

## Annex 3C

### Energy consumption and energy efficiency in the European Union

- Within the EU15, energy consumption increased by around 0.9 per cent per year between 1990 and 2003.
- Energy efficiency improved by about 10 per cent (or 0.8 per cent per year between 1990 and 2002).
- In the industrial sector, energy efficiency improved by 12 per cent since 1990, with most sub-sectors (with the exception of textiles) contributing to the improvement.
- In the household sector, energy efficiency improved by 9 per cent, with large domestic appliances demonstrating the greatest improvements.
- Transport energy efficiency improved by 7 per cent over the same period.
- Overall energy efficiency in the UK improved by 9½ per cent between 1990 and 2002, with a 12 per cent improvement in household energy efficiency. Over the same period, energy efficiency in the transport sector improved by around 6 per cent, but there was little change in industrial energy efficiency.

3C.1 Energy efficiency is increasingly recognised as a priority by the European Commission and all member countries. The major driving force is the need to meet the objectives of carbon dioxide emission reduction as agreed in Kyoto. EU member countries and the European Commission sponsor various studies and project related to monitoring and improving energy efficiency. In recent years, several Directives have been enforced: energy performance of buildings; efficiency standards for refrigerators & freezers; and labelling of major household electrical appliances. New Directives on CHP and energy services are under preparation. Assessing energy efficiency achievements is therefore necessary as an instrument to evaluate the effectiveness of the policy actions.

3C.2 Along with other EU countries, the UK participated in the development of the ODYSSEE database on energy efficiency indicators. The ODYSSEE

indicators were developed to assess the impact of the distribution of more efficient techniques and services on the energy consumption pattern at different levels of aggregation: end use, sub-sectors, sectors, and overall demand. This enables energy efficiency influences to be isolated from economic and physical influences. This article summarises the findings from the latest ODYSSEE indicators. Further information on ODYSSEE is available at : <http://www.odyssee-indicators.org/index.html>

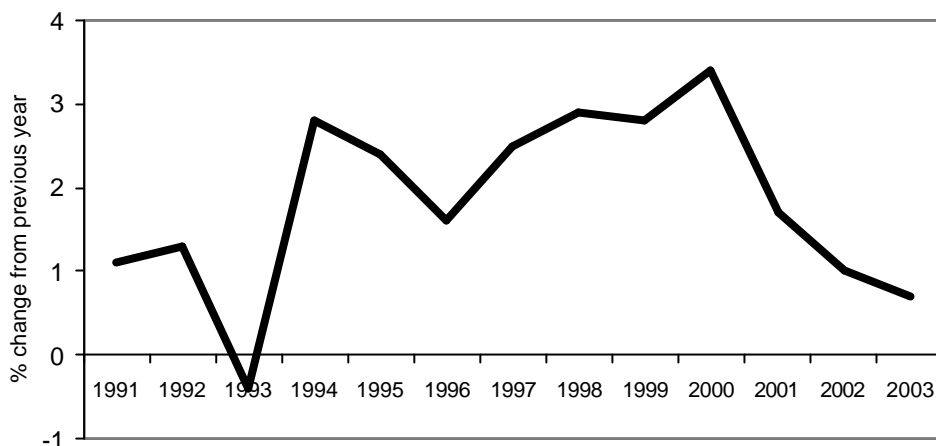
## **Background**

3C.3 A major contributor to energy consumption and energy efficiency is economic growth. Between 1990 and 2003 there were three main phases in the economy. Until 1993 there was a period of low economic growth – the average annual increase in GDP across the EU15 was 0.6 per cent. There then followed a period of more rapid growth – between 1993 and 2000 GDP increased by around 2.6 per cent per year; since 2000 economic growth rose less strongly – by 1.1 per cent per year.

### **EU15.**

The 15 European countries included in the analysis are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the United Kingdom.

**Chart 3C.1 Annual change in GDP across the EU15**

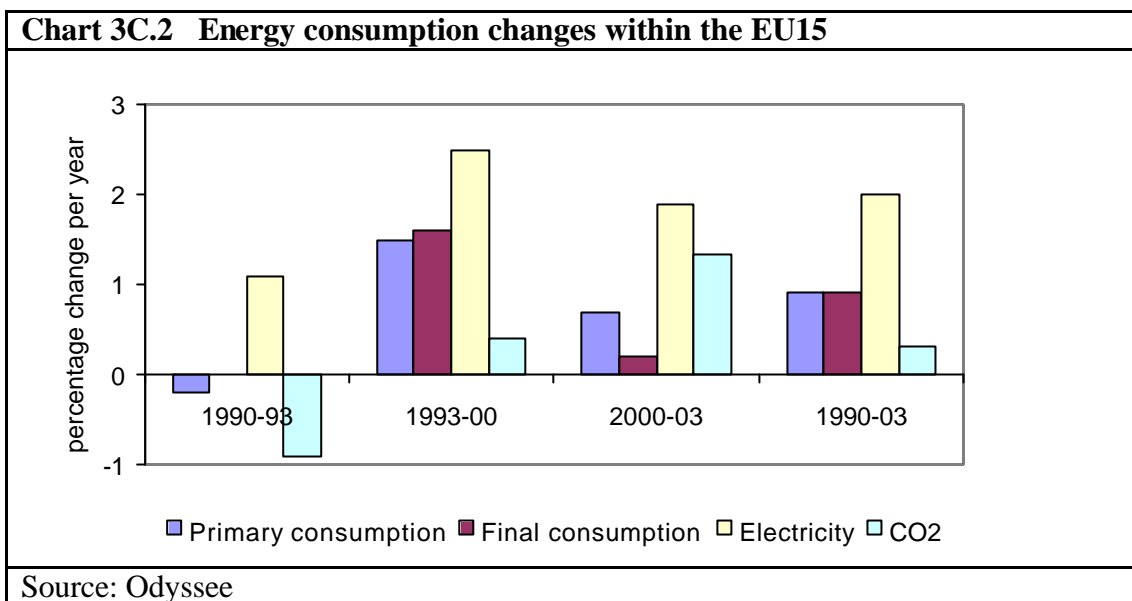


Source: Odyssee

3C.4 A second – equally important factor - is energy prices. Whilst prices of motor fuels have tended to increase annually since 1990, energy prices for consumption within homes and by industrial consumers actually declined until 1999, but rose since then. More information on international energy prices in the household sector is contained in the annex on [international comparisons of gas and electricity energy prices](#).

## Energy consumption

3C.5 Within the EU15, between 1990 and 2003 there was an average annual increase in energy consumption of 0.9 per cent per year between. However growth in energy consumption was more rapid between 1993 and 2000, coinciding with higher economic growth during this period. Electricity consumption grew at a rate more than twice that of overall final consumption. The increased energy consumption had an impact on emissions of carbon dioxide; however due to changes in the fuel mix of consumption, overall emissions increased by an average of 0.3 per cent per year between 1990 and 2003 – around one third of the average increase in energy consumption.



## Inter-country comparisons

3C.6 In recent years there have been large climatic variations from one year to another in the European Union. Between 1990 and 2003 only 3 winters (1991, 1993 and 1996) were colder than the long-term average. Overall energy consumption and in particular energy required for space heating, varies according to the external climate. Therefore when making comparisons over time and between countries temperature corrected data – using degree days - is used. The following factors also need to be taken into account: the energy intensive structure of each countries economy, and relative energy prices.

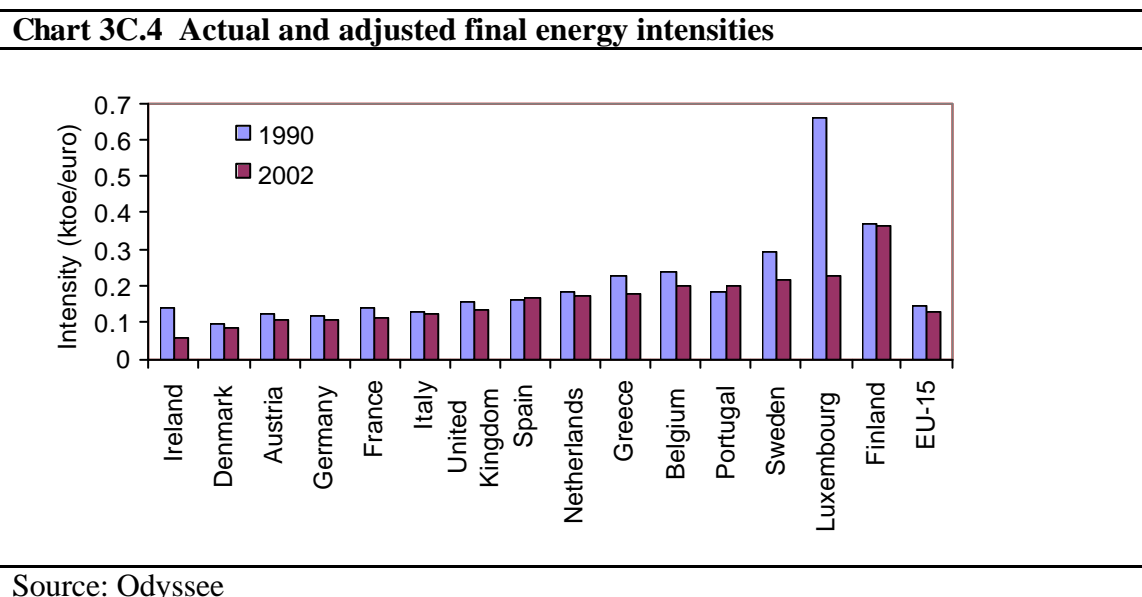
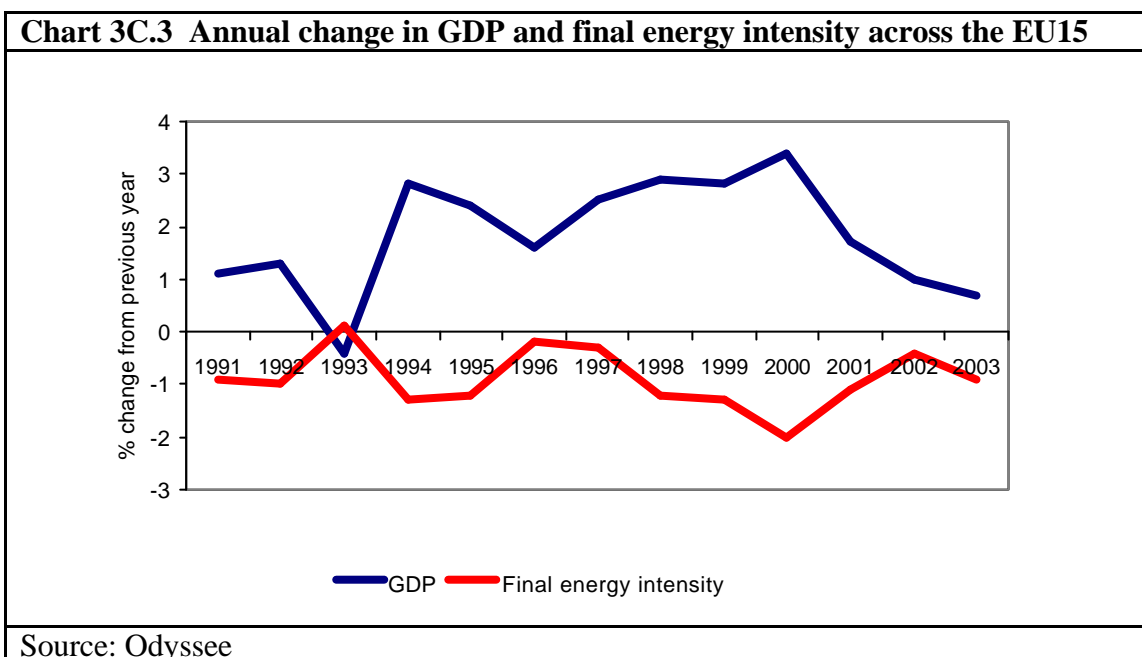
## Energy intensity

3C.7 Energy intensity is an indicator which explains how efficient the economy is using energy, whether the reason is economic or technical – a decrease in energy intensity can come from an energy efficiency improvement or from an improvement in the productivity of factors such as employment. More disaggregated indicators are required to investigate the split between energy efficiency and productivity factors.

3C.8 Both primary and final energy intensities have declined since 1990, at an average rate of just under 1 per cent per year – a total of 11 per cent between 1990 and 2003. The most improved countries are Luxembourg, Ireland, Norway, and the UK. However energy intensities increased in Spain and Portugal. Between 1990 and 2000 primary energy intensity improved faster than final energy intensity – due to energy efficiency gains in the generation of electricity.

## Comparing final energy intensity and GDP

3C.9 The final energy intensity of the EU15 countries tends to decrease slightly when economic growth is above 2 per cent per year. Otherwise it remains fairly constant. This relationship shows that part of the final demand is not correlated with GDP. During periods of steady economic growth, a more intensive use of industrial facilities as well as a faster replacement of existing equipment by new more efficient ones, helps to improve the energy efficiency and therefore to decrease the energy intensity.



## Energy efficiency

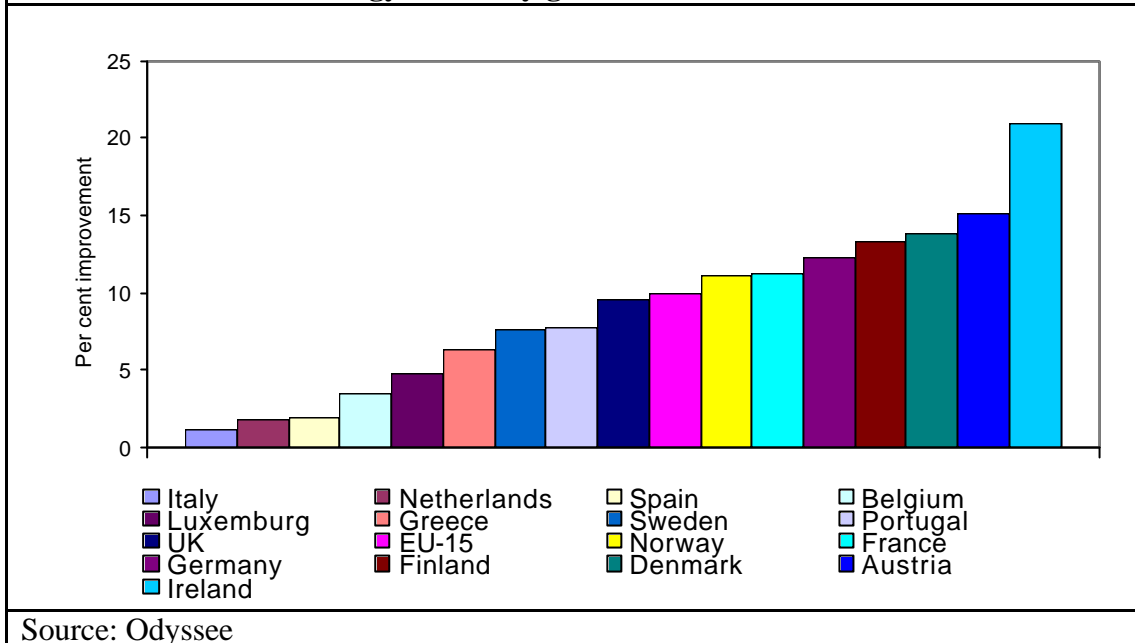
3C.10 As mentioned earlier, in order to assess energy efficiency it is necessary to examine the efficiency of the main energy end-uses and appliances, and to compile them into an aggregate energy efficiency index, weighted to take account of their relative proportion of total final consumption. Such an indicator can then be aggregated into a single indicator, which provides a more robust indicator than examining sectoral energy intensities. Odyssee have taken this work forward and developed such indicators for the EU15.

### **Odyssee energy efficiency index**

- \* Aggregates trends in detailed bottom-up indicators by end use, equipment, transport mode etc, into a single indicator for the whole sector and the country.
- \* Calculated from unit consumption indices by end-use (or equipment) and the basis of the weight of each end-use in the total consumption of the sector.
- \* In index form, different units can be combined: eg tonnes of oil equivalent per dwelling; kWh per appliance, energy consumption per head for households.
- \* Odyssee has an index reference year of 1990.
- \* A decrease in the index equates to an energy efficiency improvement
- \* The index currently consists of 26 bottom-up indicators:
  - \* 7 in the transport sector;
  - \* 8 in the household sector;
  - \* 10 in the industrial sector; and
  - \* 1 in the services sector.

3C.11 Energy efficiency improved by around 10 per cent - or 0.8 per cent per year – between 1990 and 2002 in the EU15. All EU15 countries showed improvements, ranging from a 1 per cent improvement in Italy, 2 per cent improvements in the Netherlands and Spain, up to a 21 per cent improvement in Ireland. The UK showed a 9½ per cent improvement. On a sector-by-sector basis, the industrial sector improved by 12 per cent, the household sector by 9 per cent and the transport sector by 7 per cent.

**Chart 3C.5 Overall energy efficiency gain: 1990 to 2002**



## Transport sector

- Energy efficiency improved by 7 per cent between 1990 and 2002, around 0.6 per cent per year.
- The specific consumption of cars (measured in litres/100km) decreased by around 0.7 per cent per year, with more rapid improvements for new cars since 1995 (-1.7 per cent per year). However, part of the gain is offset by a shift to larger cars.
- Since 1993 the energy used for the road transport of goods per tonne kilometre did not improve: there has been almost no efficiency progress for the transport of goods.

## Transport composition

3C.12 There has been a significant increase in the overall energy consumption with the transport sector since 1990; with an average annual increase of around 1.9 per cent.

3C.13 Road transport comprised around 80 per cent of total transport energy consumption in 2002, down from 84 per cent in 1990; however the proportion

accounted for by air transport increased from 10 per cent to 14 per cent. Passenger transport represents around two-thirds of the total transport consumption; however this proportion is gradually reducing due to a rapid growth in the transport of goods.

3C.14 There has been a rapid growth of energy use for air transport (an average 4 per cent per year increase since 1990) and also by light goods vehicles (by nearly 9 per cent per year).

### **Energy efficiency of cars**

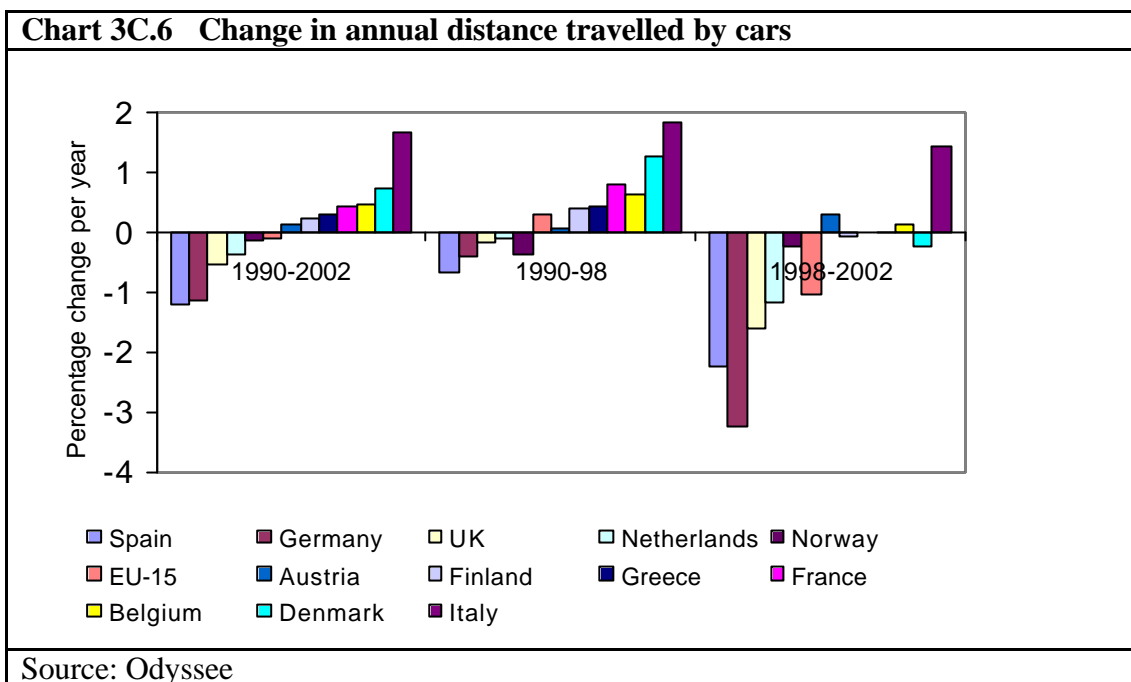
3C.15 There has been a continuous improvement in the specific energy consumption of the EU15 car fleet; it is estimated that fuel consumption has improved from 8.6 litres per 100km travelled in 1990 to around 7.9 litres per 100km travelled in 2002. There has been an even larger improvement when examining new cars – with a reduction from 7.6 litres per 100km travelled in 1995 to 6.7 litres per 100km travelled in 2002. One quarter of new cars in 2002 were below the 2008 EU carbon emissions target of 140g per km.

3C.16 Fuel consumption of new cars has reduced despite increased engine power (cars were 14 per cent more powerful) and weight (around 8 per cent heavier).

3C.17 Improvements to the specific energy consumption of cars across the EU shows different trends; largest decreases for Greece (an annual improvement of 2.4 per cent per year since 1990), Finland (1.5 per cent) and Austria (1.3 per cent); the EU average is around 0.7 per cent per year, whilst in the UK the improvement is around 0.3 per cent per year.

3C.18 As well as technical improvements, overall consumption of vehicles is affected the total distance travelled. This has also varied by country, as shown in the chart; larger reductions have been observed since 1998.

3C.19 When combining energy savings from both technical and behavioural changes, there has been an EU15 wide energy savings for cars of around 27 million tonnes of oil equivalent (mtoe) between 1990 and 2002 – 12mtoe has been due to technological factors, with 15mtoe due to reduced distances.



### Energy efficiency of goods vehicles

3C.20 The overall energy efficiency of goods vehicles is monitored with the specific energy consumption in litres per 100 kilometers; this figure decreased gradually until the mid-1990s, but has shown little progress since then. However there are large differences between countries, but these are in part explained by different definitions of goods vehicles used by countries participating in the Odyssee project. The EU15 average is currently around 31 litres per 100 kilometers.

3C.21 Another indicator is used to assess whether freight transport is becoming more energy efficient – this is monitored using unit fuel consumption per ton-kilometre. Consumption of road transport per ton-kilometre decreased between 1993 and 1998, because of better fleet management (reducing empty running of vehicles, and use of larger vehicles where appropriate). Since 1998 however, the consumption has increased.

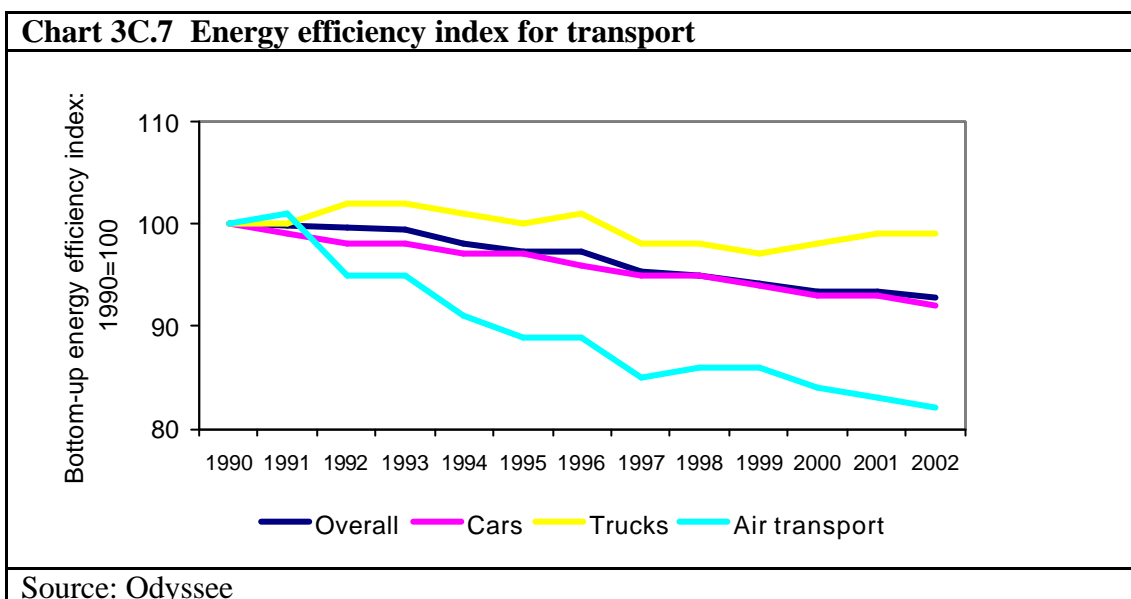
### Overall transport efficiency index

3C.22 The overall Odyssee transport efficiency index combines seven consumption indices:

- Cars (specific consumption in litres/km)
- HGV & LGV (unit consumption per ton-km)
- Air (unit consumption per passenger-km)

- Rail (unit consumption per passenger or tonne km)
- Water (unit consumption per passenger or tonne km)
- Motorcycles (toe/vehicle)
- Buses (toe/vehicle)

3C.23 The combined index shows a steady improvement of the energy efficiency of transport in the EU15 until 1999; however the reduction in efficiency for road transport of goods has caused an overall levelling of the index.



## Household sector

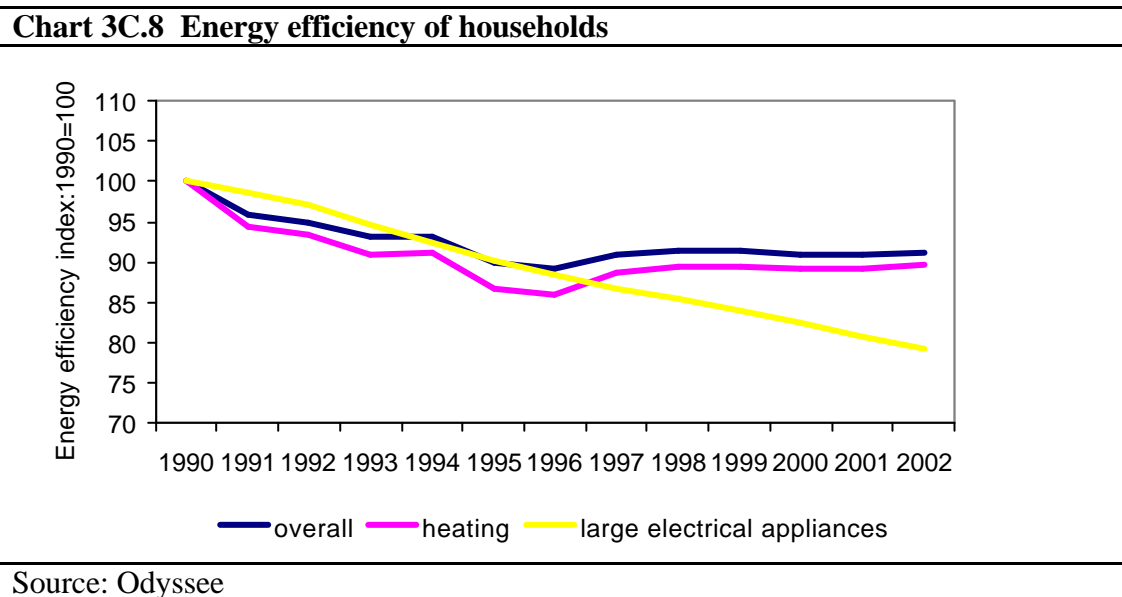
- Energy efficiency improved by 9 per cent between 1990 and 2002.
- Large domestic appliances experienced the greatest efficiency improvements: 21 per cent since 1990 – close to 2 per cent per year.
- For space heating, the improvement was rapid until 1995, but overall there were limited improvements afterwards.
- Overall consumption per dwelling is almost at the same level as in 1990.
- The influence of lifestyles and consumer behaviour (in requiring great comfort and more appliances) has offset all the energy efficiency improvements.

## Household energy consumption

3C.24 Space heating is by far the largest end-use in the EU15 countries, and accounts for 68.8 per cent of total domestic consumption; water heating accounts for a further 13.8 per cent; lighting and appliances accounts for 12.8 per cent; and cooking 4.6 per cent. The share of space heating is slowly declining; electrical appliances and lighting, on the other hand, are playing an increasing role.

3C.25 Since household consumption is dominated by space heating, it is essential that comparisons between years and countries is carried out using climate corrected figures. After climate correction, average consumption per dwelling fell between 1990 and 2002 in most northern EU countries (Netherlands, Denmark, Sweden, France, and Ireland) and in the EU15 as a whole; however the largest change occurred in Greece, where average consumption per dwelling increased by one-third between 1990 and 2002.

3C.26 Energy efficiency for household improved by 10 per cent between 1990 and 1996; however since then there has been no real progress, and in 2002, efficiency was 9 per cent lower than in 1990. Despite this, energy efficiency for large electrical appliances is still improving.



3C.27 Electrical appliances fall into two distinct categories: large appliances (including refrigerators, freezers, washing machines, dishwashers, dryers, and televisions) and a variety of smaller appliances (radio, video, DVD player, PC etc), the number of which increase annually. The large appliances account for a decreasing share of the total consumption for electrical appliances – from 53 per cent in 1985 to 45 per cent in 2001. The miscellaneous smaller appliances

represent an increase weight in this consumption, with 37 per cent in 2001 against 26 per cent in 1985. Despite the reduced share of the total for large appliances, the actual consumption has increased from around 135TWh in 1985 to 175TWh in 2002; however the energy required by the small appliances has risen from 65TWh in 1985 to 135TWh in 2002. The UK was the only EU15 country to reduce the average consumption per household for electrical appliances and lighting between 1990 and 2002; the EU15 average increase was around 1 per cent per year.

3C.28 Energy efficient labelling has played a key role in curtailing the rise in consumption for large appliances. In 2003, 45 per cent of refrigerators sold in the EU15 were 'A' rated, as were 33 per cent of freezers and two-thirds of washing machines; this compares with less than 10 per cent in each category during 1995.

3C.29 Improvements to new building standards have helped to reduce energy required for heating in new built properties; new built properties require 60 per cent less energy for heating than new built properties 30 years ago; since 1990 there has been a 25 per cent improvement.

## **Industrial sector**

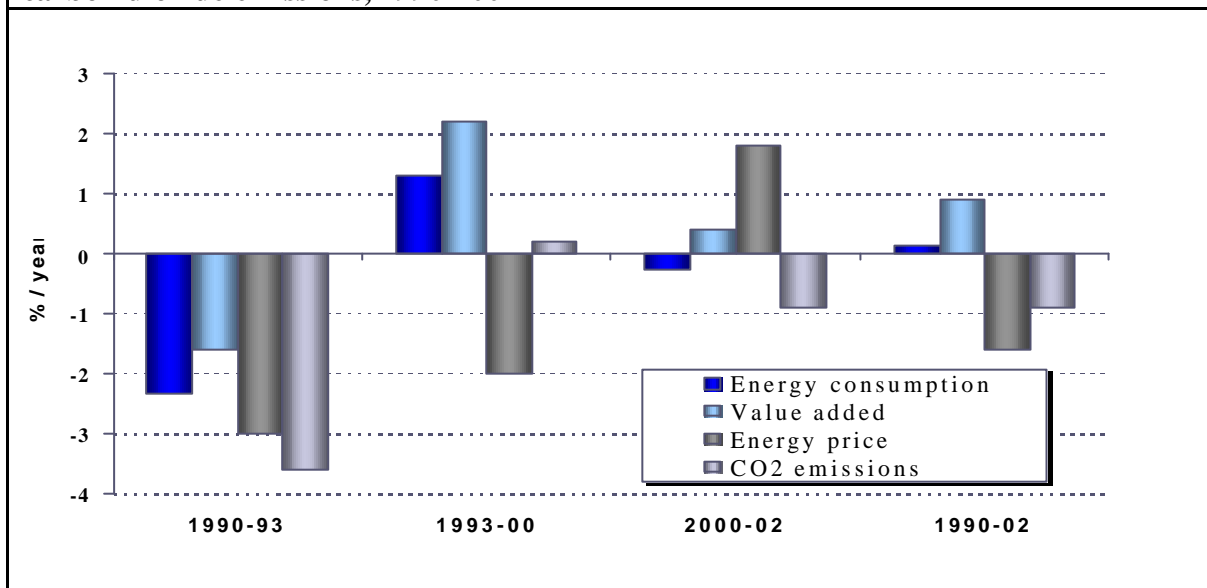
- Energy efficiency improved by around 12 per cent between 1990 and 2002. With the exception of textiles, all the remaining industrial groups showed improvements.
- Between 1990 and 1993, structural changes towards more energy intensive sub-sectors with EU industry partly counterbalanced energy efficiency improvements.
- Since 1993, the trend has reversed: structural changes towards less energy-intensive sub-sectors now strengthen the influence of efficiency improvements on actual industrial energy intensity.
- However the impact of the structural changes is limited, explaining around 10 per cent of the total reduction in industrial intensity since 1993.

3C.30 Between 1990 and 2002 overall industrial energy consumption in the EU15 remained virtually unchanged, despite a 1 per cent per year increase in Gross Value Added. During the same period, carbon dioxide emissions

decreased by around 1 per cent per year, whilst industrial energy prices fell by around 1½ per cent per year. These movements result in the energy intensity for the industrial sector falling; on a country-by-country basis industrial energy intensity only increased in Spain and Portugal. However, there was considerable variation between countries.

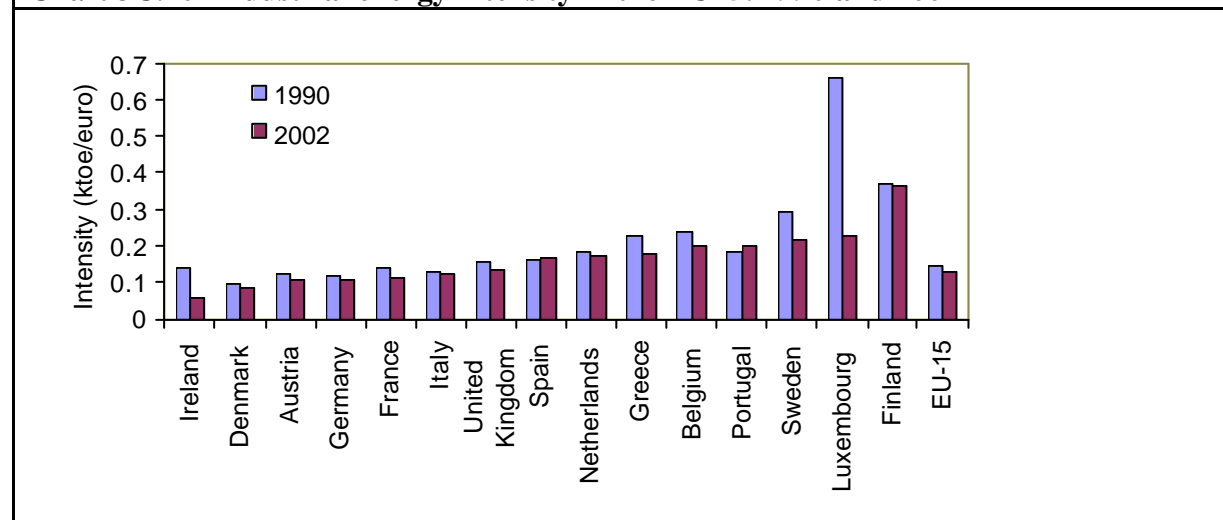
3C.31 Within industry, energy intensity varies by sub-sector. In particular there were overall reductions in the energy intensities of the chemicals, non-metallic minerals, and machinery and equipment industries; however other sub-sectors (such as the food and drink, paper and textiles industries) have shown an increased energy intensity.

**Chart 3C.9 Industrial energy consumption, gross value added, energy price and carbon dioxide emissions, 1990-2002**



Source: Odyssee

**Chart 3C.10 Industrial energy intensity in the EU15: 1990 and 2002**

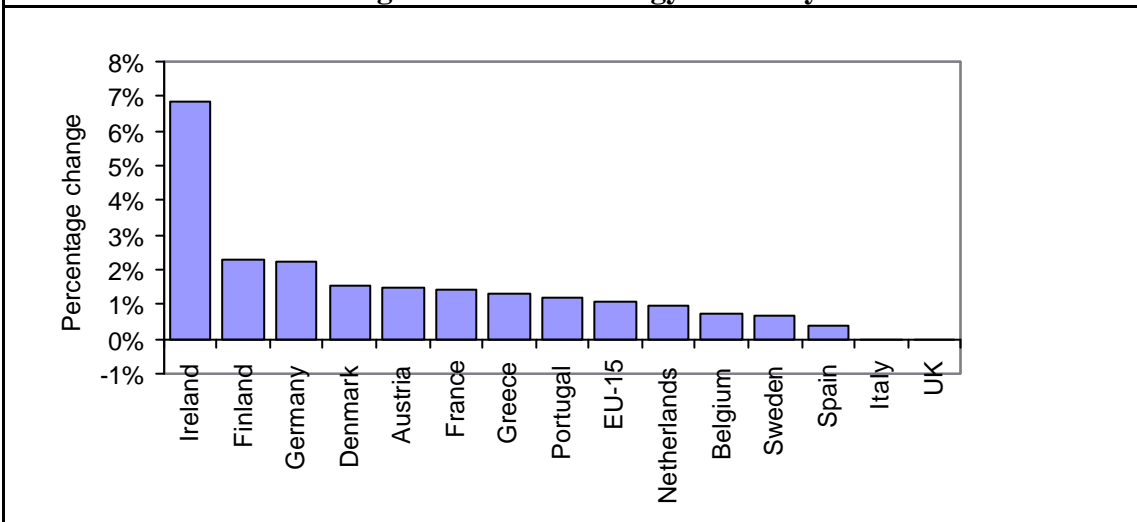


Source: Odyssee

3C.32 Structural changes within manufacturing sub-sectors EU wide have reinforced the overall intensity decrease since the second half of the 1990s (during the first half they had an opposite influence). There was a move towards more energy intensive manufacturing in Greece, Austria and Netherlands; however Ireland, Sweden, Finland, France and Belgium moved towards less energy intensive manufacturing.

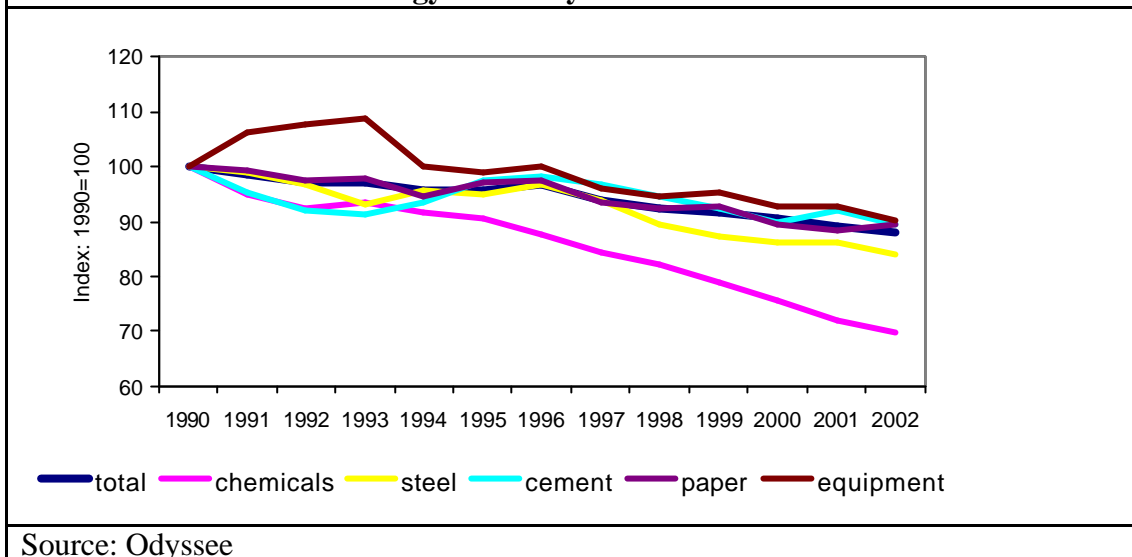
3C.33 When examining energy efficiency, there was a 12 per cent improvement across the whole EU15 between 1990 and 2002; the improvement was more rapid after 1997. On a sector by sector basis, chemicals, metals and minerals contributed the most to the improvement; however the textiles sector became less energy efficient. The improvement has been uneven across countries, but most countries typically delivered an improvement of 1 to 1½ per cent per year.

**Chart 3C.11 Annual change in industrial energy efficiency 1990 to 2002**



Source: Odyssee

**Chart 3C.12 Industrial energy efficiency index**

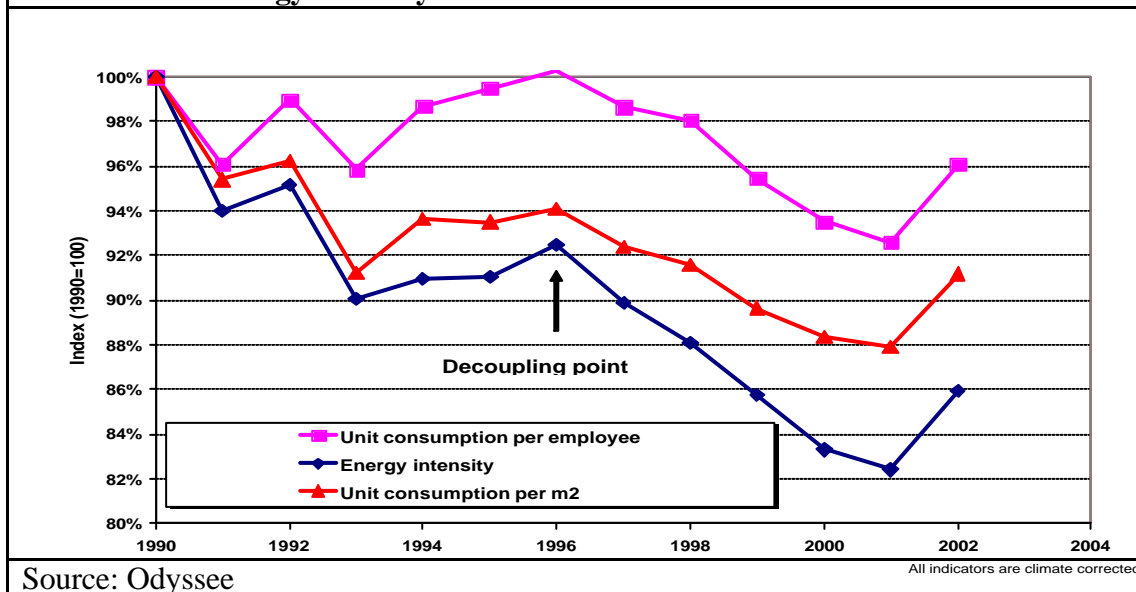


## Service sector

### Background

3C.34 Energy efficiency indicators in the service sector are still being developed by Odyssee; this is due to a lack of consistent data for all EU15 countries. However, this section provides a brief overview of some of the key factors which impact on energy consumption within this sector, and examines energy intensity and unit consumption.

**Chart 3C.13 Energy intensity in the services sector**



3C.35 Between 1990 and 2002 a decoupling of energy consumption and economic growth becomes observable in the service sector. Key factors which have impacted on service sector energy consumption over this period are:

- Value added increased by nearly 40 per cent.
- Working space increased by 30 per cent.
- Employment increased by 25 per cent.
- Labour productivity steady increase of 12 per cent.

3C.36 Overall energy consumption also increased – but energy intensity fell by around 1.3 per cent per year between 1990 and 2002. Unit consumption per employee has fallen by 0.3 per cent per year over the same period. Consumption per square meter of floor space has shown a sharper decline; a relative decoupling appeared to take place in 1996. There are small difference in unit consumption across the different types of services and countries, but larger variation for hotels/restaurants.

3C.37 Building regulations have had a substantial impact on reducing the fuel consumption of service sector buildings; for the EU15 as a whole, there was a decrease in of more than 2 per cent per year in the fuel consumption per square metre between 1990 and 2002.

### **Sources/further reading:**

[Odyssee indicators.](#)

Energy efficiency in the UK:

[Energy efficiency on DTI website](#)

[Energy efficiency on Defra website](#)