Policy and Development of Energy Resources

Edited by
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POLICY AND DEVELOPMENT OF ENERGY RESOURCES

Edited by

T. L. SHAW, D. E. LENNARD, AND P. M. S. JONES

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Preface

Publication of this book comes some ten years after the end of the 'cheap oil' era. It is often said in the energy business that it takes some 25 years for a new source to be researched, developed and promoted to a point where it makes a meaningful contribution to public requirements, and up to 50 years for this to be increased to a major amount. It is no surprise, therefore, that the shocks of the 1970s have yet to change our sources of supply. Those adjustments which have occurred have been between our *relative* uses of coal, oil and gas, and these have been made easier by the shrinking market which has followed the shocks. Reorganized production on a world scale will take much longer to achieve. It is worth remembering that the realities and implications of planned policies can usually be better seen once the immediate pressures for change are past. The low natural momentum of the energy market could therefore be to our long-term advantage.

But the world has not stood still for a decade. Governments have encouraged research into new energy sources and adopted measures to conserve oil fuels. The past ten years have seen the testing of small-scale prototypes and the planning of large-scale demonstration units. The period also brought refinements to established industries whereby methods of working have adjusted to the new economic climate and as further investments have been made. On scales large and small there are many signs of change to established practices, as there must be if significantly different patterns of energy use are to be achieved in 25 years.

The purpose of this 'World Energy Options' series is to appraise in each book the technical state-of-the-art of one energy source. The intention is to assess all sources in a consistent manner, including energy conservation and storage. The emphasis throughout will be on new technology and how the more promising developments may be exploited on a world scale. Important non-technical factors like political considerations, the provision of develop-

ment funds and the need for the environment to be carefully considered will, for each source, also be given close attention.

The main aim of the series is to report on the progress being made with the development of energy sources so that their likely value to possible users may be assessed in an up-to-date and unbiased way. It is recognized that just as advances over the past ten years have not been slow, so this trend will in many cases continue and make it necessary to up-date individual volumes as developments dictate. The series is being written to make this readily possible. Its worldwide authorship will ensure truly representative international participation, hence thorough coverage of all promising and informative progress.

When the series was planned it was questioned whether the overall message about coordinated developments in the energy sector could adequately be grasped by engineers, planners, politicians, scientists, etc. from the messages in a series of essentially unrelated technical appraisals. To the individual anxious to catch up with developments in, say, wind power, there is no doubt which volume is needed. But to those faced with making choices, perhaps for future investment or where best to direct research effort, or when participating in debates on energy policies, or just to be better informed on a subject of personal interest, there will be much greater uncertainty. This introductory volume was therefore prepared to give a broad appraisal of the unfolding energy scene, with reference not only to individual source development, but also to the many non-technical issues like economics, politics and environmental considerations which are also essential when options are narrowed down and ultimate choices made.

Subsequent volumes provide detailed accounts of the up-to-date technology about each option. In some cases these will be sufficient for progress to be assessed and evaluated in the context of specific applications. In others it will show how technology is advancing and which obstacles have still to be overcome before those sources or techniques could be exploited commercially.

Like many others, the energy industry is continually evolving within an array of constraints. It is an industry well accustomed to dealing with the intrinsic cycle of plant design, construction, commissioning, operation and decommissioning, for most plant by national infrastructure standards has the short working lifetime of 30–40 years and takes 8–12 years to advance from planning to use.

Faced with this timetable, i.e. when plant commissioned now may reach the mid-point of its working life by the end of the century, or when half the plant in use now may be decommissioned by that time, there is an obviously strong and continuing need for decisions to be taken. Not only must shorter-term public supplies using existing equipment be ensured, but work must be put in hand so that the most suitable options for both the nearer and further

futures become available for commercial development when that is timely.

This is a business in which it is folly not to have recourse to more options than need be put into practice at any time. The argument for diversified sources is strong, notwithstanding the fact that there will be no alternative but to narrow attention towards a few principal choices each time a decision to construct new plant has to be taken. In any case, preferences will differ from country to country according to local circumstances, so a wide choice will ensure that individual interests can be satisfied by a broad and stable industry.

Recent experiences have given world society good cause to think hard about its future energy options. As in the past, it will not be for lack of choice if shortfalls occur. The world is not short of energy, only the unfailing foresight to make it available in the right form and cost, and at the right time and place.

Notation

The symbols used in this book have the meanings indicated below.

M	Million (10^6)
bn	Billion (=1000M, or 10^9)
bm^3	Billion cubic metres
W	Watt (of power)
kW	Kilowatt (= 10^3W)
MW	Megawatt = (10^6W) : MWe = megawatt of electricity
GW	Gigawatt (=10^9W) : GWe = gigawatt of electricity
TW	Terawatt (=10^{12}W)
J	Joules (of energy)
kJ, MJ, GJ	10^3J, 10^6J, 10^9J respectively
kWh	Kilowatt-hour (or unit of electricity = 10^3Wh)
MWh, GWh, TWh	10^6, 10^9, 10^{12}Wh
t	Tonnes weight (metric)
Mt, Tt	10^6, 10^{12}t
ppm	Parts per million
ppmv	Parts per million by volume
m.p.g.	Miles per gallon (Imperial)
Mtce	Millions of tonnes of coal equivalent
b/d	Barrels per day (1 barrel = 35 Imperial gallons of crude oil, or 42 US gallons)
b/doe	Barrels per day of oil equivalent
toe	Tonnes of oil equivalent
U value	Thermal conductivity, e.g. rate of heat flow through building materials
R,D&D	Research, development and demonstration

Contents

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1

Introduction

T. L. Shaw, D. E. Lennard and P. M. S. Jones

For planning in the energy field it is essential to understand the resources available and the degree of readiness of appropriate technologies to harness them. Chapters 8–10 in this book therefore include appraisals of the established coal, oil, gas and nuclear power industries, and Chapter 11 is allocated to the renewable energy sources. Each gives information about the present state of development of a source and reports on the steps being taken to improve and extend its readiness for more efficient and extensive application. The timescales against which the use of each new source or technique may reasonably be anticipated are included.

Although adequate energy resources and the technology to exploit them are fundamental to meeting demands, these alone are not sufficient for economic supplies to be on hand when required. Many other factors also have to be taken into account. These vary from the degree of certainty with which energy from each source would in practice be available when required by the consumer (i.e. the dependability of the source, the technical confidence in the plant, etc.) to the foresight of planners, politicians and economists to promote new schemes in good time, and the managerial and technical competence of engineers to complete these on schedule. The political and financial institutions strongly influence the development and exploitation of new resources; hence it is appropriate that these are also covered here (Chapters 4–6).

Energy supplies cannot be organized in isolation from future patterns of demand, though this need to plan years in advance raises notorious difficulties. Whereas on the one hand there may appear to be good reason to anticipate the future on the basis of 'past trends continued', the last 20 years have seen such a marked reversal from the rapid growth era of the 1960s to the retrenchment of the 1970s as to give little firm ground for looking far

enough ahead with confidence. On a timescale much less than that needed to expoit new sources, the forward view has swung from unrestrained optimism about sustained growth to projections based on continuing contraction. In political, monetary and planning terms, the difference between these trends obviously amounts to totally different investment policies.

Short-term concern is therefore no basis for the long-term planning vital to the energy industries. Investments in this field are necessarily so great, decisions so important and development times so long as to make it essential to look ahead 25–40 years or more. Chapters 2 and 3 show the way in which this approach clarifies objectives and identifies where the emphasis of research and development to meet different energy markets is best placed. Chapter 2 deals with the more developed countries and Chapter 3 shows how the demands of less-developed areas may be affected by technological advances domestically and elsewhere relevant to their requirements.

It may be a surprise to learn that the annual average per capita energy consumption in many countries in the latter category exceeds those in much of the more-developed world. The essential factor here is the efficiency with which primary energy is converted to a useful resource. Real progress of world importance will be made by improving the ways in which this energy is used but this will fail if it is attempted at a speed which cannot be assimilated and appreciated by those directly concerned. The broader subject of energy conservation by technical means is reviewed in Chapter 13, and the increasingly important objective of equating the most efficient methods of energy generation with consumers' needs via a wide range of methods for temporary energy storage is assessed in Chapter 12.

It is sometimes said that environmental considerations have been as responsible for escalating energy prices over the past decade as were the increases in crude oil prices in the mid 1970s, though this would be difficult to defend. Nevertheless, it is true that growing concern about the discharge of gaseous and solid wastes from industries of many types has considerably tightened permissible effluent standards. Chapter 7 highlights some of the problems generally thought to be serious at present and worrying for the future.

The topics covered in this volume refer in broad terms to most of the issues which arise during the planning and development of any energy source for public supply. However, the contents do not provide more than an overview of what must be regarded as a vast though interdependent subject. They also show that the circumstances facing any two countries, whether both well-developed or both striving for advanced methods of energy use, will be unique to each though often common in their details.

There is little evidence that world concern about energy will produce harmonious views on policy; indeed there could be a good case against this. The remarks of authors contributing to this volume have therefore not been constrained by editorial policy but form frank opinions on the supply of

energy. Some conflict of views is therefore to be expected. The reasons for this must be appreciated by the reader and resolved according to his or her circumstances. The one gesture made towards coherence in this volume is that many authors report their experiences with reference to the UK, which therefore provides a common base and so helps to explain the relative position of the many necessarily interwoven topics. In broad terms, however, supply and demand in the UK are little different from those in many other countries; hence the general experiences reported will have wide relevance.

It follows that those responsible for implementing energy decisions in any country, from essential research through to plant operation, must translate lessons learned elsewhere into policies for their customers. Because national policies determine objectives, it is unrealistic for the authors of individual chapters in this volume to attempt to foresee how each practitioner will wish to proceed. What this volume *does* do, and the whole series of books reinforces, is to emphasize the state of readiness of the technology underlying each energy source (including conservation and storage), i.e. it provides the ingredients vital to the preparation of all energy strategies.

Recent history ought to have taught us the importance of robust policies based on diversified resources and full international collaboration. It should also have taught us the need for sensible national dependence on indigenous supplies coupled with competitive trading of surpluses. The world is not lacking in energy. When shortfalls arise it is either because needs have not been foreseen or that supply routes have grown too sensitive to disruption. The prospects for future supplies based on all the options presented in this volume, and in much more detail in the full series, promise to remove over the next 20 years much of the concern about energy which has recently faced the world. Equally, however, complacency now will threaten much of the variety and strength promised by the various energy technologies as these adjust to the political, financial and environmental conditions likely to exert no less an influence on future supplies.

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2

A fuels policy into the 21st century

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1 INTRODUCTION

Originally, the form of analysis presented in this chapter was the basis of a lecture to the British Nuclear Energy Society (BNES) in 1979 (Ref. 1). Since then there has been continued recession in the economies of industrialized nations, with a progressive trend for growth forecasts to become more pessimistic. As a result the forward estimate of UK energy requirements has been reduced. It is emphasized that the estimates are presented for indicative purposes, and although the change means that the timescale of events is stretched, the general conclusions of the BNES paper remain unaltered.

Most of the world's nations purchase or sell fuels in one form or another, and the interdependence arising from the balance between energy production and energy consumption is a vital determinant in each national economy. It is not realistic, therefore, to consider a national fuels policy without due consideration of the global scene. Each national strategy will of course be different, depending on local conditions, although some common threads can already be seen, in particular conservation and the substitution of oil and gas.

The UK is presently more fortunate than other industrialized nations owing to its self-sufficiency in the production of coal, oil and gas; but this is a temporary phase, and the UK's long-term energy problems will be similar to those currently being experienced by other developed economies. This chapter concentrates on the situation in the UK, but the principles apply to many other nations, if on different timescales.

The volatility of the world energy market was highlighted in 1979 when the reduction of Iranian oil exports for a few months by an amount which represented less than 10% of world production had serious repercussions for