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UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

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ANALYSIS OF THE ENERGY SECTOR IN RELATION TO INDUSTRIALIZATION SCENARIOS FOR THE YEAR 2000*

prepared by the

Global and Conceptual Studies Branch

Division for Industrial Studies

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Introduction

This paper deals with certain technical-economic aspects of the energy economy which result from past and present developments in it. Based on the findings of this part, it also elaborates on the impacts on possible future issues and by building scenarios arrives at some conclusions relating to general and industrial growth.

The study is elaborated with both econometric analysis and modelling. Econometric method was applied for analyzing and defining the tendencies of energy consumption and to identify changes in it together with the underlying factors of it. (Econometric analysis was used for the calculation of the future possible demand for energy depending on the structure and its changes in a given economy, as well).

Modelling, on the other hand, offered a macro-economic framework and served as an instrument in the elaboration of different scenarios of growth of the world economy, and equally, for measuring their impacts on the energy economy. The calculations based on these scenarios were run by a model system called UNITAD.

Thus the final model results are the outputs of a set of different stages of the investigation. Part of the results of the calculations with econometric methods is the input for the modelling. Therefore the analysis of the past and the behavioural problems preceeded the scenario building stage, which was followed in turn by the calculations with different scenarios. Some conclusions follow at the end-stage.

This paper presents in a rather reduced form the results of the different stages mentioned above. 1/

1/ The paper is based on the report of the UNIDO Project No. US/82/033A, "Development Strategies and International Policy Alternatives," elaborated by IIASA for UNIDO, as "Analysis of the Energy Sector in Relation to Industrialization Scenarios for the Year 2000" (by Ch. Lager, J. Royer, A. Smyshlyaev).

The historical analysis firstly concentrates on the sharp decline in energy intensities (terajoule per 1970s of GDP (TJ equals joule 10^{12})) observed in industrial production of major developed economies after 1973. The change in the price elasticity of energy intensity which took place in each industry between 1964 to 1980 has been explained by two components: energy savings due to technical progress and impact of change in product-mix. The product-mix effect is seen to explain a significant portion of the price elasticity (40% and above) in four industries out of five.

Five energy-intensive branches of eight major industrialized countries of North America (USA), Western Europe (Austria, France, Federal Republic of Germany, Italy, UK), Eastern Europe (Hungary), and Japan were put under examination. The annual rate of change in energy intensity in the 1970s is found to be generally negative, roughly ranging from -1% to -4% per annum. Identifying some fifteen specific commodities produced by these branches, it is then demonstrated that the decline in energy intensity can be explained to a large extent (measured in the study) by a shift of output towards the less energy-intensive commodities within each branch.

The observed shift in output-mix towards less energy-intensive commodities can be thought to be permanent, i.e., related to a long-term move, or temporary, i.e., due to a cyclical slowdown of the economy. The importance of this issue cannot be underestimated, since a permanent shift of industrialized economies towards less energy intensive commodities would strongly affect the international division of labour. Unfortunately still no general answer can be given at this stage in an analysis which is restricted to the 1970s (the picture will be much clearer when the recession is over), but the report already offers a few conclusions. In some cases, e.g., for non-ferrous metals in the Federal Republic of Germany, some qualitative evidence of temporary changes is found. The case of iron and steel, which is quantified in the study for seven countries, is yet of a different type. A permanent shift towards less energy intensive processes, which can be assigned to a long-term technical progress suggests that little ground, if any is prepared in the seven developed countries for a new international division of labour in steel.

Next an attempt was made to extend the geographical coverage of the study to the world divided into ten regions (but not including Centrally Planned Economies of Asia on which little data was available). For this purpose, the production of fifteen commodities was analyzed in 80 countries over the eleven years from 1970 to 1981. The main finding at this stage was that most developing countries increased their world shares in the production of energy-intensive goods.

Energy intensity coefficients for five sub-sectors (chemicals, non-ferrous metals, steel, non-metallic mineral products, pulp and paper) and for the primary processing sector as a whole in each of the ten regions were calculated by an econometric procedure. This was used to measure the shift towards more (or less) energy-intensive commodities within each subsector in each region, from 1970 to 1981. In developed regions, massive evidence of a shift towards less energy-intensive products is found, except in the natural-resources endowed "Other Developed" region (Australia, New Zealand, South Africa). In developing regions, and especially West Asia-North Africa, the opposite rule prevails, i.e., a shift towards more energy-intensive commodities. The fast industrialization process in new industrializing areas is also driving many developing economies towards energy-intensive components of sub-sectors.

The range of trends due to structural change in the first four developed regions are all negative, (in percent it is -0.5 to -0.7) while no significant trend was found in the "Other Developed" region, the most natural-resource endowed in basic products. In contrast, three positive trends were found in Latin America, Sub-Saharan Africa and West Asia-North Africa, with the following values (in percent p.a.): 0.5, 1.9, and 1.3, respectively. Finally two negatively sloped trends emerge for the Indian Sub-Continent (-0.4%) and for East and South-East Asia (-1.7%). (The latter figure should be interpreted with caution since it is largely due to one sub-sector, chemical industry, with a decreasing weight, not to mention the uncertainty in estimating a trend in this sub-sector). If the two components are added up we get decreasing trends of energy-intensity for the developed regions. These range from -2.1 to -2.9%. The picture is diversified for the developing regions: no overall trend exists in Sub-Saharan Africa, where the increasing intensity due to structural change compensates the decreasing intensity due to technical progress. The trend has a negative slope of -1% in West Asia-North Africa, negative trends were found in Latin America and the Indian Sub-Continent, with a slope of around -2% and a slope close to -4% was found for East and South-East Asia.

The least that can be said on the structural change effect is that the positive changes found in Latin America, Sub-Saharan Africa, and West Asia-North Africa comply with expectations since these regions are natural resources and/or energy endowed. The negative trends found in the four largest developed regions, on the other hand, suggest that close to 25% of the overall decrease in energy intensity can be attributed to structural change.

It therefore looks as if major changes occurred in the 1970s in the international division of primary processing industries: developed countries moved towards less energy-intensive industries, while an increased share of more energy-intensive industries was observed in developing regions. Even though it is too early to state that these changes can be considered as long-term trends, it is interesting to study, through simulations, to what extent they are likely to affect the world energy balance. This is the object of Part II, in which the results of the simulations done the conveniently modified UNITAD model are presented.

Part of the result of the experiments confirm expectations. But still there was one unexpected result: the total world use of primary energy in industrial sectors decreases, and so does total world energy consumption. This reflects the fact that all indirect effects of the North-South substitution in the basic products sector, when permeating other sectors of developing economies, give rise to less energy consumption than in the North (see p. 13).

The trend scenario up to 1990 together with simulation A from 1990 to 2000 can be considered as a base-line scenario up to 2000. Simulation B is a variant of it. The major macroeconomic implications of the assumptions involved in each scenario are described separately for the medium-term future (up to 1990) and for the longer term (1990-2000).

For the medium-term , a no-change policy line was adopted for the major international parameters. The 2.9% GDP growth rate was assumed for developed market economies, matched with a severe debt management, i.e., a zero growth of debt in real terms. This scenario yields a rather gloomy picture of the world economy in 1990. In the North, there is no hope to achieve a full-employment target, and developing countries would be even further away from their performances in the 70's (5.3% p.a.), with a 4.1 annual growth rate for the 1984-1990 period. The growth pattern is strongly influenced by the debt burden. The resulting growth rates for Asia are acceptable while they are rather poor for Latin America, with a 3.1% p.a. growth rate, and miserable in Sub-Saharan Africa (0.9%). In the 1980-90 decade, per capita growth rates decline in Latin America and Sub-Saharan Africa.

In the long-term base line scenario for the period 1990-2000, (simulation A) the growth rate of the North (3.1%) remained close to the medium-term rates. Additionally it was allowed that the debt burden would be alleviated; firstly by introducing a low interest rate (2 - 3%), and secondly by supposing a liberalization of trade by which the developing countries can intensify their exports to the developed ones.

The growth effect of these assumptions on the South is spectacular, since their annual growth rate reaches 6.9%, almost the target set forth in the UN development decade. In particular, Latin America achieves a 7.8% growth rate, and Africa 4.2%. The explanation lies in the success of export performance for manufactures where developing regions double up their world share over the decade (above 20% compared to 10% in 1990). Out of this share, East Asia alone makes more than 50% total manufactures exports of the South, and Latin America, another 28%. Intermediary products, in manufactures exports, becomes the first commodity group (around one third), followed by equipment and machinery (30%).

The scenario calculations show that a higher growth of the world economy would permit a fast development of energy and capital intensive industries in the South belonging to what is called here the basic products or the primary processing sector. This development, it was shown, which conforms to a rational international division of labour in the energy-endowed South, would comply with reasonable assumptions on the likely development of the energy sector. At any rate, the high growth of energy consumption in the South resulting from the development of the primary processing sector would altogether alleviate world demand pressure for energy (and therefore lower energy prices) as compared with a continuation of the present concentration of the industry in the North.

To sum up, industrial redeployment in the primary processing industry not only would tend to achieve a better South-North balance of the manufacturing sector, but it would also contribute to an optimal use of scarce energy resources at the world level.

PART I

Historical Analysis of Energy Coefficients

The long-term forecasting of energy demand is usually based on a functional relationship between energy consumption and economic activity. Therefore, the energy/output ratio and the elasticity of energy use with respect to output play a central role in energy demand analysis, and therefore they have been widely discussed and estimated. Past studies for developing countries have shown that elasticities are generally significantly larger than 1. When changes in energy efficiency caused by differing fuel mixes are excluded, Brooke (1972) found elasticities for advanced economies of around 1 and for developing countries of around 1.5.[1/]

It is observed in general that in the early stages of development, when an economy is moving towards industrialization, energy substitutes for other factors of production (particularly labor) and the share of energy-intensive basic products (basic metals, building materials) increases rapidly; this is reflected by a high elasticity of energy use.

For the industrial sector energy-demand patterns are determined by the model and structure of production, or more precisely by the technology used, and the product mix of industrial output. Several studies were published on the subject in which structural changes and modification in the production mix have been quantified. [2/]

1/ As a part of efficiency growth is excluded in Brooke's analysis, his elasticities may be slightly overestimated compared with unadjusted figures.

2/ See i.e., the following studies: Doblin (1982), (1983), Sagawa (1984), Ploger (1983), Bayer (1982), Marlin, Chateau, Criqui, Lapillone (1984).

The Change in the Structure of Production

Most of the authors found that a large part of the observed slow-down in the increase of energy demand and the decrease of the energy/output ratio was due to changes in the structure of the industrial production.

Doblin in her study of 1983 analyzes the reasons for the changing energy/output ratios for the USA, the FRG, the UK, and France over the period 1970-1981. Through the data of Table 1 a more or less constant decline in the energy/output ratios can be observed. On the other hand, increasing industrial outputs went along with decreasing energy/output ratios. This implies an elasticity of less than 1. It may be argued that this pattern is characteristic for the post-industrialized economies. Furthermore, the composition of industrial outputs also went through changes.

While total industrial production (including oil refining) has risen, the most energy-intensive branches have declined or remained at the level of 1970. The gap between the most energy-intensive production activities and total output grew increasingly after both oil shocks. This may suggest the assumption that, at least in the short run, the response of industrial management and policy makers to the rise in energy prices was not due to increased efficiency but rather to substitution of energy-intensive and therefore increasingly expensive products by other materials, and simply to a decrease in the share of energy-intensive inputs (e.g., machinery and transport equipment became more light and fragile).

Another remarkable result is that there is a negative correlation between the energy intensity of production and the value added content of output. In 1970, the six most energy-intensive industries, which accounted for nearly 80% of industrial energy demand in the USA, contributed only 33% to the value added of the manufacturing sector as a whole. While in the seventies the growth of these energy-intensive basic industries was steadily slowing down, the high-technology value-added-intensive sectors, such as electrical engineering and pharmaceuticals, grew rapidly. Therefore Doblin (1983) concludes, "all the time the breaking of the energy coefficient was a myth ... sustained cutbacks in total primary energy consumption originate from the structural change of industries and of the economy".

Very similar figures can be observed for the Japanese economy. While, despite a short decline after the first oil crisis, the Japanese GNP and output of the manufacturing sector as a whole went up, energy consumption in manufacturing industries decreased (Table 1).

The shifts in Japanese industrial energy use are results of the following:

- the increase in efficiency of energy use;
- an intra-industrial shift towards products containing high value-added (which may indicate hidden intra-industrial product mix effects); changes in the sectorial composition of the industry;
- changes due to growth of real GDP (changes in the level of economic activity) also contributed to the modification of the Japanese energy consumption.

Most of the decline in the aggregate energy/output ratio of the Japanese economy can be attributed to shifts towards high-value-added products and energy saving.

For international comparisons, Sagawa and Kibune (1984) notice that differences in the levels of the energy elasticities of GDP depend on the level of development as well as on the geographical position. Chateau and Lapillonne (1982) relate energy consumption to socio-economic variables, and note that the structure of economic activities directly determines the energy demand, and that the future development of tertiary activities will imply a growth of energy consumption slower than that of activity.

Basically the same holds for the other industrial countries as this has been assessed for the Austrian, French, Danish, American economies in the special studies published by different authors. (See the Reference published.)

The Change in the Product Mix of Industry

In addition to sectoral changes the role of product mix changes has also to be emphasized. In almost all countries and industries the share of energy-intensive products declines. Consequently, and also because of the increasing use of energy saving technologies, the energy/output ratios also decrease. The main differences of industries' energy coefficients between

Table 1. Energy consumption and total industrial production (both as index numbers, 1970 = 100) in the United States, France, the FRG, and the UK, 1970-1981

Year	Energy consumption (all fuels and electricity) (*E*)	Total industrial production (*x*)	Energy output ratio (*E* / *x* ×100)	Energy consumption (all fuels and electricity) (*E*)	Total industrial production (*n*)	Energy output ratio (*E* / *x* ×100)
	United States			*France*		
1970	100.0	100.0	100.0	100.0	100.0	100.0
1971	–	100.1		–	106.0	
1972	–	108.0		106.2	111.0	95.7
1973	106.7	117.7	90.7	113.0	120.0	94.2
1974	102.6	117.0	87.7	119.4	123.0	97.1
1975	93.3	110.4	84.5	109.8	115.0	95.5
1976	98.7	121.6	81.2	109.9	124.0	88.6
1977	100.4	128.5	78.1	111.8	126.0	88.7
1978	101.3	136.9	74.0	113.0	129.0	87.6
1979	103.7	142.9	72.6	117.1	135.0	86.7
1980	96.2	137.9	69.8	114.7	133.0	86.2
1981	89.9	141.5	63.5	109.8	130.0	84.5
	FRG			*UK*		
1970	100.0	100.0	100.0	100.0	100.0	100.0
1971	97.1	101.0	96.1	97.5	100.0	97.5
1972	98.7	105.8	93.3	98.3	102.0	96.3
1973	105.3	112.7	93.4	104.5	111.0	94.1
1974	105.4	110.7	95.2	96.4	108.0	89./3
1975	92.5	104.6	88.4	88.9	102.0	87.2
1976	97.2	112.7	86.2	92.5	104.0	88.9
1977	97.0	115.0	84.3	92.4	108.0	85.6
1978	97.6	117.0	83.4	90.9	112.1	81.1
1979	101.4	123.1	82.4	94.0	114.8	81.9
1980	97.0	123.1	78.8	77.6	107.4	72.3
1981	92.6	120.6	76.8	73.3	101.9	71.9

Source: Doblin (1982).

countries can also be partly attributed to varying production structures. The large energy output ratio of basic metal industries in Austria corresponds to a high percentage of energy-intensive products. The same is true for the non-metallic minerals industries in Italy. The relatively small energy coefficients in the basic metal sector in the FRG and in Japan is not only caused by the use of highly efficient technologies, but it is also due to a relatively small share of energy-intensive products.

To get a general overview of the possible impact of structural effects on energy requirements, Table 2 shows the percentage share of the value of 1970 US$ of identified most energy-intensive products in total constant price gross output of each industrial branch, by country.

This table shows clearly that the share of selected energy-intensive goods in total output of each branch varies from industry to industry. The best sampling is for the iron and steel industry, while for chemicals - due to the big share of petro-chemicals - it is rather low. Of course the big share of intra-industry transactions plays an important role in the underestimation of the share of selected commodities in output. In case of the pulp and paper industry the share of pulp is very low in the UK where about 80% of pulp use is imported.

The Methology and Results

To quantify the impact of changing production structures and to separate this from "other effects" (technical progress, interfuel substitution effects, unidentified product-mix effects) the following regression equation was estimated for different countries:

$$E_{jk}(t) = \beta_{jk}\exp(\lambda_{jk}\cdot t)\cdot\sum_i e_{ijk}\cdot Q_{ijk}(t) + \varepsilon_{ik}(t)$$

where

i = index of commodities
j = index of industry
k = index of country

and parameters to be estimated

β_{jk} = a scaling parameter to be estimated and which may differ from country to country

λ_{jk} = rate of energy-saving technological progress

Table 2. Percentage of identified energy-intensive output in total output

		Steel	Non-ferr.	Basic metals	Non-metallic mineral products	Chem.	Pulp and paper
FRG	70	56.9	14.8	29.5	16.5	1.9	5.7
	75	47.3	18.6	26.7	13.8	1.4	6.6
	80	50.4	16.1	26.3	11.8	1.1	5.4
Austria	70	92.9	16.8	61.0	31.1	.	18.6
	75	93.8	15.6	59.0	29.7	.	15.5
	80	94.5	13.8	53.9	26.9	.	16.8
Japan	70	.	.	32.4	14.0	1.8	10.6
	75	.	.	30.6	16.4	1.2	11.1
	80	.	.	27.3	18.3	0.7	10.9
Hungary	70	.	.	33.7	23.7	8.4	.
	75	.	.	32.0	25.5	6.4	.
	80	.	.	31.1	23.3	4.6	
UK	70	47.0	4.0	33.1	9.6	.	0.7
	75	44.9	9.7	31.8	8.7	.	0.6
	80	35.1	11.3	24.6	8.6	.	0.3
France	70	49.8	25.3	45.2	21.1	2.6	7.0
	75	49.0	24.9	44.0	18.5	2.4	7.1
	80	47.2	24.4	42.2	17.0	1.5	5.0
USA	71	38.6	30.0	33.3	7.7	2.4	16.6
	75	28.2	25.0	31.6	6.7	2.3	14.8
	80	26.5	19.3	30.4	7.1	2.2	16.2
Italy	70	43.8	19.9	42.2	66.1	3.3	0.8
	75	48.7	22.4	45.5	68.4	2.3	0.6
	80	45.7	23.2	44.4	68.9	1.6	0.2

It is assumed that the energy-saving technical progress is on average equal over all the commodities ($**_{jk}$ is the same for all commodities). A scaling parameter estimate may reflect some inter-country differences in the energy use by an industry, which are due to fuel-mix, differences in capital stock age, etc.

The authors were aware of the fact that within each industry there are other commodities which are not considerd in the model explicitly, i.e., to identify a part of output and energy inputs which are not covered by the sample of commodities, the residual part of the industry's output and the corresponding energy input was estimated. (Therefore, there appears in the model a "commodity" in value terms and its base year energy/output ratio.)

With a few exceptions product-mix effects in all countries and industries have a significant explanatory influence on changes in the energy output ratio.

As is well known, in many countries of the Third World enormous efforts have been made for establishing the basic products industries. Steel industry is one among the favorite objectives of industrialization. For only this reason already it could be of much interest that at least 25% of the decline of the energy/output ratio in developed countries is found to be attributed to changing production structures. Each country moves its production structure from energy-intensive crude steel production to less energy-intensive products (e.g., special steel, finished rolled products). Nevertheless there is a significant movement towards less energy-intensive processes too.

In almost all countries a significant shift from the inefficient open hearth to more efficient processes (oxygen, electric arc) and also to continuous casting contributed significantly to the decline of energy requirements per unit of output. Especially France and the UK, which used in 1970 a high percentage of less efficient technologies, could improve their process structures. While France shifted permanently from the open hearth to oxygen furnaces, the UK increased its oxygen as well as its electric arc capacity. Also the FRG, the USA, and Italy were able to restructure their process mix and consequently improve their energy efficiencies. As Japan used already in 1970 a small percentage of less efficient open hearth technologies, the structural improvements of total steel production were comparatively smaller than in the other countries. Japan merely shifted from oxygen to electric arc steel production. Though Japan's energy consumption in steel production per ton of steel grew from 1.75 gigajoules (GJ 10^9) in 1970 to 2.12 GJ in 1980, its total energy requirement per unit of output of iron and steel industries declined in that period.[1/]

However, the average annual rates of increase of energy efficiencies in steel production indicate that there was a global improvement of energy efficiencies in the iron and steel industries between one and two percent per year. The results coincide with the econometric estimates presented in Table 5.

While in most industrial branches a significant trend towards less energy-intensive products was observed, in the non-ferrous metals industries of at least four (FRG, UK, USA, and Italy) out of six countries a movement towards more energy-intensive commodities is seen. Austria, Japan, France, and the USA shift from energy-intensive primary aluminum production to secondary aluminum production (recovery of scrap). The FRG, Italy and especially the UK increased their primary aluminum capacity.

In the building materials industry the energy output ratios decreased in general with the exception of Japan. This increase is the result of a considerable growth of cement production. A significant tendency towards energy savings was found in all countries, including Japan, after eliminating the product-mix effects. The overall annual percentage change of "other effects" (energy savings, etc.) is around 2%.

1/ It should be kept in mind that on the one hand, electric arc steel requires more energy at the stage of crude steel production (around 7 GJ/t) than basic oxygen furnaces (around 1 GJ/t), but on the other hand, electric arc furnaces use scraps as input, while oxygen furnaces rely on a high share of energy intensive pig iron (22 GJ/t).

Table 3. Average annual percentage rate of change of energy coefficients) t-value in parentheses)

	Period	Basic Metals	of which Steel	Non-ferr.	Build. materials	Chemicals.	Pulp and paper
FRG	(1965–80)	–2.6 (9.3)	–2.5 (7.8)	–1.5 (2.8)	–4.3 (24.3)	–5.6 (17.2)	–1.0 (3.8)
Austria	(1965–80)	–2.0 (9.4)	–0.7 (4.8)	–3.8 (9.3)	–2.9 (16.2)	.	–0.8 (1.7)
Japan	(1970–80)	–2.8 (4.6)	.	.	+0.9 (2.5)	–4.0 (10.1)	–2.5 (5.1)
Hungary	(1970–80)	–1.3 (14)	.	.	–4.0 (9)	–0.7 (0.7)	.
UK	(1970–81)	–3.4 (6.6)	–3.0 (7.4)	–0.3 (0.2)	–3.2 (4.6)	.	–3.9 (5.7)
France	(1970–81)	–1.2 (4.9)	–1.3 (4.8)	–0.8 (3.2)	–1.9 (8.3)	–1.5 (5.4)	–1.4 (6.1)
USA	(1971–80)	–2.1 (3.8)	–1.7 (2.6)	–2.1 (3.1)	–2.7 (14.6)	–3.6 (5.6)	–3.1 (9.4)
Italy	(1970–81)	–1.5 (3.9)	–1.5 (4.3)	–2.2 (1.3)	–2.6 (5.0)	8.2 (12.2)	–4.2 (8.4)

Table 4. Contribution of (identified) product-mix effects: average annual percentage rate of change of energy-intensive production (t-value in parentheses)

	Period	Basic Metals	of which Steel	Non-ferr.	Build. materials	Chemicals.	Pulp and paper
FRG	(1965–80)	–1.3 (4)	–1.3 (3.7)	+1.2 (4.0)	–2.6 (25.9)	–1.8 (16)	–0.1 (1.3)
Austria	(1965–80)	–1.3 (8.9)	–0.0 (0.9)	–4.1 (10.0)	–1.0 (9.5)	.	–0.6 (4.1)
Japan	(1970–80)	–1.9 (6.3)	.	.	+1.9 (7.7)	–0.4 (10.7)	0.0 (0)
Hungary	(1970–80)	–1.9 (2.4)	.	.	0.0 (0.5)	–0.9 (2.9)	.
UK	(1970–81)	–0.8 (2.4)	–0.5 (2.3)	+2.4 (9.3)	–0.2 (3.5)	. .	–0.1 (5.5)
France	(1970–81)	–0.3 (10.3)	–0.3 (10.2)	–0.2 (4.5)	–0.6 (7.6)	–0.7 (4.7)	–0.2 (4.3)
USA	(1971–80)	–0.3 (2.7)	–0.1 (0.4)	+0.3 (1.9)	–0.1 (1.3)	–0.3 (1.3)	–0.1 (0.5)
Italy	(1970–81)	0 (0.1)	–0.1 ((0.5)	+1.0 (5.4)	+0.1 (1.3)	–1.4 (20.4)	–0.1 (5.1)

Table 5. Contribution of energy saving technical progress and other effects (interfuel substitution, hidden product-mix effects); average annual percentage (t-value in parentheses).

	Period	Basic Metals	*of which* Steel	Non-ferr.	Build. materials	Chemicals.	Pulp and paper
FRG	(1965-80)	-1.3 (17)	-1.2 (11)	-2.7 (6.9)	-1.8 (12.8)	-3.8 (14)	-0.9 (3.8)
Austria	(1965-80)	-0.7 (5.4)	-0.1 (4.9)	+0.3 (3.3)	-1.9 (9.4)	.	-0.2 (0.5)
Japan	(1970-80)	-0.9 (1.8)	.	.	-1.0 (4.8)	-3.6 (9.1)	-2.5 (6.2)
Hungary	(1970-80)	-1.1 (13)	.	.	-3.9 (10)	+0.2 (0.2)	
UK	(1970-81)	-2.6 (8.4)	-2.5 (8.7)	-2.7 (2.5)	-3.0 (4.6)	.	-3.8 (5.7)
France	(1970-81)	-0.9 (3.7)	-1.0 (3.8)	-0.6 (2.4)	-1.3 (6.4)	-0.8 (3.6)	-1.3 (5.7)
USA	(1971-80)	-1.8 (3.3)	-1.6 (2.7)	-2.4 (4.5)	-2.6 (17.6)	-3.3 (6.4)	-3.0 (13.8)
Italy	(1970-81)	-1.5 (3.9)	-1.4 (3.6)	-3.1 (1.7)	-2.7 (5.3)	-6.8 (9.5)	-4.1 (8.2)

The chemical industry is one of the most heterogeneous industries. However, it is a very important branch also from the point of view of development policy but the lack of detailed data on energy inputs inhibited a thoroughful analysis. In order to capture at least some considerable shifts in production structures of the chemical industries some energy-intensive products were selected for analytical purposes. They were taken as for representants of the branch. Yet, even in a limited commodity sample significant structural changes towards less energy-intensive products were found.

Concluding Remarks

At this stage of development it is hard to value correctly if the observed shift in output-mix in favour of less energy intensive products follows a long-term trend or is due only to short-term effects. It is clear that, if the shift towards less-intensive commodities is following a trend in the industrialized economies, that would strongly affect the international division of labour. Thus it is of interest that the technical progress in the iron and steel industry follows a probably stable trend attributed to long-term technical progress. This suggests that little ground, if any, is prepared in the seven developed countries for a new international division of labour in the steel industry.

Regional Analysis of the Structural Shifts in Basic Materials Industries

The shares of different regions in the world production of the selected energy-intensive goods are shown in the Annex. From the growth of goods produced in developed countries it follows that despite the fast growth of the manufacturing sector in many developing countries the shares of selected energy-intensive commodities were still low in the 1970s. For example the West Asia-North Africa, Indian Sub-Continent, and East and South-East Asia regions all together do not exceed 1% of the wood pulp (sulphite and soda) production, Sub-Saharan Africa's production of cement is less than 1% of the world volume of production. Steel production in these regions make up less than 0.1% of the world output and in the West Asia/North Africa it is 0.2% of world total.

Structural changes in the regional location of energy-intensive products differ among commodities, but in general it can be said that most of the developing countries increased their shares in the production of energy-intensive goods. For example, in wood pulp production (Latin America's share is now 5.5%, while in 1970 it was less than 2%). Acetylene production in this region increased from 1.2% to almost 7%, for methanol the corresponding change is from 0.3% to 2%. For basic chemical products changes are also clear - Japan's share decreased for ammoniac from 3.4% to 0.2% while Latin America' share doubled from 2.4% to 5%, in the production of caustic soda East and South-East Asia and Latin America increased their shares almost two times, for caustic carbide CPE, Asia's share increased more than three times and Latin America's share two times. One of the traditional products - cement - shows a similar pattern: all developed regions have decreased their share, while the share of developing regions, such as of the CPE, Asia, Latin America, East and South-East Asia, and the West Asia-North Africa almost doubled. Now the share of cement production is 9% in North America, 10% in Japan, 8.4% in Latin America, 10% in CPE Asia, and more than 4% in East and South-East Asia and West Asia-North Africa (each).

Less significant changes happened in steel production where only East and South-East Asia showed a jump from 0.1% to almost 1%, while other developing regions increased their shares at a modest rate (Latin America from 2.25% to 3.2%, CPE, Asia from 1% to 5.4%). Regional specialization in non-ferrous metal production (within the framework of this study) shows that only CPE, Asia increased significantly (by a factor of 2) its share in copper and aluminum, while the shift in aluminium production towards Latin America (Brazil) and the "Other developed" regions (Australia, New Zealand and South Africa) is a new phenomenon,[1/] which must be taken into account in forecasting. The data shows the stagnation in the production of energy-intensive commodities in developed regions. Recent observations in metal production gives us further strong signals to assume a stagnation of the production of metals in developed countries.

1/ There are estimates that in the late 1980s Japan will produce only 30 thousand tons compared with 1.1 millions tons in the 1970s and 350 thousand tons in 1982.

1983 was the fourth consecutive year when the aluminum production in the Western World went down. Capacities in the North continue to shut down, while an increase of production is observed in Sub-Saharan Africa and the "Other developed" region and in Latin America. This might extend to the future allocation of primary aluminum production.

Production of refined copper stayed almost at a constant level in recent years and shares of different regions are also stable.

With zinc there is a further decline in production, in addition to the decrease in North America, Western Europe, and Japan, while a continuous growth is observed for Latin America and Sub-Saharan Africa.

In the Western World during the last decades a significant slowdown in metal demand of the North could be witnessed.

Compilation of Energy/Output Ratios by Industries and Regions

In the following the overall impact of structural changes and technical progress in the basic products sector as a whole will be shown. Two different types of time series were analyzed (with regression techniques). First, energy intensities calculated on the basis of energy/output ratios (by subsectors) without taking technical progress into account but including product-mix effects within subsectors are presented. Second, the average growth rates of technical progress were taken for five sub-sectors from time series analysis of 8 developed countries. Accounting for the "best-practice-prevails"-hypothesis, growth rates of technical progress were calculated and assumed to be equal for all regions.

The following table 6 presents for the basic sectors average annual percentage rates of growth in total energy efficiency (including product mix and technical progress as well) and growth rates of structural change (including product mix, excluding technical progress). Technical progress growth rates are simply calculated by subtraction.

Table 6. Average annual percentage growth rates of energy coefficients derived from semi-logarithmic regressions (t-values in parenthesis).

Regions	Total (1)		Structural changes (2)		Technical progress (3) = (1) − (2)
	Growth rates	R^2	Growth rates	R^2	Growth rates
North America	−2.9 (39.4)	99.4	−0.5 (6.4)	80.3	−2.4
Western Europe	−2.7 (43.7)	99.5	−0.5 (8.0)	86.4	−2.2
Eastern Europe	−2.6 (50.8)	99.6	−0.6 (12.0)	93.6	−2.0
Japan	-2.6 (17.6)	96.9	0.7 (4.6)	68.2	-1.9
Other developed countries	-2.1 (19.3)	97.4	-0.2* (1.4)	18.3	-2.1*
Latin America	-1.7 (21.6)	97.9	+0.5 (5.6)	76.4	-2.2
Sub-Saharan Africa	+0.1* (0.5)	0.0	+1.9 (10.2)	91.2	-1.9*
West Asia-North Africa	-1.0 (3.9)	61.1	+1.3 (5.4)	74.6	-2.3
Indian Sub-Continent	-2.5 (32.4)	99.1	-0.4 (5.1)	72.4	-2.1
East & S-E Asia	-3.9 (22.2)	98.0	-1.7 (8.8)	88.5	-2.2

* t-value indicates that the estimate does not differ significantly from zero.

PART II

UNITAD Scenarios

As it was already mentioned above, the UNITAD world model was used for generating scenarios on overall growth with a view on energy issues. Making use of some of the features of the model, the trade of both energy and energy intensive products and the consumption of them equally as price effect and impacts were analyzed. In two sectors, namely in agriculture and in energy supply constraints were introduced. Upper bound limits of agricultural growth rates were introduced in some regions (Sub-Saharan Africa and West Asia) to simulate the low growth rates observed in these regions for various reasons, some of climatic origin, others due to a neglect of agriculture through a variety of policies (e.g., price distortions).

The upper bound limits of the energy sector are meant to simulate constraints in natural resources. For this purpose, the energy sector is subdivided into four sub-sectors, namely liquid and gas fuels, utilities, solid fuels, and refineries. The upper bound limits were essentially applied to liquid, gas and solid fuels (see below). (For the upper limits of energy supply see Table 7.)

Primary energy units were derived by adding up the endogenous figures of liquid/gas and solid fuels and an exogenous term for primary electricity (hydro-electric, nuclear and miscellaneous electricity generation).

As can be seen, the South share of world primary resources in liquid and gas fuels is assumed to continuously grow up from 48% in 1975 to 51% in year 2000.

Total primary units however hardly change in proportion between North and South (around 60% in North as against 40% in South) on account of the progressive shift, in the North, from liquid and gas fuels to solid fuels and primary electricity. (This comparison is valid since energy units of primary electricity were computed, according to OECD practice, in terms of fossile fueld input equivalent used in thermal power stations.) This analysis should not however be taken too far since many oil and gas deposits can be discovered and put into operation between today and the year 2000. In table 7, year 2000 estimates of liquid and gas fuels are on the cautious side.

Table 7. Upper bound limits of energy primary units, by region (million tons of oil equivalent).

	1975			1990			2000		
	Liquid & gas	Solid	Elec-tricity	Liquid & gas	Solid	Elec-tricity	Liquid & gas	Solid	Elec-tricity
North America	1162	437	55	986	701	354	986	956	600
Western Europe	169	230	109	300	260	295	280	260	525
Eastern Europe	708	558	44	1306	790	196	1527	996	338
Japan	4	16	23	7	12	75	7	10	135
Other developed	30	96	8	48	235	16	48	348	30
Latin America	328	10	31	547	40	90	547	62	208
Sub-Saharan Africa	125	3	6	162	8	10	162	10	24
W. Asia-N. Africa	1300	1	4	1600	3	18	1800	3	37
Indian Sub-C.	17	85	10	47	85	28	47	125	58
East & S.-E. Asia	102	13	4	236	30	26	236	47	55
CPE, Asia	69	364	15	148	655	55	215	980	116
World	4014	1813	309	5387	2819	1163	5855	3799	2126
of which									
North	2073	1337	239	2647	1998	936	2848	2572	1628
South	1941	476	70	2740	821	227	3007	1227	498

* Primary electricity (hydro, nuclear, miscellaneous) is measured as the fossile fuel input equivalent used in thermal power station.

The Scenarios and the Results of Calculations

Following a base-line scenario from 1980 to 1990 three different simulations (denominated A,B,C) were built up for a ten-year period.

- Simulation A is based on an assumption that no permanent structural changes towards less energy-intensive industries take place in the basic products sector of developed countries. So energy input coefficients in developed countries were modified by a multiplier reflecting only the continuation of trends in technological progress. No such trends were applied, by convention, to the basic product sector of developing regions in this and other simulations.

- In simulation B, two sets of exogenous assumptions were introduced: on the industrial side, developed countries specialize in less intensive processing industries (input coefficients are affected by a multiplier reflecting both the technological progress trends and the product - mix effect) on the trade side, an international division of labour progressively develops in all manufacturing goods: developing regions sell more intermediary products (produced in the basic products sector) both to developed countries and on their own markets; other commodity markets also benefit by trade liberalization but to a minor extent as compared to intermediary products. In this experiment, all other parameters, and in particular GDP growth, were kept at the same level as in simulation A, so as to derive the primary order effects of the assumptions.

- Finally, in simulation C, a 1-percentage point of annual growth rate was added up in all developing regions, in order to derive marginal growth elasticities for comparison purposes.

The result of the experiments firstly confirm expectations: when considering the industrial uses of energy, total primary units consumed in the South increase in simulation B, compared to A, while the opposite is observed in developed regions. But one interesting result emerges: the total world primary use of energy in industrial sectors decreases, and so does total world energy consumption; this reflects the fact that all indirect effects of the North-South substitution in the basic products sector, when permeating other

Table 8. Industrial consumption of energy in the world (primary units in millions of tow)

Regions	1990	2000 simulation		
		A	B	C
Developed Market Economies	3687	5593	5466	5390
Eastern Europe	1501	1858	1831	1874
Developing Market Economies	1012	1485	1547	1769
CPE, Asia	557	749	751	827
World	6757	9685	9595	9860

Table 9. Growth of the basic products sector, 1990-2000 (annual growth rates, elasticity to GDP in parentheses).

	Simulations					
	A		B		C[1]	
Developed countries	4.0	(1.2)	3.8	(1.1)	.	
Developing countries	8.4	(1.3)	9.2	(1.4)	.	
of which						
Latin America	9.5	(1.2)	10.4	(1.3)	.	(1.0)
Sub-Saharan Africa	10.9	(2.6)	12.1	(2.9)	.	(.2)
West Asia-North Africa	15.5	(1.8)	12.1	(2.9)	.	(.95)
Indian Sub-Continent	5.2	(1.1)	5.8	(1.2)	.	(1.2)
East & South-East Asia	10.1	(1.6)	11.6	(1.8)	.	(.8)

1) marginal growth elasticity to GDP.

sectors of developing economies, give rise to less energy consumption than in the North.

As can be seen in the table, there is a shift of -127 Mtoe from simulations A to B in developed market economies, matched, but not compensated by a +62 Mtoe shift in developing market economies. Together with shifts in the same direction in the Centrally Planned Economies, the end result is a net decrease of 90 Mtoe in the world at large. These figures seem small in absolute terms or in relative terms (around 1% of the world total). But it should be remembered that no assumptions on energy-saving trends were applied to developing regions, for clarity purpose. But even a small annual energy-saving trend in the basic sector of developing regions will make the world balance significantly lower. For example, a -1% annual trend, equal to one half of what applied to developed regions, would affect by a multiplier of 0.90 the energy consumption of developing regions in simulations A, B, and C. This, it may be objected, should not affect the difference between simulations B and A, unless we have reasons to believe that more energy savings take place in one of them. The argument is indeed that the introduction of energy-saving technology should go parallel to the creation of new capacity in the sector, and, as will be seen, the growth of capacity is much higher in simulation B than in A, since we simulate in the former scenario an assumption of rapid North-South redeployment of the industry. This 1% change in the world total small as it is, is therefore a clear indication of the direction of the move. Slightly higher figures obtain when measuring total energy consumption (not shown in the table) i.e., a 1.5% decrease in total consumption.

The growth of the basic products sector over the ten-year period, is illustrated by Table

As is can be seen, the growth figures and the GDP elasticities are higher in simulation B as compared to A. For all developing countries, the two elasticity figures are 1.4 and 1.2 respectively, with, as expected, the reverse ranking order in developed regions, namely 1.1 versus 1.2 respectively.

Should the basic products sector grow faster at all than other manufacturing sectors do? This is a question which should be raised considering the industrialization strategy followed in the 70s by many rapidly growing developing countries.

The natural resource endowment of many Southern countries is one of the factors which gave way to the policy of favourizing the development of (organic-based) chemicals based on oil resource, metallurgy based on metal mining and textile industries based on fibres produced by petrol chemical industry and/or agriculture. An additional factor was the policy for increasing the value added content of their exports.

There is obviously, in the latter industrialization strategy, a major difference with the first, in that a natural resources endowment induces a high export/output ratio, as will be the case for the petrochemical industry of the Gulf countries. In contrast, the iron and steel industries and the textile fiber industries are essentially oriented towards the home market - even if final products (steel intensive equipment goods such as ships and cars - or textiles and clothes) are largely meant for exports. The simulation achieved in this report is reproducing both types of strategies through capturing of the trends of input coefficients elaborated in the first phase of the project.

The Base Line 1990 - 2000 Simulation: Macroeconomic Implications

In order to let the growth possibilities improve after 1990, new assumptions were made to prevail in the 90s, essentially in the trade and financial areas. A progressive restoration of free trade was introduced in manufactures. It was not supposed that protectionist barriers would be fully dismantled but that the developed economies would make efforts for allowing that the flow of goods originating from developing economies should follow on a trend basis. The scenario, allowed a very low interest rate (between 2 and 3%) as well as prolongation by a few years the maturity periods for debts. At the same time, all developing regions were supposed to achieve a debt-service ratio lower than 20 per cent in terms of their exports.

Supply conditions were set again for two natural resources based sectors, agriculture and energy production. On the side of agriculture, upper limit growth rates higher than in the 80s were set for Sub-Sahara Africa (2.5% p.a.

instead of 2% p.a.) and West Asia and North Africa (2.8% p.a. instead of 2% p.a.). This implies not only better weather conditions but, as supported by a large consensus among International Organizations, a sound price policy and a vigorous agricultural development effort.

The overall growth of the North which is exogenously set in the model, was deliberately taken at a level not much higher than in the 80s, so as to remain on the cautious side. More precisily, developed market economies would grow at a 3.1% rate per annum, while the CPE (Eastern Europe), benefitting from better energy prices, more liberal trade conditions, and successful economic reforms, would grow at a 4.5% annual rate.

There is one more policy assumption, for allowing a contribution to the solution of the debt problem, namely it has been assumed in this scenario that large trade deficits with developing countries can accrue. It could be rational for this scenario as the present situation with high interest rates which inflate the debt burden, while protectionism prevents, the debtors to gain export earnings, offers hardly any issue.

The growth assumptions for the North and growth results for the South are shown in Table 10. As can be seen, the developing market economies reach in this scenario an exceptionally high growth rate of 6.9%, of the same order as that set for the development decade, but with a large spread among regions. The South-North growth ratio is quite high considering the low figures of the 80s. It is the result of the trade relations simulated, i.e. of the further increase of the Southern exports of manufactures to the North.

The trade in manufactures according to the simulations is as shown in Table 11.

The share of the South in world exports doubles up from 1990 to 2000, to reach at the end of the decade a little over one fifth. Out of this share, East Asia alone makes more than 50% total manufactures exports of the South, and Latin America, another 28%. Intermediary products, in manufactures exports, becomes the first commodity group (around one third), followed by equipment and machinery (30%).

Table 10. GDP annual growth rates from 1990 to 2000

		Base-line scenario 1980s	Base-line scenario 1990s
(A)	Developed Market E's (DDM)	2.6	3.1
(B)	Eastern Europe	3.5	4.5
(C)	Developing Market E's (DGM)	3.3	6.9
(D)	CPE, Asia	5.0	5.0
(E)	DDM + DGM	2.7	3.9
(F)	(C/A) ratio	(1.3)	(2.3)
(G)	World	3.2	4.1

Table 11. Trade in manufactures (in percentage of world)

	1990	2000
Developed Regions	89.7	79.4
Developing Regions	10.3	20.6
of which		
Latin America	2.4	5.7
Sub-Saharan Africa	0.4	0.6
West Asia	0.3	1.7
Indian Sub-Continent	0.6	1.3
East Asia	6.0	10.8
CPE's Asia	0.6	0.5

Table 12. Proportion of intermediary products on total manufactures exports in year 2000, by region (in %)

Latin America:	28.3	Indian Sub-Continent:	22.5
Sub-Saharan Africa:	84.4	East & South-East Asia:	29.8
West Asia–North Africa:	58.9	Centrally Planned Asia:	4.4

However, the proportion of exports of intermediary products on total manufactures export is highly variable from region to region. The following figures are supplied by the model for the year 2000. (See Table 12.)

General Conclusions

As considered in this study, the higher growth of the world economy would permit a fast development of energy and capital intensive industries in the South belonging to what is called here the basic products industry or the primary processing sector. This development, it was shown, which conform to a rational international division of labour in the energy-endowed South, would comply with reasonable assumptions on the likely development of the energy sector. At any rate, the high growth of energy consumption in the South resulting from the development of the primary processing sector would altogether alleviate world energy demand (and therefore lower energy prices) as compared with a continuation of the present concentration of the industry in the North.

To sum up, industrial redeployment in the primary processing industry not only tends to achieve a better South-North balance of the manufacturing sector along policy lines advocated by UNIDO, but it also contributes to an optimal use of scarce energy resources at the world level.

ANNEX

Estimates of the Maximum Potential Output of the Energy Sector

Modeling the supply and demand of exhaustible resources without first defining the maximum availability of the resources would mean that only very short-term conclusions could be drawn. Therefore most modelling systems designed for projections of "energy futures" are based on estimates of ultimately recoverable resources of primary energy. The scarcity of a product at any given time is then not only defined by its absolute availability but also by its production cost.

The IIASA energy modelling system is based on estimates of ultimately recoverable resources of primary energy broken down by cost categoreis for seven world regions (Table 2.1). Table 2.2 summarizes these estimates. Given these estimates of total energy resource availability, the maximum potential outputs from each source are then estimated. This not only calls for consideration of geological potentials but also requires assumptions regarding economic, technical, and environmental constraints. These include build-up constraints, reflecting the temporal and financial factors involved in introducing new capacity, as well as environmental constraints (e.g., the wastes that result from oil-shale production and the lack of adequate water supplies both strongly restrict the development of this resource). On the basis of these constraints, maximum potential production profiles are estimated. The estimates used in the IIASA energy-supply model MESSAGE (Model for Energy-Supply Systems And their General Environmental impact) are presented in Table 2.3. Since for some energy carriers in some particular regions no constraints are built into MESSAGE, and also in order to evaluate the given limits, projected outputs (after balancing supply and demand within the IIASA model system) are presented in parentheses. In the case of electricity and heat generation, projected installed capacities are given instead of projected outputs; these capacities (approximately 50% of output of electricity generation), shown in parentheses, may serve as estimates of the upper limits on production.

Annex Table 1. The seven world regions used in the IIASA energy modeling (Häfele 1981)

Region	Areas included	Region	Areas included
I	North America (Canada, United States)	V	Africa (except Northern Africa and South Africa), South and Southeast Asia
II	Soviet Union and Eastern Europe	VI	Middle East and Northern Africa
III	Western Europe, Japan, Australia, New Zealand, South Africa, Israel	VII	China and Centrally Planned Asian Countries
IV	Latin America		

Annex Table 2. Summary of estimates of ultimately recoverable resources by cost category

Resource	Coal[a] (TWyr)		Oil (TWyr)			Natural Gas (TWyr)			Uranium (TWyr)	
Cost Category[b]	1	2	1	2	3	1	2	3	1	2
Region										
I	174	232	23	26	125	34	40	29	35	27
II	136	448	37	45	69	66	51	31	ne	75
III	93	151	17	3	21	19	5	14	14	38
IV	10	11	19	81	110	17	12	14	1	64
V	55	52	25	5	33	16	10	14	6	95
VI	<1	<1	132	27	ne	108	10	14	1	27
VII	92	124	11	13	15	7	13	14	ne	36
World	560	1019	264	200	373	267	141	130	57	362

[a] For coal, only a part of the ultimate resource (~ 15 percent) has been included because the figures are already very large for the time horizon of 2030 and because of the many uncertainties about very long-term coal resources and production technologies.

[b] Cost categories represent estimates of costs either at or below the stated volume of recoverable resources (in constant 1975$).

For oil and natural gas:	Cat. 1:	12$/boe
	Cat. 2:	12–20$/boe
	Cat. 3:	20–25$/boe
For coal:	Cat. 1:	25$/tce
	Cat. 2:	25–50$/tce
For uranium:	Cat. 1:	80$/kgU
	Cat. 2:	80–130$/kgU

Source: IIASA (1981).

Annex Table 3. Implied theoretical upper limits for maximum extraction of primary energy sources and maximum production of secondary energy (GWyr/yr)

	1980		1990		2000	
Region I						
Coal	650	(679)	1100	(797)	1500	(935)
Oil	680	(715)	935	(863)	1235	(907)
Gas	–	(743)	–	(776)	–	(779)
Electricity and heat						
Hydro	55	(123)	63	(149)	73	(188)
Nuclear	42	(63)	99	(59)	220	(69)
Other	–	(434)	–	(427)	–	(489)
Total	–	(620)	–	(635)	–	(740)
Liquids						
light	–	(898)	–	(940)	–	(949)
fuel	–	(1142)	–	(1155)	–	(1095)
Coke	–	(44)	–	(41)	–	(38)
Region II						
Coal	875	(830)	1380	(1240)	1675	(1560)
Oil	710	(710)	770	(750)	820	(820)
Gas	465	(460)	770	(540)	1045	(780)
Electricity and heat						
Hydro	24	(27)	36	(41)	46	(53)
Nuclear	19	(27)	52	(75)	106	(142)
Other	–	(440)	–	(634)	–	(880)
Total	–	(494)		(750)	–	(1075)
Liquids	–	(626)	–	(698)	–	(767)
Coke	–	(0)	–	(0)	–	(0)
Region III						
Coal	550	(498)	650	(528)	800	(578)
Oil	485	(195)	490	(225)	405	(261)
Gas	310	(247)	330	(300)	350	(367)
Electricity and heat						
Hydro	74	(171)	75	(183)	75	(187)
Nuclear	33	(58)	90	(114)	219	(207)
Other	–	(413)	–	(485)	–	(638)
Total	–	(642)	–	(782)	–	(632)
Liquids						
light	–	(662)	–	(630)	–	(631)
fuel	–	(505)	–	(400)	–	(286)
Coke	–	(126)	–	(125)	–	(131)

Annex Table 3. contd./

Region IV						
Coal	38	(75)	85	(38)	140	(85)
Oil	365	(388)	545	(413)	755	(524)
Gas	–	(70)	–	(109)	–	(183)
Electricity and heat						
Hydro	20	(50)	32	(96)	50	(149)
Nuclear	8	(0)	33	(5)	73	(15)
Other	–	(30)	–	(49)	–	(62)
Total	–	(80)	–	(150)	–	(226)
Liquids						
light	–	(226)	–	(284)	–	(415)
fuel	–	(200)	–	(146)	–	(136)
Coke	–	(8)	–	(13)	–	(19)
Region V						
Coal	170	(93)	320	(151)	450	(241)
Oil	350	(321)	445	(371)	495	(403)
Gas	–	(47)	–	(110)	–	(186)
Electricity and heat						
Hydro	16	(31)	24	(64)	45	(137)
Nuclear	7	(2)	25	(8)	56	(39)
Other	–	(46)	–	(89)	–	(103)
Total	–	(79)	–	(161)	–	(279)
Liquids						
light	–	(117)	–	(216)	–	(347)
fuel	–	(99)	–	(112)	–	(110)
Coke	–	(20)	–	(31)	–	(41)
Region VI						
Coal	–	(1)	–	(2)	–	(9)
Oil	1330	(1476)	1470	(1308)	1760	(1214)
Gas	–	(71)	–	(110)	–	(206)
Electricity and heat						
Hydro	2	(5)	2	(6)	2	(7)
Nuclear	7	(0)	25	(0)	55	(0)
Other	–	(16)	–	(40)	–	(80)
Total	–	(21)	–	(46)	–	(87)
Liquids						
light	–	(122)	–	(180)	–	(272)
fuel	–	(82)	–	(84)	–	(78)
Coke	–	(1)	–	(1)	–	(2)
Region VII						
Coal	500	(470)	1206	(670)	2000	(917)
Oil	–	(143)	–	(210)	–	(322)
Gas	–	(20)	–	(51)	–	(170)
Electricity and heat						
Hydro	5	(9)	6	(3)	8	(20)
Nuclear	6	(0)	25	(2)	55	(5)
Other	–	(30)	–	(54)	–	(91)
Total	–	(39)	–	(69)	–	(116)
Liquids						
light	–	(110)	–	(177)	–	(316)

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