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Fuel and Power in Ireland: Part III

International and Temporal Aspects of Energy Consumption

by

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Contents

General Conclusions

Actual and predicted levels of energy consumption are shown in Table 7 appended.

For most countries predictions differ considerably from actual levels of consumption although the overall explanation is in both cases reasonable. The differences may arise through one or more of several causes. Important (and perhaps unmeasurable) variables may have been omitted; the assumed simple linearity of the relations may not be sufficiently close to the truth; or the cause may be the inherent errors, omissions, and inconsistencies in the explanatory variables.

On the first count, visual inspection of the energy predictions suggests that those countries with large indigenous resources of energy use more than their predicted quantities (see Charts 1 and 2 appended). This is particularly apparent for the 39 countries, where the USA, Canada, the UK, Belgium and Venezuela all exceed predictions, while Italy, France, the Netherlands, New Zealand and Switzerland all consume less than their predicted amounts; Germany is an exception. However, it seems difficult to construct a valid measure of resource availability since so much depends on the relative cost of exploiting whatever indigenous resources there may be. The problem is difficult to circumvent without comparative price data and even then it would be necessary to assume the absence of physical constraints. Unless and until the effects on consumption brought about through the availability of indigenous resources have been suitably measured and taken into account in the regressions it is well-nigh impossible to consider what other important variables have been omitted.

The second count is the possibility that the relations are not linear. This is very difficult to assess because those countries for which the explanation afforded by the regressions is worst are the same countries for which a better explanation would be afforded if the effects of indigenous resource availability were taken fully into account. In general, non-linearities become evident as increasing divergences at the limits of the distributions and these countries tend to lie towards the limits. Ireland, fortunately, lies in the central regions of the scatters of points, where predictions would tend to be less affected by non-linearities.

On the third count the possible errors in the explanatory variables must be considered. The main possible source of error seems to arise in the conversion of the values in national currencies of the Gross Domestic Products of different countries into a common unit of currency. Not only may errors from this source be significant but the chances are that they will also be systematic, i.e. that they will influence the estimates of similar types of countries in similar ways. These errors cast doubt on the usefulness of predictions made from the regression equations.

Finally, and quite separately, the data relating to the energy consumptions of different countries are themselves suspect. Random error in the explained variable is of little account, because regression analysis is a means of seeing through it, but systematic errors could be present: in the conversion of fuels into a common unit, and in the neglect of energy from non-commercial sources. Little can be said about the effects of these errors for if it were possible to assess their effects it would be possible to avoid them.

In conclusion it should be remarked that although these regression models are used elsewhere (see Part I) for forecasting, their use in this way has not been justified. They take no account of secular movements, like advances in technology, that affect all countries to a similar if not necessarily to the same extent. The chances, are, therefore, that over time the regression planes themselves are changing position.

CHART 1 (appended to Part III, Section 1): Cross-Section Regression Analysis of Energy Consumption per head in 39 countries (not all shown) in 1962: Actual and Predicted levels of Energy Consumption plotted against Gross Domestic product per head.

*Note: prediction uses four variables, of which only GDP is shown here.

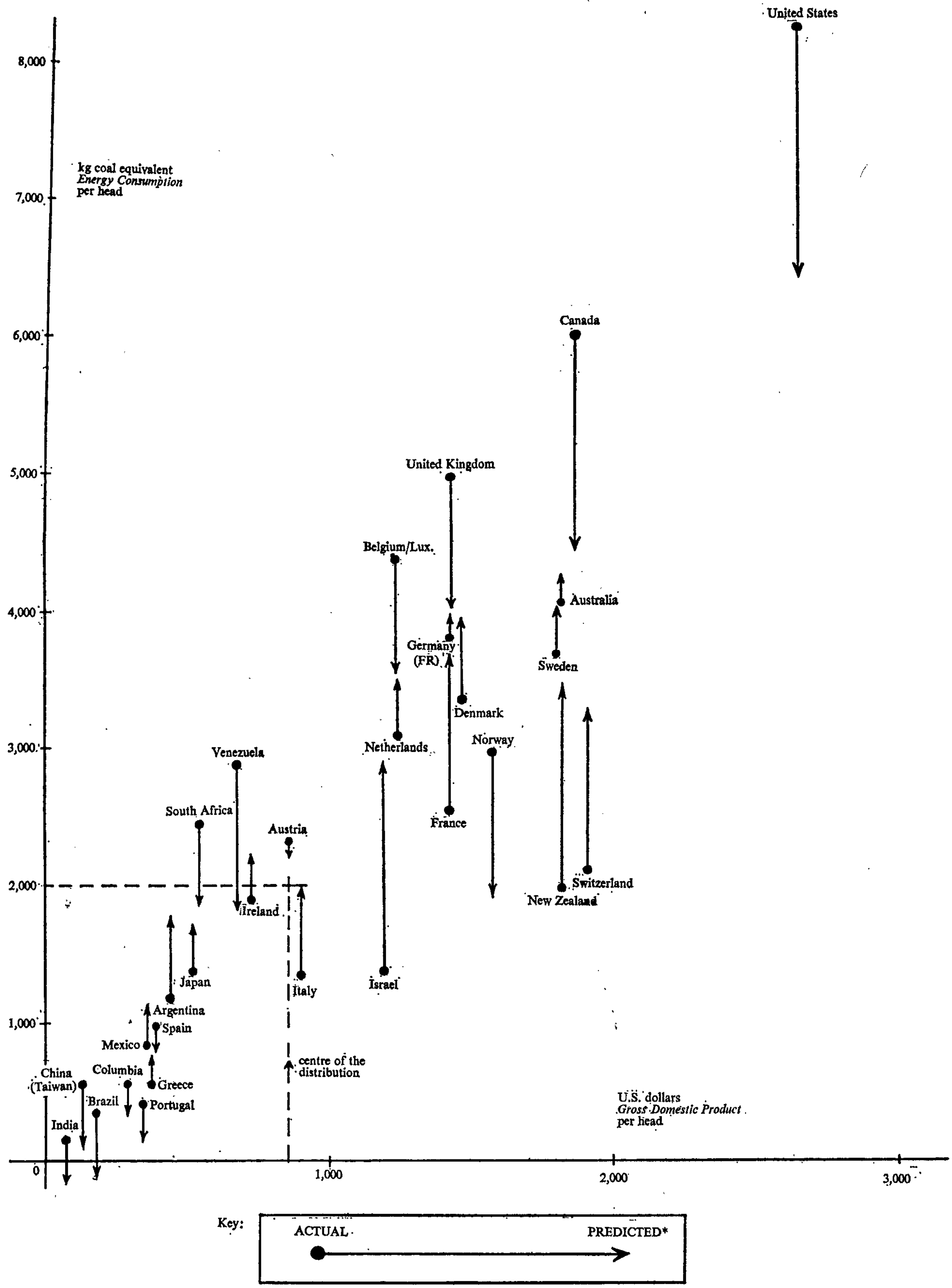

CHART 2 (appended to Part III, Section 1): Cross-Section Regression Analysis of Energy Consumption per head in 16 European Countries in 1962: Actual and Predicted levels of Energy Consumption plotted against Percent Agriculture in Gross Domestic Product.

*Note: prediction uses three variables, of which only the share of agriculture in GDP is shown here.

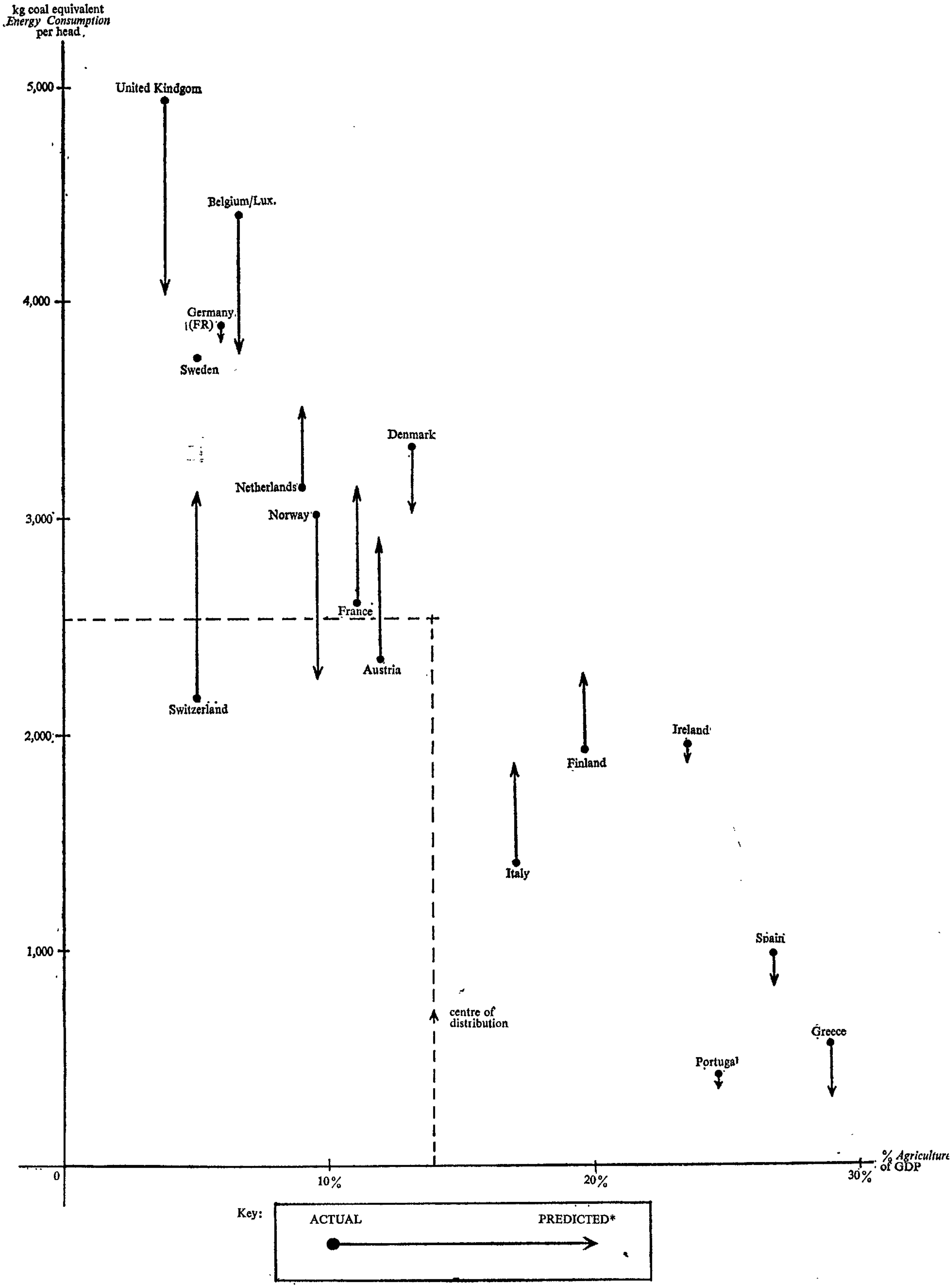

TABLE 7 (appended to Part III, Section 1): DATA USED AND RESULTS OF CROSS-SECTION REGRESSION ANALYSES OF ENERGY CONSUMPTION IN 1962 FOR 39 COUNTRIES OF THE WORLD AND FOR 16 EUROPEAN COUNTRIES

Country	$ GDP per head[1] X_1	% Agr. of GDP[1] X_2	% Hydro of All Energy X_3	Climate Index X_4	Energy Cons. per head[2] Y	Predicted Energy Consumption	
						39 Countries Regression	16 European Countries
Austria	·850	11·8	7·5	2	2·349	2·265	2·913
Belgium/Lux.	1·250	6·7	0·0	2	4·397	3·603	3·774
Denmark	1·492	13·0	0·8	2	3·343	3·923	3·049
Finland	·770	19·7	13·6	3	1·945	1·893	2·293
France	1·437	(11·0)	3·6	2	2·591	3·679	3·157
Germany (F. Rep.)	1·439	(6·0)	0·9	2	3·884	3·935	3·815
Greece	·374	28·6	1·6	0	·584	0·796	·315
Ireland	·755	23·4	1·7	2	1·948	2·226	1·869
Italy	·917	16·9	7·2	1	1·410	2·032	1·871
Netherlands	1·250	9·0	0·0	2	3·152	3·562	3·521
Norway	1·608	9·5	42·3	3	3·025	1·991	2·267
Portugal	·352	24·4	11·8	0	·416	·207	·369
Spain	(·385)	26·6	6·5	1	·987	·850	·832
Sweden	1·833	(5·0)	16·8	3	3·755	4·062	3·782
Switzerland	1·951	(5·0)	21·8	2	2·128	3·302	3·089
United Kingdom	1·454	3·9	0·4	2	4·948	4·032	4·066
United States	2·691	(4·0)	1·4	2	8·263	6·421	
Canada	1·887	6·9	11·5	3	6·015	4·458	
Columbia	·285	33·6	4·1	0	·576	·380	
Mexico	·361	(19·0)	2·2	1	·916	1·197	
Puerto Rico	·825	11·1	0·7	0	1·700	2·051	
Venezuela	·701	(7·0)	0·3	0	2·917	1·901	
Argentina	·462	21·1	0·5	2	1·194	1·758	
Brazil	·179	28·2	9·6	0	·367	—·070	
Chile	·422	9·8	5·4	2	·970	1·579	
Peru	·173	(22·0)	5·8	0	·390	·258	
Israel	1·232	10·1	0·0	0	1·398	2·917	
Turkey	·272	40·1	1·7	1	·281	·681	
China (Taiwan)	·121	29·1	4·2	0	·568	·127	
India	·073	45·1	2·0	0	·161	—·114	
Indonesia	·073	56·1	0·9	0	·117	—·239	
Japan	·551	14·2	6·1	2	1·388	1·715	
Korea	·110	36·9	1·0	1	·328	·458	
Pakistan	·074	53·9	2·3	0	·075	—·284	
Phillipines	·125	33·0	3·4	0	·169	·116	
Australia	1·843	12·5	1·7	1	4·070	4·278	
New Zealand	1·860	(22·0)	17·6	2	1·957	3·476	
Rhodesia and Nyasaland	·178	21·7	11·5	1	·415	·222	
South Africa	·554	(10·0)	0·0	1	2·437	1·870	

Notes: ( ) indicates estimate.

[1]Gross Domestic Product measured at factor cost, as also Agricultural Output with the exceptions of Mexico, Venezuela, Peru, France and Germany, where it is measured at market prices. For the United States the share of Agricultural Output is its share in Net Domestic Product.

[2]Energy Consumption measured in tons of coal equivalent a year.

For further information see text.

SECTION 2: ENERGY CONSUMPTION IN IRELAND 1950-1963, AND SOME ECONOMIC ASPECTS

Table 10 appended to this section gives details for each year from 1950 to 1963 inclusive of the quantities of fuel and hydro-electricity consumed in Ireland. In the lower part of the table the contributions from the different sources are converted into common units and aggregated to give the total energy consumed. The common unit adopted here is the British Thermal Unit (Btu), the amount of heat required to raise the temperature of one pound of water by one degree Fahrenheit. This is a very small amount of heat and large multiples must therefore be used; a convenient multiple is the billion, or million-million.

The conversion factors used for the different fuels are given in the notes to the table. It will be seen that imported coal is taken to have an average net calorific value of 25·8 million Btu's; this figure can be used as a divisor to calculate energy consumption in "coal equivalent" tons (which is done for annual totals in Table B). As conversion factors the "net" calorific values of the various fuels have been used. Net calorific values differ from gross values by the amounts of heat that escape in the steam produced by the burning of hydrogen contained in the fuel. The difference varies, therefore, with the fuel's content of hydrogen; it is significant in the case of oil, gas and turf but much less so in the case of coal. No account has been taken, in calculating conversion factors, of the efficiencies at which fuels are consumed; each fuel has been assumed to be worth as energy the whole of its net heat content. Hydro-electricity, however, has been treated differently (and the procedure adopted from here on is the opposite of that used in Section 1). The procedure followed has been to calculate how much fuel would have been used in each of the years considered to generate the amounts of hydro-electricity produced. This is a procedure much better adapted to the situation where the amount of hydro-electricity produced varies from year-to-year, because such variations have to be compensated for by increase or decrease in the amounts of thermal electricity produced and, consequently, in the amounts of fuel used for generating electricity. In Ireland the maximum variation on this account has been of the order of a quarter of a million tons of coal a year, roughly 5% of the total energy consumed.

There are no statistics available of the quantities of coal consumed in Ireland and recourse has had to be made to production statistics and to statistics of international trade in coal and other solid fuels (coke and briquettes of coal). The sum of the year's domestic production and of net imports of solid fuels during the year has been taken as total consumption of solid fuels, although in reality the sum refers to the amount available for consumption and takes no account of stock changes.

Turf consumption data have been supplied by Bord na Móna and the figures relate to that Board's sales of turf during each of the calendar years in question. No account has been taken of changes in retailers' and in consumers' stocks during the year but these are unlikely to have been of much significance. The figures for hand-won turf production are those estimated annually by the Gardaí and shown in statistics of agricultural production; they are probably not very reliable and in any case relate to production rather than consumption.

The figures for the consumption of oil products used as fuels are more reliable. They refer to deliveries made into inland consumption, including quantities used by the oil companies themselves, and have been supplied (with the permission of the companies concerned) by the firm of chartered accountants employed by the oil companies to prepare aggregate figures on their behalf. Nevertheless, these figures are difficult to reconcile exactly with import and export statistics because of differences of product classification, although there is some rough agreement between them.

In so far as has proved possible all the data relate to energy consumption within the Republic of Ireland and they exclude sales for international sea and air transport. Generally speaking, the data for 1950, 1951 and 1952 are rather less reliable than the data for later years.

Energy Consumption, 1950-1963

It is the intention here to comment on a few of the salient features of the pattern and growth of energy consumption in Ireland demonstrated by the figures in Table 10. Later on in this section their relation to the general economic development of Ireland will be discussed. Some of the aspects to be treated here have already been touched on in general terms in Section 1 which dealt with international comparisons.

The question of whether to include or exclude the use of hand-won turf in the country's energy consumption has already arisen in the previous section. For some purposes hand-won turf is best included and for others it is best left out. The reader is advised, therefore, to note carefully that the term "total energy consumption" includes this turf while the term "commercial energy consumption" excludes it.

Both commercial energy consumption and total energy consumption have, in general, increased over the period considered here (see Chart 3 appended to this section). Total energy consumption has tended to grow more slowly because the use of hand-won turf is declining. The trend rates of growth were as follows:

Total Energy
Consumption 1·5% p.a. (1950 to 1963; R^2=·51)

Commercial Energy
Consumption 3·2% p.a. (1950 to 1963; R^2=·80)
4·0% p.a. (1950 to 1955; R^2=·70)
6·7% p.a. (1958 to 1963; R^2=·99)

In that the energy data relate in the case of coal to international trade and for other forms of energy to deliveries or sales of energy they cannot be taken to refer to eventual consumption, although described as such. They may include the effects of changes in stocks, and variations during the period must be seen in this light. It is likely that stock changes were most important in the case of imported coal.

It appears that coal and therefore energy consumption in 1951 was high because of a very cold winter in 1950/51. The low level of apparent consumption in 1952 and 1953 was associated mainly with falling imports of coal; this was probably due to restrictions on the supply of coal from Britain. As a result of these restrictions, coal had had to be imported in 1951 from the USA, for the first time, but the effects of the war in Korea may have limited supplies from there in 1952 and 1953. Thus, these were probably years when coal stocks were being run down.[4] They were also years of rapid penetration by oil.

After 1953 the coal supply situation in Britain appears to have eased and coal stocks could be built up again in Ireland in 1954 and 1955, perhaps to some extent explaining the apparent rapid growth in energy consumption.

Until 1955 the economy was growing fairly steadily, at a trend rate of just over 2% a year (see Chart 4 appended to this section). This period probably marked the recovery from the depressed conditions of post-war years and the increased emphasis being given to developing Irish industries.

The next three years were years of depression. There was an overall decline in economic activity. Energy consumption slumped sharply in 1956 and 1957 although possibly not as much as the figures in Table 10 indicate. The large increase of 7·5% in 1958, which accompanied a 2·9% fall in GNP at constant prices, suggests that in this year stocks run down in previous years were replenished.[4] Fuel prices had soared in 1956 and 1957, an accidental result (as far as the Irish economy was concerned) of the Suez crisis and of the shortage of British house coal. By 1958 they had returned to more normal levels and it would have been feasible to replenish fuel stocks.

Two breakdowns of commercial energy are of interest; these are the share of indigenous fuels and the shares of each type of fuel. These are shown in Table 8.

TABLE 8: SHARES OF COMMERCIAL ENERGY CONSUMPTION BY SOURCE, 1950 TO 1963

Year	Indigenous sources	Coal	Turf	Oil	Hydro-electricity
1950	16·2	62·5	4·2	25·4	7·9
1951	16·3	62·0	4·9	25·9	7·2
1952	20·4	57·0	7·7	27·5	7·8
1953	22·3	53·4	10·0	29·2	7·4
1954	26·3	50·4	9·3	28·8	11·5
1955	21·5	50·0	9·3	33·6	7·1
1956	23·4	42·9	9·7	40·0	7·4
1957	28·9	40·2	12·5	37·3	10·0
1958	29·7	40·0	12·3	35·8	11·8
1959	26·5	43·8	13·0	35·5	7·7
1960	31·5	40·2	14·9	33·0	11·9
1961	29·1	40·1	15·9	35·3	8·7
1962	29·3	32·8	17·7	42·2	7·3
1963	28·7	30·4	18·1	44·9	6·6

These figures show some marked changes. First, production of energy from indigenous sources has almost doubled its share and in 1963 supplied nearly 29% of all (commercial) energy used. This has come about largely because of the commercial exploitation of Ireland's turf resources. Turf fuel has more than quadrupled its share of commercial energy consumption within 13 years. The other major change has been the switch from coal to oil; while coal's share of the total has fallen by more than half over the period, that of oil has increased by four-fifths. Thus, coal has lost both to turf and to oil. The latter is now Ireland's most important source of energy with a share that was just less than 45% in 1963. The share of hydro-electricity shows little trend but considerable year-to-year change on account of varying annual rainfall.

The Value of the Energy Consumed

Having seen how much energy the economy required one may ask what was the value of that energy and thus what contribution the processes of production, importation, manufacture and distribution of energy made to economic activity as a whole.

There are a number of difficulties that hinder the achieving of a valid measure of the economic importance of energy. A conceptual problem is that

[4]It is understood that coal stocked in the Phoenix Park, Dublin, may have been used as buffer supplies during this period and during the period following the Suez crisis.

the normal sectoral breakdown between manufacture and consumption of goods (and services) must be cut across: energy is not only a final good for household consumption but it is also an intermediate good in the manufacture and distribution of other final goods. One must imagine, therefore, a sectoral breakdown which separates activities involved in the supply of energy from all other activities in the economy. This raises certain practical problems in that not all of the activities associated with the provision of energy are easily identified statistically. Taxation raises a further problem: some forms of energy, like road transport fuels, carry a burden of indirect tax, while others may carry an element of subsidy in their selling prices. Thus the value of energy consumed at selling prices is not the same as the aggregate value of the factors of production involved in its supply. For present purposes the value of energy consumed will be defined at selling prices.

One is looking, therefore, for the value at selling prices of the energy supplied to the rest of the economy by concerns and enterprises involved in the provision of commercial energy. Little attention will be paid to treating consistently the small amounts of energy used in their own operations by energy suppliers themselves (e.g. transport fuels used for distribution purposes by the oil companies), except where energy is transformed for sale as a secondary form of energy. In the case of the electricity and gas industries, then, the value of these industries' outputs will be counted but not the value of the energy they themselves consume.

The enterprises concerned are the Electricity Industry, the Gas Industry, the Coal-Mining Industry, the Turf Industry, the Oil Companies and the Fuel Merchants. The total value of the energy consumed by the rest of the economy is the sum of the combined gross outputs of these concerns *after* double-counting of energy transferred from one to another has been eliminated (e.g. from the Oil Companies to the Electricity Industry).

The average selling prices of the primary fuels and of hydro-electricity were estimated (details are given in the notes to Table 11 appended) and multiplied by the quantities consumed. To the resulting totals were added the gross values of the outputs less fuel costs of the Electricity and Gas Industries. The grand totals represent approximately the values at average selling prices of the energy consumed by the rest of the economy.

The results are given year-by-year in Table 11 appended (see also Chart 5 appended to this section) and for each year they are shown as percentages of GNP at current prices (relative price changes are considered later). In 1953 for example the value of the energy consumed was between £42 million and £43 million, some 8·1% of the GNP of £526 million. By 1963 the value of energy had risen to nearly £79 million, 9·6% of the GNP for that year of £823 million. Over the whole period the figures give evidence of a slight tendency for the percentage share to increase. However, it reached its maximum in 1956, when it exceeded 10%, and since 1956 it has been fairly stable at about 9·5%.

Energy Production and Transformation as a Form of Industrial Activity

Industrial Activity may be defined here as the activities of the Sectors "Industry" and "Distribution, Transport and Communication" combined. In any year the level of activity of this combined sector may be measured as its aggregate net output i.e. value added to cost of materials.

The part of this activity that is concerned with energy supply is easy to measure. It is the value of all final energy consumed less whatever part of this total value was paid for imports of fuel, and less indirect taxes on the sale of energy (subsidies are neglected). The difference represents value that must have been added somewhere within the defined sector of Industrial Activity.

Figures for each year are given in Table 11 appended. They show that, from representing about 10% of all industrial activity in the early 1950's, energy supply has increased in importance and in 1963 represented some 13%. Its share rose as high as 14·4% in 1960 and has since declined slightly, although the effect is not necessarily significant because the data are not sufficiently reliable (nevertheless, the share of energy from indigenous sources also reached its maximum in 1960).

The general increase over the whole period is the result of increased emphasis on exploiting domestic resources of turf, of the construction of the Whitegate Oil Refinery, and of the growing importance of electricity supply. These influences are countered to some extent by the tendency for energy prices to fall in real terms (see below) and, although this is not wholly a separate reason, by the economies of scale possible in energy supply—unit costs tend to decrease as output increases. It would be difficult to sort out the incidence of these various influences.

The Importation of Fuel

More than two-thirds of Ireland's needs of primary energy have to be imported. Does this mean that an increasing load is being placed on the balance of payments account because of the growth in energy consumption?

Because of the trade in refined and semi-refined forms of energy and because of the quantities of fuel that are used for other than the purposes of inland consumption (e.g. for aviation and ocean bunker fuels), the import bill on account of the inland consumption alone of energy cannot be known with any exactitude, but it is fairly easy to estimate. Net imports of solid fuels can be multiplied by average current import prices. Similarly, for the years before 1959, the quantities of oil products in inland consumption can be multiplied by average current import prices. For the years since 1959, to the import value of crude-oil can be added and subtracted the import and export values of refined products, the quantities of these being chosen in such a way as to leave a balance equal to the inland consumption of each product. The details of the method employed are not of much interest. The results are given in Table 11 appended (see also Chart 5 appended to this section).

Fuel imports have cost Ireland of the order of £20 million each year. In 1953 the figure was £18·5 million, rising to £22·8 million in 1956, falling to £16·3 million in 1960, and growing since then by over £1 million each year (on average). As a percentage of the value of all imports (less re-exports) the effects have been much more startling. From between 10% and 11% in the early 1950's fuel's share of imports had fallen to under 7% by the first years of the present decade. Their maximum share was 12·7% in 1956, the minimum 6·7% in 1962 and in 1963.

Two factors are at work. The first is the declining trend of fuel prices, which is discussed below. The second factor is the emphasis given to Irish involvement in energy supply; clearly, the greater the importance of energy production and transformation within Ireland, the lower one would expect the import bill on account of energy to be and, other things being equal, the less the relative importance of imports of energy.

Energy Prices

Of interest here are the price levels at two stages in the flow of energy from production and from importation to final consumption. The first is the price of imported fuels and the second is the price of all primary (commercial) energy consumed. The price of primary and secondary energy in *final* consumption is of more relevance to individual sectors of consumption and will not be dealt with here.

With regard to import prices of fuels (oil and coal), an import price index for mineral fuels is published in the *Irish Statistical Bulletin*. Its level in each year since 1953 is shown in Table 11 appended; the index rose from 100 in 1953 to nearly 124 in 1957, and fell again to just under 98 in 1963. This may be compared with a series of average import prices per Btu calculated from the figures discussed earlier in this section and also shown in Table 11. This latter series lies very close to the import price index until 1958; in 1959 and 1960 it dropped sharply to reach 78 (with 1953 = 100) in 1960. Thereafter it appears to have moved with the import price index but some 20 points below it.

The divergence beginning in 1959 and 1960 was caused by the commencement of operations at the Cork refinery and the consequent switch to the importation of crude petroleum which is much cheaper than refined petroleum products. Thus the average price per Btu of energy imported fell sharply in those years. The import price index remained unaffected by this switch because it expresses changes in the prices of the constituents fuels with no regard for changes in the pattern of imports.

Either series is relevant in its own way. The import price index of mineral fuels shows that there is no upward trend in fuel prices, and thus that fuel prices are falling in real terms. (For all items the import price index rose to 109·4 in 1963 related to 1953 = 100, while the consumer price index rose to 128·3 in the same year; the index for imported mineral fuels, as already noted, fell to less than 98 in 1963.) The series of average prices shows that because cheaper fuels are being used the effective price of imported energy is now much lower. The decrease in price (to 78 in 1963) is very significant when the general inflation of prices is taken into account.

There is no published index number of the price of primary energy and it has been necessary to derive one. The estimated selling prices used earlier in calculating the total value of the energy consumed in Ireland have been used for this purpose. The index takes no account of the transformation of primary energy into electricity and gas. It is based on selling prices of primary forms of energy inclusive of duty and tax and of distributors' and retailers' margins. Both the Paasche form (current-weighted) and the Laspeyres form (base-weighted) have been calculated and they are shown in Table 11 appended. There is very little difference between the two. Both indices increase from 100 in 1953 to nearly 118 in 1963, with a peak of 128/129 in 1957 after the Suez crisis.

A series of average price per Btu of primary energy is also shown. This series also follows the two indices very closely, rising above it in some years and falling below it in others but never differing by more than two or three points. Its value in 1963 was just over 116, a point-and-a-half below the price index numbers for that year. One could search for explanations for the differences, in the fluctuations in hydro-electricity consumption (in 1959 for instance) and in changing patterns of energy use but such conjecture seems of only marginal value; the main point is that there is substantial agreement about the trend in primary energy prices. That trend has, in recent years, been substantially less than the upward trend in the consumer price index (all items) and it may be inferred that primary energy prices are falling in real terms. (See Chart 6 appended to this section.)

This is an important result. As long as the elasticity between the growth of commercial energy consumption and the growth of GNP is greater than one there is a tendency for the value of energy consumed to increase as a proportion of GNP. Much of any future increase in Ireland's energy consumption will have to be imported. Thus, not only will a greater share of the national product have to be devoted to purchasing energy but also more will have to be spent abroad to buy imported fuels. The greater the stability of primary energy prices generally, and of import prices in particular, the less will these effects be.

Energy Consumption and Economic Expansion

In Section 1, which dealt with international comparisons, the level of a country's national product was shown statistically to be an important factor in predicting its level of energy consumption. In a single country a close relationship between the two is equally to be expected; an increase in national product must entail an increase in energy consumption if other things remain equal. However, more efficient use of the fuel required to carry out a given set of tasks would mean that the increase in energy consumption would be less, proportionally, than the increase in output, and in extreme cases might lead to a decreased energy consumption. Again, structural changes in the economy, and the faster or slower development of the energy-intensive sectors would affect the relationship between output and energy consumption (and the resultant effect might be in either direction). Considerations such as these do not lead one to expect a fixed relationship between total product and energy consumption but, perhaps, to expect a reasonably stable relationship during not too long a period when technological and structural changes are taking place relatively smoothly.

The stability of the relationship will depend on many factors. Among these, the price of energy may be expected to exert a substantial influence, although price changes are unlikely to exert their full effects immediately and therefore will be difficult to identify statistically. The higher the price of energy the greater the stimulus to use the most modern and efficient appliances. But consuming appliances are capital goods (or consumer durables) that are replaced at infrequent intervals, and hence there will tend to be time-lags in responses to price changes.

Another important factor is likely to be the rate of economic growth itself and variations in that rate. Thus, during a period of relatively slow economic expansion energy consumption may increase only very sluggishly in relation to economic growth. If a period of rapid expansion follows, energy consumption is likely to leap ahead in its growth because even the most inefficient consuming equipment is called into service. If the expansion continues, investment will increase at such a rate that the old equipment is soon replaced and the energy/total product growth ratio falls back to a more normal level. An interruption to that expansion and a period of depression may see the growth ratio falling sharply: when the economy is working at less than capacity the more efficient equipment is used for there is the greatest emphasis on operating to minimise costs. In the period of expansion the emphasis fell more on maximising output.

Finally, in a country where a significant part of the energy consumed is used for comfort-heating, one may expect the level of energy consumption in a given year to depend on the climate, and particularly on the temperature, during that year.

A Time-Series Regression Analysis of Energy Consumption

There are a number of other factors, apart from the national product, that may affect a country's consumption of energy, and it is the intention here to approach this general question using formal statistical procedures. A time-series regression analysis of commercial energy consumption will be carried out and a number of explanatory variables will be considered in the analysis.

The method consists of setting up and fitting a regression model to the observed levels of energy consumption in the years from 1950 to 1963. Four explanatory variables will be brought into the regression analysis. The first and, by expectation at least, the most important is the level of Gross National Product at constant (1953) prices. This measure of national product is taken because it is so commonly used in economic forecasting.

For the second explanatory variable some measure of price of energy is looked for and for the sake of convenience the average prices per Btu of primary energy will be taken (the derivation of these prices were described earlier).

The third explanatory variable is time itself, which is introduced into the regression in case there is an independent secular trend in energy consumption.

Energy consumption for heating purposes is obviously affected by the prevailing climatic conditions, of which temperature is the most important.

It is desirable, therefore, to being into the regression some variable which will measure the relative severity of temperatures during the year. Technical analysis of the relation between energy consumption and temperature indicates that for continuous heating purposes energy consumption is proportional to the temperature difference that must be be maintained between inside and outside temperatures. Over a period consumption depends on the cumulative difference in temperature (i.e. the time integral of the difference in temperature) and this is commonly measured in degree-days. An approximate degree-day[5] index was put together from weekly average temperature data (as recorded at Dublin). These data were kindly supplied by the Electricity Supply Board.

The index derived relates to what might be called "winter degree-weeks" below 65°F. Winter is presumed to extend over nine weeks at the end of the year and 17 weeks at the beginning of the next year. Because energy consumption data refer essentially to trade figures rather than to eventual consumption, winter temperatures are assumed to affect consumption in the following year. Recorded weekly average temperature differences below 65°F have been accumulated over the 26 weeks of each winter, and from these accumulated differences an index number has been derived which is taken as the fourth explanatory variable. The data are given in Table 18 appended to Section 3 of this paper.

The mathematical form of the model is the following

[5]The author has since learned that the Meteorological Service in Dublin could have furnished him with degree-day data. The Service also points out that it is customary to use 60°F. as base temperature in order to allow for other sources of heat.

$$\log Y = \beta_0 + \beta_1 \log X_1 + \beta_2 \log X_2 + \beta_3 T + \beta_4 \log X_4$$

where Y is Commercial Energy Consumption

X_1 is Gross National Product at 1953 prices

X_2 is Average Price of Primary Energy per Btu

T is Time in Years

X_4 is Index Number of Winter Temperatures.

Data for the first three of these variables are given in Table 11 appended to this section.

The results of the regression analysis are set out in Table 9. The full regression was not in fact carried out because it was seen to be unnecessary. It is clear that X_1 is the most important of the four variables, and that given X_1 it matters little which of the variables X_2 and X_4 is chosen; but that nothing is gained by retaining both. It matters little for forecasting purposes which is retained but, since there are good *a priori* grounds for keeping the temperature variable, X_4 will be retained with X.

For the regression retaining only X_1 and X_4 the regression equation takes the form

$$\begin{aligned}(Y-2{\cdot}025) \\ &= 1{\cdot}64\,(X_1-2{\cdot}739) \\ &\quad +0{\cdot}27\,(X_4-1{\cdot}999)\end{aligned}$$

A word may be added about the sign and magnitude of the coefficient associated with the temperature variable. It suggests that a 10% increase in the temperature index number is associated with a 2·7% increase in commercial energy consumption. Now, a 10% increase in the temperature index number corresponds to an increase of 52 winter degree-weeks, which in turn is roughly equivalent to an average drop of 2°F in winter temperatures. The winter of 1950/51 was the coldest during the

TABLE 9: TIME-SERIES REGRESSION ANALYSIS OF COMMERCIAL ENERGY CONSUMPTION; 1950 TO 1963

DF	b_1 GNP	b_2 Price	b_3 Time	b_4 Temp.	Residual sum of squares	S^2	R^2
13	—	—	—	—	·0526	·00404	—
12	+1·66	—	—	—	·0052	·00043	·90
12	—	−0·58	—	—	·0486	·00405	·08
12	—	—	+·0136	—	·0104	·00086	·80
12	—	—	—	+0·42	·0501	·00418	·05
11	+1·65 (±·15)	−0·20 (±·18)	—	—	·0042	·00038	·92
11	+1·50	—	+·0015	—	·0051	·00046	·90
11	+1·64 (±·15)	—	—	+0·27 (±·17)	·0042	·00038	·92
11	—	−0·58	+·0136	—	·0064	·00058	·88
11	—	−0·52	—	+0·34	·0471	·00428	·10
11	—	—	+·0138	+0·51	·0068	·00062	·87
10	+1·12 (±·50)	−0·32 (±·22)	+·0045 (±·0043)	—	·0043	·00043	·92
10	+1·62 (±·16)	−0·16 (±·19)	—	+0·24 (±·16)	·0039	·00039	·93

( ) indicates standard error

14-year period and in this winter a drop of just over 3°F in average temperatures was recorded. The warmest winter, which occurred in 1956/57, showed an average rise of just under 3°F. A 3°F change in average winter temperature can be associated therefore with a change of 4% in commercial energy consumption. Thus the range of variation in energy consumption on account of the abnormal temperatures is of the order of 8%.

The failure of the price variable to prove significant is somewhat surprising. One would expect that proportionately more energy would be used in Ireland for comfort-heating purposes whether in the home or in the factory because the country has so little heavy industry and makes so little use, therefore, of process heat. In conseqeunce one would suppose that energy demand in Ireland was relatively elastic to price changes, because her energy needs are not governed so much by technical as by human requirements. But this proves not to be the case in spite of the considerable price changes that have occurred (although, by historical accident, these changes were inversely correlated with changes in the national product and therefore the indications are less significant than they might otherwise have been). Energy demand, it seems, is highly elastic to changes in the level of economic activity and comparatively little responsive to price changes. The former is not quite the same thing as to say that energy demand is income-elastic in the usual sense, but the two cannot be very far apart.

The trend rate of growth for GNP itself, obtained by fitting an exponential time curve to GNP, was referred to earlier and was in fact 1·9% p.a. (R^2=·86). That of commercial energy consumption was 3·2% p.a. (R^2=·90). The ratio of 1·68 of these two growth rates is very close to the elasticity of 1·66 determined by correlating the two variables directly. For the period 1950 to 1955 their elasticity was 1·68 and from 1958 to 1963 it fell to 1·54. These elasticities are high in absolute terms and correspond more to the rates experienced on the Continent rather than to those experienced in Britain.

To complete the picture it is only necessary to find the corresponding relations for total energy consumption. The regressions of the latter on GNP and on time may be carried out in the same way as those described above for commercial energy consumption. Price is not included as an explanatory variable since, first, it has not proved significant in the case of commercial energy and, second, its effect on the consumption of hand-won turf could be expected to be the opposite of its effect on the consumption of commercial fuels (i.e. the more expensive are commercial fuels the more hand-won turf would be used).

The results may be summarised as follows. The trend rate of growth in total energy consumption was 1·5% p.a. (R^2=·51). The elasticity between the rate of growth in total energy consumption and that of GNP was 0·95 (R^2=·74). When GNP and time are brought into the regression together there is a worthwhile improvement in the estimated residual variance (and R^2 rises to ·79). The estimated value of the coefficient associated with GNP is +1·60 and of that associated with time is −·0061 which corresponds to an annual rate of *decrease* of 1·4% p.a.

The latter result is interesting. It implies that the elasticity of the growth rates of total energy consumption and of GNP is 1·60 if the effects of time are neglected, which is very close to the value estimated for commercial energy consumption; but that over time, and neglecting in this instance the effects of change in GNP, total energy consumption shows a declining tendency. That is, this energy is being used either more efficiently or less intensively. At least a part of this effect may be ascribed to the greater efficiency in use of the commercial fuels that are steadily being substituted for hand-won turf.

CHART 3 (appended to Part III, Section 2): Primary Energy Consumption in Ireland; 1950 to 1963

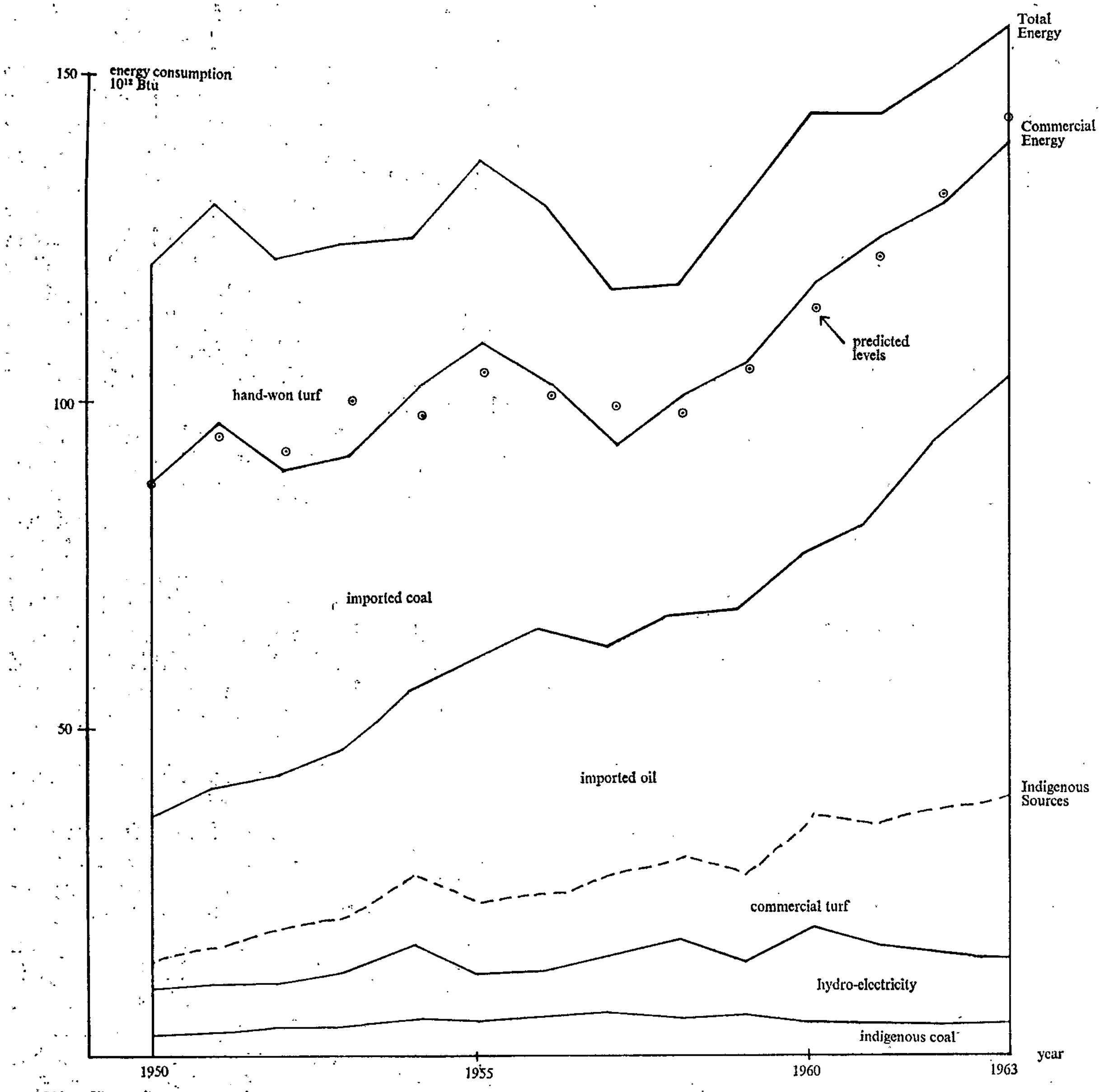

CHART 4 (appended to Part III, Section 2) G.N.P. and Energy Consumption; 1953—100

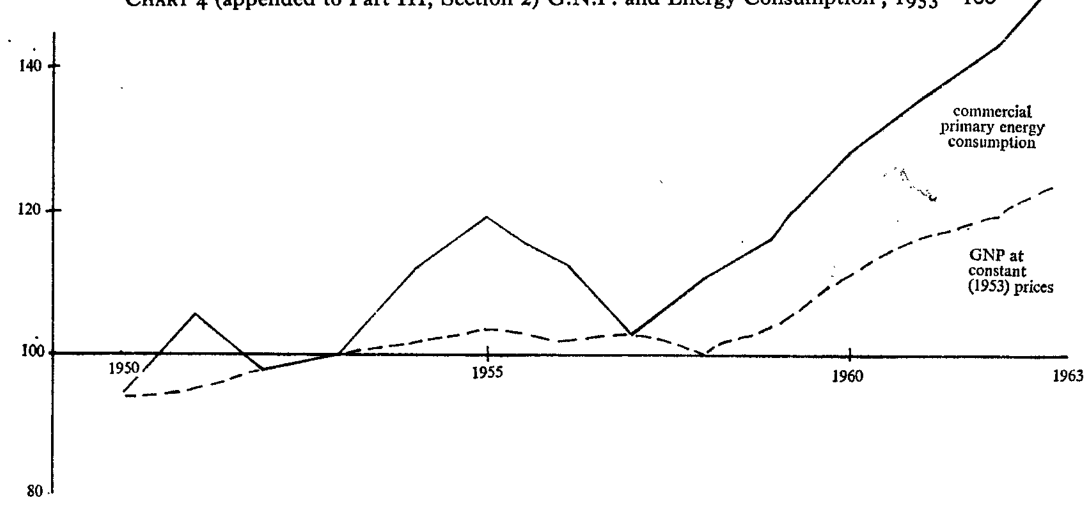

CHART 5 (appended to Part III, Section 2) Value of Energy Consumed in Ireland; 1950 to 1963

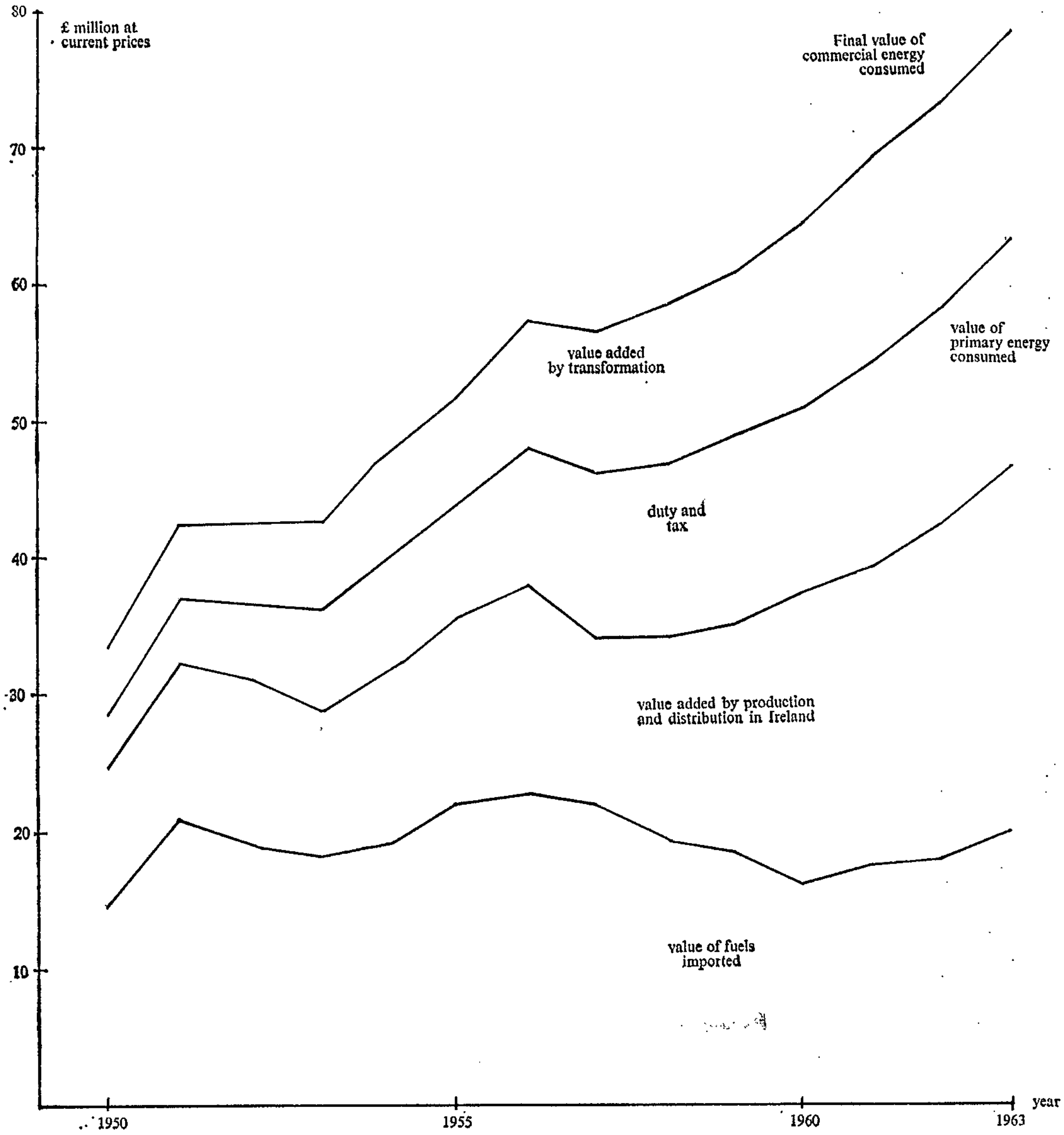

CHART 6 (appended to Part III, Section 2) Primary Energy Prices; 1950 to 1963; 1953=100

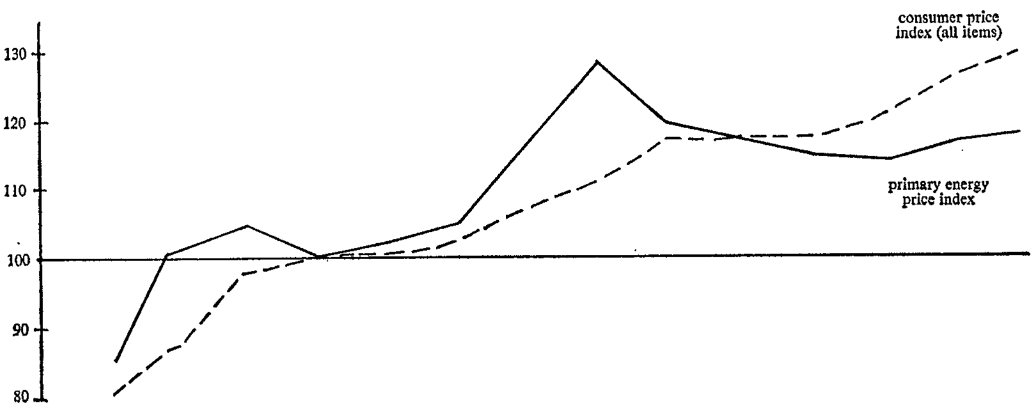

TABLE 10 (APPENDED TO PART III SECTION 2): ENERGY CONSUMPTION IN IRELAND

Form of Energy	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	Units
Coal production:[1]															
—anthracite	(95)	(100)	(100)	113	151	137	163	163	139	153	128	134	130	(130)	'000 tons
—semi-bituminous	(45)	(45)	(45)	51	51	60	73	74	62	78	76	70	75	(75)	,,
Trade in coal and coke:[2]															
Total net imports	1,962	2,169	1,812	1,728	1,791	1,901	1,476	1,217	1,355	1,579	1,629	1,724	1,447	1,436	,,
Turf Sales by Bord na Móna:[3]															
—machine turf	231	318	487	630	633	708	682	742	653	735	830	857	882	926	,,
—milled peat	0	0	0	0	0	0	0	167	392	445	620	708	920	943	,,
—turf briquettes	24	21	22	38	39	37	49	32	37	35	88	156	228	303	,,
Hand-won turf production[4] ..	2,848	3,361	3,221	3,132	2,072	2,647	2,495	2,217	1,622	2,243	2,551	1,832	(1,800)	(1,750)	,,
Hydro-electricity production[5] ..	423	428	418	437	771	540	577	689	871	611	989	793	697	684	m.kwh
Petroleum fuels consumption:[6]															
—motor spirit	(63)	69·3	72·5	75·8	80·0	84·1	87·1	71·8	78·7	81·3	85·1	91·6	96·7	104·5	m.gals
—kerosines/vaporising oil ..	(26)	26·8	27·9	28·1	29·6	29·6	29·0	25·8	27·8	27·2	25·7	24·6	23·7	23·0	,,
—gas/diesel oils	(21)	22·7	23·7	25·5	31·2	37·5	48·9	44·1	53·5	58·4	64·5	71·0	80·7	86·8	,,
—fuel oils	(38)	48·1	40·3	49·5	56·1	89·0	105·3	85·7	76·2	80·8	76·9	98·1	153·9	188·2	,,
—liquefied gases[7]	(1)	(1)	(2)	(2)	(2)	(2)	(4)	(6)	(10)	13	(15)	16	(17)	18	th. tons
Total Energy Consumption:[8]															
—indigenous coal	3·6	4·0	4·4	4·5	5·7	5·5	6·5	6·6	5·6	6·3	5·5	5·6	5·6	5·6	10^{12} Btu
—mechanically-cut turf ..	3·6	4·7	6·9	9·2	9·6	10·2	10·1	11·8	12·5	13·9	17·6	19·9	23·2	25·4	,,
—hydro-electricity	6·8	7·0	7·0	6·8	11·8	7·8	7·7	9·4	12·0	8·3	14·1	10·9	9·6	9·2	,,
Sub-total	14·0	15·7	18·3	20·5	27·1	23·5	24·3	27·8	30·1	28·5	37·2	36·4	38·4	40·2	,,
—imported coal	50·6	55·9	46·7	44·6	46·2	49·1	38·0	31·4	35·0	40·7	42·0	44·5	37·3	37·1	,,
—petroleum fuels	22·0	25·0	24·6	26·9	29·7	36·7	41·5	35·1	36·3	38·2	38·9	44·2	55·4	63·0	,,
Sub-total	72·6	80·9	71·3	71·5	75·9	85·8	79·5	66·5	71·3	78·9	80·9	88·7	92·7	100·1	,,
Total commercial energy	86·6	96·6	89·6	92·0	103·0	109·3	103·8	94·3	101·4	107·4	118·1	125·1	131·1	140·3	,,
—hand-won turf	28·5	33·6	32·2	31·3	20·7	26·5	25·0	22·2	16·2	22·4	25·5	18·3	18·1	17·5	,,
Total energy consumption ..	120·1	130·2	121·8	123·3	123·7	135·8	128·8	116·5	117·6	129·8	143·6	143·4	149·2	157·8	,,
Electricity Consumption[9] (net of generation and transmission losses)	822	914	1,017	1,148	1,281	1,393	1,500	1,541	1,674	1,801	1,999	2,109	2,332	2,571	m.kwh

( ) indicates estimate.

Notes : [1]*Source :* CIP data reported in *Irish Statistical Bulletin.*
[2]*Source : Trade and Shipping Statistics.*
[3]From information supplied by Bord na Móna.
[4]*Source : Statistical Abstract of Ireland.*
[5]*Source :* ESB *Annual Reports.*
[6]From information made available by the principal oil companies.
[7]*Source :* for 1959 onwards from OECD Oil Statistics; estimates for earlier years are based on value data for imports.
[8]The following average net calorific values have been used:

Coal	25·8 m.Btu/ton
(Irish anthracite × 1·2 semi-bit. × 0·6)	
Machine turf	13·4 m.Btu/ton
Milled peat	7·7 ,,
Turf Briquettes	19·0 ,,
Hand-won turf	10·0 ,,
Motor Spirit	138,000 Btu/gal
Kerosines	149,000 ,,
Gas/diesel	156,000 ,,
Fuel oils	164,000 ,,
Liquefied gases	43·7 m.Btu/ton

Hydro-electricity has been converted into the fuel input required to generate the same quantity of electricity at prevailing average efficiencies (which varied from 16,000 Btu/kwh in 1950 to 13,400 Btu/kwh in 1963) in thermal power stations.
[9]*Source :* ESB records. Figures for 1954 and 1960 adjusted to allow for these years consisting of 53 calendar weeks.

TABLE 11 (APPENDED TO PART III SECTION 2) ENERGY WITHIN THE IRISH ECONOMY

Item	1950	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963
Commercial primary energy consumption														
—10^{12} Btu	86·6	96·6	89·6	92·0	103·0	109·3	103·8	94·3	101·4	107·4	118·1	125·1	131·1	140·3
—million coal equivalent tons	3·36	3·74	3·47	3·57	3·99	4·24	4·02	3·66	3·93	4·16	4·58	4·85	5·08	5·44
—1953=100	94·1	105·0	97·4	100·0	111·9	118·8	112·8	102·5	110·2	1·16	128·4	136·0	142·5	152·5
	£ million (estimated)													
Value of fuels imported[1]	14·7	20·7	19·4	18·5	19·0	22·4	22·8	21·6	19·5	18·7	16·3	17·5	18·0	20·2
Value added within Ireland to the value of primary energy[2]	10·0	11·7	11·7	10·4	13·0	13·2	15·1	12·9	14·7	16·7	21·1	22·3	24·4	26·5
Tax and duty paid	3·8	4·7	6·5	7·2	7·7	8·1	9·7	11·5	12·4	13·2	13·5	14·6	15·6	16·6
Value of primary energy consumed[3]	28·5	37·1	36·6	36·1	39·7	43·7	47·6	46·0	46·6	48·6	50·9	54·4	58·0	63·3
Value added by transformation[4]	4·6	5·0	5·5	6·4	8·0	7·9	9·5	10·3	11·5	11·8	13·5	15·0	15·1	15·5
Final value of commercial energy consumed	33·1	42·1	42·1	42·5	47·7	51·6	57·1	56·3	58·1	60·4	64·4	69·4	73·1	78·8
Final value of commercial energy consumed	33·1	42·1	42·1	42·5	47·7	51·6	57·1	56·3	58·1	60·4	64·4	69·4	73·1	78·8
GNP at current prices £m.	400	421	479	526	529	552	559	581	599	636	671	718	774	823
Percentage share of GNP %	8·3	10·0	8·8	8·1	9·0	9·3	10·2	9·7	9·7	9·5	9·6	9·7	9·4	9·6
Value added within Ireland to the final value of energy[5] £m.	14·7	16·7	16·2	16·8	21·0	21·1	24·6	23·2	26·2	28·5	34·6	37·3	39·5	42·0
Total value added by Industry and by Distribution, Transport and Communication. £m.	150	162	166	180	188	195	199	196	204	220	241	268	298	323
Percentage share of total %	9·8	10·3	9·8	9·3	11·2	10·8	12·4	11·8	12·8	13·0	14·4	13·9	13·3	13·0
Value of imported fuels consumed £m.	14·7	20·7	19·4	18·5	19·0	22·4	22·8	21·6	19·5	18·7	16·3	17·5	18·0	20·2
Value of all imports less re-exports £m.	157	203	170	180	176	202	179	180	194	209	221	256	268	300
Percentage share of total %	9·4	10·2	11·4	10·3	10·8	11·1	12·7	12·0	10·1	8·9	7·4	6·8	6·7	6·7
	1953=100													
Import Prices														
—average price per Btu	78	99	105	100	97	101	111	125	105	92	78	76	75	79
—import price index for mineral fuels	..	..	..	100	97·3	101·9	107·4	123·7	104·9	97·5	96·8	96·0	95·8	97·7
Primary energy prices														
—average price per Btu	83·9	98·0	104·1	100	98·2	102·0	117·0	124·5	117·3	115·6	109·9	111·0	113·0	116·3
—Paasche index number[6]	85·4	100·8	104·3	100	101·7	104·2	115·7	128·0	119·3	116·1	114·3	114·0	116·8	117·9
—Laspeyres index number[6]	85·3	98·8	103·8	100	101·4	105·0	116·7	128·8	117·8	113·1	112·1	113·3	115·4	117·8
Consumer price index; all items	81	87	97	100	101·1	102·7	107·1	111·5	116·5	116·5	117·0	120·2	125·3	128·4
Index number of price of primary energy in real terms[7].	105	116	108	100	101	102	106	115	102	99	98	95	93	92

Notes : [1]Inland consumption of imported coal and of oil products at average import prices; for oil products since 1959 the value of crude-oil imports has been taken, and adjusted for trade in refined products.

[2]Primary energy in inland consumption at average selling prices including tax, except hydro-electricity which is included at cost. Receipts from sales of fuels were estimated as follows:

Petrol—consumption times average wholesale price net of duty, plus total duty paid, plus estimated retailers' margin;
Kerosine—vaporising oil at average wholesale price; burning oil at average wholesale price plus estimated retailers' margin;
Gas/diesel—average wholesale price net of duty, plus total duty paid, plus estimated retailers' margin on oil in road use;
Fuel oil—value of deliveries to ESB plus other consumption at average industrial prices;
Coal—value of deliveries to ESB to Gasworks and to Industry, plus other consumption at average import prices plus estimated retailers' margin;
Turf—Bord na Móna receipts from sales plus estimated retailers' margin on non-industrial sales.

[3]Value of domestic production of primary energy plus retailers' and distributors' margins on all primary energy in inland consumption.

[4]Value of gross outputs less fuel costs of electricity and gas works undertakings.

[5]Total final value of all energy consumed less net duty paid less value of imported fuels consumed.

[6]Index covers coal, turf, petrol, kerosene, gas/diesel and fuel oils, and hydro-electricity.

[7]Paasche-type price index number divided by consumer price index.

Sources : Economic data from *National Income and Expenditure*, compiled by the Central Statistics Office each year; tax data adapted from the reports of the Revenue Commissioners; import price and consumer price indices from *Irish Statistical Bulletin.* Fuel price data from a variety of sources, principally *Trade and Shipping Statistics, Census of Industrial Production* returns, and information kindly made available by ESB and Esso Pet. Co. (Ireland) Ltd.

SECTION 3: ELECTRICITY CONSUMPTION IN IRELAND

Similar analyses to those described in Sections 1 and 2 of this paper may also be applied to the consumption of electricity. Electricity is discussed in more detail in Part II of this series of papers but, because of the similarities of the analysis, it is convenient to include at this stage some parallel investigations of electricity consumption.

Economic Growth and Electricity Consumption: International Comparisons

Electricity is one of the forms in which energy is made available to the final consumer. To some extent, and particularly as a source of heat, it competes with other forms of energy. But to a great extent electricity is free from such competition because of its specialised uses for lighting, for providing motive power, and for communication.

In its competitive uses electricity demand is certainly to some degree price-elastic. And in these uses it undoubtedly also has a considerable income-elasticity. From observation it is clear that the higher the consumer's income the greater is the premium put on the advantages of cleanliness, simplicity and ease of regulation that electricity possesses above all other forms of energy. In its specialised uses also electricity is income-elastic, especially at the macro-economic level, because of the greater need for automatic devices and for rapid communication systems as an economy advances and becomes more sophisticated.

In sum one may expect electricity demand to show a marked degree of income-elasticity and one may examine this from an international point of view by comparing the electricity consumptions and the national incomes or products of a number of countries. This will be done by means of a cross-section regression analysis exactly as was done in the case of energy consumption.

The cross-section regression analysis will cover the same countries as those included in the previous analysis. The explained variable will now be not energy consumption, but electricity consumption per head of population in 1962. Data for electricity consumption relate to total production of electricity in the year in question plus net imports from abroad and they also are taken from United Nations Statistics, Series J. Mid-year population estimates are from the United Nations *Demographic Yearbook*.

The principal explanatory variable will be as before, Gross Domestic Product at factor cost in thousand of United States dollars (except in the case of the separate analysis of consumption in European countries alone, where the share of agriculture, which proved so significant for energy consumption, will be considered as an alternative). Consideration has been given to a number of other variables and of these two are selected.

The first is derived from the previous regressions and might be called the country's "intensity of use" of energy. This is defined here as the ratio between the country's actual consumption of energy in 1962 and its predicted level of consumption (for which figures are given in an appended table). If a country uses more or less energy of all kinds than an international comparison would suggest it might well use more or less electricity also. It is appreciated that, as the ratio of two variables both subject to various sorts of errors, this derived variable is not altogether a happy choice on statistical grounds alone quite apart from any question of giving it practical meaning. In the event it is rejected from the regressions.

The other explanatory variable is suggested by inspection of the data. It is apparent that countries with large supplies of hydro-electricity use more electricity than other countries (e.g. Norway). That this is so must be because of the relative cheapness of electricity in these countries and one should therefore look for some index of the relative prices of electricity in the countries concerned. Unfortunately no price data are available; but it is felt that to bring in the share of hydro-electricity production of all electricity will absorb at least part of the effect mentioned. Thus hydro's share is taken as the third variable.

As before, the regression model takes the form

$$Y=\beta_0+\beta_1 X_1+\beta_1 X_2+\beta_3 X_3$$

where Y is Electricity Consumption per head in '000 kwh

X_1 is Gross Domestic Product per head in US \$ '000

X_2 is Intensity of Use of Energy (The ratio Y(actual/Y(predicted) from previous regression)

X_3 is percentage share of Hydro-electricity in all Electricity Consumption.

All data refer to the year 1962 and are set out in Table 17 appended to this section.

For all 39 countries the results of the regression analysis are shown in Table 12. It is interesting to observe that there is more variation between the electricity consumptions of these countries than there was between their energy consumptions. X_1

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ABBREVIATIONS.

ESB	Electricity Supply Board	ECE	United Nations: Economic Commission for Europe
BnM	Bord na Móna (Turf Board)	JSSISI	Journal of Statistical and Social Inquiry Society of Ireland
CIE	Córas Iompair Éireann (Transport Authority)		
CSO	Central Statistics Office	ERI	Economic Research Institute, Dublin
CIP	Census of Industrial Production	GDP	Gross Domestic Product
HMSO	Her Majesty's Stationery Office, London	GNP	Gross National Product
OEP	Oxford Economic Papers	Btu	British Thermal Units
OEEC	Organisation for European Economic Cooperation	kwh	kilowatt-hour; 1 kwh=3,412 Btu
AER	American Economic Review	kw	kilowatt
QJE	Quarterly Journal of Economics	MW	Mega watt; 1 MW=1,000 kw
EJ	Economic Journal	p.a.	per annum
UNIPEDE	Union of Producers and Distributors of Electricity	WPC	World Power Conference

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