

Rural Electrification Now and Then: Comparing Contemporary Challenges in Developing Countries to the USA's Experience in Retrospect

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Despite its widely recognized importance, electricity is not yet available everywhere, and there are many areas of the globe which still depend on alternative sources of energy such as wood, charcoal and kerosene. In contrast, the USA was the first country to be fully electrified. This article explores the current challenges faced by developing countries, presents the historical evidence from the USA and compares these experiences discussing the policy relevance of the comparison. Far from being a smooth process, the electrification process in the USA was a long and complex transition. The article analyses the challenges and policy responses that characterized the US electrification process. One of the outstanding features of these policies is that they are quite comprehensive and include subsidies and credit schemes, house ownership policies, mass media campaigns, the provision of adequate repair service and the direct involvement of women.

Keywords: rural electrification; developing countries; US electrification; challenges

JEL Classifications: I38; L94; N42; N70; O13

I. Introduction

Energy is at the core of economic development and in the two defining moments of world economic history, the agricultural revolution and the industrial revolution, energy played a crucial role. In the former, through the development of agricultural techniques, human societies began to harness energy from the sun on a massive scale. In the latter, industrial processes have been developed through the exploitation of solar energy stored in fossil fuels.

One important aspect of modern energy systems – apart from the increase in amounts of energy used – is the improved quality of energy and its prompt availability throughout urban and rural areas. In this respect, the real last energetic breakthrough has been the process of electrification. Electricity is the most versatile form of energy used to ‘feed the socio-economic metabolism’ (Haberl, 2001) while being contemporaneously a

precondition to expand economic activities and the result of economic development. The fact that the process of electrification has been a major factor in social and economic development is evidenced by the result of a survey carried out in 1987 where researchers were asked to select the most significant technical advances of all time. Harnessing electricity received 37 per cent of the votes followed by antibiotics and vaccines with 14 and 11 per cent, respectively (National Academy of Engineering, 1990).

Enthusiasm for electricity dates back in time and in 1885, *Electrical World* reported a plan for lighting up the entire city of Paris using an artificial sun built with lamps of 200,000 candle power. This grandiose idea, which would turn night into day, proved to be impossible to realize because sufficiently powerful lights had not been invented yet (Nye, 1992). Notwithstanding the failed dreams of creating artificial suns, Paris is also known with the nickname *Ville-Lumière*. This nickname was earned twice, first because Paris was the place of birth of the Enlightenment, and second because of the city's early adoption of electricity (Beltran, 1985).

On the other side of the ocean, the USA stands out as the country that first completed the urban and rural electrification process (Nye, 1992). Electricity became commercially available in the 1880s and the electrification process ended in the middle of the following century when the grid reached virtually every rural community. Electrification in the USA did not spread evenly nor was it a smooth and spontaneous process (Tobey, 1996). Factories received electricity towards the end of the nineteenth century and urban businesses after 1910. Electricity became available to the majority of rural households and farms only after 1935 (Nye, 1992). In fact, the spread of electricity had diverse dynamics in urban and rural areas with nearly 90 per cent of urban dwellers having electricity already by 1930s, while in rural regions, by the same decade, only 10 per cent of rural households had electricity (Bowden and Offer, 1994). The main cause of this disparity was that rural private houses resulted particularly unattractive for the electrical market.

Since its beginning, the electrification process has been a driver of economic development and it has transformed everyday life. Electricity was necessary for the development of light and heavy industries (e.g. the automobile and aviation industries). At the same time, from a consumer perspective, the array of electric appliances, from fans and mixers to vacuum cleaners, refrigerators and washing machines, changed and eased domestic labour. Furthermore, the mass media revolution, with radio, films and recordings, transformed popular culture. Live entertainment events, could now also take place after dark hence increasing the number of potential attendees, an example of this was night baseball which was introduced in Cincinnati, Ohio, in 1935 (Boyer, 2001).

The electrification process in the USA was completed by the 1960s, almost a century after the process started: at that time all urban and rural dwellers in the USA had potential access to electricity. The process was accompanied and encouraged by an array of policies both directly relating to electrification, such as the subsidy schemes of the Rural Electrification Administration (REA), and indirectly facilitating electrification as exemplified by the house ownership policies.

Area	Population without electricity (million)	Electrification rate	Urban electrification rate	Rural electrification rate
Africa	587	41.9	68.9	25.0
North Africa	2	99.0	99.6	98.4
Sub-Saharan Africa	585	30.5	59.9	14.3
Developing Asia	799	78.1	93.9	68.8
China and East Asia	186	90.8	96.4	86.5
South Asia	612	62.2	89.1	51.2
Latin America	31	93.4	98.8	74.0
Middle East	22	89.5	98.6	72.2
Developing countries	1,438	73.0	90.7	60.2
Transition economies and OECD	3	99.8	100.0	99.5
World	1,441	78.9	93.6	65.1

Table 1: Electricity access in 2009, continents and regions.

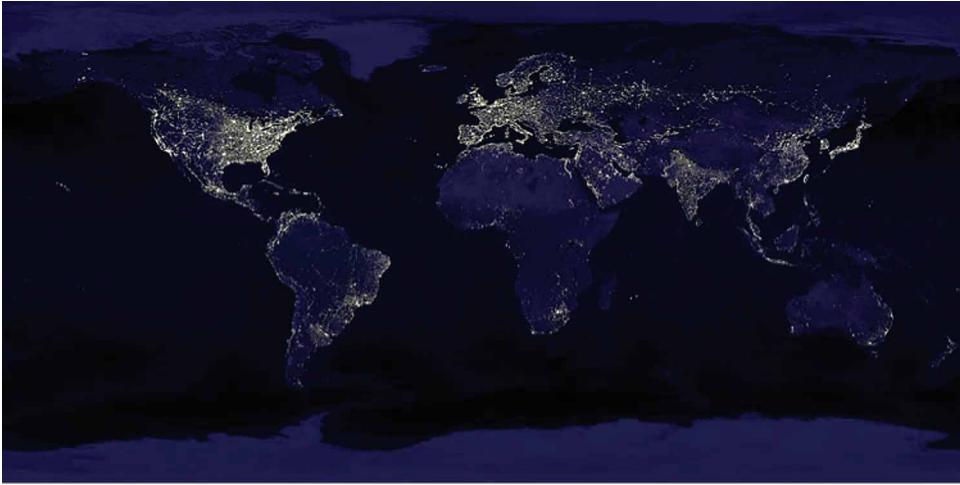
Source: International Energy Agency (2010).

The experience of the USA stands in stark contrast to the situation in rural areas of many developing countries nowadays – especially in Africa and South Asia – where full electrification is not yet a reality and energy poverty is exemplified by the lack of access to electricity (International Energy Agency, 2010). Looking at contemporary electrifications rates of developing regions, it appears that sub-Saharan Africa as a whole has electrification rates similar to the ones of the USA in the 1920s (see Table 1).

The global divide in terms of access to electricity is powerfully represented by a satellite night image of the world (see Figure 1). The image clearly shows how lighting is still not common in highly densely populated parts of sub-Saharan Africa and in Asia.

This divide in terms of energy and socio-economic causes and consequences has attracted considerable policy and academic attention. Development actors, such as the World Bank, have undertaken major projects in the sector to promote electrification, while also investing in research to estimate the most effective ways to promote electrification. However, evidence of the impact of policy intervention on the electrification sector is scant and a recent systematic overview and analysis of existing evidence concludes that ‘the evidence remains weak for many of the claimed benefits of rural electrification’ and suggests that projects should be designed in such a way as to facilitate their impact evaluation (World Bank, 2006). Implicitly, this conclusion also indicates a line of research where the assessment of alternative policy options and programmes is

Figure 1: Night satellite picture of the world. Note: Image by Craig Mayhew and Robert Simmon, NASA GSFC.



based on evidence collected globally on the outcome of recent or contemporary projects, i.e. on impact evaluations (Independent Evaluation Group, 2008).

In this article, the issue of electrification and related policies is approached from a different perspective: a historical overview of the electrification experience in the USA compared with the contemporary experience of developing countries that are now facing the challenges of the electrification process. This qualitative study is different from, but complementary to, the impact evaluation route. Through an analysis of the historical experience of the USA, it provides information on the nature and breadth of the policies that have been adopted over time and on the general characteristics of the electrification process.

This is the first article to study the case of complete electrification of the USA in the context of current experiences of developing countries. Despite the cultural and, to some extent, income per capita differences between the USA at the beginning of the twentieth century and developing countries currently experiencing the electrification process, evidence will show that the American example might help understand why the lighting revolution is not a simple process but rather requires a complex menu of inductive policies. The approach is complementary to studies (e.g. Cecelski et al., 2007; Foley, 2007; Sangarasri and Greacen, 2004; Tuntivate and Barnes, 2007) that discuss successful examples of contemporary electrification processes in developing countries. Acknowledging the fact that in the last few decades some developing countries have successfully provided electricity to their rural populations, e.g. Thailand, Costa Rica and Tunisia, and that very useful lessons can be derived from those cases, we look back at the experience of the USA to explore the process of electrification in a historical context and to determine the relevance of specific US policies.

The article shows that the electrification of the USA has been a rather long process which took decades to be completed. The success of the process was the result of evolving socio-economic conditions and several policy interventions. Many of the variables that played a role in the electrification process in the USA did not have much to do with electricity itself: cultural predisposition of people, house ownership, presence and penetration rate of mass media and emancipation of women. Several variables play an important role in the electrification process: standardization among houses, adequate and inexpensive repair services, government interest and policies, credit facilities, assumptions on return on investments and strength of competing technology. In this study, an overview is given of the role played by each of these variables both in the USA and in the selected developing societies in order to demonstrate that factors not apparently related to electricity played their part in the electrification process. Furthermore, the main challenges in contemporary rural electrification will be presented and matched with those the USA faced almost a century ago. Contrary to the mix of policies adopted by the USA over time, the current consensus considers the so-called market approach the best way to spread electricity, hereby simplifying the issue to having a product (electricity) and delivering this product to a market (typically the rural dweller of a developing country) (e.g. Reinmüller and Adib, 2002).

The timing of this article coincides with the ongoing and renewed interest in the sector: recently funded projects by the Dutch government have been launched to bring electricity in various forms to some rural areas in Africa and Asia.¹ At the same time, projects led by NGOs and private and public companies are in the process of lighting up other areas, and future projects are going to be launched soon in Benin, Guinea Bissau and Uganda. Yet another example is the project called *Lighting Africa*, jointly run by the International Finance Cooperation and the World Bank, which aims at accelerating the development of commercial off-grid lighting markets in sub-Saharan Africa as part of the World Bank's wider efforts to improve access to energy.

Following this introduction, Section II compares the USA at the beginning of the previous century to current developing countries with respect to income and electrification rates. Section III analyses the main constraints developing nations face when trying to fully electrify their territories. Section IV continues with a description of the electrification process in the USA focusing on the array of policies undertaken in order to speed up the penetration rate in rural areas and Section V concludes.

II. Progress on electrification now and then: GDP and electrification

Electrification rates and GDP in the USA between 1900 and 1960, representing respectively the starting and the ending years of the electrification process, are shown in Table 2 together with the same variables from 5 African and Asian countries based

¹See http://www.minbuza.nl/en/Key_Topics/Development_Cooperation.

Year	United States		Year	Burkina Faso		Ethiopia		Senegal		Rwanda		Indonesia	
	Ele. %	GDP		Ele. %	GDP	Ele. %	GDP	Ele. %	GDP	Ele. %	GDP	Ele. %	GDP
1900	2	4091	1997	6.2	851	n.a	605	26	1199	2.3	859	72	3703
1907	8	5065	1998	6.9	881	n.a	580	32.2	1211	n.a	677	n.a	3171
1912	16	5201	2000	n.a	898	12.7	611	n.a	1313	n.a	742	n.a	3276
1920	34	5323	2001	n.a	923	n.a	638	n.a	1337	6.2	774	84	3456
1942	50	9741	2003	11.4	996	n.a	587	36.8	1363	4.8	860	n.a.	3582
1960	95	11328	2005	n.a	1017	14	697	47.1	1439	6	943	87	4227

Table 2: GDP per capita during the electrification process in the USA, Burkina Faso, Ethiopia, Senegal, Rwanda and Indonesia.

Notes: 'Ele. %' indicates the percentage of households connected to the grid, 'n.a.' when data was not available. *Source*: Maddison (2008) for the GDP per capita computed in 1990 International Geary-Khamis dollars. Data on the electrification rate are from Nye (1992) for the USA and from Data Market (2012) for the remaining countries.

on recent data.² Three noticeable features emerge from the data: firstly, the per capita GDP increased over time both in USA and in the other countries. Indeed, apart from few exceptions due to contingent historical situations (the civil war in Rwanda and the post 1997 economic crisis in Indonesia) the per capita GDP and the electrification rate have increased continuously. Secondly, electrification rates, although with different speed, follow similar patterns in all 5 countries. It is worth noting that electrification was not a fast process in the USA and it is not particularly rapid nowadays either.

The third point is that there is a positive correlation between GDP growth and electrification rates globally, with the only exception of Rwanda (Table 2). This positive correlation – with bidirectional causality – is expected, but we can also see that it does not explain the whole variation across countries and time. Indeed, during the 1940s and 1950s, i.e. the two decades when the USA completed their electrification process and when the electrification rate almost doubled, GDP per capita increased only by about 15 per cent. Similarly, Rwanda is lagging behind Senegal in terms of the electrification rate, although the GDP difference between the two is not very large. The data also shows that developing countries are going through the electrification process at lower income levels today compared to the USA then. This could be related to a number of factors, including: (i) different relative prices that make electricity and electric appliances cheaper now compared to the 1940s and 1950s; (ii) changes to consumer preferences that now consider electricity more important; and (iii) higher investments made in the electricity sector.

The low speed of the electrification process seems to represent a common feature everywhere. If it took around 60 years for the USA to increase the electrification rate from 2 to 95 per cent, equalling a less than 2 per cent increase per year, the electrification process in the 5 developing countries shows similar trends with an increasing rate of approximately 1 per cent per year. Although there are differences among rural and urban dwellers, with the former lagging behind the latter in terms of the electrification rate, neither the environmental nor the economic problems associated with poor access to commercial energy are historically unique to developing countries. Between 1930 and 1960, the USA began specially funded programmes to electrify its rural areas and some European countries relied heavily upon their public utilities to provide universal access by the end of the first half of this century (Tobey, 1996). Even though 70 per cent of Indian rural population still remains without service, India has had a rural electrification programme for more than three decades and other developing countries have had rural electrification programmes for 20 years or more, often with the support of non-governmental organizations.

²The four African countries are Burkina Faso, Ethiopia, Senegal and Rwanda. These countries from the Sub-Saharan region are diverse – in terms of income and electrification rates – but none have completed the electrification process. Indonesia is the Asian country and it is included because its economy has shown a robust growth trajectory (and its income per capita is much higher than that of the African countries), but it has not completed the electrification process yet.

Region	Urban		Rural	
	1970	1990	1970	1990
North Africa and Middle East	65	81	14	35
Latin America and Caribbean	67	82	15	40
Sub-Saharan Africa	28	50	4	8
South Asia	39	67	12	25
East Asia and Pacific	51	82	25	45
All developing countries	52	76	18	33
Total served (in millions)	320	1100	340	820

Table 3: Percentages of urban and rural people served by electrification in developing countries, by region, 1970 and 1990.

Source: Barnes and Floor (1996).

III. Contemporary challenges to electrification

When looking at global data for electrification trends, we see that over the past 20 years, almost 1.3 billion people in developing countries have been supplied with electricity. Of these, 700 million lived in rural areas and 600 million in urban areas (Table 3). Over the same period, all regions increased the shares of households having access and nearly tripled the numbers of people served. The extraordinary achievement is magnified by the fact that the newly electrified dwellers represent twice the combined populations of the USA, Europe and Japan, testifying to the great efforts developing countries and their partners are making. Geographically, however, the process has been uneven and if China, on one hand, has accounted for nearly half the increase, service in Africa and South Asia, on the other, remains disproportionately low (Barnes, 2005). Overall, the progress in terms of electrification at the global level is driven by the progress of China and more recently of India, but a focus on less dynamic Asian countries and on sub-Saharan Africa as a whole denotes a less rosy picture with nearly half of the rural population of South Asia and more than 85 per cent of the rural population of sub-Saharan Africa still without access to electricity (Table 3).

The provision of electricity services – and the improvement of their quality – poses formidable challenges for many countries. While some of the problems are country specific, many of them are common to a number of developing countries. This article focuses on 5 issues that have been highlighted in the literature (see references below) and in the authors' experience as evaluators of electrification projects in Africa and Asia. Interestingly, some of the highlighted challenges were also faced by the US government back in the 1930s.

(i) *Rurality and electrification.* One of the main challenges faced by countries in the process of electrifying rural areas is the remoteness of villages and their distance to

power generating centres. Villages may be located at a considerable distance from the national or the regional electricity grids, they might be difficult to access (e.g. far from urban centres and with a difficult terrain with large rivers or jungles) or may suffer harsh climatic conditions – often the same factors determining low population densities.

Rural communities are, by definition, dispersed with a low population density and frequently characterised by a low level of education and income (Niez, 2010). This results in low levels of household demand for electricity that generally is concentrated at evening peak times. The low population densities imply that electricity distribution costs must be spread over relatively few people, resulting in high expenses for each unit of electricity consumed. Demand normally matures slowly as consumers wire their houses, invest in appliances, and make the switch from other fuels to electricity. As demand grows, the cost per customer for rural electrification declines. Unfortunately, this progression is difficult to predict, making returns to investment in grid extension uncertain. Combined, these conditions imply that relatively large investments in capital are required for rural electrification, combined with poor financial returns in the short run (World Bank, 2006).

Electrification programmes which have proved to be successful did not provide electricity uniformly to all rural areas. Among other factors, this has been due to investment costs, the number and size of local contributors, and the total number of potential consumers. For example in Costa Rica, rural areas have been prioritized according to their population density, level of commercial development and expected electricity demand. Similarly, in Thailand rural areas were ranked according to a variety of factors such as average household income, the number of existing commercial enterprises and the government's plans for investments in the specific area (Barnes, 2007).

(ii) *Affordability and credit.* The electricity pricing policy represents another major issue especially because households involved in the process are not wealthy enough to afford connections and electricity at prices that would be necessary to guarantee full cost recovery and profitability of investment.

High connection costs prevent most rural dwellers from electrifying their houses. When rural households in the villages of Mizque and Aiquile, Bolivia, were given the opportunity to purchase electricity services, 75 per cent of households refused the offer due to high connection costs (Torres, 1993). The Independent Evaluation Group report on the impact of rural electrification stated that in the Philippines 50 per cent of the households were connected within 3 years from the start of electrification thanks to a special line of credit that had been offered to interested households, and the total electrification rate reached 80 per cent just after 20 years (Independent Evaluation Group, 1994). In Thailand and India, there are still households in electrified villages that are not connected, even though the connection has been available for more than 20 years, because they cannot afford the connection fee.

Many electricity companies operating in developing countries have decided to finance the connection charges, allowing customers to pay back the costs in small

monthly instalments over a 5-year period. As a result of this financing scheme, the number of households that are able to purchase electricity services is likely to increase. Examples to support this are seen in the policy adopted by Yeelen Ba, a local company set up by a foundation called Rural Energy Services (Fres) in Burkina Faso, Mali and South Africa where it provides solar home systems. The idea developed by Yeelen Ba is that the customer rents the solar home system while Yeelen Ba remains the owner and assumes responsibility for its maintenance. Customers get a discount if they pay for a year upfront. Furthermore Yeelen Ba accepts delayed payments of up to 6 months if the customer signs a letter of commitment.³

Some governments have tried to make energy services more accessible and affordable to rural consumers by subsidizing them, and each country should be able to develop its own cost-saving strategies. In Thailand, electricity-related materials were standardized and manufactured locally, reducing procurement and transportation costs. In Costa Rica, the Philippines and Bangladesh, the adoption of the single-phase distribution systems, already used in the US rural electrification programme, brought major savings compared to the three-phase system currently used widely in Africa and elsewhere (Barnes, 2007).⁴ Lowering the cost of electricity provision may make electricity accessible to the poorer parts of a population, but if the process is not well directed it may prove unsustainable, and households that are larger consumers of electricity may end up benefitting more. For example, in Indonesia, subsidized kerosene for cooking and lighting is available to anyone, and richer households benefit from the bulk of the subsidy. In China, government subsidies keep the prices of household coal extremely low and consequently, Chinese urban households spend a comparatively lower percentage of their incomes on energy than do the households in other countries. Such general fuel subsidies have proven inadequate in benefiting the poor: the middle-class and comparatively wealthy households, who can afford to buy more energy than the poor, get a disproportionate share of the benefits. As a consequence, in addition to the economic inefficiency introduced by the subsidy, equity is not served. Also for rural electrification programmes, large subsidies have been ineffective in reaching the poor and in many programmes the poor face barriers of high connection costs or cumbersome application procedures (Barnes, 2005).

The affordability problem is often exacerbated by the lack of credit channels. For most people in developing countries, credit through formal channels is unavailable, except at very high rates. In some parts of Africa, for example, moneylenders charge interest rates of 100 per cent or more and access to credit is further limited by legal, regulatory and institutional barriers. However, emerging innovations in credit delivery systems, such as the Grameen Bank in Bangladesh and similar programmes, offer some

³From the website <http://www.fres.nl/nl/home.html> (accessed on July, 2012).

⁴The single-phase distribution system refers to the distribution of electric power using a system in which all the voltages of the supply vary in unison. Single-phase distribution is used when electricity is mostly used for lighting and heating purposes, with very few large electric motors.

promising approaches to providing short-term credit in rural markets. Although these programmes have been directed mainly at non-energy uses, similar instruments could be used to finance energy investments such as appliances and products (Mendis and Gowen, 1995). A recent study on approximately 1500 households living in the cities of Ouagadougou and Bobo-Dioulasso, Burkina Faso, highlighted that 80 per cent of them had difficulty in getting credit (Impact evaluation of improved stove use in Burkina Faso – Fafaso project commissioned by the Dutch Government, 2011). In rural Burkina Faso, another study on 1200 households in the province of Kénédougou, measured that 60 per cent of the interviewed households did not contract any loan in the last three years. Those having access to credit got loans from informal channels demonstrating that bank credit schemes, as well as credit offered by saving associations, are mostly inaccessible to poor rural dwellers (Impact evaluation of solar home system – Yeleen Ba project commissioned by the Dutch Government, 2011). Same type of evidences comes through the analysis of the Rural Income Generating Activities database, which collects households data for developing and transition economies (Zezza et al., 2011).

However, some poverty-oriented strategies, although confined to rather small intervention areas, are already in place. The Global Village Energy Partnership together with the Rural Energy Foundation, a Dutch NGO working to accelerate market development for solar energy in sub-Saharan Africa, offer standardized solar home systems to rural households with a 12-month credit facility. Furthermore, micro-credit institutions have become active within the renewable energy sector recently, and some of them have experience with lending programmes particularly suited for women (e.g. Grameen Shakti; IREDA; ENSIGN and Women's Union in Vietnam and Uganda; and the PV project with Uganda Women's Bank) (Cecelski et al., 2007). This said, a large share of poor households still has to finance the purchase of energy technologies through cash purchase. When the technology is proven and costs drop, systems may eventually become affordable for the poorest.

(iii) *Cultural barriers.* Despite the fact that having electricity is an appealing prospect for rural households, electricity programmes might meet resistance in some households resulting in a lower rate of electricity penetration. Women's position in particular is bound to influence the desirability and use of electricity for households. Electricity theoretically lessens the everyday burden of cooking, cleaning, washing clothes, etc., and these chores are typically done by women, who are also often the ones who spend more time at home compared to men. In patriarchal societies, where men are in charge of taking money-spending decisions, electricity-related expenditures do not receive the priority they would get had women been more involved in the decision process. For example, in Namibia and Swaziland, as a result of economic and traditional circumstances, woman-headed households constitute a large share of the population living in rural areas. While woman-headed households are energy users as much as male-headed households are, there is limited involvement of these in planning and

implementing most of the projects in the energy sector (Tobich, 2008). Women's exclusion from the planning process happens both at village and at household levels. An example of the former comes from the village of Uroa in Zanzibar which is nonetheless considered a success story due to the high level of both male and female participation in the electrification process (Winther, 2008). In the village, two important female institutions – the village mill and the kindergarten – still remain unconnected to the electricity grid whereas the male institutions such as the mosques and the fish market are connected (Winther, 2008). Turning to private consumption, almost all of the electric appliances owned by the rural electrified households interviewed in Uroa – incandescent lights, radios, fans, television sets, irons, freezers, fluorescent lights, fridges, water kettles, blenders and videos – had been purchased by men and were owned by them. Indirectly, however, women contribute substantially to the purchase of such appliances since women's income constitutes a large share of men's (Winther, 2008). Despite the women's positive evaluations of electric stoves, they find male resistance in using electricity for cooking because it is more expensive compared to free firewood (Winther, 2008).

(iv) *Institutional challenges.* One important condition commonly cited in the literature for the successful development of rural electrification projects is the need for good coordination among different institutions dealing with electrification issues. This represents a fundamental pre-requisite in order to guarantee that everyone has potential access to electricity (e.g. Haanyika, 2006; Urmee et al., 2009). Lack of coordination as well as unclear financing mechanisms can cause the failure of the project and may prevent shares of the population to have direct access to the electricity source. For example, in Ethiopia, government policy stresses the significant role of rural electrification in improving the quality of life in rural areas but, at the same time, the electrification process is left to the electric utility company without an appropriate budget provision from the government (Mariam, 1992).

In the case of South Africa's electrification programme, the policy of providing electricity specifically to the rural households has not been successful for reasons related to the availability of subsidies. In 2008, Eskom, the national power provider, launched a programme to subsidize solar water heating, but the subsidy level was too low, not clearly organized, required massive administration and control systems, and the programme has had little success. The implementation of renewable energy has been slow and the share of renewable energy in power supply is still insignificant (Niez, 2010).

Case studies on the electricity projects in Africa by the Global Network on Energy for Sustainable Development (GNESD, 2006) tried to explain the slowness of the electrification process showing the inadequacy of market-oriented policies which negatively affected the rate of rural electrification. For instance, the rural electrification rate in Kenya decreased from 16 per cent in 1993 to 8 per cent in 2001 and Zambia recorded no significant improvement in the level of access to electricity in

rural areas between 1990 and 2000, with access remaining at about 2 per cent (Haanyika, 2006).

Although China has made major efforts to restructure its energy system and has provided electricity to its remote areas, the country continues to present a strong urban–rural difference in electricity consumption with 11.5 million people still lacking electricity. One of the main problems faced by the Chinese government in providing electricity in rural areas has been the pricing mechanism for electricity: prices are still set by the government, meaning that power suppliers are not assured the necessary profits. This particularly affects the long-term investment security for investors in providing electricity. The Yunnan Province, the province with the highest rate of non-electrified households, is an example of this because it demonstrated that rural end-users limited their monthly electricity consumption to a level that made it completely unattractive to the electricity company to invest further in infrastructure and maintenance (Nie, 2010).

In most Asian countries, measures taken alongside or before reforms helped to widen access to electricity. In the Philippines, the reform measures facilitated an increase in the electrification process, with the rural electrification rate increasing from 2 per cent prior to 1998 to 3.5 per cent between 1998 and 2002. In Vietnam, the establishment of a special government department, created ad hoc in 1995 to follow rural electrification projects, helped increase the level of electricity access in rural areas from 50 per cent in 1993 to 77 per cent in 2001, and the rural electrification rate from 2.1 to 9.9 per cent during the same period (Asian Institute of Technology, 2004).

Naturally, government programmes in developing countries are not always marked by failures and there are many success stories: in Thailand, over 90 per cent of rural households do have electricity and in Costa Rica, cooperatives and the government electricity utility provide electricity to over 95 per cent of the rural population. In Tunisia, over 85 per cent of rural households already have a supply (Barnes, 2005).

IV. Challenges and policy responses of the US rural electrification process

Policy context: the rural electrification administration

In the electrification history of the USA, one government agency played a prominent role: the REA. Founded in 1935 under the Roosevelt administration as part of the unemployment relief programme, it became an agency fully devoted to the objective of electrification in 1936 (Rural Electrification Administration, 1982). The reasons that motivated the foundation of the REA were the socially and economically poor conditions of living of rural households at the time, together with the problems caused by the Depression and the dissatisfaction of the rural population with the slow progress of electrification. All these problems were reported in the Country Life Commission already in 1909. The Commission summarized the standards of living in rural areas and made several recommendations such as road improvement, better schools, the provision of a telephone system, and finally for an increased electrification rate using

cooperative organizations or power from government-owned hydroelectric power stations. In 1923, the Committee on the Relation of Electricity to Agriculture was formed with the precise idea of investigating the potential of rural areas as a market for electricity. On the basis of a simulation project it was found that agricultural production could be largely increased and costs reduced if only farms were electrified (Nye, 1990). The Roosevelt administration believed that if private enterprises could not supply electric power to the people, it was the duty of the government to do so. Electrifying farmers was a way not just to please a share of the American population but it bore also the idea of speeding up the agricultural production in the years after the Great Depression.

Barriers to electrification and policy responses

(i) *Rurality and electrification.* In the mid-1930s, the rural areas of the USA lagged significantly behind its metropolitan centres regarding their development status. Although electricity was supplied to quite a few urban areas in the country even before 1900, large rural areas did not receive any connection for many decades. Since the investor-owned electricity supply industry in the USA had always seen electricity as a commodity, private investors did not consider it neither economical nor attractive to invest in the rural market. In addition, most farmers were too poor to afford electricity. In 1900, only 2 per cent of farms had electricity and there was no prospect of more widespread electrification of rural areas (Nye, 1992). In this way, the unevenness of the development of the USA in the early twentieth century resembled that of many developing countries today, with some potential lessons for today's rural electrification programmes to be learnt (Barnes, 2005). The policy response of the US administration was to establish the REA: a specialized administration that set up and implemented a policy framework to promote rural electrification.

(ii) *Affordability and credit.* Many farmers were reluctant to request power service because of the high costs. Other households lacked knowledge about the variety of ways in which electricity could help them with so many of the tedious farm chores (Rose, 1940). Many farmers were initially reluctant to spend money on electrifying their farms, feeling that the labour-saving appliances were luxuries they could not afford. The post-war prosperity of the 1950s allowed them to dissipate a little, opening the door to easier lives as new washing machines and electric stoves were purchased (Champ, 2001).

One of the greatest successes of the REA was to provide electricity to rural households creating ad-hoc financial plans for those dwellers who could not, in principle, afford the connection and allowing different regions of the USA to tackle the process in a more adequate way. The main objective of the REA was to find funds for cooperative associations formed by rural populations and hence to financially support electrification in rural areas. Besides this, the REA provided loans at low

interest rates and assisted the cooperatives in matters concerning technical, legal and accounting issues. For many years, the interest rate was 2 per cent, and since 1945, the maximum payback period has been 35 years. The REA, whose subsidy plan was relatively easy, has funded over 1000 rural electric cooperatives and only two loans, representing a negligible amount, have been foreclosed (NRECA International, 1999). From 1938, REA had a revolving fund out of which new loans could be made. By the 1960s, the REA achieved its original objective in electrifying the rural areas of the USA but the REA and its subsidies continued its efforts to expand the electric system and to reinforce the electricity supply, which still needed appropriate funding.

Farmers could also access credit provided by many local dealers (Nye, 1992). That was the case for households that wanted to be connected to electricity but were too far from the mainline, or lived in areas where not enough neighbours had electricity. Farmers were then encouraged by government representatives to apply for a loan in order to receive electricity supply. Although most people were thrilled about receiving electricity, the REA had to fight minor resistance and the REA staff offered specific lessons on electricity use and electricity guidance. Classes proved to be more beneficial in the presence of the farmers' wives (NRECA International, 1999). In addition, everyone using an electrical water heater received a credit, since these kinds of appliances were normally used in the evening when demand was lower (Devine, 1983). Through these multiple credit line facilities, the number of electrified farms increased and their average monthly consumption rose each year from 1936 to 1941 (NRECA International, 1999).

By the mid-1950s, the Electricity Corporation introduced a credit policy which allowed 60 per cent of the farmers in the soon-to-be-electrified areas to finance their initial capital construction through a loan plan. Under this plan the farmer paid 25 per cent in cash with the remainder to be paid over a period of 6 years at a 5 per cent interest rate (Champ, 2001).

When rural electrification on a massive scale came to a close at the end of the 1950s, it was calculated that the total cost of the programme was US\$ 47.5 million of which farmers contributed just over US\$ 25 million (White, 1968).

(iii) *Culture*. Electrification was not perceived by all American farmers in the same positive and enthusiastic way. We know little about rural people's perceptions before electricity was assured but anecdotal evidence points to tactics such as refusing to sell land for the construction of power lines being very common, as well as general resistance to the electrification process.

When people were asked how electrifying their houses changed their life, some US rural farmers answered:

[...] electricity made the housewife's chores lighter and enabled us to have time for outside activities like doing community and charitable work. Electricity brought inside

the house the outside world, making our children more advanced in their education. For what concern the men of the family, electricity enabled them to accomplish more work in less time and also to spend more time with their families.

Electricity also facilitated increased sanitation level, more leisure time, and a general rise in the standards of living (Wolfe, 2000).

Notwithstanding the changes brought by electrification, not all the ex-ante expectations were fulfilled. Many authors, writing novels about how electricity played a central role, argued that electricity could prevent divorce and would permanently liberate society from darkness. Clergymen focused more on the apocalyptic aspects of electricity since the ‘electricity stored in the earth will come in contact with the heated matter inside and blow the whole world up’ (Nye, 1992). Many other people complained that the brightness of the light fixtures would hurt their eyes and that the radio corrupted their homes with its dancing music and detective stories. It was quite common that grandmothers complained that cookies did not have the same taste when cooked on the electric range and that they kept both their woodstove and the new electric range for the rest of their lives. The wiring process of houses shows that electricity continued to be viewed as something difficult to get used to: overhead lights were hung only in the living room, kitchen and the grandparents’ bedrooms. ‘The other rooms’, the grandmother claimed, ‘were just for sleeping’ (Wolfe, 2000).

The gender dimension of electrification in the USA also played a role. There is anecdotal evidence that not all housewives were particularly happy about having electricity at their disposal. Women were tied even more strongly than they had ever been before to their cast-iron hearths. Fruit preserves, cakes, jams, clean and ironed clothes and freshly baked bread may have made life easier and more pleasant for the family members, but all those activities kept women working more at home. There is some evidence showing that the condition of domestic life during the first phases of electrification required women to spend more time at home in order to protect the standard of living of their families. When women were not fully devoted to their husbands’ and children’s lives, then meals were irregular, infant mortality was higher, clothes were not ironed and often dirty, and houses were poorly maintained. One American citizen felt she could not estimate the time saved because of the changes in her work pattern: ‘Hours and hours? That would be impossible to estimate because we would not have waxed floors if we did not have lights, or have a lawn if we were without an electric pump for watering’ (Wolfe, 2000). Since American women had already gained influence over decisions made at the household level for a long time, the REA also had specific campaigns targeting women, through the use of booklets and ad-hoc conferences, to convince them of the advantages of electricity, and to give a glamorous image of electrified houses.⁵ By the turn of the twentieth century, while the

⁵See, for example, the impressive REA artwork at http://www.smecc.org/rea_posters_artwork.htm (last accessed in July, 2012).

science programme in Denver's Manual Training High School prescribed the study of the dynamo and motor (courses mainly attended by male students), other schools, mainly attended by women, introduced subjects such as economy in food preparation and the physiology of the digestive process in conjunction with sanitation, ventilation, and the art of cleaning using new electrical devices. These courses were fundamental in a time where improvements in stoves, distribution of processed foods, including canned goods, refrigerated and preserved meat, and the introduction of ready-to-eat cereals, transformed the meal preparation (Rose, 1940).

The REA agents took into account farm women's legitimate fears of electricity in both the popular farm press and agricultural bulletins by instructing them on the safe use of their appliances. As an example, the journal *What the Homemaker Needs to Know About Electricity* taught housewives the meaning of volt, amp and ohm. Several editions of a *Purdue University Extension Bulletin* instructed women not only how to select their electrical appliances, but also how to safely remove plugs from wall outlets (Davison, 1930).

Regardless of the housing condition, the amount of money needed to be able to electrify houses and the preparation received, not all US farmer households had a desire for electricity, or at least they did not feel electricity to be particularly useful in their agricultural activities.

A study in North Carolina evidenced that all participants agreed that electricity belonged to the house, not the barn. Both the private utility representatives and extension agents had accurately recognized that farm families cared more for electric light than for electrically powered farm implements. The willingness of these households to invest in household conveniences and comforts rather than agricultural production equipment challenges our understandings of patriarchy on the farm. The girlhood memories of Shirley Collier pointed out this issue. Collier attended an electrified school but lived with her grandparents in an old-fashioned house. Her grandfather desperately wanted electricity for its better lighting, but apparently could not afford a generator. Her grandmother, on the other hand, did not discuss electricity, but Collier recognized that her grandmother's silence may have indicated her grandfather's role in purchasing decisions rather than her grandmother's lack of interest. Her grandfather mainly valued the lighting and labour-reducing aspects of electricity for house activities rather than for agricultural related activities; he continued to use a lantern in the barn for the rest of his life. After the high-line arrived to their house in the mid-1940s, other relatives began to speak against the new technology (Rogers, 2001).

Electrifying the rural USA was a task facilitated by a large propaganda effort financed by the government. As soon as the REA planned the first connection schedule of rural farmers, the Power Corporation initiated a number of promotional programmes at the end of the 1930s to increase awareness about the benefits of farm electrification. Additional staff was hired to organize rural electrification field days and demonstrations at agricultural fairs throughout the USA (Krause, 1996–1997). The REA was off to a strong start in the early 1940s, but its success was by no means assured. For many

farmers, especially straight grain farmers, a number of electrical appliances and equipment seemed unnecessary. Given the high cost of bringing power to rural areas of the USA, it was difficult for many farmers to see the financial benefits that might accrue from the initial investments of wiring buildings and purchasing household and farm equipment. Simply making electricity available to agricultural households was seen to be insufficient: rural dwellers had also to be educated in its use because there was a serious lack of appreciation for electricity compared with other services. Every farmer who received service was given a free subscription to the American magazine called *Electricity on the Farm*. Other magazines and booklets were distributed, emphasizing the role of electric power in making farming more profitable. 'Machines have helped to make farming better, easier and more profitable', page 1 of the booklet reminded farmers, '[t]he disturbing truth is that we, as an agricultural nation, are far behind in our use of electric power [...] one of the most effective ways known for reducing farm labor and raising net farm income' (Champ, 2001).

Overall, the REA understood that once farmers, both men and women, would change their attitude towards electricity and no longer referred to it as something mysterious and dangerous, they would be willing to connect their houses, consume more electricity and demand more toasters, mixers, irons and washing machines. Soon enough, resistance to electrification coming both from inside and outside the household was defeated. Kerosene and gasoline stoves, which had been on the market for several decades, were not appealing anymore even when refineries began to give them away for free or at much lower prices in order to stimulate demand for their fuel (Cowan, 1979).

(iv) *Institutional challenges*. Although times were sometimes turbulent and the electrification process were not overall an easy task to fulfil, it appears that the American Rural Electrification Programme proved to be a success because its creation facilitated the provision of electricity in rural areas of the USA, an objective which, for various reasons, had failed in the preceding years (NRECA International, 1999). Indeed the institution of the REA in 1935 coincided with a considerable speeding up of the rural electrification process. The REA operated under administrations of different political leanings, received steady support and was able to continue its mission through several decades. The stability of the institutional environment is demonstrated by the fact that the REA continues to exist today, well after its basic purpose has been achieved. The institutional stability of the REA is a key characteristic to understand the success of the electrification process in the USA. Through the REA, the majority of American farmers were able to get an electricity-related loan at a reasonable interest rate from the mid-1930s till the beginning of the 1980s. As of December 1981, approximately 21 million dollars were given in the form of loans to households who wanted to electrify their household or farm (the highest amount of money were given in Kentucky, with 3 million dollars of loans) (United States, Department of Agriculture, 1982). The status of independent lending agency allowed the REA to survive across many governments and political turmoil. This is clearly in contrast with the degree

of volatility and other challenges marking the institutional environment of most developing countries (Pellegrini, 2011; Rose, 1940).

(v) *Specific challenges: housing, lobbying and technical capacity.* The major problem, however, was represented by the housing condition and the material used to build houses back in the first half of the twentieth century. House ownership represented a major issue since, in the 1940s, only 55 per cent of Americans owned the house they lived in, and most rural Americans were not willing to face major investments related to electrification. A preponderant number (82 per cent) of these houses had exterior wooden walls and they were not ready to be wired. Brick houses represented just 11.3 per cent of buildings, while houses having *stucco* amounted to 4.2 per cent. Although the exact amount of money needed for electricity-related works is not available, the statistics on the state of repair showed that almost 2 of every 10 dwelling units in the USA were in need of major repairs (Brunsman and Lowery, 1943). This average increased to about 4 in every 10 houses in rural areas (Brunsman and Lowery, 1943). The REA launched policies in favour of house tenancy and it eliminated frictions in villages among opponents and supporters of electricity (Rose, 1940). The REA understood that even small details would play a crucial role in helping the electrification process succeed: a house built by the REA did not just look fancy, its foundation was solid too.

On average, the US housing conditions during the electrification era were better than the ones found today in rural areas of Africa and South East Asia. Although the segregation of most African Americans had been an almost permanent feature of housing patterns in the USA with tangible effects on the quality of their homes, a number of government agencies, such as the US Housing Authority, were formed in order to improve housing conditions for low-income Americans from the beginning of the 1930s (Massey and Denton, 1993). The house ownership rate among USA on one side and African and Asian citizens on the other does not differ significantly: 50 per cent of American residents used to live in property houses and the same percentage of African and Asian households have been reported living in their own houses (Gwin and Ong, 2004). What jeopardizes the electrification process in rural developing areas the most is the material used for building houses because most of the dwellings are constructed with mud, concrete and sheet metal, thus requiring additional stabilization works before being electrified (Gwin and Ong, 2004).

The history of electrification in the USA also met the needs of the environmental movement, because the smoke produced burning fossil fuels had a detrimental impact on urban health and living conditions. Electricity was promoted by the anti-smoke movements as the preferred medium to feed energy in the cities because energy generation – through thermoelectric power plants – would be moved outside of urban centres. The lobby against electrification tried to demonstrate that health ailments were not related to emissions coming from smokestacks and other coal consuming sources, but rather dependent on lifestyle choices. Railway companies were an essential part of this lobby and posed the issue as an economical choice advocating

that electrification was simply not feasible. These lobbying activities resulted in controversies that involved the environmental coalition including women groups along with scientists on one side and on the other a coalition of business interests that managed to produce ad-hoc technical expertise to question the damages produced by air pollution. The intense lobbying activities managed to delay some electrification activities in specific areas, but did not succeed in stopping the process altogether (e.g. Gorman, 1999; Rosen, 2009).

Other policy measures included several types of training. Courses in rural electrification were organized and fundamentals of electricity, simple circuits, kilowatt-hour, volt, amp and ohm, and how to use meters were taught. Courses directed at farmers focused more on the use of electricity in livestock and poultry raising, on the electrification of the farm shop and on the farm welding.⁶ Other courses targeted women and stressed the healthy connotations linked to electricity and on how to eliminate sudden explosions of electrical appliances (Cowan, 1979).

V. Historia est Magistra Vitae [History is life's teacher]

The pace of rural electrification in many developing countries has been painfully slow and in many African and South Asian countries, it has proved to be even lower than the rural population growth. Programmes aiming at electrifying rural areas of the developing world face major obstacles. The low population densities in rural areas result in high capital and operating costs for electricity companies and very low return to investments. Consumers are often poor and their electricity consumption is low. Political institutions often interfere with how the programmes are planned and run, and different politicians have completely different points of view thus changing directions. The overall result is a never-ending negative spiral: rural areas still lack electricity, agricultural productivity does not grow fast enough, women are not empowered, and household members keep breathing firewood fumes.

A number of studies are being carried out – using mostly quantitative techniques – to examine the impacts of electrification programmes and the conditions that make their success more likely. While literature is useful and can shed light on several specific aspects of the challenges to electrification, at the same time, these studies cannot – because of their narrow focus – address more fundamental questions related to barriers to electrification and ways to overcome them. This study – by introducing the historical experience of the USA in a comparative setting – wishes to contribute to a long overdue debate on the most appropriate strategies to promote electrification. This article focuses on the characteristics, challenges and policy responses developing countries are now facing in the attempt of electrifying rural villages and matches them with the characteristics, challenges and policy responses that the USA historically

⁶From *Schedule of Instruction – Rural Electrification Short Course, March 3-15, 1952*, at C.V.T.S., Saskatoon, in UA: Directors'/Deans' Office Collection, Extension Division: #2106, XXX, K.1.i, *Rural Electrification – 1950–1957*.

Issue	Policy response
Rurality	The REA was set up to deal specifically with the problem of rural electrification
Affordability and credit	Subsidies were provided to farmer cooperatives. Money was lent to farmers at low interest rates and with long payback periods
Culture	Ad-hoc press campaigns, booklets, entire magazines published articles on electricity use. Women were particularly targeted
Institutional challenges	The REA was a government agency that received bipartisan support and is still operational after its main mission has been accomplished
Specific challenges	Household members were instructed how to use electricity properly in order to avoid explosions. Conferences and specific courses were organized

Table 4: Major and minor electrification policies in USA.

faced in its process of electrifying its rural areas. It argues that the main distinctive aspect of the policies put in place by the US government lays in the fact that those interventions went beyond simple policies focusing on specific aspects of electricity provision and marketing, but rather dealt with the barriers to electrification in a comprehensive manner (review in Table 4).

This article does not argue that the economic situation and policy responses to the electrification challenges of the USA apply *tout court* to any developing country, rather it cautions against an interpretation that goes in that direction. The proposition is that the study of historical experiences related to the electrification processes is interesting per se and can provide useful insights and solutions to many challenges currently experienced by developing countries.

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