Westfälisches Elektrizitätswerk A.G., discussed the construction costs of nuclear power stations and urged that they must take care that excess environmental precautions serving no useful purpose were not thrust upon constructors. This could greatly increase construction costs and the economic benefits gained from nuclear power would be lost. A degree of standardisation would enable a saving of time and money in construction. Mandel again made the now familiar point that European civilisation was in danger if its energy requirements were not met. There was, according to Mandel, no clear economic reason why it should do without nuclear energy.

In an afternoon discussion on nuclear energy economics the question of nuclear power for the less-developed countries was introduced. Mr Krymm from IAEA said that it was very difficult to generalise about LDCs. There were several constraints to their development of nuclear power. One was the difficulty in getting people to construct small units (less than 400 MW). Another difficulty was in training, siting and operating the plants, a third was financial, and lastly there was the problem of the security and price of fuel supplies.

The Wednesday and Thursday mornings were devoted to reporting on and discussing operating experience with the various reactors. Tuesday, Wednesday and Thursday afternoons were taken up with parallel sessions where detailed technical discussion of the many aspects of nuclear power were discussed. Design, construction and operation of power stations; fuel performance, management and fabrication; licensing, financing and insurance; and safety, protection and radioactive wastes were among the topics discussed in some 350 papers presented at the parallel sessions.* It was these technical discussions which, of course, made up the bulk of the conference.

Public opinion

In looking back on the conference and its importance for energy policy it is important to remember that it was a scientific and technical gathering. It is unfortunate that despite exhortations from the platform it was still an inward-looking gathering. Several prominent delegates felt that it had ducked the issues involved in a large nuclear power programme. The public concern about nuclear power and opposition to it does not just centre on technical questions. It reflects much broader concerns about the nature of our societies and the alternative development paths available. As well as technical questions about the safety of design, operation and fuel cycles, etc, there are vital philisophical questions about the nature of nuclear power, such as whether it is qualitatively different from other forms of power. There are also social and political issues inherent in continuing energy growth and economic growth, and whether this is either possible or desirable.

Although there is little concern and opposition in Europe at present it is likely to grow if the warnings of the American speakers are any guide. An anti-nuclear demonstration organised by Les Amis de la Terre took place in Paris following the conference: perhaps a portent of things to come.

Geoffrey W. Tansey

* The papers were published as Vol. 20 of the ANS Transactions pp 1-820 and distributed to the delegates. The full conference proceedings, including discussion, will be published by Pergamon Press in late 1975.

Energy resources and energy demand

Two workshops organised by the International Institute for Applied Systems Analysis, one on methods of assessing energy resources, the other on energy demand, *Laxenburg, Austria, 20-23 May, 1975*

The IIASA is a non-governmental organisation founded through the agreement of prestigious scientific institutions from 14 countries – the USSR, the USA, countries of East and West Europe and Japan. Its interdisciplinary research has to be susceptible to applied systems analysis and of interest generally to its member organisations. It is therefore concerned with science-based problems affecting life and living in the industrialised world, including the availability and use of energy.

The energy project was initiated in the summer of 1973 and is concerned with researching 'the entire range of intermediate to long term energy policy options' on both the supply and demand sides; the Institute's energy project staff numbers 20, under the direction of Dr W. Häfele of West Germany.

These two workshops were organised not simply to bring together participants from some 30 countries so that they could interact with one another, but also to provide a background of papers from over 60 contributors as a basis for indicating major areas of energy problems that the Institute's staff might then wish to develop further. Given this pattern of organisation, the wealth of material presented at the workshops seems likely to achieve a more permanent exposure to critical examination than is normal in the case of *ad hoc* conferences, after which continued contact is hampered by the participants being dispersed over continents in their own institutions and research groups.

The listing of the authors and papers at the end of this report gives a clear impression of the range of energy questions which were under discussion at the workshops. There was, however, a strongly unifying theme in the energy resources workshop – that of methods of assessing resources. In this context coal, oil and gas and uranium all received attention. Developments in the methodologies whereby the world's plentiful supplies of coal and uranium can be recognised and evaluated were presented – with some areas of disagreement as to quantities involved and how the calculations might best be made. In this respect some of the general

theoretical and empirical papers on resource assessments offered hope for a diminishing of these controversies in the future. It was, however, on the question of the world's hydrocarbon resources – and their occurrence in particular regions – that the greatest amount of controversy was stimulated, with a clear division of view between the traditional geologists, on the one hand, arguing the need for specific geological evidence before anything useful could be said on how much oil and gas there might be in a province, and the probabilistic modellers of oil and gas occurrence, on the other, arguing that experience in other places and at other times allowed analogues to be developed which could predict the magnitude of likely occurrences in new areas.

The other main debate was over the total likely oil (and gas) reserves. Dr Sickler of Shell put the conventional big oil company view that there are 2000 million barrels of oil and 5000×10^{12} cu ft of natural gas to be exploited, whilst Dr Grossling of the US Geological Survey put the range of likely ultimate reserves as starting well above the Shell figures and going to figures $3\frac{1}{2}$ times higher in the case of oil and 6 times higher for gas! Here is an area for dispute which really does have a fundamental impact on the energy options open to society, not in the 21st century but in terms of what needs to be done or does not need to be done right now for ensuring the availability of energy for the next generation. In discussion Dr Sickler agreed that his figures are not really ultimately recoverable reserves of oil and gas, but Shell's expectations as to how the situation could develop up to the year 2000 under certain assumed economic, political and technical conditions. Perhaps this turned the discussants more in favour of oil and gas as 'nearly unlimited energy resources' for at least the next three generations!

In the energy demand workshop there were both discussions on the general problems involved in relating the growth in energy use to economic development and to societal structures, and presentations on particular cases not only at country and regional levels but also in terms of particular sectors. The range of papers showed that the options open to the industrialised world for adjusting the demand for energy are much wider than are presented in the current debates on the subject viewed in a short-term context. But the difficulties involved in achieving a serious discussion on the range of options let alone the actions required to implement some of the 'more extreme' ones – such as the Swedish low-energy society proposal – are great in light of the conventional economic approach to the role of energy (as just another commodity) in the economy and the whole complex of political, social and psychological factors which are involved in peoples' decisions to do things in a particular way or to travel by a particular mode of transport.

The 'revolution of rising expectations' is perhaps most emphatically expressed in the right to use energy, which makes the control of energy use in rich, consumer societies well-nigh impossible to implement without a greater shock to the system than has yet been imposed by politically inspired energy shortages or by fears of energy shortages in the middle of the next century. And if, as the workshop on resources appeared to show, the latter is likely to be a non-event, then control on the use of energy is as yet unanswered problem – if indeed it is a problem at all.

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Energy Resources

Session I. General: classifications and activities (Chairman: M. King Hubbert)

M. Grenon, *Resource studies in the IIASA Energy Project*

WEC *WEC activities in the field of surveying world energy resources*

K. Patyi, *Decreasing role of resources in Hungary*

M.F. Searl, *Resource assessment: toward better methodologies*

J.J. Schanz Jr., Problems and opportunities in adapting USGS survey terminology to energy resources

M. Modelevsky and V. Pominov, *Classification of petroleum resources and reserves in the USSR and its comparison with classification used in other countries*

M. Albegov, *A system approach to economic estimation of fuels*

Session II. General commentary on analytical modelling for resources (Chairman: Acad. M. Styrikovich)

B.F. Grossling, *A probabilistic model of resource assessment*

G. Baecher, *Subjective foundations of exploration for resources estimation*

G. Gess, *Geological aspects of resource assessment*

G.M. Kaufman, *A comparison of models for estimating undiscovered oil and gas*

Session III. Coal resources (Chairman: Dipl.Ing. L. Petras)

G.B. Fettweis, *Contributions to the assessment of world coal resources or coal is not so abundant*

K.J. Englund *et al, Coal resources assessment in the United States*

P. Kausch *et al, The brown coal resources of the Rhineland: geology, mining and utilisation*

N. Bonneau, *Classification of French coal resources*

Session IV. Petroleum resources (Chairman: J. Masseron)

R.A. Sickler, I. *Methods and models used to arrive at an estimate of world petroleum resources* II. *A survey of petroleum resources in the world outside communist areas*

P.R. Rose, *Procedures for assessing US petroleum resources and utilisation of results*

M. Modelevsky and I. Fainstein, *Some models for long-term forecast of raw material provision for oil and gas production.*

E. Barouch and G.M. Kaufman, *A probabilistic model of the oil and gas discovery process*

Y. Rosanov, *On a hypothetical prototype of a probabilistic model of undiscovered resources*

R.E. Roadifer, *A probability approach to estimate volumes of undiscovered oil and gas*

K.J. Roy, *Hydrocarbon assessment using subjective probability and Monte Carlo methods*

Funck, *Mathematical methods for oil reserves*

P.R. Odell, *The North Sea oil province: a simulation model of its development and exploitation*

G. Baecher and J. Gros, *Extrapolating trending geological bodies*

Session V. Geothermal and uranium (Chairman: J. Cameron)

J.P. Herault, *Evaluation of geothermal low enthalpy energy resources*

J. Cameron, *A review of long-term uranium resources, problems and requirements in relation to demand, 1975-2025*

W.I. Finch and R.W. Schnabel, *Uranium resources, reserves, and methodology*

J. Brinck, *Uranium resources assessment with Mimic*

S.H.U. Bowie, *Some facts and fancies on uranium availability*

A. Brin, *Uranium from sea water*

Conclusions of the Conference by Academician M. Styrikovich.

Energy Demand

R. Bauerschmidt, *Introduction to methods used in the World Modelling Project concerning energy demand (Pestel-Mesarovic study)*

E. Berndt, *Macro model industrial and residential demand for energy*

J. Bouchet, *Electricity and energy savings in industry*

J-P. Charpentier, Toward a better understanding of energy demand

R.T. Crow and B. Ratchford, *An econometric approach to forecasting the market potential of electric automobiles*

F.W. Gorbet, *Energy demand projection for Canada*
J. Filipowicz and A. Kos, *Some problems of energy demand in Poland*
D. Finon, *Energy demand and optimisation of the energy choices*
J.R. Frisch, *About some energetical paths for the 21st Century*
R. Hamilton, *Energy prospects for the OECD area to 1985*
F. Hoffmann, *Long-term tendencies of energy demand and supply in the Federal Republic of Germany*
J.D. Khazzoom, *An application of the concepts of captive and free demand to the estimation and simulation of energy demand in Canada*
I. Lencz, *Prognoses of energy consumption especially electrical respecting social and economic development methods and experience*
M. Lönnroth, Energy and society – a Swedish study on major aspects that decide the demand for energy
G. Mäler, *Swedish energy demand, models used*
E. Medina, *International comparisons of energy consumption related to gross national product*
P. Morin, *Influence of prices on the consumption of energy*
T. Mount and L.D. Chapman, *Electricity demand, sulphur emissions and health; a model of power generation in the US and the policy issues raised by its application*
W.D. Nordhaus, *The demand for energy: an international perspective*
K.S. Parikh, *India's fuel needs and options*
W.A. Ross, *The real limits to growth*
M. Slesser, *Dynamic energy analysis as a method for predicting energy requirements*
L. Taylor, *Decreasing block pricing and the residential demand for electricity*
G. Tintner and G. Wörgötter, *The demand for energy of private households*
P. Tsvetanov, *Problems of energy demand analysis*
A.G. Vigdorchik and A.A. Makarov, *Methods of calculating power consumption in the USSR*
L. Waverman, *Residential, commercial and industrial demand for energy in Canada: projections to 1985 with three alternative models*

Book reviews

THE SOVIET ENERGY BALANCE: natural gas, other fossil fuels and alternative power sources

by Iain F. Elliot

277 pages, £8·00, Praeger Publishers, New York, Washington, London, 1975

This important and useful book attempts a comprehensive coverage of the Soviet energy balance and brings together a vast array of recent data. A short introduction on the energy mix as a whole is followed by exhaustive chapters on the individual fuels, a much briefer look at electricity and alternative power sources and a somewhat more detailed treatment of the complex subject of energy utilisation which also gives some consideration to regional variations and the importance of trade.

Fuel Facts

In the introduction it is acknowledged that since 'the Soviet economy permits (at least in theory) the planning of a single integrated energy system for the whole country, no one resource should be considered in isolation'. However, Elliot makes only a minimum effort to find such interconnectivity in the management of energy resources. Specifically, he attempts no analysis of how and to what degree essential economic concepts are used by Soviet decision makers in solving the inter-fuel, inter-sectoral and regional allocation-substitution problems that confront central planners at every step in formulating a more or less comprehensive energy policy. His more straightforward (and perfectly worthy) aim seems to be the careful and detailed elucidation of physical quantities produced, transported and, for some fuels, used in various sectors and regions and the presentation of the published costs of individual fuels.

This more straightforward task is generally accomplished very well, though several shortcomings must be noted. In his cost figures the author does not venture to clarify what interest charges are used in the Soviet data. Since the charge for capital is a crucial component of total cost and one which is not consistently employed in Soviet literature, this omission seriously impairs the usefulness and comparability of the data. For example, comparable costs on pages 208 and 272 do not match, and the two citations *from the same source* to average delivery costs of several fuels in conventional tons (pp. 233 and 235) are widely different, most likely for the reason mentioned. Nor is there much meaning in the reference to savings effected through the replacement of coal in the European USSR by various energy forms from beyond the Urals without knowing what investment charges are used for their production and transport and whether these charges are consistently applied. I also find the total omission of petroleum refining from the analysis disappointing. Since oil is not used in the crude form and the refinery mix is a crucial component of the fuel balance, this defect is difficult to excuse.

Electricity

The short, though careful and precise, section on electricity suffers from an exclusively production-oriented approach. Because, unlike fuels, electricity is non-storable and because in the USSR the productive fixed assets of that industry well exceed those of *all* fuel industries combined, no appraisal of this energy branch is possible without some attention to capacity and load factors and system intensity. These today are available for most republics and economic regions, several interconnected systems and even for a few individual plants. In contrast to the chapters on fuels, Elliot ignores the large amount of useful data available in the technical journals and related literature. Furthermore, his failure to explain the radically different methods by which primary electricity can be added to the fuel balance will leave the unwary reader confused by the three-to fourfold discrepancy in the contribution of hydroelectricity in Table 1.1 as compared to Table 1.4. Nor does the author notice such errors as the increase in the contribution of hydro-power since 1960 in Table 1.1. As the percentage share of electricity generated at hydro plants declined since 1963 (shown in every Soviet yearbook), its contribution