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Manufacturing Energy Use in Eight OECD Countries: Trends through 1988

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1. Abstract

This paper reviews the evolution of manufacturing energy use in eight industrialized nations: West Germany, Denmark, France, Japan, Norway, Sweden, the United Kingdom, and the United States. Manufacturing energy use fell in these nations by 16 percent between 1973 and 1988 while manufacturing value added increased by 41 percent. Reduced energy intensities in six industry groups — paper & pulp; chemicals; stone, clay & glass; iron & steel; nonferrous metals; and other manufacturing — were the primary source of this apparent decoupling of energy use and output. Between 1973 and 1988, intensity reductions would have driven down sectoral energy use by 32 percent if the level and composition of output had remained constant. Structural change, or shifts in the product mix, would have reduced energy use by 11 percent if the total level of output and the energy intensities of each industry group had remained constant.

2. Introduction

The industrial sector is an important consumer of energy products that accounts for one-third of total OECD delivered energy use. In light of concerns over the environmental impacts of energy utilization and the security of international oil supplies, understanding the determinants of industrial energy use is a matter of particular relevance to policy formulation. A number of complementary research strategies have been employed in the analysis of this issue. Engineering studies have explored the technical potential for raising the efficiency of energy use; econometric efforts have examined the response of energy users to changes in energy prices and other market conditions. The analysis presented in this paper is based on a third alternative — the descriptive analysis of energy use trends.

Research on the United States (Marlay, 1984; Boyd et al., 1987; Howarth, 1991), West Germany (Jochem, 1990), the United Kingdom (Jenne and Cattel, 1983; Bending et al., 1987), and other countries has pointed to considerable flexibility in the relationship between energy use and industrial activity. Long-term trends in the energy intensities of the various industry groups that constitute the industrial sector coupled with reductions in the share of industrial output originating in the production of energy-intensive raw materials led to significant reductions in sectoral energy use in most nations during the 1970s and 1980s even though industrial production grew substantially.

In a previous study, Howarth et al. (1991) generalized the results of this line of research through a comparison of trends in the energy use and economic activity of the manufacturing sectors of eight nations where detailed time series data on energy use by industry group were available: West Germany, Denmark, France, Japan, Norway, Sweden, the United Kingdom, and the United States. This paper extends our earlier effort by outlining the major trends that have developed in each country as well as the eight-nation aggregate, termed the OECD-8, between 1971 and 1988. We focus particularly on the changing importance of oil in manufacturing and the relative impacts of changes in output, industry structure, and energy intensity on the evolution of energy use. Through such an analysis, it is possible to distinguish trends that were common to all eight countries from those that were specific to particular nations.

The manufacturing sector as defined in this study includes the various industry groups involved in the processing and assembly of raw materials as they are transformed into finished goods. By convention, manufacturing excludes mining and construction, both of which are counted as part of the industrial

sector as defined in U.S. and OECD energy statistics. In addition, the energy accounts of most nations (but not the U.S.) exclude petroleum refining and other "energy sector" industries from the manufacturing aggregate. Since data on refining energy use are inconsistent between countries and are often not available at all, we exclude this sector from the present analysis.

The nations considered in this analysis account for three-quarters of total OECD industrial energy use as measured by the International Energy Agency (various years). Within the OECD-8, we estimate that manufacturing represents over 90 percent of industrial energy use, excluding the use of chemical feedstocks, which we classify as material rather than energy inputs.

3. The Data

We gathered data on each nation's energy use and industrial production for six major manufacturing industry groups: paper & pulp (ISIC* 341); chemicals (ISIC 351-2); stone, clay & glass (ISIC 36); iron & steel (ISIC 371); nonferrous metals (ISIC 372); and a residual category ("other") that includes all other manufacturing activities. This aggregation scheme was chosen because the five raw materials sectors outlined above typically account for 70 percent of manufacturing energy use but only 20 percent of manufacturing production. Changes in the relative energy intensities or output shares of these industries therefore have a disproportionate impact of aggregate manufacturing energy use and are an important determinant of sectoral energy trends. While more detailed data are available for some countries and industry groups, previous analyses have shown that this level of aggregation captures the major effects of changes in energy intensity and structural change on manufacturing energy use (Boyd et al., 1987; Jochem, 1990). The level of aggregation chosen for our analysis also ensures that the data are roughly compatible between nations.

The energy data used in this study are based on total fuels and electricity consumed for heat and power, and include, wherever possible, self-produced fuels such as waste biomass in the paper & pulp sector. Feedstocks such as naptha and natural gas used as raw materials in the chemicals sector are excluded since they are not consumed for the provision of energy services. Energy is counted in terms of its thermal equivalent at the point of utilization measured in exajoules (EJ). Electrical generation, transmission, and distribution losses are ignored. Our data, however, report energy use on a fuel-by-fuel basis, and our figures and statistics convey information regarding the break-down of energy use by fuel wherever practicable. Howarth (1991) examined manufacturing energy use trends in the U.S. and showed that the results were robust with respect to the convention adopted for the measurement of energy use. Hence our analysis is not strongly contingent on the choice of a particular energy aggregate.

Although several organizations such as the International Energy Agency (various years) collect and report data on industrial energy use, the data used in our study are rooted in the national energy balances published by each respective nation. Our experience has shown that there are often inconsistencies and ambiguities in the published international statistics. Similar difficulties concerning the use of international data were reported in studies of the residential and service sectors (Schipper et al., 1985; Schipper et al., 1986). To avoid such problems, we rely on national data to the fullest extent possible. The specific

* International Standard Industrial Classification.

sources and summaries of the data are given in the Appendix.

Manufacturing production is measured in terms of real value added. This allows us to compare production with total GDP. The data were gathered from national sources in 1980 currency and converted to U.S. dollars using the purchasing power parities published by the OECD (1989). The use of purchasing power parities for this purpose is superior to the use of market exchange rates, which are affected by international monetary imbalances and are often poor measures of the relative purchasing power of different currencies. Nontheless, our approach may fail to capture international differences in relative prices that are relevant to the measurement of output in particular sectors of the economy.

4. Trends in Energy Use, 1971-88

It is commonly believed that increased economic activity necessarily implies rising energy use and that efficiency improvements can slow the rate of increase but cannot reverse the trend. Post energy shock trends and the results of our analysis do not support that supposition. While manufacturing production in the OECD-8 rose by 3.0 percent per year between 1971 and 1988, total energy use fell by 0.6 percent per year, from 26.3 to 24.0 EJ (Figure 1). Together, these trends imply that the aggregate ratio of manufacturing energy use per unit of value added fell by 45 percent over the period of analysis.

As Figure 1 shows, the decline in energy use did not develop smoothly over time. Energy use rose from 1971 to 1973, fell in the immediate aftermath of the oil shocks in 1973-4 and 1979-80, and remained fairly constant during the 1976-79 and 1982-88 time periods. The declines were led by substantial decreases in oil consumption. OECD-8 oil use fell from a high of 8.7 EJ in 1973 to 3.7 EJ in 1988 while oil's share of total energy use fell from 30 to 16 percent. The use of non-oil fuels remained relatively constant over time.

Although aggregate electricity use increased from 3.7 to 5.3 EJ between 1971 and 1988, electricity use per unit of manufacturing value added declined by 15 percent. Thus while the share of electricity as a share of total energy use increased from 14 to 22 percent, this change apparently occurred mainly because of fuel conservation. The data provide no strong support to the hypothesis that the electricity share increased principally because of the direct substitution of electricity for fuels, although process changes directly or indirectly resulted in the substitution of electricity for fuel in some industries (Kahane and Squitieri 1987).

A review of the trends in aggregate energy use that developed in each nation considered in our analysis shows that there was considerable international variation (Table 1). In the United Kingdom, for example, manufacturing energy use declined by 39 percent between 1973 and its minimum in 1984, while in Norway sectoral energy use returned to its 1973 level after a modest decline. The country data show that the decline in energy use slowed down or even reversed in the mid 1980s as energy prices stabilized and then fell. In the U.S., for example, energy use apparently rose by 12 percent between 1985 and 1988, although this figure may overestimate the actual increase due to inconsistencies in the data (see the Appendix).

OECD-8
Delivered Energy Use by Fuel

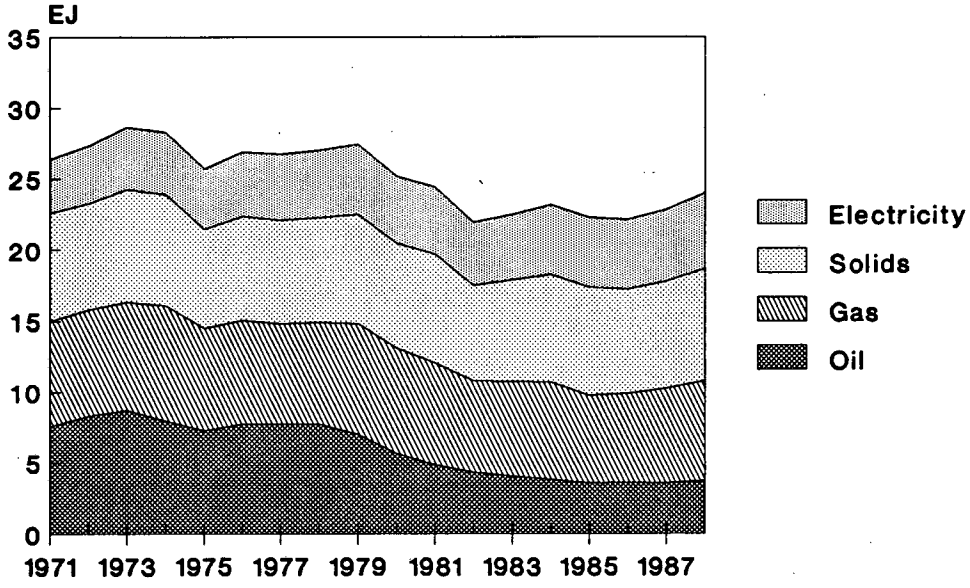

Figure 1

OECD-8
Value Added by Industry Group

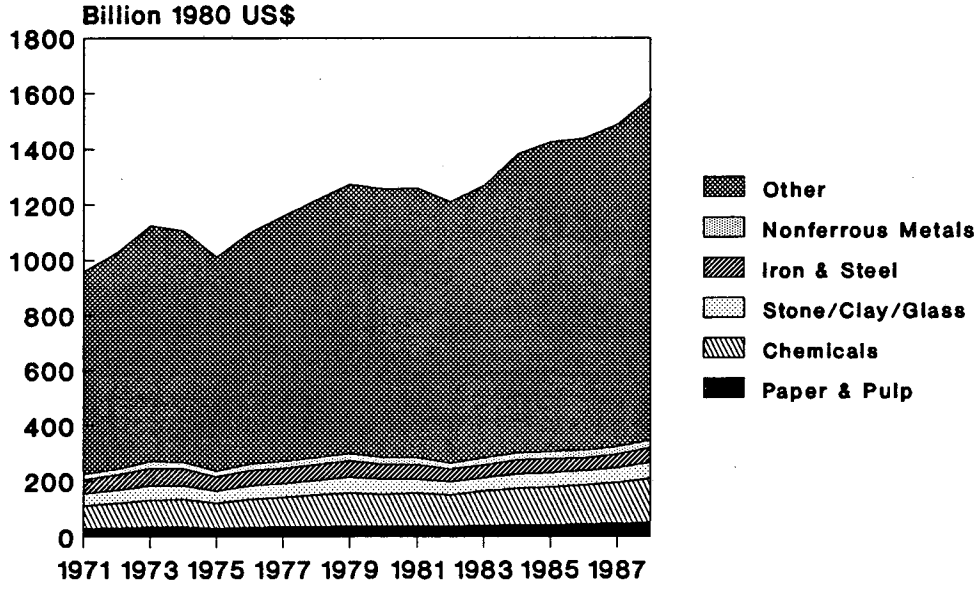

Figure 2

Table 1
Delivered Energy Use

	1971	1973	1976	1979	1982	1985	1988
			PJ				
West Germany	2559	2774	2566	2679	2236	2269	2229
Denmark	138	155	144	138	116	130	124
France	1632	1800	1663	1728	1385	1444	1401
Japan	4585	5403	5152	5074	4295	4440	4729
Norway	250	260	263	275	232	266	261
Sweden	524	570	554	544	488	493	505
United Kingdom	2494	2626	2293	2324	1698	1627	1693
United States	14153	15014	14216	14594	11504	11591	13035
OECD-8	26334	28601	26851	27356	21913	22259	23977
			1973 = 100				
West Germany	92.2	100.0	92.5	96.6	80.6	81.8	80.4
Denmark	89.2	100.0	92.9	88.9	74.7	83.7	80.1
France	90.7	100.0	92.4	96.0	77.0	80.2	77.9
Japan	84.9	100.0	95.4	93.9	79.5	82.2	87.5
Norway	96.2	100.0	101.1	105.8	89.2	102.2	100.3
Sweden	91.8	100.0	97.2	95.3	78.6	86.4	88.6
United Kingdom	95.0	100.0	87.3	88.5	64.7	61.9	64.5
United States	94.3	100.0	94.7	97.2	76.6	77.2	86.8
OECD-8	92.1	100.0	93.9	95.6	76.6	77.8	83.8

Table 2 shows that manufacturing oil use fell by 50 to 67 percent between 1973 and 1988 in every country except Japan, where the decline was a more modest 42 percent. While the rate of reduction was generally high in the 1970s and early 1980s, oil use reached an apparent plateau in many nations as oil prices eased in the mid- to late-1980s.

Table 2
Oil Use

	1971	1973	1976	1979	1982	1985	1988
			PJ				
West Germany	1053	1105	887	815	509	386	365
Denmark	107	119	99	91	68	64	50
France	809	919	791	738	444	392	352
Japan	2352	2736	2521	2348	1555	1432	1582
Norway	81	74	72	70	42	34	37
Sweden	249	264	230	208	142	112	92
United Kingdom	1178	1202	920	900	567	406	426
United States	1715	2302	2184	1817	980	740	824
OECD-8	7544	8720	7703	6987	4307	3565	3730
			1973 = 100				
West Germany	95.3	100.0	80.3	73.8	46.1	34.9	33.1
Denmark	89.9	100.0	83.3	76.2	57.1	53.4	42.1
France	88.1	100.0	86.1	80.3	48.4	42.7	38.3
Japan	86.0	100.0	92.1	85.8	56.8	52.3	57.8
Norway	109.1	100.0	96.7	94.8	56.2	45.6	50.4
Sweden	94.3	100.0	87.1	79.0	53.7	42.6	34.8
United Kingdom	98.0	100.0	76.6	74.9	47.2	33.8	35.5
United States	74.5	100.0	94.9	78.9	42.6	32.1	35.8
OECD-8	86.5	100.0	88.3	80.1	49.4	40.9	42.8

5. Manufacturing Production

Recent trends in manufacturing production provide some initial insight into the determination of sectoral energy use. As noted above, OECD-8 manufacturing output increased from 958 billion 1980 U.S. dollars in 1971 to 1585 in 1988 (Figure 2). The rate of increase was not, however, constant over time, as there was stagnation in the 1973-5 and 1979-82 periods. The share of OECD-8 GDP generated by manufacturing industries remained more or less constant at 24 percent over the period of analysis. Averaged across countries, manufacturing production was apparently driven by economic growth rather than by structural shifts between sectors.

Table 3
Manufacturing Value Added

	1971	1973	1976	1979	1982	1985	1988
			Billion 1980 US Dollars				
West Germany	139.8	153.1	151.2	163.8	154.3	168.3	181.2
Denmark	5.6	6.4	6.6	7.1	7.2	8.3	8.0
France	82.2	92.7	98.0	107.9	106.5	105.5	109.7
Japan	184.6	228.2	216.5	258.9	276.6	334.5	374.7
Norway	5.5	6.1	6.2	6.1	5.9	6.4	6.4
Sweden	14.3	15.4	16.3	15.9	15.4	17.5	18.5
United Kingdom	105.5	117.7	110.2	112.9	95.3	104.5	119.5
United States	419.9	504.7	493.5	598.7	548.8	678.7	766.8
OECD-8	957.6	1124.2	1098.4	1271.3	1209.9	1423.7	1584.8
			1973 = 100				
West Germany	91.4	100.0	98.8	107.0	100.8	110.0	118.4
Denmark	87.6	100.0	102.4	110.7	111.9	129.4	124.7
France	88.7	100.0	105.7	116.4	114.9	113.8	118.3
Japan	80.9	100.0	94.9	113.5	121.2	146.6	164.2
Norway	91.4	100.0	102.3	100.8	97.5	105.3	105.6
Sweden	92.8	100.0	105.8	103.3	99.8	113.5	120.1
United Kingdom	89.7	100.0	93.7	96.0	81.0	88.8	101.6
United States	83.2	100.0	97.8	118.6	108.7	134.5	151.9
OECD-8	85.2	100.0	97.7	113.1	107.6	126.6	141.0

A review of output trends in each country shows that there was wide variation between nations with respect to the rate of growth in the manufacturing sector (Table 3). In the United Kingdom, for example, manufacturing production fell by 19 percent between 1973 and 1982, returning to its 1973 value only in 1988. In Japan, on the other hand, sectoral output increased by a full 64 percent between 1973 and 1988. There was also variation in the relative importance of manufacturing (Table 4). In Japan and West Germany, manufacturing accounts for roughly 30 percent of GDP, while in Norway the fraction is only 13 percent.

Table 4
Manufacturing Share of GDP (%)

	1971	1973	1976	1979	1982	1985	1988
West Germany	32.6	32.7	31.1	30.5	28.5	29.2	29.1
Denmark	16.0	16.5	16.2	16.4	16.3	17.3	15.9
France	23.2	23.8	23.4	23.4	21.9	21.0	20.2
Japan	30.5	32.2	28.8	29.5	28.3	30.0	29.8
Norway	21.9	21.9	19.2	16.6	15.2	14.1	13.0
Sweden	22.8	23.1	22.8	21.4	20.2	21.2	20.8
United Kingdom	28.2	28.5	26.2	25.0	21.5	21.5	21.7
United States	19.7	21.5	20.4	21.9	20.2	21.9	22.4
OECD-8	23.8	25.2	23.6	24.4	22.7	23.9	24.1

These substantial differences in manufacturing output growth were apparently driven by macroeconomic policies and conditions specific to each nation. In Sweden, for instance, the industrial sector was stagnant during the 1970s due to the overvaluation of the krona; but in Norway and the United Kingdom the development of offshore oil resources in the 1970s drew capital away from manufacturing. Although future trends difficult to predict, the evidence suggests that manufacturing production has in the past increased with GDP. Barring unforeseen economic shocks, the prospects are for sustained growth in manufacturing output.

6. Structural Change

While trends in aggregate energy use per unit of industrial production provide some insight into the factors shaping manufacturing energy use, aggregate indicators mask important information on the impacts of changes in the structure of production on energy utilization. Industrial production is not a homogeneous activity but rather a set of heterogeneous activities with very different energy requirements per unit of value added. While the "raw materials" sector — which we define to include paper & pulp; chemicals; stone, clay & glass; iron & steel; and nonferrous metals — accounts for some 20 percent of manufacturing production in the OECD-8 (Figure 2), it accounts for roughly 70 percent of sectoral energy use (Figure 3). Since the share of output generated in these energy-intensive industries fell somewhat over the period of analysis (Table 5), it is reasonable to expect that structural change may have led to significant reductions in energy use.

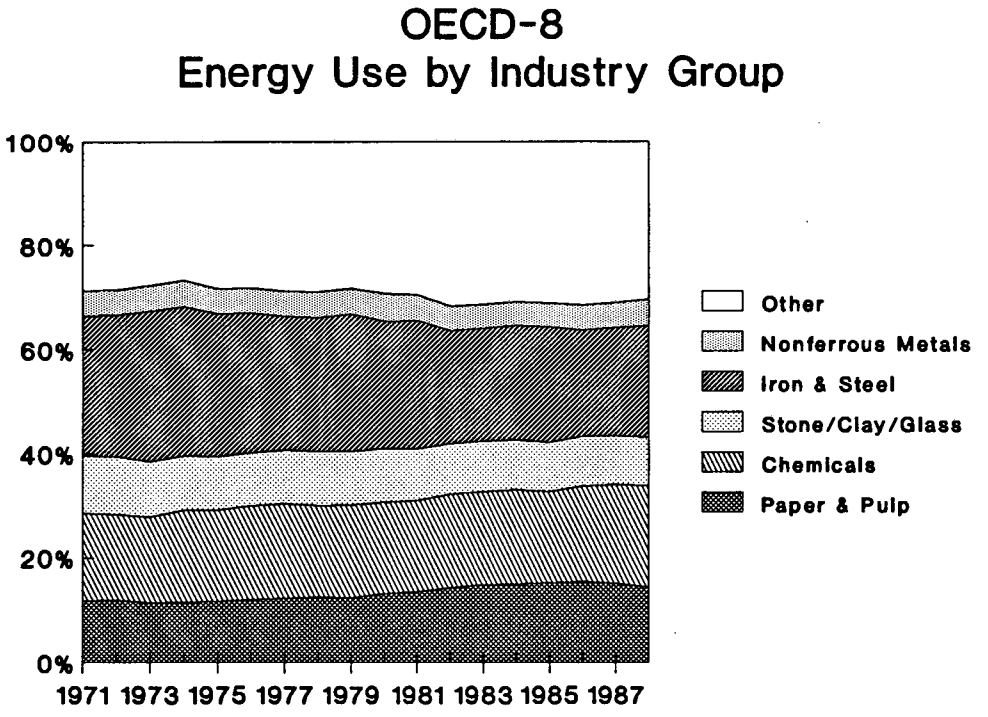

Figure 3

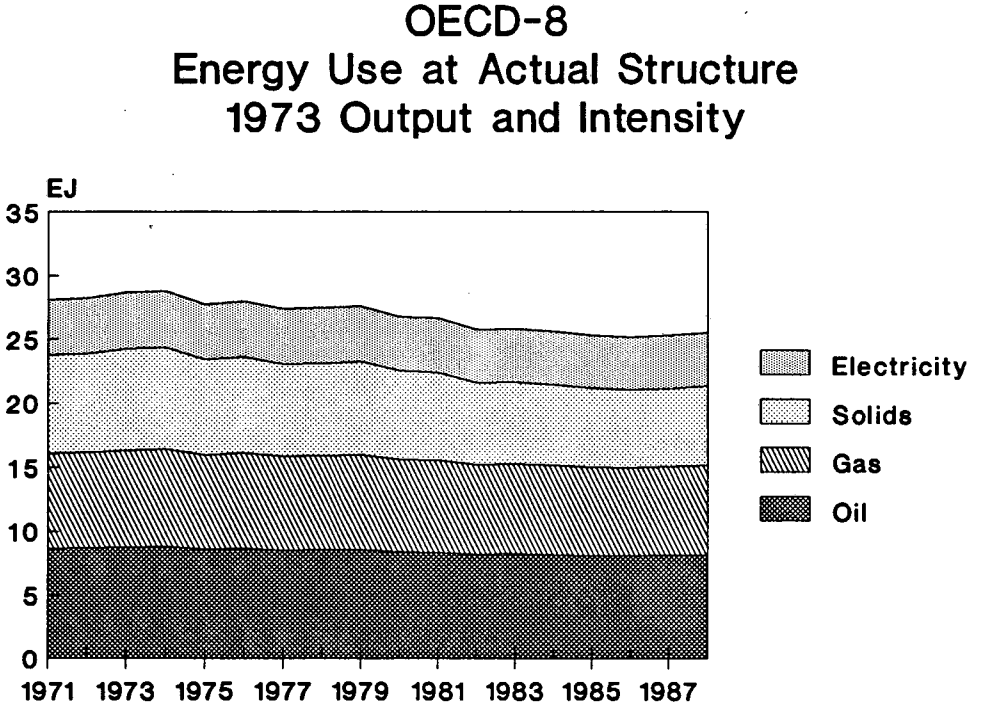

Figure 4

Table 5
Raw Materials Share of Manufacturing Output (%)*

	1971	1973	1976	1979	1982	1985	1988
West Germany	21.9	23.1	22.6	23.0	21.5	21.7	21.8
Denmark	15.1	16.5	15.9	16.5	14.8	15.0	16.3
France	21.2	21.8	21.1	22.1	21.3	22.2	24.3
Japan	27.6	27.8	27.5	27.4	24.7	22.9	23.0
Norway	23.0	23.9	24.1	25.8	25.8	28.8	31.7
Sweden	22.3	23.7	21.3	23.3	23.7	23.0	24.3
United Kingdom	21.6	22.5	22.4	22.7	22.8	23.2	23.7
United States	23.3	23.8	23.6	22.6	20.6	20.4	20.8
OECD-8	23.5	24.2	23.8	23.6	21.9	21.5	22.0

* Raw materials includes production of paper & pulp; chemicals; stone, clay & glass; iron & steel; and nonferrous metals.

To gauge the effects of structural change on manufacturing energy use, we prepared estimates of the trends in energy use on a fuel-by-fuel basis expected if aggregate output and the energy intensities of each component sector were held constant at their 1973 values. Let Q_t be total manufacturing output in year t, S_{it} be the product share of the ith industry group in year t, and I_{ijt} be the use of fuel type j per unit of production in the ith industry group in year t. Then the actual use of fuel j in year t is given by the expression $Q_t \sum_{i=1}^{6} S_{it} I_{ijt}$, and the level of fuel use that would have arisen if total output and fuel intensities had remained at base year values while the product shares followed their actual paths is $Q_0 \sum_{i=1}^{6} S_{it} I_{ij0}$ where the 0 subscript denotes the base year. This approach to measuring the impacts of structural change is closely related to Laspeyres index methods, and differs from the Divisia index approach that has gained popularity in the literature (Boyd et al., 1987). In a related study (Howarth et al., 1991), we compared the two approaches and discussed the relative advantages and disadvantages of each. In general, the empirical differences between the two are small.

The results show that structural change had a modest but measurable impact on energy use in the OECD-8 (Figure 4). Taken independently, changes in the structure of production would have reduced aggregate sectoral energy use by a total of 11 percent between 1973 and 1988. While oil, gas, and electricity use would have fallen by 7, 8, and 6 percent in this calculation, the largest impacts were on the use of solids, which would have dropped by 22 percent. These changes were apparently led by movement away from coal-intensive sectors — particularly the iron & steel sector, where production fell by 27 percent in the OECD-8 during the 1979-82 recession.

Our analysis found considerable international variation in the impacts of structural change on energy use. The proportion of manufacturing production generated in the raw materials sector, for example, ranged from 16 percent in Denmark to 32 percent in Norway (Table 5). Table 6 shows indices of the trend in aggregate energy use which would have developed in each country if total sectoral output and the energy intensities of each industry group had remained constant at their 1973 values. As can be seen, structural change drove energy use down by 12 percent in West Germany, 13 percent in the United States, and 16 percent in Japan. The structure effect increased energy use in Norway by 26 percent, while relatively little change occurred in the other nations.

Table 6
Structural Change Indices*
(1973 = 100)

	1971	1973	1976	1979	1982	1985	1988
West Germany	96.6	100.0	96.0	96.6	90.0	89.3	88.4
Denmark	98.5	100.0	97.9	99.0	93.0	93.4	95.8
France	97.6	100.0	98.4	101.7	94.6	95.4	101.5
Japan	99.1	100.0	98.7	96.8	89.5	84.8	83.7
Norway	96.6	100.0	102.2	107.5	104.6	116.4	125.6
Sweden	96.0	100.0	92.2	100.0	98.1	96.9	102.1
United Kingdom	99.2	100.0	97.5	97.8	95.9	95.8	97.2
United States	98.6	100.0	98.0	94.5	87.0	86.2	87.0
OECD-8	98.0	100.0	99.0	96.2	89.9	88.4	88.9

* Hypothetical energy use at 1973 total manufacturing output and energy intensities for each industry group, actual product shares.

The causes of the shift away from raw materials production in some nations are uncertain. Some have argued that the shift signals a long-term trend with significant implications for future energy use (Williams et al., 1987). Indeed, there is clear evidence of a shift in the type and quality of materials used to produce goods and services. Generally speaking, traditional materials such as steel and cement have lost share to plastics and composite materials, which are often less bulky than the materials they replace (Considine, 1991). There is also evidence that technological change has led to improvements in the materials efficiency of manufacturing processes and reductions in the quantity of materials embodied in finished products. Together, such trends suggest that structural change is indeed an ongoing process.

A close examination of Table 6, however, shows that the impacts of structural change on manufacturing energy use were concentrated mainly in the years immediately following the 1973 and 1979 energy shocks. Only in West Germany and Japan did structural change lead to sustained energy savings after 1982. In France and Norway, the industry mix has shifted significantly *towards* energy-intensive industries in recent years.

Part of the observed slowdown in basic materials processing may have been caused by short-term macroeconomic imbalances that bear little relationship to long-term trends. The materials sector suffers disproportionately during economic downturns, when orders for durable goods, which are materials-intensive, fall relative to GDP. Since the period of analysis examined in this study witnessed significant recessionary periods in each and every nation, the structural change that occurred over the period may be an imperfect indicator of long-term trends.

In the United States, for example, structural change had no net impact on energy use between 1958 and 1964, reduced energy use between 1964 and 1967, and increased it somewhat between 1967 and 1974 (Howarth, 1991). The substantial impacts of structural change on energy use in the mid-1970s and early 1980s were induced largely by the slump in iron and steel production that accompanied the period's recurrent recessions and high interest rates. Between 1981 and 1982, the value added of the U.S. iron & steel sector fell by 37 percent over a single year. This change alone would have been sufficient to reduce U.S. manufacturing energy use by some 10 percent. Between 1985 and 1988, the industry mix in U.S. manufacturing was relatively stable, with no net movement away from energy-intensive industries.

The case of Norway, on the other hand, shows that economic conditions which favor the growth of energy-intensive industries can lead to significant increases in energy utilization. Norway is endowed with a large hydroelectricity resource which was developed in the 1950s and today provides electricity to energy-intensive industries for as little as half a cent per kilowatt-hour. As a result, Norwegian industry relies largely on electricity for the provision of energy services, and the growth of electricity-intensive industries such as primary aluminum smelting represents a significant structural change favoring increased energy use.

7. Energy Intensity

The level of manufacturing production and its distribution between various goods and industry groups are two determinants of manufacturing energy use. Energy intensity, or the energy input per unit of output in each industry group, is the third. Ideally, energy intensity, or the energy required to perform some physically well defined task, would be the inverse of technical efficiency. But comprehensive data on industrial energy use on a product-by-product basis are not now available, and there are substantial reasons to believe that they never will become so. There are simply too many product types, and the accounting procedures too onerous, to permit the collection of such data except in narrowly focused case studies. As a result, studies of this type generally focus on energy intensities at the industry group level, which may be affected not only by technical efficiency improvements but also by changes in the mix of products produced within each industry group. We emphasize therefore that our estimates of the impacts of changing energy intensity on manufacturing energy use are not purely attributable to efficiency improvements, although technical efficiency is clearly a leading determinant of energy intensity at this level of aggregation.

Figure 5 shows the evolution in energy use broken down by fuel that would have developed if the fuel-by-fuel energy intensities of each industry group had followed their historical paths while the aggregate level and structure of manufacturing production remained constant in its 1973 configuration. According to the notation defined above, this calculation may be represented as $Q_0 \sum_{i=1}^{6} S_{i0} I_{ijt}$. Overall,

declining energy intensity would have reduced aggregate energy use by 32 percent between 1973 and 1988. These intensity reductions were based largely in reduced oil consumption. While changing intensity would have driven down gas and solids consumption by 28 and 11 percent respectively, the corresponding decrease in oil intensity was 68 percent. Electricity intensity, averaged across all eight nations and adjusted for structural change, decreased by 7 percent. Substantial energy intensity reductions were achieved in each of the six industry groups considered in this analysis between 1973 and 1988. Reductions of 27 percent were achieved in paper & pulp; 39 percent in chemicals; 33 percent in stone, clay & glass; 28 percent in iron & steel; 26 percent in nonferrous metals; and 37 percent in other industries.

A review of international trends shows that significant reductions in energy intensity were achieved in each country considered in our analysis. Table 7, which depicts trends in energy intensity adjusted to account for the effects of structural change, shows that intensity reductions ranged from 20 percent in Norway to 35 percent in Japan. These differences are presumably due in part to differences in energy prices and the relative importance of oil in the manufacturing sector. Norway, for example, largely circumvented the demand-side impacts of the energy shocks of the 1970s through its high reliance on electricity.

Table 7
Energy Intensity Indices*
(1973 = 100)

	1971	1973	1976	1979	1982	1985	1988
West Germany	104.6	100.0	97.4	93.2	88.6	83.5	77.1
Denmark	103.1	100.0	92.9	82.3	73.5	71.8	70.8
France	105.0	100.0	89.3	81.6	71.4	74.3	65.2
Japan	105.8	100.0	101.9	85.7	73.4	66.6	64.6
Norway	109.0	100.0	97.5	98.7	88.1	85.5	79.5
Sweden	103.2	100.0	99.3	92.3	80.2	78.3	72.3
United Kingdom	106.8	100.0	95.9	94.4	82.7	73.3	65.5
United States	114.9	100.0	98.8	87.4	83.2	68.9	68.5
OECD-8	110.3	100.0	98.4	88.1	79.5	70.4	67.7

* Hypothetical energy use at 1973 level and structure of manufacturing output, actual energy intensities for each industry group.

It is often supposed that industrial energy efficiency was relatively constant during the pre-1973 era of stable or declining energy prices and that the post-1973 intensity reduction constitutes a departure from previous trends. Energy intensity, however, is shaped not only by the relative price of energy, but also by long-term technological trends that are only partially motivated by the desire to conserve fuel. To what extent were these two factors responsible for the observed trends in energy intensity?

OECD-8
Energy Use at Actual Intensity
1973 Output and Structure

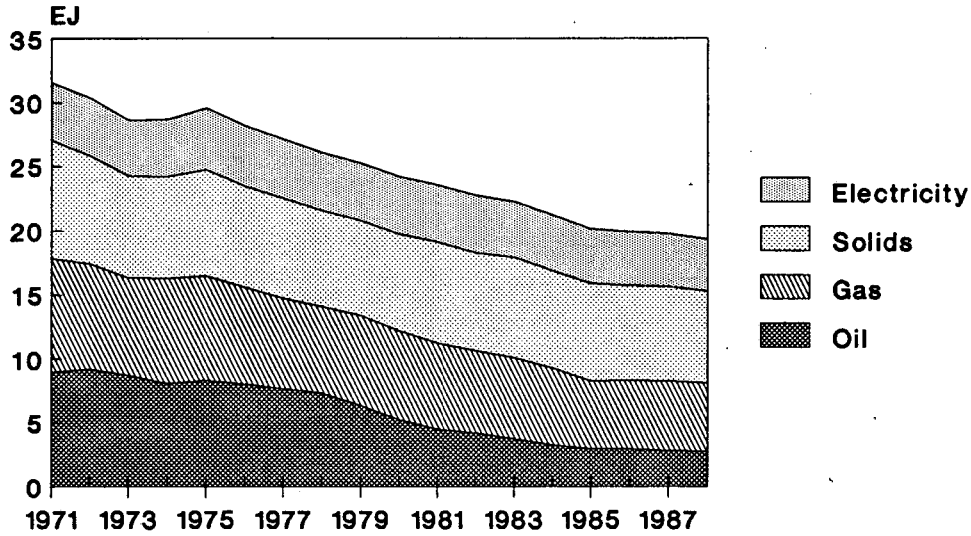

Figure 5

Manufacturing Energy Intensity
Constant 1973 Industry Structure

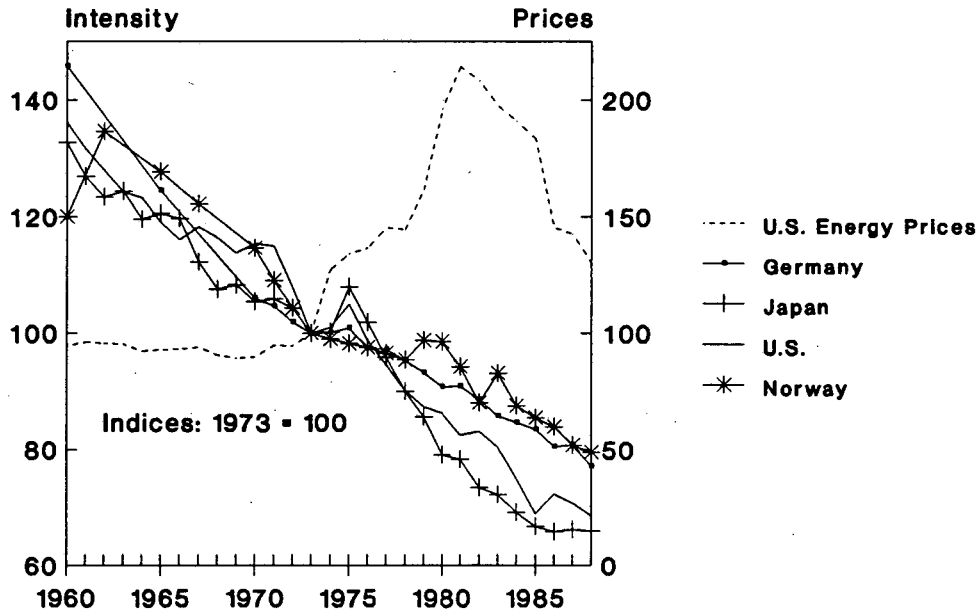

Figure 6

A review of trends in structure-adjusted manufacturing energy intensity in the United States between 1958 and 1988 suggests an interesting answer to this question. Between 1958 and 1973, structure-adjusted U.S. manufacturing energy intensity fell at an average rate of 2.4 percent per year, or 30 percent overall (Figure 6). Between 1973 and 1988, the rate of improvement was 2.5 percent per year for a total reduction of 32 percent. Contrary to expectations, the energy shocks of the 1970s apparently induced no significant acceleration in the pre-1973 trend towards reduced intensity (Howarth, 1991). Similar results hold for West Germany, Norway, and Japan, where we were able to obtain the data necessary to establish long-term trends. The figure shows that real energy prices, measured by the U.S. producer price index for energy products, were stable before the energy shock, rose sharply between 1973 and 1981, and fell substantially in the mid-1980s. These results suggest that long-run changes caused by structural change and technological progress are as important as short-run changes caused only by higher energy prices.

This finding, although interesting, must be interpreted with some care. A principal source of industrial energy intensity reductions is investment in new capital facilities. Since the annual growth rate of manufacturing production in the U.S. fell from 5.4 percent in the 1958-73 period to 2.8 percent between 1973 and 1988, the construction of new capacity slowed significantly, reducing the market penetration of state-of-the-art technologies. Higher energy prices presumably intervened, permitting the sustained reduction of sectoral energy intensity.

8. International Energy Intensity Comparisons

The measurement of differences in technical energy efficiency across nations is of considerable interest to energy analysts and policy makers. Figure 7 shows the 1988 level of aggregate manufacturing energy intensity for each nation considered in the analysis. As one might expect, there is considerable variation amongst countries. The highest energy intensity was observed in Norway, the lowest in West Germany.

Given the observed international variation in the structure of the manufacturing sector, it is clear that interpreting aggregate energy intensities as efficiency indicators would be inappropriate. For example, while the proportion of manufacturing value added generated by the energy-intensive raw materials sectors stands at 16 percent in Denmark, the corresponding figure for Norway is 32 percent. We would therefore expect the aggregate energy intensity of Norwegian manufacturing to be higher than in Denmark if the energy intensities of each industry group were the same in each nation.

To provide an overview of the extent to which international differences in aggregate manufacturing energy intensity are due to differences in industry-group energy intensities as opposed to differences in sectoral structure, we calculated the aggregate energy intensity that would have resulted in each nation in 1988 given its own industry-group energy intensities but average OECD-8 sectoral structure. Let I_{ij} be the energy intensity of industry group i in country j and S_{io} be the proportion of manufacturing output generated in that industry group for the OECD-8 as a whole. Then the aggregate energy intensity of country j given the average OECD-8 industry structure is given by $\sum_{i=1}^{6} I_{ij} S_{io}$.

1988 Manufacturing Energy Intensity

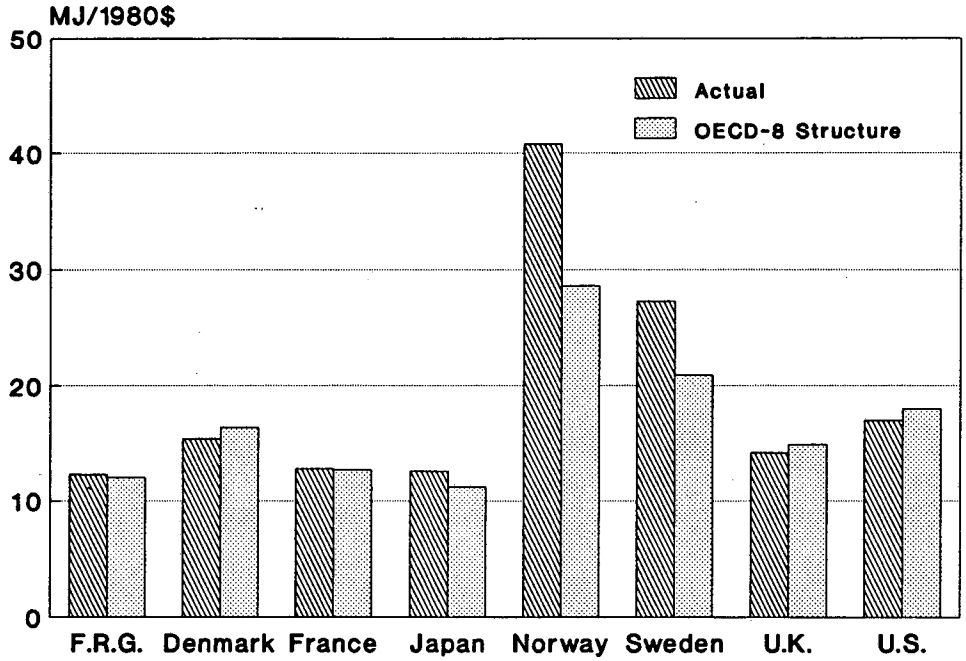

Figure 7

The results of this calculation, also presented in Figure 7, show that international differences in aggregate energy intensity are explained mainly by differences in the energy intensities of the various industry groups, with structural factors playing a relatively minor role in most cases. U.S. manufacturing energy intensity, adjusted to account for structural differences between countries, exceeds the levels in Japan and the six European nations by 60 percent and 30 percent respectively. What is most striking, however, are the high energy intensities observed in Norway and to a lesser extent Sweden, which lie 89 percent and 38 percent above those of the OECD-8 average and are considerably higher than those of the other nations.

In the absence of further information, however, it would be potentially misleading to use even structure-adjusted energy intensities to compare energy efficiency across nations. One problem relates to the conversion of each nation's value added to U.S. dollars using aggregate purchasing power parities. As noted above, this approach may not fully account for international differences in the relative prices of particular manufactured goods. While we have not studied the matter in detail, there are undoubtedly structural differences between nations that are not captured at the high level of aggregation used in this analysis. Each industry group produces a range of products with substantially different energy intensities.

In the paper and pulp sector, for example, Norwegian and Swedish energy intensities are far above the OECD-8 average. But the ratio of raw pulp production, which is very energy-intensive, to sectoral value added is an order of magnitude higher in Norway and Sweden than in other nations. Comparable conditions exist in the nonferrous metals sector, where Norwegian and Swedish energy intensities are 256 percent and 102 percent above the OECD-8 average. The production of primary aluminum accounts for a large share of energy use in this sector, and the ratio of aluminum production to total sectoral value added is over two times the OECD-8 average in Sweden and ten times the OECD-8 average in Norway.

9. Physical Energy Intensities

The examples given above underscore the danger of using energy/value added ratios to assess the technical energy efficiency of manufacturing in different countries. It is sometimes possible to measure the output of relatively homogeneous industries using physical indicators. Different grades of steel, for example, are often summed by weight to obtain a measure of steel production. Even in narrowly defined industries, however, careful and detailed analysis is required to understand why energy use per unit of physical output differs across nations (Ross and Liu, 1991). The great diversity in manufacturing activities precludes this approach for most industries. In the paper and pulp sector, for example, there is no obvious approach to adding up products as different as pulp produced for export, newsprint, and corrugated boxes on a comparable physical basis. The problem is even more extreme in the chemicals; stone, clay & glass; and nonferrous metals sectors, where the range of products is quite substantial.

Such difficulties have not precluded the examination of physical energy intensities in certain industries. A study of the steel sector in 1980, for example, found energy intensities of 4.5 Gcal/tonne in Japan, 5.2 Gcal/tonne in West Germany, 5.6 Gcal/tonne in the U.K., 5.7 Gcal/tonne in France, and 6.2 Gcal/tonne in the U.S. (Meunier and Bruyn Kops, 1984). In an analysis of cement production, Vallance (1990) found a narrow range of physical energy intensities (4030-4244 MJ/tonne in 1987) in France, West Germany, Switzerland, and Japan. Similarly, Lester (1987) observed that the energy intensity of primary

aluminum smelting was roughly comparable across world regions in 1984, ranging from 15.5 kwh/kg in East Asia to 17.3 kwh/kg in North America.

Analyses of trends in physical energy intensities in particular nations are generally similar to trends in energy/value added ratios. A study of industrial energy trends in Japan between 1973 and the late 1980s found physical energy intensity reductions averaging 1.9 percent per year in steel production, 2.7 percent per year in cement, 4.0 percent per year in paper & pulp, and 3.0 percent per year in the production of chemical fibers (Fujime, 1989). The corresponding declines in the energy/value added ratios of the iron & steel; stone, clay, & glass; and paper and pulp sectors were 2.6, 2.3, and 3.1 percent per year respectively.

Similar results have been established for other nations. In the U.S., physical energy intensity fell at a reported 3.0 percent per year between 1972 and 1988 in the paper & pulp sector (American Paper Institute, 1989). The decline in the energy/value added ratio was 2.6 percent per year. In the steel sector, physical energy intensity fell at 3.0 percent per year between 1972 and 1989 (B. Steiner, American Iron and Steel Institute, personal communication), while the energy/value added ratio dropped by 1.4 percent per year. In Norway, there were intensity reductions of 3.5 and 0.6 percent per year in cement and primary aluminum production respectively between 1976 and 1986 (Pedersen and Fauske, 1988). No overall improvement occurred in the Norwegian iron and steel sector.

10. The Changing Fuel Mix

The fuel mix is an indirect determinant of energy intensity because physical differences exist between forms of energy that effect their relative productivity. Electricity, for example, is used more efficiently than nonelectrical fuels in most applications, and oil and gas boilers are often more efficient than those that use solids. The share of solids as a fraction of total OECD-8 sectoral energy use increased from 28 to 33 percent between 1973 and 1988 despite significant declines in the production of coal-intensive goods such as iron and steel (Table 8). The share of gas rose slightly from 26 to 30 percent, with more substantial increases in the European nations. The oil share fell from 30 to 16 percent in the OECD-8, while the electricity share increased from 15 to 22 percent.

Table 8
Energy Use by Type (%)

	1973				1988			
	Oil	Gas	Solids	Elec.	Oil	Gas	Solids	Elec.
West Germany	40	24	19	17	16	32	25	27
Denmark	77	0	11	10	40	14	21	23
France	51	16	19	14	25	30	20	25
Japan	51	2	30	18	33	3	38	25
Norway	30	0	19	52	14	0	25	60
Sweden	46	0	31	23	18	0	45	37
United Kingdom	46	17	26	11	25	31	25	19
United States	15	41	30	14	6	41	34	19
OECD-8	30	26	28	15	16	30	33	22

10.1. Oil

Sharp increases in the price of oil in 1973 and 1979 were an obvious factor influencing manufacturing energy use over the period of analysis. Not surprisingly, the decline in intensity was sharpest for oil. Our calculations show that that the structure-adjusted oil intensity of OECD-8 manufacturing fell by 68 percent between 1973 and 1988. Table 2 shows that actual oil use fell by 42 to 67 percent in the nations considered in this paper, or 57 percent for the aggregate OECD-8. If the goal of the energy policies of most countries was to save oil, that goal was certainly met — at least through the mid-1980s.

A review of oil use trends by region sheds additional light on this matter. In 1973 the U.S. used 2.3 EJ of oil in manufacturing; Japan 2.7 EJ; and the six European nations 3.7 EJ. Oil comprised only 15 percent of America's manufacturing energy use as compared with 51 percent for Japan and 45 percent for Europe. By 1988, oil use had fallen to 0.8 EJ in the U.S.; 1.6 EJ in Japan; and 1.3 EJ in Europe. No substantial increases in oil use occurred in these nations after the 1985 oil price crash.

Structural change had only small impacts on oil use. In Japan, for example, structural change alone would have reduced oil use by about 11 percent through 1988 if energy intensity and sectoral output had remained constant. In Europe and the U.S. the corresponding figures are 2 and 6 percent. In general, oil was affected *less* by structural change than were other fuels. This presumably occurred because of the important decline in the output of the iron and steel industry, which is largely dependent on solid fuels.

Not all of the oil savings caused by the decline in oil intensity should be considered permanent. Some industries resorted to stop-gap measures that could be reversed when prices were fell. Many industries achieved multi-fuel capability in the 1970s. In Norway, Sweden, and France, industries were able to obtain short- or even long-term contracts for electricity as a substitute for oil for steam-raising or low-temperature process heat. In no country, however, was there a sharp rebound in manufacturing oil use or

intensity following the decrease in oil prices in the mid-1980s.

10.2. Electricity

Total OECD-8 electricity use in 1988 was about 20 percent higher than it was in 1971. The share of electricity as a fraction of total delivered energy rose in the OECD-8 and in each country as well. These changes leave the impression that electricity use was not affected by the oil shocks or was even stimulated by them. Indeed, it has been argued that increased electricity use caused a significant part of the decline in fossil fuel use. Careful inspection of the data considered in this analysis, however, tells a more complicated story.

If the substitution of electricity for fuels had been a pervasive phenomenon, electricity intensity should have increased. In fact electricity intensity decreased or remained constant in most industry groups. In aggregate, changing intensity would have led to a 7 percent decrease in OECD-8 electricity use between 1973 and 1988 if the level and structure of output had remained constant. Meanwhile, fuel intensity dropped much more substantially. The implication is that the share of electricity as a proportion of total energy use rose because of the sharp drop in fuel intensity — not because of increased electricity use. Structural change had mixed impacts on electricity use. Changes in the industry mix at constant output and energy intensity would have led to reductions in electricity utilization of 8 percent in the U.S. and 11 percent in Japan, but an increase of 3 percent in Europe.

Electricity intensities behaved in a mixed way in the nations we examined. On the whole, structure-adjusted electricity intensity decreased by 13 percent in the U.S. and 14 percent in Japan, but increased in Europe by 10 percent. The increase was led by the promotion of low-cost electricity in Norway, Sweden, and France. Some of this electricity substituted directly for fossil fuel for steam production or process heat. Electricity intensity increased for some industries and countries but decreased in others. Shifts towards electric arc furnaces in steel production, for example, served to increase electricity use. At the same time, electricity intensity decreased in the chemicals and nonferrous metals sectors due to electricity conservation and changes in the product mix.

11. Energy Price Trends

The decline in fuel intensities was partially a result of increases in fuel prices, particularly oil prices (Figure 8).* While the price of industrial fuel oil was around 75 1980 U.S.$/tonne in most nations in 1973, differences in government policies led to a significant divergence in later years. In the U.S., for example, prices peaked in 1981 at about 270 1980 U.S.$/tonne. In Sweden, on the other hand, heavy taxation caused the price to rise continuously to around 360 1980 U.S.$/tonne in 1985. With these exceptions, however, the trend was broadly similar among countries. Not surprisingly, these price increases led manufacturers to reduce their reliance on oil in favor of other fuels. A substantial decline in oil prices occurred in 1986, largely offsetting the earlier price rises. While this development did not lead to increasing oil intensity, the trend towards oil intensity reductions came to a halt.

* The price data discussed in this section were provided by the International Energy Agency.

OECD Industrial Fuel Oil Prices

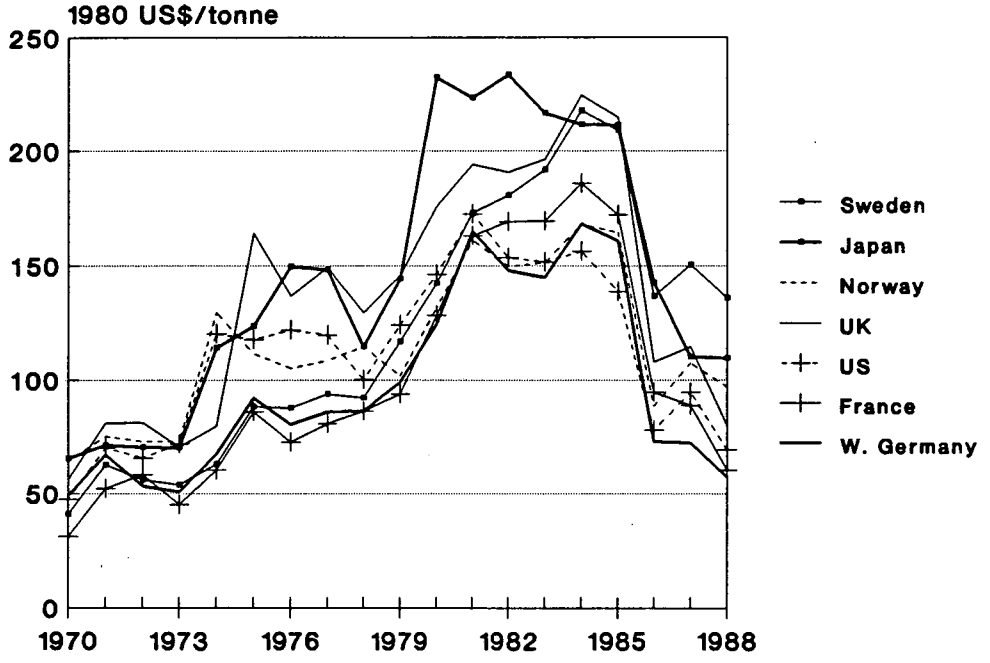

Figure 8

OECD Industrial Electricity Prices

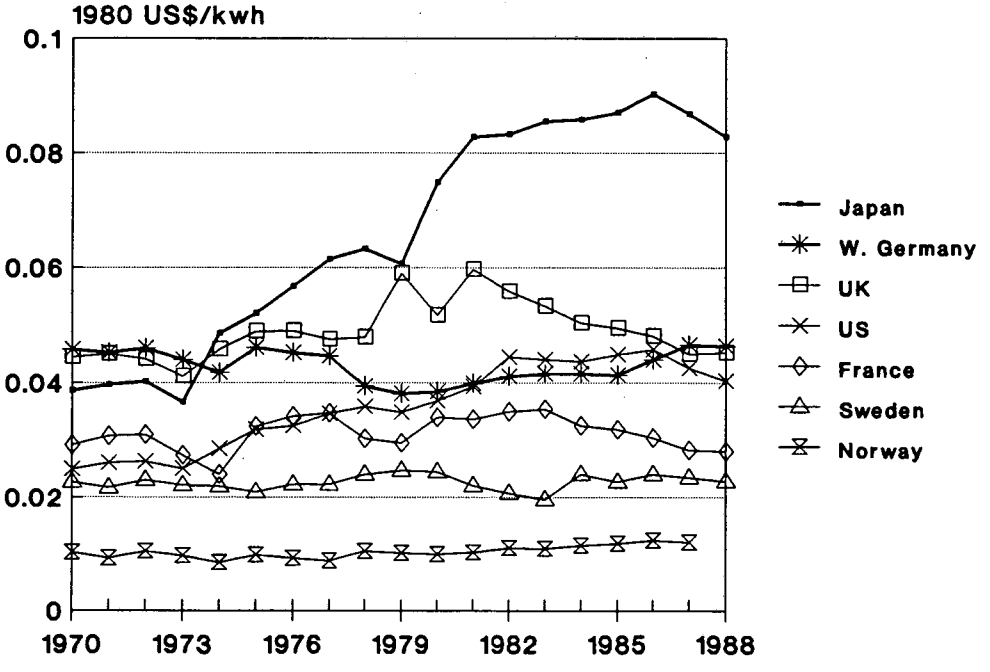

Figure 9

Figure 9 shows trends in the average price of electricity sold to industrial customers. Substantial price differences exist between countries, driven mainly by differences in the forms of energy used to generate electricity. While electricity prices remained stable in most European nations over the period, sharp increases occurred in Japan and the U.S. This may explain why electricity intensity, adjusted for structural change, generally increased in the European nations but decreased in the U.S. and Japan. As noted above, electricity prices in Norway are far lower than in other countries due to the availability of low-cost hydropower. This led to strong growth in electricity-intensive industries and retarded progress towards higher energy efficiency.

Gas prices tracked oil prices in most areas where this fuel was widely available. Because gas has long been inexpensive in the U.S., its share of total energy use is high in comparison with other nations. The disparity, however, has narrowed significantly in recent years. Coal has also been relatively inexpensive in the U.S. While the cost of purchasing coal increased in most countries during the 1970s, it has since declined at a substantial rate. An exception is West Germany, where import restrictions and subsidies to utilities that burn domestic coal have led to coal prices that were both steadily increasing and high in comparison with other nations.

12. Conclusions

Substantial reductions in manufacturing energy intensity were achieved in the eight countries considered in this analysis between 1973 and 1988 that were focused largely, although not entirely, on oil conservation. Together, these changes would have led to a 32 percent reduction in sectoral energy use if the level and structure of sectoral output had remained constant. Changes in the composition of manufacturing output had more modest impacts on energy use. The main impacts of structural change occurred following the energy shocks of 1973 and 1979, with relatively little change in recent years.

The "oil backout" in the manufacturing sector was dramatic, as total oil use in the OECD-8 fell by 57 percent between 1973 and 1988 while oil intensity, adjusted for structural change, fell by 68 percent. Electricity, in contrast, increased its market share. The substitution of electricity for oil and other fuels may have had limited impacts in some sectors, but from an aggregate perspective we found little evidence that there was substantial substitution of electricity for fuels. Electricity intensity, adjusted for structural change, increased by 10 percent in Europe but fell by 13 and 14 in the U.S. and Japan respectively.

The apparent decoupling of manufacturing output and energy use has significant implications for future manufacturing energy use trends. If the energy intensity of manufacturing continues to decline at its historic rate, we expect little growth in sectoral fossil fuel use and only modest growth in electricity use. Energy intensity is determined only partially by the relative price of energy, and long-term technological improvements should lead to continued intensity reductions even in periods of low energy prices.

13. Acknowledgements

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15. Appendix: Data Sources and Summaries

The following paragraphs describe the principal data sources used in this analysis. Summaries of the data appear thereafter.

West Germany: The energy data are from the Arbeitsgemeinschaft energy balances. The value added data are from the Deutsches Institut für Wirtschaftsforschung. The data were converted from the German SYPRO classification system to the ISIC framework as follows.

Paper and pulp: *Zellstoff- und Papierzeugung* (SYPRO 55) and *Papierverarbeitung* (SYPRO 56).

Chemicals: *Chemische Industrie, Spalt-, Brutstoffe* (SYPRO 40).

Stone, clay, and glass: *Steine und Erden* (SYPRO 25); *Feinkeramik* (SYPRO 51); and *Glasgewerbe* (SYPRO 52).

Iron and steel: *Eisenschaffende Industrie* (SYPRO 27); *Eisen- und Stahlgießereien* (SYPRO 2910); and *Ziehereien und Kaltwalzwerke* (SYPRO 3011, 3015).

Nonferrous metals: *NE-Metallerzeugung* (SYPRO 28) and *NE-Metallgießereien* (SYPRO 2950).

Denmark: The energy and value added data are based on the input-output series from Danmarks Statistik.

France: The energy data are from the Centre d'Etudes et de Rechuches Economiques sur l'Energie. The value added data are from the Institut National de la Statistique et des Etudes Economique. The data were converted from the French NCE system to the ISIC classification as follows.

Paper and pulp: *Papier carton* (NCE 35).

Chemicals: *Chimie* and *Textiles artificiles* (NCE 23-28).

Stone, clay, and glass: *Platre chaux ciments* (NCE 20); *Matériaux de construction* (NCE 21); and *Verre* (NCE 22).

Iron and steel: *Siderurgie* (NCE 16) and *Primiere transformation de l'acier* (NCE 17).

Nonferrous metals: *Metaux non ferreux* (NCE 18).

Japan: The energy data are from the energy balances prepared by the Japanese Institute for Energy Economics. The value added data are based on production indices and 1980 value added statistics from the Ministry of International Trade and Industry. The use of petroleum feedstocks in the chemicals sector, which is included in the energy balances, was eliminated by subtracting the energy content of naptha used in this sector.

Norway: The energy data and value added data are from Statistisk Sentralbyrå. Energy statistics were not available for 1971-2, 1974-5, and 1977. Figures for these years were estimated by linear interpolation based on data for adjacent years.

Sweden: The energy and value added data are from Statistika Centralbyrå.

United Kingdom: The principal energy data are from the Digest of U.K. Energy Statistics (DUKES). Information from the British Paper and Board Industry Federation was used to separate energy use in paper and pulp from the more aggregate paper, printing, and publishing sector. Energy use in the nonferrous metals sector, which accounts for only a small share of U.K. manufacturing energy use, was obtained from the Energy Efficiency Office for 1974 and 1980 and from DUKES for 1984-8; figures for other years were interpolated. The value added data are based on the industrial production series in the Annual Abstract of Great Britain. Because of changes in the level of detail reported in this source, data for the paper and pulp, ferrous metals, and nonferrous metals sectors had to be estimated based on output trends in the paper, printing and publishing and primary metals industries for 1971-4 and 1987-8.

United States: The 1971-85 energy data are from the national energy accounts prepared by the Department of Commerce. The 1988 data are from the Manufacturing Energy Consumption Survey conducted by the Energy Information Administration (EIA). Since no published data are available for the years 1986 and 1987, figures for these years were interpolated based on 1985 and 1988 energy intensities. The 1985 and 1988 statistics are not fully comparable since the 1988 survey includes small establishments not covered in the earlier series. EIA estimates that the divergence is roughly 4 percent. The value added data are based on the Federal Reserve Board's production indices and value added statistics. These were converted from 1977 to 1980 currency using the ratio of nominal to base year (1977) value added for the manufacturing sector as a whole.

WEST GERMANY	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PAPER & PULP																		
Oil (PJ)	58	58	59	55	48	53	53	54	51	49	48	44	40	36	36	36	35	35
Gas (PJ)	17	20	23	22	20	24	31	28	28	30	32	31	31	33	32	29	30	32
Solids (PJ)	15	11	10	11	10	11	12	13	14	13	14	14	18	21	21	20	20	21
Electricity (PJ)	25	26	28	28	25	29	30	31	32	33	35	35	37	38	39	40	42	44
Total Energy (PJ)	114	116	119	117	103	117	125	126	125	126	128	124	126	127	128	126	127	131
Value Added (Bn '80$)	2.82	2.95	3.16	3.19	2.75	3.10	3.25	3.32	3.50	3.60	3.61	3.54	3.60	3.76	3.85	3.97	4.14	4.40
CHEMICALS																		
Oil (PJ)	145	146	157	148	112	110	117	129	117	99	116	98	87	66	66	65	69	66
Gas (PJ)	103	96	108	111	108	134	149	149	162	141	135	121	128	131	131	129	140	151
Solids (PJ)	57	46	48	61	59	66	63	60	63	67	68	81	89	107	107	99	101	96
Electricity (PJ)	123	128	141	152	130	146	144	147	157	145	145	135	143	151	154	151	153	157
Total Energy (PJ)	429	416	454	471	409	457	473	485	500	452	463	435	448	456	459	445	463	469
Value Added (Bn '80$)	11.28	12.01	13.48	13.83	12.06	13.94	14.02	14.65	15.56	15.14	15.17	14.60	15.67	16.74	17.14	17.05	17.55	18.64
STONE, CLAY & GLASS																		
Oil (PJ)	282	281	278	224	199	187	173	174	173	147	106	76	67	65	60	70	63	58
Gas (PJ)	60	81	92	96	90	102	128	99	101	102	100	81	80	79	76	76	76	80
Solids (PJ)	40	32	27	27	21	23	25	34	41	61	80	91	102	102	83	69	70	71
Electricity (PJ)	33	35	36	33	31	24	33	34	36	36	34	33	34	34	33	34	34	36
Total Energy (PJ)	415	429	432	381	341	336	359	341	352	347	321	281	284	281	253	249	243	245
Value Added (Bn '80$)	6.75	7.06	7.21	6.72	6.18	6.64	6.80	6.96	7.31	7.37	6.61	5.76	5.75	5.75	5.44	5.57	5.50	5.82
IRON & STEEL																		
Oil (PJ)	158	183	187	164	136	134	107	107	106	67	37	27	26	25	18	40	38	39
Gas (PJ)	313	314	350	362	300	296	279	295	312	291	266	231	217	228	236	207	214	234
Solids (PJ)	322	310	361	435	334	342	321	316	357	377	374	328	312	346	360	305	283	310
Electricity (PJ)	71	75	84	86	75	75	74	78	85	85	81	74	73	79	80	76	72	79
Total Energy (PJ)	864	882	981	1048	845	847	780	795	861	819	757	660	628	678	694	628	607	662
Value Added (Bn '80$)	7.68	8.03	9.06	9.44	7.54	7.94	7.54	7.83	8.52	8.09	7.71	6.80	6.69	7.15	7.32	6.92	6.59	7.38
NONFERROUS METALS																		
Oil (PJ)	21	21	23	20	19	19	20	20	19	18	15	13	12	11	9	10	10	9
Gas (PJ)	10	13	15	9	15	18	20	21	23	24	21	19	21	22	23	22	21	21
Solids (PJ)	15	13	13	18	13	13	13	11	13	13	15	13	14	15	16	15	12	10
Electricity (PJ)	35	38	45	29	52	55	59	59	60	61	60	59	62	64	64	65	62	64
Total Energy (PJ)	81	84	96	76	99	104	111	111	115	116	111	105	110	112	113	112	106	104
Value Added (Bn '80$)	2.12	2.16	2.42	2.39	2.08	2.49	2.51	2.61	2.77	2.69	2.35	2.48	3.05	3.17	2.71	2.84	2.98	3.27
OTHER INDUSTRIES																		
Oil (PJ)	389	398	401	360	351	384	376	361	349	316	281	251	220	204	196	199	182	159
Gas (PJ)	55	73	85	104	100	104	121	139	151	160	163	158	162	175	182	179	201	196
Solids (PJ)	86	70	64	58	56	56	57	57	58	53	67	54	54	55	55	52	50	48
Electricity (PJ)	126	133	143	164	136	161	158	161	168	170	170	169	172	179	190	198	205	214
Total Energy (PJ)	656	674	692	685	642	705	712	718	726	699	681	632	608	613	623	627	637	617
Value Added (Bn '80$)	109.20	111.86	117.73	113.16	108.57	117.08	120.24	120.40	126.13	127.42	124.46	121.13	121.05	124.58	131.89	135.92	136.32	141.65
TOTAL MANUFACTURING																		
Oil (PJ)	1053	1088	1105	972	865	887	845	846	815	697	603	509	453	406	386	421	397	365
Gas (PJ)	558	596	671	703	633	678	727	730	779	748	717	641	640	668	681	642	681	714
Solids (PJ)	534	481	522	610	491	511	489	491	547	584	618	581	589	646	643	560	536	555
Electricity (PJ)	414	435	476	493	449	490	498	510	538	530	524	505	521	547	560	564	569	594
Total Energy (PJ)	2559	2601	2774	2778	2438	2566	2560	2576	2679	2559	2462	2236	2203	2267	2269	2187	2182	2229
Value Added (Bn '80$)	139.85	144.08	153.05	148.74	139.19	151.17	154.36	155.77	163.79	164.31	159.90	154.32	155.80	161.14	168.33	172.27	173.08	181.16

DENMARK	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PAPER & PULP																		
Oil (PJ)	5.59	5.40	5.97	4.04	2.91	2.89	2.21	2.49	2.46	2.26	2.05	1.88	3.09	3.03	2.34	2.54	2.03	1.46
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.52	0.93	1.46	1.64
Solids (PJ)	0.13	0.15	0.17	3.31	2.03	2.17	1.99	2.25	2.22	2.17	1.97	2.02	1.98	2.22	2.32	2.59	3.05	1.65
Electricity (PJ)	0.69	0.70	0.86	1.17	0.80	0.81	0.70	0.79	0.78	0.88	0.78	1.00	0.97	1.00	1.08	1.32	1.28	1.23
Total Energy (PJ)	6.42	6.25	7.00	8.52	5.75	5.88	4.90	5.53	5.45	5.31	4.80	4.89	6.04	6.25	6.26	7.38	7.81	5.97
Value Added (Bn '80$)	0.119	0.116	0.136	0.123	0.108	0.130	0.131	0.143	0.159	0.156	0.161	0.155	0.182	0.196	0.185	0.201	0.202	0.205
CHEMICALS																		
Oil (PJ)	8.88	11.17	16.89	17.16	15.83	16.68	19.10	9.56	5.97	6.44	7.24	6.13	5.91	6.46	6.05	5.47	4.50	4.08
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.37	0.79	1.87
Solids (PJ)	0.26	0.33	0.32	0.31	0.32	0.32	0.33	0.21	0.20	0.14	0.14	0.14	0.12	0.30	0.34	0.34	0.37	0.24
Electricity (PJ)	1.44	1.59	1.79	2.24	2.10	2.12	2.57	2.40	1.87	2.38	2.58	2.85	2.38	2.71	2.99	3.18	3.19	3.47
Total Energy (PJ)	10.58	13.09	19.00	19.71	18.25	19.13	22.00	12.17	8.04	8.95	9.97	9.12	8.40	9.48	9.61	9.36	8.84	9.65
Value Added (Bn '80$)	0.219	0.282	0.348	0.325	0.350	0.392	0.393	0.412	0.448	0.485	0.490	0.488	0.564	0.546	0.589	0.624	0.664	0.654
STONE, CLAY & GLASS																		
Oil (PJ)	28.33	30.61	31.20	20.78	19.47	21.36	17.86	18.93	17.43	14.55	10.97	9.76	6.74	6.17	5.68	5.55	5.35	5.68
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.66	2.76	3.94	3.16
Solids (PJ)	7.90	10.31	11.76	17.67	14.07	15.69	18.78	19.97	16.13	15.10	10.21	12.63	12.81	14.85	14.26	13.98	15.03	11.01
Electricity (PJ)	2.03	2.31	2.52	2.30	2.05	2.31	2.57	2.73	2.37	2.12	1.61	1.95	1.87	2.02	2.10	2.05	2.52	1.97
Total Energy (PJ)	38.27	43.23	45.48	40.75	35.59	39.35	39.21	41.62	35.94	31.76	22.79	24.34	21.42	23.05	23.70	24.34	26.83	21.81
Value Added (Bn '80$)	0.431	0.478	0.505	0.421	0.410	0.446	0.450	0.450	0.478	0.401	0.353	0.349	0.345	0.361	0.358	0.390	0.363	0.342
IRON & STEEL																		
Oil (PJ)	5.10	3.57	5.10	3.26	4.38	4.12	3.72	4.51	4.35	3.47	2.99	2.38	1.88	1.90	1.55	1.24	0.97	0.44
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.72	1.10	1.63	1.58
Solids (PJ)	2.17	1.88	1.89	1.06	1.27	1.42	1.04	1.25	1.09	0.61	0.56	0.49	0.18	0.17	0.18	0.18	0.20	0.19
Electricity (PJ)	0.60	0.39	0.65	0.92	1.02	1.70	1.67	1.95	1.79	1.96	1.73	1.83	1.76	1.76	2.11	1.93	1.63	2.33
Total Energy (PJ)	7.87	5.84	7.64	5.25	6.67	7.24	6.43	7.71	7.23	6.04	5.28	4.69	3.81	3.83	4.56	4.45	4.43	4.54
Value Added (Bn '80$)	0.055	0.076	0.048	0.037	0.049	0.055	0.039	0.054	0.062	0.073	0.070	0.057	0.064	0.077	0.083	0.082	0.081	0.086
NONFERROUS METALS																		
Oil (PJ)	0.71	0.55	0.65	0.83	0.67	0.83	1.00	1.00	1.04	0.80	0.74	0.63	0.47	0.54	0.29	0.24	0.24	0.22
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02
Solids (PJ)	0.15	0.24	0.41	0.24	0.18	0.25	0.20	0.18	0.21	0.08	0.08	0.06	0.03	0.04	0.05	0.04	0.04	0.02
Electricity (PJ)	0.15	0.11	0.13	0.21	0.16	0.21	0.23	0.22	0.24	0.19	0.18	0.20	0.21	0.24	0.23	0.21	0.21	0.18
Total Energy (PJ)	1.02	0.90	1.19	1.28	1.01	1.29	1.43	1.41	1.49	1.07	0.99	0.90	0.71	0.81	0.58	0.49	0.49	0.44
Value Added (Bn '80$)	0.029	0.025	0.022	0.031	0.028	0.026	0.026	0.020	0.027	0.036	0.025	0.019	0.033	0.034	0.032	0.019	0.018	0.019
OTHER INDUSTRIES																		
Oil (PJ)	58.57	60.12	59.42	51.54	52.96	53.45	53.95	57.65	59.53	54.03	52.21	47.24	45.51	46.91	47.72	47.34	42.68	38.26
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.72	2.86	5.26	8.77
Solids (PJ)	6.69	6.47	6.10	6.56	6.62	6.59	7.61	7.95	7.23	9.78	9.60	9.89	11.78	14.57	19.05	19.83	21.87	15.69
Electricity (PJ)	8.59	8.82	8.98	10.08	10.12	10.81	11.99	13.06	12.69	13.20	12.77	14.53	14.73	15.53	16.33	17.24	17.80	18.81
Total Energy (PJ)	73.86	75.41	74.49	68.17	69.70	70.85	73.55	78.66	79.45	77.00	74.58	71.65	72.03	77.01	84.81	87.27	87.61	81.54
Value Added (Bn '80$)	4.79	5.15	5.38	5.62	5.40	5.54	5.61	5.58	5.95	6.14	6.00	6.13	6.48	6.85	7.08	7.02	6.66	6.72
TOTAL MANUFACTURING																		
Oil (PJ)	107.19	111.42	119.22	97.61	96.21	99.34	97.84	94.14	90.79	81.54	76.20	68.02	63.59	65.01	63.64	62.37	55.76	50.14
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.86	8.03	13.07	17.03
Solids (PJ)	17.31	19.38	20.65	29.15	24.49	26.44	29.95	31.80	27.08	27.87	22.55	25.22	26.90	32.15	36.20	36.96	40.56	28.80
Electricity (PJ)	13.51	13.92	14.93	16.92	16.26	17.95	19.73	21.15	19.75	20.72	19.65	22.35	21.91	23.27	24.83	25.93	26.63	27.98
Total Energy (PJ)	138.01	144.72	154.80	143.68	136.96	143.74	147.52	147.09	137.61	130.12	118.40	115.59	112.41	120.43	129.52	133.29	136.01	123.96
Value Added (Bn '80$)	5.64	6.13	6.43	6.55	6.34	6.59	6.65	6.66	7.12	7.29	7.10	7.20	7.67	8.06	8.32	8.33	7.99	8.02

FRANCE	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PAPER & PULP																		
Oil (PJ)	53	57	62	59	52	55	56	58	58	56	45	40	46	41	30	24	23	22
Gas (PJ)	10	10	11	10	10	11	9	10	11	13	16	16	18	21	24	26	27	28
Solids (PJ)	7	6	6	5	2	3	2	2	2	2	2	3	3	4	7	7	8	8
Electricity (PJ)	11	12	12	13	12	13	14	14	15	15	14	15	15	16	19	22	25	26
Total Energy (PJ)	81	85	91	87	76	82	81	84	85	85	77	75	81	82	80	79	83	84
Value Added (Bn '80$)	2.00	2.24	2.36	2.48	2.13	2.33	2.37	2.19	2.55	2.53	2.43	2.50	2.46	2.60	2.54	2.58	2.56	2.84
CHEMICALS																		
Oil (PJ)	168	161	184	209	168	186	187	179	185	157	130	115	121	105	108	114	119	114
Gas (PJ)	32	34	43	46	46	51	63	79	87	60	83	77	79	92	94	87	88	87
Solids (PJ)	33	24	23	22	16	17	16	16	18	19	17	17	19	21	20	20	22	23
Electricity (PJ)	51	53	56	60	52	57	60	61	64	61	60	61	62	64	65	66	68	70
Total Energy (PJ)	284	272	306	337	283	310	326	335	353	296	290	270	281	282	288	288	297	294
Value Added (Bn '80$)	6.65	6.61	7.65	7.81	7.16	7.62	8.16	8.59	9.37	8.99	9.26	9.47	10.13	10.37	10.59	10.42	10.66	11.46
STONE, CLAY & GLASS																		
Oil (PJ)	174	188	189	188	155	152	149	144	134	120	82	66	79	70	64	65	65	67
Gas (PJ)	39	43	45	49	56	61	60	62	71	66	64	55	54	54	56	56	57	58
Solids (PJ)	22	16	13	13	9	8	7	7	9	25	52	50	38	40	55	48	49	50
Electricity (PJ)	19	20	21	22	21	22	22	23	24	24	24	23	22	22	26	27	27	29
Total Energy (PJ)	254	267	268	272	240	242	239	236	237	235	222	194	194	186	200	195	198	203
Value Added (Bn '80$)	5.25	5.41	5.79	5.84	5.82	5.64	5.92	5.84	5.93	6.21	5.89	5.64	5.43	5.41	5.37	5.39	6.29	6.60
IRON & STEEL																		
Oil (PJ)	103	111	118	124	98	102	96	95	81	66	37	36	31	28	18	16	14	24
Gas (PJ)	134	138	147	156	136	141	139	140	147	132	118	104	98	100	104	94	86	92
Solids (PJ)	239	241	252	279	216	222	207	205	228	231	219	189	167	183	186	159	152	158
Electricity (PJ)	28	28	32	38	35	37	37	39	41	42	40	39	39	41	34	33	33	34
Total Energy (PJ)	504	517	548	596	485	502	480	479	496	471	415	368	335	352	342	301	285	309
Value Added (Bn '80$)	2.51	2.82	2.98	3.13	2.65	3.07	3.14	3.31	3.60	3.66	3.20	2.75	2.49	2.70	2.64	2.69	2.63	3.02
NONFERROUS METALS																		
Oil (PJ)	19	19	20	20	19	17	15	14	12	12	9	7	7	5	6	5	5	5
Gas (PJ)	3	4	4	5	4	5	6	10	12	10	12	10	10	14	15	17	17	14
Solids (PJ)	18	15	17	19	15	13	14	12	14	13	11	9	11	11	11	11	9	9
Electricity (PJ)	36	36	36	40	37	38	40	38	41	43	41	37	36	37	37	38	36	37
Total Energy (PJ)	76	73	77	84	75	73	75	74	80	77	72	64	64	67	70	72	68	64
Value Added (Bn '80$)	1.05	1.22	1.44	1.38	1.37	2.02	2.19	2.02	2.42	1.91	2.26	2.33	2.33	2.31	2.30	2.77	2.71	2.77
OTHER INDUSTRIES																		
Oil (PJ)	292	338	347	325	280	280	265	274	268	236	206	180	193	171	166	144	133	120
Gas (PJ)	20	30	34	34	39	47	52	60	69	79	84	88	102	107	134	135	147	140
Solids (PJ)	41	37	35	35	27	27	29	27	28	26	28	28	34	34	36	35	32	31
Electricity (PJ)	79	85	93	93	92	100	103	108	112	114	114	118	121	124	128	137	146	156
Total Energy (PJ)	433	490	509	487	438	453	448	469	476	455	432	414	450	437	464	451	458	447
Value Added (Bn '80$)	64.79	67.83	72.47	73.87	73.43	77.31	80.69	82.93	84.02	83.89	82.40	83.84	83.55	81.72	82.09	81.68	81.27	83.00
TOTAL MANUFACTURING																		
Oil (PJ)	809	873	919	925	772	791	769	763	738	647	509	444	477	420	392	368	358	352
Gas (PJ)	238	258	284	299	291	315	329	362	397	359	377	351	361	388	426	415	422	419
Solids (PJ)	361	339	347	373	285	289	276	269	298	315	330	298	271	293	316	279	273	279
Electricity (PJ)	224	233	250	266	250	268	276	284	295	298	293	292	295	304	310	323	334	351
Total Energy (PJ)	1632	1704	1800	1863	1597	1663	1650	1678	1728	1620	1509	1385	1404	1405	1444	1385	1387	1401
Value Added (Bn '80$)	82.25	86.13	92.69	94.51	92.56	97.99	102.47	104.87	107.89	107.19	105.44	106.53	106.38	105.11	105.53	105.53	106.12	109.69

JAPAN	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PAPER & PULP																		
Oil (PJ)	195	215	236	217	197	192	179	191	195	162	147	131	132	128	114	119	135	158
Gas (PJ)	0	0	0	0	0	0	0	0	0	0	1	1	1	1	2	4	4	4
Solids (PJ)	88	92	101	94	90	98	98	99	111	105	104	113	117	126	127	129	137	150
Electricity (PJ)	67	72	77	73	76	81	83	87	92	87	83	84	87	89	91	92	97	106
Total Energy (PJ)	350	379	414	384	363	371	361	378	398	355	334	329	336	344	335	344	373	418
Value Added (Bn '80$)	5.46	5.80	6.48	6.18	5.43	6.16	6.27	6.70	7.26	7.29	6.89	7.08	7.49	7.88	8.23	8.47	8.98	9.76
CHEMICALS																		
Oil (PJ)	440	426	445	415	372	411	413	397	441	360	335	307	232	271	275	270	260	271
Gas (PJ)	60	53	50	47	48	47	45	42	41	46	40	37	37	39	38	32	41	38
Solids (PJ)	18	14	16	17	16	14	12	10	15	17	20	26	33	57	70	72	63	68
Electricity (PJ)	172	179	190	183	176	181	181	183	185	169	164	160	168	176	177	175	184	192
Total Energy (PJ)	690	672	701	662	612	653	651	633	682	592	559	529	469	543	559	549	547	570
Value Added (Bn '80$)	15.02	15.94	18.06	17.87	16.24	18.15	19.07	21.38	23.15	23.03	22.97	23.52	24.90	26.90	27.73	28.15	30.30	32.84
STONE, CLAY & GLASS																		
Oil (PJ)	451	493	528	474	434	460	464	502	472	291	174	151	172	150	137	143	146	172
Gas (PJ)	3	3	3	3	3	3	3	3	3	4	4	4	6	7	9	9	9	10
Solids (PJ)	23	20	23	22	19	18	17	24	54	191	274	251	231	248	240	213	220	235
Electricity (PJ)	50	55	60	56	55	59	61	66	73	73	70	70	71	73	72	69	70	74
Total Energy (PJ)	526	570	615	555	510	540	545	595	602	559	522	476	478	479	458	435	445	491
Value Added (Bn '80$)	10.60	11.32	13.07	12.10	10.34	11.40	11.91	12.60	13.38	13.69	12.88	12.53	12.69	13.13	13.07	12.61	13.07	14.28
IRON & STEEL																		
Oil (PJ)	491	492	588	546	461	473	389	374	355	234	165	130	119	120	109	114	121	130
Gas (PJ)	3	3	4	6	6	7	12	18	14	15	20	22	23	25	26	24	25	25
Solids (PJ)	1153	1218	1425	1427	1364	1365	1283	1201	1304	1353	1295	1190	1199	1276	1254	1149	1212	1265
Electricity (PJ)	216	235	265	265	250	275	263	264	284	272	262	253	253	264	263	246	255	269
Total Energy (PJ)	1863	1949	2282	2244	2081	2120	1947	1857	1957	1874	1742	1595	1594	1685	1651	1533	1613	1689
Value Added (Bn '80$)	14.87	15.80	19.00	18.70	16.00	17.54	17.30	17.78	19.70	20.02	18.74	18.30	17.84	19.68	20.10	18.90	19.28	21.02
NONFERROUS METALS																		
Oil (PJ)	50	52	66	54	44	44	42	57	64	59	49	46	42	44	46	53	42	43
Gas (PJ)	1	2	2	3	3	3	3	3	3	5	2	2	3	4	4	5	6	6
Solids (PJ)	19	19	19	17	16	21	17	16	21	18	16	16	16	17	17	15	16	16
Electricity (PJ)	91	104	110	108	100	103	111	102	105	103	83	61	62	66	63	58	55	57
Total Energy (PJ)	161	176	196	182	163	171	174	179	193	185	149	125	123	131	131	131	119	122
Value Added (Bn '80$)	5.06	5.73	6.79	5.95	5.28	6.30	6.61	7.10	7.44	7.43	7.12	6.88	7.10	7.46	7.44	7.37	7.93	8.42
OTHER INDUSTRIES																		
Oil (PJ)	725	780	873	896	861	940	906	883	821	810	852	790	772	754	751	722	750	809
Gas (PJ)	30	31	36	39	39	41	36	32	31	32	42	43	48	52	55	57	60	68
Solids (PJ)	26	27	26	25	29	35	33	32	51	45	58	54	55	59	66	58	54	59
Electricity (PJ)	213	238	260	242	256	281	298	320	339	341	348	354	382	410	433	441	474	506
Total Energy (PJ)	994	1076	1195	1203	1185	1298	1273	1267	1242	1228	1300	1240	1257	1276	1305	1278	1338	1441
Value Added (Bn '80$)	133.63	143.66	164.75	158.11	140.88	156.91	164.56	175.12	187.97	200.47	206.61	208.26	216.61	244.21	257.91	255.18	262.39	288.43
TOTAL MANUFACTURING																		
Oil (PJ)	2352	2458	2736	2602	2369	2521	2394	2406	2348	1917	1723	1555	1468	1469	1432	1422	1453	1582
Gas (PJ)	97	92	96	99	99	101	99	98	93	101	108	109	117	128	134	131	145	150
Solids (PJ)	1327	1390	1609	1602	1533	1550	1460	1383	1556	1729	1766	1649	1651	1784	1775	1635	1703	1793
Electricity (PJ)	808	883	961	927	913	980	998	1023	1078	1046	1009	982	1022	1078	1099	1082	1136	1204
Total Energy (PJ)	4585	4822	5403	5230	4914	5152	4951	4909	5074	4793	4606	4295	4259	4459	4440	4271	4436	4729
Value Added (Bn '80$)	184.65	198.24	228.16	218.91	194.16	216.46	225.71	240.67	258.89	271.94	275.20	276.56	286.62	319.26	334.48	330.68	341.94	374.75

NORWAY	1971*	1972*	1973	1974*	1975*	1976	1977*	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PAPER & PULP																		
Oil (PJ)	25.76	24.76	23.76	22.08	20.41	18.73	18.00	17.26	15.80	16.98	11.94	10.06	4.91	3.36	5.83	11.40	5.91	5.07
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	4.08	4.15	4.22	4.04	3.85	3.67	3.69	3.71	4.39	4.61	7.40	6.22	6.85	7.95	11.11	11.29	12.20	11.32
Electricity (PJ)	13.66	13.79	13.92	14.20	14.49	14.77	13.15	11.52	13.93	13.56	16.04	15.38	18.28	21.90	21.09	16.41	20.52	21.74
Total Energy (PJ)	43.50	42.70	41.90	40.32	38.75	37.17	34.83	32.49	34.12	35.15	35.38	31.66	30.04	33.21	38.03	39.10	38.63	38.13
Value Added (Bn '80$)	0.235	0.244	0.253	0.242	0.231	0.219	0.223	0.227	0.253	0.262	0.274	0.264	0.279	0.334	0.356	0.351	0.346	0.381
CHEMICALS																		
Oil (PJ)	8.67	7.93	7.20	6.97	6.75	6.52	7.13	7.74	9.76	6.68	7.76	5.99	4.53	4.38	5.25	6.24	4.92	4.27
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	4.65	4.56	4.47	4.50	4.54	4.57	4.43	4.28	4.79	4.48	3.96	3.85	4.28	5.32	5.18	5.09	4.10	4.66
Electricity (PJ)	18.37	19.03	19.69	19.40	19.12	18.83	18.06	17.29	20.19	20.09	20.04	20.19	22.98	24.42	21.55	19.29	17.35	18.32
Total Energy (PJ)	31.70	31.53	31.36	30.88	30.40	29.92	29.62	29.32	34.74	31.25	31.76	30.03	31.78	34.12	31.99	30.62	26.38	27.25
Value Added (Bn '80$)	0.291	0.312	0.333	0.331	0.330	0.328	0.329	0.330	0.383	0.399	0.432	0.437	0.474	0.604	0.547	0.548	0.628	0.627
STONE, CLAY & GLASS																		
Oil (PJ)	17.07	17.13	17.18	17.01	16.84	16.66	15.93	15.20	14.58	12.72	8.36	4.77	3.55	3.82	3.96	3.44	3.00	3.81
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	1.04	0.97	0.90	0.95	1.00	1.05	1.08	1.11	1.87	2.51	4.78	7.69	7.58	6.51	5.68	5.55	4.37	4.76
Electricity (PJ)	2.46	2.55	2.63	2.64	2.64	2.65	2.57	2.50	2.68	2.49	2.40	2.76	2.35	2.39	2.67	2.87	2.86	2.88
Total Energy (PJ)	20.58	20.64	20.70	20.59	20.48	20.36	19.58	18.81	19.13	17.72	15.54	15.22	13.48	12.71	12.30	11.86	10.23	11.45
Value Added (Bn '80$)	0.275	0.288	0.301	0.300	0.299	0.298	0.288	0.279	0.282	0.286	0.274	0.269	0.263	0.246	0.253	0.278	0.281	0.259
IRON & STEEL																		
Oil (PJ)	1.19	1.37	1.55	1.41	1.28	1.14	0.95	0.76	1.60	1.13	1.30	0.97	1.09	3.36	1.18	1.68	1.55	1.59
Gas (PJ)	2.10	2.12	2.14	2.06	1.99	1.91	1.89	1.87	2.16	1.97	1.99	1.55	2.05	0.00	2.19	1.97	1.59	0.00
Solids (PJ)	23.39	24.93	26.46	26.26	26.05	25.85	24.50	23.15	29.78	26.34	24.66	23.43	24.94	7.95	28.27	24.39	24.56	28.84
Electricity (PJ)	25.70	27.63	29.55	29.69	29.82	29.96	28.67	27.38	31.91	29.39	27.01	25.35	31.16	21.90	33.53	32.36	28.76	31.36
Total Energy (PJ)	52.39	56.04	59.70	59.42	59.14	58.86	56.01	53.16	65.45	58.83	54.96	51.30	59.24	33.21	65.17	60.40	56.46	61.79
Value Added (Bn '80$)	0.206	0.221	0.235	0.240	0.245	0.250	0.231	0.212	0.246	0.200	0.253	0.222	0.268	0.291	0.274	0.260	0.242	0.286
NONFERROUS METALS																		
Oil (PJ)	5.51	5.77	6.04	5.89	5.73	5.58	5.66	5.74	5.78	5.91	5.38	4.39	4.85	4.61	4.69	4.70	4.59	4.17
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	6.07	6.04	6.02	6.08	6.14	6.20	6.04	5.87	5.42	5.86	5.49	4.77	4.87	6.36	6.66	6.39	5.10	4.70
Electricity (PJ)	44.71	46.53	48.34	48.29	48.25	48.20	49.25	50.30	51.55	52.05	50.52	49.39	50.97	56.93	54.95	55.59	60.07	60.70
Total Energy (PJ)	56.29	58.34	60.40	60.26	60.12	59.98	60.95	61.91	62.75	63.82	61.39	58.55	60.69	67.90	66.30	66.68	69.76	69.57
Value Added (Bn '80$)	0.266	0.295	0.324	0.348	0.372	0.396	0.390	0.384	0.411	0.366	0.314	0.333	0.430	0.433	0.408	0.416	0.470	0.476
OTHER INDUSTRIES																		
Oil (PJ)	22.88	20.73	18.58	20.12	21.66	23.19	22.26	21.32	22.90	19.27	17.96	15.57	14.30	9.33	12.94	15.67	15.31	18.54
Gas (PJ)	0.56	0.53	0.50	0.49	0.47	0.46	0.50	0.54	0.70	0.55	0.43	0.05	0.01	1.97	0.00	0.00	1.25	0.00
Solids (PJ)	6.05	6.06	6.06	6.88	7.70	8.52	8.75	8.98	10.81	10.41	10.35	6.92	11.52	38.24	12.53	12.13	12.06	11.55
Electricity (PJ)	16.05	18.29	20.54	21.72	22.90	24.08	21.86	19.64	24.26	19.90	24.48	22.27	22.46	34.75	26.26	24.29	25.06	22.28
Total Energy (PJ)	45.54	45.61	45.68	49.20	52.73	56.25	53.36	50.48	58.67	50.13	53.22	44.81	48.29	84.29	51.73	52.09	53.68	52.36
Value Added (Bn '80$)	4.26	4.43	4.61	4.64	4.67	4.70	4.63	4.57	4.52	4.47	4.37	4.38	4.18	4.31	4.54	4.63	4.62	4.36
TOTAL MANUFACTURING																		
Oil (PJ)	81.09	77.69	74.30	73.48	72.65	71.83	69.93	68.02	70.42	62.69	52.70	41.75	33.22	28.85	33.85	43.13	35.29	37.46
Gas (PJ)	2.66	2.65	2.64	2.55	2.46	2.37	2.39	2.41	2.86	2.52	2.42	1.60	2.06	1.97	2.19	1.97	2.84	17.03
Solids (PJ)	45.28	46.71	48.13	48.71	49.28	49.86	48.48	47.10	57.06	54.21	56.64	52.88	60.04	72.33	69.43	64.84	62.39	68.71
Electricity (PJ)	120.96	127.81	134.67	135.94	137.22	138.49	133.56	128.63	144.52	137.48	140.49	135.34	148.20	162.29	160.05	150.81	154.62	157.28
Total Energy (PJ)	249.99	254.86	259.74	260.68	261.61	262.55	254.36	246.16	274.86	256.90	252.25	231.57	243.52	265.44	265.52	260.75	255.14	260.56
Value Added (Bn '80$)	5.53	5.79	6.05	6.10	6.14	6.19	6.09	6.00	6.10	5.99	5.92	5.90	5.89	6.22	6.37	6.48	6.59	6.39

* Energy data interpolated based on figures for adjacent years.

SWEDEN	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PAPER & PULP																		
Oil (PJ)	83.31	85.71	91.63	84.66	68.34	72.21	69.63	70.17	69.59	63.45	52.40	42.65	32.30	29.71	29.73	28.22	24.73	21.39
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	97.56	102.96	111.44	111.32	109.50	95.36	99.54	109.19	111.70	107.88	108.49	101.17	115.50	122.08	125.35	126.27	128.17	134.33
Electricity (PJ)	38.23	41.48	46.48	47.63	43.92	45.68	45.32	48.65	51.59	50.03	50.70	47.80	53.40	59.33	60.55	59.94	66.78	70.99
Total Energy (PJ)	219.10	230.16	249.55	243.60	221.76	213.25	214.49	228.01	232.88	221.36	211.58	191.62	201.19	211.11	215.63	214.44	219.68	226.71
Value Added (Bn '80$)	0.955	0.996	1.127	1.215	1.016	1.063	1.017	1.106	1.186	1.175	1.148	1.094	1.200	1.246	1.246	1.307	1.415	1.478
CHEMICALS																		
Oil (PJ)	14.26	14.80	14.83	13.74	12.22	13.48	13.16	13.11	13.07	12.72	11.83	10.70	10.41	9.73	9.81	6.91	6.45	7.54
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	1.22	0.41	0.66	0.88	0.92	1.17	1.19	1.44	2.49	3.19	2.96	3.46	3.61	4.00	3.07	4.82	5.07	5.36
Electricity (PJ)	14.97	15.06	16.71	17.27	16.76	16.87	15.74	16.15	16.62	16.58	15.98	15.87	18.19	19.06	19.42	19.47	21.18	21.32
Total Energy (PJ)	30.45	30.28	32.20	31.89	29.90	31.52	30.08	30.70	32.18	32.49	30.78	30.03	32.20	32.79	32.30	31.20	32.70	34.22
Value Added (Bn '80$)	0.795	0.874	0.989	1.041	0.929	0.948	0.912	0.949	0.998	1.113	1.112	1.148	1.231	1.243	1.278	1.251	1.377	1.427
STONE, CLAY & GLASS																		
Oil (PJ)	37.02	38.77	37.12	35.51	33.29	30.14	27.00	23.49	23.75	22.79	19.00	14.82	12.74	11.12	10.30	9.50	9.91	9.60
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	5.91	4.25	6.59	4.94	4.03	4.71	6.01	6.66	7.67	7.80	6.54	9.18	9.51	11.17	10.52	10.24	10.72	11.56
Electricity (PJ)	4.51	4.53	4.67	4.51	4.36	4.28	4.09	4.08	4.24	4.38	4.20	4.22	4.28	4.32	4.45	4.37	4.83	4.77
Total Energy (PJ)	47.44	47.55	48.28	44.90	41.62	39.13	37.11	34.22	35.65	34.97	29.74	28.22	26.53	26.61	25.37	24.16	25.53	25.93
Value Added (Bn '80$)	0.623	0.603	0.628	0.624	0.633	0.623	0.571	0.551	0.576	0.557	0.488	0.495	0.502	0.501	0.492	0.496	0.514	0.525
IRON & STEEL																		
Oil (PJ)	34.51	36.20	39.21	38.85	37.40	32.26	29.10	28.95	28.98	24.98	19.88	16.83	15.76	15.40	15.30	15.23	15.78	15.39
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	45.53	41.08	44.93	52.07	58.09	51.62	38.59	40.03	46.21	38.94	30.99	29.78	33.99	36.27	37.70	36.99	35.93	36.45
Electricity (PJ)	19.52	19.64	20.86	21.28	21.11	20.22	17.95	17.82	18.80	18.49	18.22	17.48	17.85	19.70	19.73	18.94	18.76	19.56
Total Energy (PJ)	99.56	96.93	105.01	112.21	116.60	104.10	85.64	86.80	93.98	82.41	69.08	64.09	67.60	71.36	72.73	71.15	70.47	71.41
Value Added (Bn '80$)	0.679	0.670	0.734	0.801	0.738	0.675	0.603	0.645	0.762	0.752	0.697	0.739	0.773	0.848	0.830	0.789	0.793	0.882
NONFERROUS METALS																		
Oil (PJ)	2.60	3.11	3.25	3.23	3.28	3.49	3.41	3.64	3.75	3.78	3.37	3.26	3.26	2.89	2.94	2.98	2.55	2.50
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	1.73	1.86	1.93	2.01	1.85	2.73	2.21	2.75	2.34	2.02	2.35	2.49	2.62	2.58	2.78	2.37	2.37	2.43
Electricity (PJ)	7.49	7.67	8.04	8.12	7.82	8.17	8.09	8.18	8.13	8.14	8.06	8.20	8.59	8.90	9.05	8.53	8.93	9.67
Total Energy (PJ)	11.81	12.64	13.22	13.35	12.95	14.39	13.71	14.57	14.22	13.95	13.78	13.96	14.46	14.37	14.78	13.89	13.85	14.60
Value Added (Bn '80$)	0.136	0.144	0.167	0.182	0.156	0.159	0.154	0.165	0.172	0.176	0.156	0.166	0.172	0.173	0.174	0.174	0.176	0.175
OTHER INDUSTRIES																		
Oil (PJ)	77.00	77.98	77.66	69.96	72.49	77.99	74.17	71.96	69.14	62.28	60.84	53.37	47.09	44.33	44.19	41.71	40.15	35.38
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	6.82	6.03	8.57	9.51	25.47	35.34	23.67	23.51	25.85	25.98	25.38	25.49	29.39	30.56	36.91	36.24	38.60	38.48
Electricity (PJ)	31.34	33.05	35.62	35.76	35.13	38.53	37.53	37.99	39.71	38.95	40.27	41.33	43.37	47.79	50.98	51.75	53.92	58.57
Total Energy (PJ)	115.15	117.05	121.95	115.29	133.15	151.86	135.37	133.46	134.69	127.20	126.49	120.19	119.86	122.67	131.97	129.64	132.61	132.43
Value Added (Bn '80$)	11.10	11.08	11.74	12.36	12.80	12.81	12.09	11.51	12.19	12.18	11.83	11.71	12.26	13.10	13.44	13.57	13.77	13.99
TOTAL MANUFACTURING																		
Oil (PJ)	248.69	256.56	263.71	245.94	227.02	229.57	216.47	211.31	208.28	190.00	167.32	141.63	121.56	113.17	112.27	104.55	99.56	91.80
Gas (PJ)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Solids (PJ)	158.76	156.60	174.12	180.72	199.87	190.93	171.21	183.59	196.25	185.82	176.70	171.57	194.62	206.65	216.33	216.94	220.86	228.61
Electricity (PJ)	116.06	121.43	132.38	134.59	129.09	133.75	128.72	132.87	139.08	136.57	137.43	134.91	145.66	159.09	164.19	163.00	174.41	184.89
Total Energy (PJ)	523.52	534.59	570.21	561.24	555.97	554.25	516.40	527.77	543.61	512.38	481.46	448.11	461.84	478.92	492.79	484.49	494.83	505.31
Value Added (Bn '80$)	14.28	14.37	15.39	16.22	16.27	16.28	15.34	14.93	15.89	15.95	15.43	15.35	16.14	17.12	17.46	17.58	18.05	18.48

UNITED KINGDOM	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PAPER & PULP																		
Oil (PJ)	54	51	49	46	43	46	41	42	41	35	27	22	18	15	12	9	7	7
Gas (PJ)	6	17	18	21	19	27	28	25	24	23	20	20	23	25	26	28	30	29
Solids (PJ)	46	39	34	31	27	28	27	26	27	24	19	18	16	13	14	15	16	16
Electricity (PJ)	6	6	6	6	6	7	7	10	10	11	8	8	8	8	9	10	11	10
Total Energy (PJ)	112	113	107	103	95	109	102	102	102	93	75	69	65	60	61	62	63	63
Value Added (Bn '80$)	3.16	3.31	3.59	3.59	3.10	3.25	3.36	3.41	3.47	3.12	2.89	2.75	2.81	2.86	2.83	2.89	3.17	3.47
CHEMICALS																		
Oil (PJ)	146	162	185	159	142	148	158	151	150	120	101	94	78	81	67	98	80	94
Gas (PJ)	50	80	91	107	103	119	124	122	133	142	123	125	127	110	111	79	118	77
Solids (PJ)	76	33	26	23	19	20	20	18	18	14	14	13	28	15	23	28	37	43
Electricity (PJ)	49	47	50	49	45	51	52	50	53	47	46	46	46	49	51	48	51	54
Total Energy (PJ)	320	321	352	338	310	337	354	341	354	323	284	279	279	256	253	254	287	268
Value Added (Bn '80$)	8.26	8.70	9.77	10.16	9.10	10.27	10.53	10.68	10.94	9.81	9.75	9.78	10.52	11.12	11.49	11.75	12.56	13.13
STONE, CLAY & GLASS																		
Oil (PJ)	117	105	98	90	66	66	62	59	57	46	39	36	32	28	27	25	26	30
Gas (PJ)	23	43	53	56	55	58	60	62	59	51	46	46	47	56	62	65	70	67
Solids (PJ)	110	99	110	97	96	81	81	84	91	81	62	70	64	52	54	55	46	48
Electricity (PJ)	17	17	18	17	17	18	18	19	19	19	17	17	18	23	24	24	26	28
Total Energy (PJ)	268	265	279	260	235	223	221	224	225	198	164	169	161	159	167	168	168	172
Value Added (Bn '80$)	6.46	6.83	7.57	7.20	6.63	6.64	6.59	6.75	6.60	5.88	5.26	5.56	5.73	5.96	5.93	6.01	6.33	6.97
IRON & STEEL																		
Oil (PJ)	231	220	218	174	143	135	127	122	123	69	60	53	45	38	30	29	26	35
Gas (PJ)	81	89	91	77	76	85	87	78	90	67	66	59	63	69	77	74	80	76
Solids (PJ)	345	321	347	297	261	297	262	244	269	133	180	163	172	174	186	166	188	201
Electricity (PJ)	36	35	38	36	36	42	41	43	48	33	37	34	33	29	28	27	28	29
Total Energy (PJ)	692	666	694	585	516	559	517	488	530	302	343	310	314	310	322	296	322	341
Value Added (Bn '80$)	3.14	3.14	3.49	3.20	2.77	2.90	2.86	2.88	2.97	1.98	2.27	2.25	2.24	2.16	2.38	2.36	2.55	2.87
NONFERROUS METALS																		
Oil (PJ)	15	16	17	17	17	17	17	17	17	17	12	9	6	5	5	5	4	4
Gas (PJ)	12	12	14	14	14	14	14	14	15	15	15	16	16	16	16	15	16	16
Solids (PJ)	18	18	20	20	18	15	13	11	8	6	7	9	11	14	34	34	34	29
Electricity (PJ)	23	23	26	26	26	27	28	28	29	30	26	23	20	18	16	15	16	13
Total Energy (PJ)	67	70	78	76	75	74	72	71	70	68	64	60	56	53	70	68	71	64
Value Added (Bn '80$)	1.82	1.82	2.02	1.85	1.60	1.62	1.62	1.59	1.63	1.56	1.50	1.40	1.44	1.58	1.57	1.55	1.68	1.88
OTHER INDUSTRIES																		
Oil (PJ)	616	646	635	560	516	508	515	511	512	422	379	353	322	288	266	263	241	257
Gas (PJ)	91	130	178	203	207	227	243	251	257	255	228	228	198	230	246	254	268	253
Solids (PJ)	193	149	155	146	118	111	118	108	119	97	102	97	91	78	84	98	89	93
Electricity (PJ)	134	135	149	139	140	147	149	152	156	147	143	138	142	156	158	165	170	183
Total Energy (PJ)	1034	1060	1117	1047	981	992	1025	1022	1043	921	849	811	750	751	754	779	768	786
Value Added (Bn '80$)	82.67	83.88	91.24	90.23	84.98	85.57	87.35	87.71	87.30	80.78	74.34	73.56	75.26	78.41	80.28	80.86	85.08	91.22
TOTAL MANUFACTURING																		
Oil (PJ)	1178	1201	1202	1046	927	920	920	903	900	709	618	567	502	455	406	429	384	426
Gas (PJ)	263	371	444	478	474	530	554	553	578	553	498	495	474	506	539	515	582	519
Solids (PJ)	789	659	692	614	539	552	522	490	532	355	383	370	381	345	395	396	410	430
Electricity (PJ)	264	263	288	273	271	291	295	302	315	287	277	266	267	283	286	288	302	317
Total Energy (PJ)	2494	2494	2626	2410	2211	2293	2292	2248	2324	1905	1777	1698	1624	1589	1627	1628	1678	1693
Value Added (Bn '80$)	105.50	107.67	117.67	116.23	108.18	110.24	112.31	113.03	112.93	103.13	96.01	95.29	98.01	102.08	104.49	105.43	111.38	119.54

UNITED STATES	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986*	1987*	1988
PAPER & PULP																		
Oil (PJ)	436	583	578	502	494	551	551	557	472	406	312	277	260	220	195	201	205	205
Gas (PJ)	534	456	401	472	413	392	384	376	453	457	477	442	478	486	443	452	457	452
Solids (PJ)	1083	1110	1132	1156	1054	1203	1268	1332	1338	1339	1463	1416	1595	1699	1696	1695	1674	1614
Electricity (PJ)	126	133	137	147	141	156	160	165	167	179	188	181	187	193	190	196	200	200
Total Energy (PJ)	2179	2282	2248	2277	2102	2302	2363	2430	2429	2381	2440	2317	2519	2598	2525	2544	2535	2471
Value Added (Bn '80$)	16.95	18.44	19.74	19.58	17.01	19.34	20.06	21.43	22.23	22.19	22.55	21.95	24.04	25.52	25.60	27.33	28.96	30.14
CHEMICALS																		
Oil (PJ)	234	318	337	324	312	372	449	448	320	215	169	153	143	124	108	124	141	165
Gas (PJ)	1553	1559	1617	1955	1707	1796	1627	1564	1696	1661	1607	1426	1463	1543	1297	1502	1721	2024
Solids (PJ)	507	431	391	394	351	344	375	337	350	348	384	354	399	417	370	374	377	392
Electricity (PJ)	352	404	431	433	437	498	512	504	504	463	461	420	445	479	452	445	436	439
Total Energy (PJ)	2647	2712	2778	3105	2807	3010	2962	2853	2871	2687	2621	2354	2451	2564	2226	2445	2675	3020
Value Added (Bn '80$)	36.65	41.22	45.07	46.71	42.55	47.64	51.33	54.82	57.18	54.62	57.80	53.28	58.52	62.42	65.24	68.58	71.92	77.97
STONE, CLAY & GLASS																		
Oil (PJ)	141	190	189	151	148	164	187	185	111	74	63	55	60	56	54	56	55	56
Gas (PJ)	823	807	763	799	661	663	595	611	646	589	531	456	510	486	422	453	463	491
Solids (PJ)	284	293	287	295	296	329	402	402	430	389	409	327	345	383	369	381	375	383
Electricity (PJ)	90	98	103	104	100	106	112	118	119	110	109	100	100	109	119	122	120	122
Total Energy (PJ)	1338	1388	1342	1349	1206	1261	1296	1316	1306	1162	1112	938	1015	1034	964	1012	1012	1052
Value Added (Bn '80$)	13.85	15.34	16.57	16.29	14.42	16.15	17.31	18.78	19.23	17.69	17.16	15.44	17.16	19.63	20.00	20.81	20.63	21.27
IRON & STEEL																		
Oil (PJ)	198	279	317	306	260	294	308	332	248	127	112	75	71	59	47	41	44	47
Gas (PJ)	994	998	1094	1068	910	874	849	891	1038	885	913	650	696	725	629	540	578	615
Solids (PJ)	1720	1784	1941	1848	1564	1643	1586	1693	1644	1315	1347	814	947	942	920	849	976	1116
Electricity (PJ)	212	223	258	265	227	243	260	276	288	251	262	189	177	215	207	181	198	215
Total Energy (PJ)	3124	3283	3610	3487	2960	3053	3003	3193	3218	2577	2633	1728	1892	1941	1803	1610	1796	1993
Value Added (Bn '80$)	20.97	23.52	26.90	25.98	20.90	23.05	22.91	24.68	24.80	19.91	21.35	13.39	15.26	17.01	16.36	14.57	16.20	17.92
NONFERROUS METALS																		
Oil (PJ)	45	68	73	57	55	57	60	59	45	30	28	23	23	19	14	19	25	32
Gas (PJ)	421	416	436	454	341	344	353	349	373	365	304	258	267	262	212	247	285	342
Solids (PJ)	71	74	66	51	42	40	40	37	45	36	34	32	32	28	23	39	55	77
Electricity (PJ)	233	254	303	345	290	314	333	343	357	357	352	254	255	301	273	283	294	322
Total Energy (PJ)	770	811	878	906	728	755	787	788	821	787	718	568	577	610	522	588	659	773
Value Added (Bn '80$)	9.59	10.71	11.96	11.65	9.09	10.50	11.09	11.70	12.08	10.83	10.95	8.99	9.56	10.97	11.01	11.22	11.49	12.40
OTHER INDUSTRIES																		
Oil (PJ)	660	827	809	614	686	746	823	830	621	483	415	397	394	356	322	311	310	317
Gas (PJ)	1926	1865	1768	1783	1633	1589	1547	1610	1712	1684	1624	1591	1669	1675	1473	1456	1427	1396
Solids (PJ)	740	737	711	630	580	627	661	691	703	703	705	658	715	756	745	818	818	892
Electricity (PJ)	769	820	870	842	845	874	908	924	914	899	914	954	963	1025	1012	1035	1072	1121
Total Energy (PJ)	4096	4250	4158	3869	3744	3835	3939	4055	3950	3768	3657	3600	3741	3813	3551	3621	3627	3725
Value Added (Bn '80$)	321.87	354.69	384.49	376.99	343.84	376.77	414.24	443.66	463.16	455.74	463.52	435.71	467.18	527.04	540.49	550.70	573.52	607.10
TOTAL MANUFACTURING																		
Oil (PJ)	1715	2264	2302	1954	1954	2184	2378	2412	1817	1335	1099	980	951	835	740	752	780	824
Gas (PJ)	6251	6101	6079	6529	5665	5657	5355	5401	5919	5640	5454	4823	5083	5178	4475	4650	4931	5319
Solids (PJ)	4405	4430	4529	4374	3888	4185	4332	4492	4510	4129	4342	3602	4033	4225	4124	4156	4275	4473
Electricity (PJ)	1782	1932	2104	2135	2040	2190	2285	2330	2348	2259	2285	2098	2128	2322	2252	2262	2319	2418
Total Energy (PJ)	14153	14727	15014	14993	13547	14216	14350	14635	14594	13363	13181	11504	12195	12560	11591	11821	12305	13035
Value Added (Bn '80$)	419.89	463.92	504.73	497.21	447.81	493.45	536.95	575.07	598.70	580.98	593.33	548.76	591.71	662.59	678.70	693.22	722.72	766.79

* Energy data interpolated based on energy intensities in adjacent years.

OECD-8 TOTAL	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988
PAPER & PULP																		
Oil (PJ)	910	1081	1105	990	925	990	970	992	904	792	647	570	536	476	425	433	437	455
Gas (PJ)	566	503	452	525	461	454	451	439	515	523	545	510	550	566	528	540	548	547
Solids (PJ)	1342	1365	1398	1415	1298	1444	1512	1588	1610	1598	1720	1674	1873	1994	2005	2007	1999	1957
Electricity (PJ)	288	305	322	330	320	348	354	367	382	390	395	388	406	427	431	438	463	480
Total Energy (PJ)	3105	3253	3277	3261	3004	3236	3287	3386	3411	3302	3307	3142	3365	3463	3389	3416	3447	3438
Value Added (Bn '80$)	31.70	34.09	36.86	36.60	31.79	35.58	36.67	38.52	40.61	40.33	39.95	39.34	42.06	44.39	44.84	47.10	49.77	52.67
CHEMICALS																		
Oil (PJ)	1165	1246	1346	1292	1142	1264	1365	1335	1242	976	877	791	682	669	645	690	684	726
Gas (PJ)	1798	1822	1909	2266	2012	2146	2007	1956	2121	2050	1989	1786	1834	1915	1671	1830	2109	2379
Solids (PJ)	698	554	509	522	467	466	491	446	472	472	509	499	576	626	599	604	610	633
Electricity (PJ)	782	846	907	916	878	971	985	982	1002	925	914	860	908	966	943	928	933	954
Total Energy (PJ)	4443	4468	4673	4996	4499	4847	4848	4719	4836	4423	4289	3936	4000	4176	3858	4052	4336	4692
Value Added (Bn '80$)	79.16	85.95	95.69	98.08	88.72	99.28	104.76	111.82	118.03	113.58	116.97	112.73	122.01	129.94	134.61	138.37	145.66	156.75
STONE, CLAY & GLASS																		
Oil (PJ)	1249	1343	1367	1200	1072	1097	1096	1122	1002	729	503	413	433	390	362	378	372	402
Gas (PJ)	948	977	956	1003	866	887	846	836	880	812	744	642	697	683	627	661	678	709
Solids (PJ)	493	475	480	477	460	480	558	579	651	773	900	819	810	857	832	796	791	814
Electricity (PJ)	217	235	248	243	233	237	256	270	280	271	262	251	253	270	283	285	287	298
Total Energy (PJ)	2907	3031	3051	2923	2630	2701	2756	2807	2813	2585	2408	2126	2193	2200	2104	2120	2128	2222
Value Added (Bn '80$)	44.23	47.33	51.64	49.50	44.74	47.84	49.84	52.21	53.79	52.09	48.91	46.04	47.87	50.98	50.91	51.56	52.98	56.06
IRON & STEEL																		
Oil (PJ)	1221	1326	1473	1358	1140	1176	1061	1065	949	593	435	341	311	291	240	258	262	293
Gas (PJ)	1527	1544	1688	1670	1430	1405	1368	1425	1603	1392	1385	1068	1100	1146	1075	942	985	1044
Solids (PJ)	3850	3942	4399	4366	3824	3947	3723	3723	3879	3473	3471	2738	2857	2966	2972	2689	2872	3115
Electricity (PJ)	609	644	727	742	675	724	723	748	798	733	729	634	626	671	667	616	636	680
Total Energy (PJ)	7207	7456	8287	8136	7069	7252	6874	6960	7229	6191	6020	4780	4893	5075	4954	4505	4755	5132
Value Added (Bn '80$)	50.12	54.27	62.44	61.53	50.89	55.48	54.62	57.38	60.66	54.69	54.30	44.50	45.62	49.92	49.98	46.57	48.36	53.46
NONFERROUS METALS																		
Oil (PJ)	158	184	209	179	164	164	164	178	168	146	124	107	99	93	88	100	94	101
Gas (PJ)	448	446	470	483	377	384	396	398	427	418	353	306	317	317	271	307	345	400
Solids (PJ)	149	147	145	133	111	111	105	96	110	94	90	86	91	94	112	122	135	147
Electricity (PJ)	470	509	576	604	562	594	630	630	652	653	621	492	495	552	517	523	533	563
Total Energy (PJ)	1225	1286	1400	1399	1214	1253	1296	1301	1357	1311	1191	994	1006	1056	988	1052	1107	1212
Value Added (Bn '80$)	20.07	22.10	25.15	23.79	19.97	23.51	24.59	25.59	26.96	24.99	24.68	22.60	24.11	26.12	25.63	26.36	27.46	29.42
OTHER INDUSTRIES																		
Oil (PJ)	2842	3148	3220	2897	2840	3012	3035	3011	2723	2402	2264	2086	2008	1873	1805	1743	1713	1754
Gas (PJ)	2123	2129	2102	2163	2019	2007	1999	2092	2221	2210	2142	2109	2179	2242	2091	2084	2110	2061
Solids (PJ)	1105	1039	1012	917	849	906	938	956	1002	970	1005	933	1002	1066	1055	1128	1114	1188
Electricity (PJ)	1377	1471	1580	1546	1538	1636	1688	1736	1764	1743	1765	1811	1861	1993	2015	2070	2163	2280
Total Energy (PJ)	7447	7787	7914	7523	7246	7561	7660	7794	7710	7326	7176	6939	7050	7174	6966	7025	7101	7282
Value Added (Bn '80$)	732.3	782.6	852.4	835.0	774.6	836.7	889.4	931.5	971.2	971.1	973.5	944.7	986.6	1080.2	1117.7	1129.5	1163.6	1236.5
TOTAL MANUFACTURING																		
Oil (PJ)	7544	8329	8720	7915	7283	7703	7691	7703	6987	5639	4849	4307	4069	3791	3565	3602	3563	3730
Gas (PJ)	7410	7421	7577	8110	7164	7283	7067	7145	7767	7405	7157	6420	6677	6870	6262	6363	6777	7139
Solids (PJ)	7638	7522	7943	7831	7010	7355	7328	7388	7723	7381	7695	6749	7207	7604	7575	7346	7520	7854
Electricity (PJ)	3742	4009	4361	4381	4205	4509	4635	4732	4879	4714	4686	4436	4549	4879	4857	4859	5015	5255
Total Energy (PJ)	26334	27281	28601	28239	25662	26851	26721	26968	27356	25140	24387	21913	22503	23144	22259	22170	22875	23977
Value Added (Bn '80$)	957.6	1026.3	1124.2	1104.5	1010.7	1098.4	1159.9	1217.0	1271.3	1256.8	1258.3	1209.9	1268.2	1381.6	1423.7	1439.5	1487.9	1584.8

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