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National Economic and Social Council
An Chomhairle Náisiúnta Eacnamíoch agus Sóisialach

Irish Energy Policy

No. 74
October 1983

1. The main task of the National Economic and Social Council shall be to provide a forum for discussion of the principles relating to the efficient development of the national economy and the achievement of social justice, and to advise the Government, through the Taoiseach on their application. The Council shall have regard, inter alia, to:
(i) the realisation of the highest possible levels of employment at adequate reward,
(ii) the attainment of the highest sustainable rate of economic growth,
(iii) the fair and equitable distribution of the income and wealth of the nation,
(iv) reasonable price stability and long-term equilibrium in the balance of payments,
(v) the balanced development of all regions in the country, and
(vi) the social implications of economic growth, including the need to protect the environment.

2. The Council may consider such matters either on its own initiative or at the request of the Government.

3. Members of the Government shall be entitled to attend the Council's meetings. The Council may at any time present its views to the Government, on matters within its terms of reference. Any reports which the Council may produce shall be submitted to the Government and, together with any comments which the Government may then make thereon, shall be laid before each House of the Oireachtas and published.

4. The membership of the Council shall comprise a Chairman appointed by the Government in consultation with the interests represented on the Council,
Ten persons nominated by agricultural organisations,
Ten persons nominated by the Confederation of Irish Industry and the Irish Employers' Confederation,
Ten persons nominated by the Irish Congress of Trade Unions,
Ten other persons appointed by the Government, and
Six persons representing Government Departments comprising one representative each from the Departments of Finance, Agriculture, Trade, Commerce and Tourism, Labour and Environment and one person representing the Departments of Health and Social Welfare.

Any other Government Department shall have the right of audience at Council meetings if warranted by the Council's agenda, subject to the right of the Chairman to regulate the numbers attending.

5. The term of office of members shall be for three years renewable. Casual vacancies shall be filled by the Government or by the nominating body as appropriate. Members filling casual vacancies may hold office until the expiry of the other members' current term of office and their membership shall then be renewable on the same basis as that of other members.
6. The Council shall have its own Secretariat subject to the approval of the Taoiseach in regard to numbers, remuneration and conditions of service.
7. The Council shall regulate its own procedure.

NATIONAL ECONOMIC AND SOCIAL COUNCIL

Irish Energy Policy

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CONTENTS

PART I
The Council's Comments on Irish Energy Policy

PART II
Irish Energy Policy
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LIST OF TABLES

LIST OF FIGURES

PART I

THE COUNCIL'S COMMENTS ON IRISH ENERGY POLICY

INTRODUCTION[1]

Background

1. While many issues relevant to energy policy have been prominently debated over the last half-century, a number of developments in the 1970s increased public awareness of energy matters and resulted in increased attention being focussed on energy policy. These developments included *firstly*, the massive increase in oil prices in 1973 which brought to an end the era of cheap energy supplies. Any complacency during the 1973-79 period when the real price of oil declined was removed by a further steep rise in oil prices in 1979. These oil price developments, which resulted in a large and rapidly increasing share of our resources being devoted to the acquisition of energy, served to highlight our heavy dependence on one energy resource from a politically unstable region. *Secondly*, the discovery of commercial quantities of gas off Kinsale together with prospective discoveries of oil underlined the need for policies on the development, allocation and pricing of indigenous energy sources. *Thirdly*, there was extensive discussion of the desirability or necessity of nuclear based electricity generating capacity.

2. The country's obligations as a member of the European Communities (EC) and the International Energy Agency (IEA) also served to focus attention on energy matters. While the original six members of the EC agreed the broad outline of a common energy policy in 1964 it was not until the oil crisis of 1973 that concrete measures were agreed. As a member of the EC Ireland was required to comply with a number of directives, notably, the holding of minimum oil stock reserves of 90 days requirements and restrictions on the use of oil and gas in new power stations.

3. The IEA was established in 1974 as an autonomous body within the framework of the OECD to undertake a comprehensive energy co-operation programme. Our obligations as members of this organisation include limitations on oil imports and efforts to implement certain principles in the energy policy area. These principles are contained in Appendix I.

[1] Following discussions in the Economic Policy Committee, and in the Council, these comments were drafted by Gerry Danaher of the Council Secretariat.

4. As a result of these developments the Department of Industry, Commerce and Energy published a discussion document in 1978 on some current energy problems and options. While some public discussion subsequently ensued on these options there was no official response to the discussion, partly because the nuclear issue receded following the tapering off of electricity demand.

5. The terms of reference for the Council study of energy policy were as follows:

- to examine the prospective supply and demand for energy;
- to consider sources of energy other than oil which could be made available at acceptable terms;
- to consider the relationship between the likely rate of economic growth and the rate of increase in energy consumption;
- to examine the possibility of reducing the energy intensity of growth;
- to examine the optimal use of non-oil sources of energy;
- to consider the role of pricing policy for the different fuels, including tax and subsidy policies;
- to examine the scope for energy conservation, over and above what might occur through reactions to changes in energy prices.

6. The study was undertaken by Professor F Convery (Resource and Environmental Policy Centre, UCD) Ms S Scott (ESRI) and Mr C McCarthy (DKM Economic Consultants) and is published as Part II of this report.

7. The Council in drawing up the terms of reference was aware of the very wide nature of the study. It requested the consultants to avoid duplication with other research being carried out in the area. The consultants in their preface, detail their response to this request.

Approach to the study

8. A common approach to a study of energy policy is to project for a number of years ahead the likely supply and demand situation for energy resources. The policies required to ensure that a gap between demand and supply does not emerge are then usually examined together with the optimal mix of primary energy sources to generate requirements. This approach provides an overall framework within which all sources of energy can be related to one another and whereby the consequences of choices in one area for other areas can be evaluated. The consultants

eschewed this approach partly because it was being undertaken by the NBST[2] but also because they felt that outlining the principles which should guide energy policy would be more appropriate.

9. In their report the consultants attempt to identify market failures and to suggest appropriate policies to deal with these failures. Market failure means that the necessary conditions for the efficient operation of markets do not obtain, for example, the existence of monopolies, the absence of adequate information on the part of producers and consumers etc. The consultants emphasise the importance of ensuring that price signals reflect opportunity costs and thus ensure efficient allocation of energy resources. The consultants argue that if the price signals do reflect opportunity costs the market will deliver the appropriate response.

[2] *Energy Supply and Demand in the Next Thirty Years*, NBST (1980).

SECTION 1

ENERGY PRICING

Pricing policy: general aspects

1.1 An important instrument for the implementation of energy policy and the achievement of energy policy objectives is the level and structure of energy prices. They determine in substantial part the innumerable decisions of producers and consumers. Prices influence demand through consumer decisions and supply through producers' investment programmes.

1.2 Given the importance of pricing strategy in energy policy it is necessary to consider the extent to which the prices of various energy sources are under domestic control, either directly or indirectly. Oil, which in 1981 accounted for 62% of primary energy input in the economy, is an internationally traded product and the internationally determined price sets the cost of oil to the Irish economy. Coal accounted for 10% of primary energy input in 1981, the bulk of which was imported. While the cost to the economy of these two energy sources is the world price, the price to the final consumer may diverge from this due to domestic pricing strategy, taxation or subsidies. Indigenous sources of energy, for example gas and peat which together account for a quarter of primary energy input, allow more flexibility with regard to pricing, though the oil equivalent price represents the opportunity cost of these energy sources to the economy.

1.3 One of the main principles which the consultants recommend should guide an energy policy is that of market clearing pricing. The consultants recommend that State-owned energy resources should be allocated to those users who are willing to pay the most for them in either the private or public sector and that a market clearing price be charged. The Council believes that the implications of basing a pricing policy on this principle need to be examined closely.

1.4 Every energy pricing decision is likely to involve a wide range of considerations other than energy policy considerations, for example,

industrial, social, macro-economic and environmental factors. In some cases there may be a direct conflict between energy policy and other policies, in other cases it may be possible to make an energy policy decision serve the purpose of other policies.

Energy pricing policy and industrial policy

1.5 One particular situation where a conflict may arise is with industrial policy, one of the objectives of which is the promotion of the competitiveness of the traded sectors. A pricing strategy which gives priority to the latter would result in lower energy prices to the traded sectors than would obtain under the market pricing criterion recommended by the consultants. This would result in an implicit subsidy of an amount equal to the difference between the market clearing price and the actual price accruing to the traded sector. The rationale for this strategy is that in its absence domestic output, employment and exports would be lower.

1.6 The strategy, however, has a number of undesirable side effects:

- (i) since energy prices would be below market clearing levels the strategy would encourage consumption and discourage conservation;
- (ii) if all fuels are not equally subsidised then production of non-subsidised fuels is discouraged;
- (iii) if the price is set below market clearing levels then price ceases to act as an allocative mechanism and some form of non-price rationing is required. Some criterion will then be necessary to find the most appropriate customers. This is likely to be less satisfactory than the use of a pricing mechanism since it is difficult to envisage a set of criteria in which some element of discretion would not be involved;
- (iv) part of the rent from the indigenous sources of supply would accrue to energy consumers rather than to the citizenry as a whole;
- (v) removal of the subsidy at any stage would be difficult since investment decisions would have been taken on the basis of the subsidy.

1.7 In Irish conditions market forces do not always exist to determine a trading price for energy resources. For certain resources there may only be a single supplier and a very small number of significant consumers. In the case of natural gas, exploitation of the resource in the short term could not have occurred at the desired level in the absence of the ESB as the single major consumer. In such circumstances, if the resource price is to reflect the true value of the resource to the State, the resource should be traded at the price at which it is marginally more attractive to the consumer than is the competing fuel. To pitch the price at a lower level is to subsidise the consumer of the resource with the adverse consequences as set out in paragraph 1.6.

1.8 The Council acknowledges the present concern regarding the price of Irish energy to industry relative to that of competitors. If this results from factors other than the price of primary fuels appropriate action may be necessary to minimise the burden on the traded sector. The Council is also conscious of the fact that setting the price of a particular energy resource at a level marginally below that of a competing fuel might not improve the position of consumers in the traded sectors if the price of the competing fuel is higher in Ireland than elsewhere.

1.9 The Council believes that maintaining the price of fuel below market clearing levels is not an appropriate instrument for promoting the competitiveness of the traded sectors, given the undesirable side effects outlined in paragraph 1.6 and that it would be impossible to exclude other sectors from the benefits. While generally favouring the use of market clearing pricing the Council believes that the price of competing (as defined in paragraph 1.7) fuels relative to prevailing international levels should be examined. Where significant differences are found to exist the Government should state its policy in relation to the elimination of these differences.

Energy pricing policy and social policy

1.10 Another issue to be considered in the context of energy pricing is the extent to which certain lower income groups may suffer disproportionately from increases in energy prices. However, design of a pricing strategy to protect less well off groups has a number of undesirable side-effects, similar to those which arise from attaching priority to the promotion of the competitiveness of the trading sectors. The Council believes that the protection of less well off groups is not an appropriate objective of energy pricing policy.

1.11 The Council recognises, however, that there are a number of social policy goals enshrined in energy policy which are not as narrowly based or as readily identifiable as the explicit measures taken to help lower income groups. These include, for example, the founding and development of Bord na Mona in a period when turf was not an economically competitive fuel and the rural electrification programmes. While the removal of social objectives from the ambit of energy policy may prove quite difficult, the Council believes that the costs of these

policies should be quantified and should appear directly in the accounts of State agencies.

1.12 It is difficult to find a general formula to express the right balance between the conflicting considerations: between pricing for competitiveness, pricing for social equity and pricing for efficient and effective energy usage. While market related pricing will encourage the optimal allocation of resources, energy efficiency and conservation, there may be occasions when a departure from this criterion might be desirable. In considering the desirability of these departures it is important that the differences in cost between alternative courses of action be determined as precisely as possible. It is vital that these departures do not become so pervasive that the concept of an overall energy policy is lost.

SECTION 2

ELECTRICITY GENERATION

2.1 The electricity industry has a central position in our energy economy. In 1979, 31% of total primary energy input was converted into electricity, compared to 25% in 1973. The mix of primary fuels used in the generation of electricity has changed over the last number of years, reflecting, in particular, the availability of natural gas. The percentage of units generated by oil fired stations has declined from a peak of 73% in 1979 to 40% in 1982 while the percentage by gas fired stations has increased from 7% in 1979 to 36% in 1982. Over the same period the contribution of peat has declined from 19% to 14%. This impressive substitution record should, however, be seen in the context of the rapid capacity increase in recent years and the consequent present over-capacity.

2.2 There are five important issues which should be considered in an analysis of policy on electricity generation:

- (i) the mix of fuels used to generate electricity (which depends upon the mix of installed capacity);
- (ii) the efficiency with which primary energy is converted into electricity;
- (iii) the cost of primary fuels to the ESB;
- (iv) the price charged by the ESB for electricity; and
- (v) installed electricity capacity in relation to demand.

Issues (i) and (ii) involve detailed operational matters which are not addressed in this report. The remainder of this section is devoted to issues (iii), (iv) and (v) which raise broad policy issues.

Electricity pricing

2.3 As discussed in the section on pricing policy the consultants argue and the Council agrees, that in order to ensure an efficient allocation of resources consumers should be charged prices which reflect the costs of provision, i.e. the price signals which consumers are receiving at the margin should reflect the full costs of providing the increments in supply. Up to 1973 the ESB offered declining block rates such that the price charged for each additional unit consumed

declined. The consultants argue that this was an appropriate strategy as the ESB was capturing economies of scale in plant construction such that the extra cost of providing an additional unit of electricity was below the average cost. After 1973 this strategy was changed and the rates charged were independent of consumption.

2.4 There is now substantial excess electricity generating capacity. The ESB's present installed capacity is 3,274 megawatts compared to an overall peak demand of 2,000 megawatts[1] while present plans provide for the addition of 1320 megawatts between now and the end of 1988. Much of this expansion is related to fuel diversification, for example, at Moneypoint where 900 megawatts of coal fired capacity is being installed. The present level of excess capacity is due partly, also, to a downturn in electricity sales. During the 1970s, excluding the recession years of 1975 and 1976, electricity sales grew at approximately 8% per annum. In 1981 sales declined by 2.3% but recovered somewhat in 1982, growing by 1.6%.

2.5 The Council, while recognising the difficulties which attach to utility planning, particularly in a rapidly changing energy market, is nevertheless seriously concerned about the massive burden imposed on electricity consumers and on the economy by the unprecedented surplus of installed generating capacity either on hands already or in course of construction for the ESB. The Council agrees on the urgent necessity of reviewing the present generating programme which, as indicated in *Public Capital Programme 1983*, is being undertaken. The Council believes that the possibility of postponing further additions to installed capacity should be pursued. The Council recommends that the results of this review should be published. The Council believes that the review should also examine the arrangements which exist for planning future capacity with a view to minimising the risks of similar situations arising in future. In this context consideration should also be given to publishing draft plans for future generating programmes to ensure as wide a discussion as possible.

2.6 The present degree of excess capacity has implications for the pricing strategy of the ESB. The pricing strategy also has implications for the future generating programme through its influence on the demand for electricity and through its effects on investment in own-generation and in combined heat and power systems. In a situation of excess capacity any price which can be obtained for an additional unit of electricity greater than the additional fuel and operating costs in-

[1] ESB *Annual Report* for year ended 31 March 1982.

curred in generating that additional unit will make a contribution towards the capital costs which have been incurred in installing existing capacity. This marginal cost pricing strategy if adopted, would encourage the demand for electricity.

2.7 While such a strategy could not be continued indefinitely and could run counter to conservation efforts the Council considers that its adoption could be appropriate in present circumstances since the capital costs are already sunk and less advantageous capital spending on other forms of energy may be curtailed. It would also be desirable, given the unfavourable comparison of electricity prices to industry in Ireland vis-a-vis other EEC countries, that the strategy should be designed such that the bulk of the benefits accrue to the traded sectors. In order to minimise the disincentive to conservation which this strategy would entail the Council believes that its introduction should be accompanied by a publicity campaign to emphasise that the strategy is temporary.

2.8 The electricity pricing strategy also has implications for the competitiveness of the trading sectors. Electricity prices in Ireland are higher than those in other EEC countries and have been increasing more rapidly in recent years. This undoubtedly imposes a burden on the traded sectors. The reasons for this divergence include:

- the high level of excess capacity;
- the capacity mix, with no coal or nuclear plant in the system;
- the number of small stations in the system;
- the absence of an operational interconnector with other systems;
- extensive rural electrification to a dispersed population.

Another factor which has an effect on the level of electricity charges — the cost of primary fuels to the ESB — is considered below.

Cost of primary fuels to the ESB

2.9 As indicated in the section on pricing, both crude *oil* and *oil product*, are internationally traded commodities, the prices of which are therefore primarily determined on international markets. However, there are domestic influences also operating on the price, for example, taxation policy, the operation of the INPC and compulsory offtake from Whitegate.

2.10 The National Prices Commission, to whom applications for increases in electricity charges must be made, has commented on a number of occasions on the obligation of the ESB to buy certain

quantities of fuel oil from the INPC. In the 1981/82 period these purchases were at prices considerably in excess of those available from their other normal sources of supply and according to the National Prices Commission the additional cost was about £3m in that period. In the year 1982/83 the ESB estimate that the requirement on them to purchase around 36% of their fuel oil from the INPC will result in an extra cost of approximately £5m.

2.11 Bord na Mona was given powers of compulsory acquisition in the Turf Development Act (1946). With this facility and having been provided with adequate capital at advantageous terms by the State, together with a guaranteed market at above fuel equivalent prices in sales to the ESB, it was able to capture economies of scale in bog drainage and exploitation. The Bord supplies *peat* to the ESB for its peat fired generating stations, contributing 14% of the ESB's primary fuel requirements in 1982. Prior to 1973-74 the ESB was required by the Government to pay a price for peat which was substantially in excess of the price at which they could import oil of equivalent energy value. This was necessary in order to keep Bord na Mona financially viable. After the 1973/74 oil price rise the price for peat tended to be set below that of competing fuels. This situation has changed again recently and the price of peat to the ESB is now greater than its equivalent energy value.

2.12 Hydro and coal account for the remainder of the ESB's primary fuel sources. In the case of hydro, use of the *water* is vested in the ESB, hence the question of pricing does not arise. *Coal* accounts for only a negligible proportion of the primary fuel requirements of the ESB though its importance is likely to increase significantly when the Moneypoint coal fired station comes into operation. However, since most of the ESB's requirements will be imported, domestic control of the price will be limited.

2.13 From the review of the cost of primary fuels it is clear that there has been a considerable amount of non-market transfer pricing between the various State agencies involved in the energy area. In general it appears that policy with regard to energy pricing is somewhat ad hoc and un-coordinated. The Council notes that the Government has set up two inquiries in this area. The first is a review of the electricity generating programme to assess the need for existing levels of capacity and planned additions thereto and the second to inquire into the reasons for present high electricity prices. The two issues to be examined are clearly interdependent. The Council believes that the inquiry into electricity prices should be sufficiently wide to include consideration of the issue of non market pricing between the various state agencies, not only from the viewpoint of high electricity prices but also from an overall energy efficiency perspective.

Nuclear energy

2.14 Given the present degree of excess electricity generating capacity the need for constructing a nuclear generating station in this country has receded. Since this matter was last under serious debate some years ago, there have been significant developments which the Council believes should be taken into account in any future presentations which may be made to relevant Ministers by the ESB or the Nuclear Energy Board. The Council recommends that if, at any stage, it appears likely that the installation of such a station will become necessary there should be full public disclosure of all relevant data so that all sections of the community will be in a position to express their views from well informed positions. The Council goes further than the consultants in this respect in recommending that not only a full financial appraisal should be carried out but that this should be accompanied by exhaustive studies on the environmental and security implications. The Council notes in this respect the commitment entered into by the Government when this matter was the subject of serious debate in recent years that there would be a special public tribunal to inquire into all aspects of the proposal.

SECTION 3

EXPLOITING INDIGENOUS OIL

Allocating exploration licenses

3.1 In 1975 the licensing terms for exploration for offshore oil and gas were issued and companies were invited to apply for exploration licenses. The main criteria to be used in allocating licenses were as follows:

(i) the technical competence of the applicants;
(ii) the financial resources available to them;
(iii) previous exploration experience;
(iv) the possibility of reciprocal business opportunities in the applicants' country of origin.

The importance of drilling commitments was clearly recognised in the licensing terms and accompanying literature. The terms also made provision for applicants willing to offer:

(a) participation to the State in excess of the indicated norm;
(b) commitments to establish industrial development projects;
(c) signature bonuses (i.e. cash down payment).

3.2 A second licensing round was announced in 1980 for a specified set of blocks, on the same terms. An additional criterion not mentioned in the first round was the willingness of applicants to supply crude oil to the INPC.

3.3 In effect the allocation of exploration licenses is at the discretion of the Minister with companies bidding against one another primarily in terms of drilling commitments. An alternative system examined by the consultants is a sealed bid auction system whereby the applicants bid in cash for the licenses. It is possible, however, to design this system such that other objectives are also achieved, for example, the winning bid could have a minimum drilling commitment imposed on it. The consultants, having reviewed the arguments regarding discretionary allocations and cash auction methods, recommend that in future licensing rounds at least some of the exploration licenses should be allocated using the auction method.

3.4 In the past applicants have been free to offer signature bonuses and large sums have, in fact, been paid to the State under this heading. Until such time as a further commercial oil find is made, the Council assumes that the emphasis on drilling programmes will continue. It is obvious that it is not possible to maximise commitments under both heads, i.e. to have maximum drilling obligations on the companies and at the same time to expect maximum cash payments. The Council agrees with the consultants that the Department of Industry and Energy could consider bids on cash terms for certain blocks provided, however, that appropriate exploration requirements are attached to them. This expression of view is put forward on the assumption that no serious diminution in the momentum of exploration is brought about and, furthermore, that any amounts paid to the State under this system would not be in substitution for taxation, royalty payments or State participation.

Capturing the rent

3.5 A rent is said to exist where a payment to any factor owner exceeds the minimum payment required to retain a factor in that use. In the case of a discovery of oil or gas the returns, under a normal tax regime, earned by the companies in extracting the find are likely to be significantly in excess of the return required to ensure extraction. As the resource belongs to the State the latter must devise a means of capturing this rent on behalf of the State. As the amount of rent will vary with the level of oil prices and the size of the exploration and development costs the Council believes that flexibility is necessary in any rent-capturing regime. This flexibility would enable the Government to respond to variations in costs and prices in order to maintain desired rates of production and exploration. As discussed later this flexibility is also desirable in the context of a depletion policy.

3.6 At present an output royalty estimated as a percentage of the value of oil produced and varying with the level of production is applicable on total production. A single payment production bonus is also payable if the output of the field is over a certain level. The State has the right to participate up to a maximum of 50% in the exploitation of any commercial discovery of petroleum. It is necessary to bear in mind (and the point is made clear in the published licensed terms) that this right of the State is to participate on a carried basis i.e. the State can decide that it will have up to a maximum of a 50% interest in a field after its commerciality has been established but it will not be obliged to contribute any funds to the development of that field until such time as production has been achieved. After that point, the State's share of development costs would be paid for out of the revenue accruing

from the sale of its 50% share of the field output.

3.7 The consultants compare the present Irish situation with regard to rent capture with that of the UK and Norway, both of which have made substantial discoveries in the North Sea, and the US. In the case of the UK and Norway the 'Government take' amounts to 87% and 85% respectively while in the US the 'government take' is 73%. These figures do not include the returns from State participation or the lump sum bid payment for drilling rights. Assuming an Irish corporate tax rate of 50% and participation by the Government in the venture then the 'Government take' would amount to 81%.

3.8 Ireland is in a similar position to the UK and Norway before they applied a Petroleum Revenue Tax and a Special Tax, respectively. These were applied in both countries *after* the North Sea discoveries. The Council agrees with the consultants that it is appropriate for Ireland to be in this situation, particularly as there are at present no commercial discoveries of oil. If commercial discoveries are made Ireland is in a position to capture the rent.

3.9 There are a number of ways by which this capture can be achieved. As shown above, State participation can be undertaken which would increase the 'take' to 81%. Another option is to impose a special tax akin to that of Norway or the UK. It should be noted that State participation and special tax are not mutually exclusive options, elements of both can be combined if desired. The Council attaches considerable importance to the maintenance of the State's participation rights in any offshore finds. Apart from the considerable financial benefits of State participation, especially on a carried basis, the advantages of involving the State directly in the exploitation of publicly owned resources have been well accepted by many countries whose circumstances in relation to petroleum development are relevant to the Irish situation. It is only by becoming directly involved in this way with total access to all relevant information that the interests of the State can be adequately protected. Furthermore, the building up of a national competence in the area of petroleum exploration and development can be accomplished in this way, and the achievements of other small countries in this respect have been notable. Equally, the experience of many countries has demonstrated that reliance on the more traditional mechanisms for protecting the interests of the State does not produce the best results.

Depletion policy

3.10 Another decision which will arise in the event of a commercial oil find is the rate at which the oil should be extracted and also the rate at which further exploration should proceed. These decisions will depend upon a host of considerations including: the likely rate of increase in oil prices (which gives the rate of return from leaving the oil in the ground) compared with the rate of return on alternative investments if the oil is extracted and the rent captured; the ability of the economy to absorb an oil find; the relative strengths of the traded and non-traded sectors etc. The Council recommends that an evaluation of these considerations should be carried out and published and justification provided for any proposed rate of depletion before any decisions are taken.

3.11 There are a number of policy instruments available to achieve the desired rate of depletion. *Firstly*, the production plan for any particular field must be approved in advance and there is provision in the 1975 licensing terms for consultation by the relevant Minister with the licensees regarding the appropriate level of production, the clear intention being that voluntary agreement should be reached, rather than a compulsory regime imposed. *Secondly*, both the short license period and the surrender provisions attached to the licenses also facilitate the maintenance of control on the rate of depletion.

SECTION 4

OIL: SUPPLY AND PRICING

4.1 With the substantial increase in oil prices in 1973 and 1979 one of the major objectives of energy policy became the reduction of the dependence on imported oil in overall energy requirements. A number of strategies have been adopted to achieve this objective, including the encouragement of off-shore oil and gas exploration, reduction of the dependancy on oil in electricity generation through investment in generating stations which use alternatives to oil and strategies aimed at conservation. As well as measures aimed at reducing dependence on imported oil two other measures were taken with the stated aim of improving the security of supplies: the setting up of the INPC and the purchase of the Whitegate oil refinery.

Irish National Petroleum Company

4.2 The INPC was set up in 1979 with a view to improving the security of oil supplies through contracts with the oil exporting countries, thereby bypassing the major oil companies for a portion of the country's supplies. The INPC negotiated oil contracts with Iraq and Saudi Arabia though supplies from the former were interrupted due to an outbreak of hostilities between Iran and Iraq. These contracts were at official OPEC prices. The contract with Saudi Arabia has now expired and the INPC is receiving supplies from BNOC and the spot market. It was stated on the setting up of the INPC that it would not be allowed "to pass on inefficiencies in the form of higher prices, less attractive terms or whatever and retain major accounts because they happen to be another State body". However this principle has not been adhered to and severe burdens have been placed on its customers, apart altogether from the burden of Whitegate.

4.3 The decline in spot market oil prices in 1982 focussed attention on the costs of the INPC oil contracts. The consultants estimate that in 1982 there was a price differential of $85 per tonne for premium grade petrol between the spot market rate and the rate being charged by the INPC. However, this may not be an appropriate yardstick against which to measure the costs of the INPC strategy unless those to whom the INPC were supplying the oil would have purchased oil on the spot market in the absence of the INPC. However, despite some dispute about the actual amount there was undoubtedly a cost disadvantage associated with the INPC strategy.

4.4 The Council recognises the constraints which arise in attempting to balance security of supply with cost disadvantages. In particular, it acknowledges that it is not possible to have a supply regime which depends on long term contracts when spot market prices are high and then expect to change to the spot market when conditions change. Customers who rely unduly on the spot market bear the consequences when the market hardens and prices move upwards.

4.5 A number of questions are relevant when examining the future role of the INPC. *Firstly*, can the INPC secure oil at more advantageous prices than non-Government companies or is there likely to be a cost disadvantage associated with the INPC strategy of government to government contracts? The answer to this question depends upon the form of the contracts into which the INPC enters, for example, the presence of variation clauses, and the future movement of non-contract prices. The INPC will secure supplies at more advantageous prices if the market price rises during the period of the contract and if a variation clause does not exist or the variation clause is such that contract prices do not rise to the same extent as market prices. There is therefore a risk, which is impossible to quantify, that cost disadvantages could arise (as already have occurred) from the INPC strategy.

4.6 The *second* question which arises, therefore, concerns the benefits in terms of security or in terms of other objectives which accrue to the State as a result of incurring this risk. It was stated by the then Minister for Industry, Commerce and Energy on setting up the INPC that the company would make a significant contribution towards improving the security and continuity of oil supplies. This belief was based on a perceived desire on the part of oil exporting countries to deal directly with national oil companies of consuming countries. However, the Council is not aware of any evidence which suggests that they are more secure than private contracts. It is relevant to note in this context that, despite the contract with Iraq, supplies were interrupted due to an outbreak of hostilities between Iran and Iraq. It is also relevant to note that in the event of oil shortages, international rationing of supplies would be carried out under the aegis of the IEA with each country receiving a certain allocation. It is very unlikely that the IEA would omit from consideration any government to government contracts (if such contracts were honoured during a supply shortfall) when assessing each country's allocation. Thus, the security benefits of the INPC are unclear.

4.7 In the light of the considerations in the preceding paragraphs regarding possible cost disadvantages and uncertain security benefits arising from the operation of the INPC the Council believes that the alternative mechanisms available for ensuring security and continuity of supply should be examined. In this context the future role of the INPC should also be examined.

Whitegate oil refinery

4.8 The other recent development in the attempt to ensure security of supply has been the purchase by the Government of the Whitegate oil refinery. The refinery is now operated by the INPC which processes its own purchases of crude through the refinery. Products are sold from Whitegate under a compulsory offtake regime with all oil distribution firms in the Republic required to take 35% of their total sales from Whitegate. In effect the INPC can fix its own prices so as to cover its costs and there is thus no incentive for it to operate efficiently.

4.9 The consultants argue that since it is probable that crude oil and refined oil are likely to be both scarce, simultaneously, the security benefits of refining oil in Ireland are not clear. The Council agrees with the consultants and considers it unrealistic to expect that crude contracts would be honoured during a supply disruption if product contracts were not. The Council believes that the future of Whitegate should be evaluated and that this evaluation should take into account the degree of security of supply obtained as against any cost disadvantage which might arise.

Oil stockpiling

4.10 The discussion on security of oil supplies has so far concentrated on the negotiation of long term government to government contracts and the maintenance of indigenous refining capacity. Another option is the maintenance of stocks of oil. However, as in the case of the options already discussed this strategy is not costless. The net cost of this strategy depends upon the cost of funds tied up and the physical cost of this storage compared with the rate of increase in the price of oil.

4.11 At present, Ireland, as part of its obligations as a member of the EEC and IEA, maintains a minimum of 90 days stocks of oil. A part of these stocks is held at the Whiddy oil terminal and the remainder is held at Whitegate and at the terminals and depots of the oil companies and large consumers. Approximately 25% of the stocks is held abroad. The Council believes that the question of storage and stockpiling covering such factors as cost, structure, level and location should be examined.

In this context the review of the alternative mechanisms for ensuring security of supply recommended in paragraph 4.7 should be taken into consideration.

International comparison of petroleum product prices

4.12 The Council notes the extensive public debate which has taken place recently regarding the level of Irish oil prices vis-a-vis other European countries. The Council believes, however, that such comparisons should be treated with caution, given the reputed unreliability of data in this area. While the Council believes that there are many reasons for these differentials, it is glad to note that the price control system applicable to oil products is at present the subject of a special examination by the National Prices Commission to ensure that it serves current needs adequately.

SECTION 5

NATURAL GAS: ALLOCATION AND PRICING

5.1 In 1974, a gas field of one trillion cubic feet was discovered off Kinsale. The size of the field has since been re-estimated at 1.35 trillion. The terms of the Marathon Agreement are such that the aggregate of State take in terms of royalty and taxation cannot exceed 30% during the first 5 years of commercial production, and thereafter the ceiling is 40%. It is envisaged that the normal rate of taxation will be collected from Marathon and that each year repayments of the excess amounts paid (to bring them down to the ceiling indicated) will be approved by the Oireachtas.

5.2 In compliance with the State's obligations to assist in providing a market for the gas, the various possibilities were examined by a group consisting of the relevant Departments and State development agencies. Two potential markets were initially identified for the gas, the ESB and NET. These two bodies under the guidance of the Department of Industry and Commerce, undertook the negotiations with Marathon for the supply contract. It appears that at this time an allocation of gas to Dublin was not a serious option and, indeed, a subsequent and separate detailed examination concluded that the national interest would not be served by bringing gas to Dublin.[1] The deterioration in the position of the Dublin Gas Company, and the desire to rescue it by providing it with a supply of natural gas, came about at a later stage. It also appears that, while the initial allocation for electricity generation was not regarded as a prime use for the gas, the offtake by the ESB was regarded as essential for the purposes of ensuring commercial exploitation of the field. The allocation of gas for fertiliser manufacture was approved by relevant authorities at the time.

Natural gas allocation

5.3 The criterion adopted by the consultants in deciding the optimal allocation of natural gas was to maximise the rent earned for the

[1] Department of Industry, Commerce and Energy 1978, Press Release: Report of Inter-Departmental Committee on Allocation of Kinsale Head Gas, 10 April.

State. This would be achieved according to the consultants by allocating the gas to those who could pay most of it.

5.4 By using gas for base load electricity generation the ESB would be substituting fuel oil with gas. In 1981 fuel oil was imported at the equivalent of 30p per therm. The cost per therm of delivering Kinsale gas to the ESB generating stations in Cork was approximately 9p. Use of the gas for base load electricity generation would thus yield a rent of 21p. By using gas for peak electricity generation the ESB would be substituting natural gas for gas oil, the 1981 import price of which was 46p per therm. A rent of 37p per therm would therefore accrue from using natural gas for peak electricity generation.

5.5 The consultants then consider the allocation of gas to NET for fertiliser manufacture. Given that the capital costs of the NET Marino Point plant have been incurred the question becomes: can NET afford to pay a price for the gas equivalent to the next best (in terms of rent generated) alternative? The consultants argue that if NET could cover its non-fuel operating costs out of revenues and pay a market price for the gas then it should be permitted to keep its gas allocation. Given the current outlook for the fertiliser industry this appears unlikely. At present NET appears to be paying no more for the gas than the cost price (approximately 9p at 1981 prices). The rent foregone from allocating gas to NET (using the criterion of the next best alternative which is allocating the gas to the ESB for base load generation) in 1981 was therefore £40m, i.e. 21p by 190m. therms. This £40m is therefore an implicit susbidy to NET.

5.6 It is sometimes argued that there are strategic advantages in having an indigenous source of fertilizer supply. Such a view rests on the proposition that the risks attaching to supply interruptions from sources outside Ireland are sufficiently great to warrant a diversion of part of the country's factors of production into the production of fertilizer supplies that cannot be justified on the basis of economic and commercial criteria. The Council understands that international developments in the production of fertilizers from hydrocarbons are favouring increasingly those producers with access to supplies of feedstock with a minimal economic rent: the latter often arises because of a lack of alternative opportunities to dispose of natural gas. There is, therefore, pressure for a long-term over-supply of fertilizer with consequent effects on prices. Such trends, if verified by further investigation, would lessen considerably the force of the "strategic" argument as applied to NET. Since there is a significant economic rent to be obtained from the use of gas other than for fertiliser manufacture the

Council recommends that consideration of trends towards over-supply should be reflected in any continuing reappraisal of the future of NET and of the price at which gas is offered to NET.

5.7 The agricultural co-operatives comprise another segment of the economy which is energy intensive and which merits consideration for a supply of natural gas. The Council believes that if a rent can be secured, at least equal to that received from supplying gas to other purchasers, that the cooperatives be offered a supply of natural gas.

5.8 In 1980 a further investigation of the town gas industry was carried out. It concluded that significant changes in the management and efficiency of the Dublin Gas Company would have to be brought about before an allocation of gas for Dublin could be decided upon. A fourfold increase in consumption in the Dublin area was considered necessary to sustain a viable project. In assessing the rent which would accrue from piping the Gas to Dublin the consultants estimate that the project could bear an onshore delivery price of 34p (1981 prices). Subtracting the price to Marathon of 6.5p yields a potential rent of 27.5p which compares favourably with the rent generated by the ESB for base load electricity generation and is only slightly below the rent from peak generation. The consultants conclude therefore that piping the gas to Dublin contributes to maximisation of the rent.

5.9 While it appears to the Council that the arguments in favour of piping natural gas to Dublin have now been fairly well established, it regrets to note that the full facts in relation to this project have not been published. In the Council's view the magnitude and importance of the decision involved here is such as to warrant such publicity. In any such public debate the Council would deem it appropriate not only to examine the economics of the project but also the options available as regards the organisational arrangements, public or private, to be adopted for the distribution of the gas in Dublin and other centres of consumption. The financial arrangements and other considerations which will have a bearing on the welfare of many citizens for a long time to come would seem, to the Council, to be matters suitable for public disclosure and debate.

5.10 One issue which has not been explicitly addressed in considering the allocation of gas is the efficiency of conversion of gas to other energy forms. On this criterion it is generally acknowledged that conversion to electricity, for example, is not the most efficient use of the gas. However, a strategy of allocating natural gas to those willing to pay most for it allows for this consideration since consumers, in cal-

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5.10 One issue which has not been explicitly addressed in considering the allocation of gas is the efficiency of conversion of gas to other energy forms. On this criterion it is generally acknowledged that conversion to electricity, for example, is not the most efficient use of the gas. However, a strategy of allocating natural gas to those willing to pay most for it allows for this consideration since consumers, in calculating the price which they are willing to pay for natural gas, will take into account the relative efficiency of natural gas conversion. In other words the greater the conversion efficiency the more consumers for that particular usage will be willing to pay. Hence, natural gas will be allocated to the uses of greatest efficiency of conversion.

Pricing of natural gas

5.11 Having identified the mix of uses which maximises the rent it is necessary to consider to whom the rent should accrue and the most appropriate means of ensuring that it does accrue to them. Since natural gas is a resource owned by the citizenry, any rent should accrue to the citizenry and not to some of the citizenry only.

5.12 In order to capture the rent for the state a rent generating price must be charged somewhere along the transmission chain and the resulting rent appropriated by the Government. If we take as an example the allocation of gas to the ESB then the chain goes from Marathon to BGE to the ESB to the final consumer. If a "rent capturing" price is paid to Marathon by BGE then the rent accrues to Marathon and the Government should ideally design a taxation/royalty system to ensure the rent accrues to the State. (It seems, however, to be precluded by the agreement from doing so.) If BGE pays Marathon a price below the rent capturing price, then depending on the price charged by BGE to the ESB the rent may accrue to BGE. If not and the ESB charges its customers a rent capturing price then the rent accrues to the ESB. In order to ensure that decisions by the users of the gas reflect the opportunity cost of gas to the economy it is desirable that rent capturing prices are charged early in the transmission chain.

5.13 In 1978 the Minister issued guidelines on pricing. The guidelines specify that natural gas should be allocated on the basis of market prices and that the price arrangements then existing with the ESB should be reviewed as soon as possible to determine an appropriate energy related price.

5.14 However, BGE's annual report for 1982 stated that the ESB had estimated that natural gas substituted for imported fuels to the value of approximately £140m in 1982 while the cost of natural gas to the ESB was £85m. A rent of £55m therefore accrued to the ESB in 1982 from the use of natural gas. NET appears to be paying only cost plus a transmission charge resulting in rent foregone of a minimum of £40m in 1981. The consultants, having allowed for the exploration and development expenses of Marathon, estimate that Marathon is receiving part of the rent. Some surplus profits from BGE have been transferred to the

exchequer in recent years (£33m in 1982) indicating that at least part of the rent is accruing to the citizenry at large.

5.15 From the limited amount of information which can be pieced together it appears that the implementation of a stated pricing policy did not occur in the past. In reality this means that decisions were taken on the use of a primary indigenous resource on the basis of artificial prices which did not reflect the opportunity cost of natural gas to the economy. This "artificial" pricing also had implications for inter-fuel substitution, investment in conservation and investment in alternative sources of energy.

SECTION 6

CONSERVATION

6.1 The consultants identify and examine a number of policy approaches to energy conservation. These are: information and exhortation; regulation; investment; and taxation and subsidies. The consultants have put forward a number of specific recommendations on conservation, especially in relation to motor vehicles. The Council recognises that other factors apart from energy considerations must be taken into account in assessing these recommendations. It recommends that the consultants' detailed recommendations should receive further examination in the relevant Departments and agencies. The Council, however, wishes to comment on a number of more general issues in the conservation area.

Information and exhortation
6.2 The rationale for the provision of information is that energy consumers may not be adequately informed of the energy implications of their choices. For each individual consumer the cost of acquiring such information may be prohibitive. As there are economies of scale in the collection and provision of information the Council believes that it is an appropriate for Government to collect and provide information to consumers.

Direct public investment
6.3 The consultants identify two major categories of investment which are relevant to energy conservation. These are investment in energy conservation in buildings which are owned or leased by the Government and investment in "waste heat" utilisation and combined heat and power facilities. The Council agrees with the consultants that the Government should lead by example in implementing an appropriate energy management strategy.

6.4 The use of power generating units solely to generate electricity leads to considerable volumes of heat being wasted. When a primary fuel is converted into electricity, only about 40% of energy available can be converted into electricity with the balance being in the form of waste heat. A combined heat and power system is one which utilises this waste heat.

6.5 In recent years there has emerged a renewed interest in "combined heat and power systems" (CHP) as a means of using the waste heat associated with thermal power stations. Such schemes seek to take hot water that is a by-product of electricity generation and transmit this water to potential users in industry and the domestic and commercial sectors through a network of insulated pipes. This is, in effect, a district heating scheme, which is a particular application of CHP. The implementation of a district heating system in a major urban area would involve both heavy capital expenditure and a new source of competition with other sources of energy for space heating, especially natural gas. There are many potential attractions associated with CHP schemes particularly fuel efficiency. It is therefore important that the potential for commercially viable schemes of this type be constantly monitored.

Taxation
6.6 The Council believes that while the level and rate of change of oil taxes must be determined primarily by the revenue needs of the exchequer, energy policy considerations should be borne in mind when taking decisions. This is best achieved through consultations on these issues between the Departments of Finance and Industry and Energy.

6.7 Given the present weakness of world oil prices there is a danger that efforts at conservation might be diminished. The fall in oil prices is due primarily to a reduction in demand as a result of recession in the oil consuming countries, conservation efforts and inter-fuel substitution. However, since oil is a non-renewable resource its price will ultimately reflect a scarcity situation. The current outlook does not therefore reflect the underlying medium and long term trends. The International Energy Agency argues that these trends point to "oil supply stringency later in the 1980s". The Council believes that policies for promoting energy conservation with a view to achieving efficient energy usage should not be relaxed as a result of the fall in oil prices.

SECTION 7

RENEWABLE ENERGY RESOURCES

7.1 In discussing renewable energy resources it is important to be clear on the present state of scientific knowledge. The only currently viable renewable resource in Ireland is hydro-power though the scale at which it is viable varies. A demonstration programme on its potential is currently in progress in small river catchments. The other renewable resources which appear to offer the most significant contribution are wind power and energy crops. In their report the consultants concentrated primarily on these two.

Wind power

7.2 With regard to harnessing the wind for power generation a number of technical problems arise, in particular the reliability of wind machines with consequences for the financial viability of projects and the intermittent nature of the wind with its implications for back up capacity. There are also some safety and environmental problems which need to be resolved. Finally, there are data deficiencies which render any investment appraisal difficult.

7.3 The Council agrees with the consultants that while in the long term there may be scope for wind power, in the short term, data collection should continue while drawing where possible on international experience.

Energy crops

7.4 The consultants attempt to determine the extent to which energy crops can provide a better net financial return than the best competing use. They calculate the maximum amount which an investor in energy crops could afford to pay per acre for land and still cover all costs out of revenues under a number of assumptions. For example, if £17 (1981£'s) is received per ton of dry wood, an investor, borrowing at a real rate of 2% could afford to pay a landowner £65 per acre per annum for wet mineral land in order to use it to grow energy crops or £27 per acre for peatland.

7.5 This return appears very favourable when compared with the

returns per acre for similar land in agricultural usage. However, the consultants argue that more research needs to be undertaken to determine more precisely the output to be expected from energy crops on a wide variety of sites under normal management conditions. While a demonstration project is currently underway it is very narrowly based, being confined to peatlands under State jurisdiction.

7.6 The Council agrees with the consultants that the demonstration project should be widened to include wetland mineral sites and privately owned land. Consideration could also be given to some analysis of the prospects for private use of energy crops as distinct from commercial exploitation. It also believes that the involvement of State bodies in the development of energy crop production and utilisation should be co-ordinated, and the required resources provided in the context of the role of such bodies and energy resources in the national energy research, development and demonstration programme. The Council recommends that no non-commercial burdens should be imposed on State bodies with a view to making any project appear viable.

Other renewable resources

7.7 Other renewable energy resources such as solar energy tidal power and wave energy are at a very early stage of development and can only be treated in the context of energy R&D policy. The Council believes that while there should be maximum utilisation of EEC energy research funds, any claims on the EEC energy research budget should take into account the potential for commercial exploitation in Ireland (for example, the West coast might prove a zone of significant potential for wave energy) and the extent to which it is possible to draw from international experience. The Council also believes that a joint cross-border project, for example, on the exploitation of wave energy might be put forward with a view to increasing EEC support for research on energy.

SECTION 8

INSTITUTIONAL ISSUES

8.1 The institutional arrangements for formulating and implementing energy policy have undergone some changes since the mid 1970s. Prior to 1977 responsibility for energy matters rested with the Department of Transport and Power. In 1977 responsibility was transferred to the Minister for Industry and Commerce which then became the Department of Industry, Commerce and Energy. By 1980 the increased involvement of the State in energy matters gave rise to the creation of a separate Department of Energy with responsibility for energy, mines, minerals and petroleum. In July, 1981 a further change resulted in the creation of the Department of Industry and Energy as the responsibility of one Minister.

8.2 Other institutional developments included the setting up of BGE in 1976 to acquire and distribute natural gas, the impetus being provided by the need to have a public mechanism to deal with Kinsale gas after it had been delivered onshore. The INPC was established in 1979 to play a national role in the acquisition of crude oil and oil products for distribution in the Irish market and later its activities were expanded through the acquisition of the Whitegate oil refinery. While detailed legislation to establish the INPC as a statutory corporation was prepared at one time, it has never been introduced into the Oireachtas. In 1980 the Institute for Industrial Research and Standards was given primary responsibility for carrying through the energy conservation programme on a national basis and this, of course, involves the active co-operation of many other public entities such as the ESB, Bord na Mona, An Foras Forbartha, local authorities, health boards and central Government Departments. Even before this the IDA had been giving grants for the installation of energy saving equipment in factories and they still continue to discharge that function. In more recent years the NBST has begun to make its contribution in energy matters.

8.3 The foregoing list of agencies having an interest in energy matters is not exhaustive and it is clear that the overall picture of relationships between them is a complicated one. The Council is, however, very clearly of the view that while there may be many agencies charged with

responsibility in the energy field, including supply, conservation, exploitation and research and development, the overall control and responsibility for policy making rests with the Department of Industry and Energy. The Council believes that there is a need for the enunciation of more clear cut policies by the Department and a clear delineation of the subsidiary roles allocated to all other agencies whose duties are to carry through the policies laid down by the central Department. Of particular concern to the Council is the question of enunciating overall principles in relation to the pricing of energy products not only between public sector agencies themselves but between the public sector agencies and the consumer at large.

8.4 At the very least there is a need to ensure that the resources allocated to the various public agencies in the energy area are used to the best advantage, that any overlapping between them is eliminated and that the activities of all are fully co-ordinated by the Department of Industry and Energy.

8.5 There is a danger that complex institutional arrangements could result in energy considerations becoming a residual concern in Government policy formulation. The Council believes that the arrangements at Departmental level should be designed to ensure that advice on a consistent and coherent energy policy is available to Government.

8.6 In their report the consultants pointed to a shortage of certain analytical skills in public agencies having responsibility for energy matters. Clearly there is a need to have adequate expertise in the public sector to advise on the complex issues covered by this report and the Council is glad to note that improvements in this respect have taken place in recent years. While there are many different facets of energy administration requiring skills of different kinds, the Council believes that the analysis of its recommendations in relation to the pricing of energy will be of crucial importance.

8.7 The consultants identify a number of deficiencies in data availability, in particular energy price data and sectoral energy consumption data. The Council agrees on the desirability of improvements in this area and it has also expressed its concern at the lack of published data in regard to various projects for energy utilisation whether these relate to public or private sector entities. An effective energy policy depends to a considerable degree on the availability of adequate data to ensure that decisions can be taken on the basis of informed analysis. Publication of data also has its relevance in relation to the recommendation on the subject of pricing since it is a matter of prime importance that where decisions are taken to depart from market pricing the costs and consequences involved should be clearly identified by the relevant institutions and made a matter of public knowledge.

SECTION 9

CONCLUSIONS

9.1 Energy policy is an area with many and varied interrelationships. The interdependencies between different strands of policy are complex. This report does not attempt to trace all these interdependencies. Rather, it presents some general principles which should define the broad outline of energy policy. The need to balance conflicting considerations in a wide variety of circumstances, while still preserving the structure of a reasonably coherent and consistent energy policy, is vital.

9.2 It is clear that, up to now, many policy decisions in the energy area have been taken on an ad-hoc basis to deal with particular problems or crises as they arose or to provide advantages for particular categories of consumers or segments of the economy. In some cases decisions were taken for reasons that had little to do with energy policy. Other decisions have been characterised by a desire to proceed with early development when, perhaps, postponement might have been to the national advantage. Other energy decisions have been seriously upset by subsequent developments which might not have been foreseen at the time they were taken.

9.3 The Council believes there is a danger that the semblance of a consistent and coherent energy policy, may be lost. It also believes that insufficient consideration is paid to the losses in energy efficiency which result from the use of energy policy instruments to achieve non-energy related objectives. The Council is particularly concerned at the apparent inconsistency in the matter of pricing policy where it is difficult to quantify the degree of inter-agency transfers.

9.4 An outstanding example of this inconsistency is the cost of primary energy resources to the ESB. The price of natural gas to the ESB was below the energy related price while the ESB was obliged to buy certain quantities of fuel oil from the INPC at prices in excess of those available from their normal sources of supply. For many years, particularly prior to 1973, the price of peat was in excess of its energy equivalent value whereas in more recent years the price was below that value. At present, it is again in excess of its energy equivalent value. Decisions taken by the ESB on the usage of primary fuel resources are therefore, not based on the opportunity cost of these resources which thus lead to a misallocation of resources.

9.5 The Council is generally in favour of the use of market clearing pricing. It believes that the price of competing fuels relative to prevailing international levels should be examined. Where significant differences are found to exist the Government should state its policy in relation to the elimination of these differences. The Council wishes to make it clear that in expressing favour with market related pricing it has in mind not only exchanges between public sector agencies but also exchanges between the public sector and private sector. If deviations from this principle are deemed desirable then the Council believes that the effects should be costed and should appear explicitly in the accounts of the relevant agencies.

9.6 The Council has expressed its concern at the degree of excess electricity generating capacity and the burden which this places on the economy. There is a clear need for a thorough review of the ESB's generating programme and also of the methods which ought to be adopted in the future with a view to ensuring that these expensive surpluses do not arise to any avoidable extent. The Council would wish to see this review published. Given the degree of excess capacity now existing the Council believes that, since the capital costs are sunk, the ESB should adopt pricing strategies which would promote the maximum utilisation of all existing plant. It would also be desirable that this marginal cost pricing strategy be designed such that the bulk of the benefits accrue to the traded sectors.

9.7 The Council believes that the future of the Whitegate oil refinery should be evaluated and that this evaluation should take into account the degree of security of supply obtained as against any cost disadvantage which might arise. In reviewing alternative mechanisms available for ensuring security and continuity of supply the future role of the INPC should also be examined.

9.8 One of the most significant aspects of energy policy at present is the search for, and optimal utilisation of, indigenous resources. In this respect prime importance attaches to the programme for petroleum exploration, primarily offshore. The Council is glad to note the encouragement which is being given to petroleum companies to take up licences on reasonable terms. The maximisation of the exploration programme in the years immediately ahead should, in the Council's

view, be a matter of the highest priority. The Council is satisfied that the licence terms provide a fair return to the petroleum companies and to the State which is in a position to capture the available rent by a variety of means including State participation on the terms which have been published. With some reservations, the Council agrees with the consultants that some oil exploration licences could in future be auctioned using a cash auction system provided, however, that it does not diminish in any way the rate of exploration or interfere with other forms of State participation.

9.9 The only commercial off-shore energy find so far is the Kinsale gasfield and, accordingly, the utilisation of this limited resource is a matter of considerable importance. While recognising the validity of past decisions relating to the allocation of natural gas, the Council believes that account must be taken of developments since the initial decisions were taken. It has, accordingly, agreed with the consultants' view that insofar as NET or any other consumer is concerned the relevant question to ask is whether it can pay the going market-related price.

9.10 Bearing in mind the finite nature of the reserve the Council is also concerned with the plans for greatly increased consumption of gas in the Dublin area especially since the full implications of this in relation to the life of the field, and the alternatives which may or may not be available when the resources have been used up, have not been published in detail. Any major decision affecting the life of the field, should, in the Council's view, be fully aired in public. Finally, the Council notes that while there has been a great deal of debate on the terms on which gas is supplied to NET and the ESB there is no detailed public information in relation to the arrangements – financial and institutional – for bringing gas to Dublin and distributing it there, and it feels that this omission should be rectified as soon as possible.

9.11 The Council recommends that the detailed recommendations put forward by the consultants in relation to the energy conservation programme should receive further consideration in the relevant Departments and agencies. However, as a general principle the Council believes that the energy savings achieved in any conservation programme must adequately remunerate the costs incurred and that this principle should be imposed on all the relevant agencies by the Department of Industry and Energy. The Council has also noted with some concern that there is a clear need for a renewal of the energy conservation momentum in both the public and private sectors. Inasmuch as energy conservation is in effect an improvement in national efficiency, interest in it should not be diminished on the grounds that the petroleum supply situation has temporarily improved. With regard to renewable energy resources the Council believes that further work is required before any investment decisions are taken.

9.12 The overall picture of relationships between agencies having an interest in energy matters is a complicated one. The Council is of the view that the overall control and responsibility for policy making should rest with the Department of Industry and Energy. There is a need for the enunciation of more clear-cut policies by the Department and a clear delineation of the subsidiary roles allocated to all agencies. Of particular concern is the question of principles in relation to the pricing of energy products not only between public sector agencies but between the latter and the final consumer.

9.13 An effective energy policy depends to a considerable degree on the availability of adequate data to ensure that decisions can be taken on the basis of informed analysis. The Council agrees with the consultants that there is a need to improve energy price data and sectoral energy consumption data.

9.14 In these comments the Council has endeavoured to express its own views on the main issues raised by the consultants, and on some additional points which also seemed relevant. However, considerations of space would not allow the Council to offer observations on each and every detailed point which is made in the consultants' study. The Council's view on these matters would not coincide with those of the consultants in all cases.

APPENDIX 1

The International Energy Association

The twelve principles for energy policy adopted by the International Energy Agency in October, 1977 can be summarised as follows:—

(i) reduce oil imports by conservation, supply expansion and oil substitution;
(ii) reduce conflicts between environmental concerns and energy requirements;
(iii) allow domestic energy prices sufficient to bring about conservation and supply creation;
(iv) slow energy demand growth relative to economic growth by conservation and substitution;
(v) replace oil in electricity generation and industry;
(vi) promote international trade in coal;
(vii) concentration of the use of natural gas on premium users' requirements and development of the infrastructure necessary to expand the availability of natural gas;
(viii) steadily expand nuclear generating capacity consistent with safety, environmental, and security standards satisfactory to the countries concerned and with the need to prevent the proliferation of nuclear weapons;
(ix) emphasise research and development, increasing international collaborative projects;
(x) establish a favourable investment climate with priority for exploration;
(xi) plan alternative programmes should conservation and supply goals not be fully attained;
(xii) co-operate in evaluating work energy situation, research and development and technical requirements with developing countries.

PART II

IRISH ENERGY POLICY

by

F J Convery
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PREFACE

This study was commissioned by the National Economic and Social Council to provide Council members with an overview of the major energy policy issues.

The terms of reference called for a review of prospective demand and supply for energy, and a consideration of "the sources of energy (other than oil) which could be made available at acceptable terms . . . the relationship between the likely rate of economic growth and the rate of increase in energy consumption . . . the optimal use of the non-oil sources of energy . . . the role of pricing policy for the different fuels, including tax and subsidy policies; the scope for energy conservation – over and above what might occur through reactions to changes in energy prices." A team of economists on the staff of the Economic and Social Research Institute was assigned the task of preparing the overview. Since altogether less than one man-year of work was budgeted for this task, of necessity the study is largely, but not exclusively, a summary of existing research and analysis. As such, we owe a large debt of gratitude to the numerous scholars and practitioners in the energy fields in Ireland who were generous in sharing with us their knowledge and insights.

More than most areas of policy, energy is characterised by interdependencies; for example, the financial attractiveness of investment in nuclear power will depend in part on the attractiveness of production alternatives (their costs and performance characteristics) on the one hand, and consumption behaviour – including conservation – on the other. It is necessary, therefore, to be reasonably comprehensive in coverage. The problem we faced was how to reconcile this with the paucity of time and resources at our disposal. We decided to do so in two ways: the first was to focus the bulk of our attention on those issues where there seemed to us to be substantial scope for policy initiative. As such we were vulnerable to having our analyses overtaken by events. We did not address policies relating to coal and peat, except as energy pricing, investment and regulation policy generally impinge on these. We excluded them with some misgivings, because, with the commencement of electricity generation at the ESB's coal-fired plant at Moneypoint and the conversion to coal of some major industries, coal consumption is expected to rise from 0.7 million tonnes of oil equivalent (MTOE) in 1981 to 2.5-3.00 MTOE by the end of the

CHAPTER 1

FORMULATING AN ENERGY POLICY

In formulating policy, it is usual to identify objectives and the means whereby they are to be achieved.

Objectives

Two broad objectives can be identified:

1. To produce and consume energy in an economically efficient fashion. Economic efficiency in this context is defined as the pattern of production and consumption which maximizes the excess of the returns over the costs to society. Since only some of the returns and costs will be adequately valued in markets, this is a difficult objective to operationalize. However there are a number of indicators by which one can get a sense of performance in this respect. Among these are the following:

   (a) Are energy imports being purchased from the least-cost sources?
   (b) Are domestic energy resources being allocated to those users who can make the most efficient use of them? This can typically be achieved by allocating the resource in question on the basis of price such that a market-clearing price – the price at which all consumers willing to pay the price can get the supplies they desire – is arrived at.
   (c) Are energy production, transportation, conversion and consumption being carried out such that the costs of these are minimised for the output in question?
   (d) Where there are negative "by-products" e.g., air pollution, in the production/consumption chain, are they mitigated appropriately? "Appropriate" in this sense means reducing the adverse impact to a level where the additional cost of so doing just equals the resulting benefit.
   (e) Is energy production and distribution sufficiently competitive, in the sense that no one firm has enough market power to set prices? When competitive conditions are not feasible, does the policy system encourage competitive-type performance?

2. To ensure that the most economically and socially vulnerable members of the community are adequately protected against the adverse effects of rapidly rising energy prices and/or absolute shortages, and that this is done in the least-cost fashion.

   There is a difficulty in defining "adequate protection" in this context. It must derive on the one hand from the energy necessary to sustain life and a minimum degree of comfort, and on the other from the judgement of society as to what is "fair." The subsidiary objective of providing protection in a cost-effective manner is of critical importance. This can be illustrated by reference to one example: One approach to helping low-income individuals is to subsidize prices, or, in the case of State energy production enterprises, to require that they sell below market-clearing prices. However, energy is typically relatively income-elastic; an increase in income will result in a commensurate increase in the quantity consumed. Subsidizing energy prices, directly or indirectly, confers the greatest absolute benefit on those who are most affluent. Thus this mechanism is a very "wasteful" means of protecting the less well-off.

The two objectives specified above comprise in essence the goals of efficiency and equity which economists typically recognise as the twin primary concerns in evaluating policy alternatives. In the domain of energy, another objective – the achievement of security of supply – is often added. This concern arose from the post-1973 situation where policy-makers in all major oil-importing countries became eager to protect themselves against the adverse effects of supply interruptions and escalating price increases. However, this topic can be addressed as an element in the efficiency objective. The issue is, to what degree (if any) will efficiency be enhanced if the state intervenes to provide more insurance against escalating prices/supply interruptions than private producers and consumers would do in maximising their own self-interest?

It is not uncommon to find a litany of objectives – in addition to, or other than, efficiency and equity – in discussions of energy (and other) policies. These include improving the balance of payments, encouraging cross-border cooperation, and the provision of infrastructure and employment in deprived areas of the country.

We felt that, in those cases where such objectives were relevant, a framework should be established whereby the sacrifices in economic efficiency necessary to accommodate these could be established, so that the trade-offs involved are transparent. We feel that one of the structural weaknesses which has characterised state intervention in Ireland has been that agencies are given (or take) an antipasto of often conflicting objectives which makes cost-accounting and the evaluation of performance very difficult. We were anxious to avoid adding legitimacy to this profusion and confusion of goals, and so chose the achievement of economic efficiency as the fulcrum of our analysis, while providing a framework for showing the sacrifices which would be required of the citizenry in order to accommodate other goals.

Targets specifying the degree of import substitution, employment generated, government revenue raised, conservation achieved etc., may also be presented as objectives. The latter are typically means of achieving "larger" aims. They may emerge at the conclusion of analyses as appropriate elements in the achievement of efficiency and equity objectives, but should not be specified at the outset as objectives to be accomplished.

Means of achieving objectives

There are three primary means of intervention whereby the state can encourage the achievement of goals. These are: energy pricing, regulation of production and consumption, and investment.

In identifying means of achieving the objectives of efficiency and equity, we took the energy and policy systems we have as the starting point and looked at successive incremental adjustments to those components of the energy production and consumption system where, *a priori*, such adjustment seemed as if it might prove of interest. This had the (for us) compelling advantages that it concentrated scarce data gathering and analytical resources where the payoff was likely to be greatest, and supplied the beginnings of a realistic data base in the selected areas. By focussing on the implications of incremental costs and price changes, it provided the foundation for answering: (a) what the financial costs and returns were to changes from the status quo; (b) what the pricing system implied in terms of incentives for production and consumption; and (c) what costs must be borne by taxpayers if non-financial considerations – security etc., – were to be accommodated. Thus we aspired to provide a nodal point from which a variety of policy aspects could be explored in a consistent fashion, and in a manner relevant to policy-makers.

By so doing, we could conserve our analytical energies by undertaking the minimum data gathering and analysis necessary to arrive at a useful decision. For example, if it was shown that energy crops were a financially efficient investment, then it would not be necessary to calibrate the positive environmental, regional development, self-sufficiency and other arguments; the decision would stand on its financial merits, and these other desirable attributes would be "icing on the cake." Conversely, if it were shown not to be worthwhile on financial grounds, we would at least have a sense of the amount of subvention required from the tax-payer if investment in this area were to be undertaken so as to capture these other benefits.

Methodology

There is a well known theory in economics which posits that if markets are functioning "properly" – i.e., with competitive conditions, where producers and consumers are rational and adequately informed, and where all resources are owned – then, for a given distribution of income, economic efficiency will be maximised. Of course, for various reasons, markets do not function properly in many instances, and this market failure can comprise a rationale for public intervention.

There are important instances of market failure in both production and consumption of energy. By market failure we mean that the necessary conditions for effective operation of energy markets do not obtain.

The following are some important manifestations of market failure.

(i) Economies of scale in the production and distribution of electricity have resulted in the creation of a "natural" monopoly in this sector. When the marginal cost of increments in supply is lower than the average cost, setting price equal to marginal cost would result in the ESB losing money. However if price is not set equal to marginal costs, efficiency losses are incurred, because consumers have to pay a price for electricity which exceeds the costs of production of units at the margin. Conversely, if marginal costs are above average costs, marginal cost pricing would result in monopoly profits accruing to the agency. The absence of marginal cost pricing in the latter situation is not merely an academic nicety; if the price is set below the marginal costs, it means that Irish consumers would be paying a price for electricity which is below the marginal costs of providing increments in supply. They would therefore be "over-consuming," in the sense that the revenues provided for units at the margin would not cover the costs of their provision.

(ii) While the "natural" monopoly in electricity production and transmission has been given statutory expression in the creation of the ESB, a quasi-monopoly in the form of Bord na Mona, was also created statutorily by the Government. This organisation was given very strong powers of compulsory acquisition in the Turf Development Act (1946), and was enabled thereby to capture economies of scale in bog drainage and exploitation. Its primary customer is the ESB; most bogs have been developed with the intention of supplying the output to a peat-fired electricity generating station, and 20 per cent of the ESB's primary fuel (in Tonnes of Oil Equivalent) in 1979 was provided from this source. Prior to 1973/1974, the ESB was forced by the Government to pay a price for peat which was substantially in excess of the price for which they could import oil of equivalent energy value. For a while after 1973/1974 the Prices Commission prevented peat prices from rising above cost induced levels. Since then, the price for peat has tended to be set on an energy-equivalent basis with that of competing fuels.

(iii) Producers and/or consumers may not be adequately informed as to the energy implications of choices. Thus, if consumers choosing among energy appliances do not know their relative energy efficiencies, they will not be willing to pay a "premium" for the more energy efficient devices. The same clearly applies to houses, cars, etc. Similarly, a manufacturer who does not know the full energy implications of production decisions will not make optimal decisions. There has been a presumption in Ireland that householders, in particular, have not been adequately informed as to the conservation choices available and their cost-effectiveness. If there are significant economies of scale in information collection and/or transmission, this can provide an efficiency rationale for state intervention.

(iv) There are external costs imposed in energy production, transportation, conversion and consumption. An external cost can be defined as one which is not borne by the perpetrator, but rather passed on to others. Environmental costs comprise the predominant form of externality associated with energy. The quality of Ireland's air is to a substantial degree determined by the quantity of energy provided and consumed, and the manner (including timing and location) in which this is done. When the ESB and coal and oil-burning householders emit sulphur to the atmosphere as one of the "waste" products of coal and oil conversion, the costs imposed on those who ingest this sulphur are not borne by the perpetrators. Similarly, when vehicles emit lead, carbon monoxide, nitrogen oxides, etc., into the atmosphere as a by-product of fuel combustion, and these impose costs, the vehicle owners do not bear them. In these circumstances the condition of efficient market performance that all scarce resources[1] be owned is violated and market failure ensues.

In examining each area of energy conservation and supply, we first addressed the issue, either explicitly or implicitly, how and in what degree is the market failing, and (if so), to what extent are the policies vis-à-vis pricing, regulation and investment appropriate? Policy vis-à-vis pricing is particularly important.

[1] In this example the scarce resource is the assimilative capacity of the atmosphere.

Pricing

It is difficult for any policy, no matter how otherwise well designed and implemented, to be successful if the price signals being received by producers and consumers provide strong incentives contrary to that policy. If fuel price is set below the market-clearing level, then:

(i) Consumers will take more than they would have with higher prices, and will correspondingly under-invest in conservation. Posterity will be short-changed; the non-renewable energy endowment available to future generations will be reduced.

(ii) Net output of the economy will be reduced, because the returns at the margin in the favoured sectors will be less than the energy could have yielded in a sector willing to pay a higher price.

(iii) The financial returns to the citizenry as a whole will be reduced, and the regions fortunate enough to be allocated the resource in question will benefit at the expense of the others. Since the bulk of energy consumption takes place in the Eastern region, a policy of charging less than market-clearing prices will in effect comprise a very substantial subsidy to this region. If the full price is charged on the other hand, the "surplus" revenue generated can in part be directed to those regions which do not share proportionately in the resource itself, if such is desired.

(iv) Production of all other fuels – turf, energy crops, biomass, wind energy etc., – is discouraged, as these enterprises must compete with the low-priced product.

(v) The creation of high-energy consumption sectors is encouraged which poses sometimes insuperable difficulties of adjustment when either the "cheap" energy runs out or there is an effort to re-allocate to other users who are willing to pay more for it. There are metal smelters in the Netherlands for example which were allocated very large volumes of low priced natural gas at their establishment. There are at present a variety of users willing to pay much more than the smelters can now afford to pay for this allotment but a re-allocation is politically and socially difficult; the system is "frozen" into a sub-optimal pattern which would not have arisen if the charging of market-clearing prices had been adhered to from the outset. The hoped-for development of ancillary linked activity has not materialised.

The tendency to justify a cheap energy policy on the basis of its purported propulsive impacts on development should be resisted. The "cheap energy" approach masks the full opportunity costs of the development. If such development is felt to be desirable, the subsidy should be paid directly, thereby making the costs explicit. The same of course is true of all subsidies, not only those relating to energy.

(vi) The benefit of the lower price may not be passed onto the consumers, but captured by intermediaries. For example, in the case of Bord na Mona briquettes, the price is fixed ex-factory by the government (with the advice of the National Prices Commission) at a price below the market-clearing level.[2] It has been argued that some retailers can in effect capture some of the rent by such subterfuges as charging very high "delivery charges."

If market-clearing prices are charged, then agencies such as An Bord Gais which administer valuable resources for the people of Ireland will "earn" a rent, and large "profits" will be generated. This profit of course is comprised mainly of the value of the resource itself, which belongs to the people of Ireland and which should therefore accrue to them. A number of knowledgeable individuals expressed the concern that this would not in fact happen. They argued that employees, seeing the large "profits" being generated, would use their leverage to capture the rent in higher wages. In this case the prices charged would be giving the appropriate signals to consumers and producers, but the rent would accrue to the employees rather than to the citizenry in general. If a below market-clearing price is charged, then the price-signals will be wrong, and the rent will be transferred to consumers – with those consuming most getting the most rent – or to intermediaries.

We believe that the advantages of using market-clearing prices are so compelling that a determined effort is warranted to charge these and to gain the benefits thereof. State agencies which have rent-generating publicly-owned resources under their management should pay royalties and taxes at a level comparable to that which would be assessed if private companies were exploiting these resources. If this were done, then the net of tax and royalty profits would provide a reasonably accurate measure of efficiency and productivity of the enterprise, and would reduce the likelihood that the rent will be captured in the form of higher wages and salaries. It is entirely proper and desirable that employees be paid a fully competitive salary, and that they share in the growth in real returns resulting from productivity increases. It is not appropriate that they capture part of the rent accruing to the resource in question; this is created in part by the monopoly power of OPEC and belongs to the resource owners, namely the citizenry at large.

It is also sometimes argued that a State sponsored rent capturing agency will tend to dissipate the rent in relatively unproductive investments, since they will be cushioned against balance-sheet losses by the value of the resource. This has happened in some of the recently oil-

[2] The price of briquettes has since been allowed to achieve the market-clearing level.

rich countries. Again, an automatic and predictable tax/royalty regime applied to the returns of the agencies in question will remove this loss-making cushion and facilitate management in the national interest.

The case is also made that energy to industry should be priced "competitively", in some sense on a par with what competing industry in other countries must pay. A cogent expression of this point of view is provided in *Energy Report 1982*, published by the Confederation of Irish Industry (p. 39).

> "If Irish manufactured goods are to maintain cost competitiveness on foreign markets, it is essential that the cost of its inputs, including oil, must be competitive with the prices paid by foreign manufacturers for their raw materials".

In *Energy Report 1982* it is shown that in late 1981 and 1982 Irish prices – both before and after tax – for premium gasoline and residual fuel oil were higher in Ireland than the UK and the EEC average prices, while electricity prices were also relatively high.

We have considerable sympathy for firms who find themselves in the depth of a recession having to pay input costs higher than those of their competitors. However, it is unwise to focus on any particular input (in Ireland energy costs comprise about 6 per cent of industry turnover), because indigenous costs, opportunity costs, productivities, management quality etc. all vary. If the principle of "parity pricing" of energy were accepted, there would be no logical basis for not extending it to other inputs, such as labour. The concept of fixing wages on a one-to-one basis with, say, the EEC average wage level for the industry in question is illogical because productivities, other costs, the demand supply situation etc., are different. The same principle applies to non-labour inputs. However, as we show in later chapters, there are price burdens which energy consumers are forced to carry in Ireland which are in addition to the price which would emerge as a consequence of normal market forces and commercial considerations. These additional costs are generally justified on the basis of giving employment and/or providing national security in the event of supply interruptions. As we shall see, there are usually much cheaper ways of providing jobs and security. Additional fuel costs attributable to such gratuitous impositions are, of course, unwarranted and undesirable. Once policy shifts from the use of market-clearing prices, it tends to become a carousel of compensating errors. Bristow cites examples (Bristow, 1982, p. 169):

> "Ceimici Teoranta produces industrial alcohol for which there is no real market: petroleum distributors have been required to purchase this product as an addition, in quantities and at prices deter-

mined by the Minister for Agriculture. A similar market was created for Bord na Mona by the fact that the ESB was obliged to generate a high proportion of its power from peat over a period of 25 years when this fuel was more expensive than oil. Changes in relative fuel prices have, of course, eliminated this example (peat now being cheaper than oil) but the exercise is being repeated in that the ESB is now required to buy oil from the INPC, although cheaper oil is available from other sources . . . Nitrigin Eireann would have made even larger losses than it has but for the fact that the Gas Board has been required to sell natural gas to it at prices below those charged to other consumers. Similarly artificial prices are charged to the ESB".

Other considerations

(i) In attempting to identify the most appropriate role for government, we found it helpful to examine why individual consumer and producer behaviour would not produce the desired result, and then to identify the most cost-effective strategies for bringing individual decisions into harmony with overall welfare. We feel that this provides a useful framework for examining many energy policy issues, including those several topics not addressed by us.

(ii) Several billion dollars are being devoted annually around the world to research on energy supply alternatives to oil. Because of this, within two decades we can expect to see the beginning of major break-throughs on energy supply, storage, transmission and use. The OPEC cartel continues to have the ability to influence price, both upwards and downwards. The probability of a major supply interruption, such as the reduction or elimination of supplies from Saudi Arabia, is significantly greater than zero.

It follows then that there is some value in having energy policies both flexible and adaptive, and able to respond relatively quickly to changing circumstances.

(iii) Since rising real energy prices are a recent phenomenon, the historic record, even with creative econometric manipulation, is a rather uncertain guide to the future. It follows that most policy is in a sense experimental and that monitoring and evaluation should be an integral part of policy initiatives. Thus researchers at units such as An Foras Forbartha, IIRS, NBST, ESRI and the Universities should be invited to participate at the formulation stage, so that this capability can be designed – into the system. Without this, ineffective and expensive policies will be persevered with when they should be modified or dispensed with entirely.

As a corollary to this, in cases where outcomes are especially

uncertain, well-designed pilot testing of schemes should be undertaken to evaluate their worth before a nation-wide effort is launched.

(iv) Although we often cannot predict the outcome of policy, we can often know, from economic theory and experience, the direction which policy should take. Other things being equal, we know, for example that: if prices are lowered, consumption will increase; efficiency is maximized at the output where marginal cost equals marginal revenue; tax credits are more equitable than deductions. Thus we should concentrate initially on getting the direction of policy correct, and use the monitoring/evaluation capacity discussed in (iii) above to refine it over time.

(v) Outlays for energy comprise a much larger share of household expenditure for the less well-off than they do for the richer members of the community. Thus rising energy costs bear especially heavily on the former. Policy should be designed to cushion them from the effects of increasing energy prices. Keeping the price below the market-clearing level is a highly inefficient means of doing this; it subsidises most those who consume most, and those who are best able to manipulate the non-price rationing systems (who will typically be the better-off). We much prefer the use of direct transfer payments to the poorer members of the community, either in the form of a negative income tax or some expanded version of the fuel voucher system now in place.

There are a number of concepts which one encounters in the energy policy literature which in some quarters are given the status of universal truths. Used appropriately, these concepts can provide useful insights. Used inappropriately, they can provide misleading guidelines for policy, with unfortunate consequences.

Misconception No.1

A gap will develop between demand and supply at some future year, typically the year 2000.

Demand (more properly, consumption) is forecast by establishing a relationship between energy consumption and variables such as income, population and technological development; the latter are then projected to the year in question and energy consumption in that year is then estimated from the relationships identified earlier. Future supply is estimated by projecting past trends and prospective development. Making up the resulting gap – for some reason demand always exceeds supply – then becomes an objective of policy.

This approach is deficient in a number of respects. First it focuses policy attention on an irrelevant entity. In fact, as we all know, consumption must perforce adjust to the quantity supplied; the "gap" is in this sense an artificial construct of the assumptions made. Secondly, the historic data on which both the consumption and supply data are based are, of necessity, seriously flawed in one dimension; the 1959-1974 pattern of consumption took place in a period of rapidly falling real energy prices. We, on the other hand, have experienced sustained real price increases. We simply do not know what the long-term effect of such a change in direction will be; the production/consumption responses are not readily discernible from the data. Thirdly, focussing on a single far-off future point encourages policy makers to ignore the potential for adaptation, year-by-year, as circumstances change, and to build such adaptiveness into the system. Finally, the "gap" approach tends to down-play the fact that management of consumption, i.e., actually determining the level of consumption by policy measures, is now feasible and, if correctly done, appropriate; future "demand" is not a disembodied number which emerges "naturally" from the working of economic forces, unrelated to policy measures.

None of the above should be taken as implying that we are against attempting to assay trends and anticipate problems; such prognostication is indeed necessary when large investments with long-term implications are being evaluated, such as investments in electricity generating capacity. However, conventional project analysis, focussing on potential markets, prices, costs, etc. will suffice for this purpose. To identify a quantity of electricity that will be "needed" in the year 2000, and then to attempt to fill in the gap which emerges when future consumption is compared with prospective output, is not the appropriate manner in which to analyse this issue.

Since we have not in Ireland adopted the "gap" approach to energy policy analysis, the reader may wonder why we labour the point. We do so because this method has been used in other countries, notably the US, with unhappy consequences, and unfortunately, bad ideas often travel well. In addition the "gap" mentality does flavour some of the policy rhetoric one hears in Ireland. We would like to note incidentally, that we are not criticising here the NBST scenario approach (Kavanagh and Brady, 1980) wherein alternative means of achieving various levels of future consumption were identified, although the manner in which they presented their results for general public consumption might encourage this view.

Misconception No. 2

Fuels should be priced according to their energy content, measured in BTUs or other energy units.

Fuel	Equivalence TOE/MT	Price per MT	Equivalent Price (£)
Heavy Fuel Oil	0.9849	93[1]	94
Coal	0.665	53[1]	80
Sod Peat	0.313	16.50[2]	53
Wood	0.185	9.0[3]	49

1. Import price in November 1980
2. Ex-works, Bord na Mona, November 1980
3. Pulpwood loaded on lorry ex-forest, November 1980

Above can be seen the energy content, in tons of oil equivalent (TOE), of a metric ton (MT) of heavy fuel oil, coal, sod peat and wood. The price of each of these in November 1980 is listed, and then the equivalent price per TOE is presented. It can be seen that there is very wide variation, with wood getting only a little more than half the price per unit of energy that heavy fuel oil achieves. Proponents of the energy equivalence position would argue that wood should be priced equivalent to oil. Applying this logic yields a value of £17.26 per ton of pulpwood loaded, rather than the £9.00 listed. However, costs of transportation, storage and conversion differ among energy sources, as do the nature and characteristics of the energy yielded. The energy equivalent price must therefore be adjusted for all of these differences before a measure of "value" can be derived, in the sense of what is likely to emerge when willing buyers confront willing sellers.

Misconception No. 3

Energy resources – oil, gas etc. – should be processed in Ireland to get the benefit of spin-off industries.

This notion has such wide currency and has such obvious political appeal that it deserves some analysis. Obviously, any downstream development which can pay a competitive price for the fuel in question and operate profitably is to be encouraged. An issue arises if a price below the open-market price is required in order to "induce" the activity in question. A trade-off must be made between the value to the economy of a subsidy in this form and the returns yielded by spending elsewhere the revenues foregone, and this should be made explicit.

Misconception No. 4

Higher energy prices are regressive, bearing especially heavily on the poor.

The logical corollary of this is that keeping energy prices below the market clearing price is progressive, and favours the poor. Thus, politicians keep the lid on price in order to help out "the common man". There are, of course, excellent economic efficiency reasons for allowing the market clearing price to prevail, but, quite apart from that, it is interesting to see if in fact, judged on its own merits, a policy of energy price stabilisation would be progressive. It is clear from Table 1.1 that the poorest households (under £20/week) in 1979 spent a smaller share of their total energy budget, and much less in absolute terms, than the most affluent (£230 and over/week) on electricity and oil. A subsidy for these two fuels, financed by the general taxpayer, would be regressive. Conversely, the three income groups listed spend roughly the same absolute amounts on coal.

Misconception No. 5

Domestic energy resources should be fully developed, regardless of the cost, for security reasons.

There is no reason why any particular country or region of the world should have within its boundaries, attractive investment opportunities for energy supply, and Ireland is no exception. As real energy prices rise, the chances increase of viable investment opportunities arising within any given set of boundaries. However, even when such investment opportunities arise, it is clear that diminishing returns to increments in investment inevitably set in. Thus, for example, if it turns out that some investments in energy crop production are warranted in Ireland, we can be sure that, as the amount of investment increases, the most attractive opportunities will be taken up first, so that eventually the costs of an additional increment of wood-energy will equal, and then exceed, the additional benefit generated thereby.

Just as diminishing return sets into production, so also does it set into investments in conservation; as the proportion of energy conserved increases, the costs of achieving an additional increment of conservation also increase.

Misconception No. 6

Academic analyses are of little value and no relevance to the real world of policy formulation.

The real world, in this conception, refers to the socio-political environment where pressure groups, restrictive practices and consumer lobbies must be accommodated. We know that the decision-environment is complex and conflicting. For this very reason, it is important to articulate clearly what the alternatives are, in the sense of tracing out costs and implications, and what is being foregone if one is chosen over the other. Then at least the costs in terms of revenues, output, jobs, etc., foregone by accommodating to the "real world" will be known. A clear plan of action can be embarked upon, with deviations taken when neces-

Table 1.1

Expenditure shares (%) on fuel and light, by fuel type and income class, 1979, urban households

Gross weekly household income (£)	Distribution of income classes (%)	Piped Gas	Electricity	Coal (1)	Turf (2)	Other (3)	Total
Under 20	5.3	0.389	0.488	1.626	0.219	0.441	3.162
% of total		12	15	51	7	14	100
90-100	7.2	0.796	3.06	1.152	0.15	1.41	6.569
% of total		12	47	18	3	21	100
230 and over	9.6	0.962	3.880	1.544	0.446	2.346	9.179
% of total		10	42	17	5	26	100
All households	-	0.654	2.512	1.446	0.288	1.464	6.363
% of total		10	39	23	5	23	100
230 and over/under20	-	2.47	7.95	0.95	2.04	5.32	2.90

Notes: (1) Including coke
(2) Including briquettes
(3) Mainly fuel oil

Source: Household Budget Survey, 1979, Stationery Office, Dublin, 1981, p. 44.

sitated by the various pressures which are always present. There is another response to the "real" world, which is simply to react in an *ad hoc* fashion to the latest crisis or pressure, and hope that the aggregate of such responses will comprise a coherent policy. We feel that our endeavours will contribute usefully to the former approach to the "real" world; it will be irrelevant to practitioners of the latter.

Misconception No. 7

Resources, once discovered, should be exploited as rapidly as possible.

If the value of the resource in the ground is growing at a real rate which is faster than the current rate of interest (i.e., the rate which can be earned on the best alternative investment) then it is in the national interest to defer exploitation; the resource is "earning" more in the ground than the revenues yielded by its extraction would earn if invested. If a use capable of paying a high price in the future is in prospect, it may be better – depending on the timing and the magnitude of the future yields, and the interest rate – to pass-up low value market opportunities today in order to capture the higher returns later on. The guiding concept should be the maximisation of present net worth. It is difficult, of course, to predict what futre prices will be[3] and to arrive at the appropriate rate of discount, but these are difficulties common to all portfolio management, including the present case where the portfolio in question is the Irish people's energy resources.

Misconception No. 8

The conversion of energy into products which maximise export (or import substitution) value is desirable because it maximises the contribution to the balance of payments.

Providing the resource to the highest bidder will normally maximise the net balance of payments contribution. If the converting use in question cannot pay a competitive price, it may make a major gross contribution to the balance of payments. However, to the extent that capital and materials required in the conversion process are imported, these must be deducted from the gross figure; the opportunity costs – the impacts on the balance of payments of allocating the resource to the highest bidder, must be considered. Thus, for example, when natural gas is allocated to fertiliser manufacture, the net balance of payments contribution of this use should be compared with the equivalent con-

[3] With hindsight, we might have been better off to initiate drainage of our midland bogs in the 1960s and early 1970s, but defer exploitation of them. We could then have maximised our use of cheap Persian Gulf oil while it was available, and then used peat when it became commercially profitable to do so.

tribution of the use willing to pay the most for it. (If NET's gas allocation were instead used by the ESB and charged at a price related to the value of the fuel it replaces, namely heavy fuel oil, import savings of about £56 million annually could be realised by the latter).

Misconception No. 9

The rate of exploration should be maximised.

A scarcity rent is said to exist whenever a payment to any factor owner in a particular occupation exceeds the minimum payment required to retain a factor in that use. In the case of energy resources, any return to investment in excess of "normal" profits is termed rent. The bulk of energy resources are State-owned, but they are (with the exception of Bord na Mona's activity) sought for and extracted by the private sector. Any rent resulting from exploitation is available to be shared between the resource owner – typically the State – and the private sector. Other things being equal, the larger the share that is left to the private sector, the more exploration activity will be encouraged. There is, therefore, a trade-off to be made between sacrificing rent on the one hand, and encouraging exploration (and therefore the generation of future rents) on the other.

Maximisation of the present value of rents will maximise net financial returns to fit resource owners (the people of Ireland). This will be achieved at the point where the rent sacrificed by the State at the margin in resource extraction just equals the time-adjusted rent gained at the margin from the exploration thereby induced. Since in Ireland's geological circumstances we don't know what the returns to exploration are likely to be, nor do we know the relationship between rent capture and exploration effort, this criterion is at present of more theoretical interest than practical significance. However, it does tell us that, beyond some point, exploration will be encouraged at the expense of overall financial return to the citizenry; exploration should not, therefore, be maximised in an absolute sense. (This would be achieved if the private sector were allowed to capture all of the rent).

Misconception No. 10

Energy resources and the products manufactured therefrom – petroleum, fertiliser, etc. – are of strategic value and should be processed domestically even if the energy could be sold (unprocessed) at a higher price, and/or the products could be purchased on world markets at a price lower than the cost of manufacture in Ireland.

This issue arises in particular with regard to the refining of oil, where it appears that economies of scale, advancing technology and a worldwide excess capacity combine to make refining in Ireland uncompetitive with production overseas. Strategic arguments have also been made in support of Irish fertiliser manufacture. If strategic considerations are a concern, then the relevant scenarios need to be articulated — complete cut-off from overseas supplies, reduction in such supplies, rapid price escalation, etc. — and their economic, social and political implications traced, followed by a cost-effectiveness analysis of various means of dealing with these contingencies. Among the latter, stockpiling deserves particular attention. Insurance can, therefore, be acquired in different ways and to varying degrees. It is not clear that indigenous production is always the best means of achieving appropriate protection. Thus, while we recognise the legitimacy of strategic and national security considerations in certain well-defined circumstances, they should not be used as a blanket justification for courses of action which cannot be sustained on grounds of economic efficiency.

SECTION I:

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

CHAPTER 2

GENERAL BACKGROUND AND RECOMMENDATIONS

General background

Since the oil embargo was imposed in October 1973, energy policy has been perhaps the pre-eminent continuing concern throughout most of the world. Up to that time, there was a near universal complacency concerning availability of supplies; it was expected that the emerging so-called back-stop technologies – nuclear power, coal and oil-shale liquefaction, sea-bed exploration etc. – would smoothly replace the depleting oil stocks in the world's energy supply. After the initial "shock", the mid-seventies again saw ready availability of oil at stable or even slightly declining real prices, and complacency reigned once more. The supply interruptions following the Iranian revolution and the Iran/Iraq war again punctured the more optimistic expectations in this regard. There is now a general sense that, so long as much of the world's traded oil comes from an area as inherently unstable as the Persian Gulf region, we cannot be sanguine regarding future supplies and therefore prices.

Throughout the 1960s, Ireland followed the worldwide pattern of taking advantage of the declining real price of oil in this period to expand intake rapidly; oil consumption grew from 1.16 million tons of oil equivalent (TOE) in 1960 to 6.24 million TOE in 1979, but fell back to 5.07 million TOE in 1981. Oil's share of total primary energy consumption increased from 27 per cent in 1960 to 72 per cent in 1979, but in 1981 had declined to 62 per cent. After over a decade of decline, crude oil prices increased (in 1968 £) from £7.56 per ton in 1973 to £19.07 in 1975 and then to £29.94 in 1980. This fourfold increase in the real price of oil over a seven year period exerted an effect on substitute fuels, so that prices of coal, peat etc. also rose in real terms over the period.

Ireland imports over 70 per cent of its energy needs, and payments for energy in 1981 comprised 15 per cent of our total import bill (compared with 6.8 per cent in 1973). Oil accounts for 88 per cent of these energy imports, by value. We have refining capacity to meet about one third of our oil needs; Saudi Arabia is the chief supplier of crude oil. Refined oil requirements are met mainly from UK refineries, principally the Milford Haven complex in Wales. Coal is our other major energy import; Poland, the US and Britain have been the major suppliers, but Poland's share has fallen sharply.

Over the past two decades, peat and hydro power have been the only indigenous energy resources making any significant contribution to the nation's energy supplies. Peat is produced mainly by individual owners meeting their own fuel needs, and by Bord na Mona, which supplies a number of peat-fired electricity generating stations providing 16 per cent of the units (kilowatt hours) sent out in 1979/80, and also sells turf and briquettes directly to consumers. Bord na Mona's statutory powers allow it to take advantage of economies of scale, and to take a long-range perspective. In spite of these advantages, the very low prices of competing fuels which obtained up to 1974 meant that, in order to keep Bord na Mona financially viable, the price paid for peat by the ESB in this period was fixed well above that of competing fuels. Thus, prior to 1974, we imported the bulk of our energy needs, and much of what was domestically produced had to be subsidised by electricity consumers. After 1974, peat production by Bord na Mona was fully competitive with substitute fuels, and didn't require subsidisation.

The other major indigenous energy resource is natural gas. The Kinsale Head gas field was confirmed in April 1974 with a capacity of one trillion cubic feet, or nearly 25 million TOE (MTOE). In 1981 the reserves were re-estimated, and increased by 35 per cent, to 33 MTOE. Extraction for energy in 1981 amounted to 0.9 million TOE, with an additional 0.4 million TOE going to Nitrigin Eireann Teoranta (NET) for processing. The natural gas deliveries for energy purposes commenced in 1979. In 1981, total energy consumption was as follows:

	Quantity (Million TOEs)	% of Total
Hydro	0.22	3
Peat	1.12	14
Coal	0.85	10
Oils	5.07	62
Natural Gas	0.90	11
Total	8.16	100

This represents a 5.3 per cent fall in aggregate consumption from 1979, a result of the impacts of higher prices and the recession. Since the recession has deepened in 1982, it may be that consumption will fall again in 1982. If it does so, it will be the first time since the mid-1950s that consumption has fallen in three successive years. Taking the hydro, peat and natural gas together, we find that indigenous resources now (1981) provide 28 per cent of primary consumption.

Recommendations

In the chapters following, our analyses regarding conservation, energy supplies and institutional aspects are summarised, and conclusions and recommendations are provided throughout. In this chapter we summarise our recommendations. They are grouped under four headings, relating to the interdependent policy instruments available. These are investment, pricing, regulation of private sector behaviour, and administrative actions.

Investment

State investment in energy development is substantial, as can be judged from the amounts of capital allocated to the main State agencies in 1983:

	Capital (millions of 1983 £)
Bord na Mona	36.00
ESB	242.05
Bord Gais Eireann	22.00
Renewables	0.25
Other	3.70
Total	304.00

This comprises 16 per cent of the total capital budget for 1983, and 36 per cent of capital budgeted for production infrastructure (energy, transport, roads, sanitary services, telecommunications, broadcasting, postal service).

It is stated in the "Revised Public Capital Programme 1983"[1] that (p. 137):

> "Public investment will not be undertaken unless it can be shown, on realistic assumptions, that it will yield a sufficient return. . . . Programmes which are undertaken primarily for economic reasons will be judged by economic and financial criteria. . . . New guidelines are being prepared to promote more uniform and systematic appraisal and monitoring of capital projects."

We are, of course, in sympathy with these aspirations, our enthusiasm, however, being tempered by the knowledge that similar statements have been made in the past only to be gainsaid by subsequent performance. Specifically, we conclude that:

- If the government is serious about effectively managing public

[1]This is included in Budget 1983, Dublin, Government Publications.

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investment in the energy (and other) area(s), it will have to strengthen and expand its capabilities in economics and policy analysis, in the relevant engineering areas and in data gathering, storage, management and systems analysis.

To attempt to oversee nearly one-third of a billion pounds annual investment budget with anything less may do more harm than good: If the government cannot adequately discriminate between "good" and "bad" project proposals, then the evaluation system may simply serve to delay sound investments without filtering out the less desirable ones.

- The decision to invest in Whitegate be reviewed, on the basis that it adds very little to our security and provides very few jobs, at very high costs to consumers and to output and employment elsewhere in the economy. If there is a collapse of oil prices, this would provide an opportunity to replenish stockpiles and thereby provide a substantive increase in security by other means.
- If the proposal to build a nuclear electricity generating station is re-activated, that the economic analysis and assumptions justifying the proposal be presented to the public, together with the environmental and social impact assessments.
- Sound investments in conservation and in combined heat and power be actively sought out and promoted.

This applies with particular force to public sector activity. An inept investment management system could, for example, reduce investment in conservation in new hospital construction, so as to "save" money, even though such investment would have an excellent payback in terms of subsequent energy savings.

- It is too early to make investment decisions concerning wind power and biomass. Further research, development and demonstration is called for, and should be pursued vigorously.

This is an area of "discretionary" expenditure which is very susceptible to being reduced or eliminated in terms of budgetary stringency, especially if this coincides with falling oil prices. However, these are resources wherein we appear to have some "natural" comparative advantage. The payoffs could be very substantial, and further experimental work is required before we have sufficient information to make sound investment decisions.

- The decision to pipe gas to Dublin will prove to be a sound investment.

Pricing

The pricing of our indigenously produced energy – mainly peat and natural gas – is complex, and derives from a series of *ad hoc* decisions taken over time to accommodate particular interests, or to ameliorate particular problems. The price of electricity is increased on the one hand by requirements to continue to operate and to build high-cost stations for social reasons, by the very large "excess" generating capacity that the ESB is carrying, by levies ("rates"), by the requirement that the ESB buy relatively high-cost fuel oil from Whitegate. On the other hand, prices have been reduced because of the relatively cheap natural gas which the ESB has received, and by the zero VAT rating on electricity sales.

The requirement that oil companies purchase one-third of their off-take from Whitegate has resulted in higher oil prices to consumers and producers.

The overall effect of this plethora of influences on price (including excise duties) has been to give us energy prices which are among the highest in Europe.

We conclude that:

- State-owned energy resources should be allocated to those users who are willing to pay the most for them.[2] These users should at least be charged a price which clears the market. This is defined as a situation where anyone who wants to buy the resource can get as much of it as is desired at this price.

In effect this means that users will pay just above that amount which the individuals who are deprived of the resource would be willing to pay. For example, if the ESB decided that it could pay a maximum of 32p per therm for natural gas and still break even with the least cost alternatives, then another category of user will have to pay slightly above 32p to bid it away from this use. There have been moves in this direction, with the relaxation of price control on the peat briquette market, and the increases in natural gas price to the ESB. It is important that if agencies such as the ESB are required to pay market-clearing prices, that they be relieved of, or directly and fully compensated for, any investment and production which they are required to undertake for social and/or strategic, rather than commercial reasons.

- Where feasible, competitiveness in energy production and supply should be encouraged and facilitated. When competition obtains, price control is not necessary.

[2]Net of transmission costs.

- Some at least of the off-shore oil and gas exploration licences should be allocated on the basis of competitive bids, modelled on the US system.
- The excise duty (50 per cent) which is payable on new cars should be re-calibrated so that it is higher for higher-fuel consumption cars and lower for cars which have a relatively high mileage per gallon rating.
- If NET could cover its non-feedstock variable costs and pay the full opportunity costs of its natural gas intake – in practice this is likely to be at least the energy equivalent price of heavy fuel oil – then, other things being equal, it should continue to get its allocation.
- The adoption of a coherent and consistent energy pricing policy involves the use of price to allocate energy to those who can make the most effective use of it, as judged by economic efficiency criteria. However this can impose heavy burdens on the less well-off. A system whereby the most vulnerable members of the community are buffered from the most serious adverse effects of such policies should be an integral component of energy policy. Apart from the humanitarian aspects, if such a policy is not adopted, then it is likely to be difficult, politically and socially, to implement appropriate energy pricing.

Regulation

The government regulates private sector behaviour in the energy domain in a number of ways. Insulation standards are mandated for new housing. Oil companies are required to take a share of their refined supplies from a State-owned refinery, while off-shore oil and gas exporation licences are issued on a discretionary basis. While we feel that prices and incentives are generally a more economically efficient means of managing behaviour, regulation clearly has a role to play.

- Insulation standards comparable to those which apply to new private housing should be promulgated and applied to commercial and industrial structures.
- When State or private firms are required by government to depart from decisions which they would take judged on commercial grounds alone, the costs imposed thereby should be estimated, published and justified on the basis of the non-commercial goals – employment, national security etc. – to be achieved thereby.
- The quality of Dublin's air has deteriorated seriously over the past three years. Increased burning of coal by households is the primary cause. It may be desirable to regulate the type of fuel which is burned, and the nature of the combustion process. This and other choices are being analysed in a separate study.

Administrative actions

Government, by the manner in which it manages its own affairs can have a very salient influence on performance overall. There are a number of opportunities which should be acted upon in this domain.

- There are market failure reasons for expecting that the non-commercial public sector will be relatively less vigorous than the private sector in seeking out cost-effective conservation opportunities in management and investment. This should be countered by ensuring that public facilities are managed such that energy performance can be monitored and performance criteria established and implemented. Although energy managers have now been appointed for public buildings, the monitoring of performance in energy use is not yet widely practised.
- Government has provided some lead in the industrial area by requiring that new IDA-supported factories meet minimum insulation and other energy conservation standards. A comparable degree of commitment has not been shown in the area of state office rentals.
- There is little public pressure against transferring publicly owned energy resources to selected customers at prices which are below the market-clearing level. This obtains in part because what is being foregone by so doing is not explicit. One possible means of improving public awareness in this regard is to establish a Natural Resources Trust Fund, whereto a portion of the rent accruing as a consequence of the sale of publicly owned resources would be transferred. This fund could be used to finance a variety of long-term infrastructural and social investments. The size of the fund available for disbursement would of course be diminished to the extent that accommodations on the sale price were allowed, and this would convey some sense of what was being foregone thereby. We feel that there is also some symbolic value in "using" a portion of the revenues accruing from the exploitation of a wasting asset in order to make provision for the future.

CHAPTER 3

CONSERVATION

Between 1970 and 1981 the shares of the commercial and transportation sectors in total energy consumption have remained roughly stable at 12-13% and 22% respectively over the period; the industrial share has grown from 30 to 32%, with a comparable reduction in the domestic share from 35 to 33%. The quantities consumed in 1981 are listed below:

	Quantity 000s TOEs	% of Total
Domestic	2683	33
Commercial	1065	13
Industrial	2608	32
Transport	1803	22
Total	8159	100

Instead of examining the conservation opportunities in each of these sectors, we felt that it would be more interesting to examine different conservation strategies as they apply to all 4 sectors. The strategies discussed (which are not mutually exclusive) are information and exhortation, regulation and cash subsidies, pricing, and direct public investment.

Information and exhortation

These strategies have been pursued quite actively. It is difficult to evaluate effectiveness, but given that there was probably a fairly high level of consumer ignorance concerning the implications of alternative conservation strategies, it is likely to have been useful and worthwhile. In addition to the information services available, we feel that it would be helpful to provide accurate, independently derived, ratings of fuel efficiency – miles per gallon etc. – for new vehicles, and to provide energy efficiency labelling of major appliances (refrigerators, cookers, freezers, etc.). We feel that information is more useful than exhortation; indeed, the latter may be counter-productive if the government itself is not seen to be effective in its own energy management. Our only caution with regard to information is that it can not be depended upon

as the main component of energy policy. It is a relatively painless strategy in both financial and political terms, and the temptation to substitute rhetoric for action is ever-present.

Regulation and cash subsidies

Regulation

Almost all houses built since 1980 have 100 mm of roof insulation installed, while 90% of them have floor insulation. In 1976 no private estate houses had roof insulation of 100 mm and only 4% had floor insulation. This progress has resulted from normal commercial pressures – the financial returns to the dweller on the first increments of investment in insulation are very high – combined with regulations. In 1976, thermal standards were mandated for public authority housing, and subsequently the meeting of thermal standards for private housing was made a pre-requisite for the awarding by the Department of the Environment of a Certificate of Reasonable Value (CRV). Thus, for new dwellings, the situation is quite satisfactory.

The limitations of regulations are well-known. They encourage a minimal pro-forma compliance. Additional investments in conservation which may be fully justified may not be undertaken. Fundamental changes in design, which might for example utilise solar energy much more effectively than heretofore, tend to be discouraged; for purposes of getting approval, it is easier for the architect and builder to adopt the rote regulations than to be innovative. Thus regulations should not induce complacency on the part of the perspective customer – there is a role for information here – and a positive effort should be made to encourage more adventurous, energy-conservative house design, and not insist on a standard package. In spite of these caveats, in general we can count as a success the policies concerning energy conservation in new housing.

There are no regulations governing energy conservation standards in industrial[1] and commercial buildings. However, the IDA does insist on the achievement of certain energy efficiency performance minima as a condition of grants for new enterprises, expansions and re-equipment. There is not a periodic assessment of the stock of buildings in this category which would tell us what the current status is in this regard. The most salient feature of this sector is the predominance of government; about 50% of newly available office space in the country has in the past been rented to government-supported agencies, while the Industrial Development Authority is a major developer of factory space

[1] However, there has been a fall in the consumption of heavy fuel oil and gas oil by industry which implies that conservation and fuel switching is taking effect in this sector.

in its own right, and also supports financially most private industrial development. The government therefore can specify what it will require in terms of conservation investment as a customer for office and industrial space. Once the financing institutions are aware of what the largest customer requires as a pre-condition of rental, availability of finance will become contingent on the developer meeting the government's standards.

There is at present a joint IIRS/An Foras Forbartha group developing draft thermal standards for office buildings, commercial buildings and factories. We recommend that the government draw on their work to develop and implement its own standards, to apply to all new structures, rented or financially supported by the government. This, combined with the IDA's policies (see above), would in our view effect almost universal compliance, without the years of delay which seem to attend formal promulgation of regulations. It is unfortunate that action along this line was not taken before the major expansion of government during the past decade.

In transportation, it was found that, of about 3,000 cars recently volunteered for testing, 65% failed to meet engine tuning standards. Strong market-failure arguments can be made for mandating vehicle safety standards (brakes, lights, tyres, steering), to be evaluated annually, by inspection. It would be easy to add an engine tuning requirement to the safety standards. We recommend that, if vehicle safety standards are introduced in Ireland, that they be accompanied by engine tuning requirements, as identified by annual inspection. The inspection could be done by garages certified to undertake this task, as is the routine in the US. The inspection fee would be sufficient to cover all costs.

Rural travel accounts for 82% of the road mileage travelled in Ireland, so that measures relating to city traffic *per se* will have relatively little impact on total energy consumption. However, the provision of bus lanes, the provision of off-street parking (wherein market-clearing prices are charged), the encouragement of car-pooling combined with the imposition of charges related to congestion for inner city driving, all would help conserve energy.

Cash subsidies

Grants are available to manufacturing industry for both energy audits and investment in energy conservation, including conservation research. A grant of up to £50 is available to householders for attic insulation, lagging of hot-water cylinders and weather stripping of doors and windows.[2] The commercial sector qualifies for Energy Technical Consultancy grants. The housing stock in Ireland comprises some 881,000 residences, of which about one third are at least minimally insulated. The level of grant aid current in 1982 seems to be sufficient.

[2] This grant has been discontinued from December 31, 1982.

Pricing

Price is the most immediate signal given to consumers in deciding on their consumption; it is important that they not be encouraged to "over consume" as a result of government setting price below the market-clearing level. Conversely, it is important that economic and social performance not be inhibited by prices which have been made artificially high as a result of burdens imposed to achieve strategic and direct employment objectives.[3]

We recommend that An Bord Gais, Bord na Mona and other agencies managing State-owned resources charge market-clearing prices for the resources under their control. We recognize that to do so may provide large "profits" for these organizations which in fact are not normal profits, but constitute payments to the people of Ireland for their resources. It was argued to us that employees in these agencies would use their leverage to capture some of this "profit" in higher wages. In order to inhibit this and encourage good management, we recommend that State agencies which have rent generating publicly owned resources under their management should pay royalties and taxes at a level comparable to that which would be assessed if private companies were exploiting these resources.

Since the price of electricity is established on the basis of average cost, if the marginal costs of producing a new increment of electricity generating capacity exceeds the average costs, this means that the consumer at the margin is paying a price which does not cover the full cost of meeting that increment in supply. One means of conveying the appropriate message to consumers is to have an increasing block schedule, wherein the price of additional units to consumers increases the more they consume.

We recommend that the Department of Energy conduct a study of electricity pricing, to determine whether marginal costs exceed average, and what the implications of an inverted (increasing block) rate schedule would be.

For most motor vehicles an excise duty of 50% (under 16 horse power) or 60% (16 h.p. or over) is payable based on car price, together with Value Added Tax (VAT) paid at the rate of 18% on the excise-

[3] We use the term direct employment because of course the direct employment provided in a high cost refinery and/or electricity generating station is secured at the expense of job losses incurred throughout the economy as the additional costs are passed through in the form of higher prices.

duty inclusive price. Since there is no necessary correlation between car price and fuel consumption performance, the excise duties only very indirectly encourage the purchase of fuel-efficient vehicles. Road tax ranging from £5 per horse power for cars in the 4-8 h.p. range, to £11 per h.p. for those of 21 h.p. and greater is now payable annually. Since presumably horse power is closely related to fuel consumption performance, this is an energy conserving form of tax.

We recommend that the excise duty be re-calibrated such that it bears proportionately more severely on high fuel consumption vehicles. It could be assessed, for example, in the range of 70% to 30%, so as to reflect relative fuel efficiencies. We also recommend that, if a road tax is to continue to be payable annually, that it be calibrated so as to range progressively from, say, 0 to £80 per year depending on the miles per gallon rating.

Direct public investment

Government buildings

Both on its own merits and as a means of adding credibility to its leadership role in the area, it is important that the government be seen to be managing its own energy resources effectively. This involves monitoring consumption, and then establishing and implementing appropriate energy management, which includes evaluation of performance, with penalties/rewards assigned as appropriate. Such a system, with appropriately trained personnel assigned full-time to its implementation, has not been provided in Ireland. The public sector has been the least active participant in conservation measures. We recommend that all public investments in conservation which show a competitive return should be undertaken, and that, likewise, expenditure on monitoring and conservation management which yields a net return should be incurred.

Combined heat and power district heating

Combined heat and power (CHP) involves using the heat that is produced as a byproduct of power generation. In the case of electricity generating stations, the choice involves comparing the value of the heat produced on the one hand with the costs of the heat distribution system, the modifications of the generating station and the reduced (10-15%) output of electricity on the other. For industrial concerns thinking of producing their own heat and power, key considerations include the cost of a supplemntary supply of electricity from the ESB, and the price at which internally generated excess electricity can be sold. District heating systems can also produce heat alone, which is supplied to a large number of buildings from a central point.

At the peat-fired ESB station in Lanesboro, Co. Longford, heat is being utilised in greenhouses for horticultural purposes. It is reported that the ESB plans to provide a district heating system for up to 40,000 households in Dublin, supplied by "waste" heat from the Poolbeg and Ringsend power stations. There is a "pure" district heating system supplying public authority dwelling units in Ballymun, Dublin.

We recommend that an appropriately qualified team be assigned the task of identifying investment opportunities in this area, designing an incentive system which will correct for market failure problems, and that it be given the authority and resources actively to encourage the undertaking of appropriate investments. A survey of the opportunities for CHP in industry has been carried out by the NBST and IIRS. A few large industrial concerns have invested in CHP systems.

CHAPTER 4

ENERGY SUPPLIES

Oil

Oil imports

In 1979 Ireland's oil import bill came to £521 million, amounting to 11 per cent, by value, of all imports in that year. In 1981 oil imports were valued at £852 million, comprising 13 per cent of all imports for the period. Saudi Arabia is the principal supplier of crude oil, while the UK provides the bulk of our processed oil requirements. Ensuring access to world oil supplies at the prevailing price is central to the health of our economy and polity. The first and most essential requirement is to ensure that the price payable for oil be competitive with the prices which the oil companies can achieve elsewhere. When there is a reduction in world supplies and a consequent rapid upward movement in price, the temptation to use price control mechanisms to "stabilise" the domestic market should be resisted. We are world oil price takers; the oil will flow to those willing to pay the most for it.

State oil company

It is felt in several quarters that many of the oil supplying countries are willing to provide oil at advantageous price and security terms in State-to-State transactions, bypassing thereby the multinational companies. Ireland has followed the lead of a number of countries in establishing a State company – the Irish National Petroleum Corporation (INPC) – to take advantage of this propensity. The company has already achieved a significant share of the Irish market. We recommend continuance of INPC in its intermediary role if it can in fact get oil at better prices and/or on more secure terms than other suppliers. We strongly recommend that if INPC is forced to depart from strict commercial criteria – for example by requiring it to stockpile more oil than is warranted on commercial grounds, or to supply its crude for processing to higher cost refineries – this should be budgeted for separately, and subvented directly by the Government.

Prospective domestic production

Of 12 wells drilled in the Porcupine basin, three have produced oil

flows; the first of these occurred in 1978. Although no commercial oil deposit has yet been found, these recent flows sparked renewed interest in drilling in Ireland's offshore areas. The Minister for Energy announced a new licensing round covering 108 blocks, with exploration licences being issued in early 1982. The principal criterion which was used in the allocation of these was the extent to which companies were prepared to enter into firm geophysical and drilling commitments in respect of the blocks for which they have applied. For areas not included in the licensing round, the Government considered proposals on their merits. A number of exploration licences have been issued in these latter areas.

There is an output royalty assessable on all production estimated as a percentage of the value of oil produced, ranging from 8 per cent to 16 per cent depending on the average field production attained. For gas, the royalty rate will be 12½ per cent. The State has the right to participate up to a maximum of 50 per cent in the development and exploitation of discoveries, being liable for its appropriate share of exploration and development costs; the State may make these payments from its share of the petroleum. The tax rate to be applied remains unspecified, although the manner in which expenditures on exploration, development and plant and machinery will be treated for tax purposes has been published. If we assume that the tax rate will be 50 per cent, we find that under a given set of price and cost assumptions, the Irish State take would comprise 61 per cent of net income. This compares with a Government take in the UK, Norway and the US of 87 per cent, 85 per cent and 76 per cent respectively, derived using similar assumptions. These latter do *not* include the returns from State participation which can be substantial in the UK and Norway, or the lump sum bid paid for drilling rights in the US. If the State were to participate to the maximum degree allowed (50%), the State share of net income in Ireland would increase to 81%.

The oil companies presumably expect that, if oil (or gas) in commercial quantities is found, the Irish Government will take a share of net income comparable to that achieved by the other off-shore nations. Thus no great uncertainty attends the estimation of potential returns to their investment. Rent is said to exist where a payment to any factor owner exceeds the minimum payment required to retain a factor in that use. Thus, in the case of oil and gas, if a company is making "normal" profits on its investment (the minimum return required to attract the capital to the field) any return in excess of this minimum is called rent; in the case of privately owned resources, this will typically be captured by the owners. For publicly owned resources, such as offshore oil and gas, the Government, as trustees for the owners, must decide how much of this rent to take, and how to take it.

With regard to the question of how much, a key issue is the rate of exploration that is desired. The more rent the companies are allowed to keep, the more attractive exploration will be. For a small, open economy, it may well be desirable to slow down the rate of discovery and development once (if) one major find is made. In this event, a high rent capture by the Government, approaching perhaps the Norwegian level (with full State participation this can amount to 97.6 per cent of the revenues net of operating and capital costs) would be appropriate. Conversely, if very rapid expansion and development is required, then a lower State take is in order. The chief benefit of an oil gas find is not the resource *per se* or the down-stream activity generated thereby, but the revenues which their exploitation will yield to the people of Ireland. We recommend therefore that the Irish Government continue to maintain the option of capturing the bulk of the rent which accrues. We feel also that in analysing choices, it is valuable to maintain the rhetorical distinction between "normal" taxation of capital, which applies to a variety of investments, and those components of the State take which are *de facto* payments for the resources itself.

Exploration lease allocation

Leases are now allocated on a discretionary basis, with those willing to do the most drilling being favoured. In the US, leases are bid for in a sealed-bid auction, and the highest bidder typically gets the lease, if certain conditions are complied with. The auction system generates funds for the Exchequer, helps assure that the most efficient companies get the leases, reduces the potential for favouritism or corruption in lease allocations and reduces the potential for profit-taking by the licensees.

We recommend that in subsequent licensing rounds, at least some of the blocks be allocated using a sealed-bid system.

Macro-economic impact of an oil discovery

Assume a field of 250 million barrels (34.2 million tons), recovered evenly over a 20-year period, with extraction costs of $10 per barrel and a selling price of $36 per barrel. Making conservative assumptions about the Government take, we estimate that the Exchequer would benefit by about £200 million per annum on average, but that significant revenues would not be yielded for five to six years after initial development. Balance of payments effects would be of the same magnitude. The projected £200 million would amount to only one-third of the current Budget deficit incurred in 1980; it is one seventh of the balance of payments deficit occurring in 1981. Thus, while a find of this magnitude would ease the pressure both on the public

finances and the balance of payments, it by no means provides a panacea in these regards. To eliminate the balance of payments deficit on current account would require the discovery of fields in the aggregate amounting to 1,700 million barrels (233 million tons). This compares with proven recoverable reserves in the Forties field of 1,780 million barrels; this is the largest field in the UK sector of the North Sea. Total proven recoverable reserves in the UK sector of the North Sea, estimated in 1977, came to 8540 million barrels (1170 million tons) (Robinson and Morgan, 1978, p.54). If finds in the aggregate were made in Irish waters which approached the scale of the finds in the UK sector of the North Sea, this would, of course, have major ramifications for the macro-economy. However, the 250 million barrel field size is what is now (perhaps optimistically) envisaged.

If the natural resource discovery is used to permit a higher level of domestic expenditure than would otherwise have occurred, there may be alterations in the internal terms of trade and the exchange rate, with resources being shifted out of tradables and into non-tradables through a squeeze on profitability in the tradable goods sector.

Natural Gas

The conclusions we reached concerning the State take in the section on oil apply equally to prospective discoveries of natural gas.

In April 1974, Marathon confirmed a gas find off the south coast initially at 25 million tons of oil equivalent (MTOEs). Recent estimates have led to substantial upward revisions of the volume of gas in the field.[1] An annual output of about 1.1 MTOEs was envisaged at the time the find was confirmed; Nitrigin Eireann Teoranta (NET) and the ESB have been assigned 0.4 MTOE and 0.6 MTOE respectively, with the balance -0.1 MTOE – being supplied to Cork city domestic consumers and some industrial users in the environs of Cork. However, in 1981, the ESB, Cork Gas Co. and industrial consumers alone consumed 0.9 MTOE, which is a much higher rate of extraction than was envisaged initially.

We conclude that the Kinsale Head gas should be allocated to those users who are able to pay the most for it to the owners (the people of Ireland). We recommend that this be done and that the consumers be charged accordingly. The merits of charging market-clearing prices have been outlined in a previous chapter.

The price which could be paid for the gas by different customers under various assumptions was examined. It was found that, as a

[1] It has been announced by the Minister for Energy that the field is 35% larger than initially estimated, bringing it to 33.75 MTOEs.

substitute for fuel oil, the ESB could pay 30p per therm (1981 prices). If the gas is used as a substitute for gas oil (the latter is used by the ESB mainly for peak shaving) then the corresponding price payable for natural gas increases to some 46p per therm. It seems that NET cannot afford to pay any amount above costs (payment to Marathon and transfer costs from the field to the NET plant) and still cover its interest charges, capital repayments and operating costs. Thus NET yields no rent to the citizenry for the use of their resource. Based on current estimates as to prospects in the nitrogenous fertiliser business, it seems to be unlikely that NET will be able to yield a rent in the future. At current usage, if we assume that 21p per therm in rent is being foregone,[2] then the use of natural gas in fertiliser production involves giving up a net annual return of £40 million. (This is independent of the widely reported losses and debts of NET).

However, this does not mean that is necessarily in the national interest to re-allocate gas from NET to other users. This apparently anomalous position arises because the heavy capital and interest payments which NET has incurred are sunk costs, and must be borne whether or not the company continues in production. If NET could pay a market-clearing price for the gas and cover its non-fuel operating costs out of revenues, then, other things being equal, the firm should be permitted to keep its gas allocation. We did not have the data or time available to test this hypothesis.

We also examined the financial implications of piping Kinsale Head gas to Dublin. We concluded that this use could pay a rent in the range of 20 to 29p per therm (1981 prices). This compares very favourably with the zero rent return yielded by NET, based on the assumptions and, it compares well with the rent the ESB could pay for natural gas used in a base-load (fuel oil) plant, but is somewhat less than what the utility could pay for it when it is used for peaking plant (gas oil).

We conclude as follows:

(i) The decision to pipe gas to Dublin is the correct one. We are aware that some recent experiences in Ireland with major capital projects have been especially unhappy. While we were writing this report, the Cork-Dublin pipeline and Dublin City pipeline have been constructed, also within budget. Because of the attractiveness in conventional financial efficiency terms of allocating gas to Dublin, we did not need to calibrate the other substantial advantages of this strategy; these include reducing the peak (very expensive) electricity demands on the ESB and providing a very environmentally benign resource which will substitute in part for other more deleterious fuels, notably coal and high-sulphur oil.

(ii) The users should be charged close to the full rent-capturing price. If the ESB and/or Dublin gas customers are not so charged, they will capture the rent. In addition to the other adverse efficiency effects of below market-clearing pricing noted in the general conclusions section, this will result in a substantial implicit income transfer to the Eastern region, with the higher income groups (who consume more) getting the greatest subsidy.

(iii) Marathon is making a reasonable return on its investment at Kinsale with the current gas pricing arrangement. It is impossible to be definite on this score, given the diffidence about revealing revenue and cost terms. However, we are concerned at some recent press reports which argue to the effect that an upward revision of the price to Marathon (beyond existing escalator provisions) is warranted because the current dispensation discourages exploration for natural gas. The evidence available does not support this view. We do nevertheless fully support the Minister's decision to pay the world price for natural gas for prospective discoveries, and to capture the rent desired with the taxation, royalty and State participation provisions.

It was not desirable to use world price for the gas at the time the discovery was made, because of the extremely generous taxation provisions in the Marathon agreement. It was in an attempt to "compensate" for these provisions that the relatively low price was negotiated with Marathon.

(iv) Using the financial efficiency criterion, we conclude that if NET revenues can cover both non-feedstock variable costs *and* pay the full opportunity costs of its natural gas intake, i.e., in the range of 24 to 36p per therm, it should continue to get its allocation. The sunk costs are now irrelevant to the decision. If NET does not earn sufficient revenues to cover these two items, then serious consideration should be given to discontinuing the allocation.

Nuclear Energy

Attention was confined to the economic and strategic issues involved in nuclear power; the environmental, safety, security and political issues are of considerable – perhaps pre-eminent – significance, but we did not feel qualified to address these aspects in any detail.

At present, the only practical currently commercially available

[2] 30p fuel oil equivalent value, less 9p for payment to Marathon and transmission.

alternatives to the use of oil for new electricity generation are nuclear or coal-fired plants. However, as we note elsewhere in this report, the long-term prospects for both energy crops and (more speculatively) wind power in Ireland are promising. Nuclear fusion is also a possibility, but it is felt that commercialisation will not occur (if ever) until well into the next century; the same is true of the technologies for the direct conversion of solar energy into electricity.

The analyses of the economics of nuclear versus coal show no clear advantage for one over the other; the higher capital costs of nuclear counterbalance the higher fuel costs of coal. Predicting both nuclear capital costs and coal fuel costs is difficult, since both have recently tended to change rapidly. A difficulty with nuclear plants, especially in the US, has been the wide dispersion of performance efficiency, ranging from excellent to very poor; the performance of coal-fired plants is much more predictable.

The US (46%), South Africa (16%) and Canada (13%) are expected to be the leading non-communist suppliers of uranium by 1985.

It is anticipated that, by the time of commissioning, a nuclear plant could account for 15% or more of total installed capacity. This would be about twice the size of the largest non-nuclear set in the system. In order to maintain supplies when the nuclear unit is out of commission, back-up capacity of an equal size must be provided, or interconnection with another generating system e.g. Northern Ireland could be used for this purpose. The latter would be much less expensive, but it appears to be infeasible for security reasons. The former would add very significantly to the costs of the nuclear option. In considering the economics of nuclear power, any associated capital costs of this nature uniquely necessitated by its introduction into the system should of course be allocated to the nuclear plant itself.

The economic viability of the nuclear option depends crucially on the specifics of the proposal in the Irish context. These data are not yet available. The fragmentary evidence available from other countries indicates that it is a choice which on economic grounds deserves serious consideration. A nuclear plant would be among the largest investment projects ever undertaken in Ireland.

We strongly recommend that a full financial appraisal be made publicly available so that the analysis and assumptions on which the decision is to be based can be reviewed and evaluated by the professional analytical community. This will help support or otherwise the robustness of the analysis. It is important that the information made available on nuclear power be inclusive, and not be confined to a few aspects, such as environmental and security implications.

Direct solar energy

The potential for utilising solar energy directly in Ireland was reviewed comprehensively in 1975 (Lawlor (1975)); in the intervening period there have been a number of proto-type developments initiated. We feel that a new comprehensive review is now called for, to draw on the lessons of the past 6 years. We recommend that this be undertaken.

Wind

Ireland has more wind – judged in terms of duration and speed – than most other countries, and in the most wind-swept zones it has large, relatively unpopulated areas where wind-energy parks could be installed with relatively little disruption. The technology of utilising small wind machines – up to 10 kilowatts capacity – at the individual farm or enterprise level is quite well developed, and in certain circumstances is financially viable at current costs and energy prices. As is the case with all privately produced electricity, a key consideration is the price which must be paid for back-up supplies from the utility, and the price at which surplus production can be sold into the grid.

Several countries are exploring the potential of large wind machines as major generators of electricity. There are a number of difficulties yet to be overcome, which include unreliability of the machines, the electricity storage problems which is a consequence of the intermittent nature of the wind, the inadequacy of the wind data, and safety and environmental problems, including noise effects and visual impacts.

We endorse fully the emphasis being given by the Department of Energy to the utilisation of wind power. It is important that progress be maintained, and perhaps accelerated, since there is interdependence of decisions vis-a-vis wind, nuclear power, the interconnector and perhaps utilisation of natural gas in electricity generation.

We recommend that the price paid by the ESB for electricity supplied from privately owned wind machines reflect the long-run marginal costs of providing power from additions to the generating system. We also recommend that financial appraisal of the wind-power systems being tested abroad proceed in tandem with a careful analysis of our own experience, so that we will be in a position to make good investment decisions as soon as possible.

Energy crops

In Ireland, the most promising energy crops are the conventional coniferous forestry species – Sitka Spruce, Lodgepole Pine – relatively close spaced, and the hardwood species – Willow, Alder, Poplar, Birch etc. – which sprout new shoots when cut. Because of this characteristic the hardwoods can therefore be cut periodically (in for example, a 5 year cycle) and growth will automatically resume after each cutting. This process is called "coppicing". Although densely planted conifers produce very high yields, they have no proven ability to coppice. Thus, most attention is devoted to the hardwood coppicing species.

A number of agencies, including An Foras Taluntais, the Forest and Wildlife Service, Bord na Mona and the Horticultural Centre in Northern Ireland (Loughgall, Co. Armagh) have been testing the growth capabilities of a range of species for energy crop production on a variety of sites. The highest yields have been recorded in N. Ireland on drumlin-type soils; the mean annual yield over a 3 year cycle falls in the range of 13.5 to 15.8 tons of dry weight per hectare for a willow species.

Ireland has 3.372 million hectares (8.325 million acres) which are economically marginal for agriculture. The most immediately utilisable land will be the cutaway which is becoming available as Bord na Mona completes extraction of the peat; this area will eventually amount to 70,000 hectares (173,000 acres). There are, in addition, 600,000 acres of cutaway in private ownership.

Applying costs of plantation establishment and management derived from costings of the Forest and Wildlife Service, and assuming a price per dry tonne of £17, and an average annual output per hectare of 15 and 10 tons of dry matter per year on net mineral and peatland soils respectively, we estimated the following net annual returns per acre.

Site Type	Net Annual Returns per Acre (1981 £)	
	i=2%	i=4%
Peat	27	18
Drumlin and related soils	65	55

These are the amounts that could be paid annually per acre to landowners for growing energy crops on their land and still cover all non-land costs including interest charges at the real rates specified. The returns on the drumlin and related soils are comparable to the returns on the best sites with conventional forestry as discussed in *NESC Report No. 46 Irish Forestry Policy;* net returns to both energy crops and conventional forestry far exceed the average returns to agriculture.

The results must be treated with great caution, because of the tentativeness of the cost and production data. There are not yet sufficient data on which to base robust investment decisions. Assuming that 2.636 tons of wood (dry matter) are equivalent to 1 ton of oil equivalent, we estimate that 500,000 acres, comprising 6% of the marginal land and 3% of the total land area in the Republic, would meet 11% of total 1979 energy imports and 9% of total 1979 consumption.

There is at present a plethora of research activity in train, under the general aegis of the NBST, but lacking much central authority and direction. As the time for major policy decisions approaches, it is important to have within the policy-making Department (the Department of Energy) someone with singular responsibility in this area, who has the knowledge, authority and funds to mobilise resources appropriately.

We recommend that such an individual be appointed.

Thus far in Ireland we have only considered the planting of either energy crops or conventional forestry crops. It could well be of net benefit to combine the two, say by keeping a number of trees to grow to saw-log size, while harvesting the bulk of the crop periodically for energy.

We recommend that research be initiated immediately to examine the potential and implications of combining energy crop production with conventional forestry, and that (cost-reducing) strategies for planting/regenerating densely planted conifers be explored.

The preliminary results of our analysis are sufficiently encouraging so that we feel a large scale "demonstration" effort should be launched. This is in effect how conventional forestry got underway over 50 years ago. Based on preliminary trials, afforestation proceeded and the lessons resulting from practical experience were incorporated iteratively into the new planting decisions. Conventional forestry and energy crop production both have the great advantage that investment is incremental, rather than requiring a decision to be made concerning one large segment which, if it goes wrong, has very serious financial consequences. With energy crops, we can learn as we go along.

We recommend that this learning process be initiated on a range of sites. At the Economic and Social Research Institute (ESRI) a study is in progress which is examining alternative approaches towards involving private landowners in the Drumlin area in energy crop production. The results of this study will be helpful in designing the implementation of an energy crops/conventional forestry programme.

CHAPTER 5

STRATEGIC AND INSTITUTIONAL ASPECTS

The Department of Energy was established as a separate identity in 1979 and was subsequently combined with Industry. It has successfully established itself as the focal point in the formulation and implementation of Irish energy policy. It has also been successful in attracting able technical personnel on secondment from other agencies. Our primary concern regarding the ability to analyse policy choices is the paucity of staff with appropriate skills in economics and financial analysis. There are only two such individuals now in the department, and they have administrative and managerial responsibilities in addition to their analytical duties.

There is an almost infinite variety of ways and means to both produce and conserve energy; what is most appropriate will depend crucially on the associated costs and returns of alternatives. It requires expertise in financial analysis, econometrics, welfare and public choice economics, tax policy etc., with a strong grounding in micro-theory and a ready familiarity with the burgeoning literature in energy economics and policy analysis to identify and analyse choices effectively. We urge strongly that efforts be intensified to provide additional resources in these areas.

There have been two important deficiencies in the data relating to energy. Price data were not gathered and published which were consistent, comprehensive and up to date. However, the IIRS now publishes price data every quarter relating to all forms of energy. Sectoral data on energy consumption disaggregated below the level of the domestic, commercial, industry and transportation sectors are still not available in a consistent and timely fashion. This makes it difficult to evaluate the effectiveness and selectiveness of impact of policies to manage consumption. We recommend that this deficiency be corrected.

There are three choices in dealing with the problem of ensuring secure supplies of price-volatile imported commodities. These are: (i) Ignore it, (ii) Stockpile products, (iii) Subsidise domestic production facilities.

The stockpiling option involves State intervention to store quantities of oil in excess of that which is warranted using normal commercial criteria and expectations. This is expensive. If, for example, the State believes that 90 days stocks of oil should be maintained, while commercial concerns would only keep a six weeks inventory, then, at 1981 volumes and mid-1982 prices, the extra 48 days stocks would tie up £112.5 million permanently, costing £18 million per annum in interest charges. There are also downside risks of price reductions to be borne.

Option (iii) has recently (1982) been acted upon. The government purchased Whitegate oil refinery in Co. Cork which is now operated by the Irish National Petroleum Corporation and all oil distribution firms are obliged to take 35 per cent of their total sales from this source. The costs of this strategy can be substantial: The refinery in late 1982 was charging \$425 per tonne for premium grade petrol, versus a spot market price of about \$320. The total costs of this strategy are estimated to fall in the range of £36-63 million (1982 £) annually. Since the probability is that crude oil (which must of course be imported) and refined oil are likely to be both scarce, simultaneously, or both plentiful, simultaneously, the security benefits of owning a refinery are not obvious, and the costs of what benefits are derived thereby are not explicit.

It appears to us that the Whitegate refinery provides a very limited degree of security and direct employment at very substantial costs in terms of additional costs to consumers and producers and employment foregone. We feel that the acquisition and operation of the refinery by the State has not been in the public interest. We recommend that the decision to do so be reversed.

Natural Resources Trust Fund

We recommend the establishment of a trust fund, to be endowed by a portion of the revenues yielded by the exploitation of our natural resources. It would provide investment funds for projects benefitting present and future generations, including the renewal of the industrial base, the replenishment of the resource base by financing the establishment and harnessing of new resources, the provision of infrastructure and schools and the preservation of environmental and cultural amenities. This would make it easier to apply market-clearing pricing – the people could see where the money was going – and it would also help clarify the relationship between our resources and economic and social development.

SECTION II: BACKGROUND

In this section we provide some general background to the evolution of the energy "problem" and follow with a discussion of patterns of production, consumption and energy imports. In the final chapter of this section, we discuss the relationship between energy consumption and income distribution.

CHAPTER 6

GENERAL BACKGROUND

"Energy is eternal delight", the poet William Black wrote. Now, about 200 years later, energy appears to be an eternal problem; hardly a week goes by without reports and pronouncements dealing with the topic. Why has energy assumed such significance?

The three resources – wood, water and wind – comprised the world's main sources of energy until 1850; of these, wood contributed by far the largest share. They are all renewable, and all are in a sense products of the sun. Trees are solar collectors *par excellence*, storing energy from the sun. Falling water too is available because of the working of the hydrologic cycle in which the sun plays a central role, while radiant energy from the sun also generates the wind.

By 1850, these energy sources were superseded by coal. Coal, oil, and gas were formed from the fossil plant remains which accumulated at a time in the earth's history when the oxgen concentration in the atmosphere was below today's level (20 per cent). Without sufficient oxygen, the organic products of photosynthesis were produced more rapidly than they were destroyed by metabolic combustion. This unique period in the earth's history produced the world's store of fossil fuels and the oxygen needed to burn it. With the emergence of coal as the world's major source of energy, our dependence shifted from renewable to non-renewable sources. In the 1860s William Stanley Jevons, the eminent English economist, expressed concern that Britain's coal reserves would be exhausted, or that costs would increase to the point where the mining industry could no longer operate. However, in 1859 the first oil well had been drilled in Pennsylvania; with the discovery and development of further major oil fields in Texas in 1887, oil's importance on the world energy scene grew. Natural gas, although discovered in England in 1659, and used in the succeeding two centuries, did not become a major contributor to the world's energy supplies until 1925.

Periodically, since the end of World War II, there has been concern expressed that the oil and gas era would soon come to a close. However the legitimacy of such concerns appeared to be vitiated by two phenomena. The first atomic reactor to be connected to an electricity grid in the U.S. began operation in 1957. There was a dramatic expansion of nuclear electricity generating capacity during the 1960s and there was a popular conception that, as oil and gas supplies were depleted, there would be a smooth transition to nuclear energy. Secondly, these optimistic harbingers of the coming nuclear age were accompanied by steadily declining real oil prices, which seemed to belie the doomsdayer's fears that ultimate depletion was just around the corner.

Before turning to the Irish case, there are two aspects of the global historical experience which are worth noting:

- The duration of the period during which a particular set of energy sources is pre-eminent has shortened over time. The renewables – wood, water and wind – provided the bulk of the earth's energy supply for millennia; coal was the prime energy source for about 150 years; it is only a little more than 100 years since the first oil-well was drilled in Pennsylvania. This telescoping effect resulted because technological advances allowed the rapid provision of low-cost substitutes, and economic development and falling real per unit price led to sharp increases in consumption. In the U.S., consumption increased from approximately 2.5 Quads in 1850 to 78.02 Quads in 1979; in Ireland, annual primary energy consumption grew from 2.961 millions tons of oil equivalent in 1950 to 8.66 million tons in 1979 (Scott (1980), p. 43).
- Although individual energy sources have been superceded over time, with a few exceptions they have not ceased to be utilised entirely. Wood, wind, water, coal, etc., although no longer pre-eminent, have continued to contribute to energy supply, albeit (until recently) a diminishing share thereof.

The extent of current energy consumption, and its continuing growth, make it very difficult to envisage within the next 30 years a "new" source which will become the predominent fuel in the fashion of wood, coal and oil. We can look instead to a wide range of developments involving both the "traditional" fuels – passive direct solar energy, wood, falling water, wind, coal, oil, uranium (nuclear fission) and gas – and the commercially undeveloped or less well developed energy sources such as oil shale, tar sands, nuclear fusion, photovoltaic solar conversion, waves, and hydrogen fuel.

CHAPTER 7

IRELAND'S ENERGY PROFILE

Patterns of consumption and production

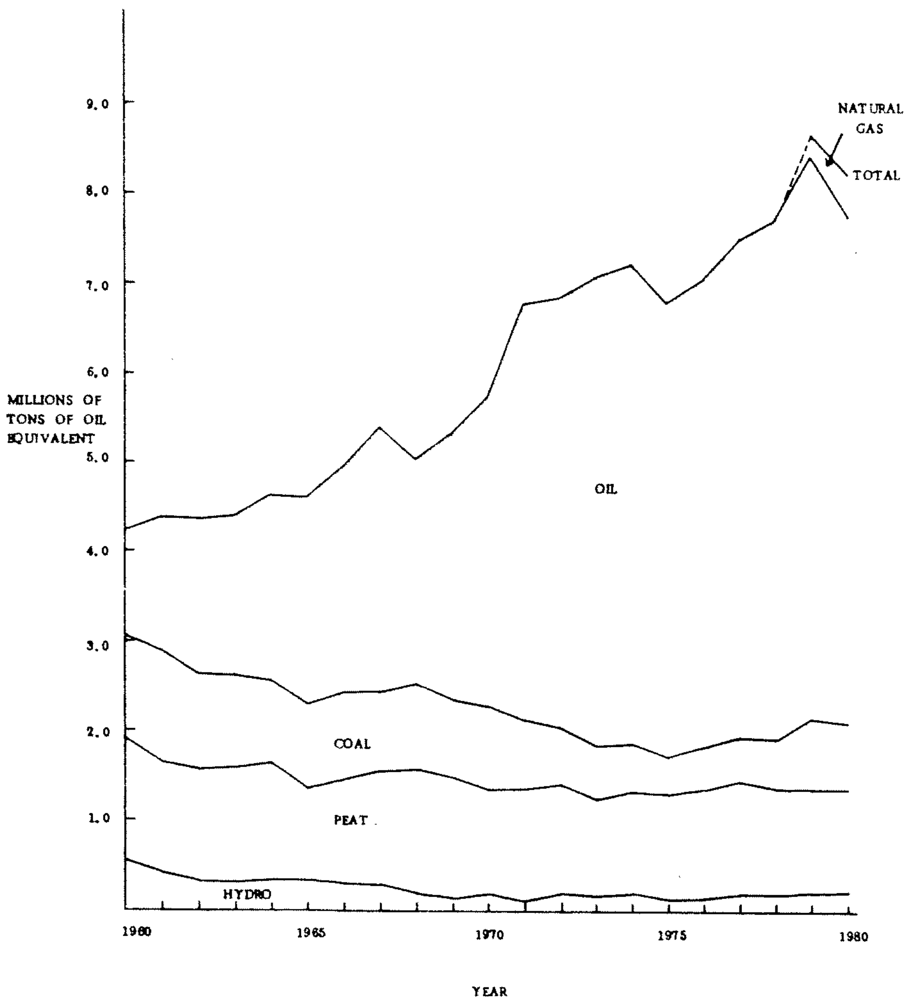
Scott (1980) and Kavanagh and Brady (1980) provide the most complete discussion available of energy consumption patterns in Ireland; what follows draws very heavily on their work. In examining these data, it is useful to distinguish between primary energy and final deliveries. Primary energy, as the name implies, refers to the energy which exists before conversion to other energy forms such as electricity. Final deliveries refer to the energy delivered to the consumers using it, e.g., the electricity taken by consumers, the gas delivered to houses and factories.

In figure 7.1 can be seen the pattern since 1960 of annual primary fuel consumption in Ireland, while in Figure 7.2 deliveries over time are presented (taken from Scott, 1980, p.6). The key determinants of consumption are the level of economic activity, price and trends in technology. The most salient feature of the primary energy consumption data is the dramatic rise in oil intake in the 1960-1974 period; consumption increased from 1.16 million tons of oil equivalent (TOEs) in 1960 to 5.33 million TOEs in 1974, a compound average annual rate of growth of 11.5%. Primary energy consumption of peat remained remarkably stable over the period, while coal consumption fell fairly consistently to reach a nadir in 1976, and has since increased sharply. The primary energy contribution of hydro is estimated from the fuel required to generate an equivalent amount of electricity. Thus, as electricity generating plant increases in efficiency, the estimated primary energy contribution of a given amount of hydro power will fall. The weather will also influence the extent of this contribution. The hydro contribution fell throughout the 1960s, but stabilised in the 1970s at about 0.2 million TOEs. In examining fuel deliveries (Figure 7.2), the most striking feature is the steady growth in electricity deliveries, a trend which accelerated in the early 1960s. Electricity's share of total deliveries grew from about 3% in 1950 to over 11% by 1977.

Both oil and electricity have advantages of cleanliness, convenience, and ease of working; these factors combined with rapidly declining real price and a growing economy to produce the dramatic expansions

Figure 7.1

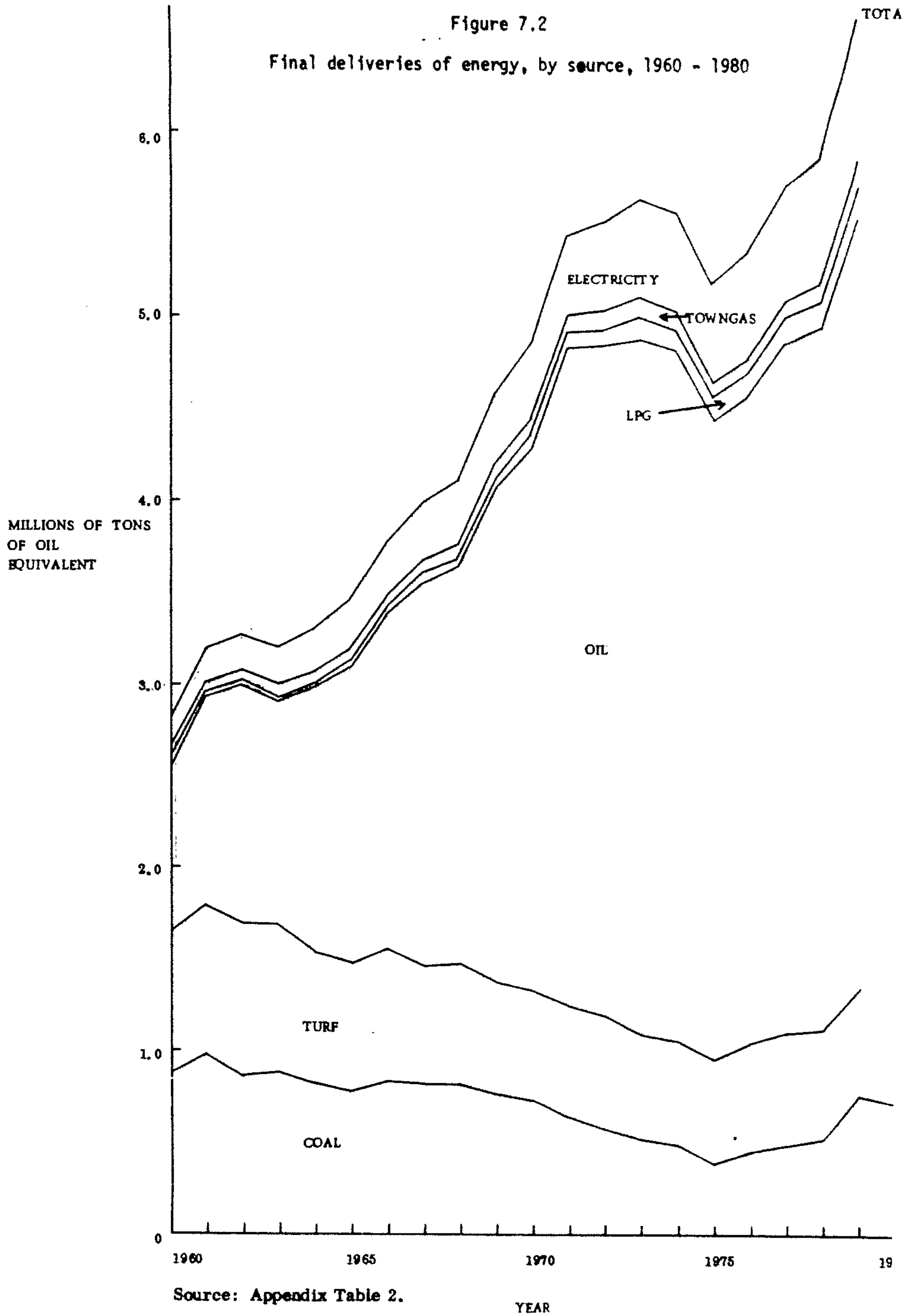
Primary energy consumption in Ireland, 1960 - 1980



Source: Appendix Table 1.

Figure 7.2

Final deliveries of energy, by source, 1960 - 1980



Source: Appendix Table 2.

in consumption noted earlier. In figures 7.3 and 7.4 the real price, over time, of different energy sources are presented. In the 1959-1973 period the price of oil declined by over 30% relative to consumer prices in general; the price of oil relative to the price of other fuels combined fell by some 25%. The real (net of inflation) decline in the unit price of electricity over the 1959-1973 period, amounting to 36%, was sharper even than the decline in oil price. This reduction in electricity price was achieved by both increasing the intake share of the cheapest fuel (oil) and making non-fuel related productivity gains, primarily by the capture of the economies of scale available from the acquisition of larger units of capacity; there has also been an increase over time in the efficiency with which a given fuel is converted to electricity.

The steady decline in real energy price over a 14-year period (1959-1973) and a more than doubling of consumption, resulted in the establishment of technologies, expectations, habits and institutions which since 1973 have been confronted with constant or increasing prices, and the possibility of non-market related interruptions in supply. The price pattern since 1973 involved a very sharp real increase – over 60% in the case of oil in 1974 – followed by either modest increases (in the case of oil) or stable or slightly declining real price in the case of coal, towngas, turf and electricity over the 1975-1978 period. In 1979/80, further substantial real increases took place, amounting to 27% in the case of oil and 7% and 51% respectively in the case of coal and towngas.

Sectoral consumption

Consumption by the industrial, domestic, transport and commerce sectors since 1970 is shown in Figure 7.5. Sectoral data have only been compiled since 1975; the estimates for earlier years were developed by Kavanagh and Killen (1980) from a miscellany of sources, and so much be interpreted with some caution. The most striking feature of the data is the constancy of the sectoral shares over time; 33% Domestic, 12% Commercial, 33% Industrial and 22% Transport appears to represent approximately the pattern of consumption over the decade.

Import dependency

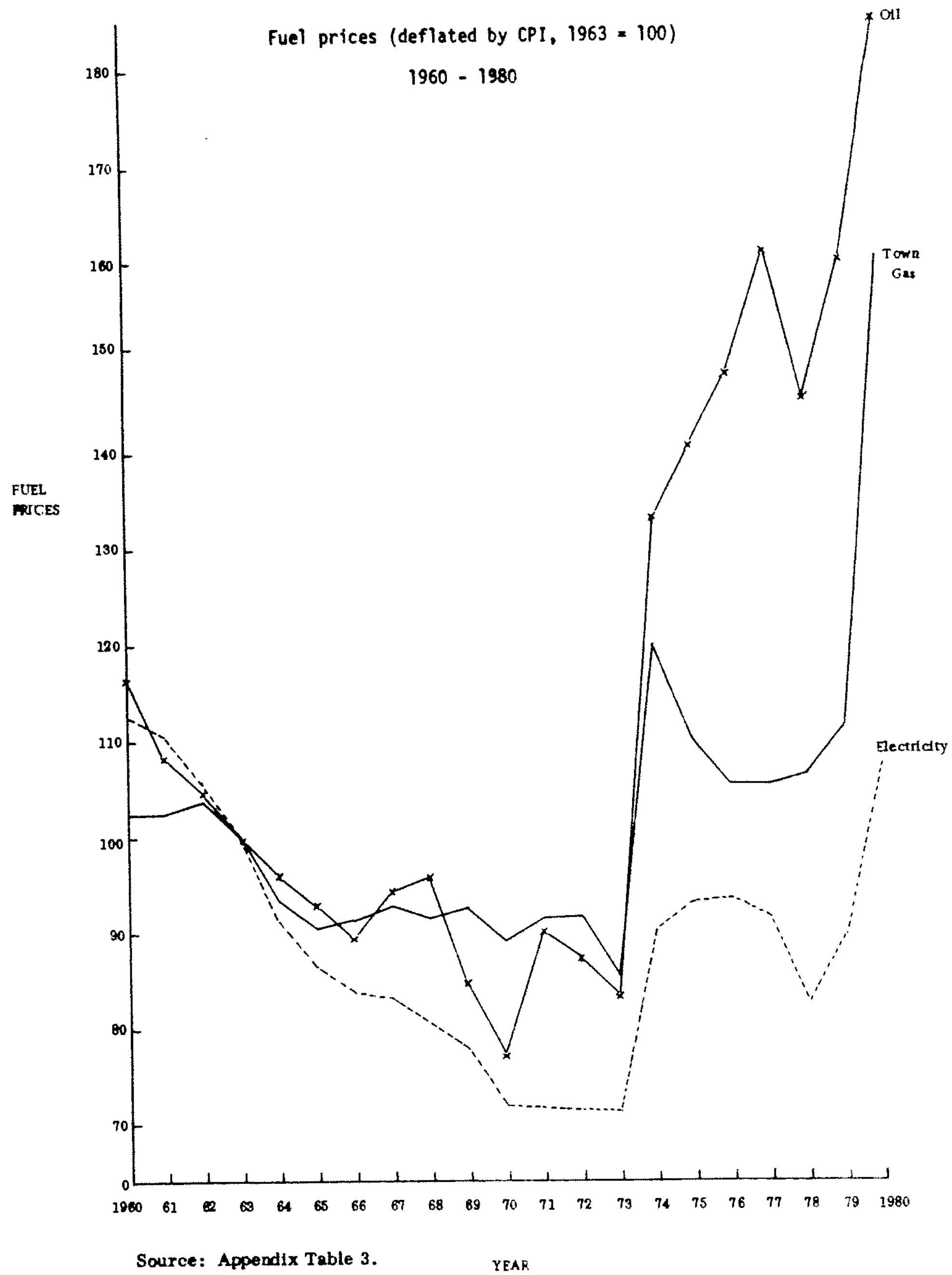
In Table 7.1 estimates of the quantities of energy domestically produced and imported are listed from 1973 to 1981. The proportion of the total which has been produced domestically has fallen in the 18-20% range over the 1973-1979 period, with a substantial increase to 28.0% in 1981, attributable to the addition of indigenous natural gas. Peat, hydro, natural gas and a small amount of native coal comprise the indigenous sources; oil and coal are the principal fuel imports.

In Table 7.2, the quantities and values of Irish energy imports are listed. In 1973 oil and coal imports amounted to 5.587 million tons

Figure 7.3

Fuel prices (deflated by CPI, 1963 = 100)

1960 - 1980



Source: Appendix Table 3.

Figure 7.4

Fuel prices (deflated by CPI, 1963 = 100)
1960 - 1980

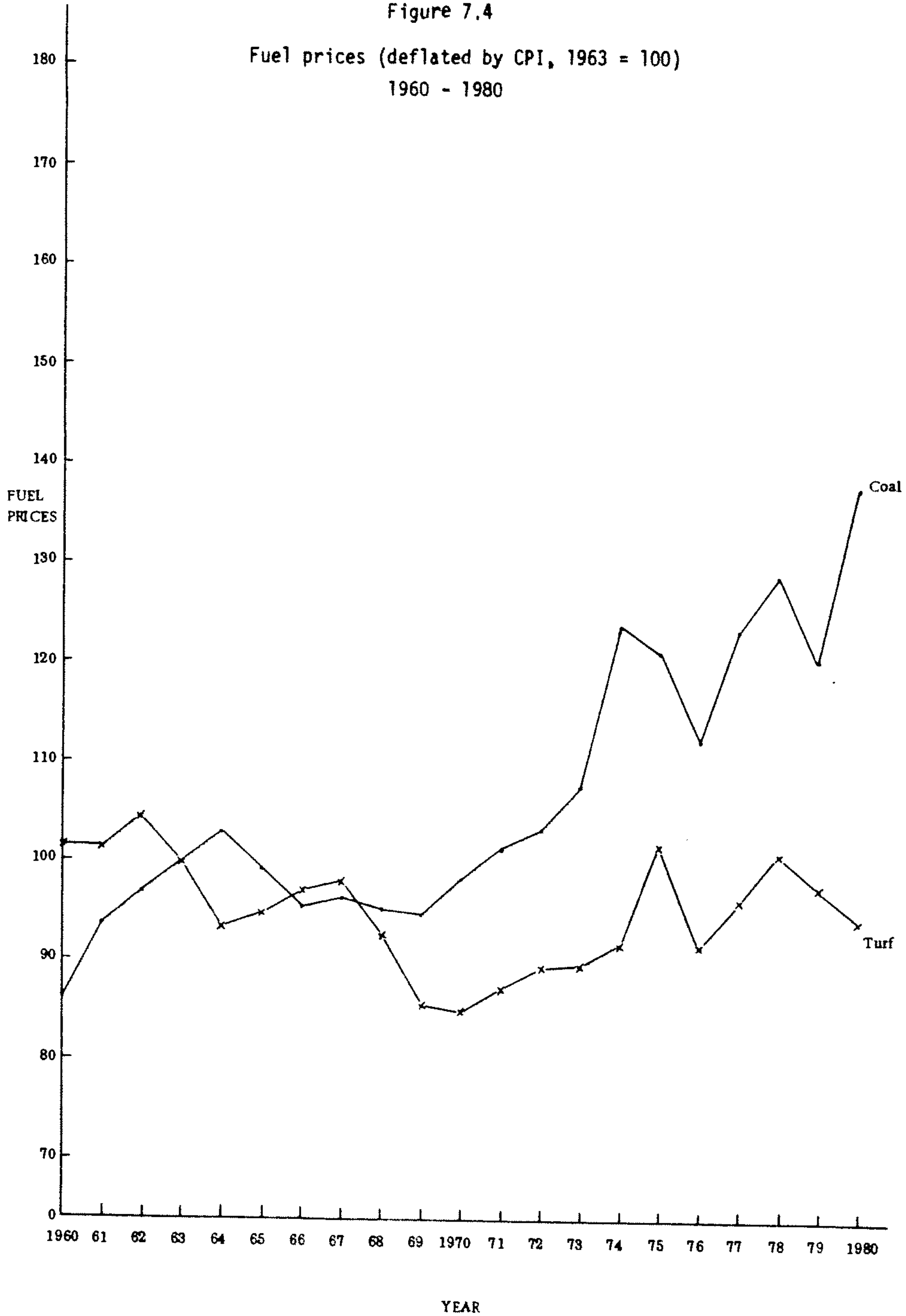
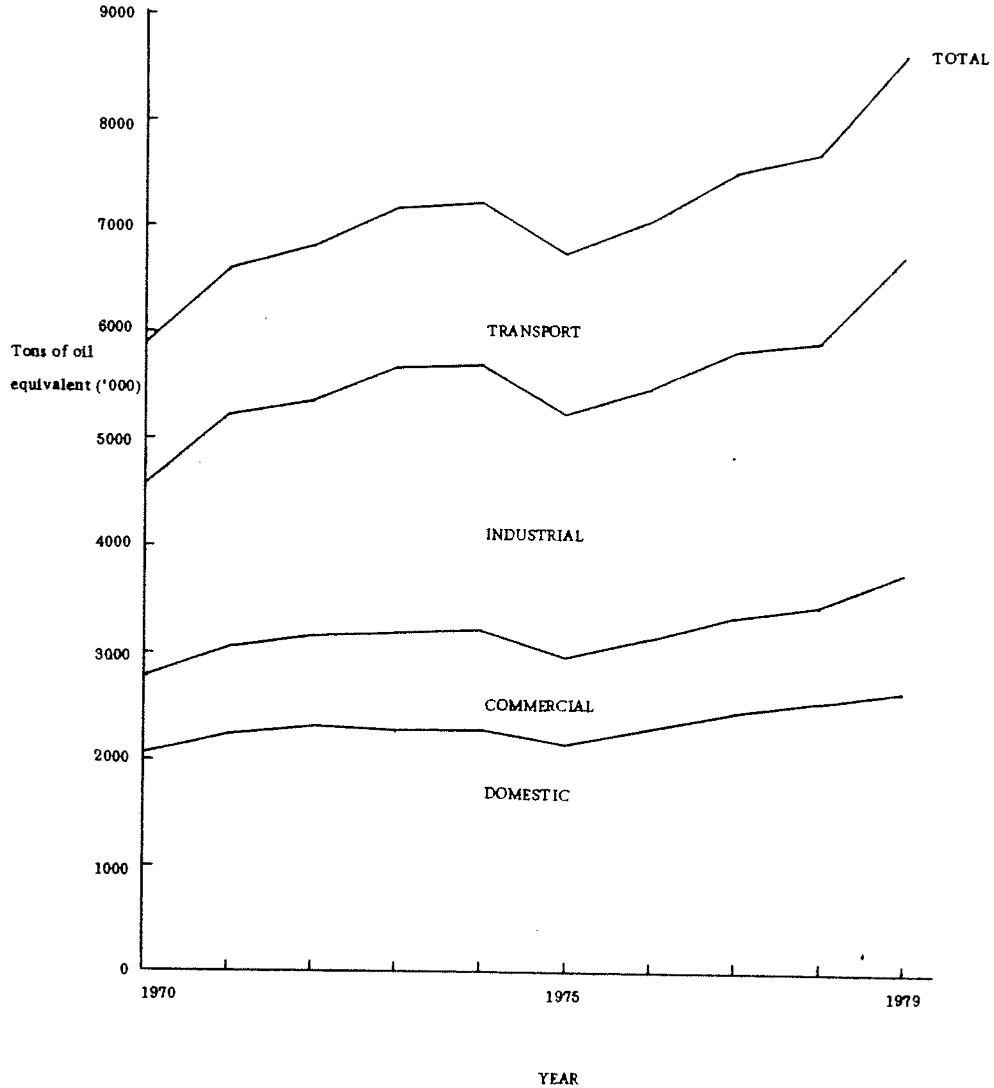


Figure 7.5

Primary energy consumed in Ireland
by sector, 1970 - 1979



Source: Appendix Table 4.

Table 7.1

Energy imports and domestic production, Ireland 1973 - 79
000s tons of oil equivalent

Year	Domestic production	Imports	Total	Domestic as % of total
1973	1312	5771	7083	18.5
1974	1385	5824	7209	19.2
1975	1352	5435	6787	19.9
1976	1391	5648	7039	19.8
1977	1478	6013	7491	19.7
1978	1388	6307	7695	18.0
1979	1675	6983	8658	19.3
1980	1903	6317	8220	23.2
1981	2283	5876	8159	28.0

Source: Department of Energy (1981) p. 5.

Table 7.2

Energy imports, 1970 - 81, Ireland.
Quantities in 000s tons, values in millions of £ current

Year		Oil			Gas	Coal	Grand total(2)	Total imports	Grand total as % of total imports
		Crude	Residual fuel oils	Total(1)					
		1	2	3	4	5			
	Quantity	N.A.	N.A.	N.A.		1200			
1970	value	21.9	8.2	43.0	0.6	9.5	53.3	676.7	7.9
1971	Quantity	N.A.	N.A	N.A.		1021			
	value	29.1	12.1	58.2	0.7	9.1	68.4	755.2	9.1
1972	Quantity	2399	1583	5237		892			
	value	21.9	11.2	53.1	1.0	9.0	63.5	842.6	7.5
1973	Quantity	2465	1607	5857		807			
	value	22.4	14.7	66.8	1.2	9.0	77.3	1138.4	6.8
1974	Quantity	2625	1743	5775		892			
	value	84.6	53.2	207.6	2.2	16.3	226.5	1626.3	13.9
1975	Quantity	2406	1544	5423		690			
	value	92.4	48.4	220.4	3.8	14.9	239.4	1699.6	14.1
1976	Quantity	1699	1797	5324		606			
	value	85.6	70.5	290.5	7.2	14.6	313.0	2337.9	13.4
1977	Quantity	2219	1841	5772		868			
	value	129.8	86.1	351.7	9.6	26.4	388.4	3083.5	12.6
1978	Quantity	2088	1735.5	5747		784			
	value	112.6	75.1	337.7	9.0	26.3	376.2	3713.1	10.1
1979	Quantity	2027	1891	6130		1167			
	value	129.4	119.7	520.6	17.6	43.9	580.6	4815.7	12.1
1980	Quantity	2114	1854	6048		1214		5420.7	
	value	222.4	160.0	722.0	22.0	59.2	803.2		14.8
1981	Quantity	653	1700	4952		1308			
	value	95.9	206.6	852.4	27.4	86.4	966.3	6575.5	14.7

Notes: (1) This includes several other petroleum products in addition to crude petroleum and residual fuel oils.
(2) Sum is greater than the total of oil, gas and coal because some additional small fuel items are included.

Source: Succession December issues of Trade Statistics of Ireland, Government publications, Dublin.

and 0.807 million tons respectively, and energy imports comprised 6.8%, by value, of total imports. By 1975, oil and coal imports had fallen to 5.423 and 0.69 million tons respectively, but energy imports comprised 14.1% by value of total imports. This of course reflected the almost four-fold increase in oil price (money terms) which took place over this period. The next 3 years were characterized by relatively stable real prices and modest growth in consumption; this resulted in successive declines in the share of imports devoted to energy supplies. However, the revolution in Iran in 1978/79 resulted in a sharp reduction in the supply of Iranian crude coming onto the market. This in turn was a primary cause of the substantial rise in price which took place in that year. Prices for oil and coal imports in selected years are provided in Table 7.3. This price rise and the continued growth in Irish energy imports reversed the 3-year declining trend in the energy share of Irish imports. In 1981 more than £1 of every £7 spent on imports was devoted to energy supplies.

Sources of energy imports

The primary sources of coal imports in 1978-1981 are listed in Table 7.4. Only three countries – Poland, the US and Great Britain – are significant suppliers. The most notable feature is the decline in deliveries from Poland, matched by the very rapid growth in imports from the U.S.

In 1981, the value of oil imports, by category, was as follows:

	Value (Million £)	Percentage of Total
Crude Petroleum	95.9	11
Gasoline	199.9	23
Fuel Oil (excluding gasoline, kerosene, gas oils)	206.6	24
Gas Oils	206.8	24
Other	143.2	17
Total	852.4	100

Source: *Trade Statistics of Ireland*, December 1981.

Crude petroleum, gasoline, fuel oil and gas comprise 82% of oil imports, by value. Import sources are listed in Table 7.5. Saudi Arabia and Kuwait contributed 90% of Ireland's crude oil intake. The closure of the Whitegate refinery in 1981 resulted in a sharp decline in imports of crude, falling from 2.027 million tonnes in 1979 to 0.653 million tonnes in 1981. This has been matched by a sharp rise in imports of refined products, mainly gasoline.

Table 7.3

Price and quantity of energy imports, selected years, Ireland.

	1973	1975	1978	1981
CPI (1968 = 100)	150.8	213.2	307.7	496.8
Oil (crude and all products)				
Quantity (tons)	5,856,656	5,423,152	5,746,805	4,952,240
Value (000s£)	66,795	220,438	337,696	852,449
£/Ton (current)	11.40	40.65	58.76	172.13
£/Ton (constant, 1968 £)	7.56	19.07	19.10	34.70
Coal (all types)				
Quantity (tons)	806,672	689,810	783,550	1,308,171
Value (000s £)	9,004	14,886	26,309	86,429
£/Ton (Current)	11.16	21.58	33.58	66.07
£/Ton (Constant, 1968 £)	7.40	10.12	10.91	13.32

Source: Trade Statistics of Ireland, December Issues.

Table 7.4

Coal imports (excluding anthracite) by source, quantity and value, 1978-81.

		Great Britain	Poland	USA	Australia	Total (1)
1978	Quantity (tons)	175,358	601,327	-	-	783,550
	Value (000 £)	6,088	20,025	-	-	26,309
	Price/ton	34.72	33.80	-	-	33.58
	% of total quantity	22	77	-	-	99
1979	Quantity	216,634	705,702	213,610	20,031	1,167,219
	Value	9,050	24,601	8,772	906	43,915
	Price/ton	41.78	34.86	41.07	45.23	37.62
	% of total quantity	19	60	18	2	99
1980	Quantity	256,236	482,520	398,342	-	1,168,360
	Value	13,575	21,596	18,472	-	55,702
	Price/ton	52.98	44.76	46.37	-	47.68
	% of total quantity	22	41	34	-	97
1981	Quantity	407,246	184,413	582,172	-	1,251,847
	Value	29,046	10,960	35,788	-	81,357
	Price/ton	71.32	59.43	61.47	-	65.0
	% of total quantity	33	15	47	-	95

Note: (1) Total includes small amounts from other countries.

Source: Trade statistics of Ireland, December issues, 1978, 1979, 1980 and 1981.

Table 7.5

Selected oil imports, 1978-81, Ireland.

Commodity and source	1978 Quantity 000s M.T.	1978 % of total	1979 Quantity 000's M.T.	1979 % of total	1981 Quantity 000's M.T.	1981 % of total
Crude Petroleum						
Saudi Arabia	765	37	1080	53	456	70
Iraq	777	38	317	16	n.a.	-
Iran	190	9	248	12	n.a.	-
Kuwait	289	14	225	11	128	20
U.S.S.R	-	-	157	8	-	-
Other	47	2	-	-	69	10
Total	2068	100	2027	100	653	100
Gasoline (including aviation spirit)						
Great Britain	379	91	448	94	835	98
Other	36	9	30	6	16	2
Total	415	100	477	100	851	100
Fuel Oil (excluding gasoline, kerosene, gas oils)						
Great Britain	1029	59	948	50	1042	61
France	84	5	322	17	362	21
Italy	213	12	126	7	25	1
U.S.S.R	217	13	125	7	49	3
Other	191	11	370	20	222	13
Total	1734	100	1891	100	1700	100
Gas oils						
Great Britain	486	68	719	83	980	91
U.S.S.R	168	23	119	14	93	9
Other	64	9	33	4	9	1
Total	718	100	871	100	1082	100

Source: Trade Statistics of Ireland, December Issues, 1978, 1979 and 1981.

Over 90% of both gasoline and gas oils are imported from Britain; this is supplied primarily from the refinery complex at Milford Haven in Wales. There is more diversity in the suppliers of fuel oil (mainly residual fuel oil), but Britain is still (1981) providing over 60% of our needs in this regard.

Liquefied propane and butane comprise the principal Irish gas imports. As in the case of refined oil, Britain is our main supplier, providing 129 thousand tons in 1981 valued at £22.278 million, which accounted for 84% of such imports in that year, by quantity.

To summarize: for our coal imports we depend primarily on Britain and the U.S.; Saudi Arabia and Kuwait are our chief suppliers of crude petroleum, while Britain is the main source of refined oil and gas products. Prospective developments in these areas will be examined when each fuel type is discussed separately in more detail.

CHAPTER 8

ENERGY CONSUMPTION AND INCOME DISTRIBUTION

Since all citizens are regular consumers of energy, distributional considerations in energy policy are of some interest. From Table 8.1 we can see that fuel and light as a percentage of household expenditure increased from 4.8% in 1973 to 5.7% in 1975, falling back to 5.6% in 1978 and 1979. In 1973 there was relatively little disparity in the shares of expenditure across social groups; the share of the lowest only exceeded that of the highest by 19%. However, in 1979 the percentage of expenditure allocated to energy by the lowest exceeded that of the highest by 92%.

This tendency for energy to take an increasing share of expenditure as one goes "down" the occupational scale is one manifestation of price inelasticity of demand for energy; the same effect is observable with income data (Table 8.2). The percentage of total expenditure devoted to fuel and light falls from 15.0% for households with under £20 gross weekly income to 4.0% for those with a household weekly income of £230 and over.

In Table 8.2 can be seen estimated household outlays on fuel and light, by income class, in 1979. Two patterns appear to stand out; the relatively high income elasticity of electricity, with expenditure growing rapidly as household income increases, and the fact that expenditure on coal tends to remain constant, while outlays on piped gas and 'other' grow somewhat more rapidly as income increases. By examining the ratio comprised of expenditure on each fuel by the highest weekly income households (£230 and over), to that of the lowest (under £20 – see Table 1.1), we can get a sense of the relative magnitudes involved. The highest income group spent 2.47 times as much on fuel and light as did the lowest group. The former spent 7.95 and 5.32 times as much as the latter on electricity and "other" (mainly fuel oil), but for coal the £230+ and over group spent 95p for every £1 spent by the under £20 category. For piped gas and turf, the ratios at 2.47 and 2.04 respectively are close to the average for all fuel and light, which is 2.90.

Other things being equal, we could conclude from this that a subsidy from the general taxpayer to electricity consumers, either through subsiding inputs – including fuel and capital – or by subsidising the sale

Table 8.1

Percentage of household expenditure spent on fuel and light, urban households (1)

	1973	1974	1975	1977	1978	1979
All households	4.8	5.5	5.7	5.5	5.6	5.6
Social group of head of household						
Professional	4.3	4.8	5.3	4.7	4.7	5.0
Salaried employees	4.6	5.2	5.4	5.3	5.4	5.0
Other non-manual	5.0	5.9	5.7	5.7	5.5	5.4
Skilled manual	4.7	5.4	5.8	5.6	5.3	5.4
Semi and unskilled manual	5.0	6.1	5.9	6.0	6.6	6.3
Other	5.1	8.6	9.0	8.3	8.9	9.6

Note: (1) The 1973 survey included the entire populaion, rural as well as urban, but for "All Households" the urban fraction was separately identified; the 4.8% listed applies to urban households, but the remaining entries in the 1973 column apply to all households.

Source: Central Statistics Office, 1976, 1977, 1979.

Table 8.2

Expenditure on fuel and light, by income class, Ireland 1979 in 1979 £

Gross weekly household income (£)	Dist. of income (%)	Expend. share (fuel + light) (%)	Piped gas	Electricity	Coal	Turf	Other	Total
Under 20	5.3	15.0	0.389	0.488	1.626	0.219	0.441	1.576
20-29	4.5	13.1	0.56	0.697	1.605	0.165	0.665	1.527
30-39	6.1	11.4	0.642	1.115	1.661	0.159	0.738	2.358
40-59	7.1	8.5	0.759	1.659	1.43	0.479	0.852	3.973
60-79	12.6	7.0	0.717	1.997	1.576	0.192	1.082	5.87
80-89	7.6	5.7	0.457	2.247	1.251	0.213	0.981	8.193
90-100	7.2	6.3	0.796	3.060	1.152	0.15	1.410	8.753
100-119	9.7	5.1	0.350	2.55	1.233	0.37	1.475	10.906
120-139	8.8	4.9	0.668	2.911	1.127	0.338	1.569	9.941
140-169	10.0	5.7	0.758	3.397	1.852	0.291	2.205	11.452
170-199	7.0	4.7	0.661	3.336	1.306	0.225	2.167	12.964
200-229	4.5	4.6	0.568	3.990	1.419	0.46	2.579	20.535
230+	9.6	4.0	0.962	3.880	1.544	0.446	2.346	13.681
All Households	-	5.6	0.654	2.512	1.446	0.288	1.464	8.780

Source: Central Statistics Office, 1981, pp. 44, 45.

price, would be regressive, in as much as the highest income households consume the most, both in absolute terms and as a proportion of outlays on fuel and light.

SECTION III: CONSERVATION

In the first chapter of this section we address the question: why conserve? A rationale for government intervention in this domain is presented. Conservation strategies can be classified into four categories: information and exhortation; regulation and cash subsidies; pricing; direct public investment. Each of these are addressed in successive chapters.

CHAPTER 9

WHY CONSERVE?

Our general analytical perspective is provided in Chapter 1 of this document. Here we highlight the dimensions that are especially applicable to conservation. There is little public interest or concern in Ireland regarding conservation of wood, steel, paper, aluminium etc. (which is not to say that we should not have concerns in this regard). What is special about energy that makes its conservation so worthy of our attention? The large and in recent times rapidly increasing share of our resources devoted to acquiring energy is one important factor. Our dependence on the politically unstable Persian Gulf region for much of our oil supplies is another. However, if market forces are working "properly", individual consumers will adjust appropriately to these changes. As prices rise, they will adjust consumption so that the value yielded by a unit of consumption at the margin is equal to the price. Consumers will adjust for perceived uncertainty by stockpiling and by diversifying supplies, both by widening the range of fuels consumed and by increasing the diversity in suppliers. We have implicitly arrived here at our sense of what is the appropriate level of consumption: It is that level where the return or utility yielded at the margin by a unit of consumption just equals the price thereof, where return incorporates considerations of price and supply uncertainty. It is clear from this definition that there can be over as well as under-conservation. If a firm can buy oil at the prevailing price and combine it with other factors to yield a net return, it is in the national interest that it be allowed to do so. To require or induce by subsidy or other means, consumption below the level at which net returns can still be made will, other things being equal, result in a reduction in aggregate net output.

From an economic efficiency perspective, the rationales for public intervention arise because the market fails in some significant sense. The policy prescriptions flow from this view. The following are the areas where government intervention appears to be warranted:

(i) *Influence on World Oil Prices*: If world consumption of oil is reduced significantly, then the price per barrel charged will fall below that which could have been charged before the reduction.[1] This price effect, spread

[1] This is an over-simplification. This response will depend in part on the extent to which OPEC members, notably Saudi Arabia, are willing to reduce output in order to maintain prices.

over all consumption, is an attributable benefit resulting from the reduced intake. Thus if the price of crude oil to Ireland could be reduced via conservation from £117.8 (average price in January-June 1980) to £100, the savings over the year would amount to up to £36 million[2] and there would be comparable savings in the processed oil categories. However, Ireland's oil consumption is such a small share of the total that, even if our intake were reduced to zero, it would have a negligible effect on world price. For a country such as the U.S., the logic of conservation on this basis is clear. Oil imports by the U.S. come to about 450 million tons annually, amounting to approximately 30% of OPEC's total production. Thus a significant percentage reduction in imports – either by lowering consumption or expanding domestic production – will have a price effect, and much of the resulting benefit will accrue to the U.S. For low consuming countries with negligible influence themselves on price, these benefits of conservation cannot be captured by unilateral reduction in consumption. If nations act effectively in concert to reduce oil consumption, then all will benefit. It is one purpose of the International Energy Agency to provide consumer market power comparable to that exercised on the supply side by OPEC. The EEC – excepting perhaps the U.K. – has the same collective interest.

There are important policy choices involved here for Ireland. If we are to assume this burden – conserve in excess of what would be justified on commercial or other grounds – in the collective interest, it is important that the others do likewise, or we will be reducing net output fruitlessly. An integral part of our conservation policy should be monitoring of performance elsewhere, with our own participation made contingent upon parallel performance elsewhere.

We have reservations about justifying particular investments, such as nuclear power capacity, partially on their effect in reducing dependence on oil, thereby lowering oil prices below what they would have been in the absence of these energy supply augmenting strategies. If subsidies are provided to this end, they should not discriminate among the non-oil supply alternatives. Thus coal, peat, solar energy (including wind and energy crops), nuclear capacity etc. should all qualify equally for such support.

If the more optimistic hopes concerning Ireland's indigenous oil resources come to pass, then on balance our immediate commercial interests will change; they will then rest with OPEC and the other producers in maximizing oil prices. However there may be longer term and altruistic reasons – e.g. the encouragement of global economic growth, and political stability in developing countries – for wanting to achieve prices below the maximum attainable.

[2]Depending on the magnitude of the consumption response.

In addition to exerting downward pressure on world oil prices, there are other market-related reasons for government intervention in conservation.

(ii) *Uninformed Consumers*: If consumers do not know, say, the heating-cost implications of an insulated versus an uninsulated house, they are unlikely to be willing to pay a premium in order to purchase the former. Builders in turn will not want to lose sales by incorporating insulation costs in the house price. The same potential difficulty applies to cars, energy using machines, appliances and the like.

(iii) *Consumer Does Not Bear the Energy Costs:* This is particularly a problem in government and related sectors. Managers and employees in most government buildings and institutions – schools, hospitals, prisons etc. – suffer no loss of pay, promotion or benefits, directly or indirectly, as a result of their use of energy or other resources. There is therefore no material incentive for them to conserve, regardless of the price level. Neither the optimum level of investment in conservation nor of individual behaviour can be expected "automatically" in these circumstances. This problem arises, but to a lesser extent, in private sector office employment.

(iv) *Separation of Private Sector Decision-Makers from the Consequences of their Decisions*: A flat-owner or renter whose payments for heat, light etc. are unrelated to actual consumption comprises one example: there is no incentive for the individual to conserve. A more significant instance in Ireland is the case where the renters of office accommodation are responsible for heat and light, but the building owners must make the investment in conservation. As long as a given rental contract is in operation, there is no incentive in this case for the owner to identify and make investments which will pay-off for the renter. When a rental contract comes up for renewal, then of course such opportunities for mutual benefit can be considered.

(v) *Average Cost Pricing of Energy*: Although there are some small variations, in general both electricity and Bord na Mona turf are priced so as to cover the costs of their production. There are monopolistic elements involved which combine with the current state of technology such that average costs can be below long-run marginal costs.

The discrepancy between average and marginal costs has a number of adverse consequences. Since consumers are not required to pay the full costs of their own increasing consumption, they tend to "over-consume" at the margin. A key condition of effective market performance – marginal cost pricing – is violated. There is under-investment in conservation; investments which would be fully justified financially with marginal cost pricing of energy will not be undertaken when the (lower) average price is assessed. There is also an equity question involved in having existing users in a sense subsidise expansions in consumption.

A further problem, not related to conservation *per se*, is that the lower average price discourages expansions in supply which are warranted on efficiency grounds but which are not financially viable because of the pricing approach. Thus private turf producers may find that average cost pricing by Bord na Mona prevents the commercial development of marginal boglands; wood chips and energy crop development generally can likewise be stifled for the same reason; industrial consumers considering investing in energy conserving combined heat and power systems may find it cheaper with average cost pricing to buy electricity from the ESB than produce their own (together with their heat requirements), although own-production in some circumstances might be fully justified financially with marginal cost pricing of electricity by the ESB. While at present there does not appear to be a large discrepancy between marginal and average prices for electricity, this is an issue which should be kept under review.

The opposite problem can also arise: if – as is now the case – the ESB has substantial excess capacity, then average cost pricing will result in prices being charged which exceed marginal costs, and "over-conservation" will result.

(vi) *Promoting Energy Conserving Technologies*: In instances where patenting and other measures are insufficient to assure that the inventors and developers of a technology reap the bulk of the commercial reward, there is a case for subvention by the tax-payer in this regard.

(vii) *Environmental Costs of Energy Production*: Hydro-electric projects can have adverse effects on fish-life, boating and general recreation. Combustion of fossil fuels in Ireland comprises the major source of a variety of air pollutants. To the extent that the damage costs are not paid by the energy consumers, the price they pay understates the full – private and social – costs of consumption.

In addition to these market-efficiency related rationales for government intervention, there can be equity/distributional reasons for such involvement.

There are a number of policy approaches to energy-conservation. These include providing information and exhortation, the use of cash subsidies and regulation, pricing strategies, and direct government investment. We consider each of these in turn. In doing so, we draw on analyses that have already been done in Ireland and elsewhere, beginning with Henry's seminal review of options in 1975-1985 (Henry, 1976); we

do not undertake original work.

It is the usual practise in analysing conservation policies to forecast consumption with and without conservation, attributing the difference to the proposed policies. We recognize the legimacy of this approach, but decided to focus on getting the direction of policy correct, rather than on achieving particular conservation targets. The precise impacts can be monitored over time and modifications made as seems appropriate.

Conservation policies are developed in the Department of Energy, which has a conservation section. There are two semi-State organizations – The Institute for Industrial Research and Standards (IIRS) and An Foras Forbartha (AFF) – which play the primary supporting roles in providing information and implementing policy. The IIRS plays the major role concerning energy conservation by industry; AFF provides analyses and advice on opportunities in housing and transportation. In addition, the National Board for Science and Technology (NBST) provides coordination and guidance on conservation-related research and development.

In most studies of energy conservation it is usual to examine separately the opportunities in the domestic, commercial, industrial and transportation sectors. We decided instead to examine conservation approaches – information and exhortation, subsidy and regulation, pricing, direct government investment and institutional developments – across sectors.

CHAPTER 10

INFORMATION AND EXHORTATION

It is important that energy consumers be adequately informed as to the energy implications of the choices before them. In the past year there has been a concerted campaign directed by the Department of Energy to convey information concerning the type of behaviour which is "wasteful", and the most cost-effective means of reducing consumption. This has taken the following forms:

(i) Media campaigns – including appearances on such widely watched shows as the Late Late Show by the Minister and personnel with technical or administrative expertise.

These have focused on the domestic consumer, and have emphasized the most cost-effective approaches to reducing energy requirements in driving and water and space heating; these latter two account for 13% and 76% respectively of residential consumption. The ESB has also developed and disemminated some excellent guidelines on conservation for the home-owner. At present prices, insulation of the hot-water cylinder, draught-sealing (weather stripping), cavity-fill (when possible) and attic insulation will recover their costs in energy-savings in 1-5 years, depending on the technical and consumption circumstances obtaining. Minogue (1980) has provided estimates of the internal rate of return to be expected from energy-conservation measures relating to space and water heating. (Table 10.1)

(ii) Active involvement of the community in consumption projects. The Department of Energy has organized a number of competitions for individuals and companies, and there is an energy hot-line number which provides information on conservation to callers.

(iii) An advisory service to the industry, commercial and public sectors provided by IIRS.

This includes a computerized boiler-efficiency testing service, as well as general advice. Fifteen specialised booklets covering different aspects of energy conservation are being prepared by IIRS. Other services provided by the IIRS include:

Energy Conservation Officers (ECO) – four in all who give free advice to industry and the commercial sector.

Table 10.1

Range of internal rate of return (%) for selected conservation measures applied to 4 typical house types

Energy conservation measures	Range of internal rate of return (%) (£1980): Average internal temperature 15.5°C	Average internal temperature 13°C
Space heating		
1. Install 50 mm attic insultation - none existing	28 to 43	13 to 23
2. Additional 50 mm on 1 above - installed at the same time	8 to 11	2 to 5
3. Install 50 mm attic insulation - 25 mm existing	10 to 12	3 to 6
4. As 1 - "Do-it-yourself" cost	34 to 52	16 to 28
5. As 2 - "Do-it-yourself" cost	10 to 14	4 to 7
6. As 3 - "Do-it-yourself" cost	11 to 15	5 to 8
7. Install secondary windows	1 to 2	negative
8. As 7 - working - living areas only	3 to 5	0 to 2
9. As 7 - "Do-it-yourself" cost	2 to 4	negative
10. As 8 - "Do-it-yourself" cost	4 to 7	1 to 3
11. Urea-formaldehyde from cavity fill to existing cavity walls	15 to 19	9 to 11
12. Internal insulation (dry-lining and 25 mm insulation) to existing single-leaf walls	3 to 5	0 to 2
13. As 12 - working-living areas only	4 to 7	0 to 4
14. Weather-strip doors and windows	10 to 15	0 to 8
15. As 14 - "Do-it-yourself" cost	25 to 32	9 to 19
16. Comprehensive air-tightening package include weather-stripping, caulking of air-gaps, porches at external doors and kitchen extract fan.	- 1 to 2	negative
Water heating		
17. 80 mm lagging jacket to hot water storage cylinders	77	77
18. As 17 - "Do-it-yourself" cost	135	135
19. Back boiler to solid fuel room heater (for houses with solid fuel space heating and electric immersion hot water heating).	15	15

Source: Minogue (1980).

Energy Management Association: This is a country wide association of 2,000 energy managers in industry designed to promote the adoption of energy saving technologies and practices.

National Boiler Testing Service: A boiler efficiency testing service which has tested and reported on over 10,000 boilers in industry, institutions and the commercial sector.

Thermal Laboratory: A new laboratory dedicated to the testing and evaluation of domestic energy consuming appliances.

The membership of the Energy Management Association is largely drawn from concerns employing less than 200 people. The regional nature of the Association assists managers with limited resources and time to make progress in this area. The Energy Conservation service is also particularly effective in this area. There are devices which enable progress to be made without making undue claims on a busy manager's time. Often, the ECO can identify a ready made solution.

There are two aspects – miles per gallon to be expected from motor vehicles, and energy consumption of appliances and machines – where independently validated consumer information would be worthwhile. Mileage per gallon estimates derived and prepared by government are provided in a number of countries, including the US, Sweden and the UK. Cooking accounts for 8% of domestic energy consumption, with other appliances and lighting amounting to a further 3%. Mandated energy efficiency labelling would provide consumers with a basis for comparison regarding this dimension.

We have noted expressions of official disapproval of those in the industrial sector who are not deemed to be conserving sufficiently. In this regard it is perhaps worth observing that, in small firms in particular, executive talent is often spread over many functions, and it may not be wise to devote much attention to conservation, even when nominally cost effective opportunities can be identified. Managers may quite correctly focus on improving product quality, labour relations, or some other dimension of their operations where the payoff to managerial input in these functions exceeds that yielded by conservation. In general, we feel that scolding and exhortation, as opposed to information concerning alternatives, are of negligible value.

CHAPTER 11

REGULATION AND CASH SUBSIDIES

The government has a wide range of choices available in mandating conservation investments and regulating energy consumption. It can also provide cash subsidies for a variety of actions.

Regulation

Domestic/Residential: In 1976 thermal insulation standards were mandated for public authority housing; the latter comprises 20-25% of new Irish housing units. In 1978 and 1979 standards were required by the Department of the Environment as a pre-requisite for the awarding of a certificate of reasonable value (CRV) for new housing. Since the lending institutions require a CRV before making loans, this in effect made insulation standards mandatory for the bulk of private housing in Ireland. Normal commercial pressures combined with these regulations have resulted in almost universal insulation of new houses; almost all houses built since 1980 have 100 mm roof insulation and 90% have floor insulation (An Foras Forbartha, 1981). In 1976 no private estate houses had roof insulation of 100 mm and only 4% had floor insulation.

Industry/Commercial: In July 1980 the Minister announced that he had asked IIRS and An Foras Forbartha to establish new thermal standards for office buildings, commercial buildings and factories. He stated that these standards would be announced as soon as possible, and that he would be consulting with the Minister for the Environment to determine whether such standards need to be made mandatory.

Mulcahy (1980) points out that normal commercial forces will not of themselves result in energy-efficient office buildings, for the market-failure reasons outlined in the previous chapter. He also notes that the public sector is the dominant renter of new office blocks. By simply exerting its market power, i.e., insisting as a condition of grant or public sector rental that buildings meet minimum insulation standards, the State could effect a major change in this area.

The public sector – through the IDA's direct investment in industrial estates and factories and its grants to the private sector – is also a dominant force in the industrial building sector. The IDA does use its leverage with grants to ensure that premises which are grant-aided – including those receiving re-equipment grants – meet minimum energy conservation standards.

The State should also be seen to be taking the lead in providing effective energy management of the existing stock of commercial structures which are occupied by State-funded organizations.

There are no regulations mandating conservation practises in industrial, farm or service production.

Transportation: There are no energy-specific regulations in Ireland concerning vehicle manufacture – e.g. a minimum or average m.p.g. target to be achieved – or performance, e.g. requirement for regular tune-ups, the use of radial tyres, etc.

Feeney (1980) estimates that the transportation sector in Ireland accounts for a higher proportion of this country's energy consumption than that of any other EEC-member country, and that transport energy use on a *per capita* basis is extremely high relative to our GDP. He suggests the following reasons for this situation:

(i) Air transport accounts for 19% of transport fuel, compared with an average of 9% for other EEC countries. Air transport's share of total fuel consumption is also relatively high.

(ii) Road transportation consumes 73% of transportation energy which is a high proportion of the transport energy budget, being for example 40% in excess of that in Great Britain. Sixty seven per cent of this energy is consumed by private cars and taxis as shown in the following table.

Gross energy consumption in road transport by vehicle type (MTOE) 1977

Vehicle Type	Gross Consumption	% of Total
Private Cars and Taxis	0.809	67
Goods Vehicles	0.312	26
Buses	0.045	4
Other	0.048	4
Total	1.214	100

Source: Feeney (1979).

Another reason for Ireland's relatively high proportion of energy devoted to transport lies in its restrictive freight regulations, which both limit the number of licensed hauliers and prevent own account operators from trading for hire and reward (Foster, Powell and Parish, 1979). This results in both economic inefficiency and waste of energy. Suggestions concerning de-regulation have been prepared by the Dublin Economics Workshop (1980). Many of these were included in the recommendations of the Transport Consultative Commission.

In terms of regulatory options, the most promising appears to be mandatory annual tuning of car engines. This could be combined with an annual vehicle safety (brakes, lights, steering) check which is now standard in most developed countries. The Department of Energy provided a free car-testing service for a short period in Dublin and a number of other centres. Of about 3,000 cars tested, 65% and 35% respectively failed to meet tuning standards as indicated by carbon monoxide and hydro-carbon emissions. It is estimated that, for the average car, correct tuning will save 80-100 gallons of petrol per year. With petrol in 1981 costing £1.90 per gallon, this works out at £152-£190 per annum. With a tune-up costing £25-£30, and required twice a year, this would appear to be a very financially efficient investment. It is surprising that more than half of the cars tested (which may not however be a representative sample) were deficient in this respect. The following possible explanations can be suggested: Drivers do not know the fuel implications of poorly tuned engines; they have a very high rate of time preference (the investment must be paid for now, while the savings payoff comes later); some drivers – e.g. those with company cars – do not bear the costs of their maintenance decisions; the opportunity cost is high of not having a car for a day while it is being serviced.

Requiring an annual tune-up test has the disadvantage that it imposes real costs on those who drive very little, and therefore do not need it, and those for whom the costs, as outlined above, exceed the resulting benefits. However, on safety grounds there are good market-failure reasons for requiring a minimum safety standard – vis-à-vis brakes, steering, lights, tyre thread etc. – and the annual test in this regard can be readily combined with the tune-up test. Such a test could be required in order to qualify for car insurance. Feenay (1980a) estimates that appropriately tuned vehicles could reduce road-energy consumption by up to 10%.

Rural travel accounts of 82% of the road mileage travelled in Ireland. Thus measures relating to city traffic will have relatively little effect on overall consumption. The dispersed nature of the Dublin residential areas makes the increased use of mass transit as a congestion relieving and energy conserving option difficult to implement effectively in the capital. However, the creation of bus lanes, the encouragement of car-pooling, combined with the imposition of penalties for inner city driving (charges related to congestion) can help in this regard. A series of recommendations along this line have been made by the Dublin Economics Workshop (Dublin Economics Workshop, 1979) and are also reflected in the Transport Consultative Commission report.

Cash subsidies

Industry: (i) The Department of Energy provides grants of up to 33⅓% to manufacturing and service industries and hotels towards the cost of engaging consultants to carry out fuel efficiency surveys.

(ii) The Industrial Development Authority provides grants towards approved expenditure on machinery, equipment, instrumentation and building modifications which will reduce energy usage in production processing and space heating in factories. The grants are 25% of approved capital expenditure in non-designated areas and 35% in designated areas.

(iii) The IDA provides grants towards the labour and material costs of R + D projects in manufacturing firms, involving a significant technical input aimed at conserving energy in the firms' own processes, or products that could be used by other firms to conserve energy in their processes. The grant may be up to 50% of the eligible expenditure, subject to a maximum of IR £50,000 for any one project.

(iv) The European Investment Bank made IR £3 million available to the Industrial Credit Company for on-lending to small and medium-sized manufacturing firms to promote energy saving investment. Firms which employ up to 250 people and which have fixed assets of up to £250 million have been eligible for the loans, which were at a fixed-interest rate of 12½% for periods of up to 10 years.[1]

Residential: A grant of up to £50 is available to householders for attic insulation, lagging of hot-water cylinders and weather stripping of doors and windows.

The residential sector in Ireland is composed of some 881,000 dwelling units. Based on a housing survey, in 1975 it was estimated that 15% of these had roof insulation. By 1979 it is estimated that perhaps 33% of the housing stock is at least minimally insulated, but no survey has been conducted since 1975 to determine progress in this regard. This leaves 581,460 without any insulation. Some of these will be too old to make investments worthwhile, but it is likely that 400,000-500,000 dwelling units remain where cost-effective insulation expenditures are warranted. There are about 25,000 dwelling units constructed each year, and annual losses amount to approximately 5,000, for a net annual increase of about 20,000, virtually all of which are insulated. Over a 10 year period we would expect a net addition of 200,000 units, with a reduction of 50,000 in the (mainly uninsulated) old housing stock. Thus without any retro-fitting, we can expect in 10 years time to have about 1 million units, of which approximately half will be insulated.

[1] We understand that this scheme has been discontinued.

The Department of Energy introduced its grant scheme for the insulation of dwellings in October 1980. Up to March 19th, 1981, 6,425 applications had been received and 3,480 grants paid.[2] If, on an annual basis, we can expect an average of 10,000 grants to be made, over a 10 year period this would reduce the uninsulated housing stock to 400,000 units, or 40% of the total. Some insulation will be undertaken without benefit of the grant, and this would, of course, further reduce the uninsulated proportion of the total.

Commercial: There are no grants available to the commercial sector, so that this sector – office blocks and service buildings generally – is discriminated against in the provision of grant aids for conservation investments. It is not clear if this has happened by default, or because it has been adjudged that comparable energy-saving responses per £ of subsidy are not achievable in the commercial/service sector.

[2] It is expected that most applications for grant-aid will be approved.

CHAPTER 12

PRICING

Pricing is broadly defined here to include provisions in the tax code which reduce or increase costs of conservation and/or consumption. We first examine pricing policies in general, and then review those which are particular to the domestic, commercial industrial and transport sectors.

The first point to be emphasised is that without the support of appropriate pricing policies, all of the other strategies – information and exhortation, regulation and cash subsidies, and direct public investment – will all be less effective. Thus, for example, if natural gas is priced well below its market-clearing price, urging users to conserve will in effect be urging them to go against their own self-interest, if the cost of conserving a unit at the margin exceeds the ("artificially" cheap) price per unit. By market-clearing price we mean that price which would result if the energy in question were sold to the highest bidders in competitive markets, so that at the prevailing price there are no unsatisfied demands.

Average versus long-run marginal cost pricing

We discussed earlier the difficulties which arise in monopoly situations when the long-run marginal cost exceeds the average cost, and when average-cost is employed as the basis for pricing. The price signals which consumers are receiving at the margin do not reflect the full cost of meeting increments in supply; the costs of such increments are spread over all consumers and so in a sense intake at the margin is subsidised by intra-marginal consumption. Although this does not appear at present to characterise electricity consumption in Ireland, it could do so in the future.

In cases where marginal costs do exceed average costs, one solution would be charge purchasers the full long-run marginal costs. This will give consumers the correct price signals concerning the full marginal costs of meeting their demands, but in the case of electricity it would also generate large "profits" for the ESB. This surplus could then be taxed away or re-distributed to the public in the form of an equal lump-sum payment per electricity consumer. However, it is very difficult to justify such an approach politically.

In 1973 the ESB changed its policy of offering declining block, or promotional rates. Under this system the price of each increment declined, and there was therefore a strong price incentive to expand consumption. This was appropriate, because prior to 1971/72 the ESB was capturing economies of scale in plant construction and fuel was cheap, so that marginal costs were below average costs. Promotional rates have now been discontinued and the rate now charged is unrelated to consumption. However, the ESB finds itself now with substantial over capacity, a condition which may persist for more than a decade. In such a situation, it makes sense to consider again the use of promotional rates, where the rates charged for units at the margin equal (or slightly exceed) the additional costs (namely fuel and plant operating costs) of their provision. As plant usage approaches full capacity once more, the attractiveness of pricing at the margin so as to cover both capital and operating costs increases.

We recommend that the Department of Energy conduct a study of electricity pricing, with special emphasis on the concept and implications of the re-introduction of promotional rates, and the use of an inverted, (increasing block) rate schedule. Then, in the event that marginal costs do diverge from average costs, appropriate policies can quickly be implemented.

Equity considerations

Whenever the use of market-clearing prices for indigenous resources is recommended, equity issues immediately arise. Those who had been receiving the energy in question for less will naturally oppose moves to force them to pay higher prices. For this reason the initial policy is crucial, since it tends to become irreversible.

The share of household expenditure devoted to fuel and light in 1978 accounted for 3.9% for the group with a gross weekly household income of £180 and over and 13.7% for the under £20 per week category. Thus energy costs bear disproportionately upon the less well-off. Policy in Ireland has recognized this by providing, free of charge to the recipient, fuel vouchers worth £3/week for people who are unable to provide for their heating needs from their own resources. These would normally be persons in receipt of long-term social welfare and health board payments, living alone either with a dependent spouse or child, with another pensioner or with an incapacitated person. Old age pensioners, widows, handicapped persons in receipt of disabled person's maintenance allowances, deserted wives and many of those receiving regular supplementary welfare allowances are included. Each person is assessed individually. The vouchers can be used to buy different kinds of fuel such as coal, briquettes, and bottled gas, and to pay electricity and gas bills. The total weekly outlay in 1978 on fuel and light by households with a gross income under £20 per week came to £3.093. This will of course have increased since 1978, but the £3 per week voucher should still meet a substantial share of the fuel and light bill for the poorest households.

We recommend that this programme be continued, and that the value of the vouchers be kept fully in line with fuel costs. In particular, if government itself is increasing energy prices, it is important that the less-well off members of the community be buffered from the effects thereof by adjusting the purchasing power of the vouchers.

We turn now to a discussion of pricing policy issues specific to the domestic, commercial, industrial and transportation sectors. Most of the tax information provided in these sections is taken from an excellent report prepared by Craig Gardner and Co. (1980).

Residential and commercial

Value Added Tax (VAT) is a tax on consumer expenditure, which is levied at each stage of the production and distribution cycle. The VAT applicable on some insulation materials is 25%, while on others it is 10%. However, when materials in either category are supplied as part of an installation contract, the rate of VAT applicable is 3% (Craig Gardner and Co., 1980). Thus, there is a substantial penalty imposed on the do-it-yourself installer.

A taxpayer may claim a deduction from taxable income in respect of the cost of labour included in expenditure on maintenance, repair and improvement (including insulation) undertaken on a private dwelling occupied by the taxpayer. It applies to labour costs in excess of £50, with an upper limit of £900 for a married couple in a tax year. The work must be carried out by an individual or firm having a valid certificate of registration issued by the Revenue Commissioners.

These two provisions provide a powerful incentive to get insulation done on contract rather than do it yourself. Given that there is also a £50 grant available, and that insulating up to a point is in any event financially beneficial to the owner/resident, we do not feel that further incentives are warranted. We have some reservations about the equity of the tax-deductible provision, since it clearly favours those paying tax at the higher marginal rates. We suspect that the bulk of the remaining uninsulated houses are occupied by less well-off families and individuals for whom this form of subsidy is relatively unattractive. Where no tax liability exists, of course the deductible provision is of no benefit whatever. We would prefer a system of tax credits, whereby some percentage of the labour costs could be deducted directly from tax liability. For example, tax credits of 10 to 15% are permitted for a variety of renewable energy and conservation investments in the US. This would eliminate the inequity among those paying tax. However,

we recognize that this issue transcends conservation policy *per se* and so we do not develop this theme further.

VAT is not payable on coal, peat, electricity, oil and gas for domestic and industrial heating.

Mulcahy (1980) suggests allowing free or accelerated depreciation of expenditure on office buildings provided that they meet energy efficient standards in design and construction. Accelerated depreciation favours more capital intensive over less capital intensive forms of expenditure. A system of tax-credits would be less distorting, and easier to cost explicitly. From a government exchequer point of view, a decision is likely to turn in part on the comparison between what is foregone in government revenues on the one hand, and the gain in the efficiency of energy utilisation on the other. This would facilitate cost-effectiveness comparisons with alternative strategies.

Minimum insulation standards could also simply be mandated. From the point of view of government, this has the advantage that no explicit loss in Exchequer revenue must be incurred. However, other things being equal, rental and lease rates would increase commensurately, and this will have an impact on exchequer outlays. This approach suffers from the difficulty which afflicts minimum standards regulation in general: it provides no incentive to the architect/engineer/builder/manager to perform above the specified minimum.

Industrial

Tax capital allowances allow the full cost of plant and machinery to be deducted from profits at the time of purchase. Annual allowances for wear and tear are also permitted. Grants towards the cost of equipment are generally not taken into account in calculating the amounts of the tax capital allowances. These tax provisions are by international standards exceptionally generous. While capital intensive enterprise is encouraged thereby, these provisions should also encourage the marginal additional investment in energy conserving buildings and processes. In the US and many other countries, it has been argued that conservation investments are discouraged, because while the capital outlay on conservation must be claimed at cost over the life of the asset, outlays on energy can be deducted directly in the year of their occurrence. This asymmetry does not exist in Ireland, since the capital costs can all be claimed in the year of their occurrence. We do not recommend any changes in the current system.

Transportation

We look first at the situation vis-à-vis vehicles, and then examine fuel.

Vehicles

Excise duties are levied on specified goods which are imported or manufactured in the State. In 1982, for motor cars, motor cycles and certain mini-buses, the rate was 50% for vehicles under 16 horse power, and 60% for those of 16 h.p. and over. For most commercial vehicles, the rate was 11.5%. No duty is normally payable on off-road vehicles such as tractors.

All motor vehicles are liable for VAT, paid (in 1982) at a rate of 18% on the excise-duty inclusive price.

Excise duty at a rate of 33% is payable on imported motor vehicle parts and accessories, to be reduced to 25% in June 1983. This is repaid if the part is used for vehicles not chargeable with excise duty, i.e. off-road vehicles.

Excise duty and VAT are assessed on price, and not on fuel consumption characteristics of the motor vehicles.

In 1982, road tax was payable annually for private cars according to the following schedule:

Horse Power Rating	Road Tax per Horse-Power (1982 £)
4-8	5
9-12	7
13-16	8
17-21	10
21+	11

Since horse power and fuel rating are closely correlated, this tax "penalises" fuel consumption, and thereby encourages energy conservation.

While in many cases we would expect more expensive cars to have relatively low miles per gallon performance, there is no necessary correlation between car price and fuel consumption performance; the excise duties only indirectly encourage the purchase of fuel efficient vehicles. Feeney (1980) has shown that, compared to countries with a comparable GDP per capita, such as Italy, Ireland has a disproportionately high share of large cars.

We recommend that the excise duty be re-calibrated such that it bears proportionately more heavily on heavy fuel consuming vehicles. It could be assessed for example, in the range 70% to 30% so as to reflect relative fuel efficiencies, and designed so as to yield the same return to the Exchequer as does the across-the-board 50% rate. Official mileage performance tests are carried out and published for all models in other countries e.g. the US; it should not prove too administratively costly or difficult to use these to classify vehicles in Ireland for tax liability purposes.

We recommend also that consideration be given to the introduction of a comparable annual assessment, ranging progressively from, say, 0 to £80 depending on the miles per gallon rating, rather than the fixed fee of £20 per annum now levied.

Fuel

There are substantial excise duties assessed on some fuels. Those applying in 1980 and 1982 are listed below:

	p per gallon 1980	1982
Petrol	61.6	85.7
Diesel (road fuel)	35.9	60.0
Diesel (off-road vehicles)	7.0	7.0
Diesel (heating oil)	7.0	7.0
Liquid Petroleum Gas (LPG) (road fuel)	30.0	56.0
LPG (off-road vehicles)	7.0	7.0
LPG (other)	7.0	7.0
Heavy fuel oil (used in industry)	7.0	4.5
Heavy fuel oil (other)	7.0	7.0

Petrol and road diesel are also liable for VAT at a rate of 18%.[1]

It is clear that the road user is especially heavily taxed, but that within the group of fuels used for on-road driving, diesel and LPG are treated relatively leniently. It is argued by some that this differential should be further widened, in order to encourage still more diversity in the fuel mix used in transportation. The rationale for this view rests on the supposition that LPG will be in plentiful supply from the North Sea, providing thereby an assured supply at a reasonable price. The choice facing the consumer is whether to incur the initial additional capital costs involved with diesel and LPG in order to capture the subsequent fuel cost savings. Clearly, the more driving that is done per unit time, the more worthwhile these options become. Feeney (1980) argues that the incentives in this regard are already quite generous, that the resulting diversity in fuels is adequate, and that no widening of the differential in favour of diesel and LPG is warranted.

This argument is impossible to evaluate without knowing what the future supply and price situation vis-à-vis the various fuels will be. However, since retro-fitting of engines for LPG can be done quite quickly, we support Feeney's view that major policy changes not be made in this regard.

Fuel price

Feeney (1979a), (1976) has done most of the contemporary work in Ireland on the responsiveness of transportation fuel consumption to

[1] Rate which applied in 1982.

price. He concludes that drivers respond to real (net of inflation) rather than nominal price changes, and that the short-run price elasticity of demand (PED) is about 0.2 while long-run PED is about 0.4 or greater. Thus a 50% increase in the real price would result in a long-term 20% or more reduction in quantity consumed, *ceteris paribus*.

Income, and particularly expected income, are the key determinants of car sales. Increasing real fuel prices will not significantly reduce the volume of car sales, but will shift the structure of the car population in the direction of more fuel-efficient models. There are also some (relatively modest) effects on miles travelled and, for a given vehicle, reduced consumption per mile travelled, achieved by better maintenance and/or better driving habits.

Although the evidence available shows that the price elasticity of demand is low, the time period for which we have evidence of increasing real price is very short; it is difficult from the evidence to discern what the long-term response will in fact be. Since the main long-term impact occurs at the time of vehicle purchase, we feel that expectations regarding future real prices will be important determinants of the extent to which high m.p.g. vehicles will be favoured. Through the excise duty mechanism, government can, if it wishes, assure consumers that, for example, future fuel prices will at least be indexed so as to keep pace with inflation. The recent pattern of real prices for petrol is presented in Table 12.1 and Figure 12.1. The real price of petrol to consumers declined steadily from 1970 to 1973, then increased sharply from 1974 to 1976, followed by declines in 1977 and 1978. In 1979-1981 there has been further real growth.

This highly erratic price pattern makes it difficult for consumers to establish consistent expectations. We can take it as given that governments are going to continue depending on excise duties on transportation fuels, in particular petrol, as a significant source of revenue. What is of relevance for policy is the conservation response, at the margin, of increments or decrements in the real price and the costs at which they are achieved. We feel that a promise by government that the real price of petrol will be at least maintained would be a useful antidote to the complacency which seems to set in as each sharp rise is followed by real price declines. In terms of conservation impact, a guarantee of real increase would of course be even more of a stimulus to acquire fuel-efficient vehicles than a policy of price maintenance. However, we recognize the political sensitivities which pertain to a frequently purchased item such as fuel – especially petrol – and the role that such items play in establishing expectations concerning inflation. We also sense that the costs of such a policy, in terms of reduced net output and consumer satisfaction, might well exceed the resulting benefits.

Table 12.1

Nominal and real retail price of petrol, 1968 = 100

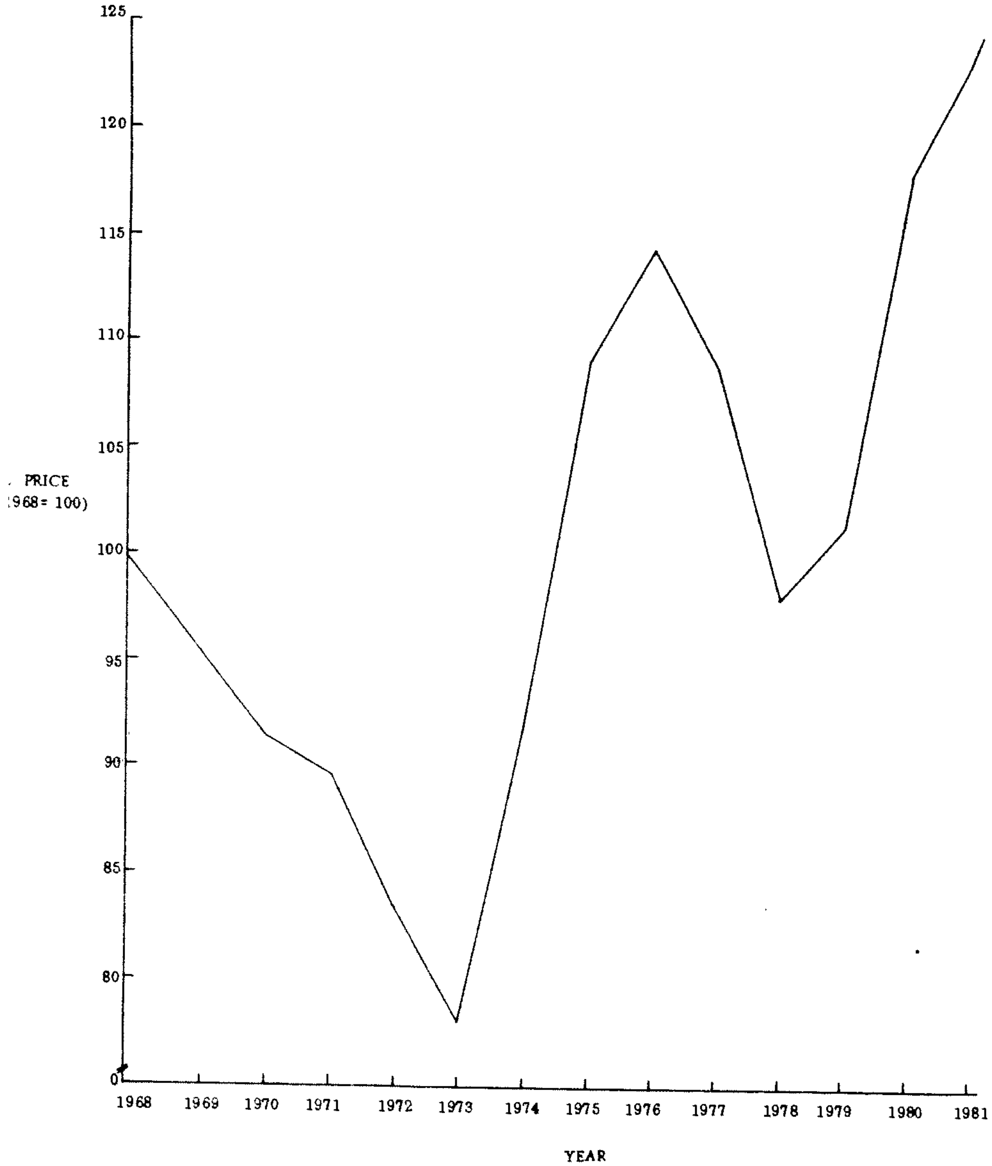
	Nominal	Real [CPI, 1968 = 100]
1968	100	100
1969	102.4	95.3
1970	106.2	91.4
1971	113.4	89.6
1972	114.7	83.4
1973	119.5	78.0
1974	165.1	92.0
1975	236.4	109.2
1976	292.3	114.5
1977	315.8	108.8
1978	306.9	98.2
1979	360.9	101.5
1980	494.5	118.1
1981(1)	583.2	124.5

Notes: (1) First quarter

Source: Bernard Feeney, An Foras Forbartha, Personal Communication May 1 st, 1981.

Figure 12.1

Real price of petrol, 1968 - 1980



CHAPTER 13

DIRECT PUBLIC INVESTMENT

With regard to conservation there are two categories of investment which are of interest; investment in energy conservation in buildings which are owned or leased by the government, and investment in "waste-heat" utilisation (mainly from power stations) and combined heat and power (co-generation) facilities.

Government buildings

We noted earlier the serious market-failure reasons which could be expected to inhibit conservation efforts in this sector. In order to deal effectively with this situation, it is necessary for the government to monitor consumption, establish and then implement appropriate energy management, which includes evaluation of performance, with penalties/rewards assigned as appropriate. The problem needs first to be recognized, and then the appropriate technical and managerial personnel should be assigned to implement the conservation programme. They should have the skills to identify the cost-effective actions which need to be taken and they should be provided with the authority and resources to ensure that these actions are undertaken.

There are substantial economies of scale in mounting an operation such as this, and the government is ideally suited to capture these economies and provide thereby a model of cost-effective conservation performance to the rest of the nation. Kelly (1981) demonstrates how a large organisation – Arthur Guinness and Son Ltd. – can undertake an aggressive and very successful effort to identify and act upon net revenue producing conservation investments. Livesey and Taylor (1980) show how these principles have been applied to government properties in the UK. There does not appear to have been a comparable commitment in Ireland.

The amount of fuel delivered to the Office of Public Works premises in 1979 was as follows:

Fuel	Tons of oil equivalent
Coal (including anthracite and slack)	392
Turf	5463
Oil	6900
Gas	412
Electricity	5063
Total	18230

This comprised only 1.67% of total commercial consumption in 1979. However, this only represents a small fraction of total government consumption. Educational establishments, health care facilities and most semi-state organisations are not included.

The IIRS has produced a useful guide for Local Authorities on energy auditing, and has also developed guidelines for energy management in public buildings. However, we gather that the response on the part of the public sector has been very uneven; some units have taken seriously the task of identifying money-saving conservation opportunities and providing appropriate monitoring and management, but many others have not. The opportunities to provide dynamic overall leadership in this area, and capture the economies of scale in technique and expertise, have not been acted upon. It is surprising to find this situation; almost 8 years have elapsed since the initial energy "shock". This deficiency transcends the foregone opportunities *per se*; it vitiates the credibility of the government as an advocate of conservation in the private sector.

We understand that there are efforts underway to provide the government with the type of capable, activist unit which has the analytical skills, authority and resources to ensure that the appropriate conservation opportunities in the State sector get acted upon, and that State encouragement of private sector conservation can be undertaken with credibility. We hope that such is the case, and we encourage rapid implementation of this concept.

Combined heat and power and district heating

Combined heat and power (CHP) refers to systems which utilise the "waste" heat from power stations, and to systems wherein heat and electricity are generated simultaneously on-site, usually in a manufacturing process. District heating refers to the dissemination to a large number of buildings of heat produced at a central production point. The heat may be the sole output of the producing plant, or it may be provided from a combined heat and power unit, as described above.

When electricity is produced, at a maximum only about 40% of energy available can be converted into electricity. The balance is typically waste heat which is unutilised and must be disposed of into the adjacent environmental media, often causing thermal pollution. The low-grade heat ejected by the power stations in the form of cooling water is at temperatures of 12-25°C. However, the plant can be designed — with some sacrifice in electricity generation — to deliver heat at about 100°C. The latter's main use is as a source of space-heating for conventional buildings. However, it can also be used in horticulture to produce tomatoes and other salad crops out of season, while the potential role of waste-heat in fish-farming is also being explored.

Since electricity consumption is highest in winter, when these other

demands will also be greatest, the power and heat requirements tend to coincide in a mutually beneficial way. With full usage of the waste heat, thermal efficiency can be expected to increase from a norm of 35% to up to 70%, yielding thereby the same amount of useful energy as the conventional thermal plant, with half the amount of fuel. Nearly all systems follow the two-line principle whereby one pipe carries the flow of heated water to consumers while the other returns the cooled water to the production plant. Prefabricated, pre-insulate pipes are now normally installed for this purpose.

The utilisation of heat from electricity generating stations has reached its fullest development in Denmark, where 11 power stations provide 10% of the country's space heating needs. A further 20% is provided by district heating supply enterprises which produce heat alone. These district heating enterprises are owned by the consumers either indirectly through the local authorities or directly in the form of cooperative companies. In Sweden, 25% of heating needs are met from district heating systems.

The use of heat from power stations for this purpose entails costs. These include some (10-15%) sacrifice in electricity output, the adaptation costs at the power station, and the costs of the distribution system. The return is the saving in outlays for fuel and heating plant which would have to be undertaken in the absence of the "waste" heat utilisation system.

Clearly, proximity to major consuming centres is a key factor determining the financial attractiveness of these systems. In this regard Dublin provides an interesting opportunity insofar as it has a large share of the nation's electricity generating capacity within the city's boundaries. There are no projects involving the use of waste heat in Dublin,[1] but at the peat-fired station in Lanesborough, Co. Longford, heat is being utilised in greenhouses for horticultural purposes. A published analysis of the costs and returns of this endeavour would be helpful.

Clearly, it is most efficient if generating stations are designed from the outset as combined power and heat units. In Denmark, while the use of natural gas in large electricity generating stations is regarded as economically wasteful, some consideration is being given to the decentralized production of electricity and heat in small gas burning units.

District heating systems operated independently of power plants are commonplace in many countries. In Ireland, the heating system at Ballymun is the only significant example of this genre. It is unfortunate

[1] However, it was reported in the *Irish Times*, April 6, 1981, p.6 that the ESB plans to provide a district heating system for up to 40,000 households in Dublin, supplied by "waste" heat from the Poolbeg and Ringsend Power Stations.

that this scheme suffered from a number of deficiencies, because it has fixed a negative impression of district heating in both the public and the official minds which is unwarranted.

On-site generation of electricity and steam

With on-site generation, a firm converts a primary fuel to meet its own electricity (power) and heat (steam) requirements. If its heat and power requirements are reasonably non-cyclical, uninterrupted and well-balanced, then, it is much more fuel-conserving to meet both of these needs internally than it is to purchase the electricity and generate the steam. In Table 13.1 can be seen the proportion of self-generation as a percentage of industrial consumption in 10 European countries; Ireland's modest contribution is a function of the small scale of industry generally here, and the industrial mix, which does not have the characteristics most favourable for CHP. Key considerations in evaluating an investment by a firm in CHP are the price at which it can sell surplus electricity to the grid, the charge that is made for a stand-by facility which allows the firm to draw electricity from the grid, and the price it would have to pay for the electricity and fuel if purchased separately. Here, the pricing policies of the utility are crucial. As noted earlier, with average cost pricing of electricity, if the average cost is lower than the marginal cost, CHP systems will be at an immediate disadvantage, since they will compete at the margin with a price which is in effect subsidised by intra-marginal consumers. Conversely, if marginal cost is lower than average cost, this will confer an advantage to CHP. If firms only get a price for their surplus electricity which reflects short-run marginal costs (fuel mainly), CHP projects may get caught in a scissors effect which makes it difficult for them to pass conventional financial efficiency tests. As long as these combined heat and power projects are small and making insignificant contributions of electricity to the grid, and the ESB has excess generating capacity, it can be argued that fuel saving is the appropriate basis on which to pay for these units. However, if the sales become substantial and, overall, fairly predictable, then it is correct to say that the contributions of CHP units are allowing the deferral of expensive new generating capacity, and the price paid should reflect this fact. CHP units should also be given all of the indulgences, in terms of exemption of VAT on fuel etc., which accrue to the ESB.

Recommendations

There appear to be two requirements for the successful implementation of district heating and on-site generation of electricity and steam. One is the establishment of a team with the primary task of identifying the financial viable investment opportunities in these areas. The second is the appropriate adjustment of the decision environment such that these

Table 13.1

Proportion of self-generation as a percentage of industrial consumption.

	1974 %	1975 %
West Germany	49.0	41.9
Austria	23.5	32.2
Belgium	44.4	38.8
France	32.7	29.9
Luxembourg	40.7	45.8
U.K.	22.1	20.7
Italy	35.8	36.8
Netherlands	25.0	23.1
Denmark	8.8	9.1
Ireland	About 6	?

Source: (Fleming, 1981)

opportunities get acted upon. We have noted the pricing conditions which would "artificially" reduce investment in this area. If these are "incorrect" they need to be adjusted, either directly or indirectly. In the Netherlands, for example, once a good district heating investment has been identified, the government will guarantee that real price increases of natural gas in the order of 3% per annum will obtain throughout the life of the investment in that project. This protects the district heating investment from the impact of a fall in gas prices (the likely substitute), which would of course, in the absence of this guarantee, reduce the value of and demand for the heat provided by the district heating system. If gas prices fall below the level guaranteed, the government will pay the district heating organisation the difference between the guaranteed price and the actual price, for the equivalent energy delivered through the system in question. In Denmark, the government provides a grant of up to 25% towards the cost of transmission grids.

In Ireland, a start has been made at the IIRS to identify the most promising opportunities for on-site generation of electricity and steam. As already noted, the ESB is providing "waste" heat from its Lanesborough plant to adjacent glasshouses, and there are plans to supply up to 40,000 houses with heat from the Poolbeg and Ringsend Power Stations in Dublin. There has been an official visit, by the Minister for Energy and officials of his department, to Denmark to examine among other things, the utilisation of district heating, including combined heat and power systems.

We feel that it is now time to assign an appropriately qualified team to the task of identifying investment opportunities in this entire area and designing an incentive system that will correct for the market failure problems noted earlier. Since the IIRS is already heavily involved in this area, it would be logical to assign it this task. It should be given the tools, authority and resources to act on the conclusions of its analyses. The full spectrum of opportunities – including the use of refuse-incineration as a source of heat and/or power, the use of small gas-fired turbines in combined heat and power systems, the utilisation of "waste" heat from the Dublin-located generating units etc. – should be kept under review. In order to maximise the credibility of the analyses, it is important that they be done independently of the main agencies likely to be affected, notably the ESB and Bord Gais Eireann, although of course some of their members will be key team participants. It is as important to examine the experiences of countries such as France, which have not embraced the combined heat and power concept as fully as Scandinavian countries, as it is to look at those which have. District heating accounts for only 3% of the combined institutional, commercial and residential heating requirements in France.

We are especially impressed by the approach adopted in the Netherlands. A small team of economists and engineers at the State-funded Netherlands Energy Development Corporation (NEOM) in Sittard do continuous inventory of the nation's waste heat, identify packages of investment opportunities, and encourage their adoption. To qualify, all projects must save at least the equivalent of one million cubic metres of natural gas per year, have a positive present net worth at current interest rates, and have a payback period less than 25 years. Subsidies are available together with the price guarantee mechanism noted earlier.

In the Irish context, given that the relatively dispersed nature of buildings will give rise to high piping costs, while the short and mild winters will result in low load factors, it is especially important that investment appraisals and programme execution be properly done.

SECTION IV: OIL AND GAS

In this section we first review our pattern of oil imports, and examine strategies for reducing our vulnerability to interruptions of supply and to oscillations of price. In the following chapter we discuss prospective domestic production of oil and gas. We focus first on the financial aspects of lease terms, then analyse alternative means of allocating exploration licences, and conclude with some thoughts on state participation. In the final chapter of this section we examine the implications for the economy of an oil find.

CHAPTER 14

OIL IMPORTS

We have had very rapid growth — a compound average annual growth rate of 11.5% — in consumption in the 1960-1974 period, followed by a very slight growth over the 6 years following. Oil is still the pre-eminent source of primary energy, contributing 68% of primary energy in 1980; this compares with contributions of 74% in 1974 and 27% in 1960.

Sources of imports

In the first 6 months of 1980, Saudi Arabia and Kuwait supplied 70% of Ireland's crude petroleum imports, with Iran (26%) and Iraq (4%) providing the remainder. About 90% of both gasoline and gas oils are imported from Britain, supplied mainly from the refinery complex at Milford Haven in Wales. In this period Britain supplied 60% of fuel oil imports, with a further 20 per cent coming from France.

Thus for crude oil imports we are dependent on the countries of the Persian Gulf region, while Britain supplies the bulk of our imports of refined petroleum products. There is one refinery in Ireland, Whitegate at Whitegate, Co. Cork, which supplies less than 40% of our refinery product needs.

Prospects

In Table 14.1 can be seen the world's oil output in 1978. The U.S.S.R. is the world's largest producer, providing 18% of the output, followed by the United States with 16% and Saudi Arabia with 13%. The concern regarding future oil supplies arises primarily for the following reasons: The big industrial producers — the U.S.S.R., the United States and Canada — are longtime suppliers, and it is acknowledged that in the coming decades they will have great difficulty even maintaining current output levels; a fall in production is a more likely prospect. Among those countries with policy-constrained output, there is substantial potential for expansion, based on oil reserves, but these countries have decided for political, social and economic reasons not to increase output beyond current levels. Furthermore, the strategic significance of the Persian Gulf combines with indigenous social and political tensions within and among the countries of the area to produce a very unstable situation politically. Analysts are divided as to the extent and signifi-

Table 14.1

World oil output, 1978, millions of tons of oil equivalent (MTOE). (1)

	Quantity	% of total
Countries with Policy Constrained Output		
Saudi Arabia	415	13
Kuwait	100	3
Iran	260	8
United Arab Emirates	95	3
Iraq	125	4
Norway	20	1
Neutral Zone	25	1
Total	1,040	33
Countries with declining output because of reserve depletion		
United States	515	16
Algeria	65	2
Libya	100	3
USSR	570	18
Romania	15	-
Canada	80	3
Venezuela	110	3
Indonesia	85	3
Quatar	25	1
Oman	15	-
Australia	25	1
Total	1,605	51
Other Countries		
China	100	3
Nigeria	95	3
Mexico	65	2
United Kingdom	55	2
Argentina	20	1
Equador	10	-
Gabon	10	-
Egypt	25	1
Other	135	4
Total	515	16
Grand total	3,160	100

Notes: (1)Original data was in millions of barrels per day, converted here to millions of tons of oil equivalent per year by multiplying by 50.

Source: Central Intelligence Agency (1979).

cance of such instability. In particular, the prospective situation in Saudi Arabia is the subject of conflicting views in this regard. However it is clear that it would be unwise in the extreme to assume that the vast physical reserves which are found in the Persian Gulf region will in the future become available in the quantities which could be expected in the same circumstances from more stable regions. The revolution in Iran, followed by the Iran-Iraq war, provides a useful antidote to complacency.

Among the other countries, China, Nigeria, Mexico and the United Kingdom are the largest producers. While overall there is some potential for expansion from this group, such expansion is unlikely to be dramatic, or in cases, too long-lasting.

It is true that the rapid increase in the real price of oil on world markets, combined with oil price deregulation in the United States, has stimulated a rapid increase in exploration, and the bringing into production of previously uneconomic deposits (including secondary and tertiary recovery from existing wells). The growth in consumption has been slowed by reduced economic growth and higher prices, the latter also stimulating the use of existing alternative fuels and the search for new sources. As a consequence of these forces on supply and consumption, the Petroleum Industry Research Foundation estimates that annual U.S. oil imports will fall from 400 million tons in 1979 to 380 million tons in 1990; others project a sharper fall in imports (Parisi, 1980). In the EEC oil imports (volume) fell by 13% in 1980 compared with 1979, and it is now expected that oil imports in 1990 will be below the limit of 472 million tons per year which the community had set as the target in the period 1980-1985. In spite of these reductions in demand on world oil supplies, it is felt by most analysts that the next two decades will see continuing upward pressure on oil prices, barring a world economic depression. The magnitude of this price increase will depend primarily on the stability of supplies from the Persian Gulf Region, the extent to which new supplies (including alternatives) come on-stream over the period and the extent to which price increases and policy measures succeed in dampening growth in consumption.

It is this combination of forces which has engendered the interest in all countries in reducing dependence on oil, and especially on imports of oil.

This interest remains in spite of the recent (early 1983) fall in oil prices. The "glut" of oil is expected by the International Energy Agency to persist well into 1984 with a consequent weakening in price. However, a vigorous recovery of the global economy, combined with a supply interruption from a major producer in the Gulf region, would quickly re-assert the upward trend in real price. In Ireland we have a further reason not to be complacent. Since oil is denominated in dollars, a weakening of the punt against the dollar will increase oil prices in Irish pounds, even when it is stable in dollar terms. This has been our experience in the 1979-1982 period.

It was notable that in our discussions with officials in Dublin almost without exception they ranked reducing dependence on overseas oil supplies as the top priority of energy policy. There are 3 strategies which can be employed to this end: reduce consumption, switch to non-oil imports and increase indigenous supplies. We will consider each of these aspects in the appropriate chapters of the text. There is a complementary strategy which we consider now, namely the nurturing of diplomatic and commercial contacts with some of the oil-supplying nations. Before turning to this topic, it is as well to point out that none of the supply interruptions we have experienced since 1973 has occurred because we were precluded in any absolute sense from access to oil; at a price, oil in any quantity desired has been available. The shortages of the Spring and Summer of 1979 were a consequence of not allowing a sufficiently high price increase to attract oil in requisite quantity to Ireland; West Germany, which has no price control on energy supplies, has suffered no shortages. The shortages in 1980 and 1981 were of course a result of the tanker-drivers' strikes. Various interruptions in the ESB's supplying of electricity and in supplies of coal and bottled gas have been due mainly to labour/management disputes. In short, our energy supply problems — as opposed to price problems — have all been self-inflicted and owe nothing to the pernicious nature of OPEC or the malevolence of oil companies.

Ensuring minimum cost imports

There are two interdependent aspects to this issue which are of significance; the first is to ensure that we receive appropriate quantities of oil, while the second is to attempt to do so at minimum cost. With regard to quantity, the first and most important thing is to allow a price to be paid for the fuel which will be competitive with what alternative destinations are willing to pay. It is precisely at the time when quantities are in shortest supply and price rises are most sharp that it is necessary to resist the temptation to try to inhibit such rises through the price control mechanism. Even when such increases cannot be justified on the usual bases of increased costs etc., they should be allowed if suppliers can get higher prices elsewhere. To do otherwise is to ensure shortages at the prevailing (Irish controlled) price. Ireland's imports comprise less than 2% of EEC imports; we have no market power to exert on world oil prices.

With regard to ensuring that supplies are provided at the minimum possible costs, existing bulk purchasers — notably the ESB — should be given a free hand to draw fully on their experience, contacts and expertise in negotiating with vendors. Competitiveness in supplying oil should be encouraged; undue market concentration should be discouraged. Fortunately, in Ireland entry into the oil supply business does not appear to be unduly restricted, as evidenced by the successful launching of a couple of new companies in recent years. However this is an aspect of Irish energy policy which warrants continuous monitoring. The establishment of a State-sponsored national oil company is another strategy for ensuring minimum cost supplies which has found favour with many countries, including Ireland. We consider the specifics of the approach adopted in Ireland in more detail.

The Irish National Petroleum Corporation Ltd. (INPC)

In his address to the first meeting of the directors of the Irish National Petroleum Corporation Ltd., on July 19, 1979, the Minister for Industry, Commerce and Energy Mr Desmond O'Malley noted that the establishment of a National Oil Company "has its genesis in my firm belief that this company can and will make a significant contribution towards improving the security and continuity of supply of our most vital fuel". He observed that the company would have at least one trend working in its favour, namely "the growing desire of oil exporting countries to deal directly with consuming countries that have national oil companies of their own."

The company is not statutorily incorporated, because this would have unduly delayed the formation of INPC. However, the Minister says that "I have been preparing the ground to propose to the government the establishment of a statutory corporation to be provided with enabling powers in relation to all aspects of the oil industry". The company is expected to break-even in its activities, and to win a share of the market on its own strengths; it will not be allowed "to pass on inefficiencies in the form of higher prices, less attractive terms or whatever and retain major accounts because they happen to be another State body". It is envisaged that INPC will supply up to 30% of Irish crude oil supplies.

The company's first year of trading was quite successful, showing an operating profit of £1.7 million on a turnover of £37 million. It negotiated contracts with the Iraqi National Oil Corporation, Petromin (the Saudi Arabian State Oil Company) to supply 500,000 tons each which, if fulfilled would have provided 16% of Ireland's imports in the contract period. However, the hostilities between Iran and Iraq have interrupted supplies from the former. There is a logical desire on the part of INPC to diversify so as to include significant supplies from countries other than those in the politically volatile Persian Gulf region. However, since other purchasers think likewise, there is typically a price premium of 1-2 dollars a barrel to be paid for oil from these favoured sources. The penalty thereby incurred at the margin must be compared with the costs of providing for supply continuity by stockpiling.

If INPC is required at any stage by the government to buy relatively expensive oil, in order to ensure a diversity of supply, or to provide storage over and above what "normal" commercial considerations would warrant, these should be budgeted for separately; if they cannot be financed from Company profits, the government should subvent them directly. To do otherwise could jeopardize the commercial viability of the organization, and make it difficult to evaluate performance.

There is clear strategic advantage in securing supplies from the North Sea, and there have been discussions with the British National Oil Corporation preferential treatment in exploration licence allocations 1980 it is stated by the Chairman that: "I welcome the recent decision by the Tanaiste that one of the factors which the government will take into account in issuing exploration licences will be the availability of long-term secure supplies of crude oil to the INPC". One of the obvious quid-pro-quos in this domain would be to give the British National Oil Corporation preferential treatment in exploration lease allocations in exchange for a commitment on their part to supply oil to INPC on advantageous terms. This implies of course that there is a scarcity rent available to be collected by the Irish public from exploration companies for the privilege of drilling in selected areas under our jurisdiction. In this context, economists say that scarcity rents exist "whenever a payment to any factor owner in a particular occupation exceeds the minimum payment required to retain a factor in that use" (Gillis, 1978, p. 98). In a sense this rent is being foregone in order to secure the supplies for INPC. If this rent were not to be captured by other means, say by auctioning off the exploration licences to the highest bidder, or maximizing the amount of drilling, then it makes sense to do so by extracting an advantageous oil supply deal. We discuss below the desirability of rent capture by the public and alternative means of so doing. If rent must in fact be foregone in order to secure those "advantageous" supplies, then the returns foregone thereby should be compared with the anticipated benefits resulting from the more secure supplies.

The key rationale in our view for a trading State oil company lies in the preference which many supplying countries are said to have for country-to-country deals. The real test of this hypothesis is whether the State company does in fact get better terms, in the form of price or security of supply, than those applying to non-governmental companies. The price and quantity terms which pertain during periods of supply shortfalls and rapidly escalating prices are especially pertinent in this regard. There are other arguments for a State oil company; it

provides a nucleus of informed and expert opinion available to the government in this domain which can be useful in a small country with limited indigenous technical and commercial skills; it can ensure supplies when commercial or strategic considerations might lead other countries to favour other destinations in preference to Ireland. However, there are other approaches to acquiring expertise and ensuring against supply interruptions which may be much more cost-effective.

We favour maintaining INPC in its current capacity only as long as it fulfils the promise made at its establishment of being able to compete effectively and dispose profitably of its oil without any indulgence as to price or other terms on the part of government sponsored and private purchasers.

CHAPTER 15

PROSPECTIVE DOMESTIC PRODUCTION OF OIL AND GAS

It is symbolic of the optimism with which the prospects for a commercial discovery within Ireland's jurisdiction are periodically viewed that we include a section with this title. After a number of dry holes had been drilled on-land in the 1960s, the search moved off-shore in 1970, and the Kinsale Gas Field was discovered by Marathon and confirmed in 1973. About 33 wells were drilled off the South coast. No further commercial discoveries were made in the area, although there was a well drilled in the Seven Heads area which flowed at a rate of 1,550 barrels per day. The vision of Cork as the centre of an oil-based boom receded. Marathon's agreement expired. However, by virtue of certain clauses therein, the company retains rights to any acreage which is covered by leases granted to it during the currency of the agreement. The (generous) terms of the Marathon agreement will apply to these leaseholds even where a find it made by an entirely different company which "farms in".

In 1976 a new wave of exploration started, concentrated this time in the Fastnet area, about 90 miles south of Bantry. Again, the results were disappointing and all but Cities Service withdrew from the area. Also during this period, 4 wells were drilled off the Donegal coasts, and they too proved barren.

In 1978, 16 wells were sunk. In that year, Phillips drilled a well in the Porcupine basin off the West Coast, which tested 730 barrels per day; in 1979 British Petroleum drilled at the Northern end of the basin, and produced a flow rate of over 5,000 barrels per day. In 1980 a further drilling by BP produced a flow rate of 1,490 barrels per day. Thus of 12 wells drilled in the Porcupine, 3 have produced oil flows. However, the results of further drilling proved very disappointing, but optimism has been re-kindled by oil flows resulting from exporatory drilling in the Celtic Sea in 1983.

Allocating leases; terms and conditions

Licensing terms to pertain in Ireland for offshore oil and gas were issued in 1975 (Department of Industry and Commerce, 1975). These terms are unusual in the extent of the detail that is provided to support the logic of the approach adopted. The Department is to be commended for being so comprehensive in its treatment in this regard. For the past

few years exploration licences have been offered under the open-door policy; the Department has been willing to consider exploration proposals as they are made by the companies. In the licensing terms published in 1975 it is stated that, in considering applications, the following will be taken into account:

(1) The technical competence of the applicants.
(2) The financial resources available to them.
(3) Previous exploration and development experience, especially off-shore.
(4) Reciprocity of business opportunities in the applicants' country of origin.

Candidates may offer, *inter alia*; provision for State participation in excess of that required; commitments to establish industrial development projects; signature bonus.

An exclusive exploration licence is valid for an initial period of 6 years which may be extended a further 3 years; it is awarded for 9 years in those cases where the water in any part of the block exceeds a depth of 600 feet. At the end of the fourth year from the beginning of the license period, the licensee must surrender 50% of the licensed area. During the first 3 years of the license period the licensee must undertake a programme of exploratory surveys and drill one exploratory well.

When a commercial discovery has been established, the licensee must apply for a petroleum lease and achieve commercial production within 5 years of its issuance.

A licensing "round", whereby companies are invited to apply for exploration leases for a specified set of blocks by a particular date, was undertaken in 1975, followed by the open-door policy. A second licensing round was announced by the Minister in November 1980, whereby a total of 108 blocks in the Celtic Sea (45), the Porcupine (46), Kish (4) and Donegal Basins (6), and the Slyne Trough (7) were to be made available. Applications were invited from the middle of November 1981 and new licences were issued in 1982. The results of seismic surveys in the Celtic Sea and the Porcupine Basin, and the results of a comprehensive examination of the geology, geophysics, and geochemistry of the former were available to prospective applicants.

In announcing the 1981/82 round, the Minister stated:

> "As my intention in opening this Second Round of licensing is to promote the thorough and expeditious exploration of our continental shelf, my principal criterion for the allocation of acreage will be the extent to which companies are prepared to enter into firm geophysical and drilling commitments in respect of the blocks for which they have applied".

He envisaged separate meetings with applicant companies solely to discuss the work programmes they have offered.

The other considerations entering into the assignment of leases included technical competence, financial resources available, relevant experience, the extent to which applicants use goods and services of Irish origin, and are willing to supply crude oil on long-term contract to the Irish National Petroleum Corporation. The latter was a new criterion.

Fees payable by licensees include £200 per square kilometer and an annual rental fee of £20 up to the beginning of the fifth year when it increases to £40; each year thereafter it increases to £80.

Financial aspects of lease terms[1]

If a commercial find of oil or gas is made, the following terms — which were first outlined in 1975 — will apply:

Royalty: An output royalty, estimated as a percentage of the value of oil produced at the export point or at the point of entry into domestic consumption will be related to the average field production attained and will be assessed at the following rates:

Average Field Production Attained	Royalty Rate
Less than: 40,000 barrels/day (bb/d)	8%
40,000 bb/d	10%
100,000 bb/d	12%
225,000 bb/d	14%
350,000 bb/d	16%

The royalty rates are applicable to total production of the field. Value will be based on the price which the petroleum would realise if sold on an arm's length basis to an independent purchaser. For gas, the royalty rate will be 12½%.

The Minister may accept royalties lower than those specified if he is satisfied that production giving a fair return on investment could not otherwise be taken.

Production bonus: A single payment production bonus may be required where the output of a field averages more than 300,000 barrels per day over a 30 day period, at a rate of £1,000,000 for each complete 100,000

[1] As consequence of (very indulgent) terms entered into some decades ago, special tax and royalty terms would apply to discoveries made in the Marathon off-shore leasing area. See "Natural Gas: Background" chapter for details.

barrels of average daily output in excess of 200,000 barrels.

State participation: The State has the right to participate up to a maximum of 50% in the development and exploitation of any commercial discovery of petroleum in the licensed area. If the State decides to so participate, it will be liable for its appropriate share of development expenditures and attributable exploration costs. The State may make these payments in cash or make them from its share of the petroleum.

Taxation: In 1975, specifications relating to the manner in which expenditures on exploration, development, and plant and machinery would be treated for purposes of taxation, were issued. A tax rate has not been specified.

Capturing the rent

As noted earlier, in economics parlance, a rent is said to exist where a payment to any factor owner exceeds the minimum payment required to retain a factor in that use. Thus, in the case of oil and gas, if a company is making "normal" profits on its achievement (the minimum return required to attract the capital to the field), any return in excess of this minimum is called rent; in the case of privately owned resources this will typically be captured by the owners. For publicly owned resources, such as offshore oil and gas, the government, as trustee for the owners (the citizenry) must decide how much and in what fashion to capture the rent. Note that "normal" corporate taxation is not rent capture as such, since it applies generally and is not specific to oil and gas.

In the U.K. and Norway, the original terms applying to exploration leases called for a modest royalty on output — 12½% in the U.K. and somewhat smaller in Norway — and normal corporate taxation. Thus, collection of the rent *per se* was left to the output royalty. With the major discoveries in the North Sea and the quadrupling of oil prices in 1973/74, it became clear that under existing terms, a large portion of the rent would accrue to the companies. Two approaches to rent capture were adopted: tax on net of royalty profits additional to normal corporate taxation — called the Petroleum Revenue Tax (PRT) in the U.K. and the Special Tax in Norway — was introduced, and provision was made for government participation (up to 80% in Norway). The PRT in the U.K. is now 70%, while in Norway its equivalent is 35%.

The PRT has some provisos which limit its impact. Five million tons of oil per field, to be taken at a maximum rate of 250,000 tons every six months, are exempted. No PRT is payable on a field which earns less than a rate of 30% on the investment in the field, while this tax may not exceed 80% of the excess of income over 30% of capital invested. PRT is deductible for computing the corporation tax, so that the 30% phase out point ensures that PRT will not cause the after tax rate of return on investment to fall below about 15%.

The effects of PRT are further cushioned by what is called the capital uplift. In addition to allowing capital expenditures to be deducted, an additional percentage, (referred to as uplift) is deductible. This increase was 75% initially but in 1980 it was reduced to 35%, so that at present capital expenditures multiplied by 1.35 are deductible.

In the U.S. an output royalty of 16.66% is payable on production from off-shore leases, as is a Windfall Profits Tax (WPT) which is applied to gross revenues net of royalties, severance taxes and costs. The WPT is 30% on newly discovered oil and 70% on already discovered deposits. Finally, normal corporate income taxation, now 49%, and any relevant state and local income taxes, are applied to the residual remaining after royalties, severance taxes, WPT and other costs have been deducted from gross revenues. Drilling rights to off-shore waters in the U.S. are auctioned-off by sealed bid, so that these payments must also be included as a component of the rental payment.

The current tax and royalty provisions in the U.K., Norway and the U.S. have been applied by Spriggs (1980) to a barrel price of $36 (Table 15.1): *These do not include the returns from State participation, which can be substantial in the U.K. and Norway, or the lump-sum bid paid for drilling rights in the U.S.* The similarity of approach to rent capture in all 3 countries is striking, with an output royalty, normal corporate taxation and a special petroleum tax applied in each case.

The Irish royalty is the same as that which obtains in Norway. If the corporate tax rate is fixed at 50% – the rate to apply to oil and gas is yet to be specified – then the highest marginal rate of royalty/taxation would yield as follows in this highly simplified example:

Price	36
Costs	10
Balance	26
Royalty (16%)	5.76
Balance	20.24
Corporate Tax (50%)	10.12
Balance	10.12
Government Tax /Royalty Take	15.88 (61%)
Company Take	10.12 (39%)

Table 15.1

Illustrative examples of tax and royalty take, UK Norway and the USA, 1980

United Kingdom		Norway		USA	
Price	36.00	Price	36.00	Price	36.00
Royalty	4.50	Royalty (12%)	4.32	Royalty (16.66%)	6.00
Operating Cost	1.00	Operating Cost	2.00	Severance (3%)	0.90
Capital Recovery	1.25	Capital Recovery	2.50	All Costs	9.00
Pre-tax revenue	29.25	Pre-tax revenue	27.18	Revenue pre WPT	20.10
		Income Tax (50.8%)	13.80		
PRT		SPT			
Uplift	0.44			WPT	5.56
Taxable Income	28.81	Revenue	27.18		
PRT	20.17	Uplift	2.50		
		Taxable Base	24.68	Pre-tax Income	14.54
		SPT	8.64		
Corporation Tax					
Taxable Income	9.08			Income Tax (49%)	7.12
Corporation Tax	4.72				
		Government Take	26.76		
		Royalty	4.32	Profit	7.42
Company Profit		Income Tax	13.80		
Price	36.00	SPT	8.64		
Royalty	4.50			Government Take	19.58
Costs	2.25			Royalty	6.00
PRT	20.17	Company Net Profit	4.76	Severance	0.90
Corporation Tax	4.72			WPT	5.56
Profit	4.36	Government Take	85%	Income Tax	7.12
Government Take	29.39	Company Profit	15%		
				Company Profit	7.33
Company Profit	13%				
Government Take	87%			Government Take	73%
				Company Profit	27%
				Windfall Profits Tax:	
				Price	36.00
				Less severance	0.90
					35.10
				Exempt Base	16.55
				Taxable sum	18.55
				WPT (30%)	5.56

Source: Spriggs (1980) pp. 57, 61, 63.

In this instance the tax/royalty take will comprise 61% of net income, with the company getting 39%. If the government takes a 50% stake, it will take 50% of the net of royalty and corporate tax balance, i.e. 0.5 x 10.12 = 5.06, thereby increasing the government take to $20.94 comprising 81% of net income.

The reader will recognise that we have vastly abstracted from real-life cases by ignoring for example the timing of cash flows, while the example above is in any event conjectural, since we do not know what the applicable corporate tax rate will be. However it is clear that, in the absence of a PRT-type tax, the Irish rent capture would be significantly below that achieved by Britain, Norway and the U.S. It is in our view appropriate at this time to be in this situation, since as yet we have no commercial deposits, and the most promising areas seem to be especially difficult. However it is important to fully maintain the ability to capture that portion of the rent desired, if commercial discoveries are made in the future. There have been suggestions occasionally in the media that the first find or number of finds be given a tax holiday of some sort. We are unambiguously opposed to this notion. The rent which accrues – not the oil or gas *per se* – is the primary benefit to a nation of exploiting these resources. In addition, it is almost inevitable that political pressures to capture some of the rent will prove irresistible, producing thereby charges and counter-charges of bad faith on the one hand and exploitation on the other. The lessons of our experience with on-shore minerals policy are of course directly apropos in this regard.

As an alternative, or in addition to capturing rent by royalty, tax and state participation, it can also be done by forcing the companies to sell to a government organisation at less than market prices. This option has been eschewed – correctly so, in our view – for oil in the 1975 regulations while the Minister for Energy, Mr Colley stated in An Dail that for future gas finds a price would be paid which was comparable to and related to the going rate for natural gas discovered offshore in Northern Europe at that time. (Dail Eireann Official Report, Vol. 325 (1), December 2, 1980, p. 152). If tax/royalty/participation provisions are not sufficient to capture a significant portion of the rent, then the reduced pricing approach is an adequate second best solution. This is what has been done in the case of the Kinsale Head Gas Field. The very indulgent tax/royalty regime prevailing in this case meant that Marathon would have captured very large rents if the company were permitted to sell the gas at world market prices. By paying a much lower price, a portion of the rent is transferred from the discoverer to the purchaser. The British Gas Council used its monopoly purchasing power to achieve the same effect in the U.K.

It is preferable to capture the rent through means other than this

mechanism. Using price creates a disincentive to discoverers to continue exploration. This is so because, with a profit-sharing form of royalty, *any* field development which covers its costs from revenues will be developed, since the discoverer will cover all costs and get some share of the rent. However, if the gas price is fixed very low, it can happen that the revenues would not be sufficient to cover field development costs, although if full market-clearing prices were payable, profitable development would be possible. By the same token, once a field has been discovered, extraction of the last quantities of the deposit – which are typically the most costly to extract – can be inhibited if the price is kept below the market-clearing level. It encourages the wasteful use of the resource, by providing it to users at lower than the market clearing price; this latter will, by definition, require non-price rationing of the resource, as there will be more demand for it at the prevailing price than can be met. This difficulty can be overcome if the intermediary agency, e.g. An Bord Gais, sells the resource forward at the market clearing price, thereby capturing the rent – roughly the difference between the price they pay the company and the price charged to the consumer, net of transfer costs – and the government in turn take this rent on behalf of the resource owners (the citizenry). This is what is now being done in the U.K. with regard to natural gas where prices to consumers are being raised to market clearing levels and the government is capturing some of the rent by imposing a levy on the throughput of the Gas Council. However this is an unnecessarily cumbersome and politically difficult manner in which to capture rent; for the company it creates a dis-incentive to fully exploit the field. We strongly endorse what is apparently the current Irish policy of allowing the sale of oil and gas *ex* well (new discoveries) at world prices, and taking the rent by other means. However, if natural gas is found in the old Marathon leasing area, where it appears that the charging of a reasonable level of tax/royalty is precluded by agreement, then a "Low" price for this gas delivered on-shore should be paid.

In the NESC *Irish Minerals Policy* (Part II) Report No. 58 a strong case is made on several grounds for specifying the tax/royalty/equity terms which can be expected to obtain in the event of a mineral discovery on land. The need for doing more in this regard than is already provided in the 1975 document for off-shore oil and gas is less pressing, because the companies no doubt expect that ultimately Ireland will follow with minor modifications the pattern already set by the United Kingdom, Norway, the U.S. and the Netherlands.

If substantial commercial oil and/or gas fields are discovered, a policy issue will arise as to the extent to which the finding of additional resources is to be encouraged. The macro-economic policy implications of a substantial oil find are developed elsewhere in this volume. However, what is of relevance here is the role of rent capture in modulating the rate of exploration and therefore, presumably, discovery. In Norway, having made large discoveries, a strong conviction developed that exploitation should proceed relatively slowly, both because of the economic and social impacts of the rapid influx of large sums of money into the Norwegian economy, and also because of the inherent conservatism of sections of the population. The highest state take in Norway can amount at the margin to 97.6% of revenues net of operating and capital costs (including "normal" profits). This comprises virtually total rent capture and is consistent with a policy of slow exploration and development. The limiting case of this approach is found in the Persian Gulf, where the countries have no interest in encouraging exploration, and can therefore capture the full rent for themselves, leaving the operators with only "normal" profits. Allowing a larger rent to the companies will result in a faster rate of exploration and development.[2] It is helpful however if the citizenry clearly understand and appreciate the significance in this regard of all policy components. While a strong sentiment for a conservative development policy existed in Norway, the government simultaneously ran large budget deficits in anticipation of very substantial oil and gas revenues to follow, which caused great difficulties for policy at the macro-economic level. This comfortable form of scitzophrenia is not unfamiliar to us in Ireland.

Auction versus administrative lease allocations

We have seen that, for the licence allocations, the extent of the drilling commitment is the key criterion by which these are allocated. In effect, companies are being invited to bid against one another in the currency of drilling commitments. It has been argued that, rather than asking them to bid "indirectly" in this fasion, companies should be required to bid directly, in cash, for the privilege of an exploration licence. Other things being equal, under this latter system, the company which is willing to pay the largest amount gets the allocation. This approach — which we call the auction method — has been compared in a very comprehensive manner by Dam (1976) with the administrative allocation of leases (discretionary allocation). Many of the points which follow are drawn from Dam's analysis.

In the Irish offshore licensing terms, it is noted that this auction approach (Department of Industry and Commerce, 1975, p. 20):

> ". . . provides the possibility of immediate and large sums to the State, and to some extent, may raise less complications than

[2] However, exploration can be slowed down by limiting the number of blocks licensed and enforcing surrender and time limit provisions. All of these controls are included in the Irish system.

> other arrangements. Experience elsewhere indicates, however, that because of the gamble involved the auction system usually discounts the true value of a prospective area. It is, therefore, not being adopted. Licences will, instead, be awarded at the discretion of the Minister for Industry and Commerce."

This view only makes sense if the auction system is being depended upon exclusively as the means of rent capture. However, in the U.S., where this approach is applied, the lump-sum bid payment is combined, as we have seen, with a 16⅔% output royalty, a 49% corporate tax rate and (since 1980) the windfall profit tax (30% on "new" oil, 70% on "old" oil). The winning bid amount — called a bonus payment in the U.S. — is payable at the outset for the exploration lease; the royalty, tax and windfall payments only become payable in the event that oil or gas is discovered. On the contrary, it can be argued that the citizenry have foregone a rent — how substantial we cannot say — by not garnering what companies would have been willing to pay for the privilege of drilling in Irish waters under the existing tax/royalty/participation conditions.

Discretionary allocation

There are a number of arguments often presented in favour of discretionary allocation. These include:

(i) The funds necessarily devoted to making the advance payments under the auction system would be more usefully devoted to drilling wells.

For the major oil companies, generating the funds internally or borrowing very competitively provide no difficulties; their Irish drilling programme is a miniscule proportion of their global operation. Thus, for the type of companies involved in Irish waters, it cannot be held that bid payments *per se* will inhibit drilling.

(ii) Selectivity of choice is foregone, since the highest bidder must be awarded the licence.

This objection is invalid, since the licence issuing authority can — and typically does — reserve the right to reject bidders who are not qualified and responsible. Furthermore, drilling and other requirements such as a minimum Irish participation can be pre-specified as conditions to be complied with by winning bidders.

(iii) The winning companies may "hoard" their leases and delay undertaking drilling.

It is not clear why a company which had paid a (frequently substantial) sum for the right to drill would then sit for an indeterminate period on this investment. However, if this is thought to be a danger, as noted already, drilling requirements can be made a condition of the lease.

(iv) It will be difficult to discriminate in favour of national companies.

Dam (1976) argues that this was a key – albeit unspoken – reason for the British decision to use the discretionary allocation approach. It would not have been possible to discriminate in favour of British companies – presumably British Petroleum primarily – and still comply with the fair competition provisions of the Treaty of Rome. This argument holds with much less force in the Irish case, since we do not have a substantial indigenous private corporate sector to be indulged in this fashion. Furthermore, the State participation provisions provide for a significant involvement by the public at large.

(v) Small companies with limited access to capital will be deterred by the-often-large-front-end payments required.

This difficulty can be at least partially overcome by facilitating joint bidding and, perhaps, allowing the bid payment to be spread over a number of years. Other forms of bidding, e.g. profit-sharing or royalty bidding wherein companies compete in the magnitude of the shares offered to the state, entirely overcome the problem of inability to raise funds, but do themselves give rise to other difficulties; these are discussed by Dam (1976) and also in Crommelin and Thompson (1977) and Scott (1976).

(vi) The auction system results in less drilling than a discretionary system when the latter favours applicants who make large drilling commitments.

Under certain conditions, this will be true, since some of the rent which would have been paid to the government is "used" instead by the companies to drill wells. The government can of course specify a minimum drilling requirement to qualify as a *bona fide* bidder. There is some indication that the key constraint on drilling in the short-term at present is not the willingness or otherwise of the oil companies to do so, but rather the availability of oil rigs. If such is the case, then a minimum drilling requirement can come close to the realisable total.

If the discretionary allocation process does induce drilling in excess of what could be achieved by other means, the policy issue is the magnitude of the implied subsidy – in bid revenue foregone – in order to induce this additional activity. Dam (1976) estimated that for the U.K., at least twice as much is foregone in rental income as the companies spend on exploration.

Auction method

There are a number of arguments which can be presented in favour of the auction approach to allocating exploration licences:

(i) It generates funds for the Exchequer.

The magnitude will range from several million pounds for those few blocks with greatest perceived potential, to negligible amounts for those where expectations are close to zero. In 1976, using a sealed-bid auction, the U.S. Department of the Interior leased its first acreage in the Atlantic, off the New Jersey coast; the winning bids totalled $1.13 billion.

(ii) It helps ensure that the most efficient companies get the leases. The most efficient companies will typically be those that can pay the most for them.

(iii) It reduces the potential for favouritism or even corruption in lease allocations.

Dam (1976) points out that there is no evidence that this has been a problem in the U.K.; there is likewise no evidence whatever in Ireland to indicate that there is a problem in this regard. However, the financial stakes are so high, and the difference in value as between one block and another so great, that it will be difficult to maintain both the reality and the appearance of impartiality in lease allocations under the discretionary system as time goes on.

(iv) It reduces the potential for profit-taking by the licensees.[3]

Under the discretionary system, once a licence to a desirable block is granted, it becomes an item of value. While transfer of interest in a lease in Ireland requires written permission from the Minister, such transfers to "financial institutions with a view to procuring finance for the development of petroleum deposits will be favourably considered". The auction system tends to retain this benefit for the citizenry.

On the basis of the foregoing, we recommend that at least some of exploration leases to be granted in future years be allocated using the sealed-bid auction method. This will be especially appropriate if commercial deposits are proved and a number of adjacent blocks are in great demand. In doing so we are encouraged by the advice recently proferred to the British government by the powerful Public Accounts Committee of the House of Commons (Committee of Public Accounts, 1980; reported on in the Financial Times, October 24, 1980). The Committee urged the government to consider auctioning future offshore oil licences.

[3] It might also be a means of capturing some of the rent in the Marathon off-shore leasing area, where, as a consequence of an agreement entered Into some decades ago, the tax and royalty terms applying to any discovery in this area will be very indulgent.

The U.K. government has already instituted a system whereby, for selected blocks, companies have to make a £5 million down payment for each block. This yielded £210 million sterling from 42 blocks in the seventh round of licencing (Financial Times, December 12, 1980).

State participation and the role of a state petroleum corporation

When the State takes equity in an oil field development, a decision must be made as to whether the participation is to be financial only or also requires full technical and managerial involvement. The latter form of participation requires that the State company – probably INPC in the case of Ireland – be fully appraised of the drilling and development decisions being made. Where the State company is participating in this fashion with a number of different companies, problems of confidentiality can arise. Information concerning the plans of firms on adjoining blocks can be of great assistance to an individual company. It is difficult in practice for a State company with a limited number of skilled personnel who are dealing with the minutae of management decisions and are operating in a number of fields to maintain confidentiality about plans in each of them. However, if confidentiality is not assured, it will probably inhibit investment, as companies wait for their neighbours to provide them with additional information. This is not a problem if policy is in any event attempting to inhibit rapid development. Thus Norway could pursue a vigorous policy of technical and managerial participation through Statoil, its state oil company, without much concern regarding this implication.

If, as in the case of both Statoil and the British National Oil Company, INPC were to get involved in exploration and development on its own, the front-end cash requirements – especially for the latter – can be very substantial; development of a 500 million barrel field can involve capital costs of well over £1,000 million. Although by international standards the Kinsale Head gas field is modest, development costs amounted to £130 million, and it has been estimated that if it were to be undertaken in 1980, the cost would be double that figure (Rohan, 1980). If the State decides to participate in field development, some or all of its share of these costs can be "carried" by the private company, being paid back from the State's share of the revenues.

The following are the primary policy considerations concerning state participation.

- If participation is financial only, it is important to have the technical, financial and managerial evaluation skills available in government service to ensure that the State gets its full entitlement.
- If participation is both financial and technical, the possible inhibiting influences of the latter on future exploration and development need to be considered. This is only relevant if it is desired to encourage exploration and rapid development, and if technical involvement embraces competing companies in different fields.
- If the State company becomes itself fully involved in exploration and development, and in downstream activities – refining etc. – the front-end capital requirements will be very substantial, resulting in a deferral of net cash flow to the Exchequer.

The economic aspects of a new commercial oil/gas discovery or discoveries are discussed in a separate chapter.

CHAPTER 16

EXPLOITING INDIGENOUS OIL: ECONOMIC ASPECTS

For the world as a whole, the question of the optimal rate of extraction of exhaustible natural resources is a key issue in intertemporal resource allocation and has received widespread attention in recent years in the technical economics journals. For an individual country, which is itself large in the context of the world market for the natural resource concerned, in the sense that its actions will be sufficiently important to alter the world price of that resource, the issue of the optimal extraction rate is also critical. However the position is different for a small country, where size in the world market is insufficient to affect world market prices, regardless of its choice of extraction rate.

There is as yet no basis for estimating what Ireland's oil resources, if any, might turn out to be. However it is already clear that the size of field being speculated about in the Gulf/Atlantic Resources prospect in the Celtic Sea, while significant in relation to Irish oil consumption, is trivial in relation to the world market.

The following Table gives data for the non-Communist world's consumption and supply balance for oil products in 1980.

World Oil Supply and Consumption in 1980 in Millions of Barrels per Day

Consumption		Supply	
U.S.A.	17.5	U.S.A.	10.3
		Europe	2.5
Europe	14.0	Other Non-OPEC	8.5
		OPEC	27.2
Other	18.0	Communist Bloc Imports	1.5
Total	48.5		50.0

The Gulf/Atlantic Resources prospect in the Celtic Sea, if it turns out to be commercial at all, might contain 250 m. barrels of recoverable oil. This would represent five days world supply. Even if the Celtic Sea resources turn out to be much larger than this, the rate of extraction would have no impact on world oil prices.

If oil is found offshore Ireland, what would be the most advantageous approach to the exploitation of the resource? In considering this question, it is important to be clear on the nature of a natural resource find in Irish circumstances. The key point to note in this regard is that the discovery of natural resources does not alter the available stock of factors of production in the economy. In effect, the discovery of natural resources is equivalent to a "discovery" of foreign exchange. Since the resources can be sold at the going world price to acquire foreign exchange, or to replace existing imports, the impact of the natural resource find is to increase the country's command over the output of other countries.

To the extent that domestic labour and capital resources are used in the extraction of the natural resource, these production factors are diverted from existing enterprises. Output in the remainder of the economy must fall, unless the factors of production drawn into natural resource extraction were hitherto unemployed.

If the natural resource discovery is used to permit a higher level of domestic expenditure than would otherwise have occurred, this may have consequences for the composition of domestic output. In particular, if consumer expenditure on non-tradable goods increases, there will have to be a reduction in the output of tradable goods. The adjustment may take the form of an alteration in the internal terms of trade and in the exchange rate, with resources being shifted out of tradables and into nontradables through a squeeze on profitability in the tradable goods sector. The experience of certain European countries which discovered natural resources and permitted consumption to rise in recent years would support the view that some such process is inevitable unless the marginal propensity to import is unity. In the latter case, all of the foreign exchange proceeds are used to buy imports and there need be no change in the pattern of domestic production. In this case also, there need be no change in the balance of supplies and demands of foreign exchange, and hence no special pressures on the exchange rate.

Before discussing the appropriate use of any Irish natural resource discovery, it is appropriate to attempt to discuss the likely macroeconomic impact. In doing this, we make the following assumptions:

(i) A field of 250 m. barrels of recoverable oil is discovered within the next year or two.
(ii) The selling price is $36 per barrel forever.
(iii) The oil is recovered evenly over a twenty year period.
(iv) Extraction costs are $10 per barrel.

The first point to stress is that, even if oil were discovered tomorrow it is unlikely to be commercially recoverable in significant quantities for several years. In addition, the oil companies would pay very little in tax in the early years of production when they would be writing off capital and exploration costs. So the Exchequer would be unlikely to derive any benefit from the oil discovery until the later years of the present decade. This has been the experience in the United Kingdom, where the Treasury had benefitted from North Sea oil only in the last couple of years, even though most of the discoveries were made in the early part of the nineteen seventies. However this phenomenon may in part be explained by the fact that, in the early years losses incurred elsewhere could be offset against profits in Britain, a practise which will not be allowed in Ireland. The assumption of an even extraction rate is unreal; in practice production tends to be greatest in the middle years of a field's life. This would be well into the next decade for any Irish discovery.

Finally the assumptions about selling prices, extraction costs and the size of the hypothesised discovery are entirely arbitrary: the purpose is purely to attempt to gauge the order of magnitude of the impact on the Irish macro economy.

The terms of the Irish system of taxation for natural resource extraction have yet to be finalised. Under the present arrangement, companies would have to pay royalties at rates around 10%, depending on the flow rate, and Corporation Tax at 50%. But this would leave the companies' share of the $26 net revenue at about $11 and the Government's share at about $15. This would be a much more advantageous share-out from the companies' viewpoint than they receive in other countries. For purposes of illustration we assume that the Governments take would be $20, which assumes in turn, that some form of addition tax is imposed.

On these assumptions, the Exchequer would benefit to the extent of about $250 m. per annum for twenty years, or $500 m. per annum if the field were exploited more quickly and were used up in just ten years.

The impact on the balance of payments, assuming that no second-round boost to imports were permitted, would be precisely the same. Of the $36 per barrel gross revenue, the oil company take and the extraction costs would be remitted abroad, assuming that mainly foreign factors of production were used in extraction, which seems reasonable. Even if some domestic factors were used, the first-round balance of payments impact would be lessened to the extent that these factors were previously employed in exporting or import subsituting activities.

In summary then, a discovery of a 250 m. barrel field in the near future would have no significant impact on the Exchequer's revenue for perhaps five or six years; thereafter, the Exchequer would benefit by about IR£200 m. per annum on average if the field were exploited over a twenty-year span. Potential benefits to the balance of payments would be of the same order of magnitude.

What is the significance of an oil find on the scale hypothesised for Irish macroeconomic policy? To begin with, it is clear that the immediate implications are small, given the likely time-scale of production and revenue receipts. On the other hand, it could be argued that the prospects of improved revenues ultimately could justify additional spending, financed by borrowing, in the interim. The following table gives data on the financial position of the Exchequer, on the balance of payments deficit, and on the foreign debt of the Exchequer and Semi-State bodies in recent years.

Exchequer position and balance of payments, 1978-1982

Year	1978	1979	1980	1981	1982
Exchequer borrowing (£m)	810	1009	1217	1832	1945 (b)
as % of GNP (a)	12.8	13.8	14.3	18.2	16.6
Foreign debt of Exchequer and Semi state bodies at end year (£m)	1391	2132	3156	5028	n.a.
Balance of payments (£m) on current account	–257	–836	–874	–1432	–980 (c)
as % of GNP (a)	– 4.1	–11.5	–10.3	– 14.3	– 8.4

(a) Based on estimate of GNP by Central Bank.
(b) Including £110m funding through private sector participation.
(c) Estimate by Central Bank.

The figures in the above table indicate that the fiscal deficit of the Exchequer has been widening steadily in recent years. The projected £200 m. per annum in additional revenue from the hypothesised oil discovery would amount to only about one-third of the current Budget deficit incurred in 1980. Similarly the large balance of payments deficit occurring in 1981 is over seven times the potential foreign exchange earnings from the hypothesised discovery.

The implication is that the discovery of a field of the size assumed would not be enough to reduce either the Exchequer borrowing requirement or the balance of payments deficit to levels which would permit a rise in consumption. Only if a much larger discovery was made would there be significant scope for the adoption of expansionary fiscal policies. For example, to eliminate the balance of payments deficit on current account would require the discovery of an oil field of 1,700 m. barrels, which would be a very large field. Even to eliminate the current Budget deficit would require the discovery of three fields of 250 m. barrels each.

Nonetheless a commercial find would ease the pressure on both the public finances and the balance of payments. The extent of whatever deflationary measures are ultimately necessary to correct present imbalances in these areas, would be reduced if oil is discovered.

However a 250 m. barrel field would amount to about six years oil consumption in Ireland and could bring the country away from total import-dependence in this area. But it is very difficult at this stage to predict whether it would be advisable to refine and use Irish oil in Ireland. This would depend to a great extent on the characteristics of the oil actually discovered which might not match, or might match only in part, Ireland's oil consumption pattern. It could be optimal to export all the product, and to continue to rely on imports for domestic consumption. Even if production were at levels as high as Ireland's oil consumption equivalent to over 110,000 barrels per day, it is likely that Ireland would be both an importer and an exporter of oil products.

CHAPTER 17

NATURAL GAS: BACKGROUND

In April 1974, Marathon confirmed that a gas field of one trillion cubic feet, or nearly 25 MTOE, had been discovered twenty seven miles south east of the Old Head of Kinsale, in about 310 feet of water. The potential flow rate was 124 million cubic feet per day or 1.1 MTOE per year, for an estimated twenty year life. The reserves were reestimated in 1981 to hold 1.35 trillion cubic feet, or 33 MTOE, i.e. an additional 35 per cent.

The initial discovery brought about a totally new situation for Ireland rendered the more challenging by the fact that the existing market for all gas (LPG and town gas) in Ireland, was but 0.2 MTOE per year. Legislation[1] requires that all petroleum discovered be vested in the Minister for Industry and Commerce. Apart from this requirement, it is fair to say that there were virtually no procedures or precedents for the Department to follow and little independent expertise to draw on, except from abroad. In the course of deciding what to do with the discovery, the Department needed first of all to have an assessment of the potential markets for natural gas in Ireland in both medium and long term. This would enable it, secondly, to enter into negotiations with Marathon on the terms for developing the field, namely on the quantities, price and timing of gas deliveries on shore. Thirdly the Department needed to establish some means, possibly through a state agency, to enable the state to have a say in certain matters and facilitate the capture of the profits or rent for the nation.

Assessment of potential markets in the mid 1970s

In the event, the first task proved difficult. Expertise was perhaps not readily available to do an economic investment appraisal of potential markets. A few partial analyses were carried out.[2,3] Circumstances for

[1] The Petroleum and Other Minerals Development Act, 1960 and the Continental Shelf Act 1968.

[2] Bunyan, Richard J. (1974). Ireland and natural gas. United Dominions Trust (Ireland) Ltd.

[3] Gowran, C. et al (1976). Parameters affecting the economies of the manufacture of ammonia from natural gas. Natural Gas Processing and Utilisation Conference. The Institution of Chemical Engineers, Dublin.

a concentrated appraisal were unfavourable, being the time when the full brunt of the 1973/4 oil crisis was being felt by an understaffed Department. Official energy data was found to be an unsure basis for estimating future demand. Future energy prices and supply appeared uncertain. One way to bypass this task would have been for the Department to auction the gas so that the potential markets and their characteristics would have made themselves known. However, even this approach might have been unsatisfactory since one of the potentially large customers, the Dublin Gas Company, apparently showed little interest in natural gas at the time.

Two markets were identified in two semi-State bodies, NET and the ESB. The proposal to allocate some of the gas to NET's proposed ammonia plant met with general approval on the strategic ground that an indigenous supply of fertilisers would be beneficial and because natural gas was deemed the best feedstock for ammonia production since prices of alternative feedstocks, namely of fuel oil and especially of naphtha, had risen sharply. With debts estimated at £190m, and with hidden subsidies in the price paid by NET for the natural gas, there is now justifiable questioning of the rationale for the allocation of Kinsale gas to NET.

The ESB, finding itself dependent on oil for 80% of its electricity generated in 1973/4, welcomed the prospect of diversifying into natural gas. The decision to allocate a large share of the gas to the ESB met with criticism from the outset. Many of the criticisms rested on technical grounds rather than economic grounds. It was widely stated (e.g. Bunyan 1974) that more useful heat could be obtained from the gas by piping it directly to consumers than by converting it to electricity for distribution to consumers. The difference is not just marginal. Allowing for all stages including the efficiency of the end user's appliance, the useful heat obtained by distributing the gas would be greater by a factor of about two. The useful heat that might be saved would amount to 0.2 MTOE per year, that is about 80 million therms or 2.3 GWH. The economic argument, which would need to take into account all the costs incurred in these two options, could not be made at this time as there was no agreed estimate of the costs of installing a pipeline and of other associated costs for distributing the gas in Dublin, its major potential market.

The ESB embarked on a programme of building gas-fired generating stations at Marina and Aghada, which totalled 390 MW of steam plant and 345 MW of combustion turbines when completed in 1982. Further gas plant is under construction at North Wall, Poolbeg and Marina.

Negotiations with Marathon

The Electricity Supply Board and Nitrigin Eireann Teoranta, both

having had some experience of large scale commercial projects, and, as we saw, having an interest in purchasing natural gas, were to act as negotiators with Marathon prior to the setting up of a state agency, Bord Gais Eireann. Marathon's original licensing agreement required that they pay a 12½% royalty and a special rate of Corporation Tax which works out at an effective rate of 30%. The ESB and NET were to aim to recover by means of the gas price some of what was foregone in the Marathon Agreement and were to act under the Department's instructions. These two bodies were capable of taking up large quantities of gas in the space of a few years – the time it would take to build their respective plants. It appears that a quick take up of gas was desired in the belief that any present benefits are better than delayed benefits. Even today we hear echoes of the view that a ready market needed to be found, as in the report (p. 67) on NET by the Oireachtas Joint Committee on State sponsored Bodies (1981): ". . . according to NET, without State equity there would be no Marino Point and hence *no market for the gas*", (our emphasis). However, unless there were unusual factors influencing Marathon's financial position one would expect Marathon to favour equally various time profiles of payment for their outlay, provided that their real discounted present values were equivalent and due consideration was taken of factors such as risk. As we will see when we discuss the theory of resource depletion, it is usually in cases where the rent or market price of the resource is expected to rise slowly or not at all that fast depletion may be desirable.

At an estimated 4 or 5 pence per therm the price negotiated with Marathon was roughly on a par with the "average" price of internationally traded gas[4] in 1975 of about 4.75 pence. We understand that there is a price escalation clause in the contract which enables a portion of the price to rise or fall in line with traded oil prices. With large oil price rises, this portion would take on a bigger share so that the gas price rises would eventually approach oil price rises. However, the base price was well below oil prices. OPEC's intention is that gas prices should be on a level with those of crude oil, on an energy equivalent basis, so that in relation to new trading contracts, the price of Kinsale gas is low. What is really at issue, however, is at what stage does the State garner the rent and how much does Marathon retain. This latter point will be discussed later.

The contract quantities were 124 million cubic feet per day (mcfd), or some 450 million therms per year, for twenty years. In 1984 the contract quantities will rise to 670 million therms in response to the reestimation of reserves. The flow however is flexible and can be

[4] Segal, J. and Niering Jr., F.E. (1980). Special report on world natural gas pricing. Petroleum Economist, Vol. XLVII No. 9, Sept.

increased three or fourfold, with corresponding curtailment of the life of the field. Some 52 mcfd or 190m therms per year were allocated to NET. A minimum of 72 mcfd or 260m therms per year was allocated to the ESB. Later some 5 mcfd from the ESB's allocation were made available to the Cork Gas Company. Further amounts are to be made available for industry and Dublin Gas.

The towngas industry

In 1977 the Dublin Gas Company asked the Minister for an allocation of Kinsale Gas. The Minister, Mr O'Malley, appointed an Interdepartmental Committee which concluded in an unpublished report that the

> "use of natural gas for base load electricity generation may not be the best use for natural gas and alternative uses should therefore be actively sought. However subject to provision for interruptibility, the use of natural gas for base load electricity generation is likely to continue for some considerable time. On the other hand, the use of natural gas for "peak shaving" electricity generation would be generally regarded as a prime use for the gas.[5]

However, the report did not consider the use of natural gas by the Dublin Gas Company to be a reasonable financial proposition. The Minister also announced that, owing to his concern about the future of the town gas industry, he proposed to arrange a review of its operations.

The resulting Towngas Review Body, in an unpublished report recognised that the fate of several towngas industries hinged to some extent on decisions relating to Dublin Gas. The towngas industry, consisting of some 8 towngas undertakings based mainly on naphtha feedstock, was facing severe problems. The price of naphtha had risen faster than oil products in general and the industry had to be indirectly subsidised by the government. Dublin Gas for example, supplying some 90% of towngas sales (outside of Cork), has had subsidies paid on its gas sales, starting at £0.7 million in 1975, rising to £4.34 million in 1979, £3.6 million in 1980 and £3.3 million in 1981. In addition the company has suffered losses. Similarly the Limerick Gas Company requires a subsidy of about half a million pounds. The Town Gas Review Committee's unpublished report, summarised in a press release of May 1980,[6] concluded that neither the technical nor organisational conditions were met by Dublin Gas, among other towngas industries, for it

[5] Department of Industry, Commerce and Energy 1978. Press Release: Report of Inter-Departmental Committee on Allocation of Kinsale Head Gas, 10 April.

[6] Department of Energy 1980. Press Release: Town Gas Industry Review Committee, Summary of main conclusions, 12 May.

to qualify for an allocation of natural gas. However, it made suggestions for rectifying these shortcomings including the engagement of consultants, to monitor progress on an agreed programme of reform and adaptation. The Committee's report also included a financial analysis of the proposal to pipe Kinsale Gas to Dublin. While tentative and preliminary, it indicated a positive rate of return could emerge, assuming gas sales to increase fourfold in ten years and assuming reforms and cost reductions were achieved by the Dublin Gas Company.

The consultants, Consumer's Gas of Toronto, reported in August of 1980 that Dublin Gas would be capable of improving its performance sufficiently to justify a supply of natural gas. Marked changes in the pattern of management control and management/labour relations would be needed and were specified in some detail.

Meanwhile in June 1980, Mr Colley, the Minister for Energy confirmed that the Republic would be willing to offer a supply of gas from Kinsale to Northern Ireland. He envisaged that this link might form part of an energy strategy in the context of this island and indeed of the EEC, with the possibility of linking up to the European gas and electricity networks.

The Cork/Dublin pipeline was completed in December of 1982 at a cost of £30 million.

Before concluding this account of recent policy in relation to gas we will outline the establishment of the State Agency, Bord Gais Eireann (BGE).

Establishment of the State Agency Bord Gais Eireann

BGE was established under the Gas Act 1976.

> "to develop and maintain a system for the supply of natural gas being a system which is both economical and efficient and which appears to the Board to be requisite for the time being". (Section 8(1)).

Ministerial approval must be given for the construction of a pipeline and the export of gas. The Minister may also give general directives as to pricing policy or the financial objectives of the Board. However it is stated subsequently that:

> "nothing in this section shall be construed as enabling the Minister to exercise any power or control in relation to a price to be charged by the Board in a particular case". (Section 11 (4)).

The Minister can also direct that the profits of the Board be paid to the Exchequer or for other purposes. The Act does not seem to require that all gas extracted from areas under Irish jurisdiction be sold to or through BGE, while in the offshore licensing terms issued by the Department of Industry and Commerce in 1975 it states only that:

> "any contract, including the parties thereto and the terms thereof, for the sale of gas whether liquefied or not must receive the prior approval of the Minister." (p. 44).

It appears then that while the Minister must approve the contract, he does not control individual price agreements. However, in 1978 the Minister issued guidelines on pricing.[7]

> "Natural gas should in general be allocated on the basis of commercial procedures and principles and other things being equal, on the basis of market prices . . .
> the pricing arrangements with the ESB in relation to its allocation of natural gas should be reviewed as soon as possible with a view to determining what would be an appropriate energy related price. The consideration of the price to be charged to the Cork Gas Company should also take into account its energy related value."

By contrast, BGE's Annual Report for 1979 contained the statement "The Board's pricing arrangements remained unchanged in 1979 and as a result a loss of £2,364,479 was incurred". The 1980 report appeared to herald in a new pricing era with the statement "The Board's pricing policy is in general energy-related and reflects movements in the price of hydrocarbons". We must assume that this policy is only implemented with new customers, for in 1981 we read:

> "At present our single largest customer is the Electricity Supply Board which accounts for 75 per cent of turnover. The approved revised pricing arrangement for the sale of natural gas to the Electricity Supply Board was in operation for the full year. This is based on the average cost of the basket of fuels used by the Electricity Supply Board and is escalated in line with the price movements of those fuels and currency fluctuations on the same basis as the Board's agreement with Marathon. Under this formula the price is less than the comparable fuel cost and was designed to enable the Electricity Supply Board to recoup the additional capital and operating costs involved in the location of the gas-fired generating facilities at Aghada and Marina.
>
> The Electricity Supply Board has estimated that natural gas is substituting for imported fuels to a value of £147 million in 1981. This compares with the cost to the Electricity Supply Board of natural gas during 1981 of £37 million"

[7] As in note 6.

and

> "Sales to Nitrigin Eireann Teoranta continue to be at cost plus a transmission charge to cover costs of supply."

While the Minister had conceded in his 1978 guideline that

> "Consideration of national interest may, however, occasionally warrant a price less than the optimal commercial price"

it appears that the "occasional" exception, at 95 per cent of sales, is more widespread than the rule. We have seen no attempt to show the value to the national interest which allegedly ensues. The use of market prices not having been established at the outset, there is clearly resistance to their introduction later.

By the end of 1982 BGE will have laid 200 miles of pipeline. In 1977 the Board completed a transmission system from the offtake point of Kinsale gas at Inch to the ESB station at Marina in Cork City and a spurline to supply NET at Marino Point. In 1979 a spur pipeline was constructed to the ESB station at Aghada. BGE's initial customers were the ESB, NET and Cork Gas Company who were established as future purchasers of Kinsale Gas before BGE's formation. However, since the Minister's directive of 1978 that alternatives to the use of gas in electricity generation be sought by BGE, over fifteen new customers have been identified. In 1979 spur pipelines were constructed to the IDA industrial estate at Little Island and the Mahon Peninsula. In 1980 the pipeline to the Cork Gas Company works in Cork City was completed, initial supplies of gas being delivered in November and a further extension of the pipeline to Ringaskiddy was laid to supply Irish Steel and the IDA industrial estate. During 1981 and 1982 the Cork to Dublin pipeline was constructed with a City Pipeline connecting the Dublin Gas Company and the ESB at Poolbeg and North Wall.

This brings us to the present and completes our sketch of policy in relation to gas over the last decade. To conclude, there appears now to be an open mind on gas allocation, natural gas being recognised as

> "too valuable a resource to allow past decisions to stand regardless of the cost incurred in present circumstances or regardless of the opportunities missed by failure to alter those allocations" (Dr M. O'Donoghue).

However the widespread implementation of stated pricing policy has yet to occur. We will now turn to the theory which should guide gas depletion and allocation decisions.

Guidelines for natural gas depletion and allocation

The objective of policy relating to gas is to maximise the benefits to the nation. Broadly speaking most economic benefit is achieved by depleting and allocating the gas in such a way that the rent is maximised, subject to consumers' willingness to pay. Before defining the term "rent" we should add that while political, social and other criteria will frequently be applied, such as job creation or reduction of dependence on oil, their application should ideally be compared with the application of the economic criterion. This will enable the political or social objectives to be costed in terms of rent foregone, and might reveal that the proposal is an expensive way to achieve these objectives compared with other ways, including ways which might not involve natural gas.

Definition of the term "rent"

Any increment which a resource can earn over and above what it must earn in order to be available is commonly called "rent" – or "economic rent" to give it its full title. This differs from the everyday usage of the word "rent".

In the case of Kinsale Gas which in 1981 Marathon delivered onshore to BGE at an estimated 6.5 pence per therm any price for which it would be sold over and above this, net of "normal" profits and transport costs including distribution and administration costs etc., is rent. This rent could be zero if the gas earns only enough to cover normal profits, the onshore delivery price and the transport costs, or indeed negative if it did not cover these costs. In the latter case it would not pay to use the gas. In other contexts, instead of "rent", the term "net price", "profit", "surplus" or "resource savings" is used. The savings referred to would be the saving in what the nation pays in total for its fuel through using gas. We use the word rent which has a disadvantage of being economists' jargon but has the advantage of covering all these terms. It applies regardless of who receives the rent, that is regardless of whether it materialises as a profit to the owner and/or distributor or as a saving to the final purchaser. Rent is simply the earnings the gas could make when all the costs of getting it to the customer have been subtracted.

All other things being equal, allocating the gas in such a way that the rent is maximised ensures that the nation derives most benefit from the resource.

If we could ignore the costs of making gas available, that is the pipeline and other distribution costs, rents would be maximised by distributing gas to substitute for the more expensive fuels, that is as a substitute for electricity, for towngas made from naphtha, for LPG and so on, the so-called premium markets. When these markets have

been exploited it would pay to substitute the remaining gas for the bulk fuels, including fuels for electricity generation.

The Kinsale field, however, is some distance away from the premium markets, so that pipeline and other distribution costs are a deciding factor. Indeed these costs could theoretically be so high as to render negative the rent from sales to the premium market, in which case the nation would lose on the project. Rather than proceed with an overall loss-making project, the nation would be better off flaring the gas into the sky. This would be a cheaper way of wasting it – better still, of course, to leave it in the ground. Alternatively these costs could reduce the rent to less than the rent from the bulk markets. In this case the bulk markets should get priority, provided that the rent they create is positive and greater than in any alternative proposal.

It is obvious then than an investigation of the pipeline and distribution costs is a primary requirement in an analysis of gas allocation. The potential rents for each feasible option should be calculated by subtracting the total costs of making gas available from the sum consumers would pay, which will be influenced by the cost of the fuel being substituted. The rents can then be compared and the combination of allocations bringing in the highest total rent should be adopted.

Who should receive the rent?

The question arises: who should receive this rent? It is a considerable sum of money. For example in the case of gas used for electricity generation in Cork, the total rent in 1981 (ignoring the question of who received it) might have been some 21 pence per therm. This figure arises because in the absence of gas the ESB would have bought fuel oil at say 30 pence and gas oil at 46 pence, but it only cost about 9 pence to deliver gas to the ESB. This is what it must fetch to cover 6.5 pence to Marathon and some 2.5 pence transport costs. So the rent in the ESB's 1981 consumption alone was some £63 million (i.e. 21 pence x 300m therms, the latter figure being a compromise of conflicting estimates of the ESB's consumption in 1981). This rent could materialise as lower prices for electricity consumers, or as higher pay to the ESB workforce or higher ESB profits perhaps to be invested in electricity infrastructure, or as a higher profit to BGE, the state's gas agency. Alternatively the rent could accrue to the Irish government to spend in some optimal manner which could include tax reduction. It could also materialise as some combination of these, and probably does. These possible destinations for the rent will be discussed in turn.

If the rent materialises as lower prices to electricity consumers, this has the undesirable distributional effect that consumers of large amounts of electricity receive more rent than consumers of small amounts. This effect is additional to other factors such as over-consumption outlined in the section on Pricing in Chapter 1. We estimate that electricity consumers actually do receive some of the rent, perhaps to the extent of a 6% reduction in electricity prices in 1980 and at least 10% reduction in 1981.

If the rent materialises as higher profits for the ESB or higher pay to the workforce this too can be criticised on distribution grounds. One cannot argue that the benefits from this national asset should accrue to such a restricted group. There would also be problems arising from demands for parity in other industries which could not afford to pay, with consequent reduction in employment perhaps.

It might be argued that BGE should receive the rent to spend on building gas distribution infrastructure. Indeed gas projects which promise a good return on investment should be undertaken. However, if the rent were earmarked exclusively for gas projects this could give rise to gas projects with low return being implemented. Meanwhile non-gas projects which promise a higher return might be unable to find finance. In the unlikely event that BGE were allowed to retain large profits, it would be preferable to have no restriction on the sectors in which they could invest.

In general, the following procedures would help to capture the rent for the nation as a whole. Assuming that options yielding high rents have been identified, the price that BGE charges for delivered gas should be related to that of the alternative fuel which would have been used in the absence of gas. This may earn large profits for BGE. To ensure that a proportion is returned to the resource owners namely the citizenry, means for transferring it to the government must be applied. There are various ways to do this. Current legislation enables the Minister to acquire the surplus from time to time. In Britain, it is proposed to put this on a regular basis by way of a gas levy on the throughput of the British Gas Corporation increasing from 1 penny sterling per therm in 1981 to 5 pence per therm in 1983. This has the disadvantage however of not being necessarily related to the surplus. We would consider that the various methods need to be discussed in order to identify a method which is appropriate to Ireland's case at present.

The question also arises as to whether Marathon or future exploration companies should receive a proportion of the rent. At 6.5p per therm in 1981, Marathon would receive some £30 million (shortly rising to £45 million) per year for the contracted minimum quantity of 450 million (rising to 670 million) therms per year over 20 years. The present value of this stream at 5% real discount is roughly £550 million. It will vary with oil prices since Marathon's selling price is linked to oil prices. Out of this Marathon must pay the costs of exploration and development, a 12½% royalty and current extraction-

costs, and their profits are subject to the special 30% rate of Corporation Profits Tax. Exploration and development costs may have amounted to £150 million in the mid seventies. This is their major expense which suggests that Marathon is receiving a part of the rent. There are many factors to be taken into account in negotiations with exploration companies, but basically they need to receive a "normal" return on their capital and, in order to explore in Ireland's territory, the expected return must be as good as elsewhere. This imposes a lower limit on the overall terms to be agreed. The world price of gas, at which Ireland could import gas, imposes an upper limit. Negotiations occur within these limits, but anything above the lower limit, taking into account taxes, expenses and so on is rent for the exploration company.

Methodology

Different options for allocating the gas will have different time profiles. In some options, such as allocation to a premium market, the rent may not materialise for many years if it takes a long time to build up the market and construct a transmission grid. Rent from the bulk markets, though lower, can occur sooner. Discounting puts the options onto the same footing for comparative purposes, and the best option or combination can be chosen.

Consideration of the choice whether to accept a low bulk rent now or a high premium rent in later years leads us to the conditions for maximising rent. If the resource is extracted and sold now the rent obtained can be invested. If the resource is left under the sea bed the return on investment of the rent is foregone, but this may be surpassed by the rise in rent resulting from the higher price in future years. So, the return on extracting and selling is the rate of interest. The return on leaving it in the ground is the appreciation in rent. If rent appreciation exceeds the rate of interest, the resource owner should delay extraction. If the rate of interest exceeds rent appreciation he should shift extraction to the present, and continue to do so until there is no longer any advantage in doing so, that is until the rate of rent appreciation equals the rate of interest (or discount).[8] Obviously

[8] A resource owner is then said to be in equilibrium, namely when $\frac{dp}{dt} = i$, where $\frac{dp}{dt}$ is the expected rate of rent appreciation and i is the discount rate. When this condition holds, the resource owner is maximising the present value of the rent. When $\frac{dp}{dt} > i$, a higher rent is obtained by shifting extraction from the present to the future, and when, $\frac{dp}{dt} < i$, increasing current extraction at the expense of future extraction will enhance the rent. This will be recognised as an exercise in portfolio selection on behalf of the Irish people. The choice is whether to hold assets in the form of resources under the ground or, by extracting and selling them, in the form of money to be exchanged for other assets or current goods and services.

this applies not only to the choice between markets, such as between the bulk market now and the premium market later, but also to the choice within markets, that is between supplying the bulk market now and the bulk market later, for example.

At this point we might mention that in a democracy, politicians may have difficulty in resisting popular pressures to realise benefits at the earliest possible moment. This underlines the need to dispel misinformed opinion by promoting a clearer understanding of the tradeoffs.

What we have given is a highly idealised view of the resource extraction, timing and allocation decision. It appears however to have been applied in several instances. When British natural gas first came on stream, it was considered (Posner 1967) appropriate to extract quite heavily and to supply the bulk market to a high degree in order to earn the rent soon. A less peaked daily demand profile would also have been a factor. It is clear that in 1967 energy price changes were not a consideration. In addition a fairly high test discount rate of 10% was being recommended, despite the fact that real long term rates of interest were perhaps half this figure. Both these factors would favour faster extraction. Similarly in the case of Middle Eastern oil production in the early 1970s, OPEC leaders would have had longer time horizons than the oil companies (who had foreseen their loss of control and therefore had high discount rates). It has been suggested that OPEC leaders were perhaps also influenced by the prevailing discussions by Forrester (1971) and Meadows (1972) of future resource shortages so that they would expect higher future price rises. Lowering of discount rates and expectations of higher prices in theory would, and in the event did, lead to a restriction in supply and, owing to OPEC's 55% share of world oil production, to a rise in price.

At present there is considerable uncertainty as to the path of energy prices. Despite recent short term movement there is some agreement that real energy prices will rise over the longer term (Petroleum Economist August 1982). The price of oil imports into Ireland have in fact risen by an average of more than 4% per year in real terms over the last three years owing to the Irish pound's decline relative to the dollar. There is less agreement on the extent of rise and on the duration, the latter being influenced by new energy finds and technical advances in existing and alternative energy sources, which in turn are influenced by price expectations. Several possible energy price rises should be tested in the analysis, which is more easily undertaken in real prices, that is, excluding inflation. Similarly, real rates of discount should be used. The use of real prices in the analysis also removes the need to convert back the results for internal rates of return into real terms, before they can be compared.

For each option, the time profile of the market and of the price that can be asked need to be estimated, along with all the costs incurred in delivering the gas to this market. The analysis should cover a significant part of the lifetime of the project. For each year the total revenue minus total costs can be calculated, giving the net cash flow which is the stream of rents to the nation. The net present value of this stream of rents and the annuity value or annual equivalent at selected discount rates can then be calculated, as well as the internal (real) rate of return, all using standard procedures.

The net cash flow or rents should be exclusive of the costs or revenues incurred in the "without" case, that is in the case where this option is not adopted.

There is one further point to discuss before we look at the options for Kinsale gas. This is the argument that since a contract has been signed with Marathon to buy a minimum quantity each year, generally speaking, annual payment amounting to £30 and later £45 millions (varying with oil prices) has to be made regardless of whether extraction is below the minimum. Therefore, immediate sales are needed to pay for this. Unusual circumstances apart, it is true that payment must be made whatever the depletion, unless a revised contract can be negotiated. However these sums of money could be earned net of costs on the sales of a mere 100-150 million therms per year in the Cork area provided customers pay a price related to that of substitute fuels. Indeed failure by the ESB, NET or any customers to pay the market price for the gas can be said to be encouraging faster depletion in order to generate funds to pay Marathon. These considerations apart, the fact that a sum of money has to be paid each year is not a reason for failing to allocate the resource in such a way that its net present value is maximised. It could possibly be better to borrow money to pay Marathon and leave the gas for later if the expected rise in energy prices or rents outweighs the interest to be paid on the money borrowed. An awareness of these issues is necessary if the nation's resources are to be exploited in a satisfactory manner.

CHAPTER 18

OPTIONS FOR KINSALE GAS

At present the main purchasers of Kinsale Gas are the ESB and NET. In addition the Cork Gas Company, Dublin Gas Company and eight other customers are now receiving gas and there is a number of prospective customers. Recent options under discussion are the piping of gas to other towns and the extension of transmission from Dublin to Belfast. There is also the option of using natural gas as a transport fuel. We will analyse the options under the five headings: electricity generation, industrial feedstock including NET's use, distribution by the Dublin Gas Company, transmission to Belfast and use as a transport fuel. While the option of distribution by Dublin Gas has now been undertaken, it is included in the analysis to illustrate some important principles.

Natural Gas for electricity generation

A minimum of 260 million therms per year have been allocated for use by the ESB. This could produce an amount of electricity equivalent to about 30% of current sales. Installed gas fired generating plant is some 720 MW or some 25% of present capacity. Over half of gas fired plant is base load. This gas burning capacity will be nearly doubled when the present conversions to Poolbeg and North Wall and additions to Marina take effect.

We need to estimate the amount of rent earned for the nation by using gas for electricity generation. Gas can be used by the ESB to replace fuel oil which as we saw above, was imported in 1981 at about 30 pence per therm. To deliver Kinsale gas to the ESB stations in Cork incurs total costs of perhaps 9 pence per therm and as we saw, rent per therm delivered to the ESB is therefore 21 pence per therm. This rent will vary more or less in line with fuel oil prices, or by slightly more because, as explained above, the price paid to Marathon will vary by less at the start.

Hydroelectricity and pumped storage apart, to generate electricity for peak demand the ESB uses combustion turbines which until recently ran only on gas oil. The 1981 import price was some 46 pence per therm. The rent from using gas for peak shaving was therefore some 37 pence per therm. Insofar as a large amount of peak electricity is sold

below marginal cost, sales are inflated and customers receive additional rent. These problems apart however, we would agree with the Minister that the use of natural gas for peak shaving represents a relatively good use for the gas.

In summary the rent gained from selling gas to the ESB in Cork in 1981 was some 21 pence per therm for base load and about 37 pence per therm for peak shaving. These rents would vary roughly in line with the prices of fuel oil and gas oil respectively.

Natural gas as industrial feedstock including use by NET

Some 190 million therms per year have been allocated as feedstock to NET's new plant at Marino Point for the production of nitrogenous fertilisers. Capacity output of the plant is 435,000 tonnes of ammonia and 310,000 tonnes of urea.

It appears that NET pays no more for the gas than the cost price. In addition NET has incurred heavy losses which would imply that this project has been producing a negative rent on the gas. However taking the situation as of now, most of the losses are incurred by the capital repayments which have to be met regardless of whether production continues or not. Such costs are the same in the 'with' and 'without' situation and can be ignored. If it can be shown that revenues more than cover variable costs and the scrap value of the plant, then rent earned by the gas arising from a decision to continue operations will be positive. The question is how does the rent compare with that in other allocations.

Before arriving at any hasty conclusions it is important to try to see if the market for fertilisers is likely to improve. If the prospects were that NET would at some future date be willing to pay a higher price, on a level with fuel oil or with the price that other prospective purchasers are willing to pay, then the outlook is brighter for this allocation.

To attempt this we need to see what is likely to happen to the determinants of fertiliser consumption. These are agricultural prices, which influence farmers' income and are in turn influenced by the effective demand for agricultural produce, and EEC policies. A second determinant is the world price of fertiliser.

Effective demand for agricultural produce, that is, demand backed up by the ability to pay, does not show signs of an imminent upsurge. Similarly, EEC agricultural pricing policy is coming under review with the stated intention of restraining artificially high agricultural prices. Meanwhile the price of fertilisers is being forced down by the excess production capacity. In their report entitled "Current Fertiliser Situation and Outlook" FAO state that "world nitrogen supply capability is expected to be greater than demand at least up to 1984/85". Their estimates for world demand and supply are summarised in the following table. We should point out that the surpluses would obviously result in lower prices.

Figures of world supply capabilities, demand and balances 1979/80-1984/85 in million metric tons N from FAO/UNIDO/World Bank working group on Fertilizers, May 1980

	1979/80	1980/1	1981/2	1982/3	1983/4	1984/5	1989/90
Ammonia							
Available for fertilizer	53.96	59.95	63.68	65.40	67.09	68.27	
Demand	53.82	56.57	59.52	62.27	65.10	67.94	
Balance	+0.15	+3.38	+4.16	+3.13	+1.99	+0.33	
Nitrogen Fertilizer							
Supply	54.35	57.14	60.50	63.87	67.17	70.37	
Demand	53.82	56.57	59.51	62.27	65.10	67.94	81.63
Balance	+0.53	+0.57	+0.98	+1.60	+2.07	+2.43	

Source: Current Fertilizer Situation and Outlook, FERT/80/3, Table 12 and 13.

In ammonia, Western Europe (not shown here) shows small deficits. The overall surplus is due to large intended capacity increases in centrally planned economies of Europe and in the USSR. For nitrogen, the situation in Western Europe reflects the world situation.

The situation in the longer term is not shown in any detail. The above table suggests a 25% increase in demand for nitrogen in the latter half of the eighties. For Western Europe the rise is forecast to be 14%. There is no discussion of the broader issues affecting fertiliser demand and it is not clear how these forecasts were obtained.

Attention is sometimes drawn to the way that other countries are dealing with the current problem of overcapacity by subsidising the price of feedstock to fertiliser producers. In some places the only alternative use for the gas is to flare it, in which case the opportunity cost is zero. Other countries again may be able to afford to use their energy resources in a suboptimal manner; in both cases, Ireland stands to benefit by importing their cheap fertilisers.

There is the argument that the increase in national security gained from having indigenous fertiliser production justifies the rent foregone. However there is a limit to the cost one is willing to pay for such strategic benefits. Given that there are now many suppliers of these products in the world the strength of the argument must have weakened. The onus is on the proponents to put a value on the benefits. If NET's net revenue on current account enables them only to pay the cost price for the gas, then the aforementioned strategic benefits currently cost some 21 pence per therm at 1981 prices in rent foregone, by reference to the ESB's allocation, or £40 million per year for NET's allocation of

gas, or about half a per cent of National Income in 1981. There may also be lower cost means of achieving security of supply, such as stockpiling or contracts.

In general, the use of natural gas as industrial feedstock would not appear to be at an advantage compared with its use as energy. Long-term conditions in the world energy market point to a rise in the price of energy, unless some unforeseen discovery or technological advance is made to enlarge supply significantly or prolonged depression decreases demand. Care must be taken not to allocate a good, whose relative price may be rising, as input to a product whose relative price may be falling. We are not ruling out the use of gas as a feedstock in certain industries. We agree with the recent review of NET (Blackwell et al) that Marino Point represents a misallocation of resources, but that, viewed from the present and ignoring past losses, a rent may be earned which would stave off closure, that is if Marino Point's current net revenue (using world prices) in 1981 was some £40m (i.e. 190m therms x 21 pence). Ideally in this event, the market price should be charged for the gas and payment of sunk costs should be explicitly subsidised. The important question raised by the Marino Point experience is why did the project not undergo ongoing economic appraisal. Serious concern had arisen during and prior to the Joint Oireachtas inquiry into State sponsored bodies in 1980 but there was no evidence of analysis of the project until the 1983 Public Capital Programme reported that an Interdepartmental Committee was analysing the options.

Natural gas for Dublin

Two years ago we undertook a preliminary analysis of the question of whether it is economic to pipe gas to Dublin. The study, given in Appendix 2, was undertaken in September 1979 prices. We outline the method and results here, updating some figures where necessary. The viability of supplying other towns can be determined on an incremental basis using a similar approach.

Ideally one should compare the costs and benefits of the option with the situation where Dublin is "without" Kinsale gas. The "without" situation could be described as the continuation of the pre-Kinsale gas situation, in which a subsidy is paid to Dublin Gas consumers, until such time when it pays the country to close Dublin Gas.

Closure of the towngas industry would entail transfer to other fuels such as electricity, LPG, gas oil, solid fuels etc. The switch to other fuels would involve the loss of convenience of towngas, namely the ease of control, saving on labour and the avoidance of storage space requirements, reordering, prepayment, ash removal and of pollution not to mention the greater choice it affords especially in terms of appliances. After closure customers would on balance pay about the same for their fuels as in the "with" case by definition, since in the "with" case, we pitched prices of gas to be competitive. Closure costs (which we ignored) might be sizeable if the Coopers and Lybrand report for the Northern Ireland Gas Employers' Board (1980) is a guide, in which closure and conversion costs were estimated at £80 million (1979 prices). In theory these closure costs should enter as negative costs in the "with" case. In this regard we can be satisfied that the net present value of our "with" situation is an underestimate.

In the appendix we show a twenty year profile of the possible streams of revenue and costs associated with the option of piping Kinsale gas to Dublin. The difference between the revenue and expenditure is the net cash flow or the stream of rents to the nation. The net present value of this stream of rents and the annual equivalent or annuity value have been calculated for selected discount rates, and the internal real rate of return is also given.

Inevitably the costs and specifications have undergone changes and will continue to do so. However the issues dealt with remain. It was thought it would be useful to present this analysis because there has not been any publicly available information on which the general reader can focus attention. The main features and results are summarised as follows.

We assumed an average real selling price some 30% to 40% lower than recent (pre-Kinsale Gas) towngas selling prices, rising at 1% per year in real terms. This would make gas competitive with other fuels, bearing in mind the features mentioned above which make it attractive. As a result we assumed that from the time of the announcement that Kinsale gas is to be piped to Dublin, sales would grow from the 1979 level of 28 million therms per annum to 100 million therms by year 16. This implies conservative annual growth rates relative to others being postulated which give 100 million therms sold in year 10.

As for the costs, we had assumed the Cork to Dublin transmission pipeline to cost £65 million at September 1979 prices which is probably double the actual outturn in real terms. We estimated capital costs incurred by the Dublin distribution network at £48 million at September 1979 prices, this is about £74 million in 1982 prices. These figures for capital costs were arrived at after reviewing the British Gas Corporation's studies of the Northern Ireland Gas Industry and of the Dublin Gas Company and after preliminary discussions with Bord Gais Eireann, the Dublin Gas Company and the Department of Energy.

The current costs of distribution within Dublin were obtained from a time-series for various years from 1968 to 1979 contained in the Dublin Gas Company accounts, expressed in real terms. We assumed a 2% per annum real rise in the price per therm paid to Marathon.

The results of this study gave the project a 14% internal real rate of

return for the base case. At September 1979 prices the net present value or rent at 5% real rate of discount was some £160 million which is equivalent to an annuity of £12 million per year for twenty years. Introducing an assumption of constant real energy prices reduced the rate of return to 12%, and the worst eventuality envisaged reduced the rate to 4%.

This suggests that the nation would receive net benefits from implementing this project, taking the twenty years as a whole. Obviously large deficits would be incurred in the initial years. However the real test of this option's worth is to compare the rent earned from allocating gas in this option compared to that in other options. Since the rent per therm in early years is negative, increasing to very high rent later we need to convert these to a form which can be readily compared with rents in other options. We might ask: what is the highest initial onshore delivery price the project can bear giving overall, say, 5% real rate of return during the next twenty years? The answer for the base case is some 24½ pence per therm or 34 pence in 1981 prices, as an initial price. The rent is this price minus Marathon's charge of 6.5 pence. This is close to the price the ESB should be willing to pay. We saw that the ESB might pay up to 30 pence per therm, the price of fuel oil, or more for peak generation. It compares very favourably with the price that NET currently pays. Taking the twenty years as a whole and given the data and assumptions used in the base case, piping the gas to Dublin is a good use for the gas.

Leaving aside the onshore price, the data can also be used to calculate the price which the Dublin Gas Company could pay for the gas, at the City gate. We can allow Dublin Gas a reasonable real return, say 5%, and ask what is the price it can pay. The answer, again for the base case, is some 31 pence per therm (or over 40 pence at 1981 prices). The difference between the 31 pence at the City gate and the 24½ pence onshore price, mentioned previously, is in fact the pipeline cost. However, unlike the highest price that can be borne, the price that Dublin Gas can bear is unaffected by varying estimates of the pipeline cost or the number of potential customers en route. What Dublin Gas can pay depends on their sales revenue and non-gas costs.

In the event, the price that Dublin Gas ought to be charged should be such as to leave no unsatisfied potential customers of BGE who would be willing to pay a higher price, or higher discounted future price. The existing deficit of the company might be a reason cited for reducing the price charged. It would however be preferable to provide financial aid, required in both the "with" and "without" natural gas situations, by other means than by lowering the price charged for gas. As outlined in Chapter 1 these same principles apply to all natural gas sales.

Since undertaking our study, the immediate prospect for energy sales has reduced and in the meantime there has been a further decline in towngas sales, reducing the initial quantities. Recent reductions in world energy prices, in so far as they reduce the price of fuels competing with Dublin Gas sales, will tend to reduce Dublin Gas selling prices. These developments imply a reduced rent from what was initially calculated. However the lower price paid to Marathon and lower capital cost of the pipeline offset this to some extent so that a sizeable rent remains.

Kinsale gas for Belfast

The issues here are complex. The ailing Northern Ireland gas industry has had its proposal to pipe North Sea gas from Scotland refused by the authorities. Part of the reason for refusal is that the proposal would require public funding and would adversely affect sales of electricity, the latter having over-capacity and having itself recently received large sums of public money. In support of the proposal it has been pointed out that closure of the gas industry will also incur costs and require public funding. Whatever the arguments, negotiations are taking place between the Northern Ireland authorities, the Department of Energy, and BGE to determine the conditions under which the Republic can supply gas, namely the price level, the timing and the quantities.

From a purely economic point of view, the Republic would be justified in supplying gas to Northern Ireland provided that the price at least covers the opportunity cost of the gas plus the relevant transport costs. The opportunity cost of the gas is what other purchasers would be willing to pay, that is an onshore delivery price in the region of 30 pence or more per therm at 1981 prices. The relevant transport costs would be any additional expenses incurred on the Cork to Dublin transmission line, which might be minor, and the cost of a transmission pipeline from Dublin to the border presumably near Newry, minus any contributions to the cost of the pipeline from sales along the route. These sales to customers en route might build up to a sizeable load so that their contributions could eventually become significant.[1]

The sale of Kinsale gas to Northern Ireland has certain attractions. Of immediate benefit to suppliers of natural gas appliances is the potential larger markets within this island if the Northern Ireland gas industry is maintained. More important is the eventual possibility of a gas transmission link-up between this island and Britain via a pipeline running between Northern Ireland and Scotland or elsewhere. This would probably be the easiest way for the Republic to have a back-up supply

[1]A discussion of the issues is given in McGurnaghan M. and Scott S. 1981, Trade and Co-operation in electricity and gas. CO-OPERATION-NORTH.

along with the other advantages of an interconnected system. It follows that agreement to pipe Kinsale gas to Northern Ireland may be encouraged by agreement to a link with Britain. To the extent that there are real quantifiable benefits the Republic might contribute to the cost of such a link. Estimates of the cost of a link with Scotland, for example, by Coopers and Lybrand and others at April 1980 prices are about £50 million, with a considerable range.

Natural gas as a transport fuel

There is some interest in the potential use of natural gas as a transport fuel. Two possibilities will be mentioned here. One is the use of natural gas to produce methanol which can be used in a 15% blend with petrol. This proposal (Glynn 1981) would involve the construction of a £59 million methanol plant (1980 prices) and certain minor modifications to cars. Since methanol leaches plastic, some plastic components in cars would have to be replaced, at a cost of less than £40 per car. This could be done when the car was being serviced. New cars could automatically have the correct components so that their adaptation is unnecessary. Reverting back to neat petrol, if desired, would require no adaptation. The blending would take place at the point of entry of petrol imports and at the refinery. After this stage the resulting blend can be used in the usual manner. The methanol would fetch a price close to the import price of petrol. Taking all the capital costs into account the author estimates the project could pay 26 pence per therm for the natural gas (or about 30 pence at 1981 prices). As the author points out this compares quite well with other options for the gas. Some 100 million therms would be used in the methanol plant the output of which however would exceed potential methanol demand in the blend market, requiring other markets to be found. This fact would caution one against this proposal until the market for the surplus is assured.

The second possibility is compressed natural gas. Here the gas is used in its original form, except that it is compressed, being sold in special refuelling stations. This proposal presupposes that there is a piped gas distribution system in existence. The non-fuel costs including operating and capital costs per therm at the point of purchase by motorists were estimated by Abram (1980) at November 1979 prices to be 14 to 20 pence per therm. At that time petrol was imported at 36 pence per therm so that the project could pay 16 to 22 pence per therm for the natural gas (21p-30p at 1981 prices), or less after piping costs have been allowed for. Vehicle conversion costs need also to be taken into account and these are considerable, being in excess of £500 per vehicle. Currently nearly a quarter of a million vehicles run on compressed natural gas in Italy, from where the above estimates were derived. With the limited availability of refuelling stations this fuel is currently best suited to vehicle fleets.

These two options are worth bearing in mind not because of their imminent applicability but because the transport fuel market has characteristics which make it promising. Its income elasticity of demand is high and its price elasticity of demand is low, even relative to other fuels. There are few alternative transport fuels. For these broad reasons these transport fuel options should be kept under review.

CHAPTER 19

CONCLUSIONS CONCERNING GAS DEPLETION AND ALLOCATION

We saw that in the first instance the aim must be to select the combination of options which yield most rent. We have argued in the section on pricing and in this chapter that on efficiency grounds the market clearing price should be charged. This leaves no unsatisfied customer willing to pay more either now or in the future (appropriately discounted). On equity grounds, the rent should accrue to the government. Naturally we would expect some divergences to occur from these broad principles but such divergences should be shown to be justified before they are accepted.

The rent is the increment which a resource can earn over and above what it must earn in order to be available. It is like a "surplus" or a "profit" additional to "normal" profits. An option earning high rents would be the supply to domestic and industrial users in the Cork area, where the gas replaces the expensive fuels: electricity, LPG, gas oil. Peak electricity generation also earns a high rent, though in so far as differential peak prices are not charged to the customer this market may be exaggerated. As far as preliminary costings inform us, a high rent is also earned by piping Kinsale gas to the Dublin market. This leads to the possibility that a number of other towns en route and along the east coast, including Belfast, are good candidates. Gas supply to the ESB for base load generation also earns a high rent. The ESB should be charged the fuel oil price so as not to encourage excessive gas use and construction of gas burning plant. There is a loss in national efficiency, both in production and consumption when underpricing occurs. Supply as feedstock to NET comes bottom of the list and the future is extremely uncertain unless, setting aside sunk costs, they can pay a price comparable to the present (or future discounted) price that other potential present (or future) options can pay.

Given the rough grading, what alterations, if any, should be made to existing allocations and what decisions should be made on potential new allocations? Obviously premium uses – defined as those paying the maximum rent – in the Cork area should be exploited to the full. Our preliminary analysis of the Cork-Dublin pipeline supported this project. There may be scope for trade with Northern Ireland, by which both sides stand to gain. The expansion to other towns en route or closeby can either be investigated on a piecemeal basis, or better, various routes and combinations of towns can be compared in order that the best one can be selected. Before the reappraisal of Kinsale reserves, there was discussion of transferring part of the ESB's allocation to other industries and Dublin (mainly the latter). In some quarters this proposal was described as "robbing Peter to pay Paul". This is indeed true, that is provided that the rents are equal and the quantities fixed. If on the other hand, one customer's willingness to pay yields a lower rent than that for the proposed customer, then the transfer would represent an improvement. Any additional sales of gas in Dublin in the medium term could yield very high rents because the incremental costs will be small. Prospective purchasers can point to high rents as support for their case for an allocation, but they then ought not to argue for a price lower than what they implied they were willing to pay. Finally, supply to NET depends on willingness to pay which will be determined by net current revenue. The strategic argument needs to be properly spelt out and quantified if it is to be used.

It is worth asking whether the increase in Kinsale reserves which came to light in 1981 should be used to increase the rate of flow over the 20 years, from 1.1 MTOE per year to 1.5 MTOE, or the length of life of the field, from 20 years to 27 years, or some combination in between. If foreseeable potential rent per therm rises on average 2 or 3% per year and if the real rate of discount is not far off these values then it is a matter of indifference as to when the gas is sold. What is important is that the highest present and future rent producing allocations should be selected and that underpricing does not occur. This is crucial. As we saw, with correct charging of customers there would be little trouble obtaining the revenue to pay Marathon. BGE's main concern therefore is to pursue allocation options which can pay well.

SECTION V: ELECTRICITY GENERATION AND NUCLEAR ENERGY

CHAPTER 20

ELECTRICITY GENERATION

In Table 20.1, annual primary energy consumption in electricity generation, by source, is listed. The heavy dependence on oil, falling in the 60-62% range over the 1973-1979 period, is notable. Moreover, this understates the significance of oil, as, on the average, the conversion of oil to electricity is more efficient than peat and coal conversion. This influence is captured in Table 20.2 where it can be seen that in 1979/80, oil-fired stations provided 65% of the units sent out, although comprising 59% of installed capacity. The hydro supply is understated in the sense that the large pumped storage facility at Turlough Hill, comprising 10% of total MW capacity, consumes more energy through the pumping process than it delivers in peak power.

There are major developments in train which will reduce sharply the proportion of oil-fired capacity. The expansions listed in Table 20.3 are planned. Thus capacity shares by fuel type in March 1982 and the expected shares in 1987/88 are as follows:

	1987/88		March 1982	
	Capacity (MW)	%	Capacity (MW)	%
Hydro	511	11	511.6	15.6
Oil	1,884	41	1,668	50.7
Peat	527.5	11	447.5	13.6
Gas[1]	730	16	645	19.6
Coal (Domestic)	60	1	15	0.4
Coal (Import)	900	20	–	–
Total	4,612.5	100	3,287.1	100

Source: Tables 20.2, 20.3 and the ESB.

Oil fired units will have fallen to 41% of capacity, with indigenous sources – hydro, peat, gas and domestic coal – contributing 39%. Of course if some or all of the gas is allocated from the ESB to Dublin consumers, then this would increase dependence on imports and reduce the indigenous share.[2] Additional flexibility is being built into the

[1] Since the table was composed, the ESB has indicated that 510 MW of oil-fired capacity at Poolbeg and 247 MW at North Wall will be converted so as to be able to burn natural gas.

[2] However, consumption of electricity would also be reduced thereby, especially peak demands.

Table 20.1

Primary energy fuel consumption in electricity generation, by fuel type, 1973-80, Ireland.

Year		Oil(1)	Coal	Peat	Hydro	Gas	Wood	Total	Total (GWH) Sales
1973	Quanity (000s TOEs)	1084	31	506	176	-	-	1797	6107
	% of total	60	2	28	10			100	-
1975	Quanity (000s TOEs)	1194	32	567	142	-	-	1935	6076
	% of total	62	2	29	7			100	
1977	Quanity (000s TOEs)	1380	23	606	204	-	-	2213	7190
	% of total	62	1	27	9			100	-
1979	Quanity (000s TOEs)	1647	31	550	215	214	-	2657	8578
	% of total	62	1	21	8	8		100	-
1980	Quanity (000s TOEs)	1454	31	555	214	420(2)	-	2674	-
	% of total	54	1	21	8	16	-	100	-

Notes: (1) The percentage shares of primary energy contributed by oil and gas understate the contribution of these fuels to electricity generation, because the average conversion efficiency for oil and gas is higher than it is for the other fuels.
(2) Estimate.

Source: Department of Energy (1981).

Table 20.2

Capacity, units sent out and costs, by source, Electricity Supply Board, 1981/82

	Hydro								
	Stations	Pumped storage	Oil	Milled peat	Sod Peat	Total peat	Coal	Gas	Total
Capacity (MW)	219	292	1668	350	97.5	447.5	15	645	3287.5
% of total	7	9	51	11	3	14	1	20	100
Units sent out	899.9	-232.5	3990.6	1204.6	187.4	1392.0	44.7	3735.9	9834.4(1)
(Millions of Kwh)	9	-2							
% of total	7		41	12	2	14	1	38	100
Costs (000s £)									
Non-capital									
Fuel	-	-	136111	31510	6353	37863	1645	56997	232615
% of total	-	-	79	10	2	12	1	8	100
Other	4309	1072	23221	14742	6090	20802	962	6921	57287
	8	3	44	27	9	36	2	7	100
Total	4309	1072	159322	46252	12443	58695	2607	63918	289933
% of total	1	1	72	13	3	17	1	8	100
Pence/unit	0.479	-	3.992	3.84	6.64	4.217	5.833	1.711	2.949
Depreciation	285	597	9291	998	17	1015	7	4287	15482
% of total	3	5	76	9	1	10	1	6	100
Total costs	4593	1670	168621	47250	12460	59710	2615	68205	305415
% of total	2	1	73	13	3	16	1	8	100
Pence/unit	0.510	-	4.225	3.922	6.649	4.290	5.850	1.826	3.106

Note: (1) Includes 3.8 million units imported into the system. The "loss" of 232.5 million units resulting from the use of the pumped storage unit have been deducted from hydro.

Source: Appendix Table A1.5

Table 20.3

Present and prospective generating capacity, ESB, 1980-89.

	Capacity	Fuel	Location
Capacity (MW) in 1980	2862.5		
1980/81	270	Gas (convertible to heavy oil)	Aghada
1981/82	170	Gas (combustion turbine)	Aghada
1982/83	85	Gas (combustion turbine)	Aghada
1982/83	40	Peat	Shannonbridge
1982/83	100	Heavy fuel oil (convertible to LPG)	North wall
1983/84	100	Heavy fuel oil (convertible to LPG)	North wall
1983/84	40	Peat	Lanesboro
1985/86	45	Coal (fluidized bed)	Arigna
1985/86	300	Coal	Moneypoint I
1986/87	300	Coal	Moneypoint II
1987/88	300	Coal	Moneypoint III
Total	4612.5		

system by designing the new units so that they can be readily converted to take other fuels. For example, the coal units at Moneypoint will be readily convertible to take heavy fuel oil, while the new combustion turbines can take gas oil or heavy fuel oil, in addition to gas.

The proportion of Ireland's primary energy consumption being converted to electricity has been growing:

	Total Primary Energy 000 TOEs	Primary Energy Converted to Electricity 000 TOEs	Electricity as % of Total
1973	7083	1797	25
1975	6787	1935	29
1977	7491	2213	30
1979	8658	2701	31

Source: Appendix Table 1 and Table 20.1.

The flexibility and cleanliness of electricity, its relatively high income elasticity and the ability of utilities to capture scale and efficiency economies, thereby maintaining price competitiveness with alternative sources, have all contributed to the increasing share of the energy consumption budget taken by electricity. However, the ability to reduce the average costs of generation by adding large units of lower cost capacity has been reversed; the new increments of capacity have tended to be more expensive than the average costs of existing units. In addition, the real growth in fuel costs and the conversion losses – the Poolbeg Station, one of the most efficient in Europe, has a 63% loss rate – are putting further pressure on electricity costs. This has been reflected in the average price paid per unit sold:

Year ended 31 March	Average Price Pence/Unit Sold (Current)	CPI	Constant Price (1968) £
1972	0.982	127.425[1]	0.771
1974	1.188	175.675	0.676
1976	2.177	221.40	0.983
1978	2.865	292.55	0.979
1979	2.797	315.775	0.886
1980	3.505	361.225	0.970
1981	4.889	431.95	1.132
1982	5.969	517.75	1.153

[1] Average of May, August, November 1971 and February 1972; similarly for the other years.

Since these prices are based on average costs, they understate the costs at the margin of expanding output. Consumers are getting the benefit of relatively low-cost capacity which has been installed in the past. This is especially true of hydro and gas capacity, as can be seen below for 1981/82 (taken from Table 20.2):

	Avg. Generation Cost/Unit Sent Out pence/unit, 1981/82	
	Non-Capital	Total
Hydro	0.479	0.510
Oil	3.979	4.225
Milled Peat	3.840	3.922
Sod	6.640	6.649
Peat (Milled and Sod)	4.217	4.290
Coal (Domestic)	5.833	5.850
Gas	1.711	1.826

The total costs listed above are derived by adding depreciation to non-capital costs.

Annual consumption of electricity has remained static over the 1979/83 period, during which generating capacity and prospective capacity in gas and coal-fired capacity has been expanded. Some commentators have questioned the wisdom of continuing the planned programme of expansion: Criticism has centred in particular on the third 300 MW coal fired set which, if installed, will bring new capacity at Moneypoint from 600 to 900 MW. If the additional coal fired unit is not built, then the electricity which it would have produced will be generated from existing oil-fired capacity. The issue can therefore be readily posed: Will the total cost of a kWh of electricity produced from this prospective coal-fired capacity be less than the *non-capital* costs of the units (kWhs) which would be produced (in its absence) from existing capacity? If the answer is yes, then expansion should proceed; if no, then it should not be built. Given the "front end" costs incurred in installing the first 600 MW at Moneypoint, it may be that the incremental costs of a further 300 MW of capacity are sufficiently low that the total costs of a unit from this source is less than the non-capital costs of a unit from existing capacity. However the choices and costs have not been posed and analysed publicly in this fashion, so that it is not possible for us to say where the national interest lies in this regard.

The pattern of ESB generated electricity consumption in selected years 1971/80 is presented in Table 20.4. The domestic sector share fell by 3% over the period, from 45 to 42%, with all of the reduction taking place in night space heating. The commercial share also dropped by 2%, falling from 22 to 20%. The industrial sector share increased, growing from 32 to 38% (the "additional" 1% is due to rounding).

There are transmission and related losses in transmitting electricity from the generating unit to the consumer. The extent of these losses can be estimated by examining the difference between units sold and units sent out. In 1979/80, there were 9644.1 million units sent out, and 8,560.3 million units sold; losses in transmission *et al*. amounted to 1083.8 million units, or 12.7% of units sold. In that year the overall thermal efficiency of conversion of primary energy to electricity was 32.9%.

Table 20.4

Consumption of Electricity Supply Board electricity, by sector, selected years, 1971–80.

Year ended March 31		Domestic			Commercial	Industrial	Total
		General supply	Night space heating	Total			
1971	Quantity	1953.5	253.2	2206.7	1082.5	1572.9	4862.1
	% of total	40	5	45	22	32	100
1973	Quantity	2226.3	307	2533.3	1231.1	1940.7	5705.1
	% of total	39	5	44	22	34	100
1975	Quantity	2393.0	256.5	2649.5	1278.2	2225.4	6153.1
	% of total	39	4	43	21	36	100
1977	Quantity	2690.7	215.0	2905.7	1384.7	2492.8	6783.2
	% of total	40	3	43	20	37	100
1979	Quantity	3207.8	195.8	3403.6	1624.1	2937.6	7965.3
	% of total	40	3	43	20	37	100
1980	Quantity	3412.1	187.6	3599.7	1722.4	3238.2	8560.3
	% of total	40	2	42	20	38	100

Source: Various Electricity Supply Board Annual Reports.

In a highly capital intensive business such as electricity generation and transmission, the very cyclical nature of consumption imposes substantial costs. There must be sufficient capacity in the system to meet demand at the peak, and also to supplement supply if a unit goes out of commission. Seasonally, in 1979/80 the weekly demand was at a minimum in August, with a consumption of close to 150 million units; it peaked in January with a consumption of over 240 million units, so that peak offtake is 60 per cent higher than the minimum. Diurnally, consumption peaks in January/February at about 1800 hours; the valley occurs at approximately 500 hours.

CHAPTER 21

ECONOMIC ASPECTS OF THE NUCLEAR ENERGY DECISION[1]

The proposal of the Electricity Supply Board to construct a nuclear power station at Carnsore Point in Co. Wexford has aroused considerable public controversy in Ireland and no Government decision on the matter has yet been made. In this section, we consider briefly the main economic issues which will have to be taken into account when that decision is ultimately addressed. These economic aspects of the decision include both general considerations about nuclear power and factors specific to Ireland.

The general considerations of most importance concern:

(a) The efficiency, i.e. production costs of nuclear as against other methods of electricity generation.
(b) The possibility of new technologies becoming available which would be viable alternatives to nuclear power, and the probable time scales involved.
(c) The availability and cost of Uranium, the ultimate raw material for nuclear electricity generation.
(d) The effects of nuclear power production on health and safety and the problems in those areas which arise in the disposal of nuclear waste.

The aspects of the decision specific to Irish circumstances include:

(e) The extent, given the lack of indigenous energy resources, to which Ireland has a choice in regard to reliance on nuclear power.
(f) The possibility of Ireland importing electricity directly, as against importing fuels for electricity generation.
(g) The problems created by the small size of Ireland's total electricity requirements relative to the minimum economic plant size for nuclear generation.
(h) The impact of a capital-intensive nuclear plant on the public capital programme and on the balance of payments deficit.

We do not propose to attempt a resolution of these complex and

[1] This chapter draws heavily on a Ford Foundation study of nuclear energy (Spurgeon *et al*).

inter-related issues here. Such an attempt, besides being beyond the scope of the present report, would also take us into areas involving ethical judgements about accident risks and possible genetic impacts of nuclear accidents. A consideration of these matters must be part of the appraisal of nuclear investments in Ireland, but it would be beyond our competence and we leave it to others.

We begin with a discussion of the general issues raised by nuclear electricity generation. The first of these is production costs.

Given that the impetus for the construction of nuclear power plants worldwide has been a desire to diversify away from reliance on oil-fired capacity, the relevant comparison of production costs is between nuclear plant and coal-fired plant, since these are the only practical alternatives to oil. The lead time on nuclear capacity is of the order of ten years. The useful life-span of the modern generation of nuclear plant would be of the order of thirty years. Thus the prediction of likely cost structures for nuclear electricity generation would involve predictions of fuel and other costs over a horizon of up to forty years.

In the light of the substantial variations, both in absolute and relative fuel costs, which have occurred in recent decades, these predictions are extremely hazardous. Small variations in fuel costs sustained over such a long period would be enough to shift the cost advantage in favour of one fuel source against another. At present, there appears to be no objective basis for predicting fuel costs over such a long time period.

Capital charges represent a larger proportion of total costs for nuclear plants than for coal plants. While the proportion varies, figures around 70% have been quoted. For coal, the proportion attributable to capital charges can be less than one half, depending on the amount of ancillary investment in transport facilities which is required. Transport facilities are much less of a factor in nuclear plants.

But there is a substantial uncertainty also regarding future capital costs. In the case of both coal and nuclear plants, future regulatory arrangements for environmental protection will impact strongly on capital cost. The pace of technological change is also rapid and unpredictable as to its impact on the cost structure.

However, the existing evidence on actual costs for coal and nuclear plant, and prospective costs for plant coming on stream in the next few years, indicates that neither fuel source is likely to enjoy a clear-cut advantage. Moreover, many of the factors which might affect production costs for one fuel would affect the production costs for the other in the same direction. There are forces at work which would serve to prevent the relative cost of electricity production from different fuel sources from diverging widely. In the limit, and notwithstanding the long lead-times in construction, there would be a corrective

switch in demand away from the dearer fuel, which would tend to reduce the relative cost divergence.

Oil, coal and nuclear fission are not the only possible options in electricity generation. The area of technological development most likely to have major impact in the longer term is nuclear fusion.

The essential economic difference between existing fission technology and fusion is that the fuel source for fusion (deuteriom) is virtually inexhaustible, and certain of the environmental problems associated with fission reactors would be less acute. However fusion technology is at a very early stage of development and commercial production, should it ever occur, will be some distance into the next century. The US Energy Research and Development Administration has estimated (in 1976) that 20 billion dollars will have to be spent before this stage is reached.

The generation of electricity by nuclear fission uses uranium as the basic fuel source. Concern has been expressed that a movement from oil-fired electricity generation into nuclear fission could ultimately run into problems of scarcity or cartelisation as has already occurred with oil.

There are important differences however. The OECD has predicted that by 1985 the geographical breakdown of non-Communist world uranium production will be as follows:

	%
United States	46
South Africa	16
Canada	13
Niger Republic	7
Australia	6
France	4
Others	8

The US share in world oil output, by comparison, is only 20%. The breakdown of supplier countries makes cartelisation less likely. In addition, total world supplies are thought to exceed existing proven reserves by a large margin.

Uranium extraction is an infant industry by comparison with coal mining or oil production. No significant world market existed until the expansion of nuclear power production in the mid-seventies. Accordingly, there has been no incentive for producing companies to explore for reserves.

For these reasons, estimates of likely world uranium reserves are more speculative than in the case of oil or coal. But recent assessments suggest that there is no prospect of any absolute supply constraints emerging over the lifetime of nuclear power plants currently at the planning stage.

The production, processing and ultimate disposal of uranium and its by-products involves radiation and other hazards. These hazards arise both because of routine emissions and accidents.

The risks from routine emissions arise in mining and in actual plant operation. The risks from accidents arise mainly from plant operation. As between nuclear and coal fired production, routine transport accidents are much more significant in the case of coal. In recent years, about 230 fatalities per annum have been attributed to coal-train accidents in the United States. Transport accidents for an equivalent output of electricity from nuclear fuel would be much less than this figure.

Power production from fossil fuels may have long-term adverse impacts on global climate. The thermal output of power production from whatever source contributes to the heating of the atmosphere. Fossil fuel combustion creates carbon dioxide emissions which heat the atmosphere through the greenhouse effect. The long term impact of these processes is not well understood, but could be of greater significance than the shorter-term accident risks to humans. For example, major climatic changes could adversely affect food production and animal populations, with major ultimate consequences for the human population.

The possibility of a major catastrophe at a nuclear reactor has dominated the public perception of the health and safety issues raised by the nuclear power proposal. This is but one of a number of such issues, and perhaps not the most important. To date, there has been no major catastrophe at a nuclear reactor anywhere in the world, although the experience to date does not provide sufficient experience to calibrate the risks in the future. The available evidence suggests that the probability of a reactor accident is very low, but that the consequences could be serious, comparable to natural disasters such as floods or earthquakes. Moreover, some of the consequences, both for the environment and for the human population, are likely to be long term and very difficult to assess. This uncertainty about the impact of reactor accidents, even if the probability of occurrence is very low, is itself an important element in the overall assessment of risk. Added to this are the uncertainties about the safe disposal of nuclear waste. While the record to date of nuclear waste disposal has been satisfactory, a track record of much greater length would be necessary before a proper assessment of risks could be made. Theoretical and experimental evidence on disposal risks have not to date produced a satisfactory alternative basis for decision.

The proposal to construct a nuclear plant in Ireland raises a number of specific questions. At present 64% of electricity generated in Ireland is produced from imported energy sources. In addition, 100% of Irish

electricity consumption is met from domestic production. There appears to be no prospect of increasing Irish energy output significantly in the short-term, and even if oil is discovered offshore, it may not be optimal to use it for electricity production. The proposal to meet predicted increases in electricity demand from a new fuel source (uranium) has been motivated by a desire to avoid excessive reliance on imported oil and coal, and to achieve the maximum feasible diversification in fuel sources. However, there is no imperative about following this course of action. If the nuclear option is ruled out for whatever reason, we could continue to rely on the existing fuel sources. If demand were to rise significantly, this would amount to a decision to confine the construction of new plants to coal. Given the coal supply situation, this is not an option which involves excessive foreseeable risks, although on pure diversification grounds it would be riskier than a mixture of coal and uranium. The other option would be to import electricity directly.

In the absence of problems about the security of supply, the choice between generating electricity domestically from imported fuels and importing foreign-generated electricity would reduce to a question of cost. Since there is a loss of power when electricity is transmitted over long distances, the relative transport costs of fuels would have to be set against the transmission losses and any differentials in production costs at home and abroad.

But the major argument in favour of national self-sufficiency in electricity production concerns security of supply. If satisfactory assurances could be obtained in this regard, the option of long-run importation of electricity is one which should be considered as an alternative to nuclear production.

The total electricity demand in Ireland by the time a nuclear plant is commissioned might be no more than 5 or 6 times the output of that plant, depending on demand growth in the interim and on the plant size chosen. Since nuclear plants are one-set plants, either the whole plant is producing or none of it is. Accordingly nuclear plant would have to be used for base load. This raises problems where the plant is large relative to the total generating capacity of the network, since down-time, whether due to maintenance or failure, has to be provided for. This is less of a problem with conventional multi-set plants, where sets can be taken out of source one at a time.

If a large single-set nuclear plant, accounting for 15% or more of total system capacity, were installed in the Republic of Ireland, it would be necessary to make provision for the supply of peak load when the nuclear plant is out of action. This could be done in essentially three ways:

(i) By constructing adequate standby capacity
(ii) By permitting blackouts
(iii) By arranging interconnection with another generating system.

Option (iii) would not involve long-term importation of electricity in significant quantities, but would rather permit the sharing of the costs of reserve capacity in the interconnected systems. Option (i), if it had to be followed, could make the whole proposal uneconomic in comparison with conventional fuel alternatives, while option (ii) might be deemed unacceptable, particularly in the light of the record of significant down time in the early years of operation of nuclear plant.

In any consideration of the economics of nuclear operation in Ireland, the arrangements to be made to deal with problems of alternative supply when the system is out of action should be treated as an integral part of the proposal. In particular, any capital costs incurred should be allocated to the nuclear plant itself, in so far as they can be ascribed to the provision of facilities uniquely necessitated by the introduction of the nuclear plant into the system.

At current prices, the cost of the proposed nuclear power plant would make it one of the largest single investment projects ever under taken in this country and would add substantially to the burdens of financing both the public capital programme and the balance of payments deficit during the years of construction. However these burdens would be added to by alternative investments also, and the nuclear proposal, while it would involve heavier balance of payments costs in the earlier years, would economise on fuel import bills subsequently, unless relative fuel costs move adversely.

In view of the pressure at present on both the public finances and the balance of payments, it would be desirable to ensure that all major capital investment projects in the public sector are subjected to stringent analyses of financial viability. In this regard, the nuclear proposal is no different from any other major public investment project. Financial analysis of investment projects were of course carried out routinely in the past by the Electricity Supply Board and by other semi-state bodies. However it has not been the practise to publish them, either in advance of the project's approval by Government or subsequently. This is undesirable, particularly in the case of large projects, since it inhibits the proper advance scrutiny of important allocation decisions, which moreover often involves the irreversible commitment of funds. We would recommend that all semi-state bodies, including the Electricity Supply Board, be required to publish their financial analyses of major investment proposals, and that these be submitted for comment to the Oireachtas Committee on Commercial Semi-State Bodies.

Our review of the economic issues raised by the nuclear power proposal has been brief and was not intended to draw conclusions. But we have found no grounds for ruling out the nuclear option on economic grounds and we believe that examination of the proposal should proceed as quickly as possible. Should a decision against going ahead with the Carnsore Plant be taken at this stage, the nuclear option should, given the long-term uncertainties which surround the issue, be kept open for further review at a later date.

SECTION VI: RENEWABLE ENERGY SOURCES

In this section, we outline some concepts appropos the analysis of wind power, and then touch on the topic of direct utilisation of solar power. In the following chapter we analyse the potential for energy crops (short-rotation forestry). We focus on wind and energy crops because it seems to us that these are the two sources which show the most promise of making a significant contribution to our energy supplies. However, we recognise also the potential of methane and wave power in this regard, and regret that we did not have the time to examine these in some detail.

CHAPTER 22

WIND AND DIRECT SOLAR ENERGY

Wind

Wind is a form of solar energy which arises because of differential heating of the earth's surface area. Ireland has two major advantages vis-à-vis this resource: It has more wind — judged in terms of duration and speed — than most other countries, and in the most wind-swept zones it has large, relatively unpopulated areas where wind-energy parks could be installed with little disruption. Thus, if wind-power is to make a significant contribution anywhere, we would expect that Ireland too should be able to avail of this source at a price that would be fully competitive with other fuels. Windmills of course have been used for centuries for grinding grain and pumping water. Today, the rising price of fossil fuels has increased the competitiveness of windmills once more for such uses at the level of the individual farm or enterprise. These machines typically start producing power at a windspeed of 8 mph, reach peak output at windspeeds of 24 mph, and shut-down at speeds of 60 mph. The potential contribution of such machines in rural areas in Ireland is substantial. However, the technology is not yet fully developed. The initial costs are expected to be of the order of £5,000, and the potential purchaser must balance this against the fuel savings. If we assume a machine life of 15 years and a real interest-rate of 4%, net fuel savings must amount in value to an average of £450 per annum (1981 £), or £75 per bi-monthly billing period, in order to break even on the investment.

Several countries — notably the US, Denmark, the Netherlands and West Germany — are exploring the potential of large wind-machines as major generators of electricity. A number of such machines are now in the proto-type to development stage. It seems to be generally felt that the difficulties of linking wind-energy into the national grid can be fairly readily overcome. The major difficulties yet remaining are as follows:

(i) The reliability of the existing large machines is in question. The shearing of the blades in particular seems to be an as yet unresolved problem. Given the high capital costs of the machines, and of their repair, break-downs of this nature seriously prejudice their financial viability.

(ii) The intermittent nature of the wind gives rise to the same storage problems as pertain to direct solar energy. A utility that, for example, loses its wind power contribution at a peak consumption time must have the capacity available elsewhere in the system to meet this shortfall. In the extreme case, this means that, to be financially viable, the full costs (capital and operating) of wind-energy must be equal to or below the fuel and other operating costs only of the alternatives; none of the capital costs of the latter can be off-set, because they must be incurred in order to give the necessary "back-up" capacity. The problem would be ameliorated if we can expect a fall in power from wind park A to be compensated for by continuing or increasing wind at park B. If, on the other hand, the wind tends to diminish simultaneously at all locations, then the difficulty remains. If there is substantial storage capacity in the system, such as pumped storage or excess hydro capacity, then wind power can be used to pump while it is available, and this resource can be drawn on when the wind is down. Ironically, the Netherlands, which is in a sense the cradle of wind-power, combines both of these difficulties; its topography makes pumped storage prohibitively expensive, while its size makes locational variation of wind speeds unlikely. A system which has a high percentage of generating capacity which can be brought on and off at short notice favours the utilisation of wind power. In addition to the hydro/pumped storage component noted above, gas-turbine capacity is of this type. These latter units have a relatively low capital cost but burn gas and/or light oils (which are very expensive). Thus there is a trade-off to be made in reducing the very capital intensive but relatively low-fuel cost base-load units[1] — heavy fuel oil, coal and nuclear — in favour of the flexible but high-fuel cost gas turbines, which can however be substituted for by wind power, when it is available. These issues are discussed in a report prepared for the NBST by SORL, Trinity College, Dublin titled "The Potential Contribution of Wind Power to the Irish Electricity Grid" and described by Hurley (1981).

(iii) Our data on wind is inadequate as a basis for the optimum siting of wind parks. Micro-climatic variations in Ireland are great; a few hundred yards could conceivably make the difference between a highly successful unit and a disastrous economic failure.

[1]Those units which provide power most economically when operated without interruption; costs of stopping and start-up are very high. They are therefore most suited to providing the basic minimum load which is in constant demand.

(iv) There are safety and environmental problems which are as yet unresolved. The shearing of blades would clearly be a problem in a populated area, while serious noise problems have arisen with demonstration units in the US. While these difficulties are amenable to technical solution, the intrusive impact on the land-scape of wind-energy parks probably is not. Since they will probably be located in relatively isolated areas of great beauty (Malin, Belmullet, Rosslare and Shannon were chosen as hypothetical locations in the SORL study) this will be an unavoidable difficulty.

Progress

In the US, the Southern California Edison Company has installed a 3 MW machine; it is estimated that this machine — built by Bendix Wind Power Products Company under contract from Edison — can be duplicated at a cost of $3 million ($1000/KW of capacity) and that the cost of wind power generated thereby will fall in the range of $0.13-0.10 (10p-8p) per kilowatt hour. However, this level of performance remains to be demonstrated in practice. The utility estimates that this is cheaper than current nuclear, geothermal or solar energy (reported in the New York Times, December 21, 1980, p. 36). However, it is very expensive relative to the costs of existing ESB capacity. Southern Californian Edison has invited proposals from others to supply it with windpower; the company will consider collaborating in projects in either a major or minor role. The Bonneville Power Administration, a major utility in the Northwestern US, based predominantly on hydro power, has installed a large windmill in its system. This is the ideal environment for windpower, since the storage capacity in the system is large. In addition, since the utilities in the US are interconnected and no issues of national security arise thereby, windpower can be offset to a greater extent against both capital and operating (including fuel) costs of alternatives.

In Ireland, it is estimated (by Noel (1981)) that the 120 KW (0.12 MW) unit being supplied to the ESB by the French Company Aerowatt for installation at Bellacorrick, Co. Mayo, will deliver power at a cost of 6-7p per kilowatt hour. This estimate is based on the assumption that all of the power produced can be delivered to the grid and used. This assumption does not hold in the case of communities unconnected to the national grid. In such locations, wind has the advantage that it is substituting for very high cost electricity, typically diesel generated. However this is counterbalanced by the fact that much of the energy produced by wind machines in such circumstances is "wasted", because power produced in excess of current needs cannot be transmitted to the grid, and storage is expensive. The ESB take a less optimistic view than

Noel of the likely costs of wind-generated electricity: for the four relatively small wind machines (a 10 KW, two 50 KW and one 120 KW) now being installed by the utility, it is estimated that cost per kilowatt hour produced will fall in the range of 12p to 36p. It is expected that the average cost per kilowatt hour produced by the ESB from all sources in 1983 will amount (in 1981 £) to 6.38p (Tinney, 1981).

The economic viability of wind-power as a major contributor to our electricity generating capacity depends crucially on the periodic availability of wind itself, and on our ability to design the system such that the wind contribution can substitute for capacity elsewhere. In this regard, decisions concerning nuclear power and inter-connection with the United Kingdom are important. Nuclear power is of course a contributor to the base-load; output cannot be adjusted to account for cyclical changes in the wind. An interconnector would conversely facilitate the use of wind-power, as energy could be imported when the wind-based contribution was reduced.

In 1980, the Minister for Energy initiated a demonstration programme in wind energy. This involved establishing machines of various types at different locations. The Department of Energy initiated work on eight projects, while the ESB commissioned 4 machines. A number of difficulties have arisen in getting the machines established and operational, so that there is still (March 1983) a wholly inadequate basis on which to make sound investment decisions concerning wind machines.

We strongly endorse the initiatives being taken in Ireland concerning this energy source. In addition to the developments noted above, data on wind availability is being further developed, updated and analysed. A project leader for wind energy has been seconded to the Department of Energy from the NBST.

It is important that progress be maintained, and perhaps accelerated, since there is interdependence of decisions vis-à-vis wind, nuclear power, the interconnector and perhaps utilisation of natural gas in electricity generation. At the same time it makes sense for us to wait for the technical problems to be solved before investing heavily in this source; most proponents of new technologies tend to be overly optimistic concerning cost and performance. Nevertheless, we feel that, in the case of Ireland, a measure of optimism is justified. In the Netherlands, it is expected that up to 2000 MW of wind-based capacity will be installed by the year 2000. Many Dutch experts feel that this is an unduly optimistic estimate. Tinney's (1981) estimates for Ireland support this latter view. He suggests that the wind-power contribution to electricity generation here may grow from 50 Giga-watt hours (GWh) in 1990 to 1000 GWh in the year 2000. Current (1981) total electricity demand is about 10,000 GWh, generated by 1982 MW.

Direct solar energy

Lawlor (1975) has provided an excellent overview of the potential for utilising solar energy in Ireland. With regard to solar radiation falling on the country, he finds that for a horizontal surface, about 100 kWh per square metre per year falls on the country and that the total amount of solar energy incident on the country is nearly 900 times the total consumption of primary energy in 1973. However, Ireland has a high ratio of diffuse to direct radiation which limits the potential for uses that require concentrating the power, e.g. in electricity generation. The variability in solar energy availability, due to our changeable climate and diurnal variation is another limiting factor. He concludes that the best prospects for the utilisation of direct solar energy in the short to medium term lie in the relatively low temperature applications of this energy source to space and water heating. Since Lawlor's study there has been some further evaluative work done on prototype "solar" houses which have been designed to utilise this energy source, and the Solar Energy Society of Ireland has been very active in stimulating interest and analysis in this area.

There is no national programme of research, development and demonstration in solar energy. Since the opportunities in the low level "passive" solar area appear to be quite promising, we feel that serious consideration should be given to mounting such a programme which would address the following areas:

- Passive solar energy – building design; prediction of thermal performance; demonstration
- Collectors – standards to assess performance (efficiency, durability, reliability)
- Storage – as for Collectors
- Modelling and Simulation – prediction of thermal and economic performance; design of efficient systems
- Space conditioning; hot water production – procedures for system evaluation; demonstration.

Such a programme would need to embrace ongoing work at such bodies as IIRS; UCD; TCD; UCC; College of Technology, Bolton Street; NIHE (Limerick); AFT; ESB; Cement-Roadstone Holdings Ltd.; and so on.

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CHAPTER 23

ENERGY CROPS

Ireland's soils are among the most productive in Europe for tree growth. Because of drainage conditions and levels of precipitation, many of these areas are at the same time difficult to work for agriculture, and are classified as economically marginal for farming. This advantage we have in the photosynthetic conversion of solar energy into woody plant matter raises the possibility of using this capability to provide a significant amount of our energy supplies. A wide range of research work has been initiated in the Republic of Ireland focusing on the growth and yield of different species, but also addressing wood transportation, storage and utilisation, and the use of systems analysis in examining alternatives. In Northern Ireland, research on the productivity of willow species has been pursued since 1973, and harvesting equipment is also being developed there.

At the Economic and Social Research Institute, an EEC-funded study of regional development and energy crop (short rotation forestry) production in Ireland is in progress. This involves an analysis of the economics of energy crop production, and an examination of the availability of private land in the border counties for growing such crops under various assumptions. What follows is a summary of some of the data and analyses prepared for this study. We first discuss briefly productivity and land availability estimates, and then examine financial aspects, and conclude with some recommendations.

Productivity and land availability

Potential yields

In NESC Report No. 46 the output achieved in Ireland by forest crops is documented. Yields per hectare in Ireland are twice that of the EEC, and are approaching three times the annual output per hectare of the Nordic countries. Three difficulties arise in considering the use of conventional forest production for energy purposes:

(i) The production listed is an average annual output over the life of the crops; the rotation length for a forest crop is 35 to 40 years, and, with normal spacing, much of the growth occurs in

the last half of this period, so that the availability of wood for energy must be deferred if the full growth potential of the species is to be realised.

(ii) Coniferous species have no proven ability to be successfully coppiced. Coppicing is the process of cutting certain hardwood species when they are young and allowing shoots to sprout from the stumps, which are in turn cut after a time. This allows frequent periodic harvests of the total crop without the expense of having to re-plant.

(iii) As forest trees approach saw-log size, they become extremely valuable for sawn timber. Even in the current extremely depressed state of the lumber market, sawlog size material still standing in the forest is fetching about £20 per ton; it would take a dramatic shift in energy prices to warrant paying this price for wood for energy.

It was considerations such as these that have led researchers to examine the potential of hardwoods such as willow, poplar and alder for energy crop production. Before reviewing their experience, we enter two caveats vis-à-vis the conclusions concerning conifers. First, if some conifers, such as Sitka Spruce and Lodgepole Pine, are spaced very closely together, early yields can be very high. The second caveat concerns coppicing. It has been noted that Sitka spruce does coppice if cut-off at about waist height above the lowest whorl. However, the feasibility of doing this periodically over a cycle, and the ages at which it is feasible, have not been determined.

The first scientific investigations of the yield potential of coppicing hardwoods were initiated in N. Ireland in 1973. Willow was the chief species investigated.

In the Republic, An Foras Taluntais (AFT) initiated species trials in 1977 on mineral soils in Carlow, followed by experimental plots laid out on cut-over basin peats at Clonsast, Co. Offaly and on improved blanket peat in Glenamoy, Co. Mayo. The Forest and Wildlife Service (FWS) also established species trials in 1977, on blanket bog, raised bog, drumlin and old red sandstone sites. Some of the highest yields from the Northern Ireland, AFT and the FWS plots are presented in Table 23.1. Although we now have quite a wide spread of plots established on a variety of site types, the data available for any particular site type are very limited. However, the known productivity of conventional forest crops, combined with the preliminary data we do have, indicate that there are grounds for optimism in this regard. Bord na Mona in 1980 initiated a major energy crops demonstration project at Clonsast on cutaway bog. The first phase of 80 hectares has been completed. For purposes of our analysis, we take as central assumptions

Table 23.1

Short rotation forestry yield data.

Location	Soil Type	Species	Total yield (dry tonnes/ha) 1 Year	2 Year	3 Year	4 Year
Castle Archdale Co. Fermanagh	drumlin	Salix aquatica gigantea			47.40	
Newton Butler Co. Fermanagh	drumlin	Salix aquatica gigantea			40.50	
Oak Park Research Centre Co. Carlow	mineral	Salix aquatica gigantea		0.40	5.30	
Oak Park Research Centre Co. Carlow	mineral	Populus trichocarpa		9.40	24.50	
Swanlinbar Co. Cavan	drumlin	Populus trichocarpa		3.79	8.10	11.18
Clonsast Co. Offaly	cutover raised bog	Salix aquatica gigantea	1.18	1.74		
Kilfinane Co. Limerick	podzol	Pinus contorta		0.82	1.14	
Ross Co. Galway	blanket bog	Pinus contorta		0.54	1.84	3.09
Tullamore Co. Offaly	raised bog	Pinus contorta		1.37	5.60	10.94

Sources: Department of Agriculture, Northern Ireland (1979), Neenan and Lyons (1980) McCarthy (1981).

average production of 15 and 10 dry (zero moisture content) tonnes of production per hectare per year on wet mineral soils and peatland respectively.

Potential land availability

There are three major potential types of land available.

(i) Cutaway bogs – land that has had its upper organic layers harvested as peat fuel.
(ii) Areas currently being acquired for conventional forest crops by the Forest and Wildlife Service.
(iii) The Drumlin and related soils. These are included in the wet mineral soils classification.

A breakdown of the total potential land-area is provided by Gardiner and Radford (1980), using a somewhat different taxonomy. They classify almost half of the country's land as marginal. (Table 23.2). What they style wet mineral lowland includes the drumlin and related soils in (iii) above.

We can summarize by saying that the potential candidate areas include:

- The cutaway areas under Bord na Mona's jurisdiction, amounting to a maximum of 70,000 hectares (173,000 acres).
- The cutaway areas in private ownership, amounting to about 243,000 hectares (600,000 acres).
- The blanket peat/Old Red Sandstone sites of the type now being purchased for conventional forestry. We do not know what percentage of this area is precluded because of elevation, aspect, exposure, slope and other difficulties. However, probably 300,000 hectares (741,000 acres) remain as potential energy crop (coniferous species mainly) land.
- The wet mineral soils amounting to over 3.5 million acres.

All but the Bord na Mona land is in private ownership. On all potential land, it must be demonstrated that energy crops can provide a better net financial return than the best competing use, a topic to which we now turn.

Economic aspects

Costs

We have two independent sources of costs of energy crop establishment. One is an actual costing done by the Forest and Wildlife Service of a plantation established on blanket bog in Co. Mayo. The other is a study by Lyons and Vasievich (1981) in which costs which could be expected to apply on cutaway bog are presented. Both of these estimates are

Table 23.2

Extent of marginal land

	Area (000s Acres)
Peat, Mountain and Hill	4,797
Wet mineral Lowland	3,531
Total	8,328

Source: Derived from Gardiner and Radford (1980).

presented in Table 23.3. It is encouraging to note that the differen less than 30% of the lower of these two.

For wet mineral soils, no fertiliser costs need be incurred, altho liming may be necessary. Roading costs will also typically be much than those incurred on peat. Incorporating these adjustments into Forest and Wildlife Service's costs, we estimate that crop establishme costs on wet mineral soils will amount to £1115 per hectare (£450 p acre).

We assume that average annual maintenance costs will amount £25 per hectare on all sites, that the crop is harvested every five yea over a 25 year period, and that the average annual production in eac 5 year period amounts to 10 and 15 tonnes of dry matter on peatlan and wet mineral soils respectively. In fact production will vary over th cycle, being probably slightly below average in the first couple of years as the root-stocks get established, then exceeding the average in the middle years before falling below again as the root-stocks lose vigour at the end of the 25 year period.

Revenues

The following prospective outlets can be identified for the output of wood energy crops. These are: domestic/institutional/industrial; existing sod-peat fired electricity generating stations which will not have a supply of peat available in the future; custom-designed wood-burning electricity generating units.

In Convery and Dripchak (1983) the delivered price which wood could expect to obtain in each of these three market categories has been estimated for 1981. By deducting costs of transport and harvesting, we arrive at standing wood values as follows:

	Price per Dry Tonne (1981 £)
Domestic, Institutional, Industrial	22
Electricity Generation – Existing Capacity	17
New Capacity	3

Analysis

Given the cost and productivity assumptions made earlier, the following present net worths and annual equivalents per acre would be yielded from investment in energy crops at real interest rates of 2 and 4 per cent (Table 23.4). With the low wood price (the maximum which a new power station could afford to pay) an investor could not afford to pay a real interest rate of 2 or 4 per cent and still cover all costs (including interest charges) out of revenues. If the price obtainable was increased to £17 per dry tonne, then an investor borrowing at a real rate of 2 per cent could afford to pay a landowner £65 per acre per annum (the

Table 23.3

Two independent estimates of the direct costs (excluding land purchase) of establishing an energy plantation with 13,333 plants per ha.

		FWS	Lyons and Vasievich
Ploughing:	£14.50/plough-hr x 10 hrs/ha	145.00	
	£ 4.50/man-hr x 5 hrs/ha	22.50	
		167.50	100.00
Drainage:	£14.50/plough-hr x 1.5 hrs/ha	21.75	
	£3.70/man-hr x 0.75 hrs/ha	2.78	
		24.53	100.00
Planting:	Plants - £32/1000 (LP) x 13,333/ha	426.66	
	Pl. distrib. - £11/muskeg-hr x 0.9 hrs/ha (incl. labour)	9.90	
	£6/tractor-hr x 2 hrs/ha (incl. labour)	12.00	
	Trenching - £3.70/man-hr x 4 hrs/ha	14.80	
	Planting - £3.70/man-hr x 80 (6 man-hrs/1000)	296.00	
		759.70	1123.00
Fertiliser:	£90/tonne of rock phosphate x 1.25 tonnes/ha	112.50	
	£105/tonne of muriate of potash x 0.15 tonnes/ha	15.75	
	£3.70/man-hr - 6.25 hrs/ha (labour)	23.13	
	Application - £3.70/man-hr x 14.2 hrs/ha	52.54	
		203.92	81.00
Fencing	£0.90/metre x 71.11 m/ha	64.00	150.00
Roads:	£3.71/metre (road improvement) x 30 m/ha	111.30	150.00
Total		1330.95	1704.00

Note: The costs per unit and the amounts apply only to the Forest and Wildlife Service estimates. The FWS and the Lyons and Vasievich costs are as of October 1980 and January 1981 respectively.

Table 23.4

Present net worth and annual equivalents, energy crops, 1981 £.

Price per Tonne (£)	Mineral				Peatland			
	i = 0.02		i = 0.04		i = 0.02		i = 0.04	
	Present worth	Annual equivalent	Present worth	Annual equivalent	Present worth	Annual equivalent	Present worth	Annual equivalent
3	- 331	-17	- 361	-23	-531	-27	-535	-34
17	1263	65	865	55	531	27	282	18
22	1833	94	1303	83	911	47	574	37

Note: i = interest rate

Source: Convery and Dripchak (1983)

annual equivalent) for wet mineral lowland and £27 per acre per annum for peatland, in order to use it to grow energy crops. The present worth estimates in Table 23.4 tell us the maximum an investor could afford to pay per acre for land and still just cover all costs out of revenues under the assumptions specified.

Actual returns to agriculture are compiled annually in the Farm Management Survey. The management and investment income and family farm income per acre in 1981 in the lowest 25 per cent of Soil Group 2 (includes wet mineral soils) and Soil Group 3 (includes peatland soils) was as follows:

	Soil Group 2	Soil Group 3
Management and Investment Income	-125	-121
Family Farm Income	4	0

Management and Investment Income represents the return to the land and management, and as such is comparable with the annual equivalents in Table 23.4. Family farm income is the income which accrues to land, management and the farmer's own labour. It is clear that, *given the assumptions specified*, energy crops could yield attractive returns when compared with the performance of the lowest 25 per cent in terms of economic performance – of agriculture in 1981. However, much work remains to be done before we could recommend that a large investment programme be embarked upon.

Recommendations

It is important that we get better estimates of the output which can be expected to be achieved by energy crops on a variety of sites under normal management conditions. Many of the experimental plots established in the Republic were designed to show the extent to which various species could survive. They are not appropriate for providing generalisable yield data. We endorse the undertaking of a major demonstration phase under the direction of Bord na Mona and partially funded by the EEC. This will generate some of the desired production data. However, this project is confined to peat-lands (including cutaway) under State jurisdiction. No information will be provided by this project concerning wet mineral soils, or the problems and opportunities of establishing and managing energy crops on privately owned land. Since the bulk of the potentially usable marginal land is privately owned, and the wetland mineral sites are among the most productive in the country, this is a serious deficiency in the demonstration phase of the R + D programme.

We strongly recommend that this deficiency be corrected, and that this effort include the rent of private land for energy crop production.

In tandem with the expansion of the demonstration project, the potential markets for project output need to be carefully examined. Getting a major wood-for-energy project going will require the commitment of the ESB to accept the output at prices which make the financial returns sufficiently attractive for growers (including the State). What arrangements are feasible, which organisations might most appropriately establish the crops, harvest and deliver the wood, are all aspects which are relevant to the viability of the energy crops concept.

We have been impressed by the volume, quality and range of work being undertaken in the energy crops area. The National Board for Science and Technology in particular deserves great credit for encouraging research and development work in all of the key areas, by a variety of agencies. There is research under way on species selection, productivity, management strategies (spacing, fertilisation etc.) harvesting systems, transportation, wood drying, and conversion systems. The work involves: An Foras Taluntais (Carlow) at a range of growth and conversion activities; the Forest and Wildlife Service on species/productivity trials; Bord na Mona on a major demonstration project; the Sugar Company on the development of harvesting equipment; the ESB on conversion to electricity, and so on. Rarely, if ever, have such a diversity of organisations and individuals been engaged on a unitary research topic in Ireland. We sense that it is now time to give a little more centralised direction to these efforts. Thus far, the NBST has encouraged and cajoled but has not had the authority or perhaps the inclination to direct. Because of the manner in which a number of organisations with different goals and research traditions initiated work at different times, it is difficult for the outsider to interpret what some of the results imply, the extent to which they can be generalised from, the overall priorities they suggest, and so on. This is not at all a criticism of the research itself, and we feel that the diversity of interests involved has been beneficial. We do feel that it would now be worthwhile to appoint a scientist in the Department of Energy with singular responsibility in this area to work with the NBST and the other parties involved in establishing priorities for the future, developing the full policy implications of existing research results, standardising terminology, estimation and reporting procedures, and allocating resources and personnel to the areas needing them. There is now a sufficient volume of work under way such that the integrative role deserves high priority. As the time for major policy decisions approaches, it is important to have on hand an individual with a clear understanding of the potentials and pitfalls of energy crops.

We observed earlier that there were several million areas of marginal land with potential for growing energy crops. However, it was noted in *NESC Report No. 46* that some of this area in the drumlin and related soils is also highly productive for conventional forestry. Thus far, we in Ireland have looked only at energy crops alone or conventional forest crops alone. It could well be of net benefit to combine the two, say by keeping a small number of trees to grow to saw-log size, while harvesting the bulk of the crop periodically for energy. The very high early productivity of densely planted conifers indicates that research should be directed towards reducing the very high planting costs associated with this density, by such means as direct seeding and/or coppicing.

Finally, transferring land from the production of milk and beef to tree growing should have a beneficial effect in terms of reducing the dairy surpluses of the European Economic Community. This in turn would reduce the subsidies required for producers, for storage and in cases where sales are made to third countries – for consumers. There appears therefore to be some logic in making at least part of the subsidy "saved" available to encourage the transfer to tree growing.

SECTION VII: STRATEGIC AND INSTITUTIONAL ASPECTS

CHAPTER 24

INSTITUTIONAL CONSIDERATIONS AND DATA NEEDS

Institutional developments

The establishment in 1979 of a separate department with singular responsibility for energy was a striking and important institutional development in the energy policy domain in Ireland. It provided an important focal point for the development, articulation and propagation of policy, and allowed the highlighting of issues and opportunities.

The Department of Energy functions as the central policy making and implementing unit. The Institute of Industrial Research and Standards (IIRS) provides the largest complement of technical expertise to the Department, having in all 17 professionals engaged in the energy area. The Minister has looked to the IIRS in particular to play a central role in the technical aspects of implementing energy conservation. An Foras Forbartha has a few researchers associated with the Transportation and Construction divisions who have provided very valuable analyses of the energy conservation opportunities in these areas. The National Board for Science and Technology (NBST) has played a central role in identifying research and developing opportunities, in encouraging participation by Irish agencies, and helping secure funds for them from agencies such as the European Economic Community and the International Energy Agency (IEA). The NBST has also itself conducted a study of Irish energy policy using a systems analysis/modelling approach.

In addition to these support units, there are the state-sponsored energy supplying/transmitting agencies which report to the Department. Of these, the Electricity Supply Board is the longest established and, by most criteria, the most significant, accounting for almost a third of the nation's primary energy consumption. Bord na Mona, as the State's premier peat producer, supplies 20% of the ESB's primary energy requirement and is also a major supplier to the domestic fuel market. Bord Gais Eireann (BGE) is now also a substantial primary fuel supplier to the ESB, supplies Cork city dwellers and some industrial users with natural gas, as well as providing it to the consumers of Dublin and points along the route thereto from Cork. The state-sponsored Irish National Petroleum Corporation (INPC) is supplying a significant proportion of the country's oil needs. We have emphasized the key role which prices play in energy production and consumption decisions. The National Prices Commission is the statutory authority charged with recommending allowable price levels. As such it has a direct bearing on energy policy.

Finally, there is a very substantial private sector involvement, ranging from the oil companies and Coal Distributors Ltd. through the smallholder supplying his own turf needs.

All policy formulation takes place within the rather fluid guidelines provided by the EEC and the International Energy Agency, and the debate is shaped to some extent by interest groups such as An Taisce, the Institution of Engineers of Ireland, the Solar Energy Society of Ireland and the Confederation of Irish Industry.

It is clear that the institutional environment for the development and implementation of energy policy is of necessity diffuse and complex. How to draw effectively on the diverse strengths in this system and arrive expeditiously at good policy decisions is an important organizational issue. We very briefly discuss organizational issues and skill requirements.

Organizational issues and skill requirements

The energy component of the Department of Industry and Energy is organized in three divisions: the Planning and Finance Division; the Petroleum and Minerals Exploration and Development Division; the Energy Supply and Utilisation Division. The latter two, with some modifications – notably the establishment of a separate energy conservation section – were carried over intact from the old parent department. The Planning and Finance Division is a new departure. It is to provide analysis and recommendations on major energy policy issues, including long-range aspects and international dimensions. By implication, the Energy Supply and Utilisation sections would be confined largely to handling the routine day-to-day tasks associated with the units in their jurisdiction. We perceive a potential difficulty here. The demarkation between a substantial policy issue and a routine decision is often difficult to draw, and in any event those dealing with day-to-day matters will often have much to offer in the analysis of policy choices, and will probably perform more enthusiastically if they are also full participants in policy formulation.

Analysing policy options competently involves understanding the technical choices available, being able to correctly identify and analyse the costs and returns associated with them, and judge their administrative and political feasibility. The Department seems to have been quite successful in attracting able technical personnel on secondment from other agencies. Since the career structure for individuals not in the administrative career track is undeveloped, this ability to avail of

the necessary skills in this fashion is fortuitous indeed. It also provides a desirable level of flexibility in adjusting to changing requirements, and facilitates informal interaction between the department and units such as the NBST and IIRS from which these people are drawn. It is notable that only in the long-established Petroleum Affairs Division do we find permanent technical posts established. We conclude that the minimum necessary technical expertise is available at the policy formulation level, either directly or in the form of advice from related agencies. The prior work of the NBST in the energy area has proved especially helpful in this latter regard. However, it was indicated to us that an expansion of the engineering advice available would be very helpful. We assume that the normal administrative mechanisms of the civil service are adept at judging administrative/political feasibility.

Our primary concern then regarding the ability to analyse policy choices is the paucity of individuals with appropriate skills in economics and financial analysis. There are only 2 such individuals now in the department, and they have administrative and managerial responsibilities in addition to their analytical duties. The following are examples of areas where analytical skills are a prerequisite for successful policy:

- Financial project appraisal.
- Estimating the supply/demand responses to alternative packages of incentives, including prices, tax changes, subsidies, regulations, etc.
- Designing programmes such that there is a feedback loop; the outcomes can be systematically appraised and the programmes modified as a result, if this is called for.
- Providing an appropriate incentive and decision-making framework to agencies such as the ESB, Bord na Mona and Bord Gais Eireann.
- Identifying and evaluating innovative policy choices being tested elsewhere.
- Determining causes of market failure, and devising cost-effective approaches to their diminution.
- Tracing the equity implications of alternative policies.
- Developing an appropriate energy pricing policy in conjunction with the National Prices Commission.

Thus skills in financial analysis, econometrics, welfare and public choice economics, tax policy etc., with a strong grounding in microtheory and a ready familiarity with the burgeoning literature in energy economics are what is required. Without ready access to such skills, the quality of policy analysis and implementation will suffer. There is an almost infinite variety of ways and means to both produce and conserve energy; what is most appropriate will depend crucially on the associated costs and returns of alternatives.

It was not merely professional chauvinism which led us to admire the pervasiveness of economists in the Netherlands energy policy system. In addition to being strongly represented in the central government, economists are heavily involved in evaluating projects at the field level where government incentives/subsidies are provided.

We recognize that a scarcity of skilled individuals makes it difficult to staff-up appropriately in this area. We understand that a demarkation dispute concerning the appropriate career track which economists should be allowed to follow in the public service compounds the problem. In spite of these melancholy manifestations of a national malaise, we strongly urge that efforts be itensified to provide additional depth in the area of analysis. We feel that the additional analytic skills should not be confined to the Planning and Finance Division, but should also be represented in the Division which has "line" responsibilities, providing thereby a complementary and unifying analytical framework.

We have confined our attention to the shortage of skilled analytical personnel at department level in the central government. The same problem arises, in lesser degree, at the agency level, where the analysis of projects or pricing decisions involving several million pounds may be the responsibility of a single individual, with little opportunity for the evaluation by professional peers; peer evaluation is an important means of maintaining rigour in analysis.

There is also need for additional resources in systems analysis, computerisation and data management.

An Energy Council

It was suggested to us that a body on which all of the significant energy interests were represented might perform a useful advisory role vis-à-vis policy. Such councils are found in many countries. In recent years a number of advisory councils e.g. the Environment Council, the Wildlife Advisory Council, have been established in Ireland. Such entities depend for their effectiveness on having independent analytical capabilities, freedom of choice as to issues addressed, some decision making authority, a willingness to be informed on the part of the bureaucracy and the political leadership and, finally, capable and informed members who are willing to make the effort necessary to arrive at sound decisions and recommendations. Before recommending the formation of another council, we would like to see the structure and effectiveness of the existing entities evaluated.

Data needs

In recent years the Department have produced quarterly and annual data on energy consumption in the series "Energy in Ireland". Total primary energy is given and broken down into four categories of con-

sumer and five categories of fuel. The latter are subdivided into products or sources. These data go back to 1973 in a consistent series and delay before release is quite short at roughly three months in the case of the quarterly data. There remain two major areas of deficiency in the data. These are energy prices and detailed sectoral energy consumption.

In the area of energy prices there does exist at present the subcategory of the Consumer Price Index called "Fuel and Light". This category obviously only deals with fuels consumed in households and excludes transport fuels. It includes (but does not give separately) coal, turf, paraffin, LPG, firewood blocks, gas, electricity and fuel oil. Delay before release is some 5 weeks. The National Income and Expenditure is another source of information on prices paid by households, excluding motor spirit and with a longer delay before release. This gives annual time series for expenditure of personal income at current prices and at constant prices, from which an energy price index can be imputed. As for the prices of imported energy, the Trade Statistics give value and quantity of imports for fuels broken down into a number of categories, from which monthly import prices can be calculated. The delay is some six months. Finally, the annual reports of various energy companies can be used to derive the average annual revenue from sales. Energy companies can be contacted for uptodate information and doubtless they receive numerous queries.

It is clear that price data are neither comprehensive, consistent nor uptodate and yet they are as important as data on quantities. We recommend the regular publication of energy price data, giving as much detail as possible.[1]

The second deficiency, the lack of sectoral energy consumption data, means that possibly large shifts in subcategories go undetected, making policy evaluation difficult. There is for example no uptodate information on the use of energy by the paper and pulp industry. In fact detailed information is already collected in the Census of Industrial Production. The deficiency could be solved by faster and more detailed publication of the results. Alternatively an additional survey could be considered.

[1] Since this was drafted the IIRS has started publishing quarterly fuel price data.

CHAPTER 25

SECURITY OF SUPPLY AND STOCKPILING

The energy form most frequently encountered in discussion of supply security in Ireland is oil, which is not surprising given that it dominates our energy imports. But we also produce energy domestically, both in primary form (turf and natural gas) and through electricity generation. There are supply risks in these areas — industrial relations problems in the ESB have caused disruption before, and the offshore gas pipeline for example, could be shut off for various reasons. These are special problems however and we will consider only the question of oil, and in particular oil stockpiling, in this section. But before we do, we would like to consider the question of "strategic" stockpiling in a more general setting.

A small open economy which imports commodities, be they raw materials or finished goods, faces two risks which might lead it to stockpile these products. The first is the risk of absolute physical shortage, at any price. The second is the risk of sudden, precipitous price rises. For almost any product or raw material one cares to think of, the first risk, outside a world war situation, is remote. There have not been sustained physical shortages (i.e. non-availability at any price) of commodities of any significance, oil included, since the end of the Second World War, almost forty years ago. Even during that War, Ireland was able to obtain some supplies of all crucial commodities, and the level of activity in the economy was at no stage abruptly reduced through absolute physical shortages. There is no great likelihood of a six-year world war ever occurring again, and in the type of world war likely to take place, security of raw material supply may well be the least of our problems.

There have, on the other hand, been regular sharp price rises and price falls for various basic commodities, including metals, oil, sugar, coffee and grain. Ireland imports many commodities which may experience sharp price rises. There is an a priori argument, therefore, for stockpiling some or all of them. In economic terms, we would have to use foreign exchange to buy the stockpiles and so any decision to do so would be formally equivalent to holding some of the foreign exchange reserves in the form of a portfolio of commodities. Thus the State would be engaging in commodity speculation, to which there would be two

costs:

(i) the interest income foregone on the funds tied up in stockpiles or, equivalently, the interest cost of foreign borrowing to finance the stockpiles, and
(ii) any costs of physical storage.

The identification of stockpiling with commodity speculation may seem surprising, but in economic terms that is precisely what it is — the State decides, at a cost, to take a "long" position in certain commodities. If the prices of these commodities rise more quickly than the costs of holding stockpiles, the State's speculation is successful and national economic welfare is enhanced. But if the prices rise more slowly than the carrying costs, the State makes a loss on its speculation, and the community is worse off. The downside risk in holding stockpiles is always present and cannot be ignored.

An alternative to stockpiling is consciously to depart from comparative advantage by subsidising the domestic production of imported commodities. But in this case essentially the same arguments apply. If the commodity does not in the event rise enough in price to offset the costs of subsidy, national economic welfare is reduced by a domestic production policy, which also unavoidably involves speculation in commodities.

There are thus three options in dealing with the problem of secure supplies of price-volatile imported commodities. These are:

(i) Ignore it, which we will see is not quite the same as having nothing done about it,
(ii) Stockpile products deemed likely to experience shortage, and
(iii) Subsidise domestic production facilities for these products.

We must proceed on the presumption that total productive resources available to the community are limited, so any decision to commit real or financial resources to stockpiling or to producing some commodities necessarily involves a reduction in the volume of resources available for other uses.

Thus under option (i), economic agents will, in following comparative advantage, select particular lines of production. Their selections will take account of price uncertainty and the risk of shortage, and they could be expected to engage in stockpiling, for example, wherever they saw supply risks. In this sense, a Government which does nothing directly to deal with the problem of secure supplies is really choosing to let market forces decide how far to go in dealing with it. It is not the same thing as deciding that no one shall do anything.

Since production and real income are maximised through pursuit of comparative advantage, a community pursuing this policy has the option of enjoying a higher level of consumption than it could do if it departs from comparative advantage. Alternatively, it could enjoy the same consumption stream, in which case it will accumulate foreign exchange reserves relative to what it would have had in the alternative situation.

The reason for this is that output and real income are higher if a country pursues comparative advantage. If, eschewing comparative advantage, it settles for a lower long-run consumption stream, it follows that choosing the same consumption stream under comparative advantage would see it accumulate foreign exchange through running a payments surplus.

Option (ii) involves stockpiling physical product or negotiating long term supply contracts at pre-determined prices either of which amounts to taking a "long" position in the commodities selected. It is important to stress that this policy only provides a hedge against upward price movements. If prices in the event fall, the policy can be costly. Stockpiling essentially involves speculation in commodities and always involves downside risks.

Option (iii) involves import substitution, through subsidising the domestic production of products which would otherwise be imported. It has affinities with option (ii) in that there are downside price risks. This is seen most clearly in the cases ofNitrigin Eireann Teoranta and Irish Steel, where costly investments were made, partly on the basis of secure supplies arguments, in product areas where supplies turned out to be abundant and cheap.

Options (ii) and (iii) are regularly advanced in Ireland, especially option (iii). But option (i), maximising output, restraining consumption and creating a stockpile of purchasing power in foreign currencies, has strong attractions for a small open economy. The onus of proof that options (ii) and (iii) are preferable must lie on the proponents of reducing output and income for strategic reasons.

Since the oil crisis of 1973-1974, there has been an understandable concern, in Ireland and in all other oil-importing countries, about security of supply and the risk of sharp, sudden price rises. This in turn has led to a greater tolerance of direct State intervention and a reluctance to rely on a laissez-faire approach, which is seen as "doing nothing". What reasons might the State have for being dissatisfied with the levels of stocks of "strategic" commodities being held by importers and traders left to their own devices?

These can only be two — the State might believe that private decisions were commercially unwise, and that higher stocks would pay off. For this to be true, it would be necessary for the state to be better than the private importers, and traders at speculating in commodities. This is a logical possibility but is not the basis on which State stockpiling is

normally promoted.

The second reason is that, accepting the commercial wisdom of the private market, the resultant level of stocks is below what the State deems desirable, for reasons to do with overriding political concerns, such as national survival in the event of a war. If a State in such circumstances decides to hold additional stocks, it must by definition expect to lose money on ordinary commercial criteria, since commercial stock levels are already being held. These levels would reflect traders' speculative holdings of price-volatile products, as well as ordinary transactions stocks, and would already discount the best available market information on price expectations.

So the State would be paying a calculable price for the attainment of its political objectives.

The kind of price involved can be very significant. Suppose the market, left to its own devices, would hold only six weeks stocks of oil products in Ireland. Suppose further that the State believes that 90 days stocks should be held and it either forces traders to hold extra stocks or does so itself. At approximate 1981 volumes and mid-'82 prices, the extra 48 days stocks would tie up £112.5 million permanently. At an interest rate of 16%, this would cost around £18m. per annum, for ever. If this were raised in taxes, it would add 3p to the price of the pint of beer, or thereabouts. This ignores storage costs.

The oil industry is much the most important in the present context — the costs involved in stockpiling many other products would be much less significant.

We would conclude, not that the State should or should not hold stockpiles, but merely that the costs should be explicitly accounted for, and that the national security or other objectives to be achieved should be as explicit as possible.

Where these objectives are the avoidance of price risks, a range of alternative strategies is available, besides stockpiling. A small economy could insure itself against upward price risks by long-term purchase contracts, by trading in commodity futures where that is possible, or by buying shares in companies, oil companies for example, whose share price would rise should there be shortage. All of these measures would involve downside risks, and all would be additional to whatever insulation against price rises the private sector voluntarily chose to arrange itself. Physical acquisition of stocks is a cumbersome and possibly costly method of insuring against upward price movements.

The Government has recently taken a major decision in the energy policy area in avowed pursuit of supply security. This concerns the purchase and operation of the Whitegate oil refinery in Co. Cork. The refinery was purchased by the State and is now operated by the Irish National Petroleum Corporation, which processes its own purchases of crude oil through the refinery. The INPC purchases crude at Saudi and other official prices, and sells products from Whitegate under a compulsory offtake regime. Under this arrangement, all oil distribution firms in the Republic are required to take 35 per cent of their total sales from Whitegate, which ensures that the entire capacity of the refinery has a guaranteed market. This arrangement has been challenged in the European Court by some of the Irish oil companies.

The INPC is empowered to charge prices in excess of those prevailing on the open market. Recently, it has been charging £425 per tonne for premium grade petrol, versus a spot market price of around £320, so the price differentials are highly significant. A report commissioned by some of the oil companies, and published in July 1982[1], estimated the total costs of the INPC Whitegate strategy at between £36m. and £63m. per annum.

The costs will fluctuate in line with the success or otherwise of the INPC's crude purchasing policy and the level of open market prices for crude oil. The likelihood is that the costs will almost always be substantial. The benefits are held to be increased security of supply. Since the probability must be that crude oil and refined oil are likely to be both scarce, simultaneously, or both plentiful, simultaneously, the security benefits of refining oil in Ireland are not self-evident.

Similar considerations arise, albeit at a smaller scale, in relation to Ceimici Teoranta. This is a state sponsored company engaged in the manufacture of alcohol-industrial and potable – and glucose. The petrol distributing companies are obliged to purchase industrial alcohol – amounting to about 0.3 per cent of total petrol sales – at a price which is typically well in excess of petrol prices.

Whatever the merits and demerits of the Government's strategy in regard to oil refining and industrial alcohol, the compulsory offtake regime has the objectionable feature that it masks the true costs of what is being done. From an economic standpoint, it would be better to let the INPC trade at market prices and pay for its losses out of an explicit vote for national security.

We would conclude that the sequence of decisions leading up to the purchase and operation of Whitegate, on a compulsory offtake basis, and the crude purchasing policy of the INPC itself, do not conform with a rational procedure for taking decisions about national security. The costs and the benefits have not been explicated, and national security has been involved as more of a slogan than as a rational justification for additional expenditure. We would suggest that existing policy in this area be critically reviewed, with the objective of identifying what degree of security the State should seek, and of identifying also the least costly method of attaining it.

[1]Whitegate Oil Refinery: An Economic Analysis of the State Takeover", DKM Consultants, Dublin, July 1982.

CHAPTER 26

A NATURAL RESOURCES TRUST FUND

We have sensed a substantial degree of public disillusionment in energy-rich countries such as the United Kingdom and the Netherlands concerning the manner in which the oil and gas revenues have been used by the governments concerned. The opinion that these "windfall" resources have not been used to build a productive base for the future, but have been frittered away on "unproductive" current consumption is a commonly encountered view. It is argued that some substantial portion of the resource-generated revenues should go into a special fund, such as a Natural Resources Trust Fund, and be used to help renew the industrial base, replenish the resource base by financing the planting of forests and the harnessing of renewable energy sources such as wind, waves, direct solar, energy crops, etc., and provide for the educational and cultural enlightenment of the present and future generations by funding the construction of infrastructure, schools and the preservation of wildlife, parks, buildings and vistas of distinction. This is the approach adopted by the Province of Alberta, Canada with some of its oil and gas derived revenues, and it seems to be very popular.

This approach is normally resisted by National Exchequers because it reduces flexibility in the spending of funds. It inhibits the optimal allocation of resources, since investment cannot be made across all sectors such that returns at the margin are equalised. This difficulty can be largely overcome by defining sufficiently widely the purposes for which the trust fund can be used. A more salient objection in the Irish case might be that the level of government indebtedness is such that any fresh resources becoming available should be devoted to reducing the debt, rather than being devoted to new projects.

We feel that serious consideration should be given to the creation of a Natural Resources Trust Fund, financed by a share of the revenues yielded from the sale of the public's natural resource endowment. Our non-fuel minerals industry is now generating some rent for the people of Ireland. The State forests should begin to yield substantial revenues within the decade. The exploitation of the Kinsale Head gas field and some of the bog land under Bord na Mona's jurisdiction will produce rents if market-clearing prices are permitted to apply. Prospective commercial discoveries of oil, gas and other minerals will likewise

produce rents for the citizenry. Assigning some portion of these returns to a fund of the nature described would help reassure the public that their future and that of their posterity was not to be entirely sacrificed in the interests of immediate increased consumption of only transitory value. It would make it easy to show what will be foregone if rent is to be sacrificed to encourage downstream development. It might make it easier to get people to defer consumption today if they could see that the fruit of their sacrifice was being invested to create a better future. However, this would require consistent and imaginative leadership at both the political and administrative levels.

APPENDIX 1

SELECTED BACKGROUND TABLES

Table A1.1

Primary energy consumption, Ireland, 1960-81
(millions of tons of oil equivalent)

Year	Hydro	Peat	Coal	Oils	Natural gas	Total
1960	0.63	1.28	1.16	1.16	-	4.23
1961	0.41	1.25	1.25	1.48	-	4.39
1962	0.32	1.26	1.05	1.75	-	4.38
1963	0.31	1.28	1.03	1.78	-	4.40
1964	0.34	1.30	0.93	2.06	-	4.63
1965	0.35	1.03	0.92	2.31	-	4.61
1966	0.31	1.17	0.94	2.55	-	4.97
1967	0.29	1.27	0.89	2.95	-	5.40
1968	0.19	1.39	0.94	2.53	-	5.05
1969	0.14	1.35	0.87	2.98	-	5.34
1970	0.20	1.17	0.92	3.45	-	5.75
1971	0.12	1.26	0.75	4.65	-	6.78
1972	0.19	1.22	0.63	4.78	-	6.82
1973	0.18	1.09	0.57	5.24	-	7.08
1974	0.21	1.13	0.54	5.33	-	7.21
1975	0.14	1.17	0.43	5.05	-	6.79
1976	0.16	1.19	0.49	5.20	-	7.04
1977	0.20	1.24	0.52	5.53	-	7.49
1978	0.19	1.18	0.55	5.78	-	7.70
1979	0.21	1.16	0.79	6.24	0.26	8.66
1980	0.22	1.15	0.73	5.62	0.49	8.21
1981	0.22	1.12	0.85	5.07	0.90	8.16

Source: Personal communication from John Brady, National Board for Science and Technology, for 1960-67 data. Energy Ireland Department of Industry, Commerce and Energy, Government Publications, Dublin, 1978, p. 17 for 1968-77 data. Energy in Ireland, issues for 1978, 1979,1980 and 1981 1978-81 data.

Table A1.2
Final deliveries of energy, by source, 1960-81, million tons of oil equivalent

Year	Coal	Turf	Oil	LPG	Town gas	Electricity	Total
1960	0.862	0.783	0.897	0.015	0.071	0.172	2.800
1961	0.970	0.814	1.145	0.018	0.063	0.181*	3.191
1962	0.853	0.829	1.309	0.015	0.067	0.191	3.264
1963	0.872	0.798	1.235	0.020	0.068	0.202	3.195
1964	0.798	0.727	1.441	0.027	0.069	0.239	3.301
1965	0.765	0.696	1.625	0.034	0.069	0.261	3.450
1966	0.815	0.727	1.838	0.030	0.070	0.287	3.767
1967	0.804	0.645	2.102	0.046	0.071	0.316	3.984
1968	0.801	0.663	2.175	0.041	0.071	0.355	4.086
1969	0.752	0.610	2.695	0.053	0.082	0.375	4.567
1970	0.720	0.604	2.957	0.068	0.090	0.413	4.842
1971	0.627	0.615	3.586	0.079	0.090	0.448	5.445
1972	0.564	0.618	3.653	0.089	0.096	0.488	5.508
1973	0.499	0.576	3.808	0.103	0.110	0.540	5.636
1974	0.466	0.571	3.775	0.109	0.109	0.551	5.581
1975	0.366	0.573	3.495	0.114	0.095	0.537	5.180
1976	0.428	0.603	3.520	0.130	0.092	0.584	5.357
1977	0.464	0.617	3.770	0.140	0.091	0.633	5.715
1978	0.502	0.594	3.843	0.145	0.091	0.679	5.854
1979	0.741	0.602	4.201	0.168	0.134**	0.751	6.597
1980	0.751	0.581	3.873	0.178	0.136**	0.737	6.256
1981	0.832	0.589	3.709	0.177	0.140	0.726	6.173

* From quarterly data.
**Includes natural gas.

Source: Scott (1980) p. 6 updated.

Table A1.3

Fuel prices (deflated by CPI, 1963 = 100)

Year	Coal	Turf	Oil	Town gas	Electricity
1950	107.85	102.81	117.08	110.98	136.03
1951	135.39	121.57	122.39	105.12	132.59
1952	101.96	120.16	135.63	100.64	127.72
1953	100.13	104.44	121.00	103.31	123.43
1954	99.43	107.54	118.16	102.90	121.72
1955	102.14	111.07	113.09	98.70	116.51
1956	118.13	111.59	124.02	120.29	121.47
1957	115.38	105.41	147.43	113.63	121.47
1958	110.17	102.61	125.16	108.81	116.68
1959	92.47	104.40	129.88	105.99	115.92
1960	86.31	101.57	116.70	102.52	112.78
1961	93.94	101.46	108.34	102.50	111.49
1962	97.12	104.46	104.46	103.89	105.56
1963	100.00	100.00	100.00	100.00	100.00
1964	103.09	93.51	95.78	93.51	91.34
1965	99.19	94.92	92.80	90.61	86.28
1966	95.63	97.20	89.35	91.15	83.88
1967	96.40	97.99	94.31	92.97	83.05
1968	95.30	92.67	95.63	91.57	80.64
1969	94.85	85.40	84.92	92.69	77.90
1970	98.41	84.99	77.06	89.16	92.01
1971	101.47	87.41	90.08	91.54	71.78
1972	103.33	89.55	87.18	91.72	71.36
1973	97.82	89.78	83.32	85.58	71.20
1974	123.95	91.94	133.21	119.84	90.28
1975	121.21	101.86	140.82	110.20	93.04
1976	112.05	91.89	148.21	105.41	90.61
1977	123.22	96.10	161.34	105.39	91.64
1978	128.83	100.98	145.53	106.60	82.89
1979	120.20	97.47	160.11	111.58	89.72
1980	137.69	94.26(e)	185.34	160.48	108.14(e)

Source: Updated from Scott (1980), p.6.

Table A1.4

Primary energy consumed in Ireland, by sector, 1970-81. 000 tons of oil equivalent.

Year		Domestic	Commercial	Industrial	Transport	Total
1970	Quantity	2087	691	1783	1318	5879
	% of total	35	12	30	22	100
1971	Quantity	2228	812	2166	1381	6587
	% of total	34	12	33	21	100
1972	Quantity	2318	839	2205	1435	6797
	% of total	34	12	32	21	100
1973	Quantity	2288	905	2490	1488	7171
	% of total	32	13	35	21	100
1974	Quantity	2303	903	2491	1509	7206
	% of total	32	13	35	21	100
1975	Quantity	2151	833	2264	1511	6759
	% of total	32	12	33	22	100
1976	Quantity	2303	860	2323	1560	7046
	% of total	33	12	33	22	100
1977	Quantity	2446	913	2490	1663	7512
	% of total	33	12	33	22	100
1978	Quantity	2539	924	2462	1770	7695
	% of total	33	12	32	23	100
1979	Quantity	2683	1094	2940	1940	8658
	% of total	31	13	34	22	100
1980	Quantity	2695	1076	2744	1818	8333
	% of total	32	13	33	22	100
1981	Quantity	2683	1065	2608	1803	8159
	% of total	33	13	32	22	100

Note: There are small discrepancies between the totals in Table 2 and those listed in Table 1; this arises because the sectoral data for the years ended 1970 to 1974 were compiled by Kavanagh and Killen (1980) from a variety of sources, and the numbers derived thereby do not tally exactly to the totals listed in Table 1.

Source: Kavanagh and Killen (1980) for 1970-77 data; Department of Energy (1978) p. 5 and Department of Energy (1979), p. 5 for 1978 and 1979 data respectively.

Table A1.5

Capacity, output and costs, Electricity Supply Board, 1981-82.

Station	Capacity (MW)	Units sent out millions Kwh	Costs (000s £)						
			Non Capital				Depreciation	Total	Total per unit pence
			Fuel	Other	Total	Pence			
Hydro stations									
Shannon (1 station)	86	403.9	-	2352	2352	0.582	48	2400	0.594
Liffey (3 stations)	38	52.6	-	342	342	0.650	29	371	0.705
Erne (2 stations)	65	326.6	-	981	981	0.300	118	1099	0.336
Lee (2 stations)	27	101.3	-	531	531	0.524	71	601	0.593
Clady (1 station)	4	15.5	-	103	103	0.665	19	122	0.787
Total	220	899.9	-	4309	4309	0.479	285	4593	0.510
Turlough Hill (pumped storage)	292	-232.5(1)	-	1072	1072	-	597	1670	-
Oil stations									
Tarbert (Co. Kerry)	620	1271.3	44972	5444	50416	3.966	4142	54558	4.292
Poolbeg (Dublin)	538	2188.9	69524	6056	75580	3.453	4057	79637	3.638
Ringsend (Dublin)	270	137.4	7192	7746	14938	10.872	354	15291	11.129
Great Island (Co Wexford)	240	393.0	14423	3423	17846	4.541	717	18562	4.723
North Wall (Dublin) - peak station	Temporarily	de-commissioned		552	552	-	21	573	-
Total	1668	3990.6	136111	23221	159332	3.979	9291	168621	4.225
Peat stations									
Milled peat									
Ferbane (Co Offaly)	90	273.7	8056	4190	12246	4.474	94	12339	4.508
Rhode (Co Offaly)	80	313.0	8589	3429	12048	3.849	118	12165	3.887
Shannonbridge (Co Offaly)	80	307.4	7629	2819	10448	3.399	514	10962	3.566
Lanesborough (Co Longford)(2)	60	208.1	4701	1946	6647	3.194	148	6796	3.266
Bellacorick (Co Mayo)	40	102.4	2535	2328	4863	4.749	124	4988	4.871
Total	350	1204.6	31510	14712	46252	3.840	998	47250	3.922

Table 5 (continued)

Station	Capacity (MW)	Units sent out millions Kwh	Costs (000s £)						
			Non Capital				Depreciation	Total	Total per unit pence
			Fuel	Other	Total	Pence			
Sod Peat									
Allenwood (Co Kildare)	40	101.5	3194	2605	5799	5.713	4	5803	5.717
Portarlington (Co Laois)	37.5	61.4	1880	1890	3770	6.140	10	3780	6.156
Cahirciveen *et al* (3)	20	24.5	1279	1595	2874	11.731	3	2877	11.743
Total	97.5	187.4	6353	6090	12443	6.640	17	12460	6.649
Total Peat	447.5	1392.0	37863	20802	58695	4.217	1015	59710	4.290
Coal (Arigna)	15	44.7	1645	962	2607	5.833	7	2615	5.850
Gas (Marina)(4)	205	1388.0	21990	4234	26224	1.889	786	27010	1.946
Gas (Aghada)	440	2347.9	35007	2867	37694	1.605	3501	41195	1.755
Total	645	3735.9	56997	6921	63918	1.711	4287	68205	1.726
Imports	-	3.8	-	-	107	2.816	-	107	1.816
Grand Total (5)	3287.5	9834.4	232615	57287	289933	2.949	15482	305415	3.106

Note: All output and costs are ex generating unit; they do not include transmission and customer service elements. Items may not sum to totals shown because of rounding errors.

(1) This unit consumed 622.0 million units for pumping. In order to deliver 389.5 million units (peak).
(2) One of the two boilers in this station burns sod peat: total MW capacity and units sent out listed under milled peat.
(3) Includes 4 stations - Cahirciveen (Co Kerry), Gweedore (Co. Donegal), Miltown Malbay (Co. Clare) and Screeb (Co. Galway), all burning hand-won sod turf.
(4) The station at Marina, Cork has 120 MW of dual purpose capacity which will burn oil or gas (listed above under 'Gas').
(5) Entries do not in some cases add exactly to totals because of rounding in the allocation of some costs.

Source: ESB Annual Report 1981-82.

APPENDIX 2

NATIONAL FINANCIAL ANALYSIS OF THE OPTION TO PIPE KINSALE GAS TO DUBLIN

We examined the potential market for gas in Dublin and attempted to quantify sales and revenue based on a possible selling price. Capital and Current costs were also estimated. Subtraction of these costs, including payment to Marathon from total revenues gives the net cash flow, which is in fact the stream of rents. A twenty year time span was used which is the official known life of the Kinsale field at present. The results will be enhanced if the life span is longer. As mentioned in the main part of the Chapter, the "without piping Kinsale gas to Dublin" situation was ignored on the grounds that closure of the gas industry is a cost overall and the "with" situation emerges as a benefit overall. There is consequently no need to net out the "without" situation for the correct conclusion to be drawn. An estimate has been made by Coopers and Lybrand of the cost of closing down the Northern Ireland gas undertakings. Their estimate of the cost of converting appliances, and of operating losses is some £80 million, undiscounted and not taking account of the loss of consumers' surplus. Since the Northern Ireland gas undertakings have roughly the same number of customers and level of sales as Dublin Gas, this estimate gives us an order of magnitude and suggests that the costs would be considerable.

Table A2.1 sets out the twenty year profile of the option. The year elapsing from the date when the decision to proceed is made and announced is year 1. Values are at September 1979 prices, the 1979 annual accounts of the Dublin Gas Company having been the most recent source of data on gas distribution costs. We now describe each item in turn as it appears in Table A2.1.

Sales and customers

Total sales of all energy in Ireland might rise on average by 2 to 3% per annum over the next decade or so. If the price of natural gas delivered to the final consumer is close to that of near substitutes, we might expect it to increase its market share by regaining ground recently lost while its price escalated relative to other fuel prices. While not in a position to do the full market analysis, we can undertake a few checks on the level of growth that is likely.

We might start by estimating total non-transport energy consumption in Dublin. One approach is to scale down national primary energy consumption, excluding transport by Dublin's share of income, in the cases of households and of commerce, or by Dublin's share of Net Output, in the case of industry, as shown in the following table.

Table A2.1

Twenty year national profile of the proposal to pipe Kinsale gas to Dublin (values expressed in September 1979 prices)

Year	Decision + Announcement	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
		← build pipe →			← convert appliances → Natural gas arrives																
Sales (m therms)	28.5	30.8	33.3	36.1	39.0	42.2	45.8	49.4	53.4	57.7	62.5	67.8	73.1	79.0	85.5	92.5	100	100	100	100	100
Customers (000)	150.862	153.5	156.3	159.1	161.9	164.8	167.7	170.7	173.7	176.8	179.9	183.1	186.4	189.7	193.1	196.5	200	200	200	200	200
Appliances Sold (000)	4.5	16.52	16.73	16.73	16.73	16.87	17.0	17.0	17.13	17.13	17.13	17.27	17.4	17.4	17.53	17.53	17.87	13.0	13.0	13.0	13.0
Natural Gas bought by Dublin (m therms)					47.297	49.81	52.40	55.38	57.72	61.15	66.2	71.71	77.51	83.75	90.87	98.11	106	106	106	106	106
											(£ million)										
REVENUE (80p/therm rising 1% p.a.)		16.48	20.18	22.10	24.11	26.35	28.78	31.46	34.35	37.49	41.01	44.80	48.80	53.41	58.38	63.80	69.66	70.35	71.06	71.77	72.49
CAPITAL COSTS																					
Pipeline		21.6	21.6	21.6																	
Adaptation of Micro-Simplex Units		0.37	0.37	0.37																	
Conversion of Customer's Appliances			0.3	7.7	2.6	2.6	2.6	2.6	1.8												
Inspection of Joints		0.31	0.31	0.31	0.33	0.31	0.31	0.31	0.31												
Orbital Main & City Gate-Works Main		6.33	8.33	8.33																	
CURRENT COSTS																					
Feedstock Costs:																					
Naphtha		14.88	16.40	18.14																	
Natural Gas (6.4p/therm rising 2% p.a.)		0	0	0	3.15	3.38	3.63	3.91	4.18	4.50	4.97	5.49	5.05	6.67	7.36	8.12	8.95	9.13	9.31	9.50	9.69
Non feedstock costs:																					
Other manufacturing		2.53	2.74	2.97	2.67	2.31	1.87	1.35	0.73												
Distribution, incl. renewal of mains & services		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
Maintenance of customers' appliances & meters		1.69	1.72	1.75	1.78	1.81	1.84	1.88	1.91	1.94	1.98	2.01	2.05	2.09	2.12	2.16	2.2	2.2	2.2	2.2	2.2
Marketing & installation of customer appliances		2.15	2.17	2.17	2.17	2.19	2.19	2.21	2.21	2.23	2.23	2.25	2.26	2.26	2.28	2.28	2.30	1.69	1.69	1.89	1.69
Other incl. administration, meter reading, bills etc.		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0
NET CASH FLOW OR RENTS		-39.4	-39.6	-47.3	5.4	7.7	10.3	13.1	17.4	22.8	25.8	29.0	32.5	36.4	40.8	45.2	50.2	51.4	51.9	52.4	52.9

NB: Figures are subject to revision.

Table A2.2

Estimating Dublin's share of primary energy consumption, 1980

	National Primary Energy consumption[1] excl. transport (MTOE)	Dublin's share[2] of income (%)	Dublin's consumption (MTOE)	(M therms)
Households	2.695	37	0.997	396
Commerce	1.076	45	0.484	192
Industry	2.694	42	1.131	449
Total non-transport	6.465	40	2.612	1037

[1] Department of Energy, Energy in Ireland, 1980, Dublin.

[2] M. Ross, ESRI. Personal Communication. Dublin means County Dublin including Balbriggan and excluding Bray. The statutory area of the Dublin Gas Company excludes Balbriggan and includes Bray, however Bray has a larger population than Balbriggan.

By this method total primary energy consumption in Dublin excluding transport is some 1,000 million therms. The existing gas supply area only covers part of the statutory area, however we are more interested in the total potential market than with existing boundaries, legal or otherwise. Neither are we concerned about the issue of whether one company or several service the area. We note that in other European countries, where gas was priced rather low, it captured 20 or 30% or more of the total primary energy market. Broadly speaking if the price is reasonable one can say that gas should capture at least 10% of the primary energy market, that is 12½% of the non-transport market. For Dublin this would amount to at least 125 million therms.

Approaching the question from a different angle, we note that the ESB have 335,579 customers in Dublin City, Dublin Northeast and South consuming 100 million therms of electricity. It might be reasonable to expect Dublin Gas to have at least 200,000 customers or 60%, compared with the current 150,000. Consumption per domestic customer might be some 300 to 400 therms of gas per year on average. Although it is not very helpful to compare Dublin with Britain, owing to Britain's higher income and lower gas prices, we note that average domestic consumption there was 555 therms in 1979/80. Gas consumption per industrial/commercial customer in Dublin in 1979 was over 2000 therms per year. If the price of gas and quality of service are competitive, one could foresee a situation in a decade or so where 180,000 domestic customers and 20,000 industrial/commercial customers consume a total of 100 million therms of gas. This would be 10% of Dublin's present non-transport energy consumption, compared with the current 2.3%.

If sales of 100 million therms are achieved by year 16, this implies an average annual growth of 8 or 9%. We note that this is the rate experienced by LPG sales over the last decade in spite of charging well above gas oil prices and close to towngas prices.

If we try to estimate the market by means of price and income elasticities there is the problem that we have no estimate for the price elasticities of demand for gas in Ireland. Own-price elasticities of demand for gas have been variously estimated

abroad by Deaton (1975) for example, giving values of -1 to -3, which we can try out. If the price of gas is initially reduced by say 30%, consumption will become 35 to 55 million therms (or 29 to 42 million therms based on 1981 sales). If the price of gas from then on rises at a general delivered energy price rise of 1% say, if average annual GNP growth is 1% to 3% per year, and if price and income elasticities for all energy are about -.5 to 1.4 respectively, then annual growth in gas consumption might be 1 to 3½% per year. Consumption in year 16 would then be 40 to 95 million therms (34-73 million therms based on 1981 sales). In a situation where the base is artificially low (the option of gas has not been available in many new housing estates), where price change is sizeable and where almost a "quality" change occurs in the product, this approach might not be very relevant. It also does not allow for growth in the statutory area.

Our attempts to estimate the market using the rather broad information available to us point to a market of 100 million therms by year 16. This is the figure we used in this preliminary analysis. However, more detailed studies have been undertaken by the Dublin Gas Company and by the Department suggesting that the Dublin market for gas may be larger and quicker to grow but with lower prices than ours.

Revenue

We assume an average selling price of 60 pence per therm in September, 1979 prices starting in year 2. We suggest that the price will rise in line with the delivered price of other fuels taken to be about 1% per year in real terms, on the grounds that crude oil might rise by 2% on average. At an average of 60 pence per therm, gas would be competitive given its advantages namely that it requires no storage, no reordering, no prepayment, no ash removal and is easily controlled. As shown in the following table which summarises domestic prices in pence per therm, it would be more expensive than gas oil though it would match the price of LPG, which has had such a large growth recently.

Capital Costs

Pipeline: An 18" diameter gas transmission pipeline of 150 miles in length laid from east of Cork to Dublin was estimated by the Irish Gas Board in 1980 to cost approximately £65 million at September 1979 prices. This amounts to £0.43333 million per mile and is consistent with the costs incurred by the Board in 1977 when they constructed the 34 mile East Cork pipeline at a cost of about £18 million. Costs have risen since then. However the proposed Cork Dublin pipeline has a smaller diameter, the East Cork line being mainly 24". The length may in fact be less than 150 miles, and there may be economies of scale in laying such a length, though we have no evidence of this. In fact a mere 12" pipe would be satisfactory for the needs of Dublin gas and in this respect we have over estimated the cost of this allocation.

Estimates of the construction time range from 3 years down to 6 months. We have used 3 years.

Adaptations of Micro-Simplex: These manufacture towngas out of Naphtha. When the natural gas arrives and until the consumers' appliances have been converted to use natural gas, the natural gas needs to be modified to resemble existing towngas.

Table A2.3

Prices of domestic heating and industrial fuels in July 1982 expressed at current and at September 1979 prices

		p/therm[1] at current prices	p/useful therm[1] at current prices	p/useful therm at Sept. 1979 prices[2]
Electricity	Dom	101.4-196.3	112.5-196.3	68.8-120.1
	Ind	101.4-254.9	112.5-254.9	68.8-155.9
LPG	Dom	117.5	143.3-180.8	87.6-110.6
	Ind	70.6-115.8	78.5-178.1	48.0-109.0
Gas oil/Kero	Dom	60.9- 72.1	81.2-110.8	49.6- 67.7
	Ind	61.2	81.8- 94.4	50.0- 57.7
Turf/Coal Anthra	Dom	30.0- 52.7	39.9-117.2	24.4- 71.7
	Ind	22.0- 37.5	29.3- 57.7	17.9- 35.3
Gas	Dom	145.0-172.3	177.0-229.7	108.2-140.5
	Ind	130.4-145.0	144.7-223.3	88.5-136.6
Gas price proposed: (i.e. 60p average at Sept. 1979 prices)		98.1	119.6-150.9	73.2- 92.3

[1] These prices were taken from Comparisons of Energy Costs, Domestic Fuels, and Commercial/Industrial Fuels, by the IIRS. Cooking is omitted in the price per useful therm.

[2] The CPI rose by roughly 63.5% between September 1979 and July 1982.

The Micro-Simplex Units can be adapted to do this. The cost of their adaptation was put at £0.85m by the British Gas Corporation in April 1977. We assume £1.1m in September, 1979, spread over the pipeline construction period, that is £0.37m for each of years 1 to 3.

Conversion of Customers' Appliances: An estimate of £11.15 million was made in 1977 by the British Gas Corporation, spread over 7 years. This would be £14m at September 1979 prices. Recent estimates give £20 million. This works out at £133 per customer. In fact, of the 240,000 appliances held, roughly 80,000 are already natural gas appliances converted to use existing towngas. To reconvert them to natural gas might take about an hour of labour. We have used £20 million spread over 7 years.

Inspection of Joints: An estimated £2.5 million will need to be spent on inspecting the joints in the distribution system, possibly over the first 8 years.

Orbital Main and Main from City Gate to Ringsend Works: We used a combined cost of £25 million spread over 3 years. We omitted a terminal value for the transmission and distribution systems in year 20. Capital costs of distribution to the suburbs, amounting to £60 million, is included under 'Distribution' below.

Capital costs

Feedstock Costs: Naphtha. We used a figure of 47.35 pence as the cost of naphtha per delivered therm of towngas rising 2% per annum in real terms, until year 4 when naphtha purchases cease. This assumes 356 manufactured therms per tonne of naphtha and 12% "unaccounted for gas".

Insofar as naphtha would still be bought in the "without" situation, while the industry was in the process of being phased out, at least part of this item should be omitted.

Feedstock Costs: Natural Gas. The landed price in 1980 was 6.4p per therm according to Petroleum Royalties of Ireland. We assume a 1% per annum real price rise till year 4 and 2% from then on. The process of natural gas conversion, in operation until consumers' appliances are adapted, operates at 90% efficiency. We assume that unaccounted for gas reduced from 12% to 6% by year 9.

Non-feedstock Costs: Detailed information on past current costs, excluding feedstock, is available in the Dublin Gas Company's annual accounts. The relevant items for selected areas 1968 to 1979 are given in table A4 below, converted to 1979 prices. 1968 to 1973 were the years when sales grew by 7.6% per year on average. Sales declined by 3.8% per year on average from then until 1979 and by 10.9% per year since.

Manufacturing: This amounted to £2.33m in 1979 or 8.22 pence per therm sold, the latter figure approaching double the 1973 cost in real terms. We use 8.22 pence per therm and ignore potential economies of scale. This item disappears after year 8 when no manufacture or conversion of gas is required.

Distribution Including Renewal of Mains and Services: This item amounted to approximately £1.5m in real terms during the past three years. We have doubled it to £3 million per year or £60 million over the 20 year period.

Maintenance of Customers' Appliances and Meters: This item has remained fairly constant at £1.6m in real terms since 1968, or between £10 and £11 per customer per year. Customers were not charged directly for maintenance though customers are now being asked to pay a nominal charge. However, we have assumed £11 per cutomer.

In fact, slot meters are also being phased out which would save an estimated £0.21 million. So we can expect our figure to be an over estimate.

Marketing and Installation of Customers' Appliances (including one year guarantee from purchase): This item in the past does not appear to have been related to any variable in particular. In 1973 when sales of appliances rose dramatically to nearly 20 thousand, marketing and installation cost per appliance sold was £82 in real terms. This presumably included a portion of overtime working. In 1979, only 4½ thousand appliances were sold and the marketing and installation costs per appliance amounted to £177. As frequently happens in such circumstances, this department appears not to have contracted prorata with contracting sales. Total expenditure halved but appliances sold fell to a quarter. We assume a cost per appliance sold mid way between the two costs above, namely £130. We also assume a constant 10,000 appliances sold per year to replace existing appliances (assuming a 24 year life for the existing 240,000 appliances). As for additional appliances we might assume about another 60 thousand appliances over the twenty years, or 3,000 per year. This would give 200,000 customers owning 390,000 appliances, conforming to the pattern of current customers, who have 1.6 appliances each. This is probably an underestimate. Total appliances sold are given in row 3 of Table A2.1.

Table A2.4

Current costs of the Dublin Gas Company for selected years 1968 to 1979, excluding feedstock, interest and depreciation (1979 prices)

	1968	1972	1973	1977	1978	1979
Costs (£000)						
Manufacturing	1,783.1	1,441.0	1,569.0	2,148.9	2,549.9	2,329
Distribution	702.2	1,124.2	1,203.1	1,545.7	1,535.3	1,572
Maintenance	1,569.9	1,649.1	865.4	1,692.1	1,688.3	1,592
Marketing	463.2	565.2	1,594.8	958.7	873.1	801
Other	2,364.0	1,618.0	2,417.9	2,463.1	2,525.5	2,538
Total costs	6,882.4	6,397.5	7,650.1	8,808.5	9,172.1	8,832
Total excl. manuf.	5,099.3	4,956.5	6,081.2	6,659.6	6.622.2	6,503
Total excl. manuf. & mktg.	4,636.0	4,391.3	4,486.4	5,700.9	5,749.1	5,702
Costs per customer (£)						
Manufacturing	12.08	9.77	10.25	13.65	16.59	15.44
Distribution	4.76	7.62	7.86	9.82	9.99	10.42
Maintenance	10.64	11.18	5.66	10.75	10.98	10.55
Marketing	3.14	3.83	10.42	6.09	5.68	5.31
Other	16.02	10.97	15.80	15.65	16.43	16.82
Total costs	46.63	43.36	50.00	55.96	59.67	58.54
Total excl. manuf.	34.55	33.59	39.75	42.31	43.08	43.11
Total excl. manuf. & mktg.	31.41	29.76	29.32	36.22	37.40	37.80
Costs per therm (p)						
Manufacturing	7.19	5.07	4.39	7.44	8.22	8.22
Distribution	2.83	3.96	3.36	5.35	4.95	5.55
Maintenance	6.33	5.81	2.42	5.86	5.44	5.62
Marketing	1.87	1.99	4.46	3.32	2.82	2.83
Other	9.53	5.70	6.76	8.53	8.14	8.96
Total costs	27.74	22.52	21.38	30.50	29.57	31.16
Total excl. manuf.	20.55	17.45	17.00	23.06	21.35	22.95
Total excl. manuf. & mktg.	18.69	15.46	12.54	19.77	18.53	20.12
Marketing per appliance sold (£)	37.97	45.69	81.51	217.89	221.72	177.06
Miscellaneous						
Number of customers (000)	147.59	147.55	153.00	157.40	153.72	150.86
Sales (million therms)	24.81	28.41	35.78	28.88	31.02	28.34
Appliances sold (000)	12.20	12.37	19.57	4.40	3.94	4.52
Consumer Price Index, 1979=100	27.20	32.20	42.64	79.90	86.24	100

Other Including Administration, Meter Reading, Bills etc.: Over the period for which we have data, this item has risen from about £2.4m to £2.5m, with one unexplained dip to £1.6m in 1970. Looking at the years of high growth, 1968 to 1973, this item is somewhat erratic and does not appear to be related to numbers of customers. We therefore assume a constant £3 million.

Net Cash Flow or Rents: These are the net benefits obtained by subtracting total costs from total revenue in each year.

Results: The net cash flow of Table A2.1 gives an internal real rate of return of 13.77% and the following net present values and annuity values for selected real discount rates.

Table A2.5

Net present values and equivalent 20 year annuity values (£m 1979 prices)

	Discount Rates				
	3%	5%	7%	10%	13.77%
Net present value	245.8	167.7	109.6	48.4	0
Equivalent annuity value	16.0	12.8	9.7	5.2	0

At 5% real discount rate, £167.7 million is the present value of the rent (at September 1979 prices) accruing to the nation from the 20 year allocation of Kinsale gas to Dublin, as outlined in Table A2.1. The rent is negative in the initial years and positive and growing in later years. If we want to find the overall rent per therm we can divide the net present value of the rent by the sum of the discounted quantities.[1] However, in other gas allocation options the rents per therm might grow with world energy prices expressed in Irish currency, so for comparative purposes the rent per therm in this allocation must do the same, then we can compare the initial rents. The program can calculate the initial rent by asking: what is the break-even initial landed price, (that is the price which gives zero net present value) which rises 2% per year say, which gives us our required real rate of return, say 5%? The answer is 24½ pence (or 34 pence in 1981 prices) implying an initial rent of about 18 pence per therm (26 pence per therm at 1981 prices) after Marathon's 6.4 pence have been subtracted. Initial prices and rents for selected real rates of return are as follows:

[1] Since NPV of the rent $= \Sigma_t \frac{1}{(1+i)^t} rq_t$ Where r = rent per therm, a constant; q = quantity of gas consumed in year t in therms; i = rate of discount

then $r = \frac{NPV}{\Sigma_t \frac{1}{(1+i)^t} q_t}$

Table A2.6

Approximate initial breakeven landed price and rents
(pence per therm at September 1979 prices)

	Internal real rate of return				
	3%	5%	7%	10%	13.77%
Breakeven landed price	27.5	24.5	21.0	15.0	6.4
Rent	21.1	18.1	14.6	8.6	0

Note: Landed prices and rents rising at 2% per year in reel terms.

If for some reason the price charged has to be reduced, in such a way that the stream of revenue reduces permanently to 70% of that given in Table A2.1, then the internal real rate of return on the allocation drops from 13.77% to just over 5½%. This would arise if for example the average price charged were reduced not by 30% but by 50% of recent (pre Kinsale gas) towngas prices, such that it would be on a par with gas oil for example. If on the other hand, with the selling prices given in Table A2.1, sales only reached 70% of the given level, the drop in revenue would be partially offset by a reduction in expenditure on feedstock, such that the internal rate of return would be 7½%.

Alternatively, if, in a situation of prolonged constant real energy prices, the price paid to Marathon and the final selling price remained constant in real terms, the internal rate of return would drop from 13.77% to 12%.

Finally combining the two "worst" eventualities, that the selling price is reduced to 70% of that given in Table A2.1 and energy prices remain constant, the internal rate of return drops to 4%.

Clearly, the single event with the worst effect on the rate of return is the permanent reduction in the selling price.

The price that the Dublin Gas Company could pay

It can be argued that the rent should accrue to the nation rather than to the people or companies who happen to live on the pipeline route or receive an allocation. If this principle is accepted, it follows that the Dublin Gas Company should only earn some "normal" level of profits. This may be expressed as some "normal" internal real rate of return. To calculate the price which Dublin Gas could pay, we can undertake similar calculations to those above, but include only the costs which Dublin Gas directly incurs. This means excluding the pipeline costs in Table A2.1. For selected internal rates of return we can ask: what is the breakeven price of natural gas Dublin Gas can pay? The following table shows the results based on the information in Table A2.1, by way of illustration.

Table A2.7

The breakeven price Dublin Gas can pay (pence per therm at September 1979 prices)
based on Table A2.1

	Internal real rate of return			
	3%	5%	7%	10%
Breakeven price	33	31	29	26

Note: Breakeven price rising at 2% per year in real terms.

It is worth noting that, owing to the comprehensive nature of this approach, once the data are given, the price which Dublin Gas should pay is determined. In order for a lower price to emerge, Dublin Gas may be tempted to raise the estimates of the costs it will incur. This however would have the effect of reducing the rent in Table A2.1 which could in extreme cases call this entire allocation into question. With penalties on either side, the incentive to make high costings is limited.

Conclusion

We would recommend this type of approach to analysing potential allocations.

Since this initial analysis of piping Kinsale Gas to Dublin was made there have been some changes in the estimates. On the negative side, Dublin Gas sales have declined from 28½ million therms in 1979 to 22½ million therms in 1981. We also note that a lower selling price is being recommended in order to achieve a higher growth in sales. On the positive side the estimated cost of the 18" pipeline has been halved and construction time has been reduced to a third so that expensive naphtha purchases can cease after one year instead of after three. While the rent per therm might be reduced from that given in Table A2.6, this allocation still pays a good rent.

APPENDIX 3

EQUIVALENCE FACTORS CALORIFIC VALUES AND UNITS

K = Kilo = 1 thousand = 10^3
M = Mega = 1 million = 10^6
G = Giga = 1 thousand million = 10^9
T = Tera = 1 million million or 1 trillion = 10^{12}
TOE = Tonne of oil equivalent = 10^7 Kilocalories
BTU = British Thermal Unit, 100,000 BTU = 1 therm
Wh = Watt-hour = 3.412 BTU
J = Joule, 1 GJ = .948 MBTU

		TOEs	MWhs	GJs	Therms
1 TOE	=	1	11.63	41.84	396.8
1 MWh	=	0.086	1	3.6	34.13
1 GJ	=	0.024	0.278	1	9.48
1 M Therms	=	2520	29300	105400	10^6

1 TOE	=	0.978	tonnes of crude oil
	=	0.939	tonnes of gasoline
	=	0.947	tonnes of kerosene
	=	0.967	tonnes of gas diesel oil
	=	1.015	tonnes of residual fuel oil
	=	0.888	tonnes of LPG (liquid petroleum gas)
	=	5.376	tonnes of milled peat
	=	3.195	tonnes of sod peat
	=	2.257	tonnes of briquettes
	=	1.504	tonnes of coal
	=	83,333	cu.ft. or 2,360 cu. metres of towngas
	=	43,614	cu. ft. or 1 235 cu. metres of Kinsale natural gas (1 million cu. ft. per day = 8369 TOE per year)[1]
	=	7.300	barrels of crude oil (varies with product)
	=	2.63	tonnes of wood (dry matter) — deciduous[1]
	=	2.41	tonnes of wood (dry matter) — coniferous[1]

[1]Net calorific Value Basis.

1 TOE = 41.84 GJ = 10^7 kCals = 40 MBtu
1 kWh = 3.6×10^3 kJ
1 EJ = 24 MTOE
1 PJ = 0.024 MTOE
1 Quad = 25.32 MTOE
1 bb1/day (crude) = 50 t/year
1 bb1 = 35 gals *or* 159 litres (approx.)

Sources: Department of Energy 1980, Energy in Ireland, Oct.-Dec. 1980.
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