EXECUTIVE SUMMARY

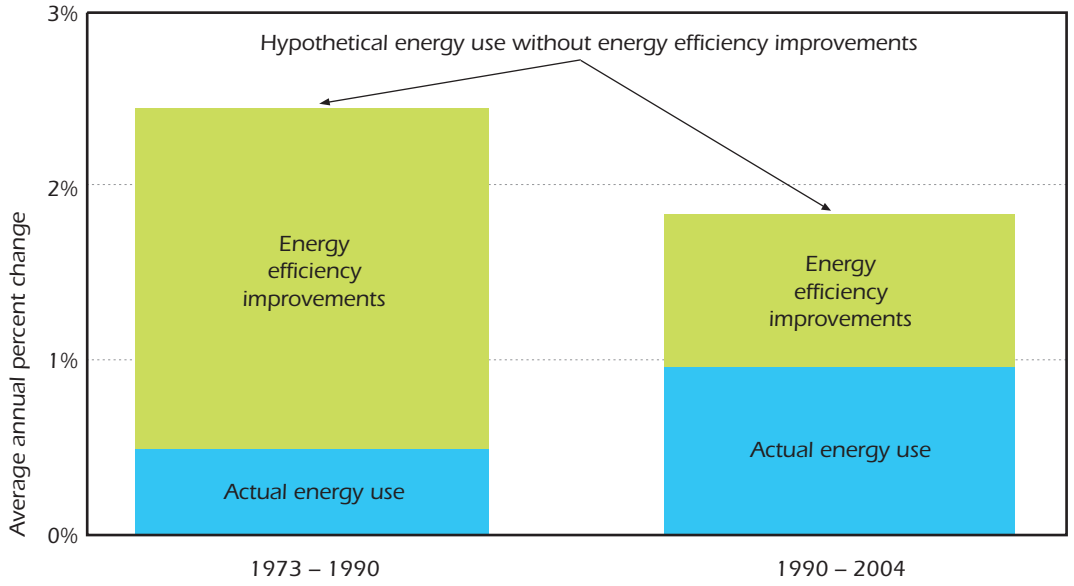
At the Gleneagles Summit in July 2005, the Group of Eight (G8) leaders addressed the interrelated challenges of tackling climate change, promoting clean energy and achieving sustainable development. They launched the Gleneagles Plan of Action (GPOA), which identifies transforming the way we use energy as a key priority. To advance this initiative, G8 leaders asked the International Energy Agency (IEA) to play a major role in delivering elements of the GPOA, including those relating to energy efficiency in buildings, appliances, transport and industry.

As part of its response, the IEA is developing in-depth indicators to provide state-of-the-art data and analysis on energy use, efficiency developments and policy pointers. This book is a major output from the indicator work and an important contribution to the GPOA.

Highlights

Economic growth in IEA countries in recent decades has increased personal wealth and created many new opportunities for individuals. People travel more, and own more and larger cars. They have more spacious and comfortable homes, with a greater number and variety of appliances. They enjoy a greater range and higher quality of shops, leisure facilities, schools, hospitals, and other services. IEA economies are steadily growing.

Figure ES.1 ▶ ***Impact of Energy Efficiency Improvements on Final Energy Use, IEA11***



This is all good news. But it has also created greater demand for the services that energy provides (*e.g.* heating, lighting, transportation). Increased service demand need not have led to a rise in actual energy use, provided that improvements in

energy efficiency kept pace. However, this was not the case. In fact, since 1990 the rate of improvement in energy efficiency has been about half of what it was in previous decades. Had the earlier rate been sustained, there would have been almost no increase in energy consumption in the IEA. Instead, final energy use increased by 14% between 1990 and 2004. This increased energy use fed directly into the level of CO_2 emissions, which also rose by 14%. By 2004, on average, each IEA citizen's energy consumption at home and for travel produced more than five tonnes of CO_2 emissions per year. Commercial and industrial activities, including the transport of goods, generated an additional six tonnes per person per year.

These findings confirm the conclusions of previous IEA analyses – that the changes caused by the oil price shocks in the 1970s and the resulting energy policies did considerably more to control growth in energy demand and reduce CO_2 emissions than the energy efficiency and climate policies implemented since the 1990s. Projections published by the IEA in *Energy Technology Perspectives 2006* show that the recent rate of improvement in energy efficiency will need to at least double for a realistic chance of a more sustainable energy future.

Data

Detailed, timely and accurate information is vital to monitor the impacts of existing energy policies and to develop the new policies that will be needed. Since the last IEA indicators analysis, published in 2004, six more IEA member countries have been added to the database. This brings to 20 the total included in at least part of the current analysis. However, building complete and reliable databases requires time, expertise and resources. Even for these countries, data are not always available for all sectors and a great deal of work remains to be done in terms of improving data quality and comparability.

Analysis

In order to change the current patterns of energy use, it is necessary to understand, in detail, the trends in energy efficiency and the other factors that influence energy consumption. This study provides an analysis of energy use and CO_2 emissions in IEA member countries[1] from 1990 to 2004. It uses a powerful analytical tool – energy indicators – to separate out the effects of changes in activity levels, structure (the mix of activities in the economy) and energy intensities (which are used as a proxy for energy efficiency).

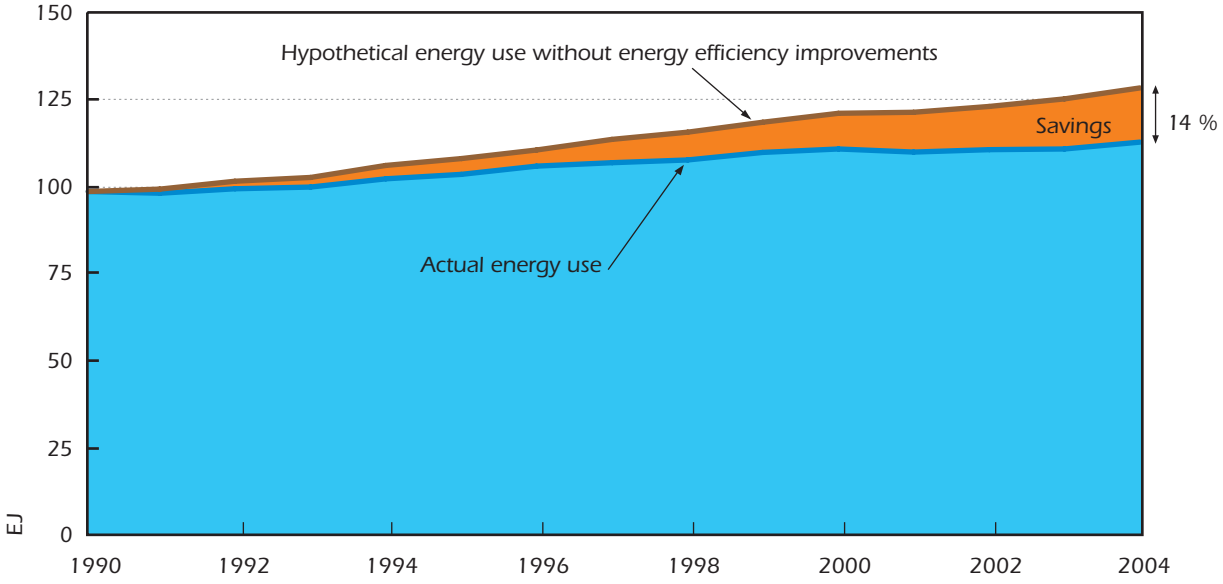
The demand for energy services, which combines the impacts of activity and structure, in IEA countries increased by 1.8% per year over the period 1990 to 2004. This was less than the annual growth rate of GDP at 2.3%, due to the fact that some energy-using activities grew more slowly than the economy as a whole. All parts of

1. Data are available for the period 1990 – 2004 for all sectors for a group of 14 IEA countries: Austria, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Sweden, the United Kingdom and the United States. A further six countries – Australia, Belgium, Greece, Ireland, Portugal and Spain – are included in the analysis of some sectors. In the analysis of long-term trends from 1973, 11 countries are included. These are Australia, Denmark, Finland, France, Germany, Italy, Japan, Norway, Sweden, the United Kingdom and the United States.

the economy contributed to this increased demand for energy services. The highest rates of growth were in the service and domestic passenger and freight transport sectors, followed by manufacturing and households. Even in the wealthiest countries, consumers have shown a robust and sustained desire to enhance their lifestyles in ways that require more energy services. This is borne out by detailed analysis of the key drivers of energy demand, such as ownership and use of vehicles, housing size and occupancy, and floor space and electricity demand in the service sector.

About half of the increased demand for energy services was met through increased energy use, and the other half through improvements in energy efficiency, which averaged 0.9% per year between 1990 and 2004. These improvements led to energy and CO_2 savings of 14% in 2004 (16 EJ [370 Mtoe] and 1.2 Gt CO_2). This is approximately equivalent to the annual final energy consumption and CO_2 emissions of Japan and translates into fuel and electricity cost savings of at least USD 170 billion in 2004. This illustrates the critical importance of energy efficiency in shaping energy use and CO_2 patterns. However, the efficiency gains were much lower than in previous decades; energy efficiency improvements averaged 2% per year between 1973 and 1990.

Figure ES.2 ▶ ***Energy Savings from Improvements in Energy Efficiency since 1990, IEA14***



Manufacturing

Of all sectors analysed, manufacturing industry achieved the largest energy savings from improved energy efficiency, totalling 21% in 2004. Improvements in energy efficiency, coupled with structural changes within the sector, were almost sufficient to offset the effect of growing output on energy demand. Actual energy use grew by 3%; CO_2 emissions increased by only 1%. The low rise in CO_2 emissions was helped by a shift in energy use from coal and oil to natural gas.

Significant differences in the energy intensity of manufacturing among IEA countries are explained, in part, by different industrial structures. Normalising for these differences has a large impact. For instance, most of the exceptionally high energy intensity of the Australian manufacturing sector is explained by its structure: raw materials production accounts for nearly 50% of manufacturing output. A much more detailed analysis of global industrial energy efficiency is contained in the IEA publication, *Tracking Industrial Energy Efficiency and CO_2 Emissions*, published in June 2007.

Households

In the household sector, energy savings of 11% from efficiency improvements were not nearly enough to counteract growth in the demand for energy services. Household energy use, adjusted for yearly variations in climate, increased by 14%, driven largely by a spectacular 48% growth in electricity use in appliances. Space heating remains, by far, the largest user of energy in this sector. However, because of the high CO_2 intensity of electricity in most countries, appliances (including air conditioning) are rapidly catching up as the main cause of CO_2 emissions. Growth was particularly strong in the use of a wide range of small appliances. Some progress is being made in space heating; the level of heat demand per unit of floor area fell by 16% between 1990 and 2004.

Even allowing for climate variations among countries, the highest per capita household energy use (in the United States) was 2.5 times greater than the lowest (in New Zealand). This variation reflects a combination of factors including dwelling sizes, building design and comfort levels.

Services

The service sector showed the most rapid growth in energy use, driven by increasing activity. Despite energy savings of 17% from improvements in energy efficiency, energy use increased by 26% between 1990 and 2004. This overall increase was driven by strong growth in electricity use, which rose by 50%.

The service sector covers a wide variety of activities in the private and public sectors including trade, finance, real estate, public administration, health, education, commercial and leisure services. Lack of disaggregated data currently makes it impossible to analyse precisely where the very strong pressures for greater energy demand arise.

Passenger Transport

Energy efficiency improvements in domestic passenger transport resulted in energy savings of 7% by 2004. The vast majority (88%) of energy use in passenger transport is in cars. There have been improvements in vehicle and engine technologies but some of these gains have been offset by consumer preferences for larger and heavier vehicles and by increasing congestion in some countries. Combined with an increasing demand for passenger travel, these trends have driven up energy use in passenger transport (excluding international aviation) by 25% between 1990 and 2004.

The growth in CO_2 emissions per capita from passenger transport was strikingly uneven from country to country. In some countries, they remained relatively stable. Emissions actually declined in Finland, Germany and the United Kingdom, reflecting limited growth in already high vehicle ownership, limited increases in distances travelled, and improved fleet efficiency (including a shift from gasoline towards diesel). In contrast, Japan had one of the most rapid rates of CO_2 emissions growth. This reflects its starting point as having one of the lowest per capita emissions due to a historically high share of rail transport and a subsequent shift towards greater travel by car.

Freight Transport

Increased levels of freight haulage have led to a 24% rise in final energy use, despite 9% savings from energy efficiency gains. Overall, the energy intensity of freight transport has declined. Improvements in the efficiency of trucking, mainly due to higher load factors and higher vehicle efficiencies, have been sufficient to offset the impacts of increases in the share of trucking, which is more energy intensive than rail or ships.

There are large differences in the level of freight CO_2 emissions per unit of GDP. Australia and Canada have the highest CO_2 emissions per unit of GDP, reflecting the importance of raw material production and the large distances over which it must be carried. However, these countries, along with the United States, have the lowest energy use per tonne-kilometre carried.

Conclusions

Since 1990, improvements in energy efficiency have continued to play a key role in shaping energy use and CO_2 emissions patterns in IEA countries. By 2004, these improvements had led to an annual energy saving of 16 EJ, which is equivalent to 1.2 Gt of avoided CO_2 emissions and an estimated USD 170 billion of energy cost savings.

However, it is clear that more could be done; energy efficiency gains have been relatively modest since 1990 and significantly lower than in previous decades. Some small encouragement can be found in the fact that the rate of improvement seems to be increasing slightly in the last few years of the period analysed. It must be acknowledged, however, that energy efficiency measures need time to take effect. Thus, the results contained in this report may not fully reflect the impact of many policies recently initiated.

Nevertheless, there is a clear need to substantially increase the rate of energy efficiency improvement in order to tackle climate change and move towards a more secure and sustainable energy future. This is indeed possible; there is still significant scope in IEA countries for adopting more cost-effective energy-efficient technologies in buildings, industry and transport.

This book highlights a number of striking trends in the continuing growth of energy demand – trends that policy makers should take into account when developing and

implementing energy-efficiency and carbon-saving strategies. Two in particular are worth mentioning here. First is the rapid increase in electricity consumption, driven by higher electricity demand from the household and service sectors. Second is the continuing growth of passenger and freight transport activity and the low rate of overall improvement in energy efficiency within these sectors, despite better vehicle and engine technologies. Governments need to establish and maintain a comprehensive framework to monitor energy consumption trends at an end-use level and should support urgent work to address the gaps in available statistical data.

Detailed analysis shows that increased demand for energy services remains deeply rooted in the lifestyle ambitions of consumers. Very strong action is needed across all sectors if this rising demand is to be counteracted by gains in energy efficiency. Governments must act now to develop and implement the necessary mix of market- and regulatory-based policies, including stringent norms and standards. This should be complemented by efforts to drive down the CO_2 intensity of electricity production by moving towards a cleaner technology mix.