Energy Consumption and CO_2 Emissions in the Residential Sector

1990 – 2004

SUSTAINABLE ENERGY IRELAND
Energy Policy Statistical Support Unit

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- conduct statistical and economic analyses of energy services sectors and sustainable energy options;
- contribute to the development and promulgation of appropriate sustainability indicators.

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Highlights

General Context

- Over the period 1990 to 2004 residential sector Total Primary Energy Requirement (TPER) increased by 31% (2.0% per annum on average) to 3,842 ktoe.
- The residential sector's relative share of national TPER has decreased from 31% in 1990 to 26% in 2004.
- The residential sector in 2004 was responsible for 25% (2,886 ktoe) of Ireland's Total Final Consumption (TFC) and is the amount of energy for which households within the sector are billed directly. The TFC of the residential sector increased by 32% (2% per annum on average) over the period 1990 to 2004.
- In 2004 residential sector energy-related CO_2 emissions were 11,376 kt CO_2, representing 27% of the total attributable to energy. The residential sector was the second largest after transport which was responsible for 32% of emissions.
- Over the period 1990 to 2004 CO_2 emissions from the residential sector increased by 7.3% (0.5% on average per annum) while transport, services, industry and agriculture respectively increased by 133% (6.3% per annum), 62% (3.5% per annum), 6.1% (0.4% per annum) and 12.6% (0.9% per annum).
- In 2004 the "average" dwelling consumed a total of 24,499 kWh of energy based on climate corrected data. This was comprised of 19,340 kWh (79%) in the form of direct fossil fuels and the remainder (5,159 kWh) as electricity.
- In 2004 the "average" dwelling was responsible for emitting approximately 8.2 tonnes of CO_2. A total of 5 tonnes CO_2 (61%) was from direct fuel use and the remainder arising indirectly from electricity use.
- There has been a significant change in the residential sector fuel mix over the period 1990 to 2004. Solid fuels (coal and peat) accounted for 53% of energy use in the sector in 1990 whereas in 2004 their share had declined to 15%. Oil and gas accounted for 59% of the fuel mix in 2004 compared with 21% in 1990.
- The total spent on energy by the residential sector in 2004 was €2.2 billion.
- The average spend (current prices) on energy per permanently occupied dwelling in 2004 was €1,513. This was an increase of 12% on 2003 and 45% on 1990.
- In 1990 4.7% of total personal consumption was spent on energy, but this fell to 2.9% by 2003. This means that energy now forms a smaller proportion of our spending than it did in 1990.
- In 1999/2000 those in the lowest income decile spent on average 10% of their disposable income on energy while the highest earners spent 2.3%. The average proportion of disposable income (as opposed to personal consumption) spent on energy across all income groups was 3.8% compared to 5% in 1994/1995 and of 6% in 1987.

Energy Consumption –Underlying Factors

- There were an estimated 1,436,798 permanently occupied dwellings in the State at the end of 2004.
- The number of permanently occupied dwellings increased by 43% (2.6% per annum) over the period 1990 to 2004.
- There was a remarkable increase in dwelling completions over the period 1990 to 2004, from 19,139 completions in 1990 to 76,954 completions in 2004, an increase of 300%. The figure of 76,954 was also the highest over the period and represented a 12% increase on completions in 2003.
- The most common house type in Ireland in 2002 was the detached house which accounted for 46% of the total. This is a reduced share compared with 1990, when detached houses accounted for 54% of the total. Flats increased their share over the period from 3.8% in 1990 to 6.4% in 2002, while semi-detached houses increased from 19% to 27%.

- Average household size declined from 3.34 persons per household in 1991 to 2.81 persons in 2004.
- The estimated average floor area of new houses grew from 130 square metres in 1990 to 149 square metres in 2004 (an increase of 13.6%). There was a slight decline in the early 1990s followed by a growth rate of 2% per annum in the latter half of the decade. 2004 saw a slight increase of 0.1%.
- Estimated average floor areas of new flats showed a stronger growth over the period from 64 square metres to 77 square metres (19.3%).
- Over the period 1981 to 2004 the estimated average floor area of the stock of dwellings increased from 97 square metres in 1981 to 112 square metres in 2004.
- A significant proportion, 25%, of the total housing stock has been built since 1996. By contrast 53% of the stock was built before the first building requirements came into force in 1979.
- The majority of dwellings, 82%, are either owned outright or are in the process of being purchased (mortgaged) representing a slight increase on the proportion (80%) in 1991.
- A significant proportion, 33%, of dwellings are located in open countryside.
- The percentage of dwellings with central heating had increased from 52% in 1987 to 90% in 2002.

International Comparison

- In 2003 Ireland's house building rate was 17 units per 1,000 of the population. This was the highest building rate in the EU -15. By comparison the average in EU-15 was 5 units per 1,000 population and 3 in the UK. Spain had the second highest level of house building with 13.8 completions per 1,000 of population.
- Ireland had a higher average energy consumption (climate corrected) per dwelling when compared with the EU-15 during the period 1990 to 2003. Ireland was 35% above the EU-15 average in 2003, but was 42% above in 1990.
- In 2003 consumption of electricity per dwelling in Ireland was 19% above the EU-15 average.
- In 2003 Ireland's CO_2 emissions (climate corrected) per dwelling were 97% above the EU-15 average.

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1 Introduction

Energy statistics are generally analysed with respect to different energy sources and the individual sectors of the economy that consume energy. This report examines energy consumption within the household or residential sector and complements existing Sustainable Energy Ireland (SEI) reports on energy consumption trends in the industry[1], services[2] and transport[3] sectors.

The residential sector consumes a significant amount of energy in Ireland, accounting for 26% (3,842 ktoe) of Ireland's primary energy consumption in 2004. The sector was responsible for 27% (11,376 kt CO_2) of energy related CO_2 emissions, making it the second largest sector after transport (32%). In 2004 the "average" dwelling was responsible for emitting approximately 8.2 tonnes of CO_2. A total of 5 tonnes CO_2 (61%) was from direct fuel use and the remainder was the result of electricity usage.

The average spend (current prices) on energy per permanently occupied dwelling in 2004 was €1,513, which was an increase of 12% on 2003 and 45% on 1990. In 1990 4.7% of total personal consumption was spent on energy, but this fell to 2.9% by 2003. The total spent on energy by the sector in 2004 was €2.2 billion.

Energy use in the sector includes energy for heating, cooking, cleaning, washing, drying, lighting, cooling and for entertainment (TV, DVD, games consoles etc.). The sector is one where considerable expansion has occurred in recent years. The number of permanently occupied dwellings increased by 43% (2.6% per annum) over the period 1990 to 2004

Given that the sector is responsible for a significant proportion of Ireland's energy requirement and, in turn, energy related emissions there is a clear incentive for policy makers to implement programmes that improve energy efficiency. Timely and comprehensive data on energy trends is needed in order to inform policy development and it is the aim of this report to provide such data.

The purpose of this report is to provide a profile of the residential sector, to track energy consumption and CO_2 emission trends and to analyse the key issues that affect energy consumption in Ireland. In addition to overall residential sector energy consumption and CO_2 emissions trends the following variables are examined in this report:

- Number of Dwellings
- Household Income
- Dwelling Type
- New Build
- Average Household Size
- Occupancy
- Floor Area
- Period of Construction
- Tenure
- Location
- Central Heating
- Fuel Prices and Expenditure on Energy
- Fuel Poverty
- Internal and External Temperature
- Penetration of Electrical Appliances
- Improvements in Energy Efficiency

It is important to note that residential energy statistics in Ireland are collected on a top down basis as a result of energy data received from energy utilities. Energy consumption by individual energy end use application (space heating, hot water, lighting, cooking etc.) is currently not collected but some estimates are made in this report.

In analysing the residential sector the report compiles data from a wide range of sources and new information is also presented. In addition the report identifies key data gaps and suggests areas for further study. This is the first time that such an exercise has been conducted for Ireland.

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[1] SEI 2004. *Profiling Energy Consumption and CO_2 Emissions in Industry 2004 Update. Sensitivity to Energy Price Changes.* http://www.sei.ie/uploads/documents/upload/publications/EPSSU_Industry_report_8nov.pdf

[2] SEI 2005. *Profiling Energy and CO_2 Emissions in the Services Sector* http://www.sei.ie/uploads/documents/upload/publications/Services_Report_2005.pdf

[3] SEI 2003. *Energy and CO_2 Efficiency in Transport. Analysis of new car registrations in year 2000.* http://www.sei.ie/uploads/documents/upload/publications/Transport_Report_11_03.pdf

The report is intended to be a first step in an ongoing process to develop and improve energy statistics in the residential sector.

The report is structured as follows:

- The relevant trends in energy and CO_2 emissions are outlined in section 2 to provide a context for the work.
- Section 3 explores the major policy developments which have, or are intended to have, an impact on energy use and emissions in the residential sector at international, European and national level.
- Section 4 profiles the residential sector and analyses the key issues that affect energy consumption in Ireland.
- Section 5 examines energy intensity trends and trends in energy consumption per dwelling.
- In section 6 trends in the residential sector in Ireland are compared with trends internationally, using data from the EU Odyssee project and Eurostat.
- Finally section 7 presents conclusions and outlines and highlights some of the key data gaps in the sector.

The national energy balance data presented in this report are the most up-to-date at the time of writing. The national energy balance is updated whenever more accurate information is known. The most up-to-date figures can be found on the statistics publications section of the SEI website[4].

Feedback and comment on the report are welcome and should be addressed by post to the address on the rear cover or by email to "epssu@sei.ie".

[4] http://www.sei.ie/content/content.asp?section_id=864

2 Energy and Environmental Context

This section provides an overview of energy and CO_2 emissions trends in Ireland, covering the period 1990 to 2004, with an emphasis on the residential sector. A more detailed discussion of energy trends in Ireland generally for the period 1990 to 2003 is available in a separate SEI publication[5], but more recent data has been included here where possible.

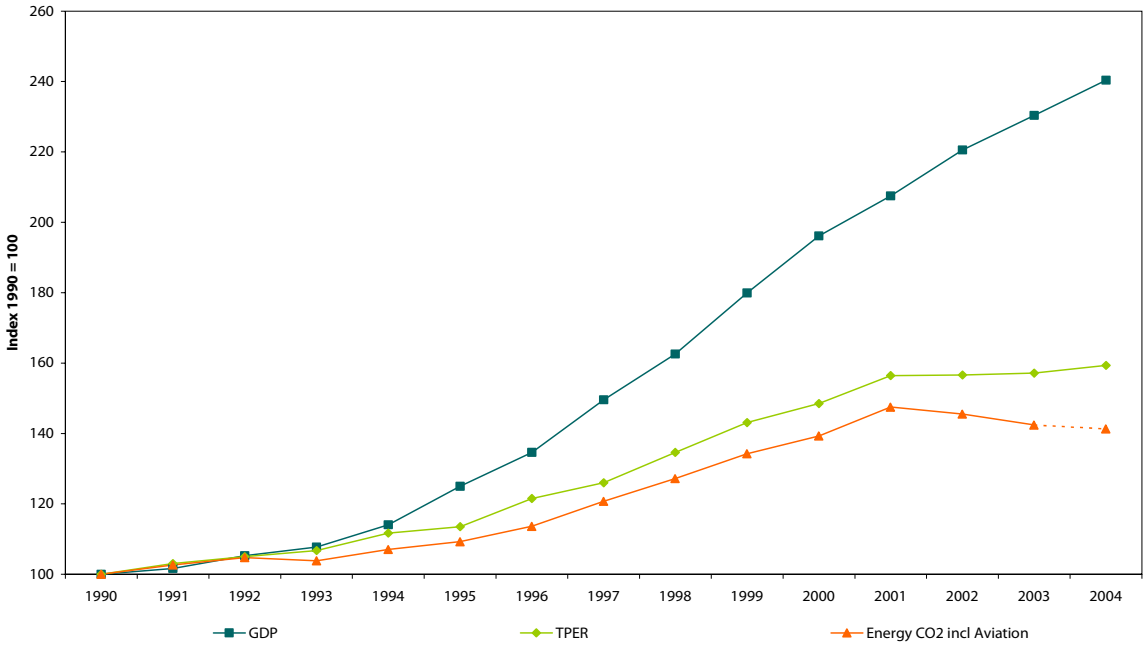
2.1 Energy Trends

Energy supply depends firstly on the demand for energy services and secondly on how that demand is delivered. Energy demand in turn is driven primarily by economic activity. Throughout the 1990s economic growth measured by Gross Domestic Product (GDP[7]) has been particularly strong, especially from 1993 onwards.

Figure 2.1 shows the variations for the period 1990 to 2004 in economic growth, Total Primary Energy Requirement (TPER[8], also known as gross inland consumption) and energy-related carbon dioxide (CO_2) emissions for the whole economy[9]. A decoupling[10] in TPER from GDP at the economy level since 1992 is evident from figure 2.1. Economic growth levels increased by 140% over the period 1990 to 2004 (or 6.5% per annum on average) while TPER increased by 59% (3.4% per annum). The decoupling is a result of changes in the structure of the economy and improvements in energy efficiency. A decoupling in CO_2 emissions and energy consumption trends is also evident from 2001.

In both cases (TPER and CO_2 emissions) a marked decoupling has taken place since 2001. Since 2001 GDP increased by 16% (5% per annum on average) while TPER rose by 5.9% (1.9% per annum) and energy related CO_2 emissions decreased by 4.2% (1.4% per annum). The main factors contributing to this decoupling have been changes in the fuel mix for electricity generation as a result of the commissioning of the new plant and some significant closures in heavy industry.

Figure 2.1: Index of GDP, Primary Energy and Energy-Related CO_2 1990 to 2004



SOURCE: CSO, EPA AND SEI

[5] SEI, 2005. *Energy in Ireland 1990 – 2003 Trends, issues and indicators.* http://www.sei.ie/uploads/documents/upload/publications/Energy_in_Ireland_1990-2003_Final.pdf

[7] GDP is in constant prices to strip out inflationary effects.

[8] Primary energy consumption includes all the fuels used directly by each sector plus the primary energy used to generate electricity attributed to each sector in proportion to its electricity demand.

[9] CO_2 emissions data from 1990 to 2003 is sourced from the EPA while the 2004 figure is an SEI estimate.

[10] The term decoupling in this report is taken to mean a weakening of the relationship, rather than a complete break, between two or more variables.

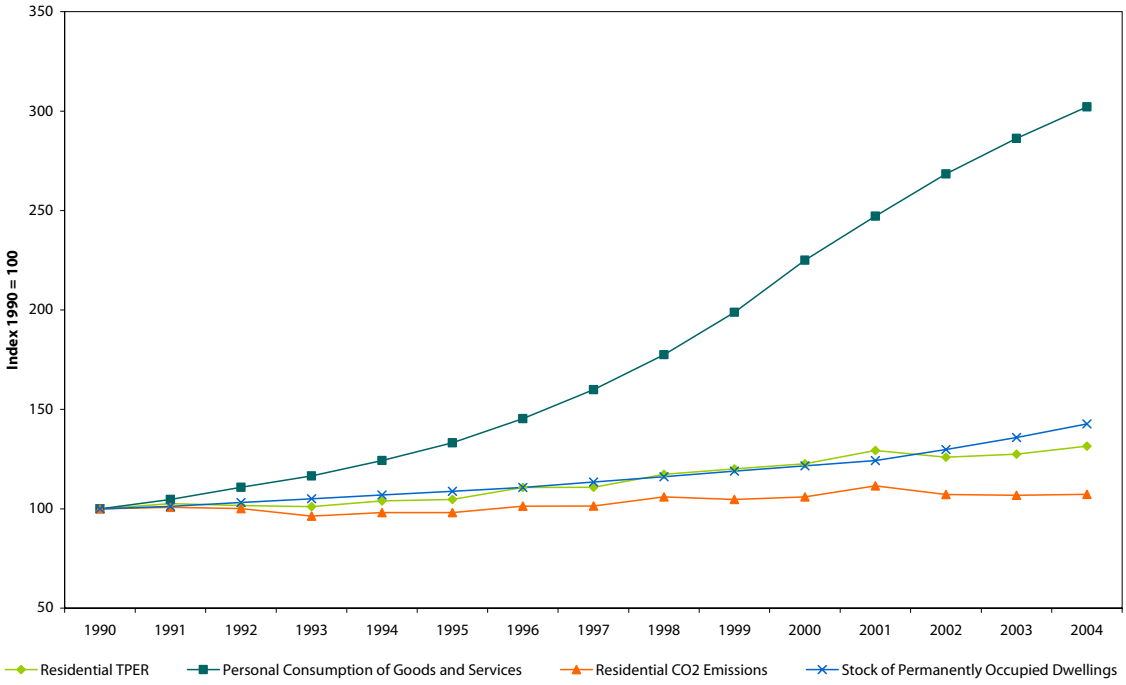
[12] The total of each individual fuel used for electricity generation and oil refining is apportioned to each end use sector according to the final consumption of electricity and oil by that sector.

Turning attention to the residential sector (figure 2.2) it can be seen that the trends in residential energy consumption and related CO_2 emissions are relatively flat when compared with personal consumption of goods and services (aggregate data in current prices), a measure of economic activity in the sector, indicating that there does not appear to be a relationship.

Over the period 1990 to 2004 residential TPER rose by 31% (2% per annum on average), residential energy-related CO_2 emissions increased by 7.3% (0.5% per annum) while personal consumption increased by 202% (8.2% per annum).

Also shown is the trend in permanently occupied dwellings which increased by 43% (2.6% per annum) over the period 1990 to 2004. It can be seen that the trends in permanently occupied dwellings and TPER tracked each other closely over the period with the stock of dwellings increasing at a slightly faster rate, particularly since 2001. There was a noticeable decoupling between the stock of dwellings and residential sector CO_2 emissions over the period.

Figure 2.2: Residential Sector Index of Personal Consumption, Primary Energy, Energy Related CO_2 and Stock of Dwellings 1990 to 2004

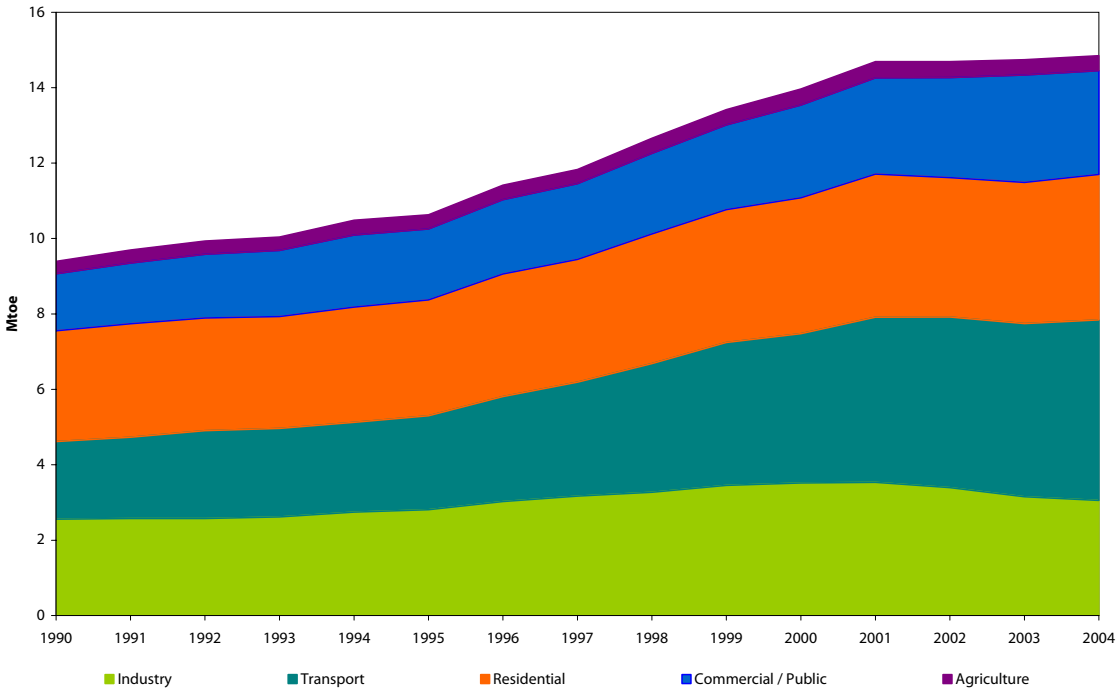


SOURCE: CSO, EPA AND SEI

2.2 Energy Supply

Figure 2.3 shows the trend in Ireland's TPER split according to the five principal sectors of the economy for the period 1990 to 2004. The average annual growth rate in energy consumption within the residential sector during this period was 2%, third in terms of growth rate after transport (6.2%) and the services sector (4.4%).

Figure 2.3: Total Primary Energy Requirement by Sector 1990 to 2004



SOURCE: SEI

The residential sector's relative share of TPER has decreased from 31% (2,938 ktoe) in 1990 to 26% (3,842 ktoe) in 2004.

Figure 2.4 shows Ireland's residential sector energy balance for 2004 as an energy flow diagram. Fuel inputs on the left totalled 3,842 ktoe and include the fuels [12] used to generate the electricity consumed by the sector. The energy transformation losses (mostly electricity generation) amounted to 937 ktoe (or 24% of residential TPER) resulting in the final energy consumption of the residential sector in 2004 reaching 2,886 ktoe. This represents 25% of Ireland's Total Final Consumption (TFC, this is the final energy consumed in industry, transport, agriculture and the services sector), and is the amount of energy for which households within the sector are billed directly[13].

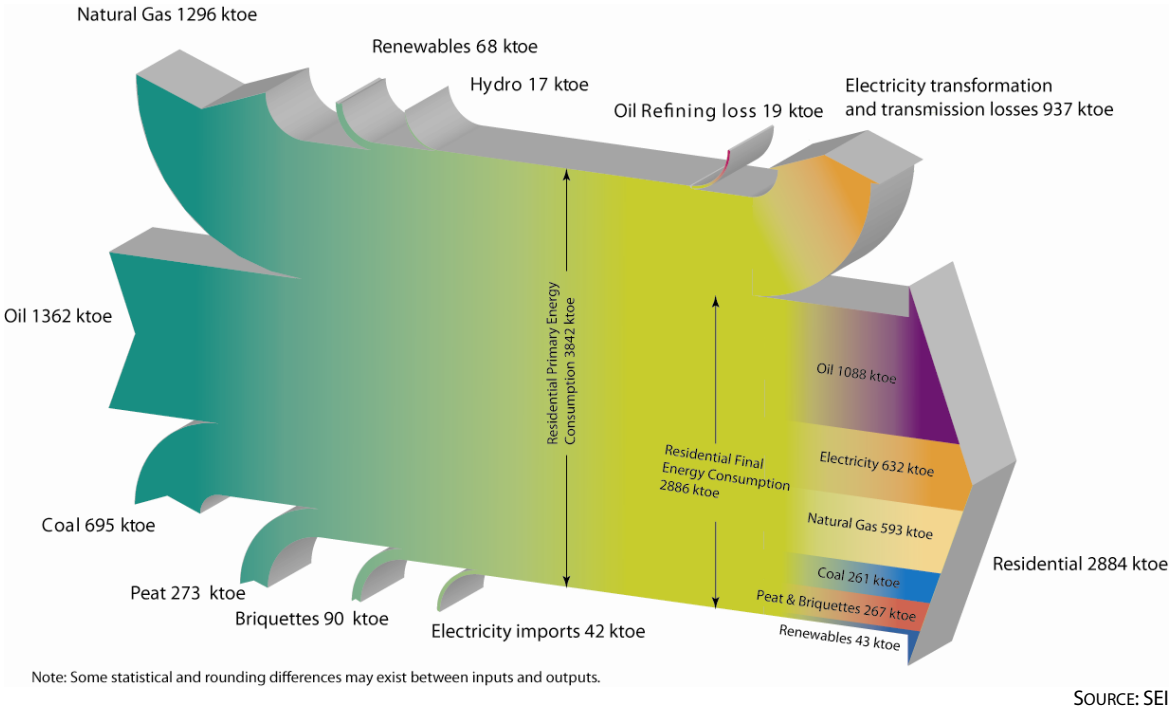
Referring again to figure 2.4 the significant dependence on oil (38% of residential sector TFC) and natural gas (21%) is noticeable as is the low penetration of renewable energy sources (1.5% of TFC).

Over the period 1990 to 2004 final energy consumption in the residential sector grew by 32%. For the other sectors the increases in final consumption were as follows:

- Industry 25%,
- Services 70% and
- Transport 132%.

[13] TFC is essentially TPER less the quantities of energy required to transform and distribute primary sources such as crude oil into forms suitable for use by consumers such as refined oils and electricity.

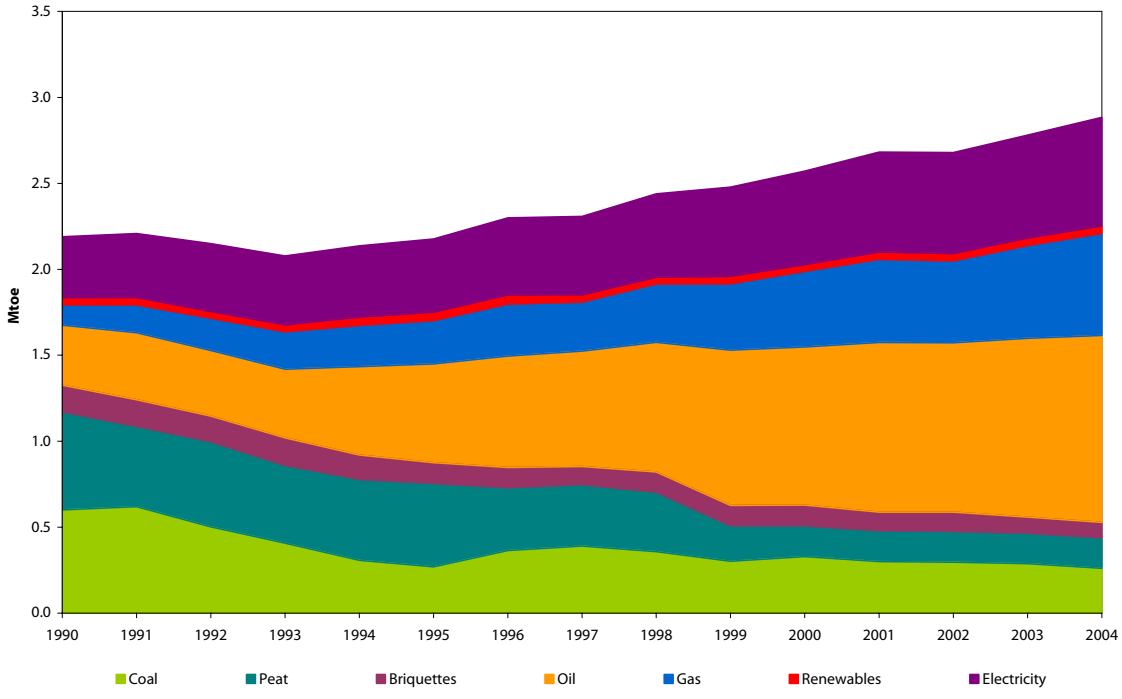
Figure 2.4: Residential Sector Energy Balance 2004



SOURCE: SEI

Figure 2.5 shows the fuel mix contributing to the overall energy bill of the residential sector for the period 1990 to 2004.

Figure 2.5: Residential Sector Total Final Energy Consumption by Fuel 1990 to 2004



SOURCE: SEI

Growth rates for each fuel are shown in table 2.1 and it can be seen that gas experienced the biggest growth rate over the period (12% per annum on average) followed by oil[14] (8.5% per annum) and to a lesser extent electricity (4.2% per annum). Solid fuels (coal, peat and briquettes) all declined over the period.

[14] It is important to point out that oil includes LPG.

This reflects a significant change in the fuel mix over the period. Table 2.1 also shows the shares for 1990 and 2004. In 1990 coal and peat were responsible for, respectively, 27% and 26% of total energy consumption in the residential sector. In 2004 coal and peat had declined to 9.1% and 6.1% of TFC in the residential sector.

Meanwhile the shares of oil and gas increased from, respectively, 16% and 5.4% to 38% and 21%. Electricity also increased its share of residential sector TFC from 16% in 1990 to 22% in 2004.

Due to the differences in energy conversion efficiencies associated with the different fuels, coupled with the differences in carbon content of fuels utilised, the energy use in the residential sector has become increasingly less CO_2 intensive since 1990.

Table 2.1: Growth Rates and Shares of Final Energy Consumption in the Residential Sector

	Growth %	Average Annual Growth Rates %		Shares[16] %	
	1990 – '04	**1990 – '04**	**2004**	**1990**	**2004**
Oil	211.7	8.5	5.6	15.9	*37.7*
Gas	405.7	12	10	5.4	*20.6*
Electricity	77.6	4.2	5.4	16.2	*21.9*
Coal	-56.5	-5.8	-9.2	27.4	*9.1*
Peat	-69	-8	0	26	*6.1*
Briquettes	-42.2	-3.8	-4.1	7.1	*3.1*
Renewables	2.2	0.2	0	1.9	*1.5*
Total	31.7	2.0	4.1		

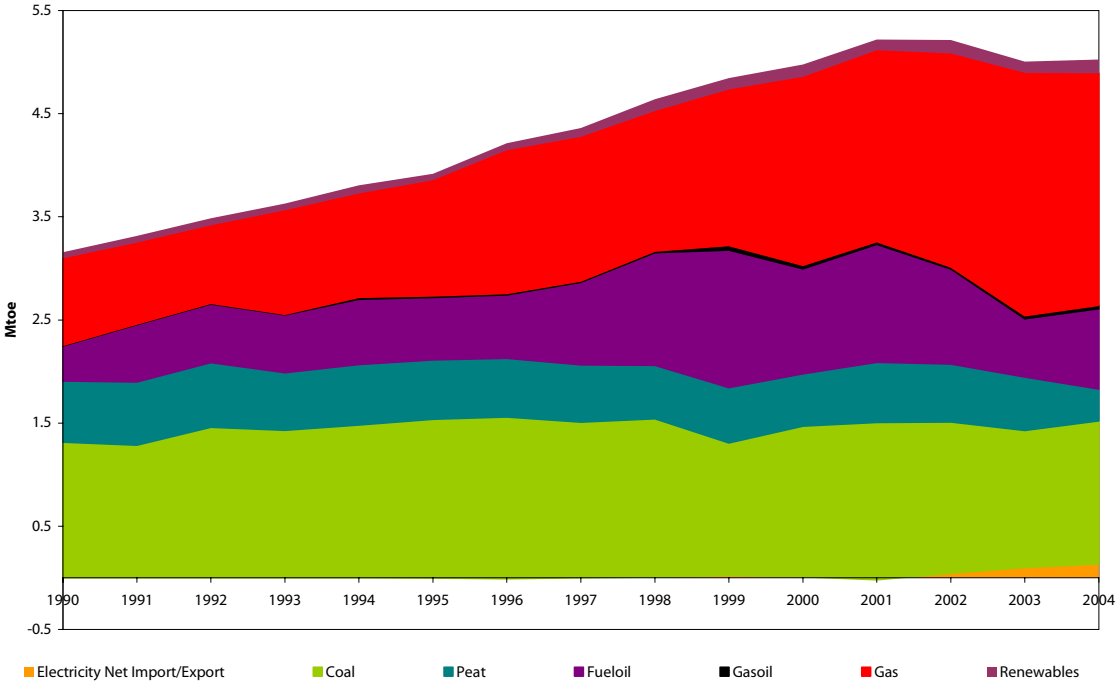
SOURCE: SEI

At this point it is useful to examine the fuel mix of electricity generation as this has important implications for CO_2 emissions. If fuels with lower carbon content, such as gas, are used to generate electricity at the expense of coal, peat and oil for example, emissions of CO_2 will decrease for a given level of electricity production. The method used to generate electricity will also have an impact. Newer combined cycle gas turbines have higher efficiencies than traditional single cycle generating systems using coal, oil or peat.

Figure 2.6 presents the primary fuel mix of electricity generation for the period 1990 to 2004. The increasing importance of gas is particularly noticeable and much of the increase in electricity generation, seen in figure 2.5 and table 2.1 is fuelled by gas. In 1990 gas was responsible for 27% of the primary fuel input into electricity generation. This has increased to 45% in 2004. Meanwhile the shares for coal and peat declined from 42% and 19% respectively in 1990 to 28% and 6.1% in 2004.

[16] Totals in table 2.1 and throughout this report may not sum to 100% as a result of rounding errors.

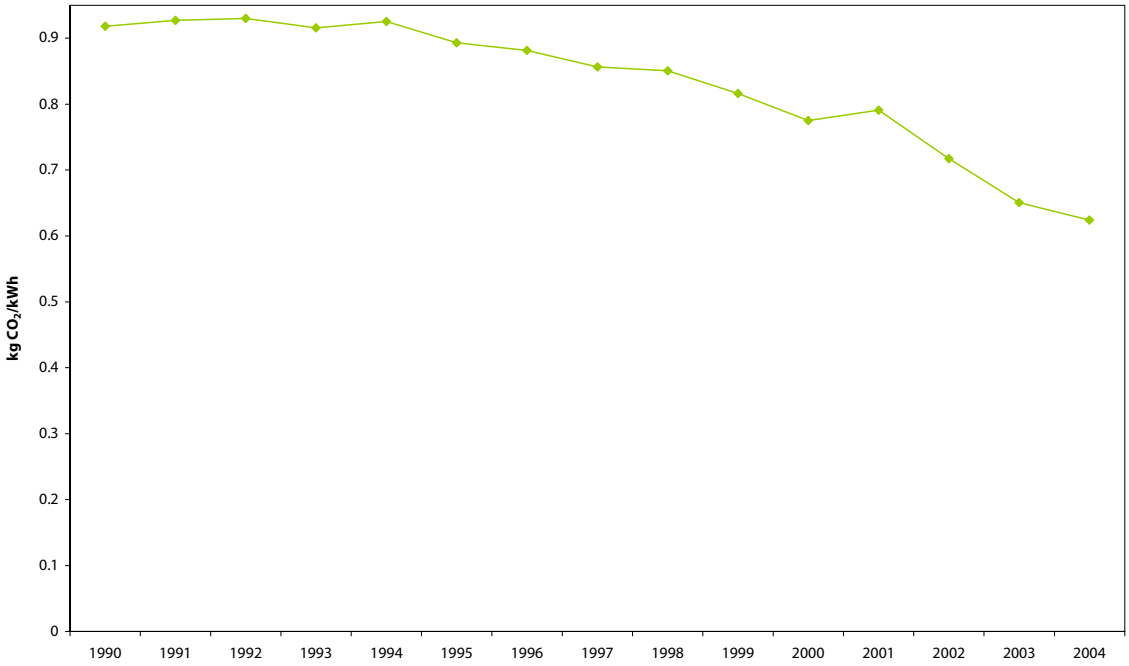
Figure 2.6: Electricity Primary Fuel Mix 1990 to 2004



SOURCE: SEI

The switch to "cleaner" fuels and more efficient electricity generation can be seen in the trend in CO_2 intensity of electricity supplied, figure 2.7. There has been a significant reduction over the period 1990 to 2004. Since 1990 the share of high carbon content fuels such as coal have been reducing with a corresponding rise in the low carbon fuel natural gas, relatively low carbon fuel oil and very low zero carbon renewables. This resulted in the carbon intensity of electricity dropping from 918 g CO_2/kWh in 1990 to 624 g CO_2/kWh in 2004.

Figure 2.7: CO_2 Emissions per kWh of Electricity Supplied

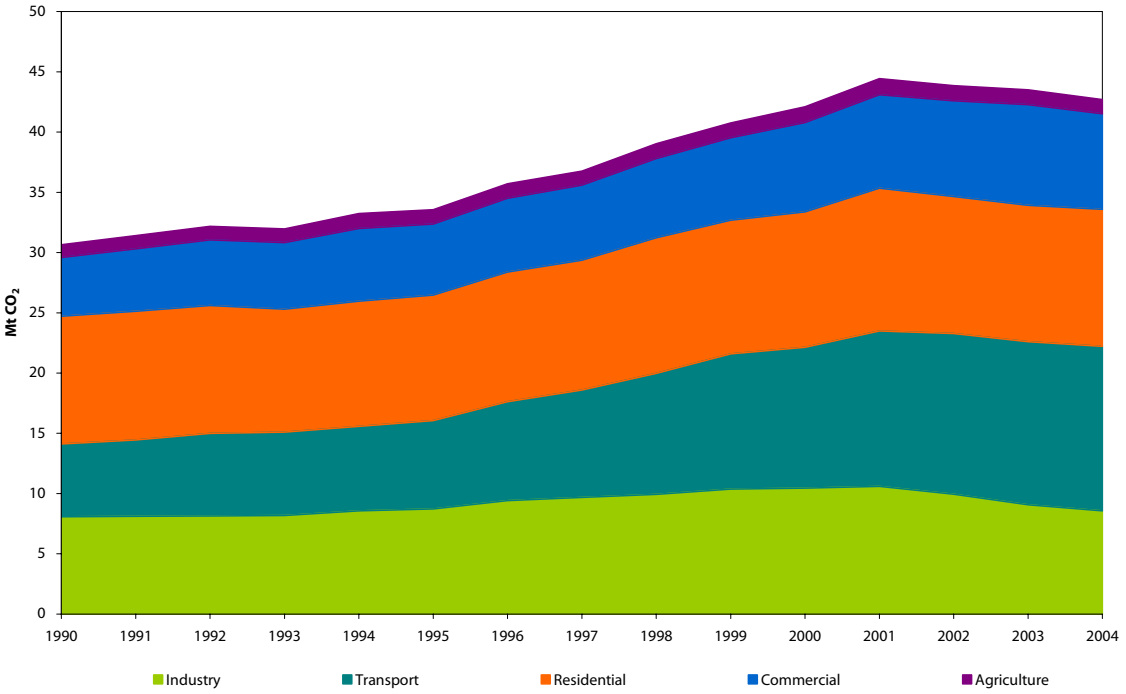


SOURCE: SEI

2.3 Environmental Impact

The increase in energy consumption across the Irish economy since 1990 has resulted in a significant growth in energy-related CO_2 emissions[17]. Figure 2.8 illustrates the sectoral breakdown of energy-related CO_2 emissions, which have increased by 41% overall (2.5% per annum on average) during the period 1990 to 2004 having peaked in 2001 at 46% above 1990 levels. Emissions associated with electricity generation and supply are attributed here to the final consuming sectors, according to their proportion of electricity final consumption.

Figure 2.8: Energy-Related CO_2 Emissions by Sector 1990 to 2004



SOURCE: SEI

The noticeable reduction in energy-related emissions since 2001 is principally due to the increased efficiency of electricity generation, particularly as a result of the two large scale combined cycle gas turbines (CCGT) that were commissioned in 2002. These new generators are less CO_2 intensive due to their higher efficiency and also because they use fuel with a lower carbon content.

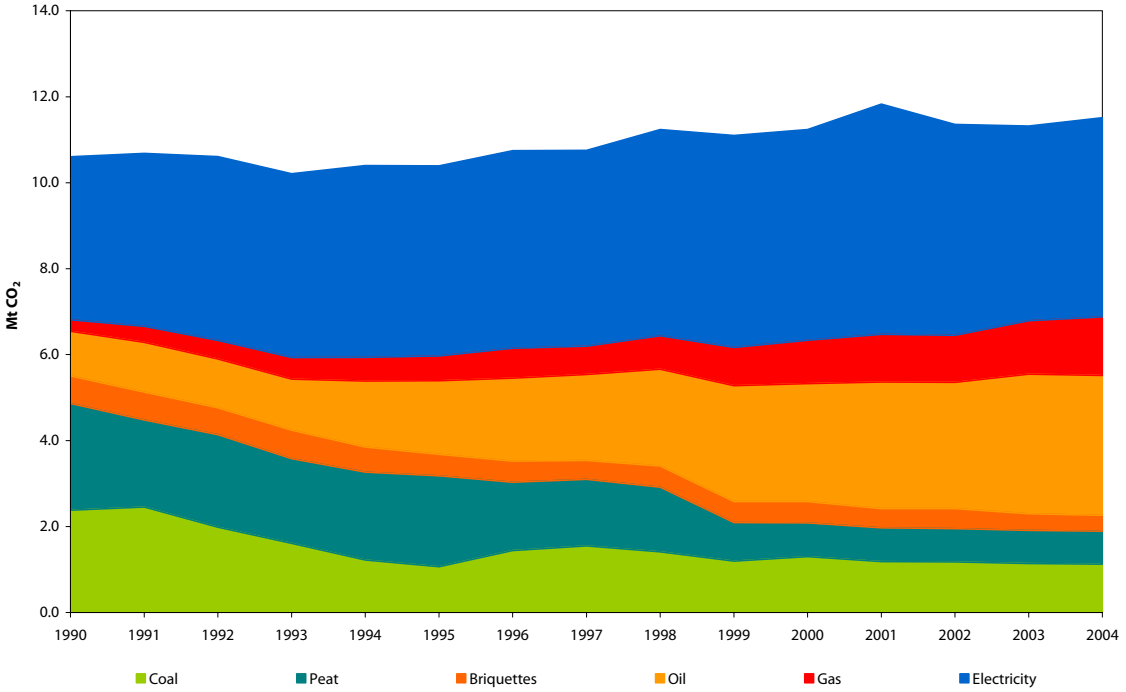
In 2004 residential sector energy-related CO_2 emissions were 11,376 kt CO_2 representing 27% of the total. The residential sector was the second largest after transport (32%).

Over the period 1990 to 2004 CO_2 emissions from the residential sector increased by 7.3% (0.5% on average per annum) while transport, services, industry and agriculture respectively increased by 133% (6.3% per annum), 62% (3.5% per annum), 6.1% (0.4% per annum) and 12.6% (0.9% per annum).

The residential sector is specifically examined in more detail with respect to energy-related CO_2 emissions in figure 2.9 and the relatively constant or flat, overall trend can be seen. While final energy consumption in the sector increased by 32% over the period, its energy-related CO_2 emissions increased by 7.3%, illustrating the effect of the changing fuel mix on energy related emissions.

[17] CO_2 emissions accounted for 96% of energy-related greenhouse gases (GHG) in 2003, the other 4% being accounted for by energy-related nitrous oxide (N_2O) and methane (CH_4). Energy consumption in all sectors in 2003, accounted for 66% of all GHG emissions.

Figure 2.9: Residential Sector Energy-Related CO_2 Emissions by Fuel 1990 to 2004



SOURCE: SEI

3 Energy and the Residential Sector

The significant growth in energy consumption and related environmental emissions over many years has raised concerns regarding energy's contribution[18] to climate change and air quality. Governments and policy makers are responding by introducing policies and measures designed to manage energy more effectively and mitigate against increased human impact on the environment.

An additional aspect of national policy in the residential sector is consideration of the need to improve people's living standards and ensure adequate comfort levels, which includes combating fuel poverty. This report, for the most part, is concerned with the former set of policies and measures.

This section identifies the major policy developments which have evolved at global, European and national level that have had an impact on the residential sector.

3.1 Global Developments

The Intergovernmental Panel on Climate Change (IPCC) was established in 1988 as an independent body under the auspices of the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO). This reflected the consensus amongst Governments that the issue of climate change needed to be investigated impartially by an independent body. The IPCC presented its First Assessment Report published in 1990[19]. The report reflected the views of hundreds of experts and stated that 60% to 80% cuts in greenhouse gas (GHG) emissions would be needed to stabilise the current level of greenhouse gases in the atmosphere.

In 1992 the UN organised a Conference on Environment and Development (UNCED, also known as the Earth Summit), which was held in Rio de Janeiro. The IPCC provided evidence to the Summit of the threat posed by climate change, thereby playing a key role in Governments agreeing the text of the United Nations Framework Convention on Climate Change (UNFCCC) in May 1992.

3.1.1 The Kyoto Protocol

This target was enhanced in 1997 through the Kyoto Protocol[20], whereby individual industrialised countries agreed to quantified GHG emission reductions that would result in an overall reduction for Annex 1 countries[21] of 5.2% below 1990 levels by the period 1998 to 2012. The Protocol assigns a specific target to each country. For example Iceland is committed to a limiting growth to 10% above 1990 levels, while the EU has agreed to an 8% reduction on 1990 levels (see section 3.2.1). The combined impact of the individual targets would then achieve the overall 5.2% target for the industrialised countries.

The Kyoto Protocol entered into force on February 16th 2005, following the ratification of the Protocol by Russia in November 2004. The targets then became legally binding for the 37 (of the 41[22]) Annex 1 parties that ratified the Protocol. As a result the proposed reduction on 1990 levels will now be less than 5.2% mentioned above. If a party to the agreement does not meet its Kyoto target by 2012 they may face[23] a *"deduction from the Party's assigned amount for the second commitment period of a number of tonnes equal to 1.3 times the amount in tonnes of excess emissions"*. This may have significant financial implications, depending on the level of the breach.

Consideration of the successor agreement to the Kyoto Protocol is scheduled to begin in late 2005 at a meeting of the parties (MoP) in Montreal.

[18] Energy was responsible for 72% of GHG emissions and 59% of transboundary gases in 2003. The 2003 figure for transboundary gases is sourced from the EPA.
[19] Intergovernmental Panel on Climate Change, 1990. *First Assessment Report.* See http://www.ipcc.ch for more information.
[20] UNFCCC, 1997. *The Kyoto Protocol.* http://unfccc.int/resource/docs/convkp/kpeng.pdf
[21] Annex 1 Parties are industrialised countries (OECD members and Economies in Transition), which have historically emitted the most GHG. Currently there are 41 Annex 1 countries.
[22] Australia, Croatia, Monaco and the USA have not ratified the Protocol.
[23] United Nations Framework Convention on Climate Change, 2002. *Procedures and mechanisms relating to compliance under the Kyoto Protocol.* Report from COP 7, Marrakech October 29th – November 10th 2001 page 76 (FCCC/CP/2001/13/Add.3).

3.2 European Policy

3.2.1 Burden Sharing Agreement

The EU target under the Kyoto Protocol is to achieve an 8% reduction in GHG emissions on 1990 levels by the period 2008 to 2012. Council Decision 2002/358[24] stipulates the targets for individual Member States according to a Burden Sharing Agreement. The UK for example has committed to reducing its emissions by 12.5% while Greece will be allowed to increase its emissions to 25% above 1990 levels. Individual national targets reflect a number of factors, including the country's historical emissions and the stage of development of its economy in the base year. The target for Ireland is 13% above 1990 levels (see section 3.3.2).

3.2.2 Energy Performance of Buildings Directive

Directive 2002/91/EC on the energy performance of buildings[27] responds to the key role buildings play in the consumption of energy. The Directive, known as EPBD, applies to the built environment as a whole but only the provisions relating to the residential sector are discussed in this report. The main provisions relevant to the residential sector are:

- It sets out a general framework methodology for calculating the energy performance of buildings. Provision is made for a review of this methodology;
- It requires Member States to set minimum energy performance standards (both for new build and major refurbishment) using a methodology based upon the general framework methodology. These standards are to be reviewed regularly;
- For almost all buildings, an energy performance certificate (or energy rating) is to be supplied by the owner to a prospective buyer or tenant when constructed, sold or rented. This certificate may include a CO_2 indicator;
- The Certificate is to be accompanied by recommendations for cost-effective improvements to energy performance. (However there will be no legal obligation on vendors or prospective purchasers to carry out the recommended improvements);
- It requires measures to be taken to improve the energy efficiency of boilers fired by non-renewable liquid or solid fuel, and of older heating systems.

The Directive must be legally transposed in Member Sates by 4th January 2006 but Member States have the option of an additional 3 year period to apply the provisions on energy performance certificates[25]. Details of the proposed Irish response to this directive are discussed in section 3.3.7.

3.2.3 Minimum Efficiency Requirements[26]

The EC has also introduced minimum efficiency requirements, the aim of which is to lower energy consumption of household appliances by improving product design. These standards currently apply to new oil and gas heating boilers, household electric refrigerators, freezers and fluorescent lighting.

The boiler efficiency Directive[27] is a particularly important policy document for the residential sector given the large number and energy requirement of household boilers. The Directive determines the essential requirements to be met by new hot-water boilers fired with liquid or gaseous fuels with a rated output of no less than 4 kW and no more than 400 kW.

3.2.4 Labelling

The European Commission (EC) introduced a framework Directive for labelling residential appliances in 1992, the aim being to increase consumer awareness by explicitly stating on a label the tested energy use of the appliance. This facilitates comparisons of different models based on energy, and associated economic, performance. A number of separate Directives have brought into force the intent of the original Directive since 1992 covering following appliances: electric refrigerators, freezers, electric ovens, oil and gas boliers, air conditioning units, lamps, dishwashers, washer-driers, tumble driers and washing machines.

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[24] European Union, 2002. *Decision 2002/358/EC on an EU Burden Sharing Agreement.* *http://europa.eu.int/eur-lex/pri/en/oj/dat/2002/l_130/l_13020020515en00010020.pdf*

[25] SEI, September 2004. *Note on EU Directive on Energy Performance of Buildings* http://www.sei.ie/uploads/documents/upload/publications/EPBD-note-Sept_04.pdf

[26] Full details on labelling and minimum efficiency requirements are available directly from http://europa.eu.int/comm/enterprise/electr_equipment/legislat.htm

[27] European Union, 1992. *Directive on the Efficiency Requirements for New Hot-Water Boilers Fired With Liquid or Gaseous Fuels.* http://europa.eu.int/scadplus/leg/en/lvb/l21019.htm

The EC in its Green Paper on Energy Efficiency (2005)[29] signalled its intent to increase the number of appliances covered by labelling.

In addition a consortium of appliance manufacturers has made voluntary agreements with the EC covering the cessation of production of grade E, F and G washing machines as well as including energy efficiency labels on televisions and video players.

3.2.5 Green Paper on Energy Efficiency[30]

The EC published a wide ranging Green Paper on Energy Efficiency on the 10th June 2005. The Green Paper outlines the reasons for promoting energy efficiency and proposes a series of actions for discussion and comment by interested parties.

The Paper states that it is possible to achieve savings of 20% by 2010 if appropriate initiatives are implemented. Table 3.1 gives a general indication of the potential cost effective savings by 2020 from various initiatives. It can be seen that the largest proportion (32%) of potential savings is expected to come from the built environment, which includes the residential sector.

Table 3.1: Green Paper on Energy Efficiency - Potential Savings EU -25

Potential Savings by 2020	Mtoe
Buildings: Heating and Cooling	41
Electrical Appliances	15
Industry	16
Transport	45
CHP	40
Other Energy Transformation, etc.	33
Total Energy Savings	190

Source: Green Paper on Energy Efficiency

3.2.6 Air Quality

The first international agreement on air quality was agreed at a ministerial level meeting was held in Geneva in 1979, which was organised by the UN Economic Commission for Europe (UNECE). The meeting resulted in the signature of the Convention on Long-range Transboundary Air Pollution by 34 Governments and the European Community (EC).

In June 1999 the European Commission presented a proposal for a directive setting national emission ceilings (NECs) for four air pollutants that cause acidification and the formation of ground-level ozone: sulphur dioxide (SO_2), nitrogen oxides (NO_x), volatile organic compounds (VOCs), and ammonia (NH_3). After two years of negotiation, Directive 2001/81/EC, the 'National Emissions Ceiling Directive' (NEC[31]) was adopted by the Council of Ministers and the European Parliament in July 2001.

The aim of the directive is to gradually improve, through a stepwise reduction of the four pollutants, the protection both of human health and the environment throughout the EU. By means of EU strategies to combat acidification and ground-level ozone, the directive establishes interim environmental quality targets that are to be attained by 2010. Ireland's obligations under NEC Directive are detailed in section 3.3.3.

3.2.7 EU Emissions Trading Directive

The Kyoto Protocol established a number of mechanisms that a party may use to help meet its emissions target, provided that it is complying with its methodological and reporting obligations under the Protocol. Emissions trading between United Nations Framework Convention on Climate Change (UNFCCC) Annex 1 parties under the International Emissions Trading (IET) scheme is one of the mechanisms provided.

The scheme will not be in operation until 2008 but in advance, Directive 2003/87/EC[32] established a pilot, EU-wide IET scheme, which came into effect in all EU member states on 1st January 2005. The Directive applies to all

[29] European Union, 2005. *Green Paper on Energy Efficiency*. The full text of the Green paper or a summary can be found at http://europa.eu.int/comm/energy/efficiency/index_en.htm
[30] Ibid.
[31] Available from http://europa.eu.int/eur-lex/pri/en/oj/dat/2001/l_309/l_30920011127en00220030.pdf
[32] European Union, 2003. *Directive 2003/87/EC of the European Parliament and of the council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC*.

combustion installations across the EU with a rated thermal input exceeding 20 MW as well as a range of other sites with activities such as steel and cement production, paper, ceramics and glass manufacturing. The scheme is expected to cover 45% to 50% of the EU's total CO_2 emissions.

While this measure does not directly apply to the residential sector the IET scheme has the potential to have a significant impact on residential sector emissions through price signals stimulating reduced carbon intensity of electricity generation.

Other policies, proposals and supporting measures that impact on energy consumption in the residential sector include additional proposals relating to energy efficiency, the EU 6th Framework Programme support for energy research, development and demonstration projects and the EU Intelligent Energy in Europe programme supporting analysis and promotional activities.

3.3 Irish Policy

3.3.1 Green Paper on Sustainable Energy

The Government's Green Paper on Sustainable Energy published in 1999[33] presented growth projections for energy consumption up to 2010 and set out a number of options for meeting our energy requirements in a more environmentally and economically sustainable way.

The Green Paper highlights the significant part the residential sector has to play in energy efficiency and management. It forecasts that by 2010, without intervention, that housings built before 1981 (i.e. those which have the least energy efficiency) will account for 47% of the housing stock but will account for 79% of energy use for heating and hot water in the residential sector. The rate of growth in the sector has exceeded the forecasts in the Green Paper and newer data from section 4.5 of this report shows that 53% of the housing stock was built before 1981.

In order to address this disparity the Green Paper suggests a programme of energy labelling for dwellings when they are sold and this is especially aimed at pre 1980s housing. Other recommendations to improve energy efficiency include economic and regulatory instruments, information and awareness campaigns and funding of relevant research. Some of these recommendations have been addressed by Ireland's response to the Energy Performance of Buildings Directive (see section 3.3.6).

3.3.2 Response to Kyoto

Ireland ratified the UNFCCC on 20th April 1994 and the Kyoto Protocol to the UNFCCC on the 31st May 2002. Ireland's target under the Protocol arising from the EU Burden Sharing Agreement is to limit annual GHG emissions to 13% above 1990 levels by the period 2008 to 2012. Ireland's national target reflects a number of factors, including the relatively underdeveloped state of the economy in the base year (1990), as well as subsequent economic growth levels, available projections of GHG emissions at the time of the agreement and anticipated wealth by the commitment period.

As shown in figure 3.1, Ireland's limit for the period 2008 to 2012 under the Kyoto Protocol was reached in 1997. By 2001, emissions levels reached 31% above 1990 levels, and this was followed by a reduction in emissions since then. Based on EPA data, Ireland's GHG emissions[34] in 2003 were 25.3% above 1990 levels. Given that energy consumption in 2002 and 2003 remained at 2001 levels this constitutes a significant decoupling of emissions growth from energy growth. This is largely attributed to fuel mix changes associated with the increased consumption of gas and renewable energy, which are less carbon intensive than oil and the solid fuels. In 2001, the most recent year for which comparable data are available, Spain, Portugal and Monaco were the only Annex 1 countries at a higher level than Ireland compared to the base year and their emissions had increased by 33%, 36% and 41% respectively[35].

Ireland is working towards its Kyoto target through a wide range of policies and measures and also with the aid of European initiatives such as the Energy Performance of Buildings Directive and the EU Emissions Trading Directive (Directive 2003/87/EC). The proposed Irish response to the Buildings Directive is discussed in section 3.3.7. The Environmental Protection Agency (EPA) is responsible for key elements of the response to the Emissions Trading Directive[36] and has published a National Allocation Plan (NAP) which indicates:

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http://europa.eu.int/eur-lex/pri/en/oj/dat/2003/l_275/l_27520031025en00320046.pdf

[33] Government of Ireland, 1999. *Green Paper on Sustainable Energy.* http://www.dcmnr.gov.ie/Energy/

[34] Energy consumption, required to meet our demand for electricity, heating (and cooling) and transportation, was responsible for 58% of Ireland's GHG emissions in 1990, rising to 66% in 2003.

[35] UNFCCC, 2004. *United Nations Framework Convention on Climate Change - The First Ten Years.* http://unfccc.int/files/essential_background/background_publications_htmlpdf/application/pdf/first_ten_years_unfccc.pdf

[36] Full details of the Emissions Trading Scheme and the Irish response can be found at http://www.epa.ie/Licensing/EmissionsTrading.

- The proportion of national emissions that will be assigned by the Government to emissions trading and
- The portion assigned to emissions trading that will be distributed among those covered by the scheme.

Figure 3.1: Greenhouse Gas Emissions in Ireland 1990 to 2003

SOURCE: EPA[38]

3.3.3 Air Quality

As mentioned in section 3.2.6, Ireland has obligations relating to Transboundary Gas emissions under the NEC Directive. Table 3.2 compares 2003 and 1990 values for SO_2 and NO_x together with the emissions limits for the year 2010, which emphasises the challenge ahead. Emissions from the residential sector are also included and it can be seen that account for a small proportion of the total, 4.1% of NO_X and 16% of SO_2 in 2003. Most of the emissions from the residential sector are attributable to the burning of fossil fuels.

Table 3.2: SO_2 and NO_x Emissions and NEC Directive Ceilings for 2010

	1990 (kt)	2003 (kt)	2010 Ceiling (kt)	Residential Sector Emissions in 2003 (kt)
NO_X	115	120	65	5
SO_2	178	76	42	12

Source: EPA

3.3.4 National Climate Change Strategy

In October 2000 the Government published the National Climate Change Strategy[39] (NCCS). This strategy provides a framework for achieving GHG emissions reductions in the most efficient and equitable manner while continuing to support economic growth. The NCCS projects that in the absence of the measures detailed in the strategy, Ireland is likely to overshoot the Kyoto target by up to 13 Mt CO_2 and will reach 74 Mt CO_2 (or 37%) by 2010.

[38] EPA, 2003. *Ireland National Greenhouse Gas Inventory Report*. See www.epa.ie for more details.
[39] Government of Ireland, 2000. *National Climate Change Strategy*. The National Climate Change Strategy may be accessed at www.environ.i.e./environ/envindex.html and click on "climate".

The residential sector is linked to the wider built environment sector in the NCCS and the strategy targets a 0.9 Mt CO_2 reduction in emissions that is to be achieved through energy efficiency measures in the sector. Three key areas are identified in the NCCS with regard to the built environment sector:

- Increasing efficiency in new homes through revisions of the Building Regulations (0.25 Mt CO_2 saving),
- Energy efficiency improvements in the existing stock (0.4 Mt CO_2 saving),
- Fuel switching to "cleaner" fuels (0.25 Mt CO_2 saving).

The NCCS also reiterates the proposal set out in the Green Paper for an energy efficiency certificate.

A progress report on the implementation of the NCCS published in May 2002[40] provides details of the updated Building Regulations and projects that as a result of their introduction (on current patterns of fuel use) there will be a reduction of 300,000 tonnes CO_2 per annum through 2012 as opposed to the 250,000 tonnes set out in the strategy.

3.3.5 Building Requirements / Regulations[41]

Before 1976 there were no specific requirements or regulations aimed at limiting energy use in buildings. In 1976 the first requirements (in the form of "Draft Building Regulations") were introduced setting insulation standards for all state funded-housing. These took the form of specific requirements for the maximum allowable rate of heat loss (maximum U-value) through walls, roofs and floors and an overall allowable value for the building as a whole[42].

These requirements were superseded by expanded versions, to include all new build, and revised in iterations in 1979, 1982 and 1992 when energy legislations were ultimately introduced. The most recent revision was signed into law by the Minister for the Environment and Local Government on the 6th June 2002 amending Part L of the Building Regulations. The new regulations enhance insulation requirement for new dwellings and for retrofitting of existing buildings on or after 1st July 2002.

Proposals for a further upgrade of Part L standards for non-residential buildings were published for public/ industry comment in mid 2004[43].

It is important to note that the Building Regulations only apply to new buildings, extensions and material alterations.

3.3.6 Labelling and Minimum Efficiency Requirements

The minimum efficiency standards and requirements for labelling discussed in sections 3.2.3 and 3.2.4 have been transposed into Irish law.

Retail outlets are inspected on a regular basis to check if they are complying with the energy labelling regulations.

3.3.7 Proposed Response to the Energy Performance of Buildings Directive

Ireland's proposed response to the Energy Performance of Buildings Directive (EPBD) is contained in a Draft Action Plan[44] which has been prepared by an Inter Departmental Working Group, comprising officials of the Department of the Environment, Heritage and Local Government (DEHLG), Department of Communications, Marine and Natural Resources (DCMNR), and Sustainable Energy Ireland (SEI). The draft action plan consultation period for the EPBD ran from 29th April to 29th July 2005. SEI has a lead role in supporting and funding the development of practical measures required for implementation of the EPBD.

A key measure set out in the Directive (section 3.2.2) and carried forward in the Draft Action Plan is a requirement for a Building Energy Rating (BER) certificate (effectively an energy label) at the point of sale or rental of a building, or on completion of a new building. SEI's Home Energy Rating programme (the objective of which was to find ways to make energy efficiency in homes explicit and transparent) has been expanded considerably to embrace the requirements of the EPBD.

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[40] Government of Ireland, 2002. *Progress Report on the Implementation of the National Climate Change Strategy*. http://www.environ.ie/DOEI/doeipub.nsf/0/fecdecefd52bc7bc80256b76005db5ee/$FILE/ccrpt2%5B1%5D.pdf

[41] More information on various iterations of the Building Regulation can be found at http://www.environ.ie/DOEI/DOEIPol.nsf/wvNavView/wwdConstruction?OpenDocument&Lang=en

[42] Environmental Research Unit, 1992. *Review of Building Energy Use and Related CO_2 Emissions*

[43] Full details of the proposed amendments and the consultation process are available at http://www.environ.ie/DOEI/DOEIPub.nsf/0/59ef0c8667f7af1780256f0f003dbdd0?OpenDocument

[44] A copy of the Action Plan is available at http://www.sei.ie/content/content.asp?section_id=1424

It is proposed that the BER requirement will apply to:

- New residential buildings from (1 January 2007),
- Other new buildings (including non-residential buildings and public service buildings) from 1 January 2008,
- Existing buildings (including existing residential and non-residential buildings when sold or let, and large public service buildings) from (1 January 2009).

The proposals for a further review of Part L of the Building Regulations mentioned above (section 3.3.4) are a requirement of the Directive. Furthermore, revised minimum standards for new build and major refurbishment of existing buildings must be reviewed at least every five years.

To provide access to the full community of interests in relation to news, reference material, discussion, consultation documents and other information, a dedicated national EPBD website (www.epbd.ie) has been established.

3.3.8 Fuel Poverty

The issue of fuel poverty is one which has important implications for health, quality of life and energy efficiency. It has been defined as the "*inability to heat one's home to an adequate, i.e. safe and comfortable, temperature owing to low income and poor, energy inefficient housing*[45]." A quantitative definition often used[46] is the need to spend more than 10% of net household income on fuel to achieve an acceptable level of comfort and amenity. Fuel poor homes often use solid fuels and stand alone heaters as opposed to more efficient central heating units and cleaner fuels such as oil and gas[47]. Healy and Clinch[48] found that in 2001 there were 62,000 households in Ireland which experience persistent fuel poverty while a further 165,000 are subject fuel poverty intermittently.

A number of studies such as "Homes for the 21st Century"[49] and "A Review of Fuel Poverty and Low Income Housing"[50] have examined the issue of fuel poverty in greater detail and Homes for the 21st Century indicated that fuel poverty levels in Ireland are amongst the highest in northern Europe. According to the study the poor thermal efficiency of older dwellings in Ireland is one of the reasons for this.

A number of different Government Departments have a role in dealing with the issue of fuel poverty. It is outside the remit of this report to provide an exhaustive list of policies and measures but some of the key instruments which will have an impact on energy efficiency are as follows:

- Green Paper on Sustainable Energy (1999)

The Green Paper advised the Minister of Social and Family Affairs and the Minister for Communications, Marine and Natural Resources on fuel poverty programmes. It sets out a recommendation to maintain and develop policies which address fuel poverty.

- National Anti-Poverty Strategy (2002 – 2007)

The National Anti-Poverty Strategy (NAPS) set a target of the end of 2010 to ensure adequate heating systems will be available in all local authority rented dwellings and an interim target of 2007 to ensure adequate heating systems will be provided in all local authority rented properties occupied by older people.

- National Climate Change Strategy (2000)

The National Climate Change Strategy (NCCS) sets out a goal of reducing the opportunity and transaction costs of investment in energy conservation and ensuring the availability of funds to those who need them most

- National Development Plan (2000 – 2006)

The National Development Plan (NDP) provided funding for SEI's Low Income Housing Programme. This programme has a key role in tackling fuel poverty, see below.

[45] SEI, 2003. *A Review of Fuel Poverty and Low Income Housing.*
Available from http://www.irish-energy.ie/uploads/documents/upload/publications/Fuel_Poverty_Report.pdf
[46] ibid.
[47] Ibid.
[48] Healy, J. and Clinch, J. 2002. *Fuel Poverty, Thermal Comfort and Occupancy: Results of a national household survey in Ireland. Environmental Research Series Working Papers*. UCD. Available from http://www.ucd.ie/pepweb/publications/workingpapers/02-08.pdf
[49] The full report or an executive summary may be downloaded from www.erg.ucd.ie
[50] See footnote 42 above.

3.3.9 SEI Residential Sector Programmes

In addition to its role in implementing the requirements of the EPBD, SEI has a number of other programmes which aim to improve energy efficiency and living standards in the residential sector. The most significant are as follows:

The Low Income Housing[51] programme supports energy efficiency upgrading measures in low income homes vulnerable to fuel poverty, through delivery of installation services on a regional basis by a network of community based organisations. These deliver the benefits of energy economy, improved comfort and reduced health risks. Two thirds of the 62,000 homes estimated to experience persistent fuel poverty are outside the local authority sector, and the focus has thus been on applying improvements in these homes which are not otherwise catered for. Currently an approximate 2,000 homes per annum are served by this programme.

The aim of SEI's House of Tomorrow[52] programme is to accelerate improvements in the quality of energy features in Irish homes and to encourage their widespread market uptake in the form of superior energy planning, design, specification and construction practices. This includes a funding scheme for demonstration projects which offers private or social housing developers support of up to €8,000 per dwelling for the incorporation of sustainable energy design and technology features in groups (typically 10 -100 units) of new homes. These developments are required to deliver a saving of over 40% in energy consumption and associated CO_2 emissions relative to what would apply under current Building Regulations. Over 55 developments comprising over 2,650 homes had been approved under this programme.

[51] Full details of the Low Income Housing programme can be found at http://www.sei.ie/content/content.asp?section_id=608&language_id=1

[52] Full details can be found at http://www.sei.ie/content/content.asp?section_id=1531&language_id=1

4 Energy Consumption and CO_2 Emissions - Underlying Factors

A number of factors shape the patterns of energy consumption seen in section 2. This section analyses a number of significant variables which underlie trends in residential sector energy consumption and CO_2 emissions. Some of the variables, such as the number of dwellings, will be expected to increase the demand for energy while other factors such as insulation will be expected to reduce demand.

The following variables are examined in this section:

- Number of Dwellings
- Household Income
- Dwelling Type
- New Build
- Average Household Size
- Occupancy
- Floor Area
- Period of Construction
- Tenure
- Location
- Central Heating
- Fuel Prices and Expenditure on Energy
- Fuel Poverty
- Internal and External Temperature
- Penetration of Electrical Appliances
- Improvements in Energy Efficiency

The approach taken in this report is to examine each variable in isolation. More complex methodologies, for example multivariate regressions analysis, are available but were considered to be beyond the remit of this first analysis of the sector.

4.1 The Housing Stock

As consumption of energy in the residential sector is dependent on the characteristics of the total stock of dwellings, it is therefore necessary to define the stock.

There are many different variables that can be used to track trends in the stock of housing, for example number of housing units, houses built, number of private households, number of private households in permanent housing units etc. The latter is one of the measures used in the Census of Population and is considered for the purposes of this report to be the indicator which best tracks the actual number of households in the country and the most useful in terms of impact on energy consumption changes. The measure does not include temporary dwellings, holiday homes that are only occupied for part of the year and non-private households, defined as a group of persons situated in a boarding house, hotel, prison or ship, etc[53].

The most recent Census, carried out in April 2002[54], stated that there were 1,279,617 private households in permanent housing units on Census night. This figure can be updated to 2004 using house construction data from the Department of the Environment, Heritage and Local Government (DEHLG).

Total dwelling completions (detailed in section 4.3) including flats/ apartments were added to the 2002 Census data to update the time series. Not every house constructed is a permanently occupied dwelling but it does provide a reasonable projection. In addition, some houses are demolished each year, estimated to be 0.06% of the housing stock by Economic and Social Research Institute's (ESRI) Irish National Survey of Housing Quality (INSHQ)[55]. This demolition factor is also applied to the Census data. It is estimated that at the end of 2002 there were 1,307,958 permanently occupied dwellings, rising to 1,436,798 by the end of 2004.

[53] More details can be found in volume 13 (Housing) of the Census. Available from http://www.cso.ie/Census/Census2002Results.htm

[54] The Census was originally planned for 29 April 2001 but was postponed because of the Foot and Mouth outbreak.

[55] ESRI, 2003, *Irish National Survey of Housing Quality*. A full copy of the report or an executive summary can be downloaded from http://www.environ.ie/DOEI/DOEIPub.nsf/0/96ffd2d2ffab95f880256f0f003dbcf6?OpenDocument. The study was commissioned by the Department of the Environment, Heritage and Local Government. The field work for the report was conducted from September 2001 to Summer 2002. For convenience in this report data from the INSHQ will be referred to as being from 2002.

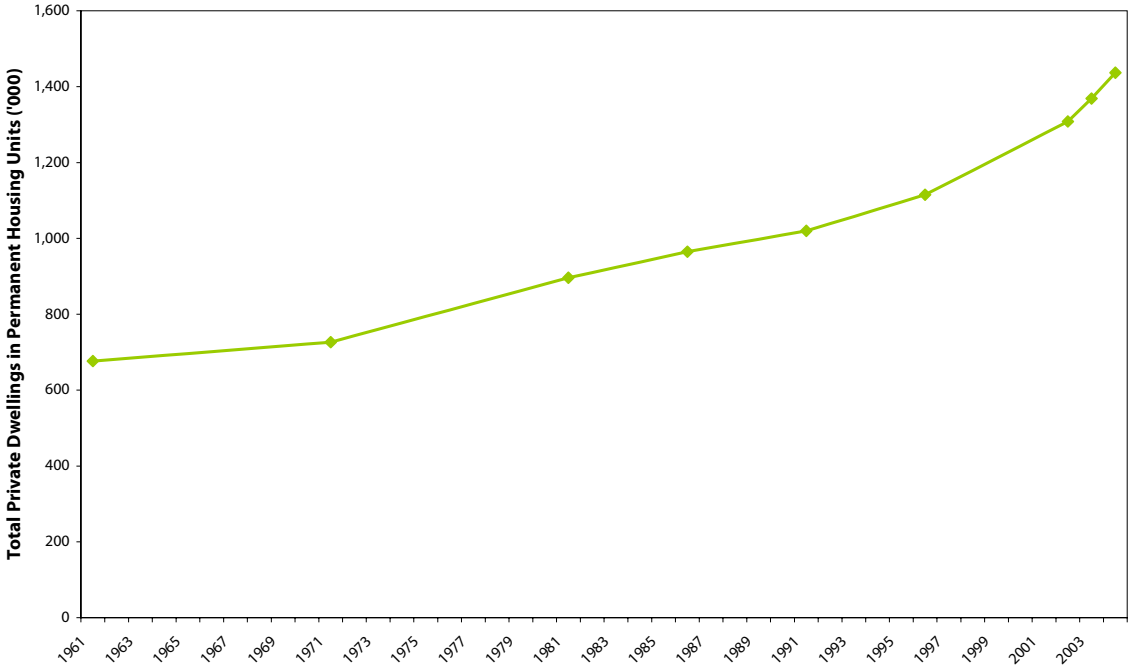
The trend from Census data since 1961 is presented in figure 4.1 and table 4.1. Over the period 1961 to 2004 the number of private households in permanent housing units increased by 112%.

Table 4.1: Private Households in Permanent Housing Units

	1961	1971	1981	1986	1991	1996	2002	2003	2004
Number	676,402	726,332	896,054	964,882	1,019,723	1,114,974	1,307,958	1,368,517	1,436,798

Source: CSO, DEHLG and SEI

Figure 4.1: Private Households in Permanent Housing Units (Selected Years)



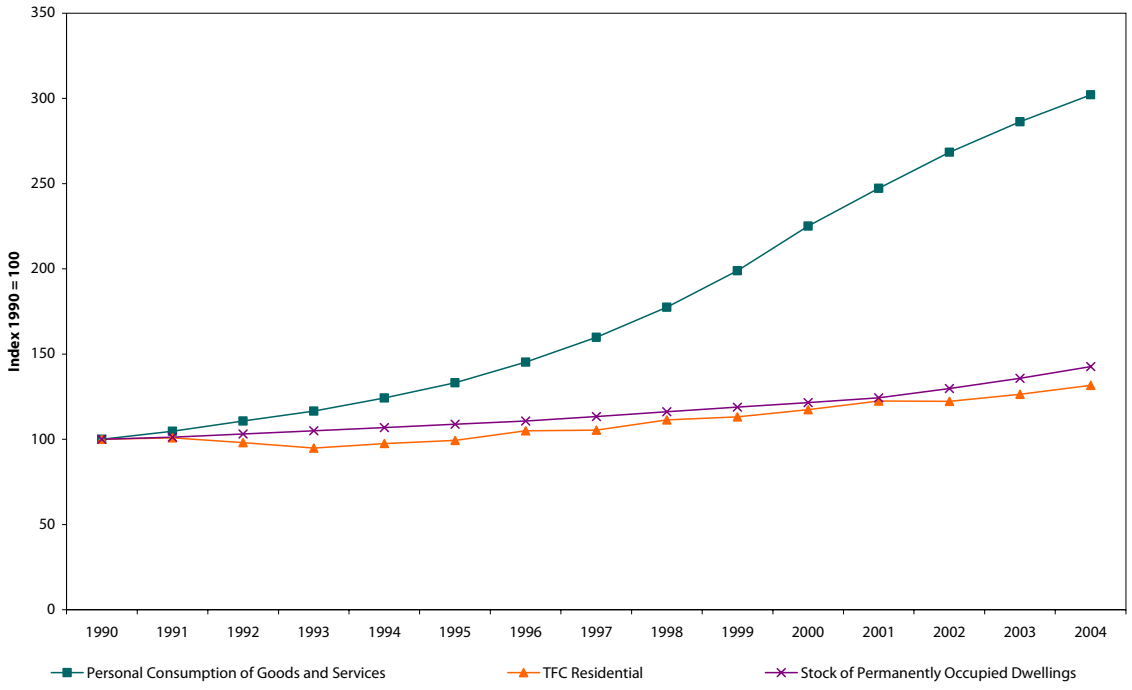
Note that the trend is interpolated linearly for years where data are not available. *Source: CSO, DEHLG and SEI*

4.2 Stock of Dwellings, Household Income and Energy Consumption

Section 2 examined the relationship between economic growth, primary energy consumption and energy related CO_2 emissions at the economy level and between personal consumption of goods and services, primary energy consumption, energy related CO_2 emissions and the stock of dwellings for the residential sector. This section compares the stock of dwellings, final energy consumption and personal consumption of goods and services.

Figure 4.2 present an index of personal consumption of goods and services (aggregate data in current prices) plotted against final energy consumption (TFC) and the stock of dwellings for the period 1990 to 2004. Data on the stock of dwellings is that seen in section 4.1. Table 4.2 details the percentage average annual growth rates for three different periods along with the total per annum growth rates for the period as a whole.

Figure 4.2: Personal Consumption versus Stock of Dwellings and Residential TFC 1990 to 2004



Source: CSO, DEHLG and SEI

Over the period 1990 to 2004 the stock of permanently occupied dwellings increased by 43% while residential TFC increased by 32%.

It can be seen that there was a close relationship between the stock of dwellings and residential sector TFC over the period although the stock of dwellings increased at a slightly faster rate particularly since 2001. Figure 4.2 also shows that during the period 1990 to 1993 the growth rate of the stock of dwellings increased by 1.6% per annum on average while residential TFC declined by 1.7% per annum. This indicates that efficiency gains were made most likely as a result of fuel switching, as seen in section 2.

Personal consumption of goods and services increased by 202% (8.2% per annum on average) over the period.

Table 4.2: Percentage Annual Growth Rates in Personal Consumption, Completed Dwellings and TFC

Percentage Average Annual Growth Rates %	1990 to 1993	1993 to 2002	2002 to 2004	1990 to 2004
Personal Consumption of Goods and Services	5.2	9.7	6.1	8.2
Stock of Permanently Occupied Dwellings	1.6	2.4	4.8	2.6
Residential Final Consumption	-1.7	2.9	4.2	2.0

Source: CSO and DEHLG

4.3 Type of Dwelling and New Build

In addition to the number of households, a key variable impacting on energy consumption in the residential sector is the type of dwelling. Flats and or apartments, hereafter referred to as flats, are typically expected to have the lowest heat loss while detached houses will have the largest as a result of having a larger surface ratio. It has been estimated that up to 25% of the heat from a dwelling can be lost through its walls[59]. It follows that a dwelling with a larger surface area will be expected to have a greater potential for heat loss. If the proportion of flats in the stock is increasing it may therefore be assumed that the stock is becoming more energy efficient and vice versa.

[59] Source SEI. See http://www.sei.ie/content/content.asp?section_id=499&language_id=1 for more details.

Data on accommodation type is available from a number of sources such as the Census of Population, INSHQ and the CSO Quarterly National Household Survey (QHNS). For this report the INSHQ data was chosen over the Census and QHNS data because it can be compared to a similar dataset from 1990. In the following tables and figures, for consistency, the numbers for 2002 refer to those seen in table 4.1 i.e. referring to the end of 2002 as opposed to those in the INSHQ which refer to the period from September 2001 to Summer 2002.

Table 4.3 illustrates that the most common house type in Ireland in 2002 was the detached house which accounted for 46% of the total in 2002. This is a reduced share compared with 1990, when detached houses accounted for 54% of the total. Flats increased their share over the period from 3.8% in 1990 to 6.4% in 2002, while semi-detached houses increased from 19% to 27%.

Table 4.3: Stock of Private Households in Permanent Housing Units –Type of Accommodation

Dwelling Type	2002 Number	2002 % of Total	1990 % of Total
Detached House	602,969	46.1	54.2
Semi-Detached House	355,765	27.2	18.7
Terraced House	258,976	19.8	23.2
Flat / Apartment[60]	83,709	6.4	3.8
Other	5,232	0.4	0.1
Total	1,307,958	100[61]	100

Source: ESRI, CSO and SEI

While the above refers to the stock of houses data are also available for the number of completed dwellings by type. Figure 4.3 and table 4.4 show the numbers of house completions by type from 1992 to 2004, 1992 being the earliest year data are available. Data are sourced from DEHLG, which in turn is obtained from dwellings connected by ESB to the electricity supply. A comparable dataset is not available before 1992.

Table 4.4: New Dwellings Completed by Type

Completed Dwellings	Growth % 1992 – '04	Annual Average % Growth 1992-'04	Shares %	
			1992	2004
Detached House	283	11.8	16.0	17.7
Semi-Detached House	400	14.4	34.2	49.3
Terraced House	64	4.2	7.0	3.3
Flat / Apartment	329	12.9	17.0	21
Other	17	1.3	25.8	8.7
Total	247	10.9	100	100

Source: DEHLG

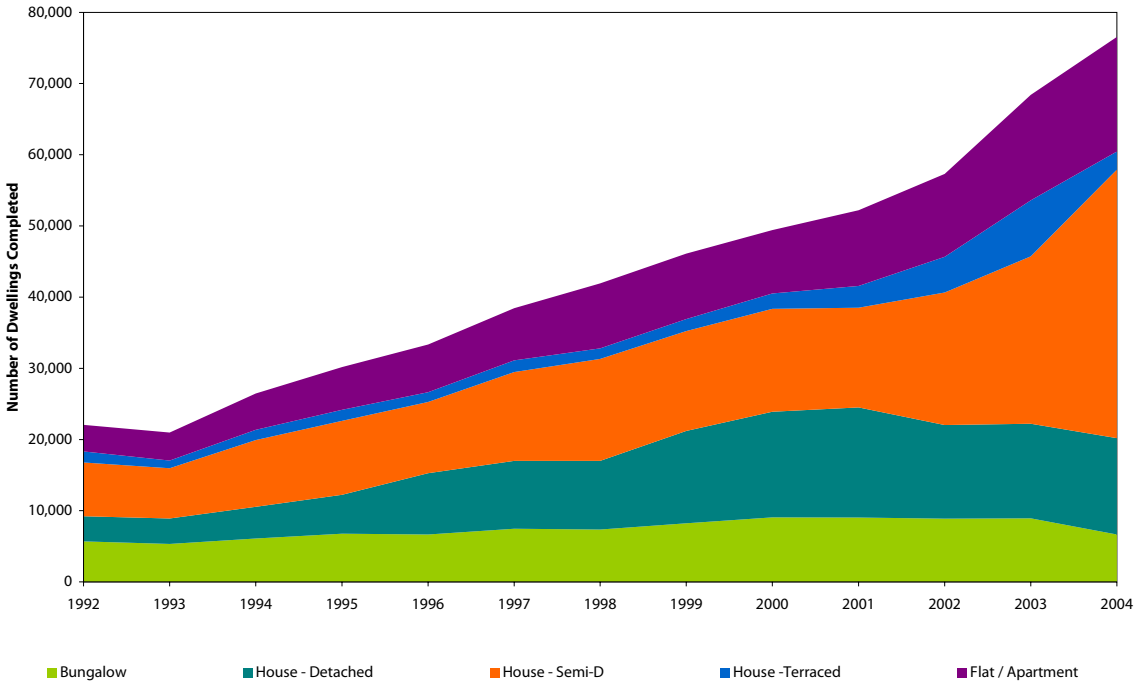
It can be seen that over the period 1992 to 2004 that semi –detached houses have experienced the most growth (400% or 14.4% per annum on average), followed by flats (329% or 11 % per annum) while the "other" category which includes bungalows has shown the smallest increase (17% or 1.3% per annum).

The growth in the total number of completions is striking. There was a dramatic increase over the period, from 19,139 completions in 1990 to 76,954 completions in 2004 (an increase of 300% or 10% per annum on average). Record dwelling completions were experienced for the tenth year in succession in 2004. Growth in 2004 was a 12% increase on completions in 2003.

It is interesting to note that the European Housing Review[62] argues that Ireland has, historically, had a shortage of housing which is reflected in the high average household size (see table 4.5).

[60] This refers to both converted and purpose built flats and apartments.
[61] Percentage totals in this report may not sum to 100 as a result of rounding errors.
[62] Ball, M. Royal Institution of Chartered Surveyors, 2005. *European Housing Review 2005* (page 85). Available from http://www.rics.org/Property/Residentialproperty/Residentialpropertymarket/European_housing_review_2005.html

Figure 4.3: New Dwellings Completed by Type 1992 to 2004



Source: DEHLG

The level of new house completions is remarkable when compared with levels elsewhere in Europe. In 2003 Ireland's house building rate was 17 units per 1,000 of the population. This was the highest building rate in the EU -15. By comparison the average in the EU–15 was 5 units per 1,000 population and 3 in the UK[63]. Spain had the second highest level of house building with 13.8 completions per 1,000 of population.

In Ireland, of the 76,954 dwelling completions in 2004, 71,808 were private dwellings (93%) while the remainder were made up of local authority dwellings (5%) and voluntary non-profit houses (2%). The point is examined further in section 4.7.

4.4 Average Household Size and Occupancy

While the number of households is increasing the size of these households in terms of the number of persons making up a household is declining. This is important as for example, other things being equal, two people living in two separate households will typically consume more energy than two people living in the same household. Table 4.5 presents the average household size for selected years from 1961 to 2004.

Data from 1961 to 2002 is from the Census from those years while figures for 2003 and 2004 are estimated using CSO population data and the estimates of permanently occupied dwellings from table 4.1.

Table 4.5: Average Number of Persons per Household

	1961	1966	1971	1979	1981	1986	1991	1996	2002	2003	2004
Number	3.97	4.01	3.93	3.72	3.66	3.53	3.34	3.14	2.94	2.90	2.81

Source: CSO and SEI

Average household size declined by 29% over the period 1961 to 2004 and by 16% from 1991 to 2004. In addition CSO data reveals that the proportion of one person households has increased from 13% in 1961 to 22% in 2002.

[63] DKM Economic Consultants, 2004. *Review of Construction Industry 2003 and Outlook 2004 – 2006.* Available from http://www.environ.ie/DOEI/doeipub.nsf/0/15b8c68f9f4b524780256f0f003dbdf1/$FILE/Review%20and%20Outlook%20for%20the%20Construction%20Industry.pdf. The study was funded by the Department of Environment, Heritage and Local Government.

As mentioned above, by international standards the average household size in Ireland is quite high. For example in 2001 in Germany the average was 2.1 persons per household while in Denmark it was 2.2[64]. In the UK in 2000 the average was 2.4.

Another factor which would be expected to affect the demand for energy in the residential sector is occupancy. Dwellings which are empty for extended periods during the day will require less energy for heating and lighting than those which are constantly occupied.

Data on occupancy is not directly available but the rate of female participation in the workforce can be used as a proxy and in recent years there has been a significant increase in the number women working. In 1994 the employment rate for women of working age was 40%. By 2004 this had increased to 56%[65].

The number of vacant dwellings is also on the increase. A study by ESRI[66] using unpublished CSO data showed that the number of habitable vacant dwellings had increased from 131,165 in 1991 to 170,154 in 2002, an increase of 30%. The total for 2002 was made up of temporary absent dwellings (16%), holiday homes (23%) and other houses /flats (61%). Regarding the other category ERSI states[67] that "*probably the biggest class of vacant habitable dwellings in the other category are dwellings held for investment purposes*".

Comparing 2002 with 1991, the holiday homes category experienced the largest growth (166%) followed by other houses/flats (15%) and temporarily absent dwellings (2.7%).

4.5 Floor Areas

A dataset is published by the CSO which shows the average floor area of granted planning permissions for flats and houses. Not all dwellings that are granted planning permission are built but the figures provide a plausible proxy for the trend in new flat and house size. Data are shown in figure 4.4 for the period 1990 to 2004 with percentage growth rates shown in table 4.6.

Table 4.6: Growth Rates of Average Residential Floor Areas per New Dwelling

	Growth %	Average Annual Growth Rates %				
	1990 – '04	1990 – '95	1995 – '00	2000 – '04	2004	1990 -2004
New Houses	13.6	-0.1	2.0	0.8	0.1	0.9
New Flats	19.3	0.3	3.1	0.1	-3.6	1.3

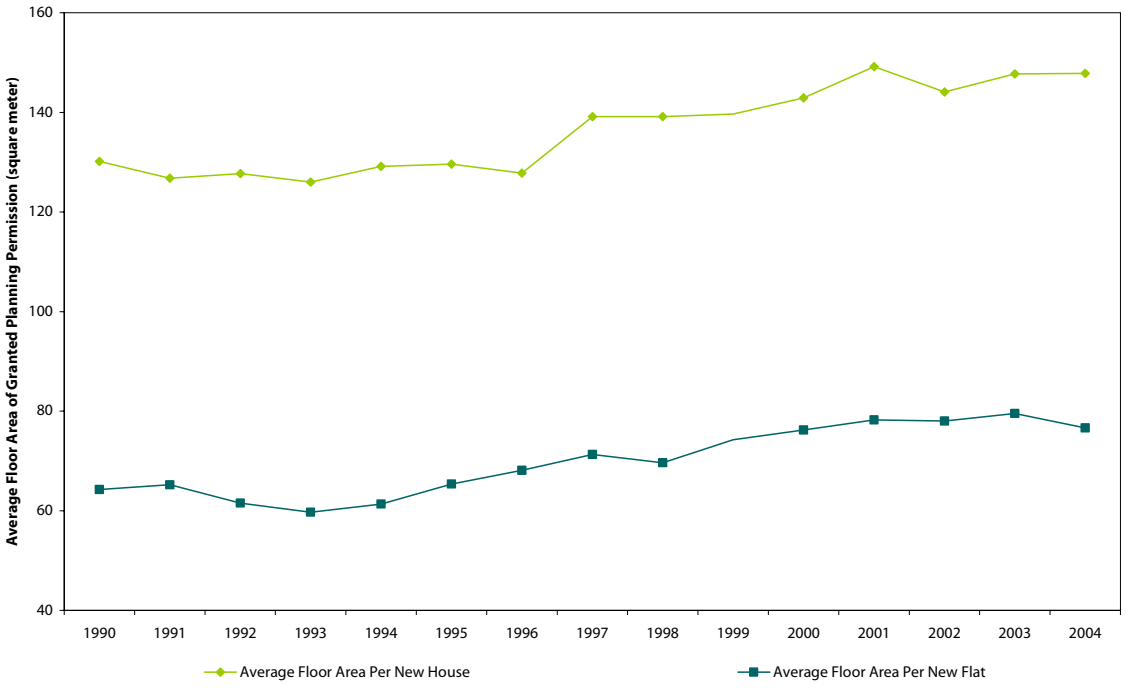
Source: CSO

Average floor areas of new houses grew from 130 square metres in 1990 to 149 square metres in 2004 (an increase of 13.6%). The average declined slightly in the early 1990s and grew at a rate of 2% per annum in the latter half of the decade. 2004 saw a slight increase of 0.1%. Average floor areas of new flats showed a stronger growth over the period from 64 square metres to 77 square metres (19.3%). The trend was reversed in 2004 when the average floor area of new flats fell by 3.6%.

The ratio of new houses to new flats granted planning in 1990 was approximately 9 to 1 whereas in 2004 it was approximately 2 to 1.

[64] Department of Housing of the Director General of Planning, Housing and Heritage (Walloon Region, Belgium), 2002. *Housing Statistics in the EU 2002.* A copy of the report is available from http://www.iut.nu/Statistiques%20logement%20UE%202002.doc
[65] Source: CSO. Quarterly National Household Survey, *Labour Force Survey*. See www.cso.ie .
[66] Fitzgerald, John. 2005. *The Irish Housing Stock: Growth in Number of Vacant Dwellings.* Available from http://www.esri.ie/advsearch.cfm?t=Find%20Publications&mId=2&detail=1&id=2192
[67] Ibid, Page 46.

Figure 4.4: Average Floor Areas of New Flats and New Houses 1990 to 2004



Source: CSO

While the above only refers to new dwellings it is also possible to estimate the trend in the stock as a whole using the CSO dataset and a model of the stock of dwellings derived using, inter alia, data from DEHLG studies in the mid 1990s[68]. Data from this model is updated incrementally, using planning permission data from the CSO minus the demolitions estimate mentioned in section 4.1. The results are presented in figure 4.5. Table 4.7 summaries the growth rates during the period. Over the period 1981 to 2004 the estimated average floor area of the stock of dwellings increased from 97 square metres in 1981 to 112 square metres in 2004.

Table 4.7: Average Floor Area -Stock

	Growth %	**Average Annual Growth Rates %**				
	1981 – '04	**1981 – '04**	**1981 – '90**	**1900– '00**	**2000 – '04**	**2004**
Average Floor Area	15.5	0.6	0.3	0.6	1.0	0.9

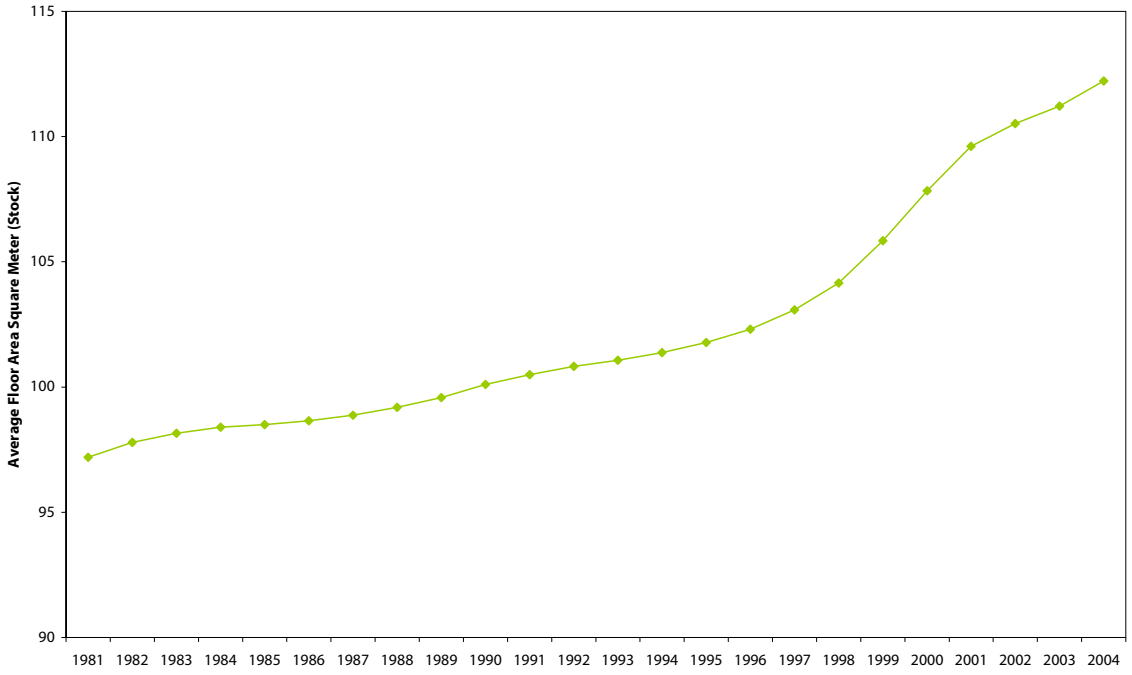
Source: SEI and CSO

Average floor area has increased steadily over the period as larger dwellings are added to the stock. The largest growth has been seen in recent years with an average annual growth rate of 1% from 2000 to 2004. The increasing trend in floor area has been offset somewhat by the growing number of flats. However, overall the dominant driving force is the number and size of large one off or non estate dwellings that have been built in recent years. For example in the first quarter of 2005 average floor areas granted for non estate houses was 211 square metres compared to 125 square metres for houses in estates and 76 square metres for flats[69].

The evidence suggests that there has been a trend towards larger dwellings. Taken in isolation, this should have had a significant impact on the amount of energy demanded in the residential sector as bigger dwellings tend to have a larger demand for heating as they have a proportionally greater wall surface area and therefore higher heat loss. This has been offset somewhat by the increasing insulation standards promoted through iterations of the building regulations. Other variables such as the changing fuel mix, more efficient heating systems, falling occupancy levels and the declining average number of persons per household have also had an impact.

[68] Kevin O' Rourke, 2005. *Personal Communication.*
[69] CSO, 2005. *Planning Permissions Data.* Available from www.cso.ie.

Figure 4.5: Average Floor Area of the Housing Stock 1981 to 2004



Source: SEI and CSO

4.6 Period of Construction

Another factor in determining the energy profile of the housing stock is the period of construction. Newer houses must conform to stricter energy efficiency standards. However, improvements in insulation standards in the existing stock through retrofitting will be expected to have offset some of the energy losses that would otherwise have occurred. Retrofitting has been promoted by various information programmes for example those run by SEI, previously the Irish Energy Centre, and also through home improvement grants which were available during the 1980s.

Table 4.8 and figure 4.6 illustrate the age profile using data from the 2002 Census and estimates based on DEHLG data up to the end of 2004 (using the same methodology as that in table and figure 4.2). It can be seen that 25% of the total housing stock has been built since 1996. These dwellings should be more energy efficient as they have been subject to more stringent Building Regulations.

By contrast 53% of the stock was built before the first thermal insulation requirements came formally into effect in 1979[70] (as mentioned in section 3.3.5 draft energy regulations were introduced in 1976). It can be reasonably assumed that pre-1980 housing stock has a poorer standard of insulation than those built after the introduction of the thermal building requirements. The percentage of pre 1980 dwellings in Ireland, while greater than 50%, is quite low when compared with other EU countries i.e. Ireland has a relatively young housing stock. For example in Denmark the proportion built before 1980 is 84% while the share built in the UK before 1985 is 87%[71].

[70] It can be seen that data are shown to 1981 as opposed to 1979 but this shouldn't significantly alter the point. In addition there were some elementary building requirements from 1976.

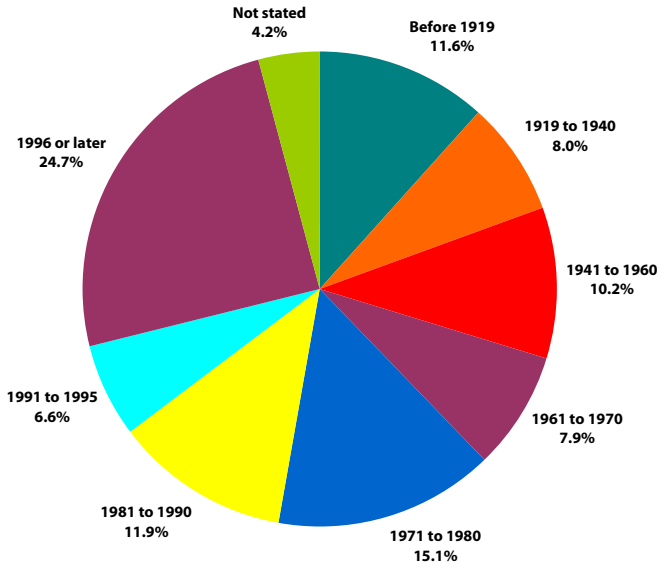
[71] Department of Housing of the Director General of Planning, Housing and Heritage (Walloon Region, Belgium), 2002. *Housing Statistics in the EU 2002.* A copy of the report is available from http://www.iut.nu/Statistiques%20logement%20UE%202002.doc

Table 4.8: Private Households in Permanent Housing Units –Period of Construction

Year Built	Number	% of Total
Before 1919	167,033	11.6
1919 to 1940	114,304	8.0
1941 to 1960	146,206	10.2
1961 to 1970	114,010	7.9
1971 to 1980	216,497	15.1
1981 to 1990	170,403	11.9
1991 to 1995	94,199	6.6
1996 to 2004	354,315	24.7
Not Stated	59,831	4.2
Total	1,436,798	100

Source: CSO, ESRI and SEI

Figure 4.6: Private Households in Permanent Housing Units – Period of Construction



Total: 1,436,798

Source: CSO, ESRI and SEI

As mentioned above, improvements in insulation standards in the existing stock have been made through retrofitting. Table 4.9, using data from the INSHQ, shows the percentage of dwellings with energy saving items categorised by dwelling age.

Table 4.9: Incidence of Energy Saving Items by Dwelling Age 2002

Year Built	Double Glazing %	Draft Stripping Windows %	Draft Stripping Doors %	Low Energy Light Bulbs %	Enclosed Porch %
Pre 1940	51	23	29	29	28
1941-1970	64	23	30	35	39
1971-1989	65	28	33	39	39
After 1990	92	33	37	38	17

Source: ESRI

While all the energy saving items are more prevalent in newer build it can be seen, for example, that just over half of the pre 1940 stock has double glazing which indicates a significant level of retrofitting has occurred.

Data is also available from the INSHQ relating to the level of retrofitting that has been undertaken between 1997 and 2002. Table 4.10 shows that 33% of dwellings built before 1940 have made improvements to the energy efficiency of the dwelling during that period compared with 40% of dwellings built between 1941 and 1989 and 11% for dwellings built since 1990. For dwellings built before 1990 the most popular form of improvements is the replacement of windows.

Table 4.10: Incidence of Energy Related Improvements by Dwelling Age during 1997 - 2002

Year Built	Replace External Door %	Replace Windows %	Replace CH /Boiler System %	Roof Insulation %	Cavity Wall Insulation %	Other Wall Insulation %	Any of These %
Pre 1940	17	21	14	9	3	4	33
1941-1970	21	25	18	9	3	4	40
1971-1989	22	26	18	6	2	2	40
After 1990	5	5	4	1	1	1	11

Source: ESRI

Further details on the incidence of energy saving items for the stock as a whole are contained in section 4.13.

4.7 Tenure

Table 4.11 and figure 4.7 illustrate the ownership profile of dwellings in 2002. Again data numbers for 2002 refer to the end of the year as opposed to those in the INSHQ. Data from the 1991 Census[72] is included for comparison. Owner occupiers would be expected to have a greater incentive to invest in energy saving measures than those in rented accommodation.

Table 4.11: Private Households in Permanent Housing Units –Ownership

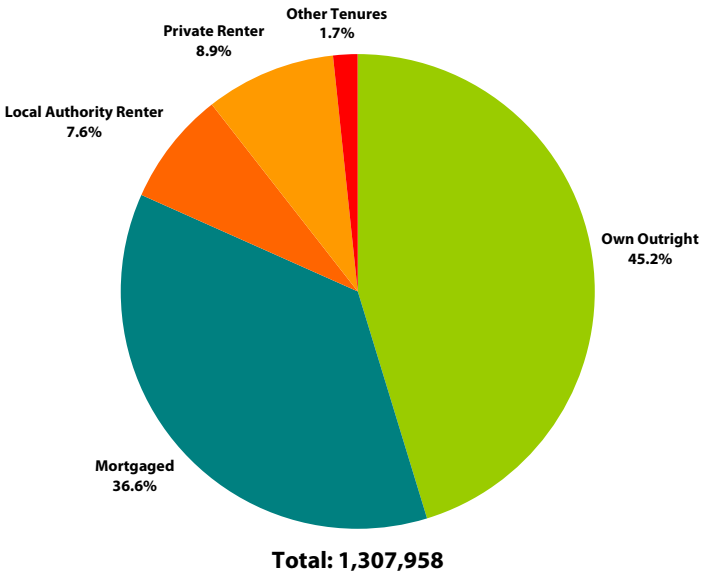
Year Built	2002 Number	2002 % of Total	1991 % of Total
Own Outright	591,197	45.2	38
Mortgaged	480,021	36.6	42
Local Authority Renter	98,097	7.6	10
Private Renter	115,100	8.9	8
Other [73]	22,235	1.7	2
Total	1,307,958	100	100

Source: CSO, ESRI and SEI

The majority of dwellings, 82%, are either owned outright or are in the process of being purchased (mortgaged) representing a slight increase on the 1991 proportion of 80%. There have been historically high levels of ownership in Ireland compared to other European countries. For example in the UK the proportion of owner occupied dwellings was 47% in 1970 and 69% in 2001[74].

[72] CSO, *Census 19 91. Volume 10 Housing*. Table 24A. Available from CSO, Skehard Road, Cork.
[73] Other includes those occupying the accommodation rent-free and renting in the voluntary and co-operative sector.
[74] Building Research Establishment, 2003. *Domestic Energy Fact File 2003*.
Available from http://projects.bre.co.uk/factfile/BR457prtnew.pdf

Figure 4.7: Private Households in Permanent Housing Units –Tenure 2002

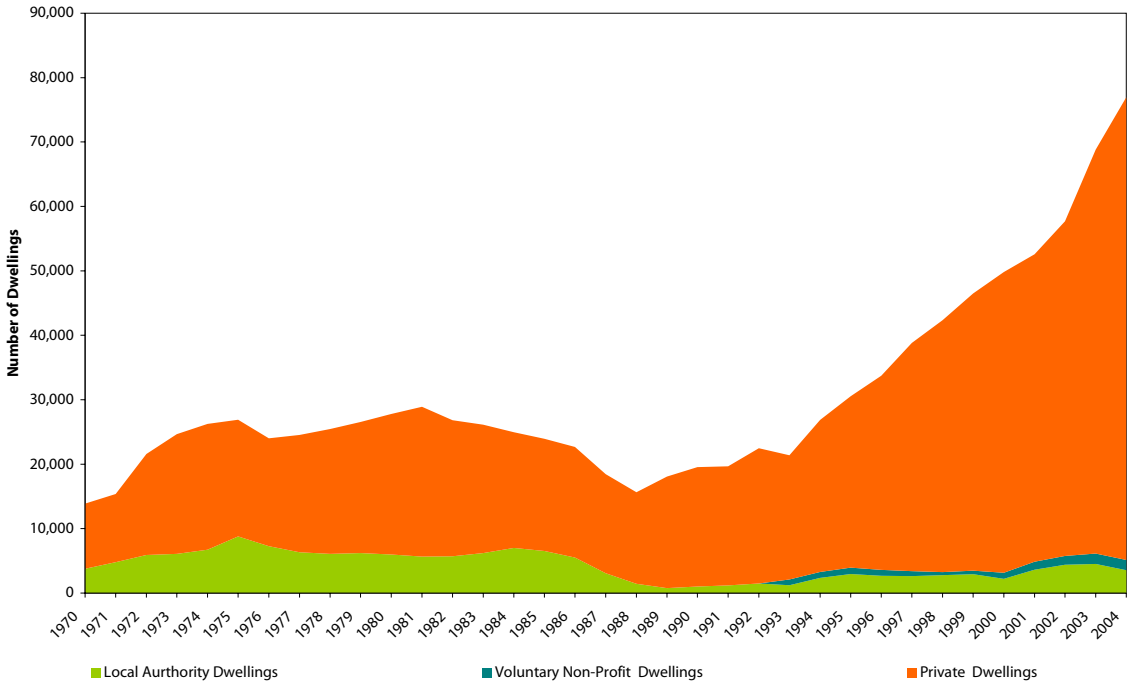


Source: CSO and ESRI

Data on the construction of new build by private, local authority and voluntary sectors are also available from a DEHLG time series that data back to 1970. Figure 4.8 again illustrates the significant increase in new build particularly since the mid 1990s. It can also be clearly seen that the majority of new build is funded by the private sector.

As stated in section 4.3, in Ireland, of the 76,954 dwelling completions in 2004, 71,808 were private dwellings (93%) while the remainder were made up of local authority dwellings (5%) and voluntary non-profit houses (2%). Figure 4.8 shows that the level of house building by the local authority sector has not kept pace with that seen in the private sector. In the past local authority dwellings made up a significant proportion of total new build in the sector, for example, 33% (8,794 dwellings) in 1975 and 28% (7,002 dwellings) in 1984. This began to decline from the mid 1980s but the proportion has begun to increase again since 2000. Finally it can be seen that an increasing number of voluntary non-profit dwellings have also being built since 1992.

Figure 4.8: Dwelling Completions Categorised by Market Segment 1970 to 2004



Source: DEHLG

4.8 Location

Location has an impact on energy consumption as non estate or one off housing tend to be larger in surface area[75] than houses in estates, as seen in section 4.5. Furthermore it may be reasonable to assume that a large proportion of non-estate housing will be located in rural areas.

There will be increased transport requirements for people working in towns and cities but living in open countryside. This will, in turn, lead to increased environmental emissions. In addition, dwellings in rural areas will not, for the most part, have access to the mains gas network which alters fuel choice.

Data in this section is taken from the INSHQ. It should be noted that the INSHQ data does not include converted apartments which are included in the Census data. Figure 4.9 and table 4.12 illustrate the situation in 2004 and it can be seen that a significant proportion (33%) of houses are located in open countryside. DEHLG estimates[76] that the split between town and country dwellings has remained at approximately 70%/ 30% respectively since the 1980s at least.

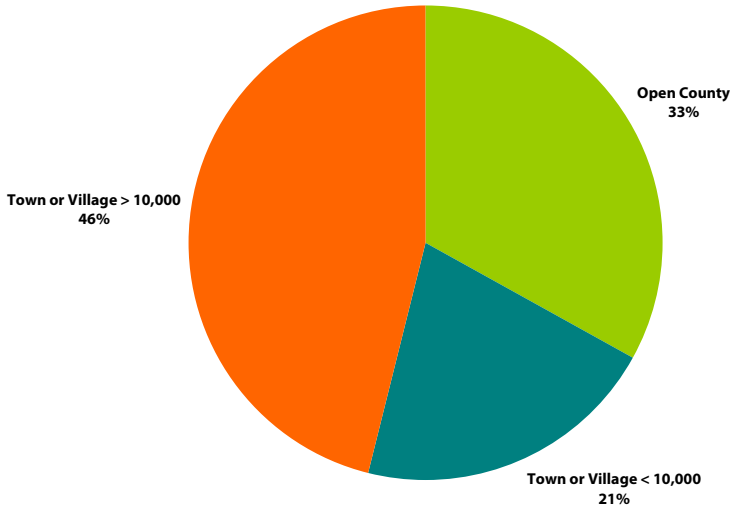
Table 4.12: Private Households in Permanent Housing Units –Location 2002

Location	2002 % of Total
Open Country	33
Town or Village <10,000	21
Town or City >10,000	46
Total	100

Source: CSO, ESRI and SEI

[75] Based on CSO data on planning permissions. Data available from http://www.cso.ie/statistics/planperm1992to2004.htm.
[76] DEHLG, 2005. *Personal Communication between DEHLG and Energy Policy Statistical Support Unit.*

Figure 4.9: Private Households in Permanent Housing Units –Location 2002



Total: 1,307,958

Source: CSO, ESRI and SEI

4.9 Central Heating

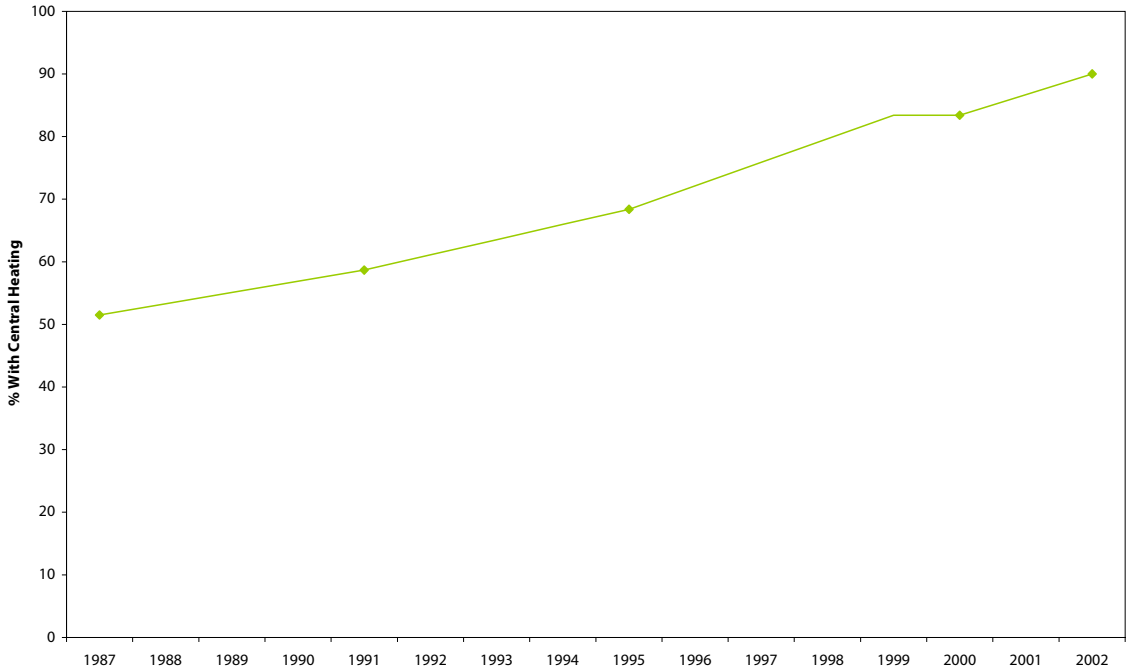
Another significant factor in residential sector energy consumption is central heating. Central heating is defined in the INSHQ as any "*heating system whereby more than one room is heated from a single source*". Central heating systems are predominantly more energy efficient than individual room heating appliances so for a given requirement of space heating less energy would be expected to be used.

On the other hand, a considerable increase in the level of comfort, in the form of higher temperatures and a move towards whole house heating, is often associated with the introduction of central heating. There may also be greater convenience using timer controls, particularly with oil and gas fired systems, which has the potential to result in greater usage. Therefore an improvement in energy efficiency associated with a switch to central heating can be offset somewhat by increased consumption through greater convenience and comfort levels. Current data availability does not permit a quantification of this last point and it is an area where further study is required.

Figure 4.10 shows the percentage of dwellings with central heating from 1987 to 2002 using data from the HBS, INSHQ and the Census. It can be seen that the proportion of homes with central heating has increased from 52% in 1987 to 90% in 2002. In 1974 it has been estimated that less than 25% of the 740,000 households in the county had central heating[77]. For comparison, in the UK in 2001, 90%[78] of homes used some form of central heating compared to 31% in 1970.

[77] Kevin O' Rourke, 2005. *Personal Communication with Energy Policy Statistical Support Unit.*
[78] Building Research Establishment, 2003. *Domestic Energy Fact File 2003*. Available from http://projects.bre.co.uk/factfile/BR457prtnew.pdf

Figure 4.10: Penetration of Central Heating - Selected Years



Note that the trend is interpolated linearly for years where data are not available. *Source: CSO and ESRI*

Figure 4.11 and table 4.13 show the changing fuel split over the period. It can be seen that the share of solid fuel has declined while central heating systems fired by oil and gas have increased. It is worth noting that the ESRI in the INSHQ[79] state that over 80% of dual[80] systems also use oil.

For comparison, in the UK the predominant form of central heating was gas which increased from 33% of homes in 1970 to over 80% in 2001. By contrast the use of solid fuels fell from 29% to 3% over the same period[81].

In Northern Ireland in 2001[82] 95% of homes had central heating 58% of which used oil as opposed to 83% in 1991 when the most popular form of central heating was solid fuel (47%).

It is important to note that for homes without central heating, solid fuel is the dominant fuel form for heating however, electric, LPG and paraffin heaters are also used to a lesser degree.

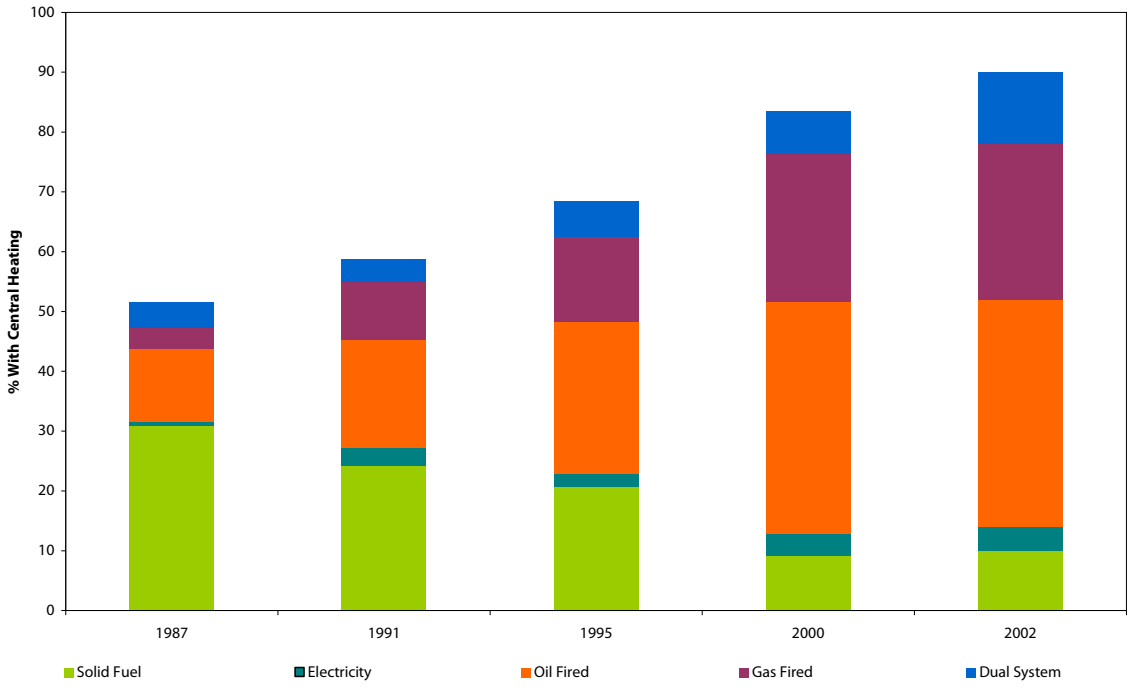
Table 4.13: Penetration of Central Heating by Fuel Type

Fuel Type	1987 (%)	1991 (%)	1995 (%)	2000 (%)	2002 (%)
Solid Fuel	31	24	21	9	10
Electricity	1	3	2	4	4
Oil Fired	12	18	25	39	38
Gas Fired	4	10	14	25	26
Dual System	4	4	6	7	12
Total Central Heating	52	59	68	83	90

Source: CSO and ESRI

[79] ESRI, 2003. *Irish National Survey of Housing Quality.* A full copy of the report or an executive summary can be downloaded from http://www.environ.ie/DOEI/DOEIPub.nsf/0/96ffd2d2ffab95f880256f0f003dbcf6?OpenDocument.
[80] The INSHQ defines duel systems as central heating systems which can be run from either solid fuel or oil, or two separate systems.
[81] Building Research Establishment, 2003. *Domestic Energy Fact File 2003.* Available from http://projects.bre.co.uk/factfile/BR457prtnew.pdf
[82] Northern Ireland Housing Executive, 2001. *Northern Ireland House Condition Survey*. Available from http://www.nihe.gov.uk/HCS/

Figure 4.11: Penetration of Central Heating by Fuel Type - Selected Years



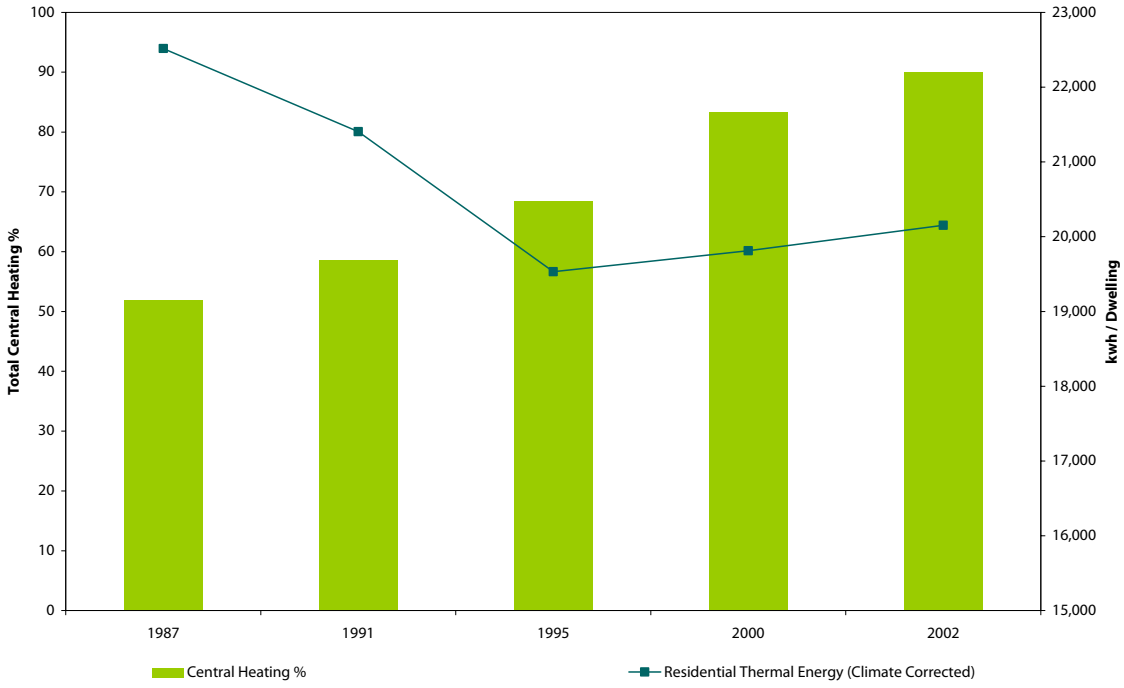
Source: CSO and ESRI

The relationship between unit consumption, i.e. consumption of energy per dwelling, and penetration of central heating is examined in figure 4.12[83]. Only thermal or fuel unit consumption is included, i.e. electricity is excluded, as it constitutes such a small proportion of central heating. The bulk of central heating is fuelled by oil, gas or solid fuels (table 4.13). Unit consumption is climate corrected, using degree day[84] data, to filter out the variations due to hot and cold years (for more on unit consumption see section 5). Central heating data are only for 1987, 1991, 1995, 2000, and 2002 so the comparison with energy consumption is limited to these years.

[83] This methodology was developed as part of an EU wide project called Odyssee, the aim of which is to develop indicators of energy efficiency. More information can be found at http://www.odyssee-indicators.org/

[84] Data are climate corrected using degree days where degree days are a measure or index used to take account of the severity of the weather when looking at energy consumption in terms of heating (or cooling) "load" on a building. A degree day is an expression of how cold (or warm) it is outside, relative to a day on which little or no heating (or cooling) would be required. It is thus a measure of cumulative temperature deficit (or surplus) of the outdoor temperature relative to a neutral target temperature (base temperature) at which no heating or cooling would be required.

Figure 4.12: Central Heating / Thermal Unit Consumption – Selected Years



Source: CSO, ODYSSEE[85] and SEI

Figure 4.12 suggests that the increase in the penetration of central heating, and associated increase in comfort and energy use, was offset by gains made through energy efficiency. This is illustrated by the decrease in thermal unit consumption (climate corrected) from 1987 until 1995.

This decrease in energy consumption is due, in part, to the switch from the use of solid fuels in open fires and backboliers to oil and gas central heating, as seen in figure 4.10. A number of other factors such as the increased insulation standards arising from revisions of the Building Regulations will also have had an impact through improvements in building fabric performance and more recently as a result of heating control requirements. The trend was reversed from 1995 when the increase in the penetration of central heating, and associated increase in comfort and energy use, was no longer offset by gains made as a result of energy efficiency improvements.

This is known as a rebound effect whereby the convenience of automated controls, whole house heating, larger houses and higher internal temperatures outweigh lower energy consumption gains achieved as a result of fuel switching to cleaner fuels.

In summary figure 4.12 intimates that while thermal energy consumption has decreased per dwelling, total energy savings were compensated by increased comfort. The last point does not take into account the social and health benefits arising from increased household comfort and convenience.

4.10 Fuel Prices and Expenditure on Energy

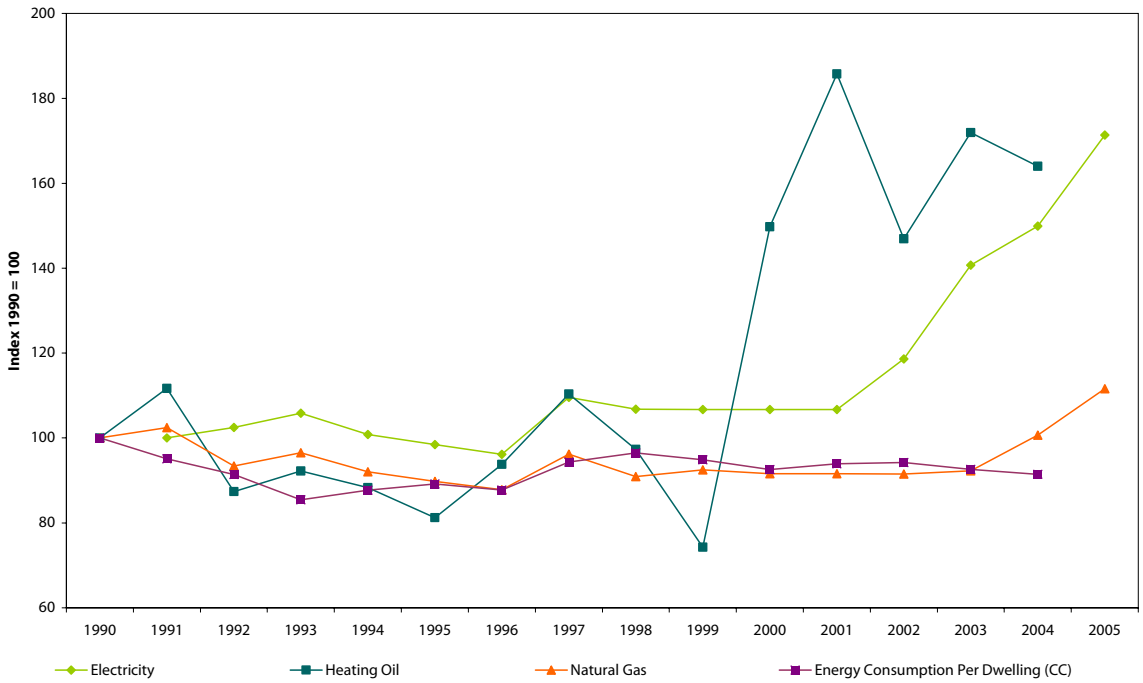
Price is clearly an important factor in discussing energy consumption and figure 4.13 presents an index of residential energy prices (current prices) for electricity, natural gas and heating oil.

Electricity[86] data are for the period 1991 to July 2005, heating oil[87] for 1990 to end 2004 while natural gas[88] data are shown from 1990 to July 2005. All data are inclusive of taxes.

[85] ODYSSEE is a cross European project which develops and maintains a database of energy efficiency indicators. More information can be found at http://www.odyssee-indicators.org/
[86] Eurostat consumption category 4161200 Households - Dc (Annual consumption: 3 500 kWh of which night 1 300).
[87] Eurostat consumption category 4131600 Households (Deliveries between 2 000 and 5 000 litres annually).
[88] Eurostat consumption category 4141150 Households - D3 (Annual consumption: 83.70 GJ).

It can be seen that over the period 1991 to 2005 household electricity prices rose by 71.4%. The price of heating oil rose by 64% over the period 1990 to 2004 but increased sharply (102%) in 2000 compared with 1999. Finally, natural gas prices increased by 11.6% over the period 1990 to 2005.

Figure 4.13: Residential Sector Energy Prices 1990 to 2005



Source: Eurostat and SEI

The climate corrected trend in energy consumption per dwelling (this indicator is discussed further in section 5) is included for comparison and the 9.3% decrease (0.7% per annum) suggests that there is a weak, or inelastic, relationship between price and energy consumption in residential sector as a whole. It has already been established that the reductions in the residential sector energy intensity were as a result of fuel switching, improved thermal standards etc. Further reasons are examined in due course.

Fuel switching by households was promoted on the basis of comfort and convenience as opposed to price. As a consequence many households switched from solid fuel backboilers and open fires to gas or oil fired central heating in the late 1980s and early 1990s. There was also a trend to replace rotting softwood windows for aesthetic reasons and for the convenience of maintenance free PVC frames with double glazing being an added bonus. These improvements involved an initial capital outlay and may have been above the means of lower income households. As a result it could be assumed that those on lower incomes would not have been in a position to upgrade their accommodation and could be more susceptible to fuel price increases.

Referring back to figure 4.13, from 2002 onwards energy consumption per dwelling begins to decrease. This could be a result of the increasing penetration of new dwellings or a change in behaviour i.e. over the longer term people became more responsive the increase in prices.

Figure 4.14 presents the average spend (current prices) on energy per (permanently occupied) dwelling from 1990 to 2004. In 2004 average spend was €1,513, an increase of 12% on 2003 and 45% on 1990. Total spend by the residential sector was €2.2 billion in 2004.

Figure 4.14: Average Spend on Energy per Permanently Occupied Dwelling 1990 to 2004

Source: CSO

Figure 4.15 shows the ratio of household energy expenditure to total expenditure. It can be seen that the proportion of total expenditure spent on fuel and power decreased over the period 1990 to 2003. The direction of the trend changed in 2002, which coincided with increasing fuel prices shown in figure 4.12. In 1990 4.7% of total personal consumption was spent on energy, but this fell to 2.9% by 2003. This means that energy now forms a smaller proportion of our spending than it did in 1990.

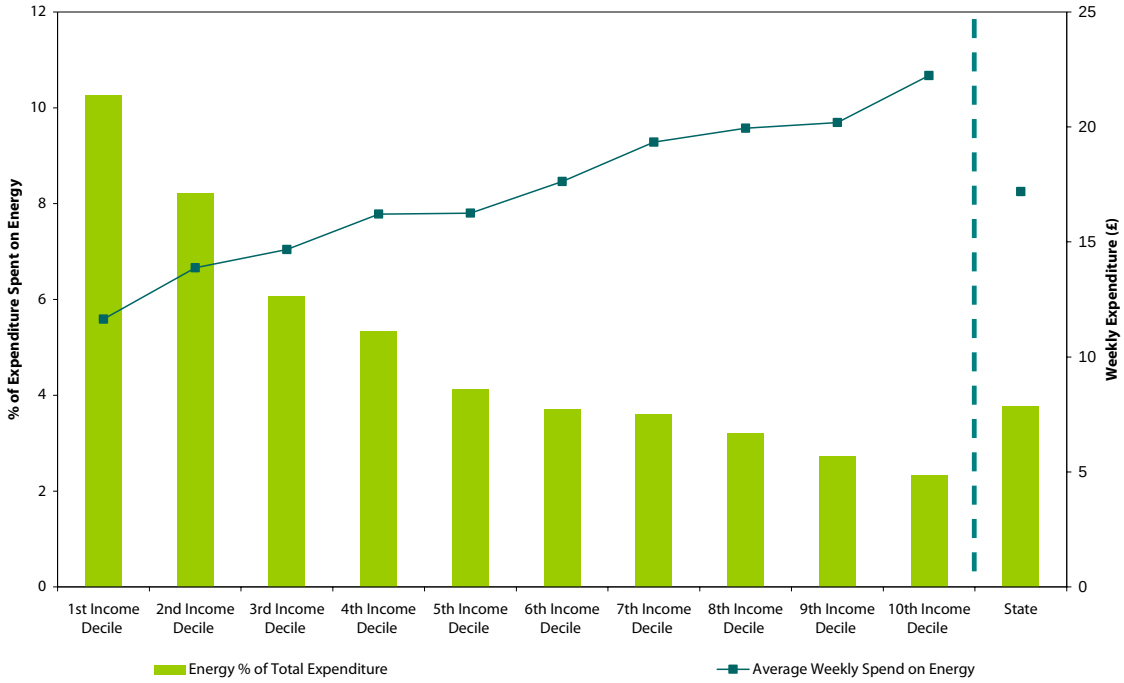
Figure 4.15: Ratio of Personal Expenditure on Fuel and Power to Total Personal Expenditure 1990 to 2003

Source: CSO

4.11 Fuel Poverty

The issue of fuel poverty was introduced in section 2 and some of the key Government responses were outlined. This report seeks to shed more light on this important issue by comparing expenditure on energy by different income groups. The data are drawn from the most recent Household Budget Survey (HBS) which provides data on energy expenditure for 10 income deciles[91].

Figure 4.16: Weekly Expenditure on Energy by Income Decile1999/ 2000



Source: CSO

It can be seen from figure 4.16 that the percentage spent on fuel increases as income falls. Those in the lowest (or 1st) income decile spend on average 10% of their expenditure on energy while the highest earners spend 2.3%. The average proportion of total expenditure spent on energy for Ireland as a whole was 3.8%. For the state as a whole in 1994/5 the amount of weekly expenditure spent on energy was 5% while in 1987 it was 6%.

It is also expected that poorer households tend to use solid fuels and stand alone heating systems as opposed to central heating fired by oil or gas. This is borne out by data from the INSHQ which states that 26% of the lowest income group do not have a central heating system compared to 3% for the highest income group.

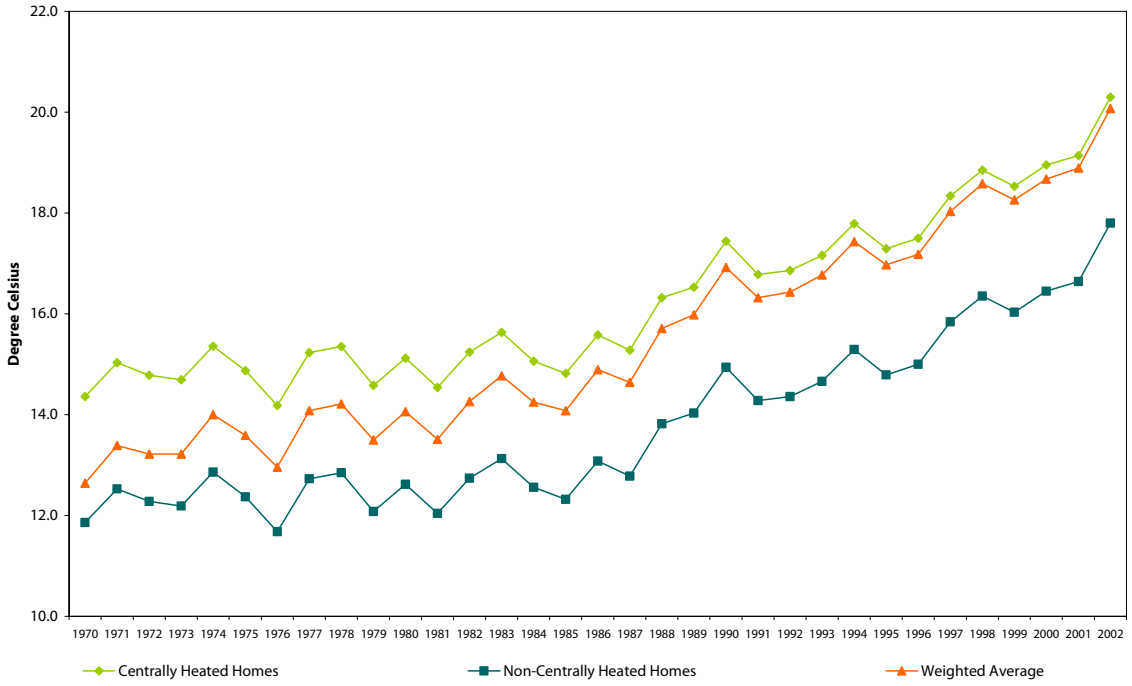
4.12 Internal and External Temperature

A key issue alluded to in section 4.9 was the increasing level of comfort that many homes experience when central heating is installed. The trend in central heating was shown in figure 4.11. Data on internal temperature is not available for Ireland but estimates are available for the UK and are presented in figure 4.17. Data are sourced from the Building Research Establishment (BRE)[92] and are based on a number of surveys carried out at irregular intervals. Their data indicates that homes heated by central heating tend to be 2.5˚ Celsius warmer than those heated by stand alone room heating systems.

[91] Income deciles are constructed by sorting all incomes by size and then grouping them into one of ten groups. For example the lowest income decile is composed of the lowest 10% of all incomes.
[92] Building Research Establishment, 2003. *Domestic Energy Fact File 2003.* Available from http://projects.bre.co.uk/factfile/BR457prtnew.pdf

The internal temperature increase over the period 1970 and 2002 was 4.75°C for both centrally and non-centrally heated dwellings in the UK (50%) but the weighted average temperature rose by 6.2°C (59%) because of the increasing numbers of dwellings which have central heating, as seen earlier (section 4.9). It may be reasonable to assert that there has been a similar increase in Ireland given the comparable increase in central heating. However the actual internal temperature levels may be different between Ireland and the UK.

Figure 4.17: UK Internal Temperatures 1970 to 2002



Source: BRE

4.13 Penetration of Electric Appliances

In addition to running various appliances, televisions, washing machines, clothes dryers, computers etc., electricity provides a number of different services to households, such as space and water heating, lighting and cooling.

ERSI[93] examined the penetration of electricity appliances using CSO HBS data by constructing an "index of possession". The index tracks the demand for appliances over time. Ten items were selected: vacuum cleaner, clothes dryer, washing machine, dishwasher, refrigerator with freezer, separate deep freeze, microwave oven, video recorder, stereo and home computer.

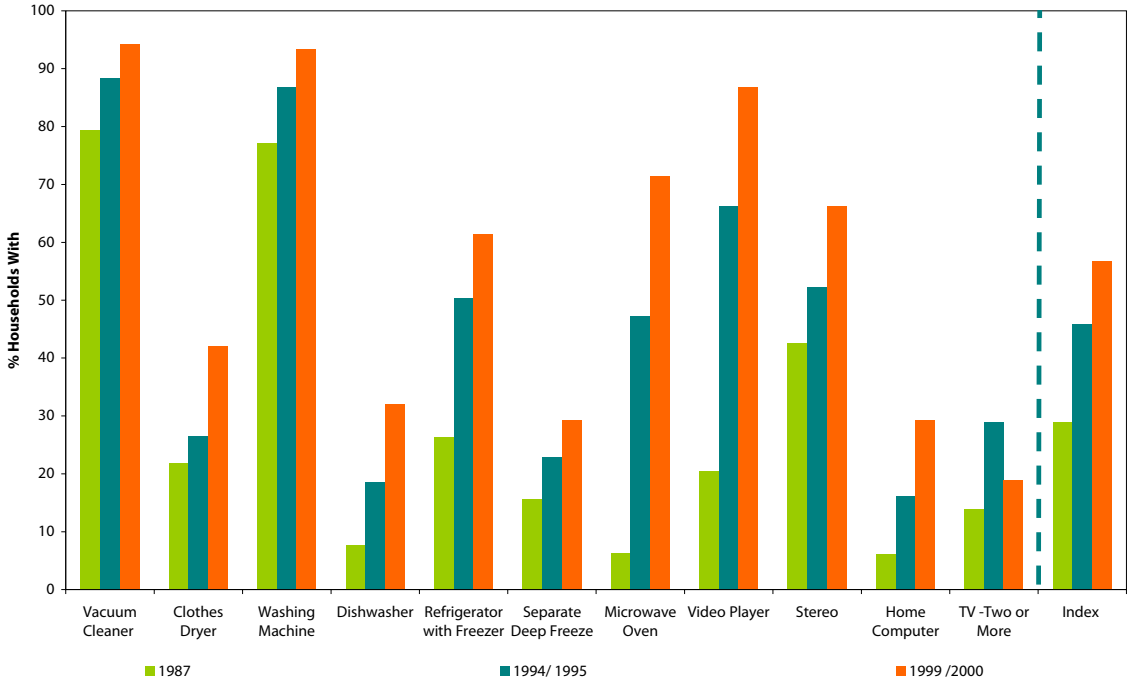
The proportion of households with one TV are not included because they were widespread at the beginning of the period, over 80% in 1987, so little useful information can be gathered by tracking their development. However, the HBS also collects data on the number of households with two or more TVs and this is included here making a total of eleven categories.

The index was constructed by adding together the percentage penetration of each appliance and dividing by the number of categories (eleven). Figure 4.18 and table 4.14 present the results of the analysis. Data for each appliance is shown for each of the three periods and the aggregate index is shown on the right of the dotted line.

The methodology does not take account of newer appliances such as satellite/ cable set top boxes, DVD players, games consoles or the wide range of convenience products such as electric blenders and toothbrushes but it does provide a trend which can be tracked over time. Another iteration of the HBS is currently in the field and this dataset will be updated once data from this becomes available in late 2006.

[93] Conniffe, D. 2000. *Household Energy Expenditures: Policy Relevant Information from the Household Budget Survey*. Available from ERSI, 4 Burlington Road, Dublin 4.

Figure 4.18: Penetration of Electrical Appliances 1987, 1994 /1995, 1999/2000



Source: CSO

Table 4.14: Penetration of Electrical Appliances 1987, 1994 /1995, 1999/2000

Appliance	1987 (%)	1994/1995 (%)	1999/2000 (%)	% Increase over the period
Vacuum Cleaner	79.4	88.4	94.2	18.6
Clothes Dryer	21.8	26.6	42	92.7
Washing Machine	77.1	86.8	93.4	21.1
Dishwasher	7.6	18.6	32	321.1
Refrigerator with Freezer	26.4	50.4	61.4	132.6
Separate Deep Freeze	15.7	22.8	29.2	86.0
Microwave Oven	6.3	47.2	71.5	1034.9
Video Player	20.5	66.2	86.9	323.9
Stereo	42.6	52.2	66.2	55.4
Home Computer	6.1	16.2	29.3	380.3
TV- Two or More	14.0	29.2	49.1	250.7
Index	28.9	45.9	59.6	106.4

Source: CSO

It can be seen that the penetration of all the electrical appliances shown in figure 4.18 has increased over the period with microwave ovens showing the largest increase (72% in 2000 compared with 6.3% in 1987). The index as a whole has risen from 28.9% to 59.6%.

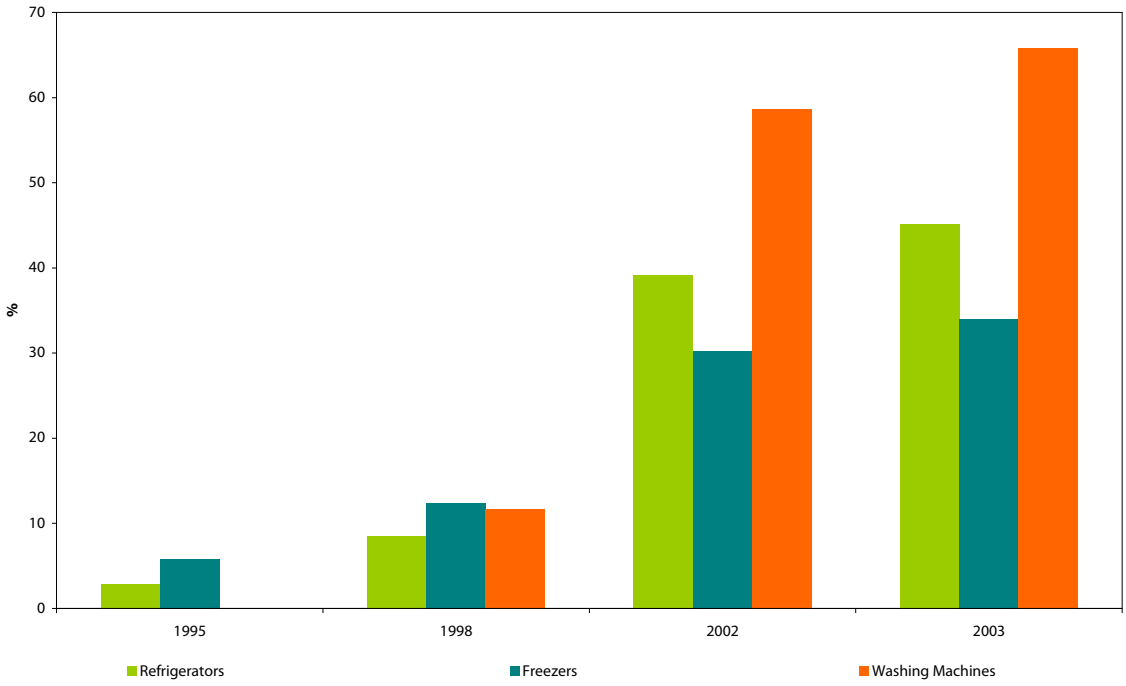
Disposable income will have an effect on the number of appliances purchased and it will be expected that the higher disposable income will lead to increased demand for appliances. Household disposable income (adjusted for inflation using CSO's Consumer Price Index, CPI) increased by 77% (5.9% per annum on average) over the period 1991 to 2001[94].

It can therefore be assumed that the increasing penetration of appliances will have had a significant effect on the demand for electricity. Some efficiency gains through technical improvements will have offset the demand for electricity. However it currently is not possible to quantify this. The labelling of appliances will also have helped inform choice.

[94] CSO 2001, 2004. *Household Incomes Regions and Counties*. Available from CSO, Skehard Road, Cork.

While data are not available separately for Ireland it is possible, using data from an EU funded project called Odyssee[95] to measure the market penetration of "A" label refrigerators, freezers and washing machines in the EU. Figure 4.19 illustrates the available data and it can be seen that the number of "A" grade appliances is growing significantly.

Figure 4.19: Market Share of "A" Label Appliances, Selected Years



Source: Odyssee

It has been previously shown that the demand for electricity has been increasing in recent years. One of the reasons for this is the increasing demand for electrical appliances which was discussed above.

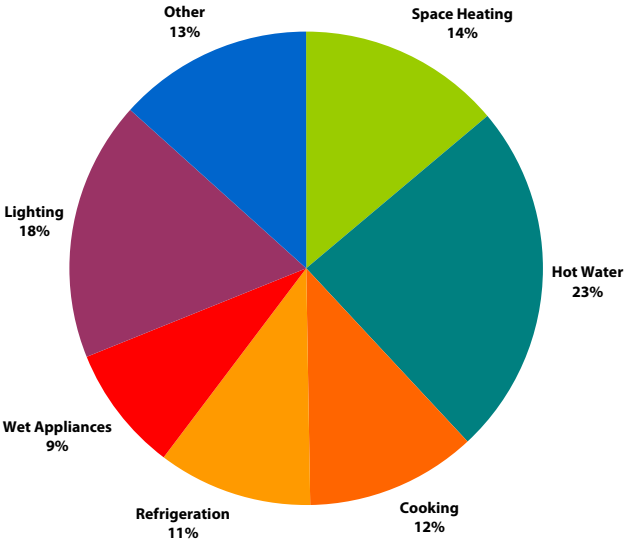
There was an increase in the number of dwellings using electricity for central heating in the 1990's but it has stabilised at a low level (4%) since 2000. To provide further understanding it is useful to examine the demand for all residential electricity services and it is possible using a new methodology[96] to do so now for the first time. The data in this section is more tentative than elsewhere in this report but it is based on the best information currently available.

The results of the analysis are presented in figure 4.20.

[95] ODYSSEE is a cross European project which develops and maintains a database of energy efficiency indicators. More information can be found at http://www.odyssee-indicators.org/

[96] Estimates for 2001 were made by an SEI working group in early 2005. These have been updated to 2004 for this report. Full details are available upon request.

Figure 4.20: Estimated Electricity End Use 2004



Source: SEI

7,350 GWh

The largest end use category is hot water which accounts for 23% of the total whereas the smallest category is wet appliances at 9%. Other, which includes the electricity used for TV's, DVD's electric kettles etc, accounts for 13% of the total. The category of wet appliances refers to washing machines, dishwashers and clothes dryers.

4.14 Improvements in Energy Efficiency

The increasing penetration of central heating and electrical appliances will be expected to increase the consumption of energy significantly, but as will be shown in detail in section 5 energy consumption per dwelling fell by 7.7% over the period 1990 to 2004. This implies that the stock of buildings has become more energy efficient. A key reason for this has been the various iterations of thermal energy standards.

Table 4.15[97] presents a basic comparison of normalised heating energy consumption of different age cohorts of Irish housing arising from progressive improvements in thermal standards introduced by DEHLG since 1979, accompanied by the installation of more efficient heating systems. It can be seen that there has been a significant decrease in the amount of energy required for heating over the period.

Table 4.15: Impact of Building Requirements

Date of Introduction	Change	Cumulative Change	Fuel Use for Heating, Relative to Base 1979
1979	-	-	100%
1982	-44%	-44%	56%
1992	-14%	-58%	42%
1997	-13%	-71%	29%
2003	-5%	-76%	24%

Source: SEI

The majority of dwellings were built before the introduction of energy specific building requirements (53% or 758,050 dwellings were built during or before 1981[98] (see table 4.8). As already seen in section 4.6 some of these dwellings have since been improved thermally by fitting or using energy efficient items.

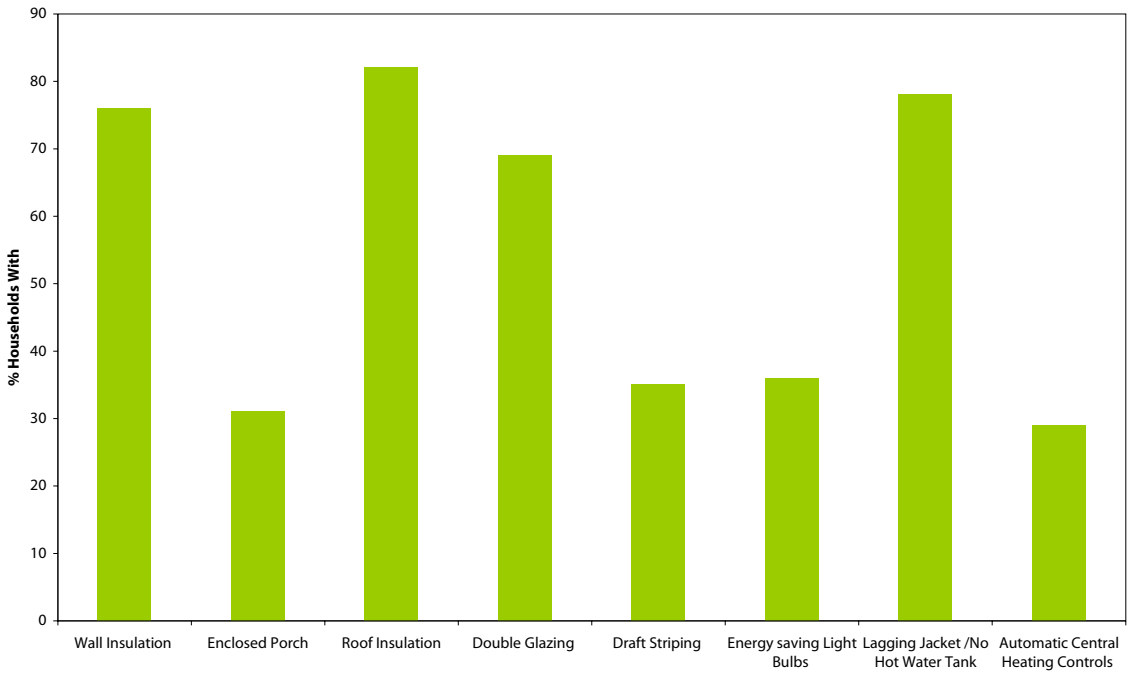
[97] SEI, 2002. *Home Energy Rating Scheme Programme Strategy, Consultation Draft.* Available from http://www.irish-energy.ie/uploads/documents/upload/publications/herstrategy_consultation_4oct02.doc

[98] As mentioned in section 4.5 the first thermal insulation requirements came into effect in 1979 while draft energy regulations were introduced in 1976.

Figure 4.21 shows the incidence of energy efficient items using data from the INSHQ. Data are only available for one year, 2002[99]. It can be seen that a high proportion of dwellings have insulation[100], either wall (76%) or roof (82%) while 69% have double glazing. The penetration of automatic timed central heating controls is lower at 29% which suggests scope for improvement as does 38% for energy saving light bulbs. To complete the picture, 31% have an enclosed porch, 35% have draft striping and 78% have a lagging jacket or have no hot water tank.

The actual amount of energy that has been saved as a result of the introduction of energy saving items cannot be currently quantified and is an area where further study is required.

Figure 4.21: Energy Saving Items 2002



Source: ESRI

[99] The CSO published a module of the Quarterly National Housing Survey in 1998 which provided the penetration rates for roof insulation, double glazing, draught stripping and CFL light bulbs. This data seems to be contradictory to that in the INSHQ and it was decided not to compare datasets but just to use data from the newer survey.
[100] Data on the depth of insulation is not available.

5 Energy Efficiency in the Residential Sector

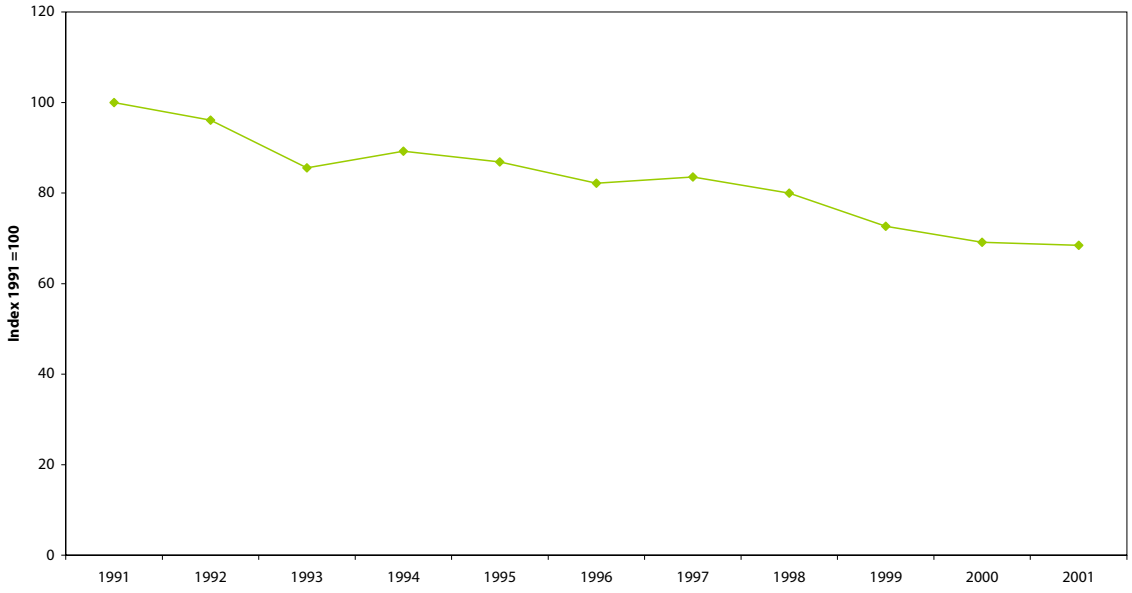
Having examined energy consumption trends (section 2) and the profile/ structure of the housing stock as well as the underlying factors behind energy consumption (section 4) this section presents a selection of energy efficiency indicators. These indicators can be used to link the data sets in order to shed further light on the factors behind energy consumption trends.

5.1 Energy Intensity

Intensity in the residential sector can be measured by relating energy to population, number of dwellings and household disposable income[101]. Figure 5.1 shows an index of climate corrected[102] energy consumption related to household disposable income (adjusted for inflation using CSO's Consumer Price Index, CPI). The index covers the period 1991 to 2001 as disposable income data are only available for that period.

The index of energy consumption to household disposable income decreased by 32% (a reduction of 3.7% per annum). In order words, the rate of increase of household disposable income is growing at a faster rate that the rate of residential sector energy consumption.

Figure 5.1: Residential Energy Consumption versus Household Disposable Income 1991 to 2001



Source: Based on SEI and CSO Data

Figure 5.2 tracks the relationship between (climate corrected) energy consumption and the number of dwellings and between energy consumption and population for the period 1990 to 2004. Over the period as a whole the ratio of energy consumption to population increased by 12% (0.8% per annum). This indicates that residential energy consumption per capita is increasing. This can be partly explained by a reduction in the average number of persons per dwelling and the increasing use of appliances which was discussed in section 4.12. The trend fell in early 1990's possibly as a result of fuel switching.

The ratio for energy consumption to the number of dwellings fell by 9.3% (0.7% per annum) over the period which implies that the stock of dwellings has become less energy intensive, partly as a result of improved insulation standards.

[101] Over the period 1991 to 2001 household disposable income (deflated using CSO's Consumer Price Index (CPI)) increased from €25 billion in 1991 to €45 billion in 2001, an increase of 77% or 5.9% per annum on average.

[102] Data are climate corrected using degree days where degree days are a measure or index used to take account of the severity of the weather when looking at energy consumption in terms of heating (or cooling) "load" on a building. A degree day is an expression of how cold (or warm) it is outside, relative to a day on which little or no heating (or cooling) would be required. It is thus a measure of cumulative temperature deficit (or surplus) of the outdoor temperature relative to a neutral target temperature (base temperature) at which no heating or cooling would be required.

Figure 5.2: Residential Energy Consumption versus Population and Number of Dwellings 1990 to 2004

Source: SEI and CSO

5.2 Unit Consumption

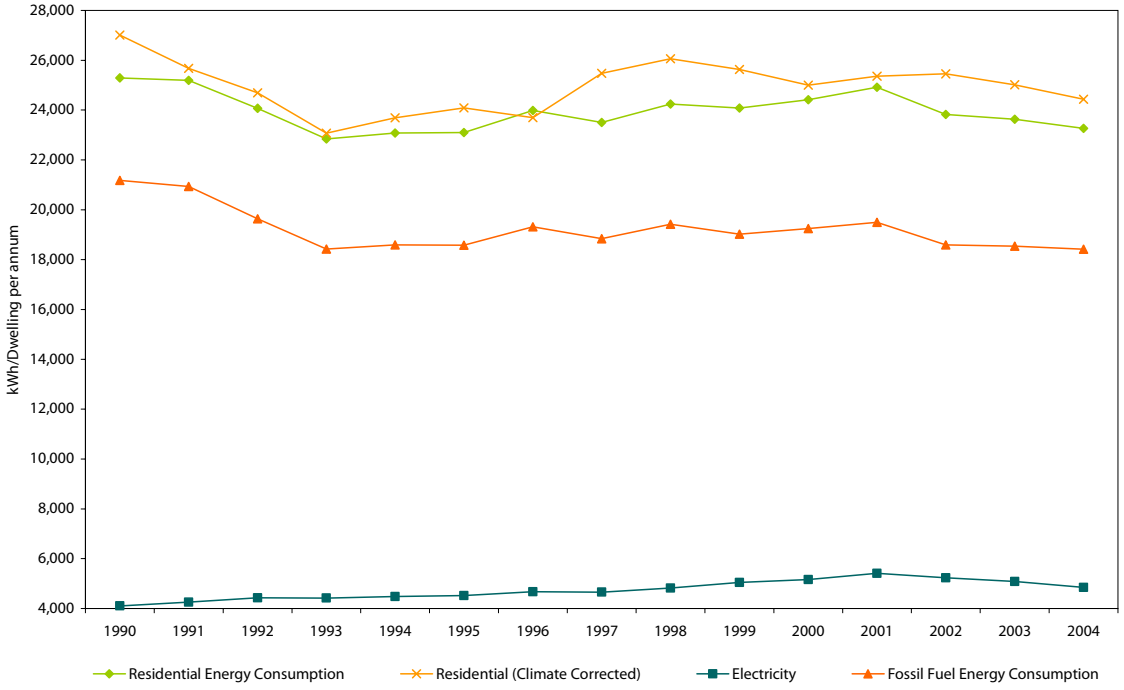
Unit consumption of energy or the amount of energy consumed per permanently occupied dwelling is shown in figure 5.3 and it can be seen that the trend in energy consumption per dwelling decreased by 7.7% during the period 1990 to 2004. In this section dwelling data is that seen in section 4.1.

While overall unit energy consumption per dwelling has decreased, figure 5.3 also shows an increasing trend in electricity consumption per dwelling. This has increased by 25% since 1990. The increasing penetration of household electrical appliances (seen in section 4.12) such as washing machines, dishwashers, clothes driers, computers and multiple televisions as well as convenience appliances is believed to have contributed to this increase. In contrast, fossil fuel consumption per dwelling has deceased by 13% over the period.

In 2004 the "average" dwelling consumed a total of 24,499 kWh of energy based on climate corrected data. This was comprised of 19,340 kWh (79%) in the form of direct fossil fuels and the remainder (5,159 kWh) as electricity.

Figure 5.3 also shows overall unit energy consumption per dwelling, corrected for climate variations. Looking at this and in conjunction with table 5.1, it can be seen that the decrease in climate corrected energy consumption per dwelling over the period was 9.3% while the uncorrected energy consumption decrease was 7.7%. It can be seen that most of the improvement in unit consumption occurred during the early 1990s.

Figure 5.3: Unit Consumption of Energy per Dwelling 1990 to 2004



Source: Based on SEI, CSO and Met Éireann data

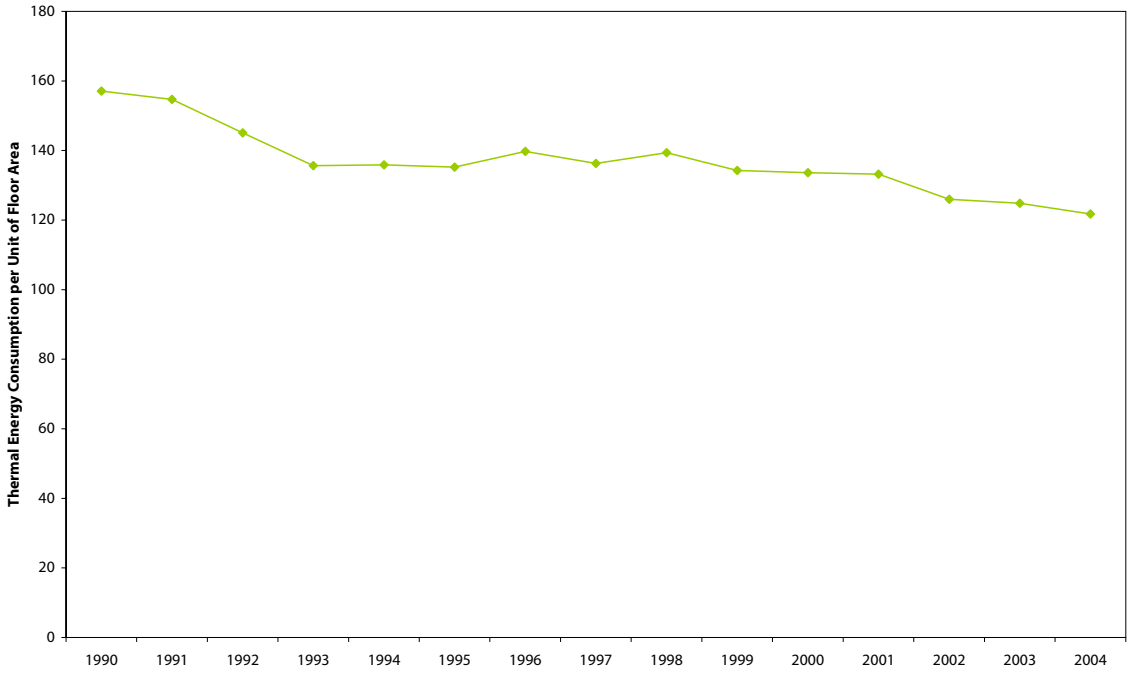
This reduction in overall and fossil fuel energy may be explained by changes in fuel mix (discussed previously in section 2) and improvements in efficiency i.e. the move away from open fires and back boilers fuelled by solid fuels to gas and oil heating. Another factor is the improvement in the energy performance of the building stock brought about by various iterations of building requirements.

It is possible using a new methodology to examine the trend in thermal consumption per square metre. Using the estimates of floor area (section 4.5), the number of permanently occupied dwellings (section 4.1) and an estimate of energy consumption for space heating[103] data for thermal consumption per square metre is presented in figure 5.4 for the period 1990 to 2004.

It can be seen that over the period thermal energy consumption per square metre fell by 26% (4.1% per annum on average). This suggests that the stock of dwellings has become more efficient over the period.

[103] It is assumed that 75% of fossil fuels and 5% of electricity is used for space heating.

Figure 5.4: Thermal Energy Consumption per Square Metre1990 to 2004



Source: Based on SEI and CSO Data

Table 5.1: Growth Rates of Residential Unit Energy Consumption and Unit CO_2 Emissions

	Growth %	Average Annual Growth Rates %				
	1990 – '04	1990 – '04	1990 – '95	1995 – '00	2000 – '04	2004
Unit Energy Consumption						
Total Energy	-7.7	-0.6	-1.8	1.1	-1.1	-1.2
Total Energy Climate Corrected	-9.3	-0.7	-2.3	0.7	-0.5	-2.1
Fossil Fuel Energy	-13.9	-1.1	-2.6	0.7	-1.3	-1.7
Electrical Energy	24.5	1.6	2.0	2.7	-0.3	0.4
Unit Energy-Related CO_2 Emissions Climate Corrected						
Total Energy CO_2	-25.9	-2.1	-2.5	-0.9	-3.1	-5.0
Fossil Fuel CO_2	-31.3	-2.6	-4.7	-1.4	-1.5	-5.7
Electricity CO_2	-15.5	-1.2	1.3	-0.2	-5.4	-3.8

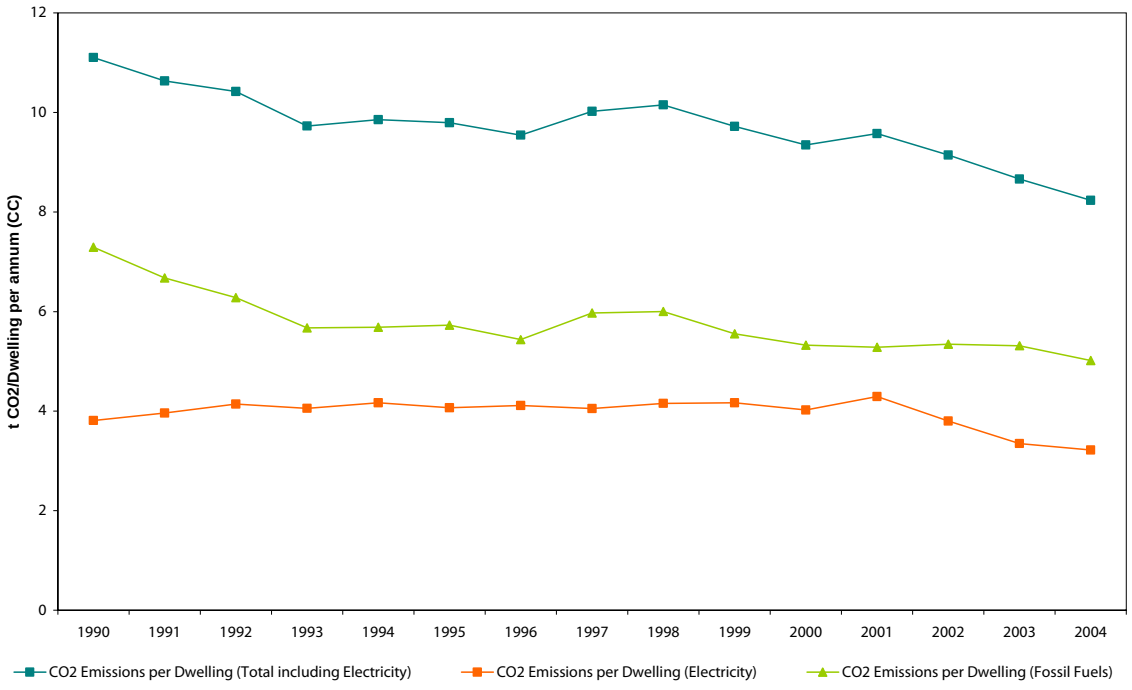
Source: Based on SEI, CSO and Met Éireann data

Examining table 5.1 and figure 5.5 it is evident that over the period 1990 to 2004 the climate corrected emissions of energy-related CO_2 per dwelling decreased by 26%. This was considerably faster than the rate of reduction for unit energy consumption. Unit fuel CO_2 emission levels decreased by 31% over the period as a result of consumers switching away from coal and peat to lower CO_2 emitting fuels such as gas and oil account for the different trends in unit CO_2 emissions and energy consumption.

Emissions associated with the use of electricity per dwelling fell by 16% over the period, despite the 25% increase in electricity consumption. This is an indirect result of the reduced carbon intensity of electricity generation. This was particularly the case since 2002 when high efficiency Combined Cycle Gas Turbine (CCGT) plants were brought on line. The increasing use of electrical appliances will, however, have offset some of the gains.

In 2004 the "average" dwelling was responsible for emitting approximately 8.2 tonnes of CO_2. A total of 5 tonnes CO_2 (61%) was from direct fuel use and the remainder arising indirectly from electricity use.

Figure 5.5: Unit Energy-Related CO_2 Emissions per Dwelling Climate Corrected 1990 to 2004



Source: Based on SEI and CSO Data

6 International Comparison

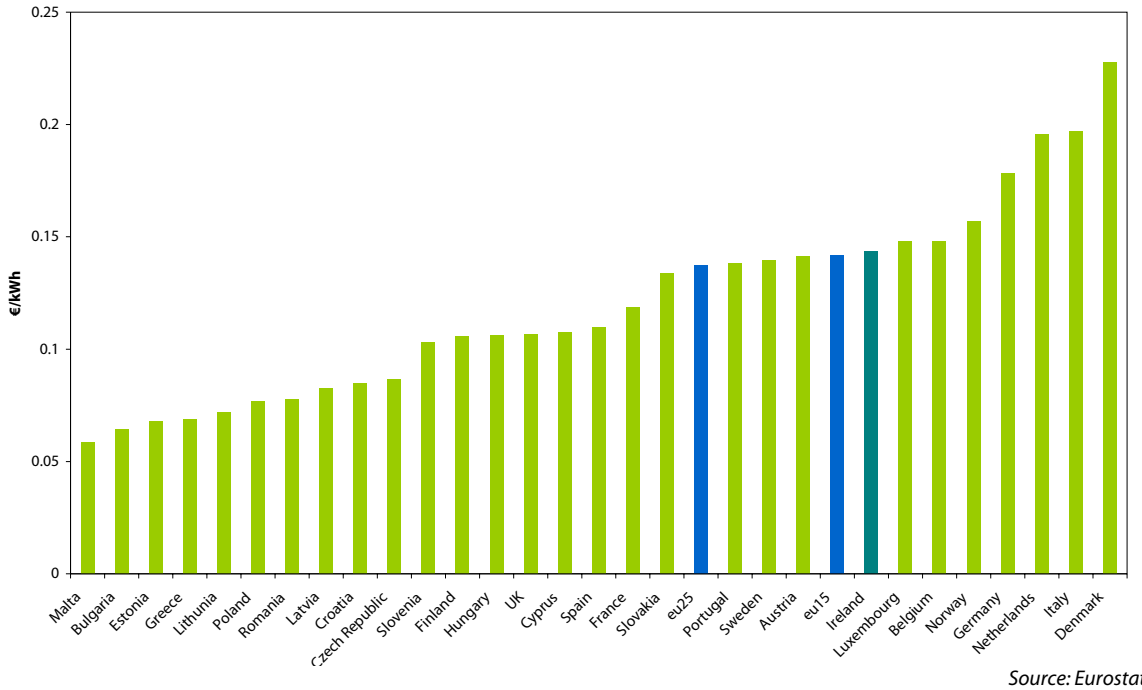
In this section trends in the residential sector in Ireland are compared with trends internationally, using data from the EU Odyssee[104] project and Eurostat[105].

6.1 Household Fuel Prices

The trend in fuel prices for Ireland was discussed in section 4.9. This section compares fuel prices (inclusive of taxes) in Ireland with the EU average and with other European counties.

Figure 6.1 presents household electricity prices for January 2005 and it can be seen that Ireland was the 8th most expensive of the counties shown. Prices in Ireland were slightly higher than the EU 15 and EU 25 average.

Figure 6.1: Residential Sector Electricity Price in Europe (January 2005)



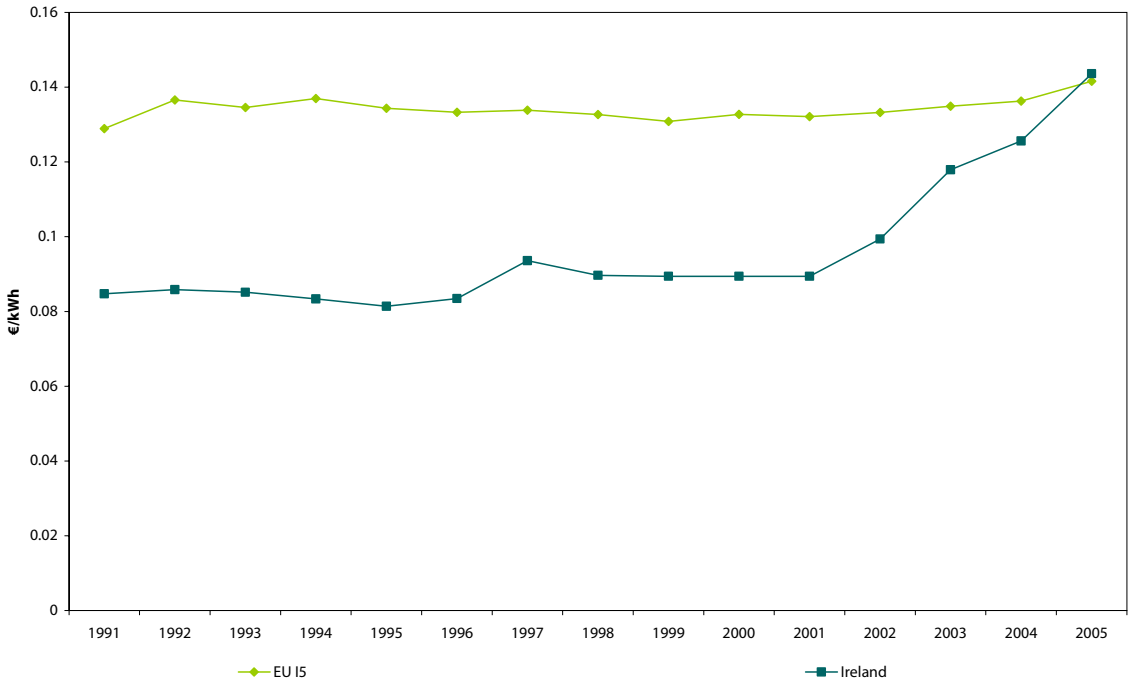
Source: Eurostat

Figure 6.2 presents a comparison between the EU (15) average electricity prices and prices for Ireland for the period 1991 to January 2005. Household electricity prices in Ireland were lower than the EU average from 1991 to 2004 but were slightly more expensive in at the start of 2005. In 1991 electricity prices in Ireland were 35% below the EU average while in 2005 they were 1.4% above. Over the period 1991 to 2005 electricity prices in Ireland rose by 69% (3.8% per annum on average) while the EU average increased by 9.9% (0.7% per annum).

The Commission for Energy Regulation (CER) in September 2005 sanctioned a 3.1% increase in the residential sector price of electricity. The increase will apply from January 2006[106].

[104] ODYSSEE is a cross European project which develops and maintains a database of energy efficiency indicators. More information can be found at http://www.odyssee-indicators.org/
[105] See http://epp.eurostat.cec.eu.int/portal/page?_pageid=1090,30070682,1090_33076576&_dad=portal&_schema=PORTAL
[106] More information can be found at www.cer.ie.

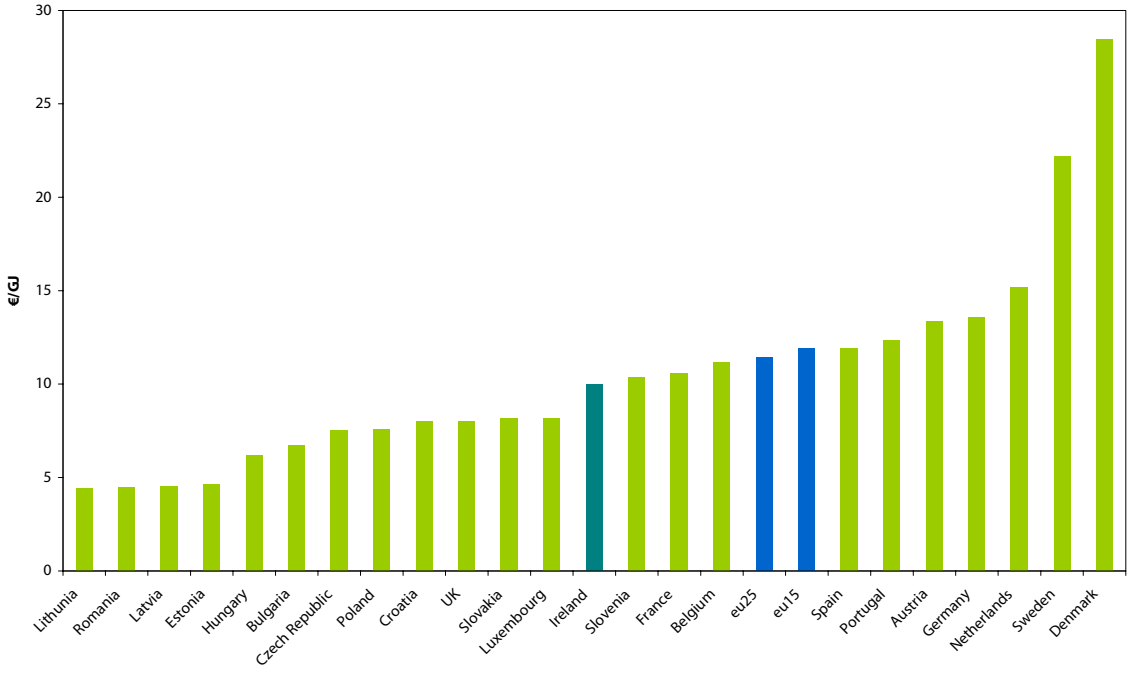
Figure 6.2: Residential Sector Electricity Prices[107] 1991 to 2005



Source: Eurostat

Household gas prices for European counties are shown in figure 6.3 and it can be seen that in January 2005 prices in Ireland were slightly below the average for the EU 15 and EU 25.

Figure 6.3: Residential Sector Natural Gas Prices in Europe (January 2005) [108]



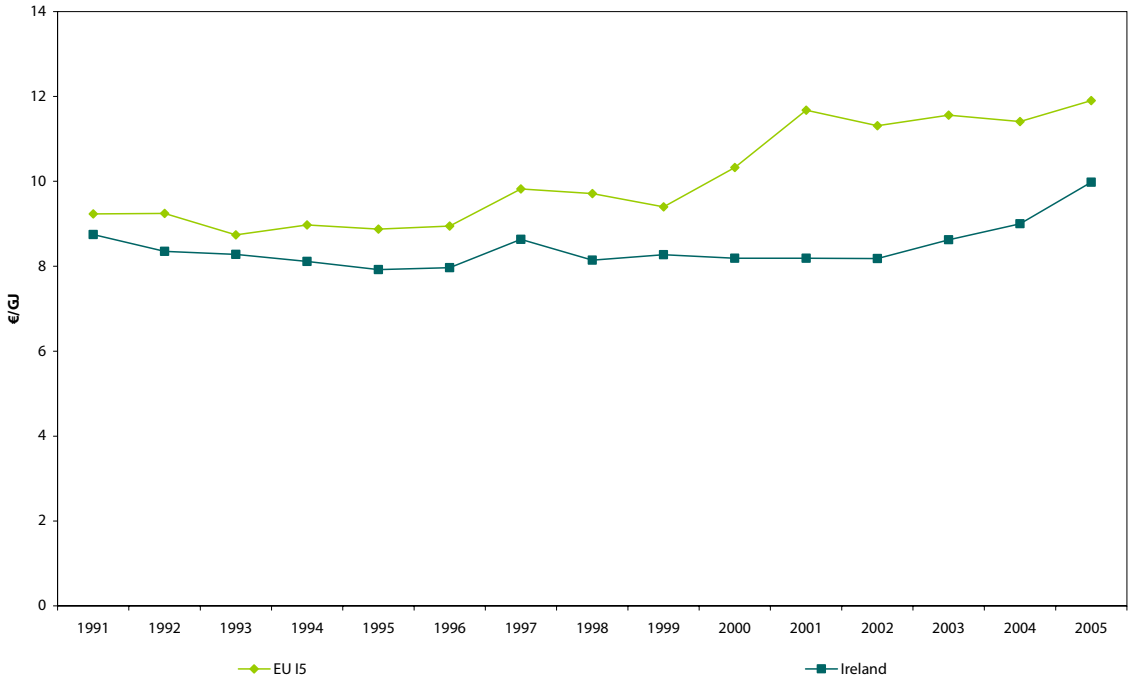
Source: Eurostat

[107] Eurostat consumption category 4161150 Households - Dc (Annual consumption: 3 500 kWh of which night 1 300).
[108] Eurostat consumption category D3 (87.3GJ/annum).

The trend in natural gas prices is shown in figure 6.4 for the EU (15) and Ireland for the period 1991 to January 2005. It can be seen that the natural gas prices were in Ireland were below the EU average from 1991 to 2005. The greatest difference occurred in 2001 when prices in Ireland were 30% below the EU average.

Over the period 1991 to 2005 natural gas prices in Ireland rose by 14% (0.9% per annum) while the average for the EU increased by 29% (1.8% per annum). The CER in September 2005 announced a 25.26% increase in the residential sector price of natural gas. The increase will apply from October 2005.

Figure 6.4 Residential Sector Natural Gas Prices 1991 to 2005

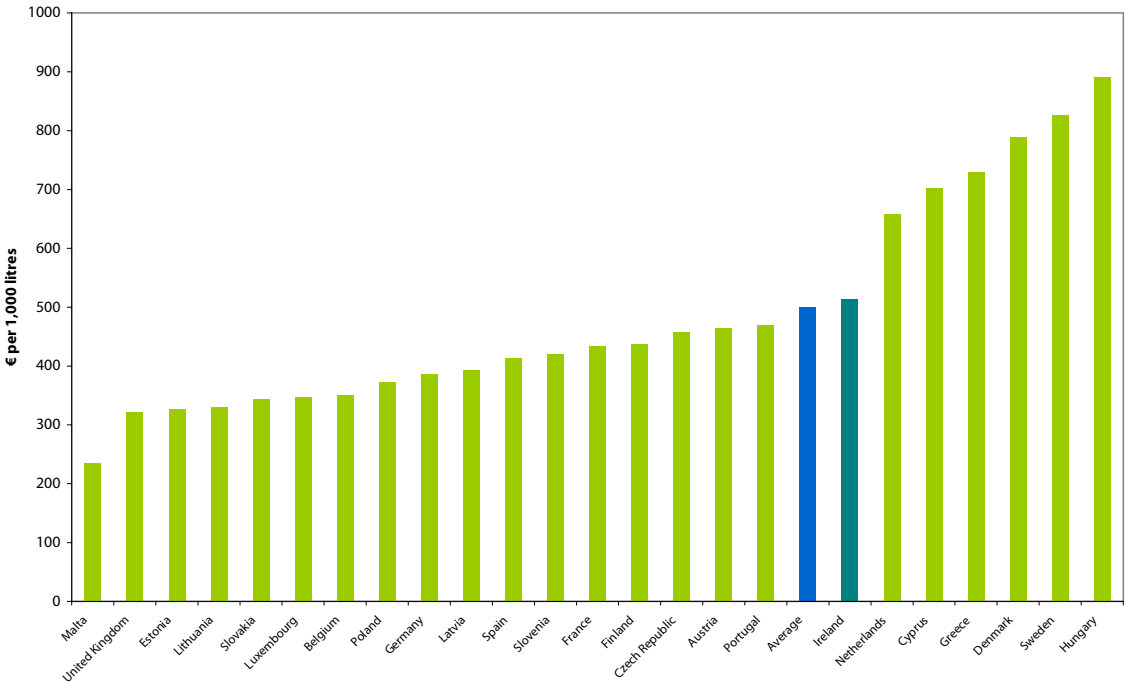


Source: Eurostat

Figure 6.5 presents household heating oil prices for a selection of European countries for July 2004. It can be seen that prices in Ireland were the 8th most expensive of the countries shown. The average of the countries shown was €500 per 1000 litres. Ireland was 2.6% above the average in 2004. Unfortunately, a time series of EU averages is not available so a comparison cannot be made.

It is worth noting that the data in figure 6.5 predates the recent (Summer/ Autumn 2005) increases in oil prices. International data is not available at the time of writing to compare the impact of these increases.

Figure 6.5: Residential Sector Heating Oil Prices in Europe (July 2004)



Source: Eurostat

6.2 Unit Consumption

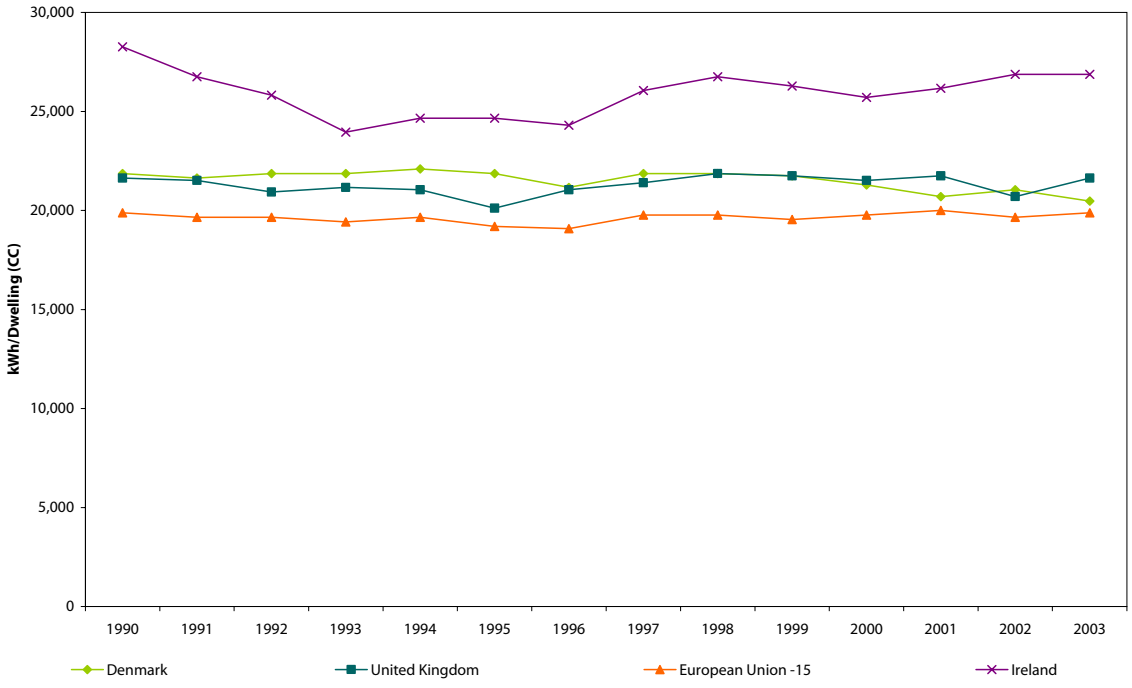
Section 5.2 presented the consumption of energy per dwelling for Ireland. It is possible using the Odyssee database[109] of energy efficiency indicators to compare the situation in Ireland with the EU-15 average and for other European counties. Data in this section is not directly comparable with the data presented elsewhere in this report due to differing methodologies and emission factors. However it is useful for inter country comparisons.

Energy consumption per dwelling (climate corrected for each country) is presented in figure 6.6 for Ireland, Denmark, the UK and for the European Union over the period 1990 to 2003.

It can be seen that Ireland had the highest consumption per dwelling in 1990 and 2003. Ireland was 35% above EU-15 average in 2003 and was 42% above in 1990. The reason why Ireland has such a high level of consumption in comparison with the EU average and the other countries is not clear. It is an area where further study is required.

[109] ODYSSEE is a cross European project which develops and maintains a database of energy efficiency indicators. More information can be found at http://www.odyssee-indicators.org/

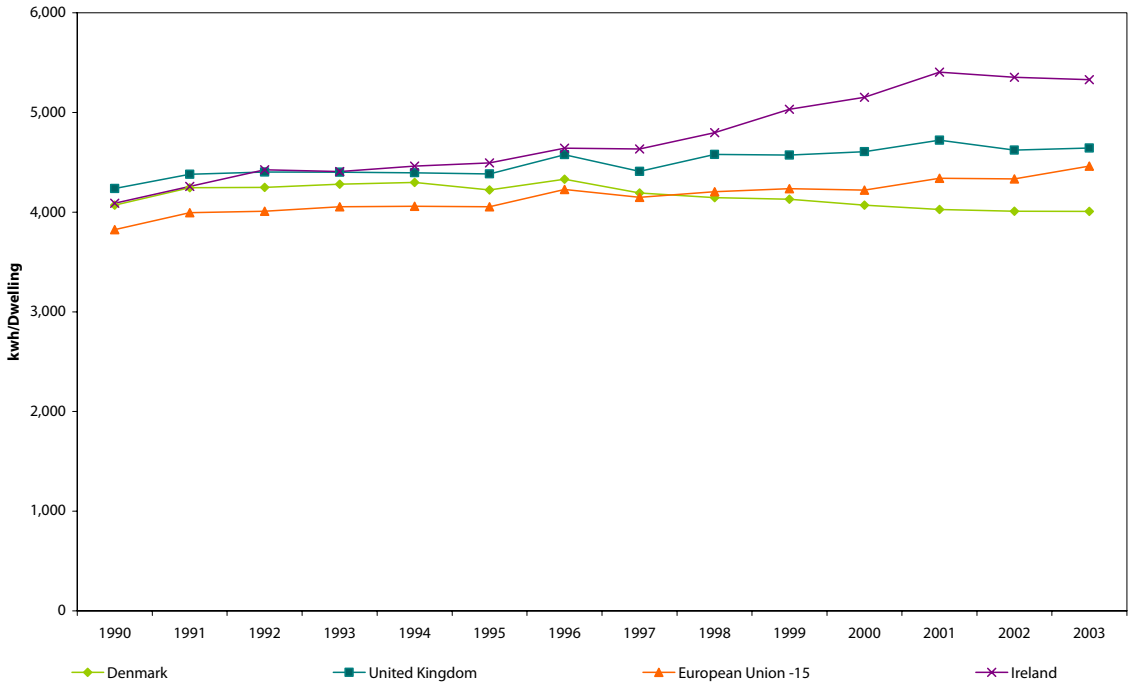
Figure 6.6: Energy Consumption per Dwelling in Europe 1990 to 2003



Source: Odyssee

Figure 6.7 presents climate corrected consumption per dwelling of electricity for the period 1990 to 2003. Of the countries shown Ireland had the highest consumption of electricity per dwelling for most of the period but particularly from the mid 1990s. In 2003 consumption of electricity in Ireland was 19% above the EU-15 average. Again, the specific reasons for this are unknown and therefore further analysis is required.

Figure 6.7: Electricity Consumption per Dwelling in Europe 1990 to 2003

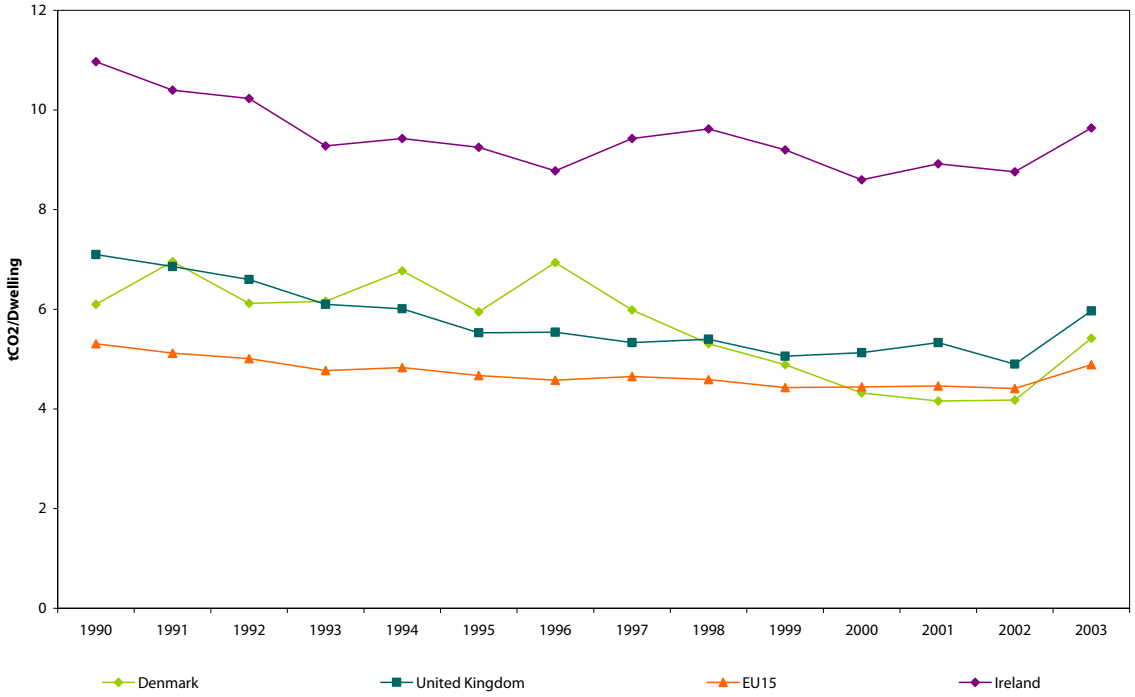


Source: Odyssee

Figure 6.8 presents climate corrected CO_2 emissions per dwelling for selected countries and for the EU as a whole. Of the countries shown, Ireland had the highest energy related emissions per dwelling in 2003 and was 97% above the EU-15 average.

One of the reasons that emissions per dwelling are high in Ireland compared to other EU countries is because of the large amount of electricity that is consumed here. Furthermore electricity generated in many EU countries has a lower carbon content as there is a higher amount of wind, hydro and nuclear used for electricity generation. These are possible explanations but this is an area where further study is required.

Figure 6.8: Energy Related CO_2 Emissions per Dwelling in Europe1990 to 2003



Source: Odyssee

7 Conclusions

The residential sector consumes a significant amount of energy in Ireland, accounting for 26% (3,842 ktoe) of Ireland's primary energy consumption in 2004. The sector was responsible for 27% (11,376 kt CO_2) of energy-related CO_2 emissions, making it the second largest sector after transport (32%).

The average spend (current prices) on energy per permanently occupied dwelling in 2004 was €1,513, which was an increase of 12% on 2003 and 45% on 1990. The total spent on energy by the sector in 2004 was €2.2 billion.

Given that the sector is responsible for a significant proportion of Ireland's energy requirement and, in turn, energy related emissions there is a clear incentive for policy makers to implement programmes that improve energy efficiency. Timely and comprehensive data on energy trends is needed in order to inform policy development and it is the aim of this report to provide such data.

This report provides a profile of the residential sector, as well as tracking energy consumption trends and analyses the key issues that affect residential sector energy consumption in Ireland. This is the first time that such an exercise has been conducted for Ireland.

Over the period 1990 to 2004 there was a close relationship between the rate of growth by the stock of dwellings (43%) and residential sector final energy consumption (32%) although the stock of dwellings increased at a slightly faster rate, particularly since 2001. The amount of energy consumed per permanently occupied dwelling decreased by 7.7% during the period 1990 to 2004. The last two points indicate that efficiency gains have been made in the sector.

The report found that a wide rage of factors have contributed to these efficiency gains in the sector, notably fuel switching, the various iterations of the building requirements, changing occupancy patterns etc.

In analysing the residential sector the report compiled data from a wide range of sources and new information, for example estimates of consumption of energy per unit of floor area and climate corrected energy efficiency and CO_2 indicators were presented.

The report identifies key data gaps that need to be filled in order to have a comprehensive understanding of energy and CO_2 trends. For example, further research is also required to assess the extent that retrofitting has had on the efficiency of the housing stock. Also it is currently unclear why Ireland has higher consumption of energy, electricity and energy related CO_2 emissions per dwelling compared to the average for the EU-15.

This report is intended to be a first step in an ongoing process to develop and improve energy statistics in the residential sector.

Data Sources

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