Energy efficiency developments in IEA countries 30 years after the oil crisis

Fridtjof Unander
International Energy Agency
9, rue de la Fédération
75739 Paris Cedex 15
France
Fridtjof.Unander@iea.org

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Abstract

This paper presents findings from a study that examines how energy efficiency and factors such as economic structure, income, lifestyle, climate, prices and fuel mix have shaped developments in energy use and CO_2 emissions in IEA countries since the first oil price shock in 1973.

The results show that IEA countries have made significantly progress in energy efficiency since 1973. However an alarming finding is that energy savings rates across all sectors and in almost all countries have slowed since the late 1980s. This indicates that the oil price shocks in the 1970s and the resulting energy policies did considerably more to control growth in energy demand and CO_2 emissions than energy efficiency and climate policies implemented in the 1990s.

Energy price developments offer some explanation of these long-term trends. The lower prices that followed the high price period of 1973-1986, combined with the fact that energy intensities were already significantly reduced resulted in considerably lower energy expenditures for both industry and private consumers from the mid 1980s. The energy share of total production cost in some industries fell by as much as 50% from the early 1980s until the late 1990s. Similarly, the share of energy costs for stationary uses in IEA household budgets fell by 20-50% over the same period, while the fuel cost per kilometre driven by private cars fell between 20% and 60%, depending on the country.

The slowing rate of energy efficiency improvements is the primary reason for the weaker decoupling of CO_2 emissions from GDP growth since 1990. Failing to accelerate improvement of energy efficiency would thus have serious implications for many countries prospects of controlling growth in future emissions.

Introduction

The International Energy Agency (IEA) was established as a response to the oil supply disruptions in 1973-74. Improving energy efficiency was a key element in most IEA countries' strategy to reduce the dependency on imported oil in the wake of the oil crises of the 1970s. The importance of energy efficiency has since then been reinforced due to increasing concerns over climate change.

Despite the importance of energy efficiency policies, efforts to quantify how energy efficiency has affected energy demand trends in IEA countries have traditionally been limited. Often demand analysis has been conducted at aggregate levels, an approach founded in the apparent correlation over time between energy demand and GDP. However, aggregated measures provide little information on how various factors, including energy efficiency, shape energy demand in different end-uses. This has motivated many countries to collect more detailed data and using these data to construct various kinds of energy indicators, many of which are relevant for assessing energy efficiency developments. Building on these national efforts the IEA has developed a database with a consistent set of data that can be used to assess energy demand and efficiency trends across most of the IEA countries.

The IEA study "*Oil Crises and Climate Challenges: 30 Years of Energy Use in IEA Countries*" (IEA 2004a), uses the IEA's indicator database to examine how energy efficiency and factors such as economic structure, income, lifestyle, climate, prices and fuel mix have shaped developments in energy use and CO_2 emissions in IEA countries since the first oil price shock in 1973. The results presented in this paper build on the recent IEA study.

The paper first gives a brief overview of the methodology and data used for this study before presenting the long-term development of disaggregated intensities and how this have affected energy savings since 1973. The next section discusses the potential impact changes in energy prices and energy cost has had on the development of energy savings, while the final section before the conclusions addresses the impact on CO_2 emissions.

Methodology and Data

The methodology used in this study builds on the analytical framework developed under the IEA Energy Indicator Project (IEA 1997, 2004a) which in turn has drawn extensively on data and analysis developed by the Lawrence Berkeley National Laboratory in the United States (Schipper et al. 2001). The project has been carried out in collaboration with governments and research institutions in a dozen IEA Member countries as well as with energy indicator projects organised by the European Commission (Ademe/European Commission 1999).

The IEA methodology for analysing energy end-use trends distinguishes among three main components affecting energy use: activity levels, structure (the mix of activities within a sector) and energy intensities (energy use per unit of sub-sectoral activity). Depending on the sector, *activity* is measured either as value-added, passenger-kilometres, tonne-kilometres, population, or built area. *Structure* divides activity further into industry sub-sectors, transportation modes, or measures of residential end-use activity. Table 1 gives an overview of the various measures applied for activity, structure and energy intensities in each sector.

The separation of impacts on energy use from changes in activity, structure and intensity is critical for policy analysis as most energy-related policies target energy intensities and efficiencies, often by promoting new technologies. Accurately tracking changes in intensities helps measure the effects of these new technologies. To separate the effect of various components over time, the IEA uses a factoral decomposition where changes in energy use in a sector are analysed using the following equation:

$$E = A \sum S_j * I_j$$

Equation (1)

Where E represents total energy use in a sector; A represents overall sectoral activity (e.g., value-added in manufacturing); S_j represents sectoral structure or mix of activities within a sub-sector *j* (e.g., shares of output by manufacturing sub-sector *j*); and I_j represents the energy intensity of each sub-sector or end-use *j* (e.g., energy use/real US$ value-added).

If indices for the changes in each of these components over time are established, they can be thought of as "all else being equal" indices. They describe the evolution of energy use that would have taken place if all but one factor remained constant at their base year.[1]

By introducing the dimension of fuel mix, the decomposition of energy use can be extended to address changes in CO_2 emissions. Fuel mix in this case represents both changes in fuel shares among end uses and changes in the utility CO_2 intensity (CO_2 emissions per unit of electricity or district heat produced). Changes in CO_2 emissions (G) in a sector then can be decomposed according to:

$$G = A * \sum S_j * I_j * F_{j,k}$$

Equation (2)

where F stands for the carbon content of each fuel (*k*) used in sub-sector (*j*). The *k* index represents two factors: changes in the utility CO_2 intensity (electricity and district heat production fuel mix and generation efficiency) and changes in the final fuel mix within each end-use sector.

The resulting indices from each sector defined above can be combined further and weighted at base-year values of energy use to measure the impact of changes in either energy intensities or economy-wide activity and structure components on overall energy use. The same approach can be applied to CO_2 emissions. With E and G in this case representing energy use and CO_2 emissions at a national level, the decomposition equations take the forms:

$$E = \sum A_i * S_{i,j} * I_{i,j}$$

Equation (1b)

and

$$G = \sum A_i * S_{i,j} * I_{i,j} * F_{i,j,k}$$

Equation (2b)

where the index *i* denotes the sectors listed in the first column in Table 1 and the index *j* denotes sub-sectors or end-uses within a sector as shown in the second column in Table 1.

Detailed data required for time-series indicator analysis exist in many IEA countries, but not yet in all of them. For this reason, this study considers energy use only in IEA countries where consistent, detailed, long-term time series going back to 1973 are available. This group, referred to as

1. There are different index-number techniques that permit analysing this relationship over time. In this book, the Laspeyeres indices approach is used. The Laspeyres approach yields a residual term due to interaction among the other factors in the decomposition. This means that the changes in the decomposition factors do not necessarily always add up exactly to the changes in energy use or CO_2 emissions. In most cases, the residual term is relatively small compared to the effects of the other factors and for simplicity has not been included in the figures or tables presented in this paper.

Table 1. Summary of Variables Used in the IEA Energy Indicator Decomposition Methodology.

Sector (i)	Sub-sector (j)	Activity (A)	Structure (S_j)	Intensity ($I_j = E_j/A_j$)
Household				
	Space Heat	Population	Floor area/capita	Heat[1]/floor area
	Water Heat	“	Person/household	Energy/capita[2]
	Cooking	“	Person/household	Energy/capita[2]
	Lighting	“	Floor area/capita	Electricity/floor area
	Appliances	“	Ownership[3]/capita	Energy/appliance[3]
Passenger Transport				
	Cars	Passenger-km	Share of total pass-km	Energy/pass-km
	Bus	“	“	“
	Rail	“	“	“
	Domestic Air	“	“	“
Freight Transport				
	Trucks	Tonne-km	Share of total tonne-km	Energy/tonne-km
	Rail	“	“	“
	Domestic Shipping	“	“	“
Service				
	Total Services	Services GDP	(not defined)	Energy/GDP
Manufacturing				
	Paper & Pulp	Value-added	Share of total value-added	Energy/value-added
	Chemicals	“	“	“
	Non-metallic Minerals	“	“	“
	Iron & Steel	“	“	“
	Non-Ferrous Metals	“	“	“
	Food and Beverages	“	“	“
Other Industry[4]				
	Agriculture & Fishing	Value-added	Share of total value-added	Energy/value-added
	Mining	“	“	“
	Construction	“	“	“

[1]Adjusted for climate variations and for changes in the share of dwellings with central heating systems.
[2]Adjusted for dwelling occupancy (number of persons per household).
[3] Includes ownership and electricity use for six major appliances.
[4] Other industry is not included in this study.

the IEA-11 in this analysis, includes: Australia, Denmark, Finland, France, Germany, Italy, Japan, Norway, Sweden, the United Kingdom, and the United States. Together these countries accounted for about 83% of total IEA energy consumption in 2001. Due to lack of more recent data for the United States results for the IEA-11 group are only presented through 1998. Refer to IEA (2004) for more information on data used for this study.

Energy Intensities and Energy Savings

Figure 1 shows the development of the intensity measures by main sector as described by equation 1 above for the group of eleven IEA countries included in this study. The figure also include the economy-wide intensity effect, which is calculated as the sum of all sectoral intensity measures, weighted at 1990 energy use shares, refer equation 1b. This intensity declined by on average 1.5% per year over the 1973-1998 period. This is less than the 1.9% average annual decline in final energy per GDP. The difference can be explained by that the IEA economies generally moved to a less energy intensive structure over this period which helped reducing energy requirements relative to GDP independent of energy efficiency improvements.

The figure clearly indicates that there has been a trend towards a slowing rate of decline in the economy-wide intensity effect. Between 1973 and 1982 this intensity fell by as much as 2.5% per year on average. Over the next eight years there was still a significant decline, although at a somewhat lower average annual rate of 1.5%. After 1990, the decline rate was down to only 0.7% per year, averaged over the 1990 to 1998 period.

This slowing rate of intensity decline trend is seen in most sectors. It is most prominent in the manufacturing sector: intensity (corrected for changes in structure) fell by 41% over the 1973 to 1998 period, but it had already declined 36% by 1986. This corresponds to an average annual rate of decline of 3.5% between 1973 and 1986 and only 0.6% per year for the next twelve years.

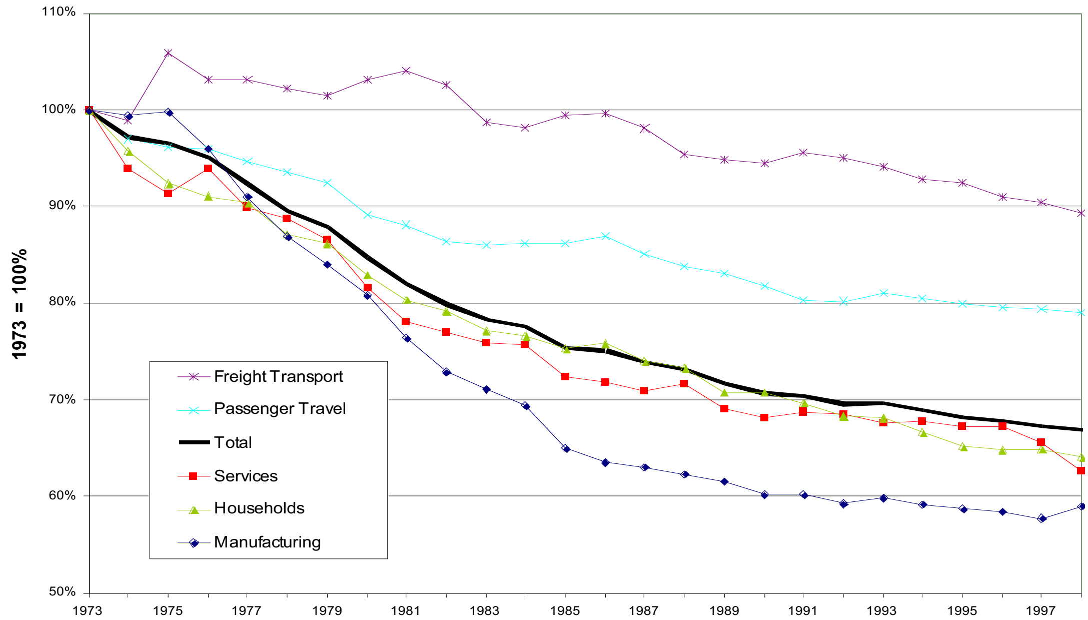

Figure 1. *Sector intensities and total economy effect, IEA-11.*

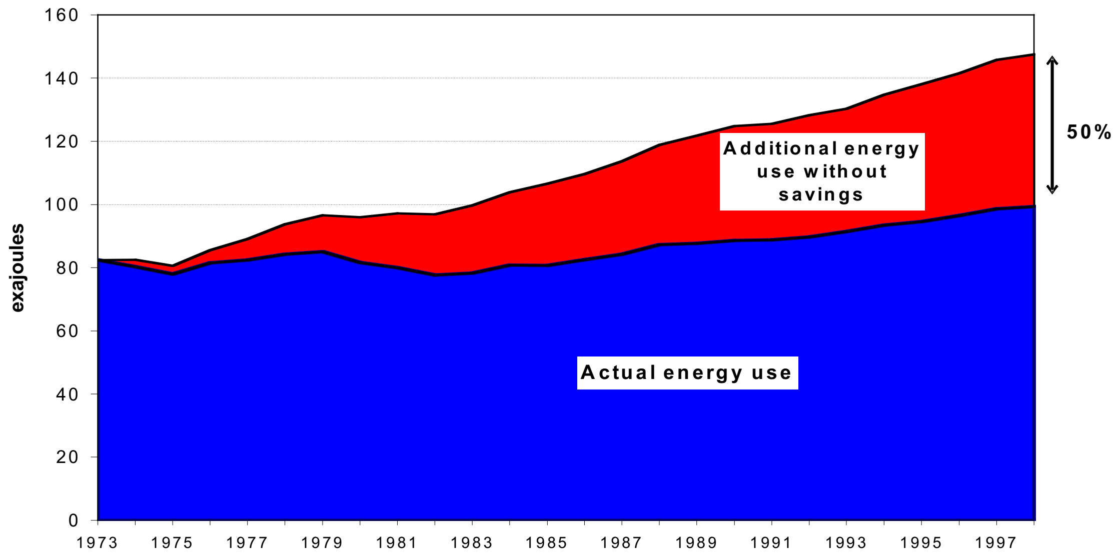

Figure 2. *Final energy use and energy savings, IEA-11.*

The service and household sectors trailed manufacturing in terms of total intensity reductions. Interestingly, the decline rates in these two sectors have followed each other closely throughout most of the period, with slightly stronger reductions than average for the whole economy. Passenger and freight transport have pulled up the average economy-wide intensity effect. While the passenger travel intensity fell at almost the same rate before and after 1986 (about 1% per year on average), the freight intensity in 1986 was at about the same level as in 1973 (both intensities calculated holding the modal mix constant). Since 1986, the freight intensity has declined at about the same rate as the passenger travel intensity.

How much did falling energy intensities in the various sectors reduce total energy use in IEA-11 between 1973 and 1998? In Figure 2 the lower area shows actual climate-corrected energy use, which includes the effect of changes in energy intensities. The upper area represents the additional hypothetical energy use that would have occurred if energy intensities had remained at the 1973-level in all sectors, which can be defined as the energy savings that took place due to declining intensities.[2 3]

Relatively steady declines in energy intensities resulted in energy savings, although the savings rates have slowed somewhat over recent years (see Figures 3-11 and 3-15). By 1998 the savings amounted to 48.2 EJ, which corresponds to 49% of 1998 energy use level. In other words, IEA-11 energy

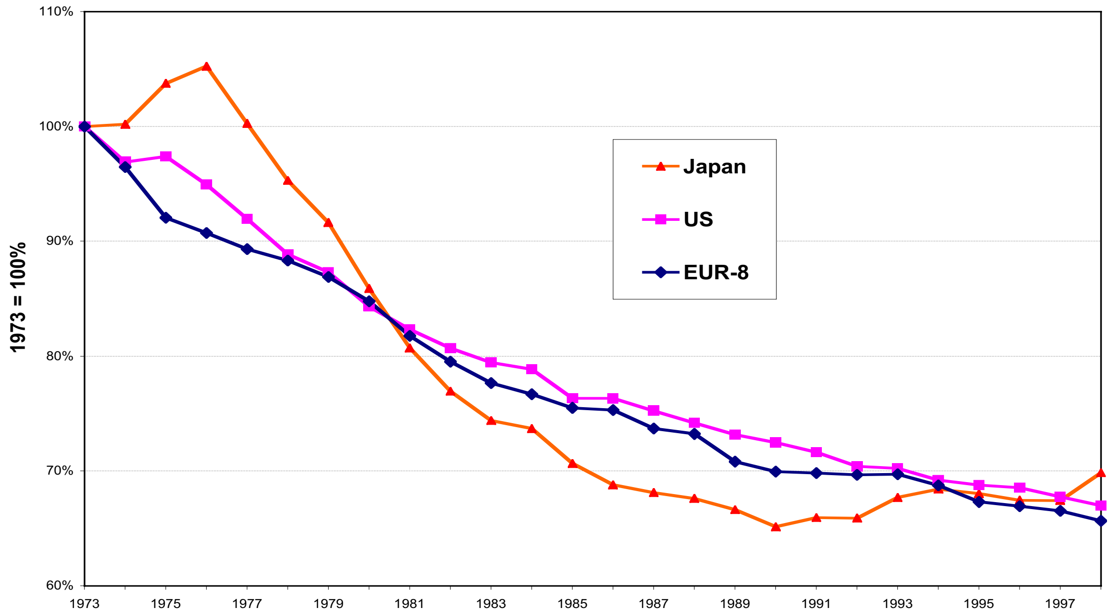

Figure 3. *Changes in economy-wide energy intensity effect.*

use would have been 49% higher in 1998 if intensities of the different sub-sectors and end-uses had remained at 1973 level.

The economy-wide energy intensity effect declined by almost the same amount in each region between 1973 and 1998: 30% in Japan, and 34% in the United States and EUR-8[4] (Figure 3).

The development of the EUR-8 and the Unites States' intensity effect closely followed each other through 1998, but it was very different in Japan. Intensity rose between 1973 and 1977 in Japan largely due to increased energy per value-added in key manufacturing industries. After 1977, falling intensities in these industries led the very dramatic decline in the Japanese intensity effect until the mid-1980s. This decline is stronger than seen in any period in any other country studied by the IEA.

As Japan slipped into recession after 1990, the economy-wide energy intensity effect shifted and started to increase. This gave the United States and EUR-8 a chance to catch up, and by 1994 intensities had fallen by just over 30% since 1973 in all three regions. After 1994, the decline in Japan more or less followed the trends in the United States and EUR-8 until 1998 when the Japanese economy-wide intensity jumped due to increased intensities in the manufacturing and service sectors.

Energy Savings and Energy Costs

What can explain the significant slowing of energy savings rates observed after the mid-to-late 1980s? The development of energy prices is clearly one factor. Oil prices shot up in the wake of the oil embargo in 1973-4 and were further exacerbated by supply disruptions induced by the Iran-Iraq war in 1979. Oil prices then fell considerably in 1986 when Saudi Arabia substantially increased its oil production. Oil prices stayed low through the 1990s but have over the last year increased significantly. Over the long term prices for natural gas and to some extent coal have more or less followed oil prices developments, although with less strong fluctuations.

It is thus hard not to attribute part of the decline in energy intensities observed before 1986 to higher energy prices. Similarly the general decline in prices that followed may offer at least partly an explanation for the slowing of energy savings rates that took place over the last part of the period covered by this analysis. However prices are only one of the factors that determine what energy costs industry and private consumers face. Thus to assess changes in the incentives for energy savings it is more interesting to investigate how energy costs have developed over time.

The following sections present analysis of energy costs for manufacturing and residential sectors for the countries included in this study.

2. Since this study uses a Laspeyres index decomposition with base-year 1990 both the intensity effect in 1973 and in any other year are weighted using 1990-structure in each sector.
3. Using this method the savings in a given year reflect the impact of the decline in intensities between 1973 and the given year. As a consequence, subtracting the savings in a year, say 1998, from another, say 1990, does not necessarily yield the savings resulting from the decline in intensities between 1990 and 1998. If savings due to changes in intensities between 1990 and 1998 are to be calculated correctly, the upper curve needs to be rebased to 1990-level.
4. EUR-8 is defined as the eight European countries within IEA-11

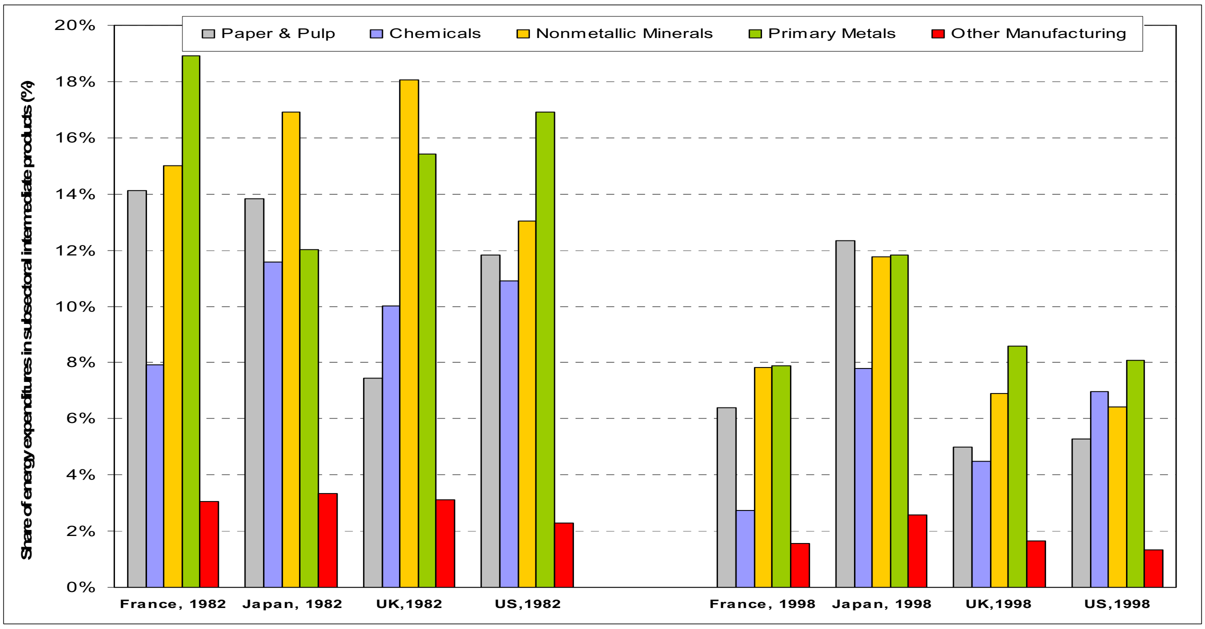

Figure 4. *Share of energy expenditures in sub-sector intermediate product costs.*
Intermediate consumption is used as a measure of total production cost. It consists of the value of the goods (such as energy, materials, machinery and equipment) and services consumed as inputs by a process of production, excluding fixed assets whose consumption is recorded as consumption of fixed capital; the goods or services may be either transformed or used up by the production process.

MANUFACTURING

The cost of energy for manufacturing depends on the energy intensity of the products produced, the mix of fuels used and the price of those fuels. For energy-intensive industries, energy costs constitute a significant share of total production costs (Figure 4).[5] Yet there are relatively large differences in this share among the countries included in this figure. Some of these differences are due to variations in sub-sector energy intensities. Differences in fuel prices also play a role, although higher intensities, especially in energy-intensive industries, tend to be related to lower prices. Access to cheap energy is often a stimulant for the production of energy-intensive materials. For example, in Australia and Norway, where energy has been relatively inexpensive, the production of aluminium – a very energy intensive process – constitutes an important share of the production of primary metals and thus drives up the average intensity for this sector (Unander et al., 2000).

In France, the United Kingdom and United States, the energy cost share fell significantly between 1982 and 1998 in all sectors. Most sectors in Japan also saw a reduction in this share, but less than in the three other countries, even though Japanese industries reduced energy intensities at a faster rate than most other countries through the 1980s. A closer examination of the data for intermediate production cost and value-added, shows that value-added increased relative to production costs in Japanese industries. This indicates that the use of other production factors also became more efficient in parallel with the energy intensity reductions. Compared to other countries, the somewhat higher share of energy expenditures in Japan in 1998 could thus be related to that the use of other production factors is more efficient, though quantification of this is beyond the scope of this study.

Figure 5 shows how energy expenditures relative to value-added changed as a function of changes in fuel prices, fuel mix and energy intensities for the primary metals sector. It confirms that energy cost relative to value-added in this sector did fall significantly at least before 1990. The figure confirms that in Japan energy expenditures relative to value-added fell more than relative to intermediate product (see Figure 4). The decline in Japan was due to the combination of rapidly falling energy intensities and significant declines in fuel-weighted energy prices that led to energy costs falling by almost 8% per year on average relative to value-added between 1982 and 1990. These two factors also reduced energy costs per value-added in the United States, United Kingdom and Japan, but to a more modest degree. Examining data for other sub-sectors show to a large extent the same picture, expenditures fell as intensities and fuel prices declined.

The impact from changes in the fuel mix in primary metals production was modest. In other sub-sectors where more significant fuel switching took place, energy costs generally increased where electricity and gas took shares from coal, while costs fell where more expensive oil (per energy unit) was replaced by natural gas.

5. The costs presented in figure 4 are calculated assuming the same fuel prices in all sub-sectors. Thus the cost share differences across the sub-sectors are probably overestimated since the energy-intensive sectors often have access to cheaper energy through various forms of subsidies, for example guaranteed long-term low price contracts for electricity.

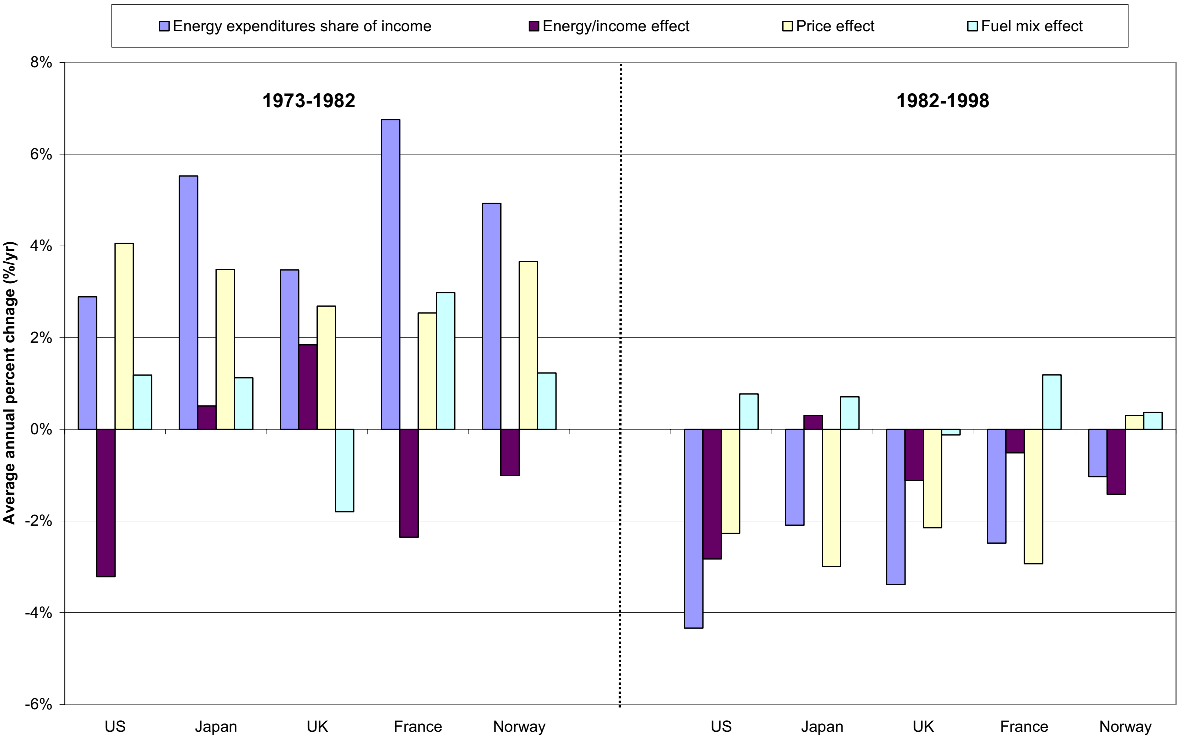

__Figure 5.__ Decomposition of energy costs per value-added for primary metals production.

After 1990 energy costs relative to value-added in the primary metals sector only fell significantly in the United Kingdom, where energy expenditures fell as prices dropped. For all countries the lack of a considerable decline in energy intensities limited further reductions in energy costs. The same tendency can be observed in other manufacturing subsectors.

It is thus tempting to conclude that today the lower share of energy costs – which results from both successful energy efficiency improvements and lower energy prices – has made investments in energy efficiency less attractive than investing in ways to reduce other production costs compared to a couple of decades ago.

RESIDENTIAL

In the majority of IEA countries residential electricity prices in real terms have undergone less dramatic changes than oil prices, and to some extent less than coal and gas prices. Fossil fuel prices increased significantly in the aftermath of the oil price shocks in 1973-1974 and 1979, and fell again with the crash in crude oil prices in 1986. For the countries included in this study, electricity prices between 1973 and 1986 increased moderately in most and declined in a few. After 1986 electricity prices fluctuated somewhat, but with a general downward trend, especially over the last few years. In fact, only in Denmark where electricity taxes increased during this period, were real prices in 2000 higher than in 1986 (Unander et al., 2004).

The share of disposable incomes that IEA households pay for energy has varied significantly over the last three decades. In the early 1970s it was between 2 and 4% in the group of countries shown in Figure 6. The share increased to between 4 and 5% by the mid-1980s and then started to decline in most countries. By 1998, it was roughly at the same level as in 1973.

What percentage of total income is spent on household energy depends on the price of purchased fuel, the mix of fuels used and the level of residential energy demand per unit of income. To better understand the development of the shares shown in Figure 6 it is interesting to look at how each of these components have evolved.

This can be done by decomposing changes in the expenditure share into changes in residential energy demand per unit of income, real fuel prices and fuel mix through holding all but one factor constant at the 1990-level. In this manner, the impact from changes in prices can be calculated as the change in real prices for oil, natural gas, coal and electricity, weighted at the 1990 fuel mix and consumption levels. Conversely, the change in expenditure share resulting from changes in the fuel mix is calculated holding relative fuel prices and energy demand per unit of income constant at the 1990-level. Then the impact from changes in energy demand per unit of income is calculated with prices and fuel mix at 1990-levels.

Figure 7 shows changes in the energy expenditure share decomposed as described above. The share of energy expenditures in disposable income increased rapidly between 1973 and 1982 in all the countries shown, indicating that energy was a much bigger burden on household budgets. The average annual growth ranged from 2.9% in the United States to 6.8% in France. In the United States, the expenditure share grew even though energy demand per unit of income fell by more than 3% per year on average. This growth was primarily driven by increased real prices for fuels and electricity, although an increased share of electricity in the fuel mix also contributed (electricity is generally more ex-

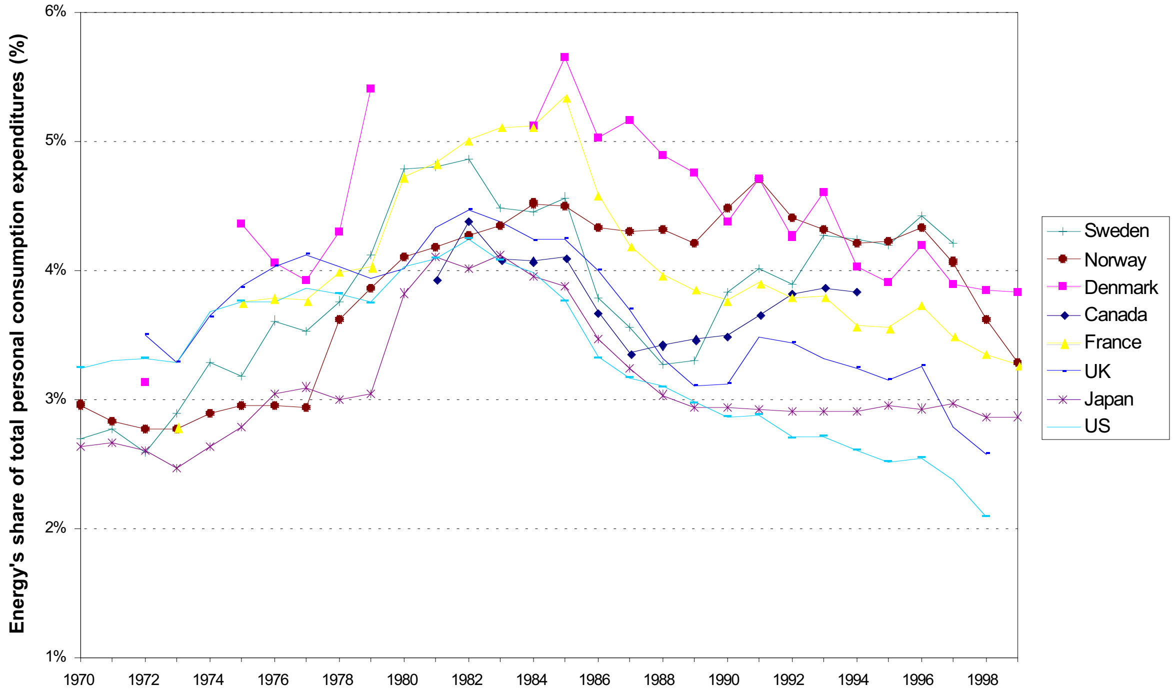

Figure 6. *Share of residential energy expenditures in total personal consumption expenditures (PCE).*

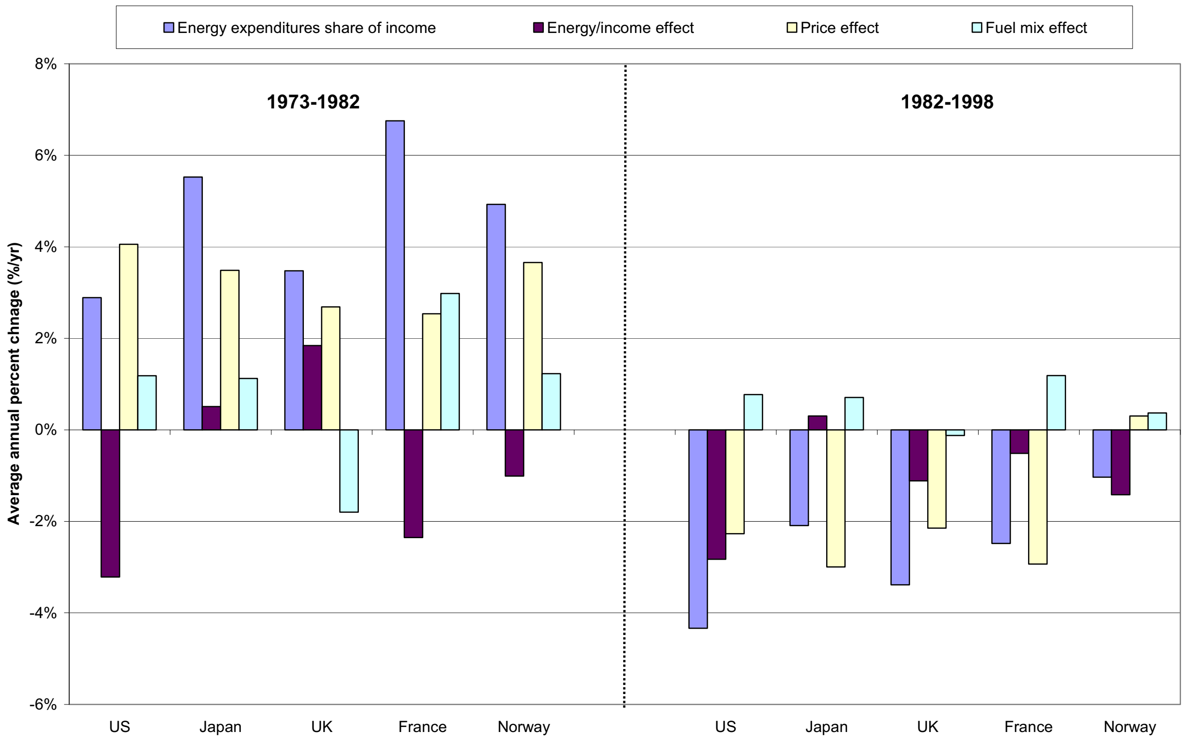

Figure 7. *Decomposition of changes in household energy expenditures shares into impacts from changes in energy demand per unit of real income, real fuel prices, and fuel mix.*

pensive than other energy carriers). Increased prices also drove up expenditures in the other countries, as did the higher share of electricity, except in the United Kingdom, where the electricity share actually fell between 1973 and 1982.

After 1982 the picture changed: the share of energy expenditures fell in all countries, as also shown in Figure 6. The main reason for this turn-around was a strong decline in energy prices in all countries except Norway. On the other hand, increased shares of electricity in the fuel mix driven

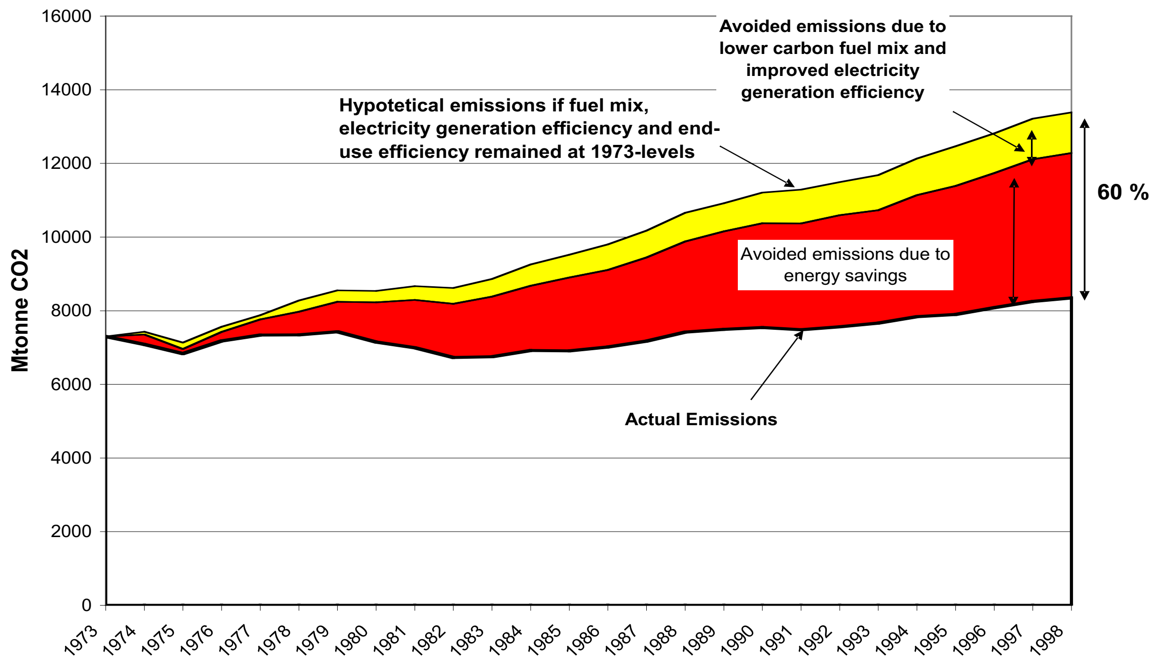

Figure 8. *CO_2 emissions and the impact of changes in fuel mix, electricity generation efficiency and end-use intensities (energy savings), IEA-11.*

by more appliances continued to induce a moderate upward pressure on energy expenditures in most countries. The fall in prices was augmented by a decline in energy demand per unit of income in all countries except Japan, where residential energy demand grew slightly faster than income. Taken over the whole period, lower growth in energy consumption relative to income helped reduce the importance of energy in the household budgets in all IEA-11 countries, except Japan. Clearly, without the energy savings achieved between 1973 and 1998, IEA households would have seen much more of their incomes being spent on energy.

Implications for CO_2 Emissions

Energy savings have been important to control growth in CO_2 emissions; between 1973 and 1998 emissions increased 15% in the group of eleven countries but they would have increased 68% without energy savings. In fact energy savings contributed much more to reducing the potential growth in emissions than the combined effect of moving towards a lower carbon fuel mix and improved electricity generation efficiency. This is illustrated by Figure 8 where the upper line shows the development of emissions that would have taken place if fuel mix, generation efficiency and end-use intensities all had remained at 1973-levels. The difference between this hypothetical emission development and the lower line (actual emissions) represents the avoided emissions due to changes in fuel mix, generation efficiency and energy savings (refer to equation 2b). In total CO_2 emissions would have been 60% higher in 1998 if none of the mentioned factors had changed since 1973. More than three-quarters of the avoided emissions were due to energy savings, i.e. 1998 CO_2 emissions would have been 45% higher without the energy savings that took place between 1973 and 1998.

Despite the overall positive contribution from energy savings recent trends of slowing rates of decline in energy intensities has seriously affected the development of CO_2 emissions; before 1990 CO_2 emissions in the group of eleven IEA countries fell relative to GDP at a rate of 2.6% on average per year, while after 1990 the annual decline rate was down to around 1%. In absolute terms emissions hardly changed between 1973 and 1990 while they have been growing at more than 1% per year since 1990.

This is illustrated in Figure 9 where annual growth rates in actual emissions are shown as the lower part of the two bars while the top levels represent the rates emissions would have increased by had the fuel mix, electricity generation efficiency and end-use intensities remained as in 1973 (refer also to the top line of Figure 2). Interestingly the average growth in these hypothetical emissions was slightly higher (2.5 % per year) before 1990 than after (2.2% per year). The avoided emissions due to lower carbon fuel mix and improved electricity generation efficiency correspond to taking off about 0.3 percentage points of the growth rate in both periods. Thus the main reason for the higher growth in emissions after 1990 is lower rates of energy savings. In fact had energy savings after 1990 kept up with the average pace of savings achieved between 1973 and 1990 CO_2 emissions for this group of countries would have remained at 1990-levels.

The slowing progress of energy efficiency improvement poses a serious challenge for future emissions prospects. If energy savings will continue as recent trends at improvement rates of 0.5-1% per year instead of more than 2% per year as generally seen before 1990, much more emission reductions will need to be come from reducing the carbon intensity of the fuel mix, e.g. through introducing renewables, to keep the reduction rates of CO_2 emissions per GDP at the same levels as before 1990.

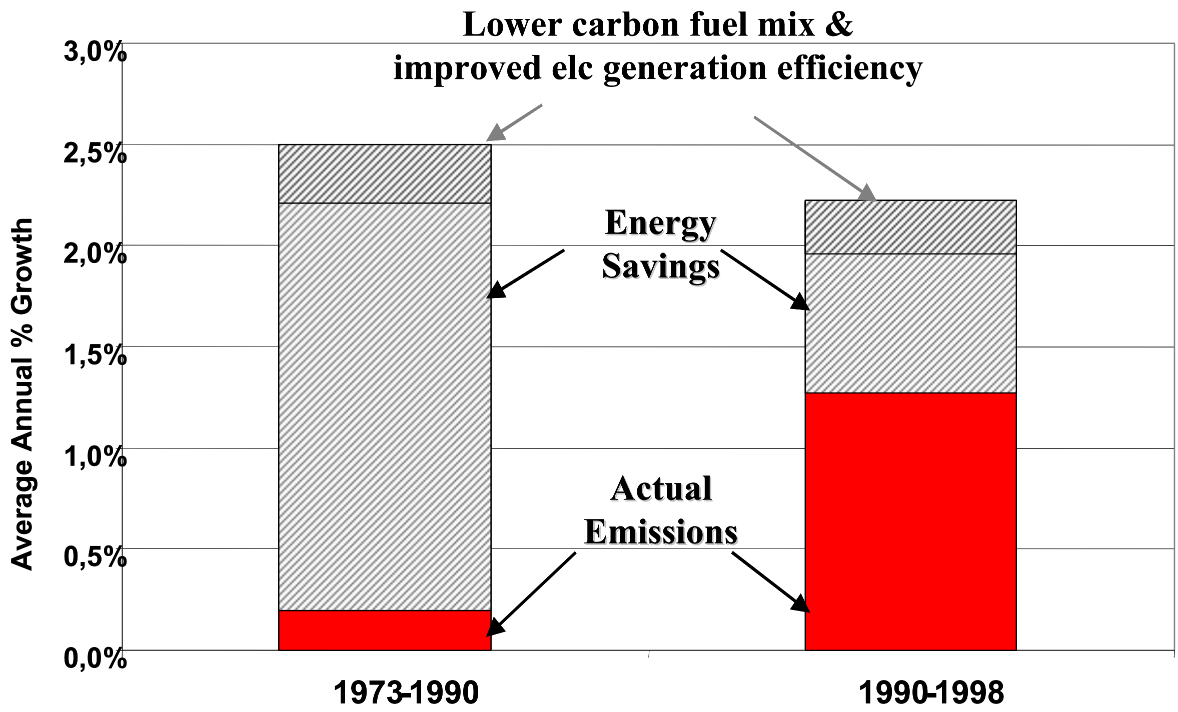

Figure 9. *Average growth rates in actual CO_2 emissions and avoided emissions due to energy savings, lower carbon fuel mix and improved electricity generation efficiency, IEA-11.*

Conclusions

The main finding of this study is an alarming one; despite significant overall improvements since 1973 energy savings rates across all sectors and in almost all countries have slowed since the late 1980s. As a consequence CO_2 emissions are now increasing rapidly in most IEA countries. This indicates that the oil price shocks in the 1970s and the resulting energy policies did considerably more to control growth in energy demand and CO_2 emissions than energy efficiency and climate policies implemented in the 1990s.

Indeed the evolution of energy prices offers some explanation for these trends. Before 1973 energy prices were generally low, so when the price hikes kicked in after 1973 there was ample room for improving energy efficiency as a response. As prices fell after 1985 the incentive for maintaining energy savings rates became less. The generally higher prices seen over the last few years could be expected to help re-accelerating energy savings, although to a lesser extent than in the 1970s and 1980s since energy intensities of most end-uses now have been significantly reduced which has in itself considerably reduced the share energy costs have in total expenditures for both industry and private consumers.

Does this means that energy efficiency has been a victim of its own success and that most of the potential efficiency improvements have been explored? No, as also demonstrated in the in the Alternative Policy Scenario of the IEA's *World Energy Outlook 2004 (WEO-2004)* (IEA 2004b) there is still significant scope for improving energy efficiency. The Alternative Policy scenario analysed a wide range of policy measures that would lead to the introduction of these more efficient technologies. Most of these measures are already under discussion by IEA member governments. However if the potential savings identified under this scenario are to be realized governments need to go from discussing to actually implementing the measures. Furthermore, technologies are available that can provide further energy savings than those assessed in WEO Alternative Policy scenario, even at negative life cycle costs (IEA 2003). What is clear from both the assessment of past trends presented in this paper and from the scenario analysis of WEO 2004 is that energy efficiency must be a key component if growth in future CO_2 emission is to be contained.

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