by incorporating CP concepts into its directives.

(xi) Courses and curricula on CP and SD should be developed or expanded in university engineering education. Education in sanitary and environmental engineering has been based almost exclusively on EOP concepts. Predominantly, throughout the world, chemical, mechanical and civil engineering courses have placed little emphasis on the need for CP or on the ways that engineers can contribute to the development and implementation of CP. The principal developers and promoters of CP technologies in industry are chemical and mechanical engineers, and these people should be well prepared for this task through university programs that include CP courses and curricula." (APO, 1995).

4.7.2 Review of National Cleaner Production Centers

UNIDO and UNEP have sponsored internal and independent evaluations of the NCPCs. Reviews in 1999 and 2001 indicated that the centers were generally successful but that several steps needed to be implemented to improve impact and sustainability (Luken and Navaratil, 2004).

On the subject of transfer of technology from abroad, the 1999 review emphasized that transfer of technology involves a broad set of processes (selection, acquisition, adaptation) carried out primarily by the private sector but influenced by the governments and communities. The implication therefore, was that the role of development agencies is primarily to develop national capacity to manage this process effectively, rather than to provide specific technologies.

Early reviews of NCPCs by UNIDO and UNEP highlighted that CP is not purely a technological or engineering concept but is also – or even primarily – a managerial one. It advocated that projects supporting CP should be conceived as a component of continuous improvement encouraged or imposed though a quality management system or environmental management system. In keeping with the concept of embeddedness, the UNIDO assessment also emphasized that countries should adopt CP policies that are supported by a supportive policy environment. The report's authors further noted that achievement of this requires extensive awareness-raising, training and demonstration activities. In essence, the UNIDO assessment showed that the basic framework for CP – through education, financing and incentives and disincentives for transitioning to a broad CP approach to development – has to be diffused within the broader development framework to optimize impact and be sustained.

A very comprehensive "Independent Evaluation of the UNEP-UNIDO Cleaner Production Programme" (2008) assessed the impacts of the NCPC's activities in 37 countries between 1994 and 2007. The conclusion was that the program had generated a "richness of experience and expertise, and that reasonable progress had been made in putting CP on the agenda by delivering professional training and by helping to facilitate the implementation of low to medium cost technology options. The report noted that there are pockets of excellent results, but also much lower quality work. The author of that report highlighted that the program has the potential to effectively capture and disseminate best practices through a strong partnership with the emerging network of CP support institutions A significant challenge for the NCPC program is to adapt to the changing interests and demands from governments and the private sector. (Independent Evaluation Group, 2008).

In response to this evaluation, UNIDO and UNEP developed a new strategy for the NCPC program that was approved in 2009, which was designed to scale-up CP so that it becomes common practice rather than isolated initiatives by (i) expanding and strengthening the NCPC network and its skills and capacity in knowledge management, (ii) mainstreaming governmental policies and enterprise finance processes, and (iii) creating or strengthening the national innovation capacities (UNEP/UNIDO, 2010).

The most recent review of the twenty-year history of the NCPCs showed that expectations have been generally met. Particularly noteworthy for purposes of this thesis was the finding that, while the NCPCs were successful in greening individual enterprises, there was not much diffusion across industrial sectors. Similarly, the scale of change was not sufficient to achieve measurable improvements in environmental quality (Luken et al, 2015).

4.7.3 Japan International Cooperation Agency Review

In 2001, Williams and Warford undertook a detailed review of donor strategies and methodologies for promoting CP in developing countries on behalf of the Japan International Cooperation Agency (JICA). The objective was to assist JICA in determining how it could most effectively provide such support. The review highlighted the following as key elements of an effective CP support program (Table 4.4):

(i) Awareness-raising and education are critical and are needed upfront and throughout the on-going evolution of the efforts beyond the initial phases. The successful use of CP 'circles' for improving awareness among SMEs was noted.
(ii) Regulatory instruments, including permitting and voluntary approaches have greater impact than "pollution taxes." This implied a need for strong environmental agencies.
(iii) Incentives should help industry to become more effective in "self-regulation" via using CP thereby reducing the need for external regulatory monitoring. However, sound, consistent, external, un-announced monitoring and enforcement were also essential to make the system function properly.
(iv) Technical and management training in CP is essential, especially for SMEs. Incorporating CP into academic curricula of technical colleges and universities was urgently needed.
(v) Communities need support to be equipped to apply pressure and support for preventative action.
(vi) Economic instruments in line with the polluter-pays principle are needed but should be kept administratively simple (such as charges levied on inputs, and deposit charges on products) as opposed to more complex charges on waste emissions.
(vii) Financing mechanisms are needed, particularly innovative financing that can be affordably accessed by SMEs (Williams and Warford, 2001).

The JICA study reviewed the role of public policy and institutional relationships in promoting a transformation to CP, highlighting the need for political commitment and effective governance, which in turn pointed to the need for development based on shared interests and goals, and the central importance of strong partnerships among businesses, governments, NGOs, development institutions and research communities.

The JICA study also took a critical look at the policies, activities and performance of CP programs supported by several key international assistance organizations (especially multilateral development banks and the United Nations) and bilateral assistance organizations. While acknowledging that there had been substantial progress through training, workshops, and demonstration projects, there remained serious indications that the CP assistance programs were not generating adequate impacts since the authors found that CP had generally not yet been (i) internalized into the regular decision-making policies and processes of companies, particularly not within SMEs; (ii) incorporated as a cross-cutting theme in educational systems; (iii) a targeted program area of many research and development (R&D) institutions; (iv) integrated as an integral element of governmental policy frameworks, policies and incentives; and (v) found to be readily financeable. The JICA study highlighted fragmentation, duplication and lack of continuity of donor programs as critical challenges; therefore, they recommended strengthened partnerships and coordination among donor's CP activities.

Table 4. 4: Enabling Conditions for Successful CP Implementation Based on a Review of Many CP Assistance Programs.

Policies, Instruments and Other Factors	National/*Local Governments* (General Economic/ Social Policies & Conditions	Environment or Industrial Ministries Policies & Actions	Private Industry (Policies & Actions)	Communities & NGO'S (initiatives
General awareness and education	*	*		*
Technical education	*	*	*	
Public participation	*			*
Government Decentralization	*			
Industrial Strategy: location and components	*	*		
Privatization policy	*	*		
Trade policy	*			
Banking and financial reform	*			
Legal policy: Liability for environmental damage	*	*		
Environmental Training		*	*	
Financial support	*	*		
Market based instruments (e.g. pollution taxes)	*	*		
Monitoring and inspection, penalties		*		*
Command & Control/regulatory standards	*	*		
Dissemination of CP techniques to SMEs		*	*	*
Environmental Auditing		*	*	*
Ind. Estates, waste exchange, collective treatment		*	*	

Source: Williams and Warford, 2001.

4.7.4 The Asian Development Bank Review

A critical review was undertaken by ADB in 2002 in order to help formulate its strategy for future support for CP in Asia. The study had a similar overall conclusion as by JICA (above) and noted that most programs have failed to be adequately strategic because they lacked a clear approach to change the behavior of decision-makers in industry and government. Programs to promote CP have particularly failed to address the underlying policies and the integrated planning that is needed to produce synergy among resources to achieve the rapid spread of CP. It showed that even where public policy had been part of a CP program, it was treated as secondary to information, training and demonstration.

The ADB concluded that, while tactical solutions will differ by country, the underlying premises of the approach should not differ significantly, and should:

(i) include a dialogue among public and private sector stakeholders to identify broad national goals, policy objectives and to develop a national plan for CP that catalyzes the development of public policies that will promote achievement of goals of the national plan for implementation of CP;

(ii) promote CP principles across sectors (e.g., tourism, local government, transportation, financial institutions, energy, health care facilities, educational institutions, etc.), not just within manufacturing;

(iii) use the leverage of the general educational system and the media to create awareness of the impact of industrial pollution on human health and the environment;

(iv) promote the development and implementation of appropriate market-based instruments and mechanisms of public reward for good performance and censure for poor performance;

(v) stress development and allocation of national resources to avoid dependence on external aid, particularly lending by local financial institutions to SMEs for investments in CP;

(vi) assess longer-term incentives and mechanisms that will shape sustainability of development by securing CP as the norm; and

(vii) focus support on the needs of SMEs (ADB, 2002).

The ADB also concluded that there was an urgent need to strengthen networking among international assistance agencies and programs to promote communication of objectives, actions and concerns, and to thereby, avoid duplication.

An important recommendation of the ADB analysis was that, if greater attention is to be provided to SMEs, then local governments need to be central to CP programs since they have much greater influence over SMEs than do the national governments. They issue local operating permits, have communities that live around the SMEs, and are directly influenced by SME pollution. Local governments also stand to gain substantially from broad application of CP at the local level in terms of reduced public health risks due to pollution, reduced demand for local government services such as water, electricity and waste collection, treatment and disposal since in many developing countries cities and towns, where cost recovery is often not very efficient, providing key services such as water supply, water treatment, and waste management to the local population are elements that collectively are the most expensive budget items.

All of the aforementioned reviews of CP programs highlighted upon the need for finance. In 2002, ADB conducted a global study of financing mechanisms to promote CP. The study documented that there is no shortage of capital for financing available for making CP improvements. In Malaysia, for example, over US$1billion was available on preferred terms for SMEs seeking technology upgrades that can promote CP. Large amounts of debt and equity capital have been available in many developing countries to support CP, through programs such as the IFC program. The main obstacles among SMEs to availing of this financing were lack of collateral and inadequate preparation of financing proposals (ADB, 2002). It was noteworthy that the same was true for the scaling-up of industrial energy efficiency investments eligible for CDM credits (World Bank, 2010). In its study of CP financing, the ADB found that the most successful mechanism for improving SME access to capital for CP financing is through provision of loan guarantees. Such guarantees overcame the basic barrier to debt financing caused by lack of collateral. Loan guarantees were particularly cost-effective when used to support CP investments, because CP investments tended to be inherently profitable since they increased resource efficiency and decreased pollution control costs, improved worker health and safety and enhanced customer satisfaction.

The ADB study further suggested that CP assistance programs, working with local governments, should develop CP loan guarantee instruments. International financial institutions such as the ADB or IFC can/should establish a loan guarantee program that is implemented through a local financial intermediary bank. The role of the local government should be to assist the financial intermediary to market the program to SMEs, using the governmental regulatory authority as a leverage point. Such an approach could overcome one of the most significant barriers to CP adoption and financing, and is consistent to the approaches used in providing financial support by MDBs and others for sustainable development in developing countries (Hamner, 2002).

4.8 Conclusions

In this chapter, this thesis author reviewed the experiences of numerous international and bilateral assistance programs in support of Asian developing countries efforts to adopt CP programs. While further detailed analyses at the country-level are presented in Chapters 7 and 8, the experiences described in this chapter show that the design of these programs would have benefited from a closer consideration of how to achieve change in line with the theory of ecological modernization and policy integration. The initiatives were largely stand-alone, and as a result they were not integrated into broader sector or national development policies or regulations. CP was treated as an “add-on” rather than as an integral driving force, fundamental to environmentally sustainable development. At the same time, numerous beneficial lessons can be drawn with regards to the critical elements required to embed CP into the development process. Education at several levels, effective engagement of stakeholders, a sound policy framework including financial and regulatory incentives and disincentives are all key elements that will be drawn into the subsequent chapters in discussing how to achieve wide-scale implementation and societal sustainability by adopting CP in development.

Most of the CP initiatives discussed in this chapter were initiated in the mid- to late-1990s. Some have been successful in being embedded and integrated, while some have faded away. Many Asian developing countries have emphasized sustainable consumption along with CP, as indicated by the change of the Asia Pacific Roundtable for Cleaner Production (APRCP) to the Asia Pacific Roundtable for Sustainable Consumption and Production (APRSCP). But even as this shift in attention took place, the climate change challenge dominated the policy focus and actions of governments, much more than sustainable consumption or CP. Virtually any conference in the last few years related to CP has a very strong focus on lowering fossil fuel consumption because of the heightened attention to climate change. There is a growing recognittion of the interlinkages of sustainable consumption and CP and climate action- whether related to economic efficiency, energy security, water security, food security, or local air quality. Chapter 5 addresses the rapid growth in climate change action in Asia.

5. CLIMATE CHANGE: ASIAN TRANSFORMATION TO LOW CARBON ECONOMIES

5.1 Introduction

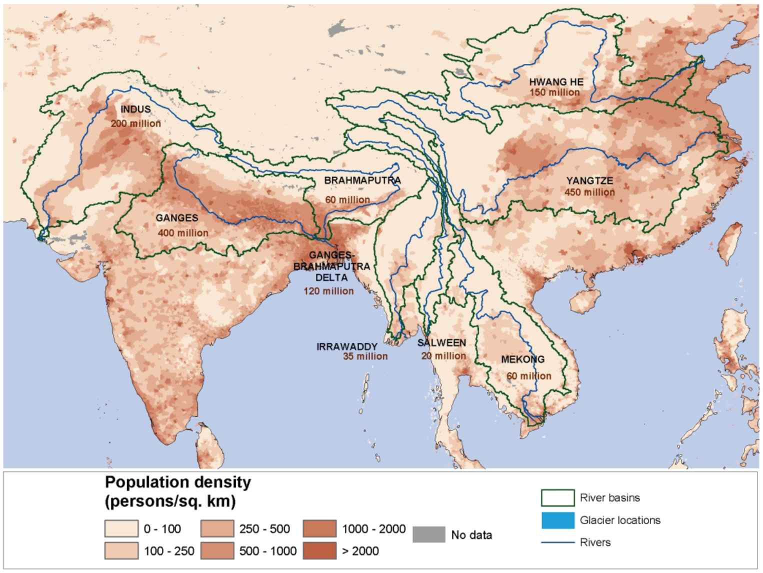
The inter-linkages between CP and climate change mitigation are quite clear. At the international and national levels, policies and technical and financial programs for low carbon and climate resilient development have the potential to strengthen national and local action on CP. At the point of action, such as the factory or municipality, making improvements in energy efficiency and in changing the types of energy used require the same types of management, technical and financial decisions and are integral to the transition to CP. This thesis author reviewed the status and lessons derived from the climate change challenges and responses, during the last few years, in order to identify potential approaches to support a broader CP future to contribute to achieving lower carbon economies, globally. The lessons from relatively recent actions, over the last decade, for policy reform, market development, technology diffusion, and innovative financing are critical for guiding analysis of options for stimulating low carbon CP development including how to overcome policy, institutional and financial barriers (research questions 1-3).

While apparently complimentary, the major difference between GHG mitigation and adoption of CP is that efforts to make the transition to a CP-society are primarily focused on improving local environmental and socio-economic conditions. Efforts to reduce GHG emissions are intended to address the global climate change challenges. In this context high emission levels of GHGs have few or no perceptible, immediate local impacts, consequently, there is often less interest in making investments in reducing GHG emissions which are for the '*global good'* than in making investments to reduce emissions of waterborne toxic substances or fine particulates because such investments can reduce the severe local impacts for the '*local good*.'

Less direct, but very real connections between CP and climate change relate to adaptation. Climate change could reverse development progress in all countries. Impacts will be felt everywhere but the poor, less resilient communities in developing and developed countries are likely to suffer the worst. Several Asian countries will suffer severe water shortages. For example, the melting of glaciers in the Hindu Kush-Himalayas will completely change the flow patterns and availability of water in rivers that supply water and generate hydropower for over one billion people (see Figure 5.1). Millions of people in low-lying coastal cities and deltaic zones across Asia will suffer impacts from sea level rise, increased storm surges, and salinity intrusion into fresh water supplies; indeed, this is already happening in several countries (World Bank, 2010(c); CIF,2009). Asia's coastal cities, which largely drive their national economies, and have a major role in the global economy, are particularly at risk- in 2000 about 466 million people including about 238 million urban residents in Asia lived in low elevation coastal zones (McGranahan et al, 2007). Some countries will also find that their natural resource base, which provides the raw materials for industry, housing, and sustenance, and is the base for tourism, are already experiencing increased stress as a result of climate changes. Such countries' leaders will therefore, need to learn to manage their economies to consume fewer raw materials, water, and to strengthen the management of their resource base and to shift to low fossil fuel systems.

However, for purposes of this thesis, the focus is on mitigation. The reasons for this are two-fold. First, a great deal of recent work has focused on the barriers to transformation to low carbon development, which may provide important lessons for CP. Second, a number of major industrializing, developing countries have taken serious steps towards the low carbon path to development. Some of these countries have also stated their intention to make the transition to cleaner productivity by building upon the potential to "marry" the two policies and actions, thereby achieving a transformation to a society based upon low carbon CP systems.

Figure 5. 1: More Than a Billion People Depend on Water from the Rapidly Diminishing Hindu Kush-Himalayan Glaciers.

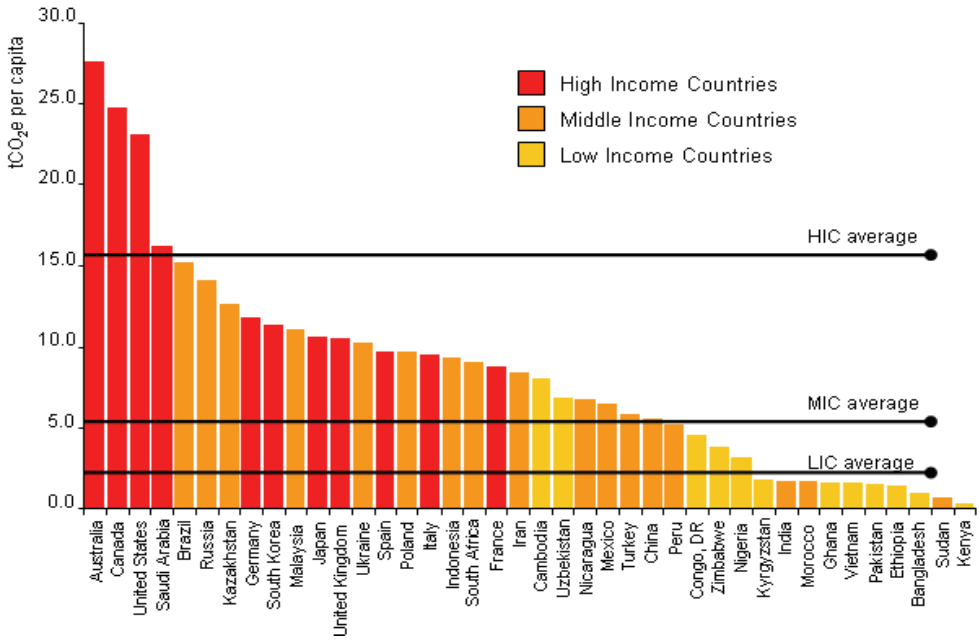


Source: SEDAC, 2013. (http://sedac.ciesin.columbia.edu/gpw/lecz.jsp).

Developing countries have legitimate development needs and they have contributed relatively little to the problem. Currently, developing countries emit about half of the global GHGs but have 85% of the global population – the average energy-related carbon footprint for a developing country person is about 0.5-3.5 tons of CO_2 per year, compared with 13.5 per year in high-income countries (World Bank, 2010(a)) (Figure 5.2). However, Asian countries like China and India, and to a lesser but significant extent, Indonesia, Malaysia, Philippines, Thailand, Viet Nam and other growing nations, are rapidly increasing their carbon footprints. A large share of their population will be middle class by 2050, and if they have a per capita carbon footprint comparable to today's developed country's middle class, the global emissions of GHGs will triple (WDR, 2010). The further these countries proceed along current emissions trajectories, the more difficult and costly it will be to reverse course. Given the stage of development of these economies, the investments being made in the next decade will largely determine GHG emissions for the next 40 to 50 years. Thus, there is a tremendous opportunity to shift to low fossil carbon growth trajectories with reasonable cost effectiveness. This opportunity will be lost if action is not taken in the next few years.

It should be noted that this thesis author's conviction is that developed countries must take the lead in climate action, both in decreasing their fossil carbon footprints and in providing the necessary finance for developing country action, particularly for adaptation. This position used to be deeply embedded in climate agreements such as the Kyoto Protocol. However, the 2015 Paris Agreement represents a fundamental shift away from a clear distinction of responsibilities of developed and developing countries. Many of the provisions in the Paris Agreement establish common commitments but with flexibility to adjust national actions based on national capacity. Nevertheless, the Paris Agreement does identify areas, such as finance, where developed countries are expected to take the lead. (UNFCCC, 2015)

Figure 5. 2: The Average Per Capita GHG Emissions/year of People in Selected Countries



Source: (World Bank, 2010(a))

5.2 Moving Towards Low Fossil Carbon Economies in Middle-Income Asian Countries

In middle-income Asian countries, with the exception of Indonesia, power generation and industry are currently the major GHG sources. Industry and transport emissions will increase at relatively higher rates in the coming years. As discussed in section 5.2.1, the global climate negotiators have been struggling for many years to come to an agreement that will limit the global average temperature increase to 2° C- current commitments will not achieve that target. As the development process increases the share of global GHG emissions from developing countries, the importance of incentives for such economies to shift to low carbon development trajectories is critically important. The opportunity to do so is through the development process itself but such countries are understandably keen on achieving economic gains at least cost, as the developed countries did. The lack of an international agreement and the limited impact of a global carbon market make this transition at the scale required to lower the GHG emission trajectory is less than likely in the near-term. Nevertheless, several developing countries are taking substantial steps in the direction of low carbon development.

5.2.1 United Nations Framework Convention on Climate Change Negotiations

The United Nations Framework Convention on Climate Change (UNFCCC) was adopted in 1992 and was entered into force in 1994 with 196 parties (negotiating countries). The third conference of parties in Kyoto in 1997 resulted in an agreement that committed industrialize countries to reduce their overall GHG emissions by an average of 5% below 1990 levels between 2008 and 2012.

Since then, parties have failed in their efforts to adopt a legally binding agreement on actions and differentiated responsibilities for addressing climate change. The Copenhagen Conference of Parties (COP) in 2009 was expected to reach an agreement that would have set the stage for a legally binding framework for addressing climate change. In spite of the attendance by numerous heads of states, the agreement was not reached and Copenhagen was deemed by many and largely reported to be a failure. (IISD, 2009)

But Copenhagen did achieve some notable accomplishments, perhaps most important being that several like-minded countries signed a parallel agreement, the Copenhagen Accord. The Copenhagen Accord created an interesting precedent. While the expressed objection from representatives of a number of countries prevented the Accord from adoption, the COP instead invited Parties to “register their support” for the Copenhagen Accord.

The Cancun Agreement also set the stage for strengthening financing processes through (i) a new Green Climate Fund (GCF) for developing countries, and (ii) extending the Kyoto Protocol flexible mechanisms (the Clean Development Mechanism and Joint Implementation) for an additional two years in hopes that agreement would be reached on market-based financing. The GCF will operate under the “guidance” of the COP, governed by a 24-member board with equal representation from developed and developing countries, with the World Bank as the interim trustee. Agreement was reached in Cancun on new mechanisms on adaptation, technology, and forestry, and on a stronger transparency system, as well as steps for their further elaboration (Pew Center, 2010).

The 17th UNFCCC COP was held in Durban, South Africa in November-December 2011. The positive outcomes of the Durban Cop included (i) an agreement to have a second commitment period for the Kyoto Protocol, (ii) a framework for operationalizing the new Green Climate Fund, and (iii) the Durban Platform for Cooperative Action. This latter agreement established a new negotiating track with the objective to establish global mitigation commitments beginning in 2020 covering all major emitting countries- developed and developing. The less positive reality was that few details were agreed upon regarding (i) the commitment period for the second phase of the Kyoto Protocol and that the commitments will be voluntary, not obligatory, and (ii) the agreed framework for the GCF is quite flexible and thus it is not clear whether the structure and business plan will attract significant funding or whether the transaction costs will make the fund attractive to the intended public and private sector recipients. It is also way too early to assess the extent to which the emission reduction commitments agreed, in principle, under the Durban Platform for Cooperative Action to be implemented in 2020 (and presumably agreed in 2015) will be legally binding (IISD, 2011).

The 2012 COP in Delhi and 2013 meeting in Warsaw set the stage for the establishment of Intended Nationally Determined Contributions (INDCs). The Lima conference in 2014 set in motion the negotiations towards a 2015 agreement, including the process for submitting and reviewing INDCs discussed in section 5.2.3 below.

The most recent COP in Paris in November/December 2015 drew a crowd of 36,000 participants. The results of the Paris COP were considered, at a minimum, to be a positive step in the evolution of climate governance and a reaffirmation of environmental multilateralism. The Paris Agreement put in motion five-year cycles whereby, each INDC will be reviewed and, based on a stock taking, will inform collective efforts on mitigation, adaptation, and climate finance. The expectation is that through these cycles, developed and developing countries will strengthen their efforts to keep global temperature rise below 2°C above pre-industrial levels. The Paris Agreement also established transparency and reporting frameworks. An important, though less publicized, element of the Paris Agreement was the establishment of a new sustainable development mechanism, which will strengthen the linkage of climate action with the achievement of the SDGs.

One of the shortcomings of the Paris Agreement was lack of a clear agreement on how climate financing would be scaled up to reach the commitment of $100 billion per year by 2020 and beyond. Nevertheless there were a number of initiatives launched or strengthened at the Paris COP that should facilitate large-scale finance to support climate action in developing countries. Hundreds of billions of dollars in commitments to GHG emission reductions and resilience measures were announced during the COP, mostly by the private sector. (IISD, 2015)

In order for the Paris Agreement to come into effect, at least 55 parties to the UNFCCC representing at least 55 percent of total global GHG emissions have to sign on. It is not currently possible to accurately predict when the Paris Agreement will come into force because of the differences in domestic approval processes for different countries. (WRI, 2016)

5.2.2 Low Carbon Growth Strategies and Related Actions

In 2006, following the 2005 Gleneagles Group of 8 (G-8) meeting of Heads of State, several of the world's advanced developing countries initiated programs to develop strategies to transform their long-term economic growth strategies to low-carbon growth strategies (ESMAP, 2009). Brazil, China, India, Indonesia, Mexico, and South Africa were among the first countries to initiate such long-term strategic planning – looking at cost effectiveness of various GHG reduction options and assessing the related financial, technical, and policy requirements to move towards a low carbon growth path. The multi-sectoral planning – energy, industry, transport, and natural resource management sectors – summarized numerous lessons that can be utilized by all developing countries.

One very important lesson was that by structurally embedding the planning within the broader national economic development strategy, a framework can be developed for policy, planning and decision-making that can: (i) support strategic, sustainable, and cost-effective low fossil carbon growth, (ii) limit climate impacts and associated management costs, (iii) help harness climate finance opportunities and implementation support, (iv) increase national competitiveness in the face of a green revolution, and (v) build dialogue, local capacity, and know-how.

But major challenges also emerged within the climate change discussions that must be addressed at the international and national levels. Two fundamental barriers are that: (i) countries generally lack the necessary institutional, policy and regulatory frameworks to plan, implement and monitor the effectiveness of multi-sectorial low-carbon initiatives and regulations for effective implementation across many sectors, and (ii) additional financing is required for the upfront costs of low carbon interventions.

It is valuable to analyze, in depth, the actions planned and undertaken in two of these countries, China and India, since they are two of the top four energy related GHG emitters. China overcame the USA as the world's biggest GHG emitter in 2006. China's share of global emissions has continued to increase- from 22.29 percent in 2012 to 23.43 percent in 2015. This compares to a declining emission by the USA from 19.05 percent in 2012 to 14.69 percent in 2015 (IEA, 2012; Burck et al, 2015).

Table 5.1 shows the top five energy-consuming countries along with their populations, GDPs and consumption data in 2012. These data help one to put the challenge in perspective, which developing countries face in moving towards low carbon economies as compared with many developed countries with much higher per capita consumption.

Table 5. 1: The Top Five Energy-Related CO2 Emitting Countries in 2012.

Country	Share of Global energy-related CO2 Emissions	Share of Global Primary Energy Supply	Share of Global GDP	Share of Global Population
China	22.29%	17.37%	17.31%	19.93%
USA	19.05%	18.62%	18.39%	4.55%
Russia	5.42%	5.60%	2.59%	2.12%
India	4.86%	5.06%	6.75%	17.05%
Japan	3.92%	4.04%	5.63%	1.91%
Germany	2.74%	2.73%	3.68%	1.23%

Source: IEA, 2012

Obviously, the actions taken in China and India and to a lesser extent in the smaller industrializing countries in Asia, with a growing share of the global population, economy and consumption, are key to the future of the globe and indicative of the options and challenges that other industrializing developing countries face in transforming to low carbon economies.

5.2.3 Indicative Nationally Determined Commitments

The historic December 2015 Paris Agreement on global climate change action was largely anchored on the implementation between 2020 and 2030 of Nationally Determined Contributions (NDCs). Asia's developing countries, in support of reaching an international agreement on climate change, have prepared their Intended NDCs (INDCs), appropriate to their national circumstances to achieve climate resilience and reduce GHG emissions. The NDCs are voluntary, but viewed as firm commitments once the Paris Agreement is ratified and comes into effect.

All but two Asian developing countries, Timor Leste and Uzbekistan, submitted INDCs to UNFCCC indicating the countries' commitments for adapting to climate change impacts and reducing GHG emissions starting in 2020 (in most cases, effective until 2030). The NDCs should eventually serve as country-driven roadmaps for climate action, which international institutions and other sources of climate/development finance and technical assistance will utilize to identify sectors and locations for which they provide climate change-related support. The GHG emission commitments of larger Asian developing countries are shown in Table 5.2. Most of these commitments are consistent with the individual country national climate change plans (Amponin and Evans, 2016). The GHG reduction commitments of the largest countries such as China and India, while substantial, have been criticized as lacking transformative ambition (Chang, 2015).

Table 5.2: Selected Asian Developing Country Greenhouse Gas Emission Reduction Commitments from Indicative Nationally Determined Commitments (INDCs) Submitted to the 2015 Paris Climate Conference

Country	GHG Emissions Reduction Contribution
Armenia	commits to reduce 633 m tons CO2e from 2015-2050
Azerbaijan	35% by 2030 compared to 1990 levels
Bangladesh	5% by 2030 compared to BAU 15% by 2030 compared to BAU (with international assistance)
China, People's Republic of	CO_2 emissions to peak by 2030; CO_2 emissions per GDP by 60-65% by 2030 compared to 2005 levels
Georgia	15% by 2030 compared to BAU 25% by 2030 compared to BAU (with international assistance)
India	33%-35% by 2030 compared to 2005 (emissions intensity of its GDP)
Indonesia	29% by 2030 compared to BAU 41% by 2030 compared to BAU (with international assistance)
Kazakhstan	15%-25% by 2030 compared to 1990
Kyrgyztan	11.49%-13.75% by 2030 compared to BAU 29%-30.89% by 2030 compared to BAU (with international assistance)
Malaysia	45%by 2030 relative to emission intensity of GDP in 2005 (35% on an unconditional basis and a further 10% is conditional upon receipt of climate finance, technology transfer and capacity building from developed countries)
Pakistan	Pakistan will only be able to make specific commitments once reliable data on our peak emission levels is available but is commited to reduce its emission
Philippines	70% by 2030 compared to BAU (with international assistance)

Sri Lanka	7% by 2030 compared to BAU by 2030; 23% (with international assistance)
Tajikistan	80%-90% by 2030 compared to 1990 levels
Thailand	20% by 203 compared to BAU
Viet Nam	8% by 2030 compared to BAU 25% by 2030 compared to BAU (with international assistance)

Source: country INDC submissions to UNFCCC

5.3 Financing Low Carbon Growth

All countries face difficult challenges to finance investments and to institute supportive policies and programs to meet their infrastructure and other development needs. The challenge is magnified when shifting such investments to minimize GHG emissions. Both public and private investment sources, including households, are important for all countries as they seek to move to reduce their carbon footprints. The 2010 World Development Report (WDR) summarized the instruments available to support low carbon investments in developing countries (Table 5.3) and highlighted the need to use these instruments in catalyzing climate action, mobilizing additional resources, re-orienting public and private financial flows toward low-carbon and climate resilient development, and for supporting the research, development and deployment of climate-friendly technologies.

In response to the Copenhagen Accord commitment to establish a new climate finance mechanism(s) reaching $100 billion per year by 2020, the United Nations Secretary General's High-Level Advisory Group on Climate Change Financing undertook a 10 month study to identify potential sources of funds. The November 2010 final report of the AGF determined that such funding was feasible but it will require multiple sources, effective combinations or blending of sources, and a vibrant carbon market with a carbon price in the range of $20 to $25 per ton of CO2e in 2020 (UN, 2010).

Table 5.3 summarized the existing sources of multilateral climate change finance. Several of these funds were used to channel the $30 billion, 'Fast-Start' funding which was committed to by developed countries through the Copenhagen Accord in December 2009. The Fast-Start funding started disbursing in funds in 2010 and continued through 2012. The Paris Agreement in 2015 reconfirmed the donor governments' commitment to provide $100 billion per year by 2020. It is estimated that $62 billion in climate finance was provided by donor countries in 2014 (OECD and Climate Policy Institute, 2015).

The Climate Policy Initiative estimated that the average annual climate finance flow in 2014 was about $391 billion (Figure 5.3) compared to $364 billion in 2011. Of this, only $25 billion was for adaptation and the balance was for mitigation. This may be compared to the IEA estimate that if global temperature rise is to be kept at 2°C, incremental investments of $36 trillion will be required from 2012 to 2050, or about $1 trillion per year. (Buchner et.al., 2012 and 2015) Estimated annual requirements for climate resilient development alone from 2015 to 2050 will be about $100 billion (World Bank, 2010(c)). Demand in China accounts for much of the increase in private sector finance- mainly for renewable energy development. (Buchner et.al., 2015).

Table 5.3: Existing Multilateral Instruments of Climate Finance

Name	Focus	Year Operational	Funds Pledged ($million)
Green Climate Fund	Adaptation/ Mitigation	2015	10,300
Adaptation Fund	Adaptation	2009	474
Least Developed Countries Fund	Adaptation	2002	1,211
Pilot Program for Climate Resilience	Adaptation	2008	1,200
Special Climate Change Fund*	Adaptation	2002	344
Congo Basin Forest Fund	REDD+	2008	186
Forest Carbon Partnership Facility	REDD+	2008	743
Forest Investment Program	REDD+	2009	771
UN REDD Programme	REDD+	2008	249
Clean Technology Fund	Mitigation	2008	5,600
GEF Trust Fund	Mitigation	2010	1,350
Scaling Up Renewable Energy Program for Low Income Countries	Mitigation	2009	780

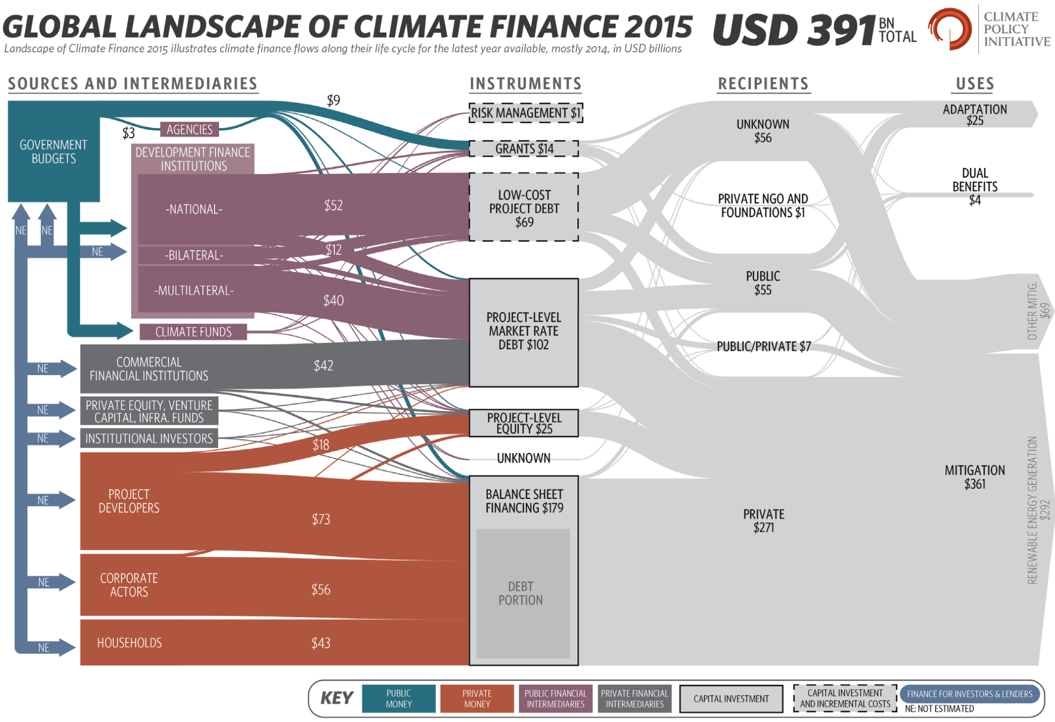
Source: World Bank, 2010(a); GCF, 2015; Haites, 2014 updated by author

Table 5.4: Sources and Volumes of Climate Finance Flows in 2010/2011

	SOURCES & INTERMEDIARIES (*)	ANNUAL FLOWS OF DIRECT CLIMATE FINANCE (2010 / 2011, USD BILLION)
PUBLIC	Government budgets (5%)	16.0 - 22.6
	Development Finance Institutions* (21%)	76.8
	• Climate Funds* (<1%)	1.5
	Sub-total public (26%)	***92.7 - 99.3***
PRIVATE	Corporate actors (21%)	69.3 - 80.5
	Institutional investors (<1%)	> 0.6
	Project developers (34%)	115.0 - 129.3
	Households (9%)	32.3
	Commercial financial institutions* (10%)	30.7 - 40.4
	Venture capital, private equity & infrastructure funds* (1%)	2.4
	Sub-total private (74%)	***250.3 - 285.5***
TOTAL	***Total***	***343.0 - 384.8***
	• *Sub-total sources (68%)*	*233.2 - 265.3*
	• *Sub-total intermediaries (32%)*	*109.9 - 119.6*

(Buchner et al, 2012)

Figure 5.3: Sources And Flows Of Climate Finance In 2014 Included A Substantial Share By The Private Sector With Most Of The Total Allocated For Mitigation



(Buchner, et al, 2015)

5.3.1 The Important Roles of Carbon Markets

In preparation for, and as a follow-up to the Gleneagles G-8 Summit in 2005, both the Stern Review on The Economics of Climate Change (2006) and the World Bank Clean Energy Investment Framework (2006) highlighted the importance of a vibrant carbon market to stimulate investments in low carbon development in developing countries. Carbon finance is now a proven tool to support greenhouse gas mitigation. This point was further emphasized by the Secretary General's High Level Advisory Group on Climate Financing (UN, 2010).

The carbon market is the most visible result of early regulatory efforts to mitigate climate change. Regulation constraining carbon emissions spawned an emerging carbon market that was valued at about US$10 billion in 2005 when the Kyoto Protocol came into effect, increasing to US$64 billion in 2007 and reaching US$176 billion in 2011 (World Bank, 2012(e)). Its biggest success was to send market signals for the price of mitigating carbon emissions. This, in turn, has stimulated innovation and carbon abatement worldwide, as motivated individuals, communities, companies and governments have cooperated to reduce emissions.

To date, the most prominent market instrument involving developing countries has been the Clean Development Mechanism (CDM). The CDM was the largest source of mitigation finance to developing countries until its demise in 2012. It demonstrated the ability of markets to complement and leverage other resources to unlock low-carbon investments through addressing barriers, driving innovation, and creating a revenue stream that sustained projects over time. Under the CDM, emission reduction activities in developing countries generated “carbon credits,” measured against a pre-agreed baseline and verified by an independent entity, under the aegis of the UNFCCC and trade the credits on the carbon market.

For example, a European power utility may acquire emission reductions (through direct purchase or financial support) from a Chinese steel plant embarking on an energy-efficiency improvement project. Developed through a “learning-by-doing” approach, and certainly experiencing numerous growing pains and suffering the impacts of mixed signals from climate negotiations, the CDM achieved impressive results. As of mid-2015, there are 7,645 registered CDM projects, 2,587 of which have issued certified emission reductions (CERs). The overall emission reductions from CDM and JI were about 1.5 billion tonnes of CO_2e during the Kyoto Protocol’s first commitment period, which ended 31 December 2012. The combined reduction from all of the registered projects will be about 8.5 billion tonnes by 2020. While this is a small fraction of the reductions necessary to achieve a 2°C increase in average world temperature, it demonstrates the potential of using a carbon market mechanism in developing countries. Had the Kyoto Protocol survived the politics of climate negotiations, the World Bank estimated that CDM emission reduction agreements could raise $15–24 billion in direct carbon revenues for developing countries, depending on the carbon price, with a high proportion going to Asia’s industrializing countries (Table 5.5) (World Bank, 2010(d)). Since the World Bank revue, the carbon market price has dropped from about $20 to less than a dollar.

Table 5.5: Regional CDM Delivery and Carbon Revenues by 2012.

Region (country)	**Million CERs**	**$ billion**	**% of Total**
East Asia (China)	**871** (786)	**10.5** (9.4)	58 (52)
South Asia (India)	**250** (231)	**3.0** (2.8)	**17** (16)
Latin America	**230**	**2.8**	**16**
Middle East and North Africa	**15**	**0.2**	**1**
Sub-Saharan Africa	**39**	**0.5**	**3**
East Europe/ Central Asia	**10**	**0.1**	**1**

Source: adapted from World Bank, 2010(a).
*1 mCER = 1 million tonnes of CO_2 equivalent. Volumes include withdrawn and rejected projects.

In addition to stimulating over $150 billion in investments in low carbon development (World Bank, 2010(a)), and contributing to technology transfer and diffusion, CDM and JI projects have generated significant developmental co-benefits. The mechanisms raised overall awareness about low carbon solutions and leveraged capital for climate-friendly projects in many developing countries, thereby, stimulating the establishment of country-level institutional and regulatory frameworks. In many cases, CDM projects, in particular, have supported basic development needs and local environmental quality by improving access to clean energy, reducing local environmental health risks by reducing reliance on inefficient biomass and improving solid waste management practices, improving local natural resource management, and generating employment (World Bank, 2010b).

Of course the key barrier is currently the lack of a decision on the Kyoto Protocol's long-term future. Out of frustration due to lack of progress on new market instruments under the UNFCCC, the EU and Japan are entering bilateral agreements with key developing countries for purchasing emission reductions from sectorial crediting mechanisms. Several developed and developing countries are already establishing national market mechanisms such as domestic emissions trading schemes with potential linkages to other trading systems.

Such mechanisms were primarily intended as a stimulus to achieve domestic development priorities with the potential to help shift away from the 'business-as-usual' greenhouse gas trajectories. The Tokyo metropolitan area launched its own mandatory cap and trade scheme in 2010 that targeted office and commercial buildings (including universities) and factories. The Korean government is running a project-based GHG reduction Korea Certified Emission Reduction program in support of meeting its voluntary target of 30% reduction by 2020. Brazil and Mexico are establishing national cap and trade schemes in order to meet their voluntary targets, with Mexico considering expansion to include sectorial crediting. India's National Action Plan on Climate Change makes specific provision for the use of market-based instruments to increase energy efficiency and the use of renewable energy. Finally, in 2008 China established three voluntary market exchanges (in Beijing, Shanghai, and Tianjin) working through the private sector and municipalities to test the use of domestic carbon trading in support of the national low carbon strategy but without involvement of the national government (World Bank, 2010 (c) World Bank, 2010 (d)).

At the present time, through a program called the 'Partnership for Market Readiness,' (PMR), several middle-income countries are implementing innovative and cost effective ways to scale up emission reductions and to induce climate finance, including through carbon market instruments. Brazil, Chile, China, Colombia, Costa Rica, India, Indonesia, Jordan, Mexico, Morocco, Peru, South Africa, Thailand, Turkey, Ukraine and Vietnam are the first movers in this direction with varying levels of market development already underway. (World Bank, 2013(b)).

The PMR is country-led. It provides systemic support to enhance countries' technical and institutional capacities in order to implement market-based instruments, such as a domestic, emissions trading system (ETS) or a scaled-up crediting mechanism. As countries are at different stages of development and market readiness, each approaches the use of market instruments in a different way. Some focus on building core "readiness" components, such as systems for monitoring/reporting/verification (MRV), data collection, baseline setting, and establishing regulatory institutions. Others, including China and India, go further, in working toward a pilot of a domestic or international market-based scheme.

While the global carbon market has more or less dried up due to lack of political support for the Kyoto Protocol, it is noteworthy that several developing countries stated in their INDC submissions in 2015 that they intend to use carbon market mechanisms. There is a strong movement by many private sector institutions to reinvigorate a market-based price and trading of carbon.

5.3.2 Use of Concessional Finance to Support Low Carbon Growth Strategies

While carbon markets have successfully stimulated investments in low carbon development by increasing the revenue stream and thereby, the financial rate of return of many projects, many other projects and programs have not been able to move forward because of the higher incremental costs of technologies or other risks that made it difficult to obtain up-front financing. The issue has never been a shortage of finance, it has rather been a shortage of affordable financing. In 2008, the World Bank, working with several donor and recipient countries, other MDBs and other stakeholders, established the Climate Investment Funds (CIF) to test how to overcome this major barrier and to demonstrate how innovative strategies can initiate transformational change at the policy, institutional, and market levels.

Currently capitalized at over $8 billion, the CIF provides developing countries with grants, concessional loans, and risk mitigation instruments that leverage significant financing from the private sector, MDBs, and other sources. One of the funds, the Clean Technology Fund (CTF), finances the scaled-up demonstration, deployment, and transfer of clean technologies in industrializing countries or regions that have the potential for significant greenhouse gas abatement. The initial CTF capital of $4.3 billion was committed within 18 months of establishing the fund. The current capital of $5.5 billion is being blended with other sources of grants, international and domestic public sector finance, international and domestic private sector finance, and carbon market revenues (CDM-based). It is expected to leverage a total investment in renewable energy, energy efficiency and clean urban development and transport of over $50 billion. (CIF, 2014)

The main lesson, thus far, is that concessional finance is a key element of any financing strategy intended to stimulate large-scale and rapid transformation towards low-carbon development in developing countries. This is not surprising, since at a much smaller scale the Global Environment Facility (GEF) had similar early achievements (GEF, 2008). Many developed countries have also used similar approaches (mostly targeted subsidies) to achieve the same objectives. The CTF's subsidy design with concessional loans priced below market rates with longer maturity than commercial loans, has proven to be an appropriate instrument to cover risks and costs associated with the introduction of clean technologies.

Other relevant lessons are that concessional finance helps to break down barriers to private investments in energy efficiency and renewable energy projects since many financial institutions hesitate to develop energy efficiency or renewable energy financing lines without a source of concessional finance or other guarantees to absorb financial losses greater than the risks they take in other typical business lines. In addition, perceived risks inhibit investors from financing renewable energy projects in markets where the sector is not yet developed and there is no track record. To address the barriers to early entrants, such funds can be used to cushion the risks (through subordination, guarantees, or equity gap coverage), offset the upfront costs (through lower pricing on investments), or both. In any case, it is important to engage and to obtain the support of key stakeholders when designing such a fund, which includes the private sector, governmental ministries, technical intermediaries, financial institutions, industries, consumers, civil society groups, and local communities (Radner, 2010).

The GCF was established in December 2011 at the Durban COP. The GCF, headquartered in Songdo, South Korea, has received commitments for initial capitalization from donor countries and some developing countries totaling about $10 billion. Operational details, business model, policy and operational guidelines, and many other critical decisions are still being developed. The intent of the GCF is to become the primary source of international public sector funding for public and private sector investments in low carbon and climate resilient development in developing countries. The politics of the UNFCCC negotiations are unavoidable in establishing such a fund. It is too early to assess its eventual capitalization or whether it will be able to deliver funding at the scale and with the low transaction costs required to achieve its objectives.

5.4 Conclusions

This Chapter has outlined the dilemma that the world faces due to climate change, particularly for developing countries that are less resilient to climate impacts. The global climate negotiations faltered for almost twenty years but now they seem to have become much more constructive. Nevertheless, with current commitments for GHG reductions, the global temperature rise is expected to reach 2.7° to 3.7°C by the end of this century, which is much higher than the agreed target of 2°C and with potentially catastrophic consequences.

Nevertheless, in many ways the year 2015 can be seen as a turning point for successful multilateral efforts to address local and global environmental issues. The Paris COP and the adoption of the Sustainable Development Goals, in many ways set the sustainability stage for the coming decade(s). Significant action was already underway outside the climate negotiations process, and valuable lessons have been generated that can be built upon. The experience with carbon markets and innovations for financing low-carbon and climate resilient development such as the Climate Investment Funds of the multilateral development banks have demonstrated success.

Several Asian developing countries, including its two largest carbon consumers and emitters – China and India – have taken serious steps towards low-carbon development. China's and India's experiences with low carbon and CP development are discussed in detail in the next chapter.

6. CLEANER PRODUCTION AND LOW CARBON DEVELOPMENT IN ASIA'S LARGEST ECONOMIES- CHINA AND INDIA

6.1 Introduction

The previous two chapters reviewed (i) the experience of numerous internationally and regionally assisted CP technical assistance programs for capacity development and demonstrations and (ii) the emergence of climate change as the predomonant global sustainability challenge which both threatens the well-being of highly vulnerable Asian developing countries but also relies on their actions to substantially slow the growing GHG emissions from the region. Obviously CP and climate-smart development are both necessary priorities for Asian developing countries.

This Chapter is focussed upon the country level for the two major emerging economies in Asia: China, and India. The review covers not only the countries' various policies and programs to adopt CP as part of their respective industrial development priorities but also the more recent initiatives to transition their economies to low carbon (research questions 1 and 3).

During the last 40 years we have seen remarkable changes in the global economy and regional and country economic developments. Asia has experienced the most rapid economic growth – clearly the world's development *'success'* story is Asia. The rapid rise of several Asian emerging economies is expected to continue for the next couple of decades, though at declining growth rates. Even at the lower growth rates, several of the Asian developing countries' will continue to outperform most developed countries. This has, and is expected to continue to result in remarkable achievements in terms of poverty reduction, but not environmental sustainability.

Asia's emerging economies, particularly China, are leading the world out of recession (ADB, 2013). The past and projected growth of these emerging economies has largely been on the back of strong industrial development. However, this economy-driving growth has generally been achieved with inefficient and highly polluting processes leaving behind serious environmental degradation and rapid increases in human health impacts, including millions of premature deaths. The industrial base presents massive opportunities for improvements in efficiency and environmental management. The resource intensity of manufacturing has actually increased during the last few years and overall an increase in GHG emissions at the regional level is resulting from a higher GHG-emitting fuel mix. The increasing affluence with millions of households enjoying the comfort of discretionary income that can be spent on consumables beyond meeting their households' basic needs is the main driver – twice as important as population growth over the last decade (UNEP and CSIRO, 2013).

This worsening situation in terms of environmental pressures is taking place in spite of numerous policies, regulatory, and other national measures in each of the region's most rapidly growing middle-income countries - China, India, Indonesia, Malaysia, Philippines, Thailand and Vietnam. Thailand and the Philippines where CP surveys were undertaken as an input to this thesis are discussed in Chapter 7.

China and India are reviewed in much more detail in this chapter because of their relative large sizes, populations and impacts, as well as their rather unique efforts to address the resulting local and international environmental challenges. This Chapter summarized the programs and then addressed three key questions for each country. Have the national policy frameworks and the national programs of activities relating to CP and low carbon economic development been considered in isolation of each other or have they been integrated? What are the impacts to date and the outlook over the coming years? Finally, what were the lessons learned and how can they guide future directions for integrated "cleaner and low carbon production."

6.2 China

6.2.1 Population and Economic Growth

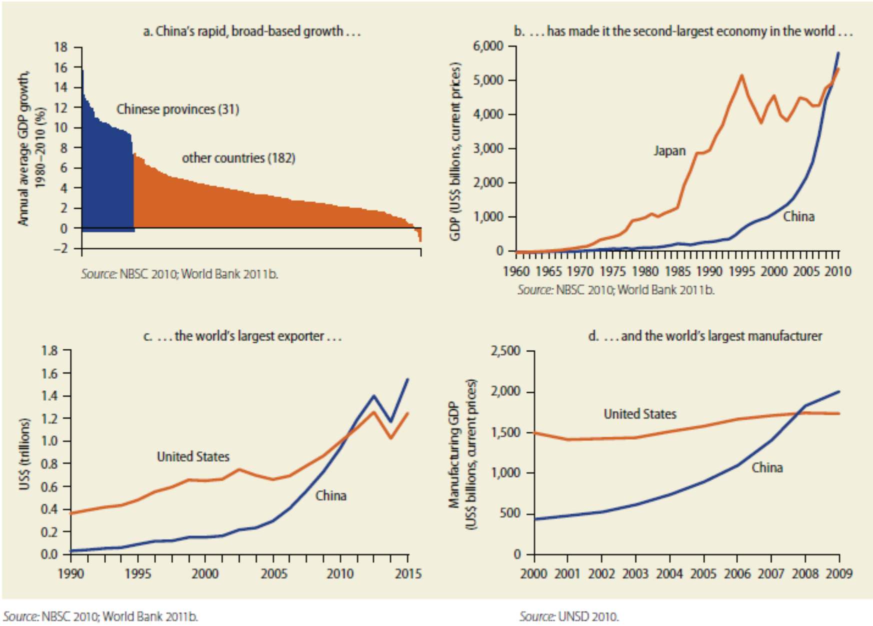
China's economy is currently second in size only to that of the United States, having overtaken Japan in 2010. It is already the world's largest manufacturer and exporter. Even if China's rate of growth of GDP is reduced by one-third of the average over the last decades (6.6 percent GDP growth as compared to an average of 9.9 percent over the last 30 years) then China will become a high-income country before 2030 and will have the world's largest economy (see Figure 6.1). Much of the continuing growth will be industry-based (see Table 6.1) and will be increasingly concentrated in cities. Over the coming twenty years, the increase in the number of urbanites each year in China will be the equivalent of 21 "Rotterdams" (2012 population) (World Bank and Development Research Center of the State Council, 2013; 2014) with a projected 2030 urban population of about one billion (McKinsey Global Institute, 2009). Two examples of what this economic and urban growth means: China's vehicle fleet is expected to grow ten-fold from 2005 to 2030 and urban floor space will have to be doubled during that same time-frame (McKinsey and Company, 2009).

6.2.2 Industrialization from a Historical Perspective

Before 1953 about 70 percent of industry was located in the eastern coastal belt. However, from 1953 to 1978 the location of Chinese industrial firms was largely determined by strategic military concerns rather than strategic economic development objectives. From 1965 to 1978, large industrial firms were located according to geographic proximity to mountains, dispersion and concealment. In 1980 economic interests re-entered the decision-making process leading to relocation and agglomeration of Chinese manufacturing, with priority given to development of the eastern coastal areas, and particularly the establishment of special economic zones in the southern coastal zone up until about 1995. The objective was to attract foreign investment and to improve access to global markets. With rapid development of non-state owned enterprises, the number of industrial firms grew dramatically from 5.19 million units in 1985 to 10.02 million in 1995 (Wen, 2004).

China's primary industries include agriculture, forestry, mining and the extraction of coal, oil, gas, ferrous and non-ferrous ores and building materials. Traditional secondary industries include processing of iron, steel, and non-ferrous metals; chemicals; petrochemicals; building materials; power generation; textiles; and pulp and paper (ADB, 2001). These industries made up the foundation of the old economy and were mostly SOEs that were not market driven and enjoyed a largely protected domestic market. Operations were prone to corrupt practices, were mostly poorly managed, and heavily over-staffed. The manufacturing was often with inefficient, energy- and material-intensive and grossly polluting technologies.

Figure 6.1: China's Economic Growth Compared To That Of Japan And The United States



Sources: NBSC, 2010; World Bank, 2011, UNSD 2010

Table 6.1: China's Projected GDP Will Continue Impressive Growth And Industry Will Continue To Play Major Roles.

	1995-2010	2011-2015	2016-2020	2021-2025	2026-2030
GDP/yr (percent)	9.9	8.6	7.0	5.9	5.0
Industry/GDP ratio	46.7	43.8	41	38	34.6

Sources: China 2030, World Bank and Development Research Center 2013

In the late 1990s some additional secondary industries emerged including the manufacture of electrical and electronic products for personal/household/business use, automobiles, and household white goods such as washing machines and refrigerators. New enterprises in these sectors were often developed with foreign investment and with partnerships, typically through joint ventures. They were strictly market-driven and generally better managed than SOEs. Another result of this dramatic shift was an emergence of cleaner technologies and more efficient use of raw materials and inputs, and a nascent responsiveness to environmental challenges and in a few cases the adoption of more innovative approaches such as LCA and eco-design (ADB, 2001).

6.2.3 Environmental Costs of Rapid Development

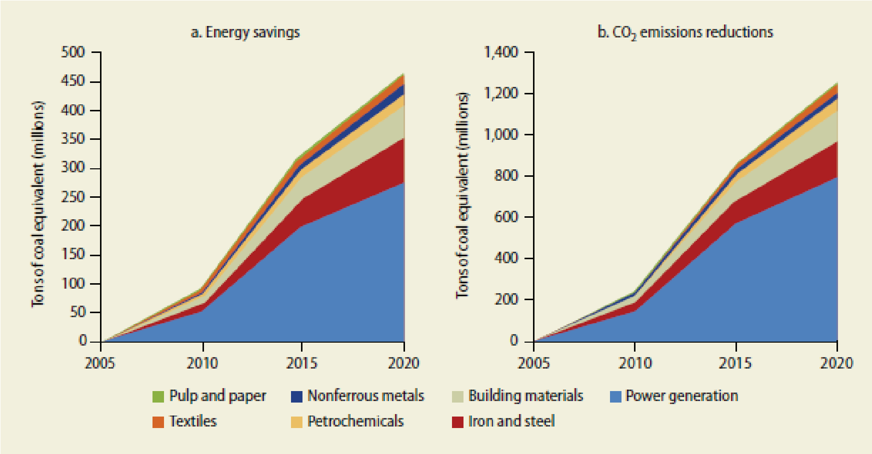
High resource consumption, severe environmental pollution, degraded ecosystems and loss of ecosystem services have become the by-products of China's rapid economic growth. The State Environmental Protection Administration (SEPA) (later to become the Ministry of Environment) estimated in 2000 that industry accounted for about 40 percent of the water pollution and 80 percent of the air pollution. As discussed in the section 5.2.4, traditional command and control approaches and economic instruments had been widely employed in the 1990s but enforcement was generally weak (Wang, 2003).

China is the largest producer of coal in the world and the second-largest energy consumer, following the United States. In 2003, coal accounted for about 67 percent of China's primary energy production (Shalizi, 2007). As a result of the extensive use of coal, China's sulfur dioxide (SO_2) emissions increased 53 percent from 2000 to 2006. Environmental regulations have reduced emissions resulting in decreasing acid rain pH values and frequencies across East Asia (Lu, 2010).

China already has the world's largest annual emissions of $CO_{2.}$ National emissions will continue to increase until 2030 by which time it is expected that coal-fired power generation will have tripled from 2005 levels (McKinsey and Company, 2009). In 1980 China had one of the highest energy intensities in the world. From 1980 to 2003, energy intensity in China declined by an extraordinary 4.8 percent per annum - more than double the decline rate in the US (Shalizi, 2006).

While power generation has the greatest potential for GHG emission reductions, opportunities to dramatically reduce energy consumption and GHG emissions from industry are also significant, as shown in Figure 6.2. The industrial sector accounts for over 70 percent of China's energy consumption. Coal-fired industrial boilers and furnaces are the largest single point sources of urban air pollution. Industry and services sectors are expected to continue to have the largest share of energy consumption - about 60 percent over next two decades. (Yu et.al., 2015)

Figure 6.2: Chinese Industry Energy Savings and CO2 Emissions Reduction Potentials Projected to 2020.



Source: Feng and others 2011.

Many of the very serious consequences of China's rapid industrial growth were discussed in Chapter 3. However, there are also severe legacy issues remaining to be tackled as a result of the pre-1990 transition – in particular, many industrial brownfields remain, many of which are in urban areas. These include:

- heavy metal contaminated sites, mainly from steel, iron and smelting plants, ore tailings as well as chemical solid waste piles; typical contaminants are arsenic, cyanide, lead, cadmium and chrome;
- persistent organic pollutant (POP) contaminated sites are still being discovered and even though some of the worst pesticides have not been used for many years, some remain in the soil along with polychlorinated biphenyls (PCB) capacitor dismantling and burial sites;
- organic contaminated sites such as petrochemicals and coking materials, organic solvents, benzene and hydrocarbons, often mixed with other contaminants such as heavy metals; and
- electronic processing waste sites. Incorrect disposal of electronic waste can affect human health. The main contaminants are heavy metals and POPs (brominated flame retardants and dioxin) (Xie and Li, 2010).

In an effort to better understand the '*real costs,'* of such industrial waste, legacy issues and more recent degradation due to resource intensive, low efficient production, China began exploring the use of environmental accounting systems in the 1980s. The expectation was that having a better understanding of natural assets and giving them value, in order to determine the country's natural capital base, would lead to a better appreciation of the need to change the economic growth mode. This would require shifting from high growth driven by high resource consumption and severe environmental pollution to high growth enabled by low resource consumption and low environmental pollution. However, the current national economic accounting system still does not take into account the consumption of natural resources and deterioration of the environment caused by economic growth, so it cannot reflect the decrease of national well-being caused by the consumption of natural resources (Shi et al, 2011).

Nevertheless, some important environmental cost assessments have been performed. The estimates of costs of environmental degradation have mostly focused on impacts to human health and productivity as well as on waste management for pollution. The World Bank and the State Council's Development Research Center recently assessed the costs of environmental degradation and resource depletion at about 10 percent of GDP, with air pollution losses at 6.5 percent GDP, water pollution at 2.1 percent and soil degradation and loss at 1.1 percent (World Bank and Development Research Center of the State Council, 2013).

A more comprehensive effort at environmental accounting to measure green national savings was undertaken in 2009. Based on 2005 data, Shi Minjun and Ma Guoxia performed a monetary assessment of China's resource consumption loss, ecological degradation loss, and environmental pollution loss. In 2005, they estimated that China's resource and environmental costs including resource consumption, ecological degradation and environmental pollution was US$401.96 billion, accounting for about 13.47 percent of GDP that year. The total environmental pollution loss was US$74.84 billion accounting for 2.32 percent of GDP. The provinces with the largest environmental pollution losses are the heavily urbanized and industrialized eastern provinces. The total loss caused by water pollution across China was US$36.44 billion, accounting for 1.22 percent of GDP. In that, human health loss was US$3.51 billion, agricultural crop loss US$1.92 billion, fishing industry loss US$2.6 billion, pollution caused water shortage loss US$26.87 billion, and protection expenditure US$1.53 billion. The total air pollution loss was US$41.37 billion, accounting for 1.19 percent of GDP. In that, human health loss is US$22.09 billion, agricultural loss US$ 12.22 billion, and reduction costs of GHG annual increase US$ 4.12 billion. The total ecological degradation loss totaled US$54.78 billion accounting for 1.7 percent of GDP. The most significant sources due to ecological degradation were inappropriate agricultural practices. The loss due to soil erosion was US$46.96 billion and for land degradation US$ 7.99 (Shi et al, 2011).

Another way of looking at the impact of China's development process is to compare its ecological footprint with other countries' ecological footprints. An ecological footprint is a measure of the area of biologically productive land and sea required to produce the renewable resources required for consumption and waste assimilation of a population using prevailing technologies. The ecological footprint is expressed in "global hectare"/unit productivity (gha) which is the annual productivity of biologically productive land or sea compared with world-average productivity. Another way of expressing the ecological footprint for a country like China is as an expression of the total biological resources used by the Chinese economy.

Hubacek et al (2009) analyzed and compared China's national and Beijing's metropolitan ecological footprints, using 2001 estimates and 2020 projections. The 2020 projections were based on a World Bank projected average annual GDP growth of 6.6%. Population estimates used were national at 1.43 billion and Beijing at about 18 million (up from about 11 million today). In 2001 the ecological footprint for China was 1.78 gha/capita compared to global average of 2.1 gha/capita. Manufacturing accounted for about 23 percent and energy about 19 percent. 2020 projection is 2.13 gha/capita with about 32 percent from manufacturing and 27 percent from energy. The ecological footprint for Beijing was about 4.99 gha/capita in 2001 with 32 percent manufacturing and 27 percent energy compared to 9.93 gha/capita in 2020 with manufacturing at 28 percent and energy at 35 percent. Countries like the US currently have an estimated ecological footprint on a per capita basis (gha/capita) about 9 times that of the poorest countries (Hubacek et al, 2009).

Hubacek's study highlighted two very important issues. First was that the growth of the economy, if it continues to be coupled with waste and inefficient resource intensity, will significantly exacerbate the loss of environmental values and human quality of life over the coming decade. Second, there was a significant differential in cosumption and impact between cities and rural areas and this will grow very rapidly as cities and the economy grow, concurrently spawning rapid increases in consumers. A third reality should be noted - even though the per capita footprint is slightly lower than the world average, China's population is the largest in the world and thus at the national level China has a huge ecological footprint.

6.2.4 Environmental Governance from a Historical Perspective

China held its first national conference on environmental protection in 1973 (Zhang and Wen, 2008). The Chinese economic and environmental systems' Leninist architecture was oriented toward political control, through multiple administrative layers, each overseen by a political unit of the Chinese Communist Party, resulting in an extraordinarily complex network of horizontal and vertical authority. In the absence of strong domestic official or public support for environmental protection, external pressures stimulated environmental policy - the 1972 Stockholm Conference was an important starting point. Environmental concern was expressed as a key issue by early international contacts as China recovered from the turbulent cultural revolution.

China's first environmental unit was established in 1974, responsible to coordinate national efforts from the State Council. This unit had no administrative authority. China's framework of environmental law, the Environmental Protection Law, was passed on a trial basis in 1979. It included new industrial pollution control regulations but these were largely ignored until 1987 when the National Environmental Protection Authority (NEPA) was given cabinet-level status reporting directly to the State Council (Sims, 1999).

Little environmental protection occurred until the 1992 Rio Earth Summit, which helped to stimulate the national government into action. Two months after the 1992 Rio Conference, China issued "Ten Strategic Policies for Environment and Development" and in 1994 they published the world's first national Agenda 21 (Zhang and Wen, 2008).

A series of laws and regulations and institutional measures were approved over the 1990s. At the same time, economic reforms and decentralization made the environmental governance situation even more complex with increased influence from local government with limited material and human resource base. In recognition of limited institutional capacity and lacking domestic environmental expertise, numerous technical assistance and capacity building programs were initiated with support from bilateral and international organizations. This assistance played a significant role in assisting the shaping of China's environmental policy, institutional, and legal framework.

In the early 1990s, a network of environmental protection offices was established in order to extend environmental controls to lower levels of government, ranging from provincial and city-levels to districts, towns and villages. One of the key focal areas of foreign assistance was to build the capacity- and technology-base for both the central and the provincial environmental programs. China was very proactive in securing environmental loans from the World Bank and ADB, recognizing the importance of investing in capacity and technology.

During 1991-1995, fourteen environmental laws were passed, twenty administrative rules on environmental protection enacted and more than 350 environmental standards were approved. With the decentralization of regulatory enforcement came the problem of consistent enforcement. A number of studies were undertaken to understand what drove compliance and lack of compliance with environmental regulations in China in the 1990s. The objective of such studies was to better appreciate and enable filling of capacity and regulatory gaps, as it was clear that industry, in particular, was very inconsistent in compliance. It appears that in most cases government regulators were following the rules though they were frequently not strictly enforced. Under-reporting and under-assessment were common problems (Dasgupta, 1997). A critical question then was what drove the inconsistent enforcement of regulations. Wang et al (2003) analyzed the determinants of the relative bargaining power that firms may have in their relation with local environmental authorities pertaining to the enforcement of pollution charges. The study assessed regulatory performance of 640 industrial plants in Zhenjiang, covering the period 1993 to 1997, most of which were SMEs. Of the total, 26 percent were SOEs. Only four percent of the enterprises were large, but they accounted for approximately one third of the total value of output of the enterprises. The study showed that firms from the private sector appeared to have less bargaining power than SOEs. Firms facing an adverse financial situation had more bargaining power and were more likely to pay less pollution charges than what they should be paying (less enforcement). Finally, the higher the social impact of a firm's emissions (as measured by the presence of complaints), the smaller the bargaining power of the firm with local environmental authorities (Wang et al, 2003; McElwee, 2011).

The role of community pressure took a much greater role following the 1992 Rio Summit than it had in the past. Wang and Chen (1999) sought to better understand the relative importance of community pressure on pollution control with respect to formal pollution regulation. The study showed that both formal pollution control regulations and community variables were significant determinants of enterprises' behavior in terms of wastewater management. In 1994, 1500 industrial enterprises were selected randomly across China. Of these, 200 firms discharged COD at levels above the standards and paid discharge levies. City-level data about average wage, water pollution discharge concentration, and population density were collected to get a good understanding of the community characteristics around the factories. The study showed that informal regulations – that is, community pressure – appeared to be at least as effective in reducing/avoiding environmental degradation as formal regulations. In addition, the strong impact of community pressure on industries' discharge performance in China may not stop even if the plants were in compliance, because as long as a community is dissatisfied with its pollution situation, the pressure from the community continued. This pressure can either be directly imposed on polluting plants, or indirectly via government pollution control authorities through citizen complaint programs. The overall conclusion was that it is cost-effective for the government to provide pollution information services to communities (Wang and Chen, 1999).

Another key question on drivers of compliance and non-compliance is the role of markets. A survey of 321 enterprises was undertaken to ascertain the extent to which external environmental pressure on Chinese firms is a contributing factor to their environmental behavior. The study broke firms into three environmental behavioral characteristics: (i) environmentally defensive, (ii) environmentally preventative and (iii) environmentally enthusiastic. Push-back against enforcement, or environmentally defensive behavior of firms was most likely a reaction to new governmental regulations; that is firms might try to avoid or delay action. In many cases they took some preliminary measures. Such firms considered environmental management as an avoidable cost. Actions taken to be in compliance, referred to as environmentally preventive behavior in the study, were more likely driven by pressure from markets, because image has become an important criterion for consumers and investors.

The study also showed that pressure from communities and NGOs was a key factor for proactive positive actions, termed environmentally enthusiastic behavior in the study - those firms that were already in compliance with regulations and interested in doing more. The authors of this study also encouraged greater access to information on behavior and performance of enterprises that facilitate action by communities and NGOs in support of regulatory compliance. The overall conclusion was that pressure from governmental regulations, markets, community pressure and NGOs played significantly positive roles on environmental behavior (Liu, 2009). There continues to be a need for improved participation of local government, local communites, and CSOs in policy formulation and implementation in order to better understand and address the barriers to improved environmental governance. This will also reduce the existing ambiguities in policies and regulations and stimulate greater innovation (Kostga and Mol, 2013; Ran, 2013, Schroeder, 2014).

A new environmental protection law was put into effect in China on 1 January 2015. The intent of this new law is to improve alignment of environmental protection with economic and social development. It includes provisions that should improve overall governance including more stringent reporting requirements and stiffer penalties for non-compliance, and strengthened public awareness and participation, including protection of whistleblowers. The new law places greater accountability for enforcement on local governments. (Zhang and Cao, 2015) The new law does not facilitate policy integration with climate change initiatives or the CP law- but it does not appear to inhibit actions for such integration. It is too early to tell to what extent environmental governance will be improved as a result of the new law.

6.2.5 China’s Role in Early International Environment Agreements

Starting from 1990, China took a proactive role in environmental policy formulation, at both the domestic and international levels. The National Climate Change

Committee was established in 1990. At the international level, China was responsive to the Montreal Protocol on Substances that Deplete the Ozone Layer (Montreal Protocol) as one of the early movers with a national strategy for the phase-out of ozone depleting substances (Sims, 1999) and China ratified the United Nations Framework Climate Change Convention (UNFCCC) in 1992, prepared the first national GHG inventory in 1994 (Gu et al, 2014), and ratified the UNFCCC Kyoto Protocol in 2002. China's role in the climate change agenda is discussed in detail in Section 5.4 of this Chapter.

The Montreal Protocol was the testing ground for active participation by China in international environmental collaboration. China became the world's largest producer and consumer of substances that damage the ozone layer as a result of phasing out of ozone depleting substances (ODS) by industrialized countries. As a signatory to the Montreal Protocol China was obliged to undertake control measures and schedules for phase out of use and production of certain ODS. A key provision was agreement to phase out CFCs and halons by 2010. China satisfied Protocol requirements for a mandatory freeze on consumption and production of CFCs in 1999 and met the 2002 halon reductions by 1998. China has been a major beneficiary of the 1990 Multilateral Fund to assist signatory developing countries to wean themselves from ODS. Part of the pressure came from China's own industries' desire to meet export conditions and in 1993 responded to pressure from the refrigerator manufacturers who wanted to export to Europe by establishing a labeling program, in part to certify compliance with the Protocol (Zhao and Ortolano, 1999; Zhao, 2005).

6.2.6 Cleaner Production in China

6.2.6.1 Action Leading to the Cleaner Production Promotion Law

China started exploring the potentials of CP in the early 1990s, at about the same time as other industrializing Asian countries. The Chinese National Cleaner Production Centre (CNCPC) was established in December 1994, affiliated with the Chinese Research Academy of Environmental Sciences and under the State Environmental Protection Administration (SEPA - which was to later become the Ministry of Environmental Protection). The staff of the CNCPC was responsible to support policy and technical discussions among various stakeholders and related research and development and awareness rising. Initially CNCPC was set up as a market-oriented service provider but has shifted to become more of a public-interest oriented institution providing both policy advice and technology support functions (UNIDO/UNEP, 2010).

In 1995 the Chinese government decided to undertake a pilot CP program indicating interest to shift away from the traditional reliance on EOP as its principal environmental protection strategy. SEPA's "Ten, One Hundred, One Thousand, Ten Thousand" program was designed to promote CP in 10 heavily polluting industrial sectors in 100 cities throughout China. The goal was to implement CP in 1,000 enterprises and to train 10,000 people in CP concepts and methods. This initiative also signaled the governmental policy decision to shift from the existing (at the time) inefficient, "extensive" industrial production practices to "intensive" production promoting greater efficiency in the use of resources (Ortolano et al, 1999).

During the 1990s there were many bilateral and multilateral initiatives to support China's adoption of CP (at least 41 with international support). Many focused on capacity development within research and government. Numerous training courses were run, about 400 audits undertaken (with only two paid for by the enterprises themselves- the rest covered by donors or the government), and CP guidelines produced for industry sectors. But there is little evidence of broad adoption of CP by industry as a result of the support for audits by the end of the 1990s - many individual enterprises benefited but there was virtually no diffusion. Experience from one of the most successful early programs, a CIDA-funded technical assistance (TA) that included audits, followed by engineering design and support for accessing finance, showed the importance of a more comprehensive approach to the provision of CP technical assistance (Evans, 1999).

One of the early TAs that included funding from audit to implementation was a World Bank/UNEP demonstration project performed during 1993 to 1995. This project included detailed audits of 29 enterprises. The project was reviewed by Peltier and Ashford (1998) in comparison with a French water fund in order to better understand the level of innovation, type of process targeted, and process flow-oriented categorization of technologies. The assessment distinguishes between (i) EOP versus CP, (ii) diffusion of existing technologies versus innovation of technologies, and (iii) whether initiatives are targeting primary, secondary or ancillary processes. The study concluded that technology forcing regulatory instruments directly affect the management of technology, while economic incentives addressing exclusively economic variables influence technological management in a more indirect manner. The World Bank/UNEP program showed that waste recovery options were considered more profitable than process changes and ancillary processes were more profitable than primary and secondary processes. It also demonstrated an aversion by Chinese enterprises toward technological risk, and thus process changes were less preferred than waste recovery and options targeting primary, and secondary processes were less preferred to ancillary. This further underscored reluctance toward technological innovation. Another conclusion was that the separation of environment and production competence and management inside the enterprise reduced opportunities to find and to implement improved process technological options. The project concluded and the subsequent review re-enforced the need for improving financial incentives as well as further TA for the education of managers, demonstration projects, and technology options.

China experienced a dramatic growth of public awareness and pressure to address the worsening environmental situation in the mid- to late 1990s. One governmental response was the adoption of an environmental labeling scheme in 1994 through which companies could receive certification that products are safe and environmentally friendly (Lohani and Ghosh, 2000; Wang et al, 2002). Between 1995 and 1998 two major national surveys were undertaken to assess the attitude and awareness of Chinese consumers regarding environmental issues. The China Environmental Protection Foundation commissioned the first, "Environmental Awareness of Chinese Citizens" with about 3,600 respondents. The second was the "National Survey on Public Environmental Consciousness" by SEPA with about 10,500 respondents. Both surveys indicated a high level of awareness and concern about environmental degradation. Public knowledge of regulations was much higher in youth groups than in adults. The surveys showed that lack of compliance with environmental regulations was seen as the key reason for environmental degradation. In 1998, only 25 percent of consumers would consider environmental issues when purchasing goods, with the urban population being generally more aware and willing to consider such issues as consumers than the rural population.

Retailers were also surveyed with regard to their attitude toward cleaner or greener products. In particular, they were asked for their views on environmental labeling, their perceived role in encouraging CP, and their view on the impact of labeling of products on consumer behavior. Generally, the retailers had little interest since they did not consider environmental issues to be relevant to their business. While 64 percent had heard of green products, none of the firms surveyed were aware of the official government-labeling program. They were generally not interested in promoting such actions since their concern was purchasing goods at the lowest price, even though 50 percent considered that it would improve their image (Ma and Ortolano, 2000; ADB, 2002). Consumer environmental knowledge is only now taking hold in China. The necessary government-supplier-consumer dynamics- domestic pressures- required to change behavior is still less of a driving force in China than the ongoing changes in international regulatory and supply change pressures (Zhu and Sarkis, 2015).

By the end of the 1990s, the government had determined it would fully integrate CP in the environmental regulatory and industrial development policy frameworks. In drafting the 10th Five Year National Economic and Social Development Plan, 2001-2005 (10th Five Year Plan) it was decided to set a target of reforming at least 50 percent of existing SOEs, and transforming them into market-oriented enterprises. The 10th Five Year plan targeted metallurgical, chemicals including pharmaceuticals, petrochemicals, building materials and power generation. Within the 10th Five Year Plan was the National Environmental Plan, which, among other objectives, set broad policy goals and support to promote CP. The ADB was asked to assist the government in developing a CP policy framework based on a thorough assessment of barriers and incentives (Huq et al. 1999).

ADB consultants for the Technical Assistance study, Policies for the Promotion of Clean Technology (PA Consulting Group, 2001) used questionnaires to 190 enterprises and follow-up interviews at about 62 enterprises from 11 provinces and covering 11 sectors (metallurgy, electronics, machinery manufacturing, light industry, electric machinery, hotels, coal, and pharmaceuticals) with staff and managers of SOEs, town and village enterprises (TVEs), and international joint ventures to identify and assess barriers to adoption of CP. The key barriers identified included:

- Doubts regarding the profitability of CP measures, both absolutely and in comparison with other potential investments;
- Belief that CP is the responsibility of environmental management personnel;
- Water subsidies reduce financial viability of investing in water conservation;
- Some or all of the societal benefits of proposed CP measures not accounted for in financial appraisal by enterprises. Unless internalized by enterprises, private costs of environmental degradation differ from social costs;
- Staff lack experience in preparing a business case for investment in CP and banks reluctant to make loans, particularly if investment does not generate a positive financial rate of return to the enterprise;

- Perception that an enterprise cannot practice CP because its production technologies are not as advanced as that of OECD countries. This perception overlooks the significant possibilities for improving operational performance through better management and retrofits;
- Lack of in-house skills to conduct audits and, in particular, to undertake the engineering work required to implement identified CP measures. Many enterprises lack the finance to hire outside expertise;
- Insufficient access to information on CP among intermediary organizations able to provide CP services;
- Inadequate understanding of the CP concept, especially by more senior managers, leading to the view that if they have a full EOP they do not need CP. Many were already satisfying environmental regulations so there was a lack of incentive to adopt CP; and
- Enterprises' environmental performance is not subject to general public scrutiny.

Staff at joint venture companies perceived far fewer barriers, suggesting that management style lies at the heart of many SOE difficulties regarding CP.

A policy framework was proposed to address these barriers. The framework included four key elements: (i) awareness and information, (ii) market development, (iii) financing, and (iv) regulation, as follows.

- *Awareness and Information* for senior government officials and managers in the industrial, commercial and financial sectors would increase understanding of the principles of CP, benefits to business and the environment, and technological solutions. The relationship between CP and EOP would be a priority. Complementing the strategy is the need for a long-term commitment from the Government including to promote public involvement;
- *Market development* includes policy measures for public disclosure of specific pollutant emissions and discharges from enterprises, green purchasing policy by government, adoption of a formal environmental management system and seeking ISO 14001 accreditation, reducing water subsidies, internalizing costs of environmental degradation to enterprises, increasing public awareness of existing eco-labeling systems, developing supplier clubs including foreign investors and leading Chinese manufacturers and Chinese supplier enterprises that show willingness to adopt CP, preparing unified guides for investors covering investment, and approval of procedures to aid the swift identification of CP investments;
- *Financing* mechanisms were proposed to utilize funds generated by the pollution levy system. (This system supported an investment of about 28.5 billion RMB in pollution control over 1984-1997, about one-fourth of the total investment). With the pollution levy system at the core, financing mechanisms could be designed to attract finance from other sources including local commercial and development banks and other financial institutions;
- Strengthening enforcement of *regulations* was considered critical for other measures to have an impact, both for existing and for future regulations since there was already discussion in the late 1990s about a Cleaner Production Law (Huq et al, 1999).

An initial response by the government was the establishment of the Green-Watch Program in 2000. Green-Watch, modeled after Indonesia's Program for Pollution Control Evaluation and Rating (PROPER), was an incentive-based pollution control program in which the environmental performance of firms was rated and reported to the public. Under Green-Watch, firms were rated from best to worst using five colors - green, blue, yellow, red and black - and the ratings disseminated to public through media.

The World Bank assessed the program's impact in 2002, by which time about 2,500 firms had been rated. The review showed that Green-Watch was a significant incentive for firms to reduce pollution, even in settings where environmental NGOs play a small role and there was no formal channel for public participation in environmental regulations. In some cases the disclosure requirement was adequate to shift the balance of environmental initiatives between polluters and regulators. Prior to disclosure, local enterprises generally resisted regulators' attempts to monitor them more closely. After disclosure, environmental degradation by specific firms attracted widespread publicity through the media, and companies perceived an impact on their public image and the market image of their products.

Under Green-Watch, enterprises that improved their performance tended to immediately request new monitoring reports so that their public ratings could be improved. Enterprises with poor ratings shifted from passive to active solicitation of inspections. Many enterprises showed a desire to improve their performance prior to public disclosure when they were informed of their ratings and given sufficient time to invest in corrective measures. At the same time, enterprises with good ratings felt pressure to maintain these ratings. Interestingly, much of the resistance to Green-watch came from local governments (Wang et al, 2002). PROPER in Indonesia had similar results, showing the importance of informing firms of their ratings before public disclosure and allowing time to respond through appropriate improvements. (Ambumozhi et al, 2011)

6.2.6.2 The Chinese Cleaner Production Promotion Law

On the 29^{th} of June, 2002 the Chinese Standing Committee of the 9^{th} National People's Congress adopted the world's first national Law on Promoting Cleaner Production. The CP Law, which came into effect on 1 January 2003, is considered the most significant of a number of initiatives by the Chinese government to establish CP nationwide as one of China's key strategies for sustainable development (UNEP, 2004; Mol and Liu, 2005).

The Law has 42 articles in six Chapters. Chapter 1, General Provisions, stipulates the general goal, definition, scope, government institutional administrative framework and commitments for support. Chapter 2, Cleaner Production Popularization, lays out the roles and responsibilities of various government agencies for promoting CP. Chapter 3, Cleaner Production Implementation, specifies the requirements of enterprises in applying CP. Chapter 4, Encouraging Measures, outlines a set of possible incentives for enterprises including reputational and financial measures. Chapter 5, Legal Liabilities, specifies penalties to be enforced in the case of violation of the Law. Chapter 6 specifies the date the Law comes into force.

An interesting debate during the drafting of the Law was whether to make the law environment-centric or business-centric. The decision was to emphasize "production", stressing that CP is good for business competitiveness. The goal of the Law is "to promote CP, improve the resource utilization efficiency, to reduce and avoid the generation of pollutants, to protect and rectify the environment and safeguard human health, and to pursue social and economic sustainable development." The definition of CP under the Law is "reducing pollution at the source, improving resource utilization efficiency, reducing or avoiding the generation and emission of pollutants in the course of production, service and product use by continually adopting improved design, using cleaner energy and raw materials, applying advanced process technology and equipment, and improving house-keeping and comprehensive resource use in order to alleviate and remove negative impact on human health and the environment."

The Law divided requirements and obligations of enterprises into three categories - general, voluntary and obligatory. General requirements include a long list of measures such as reviewing CP options as part of an environmental impact assessment; taking into account life-cycle impacts on human health and the environment when designing products and packaging, including giving preference to less toxic, degradable and recyclable options; and greening the construction sector. Voluntary standards were intended to encourage enterprises to adopt additional CP measures beyond regulatory compliance. Such standards include voluntary agreements with economic and trade commissions or environmental protection bureaus to publicize additional efforts and their benefits and participation in accredited environmental management system certifications (Han, 2002; McElwee, 2011).

Certain categories of enterprises must undertake CP actions or face legal sanctions - fines ranging from US$ 8,152 to US$ 16,304 and/or penalties applicable to other relevant civil and criminal laws. Under the Law, large electric and mechanical equipment and select other products are subject to a material labeling scheme, toxic materials and dangerous wastes cannot be used for fertilizer or as fill material for reclaiming land, toxic and hazardous construction and decorative materials are banned, designated products and packaging are subject to a mandatory recycling program, enterprises using toxic materials must carry out CP audits, and select polluting enterprises must disclose waste loads (Han, 2002). Under the Law, it is mandatory for all enterprises to monitor their consumption and waste and to conduct sufficient CP audits where necessary. Enforcement of the law is almost exclusively at the local level, mostly provincial governments (Mol and Liu, 2005). A key element of the CP Law is the provision of guidelines and capacity development to facilitate the ability of enterprises to meet their obligations. In the early 2000s SEPA began a process to develop CP guidelines for about 90 industrial sectors, starting with petroleum refining, coke manufacturing, and leather tanning (Yanying, 2004).

The Law also provides a number of market-based and demand-side supportive measures. Some supportive measures include the provision for financial support for CP research, demonstration projects and training programs. A special allocation was made for supporting CP in SMEs. In addition, enterprises that utilize waste for the manufacture of products or that recover and reuse raw materials are eligible for reduction or exemption from value added tax and costs for training and auditing could be accounted as production costs (Yanying, 2004).

The CP Law was adopted as a key element of China's effort to shift to a more sustainable development path under its "circular economy" approach. The circular economy approach, influenced by the efforts to achieve industrial symbiosis through eco-industrial parks (Jiao and Boons, 2014), was intended to meet development needs with maximum efficiency of natural resource use, balanced economic structure and rational consumption. It addresses resource use efficiency at three levels where resources, products, and services circulate. It starts with CP at all production processes and products. The 1st level is the reduction of consumption and emissions. The 2nd level is to reuse and recycle resources within industrial parks and clustered industries so that materials will circulate fully within the production and consumption system and ensure optimum efficiency in use of resources to produce goods and services. The 3rd level is to integrate the various production and consumption systems in a region where the resources will circulate between different systems of primary, secondary and tertiary industries and urban and rural areas (UNEP, 2005).

6.2.6.3 Experience Post-CP Promotion Law

Shortly after the CP Promotion Law took effect in 2003, the Chinese government also promulgated the Small- and Medium-Sized Enterprise Promotion Law aimed at promoting healthy and sustainable development of Chinese SMEs. The law stipulates CP and designates special fines to promote SMEs. SMEs in China are enterprises that have either less than 2,000 employees or US$ 48.91 million annual sales or US$ 65.22 million fixed assets. SMEs accounted for over 99 percent of the total number of manufacturing establishments in China in 2002. About 150,000 small polluting enterprises were closed, merged or transformed by the government between 1996 and 2003. This was a critically important step if the SMEs were to be an active "participant" in CP in China, recognizing they have somewhat different barriers to the adoption of CP than larger enterprises (Shi, 2008).

A number of actions were initiated after the CP Promotion Law came into force. In 2003, the Ministry of Finance issued regulations for funding CP law implementation. In 2004, the National Development and Reform Commission (NDRC) and SEPA issued "Interim Measures for CP Audit" with specific requirements and procedures for audits. Audits were considered the most important supplement to the Law up to that time. "Procedures of CP Audit for Key Enterprises" was issued by SEPA in 2005; and CP standards for 15 industrial sectors were issued by SEPA in 2006, 7 more in 2007 and 15 more in 2008. The State Council issued the "Comprehensive Work Program of Energy-saving and Emission Reduction" in 2007. The Ministry of Environmental Protection in 2008 issued the "Notice of Strengthening Further Production Audit for Key Enterprises" and "Guideline for Assessment and Acceptance of Cleaner Production Audit for Key Enterprises" requiring local environmental administrations to perform reviews and report on all of the compulsory CP audits (Ning, 2009). By the end of 2008, Ministry of Environmental Protection had organized 226 national training courses for CP auditors - a mandatory 5-day course - with over 12,000 individuals being certified following the training (Jie, 2009).

The NDRC has been responsible for promoting CP technologies and technology innovation. The agency carried out national inventories of CP technologies in 2000, 2003, and 2006. The 2000 inventory identified 57 CP technologies in 5 key sectors - metallurgy, petrochemical, chemical, light industry, and textiles. The second survey identified 56 CP technologies and added non-ferrous metals and building materials as sectors. The third included 28 technologies. The economic and trade administrations at provincial and other administrative levels, use the inventories as a basis for reviewing and approving CP projects which get some kind of financial incentive.

Selective analyses of the impact of the CP Promotion Law were undertaken in the years following it's coming into effect to assess compliance and its barriers. Generally, there has been a notable reduction of some barriers - particularly those related to awareness (Shi, 2008). According to incomplete data from 33 provinces, autonomous regions and municipalities in 2007, the CP program had saved 3.69 billion kWh electricity and 380 million tons of water; avoided using 7 million tons of coal; avoided discharge of 60 trillion tons of wastewater, 95,000 tons of COD, and 71,000 tons of SO_2. Reduction of pollution was valued at about US$ 2.45 billion while energy and other material consumption savings at about US$ 9.78 billion. By the end of 2007, CP audits had been carried out in about 10,000 enterprises and more than 300 organizations established to provide such audits (Ning, 2009).

A survey was undertaken of enterprises that fall under the compulsory CP audit regulations in 27 provinces and cities, with the objective of differentiating driving forces at the enterprise level. The study showed that poorer regions and cities of China have been substantially weaker in implementing the law. There was less pressure from public and government in such cases. In some cases, the audits were carried out but not made public - with about 40 percent of the compulsory enterprises having had audits but only 27 percent were published (Zhigang, 2009).

One of the most detailed studies on the implementation of the CP Promotion Law was based on a questionnaire survey of Chinese SMEs designed to quantitatively identify, rank and prioritize the barriers to adoption of CP. The study compared the perspectives of government, industries and experts in order to better understand the underlying reasons for ineffective CP policies and on possible measures to improve policy effectiveness. The study was unique in its focus on establishing relative weights of importance of various barriers.

Twenty barriers for SMEs were identified and grouped into four major categories (i) policy and market barriers, (ii) financial and economic barriers, (iii) technical and information barriers, and (iv) managerial and organizational barriers. The first two categories are essentially external barriers since enterprises have little control on these factors as compared to the last two, which are largely internal barriers within the span of control of the enterprise. The study showed that the dominant barriers to CP implementation are in the policy and finance categories, particularly (i) the absence of economic incentives, (ii) lax environmental enforcement, (iii) high initial capital cost, (iv) poor financial performance of CP, and (v) difficulty in accessing finance/capital for CP. (Shi, 2009)

Experience of larger firms in the implementation of the CP Promotion Law has been somewhat driven by the changing roles that local politics and stakeholder participation has played in the last decade in China. A survey of 791 manufacturing firms showed that using local political capital is still an important, but declining mechanism for avoiding compliance. At the same time, while broader stakeholder participation has improved and roles and actions have increased in importance and impact, the corporate influence on governance can still reduce the effectiveness of such participation. (Lin et.al., 2014; Lu and Abeysekara, 2014)

A comparison of studies on barriers indicates that (i) awareness of the economic and environmental benefits of CP at the management level and (ii) technological hurdles at the operational level are no longer the most prominent barriers, as the previous studies had concluded. This indicates a certain level of success from CP promotion efforts - by 2002 there were 20 local and sectoral CP centers in China and more than 500 CP training workshops and more than 10,000 people trained.

Another significant finding was that the three different stakeholder groups have different perspectives on priority importance of various barriers (see Table 6.3). The enterprise group considered the financial and economic barriers and technical and informational barriers as more critical than the management and organizational barriers. The governmental stakeholder group considered the internal management and organizational barriers were of greater importance than did the enterprises. The expert group considered the policy and market barriers to be of greatest importance.

The China CP Law relies on mandatory and voluntary audits. Of seven major internationally supported projects in the 1990s, six involved demonstration projects including 59 CP audit demonstrations. These demonstration audits were a primary mechanism for promoting CP audits in China. Factories that provided financial incentives for their workers who participated in demonstration projects, and particularly in audits, were much more successful than those that did not. In many cases this stemmed from the lack of financial incentives at the management level because it was not clear managers that the CP actions were lowering costs, a consequence of project design focused on environmental benefits as opposed to the financial benefits. (Cushing, 1999)

The impact of CP audits is still limited to a small percentage of enterprises. For example, one province is reported to have planned 500 audits between 2003-2007 out of over 25,000 registered enterprises. In several provinces only 2 or 3 percent of enterprises have been audited. In many cases, companies are primarily interested in gaining CP audit certification, but in many cases recommendations are not implemented. Company managers are still reported to have an indifferent attitude toward CP, so that despite initial achievements, the effects of CP measures do not persist in the long-term. This problem is exacerbated by a weak supporting environmental technology industry, which was described as “lagging 10-20 years behind advanced world technology level” (Hicks, 2007). The success of the mandatory CP audit system is affected by the clarity of understandings of liabilities and responsibilities of various governmental organizations, CP capacity in the firms, standardization of supervision, and transparency of reporting. Weak government enforcement continues to reduce the overall beneficial impact of the audit system. (Bai et al, 2015).

Table 6.2: Barriers to Broad Implementation of China's Cleaner Production Law.

Ranking	Government	Enterprises	Experts
Level 1			
1	Financial and economic	Financial and economic	Policy and market
2	Policy and market	Policy and market	Financial and economic
3	Managerial and organizational	Technical and information	Technical and information
4	Technical and information	Managerial and organizational	Managerial and organizational
Level 2			
1	Poor financial performance of CP	High initial capital cost	Lax environmental enforcement
2	High initial capital cost	Absence of economic incentive policies	Absence of economic incentive policies
3	Absence of economic incentive policies	Lax environmental enforcement	Weak public awareness and pressure
4	Lax environmental enforcement	Difficulty in accessing financial capital	Poor financial performance of CP
5	Difficulty in accessing financial capital	Poor financial performance of CP	High initial capital cost
6	Higher priorities to production expansion/market share	Lack of effective evaluation measures for CP	Difficulty to access information on CP
7	Lack of financing service for SMEs	Lack of financing service for SMEs	Lack of effective evaluation measures for CP
8	Lack of market preference/demands	Lack of access to external technical support	Difficulty in accessing financial capital
9	Weak public awareness and pressure	Lack of market preference/demands	Lack of access to external technical support
10	Concern about competitiveness	Inadequate industrial self-regulation	Lack of market preference/demands
11	Lack of effective evaluation measures for CP	Weak public awareness and pressure	Lack of financing service for SMEs
12	Inadequate management capacity	Limited in-plant expertise/capability	Limited in-plant expertise/capability
13	Lack of awareness of CP	Difficulty to access information on CP	Inadequate industrial self-regulation
14	Inadequate industrial self-regulation	Higher priorities to production expansion/market share	Concern about competitiveness
15	Management resistance to change	Concern about competitiveness	Lack of technical training on the workshop floor
16	Difficulty to access information on CP	Management resistance to change	Inadequate management capacity
17	Lack of access to external technical support	Additional infrastructure requirements	Lack of awareness of CP
18	Limited in-plant expertise/capability	Lack of awareness of CP	Higher priorities to production expansion/market share
19	Additional infrastructure requirements	Lack of technical training on the workshop floor	Management resistance to change
20	Lack of technical training on the workshop floor	Inadequate management capacity	Additional infrastructure requirements

Source: Shi, 2009

One of the government efforts since China's entry to the World Trade Organization (WTO) in 2001, and in support of the CP Promotion Law, has been the promotion of green supply chain management (GSCM). A comparative review of drivers and practices was carried out for the automobile industry, thermal power and electronics industry showing that GSCM was much more successfully applied in export-oriented industries or industries that were a part of the supply chain of an exported product. Clearly globalization and China's entry to the WTO have helped promote GSCM practices in manufacturing enterprises. Export and sales to foreign customers are two major drivers for improving environmental performance. Kyoto Protocol requirements (and opportunities) and international pressures for reducing GHG emissions have generated more pressure on high-GHG emitting industries. But different industries face a range of varying competitive pressures, as well as uncertainties in technology options. While different industries face different types and intensities of pressures to deal with environmental issues, it appears that Chinese companies continue to be most responsive to regulatory pressures. Marketing is a relatively important driver with multinational ownership, multinational customers, and exports to developed countries reported as a driver for self-regulation of environmental performance. Concern about environmental performance of suppliers is a less important driver (Zhu, 2015).

Guan et al (2014) compared the implementation of the China CP law in two provinces, Hangzhao and Guiyang. They found that there were a number of differences in levels of accomplishment between the two provinces. Incentives for CP were much higher in Hangzhao, where local government officials and other stakeholders have been much more adaptive in applying the central policies at the local level. A driving force in Hangzhao was the need to conserve energy since the province suffered from power shortages for several years. Another reason for higher levels of success in Hangzhao was that the government is financially much stronger and could therefore, allocate significant budgets to support CP. Guiyang's government allocated no financial support to promote CP. As a result Hangzhou established a cadre of technology and service organizations to support CP initiatives, whereas, Guiyang lacks such technical support. A final substantial difference was that Hangzhao provided subsidies to select enterprises, which the authors credit for the rapid uptake by industry.

In general, studies on the implementation of the CP Promotion Law conclude that there continues to be a number of challenges and that the overall impact has been less than satisfactory. At the macro-level, there continues to be a tension between economic growth and environment, indicating even more forceful action is required by the government to achieve convergence between CP and other environmental regulations so that CP is seen as an economic solution (Duan Ning, 2009). Hicks considered the problems to be rooted in the difficulty of inducing enterprises to undertake CP measures and of providing sufficient resources to ensure the quality and sustainability of CP implementation. Thus, further creating a market-awareness is required to convince enterprises that CP can provide economic benefits as well as improve environmental performance (Hicks, 2007). Shi (2008) considers that a major prevailing constraint is the "lax environmental enforcement and lack of financial service institutions, which are deeply embodied in China's current political and economic systems. They will remain outstanding shortcomings of CP implementation in China."

Large companies in China are demonstrating an increasing willingness to address environmental and social responsibility issues (Hicks, 2007). Nevertheless, conflict between industry and environmental protection are now more serious and complex, which requires strengthened governance, expanded and improved capacity building (particularly to shift mindset from EOP to CP), and further efforts to secure international cooperation and public participation (Zhang and Wen, 2008). Weak technological innovation capacity within many companies requires more effective partnership with external innovation centers (Shi et al, 2010).

There is still an inadequate level of acceptance and willingness to implement innovative technical and managerial measures. Financial, technical and human resource constraints in SMEs continue to be major barriers to wide-scale adoption of CP in China, since SMEs form the backbone of Chinese industrial development. But more broadly is the lack of strong enough incentive mechanisms to stimulate action by large, medium and small industrial enterprises. Local and provincial governments still lack the human and financial resources needed in spite of the considerable efforts and progress in meeting capacity needs (Hicks, 2007).

One of the impressions this thesis author has after thoroughly reviewing CP programs in China is that the technical support to China for CP from multilateral and bilateral development assistance organizations has tapered off significantly since the early 2000s. This may be indicative of a shift of priorities of such organizations from CP and local environment to the climate change agenda. It may also be a result of a general reduction in bilateral aid for China or perhaps a shift in demand from China. Very few major programs of assistance have been provided since 2005. The European Union and Austrian Development Cooperation have a “Capacity Building and Establishment of Cleaner Production Service Units and Campaigns for the Industry in the Less Developed Regions of China” project that was undertaken during the period 2008-2011. The support was provided in response to the European Union policy to stimulate sustainable production and consumption in Europe and in Asia and the Chinese governmnet policy to support less developed provinces. Even this project was in response to increased pressure to address climate change (Centric Austria International, 2011).

6.2.7 China’s Growing Role in Climate Change

China’s energy consumption more than quadrupled from 1980 to 2007. As shown in Figure 6.2, much of the growth is due to urban and industrial manufacturing growth (China FAQs June 2, 2010). China is the world’s largest coal producer and consumer. About 70% of China’s energy production is coal-based. According to the International Energy Agency, this would need to be reduced to about 30% by 2050 and its energy intensity by 3.1% if a 450 ppm target is to be reached.

Clearly coal is the greatest challenge for reducing GHG emissions in China. China has been proactive in de-carbonizing its economy with a long history of policy-driven actions. As early as 1980, after years of Soviet-like growth with focus on production and not efficiency, China declared it would quadruple GDP while only doubling energy consumption over the next 20 years. Both of these goals were exceeded and two of the policies, investment in energy efficiency and establishing centers of expertise in energy efficiency throughout the country, have had far-reaching impacts and were ahead of their time (Levine, Zhou and Price, 2009; NDRC, 2015).

China was one of the first developing countries to pass a renewable energy law (2005)[4] and already has the world's largest renewable energy power capacity (McElwee, 2011). The new law resulted in a number of policy reforms to stimulate development of renewable sources and set targets for wind production. In 2003, only 3% of energy consumed was from renewable sources. Renewables could make up as much as 40% of the energy supply by 2050. China's energy intensity was decreased by 30% between 1995 and 2004 and the efficiency of its coal-fired power plants grew by 15% to an average of 34% (IEA, 2008).

Consistent with the aforementioned low-carbon growth strategy, China has been targeting industrial energy efficiency for many years with varying degrees of impact and priority. The sharp increase in China's GHG emissions is the result of rapid growth of energy-intensive, heavy industries such as steel, cement and aluminum (Figure 6.2). After mandating a reduction in energy intensity in 1980, energy efficiency initiatives taken were highly cost effective and straight-forward – measures such as repairing leaky pipes, replacing inefficient boilers and similar energy intensive mechanical equipment, and improving poor production- and energy-management practices (Levine, Zhou and Price, 2009). Nevertheless, in 1997, industry consumed 76% of China's primary energy (Price et al, 2000) and energy efficiency appeared to have become less of a concern to national decision-makers.

During the 1990s, major manufacturing plants were under limited pressure to pay attention to energy efficiency and many no longer employed managers with expertise or responsibility for energy efficiency, even though by law large industries were required to have an energy manager. At the same time the Government priority and budgets for energy efficiency were lower, resulting in, among other impacts, the decline of many of the energy conservation centers and reduced incentives for government officials to enforce relevant regulations. Levine, Zhou and Price (2009) also attribute China's accession to the World Trade Organization (WTO) as increasing the Government's focus on rapidly increasing exports supported by rapid energy-intensive industrial growth and thereby, decreasing its focus on energy efficiency.

Recognizing that the growth pattern of the late 1990's up to 2005 was not sustainable from energy consumption or climate perspectives, the Government mandated a 20 percent reduction in energy intensity production by 2010- a 19 percent reduction was achieved. The initiative was one of several that were intended to decouple resource consumption and waste generation from economic activity. [5] It remains unclear whether these measures and achievements have sufficiently countered the impact of rapid industrialization and urbanization and the embedded emissions from those processes. (UNEP, 2011)

In addition to the Low Carbon Growth Strategy described above, a number of regulations and initiatives have been implemented by the Government to try to achieve this target, in spite of the massive challenges faced in such a large and diversifying economy. These included:

- updating the national energy conservation law;

[4] China's Cleaner Production law was passed three years earlier in 2002.
[5] In the late 1990s until 2010 China was successful in decoupling rates of increase in freshwater consumption and economic growth. Case studies on decoupling indices indicate that industrial wastewater discharge and solid waste generation began to decouple from economic growth in the 1990s. Efforts to decouple mineral consumption have not been successful.

- providing incentives for energy efficiency and waste management;
- enacting regulations to provide preferential tax treatment for use of energy efficient equipment;
- adopting appliance standards and product energy efficiency labeling;
- investing in projects to renovate coal-fired industrial boilers to shift from coal heating to combined cycle district heating and power, which is much more efficient since it requires less coal per unit heat energy,
- reducing and substituting oil consumption with natural gas consumption, and upgrading energy conservation in buildings.

These initiatives were estimated to have reduced China's GHG emissions by about 250 million metric tons carbon equivalent per year, or about 40% of the 2010 target for energy intensity by 2008.

In April 2006, the Chinese government initiated the Top 1,000 Energy-Consuming Enterprises Program. Under this initiative, the country's major industrial operations were committed to reaching the 2010 target. The enterprises, including iron and steel, petroleum and petrochemicals, chemicals, electric power, nonferrous metals, coal mining, construction materials, textiles, and paper, combined account for about half of China's industrial energy consumption and about 30% of the national consumption (Levine, Zhou and Price, 2009).

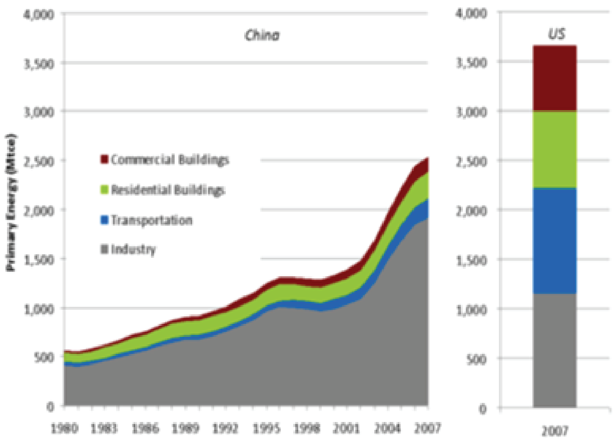
China enacted new national energy efficiency regulations, effective on January 1, 2011, establishing utility demand-side management. Among other advances to improve energy efficiency, the regulations will result in power utilities allocating a portion of their revenues to assist factories, businesses and the housing sector to invest in energy efficiency (Yew and Ho, 2010). Indications are that these policy reforms and programs are having an impact – in 2006 the country achieved its first energy intensity reduction since 2001 with a reduction of 1.8%, and 4.0% and 4.6% in 2007 and 2008, respectively. (http://www.chinafaqs.org/library/timeline-chinas-energy-efficiency-policies, Oct 7, 2009).

China's 2015 INDC was designed to support implementation of its national strategies on climate change. China will strengthen laws and regulations, integrate climate change related objectives in national economic and social development plans, formulate a long-term strategy and roadmap for low carbon development, implement the National Program on Climate Change (2014 to 2020) and provincial climate programs. Among other measures China intends to improve the overall administration of climate change-related work, and apply carbon emission-related indicators to improve performance evaluation and accountability for meeting low carbon development targets. A carbon emission trading mechanism, built on China's ongoing pilots, will be adopted in 2017.

The INDC also emphasizes the importance of climate resilience and includes a number of priority actions particularly focused on water resource management and water conservation, disaster management, biodiversity conservation, urban zoning and infrastructure standards, and mainstreaming climate change in the planning, engineering and construction of major projects. China's INDC recognized a need to scale-up scientific research and development and commercialization relating to climate change issues. Key commitments include:

- Achieve peaking of CO2 emissions around 2030, with best efforts to peak earlier;
- Lower CO2 emissions per unit of GDP by 60-65% by 2030 compared to 2005 level;
- Increase the share of non-fossil fuels in primary energy consumption to around 20 percent; and
- Increase the forest stock volume by around 4.5 billion cubic meters on the 2005 level.

Figure 6.3: Energy Consumption by Major End Use Sectors in China and the USA



Source: China FAQs, 2010.

6.2.7.1 Energy And Climate Change As Drivers Of Environmental Change In China

Industrial energy use in China grew at an average annual rate of 5 percent from 1980 to 1997, about 5 times faster than the average growth that took place in the industrial sector worldwide during the same time period. In 1997 the industrial sector consumed about 76 percent of China's primary energy supply. About 80 percent of energy use in industry was by heavy industry, the most consumptive being chemicals, ferrous metals and building materials.

The rapid increase of industrial energy consumption spurred the Chinese government to pass the Energy Conservation Law in 1997, which provided broad guidance on the establishment of energy efficiency policies and requires substantial improvement in industrial energy efficiency (Price et al, 2001). This resulted in some success in reducing local emissions for a few years in the late 1990s. Even though GDP grew by a third in the period 1997-2001, there was almost no increase in CO_2 emissions. This gave rise to much optimism regarding the potential for decoupling the growth in energy requirements from the growth in GDP. Several factors explained this apparent decoupling - the closing of a large number of small and inefficient coal producers was a key factor.[6] But the decoupling was not sustained. Low power tariffs, blackouts, and power shortages arising from a 9-10 percent per annum GDP growth required China to use all of its power generating capacity no matter how inefficient (Shalizi, 2006).

The 10th Five Year Plan in 2001 included a number of energy efficiency policies including specifying gradual energy intensity reductions over time for selected industry subsectors. In the early 2000s a number of energy efficiency projects were undertaken but there was little focus on a comprehensive energy efficiency strategy. However, there was an initial effort to link decarbonization and energy efficiency policies, including provision of government support in the form of financial incentives, demonstration projects and training (Price et al, 2001).

One of the key initiatives in response to the 10th Five-Year Plan was the establishment of three energy service companies (ESCOs) in June 2004. By the end of their first year of business they had entered into energy performance contracts with 315 enterprises with aggregate investments of over $95 million. The project successfully demonstrated the tremendous industrial energy efficiency potentials and barriers. An example of a success story is the Nanjing Chemical Plant, which made major retrofits with investment of $544,000 and reduced energy consumption by about 5 percent while increasing production capacity by 33 percent. Energy savings alone were $565,000/year (Hu et al, 2005).

A number of barriers to implementing large-scale energy efficiency measures were identified based on experience in the early 2000s. Some key challenges were an inadequate legal framework, insufficient funding and ineffective funding mechanism, shortage of specialized professionals, and pricing that fails to give consumers adequate signals to invest in energy efficiency. An additional constraint was due to the fact that much of the industrial base was in transition, attempting to cope with enormous economic change and restructuring, which made it difficult to commit to energy efficiency projects (ESMAP, 2009).

The 11th Five-Year Plan (2006-2010) called for a twenty percent reduction in energy intensity per unit GDP. Industrial plants in or near urban centers were a major focus of efforts to reduce the energy intensity of the economy during the 11th Five-year Plan. Overall the effects and experiences were positive. The core elements of the industrial energy efficiency reforms - administrative targets and incentives, a focus on the biggest emitters, and incentive programs to accelerate new technology adoption proved reasonably successful in China (Baeumler et al, 2012; Price et al, 2010).

The most recent global financial crisis struck at the mid-point of the 11th Five-Year Plan. Rather than alter the path laid out, China apportioned about one-third of its $647.5 billion fiscal stimulus plan to green measures, about 3 percent of GDP. At the end of the last decade, the renewable energy sector was valued at about $17 billion and employed about one million workers (about one percent of the working

[6] Another factor was the declining fertility rate, reducing births by more than 300 million, leading to a reduction in GHG emissions by about 150 million tons of carbon per year (C/yr) (Chandler et al, 2002).

population). China became the world's leading producer of solar cells, wind turbines, energy-saving lights and solar water heaters, and intends to lead in production of fuel-efficient cars. Making such progress required considerable policy shifts, including adopting feed-in tariffs, power generation targets for renewables, lower sales taxes for fuel efficient cars and higher taxes on petrol and diesel (Barbier, 2010).

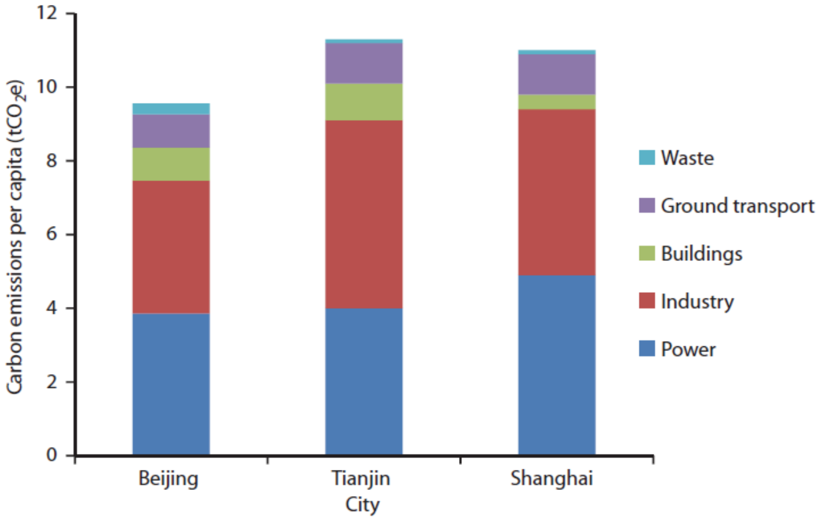
The 12th Five-Year Plan (2011-2015) includes many new industrial policies to support clean energy industries and related technologies. Strategic and emerging industries like nuclear, solar, wind and biomass energy, and hybrid and electric vehicles, and energy saving and environmental protection technology industries are being promoted to replace the "old" strategic industries such as coal and telecom, that are heavily state-owned and have long benefitted from government support. The new industry policy includes support for new strategic industries, including access to dedicated state industrial funds, increased access to private capital, or industrial policy support through access to preferential loans or R&D funds (Prasad, 2011). The most recent decisions by the Chinese Government as outlined in its December 2015 INDC, build upon the 12th Five-Year Plan and related climate strategies.

Several studies have shown that China can meet its energy efficiency targets but that it will not be easy or inexpensive in terms of capital investment. What is very clear is that a business-as-usual scenario is untenable. Assuming annual growth rates of 6-7 percent over the current decade, tapering to 3 percent by 2050, China's reliance on coal for primary energy would be as high as 63 percent. Primary energy demand will double from 2000 levels by 2020 and quadruple by 2050 (Shalizi, 2006). Dramatic shifts in energy efficiency and generation are required but new technologies such as carbon capture and sequestration will have to be employed. Technologies currently used in China will not be adequate to achieve energy security and low carbon growth (Price et al, 2010).

But the challenge is massive. China is set to add 350 million urbanites over the next twenty years. About 40 percent of China's building stock is yet to be built, so the option exists now to optimize energy efficiency measures from the outset. Industry and power generation are the major contributors to the carbon footprint of Chinese cities, especially because of coal. Data from Beijing, Shanghai and Tianjin suggest about 40 percent carbon emissions is from power generation and 40 percent from industrial activities. Thus, if the 12th Five-Year Plan target to reduce carbon intensity by 17 percent is to be met, action must be taken at the industrial and city levels (Baeumler et al, 2012). Building energy consumption accounts for more than 30% of national energy consumption in recent years. The growth of building floor area and population, combined with the improvement in living standards, meaning that the energy consumption of the urban civil building sector will continue its high growth trajectory in the next few decades (Ma et.al, 2015).

McKinsey and Company (2009) assessed a range of low carbon options resulting in an estimate investment of about $192 billion per year on average from 2010 to 2030, about 1.5 to 2.5 of projected GDP, would enable China to limit its 2030 GHG emission growth to an increase of about 10 percent over 2005 levels. But there is a limited window of opportunity to capture the full potential of low carbon technology options because China will continue to add to its power generation, building, industrial, vehicle and other stock. It is very expensive to retrofit such stock. Most of the low carbon gains rely on use of low carbon technologies at the outset. A five-year delay would result in a loss of about 30 percent of the GHG reduction potential and a 10 year delay would result in a 60 percent loss.

Figure 6.4: Industry and Power Generation are main sources of carbon emissions in Chinese Cities



Source: Baeumler et al, 2012.

It would appear that China is positioned to achieve its low carbon growth objectives. The Chinese institutional environment ensures that local government is responsive to quantifiable indicators for which they are held accountable by higher authorities. The target in the 12th Five-year Plan provides a strong incentive to meeting its objectives (Baeumler et al, 2012). There is also a growing level of awareness and recognition by the private sector to take measures to improve energy efficiency. A 2010 survey of 2,800 managers of a variety of facilities, including 40 percent from manufacturing enterprises showed that 80 percent consider energy efficiency improvements as “very or extremely important” compared to 53 percent in the United States and 55 percent in Europe. For the Chinese respondents, cost savings are the most important driver while reducing GHGs, enhancing image, and attracting or retaining customers who prefer green energy efficient suppliers were the other reasons given. Even though they were still feeling the impact of the recession, 52 percent reported that they had increased their investment in energy efficiency in 2009/2010 (Supple, 2010).

However, achieving the rapid and large-scale energy transformation desired by China faces a number of barriers. Similar to the problems faced for at-scale transformation for CP, the low carbon energy sector suffers from a lack of human resources, cost of trial and error and transition causing temporary shutdowns of facilities, lack of economic incentives, and low financial rates of returns (McKinsey, 2009). Technical support programs will need to be scaled up. Financing structures need to be fundamentally rethought, with better access by cities and companies to debt and capital markets. Innovative financing mechanisms that focus on supporting low-carbon development, such as carbon finance, environmental or green bonds, and various concessional finance programs will be required (Baeumler, 2012). These need to be tailored to address the risks that industry faces, particularly SMEs, such as the uncertainty about return on investment and lack of technical expertise to identify opportunities. Over 50 percent of Chinese respondents to the 2010 survey require less than a 3-year payback when making significant energy efficiency investments, thus financing instruments need to be supportive of their rather low-risk profile (IEA, 2014).

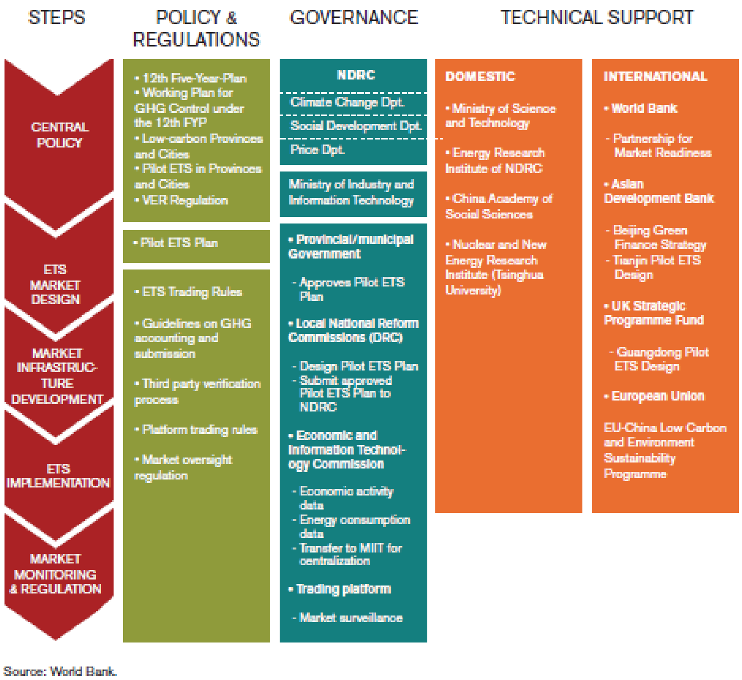
Administrative tools critical to China's growth in the past three decades will remain important in the short-term. But gains can be achieved from integrating policies and approaches based on market mechanisms whenever possible. Strengthening market-based tools within this administrative structure would increase effectiveness. This could include support for the nascent financial sector to provide credit for energy efficiency (Baeumler et al, 2012).

Similar to the situation for CP described earlier in this chapter, policy reforms aimed at decoupling energy growth from GDP and decoupling emissions growth from energy growth are essential to achieve accelerated, at-scale transformation. The first can be achieved by a combination of reduced energy intensity (structural shifts away from manufacturing) and increased energy efficiency. The second requires elimination of coal as the primary energy source (or capturing and sequestering its emissions). Shalizi (2006) showed that such decoupling would result in substantial reductions in energy use and carbon emissions. The combined effect of measures acting on demand and measures acting on supply is much stronger than the effect of either set of measures alone, with benefits increasing over time with marginal adverse effects on GDP. Demand-side policies would reduce emissions by 23 percent by 2050 and supply-side policies would reduce emissions by 20 percent by 2050. Rapid and effective industrial structural adjustments have very high potential to further improve energy efficiency and conservation and reduce GHG emissions. One study showed that Beijing GHG emissions could be reduced by 46 percent with energy savings of 40 percent by 2020 as a result of industrial restructuring (Mi et.al., 2015; Chang, 2015).

Decarbonization implies higher capital costs and higher consumer costs during the transition, but additional requirements for energy investments will drop by 2050. However, delaying the implementation of decoupling policies will result in higher investment requirements in the future and the environmental benefits will never quite catch up with the benefits from earlier implementation. Thus, with a delay in implementation, both the costs of investments and the benefits of emissions reductions are shifted to the future. The cumulative financial cost-reducing benefit of delaying investments does not offset the increased cumulative emission cost associated with prolonged reliance on fossil fuels at a carbon cost of about $4.3/ton CO_2 with a discount rate of 8 percent per annum (Shalizi, 2006). If the environmental and social and real economic costs of continued development relying on inefficient fossil-fuel driven technologies are internalized, the astronomical costs of delay would be better understood.

The Chinese policy decision-makers have recognized that continued reliance on fossil-fuel driven costs are a burden to the national economy. In addition to the targets set in the last three Five-Year Plans, China's NDRC has recently proposed capping the GHG emissions from 2016, effectively decoupling the target from economic growth. This will facilitate China having its GHG emissions peak in 2025, five years earlier than currently estimated (Reuters Point Carbon, 2013). In addition, China is well advanced in developing a carbon market. China was the largest CDM seller, with 71 percent of all CERs by 2011, and gained valuable experience in carbon pricing and trading over the last several years. China has initiated carbon-trading pilots working with the Partnership for Market Readiness. The most advanced pilot is in Beijing, but a total of seven cities and provinces have launched pilots. Figure 6.5 shows the steps and roles the government of China has laid out for establishing a nation-wide carbon market- now planned to be operating by 2017 (Kossoy, 2012; NRDC, 2015). While the price of carbon that will be reflected in the market will certainly not reflect the total economic, social and environmental cost, the process of placing a value on carbon is a very important step in the process of decarbonizing the economy.

Figure 6.5: Carbon markets are under development in China with a national market scheduled to be in operation by 2017



Source: World Bank State and Trends in the Carbon Market, (Kossoy, 2012)

China's INDC is built on a platform of integration whereby climate-change-related objectives will be embedded in national economic and social development plans. The INDC outlines a potentially transformational direction for industrial development as follows: “embark on a new path of industrialization, developing a circular economy, optimizing the industrial structure, revising the guidance catalogue of the adjustment of industrial structure, strictly controlling the total expansion of industries with extensive energy consumption and emissions, accelerating the elimination of outdated production capacity”.

The INDC further outlines industrial reforms including:

- promote low-carbon development of industrial sectors, implementing *Action Plan of Industries Addressing Climate Change (2012-2020)* and formulating carbon emission control target and action plans in key industries;
- research and formulate GHG standards for key industries;
- effectively control emissions from key sectors including power, iron and steel, nonferrous metal, building materials and chemical industries through energy conservation and efficiency improvement;
- strengthen the management of carbon emissions for new projects and to actively control GHGs originating from the industrial production process;
- construct a recycling-based industrial system, promoting recycling restructure in industrial parks, increasing the recycling and utilization of renewable resources and improving the production rate of resource. (China INDC, 2015)

6.3 India

6.3.1 The Economic and Industrial Setting of India

India has world’s second largest population and the fourth largest economy. India’s growing population, from 1.25 billion today to an expected 1.47 billion by 2030 will undergo the world’s most dramatic urbanization, from 377 million in 2011 to about 600 million in 2031. That will be an increase in the number of urbanites of over 200 million in just 20 years. Urban poverty is a serious challenge, with the increase in the urban poor estimated at over 34 percent from 1973 to 2004 (GOI, 2012). But urbanization has also been accompanied by a booming middle class, estimated at 59.6 million people in 2010 (Kharas, 2011) increasing to about 583 million by 2025 (McKinsey Global Institute, 2007) This urban middle income boom represents a massive collective appetite for consumables and demand for energy and infrastructure. India’s potential ability to bounce back from the current global economic crisis is high compared to many other countries because of its demographic advantage, increasing disposable income, and expanding middle class. Domestic consumption is likely to fuel growth in India for several years (Narsalay et al, 2012).

India’s economy grew at almost 6.6 percent per year in the 1990s (Pew, 2002). During the country’s 10th Five Year Plan (2002-2006) and at the beginning of the 11th Five-Year Plan (2007-2011) up until 2007, India’s economy was growing robustly, averaging 7.8 percent, until the global economic crisis. Even so, GDP growth averaged 8 percent during the 11th plan period (GOI, 2012). India’s growth rate decelerated in the last few years, with GDP dropping from 6.2 percent in 2011 to 5.0 percent in 2012, the lowest in a decade. This was due to a combination of a slump in industrial output and investment and delays in resolving structural impediments to growth, both compounded by the slowing global economy. Expansion of manufacturing was one of the weakest since economic reforms started in 1991. It is expected that general economic growth will pick up modestly in the coming years, with GDP potentially reaching 6.5 percent in 2014, if the industrial expansion targets are met (ADO, 2012).

The Government of India has set a target of reaching a 9 percent GDP annual growth rate by the end of the 12th Five-Year Plan (2012-2016). In order to achieve this, a target of 10 percent growth/annum of the manufacturing sector by 2015-2016 has been set (GOI, 2012). The National Manufacturing Policy aims to increase manufacturing's contribution to GDP from 15 to 25 percent by 2022 and create 100 million new jobs (Accenture, 2012). The government has set out a number of accompanying supporting actions designed to improve productivity. This recognizes that manufacturing has not grown as expected, contrary to experience in other emerging market countries. The share of manufacturing contribution to national GDP has been somewhat stagnant for the last three decades. There are a number of reasons for this situation. India ranks very low in terms of ease of doing business. The conditions of physical infrastructure, particularly energy and transport, are not supportive of manufacturing as they should be. Technological depth required to increase international competitiveness is relatively low. And finally, while micro-, small-, and medium-sized enterprises (MSMEs) serve as the foundation for manufacturing, they have not been a central focus of strategic planning and support (GOI, 2012). There are more than three million MSMEs (Sathaye, 2010) generating 70 percent of India's industrial pollution (World Bank, 2013).

If the Indian government's plans to stimulate rapid growth in manufacturing are successful, it will require a doubling of capital industrial stock over the coming ten years, and will provide an opportunity to introduce new, clean technologies. A major stumbling block in greening industry has been the lack of financial resources for clean technologies to replace obsolete and inefficient systems. This is particularly true for many MSMEs that use cheap, but inefficient and polluting technologies and processes, and most not able to meet pollution control regulations. The government is exploring the use of different technical assistance, economic instruments and funding mechanisms to facilitate CP across all industrial sectors, but with particular attention to MSMEs. Perhaps, the greatest financial innovation is to support energy efficiency and low carbon energy generation, discussed later in this section. There is also recognition that subsidy policies in the energy, water and agriculture sectors have led to inefficient use of resources, increased waste, and limited innovation. A good example was the dismantling of the Administered Pricing Mechanism in 2002, which led to the removal of subsidies on most petroleum products. This policy was later reversed, leading to a large and regressive subsidy on diesel that distorted the use of energy in transport and industry and dramatically worsened air quality, especially in major cities.

6.3.2 The Need for Cleaner Production and the Current Costs of Environmental Degradation in India

Pollution and degradation of its natural resource asset base is having devastating impacts on India's economy- though not accounted for in national accounts. A recent study in India on the costs of environmental degradation assessed costs of (i) urban air pollution; (ii) water pollution, inadequate water supply, poor sanitation and hygiene; (iii) agricultural damage from soil salinity, water logging and soil erosion;

(iv) rangeland degradation; (v) deforestation; and (vi) natural disasters. Costs were estimated based on health impacts, lost income and increased poverty. The cost of environmental degradation was estimated to cost India about $80 billion annually, or about 5.7 percent of the GDP in 2009 (the reference year). As shown in Figure 6.6, urban outdoor air pollution exacted the highest costs- about $23 billion per year. This was followed by indoor air pollution at about $15 billion per year. Losses were concentrated among the poor, particularly children. (World Bank, 2013)

6.3.3 The Cleaner Production Experiences in India

The environmental policy and legal framework in India relevant to CP includes the Environmental Protection Act of 1986, a Policy Statement for Abatement of Pollution in 1992 which was explicit in promoting technology for pollution prevention and the Environmental Action Program of 1994 issued by the Ministry of Environment and Forests, which further focused on CP and on avoiding and managing hazardous materials and wastes. The National Environment Policy adopted in 2006 built upon the earlier policies, substantially strengthening requirements for waste management and incentives for clean technologies, innovation, environmental management systems and eco-labeling. (GOI, 2006)

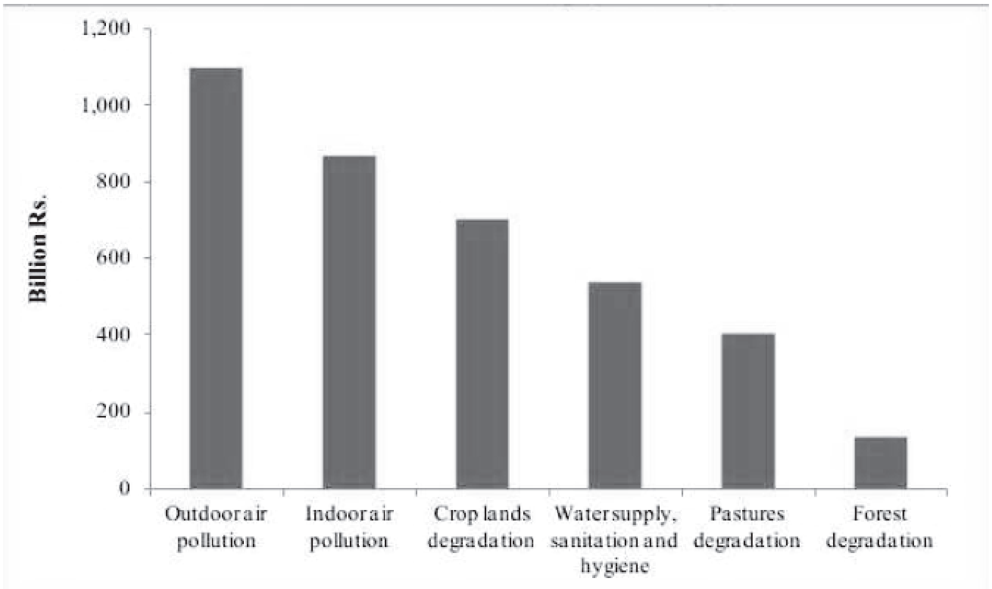


Figure 6.6 Annual costs of environmental degradation in India are about $80 billion (source World Bank, 2013)

Efforts to support increased implementation of CP approaches have been underway since the early 1990s. The government launched an eco-labeling scheme in 1991, Ecomark, which identified products that met national environmental and quality standards. Public disclosure and participation have been at the center of many initiatives, perhaps the most sustained being the Waste Minimization Circles which have supported lesson sharing among similar industries, stimulated entrepreneurship, and strengthened public participation, awareness, and local governance. The focus is now on supporting small-scale industries (National Productivity Council of India, 2013; GOI, 2012). A grant-in-aid scheme for "development and Promotion of Clean Technologies" was initiated by Ministry of Environment and Forests in 1994. The main objective was to optimize the consumption of raw materials and reduce waste generation using technologies that did not require changing production processes or unit operations, with priority recipients being MSMEs. This was complemented by a "Central Sector Plan Scheme", which supported piloting and demonstrating technology in highly polluting, mostly larger-scale industry (MOEF, 2012).

UNIDO and UNEP supported the establishment of a National Cleaner Production Center (NCPC) in India, based in New Delhi at the National Productivity Council, in 1995. Like other national NCPCs, the India center actively supported in-plant demonstrations, training, awareness-raising and other approaches with UNIDO and UNEP assistance and in collaboration with a variety of international, national and local private and public partners, then established regional CP centers in heavily industrialized or industrializing states, including Gujarat, Karnataka, Punjab and West Bengal in the late 1990s (Luken, 2007).

A number of internationally supported projects were undertaken in India in support of CP implementation, often as an element of broader environmental management programs. One of the longer lasting initiatives was the World Bank's two-phased project from 1990 to 2002 that included provision of industrial extension services for promoting CP. Much of that work was done through regional CP centers, and assistance to development finance institutions to prepare feasibility studies for CP investments (Luken, 2007). The Gujarat Cleaner Production Center (GCPC), a participant in the World Bank-supported program, has since demonstrated the sustainability of such support mechanisms. The state of Gujarat is one of most industrialized in India, as it is a major producer of chemicals and petrochemicals. Established by the Gujarat Industrial Development Corporation in association with UNIDO and NCPC, the Gujarat GCPC participated in the World Bank *India Environmental Management Capacity Building Technical Assistance Project* (1998), to develop and roll-out a CP strategy. The Gujarat GCPC remains very active today with a broad mandate from plant-level to eco-industrial park promotion, serving as a bridge between government and the private sector (pers. comm., GCPC, 2013; Tetra Tech, 2002).

Two other early CP projects that were undertaken as components of larger environmental programs are noteworthy because they also helped influence the government consideration of choosing between EOP and CP policies for dealing with rapidly worsening industrial pollution problems. In 1993, as part of its development assistance program the Danish government supported the preparation of an Environmental Master Plan for Dakshina Kannada District in Karnataka, a rapid industrial growth area. The project was designed to create an enabling environment to promote CP. A second project that was performed a few years later involved industrial waste from the textile industry centered in Tirupur. The Indian court shut down 44 plants because of their devastating pollution loads, demonstrating the powerful role that community pressure plays in such areas. ADB consultants engaged the Tirupur Exporters Association as a key stakeholder in order to identify and implement methods to avoid and reduce waste loads. This project was important because it opened the door for cluster approaches to CP (Environmental Management Centre, 1998; Misra, 2002).

One of the first major, stand-alone CP projects in India was the Demonstration in Small Industries for Reducing Waste (DESIRE) project. This was implemented from 1993 to 1995 by the National Cleaner Production Center of India and the Indian NCPC with support from UNIDO. The objective was to use practical demonstrations of waste minimization techniques in clusters of small-scale industries. The demonstrations were done in twelve companies in three industrial sectors - agro-residue based pulp and paper, textile dying and printing, and pesticides formulation. The intent was to demonstrate and validate the financial and environmental benefits of CP. The project design was based on the groundbreaking Dutch PRISMA regional waste prevention project, using practical waste minimization audits conducted by national consultants working with enterprise staff. Some of the region's first CP guidelines, tailored to local SME conditions, were prepared. A number of recommendations for CP policies were developed taking into account the results of an assessment of constraints and opportunities for applying CP in small-scale industries.

A review of the DESIRE project impact showed that about 540 waste minimization options were identified in twelve demonstration projects. Within 15 months, 38 percent of the options had been implemented. Another 32 percent were considered feasible with about half being implemented. About 30% of the options were considered by the factories to be infeasible because of lack of ready access to technology or requiring too large capital investment with inadequate financial return. A financial impact analysis of the first 196 options in eleven demonstration projects showed full recovery of the investment in less than six months for the pulp and paper and textile industries and in less than 14 months for the pesticides formulation industry (Van Berkel, 2004; Environmental Management Centre, 1998).

A separate review of implementation of CP in India identified a number of constraints to wide-scale adoption. There remained a perception that technology and other costs will put enterprises at a competitive disadvantage. In addition, several had already invested in common wastewater treatment facilities and secure landfills for hazardous waste and were not willing to spend more on the "environment". This was exacerbated by the availability of financial incentives for EOP, but not for CP. Other barriers identified were a lack of awareness of the benefits of CP; a lack of time and skills in MSMEs; larger enterprises valued operational knowledge of current processes, thus stifling innovation; MSMEs generally do not engage in long-term planning; lack of transparency from pollution control statutory agencies and the focus of pollution control boards is on compliance; and a lack of a grassroots level institutional framework (Rathi, 2003).

Recognizing the lessons being generated from the aforementioned and other projects, the government sought support from the Asian Development Bank to assist the development of a policy and financing framework for CP. Much of the effort of the Waste Minimization Circles, NCPC, and regional CPCs has been successful in promoting cleaner productivity related improvements and bringing entrepreneurs from MSMEs to discuss their environment and productivity issues on a common platform. A number of companies were supported but the growth of investment in

CP, particularly by SMEs, and improvement in environmental performance was less than encouraging. Thus the government developed a National CP Action Plan to ”enhance the quality of life and to conserve the resources available for sustaining development; by implementing the philosophy, policies, and practices of CP/CT in all sectors of the economy.”

The ADB study focused on the financing barriers for MSMEs to implement the CP strategy. Several barriers were similar to those being experienced in other countries in the region. They included lack of full cost pricing, high import duties, lack of access to capital, lack of financial institutions and frameworks, corruption, lack of human and institutional capacity, poor access to technology, inadequate awareness, lack of confidence in unproven technologies, and insufficient R&D. After consulting with numerous stakeholders, including twelve central government ministries and agencies, pollution control boards, banks, financial institutions, state-level financial corporations, chambers of commerce, research institutes, institutes specializing in SMEs, NGOs, professional institutions, media, and state and local governments, a set of recommendations was provided, which highlighted the need for policy integration. The study showed that many MSMEs were willing to invest in CP if the terms were concessional and the payback was less than one year. But the (i) policy and regulatory barriers, (ii) technology barriers, (iii) informational barriers, (iv) market barriers and (v) local capacity barriers prohibited them from doing so (Tetra Tech, 2002).

The financing challenge was further analyzed through a 2000 World Bank study in South Asia (de Lucia, 2001). A key barrier for MSMEs is access to credit. In addition, MSMEs need (i) a broader menu of financing support and financing services, especially guarantees and other credit conditioning and equity or quasi-equity investment monies; (ii) financing for pre-investment work (feasibility studies and so on); and (iii) support to development finance intermediaries which otherwise find it not worthwhile to work with the smaller enterprise, including measures to reduce or buy down transaction costs for early financing transactions (de Lucia, 2001).

Since the mid-2000s, consumption and resource intensity increased dramatically in India. (UNEP and CSIRO 2013). As noted above, this was accompanied by stagnant industrial growth and, as noted in Chapter 2, continuing environmental degradation due in part to inadequate industrial waste management. Some indications of energy intensity trends of key industries are presented in Figure 5.7. The government of India sought to address this challenge in the National Environmental Policy of 2006 and through its five-year planning process. The 12th Five- Year Plan (2012-2016) is unique in its emphasis on sustainable and equitable development. Thus a key objective of the 12th Five-Year Plan is to achieve its industrial growth targets in an environmentally and socially sustainable manner. It has identified the following as priorities in this regard:

- Mainstream and promote green business, as a primary focus at the corporate level;
- Protect natural resources;
- Address funding issues that constrain the transition to a sustainable industrial model, particularly for MSMEs;
- Support access to cleaner technologies by providing financial and technical support;

- Develop a framework for promotion of green products;
- Promote green public procurement through price incentives on government tenders;
- Encourage and develop voluntary rating programs;
- Create centers of excellence to promote green products and processes;
- Create incentives for life cycle inventories
- Create incentives for export of green products
- Strengthen and reform regulatory institutions;
- Implement the polluter-pays principle with pricing for specific pollution loads over a defined standard;
- Establish an integrated chemical management policy and regulatory regime;
- Adopt market-based emission trading schemes;
- Strengthen stakeholder participation (such as Waste Minimization Circles), including industrial associations, for improving environmental management of MSMEs;
- Create a common infrastructure for MSMEs in clusters;
- Short-term action to increase voluntary disclosure of environmental performance of enterprises; and
- Take long-term steps to compare environmental performance of enterprises with industry-specific benchmarks.

The government is also considering the establishment of new eco-industrial parks, recognizing the potential environmental and economic benefits of bringing together a community of manufacturing and service businesses to collaborate in managing and optimizing resources and minimizing wastes. The initial focus is on converting Special Economic Zones and townships along the Mumbai-Delhi industrial corridor into eco-industrial hubs (GOI, 2012).

In 2013, the Clean Technology Division of MOEF announced a new technical assistance and financing scheme for the "Development and Promotion of Clean Technology and Waste Minimization Strategies". This initiative merges, and builds on the lessons from the aforementioned Development and Promotion of Clean Technologies and Central Sector Plan schemes to streamline processes and improve linkage with R&D of technologies, again with priority being given to MSMEs. The objectives are to:

- Identify priority areas and develop economically viable clean technology and waste minimization strategies for MSMEs through interface with industry, R&D establishments, and academic institutions,
- Promote the adoption of such strategies by industry and industrial clusters through pilot and demonstration projects of prototypes; and
- Import and upgrade clean technologies, including demonstration through pilots.

Also in 2013, the Ministry of Micro, Small and Medium Enterprises (MSME) and Federation of Indian Chambers of Commerce and Industry launched a new Cleantech Programme for SMEs supported by UNIDO and the GEF. This program will promote clean energy technology and entrepreneurship in selected SME clusters through a clean technology platform and competition (GEF and UNIDO, 2013).

6.3.4 India's Growing Role in Climate Change

A low-carbon growth study (LCGS) was undertaken in 2005 in India to help the Government of India identify low-carbon growth opportunities, up to 2032, in major sectors of the economy. It showed how dramatically different the Indian challenges and opportunities were in comparison with other major emerging economies such as China. The Indian economy currently has a relatively low carbon footprint, largely due to the 400 million who lack access to electricity and low energy consumption of the poor (World Bank, 2011(a)). Though India is ranked third in national emissions due to the size of its economy and population, the per capita CO_2 emissions from fuel combustion, at 1.2 tons in 2007, was a fraction of the global average of 4.4 tons. During the last decade while India's economy has grown dramatically, its emission intensity has declined – in 2007 India's GHG intensity was 20% below the world average and 15% and 40% lower than the US and China intensities, respectively (Pew and TERI, 2008). India is one of the 20 countries in which CO_2 emission intensity declined successively since 1994 until 2006 (Kojima and Bacon, 2009).

The Climate Change Performance Index (CCPI) for 2011, prepared by Germanwatch and Climate Action Network - Europe, evaluates and ranks the 57 highest emitting countries based on their emissions and climate policies. The evaluation gave India particularly high marks for framing and implementing climate policy (CCPI, 2011). Many of these policies were contained in 5-year national development plans or other national policies for purposes of accelerating economic growth in a sustainable manner rather than for purposes of mitigating GHG emissions. A transformative action was the adoption by the Indian government of the Integrated Energy Policy in 2006, which promotes energy efficiency in all sectors, removes barriers to the use of clean technologies and supports the development of renewable energy (GOI, 2008). TERI estimates that if such policies were not in place, India's GHG emissions would have been about 20% higher compared to 'business-as-usual' scenarios in both 2021 and 2031 (Pew and TERI, 2008).

India launched its first National Action Plan for Climate Change (NAPCC) in June 2008. The NAPCC relies on the development and use of new technologies and an institutional framework tailored for effective implementation, including through public-private partnerships. It outlined eight "national missions" to be implemented through 2017. These include the National Solar Mission, the National Mission for Enhanced energy Efficiency, the National Mission on Sustainable Habitat, the National Water Mission, the National Mission for Sustaining the Himalayan Ecosystem, the National Mission for a Green India, the National Mission for Sustainable Agriculture, and the National Mission on Strategic Knowledge for Climate Change (GOI, 2008).

The NAPCC recognized that India faces tremendous challenges for it to substantially reduce its emissions below the current levels, partly due to its limited resources of alternative energy and economically available carbon storage sites (geological formations suitable for storing injected CO_2 that is stripped from coal-fired power plant emissions)(GOI, 2008). Like China, India relies heavily on coal. India uses coal to meet about 53 percent of its energy demand. India's energy intensity would have to be reduced by 2.5 percent a year from now to 2050, in order to significantly contribute to achieving a CO_2 concentration of 450ppm by the end of the century. This would require a doubling the efforts of the past decade. While the efficiency of coal-fired power plants in India has been improved in recent years, the average is still low at 29 percent. India has a large potential to improve energy efficiency, by reducing transmission and distribution losses, which are about 25 percent, the world average of 8 percent (World Bank, 2011(a)).

The industry sector is the largest user of commercial energy in India, accounting for 42% of the country's total commercial energy use during 2004-05 and growth rates exceeded 10% in 2006 (UNIDO, 2009). The NAPCC reports that direct CO_2 emissions from industrial sources accounted for nearly 31% of the total CO_2 emissions from the country (data for base year 1994) with about 60% of emissions from industrial fuel consumption (GOI, 2008).

The India low carbon growth strategy (LCGS) looked at emissions from six industrial sectors: (i) iron and steel (further separated into large integrated steel plants and small operations), (ii) aluminum, (iii) cement, (iv) fertilizer, (v) refining, and (vi) pulp and paper. Iron and steel dominates, accounting for nearly half of the total CO2 equivalent emissions in 2007 (Gaba et al, 2011).

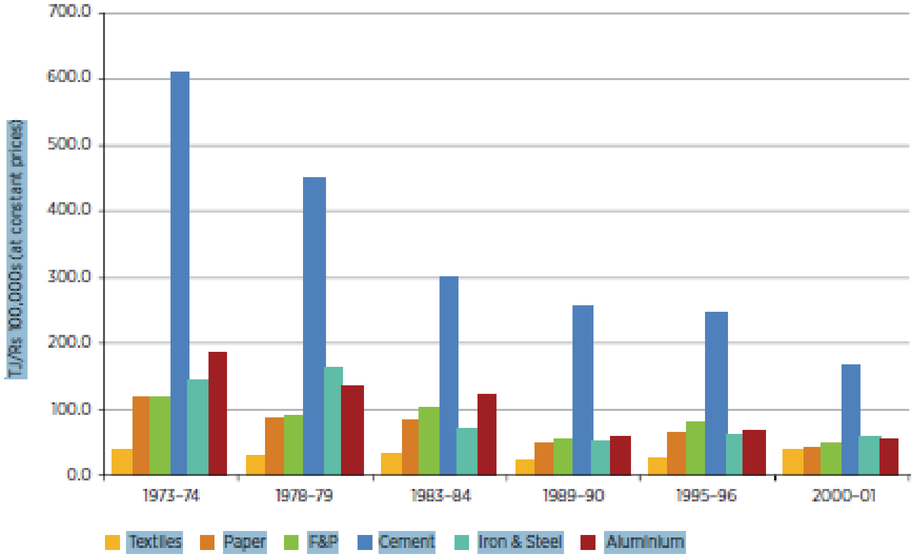
Figure 6.7 shows the projected emissions of these industrial sectors based on two scenarios. Scenario 1 reflects the NAPCC's goals. It is based upon substantial investments in low-carbon energy development and energy efficiency including provision of newer, more efficient, industrial processes. Scenario 2 is an "all-out stretch" whereby, policy and subsidy reforms, and necessary additional funding make it possible to maximize the use of energy efficiency and renewables for meeting industrial energy needs. The adoption rates of such changes are projected to be accomplished in 80% of the manufacturing facilities by 2020. This is based upon planned implementation of 340 greenhouse gas emission-reducing measures that have already been adopted commercially since 2006 in India and that have a financial rate of return of at least 10%. Such measures include energy efficiency improvement measures for all forms of energy as well as a few processes unrelated to energy use releasing greenhouse gases. Compared to Scenario 1, CO_2 equivalent (CO2e) emissions per ton of product are reduced by almost 20% on average by 2020 (World Bank, 2011(a)).

6.3.5 Energy and Low Carbon Growth

In the last twenty years, India has faced, and continues to face a major challenge in meeting the energy demands of its growing economy. A GDP growth rate of 8 percent requires an energy growth rate of 6 percent. Not only is India committed to meeting the energy needs of a growing industrial sector and rapid urbanization inhabited by a growing middle class, but it also needs to meet the needs of about 400 million poor who lack access to modern energy (GOI, 2012).

Coal is the most abundant primary energy source in India, amounting to 53 percent of installed commercial energy. But most of the country's coal reserves are in forest areas traditionally inhabited by India's tribal population. As a result, meeting domestic coal demands has been difficult. Meeting current planned energy generation capacity will require an increase of domestic production of coal from 540 million tonnes in 2011-12 to 795 million tonnes in 2016-17. Even then India will need to import 185 million tonnes of coal in 2016-17 (GOI, 2012). Because of severe electricity supply shortages, huge quantities of diesel and furnace oil are being used by all sectors, particularly by industry (CTF, 2012). By 2050, there is likely to be a 3.8-fold increase in primary energy demand with coal fueling 58 percent of the generation capacity (Shalizi, 2006).

Figure 6.7: Carbon Dioxide Equivalent Emissions from Six Industries Demonstrating Options in India for Low-Carbon Development



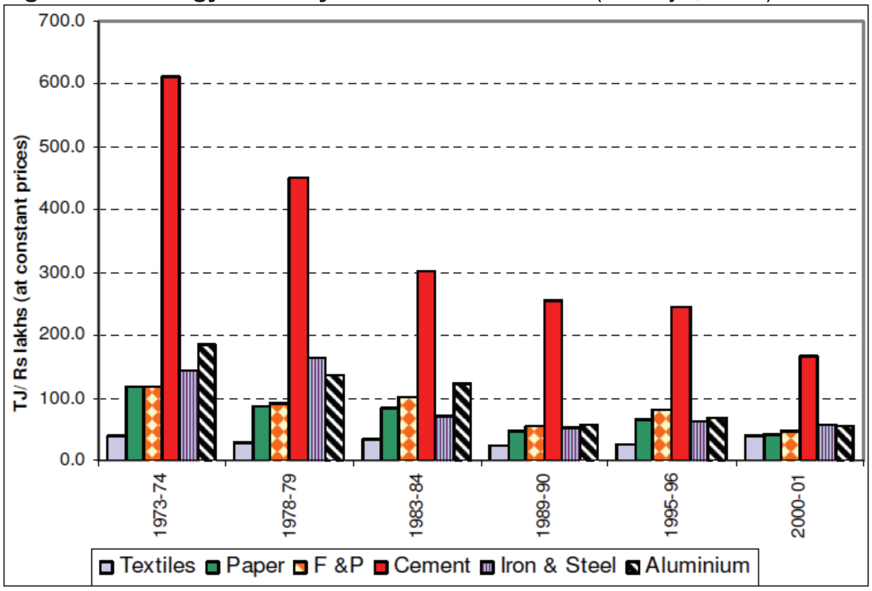
Source: Energy Intensive Sectors of the Indian Economy, World Bank, 2011(a)

Because of its reliance on coal, and because of the many inefficiencies in the way energy is consumed, India's gross GHG emissions are the world's sixth largest (McKinsey, 2009). India's energy consumption level on a per capita basis is low, but is expected to grow substantially in the coming decades (CIF, 2012). Market reform in the 1990s improved India's fuel quality, technology standards, infrastructure and operating practices. Energy use grew at 7% with electricity at 8% in the 1990s (Pew, 2002). In the last decade, India's intensity of GHG emissions per unit of GDP, are on par with the global average. However, India's per capita electricity use is one-sixth of the world average and per capita GHG emissions are among the lowest in world. India's per capita emissions in 2031 are projected to be lower than the global average per capita emission in 2005 (GOI, 2012).

The mounting pressure on conventional energy sources resulted in an energy efficiency target of 5 percent reduction in annual energy consumption by 2015. This target was set in India's first National Action Plan on Climate Change in 2008 (Gaba, 2011). With 35 percent of final energy consumption and a contribution of less than 20 percent of GDP, industry in India is particularly energy- and carbon- intensive (Sathaye et al, 2010).

India's historic energy intensity by industry sectors is shown in Figure 6.8. Late 2009, India announced it would reduce GHG intensity of its GDP by 20-25% from 2005 levels by 2020 (NPC, 2011). The government developed a low carbon growth model to analyze key sectors which have energy saving and GHG emissions reduction potentials. The model looked at five major sectors in the economy: electricity transmission, transportation, residential buildings, non-residential buildings and industry, which combined accounted for 60 percent of GHG emissions in 2004. The low carbon growth study showed opportunities for substantial savings, among others, through energy efficiency measures in the industry sector. But the tendency for a growing industrial enterprise is to choose production capacity expansion over energy efficiency improvement to increase market share, even if both energy efficiency and capacity expansion give positive rates of return (Sathaye, 2010; Gaba et al, 2011).

Figure 6.8: Energy Intensity of Industries in India (Sathaye, 2010)



India was a major beneficiary of the CDM, recording about 25 percent of all CDM projects, second only to China. Almost 3,000 projects were submitted between 2003 to 2011, most of them for industrial energy efficiency, fuel switching, and processes, as well as some for municipal solid waste and renewable energy (EBTC) (Urpelainen, 2012). The government of India recognized in 2010 that additional sources of finance would be required to achieve its low carbon path. The National Clean Energy Fund was set up in 2010, which aims to raise funds through a tax on coal. It is expected that the coal tax revenues will reach US$ 1.67 billion by 2015. The proceeds will be used to support projects, programs and policies that promote clean energy.

The government also adopted a Perform Achieve and Trade (PAT) scheme in 2010 to promote energy efficiency of manufacturing industries. PAT is an energy intensity type of cap and trade mechanism but does not place a cap on the total energy consumption of an industry. The first PAT cycle is 2012-2015, during which select energy intensive industries are assigned energy saving targets leading to a 4.2 percent energy intensity reduction. The next cycle will include more industries and the design will reflect lessons learned in the first cycle (GOI, 2012). A Renewable Energy Certificate mechanism was launched in 2012 to promote renewable energy and meet the country's renewable Purchase Obligations targets. Energy distribution companies will be required to meet a percentage of electricity by buying renewable energy or purchase RECs. The initial target (2010) was for 5 percent of the nationwide share of electricity to be sourced from renewables, increasing by 1 percent per year for 10 years. The 2011 market value was about $22.6 million (Sargsyan et al, 2011). These schemes are being built upon to establish a domestic market tailored to India's circumstances.

Like most other countries, India submitted an INDC late 2015. India's INDC is backed by a number of national strategies and plans. Key commitments include:

- reduce emissions intensity of gross domestic product (GDP) by 33-35% by 2030 from the 2005 level.
- achieve about 40% cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030 with the help of transfer of technology and low-cost international finance including from Green Climate Fund.
- create additional carbon sink of 2.5-3.0 million tonnes of carbon dioxide (CO_2) equivalent through additional forest and tree cover by 2030.
- better adapt to climate change by enhancing investments and development programs and sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health and disaster management.
- mobilize domestic and new and additional funds from developed countries to implement these actions to fill the resource gaps.
- build capacity, create domestic framework and international architecture for the diffusion of cutting-edge climate technology in India and for joint collaborative research and development for future technologies.

India's preliminary INDC estimate is that at least $2.5 trillion at 2014-15 prices will be required for meeting India's climate change actions between now and 2030. Preliminary estimates indicate that India would need around $206 billion between 2015 and 2030 for adaptation. Mitigation activities for achieving moderate objectives for low carbon development would cost about $834 billion until 2030- this is a low order estimate.

6.4 Conclusions

Together, China and India will have a major impact on the level of the world's success or failure in transforming societies to become sustainable. By 2030, the two countries combined will be the home of 35 percent of the world's population. About 54 percent of their combined 2.9 billion people will live in cities at that time. China will be the largest economy in the world by GDP based on purchasing power parity (PPP) and India will be the third-largest economy by 2030.

These two economies have been growing rapidly for the last two decades relying on massive investments in fossil-fuel-driven energy and industry, resulting in severe environmental degradation. In the 1990s both China and India adopted CP as a priority policy intervention for improving efficiency of industrial production and reducing its environmental impacts. Important lessons were learned regarding the barriers to implementing those policies, as well as the drivers to improve their success at the firm, community, and national levels. China was particularly progressive in the sense that it established a Cleaner Production law in 2002.

Both countries in the 1990s and 2000's focused on how to improve capacity of government and private sector, stimulate greater awareness and participation by a broad range of stakeholders, and implement programs targeted to improve adoption of CP by various manufacturing sectors. In China, the use of eco-industrial parks to stimulate industrial symbiosis was instrumental in establishing broader strategic development directions for the circular economy. In India a variety of financial and technology support incentives were institutionalized to stimulate an industrial transition towards CP.

In the last few years, China and India have shifted national policy and finance attention to climate change. Both countries suffer from energy shortages, particularly India, and have the potential to achieve energy security through use of low carbon technologies, and to dramatically reduce their growing contributions to global GHG emissions. Their INDCs are progressive, improving the chances that economic growth will be decoupled from fossil carbon reliance. This is much easier said than done since much of the economy, including many resource dependent cities, is tied to extraction and use of fossil fuels (Li et.al., 2015) The INDCs also recognize the need and set the stage for an improved focus on policy integration as both countries recognize the need to fully integrate their climate change strategies into the economic and social development processes and plans.

The lessons learned to date from attempting to adopt CP and low carbon development paths and understanding and planning to overcome the challenges ahead for both of these rapidly urbanizing and industrializing nations provides an important basis for answers to the thesis questions. The next Chapter derives lessons for CP and low carbon development which have been gained from the thesis survey and case study work in Thailand and the Philippines in the late 1990s, and from experiences and lessons learned since then. The combination of the lessons learned from China, India, Thailand, and Philippines cases together with the substantial knowledge base drawn from the literature is evaluated in detail in Chapter 8.

7. CLEANER PRODUCTION AND LOW CARBON DEVELOPMENT IN THAILAND AND PHILIPPINES

7.1 Introduction

The previous three chapters reviewed the experiences of numerous CP and low carbon development initiatives in Asian developing countries since 1995, including a detailed look at the experiences and plans in China and India. This chapter is focussed at the country level on Thailand and the Philippines. The review covers not only the countries' policies and programs to adopt CP as part of their respective industrial development priorities but also the more recent initiatives to transition their economies to be low carbon (research questions 1 and 3).

Case study surveys in Thailand and Philippines were undertaken as part of this thesis author's research in 1995-1997 in support of the thesis work and as an element of a major initiative to finance large-scale CP development. The case studies, while dated, nevertheless provide useful lessons that can be applied as countries' CP efforts evolve to include consumption as well as production, and as countries increase their focus on achieving low carbon development.

Government leaders of both Thailand and the Philippines recognized the potential benefits of establishing CP policies and promoting adoption of CP as a core element of industrialization. They were also both beneficiaries of international technical assistance, multilateral and bilateral, throughout the 1990s. This thesis author was fortunate to have had the opportunity to participate in that developmental process and to integrate some elements of the thesis research into the broader CP work programs in each of the two countries. At that time, in the 1990s, both countries were experiencing a growing concern and recognition of the impacts of industrial and other sources of environmental pollution. Both countries had EOP regulatory frameworks, but were experiencing mixed levels of success in enforcing the regulations. Foreign investment in their industrial development was growing, helping to generate greater interest by industry to reduce their pollution levels and impacts and improve production efficiency.

The financial crisis of 1997/98 had a devastating impact on the economies of both countries, particularly Thailand, and the CP programs also suffered due to reduced governmental support and lowered priority. The two case studies presented in this chapter were undertaken prior to the 1997/98 financial crisis, but the lessons learned, combined with an understanding of the evolution of CP after the 1997/98 crisis are relevant when considering the scaling-up and broadening of such policies and programs to address CP across sectors with special focus upon decreased resource intensity and improved efficiency challenges as the countries' economies improved after the most recent global economic crisis.

7.2 Establishing a CP Program in Thailand

Thailand experienced rapid population growth and modest industrialization on its agricultural and natural resource backbone from 1960 (population 26 million) to 1980 (population 47 million). The primary focus of industrialization was import substitution, with high levels of protection. By the middle of the 1970s, population growth trends were downward (current population about 67 million) and the economic focus was shifted from agriculture to export-led industrialization- key factors in Thailand's high rates of economic growth into the 1990s. (Siriprachai, 2009; Panayotu and Purasak, 1990). From 1981 to 1997, annual Thai GDP growth was higher than 8 percent and manufacturing contributed 75 percent. The country was home to over 120,000 factories and 30 large industrial estates. SMEs contributed about 90 percent of total output. But in 1997 the Thai economy collapsed and manufacturing struggled to survive- many smaller enterprises had to close. Following the collapse, services overtook manufacturing as the largest contributor to economic growth. From 2000 to 2007, annual GDP growth was around 5-6 percent. The 2008 financial crisis put a halt to such growth in Thailand. Recovery has been slower than that of many other countries in the region- partly a result of political turmoil- the Thai economy grew by about 0.9 percent in 2014. It is projected to increase up to 3.5 percent in 2015 (World Bank, 2015).

A number of initiatives to integrate CP into industrial waste management systems have been studied and some have been implemented in Thailand since the early 1990s. The initial activities were largely undertaken by the government, and by some industrial associations with support from international assistance agencies. Several bilateral projects were intended to raise awareness of CP in Thai industry. One of the first was the USAID-supported Federation of Thai Industries "Industrial Environmental Management Program" from 1990 to October 1995. The project promoted US cleaner technologies and included environmental audits in the textile dyeing, printing and finishing industries; pulp and paper industries; food processing and chemical industries; and the implementation of a number of pilot CP projects.

Towards the end of the USAID program, several other bilateral and multilateral initiatives were launched. From 1994 to 2001 German bilateral aid supported the Department of Industrial Works (DIW) in establishing an advisory program for industry sectors, focused on industrial waste management including preparation of industrial environmental management guidelines, policy-based initiatives and economic instruments such as promoting the polluter-pays principle, and technology and managerial know-how transfer. An important element of this program was the implementation of a few factory-scale CP demonstration projects, generating broader awareness of CP potentials. Similar demonstrations by the Carl Duisberg Gesellschaft (CDG), working with local academic institutions such as the Asian Institute of Technology (AIT), Chulalongkorn University and Chiang Mai University focused assistance on SMEs in the textile, electroplating and food industries.

By 1995, there was a heightened level of CP awareness in government agencies responsible for industrial development policy and pollution-related regulatory actions. The Ministry of Science, Technology and Environment (MOSTE) and Ministry of Industry (MOI), supported by academia and environmental think-tanks such as TEI, initiated an integrated effort to strengthen enforcement of industrial pollution control regulations and to avoid generation of such wastes and improve industrial efficiency through CP. The MOI established a CP center, starting with a major national workshop. With support from UNIDO, UNEP, and the WEC, the new Center brought together a range of key stakeholders from MOSTE, MOI, TEI, the Federation of Thai Industries, and others to participate in the first national CP workshop.

The objective of the 1995 workshop was to have an open brainstorming on how Thailand could implement a major initiative to promote CP in Thai industry. A first order analysis for the workshop showed how institutionally complex the program would be, given the range of stakeholders, and that a number of relevant initiatives had already been undertaken but with little impact in terms of extension or scale or sustainability.

The second order analysis was to understand the barriers. Industry members of the Association of Thai Textile, Bleaching, Dyeing, Planning and Finishing Industries expressed interest in initiating CP programs in order to meet government pollution regulations and improve access to global markets. However they explained that they were constrained by lack of access to finance since banks were not willing to provide loans for CP efforts. The Federation of Thai Industries expressed that the constraints were the costs of technology and unequal law enforcement by the Government. Some industry representatives also explained that their licensing agreements with foreign companies prohibited switching production technologies. The TEI considered the primary constraints as access to technology, marketing, funding and finance, and that the existing national legal framework favored end-of-the-pipe pollution control. The MOSTE emphasized the lack of information and awareness and inadequate human resources. The Thailand Institute of Scientific and Technological Research and Chulalongkorn University, whose roles were more in research and development, expressed the constraints as being budget and personnel. The MOI identified lack of competent staff and lack of interest on the part of industry as being their major barriers.

Most of these participants identified lack of human resources as a critical barrier. The participants concluded that external support would be required for (i) development of strategy and promotion schemes; (ii) awareness raising materials, manuals, literatures, videos, etc.; (iii) expertise on CP applied to specific industries; (iv) demonstration of CP equipment; (v) specific technology/CP information; (vi) training-of-trainers for CP; and (vii) adoption of CP audit procedures. It was agreed that a Thai CP Center should be established with its central objectives should be to promote cleaner industrial production through dissemination of information, to organize demonstration projects, to coordinate training programs, to identify needs and provide advisory services to industry, to stimulate applied research in CP technologies and provide advice to key policy makers of the advantages of incorporating CP. The meeting did not appear to come up with a timetable for CP. (Feria, 1996; TEI and UNIDO, 1998)

Bilateral assistance to Thailand from countries like Australia, Canada, Denmark, and Japan was initiated or scaled-up in the mid-19990s to bolster the fledgling CP program. ADB also became a major source of multilateral support. The most substantive bilateral assistance was the Danish supported project, “Promotion of Cleaner Technology in Thai Industry", which was designed to strengthen Thai environmental auditing and clean technology expertise at the implementing/advisory level. The project became operational in May 1996 and was channelled through TEI and the Federation of Thai Industries. Food, electroplating and textile industries were given priority, including some factory-scale CP demonstration projects. In addition, a clean technology information center was established at TEI to collect and disseminate national and international information on CP to Thai audiences. (UNIDO/TEI, 1998; Chokchaitrakulpho, 2002)

The Thai CP program became much more substantive and prominent after MOSTE organized a "Workshop on Determination of Direction and Coordination of Work of Pollution Control and CP" in February 1997 in Bangkok. The workshop was attended by a number of participants from a wide range of concerned organizations. Participants focussed on overcoming barriers to adopting a national-scale industrial CP program. The lack of a clear governmental CP policy and strategy at the national level was viewed by all stakeholders as the most critical barrier to widespread adoption of CP. As such, there was neither a "carrot" nor a "stick" for the industry to understand and then adopt the CP concept in their daily operations. This showed a clear need for a national CP policy and accompanying action plan from the government, and this conclusion guided the subsequent efforts to scale-up a national CP Program.

That 1997 national workshop was an important step for Thailand's efforts to get a handle around the growing, and often weakly governed industrial pollution problem, and set the stage for substantial new technical assistance and investment programs in support of CP. It also set the stage for Thailand, with support from the ADB and the Danish Government, to host the first *Asia Pacific Roundtable on Cleaner Production* in Bangkok in November 1997. Concurrently, the Pollution Control Department of the Ministry of Science, Technology and Environment took the lead in policy formulation and designing a national institutional framework, with assistance from ADB (Huisingh, 1998).

7.3 Samut Prakarn Thailand Case Study

7.3.1 Introduction to Case Study Area

Samut Prakarn Province in Thailand was selected as a case study area for this thesis because it was one the most rapidly industrializing zones in Thailand, suffered from heavy industrial pollution, and was the location of most of Thailand's CP projects. Samut Prakarn Province, one of five provinces that comprise the Bangkok Metropolitan Region, is situated southeast of Bangkok City and spans the Chao Phraya River between the southern boundary of the metropolis and the Gulf of Thailand. At the time of the case study (1997) the population of the province was estimated to be 1.4 million persons, including an estimated 300,000 temporary industry and construction workers. The average annual population growth rate for the whole province was about 3.5 percent but exceeded 10 percent in some rapidly industrializing areas. This growth rate may be compared with the 1997 national average rate of growth of less than 2 percent.

Sanitation and wastewater management facilities in Samut Prakarn Province were inadequate and what infrastructure was available was ineffective in dealing with the large wastewater flows generated by residents and over 4,000 factories. Most houses and other buildings have cesspits or septic tanks, which are generally inadequate or unsuited to the high density of development. Most of the effluent and sewage from septic tanks was discharged either to canals or to roadside drains. The drainage systems served the most urbanized districts, but were comprise of flat-graded drains designed to convey rainwater to the canals. When it does not rain, these drains accumulate large quantities of septic wastewater. The result has been severe degradation in water quality and deterioration in public health as evidenced by the increase in the incidence of water and sanitation-related diseases (see Tables 6.1 and 6.2). The severity of the pollution problem led to the designation of Samut Prakarn Province as a pollution control area in 1994, which ensured Governmental priority for funding for environmental improvements.

At the time of the case study, of the 757 major wastewater generating industries in the province, only about 230 operated in-house treatment facilities. The results of field inspections as part of an ADB-financed study indicated that only about 10 factories in the east bank area produced effluent that regularly conformed with the Government's effluent standards and none of the factories in the west bank area appeared to be meeting the standards.

Water quality in the canals in the province had deteriorated to critically low levels, with large numbers of waterways exhibiting dissolved oxygen (DO) levels of zero. A DO level of at least 2 milligrams/liter (mg/l) is considered essential for the maintenance of aquatic ecology. Without effective pollution control, it is conceivable that most of the canals in Samut Prakarn Province could eventually become entirely septic. Most of the beneficial uses of the water from the Chao Phraya River, except navigation, have now been lost.

The poor public health conditions for those living along the waterways and in proximity to the factories discharging wastewater degraded quality of life. The families living in these areas experienced unpleasant odors, illness due to exposure to inadequately treated domestic waste and toxic effluents from inadequately treated factory waste and the loss of the khlongs (canals) as a source of water and seafood. The situation was further exacerbated by the low-lying nature of Samut Prakarn. The average elevation is 1-2 m above sea level but there are now areas below mean sea level due to subsidence from over-pumping of groundwater, primarily for industrial water supply. This has resulted in permanent bodies of stagnant water in many areas and periodic flooding due to tide and rainfall in the catchment. The latter can result in the inundation of living and food preparation areas with a hazardous cocktail of solid waste and untreated domestic and factory waste.

According to Department of Health records in 1993, water-related diseases accounted for 4 of the top 10 causes of morbidity in Samut Prakarn (see Tables 7.1 and 7.2). It was likely that some of the cases of food poisoning were a result of the fecal-oral transmission of pathogens. According to Ministry of Public Health statistics, Samut Prakarn has rates of incidence of diarrhea and severe diarrhea, which are above the average for Central Region Provinces. This is indicative of the seriousness of water-related diseases in Samut Prakarn.

Table 7.1: Poor public health due in part to environmental degradation in the early 1990s stimulated waste management and CP initiative: The Top ten Reported Cases of Sickness in Samut Prakarn (1993)

	Disease Type	Reported Cases of Sickness	Sickness Rate per Population (100,000 persons)
1	Diarrhea	18,656	2,035.95
2	Conjunctivitis	1,979	215.97
3	Fever	1,312	143.18
4	Pneumonia	1,133	123.65
5	Severe diarrhea	929	101.38
6	Dysentery	657	71.69
7	Chickenpox	550	60.02
8	Food poisoning	518	56.53
9	Non-gonococeal arthritis	477	50.06
10	Gonorrhea	467	50.96

Source: Samut Prakarn Provincial Health Department

Table 7.2: Incidence of Water-Related Infections in Samut Prakarn (per 100,000 persons, 1990 – 1992) show severity of water pollution

Water-related infection	1990	1991	1992
Diarrhoea	2,543 (2,124)[1]	2,814 (2,236)	2,482 (2,329)
Severe diarrhoea	272 (70)	698 (60)	343 (40)
Typhoid	6 (106)	16 (86)	50 (76)
Dysentery	48 (121)	116 (133)	54 (124)
Helminth related disease	677 (854)	533 (781)	570 (799)
Malaria	66 (996)	62 (735)	43 (695)

1. Average rates for the Central Region Provinces are given in brackets
Source: Division of Health Statistics, Ministry of Public Health

No information was available on the health effects in the Province of exposure to toxic materials and toxic wastes. The general disregard of the Government and industry to the issue of industrial pollution no doubt resulted in long-term health impacts to the community. Data from the Provincial Fisheries Department indicate that higher than permissible levels of copper and lead were found in seafood caught off the coast of Samut Prakarn. The industrial pollution surveys undertaken as part of the ADB Samut Prakarn studies in 1987 and 1994 showed that significant quantities of toxic and hazardous wastes were discharged to the receiving aquatic environment and, as noted by the research, those families living in low-lying and often informal housing around factories, were clearly exposed to the health risks.

Industrial growth in Samut Prakarn far outpaced the rest of the country during the rapid industrialization of Thailand from 1980 to 1995. This is exemplified by the differences in data collected for two ADB studies carried out in 1987 and 1994 with regards to number of industries, land area used by industry and gross provincial product. The Provincial industrial growth prior to the case study is characterized in Table 5.3. Industries range from food processing, pulp and paper, textile and associated clothing manufacturing, chemicals, car and other forms of transportation vehicle assembly plants, and other heavy industries including steel, zinc and metal plating, and many others. At the time of the thesis survey, textile industries contributed about 24 percent of total wastewater flows, while pulp and paper factories generated about 14 percent, and food-processing industries contributed about 11 percent of the total. Together, these three sectors made up about 49 percent to the total industrial wastewater flow.

Two industrial estates have been developed by the Industrial Estate Authority of Thailand (IEAT). Bang Pu Industrial Estate had 186 factories, including several chemical plants, and employed about 32,000 people. Bang Pli Industrial Estate had about 100 factories employing about 10,000 people.

By far the majority of industrial developments are on privately owned, small plots of land. The industrial growth has predominated along roads where private plots of marshy land have been filled and developed. This has resulted in ribbon development along the main roads. All types of industries are located in these ribbon developments. Large car manufacturing plants, food industries and chemical factories can be found next to each other. Numerous tanning and dying industries are located in the south-west area near the mouth of Chao Phraya River, while concentrations of textile industries are found in one of the most densely populated urban zones. In addition to the above developments, there are also numerous small industries (including home industries) scattered throughout the region. (ADB, 1995)

7.3.2 Case Study Methodology

7.3.2.1 Survey Design

A structured survey of industries in Samut Prakarn was undertaken by team of Thai students under the supervision of this thesis author. The survey was designed to accomplish two objectives. The first was to determine willingness-to-pay for connections to a newly proposed central (regional) wastewater collection and treatment facility[7]. The secondary objective of the survey was to assess readiness of factories to participate in a CP initiative. In particular the survey collected information on (i) current waste management practices and awareness/willingness/barriers to adopt CP in order to design a new provincial CP support program and (ii) to assess the willingness-to-pay (WTP) for environmental services (mainly centralized wastewater management) and CP services. The survey was also designed with the intention of building on the experience so that the survey could be improved and replicated in other areas in Thailand and in other countries.

[7] A subsequent willingness-to-pay study was undertaken building on the results of the thesis survey- “Water Quality Improvements: A Contingent Valuation Study of the Chao Phraya River” (Tapvong and Kruavan 1999)

Based on experiences with similar analytical requirements (mostly for water supply development) in developing countries, the author initially proposed to undertake a structured survey of industries in Samut Prakarn using the contingent valuation method (CVM). The use of CVM was deemed appropriate since a major objective was to determine willingness-to-pay for environmental services. In doing so, rather than attempting to infer from behavioral information how much an industry is willing to pay for improved production/waste management, one asks outright how much the industry would be willing to pay to improve production or avoid pollution charges/penalties. This approach has several important advantages over indirect methods. It can be used to value services that are impossible to assess with indirect approaches. For example, it can be used to evaluate the benefits of increased availability of financing for factory improvements, or the reaction of industries to pollution charges or penalties which have not been enforced in the past but are about to be invoked, or the reaction of industries to alternative approaches to technical or managerial support related to a CP program. (Mitchell and Carson, 1989)[8]

For the Samut Prakarn case study, WTP was defined broadly. WTP may cover critical questions such as the conditions an industry may require in order to connect to a centralized waste management system and/or induce participation in a CP program and incentives and disincentives an industry may respond to in determining whether to invest in environmental improvement and the role of CP in such an investment.

As experienced in the case study survey, this direct approach had two obvious drawbacks: (i) the individual may not know how the industry would react if offered the opportunity to participate at a specified price; and the individual may know but not tell the truth. In either case, whether or not respondents answered WTP questions accurately is an empirical problem.

Contingent valuation surveys are typically based on either of two types of WTP questions. (1) Respondents may be asked a direct, open-ended question such as: "What is the maximum amount of money you would be willing to pay (for a specified good or service)?" Or (2) respondents were presented with a specific choice which requires a yes/no answer: for example, "Suppose the government imposes a fee for wastewater disposal and provides an option of participation in a CP program which would reduce your waste discharge volume or waste characteristics. Assume that with your present production and housekeeping practices, the waste discharge fee was x (in local currency), and that the monthly tariff (perhaps for a given volume of waste) was y as opposed to a and b if you invested c in the CP action. Would you choose to invest in the CP action?"

The two formats yielded two different types of data. Responses to direct, open-ended questions were in the form of "point" estimates of industries' WTP; that is, they elicited a specific estimate for each industry in the sample. Answers to the yes/no questions provided less precise information: all that we know from a single

[8] The CVM approach has recently been used to understand willingness-to-pay for climate protection (Masud et.al., 2015).

respondent's answer is that the industry would be willing to pay the specified amount (or presumably any lower sum).

There were six main options for using open-ended and yes/no questions in a contingent valuation survey. Option 1 involved asking only a single direct, open-ended question. If respondents could always provide accurate, reliable answers to such a question, this clearly would be the preferred question format. Option 2 was to ask a single yes/no question of each respondent, but to vary the price offered across respondents. Options 3 and 4 both involved asking the respondent two WTP questions. Option 3 was a combination of Options 1 and 2. Each respondent was asked a single yes/no price question, and the specified prices are varied across subsamples of respondents just as described above. After the respondent answered the yes/no question, he (or she) was then asked a follow-up, direct question regarding the maximum the industry would be willing to pay. Option 3 had an important advantage over either Option 1 or Option 2: it yielded two distinct sets of data on respondents' willingness to pay, each of which were analyzed to develop estimates of industries' WTP. Since the follow-up, open-ended question was asked second, there was no risk that asking it would influence the answer to the yes/no question. Responses to the yes/no question were analyzed just as with Option 2.

Answers to the open-ended follow-up question were analyzed to elucidate the determinants of the respondents' WTP bids. In this case one of the determinants of a respondent's WTP bid was the price that was offered in the yes/no question. Ideally, the price offered in the yes/no question should not influence the final answer to the follow-up, open-ended question, but this was tested statistically in a multivariate model of the determinants of the WTP bids. Option 3 was generally considered to be one of the most desirable question formats for contingent valuation surveys.

Option 4, which involved two yes/no questions without follow-up, is known as an "abbreviated bidding game": the first question asked whether the respondent would pay *x*; the second question posed some higher or lower price (*s'*). The two yes/no questions defined four categories for the WTP bids: (1) yes-yes, (2) yes-no, (3) no-yes, and (4) no-no. The respondent's answers to these two yes/no questions determined which of these four categories into which the WTP bid was selected.

Option 5 can be termed the "abbreviated bidding game format with follow-up". Using the modified version of Option 4, Option 5 required that a respondent answered either one or two yes/no questions and one direct, open-ended question:

Group 1: Low Starting Value

- Step 1: Ask the low starting value; if the answer is no, go to Step 3; if yes, go to Step 2.
- Step 2: Ask the high starting value (the initial value for group 2); whatever the answer, go to Step 3.
- Step 3: Ask the respondent's maximum WTP for the service described.

Group 2: High Starting Value

- Step 1: Ask the high starting value; if the answer is no, go to Step 2; if yes, go to Step 3.
- Step 2: Ask the low starting value (the initial value for group 1); whatever the answer, go to Step 3.
- Step 3: Ask the respondent's maximum WTP for the service described.

As with Option 3, there was little cost associated with asking the follow-up question. Option 5 (using the modified version of Option 4) was one of the more desirable question formats.

Option 6 involved asking the respondent three yes/no questions. This question format, termed a "bidding game", was one of the first procedures used in the early development of the contingent valuation method. The principal advantage of Option 6 was that the series of three yes/no questions could be used to simulate a market-like bargaining process in which the enumerator raised or lowered the price depending on the respondent's answer. This feature of the bidding game format has proved to be of value in some developing countries. However, the available evidence indicates that respondents' answers to later questions in a bidding game are conditioned on the starting value and the responses given to each previous question (this effect may also be present in Options 4 and 5). Thus, many analysts have concluded that little additional information is obtained by rapidly asking such yes/no questions. Most researchers and practitioners working with the contingent valuation method in industrialized countries have abandoned the use of the bidding game question format.

For developing countries, on the other hand, there is some anecdotal evidence that bidding games may be a useful approach for asking WTP questions. People in such areas are often quite comfortable with the bargaining style of a bidding game, and, in fact, may even be offended if the enumerator stops after venturing only one question. The appropriate question format for a specific site and culture must be based on judgment and experimentation.

The two main concerns were whether respondents will answer WTP questions honestly and accurately, and whether WTP responses are reliable measures of value. In this context reliability can be viewed either as the variance of a sample of WTP responses around the "true" mean WTP, or as the probability that a respondent's answer to a WTP question would be the same if he or she could be repeatedly tested (or asked the WTP question many times). If the reliability of WTP responses is poor, answers to WTP questions may be of little value, even though respondents did not intentionally give inaccurate answers.

Systematic (that is, nonrandom) differences between respondents' answers to WTP questions and their true willingness to pay can arise for other reasons. Respondents in a particular cultural context may feel it inappropriate to answer some kinds of questions in specific ways or may attempt to give answers that they think will please the enumerator. This "compliance bias" can result in substantial differences between reported and true WTP values.

Differences can also occur because the description of the pollution fees, costs of CP, benefits of CP or other goods or services and the terms under which it would be provided (the "CV scenario") might not convey what the survey designer intended. This is not a "bias" introduced by the respondent, but an error introduced by the survey designer. It results from miscommunication: the respondent provides an answer to a question that the designer does not realize was asked or implied by the wording or format of the survey. If a significant number of respondents misinterpret the scenario, and reply in a similar way, this systematic error may distort the survey results. One of the critical elements of the CV scenario is a convincing argument that the government will enforce pollution control regulations and industries will for the first time be subjected to such enforcement.

One often-overlooked source of unreliability in aggregations of WTP responses is sampling error. Many contingent valuation studies reported in the literature have used quite small sample sizes, such that the results can be generalized to the population only with wide confidence intervals. Poor, nonrandom sample selection procedures may likewise introduce systematic biases into a study. This study took into account the sample size requirement to minimize confidence intervals.

Despite these potential pitfalls, recent assignments of contingent valuation studies suggest that self-reported preference from WTP questions for goods and services with *use value* are generally much more reliable than economists have traditionally thought. Such studies have been applied primarily for planning improved water and sanitation services but based on discussions with specialists in ADB; the method was determined to be applicable for the thesis study.

The Samut Prakarn case study survey design utilized a combination of CVM options 5 and 6. The author prepared a draft questionnaire in English. The draft questionnaire was used for an initial trial survey in four large multinational factories where the discussion could be in English. The draft was revised on the basis of the first trial and was then translated to the Thai language. The survey is included as Appendix 1. A variety of approaches were then used in conducting two more trial surveys, a total of 20 factories of varying sizes, with the format of the questionnaire being revised following each trial (the questions remained the same). The additional trial surveys were required to ensure that the target respondents of the survey, the owners or general managers would be willing to participate in the survey and to determine whether WTP responses appear accurate and reliable. The comments from the trial survey factory managers were consistent in emphasizing the need to minimize the interview time with the factory managers.

Based on a critical assessment by the Thai survey team leader and this thesis author, the survey was divided into two main parts. Part 1 was designed to enable completion by the factory managers without the presence of the survey team. The Part 1 questions referred to factual information on the respondent's background, the production and waste streams, and the production and waste disposal costs. Part 2 questions were reorganized to facilitate efficiently conducting the survey and compartmentalized to facilitate ease in data analysis.

Another important objective of the trial surveys was to provide training and guidance for the surveyors. Eight fourth-year sanitary engineering students from two of the leading Thai universities (Kasetsart and Chulalongkorn) volunteered to work with the survey team leader. These students were selected because of their interest in CP and their expectations to prepare research papers on the basis of the survey. The students went through a weekend training program on the survey objectives, scope, and technique, utilizing guidelines prepared by the author. The author periodically met with the students and Government counterparts participating in the surveys in order to review the survey results. This enabled the recording of the students' observations of the factory managers' responses as well as the students' opinions on how the survey process could be improved.

7.3.2.2 Sample Size, Selection and Procedure

The target sample size selected was initially 100 factories, with about equal representation for small, medium and large enterprises, and proportionate representation of types of industries. The number of factories selected was based on the availability of resources to carry out the survey as well as the consideration that it could represent at least 10 percent of the major polluting factories. It was originally planned to pre-select factories to be surveyed utilizing a 1994 factory database. These factories covered a range of small, medium and large-scale factories, a diversity of types of factories, and the major polluting industries in the area. However, it was found that there were too many inaccuracies in the database- the geographic information system (GIS) used to locate and provide information on production and waste flows was not sophisticated enough to be applied for the CP survey. As a result, the survey team developed a new GIS-based factory map/database.

In conjunction with the development of the GIS, the survey team made initial contacts with prospective participating factories. This task was made difficult by the lack of any accurate directory of factories. It was found that English language names of factories do not often correspond with the Thai name. The listings of addresses and telephone numbers of many of the factories were inaccurate. It was particularly time consuming to track down and contact owners and managers of small factories. Eventually, by using the directories of the DIW, FTI, and several factory clubs, it was possible to identify and locate several hundred factories. Based on the limited information available on each factory, a list was made of those to be contacted for the survey.

A total of 479 factories were contacted at least once by phone (most were contacted two or three times) to determine their willingness to participate in the survey. This step was also a challenge. First, in large (over 1,000 employees) and some medium-sized (200 to 1,000 employees) factories, it was difficult to gain access by phone to the general manager. It was very important to be prepared and able to explain clearly and briefly about the survey objectives and expectations. It was relatively easy to contact the owners or general managers of small-size (less than 200 employees) and some medium-size factories but they were generally much more reluctant to participate in the survey because of the financial crisis which had just started affecting Thailand. It was particularly important to convince the owner/general manager that the individual factory responses would not be released to anyone.

Out of the 479 factories contacted, 83 agreed to participate in the survey. An interview schedule was agreed with each factory. Following the aforementioned student training, three student survey teams were formed (two students on each team). For the first week of the surveying, an experienced survey team leader accompanied each team. This was to ensure proper procedures were followed in approaching and questioning the interviewee and recording the results. It was possible to interview two factories each day. At the end of the survey day the teams and the team leaders met together to discuss the lessons learned and the next day's program.

The author prepared a standard interview procedure and related instructions to be followed by the survey teams. The procedures and instructions were modified as required on the basis of the experiences of the survey teams. The first task in the interview was to assess the attitude of the interviewee regarding environment, as this was expected to affect the responses to the survey questions. Age, education level and type of education (e.g., engineer, economist, or business), income level, number and age of children (this sometimes influences attitude about environment), concern about the villagers or inhabitants of the area around their factory, and similar influential factors on attitude were assessed and recorded. When asking yes or no questions the interviewers attempted to get clarifications as deemed appropriate. When asking questions intended to give financial WTP indications and referring to investment costs, fines and other financial disincentives, costs of services for qualifying for ISO 9000 and 14000, the interviewers did not limit the questions to the monetary ranges in the questionnaire. The purpose was to narrow down the amount considered reasonable by the interviewee.

7.3.3 Case Study Results

In general, the priorities for the manager were production cost, efficiency, and profitability. Many included improved housekeeping as a high priority. Environmental commitment was very secondary- but this attitudinal attribute was more related to the education of the owner/manager than the size of factory.

The responses to queries regarding CP were mixed- with a strong awareness on the part of several factory managers and a complete lack of awareness from many others.

The barriers to CP highlighted by industry at the workshop on CP referred to in section 6.2, were repeated by several managers. Several noted that inconsistency by the Government in environmental regulatory policy and lack of enforcement resulted in factory leaders ignoring regulations because it was easier to pay "fines" and also because about 20 percent of factories were not inspected by government officials the previous year. If the Government actually enforced existing regulations, that would be viewed as the most important disincentive (show that they mean what they say). Increased costs for water and wastewater were much less of a concern or disincentive.

The most important incentive to encourage adoption of CP was a tax/duty break. Improved access to attractive financing was the second most important incentive. Other key messages from those surveyed, regardless of factory size, were (i) training/awareness/demonstration projects should be delivered through industry associations (not government) and (ii) if assistance provided is considered reliable, they will form a factory team.

Large factories were particularly concerned with confidentiality in participating in any program where lessons would be shared. Multinationals' policies were driven more by parent companies than local regulations/policies. Large non-multinationals, mostly export-oriented, were willing to consider investments, ISO certification, etc as medium-term business developments.

Financially sound, export-oriented medium-sized factories responses were similar to large non-multinationals. However, small and most medium-sized factories were preoccupied with the prevailing economic crisis- not interested in talking about anything but how to stay in business. Many smaller factories were not eligible for membership in associations or otherwise not active in associations. Most of their production for domestic consumption and there was a general lack of awareness of linkages with product and consumer chains.

It was found that the likelihood of increased water supply costs and planned introduction of wastewater levies was not a major concern for many respondents. This was a surprising result, and probably was linked to the lack of awareness of the current costs, particularly for small and medium sized factories. Most factories (97 percent of the sample) operate an existing in-plant pretreatment system that had not been upgraded or renovated for 10 years. Over half of factory managers surveyed were unable to estimate either their total factory capital costs or their total treatment capital costs. Of the 30 percent who could make an estimate, half valued their treatment plants at 10 percent or less of their capital cost (excluding land). Very few factory managers surveyed were able to estimate either total production costs of their plant or the operating costs of the treatment system. Of the 30 percent able to answer, the operating costs of the treatment plant accounted for 1 percent or less of total production costs for the majority of firms. Almost half of the managers planned to upgrade and/or renovate their waste treatment facilities, suggesting the possibility that industries may be keen to participate in a CP program on the basis of minimizing expenditure on individual pretreatment facilities. But most managers planned to utilize the same pretreatment process.

Table 7.3: Overview of Samut Prakarn Cleaner Production Survey Results

Items	Numbers	% of Interviewees
Total Factories Approached	479	100.00%
Factories given interview (Questionnaire	87	18.16%
Factories providing information in	75	86.21%
Factories providing just Part 6 of Form 1	77	88.51%
Factories Size (based on number of		
Small scale: < 200 employee	38	43.68%
Medium Scale : 200 – 1,000 employee	42	48.28%
Large Scale: > 1,000 employees	7	8.05%
Factories Type Distribution		
Food Processing Industries	23	26.44%
Textile Industries	21	24.14%
Paper Industries	6	6.90%
Chemicals Industries	14	16.09%
Others	23	26.44%
General Information about the factories		
More than 20 years old	43	49.43%
Produce for domestic consumption	51	58.62%
Employ Batch process only	26	29.89%
Machinery		
< 200 Horse Power	3	3.45%

200-5,000 Horse Power	31	35.63%
5,001 to 50,000 Horse power	31	35.63%
Capital Investment		
<100 million Baht	31	35.63%
100 – 2,000 million Baht	32	36.78%
> 2,000 million Baht	3	3.45%
Production Cost		
<10 million Baht	9	10.34%
10 – 100 million Baht	14	16.09%
101 – 1,000 million Baht	26	29.89%
> 1,000 million Baht	7	8.05%
Monthly Groundwater Usage in cu.m.		
<. 1,000 cu.m.	6	6.90%
1,000 – 5,000 cu.m.	13	14.94%
5001 – 10,000 cu.m.	9	10.34%
10,001 – 50,000 cu.m.	20	22.99%
> 50,000 cu.m.	5	5.75%
Monthly Water Supply Usage		
<. 1,000 cu.m./day	17	19.54%
1,000 – 5,000 cu.m./day	9	10.34%
5001 – 10,000 cu.m./day	2	2.30%
10,001 – 50,000 cu.m./day	9	10.34%
> 50,000 cu.m./day	3	3.45%
Recycle Practice		
Water recycle	26	29.89%
Steam Recycle	21	24.14%
Incur following cost as percentage of total		
1-5 % on energy	23	26.44%
< 0.5 % on water	30	34.48%
> 80 % on raw materials	16	18.39%
< 0.5 % on wastewater treatment	18	20.69%
Annual Electricity Cost		
Pay up to 10 million Baht/year	44	50.57%
Pay 10 – 100 million Baht/year	18	20.69%
Pay >100 million Baht/year	3	3.45%
About wastewater treatment plant		
Has WWT plant	56	64.37%
Has effluent BOD > 20 mg/l	15	17.24%
Has general problem with WWTP	14	16.09%
Has plan to upgrade WWTP	20	22.99%
Daily Wastewater generated in cu.m		
< 100 cu.m./day	25	28.74%
101 – 500 cu.m./day	18	20.69%
501 – 1,000 cu.m./day	10	11.49%
> 1,000 cu.m./day	10	11.49%
Cost of wastewater treatment		
< 10 Baht/cu.m.	15	17.24%
10 – 15 Baht/cu.m.	3	3.45%
16-20 Baht/cu.m.	4	4.60%
21-30 Baht/cu.m.	3	3.45%
> 30 Baht/cu.m.	4	4.60%
Monthly Operating cost of WWTP		
<20,000 Baht/month	9	10.34%
20,001-100,000 Baht/month	7	8.05%
100,001 – 400,000 Baht/month	10	11.49%
> 400,000 Baht/month	5	5.75%

Table 7.4: Opinion of Managers or Managing Directors of Samut Prakarn Factories

	Total respondents processed =	77						
The factory profit will be significantly affected if								
1	Water supply cost is increased to 20 Baht/cu.m.	9.1%	10.4%	15.6%	2.6%	27.3%	35.1%	1
2	Wastewater discharge fee of 10 Baht/cu.m. is applied	7.8%	10.4%	27.3%	3.9%	28.6%	22.1%	1
The factory should invest in cleaner production facilities if								
3	Production efficiency is demonstrated	0.0%	0.0%	1.3%	5.2%	51.9%	41.6%	1
4	Higher profits overtime are demonstrated	0.0%	1.3%	2.6%	6.5%	59.7%	29.9%	1
5	It affects public environmental health & future generation's welfare	2.6%	3.9%	10.4%	7.8%	51.9%	23.4%	1
When government requires wastewater effluent standards compliance for Samut Prakarn factories, my plant will								
6	Have no change as existing failities has no problems	0.0%	6.5%	16.9%	13.0%	37.7%	26.0%	1
7	Send wastewater to central facility if it is cheaper	3.9%	13.0%	11.7%	13.0%	32.5%	26.0%	1
8	Replace my wastewater treatment facilities	16.9%	27.3%	23.4%	22.1%	9.1%	1.3%	1
9	Introduce some equipment to reduce pollution	0.0%	5.2%	15.6%	22.1%	49.4%	7.8%	1
10	Improve housekeeping to reduce pollution	0.0%	2.6%	7.8%	13.0%	63.6%	13.0%	1
11	Implement water recycling and reuse	5.2%	2.6%	26.0%	18.2%	28.6%	19.5%	1
12	Upgrade my wastewater treatment facilities as it is more feasible	1.3%	9.1%	15.6%	19.5%	41.6%	13.0%	1
Reasons for your wastewater discharge improvement								
13	Avoid government prosecution for Samut Prakarn WW Std. violation	6.5%	7.8%	18.2%	31.2%	23.4%	13.0%	1
14	Improvement of surrounding environment and for future generation	1.3%	2.6%	2.6%	10.4%	41.6%	41.6%	1
15	Others, specify	0.0%	1.3%	1.3%	88.3%	3.9%	5.2%	1
Government should stimulate Cleaner Production Investment by								
16	Stringently enforce environment control regulation	1.3%	2.6%	6.5%	5.2%	63.6%	20.8%	1
17	Provide investment facility for enabling finance and capital costs of CP	0.0%	1.3%	6.5%	6.5%	51.9%	33.8%	1
18	Provide tax or duty incentives to reduce the cost of investment in CP	0.0%	1.3%	0.0%	7.8%	41.6%	49.4%	1
19	Provide income tax breaks for factories shifting from polluting to cleaner	0.0%	3.9%	13.0%	19.5%	32.5%	31.2%	1
20	Increase income tax levied on factories not shifting from polluting to	0.0%	6.5%	26.0%	7.8%	46.8%	13.0%	1
21	Increase the amount of fines for factories not meeting PC regulation	1.3%	5.2%	28.6%	7.8%	46.8%	10.4%	1
22	Increase severity of penalties for factories not meeting PC regulation	3.9%	6.5%	28.6%	9.1%	36.4%	15.6%	1
23	Provide technical assistance & training for factories interested in shifting	1.3%	0.0%	1.3%	16.9%	37.7%	42.9%	1
24	Allow plant expansion if total pollutant discharge is reduced	1.3%	2.6%	16.9%	7.8%	50.6%	20.8%	1
25	Modify environmental standard to reflect reduction in wastewater volume	2.6%	9.1%	22.1%	10.4%	50.6%	5.2%	1
26	Others	0.0%	0.0%	2.6%	92.2%	1.3%	3.9%	1

7.4 Thai CP Experience and Directions

7.4.1 Samut Prakarn Cleaner Production for Industrial Efficiency Project

Since the Samut Prakarn survey was undertaken in 1997 a number of CP initiatives and later sustainable production and consumption initiatives have been implemented in Thailand. By far the largest of these was the Samut Prakarn Cleaner Production for Industrial Efficiency project (CPIE). The thesis survey was intended to contribute to the design of this CP project. The CPIE project was a 3.5-year (1998-2002) non-regulatory program to promote implementation of CP technologies and practices in Samut Prakarn Province. It was implemented as an element of a major wastewater management program for the Bangkok Metropolitan region by the Thai Pollution Control Department of the Ministry of Natural Resources and Environment with funding of about $10 million from ADB and the Japan Bank for International Cooperation (JBIC).

The focal point of the CPIE project was the "20/20+" program, a voluntary commitment program for industry aimed at achieving measurable reductions in water consumption, wastewater generation, energy consumption, and other environmental benefits through the use of CP. The project is believed to be one of single largest CP technical assistance (TA) project ever undertaken in Asia-Pacific.

It was recognized early in the program design stage that, in order to be effective in achieving significant environmental and economic gains, in long-term commitments by hundreds rather than dozens of companies was required. This could not be accomplished using the audit and demonstration project approach that had been attempted by several donors in the region (APO, 1995) due to the large number of companies and the small number of experts available. Early attention was given to sustainability of CPIE thus it was designed to focus on teaching companies about the concept of CP and how it can be implemented by the companies on their own. (In-Na, 1999; Kositratna et al, 2002)

The CPIE 20/20+ Program was named after its goals of encouraging industry to achieve a 20 percent reduction in water consumption and wastewater generation, a 20 percent reduction in energy consumption, and additional environmental improvements (the "+"). The following table presents the estimated savings from the factories participating in the 20/20+ Program.

Table 7.5: Estimated Annual Material and Cost Savings from CPIE Project Participants

Media	**Annual Quantity Saved**	**Annual Savings**
Water Used	1,667,000 m^3	$483,000
Wastewater Generation	1,019,000 m^3	$530,000
Electricity Used	53,872,000 KWH	$7,046,000
Total		**$8,059,000**

(savings expressed in US$ are converted from Thai baht at 32 baht to $1)

The project also demonstrated the potential for significant benefits to the government and Thai society in that it generated annual savings of about $1,375,000 in increased tax revenue, $260,000 in industrial productivity gains, $87,000 in savings from reduced greenhouse gas emissions (based on carbon market values in 2001), and $250,000 in savings from reduced land subsidence.

Several of the primary goals for the CPIE project were more non-quantifiable such as its successful demonstration of the effectiveness of the CPIE extension model for use in other locations and sectors, the increased awareness of the value of CP among government officers, the increased awareness of environmental concerns among the public, and improved relationship between PCD and industry. Some of the lessons learned from the project include:

- General overarching lessons learned
  - Senior management commitment is critical
  - CP may be a low priority, even where management is committed
  - Do not discount the value of success from low-tech CP implementation.
- Planning and development of CP promotion programs
  - Work interactively with all key stakeholders
  - Allow sufficient time to develop and test market the program idea
- Recruiting of organizations to participate in CP promotion programs
  - Sell the concept of CP before trying to sell the program

  - Recruiting is a marketing rather than technical effort
  - Use industry to industry contact as much as possible
- Public awareness building/outreach
  - Plan a budget for public outreach as a project cost from the onset
  - Work through schools and other community institutions.

The project also generated some recommendations regarding policy changes to encourage increased use of CP among industry in Thailand. At the top of the list was improved enforcement of existing environmental regulations. Second tier priorities were: (i) develop tax incentives for implementing CP, (ii) promote CP from a global trade and competitiveness standpoint, and (iii) develop national public awareness campaign about the societal benefits of CP. (ICF 2003)

A post-CPIE project survey was undertaken in 2002 to assess the initial sustainability of the initiatives undertaken through the project. The post project survey revealed that most of the CPIE initiatives were being maintained but that there continued to be a low level of confidence that the government would continue the support for CP. (Chokchaitrakulpho, 2002)

Another post-CPIE survey was undertaken in 2003. It was found that CPIE had been effective in raising awareness about the benefits of CP and that the networks of manufacturers formed under the project were self-sustaining. However, lack of funding for longer-term investments was seen as a barrier in most firms- particularly SMEs. In addition the SMEs, in particular, felt little pressure from the government to improve environmental performance. (Norgaard, 2003)

7.4.2 Other CP-related Initiatives in Thailand

The Thai Life Cycle Assessment Network was established by Chiang Mai University in 1997. Several life cycle inventories and assessments have been carried out since the initial inventory by TEI in 2000. A database from the inventories was established in 2006 (Curran and Notten, 2006) and continues to be available through the Federation of Thai Industries.

The Thai Network of Eco-efficiency and Cleaner Production (TNEC), housed at TEI, was established in 1999 as an NGO working informally with members from various organizations nationwide, seeks voluntary participation in CP programs. Periodic meetings continue to be held to provide an opportunity for the exchange of information and knowledge, as well as to strengthen partnerships among its members. The meetings have brought together ideas, suggestions and experiences from actual applications of eco-efficiency and CP concepts, such as in research and development of CP, development of environmental curricula, eco-tourism, local environmental management, human resource development, environmental policy, and sustainable development. (Personal communication Dr. Chaiyod Bunyagidj, June 2013)

These various programs and projects contributed to the decision by the government in 2001 to adopt a CP policy for industry and subsequently in 2002 to incorporate a CP master plan for industry into the 9th National Economic and Social Development 5-year Plan (2002-2006). The Thai Master Plan on Cleaner Production was adopted in 2002 (PCD, 2002). A supportive national waste management plan was adopted in 2003, including measures to support resource efficiency and sustainable production and consumption (Sharp and Sang-Arun 2012). Concurrently in 2003, a support program for CP in SMEs was implemented with funding from Germany. By 2006, the government had adopted a broad, integrated sustainable production and consumption model across most development sectors and including green public procurement (requirements adopted in 2008) and eco-labeling initiatives. This model is guiding the current initiatives relating to CP (TEI 2006, Bunyagdij, 2014) such as the 2010 Eco-Industrial Estate and Networks initiative of the IEAT. This IEAT initiative, currently planned to support conversion of industrial estates to eco-industrial estates through 2019, has established standards and master plans thus far implemented by nine of the countries largest industrial estates. (IEAT, 2015) Similarly, the Thai Board of Investment initiated a Productivity Enhancement Scheme in 2008, providing fiscal incentives such as tax holidays to encourage companies to use renewable energy, reduce energy consumption and replace machinery to improve production efficiency. The scheme also provided access to support by SMEs that generally cannot benefit from tax holidays. (Switch-Asia, 2015; PwC, 2014)

Currently, the longest running CP-related, internationally funded support program in Thailand (and in Asia for that matter) is Switch-Asia. Funded by the European Commission, Switch-Asia has been supporting Thailand since 2007 to develop a sustainable consumption and production (SCP) policy and institutional framework supported by financing and other strategic support mechanisms. The current Switch-Asia support will run until 2017. A second Switch-Asia is being planned to run into the next decade.

7.4.3 Fast-forward: Shifting from Cleaner Production to Sustainable Consumption and Production to Low Carbon Development

When the Samut Prakarn survey and CPIE were undertaken, the population of the BMR was about 8.5 million. By 2010, BMR had about 14.5 million people and generated over 44 percent of the national GDP. The economic output of manufacturing has significantly increased particularly in the automotive, electronics, food processing, metalworking and textile industries. The BMR accounted for 77percent of Thailand's manufacturing output in 2009. Industry is the largest user of electricity accounting for about 29 percent of demand. (OECD, 2015)

In spite of considerable economic and social development progress, BMR still has about 2 million people living in urban slums. About 46 percent of wastewater generated is treated and untreated wastewater continues to be discharged into drainage systems, canals, rivers and eventually into the Upper Gulf of Thailand, all of which remain severely polluted. The upper Gulf BMR continues to be affected by land subsidence (Panya, 2010). Serious public health risks due to water pollution, particularly during flood events continues to be a problem throughout the area, particularly in low lying areas with poor drainage. (OECD, 2015; ADB 2002, World Bank, 2011(c); PCD, 2011)

A 2013 assessment by switch-Asia of SCP policy development in Thailand notes that the plans and strategies put in place by the Thai government over the last decade positions Thailand as the leading country in the region with regards to SCP policy. (Switch-Asia, 2013) In particular the 11th National Economic and Social Development Plan (2012-2016) includes a clear structure for further implementation of SCP initiatives. The focus of the 11th 5-year plan is to transition production and consumption behavior toward a “low-carbon and environmentally friendly economy”. Energy efficiency in transportation and logistic sector is emphasized and incentives for new industries and exporting industries to minimize their carbon footprints and pollution emissions were proposed. (NESDB, 2012)

Sustainable consumption and production is central to the current National Environmental Quality Management plan adopted in 2012. A number of initiatives, in addition to those noted, have been implemented by different government departments, in the last few years. For example the Green Industry Mark promoted by the Ministry of Industry and the Green Procurement program of the Ministry of Environment and Natural Resources have supported a rapid expansion of eco-labeling. More recently the Ministry of Energy has taken a number of steps to introduce energy-saving and renewable energy and a carbon reduction labeling system has been adopted since 2009. The National Economic and Social Development Board has indicated that the 2017-2022 national economic and social development plan will include SCP as an integral part of the policy format based on the current national sustainable consumption strategy and the national sustainable production strategy which covers the period 2012-2016. The assessment noted however that while the policy framework is very strong the implementation of SCP initiatives is still weak at both central and local levels. Awareness and acceptance of SCP in particular among small and medium enterprises is still somewhat weak. (Switch-Asia, 2013)

Corporate strategies aimed at greening consumption have become more visible in Thailand because of an increase in sustainable products, environmental information flows, and promotion of sustainable consumption. The results of efforts across sectors have varied but a common underlying factor across sectors/industries is that environmental communication strategies directed at consumers have been successful in supporting a transition to CSP (Thongploo et.al., 2014).

As can be derived from the shift in focus from CP to SCP over the last decade, substantively this has resulted in a concentration of guidance, incentives and investments in low carbon initiatives. Thailand has recently adopted two national master plans relating to climate change. These national plans build upon two earlier sectoral plans promoting renewable energy- the 2008 National Renewable Energy Development Plan and the 2012 Alternative Energy Development Plan, both indicating Thailand’s high priority to the low carbon energy development. (CIF, 2012) The more recent national plans include the 2014 Climate Change Master Plan by the Ministry of Environment and Natural Resources and the 2012 NESDB master plan that focuses on energy prices and food security. The NESDB plan proposes long-term economic growth and development directions consistent with low levels of carbon emissions- not more than 10 tons of CO2 equivalent per person by 2050. This is based on decoupling carbon emissions from an expected economic growth rate of 5.3 percent per year on average until 2050. (ODI, 2014)

However, a climate public expenditure and institutional review shows that the policy direction for low carbon development has not been funded in the national budgetary process or through extra-budgetary funds. Most of the mitigation actions are market oriented in nature, thus leaving the lead role to the private sector. Adaptation to climate impacts is also a high priority for the government as noted in the new environment ministry plan, but again, budgeting has not matched strategy.

Institutionally there are 137 agencies involved in the delivery of climate activity in the Thai government. Local government has a degree of freedom to pilot and develop interventions but the bulk of action is through the relatively centralized administration system of Thailand. The dilemma noted in the institutional review was how to design policies and guidelines that provide the necessary clarity in defining climate change adaptation and mitigation activities and investments and, at the same time, preserve the incentives and entrepreneurship that motivates local administrations to design activities which are both technically sound and politically feasible. (ODI, 2014)

The Thai INDC submission to the UNFCCC late 2015 outlines how Thailand plans to reduce its GHG emissions by 20 percent from the projected business as usual level by 2030. The level of contribution could increase up to 25 percent subject to adequate and enhanced access to technology development and transfer, financial resources and capacity building support. The INDC is a good start at integrating the policies and plans that currently drive low carbon growth, including the country’s national economic and social development plans, Climate Change Master Plan 2015-2050, Power Development Plan 2015-2036, Smart Grid Development Master Plan 2015-2036, Energy Efficiency Plan 2015-2036, Alternative Energy Development Plan 2015-2036, Environmentally Sustainable Transport System Plan 2013-2030, National Industrial Development Master Plan 2012-2031, and Waste Management Roadmap.

Thailand's INDC also proposes the use of market-based mechanisms and will explore potential participation in bilateral, regional and international market mechanisms. Thailand has already launched several support mechanism such as feed-in tariffs, tax incentives and access to investment grants and venture capital to promote renewable energy.

Some of the key barriers for a low carbon transition in Thailand include lack of support by financial institutions for energy efficiency and renewable energy investments, lack of domestic technological and technical resources and negative public perception particularly against waste-to-energy and biomass power plants. Technical capacity and effective coordination across different sectoral agencies and government bodies is lacking. (Thailand INDC, 2015)

7.5 The Philippine Case Study

7.5.1 Introduction to Case Study Area

Perhaps more external assistance for CP has been provided to the Government of the Philippines over a longer period of time than to any other Asian developing country. A great deal of the assistance was focused on industrial sub-sectors with particular attention to technological interventions (Stevenson 1999). The USAEP support for the Philippines from about 1995 through 2002 focused, to a large extent, on ISO 14000, environmental management systems (EMS) and environmental auditing. A mid-term assessment by USAEP showed significant progress in terms of the increasing numbers of industries that have performed audits and in companies certified for ISO 14000 (Dembowski and Walsh, 2002). Typical of assessments of "progress on certification programs, success was measured in numbers of firms joining with little attention to impact on environment and health.

Other major industrial CP-related programs in the Philippines since the early 1990s include:

- The Department of Environment and Natural Resources (DENR) Industrial Efficiency and Pollution Control program supported by UNDP and World Bank initiated in 1991 which proposed institutional, management, economic, regulatory, financial, and technical measures to establish the conditions to achieve a significant reduction in industrial wastes.
- The DENR Industrial Environmental Management Project supported by USAID from 1991–1996. The project was designed to encourage sustainable growth in the industry sector, while reducing industrial pollution and improving human health and the environment. It conducted pollution management appraisals at 150 facilities nationwide to identify pollution prevention opportunities.
- The Philippine Business and Environment Industrial Waste Exchange Program supported by USAID from 1994-2002 to promote resource recovery and recycling in industries.
- The ASEAN Environmental Project with support from USAID started in 1995 to conduct waste reduction assessments of the industry sector (e.g., food, cement, pulp and paper, and iron and steel).
- The APO Green Productivity Program initiated in 1997 to assist industries to minimize all pollution sources to achieve continuous improvement and higher productivity in the industry sector.
- The DENR Industrial Initiatives for Sustainable Environment supported by USAID from 1998–2002 to (i) promote the widespread use of environmental management systems and pollution prevention practices in industries in the Visayas and Mindanao; and (ii) establish policy incentives to adopt them to enhance stakeholder awareness of CP, and strengthen local consulting capacity to support the adoption of pollution prevention.
- The Department of Trade and Industry-Board of Investments Private Sector Participation in Managing the Environment program supported by UNDP from 1998–2002 to enhance the (i) business competitiveness in the global marketplace through environmental management, and (ii) private sector's voluntary participation in protecting the environment and reducing pollution of industries. It maintains a database of environmental information (e.g., regulations and clean technologies). It also formulated Business Agenda 21 policy statements for various industries and chambers of commerce.
- The DENR Environmental Technology Assessment System Preparatory Study supported by UNIDO from 1997–1998 to (i) develop a basic system design and pilot program for the specific needs and situation in the Philippines, and (ii) evaluate the system's potential benefits and financial sustainability. The system is a support mechanism for the industry sector to identify, evaluate, select, and

acquire cost-effective technologies for pollution prevention and control.

In 1999, UNIDO evaluated the results of a number of these initiatives and concluded that (i) many firm's leaders were aware of CP as a practical means to reduce costs, but measuring how much they benefited from it, is difficult; (ii) most firm's leaders would not make substantial capital investments in CP, except with new plants; (iii) supportive policy elements are needed in finance, environment, education, and science and technology; and (iv) integrated national CP policy and planning is needed to accelerate adoption of CP. (UNIDO, 1999)

An ADB review of CP initiatives in the Philippines determined that an adequate policy foundation for achieving wide-scale adoption of CP practices in the manufacturing or other relevant sectors has not yet been laid in the Philippines (ADB, 2000 (c)). In view of this, ADB assisted the Philippines to assess various policy options and analyze win-win policy reforms and related institutional reforms necessary to achieve greater industrial efficiency, productivity, profitability and reduced resource waste and pollution. ADB worked with the government to understand the barriers, constraints, limitations and bottlenecks facing such reform. Discussion with individuals experienced over the last several years in promoting CP in the Philippines confirmed a serious gap in current knowledge of the attitudes of industry owners and managers. (personal communications with O. Castilla and R. Stevenson 1999) A survey was undertaken to strengthen the understanding of the barriers, incentives and other actions by key stakeholders required to support an accelerated, large-scale adoption of CP by industry.

The TA's primary purpose was to enhance DOST's capacity to promote sustainable development in the Philippines, and to strengthen the competitiveness of its industry sector through the understanding and adoption of CP practices. The TA's outputs included (i) guidelines and tools for local industries to facilitate their adoption of CP practices; (ii) support mechanisms primarily for the industry sector to identify, evaluate, select, and acquire cost-effective technologies for CP; (iii) TA to SMEs including CP assessment, training, and demonstration programs; (iv) a business plan for DOST to promote CP in the country; (v) training programs to improve the technical capacity of CP promotion for staff from the government, industry, and banking sectors; and (vi) technical manuals on CP for specific industry sectors.

7.5.2 Case Study Methodology

There had not been a relevant survey of industrial leader's attitudes on CP since the financial crisis of 1997/1998. An attitude survey was designed based on a modified version of the 1997 Samut Prakarn Cleaner Production Survey (see Section 5.2 above) and an attitude survey designed for SMEs in Colorado, USA (Colorado Pollution Prevention Partnership 1994). The survey form is presented in Appendix 2. A difference between the Philippine survey and the Samut Prakarn survey was that willingness-to-pay for waste management systems was not an element of the Philippine survey. Rather, the objective was to develop an information base describing the attitudes of factory owners and managers to the introduction of CP practices and technology. The survey questions focused on defining the concerns of factory owners/managers regarding the various barriers to the adoption of CP practices in the Philippines.

Another difference in the implementation of the Philippine survey from the Samut Prakarn survey was that interviewees were targeted SMEs, representing links in the supply chain of major industries. Several large industries (such as Nestle, San Miguel, Union Cement, Swift Foods, Ford) were identified and their cooperation/assistance committed in order to follow the supply chain upstream. Factories and producers representing the key links in the supply chain, totaling about 50 companies were interviewed. The large end-user companies agreed to endorse the survey so that the Attitude Survey Team appeared to be representing the end-user, and indeed the results were reported back to the end-user. Another 50 SMEs were interviewed using the same form but without reference to the supply chain.

7.5.3 The Philippine Survey Results

The survey was performed during April-May 2000 by a group of graduate students from several Manila-based universities. The supply chain approach successfully opened the doors to a number of producers and suppliers that may have otherwise been inaccessible. While the approach introduced survey bias, it helped establish the relative importance the supplier/producer gives to the requirements of the end-user in determining whether they will adopt CP practices and technologies. The results of the survey are summarized as:

- Philippine factory leaders were aware of CP.
    - 96 percent of the factories practiced Clean Housekeeping Techniques
    - 48 percent of the factories were aware of CP
    - 60 percent of the large-sized factories are aware of CP

- Factories that used harmful materials or chemicals were aware of the environmental risks and of the need to minimize use of such materials. Of the factories that used harmful materials or chemicals:
    - 84 percent had tried to reduce the use of these materials
    - 52 percent recycle or treat the materials
    - 48 percent store, sell or dispose of the materials

General conclusions that can be drawn from the survey include:

- Dissemination of information on CP is necessary to stimulate factories to adopt CP methods and processes. The factories surveyed ranked the combination of lack of information, in-house technical expertise or technical extension worker to see through implementation of CP methods and processes as the foremost barrier to their adoption of CP methods and processes.
- Technical assistance on implementation of CP is necessary to stimulate factories to adopt CP methods and processes. The factories highest ranked need was for technical assistance to conduct waste audit and feasibility study for CP alternatives.
- Almost 90 percent of the factories consider that the government should provide technical assistance and training for factory owners interested in shifting from polluting processes to CP, as a key measure to stimulate investment in CP.

- The factories second priority need was their need for reliable and continuous information on CP.
- The factories surveyed are convinced that adoption of and investing in CP methods, processes and equipment is a good investment.
    - 58 percent of the factories said that implementation of stronger waste reduction measures will make the quality of their products better.
    - 60 percent of the factories said that cost of waste prevention would be less than the costs of waste storage and treatment.
    - 58 percent of the factories said that cost of waste prevention would be less than the costs of waste disposal.
    - 73 percent of the factories said they are willing to invest in CP approaches if cost of wastewater and water supply will be reduced by 50 percent.
    - 71 percent of the factories said they are willing to invest in CP approaches if the investment recovery period is two years.
- Lack of financial resources is a major barrier to the factories' investing in CP methods, processes and equipment.
    - 80 percent of the factories said that investment recovery period is important in their deciding whether or not to invest in some new equipment.
    - The smaller the size of the firm, the shorter is the required investment recovery period.
    - About 50 percent of the factories surveyed will need to avail of loans if they invest in new CP equipment they.
- Fiscal incentives will stimulate the factories to invest in CP facilities
    - 73 percent (maximum) said they are willing to invest in CP approaches. However, 92 percent of the factories will invest in new processing equipment, as a means to achieve CP, if government offers financial incentives (investment subsidies, accelerated depreciation, tax credits, tax deductions).
    - 89 percent of the factories agree that, to stimulate investment in CP, government should provide an investment facility for enabling financing of capital costs of CP processes.
    - 86 percent of the factories agree that, to stimulate investment in CP, government should provide income tax breaks for factories, which shift from polluting processes to CP processes.
    - 86 percent of the factories agree that, to stimulate investment in CP, government should encourage local banks to extend more credits to SMEs at interest rates reasonably lower than market rates with longer repayment period.
    - 82 percent of the factories agree that, to stimulate investment in CP, government should encourage banks and government guarantee institutions to collateralize SME loans.
- Strict Government implementation of existing environmental regulations will stimulate the factories to invest in CP facilities.
    - 86 percent of the factories agree that, to stimulate investment in CP, government should stringently enforce environmental pollution control regulations.
    - In ranking major drivers that companies would consider to adopt CP practices, compliance with government regulations was ranked No. 2.

- Consideration for Public Health and Welfare will stimulate the factories to invest in CP facilities.
  - 89 percent of the factories agree that a factory should invest in CP processes regardless of the benefits because it is in the interest of the public environmental health and future generations welfare.
  - Public health and welfare ranked number 1 among the major drivers that company would consider to adopt CP.
- Consumer/buyer demand will stimulate the factories to invest in CP facilities.
  - 71 percent of the factories agree that, if their consumers or buyers of products would recommend process changes to improve our production process or output, they will abide by such demands.
  - However, Customer Chain or Supply Chain leverage ranked only 6th among 7 major drivers that company would consider to adopt CP.

7.6 The Philippine CP Experiences and Future Directions

Philippine industrial development stagnated in the last three decades, after being considered second to Japan in the industrialization process in East Asia in the early 1960s. The Philippines has been the industrializing in the last 20 years. The share of manufacturing in GDP in 1980 in the Philippines was 25.7 percent as compared to 21.3 percent in 2009. This decline of 4.4 percent was comparable to increases of between four and 15 percent in comparable countries such as Indonesia and Malaysia and Thailand. There has been a proliferation of export processing zone industrial manufacturing in the Philippines, particularly for electronics and auto parts, which indicates that the manufacturing stagnation is due to the collapse of home-oriented manufacturing, which is not been able to compete in the globalized market. (Ofreneo, 2012)

After serious impacts from the 1997/98 Asian financial crises the Philippine economy has shown strong performance since 2000. Average annual growth rate of GDP over the last decade reached 4.8 percent as compared to 2.9 percent in the 1990s and 1.7 percent in the 1980s. (Usui, 2012) the performance in terms of environmental management since 2000 has been highly variable. The Philippines has comprehensive laws and policies but continues to suffer from weak implementation because of inadequate capacity and financial constraints both at the national and local levels. A World Bank review in 2009 recommended a shift in strategy towards more devolution to local levels of government, enhanced resource map mobilization for environmental management, better prioritization, retooling of human resources, and improvements in environmental information systems and public access to such information. The air and water pollution, particularly in urban areas, is a significant factor in that they both have significant impacts on the gross national product. It is estimated that more than one million people get sick every year due to outdoor air pollution in urban areas resulting in a loss of about 1 percent of the GDP. Most of this is the particular mission-based but industrial emissions continue to be significant. About 34 million cases of water pollution, sanitation, and hygiene related illnesses occurred in 2003. Again most of these cases were due to poor sanitation and hygiene but industrial emissions clearly exacerbate the problem which leads to somewhere between one and 2 percent of national product loss each year.

There's been little work done on resource intensity or material flows in the industrial sectors in the Philippines in the last several years. However, what limited work has been done indicates that there have been some efficiency gains in consumption of raw materials. A 2012 SWOT (strength/weakness/opportunity/threat) analysis of sustainable consumption and production challenges and opportunities resulted in the following:

- Strengths
  - Initiatives in establishing and promoting CP
  - Efforts to strengthen the institutional framework for management of environmental and natural resource management are being undertaken
  - Service's sector sustains the economy despite financial crisis and low growth posted by the agricultural sector
  - Renewable energy law, biofuels act and climate change act are timely legislations that can help decrease reliance on fossil fuels
- Weaknesses
  - Reliance on fossil fuels affects the economy, continues to increase GHG emissions,
  - Monitoring of environmental quality has been sporadic/intermittent due to lack of manpower and functional equipment
  - Poor performance of agricultural sector
  - Fisheries lacked diversity
  - Crop production extremely affected by climate
  - Land productivity decreases
- Opportunities
  - Raw materials sufficient and could catalyze industrial growth provided a proper development framework
  - Efficient agricultural sector can reduce food importation
  - Green jobs can emerge from a solid implementation of reforms and promoting investments in green industry
  - Research and development in energy, and particularly renewable sources, can reduce the current reliance on fossil fuels
  - Potential to reduce the waste stream and lifecycle concept
- Threats
  - Impacts of environmental degradation on the poor may not be easily countered
  - Service's sector diverts the output of manufacturing-based skilled human resources
  - There are imbalances in investments going into the different economic sectors
  - Profits from foreign investments in resource extraction and polluting industries could benefit source of investment more than the local and affected community

The analyses also showed that, in spite of extensive legislation on environment natural resource management (there were 11 “significant” environmental laws passed between 1990 and 2010) (Ofreneo, 2012), the national potential in supporting SCP was yet to be demonstrated (Chiu, 2012). Ofreneo (2012) attributed this to “the twin problems of policy inconsistency and indecisiveness”. Opportunities exist as raw materials can be utilized in various economic sectors and there is tremendous potential to reduce the waste streams and to generate green jobs through investments in green industry and energy management. (Chiu, 2012)

The Government of the Philippines has given high priority to addressing the challenge of strengthening industrial growth. The Philippine Institute for Development Studies in 2013 recommended that the government should adopt a new growth model where the industrial sector plays a key role in generating investment, employment, and innovation. This is based upon the fact that the performance of the manufacturing industry in the past 20 years has only slightly improved. The researchers found that the linkages between SMEs and large enterprises have remained weak and that SMEs in the Philippines continue to face product competitiveness problems and are continuously beset by difficulties in financing as well as lack of technology and market access.

The Philippine Development Plan 2011-2016 gave priority to supporting industrial growth including firm level assistance to potential new and existing SMEs and the use of the in-depth industry-cluster approach. A midterm review of the implementation of the development plan showed that the Philippines continue to lag behind other countries in terms of foreign direct investments for industry. The review noted that the size distribution of firms has changed little in the past two decades, with the proportion accounted for by medium-sized enterprises, while the bulk of the industries were comprised of small- and micro-enterprises. The small- and micro-industries lack access to new technologies, have weak technological capabilities, and have failed to engage in research and development activities. They also found a lack of awareness for science and technology and a scarcity of science and technology human resources as an important barrier. On the basis of the review, the governmental leaders decided to expand their support industry, particularly the agro-industry and manufacturing.

The National Development Plan includes a review of implementation of the national strategic framework on sustainable and climate resilient environment and natural resources. This framework includes strengthening the enforcement of environmental regulations, promoting eco-friendly production technologies and energy efficient infrastructure and transport facilities, and promote appropriate technology for waste management and establishing markets for recycled products.

The review highlighted a number of deficiencies that were inhibiting achieving the plan objectives for sustainability. They noted that the implementation of environmental legislation remains weak, with deliverables not completed on time due to the absence of operational mechanisms such as funding and sanctions for noncompliance. They also called for rationalization of the numerous environmental laws and strengthening monitoring and reporting. Conflicting and overlapping mandates of government agencies lack of manpower and expertise at the local level, and limited availability of timely data and an integrated database, and inadequate and non-sustained financing were all assessed as major constraints to achieving planned objectives. (National Economic Development Authority, 2014)

One likely reason why the Philippines has not maintained its focus on CP is the very high priority the government is giving to addressing climate change risks. The Philippines is considered to be the world's third most vulnerable country to the climate impacts of extreme weather events and sea level rise. Philippines large coastal population is highly vulnerable, much of which is urban including informal settlements accounting for about 45 percent of the urban population. The government passed a Climate Change Act in 2009, which was designed to strengthen, integrate, consolidate, and institutionalize previous specific sector-based government initiatives. The act required the formulation of a National Framework Strategy on Climate Change (NFSCC) and National Climate Change Action Plan (NCCAP). The NCCAP gave priority to food security, water sufficiency, ecosystem of environmental stability, human security, climate smart industries and services, sustainable energy, and capacity development as the strategic direction for 2011 to 2028.

The NCCAP provided a unique opportunity to integrate CP with climate action through its focus on strategic actions for climate smart industries and services. This element of the plan supports public-private partnership for investments in climate smart industries, providing incentives for business practices that incorporate eco-efficiency, improve enforcement of environment laws, assist SMEs in developing capacity for eco-efficient production, provide training for eco-efficient production, and assist enterprises to adopt and implement environmental management systems for CP and environmental cost accounting. The plan also includes provision for developing baseline information on climate smart industries, services and green jobs. The NCCAP also supported the collection, analysis and reporting of the plan's implementation. (Climate Change Commission, 2010)

A 2013 World Bank review of climate change policy reforms and actions notes that the Philippine government's development plans are only partially aligned with the NCCAP. Major challenges are the complexity of institutional arrangements and lack of consistent strategic direction. The World Bank study noted that there is not a clear organizational model to execute and deliver the climate results. It also noted the lack of institutional capacity for monitoring and evaluation as key barriers. Nevertheless, climate appropriations in the national budget have increased considerably, about 26 percent annually on average since 2008. However, financing gaps continue to be a major challenge. A number of recommendations were provided for government consideration including the need to rationalize and harmonize climate financing instruments and regulatory and policy instruments. (World Bank, 2013)

7.7 Comparative Analysis of Thailand and Philippines Case Studies and Subsequent Actions

The two case studies described in this Chapter, the Samut Prakarn survey and CPIE and the Philippine survey, are largely consistent in terms of responses from industry. The surveys revealed that in both countries, factories' management felt that in order to stimulate investment in CP processes:

- The government should stringently enforce environmental pollution control regulations;
- They should increase the amount of fines and severity of penalties four factories which do not meet pollution control regulations;
- They should provide tax or duty incentives to reduce the costs of investment in CP;

- They should provide income tax breaks for factories, which shift from polluting processes to CP processes;
- They should increase income tax levied on factories, which do not shift from polluting processes to CP processes;
- They should provide investment facilities for enabling financing of capital costs of CP processes; and
- They should provide technical assistance and training for factory owners interested in shifting from polluting processes to CP processes.

If such incentives and disincentives are consistently provided, the majority of those surveyed in Thailand and Philippines indicated that they would be prepared to invest in CP if it is demonstrated that the capital investment will generate improved production efficiency and higher profits over time.

Comparative analyses of the survey results showed that the only significant differences between the Philippine and Thai attributes were that the Philippines scored significantly higher on the need for income tax breaks and the view that a factory should invest in CP processes regardless of the benefits because it is in the interest of public environmental health and future generations' welfare (95 percent confidence level). The Philippine industries were also more prone to respond to public pressure and increased enforcement of pollution control regulations whereas, the Thai industries considered the lack of enforcement and higher tariffs and fees as being greater disincentives to continuing with current practices.

7.8 Conclusions

Thailand and the Philippines were early movers in Asia with regards to promotion of CP in industry and in other development sectors in the mid-1990s. Both countries, and in particular Thailand, suffered from the financial crisis in 1997/98 to the extent that CP initiatives such as CPIE and many other environment-related programs were eliminated or reduced in scope. In the mid-2000s, after overcoming the severe setbacks from the 1997/98 financial crisis, the two countries shifted to the broader focus of CSP.

Both Thailand and Philippines have indirectly bolstered adoption of CP concepts by aggressively promoting renewable energy and energy efficiency, in support of energy security and low carbon development. Both countries INDCs highlight the reality that the countries are highly vulnerable to climate and disaster risks and that the mitigation measures to be undertaken are being done in line with sustainable development objectives that promote economic growth. Similarly, both countries INDCs emphasized the need for additional financing resources, technology development and transfer, and capacity building to achieve optimum low carbon and climate resilient development objectives.

The experiences from the industrial surveys in Samut Prakarn, Thailand and Manila, Philippines are relevant to the countries' CSP and low carbon development objectives. The lessons learned from these case studies were brought together with multiple lessons learned from other countries in the following Chapter.

8. CLEANER PRODUCTION BARRIERS AND DRIVERS: PROGRESS AND OPPORTUNITIES IN ASIAN DEVELOPING COUNTRIES

8.1 Introduction

The previous two chapters presented results of CP case studies in China, India, the Philippines, and Thailand highlighting the numerous stakeholders at the community, city, national, and international levels that need to participate and hopefully push governments and industries in the same policy, regulatory, investment, technology, and productivity directions. The case study results highlighted many of the barriers to CP and some of the measures that have been undertaken to overcome such barriers during last twenty years. The case studies also showed how the countries have shifted their focus and resources from CP for industry in the 1990s, to CSP for broader society in the 2000s, and more recently to climate change.

This chapter builds upon the information derived from the case studies on stakeholders, barriers and drivers, comparing the results with a number of relevant references from across Asia. This substantial information base was analyzed and digested in order to prioritize actions that are needed to achieve a rapid transition to CP, at a scale adequately significant to impact on environmental quality at the regional and global levels (research questions 1-4).

8.2 The Challenge: To Achieve Wide-scale Adoption of Cleaner Production Practices

This thesis author, at the Second Asia Pacific Roundtable for Cleaner Production in 1999, described the challenge for CP as being implementation at a scale that changes the environmental degradation trajectory being experienced across Asia.[9] More than fifteen years later, and after the regional focus shifted to SCP, there are many examples of progress in the right direction but little evidence that the scale required is being approached. Akenji (2011) noted that despite recognition of the need, and related promulgations for SCP by regional bodies such as ASEAN and the Asia Pacific Forum for Environment and Development, the APRSCP (see Chapter 4), and by national governments, supported by considerable bilateral and multilateral aid, SCP policies have so far not been met with sufficient follow-through to implementation. In spite of numerous demonstration and pilot projects and capacity development, on the whole SCP has not been mainstreamed in development actions and finance. (Akenji, 2011)

Now in 2015, the global focus is largely on climate change and priority is being given to investments in climate resilient, low-carbon development at a scale sufficient to dramatically lower the vulnerability of millions of urban and rural households through massive investments in climate resilient, low carbon infrastructure and agriculture while there is still an opportunity to do so in a cost effective way. Undertaking small climate resilient and GHG emission reduction projects and hoping that these will be

[9] Speech by James Warren Evans at the Barcelona APRCP conference 1999.

replicated at a large enough scale to reduce the vulnerability of the very, very large populations at risk is no longer an option. Investments in low carbon, climate resilient development must be undertaken at a massive scale and this will require development finance on a massive scale. (Evans and Lay, 2015)

In the same vein, "scale" in adoption of CP by industry and other sectors needs to be made now, not only to slow down current and future GHG emissions at a pace and tonnage adequate to achieve a 2°C rather than 3° or 4°C world this century, but also to achieve its original objectives of optimizing resource productivity and minimizing waste and its impacts on the local environment and upon human health and quality of life.

Asia continues to be well positioned to play a significant role in achieving large-scale benefits from CP. But this will not be accomplished by one-off projects in hopes that they will be scaled-up and replicated. As discussed previously in this Thesis and in numerous journal articles and proclamations, there are many practical reasons for firms to adopt principles of CP on their own initiative. Yet despite the apparent advantages of CP to business and cities and the resources spent to promote it, the concept is not yet spreading rapidly enough even to keep pace with the growth of production. Both international donors and national organizations have based their programs primarily on a belief that making available information, skills and financing, and showing a few industry leaders how CP can help their bottom line will cause many other firms to follow the leaders and seek out the available resources. There have been many successful actions with individual firms, but as noted in previous sections, the spread of concepts and practices needed to achieve CP on a wide scale is not yet happening.

The challenge is to change the behavior of not just a few demonstration firms but of millions of decision-makers in the many activities that have an environmental impact - in industry, services and government. To do so, one must somehow alter the complex of conditions in which these decision-makers make their decisions, including not only the technical and managerial resources available to them, but also more importantly, the array of rewards and penalties they confront. At the country-level, a holistic perspective is required to establish conditions that will bring about widespread change in perspective. A regional review of this challenge in 2000-2001 by ADB determined that individual countries needed, but generally lacked frameworks which integrated relevant national strategies and public policy required for broad economy-wide adoption of CP (ADB, 2004).

Several CP project performance assessments have shown that the narrow definition of CP adopted by some developed countries is not satisfactory if the objective is to accomplish significant changes in environmental quality and resource productivity. The ADB adopted CP policy guidelines in 2004 that promote CP to include (i) concepts of pollution prevention, waste minimization, eco-efficiency, and cleaner technology but also (ii) consider impacts of resource extraction, all stages of production, distribution, use, disposal and other aspects of life cycle analysis and design for the environment; (iii) strive to reduce the use of natural resources or materials through-put per unit of product; and (iv) include management issues. Improving environmental quality for purposes of public health and quality of life is a re-emerging priority- more than one million Chinese died during and soon after the extra severe regional, six-week long smog in 2013.The longer term decrease in quality of life and shortening of life due to that smog is estimated to be in the millions. Thus addressing environmental impacts includes the need to address the direct and indirect human health impacts in the short and longer term.

CP therefore, has much in common with a comprehensive environmental management system, industrial ecology and general concepts of sustainable development. In its full definition, concepts of CP are readily and productively applied in areas beyond industrial processes, most obviously in the delivery of urban services but also for many sectoral developments. The development of a national strategy, building on the strengths of stakeholders and relying on effective partnerships, is essential for its achievement (ADB, 2004).

While many Asian governments have adopted CP or SCP policies, most remain focused on economic growth that they measure in the classical terms of financial assets and capital stock, often ignoring natural and human capital. One of the problems is that CP is often associated with the protection of the environment rather than with the production efficiency and materials productivity and human health risk reductions. Environmental issues have been elevated in most Asian countries, but continue to take a back seat to “real” sector development and economic growth. (OECD, 1999)

The essence of CP cuts across the policy and the agendas of many sectors of the economy and can be an important unifying focus for collaborative efforts toward sustainable growth. CP is a perspective and a decision-making, process that simultaneously take into account both economic progress and environmental sustainability. It is measured as the reduction of both the impact of pollutants produced and the natural resources consumed for each unit of product or service, leading to growth and development that are economically, environmentally and socially sustainable.

The cooperation of many public and private sectors of activity is needed to achieve CP on a national scale. The principles of CP originated in manufacturing, but they are equally applicable to activities in transportation, mining, health services, agriculture, forestry, education, tourism and many other sectors. They apply to all levels and aspects of government that provide facilities and services to their citizens, consuming resources and impacting the environment. Education, financial and professional organizations influence the behavior of business and can significantly contribute to achieving CP. Community and volunteer organizations are comprised of citizens impacted by the actions of business and government who can contribute constructively to motivate change toward greater efficiency. All of these are stakeholders in a national process of achieving CP, and a national comprehensive policy and strategy for the achievement of CP can benefit all.

Achieving CP demands a new perspective and offers a substantial resolution of the conflict traditionally seen between achieving industrial and economic growth and preserving the environment. A principal focus of industrial development policy is achieving growth and expanding markets through greater production efficiency and resultant competitiveness. The central foci of environmental policy are conserving natural resources and preventing the degradation of the environment and human health from the byproducts of industrial production, transportation, energy generation, agriculture, urban development and other forms of private and governmental activity. All of these concerns center on efficiency and materials productivity. CP prevents impact on the environment and human health and the depletion of natural resources, but it does so by increasing efficiency of production and the productivity of resource use. CP thereby, responds to the objectives of national socio-economic development, but in particular both industrial development policy and environmental policy, demonstrate the complementarity of the two interests and can provide a common forum in which their respective supporters can productively work together.

Why governments have not seen that CP bridges the conflict perceived between national objectives for the environment and those for production efficiency and global competitiveness needs to be understood in order to achieve a transitional shift. Cleaner production should be viewed as the “unified force theory” of sustainable development, with the potential to achieve otherwise conflicting objectives through integrated policy and strategic planning. Reflecting on a decade of hard work by many to promote implementation of policies, concepts and tools of CP (1994-2004) one realizes that the approaches used have been almost always too heavily dependent on “cleaner technology”, with programs top heavy in technical skills and weak in institutional, policy and political reach. Consequently, the perspectives that would cause national policy makers and planners to grasp the potential of CP have been poorly presented, at best. Programs have been located at a functional level, often within an environmental agency already seen as the enemy by industry and a special interest by those responsible for broader national perspective. Alternatively, programs have been located within organizations responsible for industrial or business development, seen also as representing narrow and often self-serving interests. (Stevenson and Evans, 2004)

Donors and national programs should focus on building a broader national interest perspective and the institutional capacity to integrate policy and to plan strategically for CP, and most importantly to addressing the national policy implications and benefits of pursuing CP as a national perspective and goal. An essential start to this would be basing donor programs in support of achieving CP at a level of government with crosscutting perspectives, such as the national economic planning agency. (ADB, 2004)

Capturing the attention and building the understanding of policy-makers is a difficult undertaking. But unless policy-makers effectively mainstream CP into the development process, the growth of production and its resultant impacts on the environment, natural resources and human health will continue to outstrip the spread of CP. (Evans, 2015)

8.3 Understanding the Barriers, Drivers and Stakeholders for Large-scale Adoption of CP

Most Asian national environmental institutions are now aware of and have recognized the benefits of the CP approach to environmental management. Many of the Asian developing country governments have adopted CP as a pillar of their environmental management strategy. The main driver for such policy directions is recognition of the financial, economic, environmental and human health benefits. Second, which stresses the urgency of the shift to the preventive approach, is avoidance of excessive investment in pollution control technology. Third, considering the major structural shift towards industrialization throughout the region, the preventive approach is the only way to reduce or to control total waste generation in developing countries where economic activity and population levels are both increasing at a rapid pace (Chandak and Huisingh, 2002; Boons and Huisingh, 1992).

While there is no reason for developing countries to delay implementation of appropriate, CP approaches suited to the industrialization level of a country, there remain some difficult barriers to implementing this paradigm shift. These barriers, discussed in detail in the following sections, vary from country to country. Most countries however, face common barriers such as: limited general awareness of CP and its inherent advantages over pollution control strategies at the management or decision-making level; lack of good technical human capital base to evaluate, assimilate, diffuse, adapt, improve and develop information on cleaner technologies; absence of good information networks on existing cleaner technologies, trends in technology, product markets and technology suppliers or vendors; and lack of expertise available to assist corporate and government leaders to develop and implement CP approaches for improved economic development. The most significant barrier is attitudinal in nature, which includes negative attitudes of factory management, governmental officials, sanitary engineering consultants and academics and other key actors towards changing established processes or practices; and reluctance to take risks with new technologies for fear of compromising other business goals and practices.

Institutional, legal and regulatory barriers relate to the absence of the appropriate institutional, legal and regulatory framework that could, among others, facilitate the transfer, assimilation, diffusion and adoption of cleaner technologies to developing countries. Poor compliance monitoring and weak enforcement of environmental regulations (e.g., environmental standards) is considered a major barrier. Considering various technical and financial barriers to overcome, the interest of industries in joining voluntary CP programs is understandably low, especially if such industries are able to avoid environmental compliance in view of lax enforcement and poor monitoring by a government. Industrial leaders do not see a real need to adopt CP measures aimed at reducing effluent and/or emission concentration levels, as they do not encounter problems with the enforcement agency regardless of the industries' environmental performance. There is therefore, a need to properly enforce and regularly monitor industries' compliance with environmental standards and regulations (Zarsky, 2001; Wang, 2002; Afsah, 2000).

These barriers are most obvious in small and medium sized enterprises (SMEs); whose owners/managers often have little appreciation of the potential benefits. Such lack of awareness combined with a long-standing skepticism of government's ability to follow through on environment programs, results in a serious attitude-related unwillingness to participate in such programs. The majority of industries are family-owned and operated as SMEs, many of which are not legally registered and therefore, are difficult to regulate from a pollution control perspective, additionally, they operate on a cash-flow basis (hand-to-mouth) and therefore, have limited resources or know-how to shift to CP. Such SMEs are the primary source of industrial pollution. Thus a CP production program specifically designed for SMEs has the potential to maximize benefits to environmental quality as well as industry.

Complex and often inconsistent legal, institutional and governance accountabilities at the national and local levels present significant hurdles in many countries in the region. Castillo (2001) prepared a detailed assessment of the environmental and industrial and other relevant policies and legislation in the Philippines in 1995 in order to conceptualize a national CP policy and program. At that time there were about 27 environmental policies and regulations and about six organizations responsible for overseeing such policies and regulations. While not quite as complex, industrial, energy, agriculture and tourism policies and institutions also presented significant complexity in deriving sensible plan production policy. Further, there was no comprehensive national plan integrating the various stakeholders and resources needed to achieve CP. Castillo also noted that while the individual regulations, policies and directives were of high quality, the enforcement and political will was weak. She concluded that a national CP policy was required, which would serve to integrate policy and institutional responses. (Castillo, 2001) Now in 2015, a review of the Philippine policy and institutional framework showed that the accountabilities continue to be complex and potentially ambiguous, largely as a result of a priority focus on climate change and the introduction of new policies and institutions that would be relevant to CP (see Chapter 6).

Experience in Asia, to date, shows that the complexities and ambiguities, while not likely to be eliminated, need to be understood and collaborative action, at all levels, needs to be facilitated. For this wide-scale adoption of CP to take effect requires “facilitation” at a new level of a multitude of actions- one that will of necessity rely on multi-stakeholder partnerships that are capable of overcoming barriers (Evans, 2002). The following sections outline the main barriers to large-scale adoption of CP and the drivers and stakeholders that cause such barriers or have the potential to remove them.

8.4 Common Barriers to Adoption of CP in Asian Developing Countries

A number of surveys have been undertaken in different Asian developing countries to identify the key barriers to CP. Barriers vary according to specific context, for example from sector to sector, stakeholder to stakeholder, and country to country where they may manifest themselves differently with the transition of the economy. Barriers may be behavioral or organizational, financial, informational or technology- overcoming them requires clarity of how they influence decision-making and how they might be interconnected with each other as well as drivers of change (Cagno and Trianni, 2014). Based on the comparative analysis of barriers identified through the Thai and Philippine surveys undertaken as a part of this thesis research, it is clear that there are commonalities. Consequently, it was deemed useful to establish a broad understanding of barriers and their interconnectivity to wide-scale adoption of CP in Asian developing countries in order to identify potentially common driving forces and barrier-breakers.

It is also potentially, useful to distinguish the barriers particular to one or more stakeholders or actions considered of high priority for achieving rapid and large-scale adoption of CP. Given the twenty year timeframe of this thesis work, there is an opportunity to assess (i) what actions have and have not worked in terms of barrier-breakers, (ii) which stakeholders are key actors in achieving transitions to CP, and (iii) if and how the evolving focus from CP to CSP to CC (climate change) alters the barriers, drivers and stakeholder actions.

Detailed studies of barriers have been undertaken in several Asian countries, many funded by ADB as technical assistance grants for which this thesis author was directly involved. Other studies prior to and since the ADB studies have contributed to the understanding of barriers and drivers. The following is a broad assessment of the barriers in order to establish a general understanding of the range of issues that need to be well understood to achieve a transformation to CP across the region. Stakeholder group specific barriers are described in some of the subsequent descriptions.

One of the first countries in developing Asia to give significant attention to CP was India, largely because of the country's attempt to industrialize with minimum import of technologies and the severe industrial pollution being generated. Consequently, early work on CP in India was focused on clean technology. Based on studies performed by the Confederation of Indian Industry, National Productivity Council, and Indian Institute of Technology, and information generated by India's Waste Minimization Circles[10], Chandak (1994) identified the following as key barriers to CP in the early 1990s:

- Lack of concern for the environment
- Lack of public/consumer pressure
- Media - specific legislations
- Lack of enforcement
- Reliance on "command-and-control" strategies as opposed to use of Market-Based Instruments
- Emphasis on quick-fix solutions
- Lack of awareness/information
- Lack of capital resources and concern for costs
- Lack of adaptation support
- Lack of R&D
- Confusion in understanding differences between CP techniques and technologies
- Absence of demonstration units
- Concern for competition constraining multiplier effect

Chandak (1994) focused on barriers for demonstrating CP in Indian SMEs, categorizing the barriers as organizational, systemic, attitudinal, technical, governmental, and economic:

- Organizational Barriers
    - Non-involvement of employees
    - Vested decision-making powers

[10] These *"Waste Minimisation Circles"* are voluntary forums of industries in an industrial cluster. The objective is to collectively identify and exploit waste minimization opportunities in member industries.

    - Emphasis on production
    - High staff turnover
    - Lack of recognition
- Systemic Barriers
    - Poor record keeping & reporting
    - Inadequate & ineffective management systems
    - Lack of systems for professional development
    - *Ad hoc* production planning
- Attitudinal Barriers
    - Lack of housekeeping culture
    - Resistance to change
    - Antagonism between work-force and management
    - Lack of leadership
    - Lack of effective supervision
    - Job insecurity
    - Fear of failure
- Technical Barriers
    - Limited or non-existent training
    - Limited access to technical information
    - Technology limitations
    - Technology gaps
    - Limited in-house maintenance facilities
- Governmental Barriers
    - Lack of infra-structure
    - Lack of incentives
    - Emphasis of end-of-pipe approaches
    - Industrial policy
    - Piecemeal legislation
    - Lack of institutional support
- Economic Barriers
    - Resource pricing and availability
    - Availability and cost of funding
    - Exclusion of pollution control costs
    - Inadequate investment planning
    - *Ad hoc* investment criteria
    - Prevalence of production-related fiscal incentives

An ADB-financed technical assistance (TetraTech, 2002), performed at the state-level in India almost ten years after the previous lists of barriers were compiled generated a more detailed list as follows:

- Lack of full cost pricing, which internalize environmental and social costs.
- Poor macroeconomic conditions, which could include the underdeveloped financial sector, high import duties, high or uncertain inflation or interest rates, uncertain stability of tax and tariff policies, and investment risk
- Low private sector involvement because of the lack of access to capital, in particular inadequate financial strength of smaller firms
- Lack of financial institutions or systems to ensure initial investments for the utilization and extended use of transferred technologies

- Low, often subsidized conventional energy prices resulting in negative incentives to adopt energy saving measures and renewable energy technologies
- Lack of markets for CP due to lack of confidence in economic, commercial or technical viability, lack of manufacturers, lack of consumer awareness and acceptance of CP
- Lack of supporting legal institutions and frameworks, including codes and standards for the evaluation and implementation of CP
- Lack of understanding of the role of developed and developing countries and international institutions in the failures and successes of past technology cooperation
- General lack of support for an open and transparent international banking and trading system
- Institutional corruption
- Reluctance to identify and make available CP that are in the public domain
- Insufficient human and institutional capabilities
- Inadequate vision about and understanding of local needs and demands
- Inability to assess, select, import, develop and adapt appropriate technologies
- Lack of data information, knowledge and awareness, especially on "emerging" technologies
- Lack of confidence in unproven technologies
- Risk aversion and business practices that favor large projects in financial institutions
- Lack of science, engineering and technical knowledge available to private industry
- Insufficient R&D because of the lack of investments in R&D, and inadequate science and educational infrastructure
- Inadequate resources for project implementation
- High transactional costs
- Lack of access to relevant and credible information and potential partners to allow for the timely formation of effective relationships, which could enhance the spread of CP.

The ADB study expanded on some of the key barriers, noting in particular that large-scale adoption of CP would require attitudinal shifts, policy reorientation, modified international terms of trade and greener credit facilities. In particular, the study showed that:

- CP promotion, adoption and financing is significantly impacted by policies and legislation and then, ultimately, through regulations and executive orders based on the legislation.
- There are several primary and secondary stakeholders in the country such as regulators and developers, financing and lending institutions, the industrial units, public and a host of institutions involved in CP identification, screening, promotion and verification initiates. Consultation with selected stakeholders revealed that financing CP in India requires involvement of stakeholders from all the sectors in order to change the behavior of business decision-makers. The objective of CP financing strategy and plan should be to create conditions through awareness, information, and a combination of incentives and disincentives that will cause the decision maker to take appropriate action to conserve resources and reduce the environmental impacts. Financing CP/CT

decisions must therefore, be made from the perspective of the businessperson as well as from the perspective of the lending organization.

- Pressures or threatened penalties such as community pressure, regulatory monitoring and enforcement, loss of market or competitive advantage were weak.
- Rewards such as new markets, preference in procurement, less government oversight, lower production costs and public visibility for success were lacking. (TetraTech, 2002)

In Thailand, following a number of CP projects supported by various donors in the first half of the 1990s, the government decided to initiate a series of meetings and workshops with key stakeholders with the intent of developing a national CP policy. In 1996 the ministries of Industry and Science, Technology and Environment brought together numerous stakeholder groups to discuss and prioritize the issues that must be addressed in order to successfully integrate CP into industrial development and waste management. Not surprisingly, the issue given the highest priority by any given stakeholder group was related to an individual group's "stake". For example, the education and training obstacles were considered the highest priority by the academic and research institutions represented at the meeting, whereas the lack of clear policy, weak/inconsistent enforcement of existing pollution control regulations and lack of funding were highlighted as priority barriers by industrial associations and industry. The priority barriers identified at the 1996 workshop (UNIDO and TEI, 1998) are summarized as follows:

- Shortage of funds and experts for education and training
- Lack of recognition of importance of CP by executives
- Lack of financial incentives
- No clear definitions of CP
- Implementing agencies do not have good knowledge and understanding of CP
- Laws and regulations of Thailand are control oriented
- The voluntary nature of CP not clearly understood so that some factories perceived that once CP is initiated and later for some reason could not be complied with, they would be prosecuted
- Regulations emphasize usage of end of pipe measures.
- Entrepreneurs do not understand the pollution control laws and measures.
- CP measures not established in the existing legal measures.
- Government has not yet provided tax exemption for equipment used in CP thereby, resulting in red tape in importing clean technologies and necessary equipment and accessories.
- Lack of cooperation and exchange of information on CP among government agencies resulting in government personnel having inadequate technical competence to advise industries.
- Lack of a Thai national policy
- No coordinating agency responsible to take the lead.
- Private sector, in particular SMEs, lack understanding and information on CP leading to a lack of cooperation by them.
- Among donors, there is no coordination and work on CP is performed on a project-by-project basis developed by individual Thai organizations and

proposed to donor organizations without coordination, which results in duplication.

- Lack of overall coordination/support amongst various stakeholders to the various activities.
- Decision-makers do not have a vision on CP related matters.

As noted in Chapter 7 in describing the Thai CP survey and the Philippine CP surveys in 1997, the following variables or attributes were compared as shown in Table 8.1. In most cases the industrial leader's responses to the questionnaires were similar. The Philippines scored significantly higher than Thailand on the variable "in order to stimulate investment in CP processes and factories, the government should provide income tax breaks for factories, which shift from polluting processes to CP processes". In addition, a significant number of Philippine factories, 89 percent as compared to 75 percent in Thailand, also agreed that a factory should invest in CP processes regardless of the benefits because it is in the interest of public environmental health and future generations' welfare.

Table 8.1 Comparison of Responses of Thai and Philippine Factories from 1997 CP Surveys

COMPARATIVE ANALYSIS ON SELECTED VARIABLES COMMON IN BOTH THAILAND AND PHILIPPINES DATA

Using top-two boxes (strongly agree + agree) responses

		Phil	Thai
Base: All factories		*84*	*77*
		%	%
In order to stimulate investment in cleaner production processes in factories, the government should...			
1	stringently enforce environmental pollution control regulations	86	84
2	increase the amount of fines and severity of penalties for factories which do not meet pollution control regulations	63	55
3	provide tax or duty incentives to reduce the cost of investment in cleaner production	86	91
4	**provide income tax breaks for factories which shift from polluting processes to cleaner production processes**	86*	64
5	increase income tax levied on factories which do not shift from polluting processes to cleaner production processes	63	60
6	provide an investment facility for enabling financing of capital costs of cleaner production processes	89	86
7	provide technical assistance and training for factory owners interested in shifting from polluting processes to cleaner production processes	89	81
Incentives to adopt Cleaner Production			
1	A factory should invest in cleaner production facilities if it is demonstrated that the capital investment will generate improved production efficiency and higher profits over time.	90	92
2	**A factory should invest in cleaner production processes regardless of the benefits because it is in the interest of the public environmental health and future generations' welfare.**	89*	75

** - significant difference at 95% confidence level*

A 2002 ADB Technical Assistance, "National Policy, Strategy and Action Plan for the Integration of Cleaner Production into Industrial Development in Sri Lanka", included a survey of Sri Lankan stakeholders to understand the barriers and necessary measures to get over such hurdles. The key findings were that stakeholders felt that an overarching prerequisite for any progress on sustainable industrial growth was to have and effectively use strengthened, clear and consistent economic development policies. Barriers to CP expressed by stakeholders included:

- Attitudes of the banks towards industry are poor. It is difficult to obtain loans and the interest rates are very high.
- Companies are not aware of CP in general. They are concerned primarily with meeting end-of-pipe requirements. There is therefore, no particular interest in CP.
- Even if companies are interested in CP, there is no information source. In this regard an Authority/Body comprising of Govt./Private sector officials should be made available to advise the industry.

- Lack of familiarity by governmental officials with economic instruments hinders use of market mechanisms to achieve CP.
- The government does not have sufficient staff for monitoring the industries. The staffs that come for inspection are inadequately trained and the frequency of inspection is also low.
- Pollution charges have little potential as a useful tool to achieve CP because they are not well understood, and are seen as just one more cost to the firm. What new policies, programs, incentives, resources, etc. would make a difference in convincing firms to pursue CP?
- Incentives such as tax rebates for investment and lower bank interest rates could motivate companies to invest in CP. However, the overriding need in the textile sector was plant modernization in order to produce competitive textiles, quality wise.
- A comprehensive training/education program for CEO's and others would be required initially.
- Monetary incentives, e.g., market based incentives, will help to motivate people. Recognition rewards at company level or at employee level have a lesser effect. (ADB, 2002(a))

Barriers and actions specific to one or more CP stakeholders are described in the remainder of this Chapter. It is noteworthy that developed and developing countries face similar barriers- though somewhat more specific to the specialized industries that CP has generated, for example energy efficiency/clean energy and specialized service providers for CP in different sectors. Delivery of clean energy alternatives faces barriers similar to those described above such as: insufficient knowledge, tools and resources; inadequate policies and regulatory measures; and difficulty of venturing into alternative policy paradigms, the development and formulation of which require a better understanding of technological functions and the capacity for assessing technological options (James, 2000).

The US EPA assessed the challenges that CP service providers face. The firms surveyed identified as priority barriers (i) the increased short-term costs they incur as a result of slow acceptance by regulators to new clean technologies, (ii) reduced revenues because customers' view CP as a discretionary expenditure, (iii) lack of education and training of customers and/or ignorance by customers of relevant regulations, and (iv) lack of clarity or changing regulations and uneven enforcement of environmental regulations. One of the conclusions of the US EPA resulting from this survey was that the demand exerted by international consumers would dictate how quickly and how green industry would shift towards cleaner industrial production. In this regard they gave high priority to eco-labeling, environmental audits, green financing, an environmentally reporting as a means to inform, educate and influence consumers. (McCabe and Miller, 2004)

Perhaps, the largest "industry" that has emerged from the demand for CP by manufacturing enterprises is "green manufacturing". A growing number of organizations have begun working towards implementation of green manufacturing because of increased concerns about increasing pollution, depleting natural resources, and climate change. Successful implementation of green manufacturing faces a number of barriers as well. Mittal and Sangwan (2014) performed an analysis of the barriers from environmental, social and economic perspectives, in order to recommend those barriers that should be addressed first given limited resources to remove barriers in developing countries. The study identified and prioritized twelve barriers to green manufacturing. The highest was lack of awareness/information about available technology choices and limited information diffusion. This was followed by technological risks of immature and unproven technologies, materials, operations and industrial processes; followed by complex or weak legislation and weak enforcement of environmental laws. The key barriers to remanufacturing in India, a major new form of green manufacturing, were competitive pricing, lack of quality guidelines/policy, and lack of government support (Sharma et.al, 2016).

In the early stages of CP implementation, a priority focus was on reduction of exposure to toxics. The regulatory approach to management of toxics in industrial processes and wastes was not a natural institutional or technological fit with more conventional waste management in most developing countries. Rapidly industrializing Asian developing countries were faced with a distinctive set of barriers, similar to those experienced in developed countries, because of the challenge of tailoring (i) organizational structure of regulatory agencies; (ii) compliance and enforcement policies; (iii) regulatory role making procedures; (iv) guidelines regarding relative toxicity; (v) financing including the major barrier to CP finance for SMEs. The practical problems faced by smaller businesses often revolve around the lack of knowledge. With very limited, if any, formal training on health and environmental safety issues by the employees, the trade associations pointed out that such small businesses need support. The lack of regulatory impetus combined with the skill and knowledge deficiency results in little chance that individuals in these settings will have incentive or opportunity to learn about CP and to put it into practice. Small businesses lack information on alternatives while larger companies are more likely to have devoted resources to discovering alternatives. In some developed countries, the solution involved provision of needs-based targeted technical and compliance support to SMEs. In addition, larger companies, through industry associations, provided technical information on toxics use reduction and management based on the larger firms' research and development. (Geiser et al, 1994)

A common theme throughout the various assessments of barriers to CP was the complexity and often duplication of policies and regulations governing CP and resulting ambiguities of responsibilities and accountabilities of various stakeholders-particularly from government, but also research and academic institutions and other stakeholders. Governmental agencies, corporate departments, and research and academic institutes are typically set up according to discrete sectors and disciplines, each with its own interests (and interest groups), virtually ensuring policy segregation. It is possible that the evolving focus of governments and industry on energy efficiency/GHG reductions may be a motivating factor to overcome inertia relating to CP. Understanding this inertia can only be achieved by understanding the barriers and drivers (Stal, 2015). The recognition of the Paris Agreement on the need for integrated action on climate and the SDGs is a positive signal, but most governments and other relevant organizations are still focused on a relatively narrow element of the challenges.

Breaking down silos and achieving efficient and effective integration is a major challenge in and of itself. Integrating policies analytically and deriving policies based on integration goes beyond the role of policy analysts and more into political roles, proposing a concept of integration rather than presenting alternatives and suggesting how they work under various scenarios. Such barriers will need to be addressed in tandem with those barriers described above if CP is to be successfully transformative. However, the implications of using integration as a tool of analysis are different from those of using it as a tool for implementing policy. First, in analysis, introducing the concept of integration bears the risk of reducing analytical rigor and increasing the chances of superficiality. Second, in attempts at cross-sectoral analysis, one is forced to higher levels of abstraction, and this may divorce the analysis from the challenges of the "real world." (Schnurr and Holtz, 1998; Waage et al, 2005)

8.5 Enabling Conditions for Successful CP

In preparation for the 2nd European Roundtable for Cleaner Production (now the European Roundtable for Sustainable Consumption and Production), a survey of practitioners was undertaken to identify the five most important success factors for CP. In order of priority, the survey results identified the following factors: (i) cooperation, training and communication, (ii) assessing tangible benefits, (iii) leadership and management commitment, (iv) commitment and motivation of employees and external key actors, and (v) factors ensuring good project management and other conditions. (Zwetsloot and Geyer, 1995)

Overcoming these barriers aligned well with the broad success factors from the 1995 European Roundtable. Clearly the rapid adoption of CP in Asia seeks to change the perspective and behavior of enterprise decision makers, and must be rooted in several critical assumptions. The lessons from the previously described barrier studies, surveys and experiences point to the following "enablers".

- CP should be approached as a behavioral change challenge, seeking to create a combination of conditions (pressures, incentives, facilitation, and awareness) and balance of forces that will cause the enterprises' decision-makers to see that adopting CP is in the best interests of their enterprises. The prevailing assumption that demonstrated success and access to information and technical support will induce widespread adoption has been proven to be false.
- Adoption of CP must be voluntary by enterprise decision-makers (owner, chief executive officer, financial officer, etc.). Enforcement of environmental regulations is an important part of the balance of forces acting on a decision-maker, but in most Asian developing countries enforcement is inadequate to reach all enterprises. Further, the present structure of most regulations encourages end-of-pipe solutions rather than CP.
- Promotion of CP must be approached strategically, setting national goals, formulating public policies to support those goals, thinking strategically to identify the wide range of concerned parties and their interests and the resources that they can collectively bring to bear to achieve the common goal, and collaborating tactically to identify those programmatic actions that will achieve the conditions necessary for widespread behavioral change.
- Promotion of CP will be achieved at scale through collaboration among national stakeholders. It is not the domain of a single governmental agency, or of only the

manufacturing sector within the private sector. Only through the combined and efficiently targeted use of scarce resources can national goals be achieved.

Table 8.2 summarized the key CP stakeholder groups and their respective roles in CP policy formulation, enabling actions and implementation functions. The multiple roles of each group are indicative of the complexity of scaling-up implementation of CP and the need for carefully designed and implemented collaborative efforts.

Table 8.2: Matrix of Key Stakeholder's Relationships to Policies and Instruments for Fostering and Supporting Implementation of CP

Policies, Instruments and Other Factors	***National/Local Governments (General Economic/Social Policies & Conditions***	***Environment or Industrial Ministries Policies & Actions***	***Private Industry (Policies & Actions)***	***Communities & NGO'S (Initiatives)***
General awareness and education	*	*		*
Technical education	*	*	*	
Public participation	*			*
Government Decentralization	*			
Industrial Strategy: location and components	*	*		
Privatization policy	*	*		
Trade policy	*			
Banking and financial reform	*			
Legal policy: Liability for environmental damage	*	*		
Environmental Training		*	*	
Financial support	*	*		
Market based instruments (e.g. pollution taxes)	*	*		
Monitoring and inspection, penalties		*		*
Command & Control/regulatory standards	*	*		
Dissemination of CP techniques to SMEs		*	*	*
Ind. Self-reliance (Env. Auditing, PC managers)		*	*	*
Ind. Estates, waste exchange, collective treatment		*	*	

(Source: modified from Chandak, 1994)

The strategic elements will differ from country-to-country, given differing business cultures and financial conditions, and the tactical solutions will almost certainly differ by country. However, the underlying premises of the approach should not differ significantly, and the strategy for each country should therefore, include the following elements:

- Bringing together, in a neutral forum, all public and private sector stakeholders to jointly identify broad national goals, policy objectives, and a national plan for CP;
- Formulating public policies that will promote achievement of those goals, integrating policies across sectors (e.g., integrate environmental policy versus

industrial development policy to avoid conflicting directions), starting the long process of policy adoption;

- Identifying those conditions of pressure, reward, facilitation, and awareness that will combine in the specific national business climate, regulatory regime, and financial conditions to change the perspective and behavior of decision-makers in a wide range of business enterprises, especially SMEs;
- Developing a national action plan for the promotion of CP that is derived logically from the strategic goals and the conditions for change, and which integrates the concerns and the resources of all interested parties, especially the affected business sectors;
- Incorporating into the action plan and devising actions to accelerate the adoption of CP principles in sectors beyond industry (e.g., tourism, local government, transportation, financial institutions, agriculture, medical, and energy, etc.);
- Establishing an independent body, representing the public and private sectors, to monitor progress in the adoption of public policy and the implementation of the action plan, and to continually improve the plan and seek new resources for its implementation. The plan must not be allowed to become a static document or so officially endorsed that it is not easily modified to meet changing conditions;
- Using the leverage of the general educational system and the media to create widespread understanding of the impact of industrial pollution on human health and the environment and of sound business options to prevent that impact through CP;
- Giving special attention to the use of MBIs and to mechanisms of public reward for good performance and censure for poor performance;
- Inviting participation of international donors and lenders in the planning process and encourage communication and collaboration among them to most efficiently accomplish the elements of the plan;
- Stressing development of national resources to avoid dependence on external aid. For example, promoting lending by local financial institutions to SMEs for investments for CP;
- Giving special attention to the forces affecting the application of CP in new investments (e.g., investment incentives) as they will with time shape the future of CP in an industrializing nation more than any other factor;
- Focusing technical assistance and facilitation to the needs of SMEs, such as simplified approaches to environmental management and CP, and assistance in preparation of proposals to access local financing; and
- Promoting networking for exchange of operational and technical information, especially among relevant Asian experiences.

Most of the elements of a strategy designed to accelerate implementation of CP, such as those referred to in the foregoing list, constitute a national process. There are certain elements, however, that can also apply across national boundaries. They include:

- Networking among all stakeholders for exchange of operational and technical information, especially among relevant Asian experiences;
- Networking among external donors and lenders, and other concerned international organizations to promote communication about objectives, actions, and concerns, and to achieve coordination to avoid duplication of programs and collaboration to gain synergy in their actions;

- Extending local lending to SMEs through a multinational loan guarantee facility;
- Development of international investment funds focused on encouraging local investment in and manufacture of cleaner technologies; and
- Development of broad guidelines and training programs, such as for a national integrated policy framework or a national action plan, or for the application of concepts such as industrial ecology (ADB, 2000(b)).

In many countries, the challenge of access and affordability for clean technologies has been a challenge. The increased attention to access to technologies to improve industrial energy efficiency energy has also improved the understanding of the need for policy-based actions in developing countries, particularly applicable to larger countries like China and India with strong R&D capacity, to improve access and affordability. A phased approach is likely to be necessary as presented in Table 8.3.

Table 8.3 Policy Instruments to Improve Access and Affordability of Clean Technologies

	Description/definition	**Issues to address to move to next stage**	**Policy support**
Technically viable	The basic science is proven and tested in the lab and/or on a limited scale. But some technical and cost barriers remain.	Development and demonstration to prove operational viability at scale and to minimize costs.	Technology development policies: Substantial public and private R&D. Large-scale demonstration. Internalize externalities through resource pricing. Technology transfer.
Commercially available and economically viable	The technology is available from commercial vendors. Projected costs are well understood. Technology is economically viable justified by country's development benefits. But technology cannot yet compete, without subsidy, other incentive and/or internalization of local externality	A lack of level playing field between clean technologies and older/dirtier/less efficient technologies, and internalization of domestic economic values required	Domestic policies to provide a level playing field: Remove subsidies supporting older/dirty/less efficient technologies. Internalize local externalities. Provide financial incentives for clean technologies.
Financially viable	Technology is financially viable to protect investors, with cost competitive or high financial returns and short payback periods for demand options	Market failures and barriers hamper accelerating adoption through the market	Regulations, with financial incentives to remove market failures and barriers. Support for delivery mechanisms and financing programs to expand adoption. Consumer education
Widespread	Technology is being adopted widely through market operation		

Source: Modified from World Bank World Development Report 2010.

8.6 Defining and Strengthening the Roles of Key Stakeholders

8.6.1 Who are the Key Stakeholders

The previous section on barriers identified the key stakeholders in the successful adoption of CP at a rapid pace and large-scale. For purposes of the current analysis, these stakeholder groups are (i) government (in most cases national but could be provincial or state depending on mandate and authority), (ii) local government and communities, (iii) national and local financial institutions, (iv) clean technology centers, (v) civil society organizations (CSOs) (which include community-based organizations and the broad spectrum of other NGOs), (vi) academic and research institutions, (vii) industry associations, (viii) business and industry (enterprises), and (ix) international assistance agencies.

Experience in several Asian developing countries revealed that stakeholders relate to the processes of CP at different levels and with different degrees and capacities. Some of them are directly affected by or affect the outcome, negatively or positively, of CP initiatives (communities in the vicinity of industries, factory employees, manufacturers, businessmen, industrialists) and fall into the category of primary stakeholders. Other stakeholders, those who may influence CP by influencing policy and regulatory mechanisms (law enforcement, activists, CSOs, financial institutions, donors), play more of a facilitating role. Views and perceptions held by these stakeholders vary and are determined by the institutional framework and the environmental context in which they are placed and the degree of their participation in the process. (TetraTech, 2002; CPIE, 2003; ADB, UNEP, UNIDO, USAEP, 2003; UNEP, 1994; Ichikawa, 1995)

The interactions of stakeholder groups to support CP and CSP have been key to achieving the progress to-date. Network building has been achieved at the local, national, regional and international levels through formal processes such as the national and regional roundtables and more informal processes such as through community consultations and engagement. International networks such as the Greening of Industry and regional networks such as the APRSPC continue to play important roles in bringing together various stakeholder groups (Sarkis et.al., 2015; Tseng, 2013). The roles of informal networking at the city and community levels will become increasingly important as various stakeholders need to come together to seek ways to improve resilience to climate impacts (Reed et.al., 2015) such as resource use efficiency and exacerbation of local pollution.

Lessons from Asian developing countries are consistent with assessments by others as to stakeholders and their roles. For example, Chandak and Huisingh (2002) focused on facilitating organizations, which they categorized as (i) financial institutions, (ii) educational institutions, (iii) NGOs, (iv) technical advisors and consultants, and (v) industry associations. In an earlier analysis of CP stakeholders, Boons and Huisingh (1992) distinguished between direct and indirect influences of these groups. They highlighted the important role that environmental NGOS (local and international) were taking to indirectly instigate government to impose rules on corporations, or get consumers to prefer products produced by firms with sound environmental operations. They also recognized financial institutions, trade associations, labor unions, and universities (through their education and research programs) as important influencing bodies.

The establishment of coalitions and multi-stakeholder partnerships is increasingly seen as absolutely essential for increasing the pace and scale of adoption of CP because there are no single approaches or actions adequately effective at achieving CP objectives. The key to successful implementation of CP or other sustainable development actions, at scale, is to achieve development based on shared interests and goals and relying on strong partnerships between business, government, NGOs, development institutions, research and academic institutions and local communities (Evans et al, 2015).

8.6.2 National or Regional Government

National governments, and in some cases state or provincial governments, are the primary driving forces for adoption of CP. Governments must show leadership- both political and bureaucratic- and establish policy, plans, incentives and disincentives if CP potential is to be optimized at the national level.

Overcoming many of the barriers described in the previous section requires such leadership and policy guidance by government. Of course many of the needed actions by government, if effective, go way beyond facilitating CP, but are critical to the broader sustainability agenda. Leadership is particularly crucial in valuing resources and regulating their use. Natural resources continue to be regarded as free or almost free goods in most Asian developing countries. This is particularly true for the use of water. The market costs on which a manufacturer makes choices among inputs reflect almost exclusively the cost of processing and delivery, perhaps slightly the relative scarcity of the resource, and almost not at all the impact of its extraction and processing on the environment or the stock of natural capital.

Many existing environmental standards and regulations promote end-of-pipe solutions rather than CP. Most regulatory regimes have been developed with the assumption that industrial wastes will be generated and must be treated and disposed. Fiscal measures and industrial pollution control regulations often make end-of-pipe solutions more profitable to the manufacturer than seeking CP alternatives (Evans and Stevenson, 2001).

Political leaders, supported by a committed civil service, are the only actors who can address such challenges. Weak public policy with strong backing by politically influential individuals may achieve more than well-conceived policies with no backing. It is important that the concepts and the importance of CP be endorsed at the highest level of government.

By the time the industrializing Asian developing countries started considering CP as an industrial development direction, many developed countries had gone through the transition (at least partially) and had learned a number of lessons that, if transferred to developing countries might help them to avoid some pitfalls and progress at an accelerated pace. Baas et al (1992) argued that developed country governments should assist developing countries to shift from end-of-pipe technology to CP, providing guidance on government policies and practices for promoting CP such as regulatory mechanisms, economic instruments, voluntary instruments, technical assistance, and policy. Experience of developed country regulatory systems evolution is particularly relevant to developing countries- systems that are participatory, decentralized, flexible, simple and clear, preventive, inducer of innovation, multi-instrumental, rigorous on enforcement, performance-based, planned and gradual, supported by adequate resources, measured and communicating, and reflexive (de Miranda Ribeiro and Kruglianskas, 2015).

There were many valuable lessons to transfer from Europe, the USA and other industrialized countries. One of the pioneering, innovation-oriented CP programs upon which much of the technical assistance foundation was built in Asia was the Dutch PRISMA project on industrial successes with waste prevention, initiated in 1988. A by-product of PRISMA and similar early work in the USA was an appreciation for the need to change the way government and industry and other stakeholders related to and worked with each other. The PRISMA experiences demonstrated the need for government to make clear the linkages of CP and existing regulatory frameworks and monitoring processes. Early lessons indicated that governments should facilitate transition by shifting focus from enforcement to voluntary action, provide guidance and national coordination to ensure that the various activities are comparable and generate a basis for further action, and support the preparation of educational support mechanisms on the prevention of waste. Early experiences in Europe pointed towards the need for governments to give high priority to prevention-oriented demonstration projects in companies and to strengthen coordination among various organizations for the transfer of technology. It was also recognized that governments needed to adjust permitting processes to encourage CP, and to maintain strong monitoring and reporting roles in order to generate a database in support of effective enforcement of regulations (Baas et al, 1992; de Hoo et al, 1991; Van Berkel, 1995; Baas, 2005).

UNEP (1994) reviewed a number of governments' approaches to CP, proposing suggestions on roles of government, including the use of voluntary agreements and codes of conduct backed by regulations that could result in a governance environment conducive for industry to voluntarily adopt CP. With regards to actual introduction and use of voluntary mechanisms, the Danish experiences are noteworthy. By 1994 Denmark already had twenty years of experience in shifting from regulatory practices through several rounds of regulatory reforms, streamlining existing regulations and making it more effective including introduction of several new policy instruments and an increase in the flexibility of the regulatory system. The Danish Government shifted from a regulatory regime to broaden the choice of instruments based on cooperation intended to harness market forces. This, in turn, changed the interactions of the actors involved in policy making, engaging greater input from industry and the public to agree on voluntary agreements. The Danish Ministry of Environment provided advisory services for enterprises, particularly small and medium-sized enterprises that faced difficulties in complying with the overall policy objectives. It also introduced labeling indicating whether products or goods contain recycled or recyclable materials.

At about the same time, the USA, also experimenting with voluntary approaches, recognized the importance of integrating environmental programs since experience showed that the medium-specific regulatory approach - air, water, or land - encouraged end-of-the-pipe pollution controls to treat, store, or dispose of waste, rather than encouraging CP. Thus the USA piloted multimedia, or integrated approaches to environmental management as alternatives to the traditional medium-specific approach at the state-level to encourage pollution prevention. The results were reduced compliance costs to industry because of increased efficiency. This led the USEPA to selectively integrate its responsibilities to maximize flexibility needed to effectively meet environmental priorities (USGAO, 1996; USNAPA, 1995).

The Netherlands' experience was also valued in developing voluntary agreements with different sectors of industry. By 1994, the national government was engaged with fifteen industry sectors to reach agreements following consultation with local governments, the industry sectors including employers and trade union associations, and NGOs (MHSP 1994). Many of the bilateral technical assistance projects to Asian industrializing countries such as Indonesia, Thailand and Philippines, with funding from The Netherlands, Denmark and other donor countries in the mid-1990s built on the European experiences of demonstration projects and shifting from a regulatory to voluntary enforcement regime. Unfortunately, the lessons from Europe and USA were only partially relevant to the Asian situation; the difference being that Europe and USA moved from effective regulatory enforcement to voluntary actions, whereas Asian developing countries had not yet achieved effective regulatory enforcement. The Asian countries, lacking not only strong environmental governance but also a CP policy framework, were generally unsuccessful in establishing a foundation for transitioning or leapfrogging to CP (ADB, 2004; Evans, 2014).

From 1995 until 2002, this thesis author was involved in the provision of technical assistance to all of the rapidly industrializing Asian developing countries, often partnering with UNEP, UNIDO and bilateral donors in delivering the assistance. That experience showed that most governmental agencies and ministries did recognize the significance of industrial pollution and natural resource depletion, but within a given country, their respective roles and responsibilities were often unclear and commitments uneven. For example, in 2000 when ADB was supporting CP at the state-level in India, the Ministry of Environment and Forests, State Pollution Control Boards, and Department of Energy were largely responsible for policy, planning, implementation, monitoring, and ensuring compliance with the applicable environmental statues in the country. The Ministry of Industry was responsible for developing, planning and implementation of industrial policy for catalyzing industrial growth in the country. Similarly, the Ministry of Finance was responsible for national financial planning and policy formulation and implementation. The lack of a uniform understanding and commitment for promoting CP at the national level by various ministries and regulatory agencies, and lack of commitment from industrialists and manufacturers, demonstrated the need for synergy and rationalization of policies and procedures for effective implementation of various regulatory and financial mechanisms for creating an appropriate environment for CP (TetraTech, 2002).

This situation in India was indicative of most other countries in the region. OECD (1999) recommended that developing countries establish or strengthen their respective legislative and regulatory framework for environmental protection, and its enforcement in order to make CP programs more effective. ADB, working with UNEP, UNIDO and the US Asia Environment Partnership (USAEP), consulted with stakeholders across the Asia region, and concluded that governments' focus, in addition to the leadership role discussed earlier in this section, should be to establish an effective policy and planning framework conducive to diffusion of CP across the economies (Evans and Stevenson, 2003). While considerable progress has been made in terms of government capacity to stimulate the changes required for CP, many still lack the necessary capacity to support technology diffusion and financing through necessary policy, regulatory and institutional reforms (Suzuki, 2015).

8.6.2.1 National Government's Critical Role in Getting the Policy Framework Right

An appropriate underlying framework of policy, integrated across many sectors and reflected in combinations of regulatory requirements, promotion programs, market-based instruments and other tools is essential for economy- or sector-wide uptake of the principles of CP. Most governments are understandably focused on economic growth. In the last two decades a number of Asian developing countries have recognized CP or related concepts as a national policy issue. But still in 2015, in most countries, environmental policies often remain inconsistent with industrial development and investment promotion policies, and concepts of CP have generally not been mainstreamed in the public policies of the many aspects of economic activity that impact the environment and the natural resource base.

Much of the enormous collective effort to reduce industrial pollution and to promote CP globally has focused on one or more of an array of specific initiatives, from market-based instruments to greening the supply chain to improving access to financing, and so on- a long list of worthwhile but relatively narrowly focused solutions. Most programs to promote CP have failed to address the underlying policy framework and the integrated national planning needed to use resources efficiently and achieve the rapid spread of CP. Without the mainstreaming of CP concepts and objectives into policy for the many sectors of government and the economy, the adoption of CP is likely to continue to spread much more slowly than is otherwise possible, and is critically needed, in order to have a positive impact on country-level environmental quality and resource productivity.

Cleaner production is a crosscutting, multi-sectoral issue. There is no single policy for CP, and the promotion of CP does not belong to any single government department or agency. Concern for the promotion of CP should be an integral consideration of many areas of policy. The overall objective in the use of public policy to promote CP is to harmonize the objectives of various sectors (e.g., environmental vs. industrial development vs. trade promotion) through the integration of public policy elements that promote CP within the policy agendas of each sector and make it a routine consideration in the decision-making of each sector.

Even in countries that have legislated CP such as China, and in countries that have included CP/SCP objectives in their national development plans such as India, Philippines, Sri Lanka, Thailand, and Viet Nam, the integration of environmental and sectoral and economic policies is generally non-existent or at least inadequate. CP objectives need to be embedded within the development goals of development sectors, as mainstream objectives tailored to the specific sector. In this way, a national or regional government can establish clear goals and accountabilities for the relevant sectoral agencies. (ADB et al, 2003; Evans, 2014; ADB, 2002(a))

8.6.2.2 Policy And Planning Requires Broad Stakeholder Participation, Which Is Led By Government.

Policy formation and integration, and planning policy implementation requires coordination and collaboration in designing, planning, and implementing, to establish clear objectives and divisions of responsibility. The necessity and importance of participation of multiple stakeholders increases as policy objectives become more complex, such as introduction of extended producer responsibility, or relies on public engagement for successful implementation, such as eco-labeling and environmental performance disclosure (Lindhqvist, 2000; Wang et al, 2002; Ghosh and Lohani, 2000). Multi-stakeholder fora and user-friendly information systems give people an opportunity to provide input into policy decisions. The national or provincial/state governments play a crucial role in requiring and facilitating participation and ensuring that a participation strategy reflects the prevailing political, social, and cultural conditions. Systems of governance that anticipate societal responses to various integrative measures and accommodate the policy objectives of a range of stakeholders and sectors are crucial. In this perspective, governance means the inter- and intra-organizational arrangements, decision-making processes, incentives, and disincentives through which governmental and nongovernmental actors—including the public, communities, and the private sector—influence decisions about societal priorities and resource allocations. (Witmer,1994; Schnurr and Holtz, 1998; ADB et al, 2003)

8.6.3 Local Government and Communities

While the national or state/provincial governments drive the policy and set the stage for the aforementioned multi-stakeholder fora, the burden of implementation falls on local government. It is in the interest of local governments and communities to drive the implementation since they are the main beneficiaries of CP. Environmental quality and productivity, either benefit or harm local communities' economic prospects and quality of life. Local government is often responsible for providing key services such as water supply and waste removal to the local population. In some cases, they also provide electricity. CP dramatically increases the efficiency of these services, so the same amount of water or energy or waste removal serves a much larger population. For local governments, this can have tremendous impacts on their budgets.

Local governments are often the most important channels for influencing the adoption of CP in new investment. In the Philippines, for example, all companies in a municipality are required to have a current Mayor's Operating Permit. This is generally a token requirement necessary for local taxation purposes; it is not typically used to impose conditions on businesses. However, there is no reason why a mayor could not impose various CP conditions on issuance of a permit. For example, if a polluting factory wishes to expand production significantly, the mayor's office could require that a CP assessment be conducted by a reputable independent organization, and that the factory management must demonstrate that they have fully considered and implemented relevant CP options. Often this will help to reduce pollution significantly, since the factory is already in the mode of new investment and it can finance CP improvements that are cost effective along with the rest of the project.

Communities and community-based organizations (CBOs), often working with local government can be key to improving transparency and accountability of various stakeholders at the local level. But both face serious hurdles in effectively fulfilling their many roles. First, in most Asian developing countries, the norm is secrecy, not transparency. Businesses are not inclined to report publicly on their operations, especially on their environmental performance. Lack of transparency makes it very difficult for communities impacted by an industry to even know the nature of the risks they incur, much less bring pressure for change. (Evans and Hamner, 2002) Second, many local governments, while responsible for issuing operating permits and monitoring and enforcement, are often weak (Norgaard, 2003). These barriers are somewhat more complex when focused on promoting CP, largely because of less experience and awareness by the local stakeholders. Carnegie et al (2000) concluded that a key element of support for the community-local government-local industry partnerships might be through community education initiatives. A successful community education system may facilitate knowledge, understanding, innovation, action, and change. This, in turn, can promote creative and more competitive CP practices. Indeed, most of the examples given below include academic and local think-tank partners to help overcome the knowledge gaps. As the focus shifts from CP to CSP and climate resilience, the need to improve the community organization and communications for effective community action is increasing in importance (Spires et.al., 2014).

A recurring barrier given very high priority in India, Philippines, Sri Lanka and Thailand is the weak or incomplete enforcement of pollution regulations. (ESCAP, 2005) A similar constraint was found in China where the World Bank undertook an analysis of the determinants of the relative bargaining power that firms may have in their relation with local environmental authorities pertaining to the enforcement of pollution regulations and charges. A survey of 640 industrial plants in 1997 showed that those firms that were the objects of citizen complaints were most likely to be inspected and had the least bargaining power (Wang et al, 2002(b)).

Poor enforcement results partially from a lack of enforcement resources, but also significantly from a reluctance of government to confront influential firms or to appear to impede the economic growth and inflow of investment capital to the country. In the initial years of the Green Watch public disclosure initiative in China, local governments were highly resistant. Some local governments resisted on the grounds that disclosure may threaten local employment by reducing polluters' profits. In addition, some were concerned about the additional administrative costs imposed by disclosure programs. Finally, some local authorities worried about how disclosure may affect relations between local companies and communities. Under these circumstances, financial support from provincial government is needed to underwrite the startup costs for local disclosure programs. The study also showed the need for regular reporting, increasingly provided by community-based organizations (CBOs) (World Bank, 2002).

Local community CP stakeholders/facilitators are likely to include CBOs, local government, commercial banks, industrial associations, consumer groups, and retailer groups. Many local governments are increasingly supporting participatory approaches, recognizing the potential benefits of greater environmental protection at lower cost and with more effective implementation. In what Zarsky referred to as a "multiple agent" model, the state retains key responsibility for identifying and promoting the social good, including command-and-control regulatory activities, but also actively, creatively, and strategically engages business and civil society in defining and achieving the goals of good environmental governance. Local communities and business associations increasingly initiate and implement their own activities, perhaps calling on governments for assistance or policy response, instead of simply responding to governmental initiatives and regulations (Zarsky, 2001).

Community-based organizations and consumer groups often have dual roles. They are often the advocates of change, by putting pressure on industry and government to improve environmental governance. Such pressure ranges from supporting functions in partnership with local government and industry. Examples are the development of voluntary instruments such as eco-labeling. Local community groups can help to monitor and impose sanctions on industrial pollution, thereby supporting or replacing local government's role. In the more extreme case, such groups organize boycotts, demonstrations and even vigilante actions.

Members of CBOs and consumer groups are also the developers of the local economy and employees of local industry and are often led by representatives of the academic community. They are affected by many of the instruments most effective in stimulating CP, such as water and energy pricing. Often they are advocates of not increasing such resource prices since they also pay for water, electricity and gasoline. They are the "vote bank" so politicians listen to them. They represent public opinion and popular demand and thus can help galvanize political will. Environmental and CP awareness and education programs targeted to these groups are essential to enable them to balance the costs and benefits to them of basing local development on CP principles.

There are many Asian developing country cases of government-supported constructive engagements to enhance cooperation among industrial facilities, communities, workers and government regulators with the objective of improving industrial environmental performance. Public disclosure programs have received considerable attention. These usually entail five elements (if successful): (i) detecting environmental risks, (ii) assuring reliable information, (iii) disseminating the information to those at risk from the pollution, (iv) allowing public- and private-sector agents to act on the information to create pressures for pollution control, and (v) disseminating the results to industry. (Tietenberg, 1998; Afsaf, Blackman and Ratunanda, 2000) Some examples include:

- In Mindanao Philippines, local governments supported community groups to attend workshops where they learned how to monitor water quality and watershed stability in streams and lakes. The government utilized the results of monitoring to prepare a natural resource management plan. An NGO was formed, and the head of the NGO served on the Natural Resource Management Council, as a direct link between the community-based water monitors and the government (UNCSD, 1998).
- Community pressure in China has dramatically increased over the last several years. A study of 200 factories and the communities around them showed that both formal pollution regulation and community variables were significant determinants of the factories' behavior in terms of wastewater management. Informal regulations appeared to be at least as strong as formal regulations. The strong impact of community pressure on industries' discharge performance in China may not stop even if the factories were in compliance because as long as a community is dissatisfied with its pollution situation, the pressure from the community continues. This pressure can either be directly imposed on polluting plants, or indirectly via governmental pollution control authorities through citizen complaint programs. The study demonstrates that it is cost-effective for the government to strengthen awareness of, and provide information to communities (Wang, 2002(a)).
- The Indonesian Program for Pollution Control, Evaluation, and Rating (PROPER), the first major public industrial waste disclosure initiative in Asian developing countries, uses public disclosure of ratings to create incentives for industry to improve environmental performance. NGOS, communities, and the media play a key role in putting pressure on polluters to improve performance. It

helped push governmental regulatory bodies to enforce regulations proved to be a strong incentive for industries to react to peer pressure- to improve performance in order to have a rating comparable to or better than their competitors. The Philippines Eco-watch and Thai Green Label are similar initiatives (Afsah et al, 2000). A survey of 146 participating factories in Indonesia concluded that the most important impact was improved understanding of factory managers regarding their own plants' emissions and prevention/abatement opportunities. High ratings were given also to increased pressure from communities living around the factories, pressure from news media, and also to improved opportunities for obtaining ISO 14001 certification (Afsah et al, 2000).

- A community in Sumatra, Indonesia claimed severe health damage from a local paper factory. Formal regulations were reportedly ineffective in forcing the mill to comply with environmental regulations. Supported by local and national NGOs, the local communities applied pressure for cleanup and compensation with the government acting as a mediator instead of as a regulator. The pressure on the company was compounded by international financial markets, which forced the company to upgrade its processes (World Bank, 1999).

8.6.4 Civil Society

A 'multiple agent" approach to environmental governance is emerging in many Asian countries. In this "multiple agent" model, the state retains key responsibility for policy and planning for meeting environmental standards and in most cases government retains command-and-control regulatory activities. The fundamental difference is that governments seek to actively, creatively, and strategically engage business and CSOs[11] in defining and achieving the goals of good environmental governance. Moreover, the multiple agent models suggest that civil society and business can be self-organizing. They can initiate and implement their own activities, perhaps calling on governments for assistance or policy response, instead of simply responding to government initiatives and regulation. (ADB, 2001(b))

The roles of civil society, in stimulating CP were highlighted as early as 1992 by Boons and Huisingh (1992). They outlined ways in which CSOs can influence corporate decisions and activities such as through engagement with social actors to influence consumer demands and to generate greater awareness of CP across society. At that time in Asian developing countries there was very limited engagement of local CSOs in supporting CP- international CSOs and a fledgling group of regional and national CSOs were largely focused on biodiversity conservation and impacts of economic development projects. (Evans 2014) But by the mid-1990s CSOs, particularly in Philippines, began playing an active role in promoting CP. While governments will remain the central player in developing and implementing environmental policy for the foreseeable future in Asia, the roles of civil society have been increasing in every industrializing Asian developing country in stimulating political will, and raising awareness on the lack of technical and

[11] CSOs are defined as organized civil society and can come in many forms, some informal and some as formal entities such as non-governmental organizations (NGOs), CBOs, faith-based organizations (FBOs), among many others. This is when a group of individuals come together for a common purpose, as to fulfill a particular mandate driven by need.

regulatory capacity, and the impacts of environmental degradation on local communities. (ADB, 2001(c); Akenji, 2011)

Most industrializing Asian developing country governments now appreciate that governance based on engaging business and civil society can help to overcome many of the barriers mentioned in section 8.1. Public opinion and popular demand, for example, can help galvanize political will; local community groups can help to monitor and impose sanctions on industrial pollution; and the private sector can invest in public goods and innovate in ways that enhance company productivity, competitiveness, and environmental performance. The recognition and appreciation of the potential benefits of engagement with CSOs by business, including SMEs, has improved over the last decade because of the impact on consumer awareness (Horangozo and Zilahy, 2015).

Civil society can help promote better environmental governance through a variety of – often multiple – roles. It is not unusual to find advocacy groups in Asia today who are also watchdogs and/or think tanks, and visionaries who are also problem solvers (see below for some examples). Almost all play the role of educators. The flexibility of civil society groups, mean that they can often mix and match their roles in response to changing circumstances. Five broad roles that CSOs are supporting CP in Asia, usually in tandem with other stakeholder groups, are (i) intellectual leadership, (ii) specific issues advocacy, (iii) technical support providers for problem-solving, (iv) watchdogs, and (v) educators.

International CSOs have greatly increased their advocacy and “on-the-ground” project work in Asia. Their assistance has also stimulated a number of regional CSOs that bridge the global network and advocacy work and local actions (Zarskey, 2001). Many of these groups play a role as business support organizations. Besides the advocacy role of CSOs, they have in some cases been supportive to local commercial banks by sharing knowledge and experience in support of CP initiatives (Juecken, 2001). The role of networking with CSOs and commercial banks and local business organizations will become increasingly important as climate finance starts filtering down to the local level. (Evans, 2014)

One example of international CSO leadership is IPEN[12], undertaken to support the Strategic Approach to International Chemicals Management (SAICM), an initiative discussed in the Business Associations section of this chapter, below. A consortium of six international NGO networks joined together to form IPEN in 1998 to tackle chemical toxicity issues. IPEN undertook the “*SAICM NGO Global Outreach Campaign*” in 2009. The aims of this campaign are raising awareness about the harms caused by exposure to toxic chemicals and broadening the base of CSOs working on issues related to the implementation of SAICM. The partnership produced “*An NGO Guide to SAICM: The Strategic Approach to International Chemicals Management.*” The NGO networks participating in the campaign adopted an *“NGO/CSO Global Common Statement on the Strategic Approach to International Chemicals Management.”* This statement was circulated for endorsement by NGOs and other civil society organizations in more than 80 countries with the aim of

[12] IPEN originally was the acronym for “International POPs Elimination Network”, however that name was dropped- it now stands for “A toxics-free future”.

securing more than one thousand organizational endorsements, including commitments to work to implement SAICM policies such as promoting reforms of domestic chemicals assessment and management laws, policies and practices. By 2013, IPEN had 700 member organizations in 116 countries and had implemented more than 300 NGO-SAICM projects in 64 countries (IPEN, 2014).

International, regional and national CSOs have been active through policy processes, pushing for the right policies to address unsustainable consumption and production. In China, Cambodia, Thailand, Korea and other countries, CSOs have been active participants at SCP roundtables and in the provision of input to NSSDs. The first national consultation in the region towards the United Nations Earth Summit in 2012 (Rio+20) was organized in Sri Lanka by civil society, through the Climate Sustainability Platform. At the CSD-18 session in New York, interventions were made by IGES, on behalf of NGO Major Groups at the High Level Segment on SCP.

The role of green consumer advocates is a growing niche for CSOs, with some groups established as independent certifying agencies. Groups such as the Forest Stewardship Council and Marine Stewardship Council were established with support from international CSOs. With support from national CSOs and in response to market demands, many Asian producers are meeting the FSC and MSC standards and some countries are establishing their own certification schemes.

Local CSOs in Asia have demonstrated that they are particularly well positioned to support awareness raising, monitoring and reporting to strengthen regulatory compliance. Without such awareness raising, there is often little pressure from the public, even from those directly impacted, on government to take decisive action to reduce environmental degradation. Local and informal knowledge and feedback from local civil society becomes all the more important when resources for monitoring of local environmental conditions are lacking.

Examples of national and local CSO leadership are increasing in Asia. Some diverse examples are described below:

- Awareness raising: In Indonesia, national and local CSOs played a key role in reducing pollution of 24 of Indonesia's most polluted rivers as part of the Government's Clean River Program by providing pollution monitors and community organizers that the Government could not afford. (AEO) In Vietnam, two CSOs- Center of Support for Combatting Climate Change and Action for the City- initiated a campaign to encourage local communities to promote more sustainable lifestyles. In addition to media activities, the CSO joint venture campaign organizers get people and businesses to pledge to become more green producers and consumers. (Akenji, 2012) Even in China, a country not known for its tolerance of civil society actions, local communities are engaged with the government to support the Green Watch program. In India, several CSOs through governmentally sanctioned programs such as the Green Rating project have pressured industrialists to comply with environmental regulations. They have also supported CP public awareness campaigns and effective use of media to encourage political support for adoption of CP (Tetra Tech, 2002).
- Mediation: CSOs can also play an important mediating role. In Sri Lanka CSOs have represented the views of the community with regard to conflicting issues

through mediation with industrialists, private sector, local government and civil society (IRG, 2002; ADB, 2002(b)).

- Strengthening Corporate Accountability: Holding corporations accountable is also a core activity of CSOs. Examples are plentiful across Asia- CSOs have pushed for CSR reporting, organized boycotts of companies or products considered unsustainable, and organized campaigns demanding more transparent production and marketing practices.
- Grassroots action: Again there are numerous examples of CSO and CBOs working together to mobilize grassroots action. For example, the Indian Office of the Global Alliance for Incinerator Alternatives (GAIA), mobilizes grassroots action is against polluting, end-of- pipe waste-management activities. "Zero Waste for Zero Warming" is one of GAIA's coordinated campaigns. GAIA members share information online and in regional meetings; organize trainings and skill share events; provide technical support to member groups and communities; and provide mini-grants for advocacy and education campaigns to stop the expansion of incineration as a method of waste management. According to GAIA, its members in the region have contributed to the cancellation of the Broga mega-incinerator project in Selangor, Malaysia, and the success of waste-reduction projects at the 2002 World Cup in South Korea and the 2005 Southeast Asian Games in the Philippines (GAIA, undated)
- Partnering with private sector: CSO partnerships with business and the private sector have been instrumental in bringing solutions to many local sustainability issues. Two excellent examples are:
    - The Thai Business Initiative in Rural Development (TBIRD), a 1988 initiative by the Thai CSO, Population and Community Development Association (PDA), is an excellent example of constructive engagement. The TBIRD concept established by Kuhn Mechai Viravaidya is that the corporate sector should take responsibility for local development. The basic idea is to mobilize a relatively untapped corporate sector to participate in rural development, particularly to help develop basic business skills of villagers and to provide market opportunities. Each company adopts one village and assists in its development until it reaches the self-reliance stage. Government and CSOs serve as facilitators. The corporate sponsor has diverse resources (employees, market knowledge, contacts, and finances) that can significantly improve the village's economy. Sponsors have the opportunity to engage in socially beneficial and environmentally sound business activities, while villagers get the chance to become owners of community-based industries. Particularly successful are the Environmental Conservation and Education programs, including income-generating projects. The TBIRD model was adopted by the Thai Government, thus leveraging several million Baht in local resources to successfully promote social and economic development in particular (PDA, 2000). The TBIRD concept can readily be adopted in many developing countries for improving the sustainability of rural development and applying CP concepts at the community as well as small cottage industry, and SME development.
    - Since 2006, a local NGO from Nikaweratiya, Sri Lanka, has supported experimentation on the production of oil from the Jatropha shrub in order to supplement fuel consumption in the local community of Gurugoda. With support from an international NGO, this project has

seen multiple benefits, from mitigating contributions to climate change to supporting livelihoods and, of course, the cost savings from reduced dependence on imported fuel and local-level recognition of sustainable alternatives to fossil fuel-based energy (Kobayashi, 2010; APFED, 2010). The Regional 3Rs Forum for Asia has spurred collaboration among governments, businesses, research groups and NGOs towards better technology for waste management in countries including Japan, Malaysia and Thailand. In Sri Lanka, the Federation of Electricity Consumer Societies promotes the use of environmentally sustainable energy technologies by developing the technical capacities of off-grid communities; it works together with the national government and local communities. In one such project, the Federation helped members of the remote Sinhala, Tamil and Muslim areas of Sri Lanka to generate energy for households through micro-hydro technology. Some 300 remote villages now have micro-hydro schemes, providing electricity to some 10,000 households The Federation's activities have led to establishment of national standards for micro-hydro power generation

- Capacity building and training: Many Asian national and local CSOs run capacity-building projects. For example, the Live and Learn Environmental Education, a Fijian CSO, has been running a project in which training workshops are conducted to promote environmentally sound resource and waste management practices such as composting and recycling. A unique feature of the project is the involvement of youth leaders in the training program to encourage them to disseminate their newly acquired knowledge and skills within their own community. As a part of the project implementation process, monitoring and evaluation are carried out to share successes and failures and to ensure the delivery of expected outcomes. Throughout the project activities, the people participating in the project have been changing their consumption patterns, thereby reducing waste generation and promoting resource circulation. (Kobayashi, 2010). Municipal governments, as well as the private sector, are often the beneficiaries of such capacity development, supporting community groups to play a much more significant role in environmental urban governance or strengthening capacity to secure the participation of community leaders in policy decisions such as industry siting and regulation.

8.6.5 National and Local Financial Institutions

Much of the literature on financing CP emphasizes the roles of international and national institutions in providing subsidized loans to industry. However, if the rapid shift to CP necessary for environmental change is to take place, the bulk of financing of CP initiatives will not be through international assistance agencies or national development finance institutions using subsidized or soft loans, but rather will have to come through (i) local commercial banks following normal or special channels, (ii) equity investments, or (iii) micro-credit facilities. When governments, bilateral and multilateral development finance institutions, international NGOs, and CBOs finance or otherwise support small-scale investments such as CP in SMEs, their interventions often support a bundle of community development activities and investments. A good example of this is the TBIRD program described above. The financing support is channeled to small investments by a financial intermediary (FI) who undertakes the necessary financial and related transactions. In Asian developing countries, there is a limited but growing body of such financial intermediation experience targeting support for environmentally sound investments. This experience includes project interventions with financing and other support directed toward investments in small and medium enterprises and cottage industries, some with commercial banks serving as FIs and others through NGOs and CBOs.

Potential investors in CP face difficulties in accessing financing. The problem is not lack of capital in Asia or in any of its industrializing developing countries. The problem is a shortage of bankable project proposals and of lenders prepared to take the greater risks often associated with small enterprises, especially for something they do not understand, such as CP. Typical funding channels for financing CP are commercial credit, equity, leasing, special purpose funds, and development assistance. Each channel has its own conditions (with regard to collateral, interest, maturity and ceiling of the loans) and a defined project appraisal process. A primary goal of bankers is to assess the risks of lending, minimize these risks where possible and receive an adequate return for these risks. The basic documents generally needed by a bank are the internal and external sources of finance, feasibility study report, and technical specifications. (ADB, 2005)

An important issue preventing the spread of CP financing is the relatively high rate of interest on loans by financial institutions. Also, as shown in the Thai Samut Prakarn and Philippine surveys, industrial leaders consider that incentives such as custom duty relaxation, tax exemption or depreciation advantages are needed to stimulate investments in CP. (see Chapter 6) However, most bankers cannot differentiate between CP and conventional technology loan applications, thus giving no extra advantage for the adoption of CP. Except for the low cost housekeeping and management improvements of CP, the reality is that there is little to separate CP investment from ordinary technology replacement (which is also where FIs are most likely to be involved). In order to overcome this, it can be argued that CP investments should be included into the mainstream of FI business rather than seen as a dedicated credit line. This would require that FIs build environmental requirements into credit evaluations of firms, a justifiable action taking into account the stronger market position that many enterprises could attain by reducing environmental risks and improving efficiency through CP. (OECD, 2000)

This transition of the banking sector in industrialized countries is taking place. In recent years, commercial banks have been increasingly under pressure from government, society, competitors, and their customers to improve their focus on financing environmentally sound projects and investments. The commercial banks are the first to recognize that customer risks are also bank risks and can affect the bank’s viability. The customer’s continuity may deteriorate as a result of new environmental regulations or, in the case of many developing countries, increasing pressure on regulators to enforce existing environmental regulations (Juecken, 2001). Experience through the Equator Bank’s initiative shows that FIs that are engaged in industrial finance in countries with strong regulatory enforcement may even go as far as encouraging their clients to adopt CP in order to be ahead of potential environmental legislation. (Worsdorfer, 2013)

Unfortunately, in most developing countries, the commercial banks are relatively unaware or are not pressured by environmental risks because there is little enforcement of regulations. As more constructive engagements result in mobilizing the public against such irresponsible businesses, it is likely that the FIs will be scrutinized as well. Thus, in countries where such local public involvement is more likely to take place, commercial banks are likely to be responsive in scrutinizing such loans and investments in such businesses.

An FI must have a system to assess the environmental soundness of projects based on both financial and physical information, for which specialist knowledge is needed. A bank can develop this knowledge itself or make use of the agencies that specialize in this area. In most developing countries, FIs will not be able to develop in-house capacity to assess environmental risk or identify environmental investment opportunities such as CP projects. They will need the support of consultants, academic institutions, national CP centers, and NGOs.

Sustainable FIs will have to be prepared to take additional risks, put in extra effort and time to ensure that a project or idea succeeds and be satisfied with narrower margins if they are to give ideas and renewal processes an innovative and sustainable character. This means that FIs have to be innovative in their financing mechanisms. A great deal of work has been done on this. Hamner (2002) described a number of such innovative financing and equity mechanisms, which can stimulate development of local clean products and technologies as well as assist existing companies and communities to shift to clean technologies and management systems (Hamner 2002).

The transition of the banking sector requires a more sensitized and trained management and staff to evaluate and acknowledge the benefits of CP. But to make CP lending attractive to the FI, the costs incurred in the evaluation and promotion of CP must be matched (or superseded) by an associated reduction in lending risk. A key incentive for FIs to support CP is to have an appropriate national CP policy framework and effective enforcement of environmental regulations. (OECD 2000). In order to overcome some of these challenges, governments such as China, India, and Philippines have provided technical assistance to the banking sector and financially backed specialized assistance funds enabling their development banks, and in some cases local commercial banks, to finance CP projects that may not have been considered bankable through conventional lending practices, including making loans more affordable by reduced interest rates (ADB, 2000(c); Tetra Tech, 2002). Multilateral development banks have supported many of these facilities. For example, in India the World Bank supported the Industrial Pollution Control and Industrial Pollution Prevention Project and ADB funding supported the Industrial Energy Efficiency Line. But the FIs serving as intermediary banks for both of these projects tended to lend to medium- and large-industry, avoiding small enterprises (Tetra Tech, 2002).

Some financial and insurance organizations are beginning to insist on comprehensive environmental audits to limit the environmental risk in their project financing. In order to promote a green credit policy to businesses, in 2007 China's State Environmental Protection Administration, the People's Bank of China, and the China Banking Regulatory Commission jointly issued a policy called Notes on Reducing Loan Risk by Enforcing Environmental Protection Policies and Regulations. Incorporation of environmental concerns into business planning is increasingly a prerequisite to obtain loans. There are broadening signs of sociallyresponsible investment (Akenji, 2011).

8.6.5.1 The Special Roles and Opportunities for SMEs

The ongoing transition of FIs/the banking sector described above constitutes a significant risk for small enterprises. Experience in India, Philippines and Thailand is that, unlike large industry, most SMEs lack the basic documents needed by banks for evaluating projects. (Norgaard, 2003; Tetra Tech, 2002; ADB, 2005) Further, credit and equity for small firms is often inadequate to stimulate procurement of clean technologies and adopt CP management practices. Delucia in a survey of SMEs in South Asia concluded that in addition to credit the following are needed:

- availability and access for small-scale players to a broader menu of financing support and financing services, especially guarantees and other credit conditioning and equity or quasi-equity investment monies;
- among the equity needs, especially important is financing for pre-investment work (feasibility studies etc.), to be provided on a cost-share and/or contingent payback, or "roll-in" to project equity or debt structure;
- for the FIs or other entities who are participants in providing the necessary financing and/or technical assistance to the small-scale players, assistance in, for-example, building capability to deal with small-scale players and/or buying down transaction costs for early financing transaction; and
- for the small-scale players, a menu of assistance geared to complement financing support, also possibly on cost-share basis; this would be for player capability strengthening in commercial and technical areas (deLucia, 2001).

Similar conclusions were made based on an ADB regional study of financing mechanisms to promote CP. The study found that there is no shortage of capital financing available for CP improvements in SMEs. In Malaysia, for example, substantial finance is available on preferred terms for SMEs seeking technology upgrades that can promote CP. The main obstacles among SMEs to availing of this financing are lack of collateral and inadequate preparation of financing proposals. In its study of CP financing for SMEs, the ADB found that the most successful mechanism for improving SME access to capital for CP financing is loan guarantees. These overcome the basic barrier to debt financing caused by lack of collateral or, in the case of entrepreneurs, a successful operating history. Loan guarantees are particularly cost-effective when used to support CP investments, because CP investments tend to be inherently profitable since they increase resource efficiency and decrease pollution control costs.

A coalition is needed to link CP to loan guarantees. Multilateral financial institutions or national government development finance institutions can establish loan guarantees to be implemented by local FIs. Local governments can work with CP technical assistance programs and NCPCs to assist local banks to market the program to SMEs. CBOs and NGOs, as well as environmental inspectors can inform regulated businesses of the availability and terms of the guarantee program. When a business expresses interest in financing, it can be directed to a local CP technical assistance organization that can help it evaluate its CP options and prepare proposals for financing. The business and the CP organization can approach the bank together to apply for a loan and for the loan guarantee.

Such an approach overcomes the most significant barriers to CP adoption and financing. The local government promotes CP because it is in its financial and political interest to do so. Local officials know which businesses are the most polluting and in need of CP assistance, and also know who is planning to expand or build a new factory that can benefit from CP design. Local CP assistance organizations can provide the technical resources needed to find CP solutions and to prepare financing proposals. Developmental institutions can support loan guarantees that mobilize locally available capital, so SMEs can obtain the funds they need for CP improvements (Evans and Stevenson, 2001; Hamner, 2002).

Most FIs are reluctant to serve the micro-enterprises because of perceived high risks, high costs involved in small transactions, perceived low relative profitability, and inability of the borrowers to provide the physical collateral usually required by such institutions. Microfinance, the provision of a broad range of financial services such as deposits, loans, payment services, money transfers, and insurance to poor and low-income households and their microenterprises, is a viable alternative. Microfinance services can be provided by (i) enlightened FIs, such as banks and cooperatives; (ii) semi-formal institutions, such as NGOs; and (iii) informal sources such as money-lenders and shopkeepers. International and bilateral assistance agencies, developing and developed country governments, and NGOs have all increased support for the development of microfinance. A variety of private banking institutions have also joined this group in recent years. As a result, microfinance services have grown rapidly during the last decade. Microfinance has not yet become a critical element of an effective means of integrating CP promotion in micro-enterprises in Asia- but it has tremendous potential to do so. It has been a major incentive for the transfer of small-scale solar power across South Asia. Building on that experience microfinance services can also contribute to the improvement of resource allocation, promotion of markets, and adoption of better technology (ADB, 2000(d)).

During the last twenty years, a number of countries have established funds intended to support SMEs but in the 1990s and early 2000s evidence showed that much of that funding went to larger enterprises that manipulated the regulatory system so that they could be classified as SMEs. However, as the role of SMEs in supporting regional and international supply chains and thereby, breaking into the international market became better recognized, improved credit programs emerged which of been shown to help the end intended beneficiaries. Bangladesh, China, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, and Thailand have all established some sort of small enterprise fund or a credit guarantee fund scheme for small enterprises and have adopted lending policies, which give priority to SMEs. For example, India sets aside 40 percent of net bank credit of public and private sector banks for priority sectors, which include SMEs and established a collateral free credit facility for small loans for SMEs. Similarly, Philippines mandated that banks set aside at least 8 percent for SMEs of their total portfolio and established a guarantee incubation facility and small enterprise financing facility intended to assist SMEs to overcome financing challenges (ADB, 2009).

8.6.6 Industry Associations[13]

Industry associations in developed countries were instrumental in supporting the early promotion of CP. For example, the chemical industries' Responsible Care initiative for chemical safety and environmental management launched by the Canadian Chemical Producers' Association in 1985 is now being practiced, including certification and reporting standards, in 60 countries. CP was an integral component of this industrial association's initiative with the US Chemical Manufacturers' Association publishing the "Chemical Manufacturers Association Pollution Prevention Resource Manual" in 1991. (CMA, 1991) From 1988 to 2012 chemical industries practicing Responsible Care reduced hazardous emissions by 77 percent. The Responsible Care initiative eventually led to the 2006 adoption by the International Conference on Chemicals Management of the Strategic Approach to International Chemicals Management (SAICM), a policy framework to promote chemical safety around the world.

Using industry associations and business networks as an entry point for change is particularly useful, when there is no conducive, legislative environment or when one is in a situation with poor enforcement capacity. However, the approach is also very useful when legislation and enforcement is in place, as a mechanism to achieve even further, voluntary progress. (OECD, 2000) Governments' attempts to stimulate business associations, chambers of commerce, and industrial associations to be leaders in promoting CP have varied from country to country. One of the promising approaches reported in Taipei is the corporate synergy system (CSS) where a group of manufacturing companies within a supply chain, and with support from industrial associations and government, work together to achieve production or management goals in SMEs. Associations of industries were formed over an eight-year period during which the program shifted from public awareness promotion, training, and technology demonstration to implementation of waste minimization options and life-cycle design (Chiu et al, 1999).

Working through industrial associations has been shown to improve the sustainability of CP initiatives. For example, in 1990 the US Government working with the World Environment Center (an association of industries committed to CP) established a CP program in Thailand working with the Federation of Thai Industries. By 1995, with additional support from Denmark, Germany and other bilateral donors, all of the major industrial associations in Thailand – food processing, chemicals, electroplating, pulp and paper, and textiles- had engaged with Federation of Thai Industries and TEI to strengthen the institutional basis for environmental auditing and supported the establishment of an information center for cleaner technology at TEI. That partnership has evolved over the years to focus on SCP and now includes the Thai Business Council for Sustainable Development as an important partner, but essentially remains an industry association, driven partnership. (TEI, 2012)

A USAID-funded CP project in India, and several ADB-funded CP projects have experienced a mix of positive to neutral responses by industrial associations when asked to actively assist SMEs to adopt CP. In most successful cases, when

[13] Industry associations are CSOs but are dealt with separately because of their priority focus on the interests of industry as opposed to communities or ambient environmental quality.

industrial associations take an active, leadership role, an individual factory manager or owner involved in the industrial association has experienced the benefits of CP and becomes the champion (Zobriest, 2002; IRG, 2002; PACG, 2001). In India, (i) industry-wide associations like the Confederation of Indian Industry, Federation of the Indian Chambers of Commerce and Industry, (ii) sectoral manufacturers' associations such as Cement Manufacturers Association, Indian Paper Manufacturers Associations, Fertilizer Associations and Textile and Dyes Manufacturers Association, (iii) associations of lending and financing organizations such as Indian Bankers Associations, and (iv) CP/CT promotion organizations have worked together to agree on the objectives of CP/CT. They promote CP/CT partnerships through services that emphasize the need for CP/CT audits to identify waste streams. They also analyzed the cost of waste and proposed options to eliminate or reduce it.

The Indian experience demonstrated that national industrial associations can effectively contribute to changing business behavior by encouraging entrepreneurs and industrialists to take preventive measures. They provide consulting services for CP and research and orientation programs on using waste as a resource. Industrial associations have also acted as umbrella organizations in seeing that environmental justice is meted out fairly among their membership and serve as a regulatory mechanism. (Tetra Tech, 2002)

In the Philippines, industrial associations are very active in supporting sustainability, including CP. For example, the Pulp and Paper Industry Association members share new technological information, hold monthly dialogues among its members and if needed with other stakeholders like the Department of Environment and Natural Resources or the Environmental Management Bureau, the Development Bank of the Philippines and others. Semiconductor and Electronics Industry Association has the largest number of ISO-14000 accredited companies in the Philippines. Together with the Philippine Business for the Environment, the Asia Foundation, and the World Bank, the association came up with an environmental management system manual geared towards ISO-14000 for its members. The Philippine Institute of Certified Public Accountants has played an important role in stimulating greater interest in CP. Members are introduced to environmental cost accounting in their operations. Similarly, the Philippine Business for the Environment has been active in information dissemination to business the activities happening as regards the environment through the publication of its bi-monthly magazine *Business and the Environment.* Environmental policies, rules and regulations are published in the magazine. (ADB, 2002(c))

In Indonesia, a 2002 survey of four of the country's largest industrial associations, namely Indonesian Leather Tannery Association, Indonesian Textile Association, Indonesian Pulp & Paper Association, and Indonesian Rubber Producer Group, revealed that the associations play a central role in information dissemination regarding environmental regulations. All of the associations had provided or supported CP training, workshops and seminars and, in a few cases, technical assistance for members. Some associations had initiated waste minimization and exchange programs among members and other parties. (ADB, 2002(c))

8.6.7 Cleaner Production Technology Centers

The absence of good information networks on existing cleaner technologies and practices, trends in technology, product markets and technology suppliers or vendors. There are growing numbers of such networks globally because of the increasing interest in low carbon technologies, but the main source of information on cleaner options for industrial processes and materials in many Asian developing countries are still the national clean technology centers described in Chapter 3. These centers have also been supportive in promoting the policy framework required to stimulate CP engaging industry, local authorities and other local stakeholders. (OECD, 2000)

An important role for CP centers has been and will continue to be supporting the private sector through training programs to achieve the needed technical knowledge at the local level- through training, demonstration projects, audits, information dissemination including on financing and financial benefits, library and reference facilities, and translation of key documents, all of which are essential elements of awareness raising and capacity building. (Luken et al, 2015) Many of the CP centers in Asia have worked with universities, technical and engineering schools in developing and disseminating information. While proactively training future specialists in academia is an effective way to build capacity in the medium- and long-term, CP centers can complement these efforts by organizing post-education training. A sectoral approach based on “train the trainer,” has proved to be effective in creating an active core of CP advisors. (Hamner, 1997; PACG, 2002; Tetra Tech, 2004; IRG, 2002; EBTC, 2013)

8.6.8 Academic and Research Institutions

A major barrier in every Asian developing country, intent on integrating CP into their respective industrialization processes was and in most cases continues to be insufficient human capital to evaluate, assimilate, adapt, improve and diffuse information on cleaner technologies and on CP practices. There are few trainers of CP, it is difficult for firms to find staff trained in CP, and the consulting industry still has very limited capability to deliver the specialized support services needed by industry (Chandak and Huisingh, 2002; Xiong, et al 2013; Boyle, 1999). Chiu et al (2009), in this author’s opinion, correctly state that, “In Asia more than other parts of the world, sustainable development must be more deeply integrated into university curricula as well as in campus administration and organizational culture.” This is the case simply because of the pace of demographic change, population density, and rapid economic growth.

Asian middle-income countries- China, India, Indonesia, Malaysia, Philippines, Sri Lanka, and Thailand - each have long-established research and academic institutions that specialize in appropriate technology development. These countries are quite capable of catalyzing the growth of CP through their academic systems. The content of the programs and courses vary, but the potential of such institutions in providing research services and backstopping industries for introducing CP measures is significant.

Many of the universities offering engineering and environmental programs now have specialized courses addressing control of industrial pollution and promotion of CP as part of their curricula. This of course is not unique to Asia developing countries but is being seen across most industrializing developing countries because industry is demanding that graduates have skills beyond conventional industrial or environmental engineering (Kiperstok, 2000). These academic and research institutions have been engaged in promoting conditions needed to change business behavior toward CP through a network of business with financial institutions and industries. The need to establish a competitive edge for green, low carbon development skills is already recognized some Asian developing countries (Holm et.al., 2015). Universities are well-placed to demonstrate leadership for CSP (Lozano, et.al., 2015) and indeed some Asian universities are pioneering the concept of the green campus (Geng, et.al. 2013; Foo, 2013).

Some examples of initiatives by Asian developing country universities in the Asia region include:

- In Sri Lanka, academic institutions are participating in research activities and conducting CP Audits. Major universities offer CP courses for undergraduates, as well as non-formal short courses and other training (IRG, 2002)
- Thailand launched a program in 1992 to improve instruction in the environmental engineering and sciences in the teacher training departments of thirteen selected colleges and learning institutions. Concepts and skills of industrial environmental management and waste minimization were introduced to the educational system in 1993 (ASEAN EIP, 1994). In 1996 several universities in Thailand collaborated to develop pollution prevention and control and clean technology and eco-design undergraduate and graduate courses as part of the engineering curricula. The universities were successful in securing the participation of a number of industries in terms for training and pollution prevention. Within about three years, the collaborative program had gone from two of the main Thai universities to be a partnership of over six universities and including participation of the TEI cleaner technology information center. (Mungcharoen, 1999) The Thai Dawn project (described in Chapter 6) initiated in 1997 was another major initiative by the Thai Government to improve awareness of CP- particularly energy conservation- through training and education including integrating environmental and energy awareness into the curricula of all government schools. The 4-year Dawn project reached over 300,000 students at primary and secondary levels, 23,400 teachers, 600 school administrators, and 2,400 community leaders. (Potar, 2003)
- Most state universities and prominent private universities in Indonesia have integrated CP into their environmental curriculum and in some cases provide opportunities for students to participate in the CP technical assessments and outreach. These Universities have expressed the need for support to train their lecturers on CP/Clean Technology and to obtain CP publications (books, periodicals and technical manuals) (Akenji 2011).
- The Chinese government recognized that intermediary organizations for training including academic and research institutions were key to promote CP and achieve the level of technical support and advisory services required to implement the national CP law. China’s National Cleaner Production Center and its partners in the provinces, both government and academic institutions, have been organizing training courses for CP since 2004. By the end of 2007 over 100,000 persons had received CP training. (Ning et.al. 2009) Much of the CP training in China is undertaken at the provincial and local level. A good example is CP training achieved in Luoing Province under the auspices of the Provincial Environmental Protection Bureau working through different local academic

institutions to implement training for government authorities as well as for local enterprises tailored to meet the needs of the different groups. Between 1998 and 2007, 123 different training courses were organized. (Geng et.al, 2010) Similar initiatives have been undertaken in other provinces, often with support from donors through programs such as the UNIDO Investment and Technology Promotion Office in China (ITPO-China), Switch-Asia, and the UK DFID China partnership for sustainable production and consumption.

Regional academic and research programs have played a significant role in Asia. For example, the Asian Institute of Technology (AIT), a regional graduate school based in Thailand, was one of the first to offer curricular and research opportunities on CP.

The Association of Southeast Asian Nations (ASEAN), which includes Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam, initiated a joint environmental education program in 2000. The ASEAN Environmental Education Action Plan (AEEAP), now in its 15^{th} year and is scheduled to continue through 2018, has four goals:

- Integrate environmental education and education for sustainable development at all levels of formal education;
- Provide non-formal education on socio-cultural, economic and ecological aspects of environmental protection and issues at the local, regional and international levels;
- Provide institutional and human resource capacity building relating to sustainable development; and
- Improve the exchange of environmental information, skills, and resources across member countries.

Several of the universities and research centers, working with national CP centers have focused on SCP through this ASEAN program (Akenji, 2011; ASEAN, 2014).

Much of the focus of CP training has been at the factory level and in some cases has been introduced in vocational training programs. Several of the internationally assisted CP programs of the 1990s included specialized training courses for industry managers, government officials, consultants and academics, including training targeting SMEs (Visvanathan and Kumar, 1999; Hopkinson, 2001). For example, the ASEAN environmental improvement program and specialized courses in Philippines, Malaysia, Singapore, Indonesia, and Thailand have trained more than 1000 professionals. (Hamner, 1999)

Another example is a partnership formed among Fraunhofer IFF of Germany, the Asian Society for Environmental Protection in Thailand, the Viet Nam Productivity Center, Viet Nam, and the Louth County Enterprise Board of Ireland, and funded through the European Commission's Asia Invest programme. The partnership's aim has been to empower Asian Business Intermediaries through knowledge-based networking focused on sustainability management. The partnership has brought together European and Asian researchers and business intermediary organizations to promote European know-how and information and communication technologies (ICT), along with the transfer of best practices. Over 800 representatives of SMEs were trained in Viet Nam and Thailand. (Akenji, 2011) Such training has been shown to be an indirect driver of the improved environmental performance in many industries because of the internalization of environmental objectives and active participation in meeting environmental objectives at the individual worker and team levels. (Doonan et al, 2002; Remnan and Lorentzen, 2000; Stone, 2000)

The types of training programs relying on face-to-face sessions undertaken through national and international technical assistance programs are insufficient to meet demands. Many employers find it difficult to release their employees to attend conventional training courses. Open and distance learning, either for practitioners or university or vocational students are increasingly relied upon for CP training. Such flexible courses rely on directed online study and web-based activities and in some cases include on-campus activities such as face-to-face lectures (Heart, 2000).

Asia and Pacific businesses have been developing their capacities to meet the sustainability challenge. For example, Business for Social Responsibility, a global network of over 200 majorcorporations, started the China Training Institute in 2004 as a CSR capacity-building project for brand companies and their suppliers in China. It offers long-term and short-term training ontopics such as environmental risk management and worker healthcare programs. In April 2010 the Institute held a workshop in Guang Zhou, China, n collaboration with the Cleaner Partner Project of Hong Kong government, to share experiences on energy saving in manufacturing industries. Participants explored trends of energyimproved efficiency in manufacturing industries and were presented best practices. (Akenji, 2011)

8.6.9 Business and Industry

Successful transformation to CP at a large scale requires collective participation by magnitudes of individual businesses and industries. A number of examples of industrial CP programs in Asian developing countries described in Chapters 4, 6 and 7 have led to some success, but certainly not the transformation required. Barriers were presented earlier in this chapter.

The experiences from the Thailand and Philippine industrial surveys and similar work in which this author was involved in China, India, Indonesia, Sri Lanka, and Vietnam, show that Asian developing country businesses, particularly large-scale multinational and national enterprises, do respond to pressure from governmental regulation, markets, communities, and CSOs. Experience also shows that many private sector stakeholders are prepared to participate in CP support initiatives. (Evans, 2015, Liu, 2009, Ichikawa, 1995, Yusup et.al., 2015) Various studies have identified primary driving forces for private sector action on improving environmental performance. Some studies indicate that government pressure elicits the most effective response (Doonan et al, 2002), others indicate that supply chains, local communities and consumers are key driving forces (Rao, 2005). Consumers, particularly in countries with rapidly growing middle class, are increasingly the drivers of sustainability, including through CP (Pigott, 2004; Evans 2015).

Regardless of the external driving force, management of enterprises demonstrated priority on environmental performance clearly is key in establishing an environmentally aware firm culture. It influences the way human resources management integrates environmental concerns and consequently, the capacity of employees to effectively act on environmental objectives (Remmen, 2000). It also affects the level of integration between the environmental services and the other administrative units in the rest of the enterprise, and the effectiveness of monitoring and feedback mechanisms. It is often asserted in the management literature that the environmental involvement of the top management is a primary determinant of the environmental performance of the firms (Warford and Williams, 1997; Stone, 2000; Doonan et al, 2002).

An indication that more owners/managers of firms are increasing priority for improved environmental performance, regardless of the driver, is the growth in voluntary actions, most notably sustainability reporting, environmental performance disclosure such as pollutant and hazardous substance release reports, and adoption of International Organization for Standardization (ISO) standards. For example, in 2000 there were fewer than 10 corporate sustainability reports from Asia-Pacific businesses registered with the Global Reporting Initiative (GRI) database. In 2005 that number had increased to over 60, and in 2010 there were over 300 registered reports. Information sources such as GRI have multiple benefits. For example, Chen and Tang (2015) were able to utilize GRI reports to demonstrate the importance of improving innovation as opposed to financial performance as a driver of environmental management practices.

Another indication of the growth of environmental performance as a priority for industry is the number of ISO 14001 certified companies. Indonesia and Malaysia experienced a doubling of certified firms between 2006 and 2008 (Akenji, 2012). By 2013 China and India had the largest growth rates in the world in ISO 14001 certification (ISO, 2013). The close collaboration among firms in cross-country supply chains, particularly in Asia, has been a key driver for increased ISO 140001 and similar certification (To and Lee, 2014). Another measure of management commitment is the extent to which transparent capital budgeting demonstrates a firm's commitment to cleaner technologies (OECD, 1994). A key indicator that is especially relevant to the uptake of CP is the extent to which waste management, including appropriate allocation of financial resources is given priority at the firm level (Sustainability 2002; Stone 2000). However, there is still only limited evidence that firms that are ISO 14001 certified out-perform others in waste reduction (Singh et.al., 2015).

The Thai and Philippine surveys, and experience from such programs as the Samut Prakarn Cleaner Production and Industrial Efficiency (CPIE) project, confirmed that the key drivers for businesses are the factors that have an important influence on business performance- profit margins and growth potentials. (Rao, 2008; Evans, 2014) Consequently, success and sustainability of CP initiatives will largely depend on their ability to complement or enhance business drivers. CP can enhance revenue growth and market access by improving existing products, improved and/or more secure access to international and domestic markets looking for sustainably produced goods, preference as a supplier based on environmental criteria, and the ability to charge premium prices for more sustainable products (IFC, 2011).

Commonly referenced business success factors relating to CP are cost savings and productivity resulting from lower operational (production, waste disposal and material transport) costs. Increased production efficiency and reduced risks from penalties due to legal liabilities have been shown in several of the special CP financing initiatives (described in previous sections) can increase a firm's access to capital and lower financing costs. (Sustainability, 2002; Doonan, 2002)

8.6.9.1 Special Circumstances for SMEs

Small and medium enterprises (SMEs) play a critical role in alleviating poverty and contributing to the economic growth in Asian developing countries. The SME sector played a significant role in the industrialization process in all of Asia's rapidly industrializing countries. While the backbone of production for local consumption when this thesis work was initiated in the mid-1990s, SMEs were typically isolated from the emerging process of globalization (Agbeibor, 2006). Many were not legally registered and therefore largely outside of government programs initiated to modernize industry (Evans, 2001).

By 1997, the SME sector (including unregistered enterprises) in most rapidly industrializing Asian developing countries was enjoying rapid growth, though at a slower pace than the larger national and multinational industry sectors. Globalization has dramatically changed the role of Asian SMEs at the national, regional and global levels. As a result, a number of Asian developing countries of change their priority focus from large industry to SMEs. Over the last 15 years, SMEs became increasingly involved in global supply chains and now play a critical role in the growing inter-regional trade.

Presently, SMEs together with micro-enterprises account for more than 90 percent of total enterprises in Asian developing countries. There were about 2.7 million SMEs registered in Thailand representing about 98 percent of total businesses in 2012 (Switchasia, 2015). The share of SME employees to total employment was about 97 percent in Indonesia in 2012. The SME workforce is rapidly expanding with about 22 percent per year growth in China and ranging from 5 percent in India 10 percent in Philippines, with Thailand, Malaysia, Indonesia, and Sri Lanka in between. The role of SMEs in generating GDP is also increasing – for example Indonesian SMEs contributed about 59 percent of national GDP in 2012. (Visvanathan and Kumar, 1999; ADB, 2014)

Given the relative size of the SME sector to large enterprises in Asia, the success of national efforts to improve and protect environmental quality and optimize efficient use of resources is largely dependent on SME production practices. Studies in the late 1990s of the pollution intensity from SMEs was greater than large firms, though in some cases gross pollution levels were higher from large-scale industrial polluters (Dasgupta, 1998). A number of studies have shown that plant size is often inversely correlated with emissions intensity in Asian countries. A key reason for this is that SMEs, typically family-owned with simple management structure, often utilize old and inefficient technologies and often lack waste management systems. Owners and managers of small firms typically are unaware of production efficiency opportunities or other CP technologies and are reluctant to invest in new technologies.

The environmental regulatory and policy framework in most Asian developing countries has been reformed over the last many years to address the previous deficiencies in provisions to facilitate regulatory compliance and SMEs and provide technical assistance on CP technologies and improve information dissemination. Without such provisions it is not likely that small firms would find it feasible to comply with existing command-and-control regulatory requirements. For example, a 1998 study by ADB in Malaysia found that 84 percent of total manufacturing establishments in Malaysia were SMEs that were not able to cost effectively achieve pollution control requirements. The study confirmed that improper management of hazardous waste and pollution control was a significant problem with SMEs being a primary source. At the time to study there were more than 16,000 SMEs in Malaysia and many more unregistered or illegal/ unaccounted for. A survey of 11,855 SMEs showed that about 70 percent of Malaysia's environmental pollution complaints had been directed against SMEs (ADB, 2000(c)).

Even with the governmental reforms in several countries and in spite of their greater participation in global and regional supply chains; Asian SMEs generally continue to face a number of challenges. At the global level, fair trade, good governance, political and economic stability are needed to stimulate the kind of entrepreneurship development framework required to accelerate productive and competitiveness growth of SMEs in developing countries (Agbeibor, 2006). Numerous studies have identified weaknesses in the SME sector in terms of environmental sustainability and in particular adoption of CP. A fundamental challenge is improving awareness. A 2011 study by the Institute for Global Environmental Strategies (IGES) concluded that there continues to be limited general awareness at the corporate management level of enterprises, particularly SMEs, of the principles of CP and its advantages over end of the pipe approaches to pollution control (Akenji, 2011).

The financial crises of 1997 and 2008 revealed the vulnerabilities of SMEs to financial shocks. Following the 1997 shock, and in recognition of the importance of the SME sector to supply chains, several Asian developing countries focused on integrating and modernizing SMEs into the broader industrialization process (ADB, 2009). The 2008 financial crisis was also a sever shock to SMEs in Asian developing countries, but their resilience was substantially improved as compared to the 1997 shock. (ADB, 2014)

Given the growing role of SMEs in industrialization since 2008, particularly their ability to broaden distributional impacts of economic growth as well as to manage environmental concerns, national governments are further reforming development policy to enhance the potential benefits of a strong SME sector, including contributing to sustainability. In 2011 the IFC, based on an analysis of ten years of experience supporting developing country SMEs, demonstrated the business case for investments in SMEs on the basis of the environmental and social value creation. IFC determined that it was still critical to take a strategic approach that focuses on market barriers that would lead to profitable commercial outcomes while creating environmental or social value. In most markets such opportunities exist, but limited market experience, technical insight, business skills, and investor confidence are limiting their growth. IFC concluded that support is required to engage SMEs to leverage global supply chains and standards for market access creation and to support the development of business models and approaches to increase access to sustainable infrastructure services (IFC, 2011).

While policy and regulatory measures have improved the ability of SMEs in many Asian countries to strengthen their respective roles in sustainable industrialization, most of the barriers discussed earlier in this chapter remain. Similar barriers are experienced in developed countries. For example, a recent study of SMEs in Australia identified the key barriers to adoption of energy efficiency measures as capital costs, lack of staff engagement or negative attitude, lack of time/staff commitments to other areas, unable to make physical changes to premises, unable to obtain information from landlords controlling changes, and general low morale of business. The motivators and drivers included in order of importance financial interests, meet environmental quality standards for industry, marketing, reduce impact on the environment, and lower the carbon footprint. (Meath et.al, 2016) In Eastern Europe, the influence of the EU was important for SMEs, but more important was leadership and incentives for employees to be innovative (Tomsic et.al., 2015).

SMEs have found difficulties in adopting socially responsible behaviors that a number of their suppliers insist upon (Ciliberti, 2008). SMEs across Asia often suffer from lack of entrepreneurial drive due to a weak culture of innovation and reliance on technologies brought in by multinational companies. SMEs generally lack skill and expertise in organizational management and are therefore less efficient, flexible and competitive compared to larger firms. Many SMEs in Asia have yet to take advantage of information communication technologies. A key reason for these continuing challenges is probably due to an inward looking mentality that is typical among the family enterprises that account for a large proportion of the sector SMEs. They tend to be reluctant to cluster or network and therefore find it more difficult to access information, markets, and inputs (Lim and Kimura, 2010).

SMEs require continued support in the form of incentives that provide continuous physical, financial and economic incentives to encourage technical innovation and adoption of cost-effective cleaner and pollution control technologies for increasing process efficiency, availability of bank finance for CP investments, support for formulating in presenting investment proposals through special technical assistance programs.

As was the case following the 1997 financial crisis, SMEs have difficulty gaining access to finance - worsened by the economic crisis of 2008 (ADB, 2009). Many Asian developing country governments have made substantial efforts to allocate resources to support SMEs through subsidies and safeguarding banks however success has been spotty. The SMEs are still struggling to secure long-term bank loans working capital and bridge financing (Lim and Kimura, 2010).

Studies in Korea and Taiwan indicate that a key element of an SME support package is improving networks to help to eliminate or minimize barriers such as awareness of opportunities and technologies and benefits of improving efficiency using new technology. A survey of 122 Korean exporting SMEs showed that their highest priority in terms of support was improved networks to facilitate access to information on technical and other standards in foreign markets. Both Taiwan and Korean studies indicated that networks of University professors and industrial consultants were important sources of such technical support. Overall the SMEs responses indicated that assistance was most useful when it includes provision for feedback on the assistance, including a mechanism whereby that feedback would result in corrective actions, competent personnel and agencies providing the assistance, and assistance that was well targeted to the needs of the particular SME. (ADB, 2009; Tang et al, 1999) Another key vehicle through which support is being generated is through supply chains (Rao, 2008; Frijns and van Vliet, 1999).

Moore (2010) found that the globalization of markets might have forced many SMEs to choose between what he refers to as hyper-efficient behaviors vs. more resilient, socially, environmentally and financially bound networks. The hyper-efficient behaviors create price-based networks with little focus on environmental or social objectives. He identified the challenge of establishing networks that allow for adequate efficiency within a broad-based value creation oriented framework benefiting a large number of diverse stakeholders. While primarily focused on industrialized country SMEs, the similarity with IFC's conclusions (IFC, 2011) indicated that in Asian developing countries a sustainability focus can be a successful foundation for business planning and long-term strategy development for SMEs. Such an approach clearly requires both internal and external factors to be taken into consideration within a stakeholder participatory framework. Networks of SMEs built around this objective could play a key role in facilitating value creation and improving environmental performance at the same time.

The improved understanding of the potentials for SMEs and their needs for focused technical assistance and training if such potentials are to be realized has led to a number of targeted government-sponsored programs across the region. For example, India has established a network of development institutes, regional training centers, and product and process development centers to conduct long-term, short-term, trade, and field-specific and industry-specific courses as well as vocational training programs. This initiative has reached 50,000 entrepreneurs. The Philippines, as early as 2003, established an SME development plan with streamlined training programs and deployment of SME business counselors. Thailand provides training courses arranged by governmental offices, and established a network of institutions to support entrepreneur development. In addition, the Thai Board of investment and Office of Small and Medium Enterprise Promotion each organize opportunities for SMEs to meet with larger enterprises within a supply chain to enable them to improve their opportunities to participate in the supply chain. PRC established a market development mechanism and sponsors a China international SME fair in addition to a national SME training program which provides training on production technologies, industrial policies and so on and provide mentoring and training for entrepreneurs (ADB, 2009).

Several countries are promoting SMEs' active engagement with external actors through the regional and global markets, and strengthening intraregional and national linkages across firms through networking research policy, in part to improve SME corporate social responsibility performance (Kuhndt et al, 2003; Freel, 2003). But most Asian studies identify local government as the key interlocutor for SMEs, which indicates that SME technical assistance program design needs to also account for the capacity of local government. (Berger, 2002; Norgaard, 2003; Gumbault, 1999; Pimenova, 2004).

8.6.10 International Assistance Agencies

International assistance agencies (IAAs) that have in the past or currently are supporting CP capacity development in Asian developing countries include a diverse set of organizations, but can be generally broken up into three groups- bilateral development (aid) organizations (often referred to as donor organizations), UN organizations, and multilateral development assistance organizations. The dominant multilateral, non-UN organizations when it comes to CP support (both technical and financial) has been the MDBs. These institutions continue to have a major role in supporting investments and capacity development for CP (Suszuki, 2015, Evans, 2015) and are increasingly focussed on low carbon, climate resilient development (de Jong et.al., 2015). In order to understand the potential roles of IAAs as stakeholders, it is important to understand what drives their decisions on the provision of development assistance and the history and evolution of how they prioritize their technical and financial assistance.

As has been the case with most directions in development assistance, developed country bilateral aid agencies led the way in encouraging and supporting adoption of CP in developing countries by providing technical and financial assistance. This was evident in the reviews of international assistance in earlier chapters in this thesis, in particular examples were provided in reviewing the history of assistance in Thailand and the Philippines. An exception to this generalization on directions for development assistance was the role taken by UNEP and UNIDO in the early stages in supporting CP. These two UN organizations have been engaged in CP support in a relatively consistent fashion since the early 1990s. One explanation for this is that, unlike MDBs, the UN organizations have been responsible for, or at least heavily involved in organizing the various international summits and conferences that have brought countries together on CP, such as the Earth Summit in 1992.

Generally speaking, other multilateral development assistance organizations such as the MDBs, follow the lead of the bilateral aid agencies. Bilateral aid is determined at the national level by the donor governments and is therefore often not consistent in terms of priorities. But at the macro-level, for example, the need to support developing countries improve sustainability of development (including CP), donor governments have harmonized positions. Many of these donor government aid programs were first supporters for CP in Asia in the early to mid 1990s. As a consequence, the key MDBs in Asia, the World Bank and ADB became heavily involved in CP in the 1990s.

By 1997, more than 50 international organizations, bilateral donors and non-profit organizations were providing many millions of dollars annually in programs to promote CP (CP) in Asia. ADB and World Bank placed a high priority on CP support, providing broad-based development assistance on a wide range of CP-related policy, planning, capacity building, governance and related development issues. These two MDBs were able to leverage project financing support to stimulate or support critical CP policy reforms in countries like China and Thailand, including supporting the establishment of national and local CP policies and provision of financing and technical assistance for implementing priority actions (Williams and Warford, 2001; Stevenson, 2001(a); Stevenson, 2001(b)). Experiences from these assistance programs was continuously reviewed and reported in the APRCP conferences. In recognition of the need to achieve scale in transitioning to CP, by the early 2000s there was a broad agreement among active bilateral and multilateral assistance providers on general approaches to technical assistance, focusing on policy reform, financial incentives, and strengthened networks with leadership by private sector. These approaches were largely consistent with emerging guidance on achieving development effectiveness. (OECD, 2000; Evans, 2002; Kositratna, 2002).

An important shift in the drivers and directions of development assistance occurred in the late 1990s/early 2000s. The broader history of development assistance and its relationship to the evolution of CP support provides interesting lessons for future work in this area. Until the late 1990s there was limited coordination and collaboration among bilateral and multilateral assistance organizations. However, the desire to enable a better focus and measurement of impact of aid in general in the mid-1990s led to the International Development Goals (IDGs) with leadership by the United Kingdom, Denmark, Netherlands, Norway, Sweden, and Germany. It was about this time that the influence of CSOs also increased substantially, in many donor countries and subsequently at MDBs. CSOs were recognized as good allies and bad enemies. In particular, they pushed the World Bank to improve its focus on a safeguard approach that would reduce risks to environment and local communities from the investments which is supported in developing countries.

One of the notable responses to the focus of donor countries, with considerable pressure (and subsequently cooperation) from CSOs was the preparation and publication of the Pollution Prevention and Abatement Handbook (PPAH) by the World Bank in 1998 (World Bank, 1998). This was the first major guidance in a multilateral organization to shift the approach on pollution management from an environmental management focus, primarily through public regulatory instruments. It shifted priority towards an approach that acknowledged that multiple stakeholders affect pollution management and that the objective needed to be broader than improvement in environment to include improve competitiveness and accountability. The PPAH included detailed guidance on a number of different industries regarding CP/technology options for those industries. The guidelines were framed within the World Bank's safeguard policy essentially becoming a regulatory tool for the World Bank and IFC.

Following the 1997 financial crisis, the late 1990s saw a very clear shift in focus of bilateral and subsequently multilateral development assistance organizations from economic growth towards poverty reduction. The IDGs were essentially folded into a much broader set of goals, the MDGs. These goals were set by developed country governments-viewed a rich world product when established in 2001, but over time became the foundation for agreement between international assistance organizations/donor countries and developing countries as a means to focus development assistance.

The other major change, which took place at about that time, was the 2005 Paris Declaration on Aid Effectiveness. Until about 2000, donors had limited responsibility as to extent to which their respective development assistance programs were supply driven (donor country determined) or demand driven (responsive to recipient countries priorities). The Paris Declaration and later the Accra Agenda for Action in 2008 established a partnership approach to development assistance, essentially reversing the donor driven dominance to in some cases a balanced partnership between donors and recipient countries but in most cases a recipient driven development assistance decision-making process. As a result, donors were committed to base their overall support on recipient governments' national development strategies, and conditionalities attached to development assistance were largely dropped.

The Paris Accord also improved the potential for harmonized work by donors including multilateral development assistance agencies. But the Paris Accord was largely driven by the need to strengthen development effectiveness for delivery of the MDGs. And the MDGs, while including a sustainable development goal, were poorly designed for prioritizing or achieving environmental or resource efficiency objectives such as those of CP. Thus development assistance programs in the 2000's generally experienced a reduction in focus on sustainable industrial development, CP and so on, with some exceptions. The comment “if you're not an MDG, you're not on the agenda" was frequently heard in the halls of development assistance organizations.

The MDGs are now in their final year and the dialogue in the UN shifted to the Sustainable Development Goals (SDGs). The SDGs, adopted in September 2015, will considerably strengthen the focus of development assistance on CP. This is because two of the SDG's have a strong CP focus: (i) SDG 9 on sustainable infrastructure and (ii) SDG 12 on sustainable consumption and production. Unlike the MDGs, a product of donor governments working with MDBs and the International Monetary Fund (IMF), the SDG's have much broader ownership by developing countries from the outset since they have been generated through an UN-based consultative process.

While there is currently considerable attention to the SDG's as a driving force for future development finance, in addition to poverty reduction and stability of fragile states, the climate change agenda has clearly been the priority focus of most major bilateral donors and the MDBs since 2008. This focus is consistent with a broader shift by many donor governments to focus on global public goods (GPGs) as a priority, an emerging theme over the last seven years, which has captured increasing levels of aid finance. (Davies, 2014) The potential roles of CP and sustainable consumption in protecting GPGs and avoiding global public bads are numerous.

Cleaner production at scale will directly reduce GHG emissions and reduce countries’ vulnerabilities to climate impacts by improving resource efficiency, particularly water. Cleaner production is also strongly related to improving food security, water security, and energy security in the future. Thus it was no surprise that the Leaders Declaration from the recent G-7 Summit in Germany in June 2015 included, in addition to commitments to intensify support for climate action and to incorporate climate mitigation and resilience considerations into the G7 countries’ development assistance and investment decisions, the commitment to improve resource efficiency as a critical element of improving competitiveness of industries. The G7 countries also committed to take ambitious actions to improve resource efficiency as part of broader strategies to promote sustainable materials management with an emphasis on supporting SMEs (G7, 2015).

8.7 Summary

A triangulation of academic and grey literature, and the case studies presented in the previous Chapters documented that (i) barriers identified in the 1990s and early 2000s continue to inhibit the adoption of CP at scale in Asian developing countries, (ii) these barriers can be typified as policy/legal/regulatory, behavioral, knowledge, or financial and that the types of barriers overlap and interact, (iii) some barriers are particularly important at the firm-level, community-level, city-level, national-level and international-level but they overlap and measures to overcome them generally require actions at different hierarchical levels and by several stakeholders, (iv) many of the barriers to CP are also being experienced in efforts to mainstream low carbon development in the development process, and (v) efforts to scale-up CP and low carbon development have a generally common set of stakeholders.

The key stakeholders for both CP, CSP and low carbon development include national (i) government, (ii) local governments and communities, (iii) national and local financial institutions, (iv) policy, technology and other research and training support centers including academic and research institutions, (v) civil society, (vi) industry associations, (vii) business and industry, (viii) and international organizations. Understanding the interactions among these stakeholders and the various barriers and drivers for change are essential, whether seeking to initiate or to scale-up CP or low carbon development.

The complexities of the challenges when CP was initiated in Asia in the 1990s and those emerging today in regards to stimulating the transition to low carbon development are very similar. The barriers are in many cases related to behaviors and organizations. It is important to distinguish between whether these are driven by economics, technology or lack of information (Cagno and Trianni, 2014). Understanding how these barriers and driving forces and stakeholders are interconnected at different hierarchies, and which are of greatest importance to overcome or build upon, is the key to devising a platform on which initiatives can be undertaken to scale-up low carbon/CP development in Asia. This is the focus of the next Chapter.

9. TRANSITIONING FOR TRANSFORMATION: A TRANSITION MANAGEMENT AND PARTNERSHIP FRAMEWORK FOR INTEGRATING CLEANER PRODUCTION WITH CLIMATE ACTION

9.1. The Need for Transformation

In the previous Chapters, this thesis author described numerous examples of how governmental policies, market incentives, innovative financing mechanisms, and public pressure have aligned to push individual firms and even industrial sectors to waste less and pollute less. However, CP at the scale required to significantly contribute to sustainable development will not be achieved by singular, and often sporadic efforts to internalize costs that are currently treated as externalities through pricing mechanisms, strengthened regulations and enforcement, or elevated public pressure. The adoption of sustainability measures including CP is being outpaced by inefficient use of an increasingly dwindling resource base and accelerating degradation of environmental quality and ecosystem productivity. Climate change impacts will compound these challenges, particularly in developing countries with limited resilience to such shocks.

The need for “transformational” or “transformative” actions to achieve environmental sustainability is often referred to in the international discourse, particularly on mega-challenges such as climate change and biodiversity conservation. Cleaner production, if implemented at a massive scale across Asia’s industrial sectors, cities and nations, has the potential to contribute to such transformation, but achieving such scale requires a transformation in and of itself.

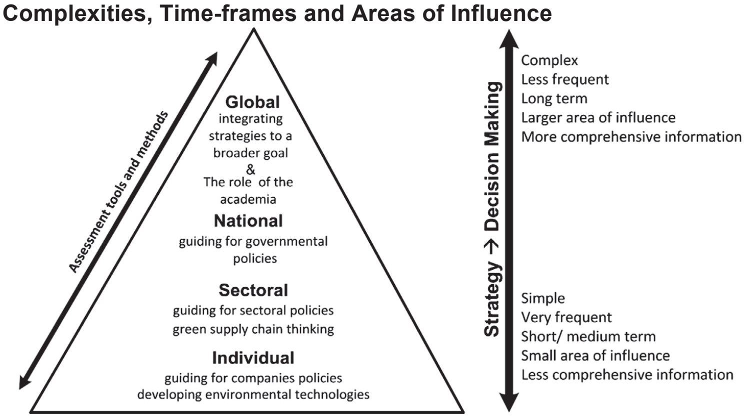
The risks and challenges related to CP are increasingly global and interconnected, particularly since much of the investment in CP has to do with energy efficiency and renewable energy development in order to reduce GHG emissions. More broadly, the sustainability of development is to a certain extent reliant on shifting to CP norms. Further, as urban growth accelerates across Asia, the opportunities for applying CP concepts are huge and could have global repercussions, as well as national and local. Fundamentally, in Asia’s industrializing developing countries (and the rest of the world) this means transforming production processes and consumption patterns, enhancing institutional capacities, and adapting planning and financing processes to enable a rapid shift to sustainability while improving economic and financial viability of development actions.

Actions to integrate CP in development are needed at all levels- from the firm to sectoral policies to the national level as shown in Figure 9.1 (Almeida et.al, 2015). Governance structures that will drive this integration are largely national, but with strong connections to the local and sub-national levels (Atkinson and Klausen. 2011). Decision-making for such increasingly complex development objectives and supporting policies and development programs is primarily through national decision-making frameworks. But decision-making of most national governments tends to be somewhat short-term. Fortunately, leaders of several Asian countries are recognizing the need for joint action, but the ability of governments to act together is a continuing challenge.

Embedding long-term public good-related objectives such as environmental quality and productivity into decision-making is crucial at all levels. The temptation is high to adopt a KISS - “keep it simple stupid” - approach to designing partnerships and programs for mobilizing large-scale CP/CC action, because the challenges are highly complex. However, experience, to-date, showed that breaking down the actions into relatively simple tasks has not succeeded in diffusion, even less so the achievement of scale. The complexities need to be taken into consideration in conceptualizing approaches to tackling the challenges of CP. In particular, consideration needs to be given to the long-term risks of actions or inactions. It is important to recognize the complexity of the systems and to avoid over-simplifying challenges by reducing intrinsically connected problems into individual parts. By considering challenges in isolation, the risk is high that recognition of complexity and dynamics of the ecological, social, and economic systems in which the challenges are embedded will not be recognized. Thus, it is critical to consider the interactions of the individual parts, and systems behaviors such as nonlinearity, feedback loops, and inertia.

The increasing uncertainty of shocks and pressures, such as the financial meltdowns in 1997/98 and 2008, require that a priority focus be given to risk management in integrated policy formulation and to design of programs for implementation of such policies. The challenge is indeed complex with many uncertainties and risks. But it should be possible to determine the highest priority elements of the bigger challenge based on identification of major gaps in the solution architecture from evaluation of experiences from actions already taken.

Figure 9.1 Decisions at Different Stakeholder Hierarchy Levels have Different Complexities, Time-frames and Areas of Influence



Source: Almeida et. al. 2015

9.2 Understanding the Gaps in the Broad CP Architecture

A review of the numerous CP initiatives in Asia, stakeholders and their roles, barriers and drivers in previous Chapters made it possible for this thesis author to identify current gaps in the broad CP architecture that should be the focus of efforts to accelerate and scale-up adoption of CP. But as noted in the previous section, this architecture is complex, and certainly not static. An analytical challenge is how to frame the transitions required to achieve transformation. One planning approach to framing the transitions, Transition Management (TM), was designed to meet the challenges that transformational sustainable development presents.

The TM approach is a relatively new practice, very much in the testing and development phase. (Van der Brugge; Loorbach et al, 2015) Based on the following "definition" from Geels and Schot (2007), the TM theoretical framework is a good fit for the challenge of understanding the broad complexities and facilitates the identification of gaps. They describe TM as:

> *"Transitions are co-evolution processes that require multiple changes in socio-technical systems or configurations. Transitions involve both the development of technical innovations (generation of novelties through new knowledge, science, artifacts, and industries) and their use (selection, adoption) in societal application domains. This use includes the immediate adoption and selection by consumers (markets and integration into user practices), as well as the broader process of societal embedding of (new) technologies (e.g. regulations, markets, infrastructures, and cultural symbols).*
>
> *Transitions are multi-actor processes, which entail interactions among social groups such as businesses or firms, different types of user groups, scientific communities, policymakers, social movements, and special interest groups.*
>
> *Transitions are radical shifts from one system or configuration to another. The term "radical" refers to the scope of change, not to its speed. Radical innovations may be sudden and lead to creative destruction, but they can also be slow or proceed in a step-wise fashion.*
>
> *Transitions are long-term processes (40-50 years); while breakthroughs may be relatively fast (e.g. 10 years), the preceding innovation journeys through which new socio-technical systems gradually emerged usually took much longer (20-30 years).*
>
> *Transitions are macroscopic. The level of analysis is that of organizational fields."*

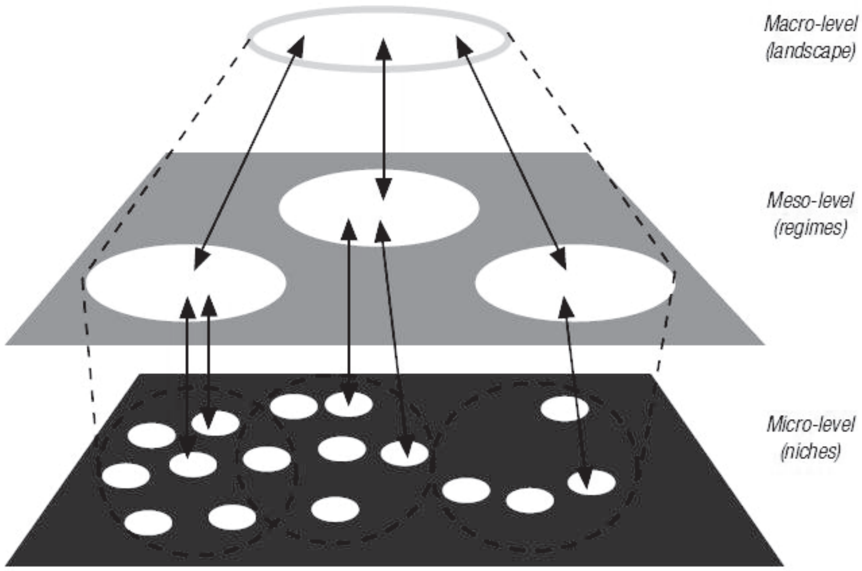
The TM approach recognizes that current top-down modes of governance, whether at the global, regional, national or city/community level, require deep connections with bottom-up initiatives as well as horizontal interactions in order to support for shifts toward inclusive sustainable development (Nevens et al, 2013; Frantzeskaki et al, 2012). Transitions are complex and non-linear, multi-level, and multi-actor (Loorbach 2007). The transition approach facilitates connections between structures, cultures, and practices of different societal actors with several (conflicting) public and private interests to cross-span multiple levels, domains, and terms (van Eindhoven, Frantzeskaki, and Loorbach, 2013). It was intended to generate reflexive analytical frameworks in recognition of uncertainties and complexities inherent in transformation (Loorbach and N. Frantzeskaki, 2012). Thus the TM approach is well suited to the challenge of CP-Climate Change transformation planning.

While it is an evolving theory and practice, a common transition framing approach is being applied to an increasing number of diverse sustainability challenges. While the approach has yet to be effectively applied in application to long-term, large-scale challenges, it has been effectively used to frame the issues and to improve understanding of the steps in transitioning. (Loorbach et al, 2015) Thus the approach is appropriate for this thesis author's objective, which is to frame the actions, required to achieve CP implementation at scale.

A multiple-level process was used to attempt to understand the long-term and complex scenarios. The process is built upon three levels: niche or micro-level, regime or meso-level, and landscape or macro-level, as shown in Figure 9.2. Framing the issues and stakeholders at these three levels, facilitates understanding the intra- and inter-structural, intra- and interactions and intra- and interdependencies of actions. Successful actions are most likely to occur at the niche level, since this represents industry, local government and consumers. They are influenced by policies, regulations and other actions from the regime and landscape levels, but more importantly, their actions and demands need to permeate through the regime and landscape levels to influence these structures (Grin et al, 2010).

The TM literature includes a number of sectoral examples of how transitions have taken place (Loorbach et al, 2015) and more recently as a way to explore ways that society can re-invent itself (transformation to sustainability) following a major "game-changer"- the 2008 financial crisis (Avelina et al, 2014). For purposes of this thesis, the question is really whether the transformational challenges and related actions can be better understood and outlined by framing them as a transition and then outlining key gaps and gap-filling actions that might lead to the transformation, recognizing that this transformation will be a co-evolutionary process with many uncertainties. It is this thesis author's view that the urgency of the challenges require every effort to stimulate and to guide to the extent possible the transformation processes. Such actions require multiple actors pushing in a common direction; that is the needed collective approach.

Figure 9.2: Transition Management Framework Relies On Understanding Actors And Actions At Three Levels- Macro-, Meso-, And Micro-.



9.3. Framing the Issues, Spatial Parameters and Stakeholders

Based on the review of the types of CP initiatives, policies, and their successes and limitations in Chapters 5-7 and the analysis of barriers and roles of stakeholders in Chapter 8, it was possible to identify the factors and combinations of actors or actions, which may prove to be the keys to overcoming the barriers to large-scale adoption of CP. The objective of the author of this thesis is to use the understanding of the multi-stakeholder complexities, barriers to and drivers of a CP transformation from the previous chapters, to delineate the key gaps in actions/actors to-date, which appear to be crucial to scaling-up CP implementation in conjunction with climate change challenges. This understanding should facilitate the proposal of a framework that addresses the gaps and builds on the proven approaches to stimulating CP in Asian developing countries.

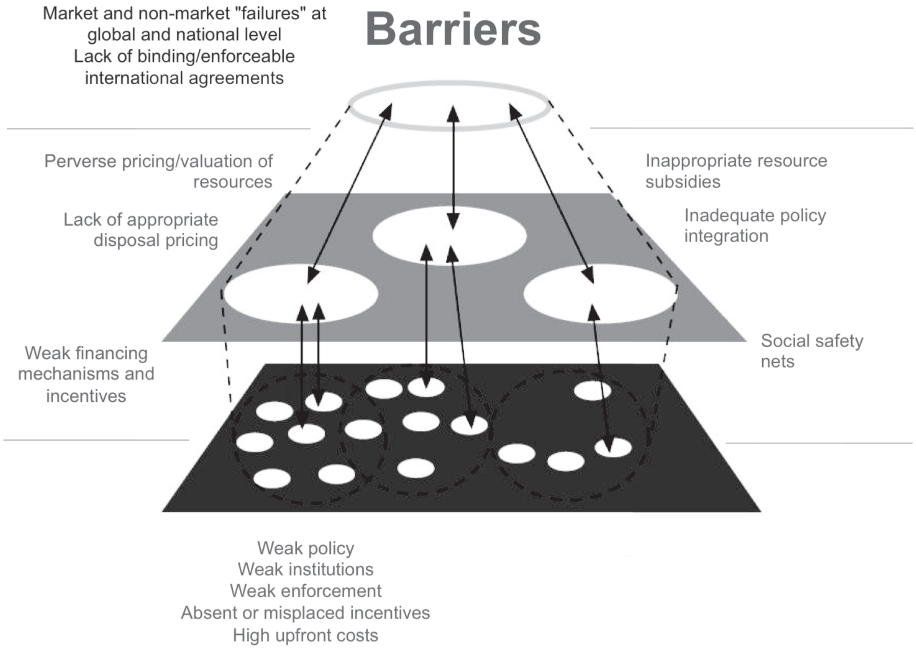


Figure 9.3: Key Barriers At Different Transition Management Framework Levels

While there are many ways to classify the key CP stakeholders, for purposes of placing them in a TM framework, this thesis author's focus is "national" since each country has different opportunities and challenges, which must be addressed at the country-level.

- For governance, that pertains to the policy, planning, regulation and enforcement, the national government aligns with the macro/landscape-level, the regional government focuses upon the meso/regime-level, and the local governments and local communities align with the micro/niche level in the TM planning processes.
- National and local financial institutions align with regime-level and niche-level regimes, respectively.
- Civil society, CP technology centers, and academic and research centers may align at each of the levels depending on the actions being considered.
- Industry associations are likely to align with the national (landscape) level and in some cases with the regional (regime) level and the local (niche) level governments.
- Businesses and industries may include multinational corporations at the landscape level, large national enterprises at the regime level, medium-size enterprises at both the regime and niche levels, and small- and micro-enterprises at the niche level.
- International assistance agencies will typically be aligned with the landscape level but may be operating at the regime or niche levels.

The transformation being sought requires the collective action of countries, and therefore, it is also important to understand the international context. Looked at through a TM context:

- International agreements driving CP, and associated financing and technical assistance would include the SDGs and UNFCCC agreements and associated support mechanisms through the UN agencies, MDBs, other IAAs, and bilateral agencies and agreements at the landscape level. It is important to note that the developed and the developing country governments are party to these agreements and their roles as recipients of support mechanisms somewhat loosely defined.
- National commitments to international agreements (such as INDCs for UNFCCC) and associated governance and implementation (involving national-level actors) are at the regime level. Regional and national support mechanisms and actors (such as ASEAN initiatives and regional and national CP centers, academic and research centers, and industrial associations) are also regime level actors.
- Sub-national and local actors and actions, in particular industry (regardless of size), local government, financing institutions, CBOs, and local supporting actors and mechanisms are at the niche level.

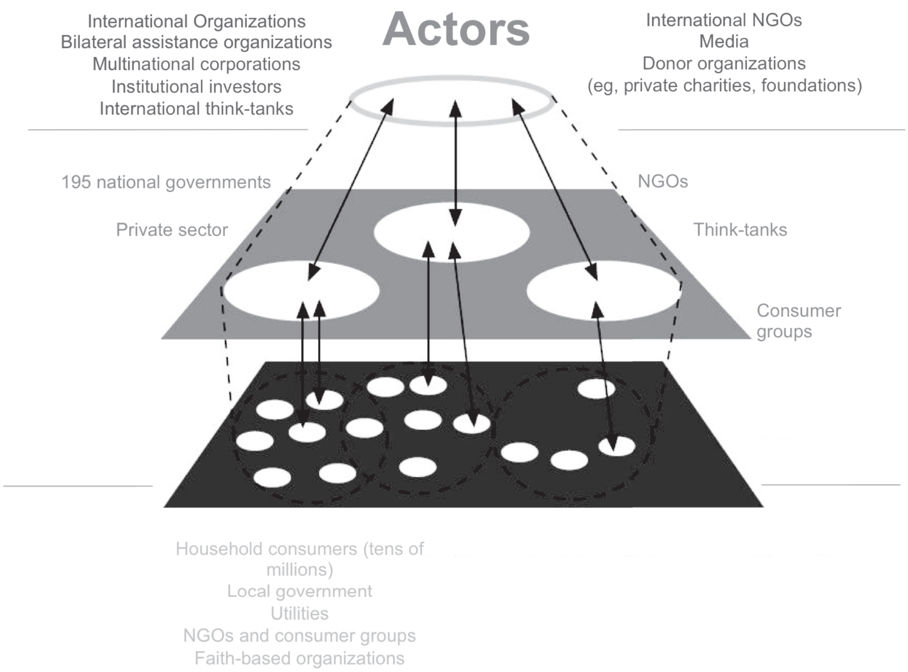


Figure 9.4: Key Actors active at different transition management framework levels

9.4 What are the Missing Pieces to the CP Scale-up Transformation?

There are a number of examples provided in chapters 4 through 8 of partnerships and other collaborative initiatives, many supported by international assistance agencies, which are designed to overcome barriers to CP. Several local-level initiatives have succeeded in overcoming key barriers to the adoption of CP at the firm-level and local-level. There are also examples of such collaborative partnerships that have had staying power and succeeded in shifting government thinking and planning, though to a lesser extent government policy. Similarly, there are many success stories whereby industry association-level initiatives, working with local governments, CBOs, academic institutions and other stakeholders, which helped to stimulate adoption of CP by a community of firms. Awareness raising has been successful in numerous cases, but based on the information presented previously in this thesis, it is clear that it has not reached the level required to achieve scale in changing either producers or consumer's behaviors at the national-level.

Given the number of success stories at the niche/micro-level and regime/meso-level, resulting from effective collaborative efforts by niche-level and regime-level stakeholders, it is this author's view that the focus of reaching scale needs to be at the landscape/macro-level. In this regard there are four key factors inhibiting large-scale adoption of CP as an integral element of a shift to sustainable development. This thesis author proposes a globally supported large-scale, long-term Asian CP initiative be framed around the following four elements of a framework.

1. Policy frameworks at the international and national levels, with cohesion of international and national policies related to CP are currently lacking. In particular, as discussed in Section 9.5, CP policy and climate change mitigation policy cohesion may dramatically improve the international and national support needed at the scale required. These policy frameworks need to sufficiently address long-term actions needed to address regulations and enforcement, economic drivers including resource pricing and financing, and behavioral changes (see Section 9.6). Strengthening governance, particularly regulatory reform, has been identified as a key challenge.
2. Financing mechanisms that serve the dual purposes of scaling-up cleaner, low carbon production and sustainable, livable urban growth are required. To achieve this will require improved cohesion of international agreements on climate change through the UNFCCC and on CP through the SDGs, and CP and climate change policy integration at the national level (see Section 9.7).
3. A new kind of multi-stakeholder collaborative partnership needs to be built and replicated at many levels and locations to support CP. (see Section 9.8)
4. Special attention must be directed to the rapidly growing urban/industrial complexes across Asia and, within these, to the SMEs. (see Section 9.9)

The initiative would build on the Asian CP successes and experiences summarized in earlier chapters, but would focus on scale of action. Such an initiative could be tailored for replication in other regions.

9.5 Integrate CP and Climate Change Mitigation

Only fundamental shifts in the mindsets of political leaders, governmental functionaries, enterprise owners and managers, financiers, and consumers can put Asian developing countries on the path to a revolutionary transformation of truly, sustainable production, consumption, and distribution of resources for the short and long-term future (Smith and Jalal, 2000). Working partnerships among governments, CSOs and private sector are needed to agree upon transformational strategies and to ensure a long-term and continuous implementation of these strategies. Private sector participation is essential in both raising finances and in delivering actions on the ground. In addition to economic and fiscal incentives, capacity building and country-wide educational campaigns need to be supported in order to change consumption patterns.

The Fourth IPCC report of Working Group III (2001) identified a number of the key challenges for scaling-up investments in low carbon, GHG mitigating measures in infrastructure development and in particular in industry and urban sectors in developing countries. The need to integrate air pollution abatement and climate change mitigation policies was seen as a critical lost opportunity in many countries because of the potentially large cost reductions compared to treating those policies in isolation. This argument can be extended more broadly to environmental policies (incentives and disincentives) in developing countries.

As discussed in previous chapters, none of the rapidly industrializing Asian developing countries have integrated, or even sought to improve cohesion of environmental policies and climate change mitigation policies. However, some have recognized this need and have indicated an intention to do so in their INDCs. The opportunities to achieve significant co-benefits in terms of local, national, and regional ambient environmental quality and resource efficiency, together with global benefits of GHG emissions reductions are potentially very high in these countries.

The argument for capturing the potential synergies and integrating national policies on low carbon development with CP development goes beyond the significant cost savings. Firstly, as discussed in greater detail in section 9.7, the barriers to large-scale adoption of CP summarized in Chapter 8, and low carbon development as summarized by the IPCC (2012) and the World Bank in its 2010 World Development Report on Climate Change (World Bank, 2010), are essentially the same.

Secondly, CP actions at the industrial- and urban-level with the highest financial rates of return are most often the improvement of energy efficiency, particularly in countries where electricity tariffs are high (CPIE, 2002). In addition, and sometimes overlooked, is that the minimization of waste flows from industry and recycling from both industry and more broadly the urban sector provides important indirect climate mitigation through the conservation of energy and materials. (IPCC, 2001) Thus there is a strong logic to CP and climate mitigation policy cohesion at a minimum, and in many cases for investing in policy and program integration.

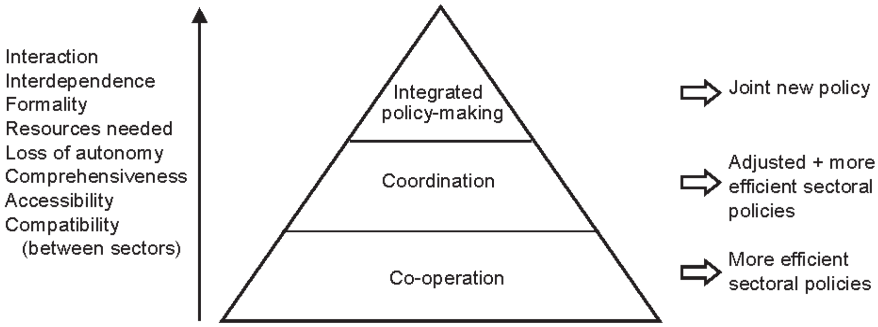
The mitigation investment barriers identified by the IPCC (2001) and the World Bank (2010) are highly consistent with each other and with the barriers to CP identified in the literature and through the surveys for this thesis as described in the previous chapters. The climate mitigation investment barriers were described as being related to pricing, financing, trade, market structure, institutional frameworks, information provision, and social and behavioral norms. Some of the key challenges in developing countries to scaling-up investments in renewable energy and energy efficiency as an integral part of their development programs include access to new technologies; inefficient manufacturing; lack of skills; inappropriate incentives and subsidies; restriction to access for financing, particularly for SMEs; inappropriate pricing; and poor access to information on opportunities.

The IPCC (2001) also reported that a key determinant for investing in energy efficiency in the industrial sector was at the enterprise-level decision-making processes and that these processes are highly reliant on the business climate, corporate culture, managers' personalities, and perception of the firm's energy efficiency and perceived risks of the investments. The IPPC stressed the importance of the firm's structure, organization, and internal communication in driving the degree of energy awareness and demand for and decision-making on investments in energy efficiency.

The alignment of CP barriers at the national-, local- and firm-levels are clear. Both the IPCC and World Bank studies recognized the importance of seeking synergies between development policies that have impact on investments in competitiveness and GHG mitigation at the country-level along with economic, regulatory, and social incentives for encouraging innovation to find new means of GHG mitigation. In any case, policies or activities aimed at such transformational change must be sustained over time and be able to cope with projected adverse impacts, as well as the high degree of risk and uncertainty posed by global and regional economic shifts, climate impacts, water security, energy security and political support.

Efforts to integrate climate change action into development are increasingly prevalent but gaps remain in understanding the specific relationships, potential synergies, and trade-offs in the integration process (Janetos, 2012; Huang et.al, 2016). The challenge of accelerating and strengthening the process of achieving integrated CP, low carbon industrial and urban development pathways calls for ambitious actions by policymakers, economic actors and the society as a whole. Persuasive political will and strong leadership at all levels, including at all levels of government, as well as in private industry and finance, are of paramount importance to overcome existing barriers and to catalyze efforts to make a change at scale beyond existing patterns, thus enabling a shift in economies and behaviors. This has been clearly demonstrated when companies or countries have attempted to understand and implement sectoral and crosscutting thematic policies (such as environment) which are often inconsistent and sometimes conflicting. (Meijers and Stead, 2004; Waage et al, 2005; IDRC, 1998; Ahmad, 2009; Witmer, 1994) As discussed in Chapters 4 - 8, many Asian countries have undertaken initiatives to make this shift. The question is, how can such actions be universal, accelerated, sustainable and at the scale necessary to achieve transformation?

Figure 9.5 Integration of National Development Policies such as Climate Mitigation and Cleaner Production can be used to Support the Development of New Joint Policies



(source: Meijers and Stead 2004)

Industrial development, to the extent that it occurs on the basis of development planning, is generally a short-term planning horizon (typically five years) with relatively narrow objectives. Such plans usually do not take into account longer-term scenarios of resource availability or technology shifts, or vulnerability to economic shocks or ecosystem and human health costs. The nature, magnitude and complexity of accelerating broad-scale adoption of low carbon CP as a standard and driving force for industrial and urban development would require the capacity to plan and implement actions on the basis of medium- and long-term rationales, avoiding the trap of focusing on short-term, narrow perspectives. This will require changing spatial and time planning boundaries and horizons, recognizing (i) that what happens in one locale has impacts elsewhere and needs to be taken into account, and (ii) the long-term should carry much more weight when decisions are made. Development planners would also need to recognize that such planning horizons also increase uncertainty in predictability of actions and responses and priorities of stakeholders. (Evans, 2015)

Achieving policy coherence and integration is much easier said than done. Incentives are needed to build on national and international synergies. At the international-level this means that the UN parties would need to agree on specific policy integration objectives and measurable targets. For example, international support will be essential to support CP/CC technology innovations that can be transferred at scale allowing developing countries to bypass outdated models. This would require addressing current barriers to technology development and transfer to and among developing countries. The UNFCCC has spent extensive time and energy debating this issue. A similar, parallel debate will no doubt emerge for SDGs. The question and challenge is whether the two can be actively and synergistically integrated to accelerate progress for innovating and implementing within developing countries low carbon and other CP technologies, built upon supportive economic and political policies, which are supported by comprehensive educational and training support on an on-going basis.

At the national-level this would require similar agreements among relevant ministries leading to a national-level strategy to meet agreed upon objectives and targets. Success or failure will be determined by actions at each level, but particularly will depend upon the effectiveness of participation of stakeholders (Schnurr, 1998). A variety of stakeholders at the landscape, regime and niche levels will need to be engaged to participate, affecting both the substance and the process of policy integration at the national-level. It is noteworthy that China has begun this process. Though without specific reference to China's CP Law, the 2014 review of climate policies and actions a number of policy, finance and technology deployment industrial development initiatives designed to concurrently achieve low carbon and local environmental improvement objectives (NDRC, 2014).

Elements encompassing a national strategy might include specific industrial development criteria and regulations, financing incentives and modalities, environmental and energy regulations, transparent and conducive investment laws, reduction of implicit subsidies for unsustainable resource input and energy use and consumption, conducive environment for stakeholder participation, including CSOs and the private sector, in governance, decision-making and implementation of actions. The partnership between government, private sector and civil society is central to achieving transformational changes.

Key consideration will need to be given to national policy support to transition business models, pricing, education, training regulations, enforcement, monitoring and feedback loops. Business models and production modes must be adapted to better focus on long-term cycles consistent with the country's' long-term sustainable development goals including new climate objectives such as the INDCs to reduce GHG emissions.

The models also need to take into account vicarious or embedded emissions by fully understanding material flows. Relatively new accounting tools and management systems are emerging as a result of improved understanding of embedded emissions and their impacts on ecosystems and ecosystem services. For example, national transition business models can build upon tools and guidelines such as ISO 14064 and the WRI/WBCSD Greenhouse Gas Protocol Corporate Value Chain. The rapid urbanization and increased consumption of growing middle classes in countries like China and India will dramatically will increase the complexity of understanding and accounting for embedded emissions but will make such accounting all the more important if countries are to successfully reduce GHGs and improve local environmental quality and productivity. (Hornweg, 2016;

Similarly, policy reforms will need to focus on decoupling the amount of resource use linked with economic activity, and environmental impacts associated with the use of the resource through all of the stages of the life cycle. As discussed in Section 6.2.7, there are many good examples in China where targeted natural resources consumption and waste emissions have been successfully decoupled from economic activities. (UNEP, 2011)

Getting the prices right helps to stimulate actions to make production efficient and clean. Such pricing relies on policies to make markets more competitive. The aim of getting prices right should be to reduce waste and pollution in an economically efficient (least-cost) manner while promoting long-term structural transformation. Effluent and emission charges and tradable emissions or effluent permits can, theoretically, help increase efficiency and raise revenue. Charges allow firms the flexibility to make decisions based on the actual costs of abatement to the firm and should lead to lower aggregate costs of compliance than use of regulatory standards based on effluent or technology criteria. Market-based instruments also offer the theoretical possibility for dynamic efficiency gains as they provide a continuous incentive for environmental improvement, including process changes.

Prices of resources such as energy, water, minerals, and timber should reflect marginal costs of their provision at point of purchase (including depletion, replanting, replacement allowances) plus the external costs imposed on society by resource extraction, transport, conversion, and use. Several Asian countries have reduced petroleum and electricity subsidies and increased tariffs in the last few years. This has helped to stimulate some investments in energy efficiency. But, in general, prices of energy, water, and transport, and pollution charges are too low to stimulate significant low carbon CP investment. Pricing is a politically sensitive issue and countries that are bold enough to use pricing mechanisms to stimulate low carbon CP transition will require considerable international support, including financing to offset socio-economic impacts.

Experience to date demonstrates the difficulty of relying on market-based instruments, which explains their rarity in the region. Pollution levies are generally set far too low to be effective in shifting biases in technology choices from end-of-pipe treatment to integrated CP process changes (Huq et al, 1999). Time will tell whether the new carbon market initiatives will be successful in placing a sufficiently high price on carbon to stimulate low carbon investments on the basis of financial viability.

In the discussions of barriers to CP in previous Chapters considerable attention was given to the need for improved regulations, and more frequently, effective regulatory enforcement. A significant determinant of firms' responsiveness to regulation is community pressure, but this is usually insufficient to achieve consistent outcomes intended by setting the regulations. Like pricing, enforcement is a highly political issue that is further complicated by exposure to corrupt practices. This issue will need to be addressed in any major new initiative to achieve a low carbon CP development transformation. Fortunately, one of the areas of progress in the climate negotiations has been in response to the demand by donors for verification of carbon emission reductions through monitoring/verification/reporting systems. Countries should be able to build on this experience in strengthening broader environmental regulatory enforcement systems.

9.6 The Need for Scale and Speed

The impacts of rapid urbanization, accelerating industrialization in some countries, and climate change are being experienced at a much faster pace than expected. The most recent WMO greenhouse gas monitor (2015) reported that GHG concentrations increased in 2013 at the fastest rate in the last 30 years and that ocean acidification is accelerating at unprecedented rates (WMO, 2015). The reduction of the natural resource base as a result of inefficient use of resources for manufacturing, increased levels of local pollution or costs to society and economies for inefficient investments in pollution abatement, likely extreme heat waves, loss of ecosystems, water shortages, sea level rise, and storm surges are going to have unprecedented impacts across Asia and globally in the next decades. These impacts will particularly hurt the poorest, least resilient countries and communities (OECD, 2012; Evans, 2015(b)).

The international community, through the UNFCC, has made progress on agreements for significant reductions in GHG emissions. Significant levels of climate finance have been mobilized and more support is promised by donor countries to help developing countries achieve climate resilient, low carbon development. The establishment of the Green Climate Fund (GCF) was a major milestone in this heavily negotiated element of the UNFCCC. The recently approved SDG's and the decision of the G7 to increase the likelihood that the international community will rally around the need and opportunities to transform industrial and urban development so that it is cleaner and more efficient. However, unlike for climate change, little has been accomplished in terms of international commitments for financing the SDGs.

Current approaches to GHG emissions reductions and CP are clearly not collectively large enough or being undertaken rapidly enough to significantly reduce the climate and local/regional environmental risks. Piloting new, interesting initiatives and one-off projects is not a sufficient response to the risks. The time has come to give priority to investments in low carbon/cleaner/resource efficient development at scales sufficient to dramatically lower the vulnerability of millions of urban and rural households to local pollution and resource scarcity risks compounded by climate impacts. Undertaking small projects and hoping that these will be replicated at a large enough scale to reduce the vulnerability of the large populations at risk is no longer an option.

9.7 Financing Climate Change Mitigation and CP Policy Integration and Action

In order to facilitate transitions to low carbon CP development in Asian developing countries, a substantial resource transfer is needed. To that end, different financial pathways that combine multiple mechanisms have to be considered. The mechanisms should play three principle roles:

- Mobilize, catalyze and leverage public and private capital at both international and domestic levels from various sources to generate the volumes of finance needed to achieve the scale of transformation required.
- Promote and facilitate access to resources at scale and in a smooth manner, to enable transformations in all countries, always considering and enhancing the potential for absorption.
- Generate synergies with overall growth and development priorities in ways that maximize the desirable transformational effects, i.e. long-term changes either to the national policies and institutional frameworks, to the national/sectoral investment climate, or to the risk-return profile of specific investments. (World Bank, 2010)

Significant donor financial support is increasing for low carbon development but not for CP. However, if countries invest the resources required to fully integrate low carbon and CP policies, including building the necessary institutional and regulatory capacities, climate finance can become a new source of capital required for large-scale investment in CP. For example, opportunities already exist to link CP with climate finance where national carbon market mechanisms are being initiated (such as the new China carbon market). Similarly, countries can establish conditions, taking care to excessively or unnecessarily subsidize sectors and avoid pitfalls that lead to inefficiencies or corruption, for accessing international climate finance, such as through the CTF or the GCF (Jakob, et.al., 2015).

An integrated national CP and climate change mitigation (low carbon CP development) policy framework can require a company or city seeking public sector climate finance to transition from high carbon to low carbon technologies to concurrently minimize waste emissions, transition to cleaner technologies (more broadly- not just relating to low carbon), improve efficiency in use of materials, reduce use and emission of toxics, and other components often included in a CP program. Access to funding would be conditional upon meeting clearly defined targets for CP as well as GHG reductions.

A key objective of all climate finance donors, whether from public sector (governments) or philanthropies, is to ensure their contributions achieve maximum impact. Donors seek mechanisms and partnerships that substantially leverage concessional contributions in order to achieve development additionality from climate finance. For example, the Clean Technology Fund (CTF) for renewable energy and energy efficiency investments has achieved leveraging of about 1:9 - that is every $1 of CTF financing results in $9 investment in low carbon action. As a result, the $5.6 billion CTF has stimulated investments totaling almost $50 billion in renewable energy and improved energy efficiency. Such funding can also stimulate financial innovation by establishing new types of funding mechanisms that tap less conventional sources of debt and equity such as institutional investors.

A new kind of financial innovation aimed at engaging partners from the private sector will be required to mobilize the billions of dollars required over the next decades for both low carbon and CP-based sustainable development. Climate finance will be crucial to support such innovations. A number of initiatives could be undertaken through partnerships that would mobilize billions of dollars for large-scale integrated CP and low carbon development initiatives. Developing country governments will need to lead, including mobilizing domestic resources for these actions, with support as required from international, donor-supported climate finance.

Several Asian developing countries could generate substantial savings from reducing/eliminating fossil fuel or electricity subsidies, which could, in turn, support local financing or borrowing for priority activities that can help to finance integrated CP/CC actions. Fossil fuel subsidy reforms are critical since they act as barriers to the deployment of renewable energy and energy efficiency concepts, approaches and technologies. Subsidy reform can generate substantial sources of revenue that can, in turn, be used to back innovative financing mechanisms. One such concept is the establishment of subsidy phase-out and reform catalyst (SPARC) bonds. The developing country government would essentially raise money from private capital markets by promising to pay investors a fixed amount in the future based on the future savings from phasing out the subsidies (Hale and Ogden, 2014).

A number of similar innovative financing mechanisms need to be explored and tested at scale, particularly those which could convince institutional investors such as pension funds and sovereign funds to invest in activities that reduce the carbon intensity of development and improve the economic and environmental efficiency of industrial and urban development. Cleaner production, including energy efficiency, generally presents a better opportunity for investments than renewable energy, but such investments have generally been small in scale and in some cases highly complex. The challenge is to effectively bundle such investments in order to reach a larger, more attractive scale and still minimize complexity of the investment vehicle.

Energy efficiency in industry and cities presents the highest potential for innovation of new investment vehicles. The economics are compelling because the investments carry relatively short payback periods. While municipalities and industries have financed many of these investments on their own or through debt fund advances from their provincial and/or sovereign governments, the opportunities to access climate finance to reach a large-scale are increasing as a result of successful climate finance pilots such as the CTF. Integrated low carbon CP development initiatives have an excellent opportunity to further the research and development into such financing initiatives.

9.8 The Need for Partnerships that Support Collective Impacts

Successful establishment and implementation of long-term transformational plans will require new types of partnership, which result in positive short- and long-term collective impacts. Collective Impact Initiatives (CIIs) are long-term commitments by a group of stakeholders to a common agenda for solving a specific social problem or cluster of integrated problems. Most CIIs are multi-stakeholder initiatives with voluntary activities by stakeholders from different sectors around a common theme, which support dialogue, institution building, rule setting, rule implementation, and rule monitoring supported by effective monitoring and feedback loops (Kania and Kramer, 2011; Evans et al, 2015).

The concept of collective impact fits the emerging needs of the kinds of collaborative partnerships that will be required to achieve the low carbon CP transformation. Some of the key conditions for successful CIIs include: (i) partners share a common vision for change including a common understanding of the problems and a joint approach to solving them; (ii) shared measurement systems in order to ensure that efforts remain aligned and partners hold each other accountable; (iii) mutually reinforcing activities whereby, partners, though differentiated, coordinate through mutually reinforcing plans of action; and (iv) continuous communication that builds trust, ensures mutual objectives, and motivates collective action.

Partnerships for sustainable development, particularly because of the varying and sometimes conflicting interests of the partner stakeholders, are difficult to manage and maintain (Van Huijstee et al, 2007). The challenges described in the foregoing paragraphs on both CP and climate action, require visionary, long-term strategies that can be broken into sequential activity programs with clear responsibilities and accountabilities of each partner. Financial resources must be adequate over an intermediate time frame in order to get one activity completed and the next one underway. When these conditions are met the potentials for building collective action for long-term impacts at a scale commensurate to the challenges are possible. Such partnerships serve multiple purposes, not the least of which are reducing potential conflicts through effective dialogues and helping to educate people and industries, government, universities and consumers through various capacity building and awareness activities (Geng et.al., 2016).

The key condition for applying the emerging model of collaborative impact partnerships to bring CP and low carbon development together, at scale with sufficient, long-term financing, is leadership. Effective and long-term leadership, usually through a dynamic partner or individual taking on responsibility suited to strengths and resources, is essential. Dynamic leadership is particularly key for getting such initiatives underway. Effective leadership will bring top-level leaders together and keep their engagement active over time. It will also help the partners to collectively tackle the challenges in a collaborative manner and to avoid pushing a particular agenda (Hanleybrown, et.al., 2012).

The need for CIIs for integrated low carbon CP development programs are likely to be met through public-private partnerships (PPPs), an increasingly common practice (Evans, 2014). Based on experience in recent years it appears that such partnerships have the potential can achieve the needed efficiency, flexibility, accountability and competence of the private sector, together with the long-term perspective and social interests of the public sector (Buse and Harmer, 2004; Buckup, 2012).

Two of the largest, most complex CIIs applying these conditions are the Global Alliance for Vaccinations and Immunizations (GAVI) and the Global Fund to Fight AIDS, Tuberculosis and Malaria (the Global Fund). GAVI and the Global Fund are both large PPPs with stakeholder partners from private and public sector sectors, developing world and donor governments, private sector philanthropists such as the Bill and Melinda Gates Foundation, the financial community, research and technical institutes, CSOs and multilateral organizations. GAVI, in particular, has been successful in stimulating financial innovation (the International Finance Facility for Immunization or IFFIm) as well as catalyzing and supporting research, development and implementation at scale. Both have strong performance measurement and reporting systems so that all of the partners, in particular, the donors, know the impact of the actions they support (Evans and Hiller, 2015; IEG, 2010).

Potential benefits of such partnerships for low carbon CP development, among other positive attributes, are that they can promote innovation and offer solutions to complex problems, transform knowledge and technology into applications for meeting local environmental and economic objectives and global GHG reduction objectives for the short and long-term.

The envisioned low carbon CP CCIs can be used to leverage proficiencies and competencies of the broad range of stakeholders to:

1. collectively achieve outcomes;

2. extend and enhance financial and other resources;
3. permit risk-sharing across partner organizations;
4. improve access to information held by other parties;
5. improve the quality and relevancy of initiatives under the partnerships due to synergies among partners;
6. facilitate greater sustainable adoption by user groups;
7. increase competitiveness and market positioning of local enterprises as a result of improved competencies.

There are potential downsides of such partnerships. They often have high transaction costs. The willingness and ability of public agencies and private firms to enter into partnerships are sometimes constrained by different incentive structures, not the least of which are the differing views on costs and risks. Finally, coordinating diverse partners and interests is challenging at best, since stakeholders usually have different mandates, missions, time horizons and reputational risks (Evans et al, 2015).

9.9 Focusing on the Urban/Industrial Complex

Another way to improve the focus of integrated CP/CC actions would be to give priority to the urban sector. As described in Chapters 3 and 4, Asian cities and their inhabitants are the industrial and economic hubs of most Asian countries, and the most significant source of the countries' GHG emissions. It will be at the city-level that the green growth/low carbon sustainable development agenda must be directed and driven. Thus the urban sector, including urban-based industry, presents the greatest opportunity for most Asian countries to contribute significantly to GHG reductions. Concurrently, the largest concentrations of populations exposed to the impacts of industrial pollution and resource scarcity and/or degradation are urban communities.

Tailoring actions to fit the city-level, across multiple cities within a country, is critical to successful transformation. Political leadership, strengthened governance, and empowered stakeholders are needed across the urban landscape, tailored to meet country-level conditions/capabilities, to undertake environmental quality actions that meet local and global objectives.

The urban setting provides the opportunity for major new low carbon CP development collective partnerships to view the challenges both from the perspective of the global community with its climate mitigation objectives and the local community concerned with providing the urban services and achieving the environmental quality that current and future local populations will need. The opportunity for local leadership to access financing for large-scale actions for CP, both industrial and urban, is by tapping new sources of climate finance. Urban leaders in Asian developing countries will only give priority to low carbon development if it is integral to meeting wider urban infrastructure and service's needs. But by bringing low carbon development and CP together, with technical and financial support to meet current and future needs, a mayor's decision to shift to a low carbon path is made much easier. The climate finance incentives dramatically increase the likelihood that integrated low carbon CP development action at the city-level will generate significant GHG reductions of the scale required.

Linking cities through the new kinds of partnerships, such as CCIs, is a priority. Such collaborative partnerships have been initiated recently for low carbon and climate resilient urban development, but the opportunity to achieve the co-benefits of local environmental improvement through CP have not been explored and implemented on large scale, long-term efforts.

As has been the case for initiatives such as GAVI and the Global Fund, designing new CCIs for low carbon CP development will need to have clear performance measures. Donor countries and other potential partners such as philanthropies providing technical and financial support to such partnerships, particularly for climate action, are highly focused on the need for targets and results, which can be monitored. National or local governmental organizations, utilities or other organizations often build capacity to assess the impacts of development finance through new partnerships.

Particular attention should be given to the SME stakeholder groups, which have been much less successful in adopting CP for the many reasons given in Chapter 8. The SMEs are a growing, not shrinking part of the Asian industrial base and with sufficient policy and financial incentives and disincentives can not only transition to low carbon CP but can be the source of much of the innovation required to achieve Regional transformation. But if the SME sectors are once again left behind, the local/national/global objectives of scaling up low carbon CP development across Asia will be difficult to accomplish.

9.10 Conclusions

The elements that might be applicable to framing transitions required to achieve transformation, particularly utilizing the TM approach and policy integration, are identified and prioritized in this chapter. Figure 9.6 outlines priority actions within a TM framework. First and most important is that the key CP stakeholders and low carbon development stakeholders are brought together in collective actions at the national-levels to achieve integrated low carbon CP development at scale and rapidly, but sustained over the long-term. National support mechanisms will be needed to assist to transition to new business models, pricing, education, and regulation.

The analyses documented the need for:

1. A globally supported, large-scale, long-term Asian low carbon CP initiative – a collective of national actions. This initiative would need to be framed around cohesive international and national policy frameworks addressing needed regulatory economic, and behavioral reforms.
2. Financing mechanisms that capitalize on climate finance for supporting integrated low carbon CP action. Financial innovation will be a fundamental requirement to mobilize the billions of dollars required for large-scale integrated low carbon CP development. Much of this financing will need to be from developing country domestic resources.

3. A new kind of multi-stakeholder collaborative partnership(s) to support such a framework.
4. Focusing on the urban industrial complex level will provide the best opportunity for achieving scale and speed objectives.

Finally, the need for sustained international and national leadership is highlighted as being of paramount importance to overcoming existing barriers and bring together the various stakeholders in the aforementioned partnerships.

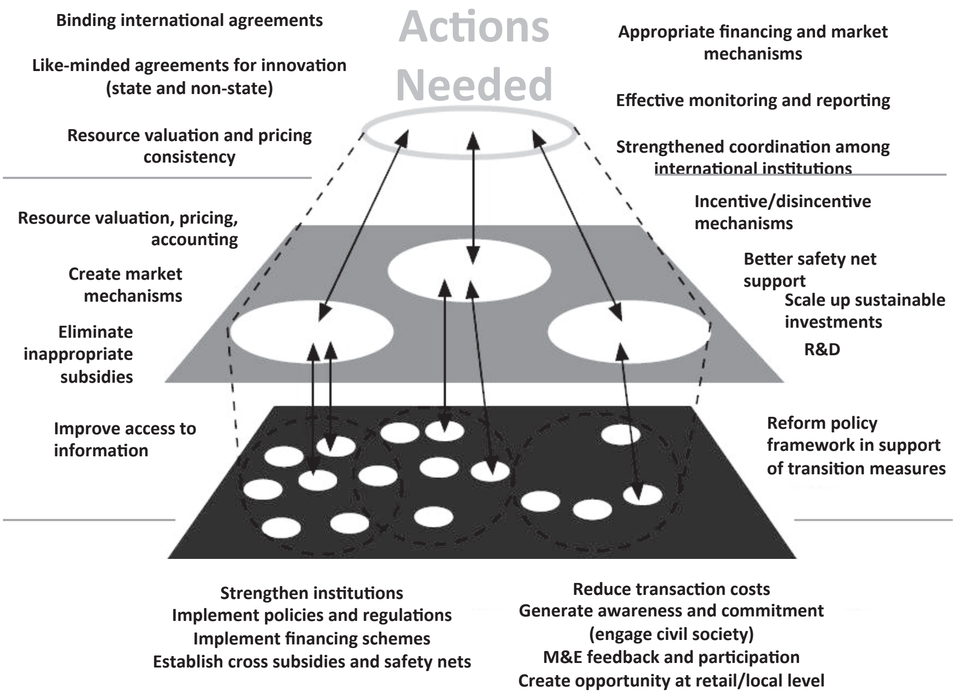


Figure 9.6: Key Actions At Different Transition Management Levels, Which Are Needed To Build A Foundation For A Low Carbon CP Transformation Framework

10. A LOW CARBON CLEANER PRODUCTION FRAMEWORK

10.1 Introduction

This concluding Chapter draws on the case studies and literature analyzed in Chapters 3-7 and particularly Chapters 8 and 9 to take up the final thesis research question. In this Chapter the thesis author proposes an integrated low carbon CP framework initiative, which he believes has the potential to assist Asian developing countries to generate and optimize the co-benefits of climate change action and local sustainability. Not only is this the culmination of the analytical process and conclusions drawn from the previous Chapters of this thesis, but in effect it is the culmination of twenty years of his efforts to identify how to achieve large-scale adoption of CP in Asian developing countries in order to significantly reduce environmental risks and to improve resource efficiency in rapidly industrializing Asian countries.

The previous Chapter outlined the priority actions within a TM framework, including identification of keys constraints to scaling up and accelerating action. These constraints tend to be at the landscape and regime levels of the transition management framework. This Chapter conceptualizes a forward-looking, multi-stakeholder collaborative partnership focused on the landscape and regime levels, but recognizing the essential inter-linkages with actions at the niche level and across all levels. Such a partnership needs a long-term outlook supported by short-term actions in order to transform Asian developing countries' development processes to achieve low carbon and cleaner production objectives. It is recognized that creating a culture of long-term thinking and envisioning to bring long-term perspectives into policymaking, planning and development actions is essential (Mont et.al., 2014) but that is not the way that development is practiced today.

This thesis author believes that this is an opportune time to transform the development process because of the positive momentum and political commitments of the UNFCCC Paris Agreement and establishment of the Sustainable Development Goals. The time-frame for action has become much more realistic in the sense that long-term objectives are being agreed-upon (to 2030 for both the Paris Agreement and the SDGs) with commitments for short-term actions, periodic monitoring and feedback mechanisms, and responsive, flexible adjustments in actions. The problem is that these two initiatives continue to follow parallel paths, particularly at the country-level, instead of being fully integrated.

This Chapter presents a conceptualization of a low carbon CP development transformation framework that brings these two paths together. But a great deal of additional analytical research and political dialogue with effective leadership will be required to translate this concept into reality. The final section of this Chapter discusses some of the immediate research needs to move the agenda forward. It is this author's hope that that research will be undertaken in a timely manner and that the leadership that has been emerging and not in 2015 on these global issues will capture the opportunity to focus on integrating the global, national and local agenda in order to achieve a much more comprehensive and cohesive program of action and that is fully integrated into the development process. The initial work may be undertaken at the Asian regional level but certainly could be expanded upon to achieve the same objectives in other regions and at the global level.

10.2 Transition Management Steps

As emphasized in Chapter 9, TM is an evolving practice. Experience to date has generated an appropriately flexible and multi-stakeholder, multi-disciplinary approach for planning and managing the transition process. There are obviously many ways to manage a complex process, but the TM process pays particular attention to the actions, actors and networks working within and across the transition levels- niche, regime and landscape. This is well suited to the adaptability that will be required to adjust to the complexities, uncertainties and timeframes required for the proposed low carbon CP development transformation proposed herein. The approach is applicable at and across different levels, whether a community, city, country, region, or global level, or whether the transition lens is a development sector or crosscutting issue such as climate change and/or CP.

Loorbach et al (2015) summarized the key elements of the transition management process, emphasizing the need for developing new transition networks that share broad goals and play mutually supporting roles in meeting the transition objective. In general, the transition management approach relies on a transition team, including representatives of key stakeholders from both the public and private sectors, and supporting experts in the particular challenge area such as the target sector, as well as transition management experts. The transition team would be responsible for the initial analytical work required to scope the challenge and options, identify key stakeholders, and assess governance and other higher-level issues. Based upon such analyses and consultation with key stakeholders, the transition team frames the dimensions and phases of the transition management process.

The transition team will frame the vision and objective, the transition pathways, phased actions, and monitoring and evaluation requirements. The framing of the challenge will result in problem structuring and establishment of transition “arenas”. A transition arena is essentially a network of actors working together to work through an element of the transition challenge relevant to those actors to establish objectives/goals. Transition arenas will develop strategies for addressing barriers to and drivers for reaching those objectives. The outcomes of transition arenas will be an improved understanding of the perspectives, assumptions and ambitions of different stakeholders, which in turn will help clarify the necessity of the transitions and the challenges posed. The key outcome is a new, shared perspective of the transition and definition and set of guiding principles to drive the transition.

The transition team, working through the networks represented in the transition arenas, will generate an integrated systems analysis, which will clarify the complexities of the system and subsystems, the dominant causal relations, feedback loops and structural weaknesses. The systems analysis will facilitate the development of sustainability visions, pathways and a transition agenda, which, in turn, will guide the subsequent policy reform, programming and planning for both short-term and long-term actions.

The need for broad stakeholder engagement in agreeing on such vision, as opposed to a governmental directive, is essential since it is the nongovernmental stakeholders that will largely drive the implementation of the transition vision. The transition team can translate the long-term vision into a series of shorter-term objectives, and related actions, recognizing that over time it will be necessary to adapt to lessons learned, changes in objectives and outlooks, and the degree of realization of successful impacts.

The next step in the process is the planning and implementation of transition experiments. These are intentionally high-risk initiatives designed to generate lessons that may contribute to the transition goals (in this case low carbon CP transformation). The lessons will help to drive and/or to refine the transition approaches. Transition experiments are likely to be required at each level- landscape, regime, and niche- but they should be designed to reinforce each other and facilitate the measurement of progress in meeting the transition objectives.

Monitoring and evaluation of the transition process is an essential element. It should be designed so that there is continuous feedback from the actions being taken to meet the transition objectives, including the high-risk transition experiments, but also to determine the progress of the transition process itself and to make corrections in the process or policies so as to steer the process in the ‘right’ direction.

10.3 A Transformation Framework for Low Carbon CP Development

Building on the analysis of the gaps and opportunities for achieving large-scale benefits by integrating climate and CP action reviewed in Chapter 9, a transformation framework for a three-tiered global initiative was proposed. The low carbon CP transformation was proposed to include actions by lead stakeholders and participating stakeholders at the (i) international level, (ii) the country level, and (iii) the city/local level. The transformation framework should build on a combination of international negotiations and support from the international community to facilitate scaling-up of low carbon CP development in developing countries. While the framework was based on the experiences and needs in Asian developing countries as described in this thesis, it is the view of this thesis author that the proposed international actions could support any developing country, particularly those that are experiencing rapid growth of their carbon and ecological footprint as a result of industrial and urban development. In fact, as the differences between developing and developed countries become more and more blurred with regards to delivering global public goods (Davies, 2014), the framework proposed herein might be effectively implemented across regions in developed as well as developing countries.

10.3.1 International Framework Agreement

At the international level, the Secretariat of the UNFCCC and the Secretariat for the SDGs, and in particular the numerous UN and other international agencies charged with supporting the SDGs relating to CP, would be charged with the responsibility to co-design and implement a joint agreement and work program in consultation with all of the appropriate stakeholders. The first task is to analyze how the climate change and SDG and international CP agreements could be integrated to achieve synergies. This recognizes that the climate negotiations and elements of the international agreements on climate change have a much longer history and are much more detailed than the new SDG relating to CP. It also recognizes that both of these international agreements are, and will continue to be in a state of negotiation and revision. However, it should be possible for the secretariats of the two international agreements to prepare a joint proposal for their respective governing bodies and to seek endorsement for the principles and business plans through which the best potential synergies could be built upon for the benefit of all parties.

Some of the key issues that would need to be addressed in the resulting international policy integration would be the challenges of market failures and resource pricing, in particular for carbon, water, and other internationally shared resources. The joint agreement would also set forth principles for linking international climate finance to CP actions as discussed in Chapter 9. The principal would be based on the responsibility of a recipient of climate finance intended for supporting a shift to low carbon technologies and actions to concurrently reduce wastes, increase efficiency of resource use, minimize exposure to toxic materials, and optimize recycling and reuse. It is recognized that the requirements for setting conditionality on use of climate finance beyond agreed climate actions is a sovereign decision that each of the participating countries will have to take. In the near-term, it is unlikely that the climate finance established under the UNFCCC, such as the Green Climate Fund, would be able to establish such conditionalities. However, access to the large volume of public sector climate finance provided by bilateral donor countries and philanthropic organizations could include such conditionalities.

The joint international agreement would need to be developed with a clear, long-term strategy for financial and technical assistance to developing countries. The need for financial and technical support for investments is reasonably obvious and a tremendous amount of experience has already been gained on establishing financial mechanisms with international donor support for both low carbon development and CP investments.

It is equally important that the international joint agreement must provide sufficient attention to the importance of critically needed technical assistance in many developing countries to help them build the necessary capacity to actualize the types of actions described in Section 10.3.2. The difficulty in shifting policy, planning including prioritization of investments, implementation, and monitoring should not be underestimated, particularly with the added complexity of shifting to an integrated CP/CC policy framework. This transition will require considerable investments in institutional capacity at the country as well as at local levels.[14]

[14] A good example of an international assistance program designed to help developing countries in transitioning to new approaches for development decision-making and detailed planning and implementation is the Climate Investment Funds (CIF) Pilot Program for Climate Resilience. (CIF 2008) A similar program could be piloted in a number of Asian developing countries to assist them to initiate the national actions for a low carbon CP transition and build the capacity to implement the

The international community, perhaps led by the multilateral development banks (MDBs), will need to develop innovative financial mechanisms that can generate significant funding at the global or regional scale, above commitments for climate finance from the UNFCCC. As noted in Chapter 9, most of the financial innovation and mobilization will be at the country-level since domestic finance will be the key source of funding for the transformation. However, at the international level there are a number of mechanisms that could be explored using public sector climate finance to leverage private sector resources, by buffering risks and adding financial security, at a much larger scale than is possible at the country-level. This could be achieved by taking a multi-country risk-sharing approach as opposed to a single country approach and relying on highly experienced and highly rated financial institutions such as the Asian Development Bank or World Bank to mobilize and manage such funds.

Finally, the joint international agreement between the climate and SDGs parties should set the stage for the kinds of partnerships and supporting networks that will be required to facilitate, and in some cases drive the transformation. It will not be necessary to reinvent the wheel in this regard. There are a number of major partnerships already established for promoting climate action that could be drawn upon to integrate the objectives of CP, and modify their supporting roles to facilitate low carbon CP development instead of “just” low carbon development. Two good examples of CCI-like partnership that could readily re-engineer itself to focus on low carbon CP development in cities are the C-40 and the Rockefeller-led 100 Resilient Cities initiative. There are several other large international partnerships and programs that could play major facilitating and leadership roles and could also serve as models for other types of initiatives.

10.3.2 National Framework

The majority of actions required to fill the gaps identified in Chapter 9 for achieving transformative changes by realizing large-scale adoption of low carbon CP development is at the national-level in the Asian developing countries. It is only at the national-level that the policy integration described in Section 9.5 can be effectively achieved. The process of national policy integration for climate mitigation and CP will need to have, as an objective, the successful mobilization of the drivers essential to support action at the city and/or local level. These policies would enable planning, regulatory, and financing by city and local leadership to implement low carbon CP development plans tailored to the local conditions. National political leadership and intergovernmental ownership (economic planning; finance; industry, energy, and urban sectors; environment and other ministries) will be required to address subsidy reforms and pricing, as well as formulate time bound action plans for reducing GHG emissions in line with NDCs and measurable objectives of CP.

It will be at the national level that decisions will be needed on conditionalities for access to climate finance, initiatives taken for financial innovation, and enabling actions for facilitating mobilization of domestic resources. At the national level, it will be necessary to consider the linkages of various networks already in place for

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transition, as well is to demonstrate to other developing countries how such a transition can be undertaken and what the costs and benefits and risks are of such an undertaking.

supporting low carbon CP development and guidance provided on how to link networks at the national and local levels.

A key decision at the national level will be how to establish the kinds of partnership(s) among various stakeholders required to drive the transition at the national, subnational, and local levels. In order to do this, it will be important to have a backbone organization responsible for managing and monitoring the national action set out in the national strategy for low-carbon CP development. Several Asian countries already have such backbone organizations established to support their national climate actions. It is likely that these organizations could be strengthened to serve a broader low carbon CP objective.

10.3.3 City/Local Level Actions

At the city/local level the key is to integrate the types of actions that are taken by local government in support of national policies relating to urban and industrial development. Local governments will need to explore how to transition current development approaches so that the low carbon CP objectives can be achieved. This will, in many cases, require revisions in strategies, plans, and financing for local development. Such change is achievable if the local visionaries provide the essential leadership and local stakeholders and networks take ownership and effectively participate (Olazabal and Pascual, 2015).

The local government will need to establish clear targets for GHG reductions as their contribution to national NDCs or similar commitments and to scaling-up CP measured as waste reductions, efficiency gains, or other locally relevant environmental or CP objectives. In many cases the experiences and networks for CP are in place at the subnational or city level through industrial associations, technology centers, academic and research institutions. Many Asian cities already have established or are developing CBO/CSO led programs to improve the sustainability of urban and industrial development. Similar local-based networks for low carbon development are fewer in number and experience. Thus, in the case of local government and industry, it is likely that the backbone for action might be through strengthened CP/sustainability networks.

Two key challenges at the city/local-level continues to be the need for improved enforcement of environmental regulations and the need for access to financing for CP. Local governments and financial institutions will need to work through the national level mechanisms to improve both of these areas in order to set the stage for scaling-up action by having the necessary incentives and disincentives at the local-level.

It is also at the local-level that special initiatives for SMEs will be needed- in most Asian countries the national GHG reduction and environmental improvement goals cannot be met without mainstream participation of SMEs in meeting the goals. Targeted awareness raising, financing mechanisms and technology deployment are essential to enable SMEs to take advantage of both low carbon and other CP benefits.

10.4 Conclusions and Next Steps

Large-scale actions on CP and climate change (CC) should be mutually reinforcing. But there is a general lack of policy coherence at the international and national levels, which is required to stimulate and maintain such mutual reinforcement. Figure 10.1 summarizes this challenge.

This thesis author is confident that the national and local actions outlined in this Chapter are highly achievable. Asian developing countries have individually and collectively taken a leadership role at all levels in pursuing sustainability, often with international support but, when such support or collaboration was not forthcoming, they have acted anyway in spite of barriers and risks. Substantial achievements have been made through CP initiatives in many countries, overcoming many barriers that are common to low carbon development challenges. But funding for CP remains a challenge- and is likely to continue to be the poor side of the sustainable development equation as climate finance is ramped up.

The framework for managing transitions described above is clearly relevant for the major industrializing developing countries in Asia. For example, in China the CP law, new environmental law, climate change regulations and the new commitments by China for GHG reductions as outlined in China's INDC are poorly linked. Integration of these national policies could dramatically improve the efficiency and effectiveness of national planning, regulating, and financing for improving local environmental quality and resource intensity as well as generating global benefits through GHG reductions. The new carbon market being implemented in China in the next two years could play an instrumental role in demonstrating how to establish conditionalities whereby, manufacturing firms or cities that receive payment for reducing GHG emissions might be paid a premium for verifiable CP actions in addition to GHG reductions. The research proposed in the following paragraphs would further delineate the policy and program integration potentials, costs and benefits needed to support governments like China to integrate national and local low carbon and CP actions. It would also facilitate the broader partnership for transformation.

The ability of the international community to recognize the importance of tackling sustainability problems in tandem has been demonstrated by the recent agreement on the SDGs. The UNFCCC and other relevant organizations coming together to effectively integrate and build synergies should be an achievable next step.

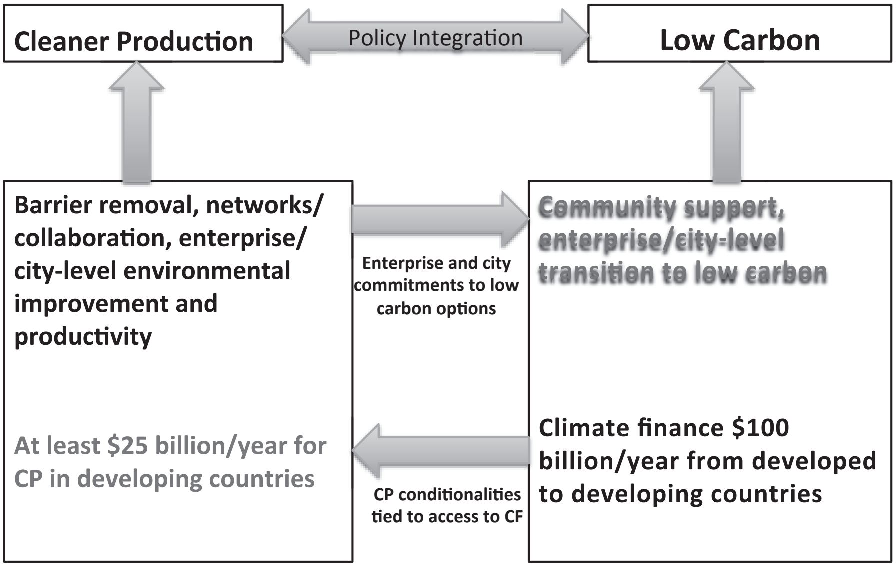

Figure 10.1: Cleaner Production And Low Carbon Development Policies Should Be Integrated Resulting In Mutual Technical And Financial Support Mechanisms

10.4.1 Getting Started

Every journey starts with the first step. The transformational journey proposed herein will probably require a number of first steps by a number of like-minded early movers.

The first action is to agree that an international effort to integrate low carbon and CP is needed. Once a core group of parties is in agreement, the next step is to engage a broader set of key stakeholders and engage in a series of discussions on how to achieve this. The UN system might take the lead but this thesis author's experience is that leadership by a nimble development partner might be a more efficient and effective way to start this journey.

If the initial objective is to support low carbon CP in Asian developing countries, it may be easier to initiate action than if a global approach is taken. At the regional level there are a number of ongoing discussions among developing countries and development assistance institutions like the Asian Development Bank and the World Bank about how these countries and institutions existing development partnerships might support the implementation of NDCs. The ADB or the World Bank could refine the country and regional dialog to broaden the discussion to integrated NDCs and CP-relevant SDGs.

Most international assistance organizations are revisiting their respective climate strategies and action plans in light of the 2015 Paris Agreement. Thus the timing is also opportune to influence their respective approaches to integrating climate and SDG support. If either ADB or World Bank, as multilateral development financing institutions, take such a leadership role, they may influence the directions of other international and bilateral assistance programs to be more holistic with long-term transformational objectives and stimulate the participation of the broader range of international stakeholders from the UN, governments, private sector, CSO's, and philanthropies to discuss how a transformative regional low carbon CP development partnership might evolve.

The second step would be for the initial partners to agree on a lead institution and governance arrangements. The lead institution would establish and mobilize a core transition management team as discussed in section 10.2.

The core transition management team would lead subsequent steps including the dialogue in participating developing countries for setting up national transition management teams to undertake the tasks discussed in section 10.3, at the national and urban levels. The core transition management team would have a broad range of responsibilities in accordance with the agreed partnership governance structure. A priority task would be to establish a systematic process for capturing lessons and converting them to knowledge products that are effectively shared among partners and other stakeholders to facilitate and guide periodic reorientation of the transition process as needed.

10.4.2 Research Required to Support Next Steps

Two major research initiatives would support the construction and implementation of a regional framework partnership for low carbon CP.

10.4.2.1 A Climate Change and SDG Collective Impact Research Initiative

The first research initiative proposed is to engage with the secretariats of the UNFCCC and the SDGs to prepare an analysis and proposal for forming a collective impact initiative partnership to plan and operationalize integration of the UNFCCC Paris Agreement and CP-related elements of the SDGs. The proposal would identify potential leadership and membership/stakeholders, specify objectives and desired outcomes from the integration, and present a strategic plan for its implementation with a targeted timeframe of 2020-2030. Such a proposal could play an instrumental role in bringing these parallel initiatives onto a single track and thereby shaping their future directions and impact. The research could indirectly serve to further the operationalization of the TM approach by applying its concepts including the transition management steps outlined in section 10.2.

10.4.2.2 National Low Carbon and CP Policy Integration

The second major area of research required relates to national low carbon and CP policy integration. The lack of policy integration described in section 10.4 for China is representative of all of the Asian developing countries. The main difference is that China has embedded more of it development objectives such as CP and low carbon development in law as compared to other countries that embed the same objectives in development policy and plans. But the lack of policy integration is consistent across the countries.

Similarly, countries have different levels of detailed policies and plans for taking low carbon action as compared to CP. Climate actions tend to be better delineated than CP. Nevertheless, while all of the industrializing Asian developing countries have submitted INDCs, understanding what “intentions” mean is difficult at best. The INDCs in principle should help an Asian developing country set priorities for investments including those which will be funded through domestic resources and those which may require external financial and technical support, whether through formal climate finance mechanisms or other development assistance mechanisms. The INDCs in principle should also help donor governments and other potential development partners for Asian developing countries to identify investment streams, programs, sectors, geographies, or projects that they consider most appropriate for use of their resources. The same holds true for guiding decision-making by governing bodies of institutions such as the Green Climate Fund and the Asian Development Bank for supporting climate action in developing countries.

However, there are a number of challenges facing Asian developing countries and those countries and institutions which intend to assist them in meeting their climate objectives. A fundamental challenge is understanding exactly (or approximately) what is “intended” by a given country. Most INDCs lack clarity in terms of (i) country priorities for domestically financed action as opposed to actions which will only be taken if external support is provided, and (ii) lack of consistency among the parties in the way they have described the actions that will be taken by them in terms of the scope of activities, timelines etc., even to the extent of understanding the prioritization of adaptation versus mitigation measures at the country-level. This lack of clarity not only makes it difficult to adopt effective strategy for domestic and international action in support of implementing INDC's but will make it very difficult to monitor/measure the actions and their benefits and compare those actions and benefits across countries in order to optimize the lessons learned from such actions and verify and certify the actions at the country-level.

Research is required to help each Asian developing country government clarify intentions and plans, and improve methodologies for reporting/measuring the intentions, and thereby better understand the external support needed to translate an INDC into a climate action plan. A key issue regarding greater clarity is the breakdown between government’s intentions for domestic financing versus donor financed or externally financed initiatives, including the linkage/reliance on external financing to mobilize domestic resources. The research should also look at the institutional capacity and regulatory framework at country-level to determine the extent to which the actions included in the INDC will generate co-benefits relating to the SDG's. Once the research clarifies a country’s intentions and priorities for low carbon development, a review of the relevant policy framework for CP would be undertaken to establish linkages, duplications and gaps. This will enable the researcher to propose specific country-level policy integration and related institutional, regulatory, and financing actions for implementing the integrated policies.

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APPENDIX 1: SAMUT PRAKARN, THAILAND CP SURVEY

Introduction to the Cleaner Production Survey and Program in Samut Prakarn

(These are the introductory comments which may be used by the survey team at the beginning of a survey session with a factory owner or manager.)

"The Pollution Control Department (PCD) and Provincial Government of Samut Prakarn have undertaken a program to improve the environmental quality of Samut Prakarn. This program includes a very large investment in centralized wastewater collection and treatment facilities for which construction will begin very soon.

One of the primary objectives of the overall environmental improvement program is to minimize the environmental degradation caused by the industrial development in Samut Prakarn. Therefore, the Government, with Asian Development Bank support, is undertaking a program, in parallel with the construction of the centralized waste water facilities, to reduce pollution from factories by improving efficiency of production processes and housekeeping in factories. Such pollution prevention measures will minimize wastes generated and thereby reduce the cost of treating wastes. In many factories the measures will also result in greater production efficiency and thereby increase profitability. Similarly, the pollution prevention measures will help some factories to meet requirements for ISO 9000 and ISO 14000 which will enlarge the potential export market. This component of the Samut Prakarn Wastewater Management Project is called the **Samut Prakarn Cleaner Production Program**. A budget of about 250 million baht has been approved to design and initiate the Program during the next two years.

The purpose of our survey is to collect information from you which will help us to design the Samut Prakarn Cleaner Production Program in order to best suit your needs. We feel that the Program must be a cooperative effort between industries, Government, and nongovernment organizations. If the Cleaner Production Program is properly designed and cooperation is available, many of the factories in Samut Prakarn will not only be able to reduce the pollution that they are currently discharging to the environment but also improve the quality of their production while saving money.

We appreciate your cooperation in undertaking this survey and we seek your continued cooperation and participation in the Samut Prakarn Cleaner Production Program. **We assure you that the information you provide will be treated confidentially and for the purpose given above.** You may be interested to know that about 100 factories will be interviewed using the same questionnaire which we are using today. "

(Initiate questionnaire, first explaining that Part A is to be filled out by the factory and returned by fax to PCD, and that if there are any questions on the Part A of the survey, the Manager can call 619-2215 for clarification.)

Instructions to Numerators for Cleaner Production Program Survey in Samut Prakarn

1. Read the attached objectives of the survey.

2. The attached introduction to the survey may be used for giving the background on the objectives of the survey in relation to the overall environmental program in Samut Prakarn.

3. The first page of the Questionnaire has a section on sources of data. This section is very important because the results will provide us an indication of the numerators' assessment of the interviewee's attitude and willingness to participate in the Cleaner Production Program. Personal information on age, income, children, and education, is important since these personal attributes to a large extent determine the individual's attitude on environment. Therefore the numerators are requested to take careful notes and try to extend the discussion with regard to any questions or any other comments of the interviewee regarding the Cleaner Production Program.

4. Part A of the survey should be given to the factory manager for completion and the factory manager should be requested to fax the completed Part A within about three days to PCD (fax number 619-2216). The factory manager should also be informed that if there are any questions on the survey, they should call 619-2215 for clarification.

5. Explain that the last series of questions on Part A, starting with question #27, should be answered by the factory owner or managing director.

6. As indicated in the objectives of the survey, it will be necessary for the surveyor to be adaptive while asking questions in Part B. Some of the following may be taken into consideration during the survey.

   (a) It is important to assess the attitude of the factory manager/owner or whoever is being interviewed, as this will affect the responses to the survey questions. As noted at the top of the questionnaire you should try to determine the age, education and type of education (e.g., engineer, economist, or business), income level, and whether the person has children (this sometimes influences attitude about environment), whether the person is concerned about the villagers or inhabitants of the area around their factory, and finally whether the person has a real concern about improving the environment.)

   (b) When asking any of the questions on a yes/no, try to get clarifications as deemed appropriate. For example, often the answers is not a clear yes/no but somewhere in between, therefore it is important to take careful notes of the responses of the interviewee and to try and draw out additional information or clarifications (remember if you are not clear on the response, then it will not be possible to use the response in the evaluation of the survey results.

   (c) Several of the questions are intended to give financial willingness-to-pay indications and refer to investment costs, fines and other financial disincentives, costs of services for qualifying for ISO 9000 and 14000, costs to upgrade wastewater treatment, etc. When asking these questions, the numerator should not be constrained by the numbers/amounts in the questionnaire. The purpose is to narrow down the amount considered to be reasonable by the interviewee. For example, on question #52, if the interviewee states that the factory would be willing to pay over B500,000 for assistance, then, rather than ask whether the factory would be willing to pay B300,000 or B100,000 as indicated in the questionnaire (which it obviously would if already indicated willingness to pay 500,000 baht), the interviewer should increase the amount- say to 1,000,000 baht. If the answer to 1,000,000 is no, then try 800,000, etc. until the interviewee gives another "yes" answer. The objective is to try and determine what the factory owner/manager is willing to pay. The questions in this regard are only guidelines and the numerators should use their own initiatives to try and determine the amount which the factory owner is willing to pay. Similarly, if the question has an amount to which the interviewee is not willing to pay, then go to a lower amount even it is not on the survey. It is also acceptable and important to be adaptive in trying to draw out what conditions the factory owners consider important in order to be willing to make investments in Cleaner Production. Therefore, if a specific question is needed to clarify such conditions or pre-conditions, then the interviewer should ask such question even if it is not on the questionnaire. We will later use such experiences to refine the questionnaire for future uses.

Objective and Scope of Cleaner Production Program Survey in Samut Prakarn

The objective of the Cleaner Production Program survey in Samut Prakarn is to determine the most important factors or conditions which must be met in order to facilitate participation of factories, particularly small- and medium-sized factories in the Thai Government's Cleaner Production Program which is being designed under the Samut Prakarn Wastewater Management Project.

The initial survey will cover 100 factories which have been pre-selected on the basis of an earlier survey which was undertaken in 1994-1995 for purposes of planning the Samut Prakarn Wastewater Management Project. These factories cover a range of small, medium and large-scale factories and a diversity of types of factories.

The survey is in two Parts. Part A presents questions regarding the factory operations and wastes generated. Part A will be left with the factory manager by the survey team to be completed and returned by the factory management to the surveyors within a short period of time. The factory managers will be informed that they may contact a telephone number to ask questions regarding the survey if necessary.

Part A of the survey will generate data which may be compared with the data collected in 1994-1995 which may indicate to a certain degree changes in attitude since 1995, changes in costs of wastewater treatment, and changes in enforcement of pollution control regulations. In some cases, it may be a check on the validity on the responses of the factory respondent. Part B of the survey will be carried out by a survey team in Thai language. The interviewee will preferably be the factory owner or factory manager, but if necessary a lower level manager may be interviewed.

Part B of the survey is designed to generate data which can be evaluated following a contingent valuation method (CVM). The CVM has been refined for use in developing countries to assess willingness to pay for water supply and wastewater services. Following evaluation of alternative survey techniques, it was determined that the CVM willingness to pay survey methodology may be the most effective in determining which factors are most important in influencing the cooperation, participation and investment of factory owners in cleaner production. The decision of how to invest limited Government funds in promoting cleaner production will, in part, be based on the evaluation of which factors or pre-conditions are most critical for securing the participation of the factory owners. In general, it is believed that the primary factors are disincentives such as enforcement of pollution control regulations, higher taxes on polluting processes vs. cleaner production processes, higher water tariffs and solid waste disposal fees, stringent hazardous waste regulations, and public pressure; and incentives such as tax breaks for cleaner production equipment, water tariff structures which reward conservation, public recognition for environmental consciousness, technical assistance, and training. The effectiveness and efficiency of a Cleaner Production Program will be a function of these factors. The survey should determine which factors have highest priority and therefore should be given greatest emphasis in the implementation of the Cleaner Production Program. Based on the determination of the relative importance of the different factors, it will then be possible to assess the cost/benefit of investments in each factor. On the basis of cost/benefit analysis, it will then be possible to determine how, and how much, investment should be made by the Government in the Cleaner Production Program.

Cleaner Production Survey in Samut Prakarn

Unit of Analysis: Factories in the Samut Prakarn Wastewater Management Project Area

Sources of Data: Factory Owner; General Manager; Production Manager; other_______
(age_____; education_______; expertise__________; how long in position _________; income (baht/month) ________; decision-making authority_________; number and approximate ages of children___________)

Questionnaire Form

Sheet No. _____

Amphoe	( )	Muang	( )	Prapradaeng
	( )	Bang Pli	( )	King Prasamutjedi
	( )	Other		

Tambon ____
Municipality ____
Sanitary District ____
Name of Factory ____
Address ____
Tel. ____________________ Fax ______________

Thank you for agreeing to this interview, Mr. ____________________. You may recall or be aware that your factory was one of about 100 factories which were surveyed in early 1995 in the planning study for the Samut Prakarn Wastewater Management Project for which construction is about to start. During the 1995 survey, a considerable amount of helpful information was provided to the Pollution Control Department (PCD) study team, and this was taken into consideration in developing the project plan. One of the aspects which was touched upon during the survey in 1995 was the potential for improvement of housekeeping and/or changes in industrial processes in order to reduce the level of pollution generated in your factory and reduce the cost of both raw materials a well as treatment of wastes.

The purpose of this current survey is to follow-up on that issue, which is called Cleaner Production or Industrial Pollution Prevention. The PCD is undertaking a project to assist factories that are interested in participating in a cleaner production program and this survey which we are undertaking now will help design that program. It is important that we update the information which was provided in 1995 with regards to your overall factory operations. This **Production and Waste Generation Information** is contained in **Part A of the Survey Questionnaire**. Please **Fill In Part A** and fax it to the Project office at 619-2216. If you have any questions please call us at 619-2215.

Part B of the questionnaire is intended to collect specific information required on the **potential for your factory to participate in the Cleaner Production Program**. We thank you very much for the opportunity to discuss this with you. Confidentiality of the information provided is assured.

PART A- Production and Waste Generation Information
(to be left with the factory manager for completion and faxed to PCD [fax number 619-2216]. If there are any questions regarding PART A of the survey, please 619-2215.)

7. What is your source of water? ( ) Metropolitan Waterworks Authority
( ) groundwater

8. What is your average monthly water bill or cost?
MWA bill- _______________ Baht/month
Groundwater capital costs and frequency of drilling new wells _________ Baht
Groundwater O&M costs
Power _________________ Baht/month
Materials _________________ Baht/month
Services _________________ Baht/month
Maintenance _________________ Baht/month
Other costs _________________ Baht/month (specify ___________)

9. What category of waste (liquid or solid) is discharged from the factory?

( ) wastewater ( ) solid waste
( ) both ( ) no waste
( ) other (specify ______________________________________)

10. What is the volume of water used and wastewater discharged? __________ cubic meter/day

11. Do you have a wastewater treatment system? ( ) yes ( ) no
If yes, what type? ____
How long has it been operating? _____________ years/months

12. Do you consider that your treatment system has led to any improvement in water quality in the surrounding klongs?
( ) yes (specify in what way you think it has improved____________)
( ) no (specify why not ____________________)

13. What is the land area and capital cost of the treatment system used?
Area of land used __________ sq wa (1 sq wa = 4 sq meters)
Land value (at present) _________ Baht/sq wa
Capital cost (civil works + plant) __________________ Baht

14. What are the O&M costs of the treatment system and number of staff employed to operate the system?
Power _________________ Baht/month
Materials _________________ Baht/month
Services _________________ Baht/month
Wages _________________ Baht/month
Maintenance _________________ Baht/month
Other costs _________________ Baht/month (specify ___________)

No. of staff employed __________

15. What is the total capital investment of the factory? _________________Baht

16. What is the total annual expenditure of the factory? ____________ Baht/year

17. What is the total annual production cost at the factory? __________ Baht/year

18. Do you have by-products and/or benefits from the wastewater treatment system?
    ( ) no ( ) yes
    If yes, specify ( ) recycled water (__________ cubic meter/year)
    ( ) reused materials (_________ Baht/year)
    ( ) other (specify __________/_________ Baht/year)

19. How do you rate the efficiency of your wastewater treatment system?
    ( ) high ( ) low ( ) other (specify _______________)
    On what basis do you make this judgment?
    ( ) passes Government inspection
    ( ) meets effluent criteria for BOD
    ( ) meets other effluent standards
    ( ) is easy and inexpensive to operate
    ( ) enables recycling/reuse of wastewater

20. What percentage of your wastewater is treated? __________%

21. What is/are the main operational problems with your wastewater treatment system?
    ( ) hydraulic overloading ( ) biological/chemical overloading
    ( ) low efficiency ( ) high operating cost
    ( ) inappropriate design ( ) high maintenance cost
    ( ) no problems ( ) other (specify _____________)

22. Do you have any proposed plan or projects for upgrading or construction of a better wastewater treatment system? ( ) yes ( ) no

23. If yes, what type(s) of system(s) are proposed? ____________________________
    Does the factory have sufficient land for new or expanded treatment facilities?
    ( ) yes ( ) no

24. If you were required to replace the treatment plant, what do you estimate the cost would be? _____________________Baht

25. What type of solid waste does your factory generate?
    ( ) Non-hazardous solid waste ____________ kg/month
    ( ) Hazardous waste ____________ kg/month
    ( ) Other (specify ____)

26. What are the toxic or hazardous waste characteristics?
    ____
    ____
    ____

27. What treatment methods are used for solid waste and what is the cost of this treatment?

Methods____

Cost ________________ Baht/year

28. Do you recycle/reuse solid wastes? ( ) yes ( ) no

If yes, what and how much solid waste is recovered, how is it used, and what is your estimated cost savings? ____

If no, are there potentials for recovery/reuse? ( ) yes ( ) no

and, if there is potential, why don't you recycle/reuse solid wastes?

____

29. How do your currently handle hazardous waste?

( ) no hazardous waste generated

( ) no specific management

( ) management system (specify __________________________________)

30. Do you have any problems with your hazardous waste treatment and management system? ( ) no ( ) yes (specify_________________________________)

31. Do you recycle any waste products for use in your factory? ( ) no ( ) yes

( ) water; description of use and quantity________________________

____

( ) non-hazardous solid waste; description of use and quantity

____

( ) hazardous waste; description of use and quantity ______________

____

32. Do you sale any of your waste by-products? ( ) no ( ) yes

( ) water; description of use and buyer________________________

____

( ) non-hazardous solid waste; description of use and buyer

____

( ) hazardous waste; description of use and buyer ______________

____

<u>The following questions should be filled out by the FACTORY OWNER or MANAGING DIRECTOR</u>**-** Please circle one answer where **#1** means **Strongly Agree** and **#9** means **Strongly Disagree**.

33. A factory should invest in cleaner production facilities if it is demonstrated that the capital investment will generate improved production efficiency and higher profits overtime.

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

34. A factory should invest in cleaner production processes regardless of the benefits because it is in the interest of the public environmental health and future generations' welfare.

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

35. In order to stimulate investment in cleaner production processes in factories, the Government should:

(i) stringently enforce environmental pollution control regulations

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

(ii) increase the amount of fines and severity of penalties for factories which do not meet pollution control regulations

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

(iii) provide tax or duty incentives to reduce the cost of investment in cleaner production

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

(iv) provide income tax breaks for factories which shift from polluting processes to cleaner production processes

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

(v) increase income tax levied on factories which do not shift from polluting processes to cleaner production processes

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

(vi) provide an investment facility for enabling financing of capital costs of cleaner production processes

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

(vii) provide technical assistance and training for factory owners interested in shifting from polluting processes to cleaner production processes

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

36. If the cost of water supply increases to B20 per cubic meter, it will significantly affect my factory profit.

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

37. If the Government charges a wastewater discharge fee at approximately B10 per cubic meter, it will significantly affect my profit.

1 2 3 4 5 6 7 8
9

Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

38. When the Government requires my factory to meet wastewater effluent standards for the Samut Prakarn Wastewater Treatment Plant, I will upgrade or replace my wastewater treatment facilities.

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

39. It is more feasible for my factory to upgrade the wastewater treatment plant than to shift to cleaner production processes to reduce pollution.

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

40. I should upgrade my wastewater treatment plant to meet industrial effluent standards in order to avoid prosecution of the Government.

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

41. I should upgrade my wastewater treatment plant in order to reduce pollution in the surrounding areas and thereby improve the environment for my neighbors and future populations.

1 2 3 4 5 6 7 8
9
Strongly Agree Undecided Disagree
Strongly
Agree
Disagree

PART B- Cleaner Production Program

42. You may be aware that the price of water is likely to be increased in the near future, and that wastewater charges will also be implemented as part of the Samut Prakarn

project. How much do you pay for your water supply now and what is your expectation for increased costs?

____
____
____

How much do you pay for your waste treatment now and what is your expectation for increased costs?

____
__

43. Have you received any complaints from villagers about pollution?
( ) no ( ) yes (specify
__________________________________)

44. Are your treatment system(s) (for wastewater, solid waste and/or hazardous waste) inspected by government officials?
( ) no
( ) yes (specify whether: wastewater/solid waste/hazardous waste)
If yes, how frequent are the inspections: ( ) monthly
( ) annual
( ) others (specify
__________)

45. What have been the results of previous inspections?
( ) satisfactory treatment provided
( ) unsatisfactory treatment

How would you describe previous inspections? ( ) strict
( ) helpful
( ) uncertain

46. Do you experience any impediments to cooperation between your factory and official agencies?
( ) no ( ) yes
If yes, specify ( ) rules and regulations
( ) unclear policy
( ) official attitude
( ) other (specify
__________________________________)

47. Do you have any problems with enforcement of rules and regulations on operation of your waste treatment system(s)? ( ) yes ( ) no

48. Has your company ever been fined for not meeting pollution control standards? ( ) no
( ) yes how many times? _______________ how much? _____________ baht
As you know, the current fine for violation of effluent standards is __________ baht.
If the fine is increased to 100,000 baht/day would you invest in cleaner production measures? ( ) yes ( ) no;
or upgrading your treatment plant? ( ) yes ( ) no

49. Are you a member of an industry club? ( ) yes ( ) no

If yes, are you an active member and how frequently do you meet? ________________

Which club is it and what benefits are most important to you? ____

50. Has there ever been assistance offered to you for pollution prevention or cleaner production from your industry club?

( ) yes ( ) no

Have you found out about any such programs through your industry clubs?

( ) yes ( ) no

51. Have you ever received assistance or offer of assistance for pollution prevention from the Government or other non-governmental organizations?

( ) yes ( ) no

Which ones? ____

When?____

Did you accept such assistance and if so, in what form was this assistance provided?

( ) yes ( ) no

52. Have you ever undertaken an evaluation of how pollution prevention may assist you to reduce raw material or water cost and pollution control cost?

( ) yes ( ) no

If yes, please describe how you think this may be of assistance or describe what action has been taken to implement such cleaner production.

____

____

53. If you have already implemented cleaner production measures, would you be willing to allow and assist in preparing a case study of your experience as part of an effort to inform other factories of the benefits and costs of Cleaner Production?

( ) yes ( ) no

54. Where are your primary and secondary markets for your products?

____

____

55. Has the consumer or buyer of your product ever visited/inspected your factory?

( ) yes ( ) no

If yes, were they concerned with the environmental conditions in and around the factory? ( ) yes, describe concerns ________________________________

56. Did they recommend any process changes to improve your production process or product?

( ) yes ( ) no

57. In your opinion, what are significant roles of certification programs such as ISO 9000 and ISO 14000 in the promotion of cleaner technologies, cleaner production, and cleaner products?

____

What should be done to assist the leaders of small and medium-sized companies to participate in and benefit from such certification programs?

Who should provide this assistance?

How should it be financed?

58. Have you ever been advised by a client that they expect their producers to meet international standards such as ISO 9000 and 14000? Are you familiar with ISO 9000 and 14000?

( ) yes ( ) no

Do you have the intention of applying to meet the ISO 9000 and 14000 standards?

( ) yes ( ) no

To qualify for ISO 9000 and 14000, do you need outside technical assistance?

( ) yes ( ) no

Will you avail of such assistance if the cost is over 500,000 Baht?

( ) yes ( ) no

Will you avail of such assistance if the cost is over 300,000 Baht?

( ) yes ( ) no

Will you avail of such assistance if the cost is over 100,000 Baht?

( ) yes ( ) no

59. Are you familiar with techniques for improving housekeeping in the factory?

( ) yes ( ) no

Have you employed techniques such as metering and monitoring and training of staff, etc.?

( ) yes ( ) no

If yes, specify the techniques.

If not, what incentive would be required for you to undertake such good housekeeping measures?

60. Are there processes known to you which you could change in your factory which will improve productivity and efficiency? ( ) yes ( ) no

If yes, why haven't you employed such processes?

____

—

61. Is financing a problem for the upgrading of your processes to improve production and at the same time reduce costs for pollution control?

( ) yes ( ) no

62. If a loan was made available to you at market rate with a repayment period of five years, would you be interested in financing the improvement of your system?

( ) yes ( ) no

63. If your water cost and wastewater charges resulted in an increase of 50% over what you are paying now for water, and this cost could be reduced to 25% by employing cleaner production and better housekeeping, would you then avail of such a loan?

( ) yes ( ) no

64. If a loan was made available to you at 1% under market rate and a repayment period of ten years was available, would you then avail of such a loan for upgrading your process? ( ) yes ( ) no

65. If the cost of water and wastewater increases 50% and you could reduce this to 25%, would you then avail of such a loan? ( ) yes ( ) no

66. If training and cleaner production is included in the above packages, would these improve your consideration of making such an investment? ( ) yes ( ) no

67. If the wastewater and water supply cost increased by 100% over what you are paying now, and you could reduce this increase cost to 50% by cleaner production approaches, would you be interested in cleaner production?

( ) yes ( ) no

Would you then be willing to make an investment and would you have the capital to do so? ( ) yes ( ) no

If the capital is not available, would you avail of a loan at market rates?

( ) yes ( ) no

If no, would you avail of a loan at 2% less than market rates with a longer repayment period? ( ) yes ( ) no

68. The Government is expected to stringently enforce the pollution control regulations which may require an upgrade of your waste treatment facilities. It is estimated that such an upgrade could cost over 2 million Baht. If you could avoid such an upgrade by investing four times as much money in a modified production process which will reduce the pollution, improve your product, and you will be able to recover the cost within two years as a result of higher profit, would you be willing to make such an investment?

( ) yes ( ) no

If yes, would you have the capital for such an investment?

( ) yes ( ) no

If no, would you avail of a loan at market rates and repayment conditions?

( ) yes ( ) no

If no, would you avail of a loan at 2% less than market rates?

( ) yes ( ) no

69. If the Government allows a duty/tax reduction on new processing equipment for factories which upgrade processes, in part as a means to achieve cleaner production, will you then invest in the improved process?

( ) yes ( ) no

70. If the Government offers financial incentives such as accelerated depreciation, investment subsidies, tax credits, tax deductions, etc., for investments in technologies, production processes or products which reduce pollution, would this stimulate you to make such investment?

____

____

What would be the most important incentives for you?

____

71. If the Government offers assistance to you in carrying out an audit of your process waste and a feasibility study for employment of cleaner production methods to improve your production as well as reduce your pollution, would you be willing to form a team of your staff to work with the Samut Prakarn Pollution Prevention consultants in carrying out such an audit?

( ) yes ( ) no

If no, if your industry club offered the same, would you then be willing to form such a team?

( ) yes ( ) no

If no, if training was to be provided to the team in conjunction with the preparation of the feasibility study, would you then be willing to form such a team?

( ) yes ( ) no

If no, if the Government stringently enforces the pollution control requirements and you recognized the potential cost savings by employing better housekeeping and cleaner production, would you be willing to hire consultants to undertake a study and audit of your processes and waste flows and prepare feasibility for making improvements for your factory?

( ) yes ( ) no

Would you establish a team of your factory workers to carry out such measures?

( ) yes ( ) no

72. If the buyer of your product indicates that they would expect the factories producing the products that they purchase to improve environmental conditions in and around the factory, would you be willing to hire consultants or avail of Government

assistance in carrying out an audit and prepare a feasibility study for cleaner production in your factory?

( ) yes ( ) no

Would you form a team to work with the consultants in such a study?

( ) yes ( ) no

73. Are you familiar with the use of voluntary agreements between the regulatory authorities and factories which could be used to achieve environmental goals and to encourage development and implementation of cleaner technologies, cleaner production processes and cleaner products with less regulation?

( ) yes ( ) no

Would you be willing to participate in a voluntary agreement program?

( ) yes ( ) no

If no, why not? ______________________________

If yes, could you suggest the best way to initiate such a program (such as through Industrial Works Department Federation of Thai Industries, Board of Trade, etc.)?

____

What organizational representatives should participate in the negotiation of the voluntary agreement?

____

How could compliance by partners best be monitored? By whom?

____

How frequently should compliance be monitored?

____

74. If the Government undertook a program of green labeling which means that companies which demonstrate environmental consciousness are awarded and companies that are not listed could not receive selected Government benefits/promotions, would this be an effective incentive to undertake a feasibility study for cleaner production in your factory?

( ) yes ( ) no

75. Does the Government provide information about cleaner technologies?

( ) yes ( ) no

If so, what mechanisms are used to provide and to disseminate this information? For example, does it use publications, computer data bases, telephone hot lines, videos, workshops, training programs, technical assistance and consultations?

— ______________________________

— ______________________________

Who is responsible for the content and delivery of such information or assistance? Who is responsible for assuring quality and effectivity of the assistance provided?

— ______________________________

— ______________________________

If the Government provides financial support for development and diffusion of cleaner technologies, how should these programs be advertised?

— ______________________________

— ______________________________

Should special attention be paid to assisting small and medium-sized enterprises to receive the information about the programs? How should this be done?

— ______________________________

— ______________________________

What kinds of information should be supplied, e.g., specifications, prices, availability of technologies, list of consultants, etc.?

— ______________________________

— ______________________________

76. Do you have questions regarding cleaner production for your factory which we can forward to Pollution Control Department officials or other experts in order to assist you in obtaining information?

List of Questions and other notes.

APPENDIX 2: PHILIPPINE CP SURVEY

Introduction to the Philippine Cleaner Production Survey and Program

*The Asian Development Bank (ADB) is undertaking the Regional Technical Assistance (RETA) Project to improve the environmental quality of industries in the following countries: Vietnam, Indonesia, Thailand, India and the Philippines.

The primary objectives are to minimize the environmental degradation caused by industries and to reduce pollution from factories by improving efficiency of production processes and housekeeping in factories. Such pollution prevention measures will minimize wastes generated and thereby reduce the cost of treating wastes. In many factories the measures will also result in greater production efficiency and thereby increase profitability. Similarly, the pollution prevention measures will help some factories to meet requirements for ISO 9000 and ISO 14000 which will enlarge the potential export market.

In the Philippines, we are undertaking this Cleaner Production Survey in order to understand the Policies and Practices of companies on why they undertake Cleaner Production programs/projects. The purpose of our survey is to collect information from you which will help us to design Programs which will provide incentives for industries to adapt Cleaner Production processes. We feel that the Program must be a cooperative effort between industries, Government, and non-government organizations. Properly and cooperatively designed, Cleaner Production Programs will allow many factories to reduce the pollution they are currently discharging to the environment, improve the quality of their production and save money.

We appreciate your cooperation in undertaking this survey. **We assure you that the information you provide will be treated confidentially and for the purpose given above.** You may be interested to know that about 100 factories will be interviewed using the same questionnaire which we are using today. "

* These are the introductory comments which may be used by the survey team at the beginning of a survey session with a factory owner or manager.

Instructions to Surveyors for Cleaner Production Program Survey

77. Read the attached <u>objectives</u> of the survey.

78. The attached <u>introduction</u> to the survey may be used for giving the background on the objectives of the survey in relation to the overall ADB RETA Project.

3. It is important that Nos. 1, 2 and 3 be answered so that the company profile can be correlated with the answers to the subsequent questions. If the answer(s) to any of Q1, Q2 or Q3 is not immediately available, the answer(s) can be faxed to us. However<u>, the surveyors must follow-up and ensure that answers are completed.</u>

4. It will be necessary for the surveyor to be adaptive while asking questions. Some of the following may be taken into consideration during the survey.

   (a) It is important to assess the attitude of the factory manager/owner or whoever is being interviewed. You should try to determine the
      1) age,
      2) type of education (e.g., engineer, economist, or business),
      3) whether the person has a real concern about improving the environment.

   (b) When asking any of the questions on a yes/no, try to get clarifications as deemed appropriate. For example, the answer is not a clear yes/no but somewhere in between. Therefore it is important to take careful notes of the responses of the interviewee and to try and draw out additional information or clarifications. (If you are not clear on the response, then it will not be possible to use the response in the evaluation of the survey results.)

   (c) Several of the questions are intended to give financial willingness-to-pay indications and refer to
      1) investment costs,
      2) fines and other financial disincentives,
      3) costs of services for qualifying for ISO 9000 and 14000,
      4) costs to upgrade waste treatment, etc.

   When asking these questions, the numerator should not be constrained by the numbers/amounts in the questionnaire. The purpose is to narrow down the amount considered to be reasonable by the interviewee.. The objective is to try and determine what the factory owner/manager is willing to pay. The questions in this regard are only guidelines and the numerators should use their own initiatives to try and determine the amount which the factory owner is willing to pay.

   Similarly, if the question has an amount to which the interviewee is not willing to pay, then go to a lower amount even it is not on the survey.

   It is important to be adaptive in trying to draw out what conditions the factory owners consider important in order to be willing to make investments in Cleaner Production.

   Therefore, if a specific question is needed to clarify such conditions or pre-conditions, then the interviewer should ask such question even if it is not on the questionnaire. We will later use such experiences to refine the questionnaire for future uses.

Objective and Scope of the Philippine Cleaner Production Program Survey

The objective of the Cleaner Production Program survey is to determine the most important factors or conditions which must be met in order to facilitate participation of factories, particularly large- and medium-sized factories in the Cleaner Production Programs which will be designed under the Philippine component of the ADB Regional Technical Assistance (RETA) Project.

The initial survey will cover 100 factories which have been pre-selected. These factories belong to ten industries and cover a range of medium and large-scale factories.

The survey is designed to generate data which can be evaluated following a contingent valuation method (CVM). The CVM has been refined for use in developing countries to assess willingness to pay for water supply and wastewater services. Following evaluation of alternative survey techniques, it was determined that the CVM willingness to pay survey methodology may be the most effective in determining which factors are most important in influencing the cooperation, participation and investment of factory owners in cleaner production.

The decision of how to invest limited support funds in promoting cleaner production will, in part, be based on the evaluation of which factors or pre-conditions are most critical for securing the participation of the factory owners. In general, it is believed that the primary factors are disincentives such as enforcement of pollution control regulations, higher taxes on polluting processes vs. cleaner production processes, higher water tariffs and solid waste disposal fees, stringent hazardous waste regulations, and public pressure; and incentives such as tax breaks for cleaner production equipment, water tariff structures which reward conservation, public recognition for environmental consciousness, technical assistance, and training.

The effectiveness and efficiency of a Cleaner Production Program will be a function of these factors. The survey should determine which factors have highest priority and therefore should be given greatest emphasis in the implementation of the Cleaner Production Program. Based on the determination of the relative importance of the different factors, it will then be possible to assess the cost/benefit of investments in each factor. On the basis of cost/benefit analysis, it will then be possible to determine

- how, and how much, investment should be made by the other factories in their respective Cleaner Production Programs
- how Cleaner Production Programs (Incentives) should be developed by the Government.

PHILIPPINE CLEANER PRODUCTION SURVEY
SURVEY INSTRUMENT

__________ Interviewer ID __________ Company Control Code

Complete after initial contact:

Name and title of contact ____

Name of company ____

Phone Number ____

Date survey to be conducted ____________________________________

Time survey to be conducted ________________________________

Control code ______________ Code number ____________

1. How many employees do you have in the company?_____________________________

2. What products do you produce?____

3. What is the company's approximate Gross Revenues (Sales)?______________________

4. Today, we use a lot of new terms to describe how we deal with our pollution. One of the most recent terms is "Cleaner Production". Have you heard of this term?

    ____ Yes
    ____ No **(Skip to question 6)**
    ____ Not sure (**Skip to question 6)**

5. How would you define "Cleaner Production"?

6. If you had to choose only one way to define Cleaner Production, which of the following would you choose?

    _____ pollution control
    _____ waste management
    _____ waste treatment
    _____ waste reduction
    _____ safe storage of waste
    _____ reducing of eliminating pollutants at their source
    _____ don't know
    _____ no answer

7. Would you say that recycling is a Cleaner Production technique?

    _____ Yes
    _____ No
    _____ don't know
    _____ no answer

8. Would you say that companies like yours use materials or chemicals that could be harmful to your employees and to the environment?

    _____ Yes
    _____ No **Go to question 15**
    _____ don't know **Go to question 15**
    _____ no answer **Go to question 15**

9. What are some of these materials or chemicals?

10 In the past year, has your company tried to reduce its use of harmful materials or chemicals?

_____ Yes
_____ No **Go to question 12**
_____ don't know **Go to question 12**
_____ no answer **Go to question 12**

11. Which harmful materials or chemicals has your company considered reducing its use of?

12. Has your company considered any plan for reducing its use of harmful materials or chemicals?

_____ Yes
_____ No
_____ don't know
_____ no answer

13. What are these plans?

14. Do you think that business like yours can reduce their use of harmful materials or chemicals?

_____ Yes
_____ No
_____ don't know
_____ no answer

15. Right now, how important do you think it is to eliminate pollution?

_____ Not at all important
_____ Not very important
_____ Important
_____ Very important
_____ don't know
_____ no answer

16. In the next 10 years, how important do you think it will be to eliminate pollution?

_____ Not at all important
_____ Not very important
_____ Important
_____ Very important
_____ don't know
_____ no answer

17. If you were to implement a new waste reduction measure, how long do you think it would take to recover your investment?

_____ less than six months
_____ six months to a year
_____ one to two years
_____ two to five years
_____ more than five years
_____ don't know
_____ no answer

18. When your company is deciding whether to invest in some new equipment or a new production process, is the amount of time it would take to recover your initial investment a factor in your decision?

_____ Yes
_____ No **Go to question 20**
_____ don't know **Go to question 20**
_____ no answer **Go to question 20**

19. In general, what would be an acceptable amount of time for you to recover your initial investment?

20. If you implemented stronger waste reduction measures, would the quality of your products and services

_____ be much better
_____ be a little better
_____ not be affected
_____ be a little worse
_____ be much worse
_____ don't know
_____ no answer

21. If you were to compare the costs of waste storage and treatment with the costs of waste prevention, do you think that waste storage and treatment

_____ Cost a lot more than waste prevention
_____ Cost a little more than waste prevention
_____ Cost the same as waste prevention
_____ Cost a little less than waste prevention
_____ Cost a lot less than waste prevention
_____ don't know
_____ no answer

22. If you were to compare the costs of waste disposal with the costs of waste prevention, do you think that waste disposal

_____ Cost a lot more than waste prevention
_____ Cost a little more than waste prevention
_____ Cost the same as waste prevention
_____ Cost a little less than waste prevention
_____ Cost a lot less than waste prevention
_____ don't know

_____ no answer

23. Does your company employ anyone who is responsible for chemical and waste management?

_____ Yes
_____ No **Go to question 25**
_____ don't know **Go to question 25**
_____ no answer **Go to question 25**

24. Is your chemical and waste management position a full-time job?

_____ Yes
_____ No
_____ don't know
_____ no answer

25. Sometimes, when companies try to start waste management programs, they discover that they don't have enough information. I am going to read you a list of topics that companies have said they need information about. After I read each item, please tell me if you feel that your company would need information about that item.

_____ information about the cost of waste reduction equipment
_____ information about the cost of waste reduction techniques
_____ information about ways to reduce your use of chemicals
_____ information about ways to reduce the amount of waste you generate
_____ information about available waste reduction technology
_____ information about materials you can substitute for current hazardous materials
_____ information about the waste management plans of other companies like yours

26. Do you have any information needs that I haven't mentioned?

Next, I am going to read several statements to you. After each statement, tell me if you agree or disagree.

27. If my company implemented new waste-reduction techniques, our profits could increase.

_____ Agree
_____ Disagree
_____ don't know
_____ no answer

28. My company's public image would improve if we improved our waste-reduction techniques.

_____ Agree
_____ Disagree
_____ don't know
_____ no answer

29. Our employees would like the company better if we improved our waste-reduction techniques.

_____ Agree
_____ Disagree
_____ don't know
_____ no answer

30. It would be difficult to implement new cleaner production techniques because our employees don't like change.

_____ Agree
_____ Disagree
_____ don't know
_____ no answer

31. Please rate how well you think company policies are communicated between management and employees. Is the communication –

_____ Excellent
_____ Good
_____ Fair
_____ Poor
_____ don't know
_____ no answer

32. On a scale of 1 to 10, with 10 being most important and 1 being least important, how important are environmental considerations to the success of your company?

|--------|--------|--------|--------|--------|--------|--------|--------|--------|
1 2 3 4 5 6 7 8 9 10

Different companies find different sources of information useful. I would like to ask you a few questions about where your company looks for the information it needs.

33. Assume you were thinking of changing one of your company's operations. What is the first place outside of your company that you would look for information?

34. What is the second place you would go for this information?

I have a list of places where some companies say they go for information. I will read this list to you one formation source at a time. Please tell me how useful you think each source would be to your company. Would it be very useful, useful, not very useful, or not at all useful?

35. Information clearinghouse
_____ very useful
_____ useful
_____ not very useful

______ not at all useful
______ don't know
______ no answer

36. A visit by an independent party who will assess the cleaner production opportunities available to your company.
    ______ very useful
    ______ useful
    ______ not very useful
    ______ not at all useful
    ______ don't know
    ______ no answer

37. Magazines in your field
    ______ very useful
    ______ useful
    ______ not very useful
    ______ not at all useful
    ______ don't know
    ______ no answer

38. Newsletters in your field
    ______ very useful
    ______ useful
    ______ not very useful
    ______ not at all useful
    ______ don't know
    ______ no answer

39. Workshops
    ______ very useful
    ______ useful
    ______ not very useful
    ______ not at all useful
    ______ don't know
    ______ no answer

Next, I am going to read a series of statements to you. After I read each one, I would like you to tell me how much you agree with it. Please tell me if you strongly agree, agree, disagree, or strongly disagree.

40. Government regulations are easy to understand.
    ______ Strongly agree
    ______ Agree
    ______ Disagree
    ______ Strong disagree
    ______ don’t know
    ______ no answer

41. The current legal limits on toxic emissions are sufficient to protect the environment.
_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

42. Government regulations are easy to comply with.
_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

43. The government is a good place to go for help on learning how to control wastes.
_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

44. Profits are the most important incentive in our efforts to reduce our pollution.
_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

45. A factory should invest in cleaner production facilities if it is demonstrated that the capital investment will generate improved production efficiency and higher profits over time.
_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

46. Complying with government regulation is the most important incentive in our efforts to reduce our pollution.
_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

47. A factory should invest in cleaner production processes regardless of the benefits because it is in the interest of the public environmental health and future generations' welfare.

_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

48. In order to stimulate investment in cleaner production processes in factories, the Government should:

(i) stringently enforce environmental pollution control regulations

_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

(ii) increase the amount of fines and severity of penalties for factories which do not meet pollution control regulations

_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

(iii) provide tax or duty incentives to reduce the cost of investment in cleaner production

_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

(iv) provide income tax breaks for factories which shift from polluting processes to cleaner production processes

_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

(v) increase income tax levied on factories which do not shift from polluting processes to cleaner production processes

_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

(vi) provide an investment facility for enabling financing of capital costs of cleaner production processes

_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

(vii) provide technical assistance and training for factory owners interested in shifting from polluting processes to cleaner production processes

_____ Strongly agree
_____ Agree
_____ Disagree
_____ Strong disagree
_____ don't know
_____ no answer

49. What other incentives would be effective in increasing your company's efforts to reduce its pollution?

Cleaner Production Program

50. Do you experience any impediments to cooperation between your factory and official agencies?

( ) no ( ) yes
If yes, specify ( ) rules and regulations
( ) unclear policy
( ) official attitude
( ) other (specify
_________________________________)

51. Has your company ever been fined for not meeting pollution control standards?
( ) no
( ) yes how many times? _______________ how much? ____________ pesos

As you know, the current fine for violation of the Clean Air Act has been increased to P100,000 pesos per day. Would you now invest in cleaner production measures?

( ) yes ( ) no;

or upgrading your treatment plant?

( ) yes ( ) no

52. Are you a member of an industry association?

( ) no

( ) yes

If yes, are you an active member and how frequently do you meet? ________________

Which club is it and what benefits are most important to you?

____

____

53. Has there ever been assistance offered to you for pollution prevention or cleaner production from your industry association?

( ) yes ( ) no

Have you found out about any such programs through your industry associations?

( ) yes ( ) no

54. Have you ever received assistance or offer of assistance for cleaner production from the Government or other non-governmental organizations?

( ) yes ( ) no

Which ones? ____

When? ____

Did you accept such assistance ( ) yes ( ) no

and if so, in what form was this assistance provided?

____

55. Have you ever undertaken an evaluation of how cleaner production may assist you to reduce raw material or water cost and pollution control cost?

( ) yes ( ) no

If yes, please describe how you think this may be of assistance or describe what action has been taken to implement such cleaner production.

____
—
____
—
____
—

56. If you have already implemented cleaner production measures, would you be willing to allow and assist in preparing a case study of your experience as part of an effort to inform other factories of the benefits and costs of Cleaner Production?

( ) yes ( ) no

57. Where are your primary and secondary markets for your products?

Primary markets:____

Secondary markets:____

58. Has the consumer or buyer of your product ever visited/inspected your factory?
( ) yes ( ) no
If yes, were they concerned with the environmental conditions in and around the factory? ( ) yes ( ) no
If yes, describe concerns ______________________________

59. Did they recommend any process changes to improve your production process or product?
( ) yes ( ) no

60. (a) In your opinion, what are significant roles of certification programs such as ISO 9000 and ISO 14000 in the promotion of cleaner technologies, cleaner production, and cleaner products?
____
____

(b) What should be done to assist the leaders of small and medium-sized companies to participate in and benefit from such certification programs?
____
____

(c) Who should provide this assistance?
____

(d) How should it be financed?
____
____

61. (a) Have you ever been advised by a client that they expect their producers to meet international standards such as ISO 9000 and 14000? Are you familiar with ISO 9000 and 14000?
( ) yes ( ) no
(b) Do you have the intention of applying to meet the ISO 9000 and 14000 standards?
( ) yes ( ) no
(c) To qualify for ISO 9000 and 14000, do you need outside technical assistance?
( ) yes ( ) no
(d) Will you avail of such assistance if the cost is over 500,000 Pesos?
( ) yes ( ) no
(e) Will you avail of such assistance if the cost is over 300,000 Pesos?
( ) yes ( ) no

(f) Will you avail of such assistance if the cost is over 100,000 Pesos?

( ) yes ( ) no

62. (a) Are you familiar with techniques for improving housekeeping in the factory?

( ) yes ( ) no

(b) Have you employed techniques such as metering and monitoring and training of staff, etc.?

( ) yes

If yes, specify the techniques____

____

( ) no

If not, what incentive would be required for you to undertake such good housekeeping measures?

____

____

63. Are there processes known to you which you could change in your factory which will improve productivity and efficiency? ( ) yes ( ) no

If yes, why haven't you employed such processes?

____

64. Is financing a problem for the upgrading of your processes to improve production and at the same time reduce costs for pollution control?

( ) yes ( ) no

65. If a loan was made available to you at market rate with a repayment period of five years, would you be interested in financing the improvement of your system?

( ) yes ( ) no

66. If your water cost and wastewater charges resulted in an increase of 50% over what you are paying now for water, and this cost could be reduced to 25% by employing cleaner production and better housekeeping, would you then avail of such a loan?

( ) yes ( ) no

67. If a loan was made available to you at 1% under market rate and a repayment period of ten years was available, would you then avail of such a loan for upgrading your process?

( ) yes ( ) no

68. If the cost of water and wastewater increases 50% and you could reduce this to 25%, would you then avail of such a loan?

( ) yes ( ) no

69. If training and cleaner production is included in the above packages, would these improve your consideration of making such an investment?

( ) yes ( ) no

70. If the wastewater and water supply cost increased by 100% over what you are paying now, and you could reduce this increase cost to 50% by cleaner production approaches,

(a) would you be interested in cleaner production?

( ) yes ( ) no

(b) Would you then be willing to make an investment and would you have the capital to do so? ( ) yes ( ) no

(c) If the capital is not available, would you avail of a loan at market rates?

( ) yes

( ) no If no, would you avail of a loan at 2% less than market rates with a longer repayment period? ( ) yes ( ) no

71. The Government is expected to stringently enforce the pollution control regulations which may require an upgrade of your waste treatment facilities. It is estimated that such an upgrade could cost over 2 million Pesos. If you could avoid such an upgrade by investing four times as much money (8 million Pesos) in a modified production process which will

- reduce the pollution,
- improve your product, and
- you will be able to recover the cost within two years as a result of higher profit,

would you be willing to make such an investment?

( ) yes

If yes, would you have the capital for such an investment?

( ) yes ( ) no

( ) no

If no, would you avail of a loan at market rates and repayment conditions?

( ) yes

( ) no

If no, would you avail of a loan at 2% less than market rates?

( ) yes ( ) no

72. If the Government allows a duty/tax reduction on new processing equipment for factories which upgrade processes, in part as a means to achieve cleaner production, will you then invest in the improved process?

( ) yes ( ) no

73. If the Government offers financial incentives such as accelerated depreciation, investment subsidies, tax credits, tax deductions, etc., for investments in technologies, production processes or products which reduce pollution, would this stimulate you to make such investment? ( ) yes ( ) no

What would be the most important incentives for you?

____

____

74. If the Government offers assistance to you in carrying out an audit of your process waste and a feasibility study for employment of cleaner production methods to improve your production as well as reduce your pollution,

(a) would you be willing to form a team of your staff to work with the ADB Cleaner Production consultants in carrying out such an audit?
( ) yes ( ) no

(b) If no, if your industry association offered the same, would you then be willing to form such a team?
( ) yes ( ) no

(c) If no, if training was to be provided to the team in conjunction with the preparation of the feasibility study, would you then be willing to form such a team?
( ) yes ( ) no

(d) If no, if the Government stringently enforces the pollution control requirements and you recognized the potential cost savings by employing better housekeeping and cleaner production, would you be willing to hire consultants to undertake a study and audit of your processes and waste flows and prepare feasibility for making improvements for your factory?
( ) yes ( ) no

(e) Would you establish a team of your factory workers to carry out such measures?
( ) yes ( ) no

75. (a) If the buyer of your product indicates that they would expect the factories producing the products that they purchase to improve environmental conditions in and around the factory, would you be willing to hire consultants or avail of Government assistance in carrying out an audit and prepare a feasibility study for cleaner production in your factory?
( ) yes ( ) no

(b) Would you form a team to work with the consultants in such a study?
( ) yes ( ) no

76. (a) Are you familiar with the use of voluntary agreements between the regulatory authorities and factories which could be used to achieve environmental goals and to encourage development and implementation of cleaner technologies, cleaner production processes and cleaner products with less regulation?
( ) yes ( ) no

(b) Would you be willing to participate in a voluntary agreement program?

( ) Yes

If yes,

(1) could you suggest the best way to initiate such a program (such as through the Department of Trade, etc.)?

____

(2) What organizational representatives should participate in the negotiation of the voluntary agreement?

____

(3) How could compliance by partners best be monitored?

____

(4) By whom?

____

(5) How frequently should compliance be monitored?

____

( ) No

If no, why not?

____

77. If the Government undertook a program of green labeling which means that companies which demonstrate environmental consciousness are awarded and companies that are not listed could not receive selected Government benefits/promotions, would this be an effective incentive to undertake a feasibility study for cleaner production in your factory?

( ) yes ( ) no

78. Does the Government provide information about cleaner technologies?

( ) yes ( ) no

If yes,

(a) what mechanisms are used to provide and to disseminate this information? For example, does it use publications, computer data bases, telephone hot lines, videos, workshops, training programs, technical assistance and consultations?

____

____

(b) Who is responsible for the content and delivery of such information or assistance?

____

____

(c) Who is responsible for assuring quality and effectivity of the assistance provided?

____

____

(d) If the Government provides financial support for development and diffusion of cleaner technologies, how should these programs be advertised?

____

____

(e) Should special attention be paid to assisting small and medium-sized enterprises to receive the information about the programs?

( ) yes ( ) no

(f) How should this be done?

____

____

(g) What kinds of information should be supplied, e.g., specifications, prices, availability of technologies, list of consultants, etc.?

____

____

79. What does your company do with most of its waste?

I have just a few more questions about your company, and then we will be finished.

80. Do you have questions regarding cleaner production for your factory which we can forward to DENR officials or other experts in order to assist you in obtaining information?

List of Questions and other notes.

____
____
____
____
____
____
____
____
____
____
____

I don't have any more questions for you. Thank you for your time and have a nice day.

APPENDIX 3: STATISTICAL ANALYSIS OF SELECTED SURVEY RESULTS

COMPARATIVE ANALYSIS ON SELECTED VARIABLES COMMON IN BOTH THAILAND AND PHILIPPINES DATA
Using top-two boxes (strongly agree + agree) responses

		Phil	Thai
Base: All factories		*84*	*77*
		%	%
In order to stimulate investment in cleaner production processes in factories, the government should…			
1	stringently enforce environmental pollution control regulations	86	84
2	increase the amount of fines and severity of penalties for factories which do not meet pollution control regulations	63	55
3	provide tax or duty incentives to reduce the cost of investment in cleaner production	86	91
4	provide income tax breaks for factories which shift from polluting processes to cleaner production processes	86*	64
5	increase income tax levied on factories which do not shift from polluting processes to cleaner production processes	63	60
6	provide an investment facility for enabling financing of capital costs of cleaner production processes	89	86
7	provide technical assistance and training for factory owners interested in shifting from polluting processes to cleaner production processes	89	81
Incentives to adopt Cleaner Production			
1	A factory should invest in cleaner production facilities if it is demonstrated that the capital investment will generate improved production efficiency and higher profits over time.	90	92
2	A factory should invest in cleaner production processes regardless of the benefits because it is in the interest of the public environmental health and future generations' welfare.	89*	75

**** - significant difference at 95% confidence level***

Comparative Analysis THA + PHI

			pooled	x1-x2	sqrt((1/n1)+(1/	denominator	t-value
	J7_i	J7_i					
Strongly Agree	31	21					
Agree	55	64					
Disagree	4	3					
Strongly Disagree	1	1					
Don't Know	-	6					
No Answer	10	5					
MEAN	**1.833**	**2.195**					
var	**0.816**	**1.665**	1.222	0.362	0.158	0.193	1.878
N	**84**	**77**					
	J7_ii	J7_ii					
Strongly Agree	27	13					
Agree	36	42					
Disagree	24	6					
Strongly Disagree	1	3					
Don't Know	1	29					
No Answer	11	8					
MEAN	**2.179**	**3.169**					
var	**1.318**	**3.028**	2.135	0.990	0.158	0.337	2.939 *
N	**84**	**77**					
	J7_iii	J7_iii					
Strongly Agree	42	49					
Agree	44	42					
Disagree	2	1					
Strongly Disagree	-	-					
Don't Know	2	-					
No Answer	10	8					
MEAN	**2.128**	**1.831**					
var	**12.789**	**1.747**	7.511	-0.297	0.158	1.185	-0.251
N	**84**	**77**					
	J7_iv	J7_iv					
Strongly Agree	43	31					
Agree	43	32					
Disagree	2	4					
Strongly Disagree	-	-					
Don't Know	2	13					
No Answer	10	19					
MEAN	**1.744**	**2.896**					
var	**1.076**	**3.884**	2.418	1.152	0.158	0.382	3.019 *
N	**84**	**77**					
	J7_v	J7_v					
Strongly Agree	30	13					
Agree	33	47					
Disagree	16	6					
Strongly Disagree	4	-					
Don't Know	5	26					
No Answer	13	8					
MEAN	**2.333**	**3.026**					
var	**2.043**	**2.762**	2.387	0.693	0.158	0.377	1.840
N	**84**	**77**					
	J7_vi	J7_vi					
Strongly Agree	34	34					
Agree	55	52					
Disagree	-	1					
Strongly Disagree	1	-					
Don't Know	1	6					
No Answer	8	6					
MEAN	**1.731**	**2.130**					
var	**0.641**	**1.983**	1.282	0.399	0.158	0.202	1.972 *
N	**84**	**77**					
	J7_ix	J7_ix					
Strongly Agree	46	43					
Agree	43	38					
Disagree	1	-					
Strongly Disagree	-	1					
Don't Know	-	1					
No Answer	10	17					
MEAN	**1.615**	**2.260**					
var	**0.785**	**3.246**	1.961	0.645	0.158	0.309	2.084 *
N	**84**	**77**					
	J2	J2					
Strongly Agree	27	36					
Agree	63	56					
Disagree	2	1					
Strongly Disagree	-	-					
Don't Know	-	2					
No Answer	7	6					
MEAN	**1.785**	**1.196**					
var	**0.479**	**1.457**	0.946	-0.589	0.158	0.149	-3.944 *
N	**84**	**77**					
	J4	J4					
Strongly Agree	41	23					
Agree	48	52					
Disagree	2	4					
Strongly Disagree	-	3					
Don't Know	2	10					
No Answer	7	8					
MEAN	**1.722**	**2.377**					
var	**0.819**	**2.369**	1.560	0.655	0.158	0.246	2.661 *
N	**84**	**77**					

COMPARISON OF MEANS BETWEEN IDENTIFIED SUPPLY CHAIN VS. NON SUPPLY CHAIN USING T-TEST

Needed Assistance to Adopt Cleaner Production

	Supply Chain (SC)	Non-Supply Chain (NSC)	T-value	
Soft loan financial resources	2.333	2.941	1.321	*significant at 80% CL (t_{tab} = 1.29)*
Technical assistance to conduct waste audit and feasibility study for CP alternatives	1.539	1.943	1.673	*significant at 90% CL (t_{tab} = 1.66)*
Technical extension workers who would see through the CP implementation and conduct training to staff	2.769	2.500	1.236	*not significant*
Reliable and continuous information	3.231	2.463	1.653	*significant at 80% CL (t_{tab} = 1.29)*

Major Barriers to Company's Adoption of Cleaner Production

	SC	NSC	T-value	
Lack of financial resources	3.200	3.630	0.291	*not significant*
Lack of in-house technical expertise/know how	2.800	2.296	0.570	*not significant*
Absence of management commitment	3.800	3.852	0.028	*not significant*
Business disruption and potential profit loss	4.200	4.148	0.034	*not significant*
Absence of technical extension worker to see through CP implementation	4.200	3.185	0.882	*not significant*
Lack of reliable information source on various information needs	4.000	3.111	0.647	*not significant*

Decision Rule: If T-value > or = T_{tab}, then the difference is significant at the selected confidence level

NOTE:
If SIGNIFICANT at any SELECTED Confidence Level (CL), we may say that the DIFFERENCE between the MEAN SCORES of the tested variable is STATISTICALLY significant
WARNING: The lower the level of significance, the larger the margin of error

	SC	NSC	T-value	
Perceived Importance of Eliminating Pollution Now	3.625	3.941	4.337	*highly significant at 99% CL (t_{tab} = 2.64)*
Perceived Importance of Eliminating Pollution in the Next 10 Years	3.688	3.971	4.808	*highly significant at 99% CL (t_{tab} = 2.64)*
Importance of Environmental Consideration to Success of Company	8.688	8.448	0.257	*not significant*

Major Drivers Companies Would Consider to Adopt Cleaner Production

	SC	NSC	T-value	
Profits	2.643	3.625	0.946	*not significant*
Compliance with government regulations	3.143	2.893	0.307	*not significant*
Public environmental health and future generation's welfare	2.786	1.931	1.646	*significant at 80% CL (t_{tab} = 1.29)*
Corporate policy of mother company abroad (if applicable)	3.546	4.563	0.566	*not significant*
Customer chain or supply chain leverage	5.250	4.816	0.653	*not significant*
Green labelling program of the government	5.833	4.824	1.465	*significant at 80% CL (t_{tab} = 1.29)*
Enhanced corporate image	4.071	3.889	0.225	*not significant*

Source of Information

	SC	NSC	T-value	
Information clearinghouse	2.571	2.955	0.491	*not significant*
A visit by an independent party	2.357	2.385	0.050	*not significant*
Magazines	1.643	2.149	1.708	*significant at 90% CL (t_{tab} = 1.67)*
Industry Association	1.714	1.955	0.637	*not significant*
Newsletter	1.571	2.106	1.779	*significant at 90% CL (t_{tab} = 1.67)*
Workshops	1.857	2.045	0.522	*not significant*

Decision Rule: If T-value > or = T_{tab}, then the difference is significant at the selected confidence level

NOTE:
If SIGNIFICANT at any SELECTED Confidence Level (CL), we may say that the DIFFERENCE between the MEAN SCORES of the tested variable is STATISTICALLY significant
WARNING: The lower the level of significance, the larger the margin of error

Incentives to Improve Cleaner Production Efforts

	SC	NSC	T-value	

Comparative Analysis THA & PHF

	Strongly Agree	Agree	Disagree	Strongly Disagree	Don't Know	No Answer
J7_i	31%	55%	4%	1%	-	10%
J7_ii	27%	36%	24%	1%	1%	11%
J7_iii	42%	44%	2%	-	2%	10%
J7_iv	43%	43%	2%	-	2%	10%
J7_v	30%	33%	16%	4%	5%	13%
J7_vi	34%	55%	-	1%	1%	8%
J7_ix	46%	43%	1%	-	-	10%
J2	27%	63%	2%	-	-	7%
J4	41%	48%	2%	-	2%	7%
J2	36%	56%	1%	0%	2%	6%
J4	23%	52%	4%	3%	10%	8%
J7_i	21%	64%	3%	1%	6%	5%
J7_vi	34%	52%	1%	0%	6%	6%
J7_iii	49%	42%	1%	0%	0%	8%
J7_iv	31%	32%	4%	0%	13%	19%
J7_v	13%	47%	6%	0%	26%	8%
J7_ii	13%	42%	6%	3%	29%	8%
J7_ix	43%	38%	0%	1%	1%	17%

	1	2	3	4	5	6								
	Strongly Agree	Agree	Disagree	Strongly Disagree	Undecided	No Answer		mean	16	49	2	1	5	4
J7_i	16	49	2	1	5	4	169	2.195	1.4275595	0.0379491	0.6483387	3.2587283	7.8691179	14.479508
	1.427559454	0.037949064	0.648338674	3.258728285	7.869117895	14.47950751								
	22.84095126	1.859504132	1.296677349	3.258728285	39.34558948	57.91803002	126.5194805	1.665						
J7_vi	26	40	1		5	5	164	2.130						
	1.27660651	0.016866251	0.757125991	3.497385731	8.237645471	14.97790521								
	33.19176927	0.674650025	0.757125991	0	41.18822736	74.88952606	150.7012987	1.983						
J7_iii	38	32	1			6	141	1.831						
	0.690841626	0.028503964	1.366166301	4.703828639	10.04149098	17.37915331								
	26.25198178	0.912126834	1.366166301	0	0	104.2749199	132.8051948	1.747						
J7_iv	24	25	3		10	15	223	2.896						
	3.595209985	0.803002193	0.0107944	1.218586608	4.426378816	9.634171024								
	86.28503964	20.07505482	0.032383201	0	44.26378816	144.5125654	295.1688312	3.884						
J7_v	10	36	5		20	6	233	3.026						
	4.104570754	1.052622702	0.00067465	0.948726598	3.896778546	8.844830494								
	41.04570754	37.89441727	0.00337325	0	77.93557092	53.06898297	209.9480519	2.762						
J7_ii	10	32	4	2	22	8	244	3.169						
	4.703828639	1.366166301	0.028503964	0.690841626	3.353179288	8.015516951								
	47.03828639	43.71732164	0.114015854	1.381683252	73.76994434	64.1241356	230.1453871	3.028						
J7_ix	33	29		1	1	13	174	2.260						
	1.586945522	0.067465003	0.547984483	3.028503964	7.509023444	13.98954292								
	52.36920223	1.956485073	0	3.028503964	7.509023444	181.864058	246.7272727	3.246						
J2	28	43	1	0	2	4	151	1.961						
	0.9235959	0.001518	1.07944	4.1573621	9.2352842	16.313206								
	25.86068477	0.06527239	1.07944004	0	18.47056839	65.2528251	110.7287907	1.457						
J4	18	40	3	2	8	6	183	2.377						
	1.895091921	0.141845168	0.388598415	2.635351661	6.882104908	13.12885815								
	34.11165458	5.673806713	1.165795244	5.270703323	55.05683926	78.77314893	180.0519481	2.369						
	1	2	3	4	5	6								

J7_i	2.195
J7_vi	2.130
J7_iii	1.831
J7_iv	2.896
J7_v	3.026
J7_ii	6.143
J7_ix	2.260
J2	3.883
J4	2.377

If company implemented new waste-reduction techniques, profits could increase	1.867	1.851	0.048	*not significant*
Company's public image would improve if improve waste-reduction techniques	1.200	1.343	0.779	*not significant*
Employees would like the company better if improve waste-reduction techniques	1.200	1.448	1.218	*not significant*
It would be difficult to implement new cleaner production techniques because employees don't like change	2.267	2.090	0.984	*not significant*
If customer or buyer of product would recommend process change to improve production process or output, will certainly abide by their demands	1.800	1.463	1.259	*not significant*

Attitude towards Government

	SC	NSC	T-value	
Government regulations are easy to understand	2.571	2.939	1.343	*significant at 80% CL (t_{tab} = 1.29)*
Current legal limits on toxic emissions are sufficient to protect the environment	3.286	3.091	0.384	*not significant*
Government regulations are easy to comply with	2.786	3.212	0.931	*not significant*
The government is a good place to go for help on learning how to control wastes	2.714	3.123	0.786	*not significant*

Decision Rule: If T-value > or = T_{tab}, then the difference is significant at the selected confidence level

NOTE:
If SIGNIFICANT at any SELECTED Confidence Level (CL), we may say that the DIFFERENCE between the MEAN SCORES of the tested variable is STATISTICALLY significant
WARNING: The lower the level of significance, the larger the margin of error

Incentives to Adopt Cleaner Production

	SC	NSC	T-value	
Profit are the most important incentive in efforts to reduce pollution	2.143	2.292	0.410	*not significant*
A factory should invest in cleaner production facilities if it is demonstrated that the capital investment will generate improved production efficiency and higher profits over time	1.500	1.846	2.516	*significant at 95% CL (t_{tab} = 1.98)*
Complying with the government regulation is the most important incentive in efforts to reduce pollution	2.357	2.585	0.545	*not significant*
A factory should invest in cleaner production processes regardless of the benefits because it is in the best interest of the public environmental health and future generation's welfare	1.500	1.769	1.116	*not significant*

Government Action to Stimulate Investment in Cleaner Production Processes in Factories

	SC	NSC	T-value	
Stringently enforce environmental pollution control regulations	2.000	1.797	0.839	*not significant*
Increase the amount of fines and severity of penalties for factories which do not meet pollution control regulations	1.857	2.250	1.015	*not significant*
Provide tax or duty incentives to reduce the cost of investment in cleaner production	1.500	1.813	0.991	*not significant*
Provide income tax breaks for factories which shift from polluting processes to cleaner production processes	1.357	1.828	1.510	*significant at 80% CL (t_{tab} = 1.29)*
Increase income tax levied on factories which do not shift from polluting processes to cleaner production processes	2.286	2.344	0.095	*not significant*
Provide an investment facility for enabling financing of capital costs of cleaner production processes	1.643	1.750	0.561	*not significant*
Encourage local banks to extend more credits to SMEs at interest rates reasonably lower than market rates with longer repayment period.	1.500	1.781	1.240	*not significant*
Encourage banks and government guarantee institutions to collateralize SME loans.	2.143	2.064	0.216	*not significant*
Provide technical assistance and training for factory owners interested in shifting from polluting processes to cleaner production processes	1.357	1.672	1.367	*significant at 80% CL (t_{tab} = 1.29)*

Decision Rule: If T-value > or = T_{tab}, then the difference is significant at the selected confidence level

NOTE:
If SIGNIFICANT at any SELECTED Confidence Level (CL), we may say that the DIFFERENCE between the MEAN SCORES of the tested variable is STATISTICALLY significant
WARNING: The lower the level of significance, the larger the margin of error

Chi-Square Test of Independence Summary Table

Variables Tested	Chi-Square Value	Significance	Statistical Conclusion
CP Awareness vs. Company size	3.10657	0.54015	Variables are independent
CP Definition vs. Company size	**22.85143**	**0.02901**	**Variables are associated at 95% confidence level**
Whether recycling is CP vs. Company size	7.32671	0.29169	Variables are independent
Whether company use harmful materials vs. Company size	6.48046	0.37157	Variables are independent
Whether company tried to reduce use of harmful materials vs. Company size	**7.79487**	**0.09939**	**Variables are associated at 85% confidence level**
Period to recover investment vs. Company size	9.06504	0.69737	Variables are independent

WARNING: The lower the level of significance, the larger the margin of error

NEEDED ASSISTANCE TO ADOPT CLEANER PRODUCTION (ASSIST)

Soft loan financial resources

	Supply Chain	Non-Supply Chain		
n	12	51		
mean	2.3333	2.9412		
variance	1.697	1.3765		
pooled variance	18.667	68.825	61	1.4342951
mean1 - mean2	0.6079			
sqrt((1/n1) + (1/n2))	0.083333333	0.019607843	0.1029412	0.3208445
t value	**1.320988602**	*significant at 80% CL (t_{tab} = 1.29)*		
df (n1+n2-2)	61			

Technical assistance to conduct waste audit and feasibility study for CP alternatives

	Supply Chain	Non-Supply Chain		
n	13	53		
mean	1.5385	1.9434		
variance	0.4359	0.8621		
pooled variance	5.2308	44.8292	64	0.7821875
mean1 - mean2	0.4049			
sqrt((1/n1) + (1/n2))	0.076923077	0.018867925	0.095791	0.3095012
t value	**1.672532435**	*significant at 90% CL (t_{tab} = 1.66)*		
df (n1+n2-2)	64			

Technical extension workers who would see through the CP implementation and conduct training to staff

	Supply Chain	Non-Supply Chain		
n	13	54		
mean	2.7692	2.5		
variance	0.5256	0.7453		
pooled variance	6.3072	39.5009	65	0.70474
mean1 - mean2	0.2692			
sqrt((1/n1) + (1/n2))	0.076923077	0.018518519	0.0954416	0.3089362
t value	**1.236452076**			
df (n1+n2-2)	65			

Reliable and continuous information

	Supply Chain	Non-Supply Chain		
n	13	54		
mean	3.2308	2.463		
variance	1.0256	1.6118		
pooled variance	12.3072	85.4254	65	1.5035785
mean1 - mean2	0.7678			
sqrt((1/n1) + (1/n2))	0.076923077	0.018518519	0.0954416	0.3089362
t value	**1.65292507**	*significant at 80% CL (t_{tab} = 1.29)*		
df (n1+n2-2)	65			

MAJOR BARRIERS TO COMPANY'S ADOPTION OF CLEANER PRODUCTION (BARRIER)

Lack of financial resources

	Supply Chain	Non-Supply Chain

n	5	27		
mean	3.2	3.6296		
variance	4.7	2.7806		
pooled variance	18.8	72.2956	30	3.03652
mean1 - mean2	0.4296			
sqrt((1/n1) + (1/n2))	0.2	0.037037037	0.237037	0.4868645
t value	**0.29058957**			
df (n1+n2-2)	30			

Lack of in-house technical expertise/know how

	Supply Chain	Non-Supply Chain		
n	5	27		
mean	2.8	2.2963		
variance	2.2	1.755		
pooled variance	8.8	45.63	30	1.8143333
mean1 - mean2	0.5037			
sqrt((1/n1) + (1/n2))	0.2	0.037037037	0.237037	0.4868645
t value	**0.570225673**			
df (n1+n2-2)	30			

Absence of management commitment

	Supply Chain	Non-Supply Chain		
n	5	27		
mean	3.8	3.8519		
variance	6.7	3.3618		
pooled variance	26.8	87.4068	30	3.8068933
mean1 - mean2	0.0519			
sqrt((1/n1) + (1/n2))	0.2	0.037037037	0.237037	0.4868645
t value	**0.028001967**			
df (n1+n2-2)	30			

Business disruption and potential profit loss

	Supply Chain	Non-Supply Chain		
n	5	27		
mean	4.2	4.1481		
variance	6.2	2.6695		
pooled variance	24.8	69.407	30	3.1402333
mean1 - mean2	0.0519			
sqrt((1/n1) + (1/n2))	0.2	0.037037037	0.237037	0.4868645
t value	**0.033946682**			
df (n1+n2-2)	30			

Absence of technical extension worker to see through CP implementation

	Supply Chain	Non-Supply Chain		
n	5	27		
mean	4.2	3.1852		
variance	3.2	2.2336		
pooled variance	12.8	58.0736	30	2.3624533

mean1 - mean2	1.0148			
sqrt((1/n1) + (1/n2))	0.2	0.037037037	0.237037	0.4868645
t value	**0.882285446**			
df (n1+n2-2)	30			

Lack of reliable information source on various information needs

	Supply Chain	**Non-Supply Chain**		
n	5	27		
mean	4	3.1111		
variance	1	3.1026		
pooled variance	4	80.6676	30	2.8222533
mean1 - mean2	0.8889			
sqrt((1/n1) + (1/n2))	0.2	0.037037037	0.237037	0.4868645
t value	**0.646917362**			
df (n1+n2-2)	30			

PERCEIVED IMPORTANCE OF ELIMINATING POLLUTION NOW (D1)

	Supply Chain	**Non-Supply Chain**		
n	16	68		
mean	3.625	3.9412		
variance	0.3833	0.2353		
pooled variance	5.7495	15.7651	82	0.2623732
mean1 - mean2	0.3162			
sqrt((1/n1) + (1/n2))	0.0625	0.014705882	0.0772059	0.2778595
t value	**4.337277872**			
df (n1+n2-2)	82	*highly significant at 99% CL (t_{tab} = 2.64)*		

PERCEIVED IMPORTANCE OF ELIMINATING POLLUTION IN THE NEXT 10 YEARS (D2)

	Supply Chain	**Non-Supply Chain**		
n	16	68		
mean	3.6875	3.9706		
variance	0.3625	0.1782		
pooled variance	5.4375	11.9394	82	0.2119134
mean1 - mean2	0.2831			
sqrt((1/n1) + (1/n2))	0.0625	0.014705882	0.0772059	0.2778595
t value	**4.807908839**			
df (n1+n2-2)	82	*highly significant at 99% CL (t_{tab} = 2.64)*		

IMPORTANCE OF ENVIRONMENTAL CONSIDERATION TO SUCCESS OF COMPANY (D3)

	Supply Chain	Non-Supply Chain		
n	16	67		
mean	8.6875	8.4478		
variance	2.0958	3.645		
pooled variance	31.437	240.57	81	3.3581111
mean1 - mean2	0.2397			
sqrt((1/n1) + (1/n2))	0.0625	0.014925373	0.0774254	0.2782542
t value	**0.256525958**			
df (n1+n2-2)	81			

MAJOR DRIVERS COMPANIES WOULD CONSIDER TO ADOPT CLEANER PRODUCTION (DRIVER

Profits

	Supply Chain	Non-Supply Chain		
n	14	56		
mean	2.6429	3.625		
variance	1.478	3.9477		
pooled variance	19.214	217.1235	68	3.4755515
mean1 - mean2	0.9821			
sqrt(1/n1 + 1/n2)	0.071428571	0.017857143	0.2988072	
t-value	**0.945673018**			
df (n1 + n2 - 2)	68			

Compliance with government regulations

	Supply Chain	Non-Supply Chain		
n	14	56		
mean	3.1429	2.8929		
variance	4.2857	2.3519		
pooled variance	55.7141	129.3545	68	2.7215971
mean1 - mean2	0.25			
sqrt(1/n1 + 1/n2)	0.071428571	0.017857143	0.2988072	
t-value	**0.307415098**			
df (n1 + n2 - 2)	68			

Public environmental health and future generation's welfare

	Supply Chain	Non-Supply Chain		
n	14	58		
mean	2.7857	1.931		
variance	2.6429	1.539		
pooled variance	34.3577	87.723	70	1.74401
mean1 - mean2	0.8547			
sqrt(1/n1 + 1/n2)	0.071428571	0.017241379	0.297775	
t-value	**1.645797884**	*significant at 80% CL (t_{tab} = 1.29)*		
df (n1 + n2 - 2)	70			

Corporate policy of mother company abroad (if applicable)

	Supply Chain	Non-Supply Chain		
n	11	32		
mean	3.5455	4.5625		
variance	6.0727	4.8347		
pooled variance	60.727	149.8757	41	5.1366512
mean1 - mean2	1.017			
sqrt(1/n1 + 1/n2)	0.090909091	0.03125	0.3495126	
t-value	**0.566471388**			
df (n1 + n2 - 2)	41			

Customer chain or supply chain leverage

	Supply Chain	Non-Supply Chain		
n	12	49		
mean	5.25	4.8163		
variance	2.2045	2.0281		
pooled variance	24.2495	97.3488	59	2.0609881
mean1 - mean2	0.4337			
sqrt(1/n1 + 1/n2)	0.083333333	0.020408163	0.3220893	
t-value	**0.653337635**			
df (n1 + n2 - 2)	59			

Green labelling program of the government

	Supply Chain	Non-Supply Chain		
n	12	51		
mean	5.8333	4.8235		
variance	0.5152	2.5082		
pooled variance	5.6672	125.41	61	2.1488066
mean1 - mean2	1.0098			
sqrt(1/n1 + 1/n2)	0.083333333	0.019607843	0.3208445	
t-value	**1.464682464**	*significant at 80% CL (t_{tab} = 1.29)*		
df (n1 + n2 - 2)	61			

Enhanced corporate image

	Supply Chain	Non-Supply Chain		
n	14	54		
mean	4.0714	3.8889		
variance	2.8407	2.6667		
pooled variance	36.9291	141.3351	66	2.7009727
mean1 - mean2	0.1825			
sqrt(1/n1 + 1/n2)	0.071428571	0.018518519	0.2999118	
t-value	**0.225293733**			
df (n1 + n2 - 2)	66			

SOURCE OF INFORMATION

Information clearinghouse

	Supply Chain	Non-Supply Chain		
n	14	67		
mean	2.5714	2.9552		
variance	2.5714	2.6798		
pooled variance	33.4282	176.8668	79	2.661962
mean1 - mean2	0.3838			
sqrt(1/n1 + 1/n2)	0.071428571	0.014925373	0.2938604	
t-value	**0.490638952**			
df (n1 + n2 - 2)	79			

A visit by an independent party

	Supply Chain	Non-Supply Chain		
n	14	65		
mean	2.3571	2.3846		
variance	1.7857	1.8966		
pooled variance	23.2141	121.3824	77	1.8778766
mean1 - mean2	0.0275			
sqrt(1/n1 + 1/n2)	0.071428571	0.015384615	0.2946408	
t-value	**0.049701877**			
df (n1 + n2 - 2)	77			

Magazines

	Supply Chain	Non-Supply Chain		
n	14	67		
mean	1.6429	2.1493		
variance	0.2473	1.1592		
pooled variance	3.2149	76.5072	79	1.0091405
mean1 - mean2	0.5064			
sqrt(1/n1 + 1/n2)	0.071428571	0.014925373	0.2938604	
t-value	**1.707658279**	*significant at 90% CL (t_{tab} = 1.67)*		
df (n1 + n2 - 2)	79			

Industry Association

	Supply Chain	Non-Supply Chain		
n	14	67		
mean	1.7143	1.9552		
variance	0.5275	1.4374		
pooled variance	6.8575	94.8684	79	1.2876696
mean1 - mean2	0.2409			
sqrt(1/n1 + 1/n2)	0.071428571	0.014925373	0.2938604	
t-value	**0.636636098**			
df (n1 + n2 - 2)	79			

Newsletter

	Supply Chain	Non-Supply Chain		
n	14	66		
mean	1.5714	2.1061		
variance	0.2637	1.1732		
pooled variance	3.4281	76.258	78	1.0216167
mean1 - mean2	0.5347			
sqrt(1/n1 + 1/n2)	0.071428571	0.015151515	0.2942449	
t-value	**1.778743012**	*significant at 90% CL (t_{tab} = 1.67)*		
df (n1 + n2 - 2)	78			

Workshops

	Supply Chain	Non-Supply Chain		
n	14	67		
mean	1.8571	2.0448		
variance	0.4396	1.3768		
pooled variance	5.7148	90.8688	79	1.2225772
mean1 - mean2	0.1877			
sqrt(1/n1 + 1/n2)	0.071428571	0.014925373	0.2938604	
t-value	**0.522452588**			
df (n1 + n2 - 2)	79			

INCENTIVES TO IMPROVE CLEANER PRODUCTION EFFORTS (H1 TO H5)

If company implemented new waste-reduction techniques, profits could increase

	Supply Chain	Non-Supply Chain		
n	15	67		
mean	1.8667	1.8507		
variance	1.2667	1.1592		
pooled variance	17.7338	76.5072	80	1.1780125
mean1 - mean2	0.016			
sqrt(1/n1 + 1/n2)	0.066666667	0.014925373	0.2856432	
t-value	**0.047549526**			
df (n1 + n2 - 2)	80			

Company's public image would improve if improve waste-reduction techniques

	Supply Chain	Non-Supply Chain		
n	15	67		
mean	1.2	1.3433		
variance	0.6	0.6531		
pooled variance	8.4	43.1046	80	0.6438075
mean1 - mean2	0.1433			
sqrt(1/n1 + 1/n2)	0.066666667	0.014925373	0.2856432	
t-value	**0.779231075**			
df (n1 + n2 - 2)	80			

Employees would like the company better if improve waste-reduction techniques

	Supply Chain	Non-Supply Chain		
n	15	67		
mean	1.2	1.4478		
variance	0.3143	0.7965		
pooled variance	4.4002	52.569	80	0.712115
mean1 - mean2	0.2478			
sqrt(1/n1 + 1/n2)	0.066666667	0.014925373	0.2856432	
t-value	**1.218224341**			
df (n1 + n2 - 2)	80			

It would be difficult to implement new cleaner production techniques because employees don't lil change

	Supply Chain	Non-Supply Chain		
n	15	67		
mean	2.2667	2.0896		
variance	0.6381	0.6282		
pooled variance	8.9334	41.4612	80	0.6299325
mean1 - mean2	0.1771			
sqrt(1/n1 + 1/n2)	0.066666667	0.014925373	0.2856432	
t-value	**0.984239183**			
df (n1 + n2 - 2)	80			

If customer or buyer of product would recommend process change to improve production proces or output, will certainly abide by their demands

	Supply Chain	Non-Supply Chain		
n	15	67		
mean	1.8	1.4627		
variance	1.6	0.7978		
pooled variance	22.4	52.6548	80	0.938185
mean1 - mean2	0.3373			
sqrt(1/n1 + 1/n2)	0.066666667	0.014925373	0.2856432	
t-value	**1.258647046**			
df (n1 + n2 - 2)	80			

ATTITUDE TOWARDS GOVERNMENT (I1 TO I4)

Government regulations are easy to understand

	Supply Chain	Non-Supply Chain		
n	14	66		
mean	2.5714	2.9394		
variance	1.6	0.7978		
pooled variance	20.8	51.857	78	0.9315
mean1 - mean2	0.368			
sqrt(1/n1 + 1/n2)	0.071428571	0.015151515	0.2942449	
t-value	**1.342628778**	*significant at 80% CL (t_{tab} = 1.29)*		
df (n1 + n2 - 2)	78			

Current legal limits on toxic emissions are sufficient to protect the environment

	Supply Chain	Non-Supply Chain

n	14	66		
mean	3.2857	3.0909		
variance	2.6813	1.5301		
pooled variance	34.8569	99.4565	78	1.7219667
mean1 - mean2	0.1948			
sqrt(1/n1 + 1/n2)	0.071428571	0.015151515	0.2942449	
t-value	**0.384463579**			
df (n1 + n2 - 2)	78			

Government regulations are easy to comply with

	Supply Chain	Non-Supply Chain		
n	14	66		
mean	2.7857	3.2121		
variance	1.7198	1.5235		
pooled variance	22.3574	99.0275	78	1.5562167
mean1 - mean2	0.4264			
sqrt(1/n1 + 1/n2)	0.071428571	0.015151515	0.2942449	
t-value	**0.931189619**			
df (n1 + n2 - 2)	78			

The government is a good place to go for help on learning how to control wastes

	Supply Chain	Non-Supply Chain		
n	14	65		
mean	2.7143	3.1231		
variance	1.2967	1.8596		
pooled variance	16.8571	119.0144	77	1.7645649
mean1 - mean2	0.4088			
sqrt(1/n1 + 1/n2)	0.071428571	0.015384615	0.2946408	
t-value	**0.786285728**			
df (n1 + n2 - 2)	77			

INCENTIVES TO ADOPT CLEANER PRODUCTION (J1 TO J4)

Profit are the most important incentive in efforts to reduce pollution

	Supply Chain	Non-Supply Chain		
n	14	65		
mean	2.1429	2.2923		
variance	1.8242	1.1163		
pooled variance	23.7146	71.4432	77	1.2358156
mean1 - mean2	0.1494			
sqrt(1/n1 + 1/n2)	0.071428571	0.015384615	0.2946408	
t-value	**0.410302422**			
df (n1 + n2 - 2)	77			

A factory should invest in cleaner production facilities if it is demonstrated that the capital investment will generate improved production efficiency and higher profits over time

	Supply Chain	Non-Supply Chain		
n	14	65		
mean	1.5	1.8462		
variance	0.2692	0.5072		
pooled variance	3.4996	32.4608	77	0.4670182
mean1 - mean2	0.3462			
sqrt(1/n1 + 1/n2)	0.071428571	0.015384615	0.2946408	
t-value	**2.515940843**	*significant at 95% CL (t_{tab} = 1.68)*		
df (n1 + n2 - 2)	77			

Complying with the government regulation is the most important incentive in efforts to reduce pollution

	Supply Chain	Non-Supply Chain		
n	14	65		
mean	2.3571	2.5846		
variance	1.7857	1.3404		
pooled variance	23.2141	85.7856	77	1.4155805
mean1 - mean2	0.2275			
sqrt(1/n1 + 1/n2)	0.071428571	0.015384615	0.2946408	
t-value	**0.545448779**			
df (n1 + n2 - 2)	77			

A factory should invest in cleaner production processes regardless of the benefits because it is i the best interest of the public environmental health and future generation's welfare

	Supply Chain	Non-Supply Chain		
n	14	65		
mean	1.5	1.7692		
variance	0.4231	0.899		
pooled variance	5.5003	57.536	77	0.8186532
mean1 - mean2	0.2692			
sqrt(1/n1 + 1/n2)	0.071428571	0.015384615	0.2946408	
t-value	**1.116046314**			
df (n1 + n2 - 2)	77			

GOVERNMENT ACTION TO STIMULATE INVESTMENT IN CLEANER PRODUCTION PROCESSES IN FACTORIES (J7i TO J7ix)

Stringently enforce environmental pollution control regulations

	Supply Chain	Non-Supply Chain		
n	14	64		
mean	2	1.7969		
variance	1.6923	0.6406		
pooled variance	21.9999	40.3578	76	0.8204961
mean1 - mean2	0.2031			
sqrt(1/n1 + 1/n2)	0.071428571	0.015625	0.2950484	
t-value	**0.838957828**			
df (n1 + n2 - 2)	76			

Increase the amount of fines and severity of penalties for factories which do not meet pollution control regulations

	Supply Chain	Non-Supply Chain		
n	14	64		
mean	1.8571	2.25		
variance	0.5934	1.4603		
pooled variance	7.7142	91.9989	76	1.3120145
mean1 - mean2	0.3929			
sqrt(1/n1 + 1/n2)	0.071428571	0.015625	0.2950484	
t-value	**1.014962756**			
df (n1 + n2 - 2)	76			

Provide tax or duty incentives to reduce the cost of investment in cleaner production

	Supply Chain	Non-Supply Chain		
n	14	64		
mean	1.5	1.8125		
variance	0.4231	1.2024		
pooled variance	5.5003	75.7512	76	1.0690987
mean1 - mean2	0.3125			
sqrt(1/n1 + 1/n2)	0.071428571	0.015625	0.2950484	
t-value	**0.990692625**			
df (n1 + n2 - 2)	76			

Provide income tax breaks for factories which shift from polluting processes to cleaner productic processes

	Supply Chain	Non-Supply Chain		
n	14	64		
mean	1.3571	1.8281		
variance	0.2473	1.224		
pooled variance	3.2149	77.112	76	1.0569329
mean1 - mean2	0.471			
sqrt(1/n1 + 1/n2)	0.071428571	0.015625	0.2950484	
t-value	**1.510359029**	*significant at 80% CL (t_{tab} = 1.29)*		
df (n1 + n2 - 2)	76			

Increase income tax levied on factories which do not shift from polluting processes to cleaner production processes

	Supply Chain	Non-Supply Chain		
n	14	64		
mean	2.2857	2.3438		
variance	2.3736	2.0069		
pooled variance	30.8568	126.4347	76	2.069625
mean1 - mean2	0.0581			
sqrt(1/n1 + 1/n2)	0.071428571	0.015625	0.2950484	
t-value	**0.09514614**			
df (n1 + n2 - 2)	76			

Provide an investment facility for enabling financing of capital costs of cleaner production processes

	Supply Chain	Non-Supply Chain		
n	14	64		
mean	1.6429	1.75		
variance	0.2473	0.7302		
pooled variance	3.2149	46.0026	76	0.6475987
mean1 - mean2	0.1071			
sqrt(1/n1 + 1/n2)	0.071428571	0.015625	0.2950484	
t-value	**0.560518843**			
df (n1 + n2 - 2)	76			

Encourage local banks to extend more credits to SMEs at interest rates reasonably lower than market rates with longer repayment period.

	Supply Chain	Non-Supply Chain		
n	14	64		
mean	1.5	1.7813		
variance	0.2692	0.872		
pooled variance	3.4996	54.936	76	0.7688895
mean1 - mean2	0.2813			
sqrt(1/n1 + 1/n2)	0.071428571	0.015625	0.2950484	
t-value	**1.239973833**			
df (n1 + n2 - 2)	76			

Encourage banks and government guarantee institutions (like the Small Business Guarantee and Finance Corp.) to collateralize SME loans.

	Supply Chain	Non-Supply Chain		
n	14	63		
mean	2.1429	2.0635		
variance	1.5165	1.1895		
pooled variance	19.7145	73.749	75	1.24618
mean1 - mean2	0.0794			
sqrt(1/n1 + 1/n2)	0.071428571	0.015873016	0.2954684	
t-value	**0.215639668**			
df (n1 + n2 - 2)	75			

Provide technical assistance and training for factory owners interested in shifting from polluting processes to cleaner production processes

	Supply Chain	Non-Supply Chain
n	14	64

COMPUTATIONS 13 OF 26

mean	1.3571	1.6719		
variance	0.2473	0.8906		
pooled variance	3.2149	56.1078	76	0.7805618
mean1 - mean2	0.3148			
sqrt(1/n1 + 1/n2)	0.071428571	0.015625	0.2950484	
t-value	**1.366891712**	*significant at 80% CL (t_{tab} = 1.29)*		
df (n1 + n2 - 2)	76			