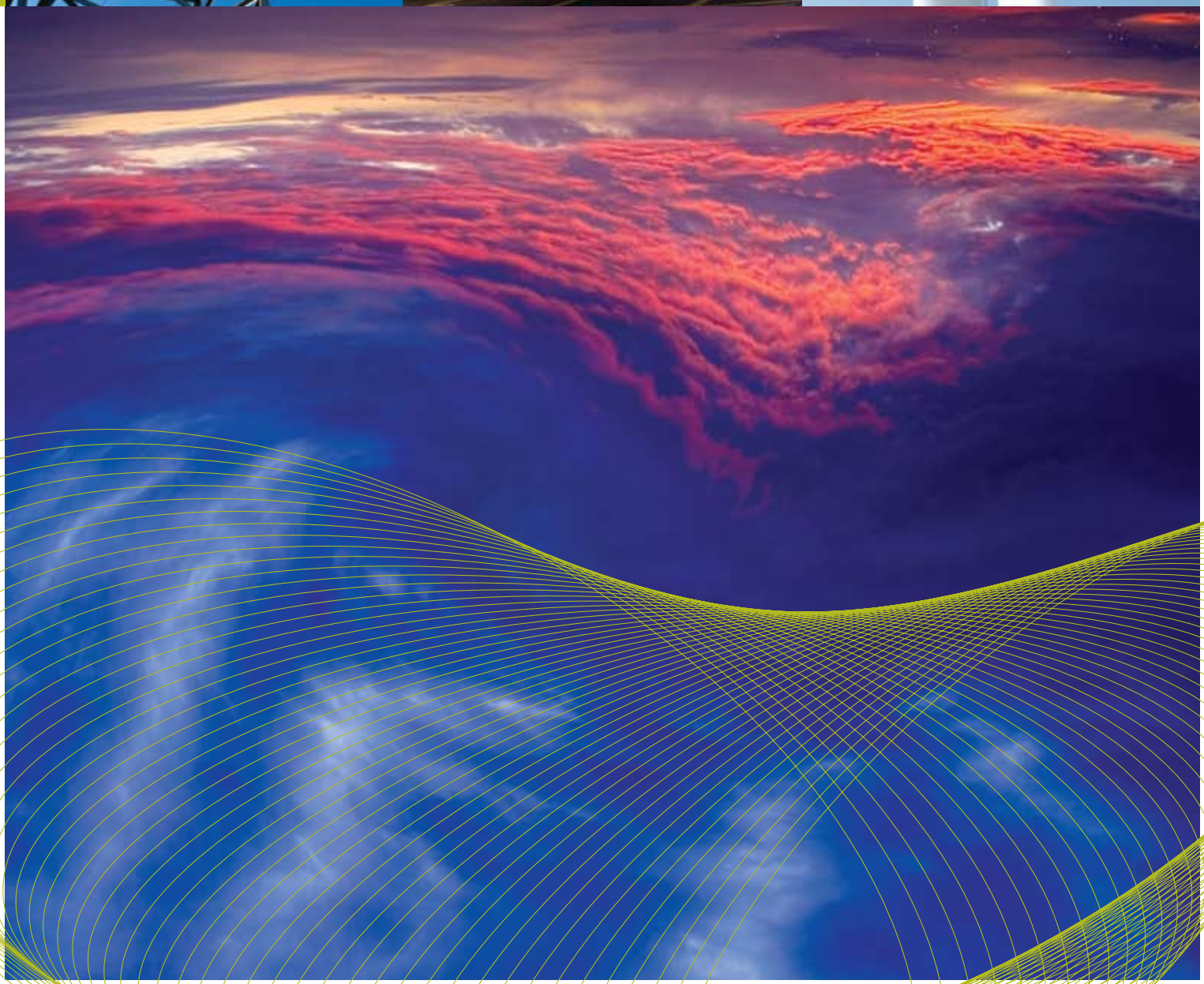
SUSTAINABLE ENERGY IRELAND

Energy Policy Statistical Support Unit

Energy in Ireland 1990 - 2008

2009 REPORT



Energy in Ireland 1990 – 2008

2009 Report

Report prepared by
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December 2009

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Sustainable Energy Ireland

Sustainable Energy Ireland was established as Ireland's national energy authority under the Sustainable Energy Act 2002. SEI's mission is to promote and assist the development of sustainable energy. This encompasses environmentally and economically sustainable production, supply and use of energy, in support of government policy, across all sectors of the economy including public bodies, the business sector, local communities and individual consumers. Its remit relates mainly to improving energy efficiency, advancing the development and competitive deployment of renewable sources of energy and combined heat and power, and reducing the environmental impact of energy production and use, particularly in respect of greenhouse-gas emissions.

SEI is charged with implementing significant aspects of government policy on sustainable energy and the climate change abatement, including:

- Assisting deployment of superior energy technologies in each sector as required;
- Raising awareness and providing information, advice and publicity on best practice;
- Stimulating research, development and demonstration;
- Stimulating preparation of necessary standards and codes;
- Publishing statistics and projections on sustainable energy and achievement of targets.

It is funded by the Government through the National Development Plan; programmes are part-financed by the European Union.

Energy Policy Statistical Support Unit (EPSSU)

SEI has a lead role in developing and maintaining comprehensive national and sectoral statistics for energy production, transformation and end use. This data is a vital input in meeting international reporting obligations, for advising policy makers and informing investment decisions. Based in Cork, EPSSU is SEI's specialist statistics team. Its core functions are to:

- Collect, process and publish energy statistics to support policy analysis and development in line with national needs and international obligations;
- Conduct statistical and economic analyses of energy services sectors and sustainable energy options;
- Contribute to the development and promulgation of appropriate sustainability indicators.

Foreword


Prof J Owen Lewis

Ireland is facing a period of challenge and opportunity as we map and develop our nation's energy policy, the impact of which will be felt for generations to come. *Energy in Ireland 1990 – 2008* is a report of significance, revealing new insights on what drives Ireland's energy demand. It details a key period in our use of energy, covering the boom years of Ireland's economy, and then reveals the first significant changes on foot of the dramatic economic changes that started to take hold in 2007/'08.

A number of interesting characteristics are revealed. 2008 was a seminal year for energy usage, where demand in some sectors decreased, but overall demand increased. It reveals where economic linkages are strongest and where other factors, such as the climate's effect on heating demand, are seen to be influential. Particular areas where economic change brought energy demand reduction include freight transport, and manufacturing. This tells us something about some of the key drivers of our patterns of energy use.

This report highlights that climate change is inextricably linked to our everyday actions, our lifestyles, our business transactions and the wider economic activity of our country. For me, this underscores the opportunity that lies within sustainable energy technologies and practices. The positive actions we are taking today are already having a beneficial effect on the Ireland of tomorrow.

The strong link between economic activity and energy usage is instructive, highlighting the centrality of energy to economic growth. The key issue now is what will happen when we come out of this recession? It is critical that the return to economic growth is not matched by a corresponding growth in energy demand. The two must be fundamentally decoupled so that Ireland's future economic successes are not undermined by deteriorating environmental patterns and unsustainable energy usage.

Thankfully, there is growing appreciation of the absolute centrality of energy efficiency in any sustainable future. Across every facet of Irish life, individuals are getting behind energy efficiency measures like never before. Economic pressures have played their role in incentivising people to save money through smarter use of energy, but awareness of the necessity of living more sustainably is increasing every day.

Enterprises throughout Ireland, from corner shops to our largest industrial sites, are tackling energy waste in their businesses and creating innovative solutions to energy challenges. SEI as the national energy authority has worked with almost 2,000 businesses of all kinds in the past two years and we know that even small business owners are seeing the tangible benefits of better use of energy in their businesses. Our large industrial users continue to push the boundaries of what is possible within their businesses, and corporate Ireland is focused on energy efficiency like never before.

Similarly, householders are increasingly aware of the benefits of improving the energy performance of their homes. SEI, through the national Home Energy Saving scheme, has offered grants to almost 35,000 householders for energy efficiency upgrades in 2009 alone. Given the large proportion of Irish homes that were built prior to the introduction of building regulations, significant opportunities exist for improving the energy performance of the building stock. This will require an increasing focus to spread and deepen retrofit activity across society at a scale well beyond what we have achieved to date.

Our work shows that there are huge gains to be made through actions that create jobs, reduce costs, reduce imports and importantly, reduce emissions as we make the inevitable and essential transition to a low carbon society.

This is positive and encouraging, but it is also just the start of a journey. It is clear that a new scale of ambition is needed to build on what we have learned so as to thrust Ireland into the forefront of the clean green revolution.

Every single business in Ireland needs to have energy efficiency at its core. And every home and homeowner needs to adopt low carbon energy technologies as a way of life, no different to ensuring that our waste is recycled and water conserved. What we can all do differently as individuals is one side of the story. The other dimension is the green business

opportunity –what innovations and new technology we can create that will harness the natural energy around us, from wind to wave to biofuels.

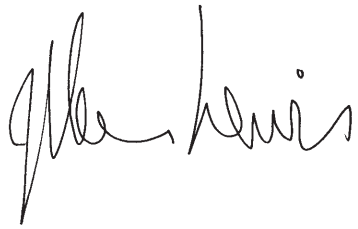
The penetration of renewable sources in energy supply is a huge story for Ireland. Wind energy deployment continues to grow and has the potential to be a major success story for Ireland as we enjoy the advantage of having the best wind resources in Europe. The rapidly growing contribution of wind to Ireland's electricity network is playing a key role in increasing the viability of a large scale deployment of electric vehicles, which are ideally suited to using this variable energy supply. The infrastructure for electric vehicles is being put in place as well, and this going to lead to further increases in consumer demand for energy efficient cars. Biofuels, which are about to start featuring significantly in the transport fuel mix, also have their part to play.

Ocean technologies, where we enjoy global advantage, continue to show strong promise and Irish companies, with the support of SEI, are pioneering the technologies to make this area a viable reality. We also need to ensure that renewable heat is not neglected –this is an important area that needs more attention. SEI intends to build on the impacts of, and learnings from, the extensive activity in renewable heat in homes and businesses. Again, the mission is to build on solid foundations to a new level of activity and impact.

Of course, all these areas create opportunities for Irish entrepreneurs, large and small. The many technological and business innovations that will drive both energy efficiency and renewable supply are huge enterprise opportunities. Markets will be global for those who find ways to address the energy and emissions challenges that every country in the world is now facing.

Ireland has significant competitive advantage here. We are of a scale that allows us to innovate quickly, and we are already seen by many global companies as a potential test-bed location for new technologies such as ocean energy and electric vehicles. Also, the nature of new cleantech solutions coincides with our enterprise strengths –information technology, software, communications, and knowledge-led services. These strengths can be the bedrock of our future prosperity and equip us to emerge as leaders in the creation and deployment of energy efficient and renewable technologies.

The alternative is to stay still and wait for another country to sell the solutions to us: –we should not allow this to come to pass. The world is moving inexorably towards carbon-free energy and SEI is firmly focused on ensuring that Ireland is to the forefront of this historic transition, supporting innovation and enterprise for a low carbon Ireland.



Prof J Owen Lewis
Chief Executive
Sustainable Energy Ireland

Highlights

Highlights – the year 2008

- Ireland's economy contracted by 3% in 2008. Energy demand grew by 1.5% and energy-related CO_2 emissions increased by 1.3%.
- Energy-related CO_2 emissions fell by 4.6% in industry and transport recorded a 1.9% reduction in emissions in 2008 compared with 2007. These sectors' energy use is more directly coupled with economic growth.
- Energy-related CO_2 emissions increased by 9.7% in the services sector and 8.8% in the residential sector. One significant factor here was the reduction in external temperatures during 2008, i.e. a return to normal weather in 2008 after a mild year in 2007.
- Imported oil and gas accounted for 81% of energy supply and Ireland's overall import dependency was 89% in 2008.

Highlights 2005 – 2008

- Since 2005, energy-related CO_2 emissions have increased by 0.2% per annum (excluding international aviation), while the economy has grown by 2.8% per annum. In contrast, over the period since 1990, energy-related CO_2 emissions grew by 2.2% per annum, while the economy grew by 5.9% per annum.
- The average annual growth in 2005 – 2008 was 8.9% for natural gas and 16% for renewable energy, while oil has reduced by 0.6% per annum and coal by 7.8% per annum.
- Transport, residential and services sectors' energy demand grew in the period 2005 – 2008 by 3.6%, 1.7% and 1.2% per annum respectively, while demand in industry fell by 2.1% per annum.

Progress towards Targets

- Renewable energy represented 4.5% of gross final energy use in 2008, up from 4.1% in 2007. Ireland's target is to achieve 16% by 2020.
- The total contribution from renewable energy to gross electricity consumption (RES-E) in 2008 was 11.9% (compared with 9.4% in 2007 and 4.9% in 1990), suggesting that Ireland is on track to meet the White Paper 2010 target of 15%.
- Between 2000 and 2007 renewable energy used for heat (RES-H) grew from 2.4 % to 3.7% before falling back slightly in 2008 to 3.6%. This suggests that a significant effort is required to meet the White Paper 2010 target of 5%.
- In absolute terms, biofuels in transport increased from 1 ktoe in 2005 (0.03% of road and rail transport [RES-T]) to 56 ktoe in 2008 (1.2%). The 2% RES-T target for 2008 contained in the White Paper was not achieved notwithstanding considerable recent growth.
- Energy-related CO_2 emissions in non-emissions trading scheme (ETS) sectors (residential, services and transport) were 6.7% above 2005 levels in 2008. Ireland's target is to reduce non-ETS GHG emissions by 20% below 2005 levels by 2020, under EU Decision 406/2009/EC.

Renewable Energy

- Renewable energy use grew by 21% during 2008 and by 16% per annum on average in the period 2005 - 2008. Since 1990 renewable energy has grown by 247% (7.1% per annum on average) in absolute terms.
- In 2008, there was a 23% increase in wind generation and a 45% increase in the contribution from hydro.
- The installed capacity of wind generation reached 1,161 MW (246 MW more than in September 2008). There are 434 MW of wind contracted for connection before the end of 2009 and a further 469 MW by the end of 2010.
- The estimated amount of CO_2 avoided through the use of renewable energy increased by 197% (6.2% per annum on average) over the period 1990 to 2008, reaching 2,242 kt CO_2 in 2008.

Electricity Generation

- Final consumption of electricity in 2008 grew by 3.1%, the same rate it had been growing at between 2005 and 2008. In 2008, electricity accounted for 17% of final energy use.
- Natural gas remains the dominant fuel in electricity generation with its share increasing to 55% in 2008. Natural gas use in electricity generation was 2,811 ktoe in 2008, 2.7% higher than in 2007.
- The carbon intensity of electricity increased by 3.2% in 2008 to 582 CO_2 g/kWh due to fuel mix changes.

Industry

- Overall final energy use in industry decreased by 5.4% in 2008 relative to the previous year, with all fuels experiencing reductions.
- Energy-related CO_2 emissions fell in industry in 2008 by 4.6%. If upstream electricity emissions are omitted industry experienced a decrease in CO_2 emissions of 5.9% in 2008.

Transport

- Energy use in transport fell for the first time in 2008 – by 1.3% to 5.6 Mtoe (42% of final energy use) due to the economic downturn. Transport energy-related CO_2 emissions also fell for the first time in 2008, by 1.9%.
- There was a significant increase in the share of transport energy from biofuels since 2006, albeit from a low base. In absolute terms, biofuels in transport increased from 1 ktoe in 2005 (0.03% of road and rail energy use) to 56 ktoe in 2008 (1.2%).
- The share of diesel in transport energy increased from 34% to 48% over the period 1990 – 2008 while the share of petrol has declined from 47% to 34%.
- Between 2000 and 2005 the share of private car label bands A, B & C was on average 35% while in 2006/07 it rose to 41%. In the period after the introduction of the new Vehicle Registration Tax (VRT) and Annual Road Tax (AMT), July to December, the share of these bands rose to 73%. In the first six months of 2009 it increased again to 78%.

Residential

- Residential energy use increased by 8.8% in 2008. When corrections for climate effects are taken into account the increase was 3.3%.
- Climate corrected, the unit energy consumption per household was just 0.7% higher in 2008 than in 2007 compared with an uncorrected increase of 6.1%.
- In 2008 the "average" dwelling was responsible for emitting approximately 8 tonnes of CO_2.
- Oil has become the dominant fuel in the residential sector, more than doubling its share from 17% in 1990 to almost 39% in 2008, followed by electricity at 23%.

Services

- Final energy use in the commercial and public services sector grew by 80% (3.3% per annum) over the period 1990 – 2008. During this period the value added generated by the sector grew by 157% while the numbers employed more than doubled (128% increase).
- Electricity consumption in services increased by 242% (7.1% per annum) between 1990 and 2008, representing 45% of energy use in the sector, up from 24% in 1990.
- The commercial and public services sector experienced an increase of 6.9% in final energy use in 2008.
- The services sector experienced an increase of 9.7% in energy related emissions during 2008.

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1. Introduction

This report examines energy trends in Ireland since 1990 with particular emphasis on 2008, discusses the underlying causes and relates the trends to Government and EU targets in order to inform the development of the policies and measures to meet the targets.

This report is based on data, compiled by SEI's Energy Policy Statistical Support Unit, which is used to generate the annual energy balance and to fulfil Ireland's legal obligations under the EU Energy Statistics Regulation and reporting to the International Energy Agency. The authors are grateful to the Government Departments and Agencies, energy suppliers and distributors for the provision of this data and acknowledge in particular those listed at the end of this report, who provided additional data for this analysis.

A companion publication, *Energy Statistics – 2008 Report*, is also available, presenting the background data to the analysis contained herein. It is intended that both these publications serve as resources for policy makers, analysts and researchers with an interest in energy use in Ireland.

Energy balance data analysed in this report was frozen on 20th November 2009. Balance data are updated whenever more accurate information is known. To obtain the most up-to-date balance figures visit the statistics publications section on Sustainable Energy Ireland's website.

An energy data service is available at http://www.sei.ie/statistics; follow the links for Energy Statistics Databank. This service is hosted by the Central Statistics Office with data provided by SEI.

This report includes an assessment of the sectoral use of energy. SEI also publishes individual reports on energy use in the industry, transport, services and residential sectors, which include more detailed analyses. Other annually published SEI reports based on EPSSU's statistical work include analysis of energy efficiency in Ireland, security of supply as well as results of surveys on renewable energy and combined heat and power. They are available on our website or in hard copy on request.

This report also discusses energy trends between 2005 and 2008, using 2005 as a reference year. This acknowledges the new policy context, aligning with the timescales in the *EU Decision 406/2009/EC on Non-Emissions Trading Scheme Effort Sharing* on greenhouse gas emissions.

Previous editions of Energy in Ireland included forecasts of energy use. Starting this year, a separate publication will be produced dedicated to energy forecasts and modelling future scenarios to inform policy. This work is being carried out by a new forecasting and modelling unit in SEI.

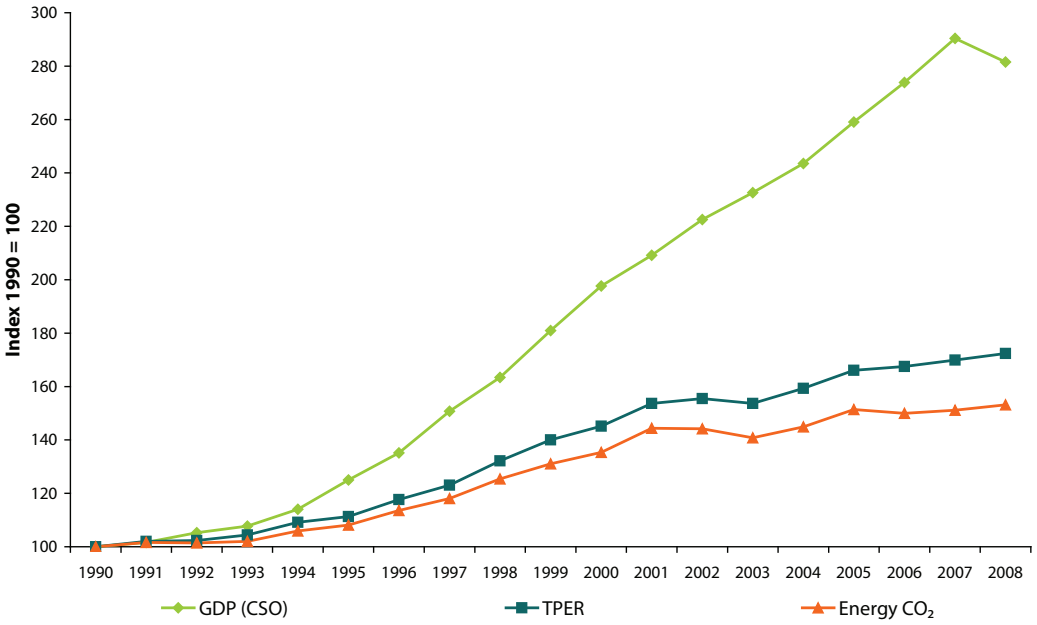
Feedback and comment on the report are welcome and should be addressed by post to the address on the rear cover or by email to epssu@sei.ie.

2. Energy Trends

This section provides an overview of energy trends in Ireland, covering the period 1990 – 2008 with a particular focus on 2008. Ireland's total energy supply (gross energy consumption) is examined first, both in terms of the mix of fuels used and consumption by individual sectors. Trends in final energy demand, i.e. the amount of energy used directly by final consumers, are then assessed. The link between energy use and economic activity, and the impacts of structural and efficiency changes are also discussed and finally electricity production is examined in its own right.

Energy supply depends on i) the demand for energy services and ii) how that demand is delivered. Energy service demand in turn is driven primarily by economic activity. Throughout the 1990s and early 2000s economic growth was particularly strong, especially from 1993 onwards. This resulted in GDP (a measure of economic growth) in 2007 being almost three times that of 1990. In 2008 the economy experienced a downturn and certain sectors, namely industry and transport, experienced commensurate reduction in energy use. This suggests that these sectors' energy use is more closely aligned with economic activity. However, the continuing energy growth in the residential and services sectors, and in overall energy demand, indicates that other factors are important. For example, 2008 was colder than 2007 and this undoubtedly contributed to higher energy demand in the heating requirements for residential and services buildings.

Figure 1 Index of Gross Domestic Product, Total Primary Energy (TPER) and Energy-Related CO_2



Source: Based on SEI and CSO data.

Figure 1 shows the relative decoupling of total primary energy requirement (TPER, also known as gross inland consumption[1]) from economic growth since 1992, in particular during 2002 – 2003 and 2006 – 2007[2]. This is a result of changes in the structure of the economy and improvements in energy efficiency. To a lesser extent, the decoupling of CO_2 emissions[3] from energy use is also evident, particularly since 1993, and this is due to changes in the fuel mix. The year 2008 is an example of just how factors other than economic factors, as measured by GDP, influence overall energy use patterns. The economy declined in 2008 while both energy and energy-related CO_2 continued to rise.

1 As energy cannot be created or destroyed energy is not strictly speaking consumed. Energy commodities, or fuels, are in effect energy carriers and allow the energy contained in them to be used for mobility, power and heat purposes. When a commodity is used the energy is not lost but transformed into a state that is no longer readily useful. When this happens the commodity that carried the energy has been consumed and is removed from the energy (commodity) balance. In this way terms such as *Gross Inland Consumption* and *Total Final Consumption* (TFC) may be interpreted as the final consumption of energy commodities.

2 In 2002 and 2003 the reduction in the carbon intensity was due to the commissioning of two high-efficiency gas-fired electricity generating plant. A similar situation occurred in 2006 – 2007.

3 Energy-related CO_2 emissions shown here (2008 data are provisional) cover all energy-related CO_2 emissions associated with TPER, including emissions associated with international air transport. These are usually excluded from the national GHG emissions inventory in accordance with the reporting procedures of the UN Framework Convention on Climate Change (UNFCCC) guidelines.

In 2008 the economy entered recession, with gross domestic product (GDP) falling by 3% compared with 2007. Primary energy use grew by 1.5% in 2008 and energy-related emissions increased by 1.3%[4]. If international aviation is excluded then the overall increase in emissions was 1.9%.

Energy-related CO_2 emissions recorded a downward trend for the two years 2002 and 2003, largely attributed to an increase in efficiency (and fuel mix change) in electricity generation with the commissioning of new plant. There were two further plants commissioned in the period 2006 – 2007, leading to further decoupling, with gas displacing coal and oil. This decoupling was also augmented by increased penetration of electricity generation from wind.

Table 1 tabulates the growth rates for the economy (GDP), primary energy (TPER) and energy-related CO_2 emissions for the period 1990 – 2008. It emphasises the high GDP growth rates compared with those for energy and CO_2 prior to 2008 and notes the decrease in GDP, the increase in primary energy and smaller increases in energy-related CO_2 in 2008.

It is interesting to compare the trend over the four-year period 2005 – 2008 with that for the whole period, given the significance of 2005 with respect to the *EU Decision 406/2009/EC on Non-Emissions Trading Scheme Effort Sharing*. Under the EU Decision Ireland's greenhouse gas emissions in non-ETS sectors (i.e. in transport, agriculture, heating in buildings, waste and small industry) are required to be 20% below 2005 levels by 2020. Over the past four years, energy-related CO_2 emissions have increased by 0.4% per annum on average (and by 0.2% per annum excluding international aviation), while the economy has grown by 2.8% per annum. Over the period since 1990 by contrast, energy-related CO_2 emissions grew by 2.4% per annum, while the economy grew by 5.9% per annum. This indicates a positive recent trend as Ireland enters the Kyoto period (2008 – 2012). However, the trend was reversed in 2008 when energy CO_2 grew by 1.3% against falling GDP.

Table 1 GDP[5], TPER and CO_2 Growth Rates[6]

	Growth %	Average annual growth rates %					
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008
GDP	181.6	5.9	4.6	9.6	5.6	2.8	-3.0
TPER	72.2	3.1	2.2	5.4	2.7	1.2	1.5
Energy CO_2	52.9	2.4	1.6	4.6	2.3	0.4	1.3
Energy CO_2 (excl. international aviation)	49.0	2.2	1.6	4.4	2.1	0.2	1.9

With reference to *Table 1*, in the overall period 1990 – 2008 and each of the five intervals the energy-related CO_2 growth was less than the TPER growth.

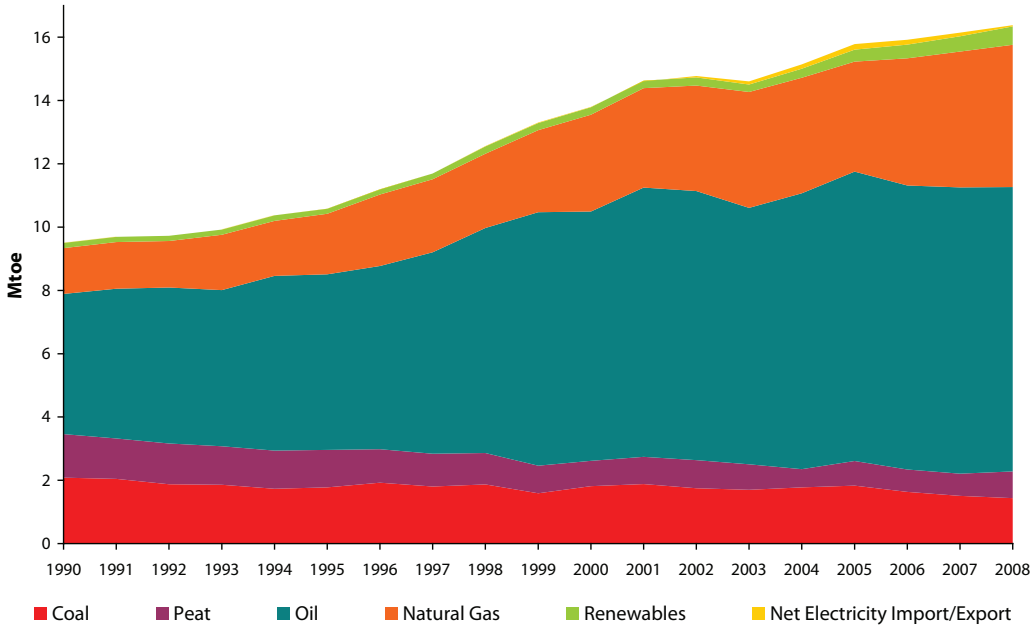
2.1 Energy Supply

Ireland's energy supply is discussed in terms of changes to the total primary energy requirement (TPER), defined as the total amount of energy used within Ireland in any given year. This includes the energy requirements for the conversion of primary sources of energy into forms that are useful for the final consumer, for example electricity generation and oil refining. These conversion activities are not all directly related to the level of economic activity that drives energy use but are dependent to a large extent, as in the case of electricity, on the efficiency of the transformation process and the technologies involved.

Figure 2 illustrates the trend in energy supply over the period 1990 – 2008, emphasising changes in the fuel mix. Primary energy consumption in Ireland in 2008 was 16.4 million tonnes of oil equivalent[7] (Mtoe).

4 Based on SEI calculations.
5 Gross Domestic Product (GDP) rates are calculated using constant market prices chain-linked annually and referenced to year 2006.
6 Throughout the report where annual growth rates are across multiple years they always refer to *average annual growth rates*.
7 A tonne of oil equivalent (toe) is a unit of energy roughly equivalent to the energy content of one tonne of crude oil. The definition in energy terms is that 1toe = 10^7 kilocalories = 41.868 gigajoules (GJ).

Figure 2 Total Primary Energy Requirement



Over the period 1990 – 2008 Ireland's total annual primary energy requirement grew in absolute terms by 72% (average annual growth rate of 3.1%). In 2008 Ireland's primary energy requirement increased by 1.5%. The individual fuel growth rates and shares are shown in *Table 2*.

Table 2 Growth Rates and Shares of TPER Fuels

	Growth %	Average annual growth rates%						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Fossil Fuels (Total)	68.7	2.9	2.2	5.4	2.4	1.1	1.4	98.2	96.2
Coal	-31.1	-2.1	-3.1	0.4	0.2	-7.8	-4.8	22.0	8.8
Peat	-38.7	-2.7	-3.0	-7.5	-0.7	2.9	20.4	14.5	5.2
Oil	102.7	4.0	4.6	7.3	3.0	-0.6	-0.6	46.6	54.8
Natural Gas	210.6	6.5	5.8	9.8	2.6	8.9	4.6	15.2	27.5
Renewables (Total)	246.5	7.1	-1.6	8.7	9.8	15.6	20.9	1.8	3.6
Hydro	38.9	1.8	0.5	3.5	-5.7	15.3	45.3	0.6	0.5
Wind	-	-	-	72.4	35.4	29.4	23.1	0.0	1.3
Electricity Imports	-	-	-	53.2	64.7	-28.3	-46.7	0.0	0.4
Total	**72.2**	**3.1**	**2.2**	**5.4**	**2.7**	**1.2**	**1.5**		

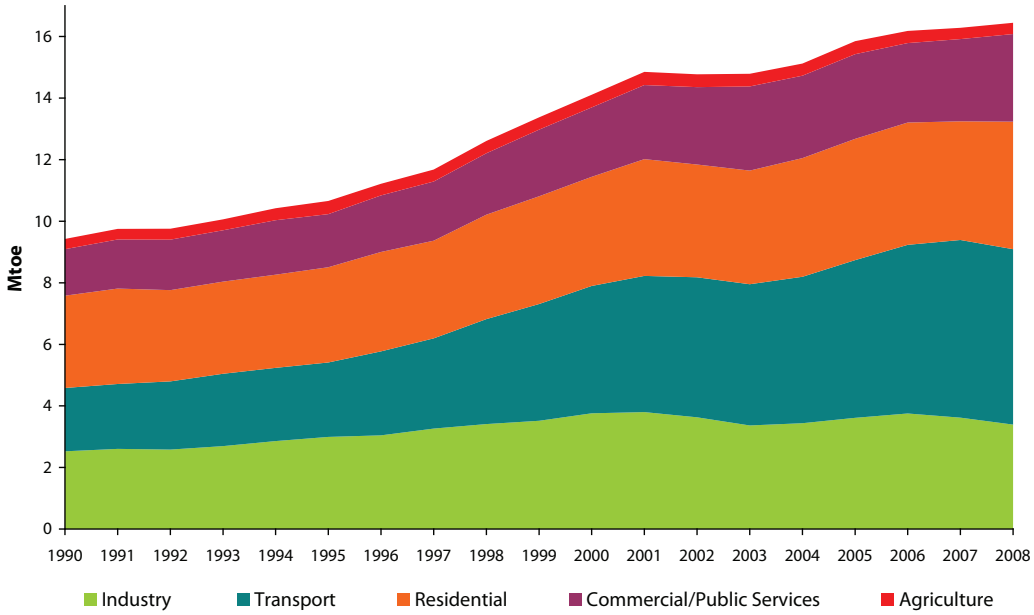
The following are the main trends in national fuel share:

- Fossil fuels accounted for 96% of all energy used in Ireland in 2008. This does not include the embodied fossil fuel content of imported electricity.
- Oil is by far the dominant energy source with that dominance increasing from a share of 47% in 1990 to a peak of 60% in 1999. Consumption of oil, in absolute terms, decreased slightly by 0.6% in 2008 with the share of oil in primary requirement in 2008 falling to 55%.
- Natural gas use increased in 2008 by 4.6% and its share of TPER was 27%. Over the four years 2005 – 2008, natural gas has increased by 8.9% per annum, while oil has reduced by 0.6% and coal by 7.8% per annum.
- In absolute terms over the period 1990 - 2008 coal declined by 31%. In 2008 the use of coal decreased by 4.8% over the previous year.
- Peat use increased by 20% in 2008 although over the period 1990 – 2008 its use declined by 39% and its share in primary energy fell from 14% to 5.2%.

- Wind energy experienced a growth in 2008 of 23%, slightly higher than the 21% growth in 2007. Wind energy represented 1.3% of primary energy requirement in 2008.
- Renewable energy in total grew by 21% during 2008 and by 16% per annum on average in the period 2005 - 2008. Since 1990 renewable energy has grown by 247% (7.1% per annum on average) in absolute terms.
- Electricity imports fell by 47% in 2008.

Figure 3 allocates Ireland's primary energy supply to each sector of the economy, according to its energy demand. The allocation is straightforward where fuels are used directly by a particular sector. Regarding electricity, the primary energy associated with each sector's electricity consumption is included to yield the total energy supply for each sector.

Figure 3 Total Primary Energy Requirement by Sector[8]



Primary energy supply gives a more complete measure than final energy demand (accounted for in the gas, oil, electricity and coal bills) of the impact of the individual sectors on energy use and on energy-related CO_2 emissions.

Table 3 tabulates the growth rates of the different sectors in terms of TPER and also provides the shares for 1990 and 2008. Transport's primary energy share increased from 22% in 1990 to 36% in 2007 and fell slightly to 35% in 2008.

Table 3 Growth Rates and Shares of TPER by Sector

	Growth %	Average annual growth rates%						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Industry	33.6	1.6	3.4	4.7	-0.8	-2.1	-6.3	26.8	20.5
Transport	177.1	5.8	3.3	11.3	4.4	3.6	-1.2	21.8	34.7
Residential	38.2	1.8	0.6	2.7	2.1	1.7	7.4	31.8	25.2
Commercial / Public	88.6	3.6	2.7	5.5	4.1	1.2	6.7	16.0	17.3
Agriculture	9.9	0.5	5.4	-1.0	0.5	-4.7	-0.8	3.5	2.2
Total	**72.2**	**3.1**	**2.2**	**5.4**	**2.7**	**1.2**	**1.5**		

In absolute terms sectoral primary energy consumption grew as follows:

8 International air transport kerosene is included in the transport sector in these graphs. Later graphs showing CO_2 emissions by sector omit air international transport energy emissions following UN Intergovernmental Panel on Climate Change (IPCC) guidelines. In addition, the effects of cross border trade (*fuel tourism*) and smuggling of diesel and petrol are not included in this analysis. Estimates of fuel tourism produced by the Dept. of Environment, Heritage & Local Government are now included in the energy balance and presented in the transport section.

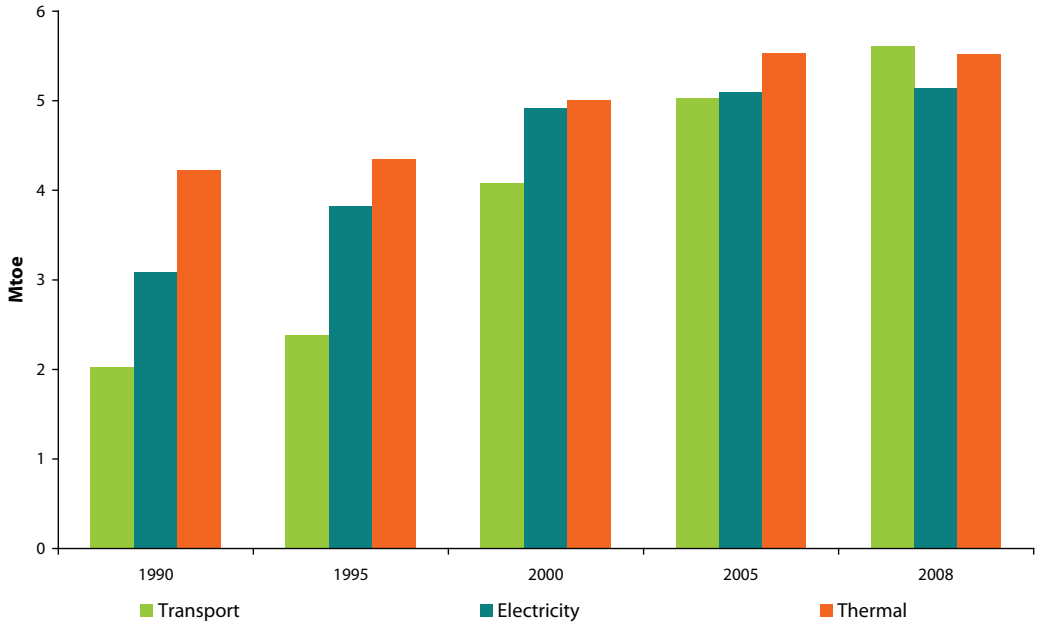
- Transport energy use grew by 177% over the period 1990 – 2008 (5.8% per annum) and consumes more than one third of all energy in Ireland. Transport primary energy use fell for the first time during 2008, by 1.2%, as a result of the economic downturn.
- Industry energy use fell by 6.3% in 2008. Industry's share of primary energy decreased to 21% in 2008 from 22% in 2007.
- Residential primary energy use increased in 2008 by 7.4%. Its share of primary energy use increased to 25% in 2008, up from 24% in 2007.
- Use of primary energy in the commercial and public services sector grew by 6.7% in 2008. Over the period 1990 – 2008 the services sector had the second highest growth of all sectors, consuming 89% more in 2008 than in 1990.
- Energy use in the residential sector and services sector are sometimes collectively referred to as energy in buildings as most of the energy use is associated with heating/cooling and lighting the buildings. In 2008, energy in buildings accounted for 43% of primary energy supply. Overall, energy use in buildings increased by 55% since 1990 (2.5% per annum) and in 2008 by 7.1%.
- Agriculture energy use fell by 10% (0.5% per annum) over the period. There was a 0.8% decrease in consumption in 2008.

2.2 Energy Use by Mode of Application

Energy use can be categorised by its mode of application; that is whether it is used for mobility (transport), power applications (electricity) or for thermal uses (space or process heating). These modes also represent three distinct energy markets.

In 1990 thermal uses for energy accounted for a significant proportion of all primary energy (45%). Electricity accounted for 33% and transport 22%. This contrasts with the situation in 2006 when almost equal amounts of primary energy were used by transport and thermal, at 34% each (slightly more by transport), while electricity accounted for 32%. In 2008, transport share was 34% with thermal at 34% and energy use for electricity generation at 32%. The changes in mode shares are shown graphically in *Figure 4*.

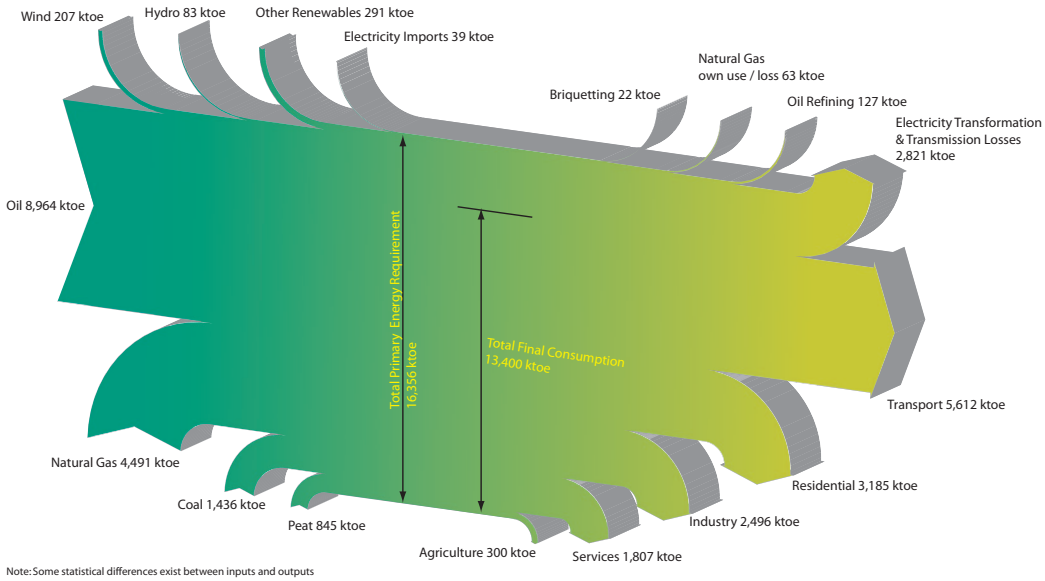
Figure 4 Primary Energy by Mode of Application



2.3 Energy Balance for 2008

Figure 5 shows the energy balance for Ireland in 2008 as a flow diagram. This illustrates clearly the significance of each of the fuel inputs as well as showing how much energy is lost in transformation and the sectoral split of final energy demand.

Figure 5 Energy Flow in Ireland 2008[9]



Oil dominates as a fuel, accounting for 55% of the total requirement. Renewables are disaggregated into wind, hydro and other renewables in this version of the diagram. Transport continues to be the largest of the end use sectors, using 42% of the final energy demand in Ireland in 2008.

Losses associated with the transformation of primary energy to electricity, power plant in-house load and electricity network losses were 17% of TPER or 2,821 ktoe in 2008.

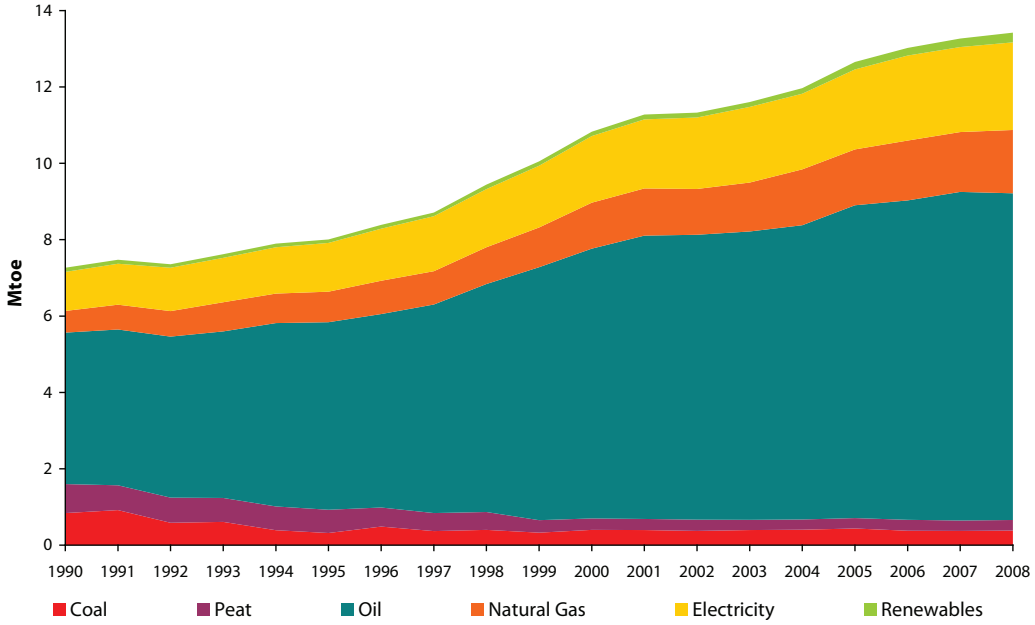
2.4 Energy Demand

Final energy demand is a measure of the energy that is delivered to energy end users in the economy to undertake activities as diverse as manufacturing, movement of people and goods, essential services and other day-to-day energy requirements of living. This is also known as Total Final Consumption (TFC) and is essentially total primary energy less the quantities of energy required to transform primary sources such as crude oil into forms suitable for end use consumers such as refined oils, electricity, patent fuels etc (transformation, processing or other losses entailed in delivery to final consumers are known as "energy overhead").

Figure 6 shows the shift in the pattern of final energy demand by fuel over the period 1990 – 2008.

9 All energy inputs shown here represent the sum of indigenous production plus, where applicable, net imports i.e. imports minus exports.

Figure 6 Total Final Consumption by Fuel



Ireland's TFC in 2008 was 13 Mtoe, an increase of 1.2% on 2007 and 85% above 1990 levels (3.5% per annum). This increase in final consumption in 2008 compares with a 1.5% increase in primary energy, indicating a slight reduction in efficiency of supply. Over the period 2005 – 2008, final demand increased by 2% per annum compared with primary energy growth of 1.2% per annum. The changes in the growth rates and respective shares of individual fuels in final consumption over the period are shown in *Table 4*.

Table 4 Growth Rates and Shares of TFC Fuels

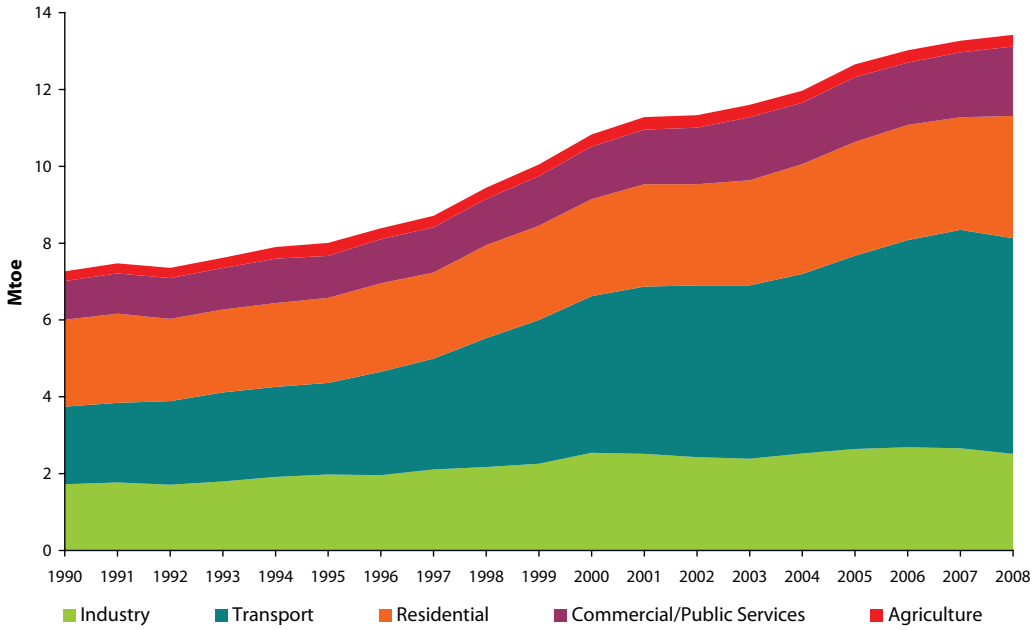
	Growth %	Average annual growth rates%						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Fossil Fuels (Total)	77.0	3.2	1.6	6.2	2.9	1.6	0.5	84.5	81.0
Coal	-55.0	-4.3	-17.7	4.6	1.8	-4.5	1.4	11.6	2.8
Peat	-63.0	-5.4	-4.2	-13.1	-2.0	0.7	3.0	10.4	2.1
Oil	115.4	4.4	4.4	7.5	3.0	1.4	-0.5	54.6	63.7
Natural Gas	191.2	6.1	7.0	8.6	4.0	4.3	5.6	7.8	12.4
Renewables	134.2	4.8	-3.1	5.1	10.5	9.4	14.7	1.5	1.9
Combustible Fuels (Total)	77.6	3.2	1.5	6.2	3.0	1.7	0.7	85.9	82.7
Electricity	124.8	4.6	4.6	6.4	3.7	3.1	3.1	14.1	17.1
Total	**84.6**	**3.5**	**2.0**	**6.2**	**3.2**	**2.0**	**1.2**		

The most significant changes can be summarised as follows:

- Use of renewable energy sources again experienced the highest growth in 2008 with final consumption growing by 15% following a growth of 9.5% in 2007.
- Final consumption of oil fell by 0.5% in 2008 with oil accounting for approximately 64% of final energy consumption.
- Natural gas growth in 2008 was strong at 5.6%. Annual growth between 2005 and 2008 was 4.3%.
- Final consumption of coal increased by 1.4% in 2008 following reductions of 4.5% per annum between 2005 and 2008.
- Final consumption of electricity in 2008 grew by 3.1%, the same rate it had been growing at between 2005 – 2008. In 2008, electricity accounted for 17% of final energy use.
- Final consumption of peat increased by 3% in 2008, mainly in the residential sector.

Figure 7 also shows the trend in TFC over the period, here allocated to each of the sectors of the economy.

Figure 7 Total Final Energy Consumption by Sector



Over the period the relative weighting of the sectors has changed. Transport has continued to increase its dominance (since the mid 1990s) as the largest energy consuming sector (on a final energy basis) with a share of 43% in 2007, while the share of industry and residential has decreased. Transport's share in 2008 fell slightly to 42%.

Table 5 Growth Rates and Shares of TFC by Sector

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	**'90 – '08**	**'90 – '95**	**'95 – '00**	**'00 – '05**	**'05 – '08**	**2008**	**1990**	**2008**
Industry	45.1	2.1	2.8	5.1	0.7	-1.7	-5.4	23.7	18.6
Transport	177.6	5.8	3.4	11.3	4.3	3.7	-1.3	27.9	41.9
Residential	41.0	1.9	-0.4	2.6	3.3	2.5	8.8	31.1	23.8
Commercial / Public	79.5	3.3	1.6	4.6	4.2	2.4	6.9	13.9	13.5
Agriculture	18.9	1.0	6.2	-1.4	1.2	-3.8	-0.4	3.5	2.2
Total	**84.6**	**3.5**	**2.0**	**6.2**	**3.2**	**2.0**	**1.2**		

The changes in growth rates are tabulated in *Table 5* and summarised as follows:

- Overall final energy consumption increased by 1.2%. This happened with a 1.5% growth in primary energy requirement.
- Transport final energy use increased by 178% over the period 1990 – 2008. Final consumption of energy in transport was 5.6 Mtoe in 2008. This represents an average annual growth rate of 5.8% and transport's share of TFC increased from 28% to 42%. Energy use in transport fell for the first time in 2008, by 1.3%. In the period 2005 – 2008, transport energy demand grew by 3.7% per annum.
- Industry's final energy use decreased by 5.4% (to 2.5 Mtoe) in 2008. Over the 1990 – 2008 period industry experienced an average growth rate of 2.1% per annum (or 45% in absolute terms) and its share of TFC dropped from 24% to 19%. Since 2005, industry energy demand has been falling at a rate of 1.7% per annum on average, in contrast to the growth levels in the late 1990s of more than 5% per annum.
- Final energy use in the residential sector increased by 8.8% in 2008 and by 2.5% per annum in the period 2005 - 2008.
- The commercial and public services sector experienced an increase of 6.9% in final energy use in 2008.
- The agricultural sector's relative share fell from 3.5% in 1990 to 2.2% in 2008 although final energy consumption grew

by 19% to 0.3 Mtoe (1.0% per annum). In absolute terms, agriculture also experienced a decrease of 0.4% in energy consumption in 2008.

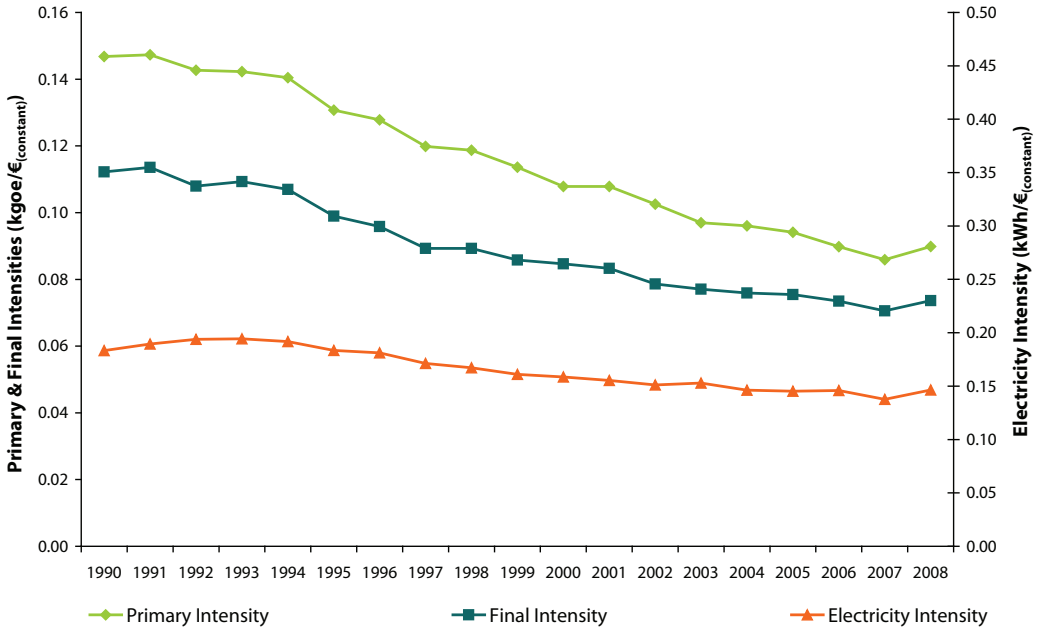
2.5 Energy Intensities

Energy intensity is defined as the amount of energy required to produce some functional output. In the case of the economy, the measure of output is generally taken to be gross domestic product (GDP)[10]. GDP measured in constant prices is used to remove the influence of inflation. The inverse of energy intensity represents the energy productivity of the economy.

The intensity of primary and final energy and of electricity requirements has been falling (reflecting improving energy productivity) since 1990 as shown in *Figure 8*. The primary energy intensity of the economy fell by 41% between 1990 and 2007 (3.1% per annum). In 1990 it required 147 grammes of oil equivalent (goe) to produce one euro of GDP (in constant 2006 values) whereas in 2007 just 86 goe was required. However, during 2008 the primary energy intensity increased by 4.6% to 90 goe/$€_{2006}$.

Figure 8 shows the trend in both primary (TPER/GDP) and final (TFC/GDP) energy intensities (at constant 2006 prices). The difference between these two trends reflects the amount of energy required in the transformation from primary energy to final energy – primarily used for electricity generation. Throughout the 1990s there was a slight convergence of these trends, particularly since 1994, mostly reflecting the increasing efficiency of the electricity generation sector. The improvement in the transformation sector (increased efficiency in electricity generation) is illustrated from 2001 onwards when primary intensity fell at a faster rate than final intensity. The decrease in primary intensity since 2001 was 20% whereas for final intensity the decrease was 15%. Conversely, the increase in final intensity of 4.3% in 2008 is related to the downturn in the economy and the effects of 2008 being colder.

Figure 8 Primary, Final and Electricity Intensity



Final electricity intensity of the economy has not been falling as fast as primary or final energy intensities. Over the period 1990 – 2007 the electricity intensity fell by 25%. This is attributed to the shift towards increased electricity consumption in energy end use. While electricity consumption increased by 125% since 1990 (4.6% average annual growth), final energy demand increased by 85% (3.5% annual growth). Electricity final intensity increased in 2008 (6.4%) and was 20% below 1990 levels.

There are many factors that contribute to how the trend in energy intensity evolves. These factors include technological

10 It can be argued that in Ireland's case, gross national product (GNP) should be used to address the impacts due to the practice of transfer pricing by some multinationals. The counter argument is that energy is used to produce the GDP and by using GNP some of the activity would be omitted. The practice internationally is to use GDP, so for comparison purposes it is sensible to follow this convention.

efficiency and choice of fuel mix, particularly in relation to electricity generation; economies of scale in manufacturing, and not least the structure of the economy. Economic structure in Ireland's case has changed considerably over the past twenty years. The structure of the economy has shifted in the direction of the high value-added sectors such as pharmaceuticals and electronics, and more towards the services sector. Relative to traditional "heavier" industries, such as car manufacturing and steel production, these more recently added sectors are not highly energy intensive. Major changes to the industrial structure include the cessation of steel production in 2001 and fertiliser production in late 2002.

Energy intensity will continue to show a decreasing trend if, as expected, the economy continues to move away from low value-added high energy consuming sectors to one that is dominated by high value-added low energy consuming sectors. This results in a more productive economy from an energy perspective but does not necessarily mean that the actual processes used are more energy efficient. There may therefore still be room for improvement.

The increase in intensities in 2008 is interesting if not unexpected. Apart from some loss of economies of scale due to the downturn which would increase intensity, energy use in Ireland is coupled with climate as well as with the economy. As 2008 was considerably colder than 2007, energy use increased at a time when the economy declined.

2.6 Energy Efficiency

Energy efficiency is defined as a ratio between an output of performance, service, goods or energy and an input of energy. Essentially improvements in energy efficiency enable achievement of the same result with less energy or achieving an improved performance with the same energy. For a more detailed discussion on energy efficiency in Ireland see the SEI's *Energy Efficiency in Ireland 2009 Report*[11]. The energy-efficiency indicators presented in this report are updated to 2008 figures.

As mentioned in section *2.5* energy intensity is a crude indicator and variation may be as a result of many factors such as economic, structural, technical, behavioural issues, or because real energy efficiency gains have been made. To better understand energy efficiency trends and to clarify the role of the energy-related factors, an approach focusing on techno-economic effects is required to clean or remove changes due to macro-economic or structural effects[12]. This type of analysis has been developed since 1993 through the ODYSSEE[13] project, which includes Irish involvement through SEI/EPSSU. A set of indicators have been developed which measure achievements in energy efficiency at the level of the main end-uses.

The indicators developed include ODEX indicators which are referenced in the Energy End-Use Efficiency and Energy Services Directive (ESD)[14]. The ODEX indicators are innovative compared to similar indices as they aggregate trends in unit consumption by sub-sector or end-use into one index per sector based on the weight of each sub-sector/end-use in the total energy consumption of the sector. The sectoral indicators can then be combined into an economy-wide indicator.

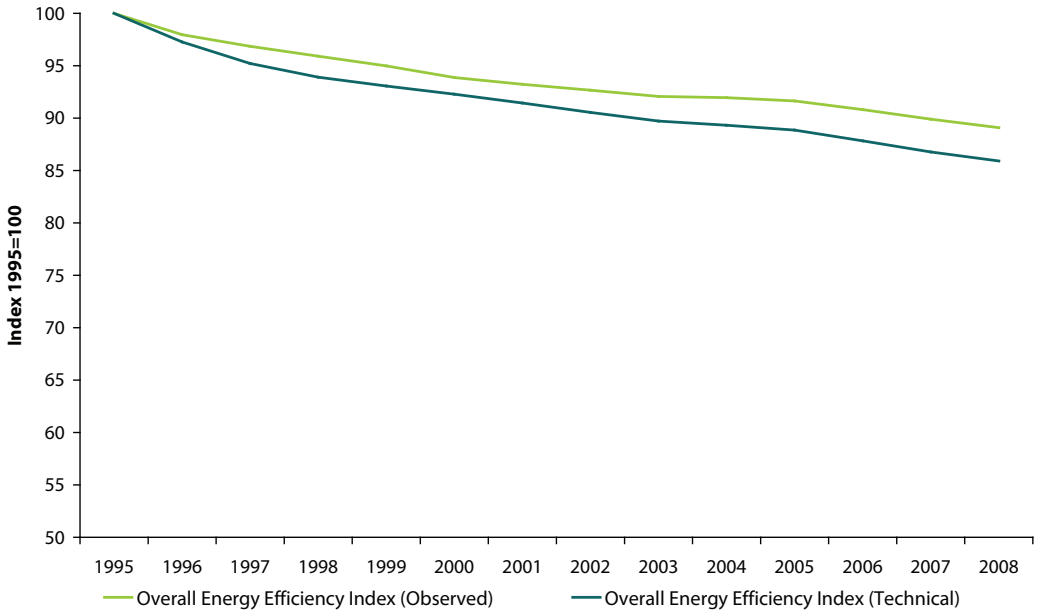
Top-down energy-efficiency indices (including ODEX) provide an alternative to the usual energy intensities used to assess energy-efficiency changes at the sectoral level or at the level of the whole country. This is because these indices include effects related only to energy efficiency. It is important to note that ODEX indicators only provide measurement of the gross energy savings realised within a sector or type of end-use. In addition to savings that result from energy-efficiency policies and measures, these savings include a number of factors – for example, price effects and autonomous progress[15]. They exclude the changes in energy use due to other effects (such as climate fluctuations, changes in economic and industry structures, lifestyle changes, etc) at the economy or sectoral level.

In the case of Ireland, the contribution from industry to the overall index is an index of intensity at constant structure as opposed to the industry ODEX. The overall energy-efficiency index for Ireland is the weighted sum of this industrial index and the ODEX calculation for both the residential sector and transport. The services sector is not included due to a lack of sufficiently disaggregated data required to create an ODEX in this sector.

Figure 9 presents both the observed and technical overall energy efficiency indicators for Ireland for the period 1995 to 2008.

11 Available from www.sei.ie.
12 Bosseboeuf D. et al, 2005, *Energy Efficiency Monitoring in the EU-15*, published by ADEME and the European Commission. Available from: www.ODYSSEE-indicators.org
13 For full details of the project go to www.ODYSSEE-indicators.org
14 See www.ec.europa.eu/energy/demand/legislation/end_use_en.htm for details and a copy of the Directive.
15 Bosseboeuf D., Lapillonne Dr B., Desbrosses N., 2007, *Top Down Evaluative Methods for Monitoring Energy Savings*, EMEEES European Expert Group Meeting, La Colle-sur-Loup

Figure 9 Energy Efficiency 1995 - 2008



The observed index shows that between 1995 and 2008 there was an 11% (0.9% per annum on average) decrease, which indicates an 11% improvement in energy efficiency. To separate out the influence of behavioural factors, a technical index is calculated and used to better assess the technical energy-efficiency progress. As shown in *Figure 9*, technical efficiency improved by 14% (1.2% per annum) from 1995 to 2008.

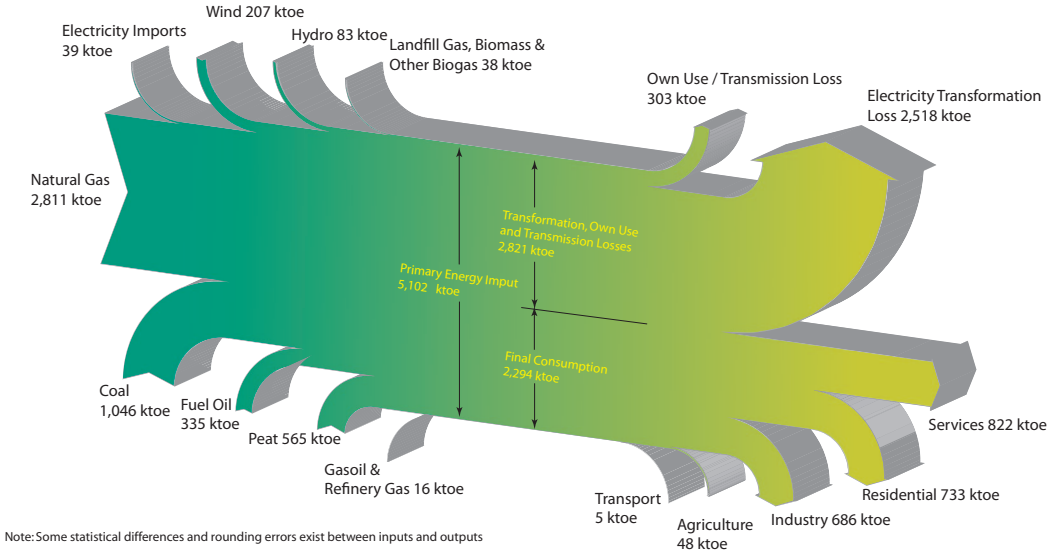
Technical efficiency gains arise from the use of more energy-efficient technologies whereas behavioural gains are the result of how technologies are used. The difference between the observed and technical indicators is the influence of behavioural effects, i.e. Ireland would have achieved the greater improvement in energy efficiency but for the increases in energy usage due to behaviour. It is important to note that behavioural effects can also be beneficial – for example, the purchase of more efficient technologies or improvements in insulation.

Note that the top-down energy-efficiency index indicators are calculated as a three year moving average to avoid short-term fluctuations due, for example, to imperfect climatic corrections, behavioural factors, business cycles, etc.

2.7 Electricity Generation

Figure 10 shows graphically the flow of energy in electricity generation. The relative size of the useful final electricity consumption compared to the energy lost in transformation and transmission is striking. These losses represent 55% of the energy inputs. The small, but growing, contribution from renewables (hydro, wind, landfill gas and biomass) is also notable, as is the dominance of gas in the generation fuel mix. In 2008, renewables accounted for 6.4% of the energy inputs (5.1% in 2007) to generate electricity with wind contributing 4% (3.3% in 2007) of total inputs. Wind accounted for 63% of the renewable energy used for electricity generation in 2008.

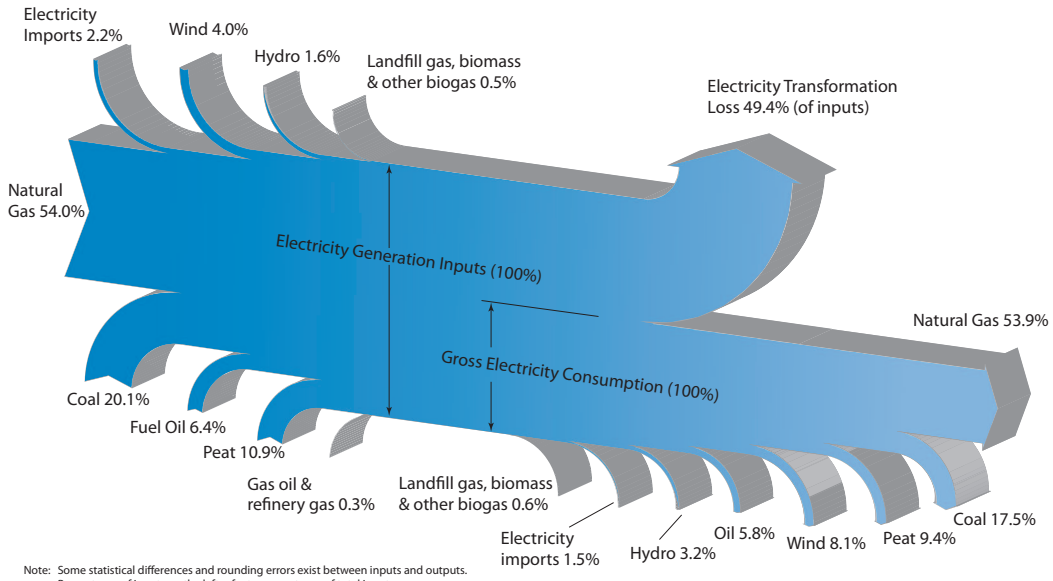
Figure 10 Flow of Energy in Electricity Generation 2008



Note: Some statistical differences and rounding errors exist between inputs and outputs

Figure 11 shows a similar picture to *Figure 10* except that the electricity outputs are shown by fuel used to generate the electricity and as percentages for the purposes of comparing with the various targets. Renewable generation consists of wind, hydro, landfill gas, biomass and other biogas and in 2008 in total accounted for 11.9% of gross electricity consumption compared with 9.4% in 2007. The national target is 15% by 2010 and 40% by 2020.

Figure 11 Flow of Energy in Electricity Generation 2008 Outputs by Fuel

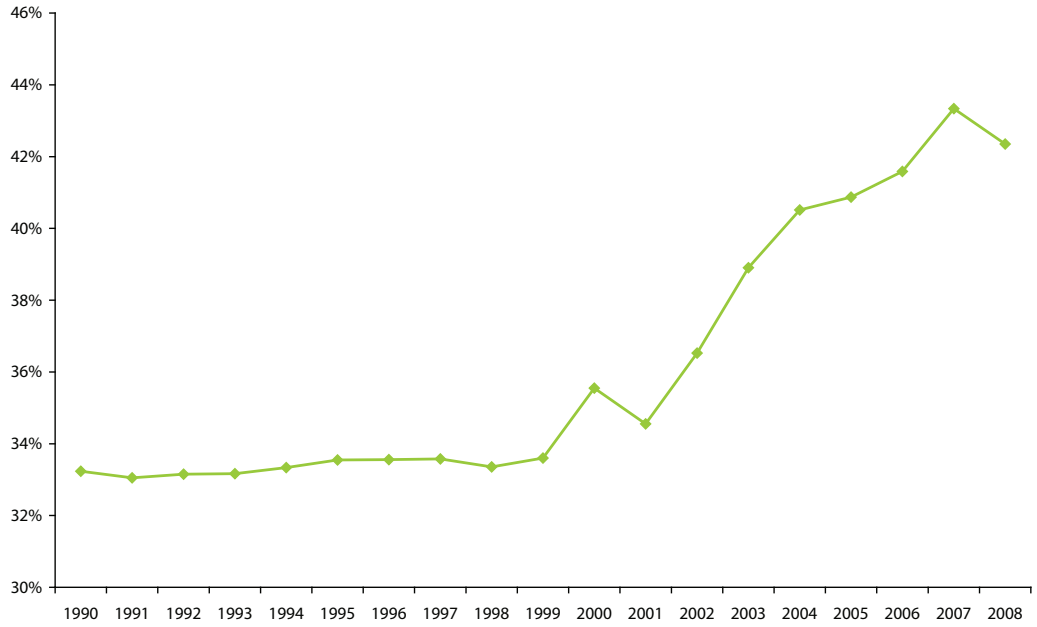


Note: Some statistical differences and rounding errors exist between inputs and outputs.
Percentages of inputs on the left refer to percentages of total inputs.
Percentages of output, with the exception of electricity transformation loss refer to percentages of gross electricity generated.

Renewables as % of gross electricity consumption = 11.9%
CHP as % of total electricity generation = 6.3%

The efficiency of electricity supply shown in *Figure 12* is defined as final consumption of electricity divided by the fuel inputs required to generate this electricity and expressed as a percentage. The inputs include renewable sources and imports and the final consumption excludes the generation plant's 'own use' of electricity and transmission and distribution losses. Hence this is supply efficiency rather than generating efficiency.

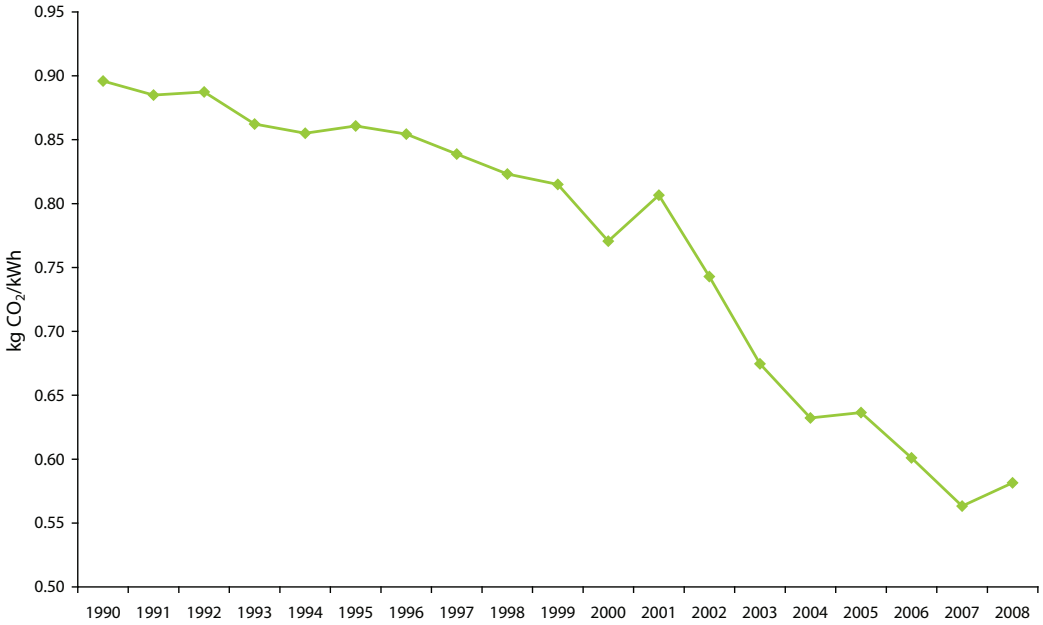
Figure 12 Efficiency of Electricity Supply



From the mid 1990s onwards the influence of the use of higher efficiency natural gas plants and the increase in production from renewable sources is evident. The sharp rise between 2002 and 2004 (from 35% to 40%) is accounted for, principally, by the coming on stream of new CCGT plant (392 MW in August 2002 and 343 MW in November 2002), an increase in imports of electricity and the closure of old peat fired stations.

There was an increase in electricity supply efficiency from 41.6% in 2006 to 43.3% in 2007, due largely to the commissioning of two further CCGT plants, Tynagh (384 MW) in 2006 and Huntstown 2 (401 MW) in 2007, and the increase in renewable electricity. During 2008 the efficiency fell to 42.4% due to an increase in peat generation.

Figure 13 CO_2 Emissions per kWh of Electricity Supplied



These shifts in generating technology and indeed fuel mix have also resulted in changes in the CO_2 emissions per kWh of electricity supplied, as illustrated in *Figure 13*.

Since 1990 the share of high carbon content fuels such as coal has been reducing with a corresponding rise in the relatively low carbon fuel oil, lower carbon natural gas, and zero carbon renewables. This resulted in the carbon intensity of electricity dropping from 896 g CO_2/kWh in 1990 to 632 CO_2 g /kWh in 2004. This downward trend was halted in 2005 when the carbon intensity of electricity increased slightly for the first time in three years to 637 CO_2 g/kWh. Carbon intensity of electricity reduced to a low of 565 CO_2 g/kWh (revised figure) in 2007. In 2008 the intensity increased to 582 CO_2 g/kWh due to increased peat combustion.

Reasons for the decrease in generating efficiency and increase in carbon intensity of electricity in 2008 are:

- A 29% increase in peat use in generation.
- An 2.7% increase in natural gas use in generation in 2008.
- A 66% reduction in use in electricity imports.

Countering these were:

- A 6.9% decrease in coal consumption in electricity generation in 2008.
- A 13% decrease in oil use.
- A 27% increase in renewable inputs to electricity generation. There was a 23% increase in wind generation and a 45% increase in contribution from hydro.

The trends in the mix of primary fuels employed for electricity generation are shown in *Figure 14*. Energy inputs to electricity generation increased by 1.3% in 2008 while final consumption of electricity increased by 3.1%. The shift from oil to gas since 2001 is also very evident from the graph.

Figure 14 Primary Fuel Mix for Electricity Generation

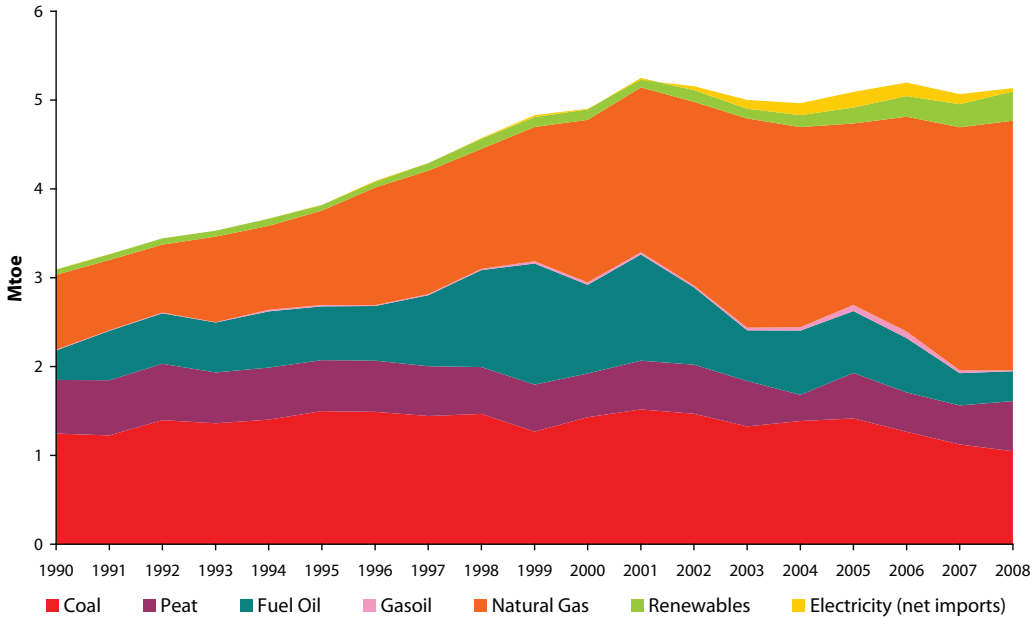


Table 6 presents the growth rates and shares of the primary fuel mix for electricity generation over the period 1990 – 2008.

The primary fuel requirement for electricity generation grew by 66% from 3.1 Mtoe in 1990 to a high of 5.2 Mtoe in 2001. Between 2001 and 2004 the requirement reduced by 5%, while at the same time the final consumption of electricity increased by 10%. In 2008, 5.1 Mtoe of energy was used to generate electricity, 1.3% more than in 2007. The fuel inputs to electricity generation were 32% of the total primary energy requirement in 2008. Electricity consumption as a share of total final consumption increased from 14% to 17% between 1990 and 2008.

Table 6 Growth Rates and Shares of Electricity Generation Fuel Mix

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Fossil Fuels (Total)	57.4	2.6	4.4	4.9	-0.2	0.2	1.5	98.1	92.9
Coal	-16.0	-1.0	3.8	-0.9	-0.2	-9.6	-6.9	40.3	20.4
Peat	-6.3	-0.4	-1.0	-3.1	0.8	3.5	29.2	19.5	11.0
Oil (Total)	2.8	0.2	12.9	10.7	-5.7	-23.2	-13.2	11.0	6.8
Fuel oil	0.3	0.0	12.6	10.5	-6.9	-21.7	-8.0	10.8	6.5
Gas oil	43.4	2.0	16.5	13.3	18.8	-46.7	-67.2	0.2	0.2
Gas	233.5	6.9	4.7	11.5	2.3	11.2	2.7	27.3	54.7
Renewables (Total)	448.5	9.9	0.9	13.4	8.9	22.3	27.5	1.9	6.4
Hydro	38.9	1.8	0.5	3.5	-5.7	15.3	45.3	1.9	1.6
Wind	-	-	-	72.4	35.4	29.4	23.1	0.0	4.0
Combustible Fuels (Total)	58.7	2.6	4.4	5.1	-0.2	0.3	1.6	98.1	93.6
Electricity Imports	-	-	-	45.6	83.6	-39.6	-66.2	0.0	0.8
Total	**66.2**	**2.9**	**4.3**	**5.2**	**0.7**	**0.3**	**1.3**		

The main trends are:

- Natural gas remains the dominant fuel in electricity generation with its share increasing to 55% in 2008. Natural gas use in electricity generation was 2,811 ktoe in 2008, 2.7% higher than in 2007. Between 2005 and 2008, natural gas increased by 11% per annum displacing oil and coal.
- Fuel oil had a share in electricity generation of 11% in 1990; this rose to 17% in 2002 but had fallen back to 6.5% in 2008. Consumption of fuel oil decreased in 2008 by 8% to 0.3 Mtoe.
- The share of coal used in electricity generation has reduced from 40% in 1990 to 20% in 2008. In absolute terms the consumption of coal has fallen by 16% over the period (1% per annum) to a figure of 1 Mtoe. There was a decrease in coal use in 2008 for electricity generation of 6.9%.
- Peat consumption in electricity generation increased by 29% to 566 ktoe in 2008.
- Renewable energy use for electricity generation increased its share from 1.9% to 6.4% between 1990 and 2008. In 2008 there was a 27% increase in renewables in the electricity fuel mix with the increase primarily coming from increased wind generation. Wind contribution to electricity generation increased by 23% in 2008.
- Electricity imports decreased by 66% in 2008 following a 25% decrease in 2007.

The primary energy attributed to hydro and wind is equal to the amount of electrical energy generated, rather than the primary energy avoided through the displacement of fossil fuel based generation[16] (see *Renewable Energy in Ireland – 2008 Report*). It is therefore more common to see the share of hydro and wind reported as a percentage of electricity generated. The share of electricity generated by renewables was 11.9% in 2008, up from 9.4% in 2007.

2.8 Electricity Demand

Figure 15 shows the final electricity consumption in each of the main sectors. A striking feature is the more than double the difference between fuel input (see *Figure 14*) and delivered electricity output in 1990 (*Figure 15*). This difference is because electricity in Ireland is predominantly generated from fossil fuels (93% in 2008) and therefore actual energy requirement has always been somewhat higher than final electricity consumption. This ratio of primary to final energy in electricity consumption reduced from 3.0 in 1990 to 2.2 in 2008. Final consumption of electricity increased by 3.1% in 2008 and this was achieved with a 1.3% increase in the fuel inputs to electricity generation. Over the period 2005 – 2008, electricity demand increased by 3.1% per annum on average while the fuel inputs increased by 0.3% per annum.

16 An alternative approach based on *primary energy equivalent* was developed in a separate report: SEI (2007), *Renewable Energy in Ireland – 2007 Update*. Available from www.sei.ie/statistics.

Figure 15 Final Consumption of Electricity by Sector

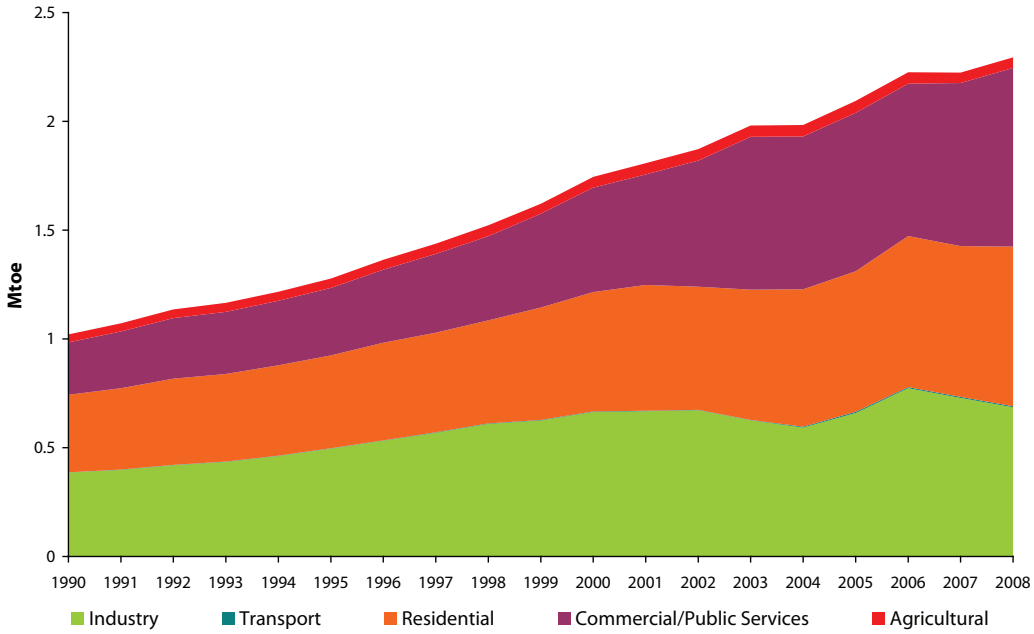


Table 7 tabulates changes in individual sectors' electricity demand and the impact on their shares of final consumption of electricity. The electricity use in transport includes that used by the DART and reflects the arrival (testing and operation) of the LUAS. In absolute terms electricity consumption in transport is small at 5 ktoe.

Industry was the only sector to experience a reduction in electricity demand during 2008 (-5.9%). The commercial/public services sector experienced the largest increase in electricity consumption in 2008 recording an increase of 9.7%. Transport use increased by 7.8% but this is from a very low base. Residential sector electricity demand increased by 5.7% in 2008. In 2008, electricity demand grew by 3.1%, the same annual growth as occurred between 2005 and 2008.

Table 7 Growth Rates and Shares of Electricity Final Consumption

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Industry	77.9	3.3	5.2	6.0	-0.1	1.3	-5.9	37.8	29.9
Transport	243.6	7.1	2.4	7.6	17.8	-2.3	7.8	0.1	0.2
Residential	105.8	4.1	3.7	5.1	3.3	4.3	5.7	34.9	32.0
Commercial / Public	241.9	7.1	5.2	9.2	8.7	4.1	9.7	23.6	35.8
Agriculture	30.6	1.5	3.1	2.7	2.4	-4.4	0.1	3.6	2.1
Total	**124.8**	**4.6**	**4.6**	**6.4**	**3.7**	**3.1**	**3.1**		

2.9 Energy and the Economic Downturn

In 2008 the economy in Ireland entered recession with gross domestic product (GDP) falling by 3% compared with 2007. Primary energy use grew by 1.5% in 2008 and energy-related emissions increased by 1.3%. If international aviation is excluded then the overall increase in emissions was 1.9%. At first glance this is a disappointing development in terms of energy policy goals. A key goal of energy policy generally is to increase economic growth and simultaneously reduce primary energy and emissions but what happened in 2008 was the opposite.

On closer examination however, it is clear that while the economic recession affected the energy use of certain sectors more than others, there were other effects, such as weather effects and fuel mix changes, that also had a significant impact on energy use and emissions.

The fuel mix changes contributing to the overall energy changes in 2008 relative to 2007 can be summarised as follows:

- 20% increase in peat consumption
  - 3% increase in end use and
  - 29% increase for electricity generation
- 4.6% increase in gas consumption
  - 5.6% increase in end use and
  - 2.7% increase for electricity generation
- 4.8% decrease in coal consumption
  - 1.4% increase in end use and
  - 6.9% decrease for electricity generation
- 0.6% decrease in oil consumption
  - 0.5% decrease in end use
  - 23% decrease for electricity generation
- 21% increase in renewables
  - 15% increase in end use
  - 23% increase in wind energy and
  - 45% increase in hydro.

On a sectoral perspective, the industry and transport sectors experienced reductions (4.6% and 1.9% respectively) in energy-related CO_2 emissions arising from the economic recession. Regarding other sectors, a significant proportion of energy use in the services and residential sectors is related to heating buildings and was more affected by weather patterns experienced in 2008. As a result, energy-related CO_2 emissions in the services and residential sectors increased by 9.7% and 8.8% respectively.

In industry, energy demand decreased by 5.4% in 2008. There was a bigger reduction in electricity demand (5.9%) than in direct fuel use (5.3%). While reduction in most fuels reflects the recent trend (over the four years 2005 – 2008), what was different in 2008 was the 4.5% reduction in gas demand (in contrast with a 3.2% average annual growth rate over the period 2005 – 2008) and the 5.9% reduction in demand for electricity (in contrast with a growth of 1.3% per annum 2005 – 2008).

In transport, certain modes of transport were affected more than others due to the recession. The overall demand reduction in 2008 was 1.3% but for aviation there was a 7.0% reduction, contrasting with a 4.2% growth per annum in 2005 - 2008. Road freight experienced a 7.6% reduction in demand in 2008 in part due to the downturn in construction activity and also due to the recession generally. Road private car transport remained at 2007 levels in 2008 in contrast with a 4.5% annual growth over the period 2005 – 2008. During 2008 the overall mileage of private cars registered a minor increase but mileage of diesel private cars increased by 14% while mileage for petrol private cars decreased by 0.5%. Interestingly, energy demand for rail transport and for public service vehicles increased by 6.2% and 15.4% respectively.

Energy use in buildings is affected by weather patterns and the temperature of one year relative to the previous year is captured in terms of degree days. The number of degree days for Ireland in 2008 was 11% higher than in 2007 (although still 2.7% below the long-term average).

Residential energy use increased by 8.8% during 2008, but when corrections for climate effects are taken into account the increase was 3.3%. Electricity demand increased by 5.7% while direct fuel use increased by 9.5%. The growth for electricity was higher than the average in the period 2005 – 2008 (5.7% compared with 4.3%) but the difference for direct fuel use was significantly greater than the overall recent trend (9.5% compared with 1.8%). Natural gas use increased by 13% in 2008 (3.3% per annum in 2005 – 2008). Oil increased by 9.4% in 2008 (1.9% per annum in 2005 – 2008). There was a more significant increase in solid fuels that may be related to the high oil and gas prices in 2008. Coal and peat briquettes increased by 9.7% and 25% in 2008 respectively in contrast with the 2.4% per annum reduction and 5.4% per annum increase respectively over the period 2005 – 2008.

In the services sector, energy demand increased by 6.9% in 2008, or by 1.9% after removing the weather effects from the data. Electricity demand increased by 9.7% in 2008 compared with a growth of 4.1% per annum during 2005 – 2008. Direct fuel use increased by 4.7% compared with 1.0% per annum in 2005 – 2008. Oil demand reduced in 2008 while gas demand grew by 11%. Renewable energy grew by 50% although from a very low base.

3. Key Policy Issues

The energy trends discussed in section *2* may be analysed to assess performance with regard to Government policies and targets, in particular those detailed in the *Energy White Paper (2007),* the *National Climate Change Strategy 2007 – 2012,* and EU Directives related to renewable energy, CHP, energy efficiency and greenhouse gas and transboundary emissions. This section discusses a number of key energy policy issues, grouped under the three pillars of sustainable energy development, namely:

- environmental responsibility;
- security of supply;
- cost competitiveness.

3.1 Environmental Responsibility

The key policy areas, which are discussed under this pillar, are: limiting energy-related greenhouse gas and transboundary gas emissions; accelerating the penetration of renewable energy and increasing the deployment of CHP.

3.1.1 Greenhouse Gas Emissions

Ireland's commitment to the Kyoto Protocol, which is an international legally binding agreement to reduce GHG (greenhouse gas) emissions, is to limit the growth in annual emissions to 13% above 1990 levels in the period 2008 to 2012.

In 2008, the EU agreed a Climate Energy Package that included a target to reduce greenhouse gas emissions across the EU by 20% below 1990 levels by the year 2020. This resulted in two specific pieces of GHG emissions legislation affecting Ireland:

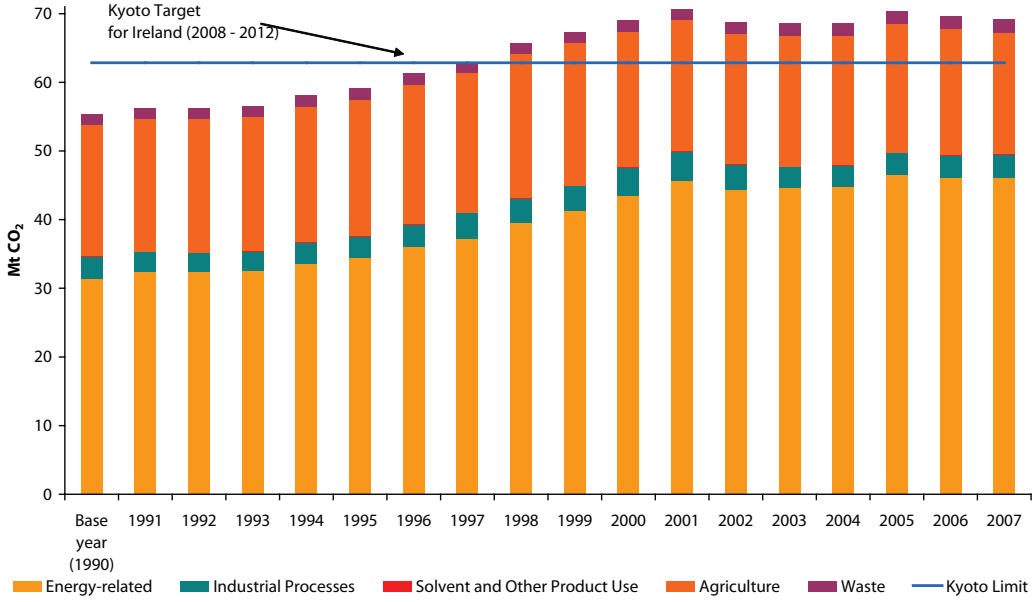
- Directive 2009/29/EC requiring emissions trading scheme (ETS) companies to reduce their emissions by 21% below 2005 levels by 2020;
- Decision 406/2009/EC requiring Ireland to reduce non-ETS emissions by 20% below 2005 levels by 2020.

EPA[17] published projections of greenhouse gas emissions in September 2008. These suggest a non-ETS emissions cap for Ireland of 40.6 $MtCO_{2eq}$ per annum over the Kyoto period and 37.9 $MtCO_{2eq}$ in 2020.

Figure 16 shows the trend in annual GHG emissions for the period 1990 – 2007. The emissions are grouped according to the individual source. These are energy, industrial processes (including cement production), solvent and other product use, agriculture and waste.

17 EPA 2008 *Ireland's National Greenhouse Gas Emissions to 2020* includes a comparison with Ireland's Kyoto limit for 2008 – 2012 and with the proposed EU target for 2020.

Figure 16 Greenhouse Gas Emissions by Source 1990 – 2007[18]



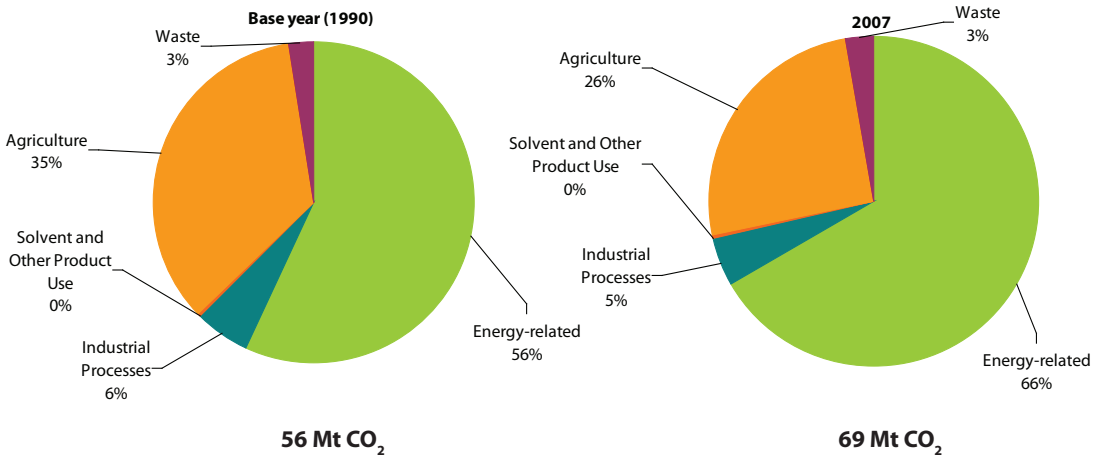
Source: Based on EPA data.

It is clear from *Figure 16* that Ireland's Kyoto target for the period 2008 – 2012 was breached in 1997. By 2001, annual GHG emissions peaked at 27% above 1990 levels. It is also evident from *Figure 16* that the most significant area of growth is in energy-related emissions, in particular since 1995 although levelling off since 2001.

In 2002 there was a reversal in the upward trend for the first time with GHG emissions dropping to 24% above 1990 levels. This downward trend continued in 2003, the first full year of operation for the two new CCGT power plants and the first full year without fertiliser production. Figures from the EPA show that emissions increased to 26.7% above 1990 levels in 2006 and figures for 2007 show that they've fallen back slightly to 24.5% above 1990 levels (10.1% above the target).

Figure 17 shows the GHG emissions by source for 1990 and 2007, illustrating the increased role of energy as an emissions source.

Figure 17 Greenhouse Gas Emissions by Source

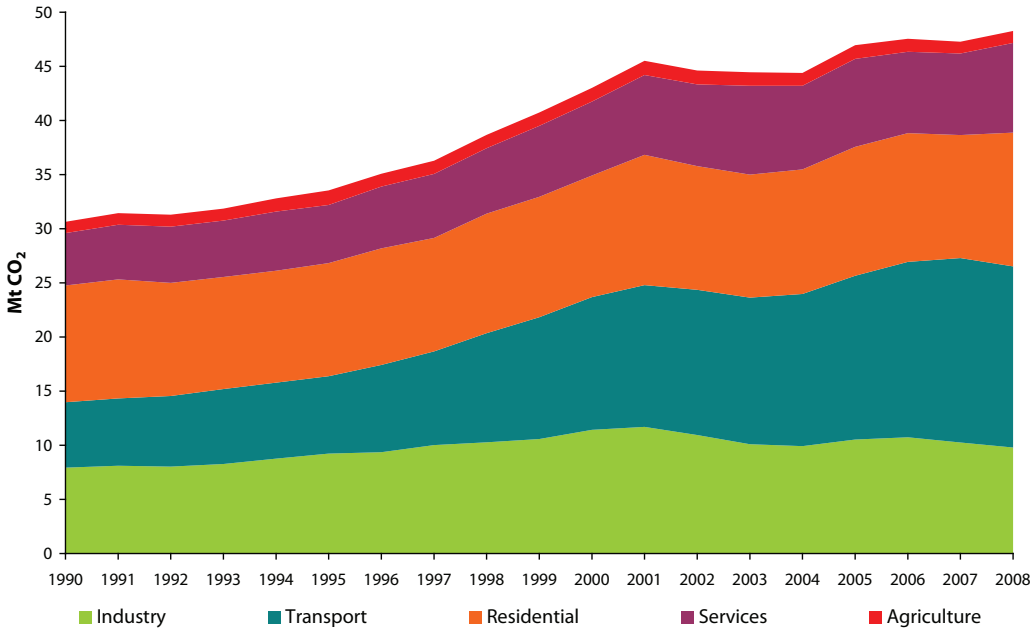


The share of GHG emissions arising from energy-related activities was 66% in 2007 compared with 56% in 1990. The share from agriculture dropped from 35% to 26% in the same period. It is interesting to note that for the EU as a whole, energy production

18 *Figure 16* and *Figure 17* based on 2007 data submitted by the EPA in April 2009.

and use represented 80% of GHG emissions in 1990[19]. The significant role of agriculture in the Irish economy underlies Ireland's variance from the EU average.

Figure 18 Energy-Related CO_2 Emissions by Sector[20]



To examine more closely where the growth has been occurring, *Figure 18* shows the sectoral breakdown of energy-related CO_2 emissions [which represent 96% of energy-related GHG emissions, 4% accounted for by energy-related nitrous oxide (N_2O) and methane (CH_4)]. Energy-related CO_2 emissions in 2008 were 53% higher than 1990 levels.

These growth rates are also presented in tabular form in *Table 8*.

Table 8 Growth Rates and Shares of Primary Energy-Related CO_2 by Sector

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Industry	22.1	1.1	3.1	4.3	-1.7	-2.5	-4.6	25.8	20.0
Transport	176.3	5.8	3.4	11.4	4.3	3.4	-1.9	19.8	34.8
Residential	14.7	0.8	-0.6	1.4	1.2	1.3	8.8	35.2	25.7
Commercial / Public	71.4	3.0	2.1	4.9	3.5	0.7	9.7	15.8	17.2
Agriculture	5.0	0.3	5.1	-1.2	0.2	-4.8	0.6	3.4	2.3
Total	**52.9**	**2.4**	**1.6**	**4.6**	**2.3**	**0.4**	**1.3**		

The most significant area of growth overall since 1990 was in the transport sector, where CO_2 emissions in 2008 were 176% higher than those in 1990 (6.3% average annual growth rate). In 2007 they were 182% higher. Transport energy-related CO_2 emissions fell for the first time in 2008 by 1.9%. Energy use in transport accounted for more than one third (35%) of energy-related CO_2 emissions in 2008 and is by far the largest CO_2 emitting sector – emitting one and a half times the energy-related CO_2 emissions in industry. Energy-related CO_2 emissions also fell in industry in 2008, falling by 4.6%. Under the emissions trading scheme only the emissions directly generated on site by industrial entities is taken into account. If upstream electricity emissions are omitted industry experienced a decrease in CO_2 emissions of 5.9% in 2008. These two sectors' emissions are directly coupled with the economy and the reduction is mainly as a result of the downturn that started in 2008.

19 Eurostat (2008), *Energy, transport and environment indicators pocketbook.*

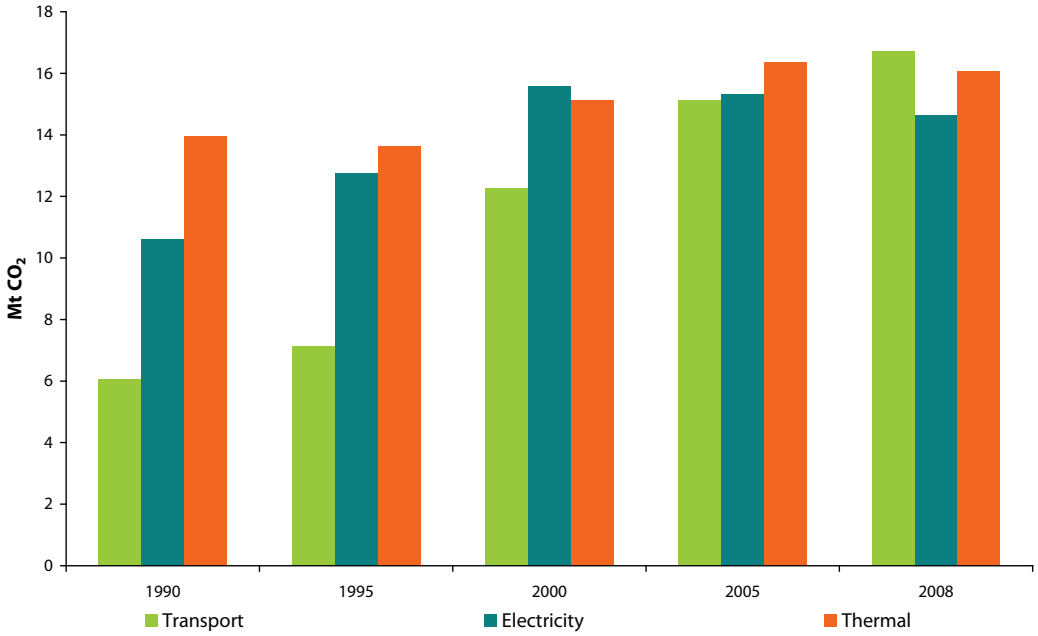
20 *Figure 18* and *Table 8* are based on SEI estimates and use a different methodology to that used by EPA for compiling the national inventory. International air transport emissions are excluded from the national GHG emissions inventory in accordance with the reporting procedures of the UN Framework Convention on Climate Change (UNFCCC) guidelines and are also excluded here.

The residential sector experienced an increase of 8.8% in primary energy related emissions during 2008 and services experienced an increase of 9.7%. In both these sectors a significant portion of energy use relates to space heating, therefore when looking at yearly changes it is important to take the weather into account. As 2008 as whole was considerably colder than 2007, this would have contributed to the increase in energy and emissions. In services additional increases may be due in part to increased use of outdoor heaters (gas and electric) for the convenience of smokers in hotels, restaurants, pubs etc.

Agricultural energy-related CO_2 emissions increased by 0.6% in 2008 but the sector's share of these emissions is small at less than 2.3%. This is small compared to other agriculture related greenhouse gas emissions due primarily to livestock and also fertiliser use.

Figure 19 illustrates the variations in emissions by mode of energy use. Here the emissions are allocated according to whether the energy used is for mobility (transport), in the form of electricity (power) or as thermal energy (for heating). These modes also represent distinct energy markets. The graph presents the emissions at five-yearly intervals and for 2008.

Figure 19 Energy-Related CO_2 Emissions by Mode of Energy Application



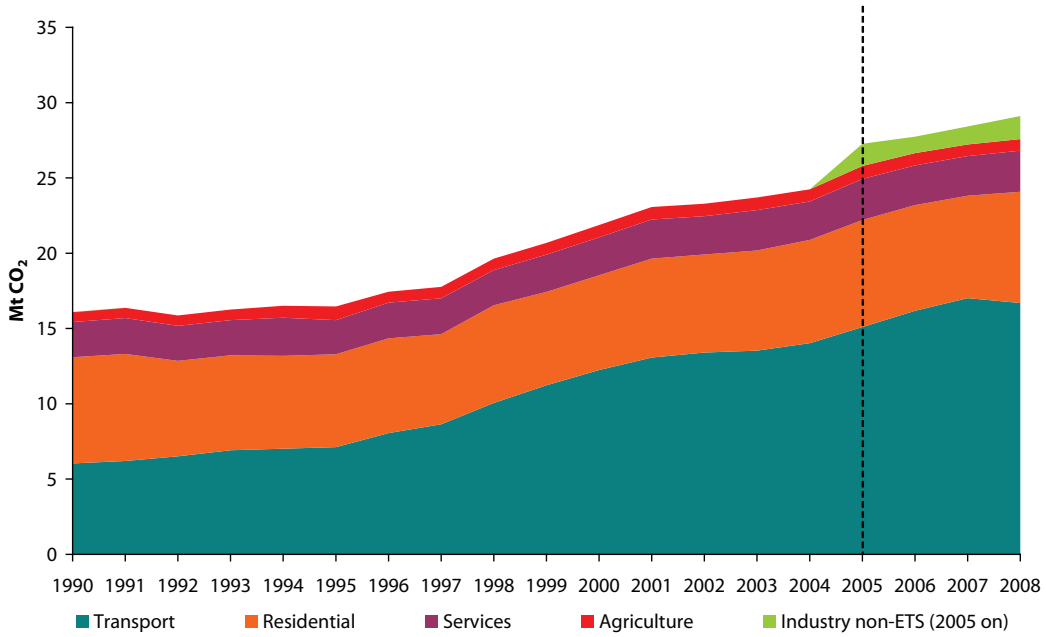
The growth in emissions related to mobility (176% over the period) is again striking, although they fell slightly in 2008 as mentioned above. Electricity was the dominant mode in terms of emissions from 1996 until 2002. Transport became the dominant mode since 2006.

In 2008, energy-related emissions from electricity increased by 2.3% from the 2007 level compared to an increase of 3.1% in final consumption of electricity. Overall electricity generation emissions were 38% above 1990 levels. Emissions from thermal energy applications increased by 2.3% in 2008 and overall the thermal mode emissions were 15% above 1990 levels.

Given the policy focus on the non-emissions trading sectors[21], *Figure 20* shows the trend in energy-related CO_2 emissions for the transport, residential, services and agriculture sectors and non-ETS industry from 2005 onwards. This excludes emissions associated with electricity usage by these sectors as these emissions are included in emissions trading. The historical data is not sufficiently disaggregated to include, prior to 2005, the energy-related CO_2 emissions associated with thermal energy usage by manufacturing companies that are not participating in emissions trading.

21 EU Decision 406/2009/EC.

Figure 20 Non Emissions Trading Energy-related CO_2 (non-ETS industry from 2005 onwards)



Energy-related CO_2 emissions associated with the non-emissions trading sectors have grown by 71% (or 3.1% per annum on average) between 1990 and 2008. This represents a faster growth rate than for total energy related CO_2 emissions, which grew by 53% (or 2.4% per annum) over the same period. Non-ETS sectors (including non-ETS industry) energy-related CO_2 emissions increased by 6.7% (2.2% per annum) between 2005 and 2008 and by 2.4% in 2008. The 6.7% increase since 2005 is in the context of the requirement under EU Decision 406/2009/EC to achieve a 20% reduction on 2005 levels by 2020.

3.1.2 Transboundary Gas Emissions

Emissions of sulphur dioxide (SO_2) and nitrogen oxides[22] (or NO_x) are associated with acid rain, smog and other environmental impacts (including acidification and eutrophication) that are commonly described as air quality issues. An interrelationship between sulphur emissions in continental Europe and the acidification of Scandinavian lakes was demonstrated by scientists during the 1960s. Following the Stockholm conference in 1992, several studies confirmed the hypothesis that air pollutants could travel several thousands of kilometres before deposition and damage occurred. This also implied that cooperation at the international level was necessary to solve problems such as acidification.

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' 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. *Table 9* compares 2007 values (from EPA) for SO_2 and NO_x together with the emissions limits for the year 2010. The data emphasises the challenge ahead with respect to NO_x and indicates the significant progress in reducing SO_2 levels.

Table 9 SO_2 and NO_x Emissions and NEC Directive Ceilings for 2010

	1990 (kt)	2007 (kt)	2010 Ceiling (kt)	% reduction on 2007 to meet 2010 Ceiling
NO_x	127	121	65	46%
SO_2	183	54	42	22%

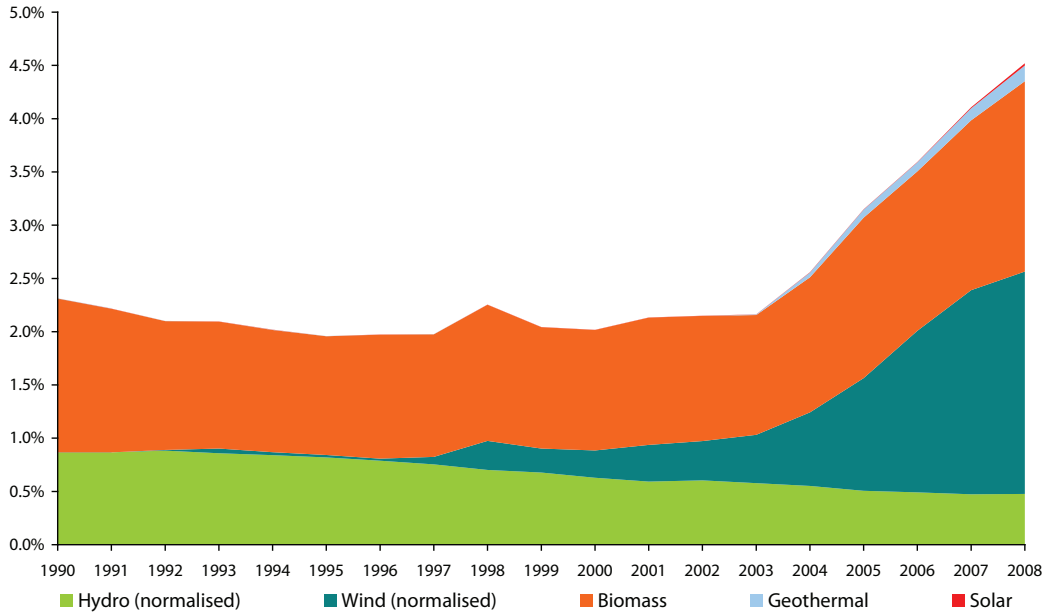
22 Collective term for nitric oxide (NO) and nitrogen dioxide (NO_2)

3.1.3 Renewable Energy

The target for Ireland in the European Renewable Energy Directive (2009/28/EC) is a 16% share of renewable energy in the final consumption by 2020. *Figure 21* shows the contribution as per the Directive from 1990 to 2008. The contribution from renewables in 1990 was 2.2% rising to 4.5% in 2008[23]. The Total Final Consumption (TFC) in the Directive is a slightly different TFC as conventionally defined in the energy balance. The Directive specifies final consumption of energy as the energy commodities delivered for energy purposes to manufacturing industry, transport, households, services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution. Total Final Consumption (TFC) is usually calculated as the total primary energy less the quantities of energy required to transform primary energy. Hydro and wind electricity generation are normalised as per the Directive.

A more detailed discussion of renewable energy in Ireland can be found in SEI's publication *Renewable Energy in Ireland*[24]. This section presents key graphs from the *Renewables* report.

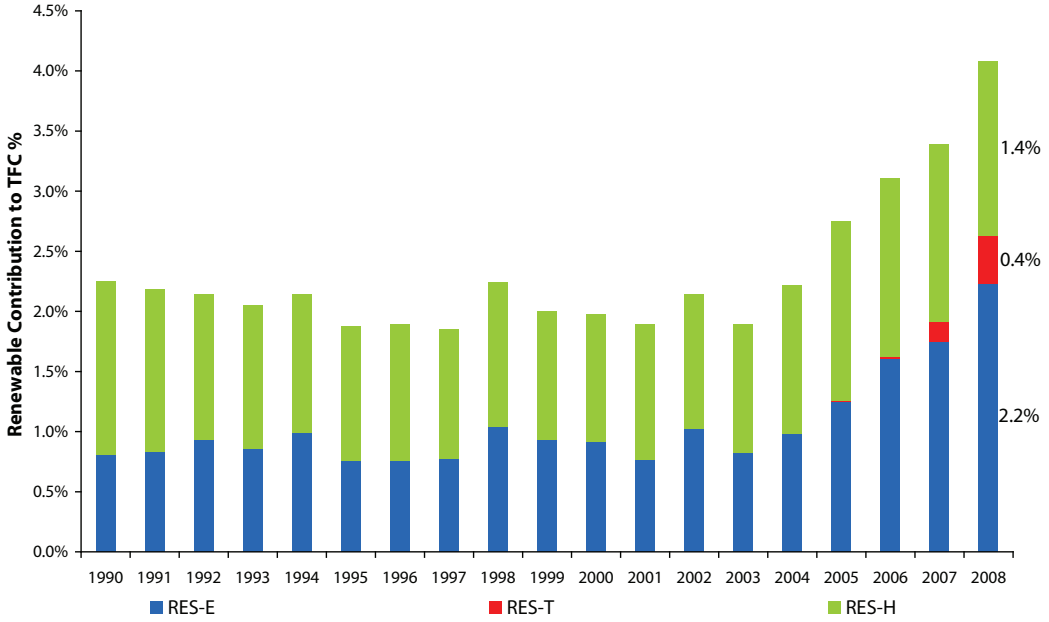
Figure 21 Renewable Energy (%) Contribution to TFC (Directive 2009/28/EC)



The renewable energy contribution includes electricity generation, transport energy and thermal energy generated by renewable sources; these are termed RES-E, RES-T and RES-H respectively. *Figure 22* shows the renewable energy percentage contribution to TFC by mode.

23 Calculated as per Directive 2009/28/EC.
24 Available from www.sei.ie/statistics.

Figure 22 Renewable Energy (%) Contribution to TFC by Mode



Source: SEI

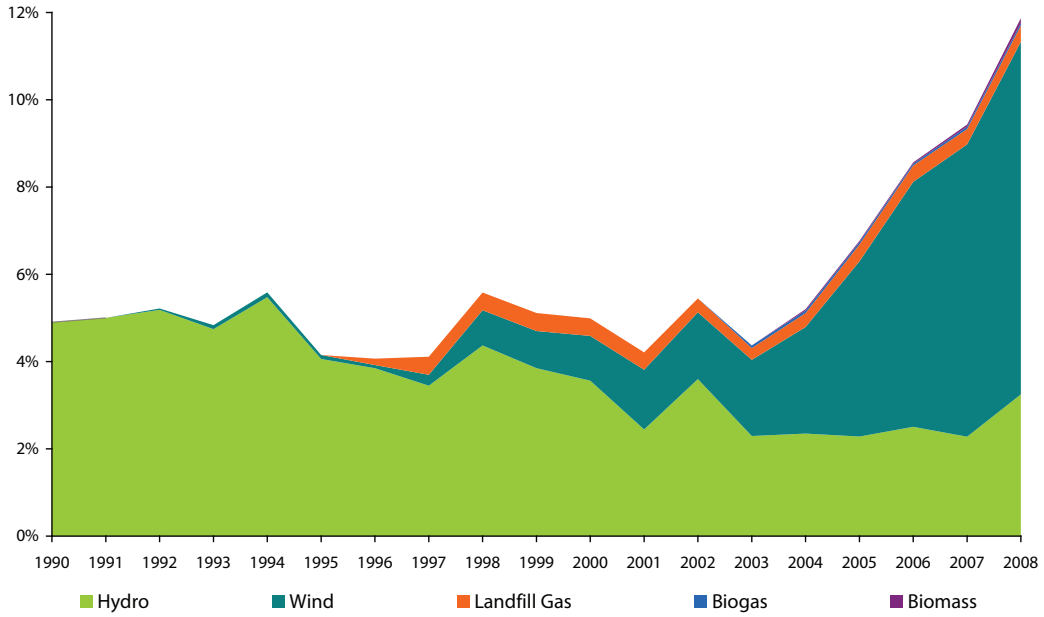
The national target for electricity generation specified in the 2007 *Government White Paper* is 15% by 2010 and 33% by 2020. It was announced in the Carbon Budget in October 2008 that the 2020 target was to be extended to 40% of gross electricity consumption to come from renewable energy. The contribution of renewable energy to gross electricity consumption[25] from 1990 – 2008 is shown in *Figure 23*.

While the contribution from hydro has declined, *Figure 23* shows how electricity production from wind energy has increased to the point that it accounted for 68% of the renewable electricity generated in 2008. Electricity generated from biomass accounted for 5% of renewable electricity. Biomass consists of contributions from solid biomass, landfill gas and waste water biogas. Wind, hydro and biomass-generated electricity in 2008, respectively, accounted for 8.1%, 3.2% and 0.5% of Ireland's gross electricity consumption.

The total contribution from renewable energy to gross electricity consumption in 2008 was 11.9% (compared with 9.4% in 2007 and 4.9% in 1990), suggesting that Ireland is on track to meet the 2010 target of 15%.

25 Defined as total electricity generated plus net imports.

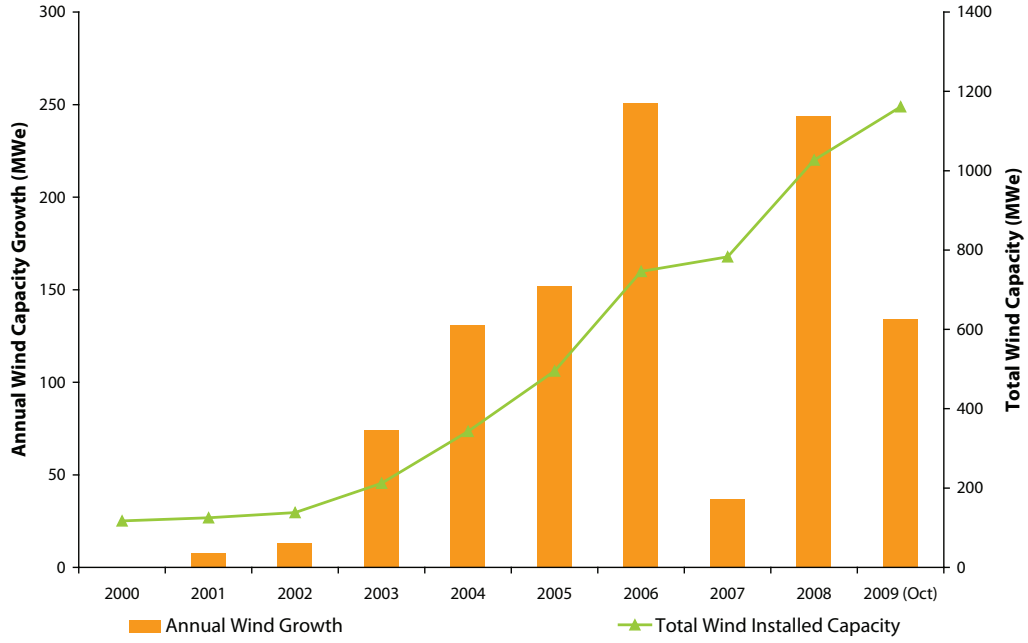
Figure 23 Renewable Energy Contribution to Gross Electricity Consumption (RES-E)



The share of electricity from renewable energy has more than doubled between 1990 and 2008 – from 4.9% to 11.9%, an increase of 7 percentage points over eighteen years. Most of this increase took place in the seven years since 2000.

A key focus of national renewable energy policy has been wind energy, due to the size of the wind energy resource in Ireland and the cost competitiveness of the technology. *Figure 23* shows how electricity production from wind energy has increased and wind energy in 2008 accounted for 8.1% of gross electricity consumption.

Figure 24 Installed Wind Generating Capacity 2000 - 2009 (Sept)[26]



Source: Eirgrid

26 October 2009 data from Eirgrid.

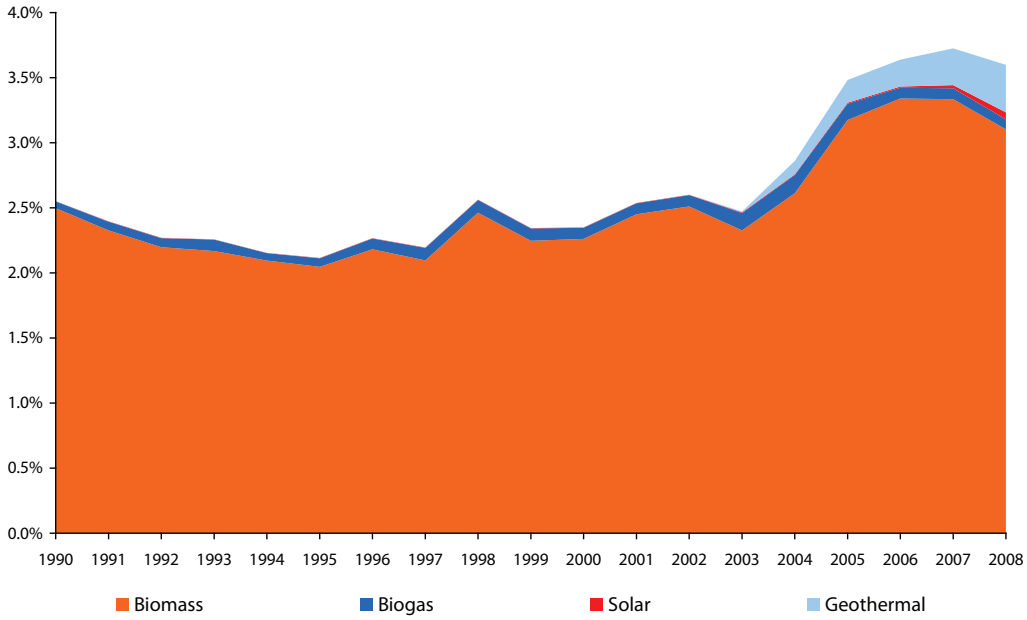
Figure 24 shows the annual and cumulative growth in installed wind generating capacity since 1990. By October 2009 (latest figures) the installed capacity of wind generation reached 1,161 MW (246 MW more than in September 2008). The peak recorded wind power output[27] was 1,064 MW delivered on 24th October 2009[28]. *Figure 24* also shows the rate of growth in wind power in terms of installed capacity.

Based on data published on Eirgrid's website there are 434 MW of wind contracted for connection before the end of 2009 and a further 469 MW by the end of 2010. There are an additional 541 MW contracted, 81 MW of live offers, 4,008 MW being processed within Gate 3 and a further 9,622 MW in the queue for grid connection.

Figure 25 shows the contribution from renewable energy to heat or thermal energy uses. The increasing activity in specific sub-sectors of industry, as well as some incentives for residential biomass heat systems, has led to biomass increasing from 105 ktoe in 1990 to a high of 181 ktoe in 2006 but falling to 171 in 2008, representing a growth of 62% (2.7% average annual growth). The national target specified in the *Government White Paper* is: 5% of all heat to come from renewable energy sources by 2010 and 12% by 2020.

There was a decline in the contribution from renewable energy to thermal energy in the early 1990s, from 2.6% in 1990 to 2.1% in 1995. Between 2000 and 2007 RES-H grew from 2.4 % to 3.7% before falling back slightly in 2008 to 3.6%. This growth in renewable energy (dominated by biomass) that has occurred is mostly due to increased activity in the industrial sub-sectors where the biomass is mostly used (wood and food sectors). There has also been recent growth in renewable energy use in the residential and services sectors with the introduction of grant support schemes, but the increases here have to date been small in volume with respect to overall thermal renewable energy consumption. This suggests that a significant effort is required to meet the 2010 target of 5%.

Figure 25 Renewable Energy Contribution to Thermal Energy (RES-H)



The *White Paper* target for Renewable Energy Sources in Transport (RES-T) is to achieve 5.75% of petrol and diesel transport energy from renewable energy by 2010 and 10% by 2020. The Minister for Energy issued a consultation paper[29] on the introduction of a biofuels obligation scheme in October 2008 and proposed therein that the 2010 target be reduced from 5.75% to 3%. The 2020 target of 10% is a European target and remains unchanged. On 9th November 2009 the Minister published details of regulations which will compel fuel suppliers to include biofuels in their annual sales. Under the proposed

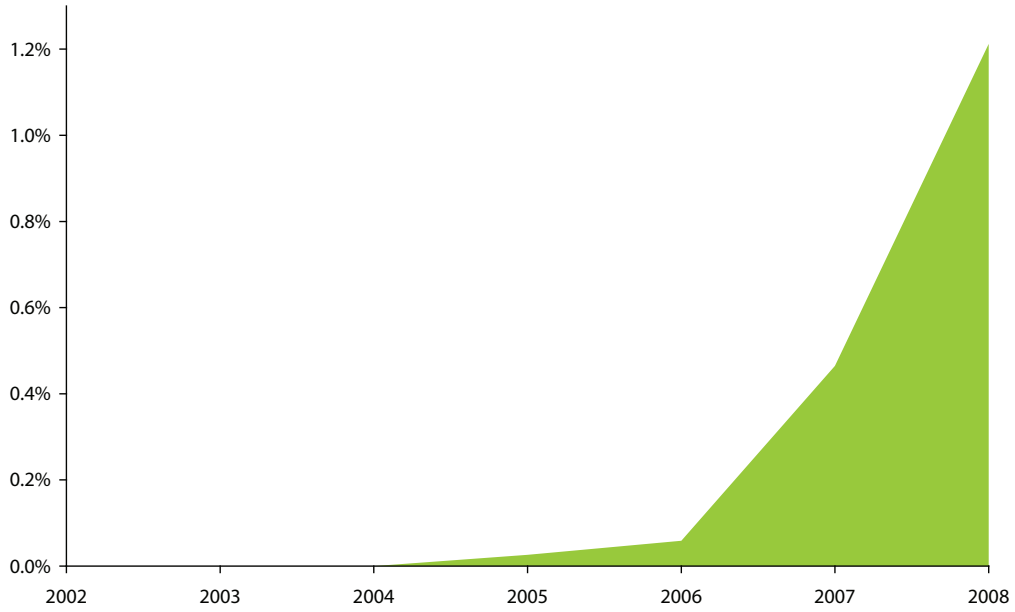
27 Source: Eirgrid. Wind power is published as 15 minute average data on http://www.eirgrid.com/operations/systemperformancedata/windgeneration/

28 CER, Nov. 2009, Generation System Performance Report: Quarter 4, 2009, http://www.cer.ie/en/electricity-security-of-supply-generation-adequacy.aspx?article=c2ab80fd-4d23-49aa-83f9-f7d5f25ce771

29 DCENR 2008 *Public Consultation on the Biofuels Obligation Scheme September 2008.* Available from www.dcenr.ie

legislation, fuel suppliers will have to include an average of 4% (by volume) biofuels (equivalent to approx. 3% in energy terms) in their annual sales from July 2010.

Figure 26 Renewable Energy as a Proportion of (Petrol & Diesel) Transport (RES-T)

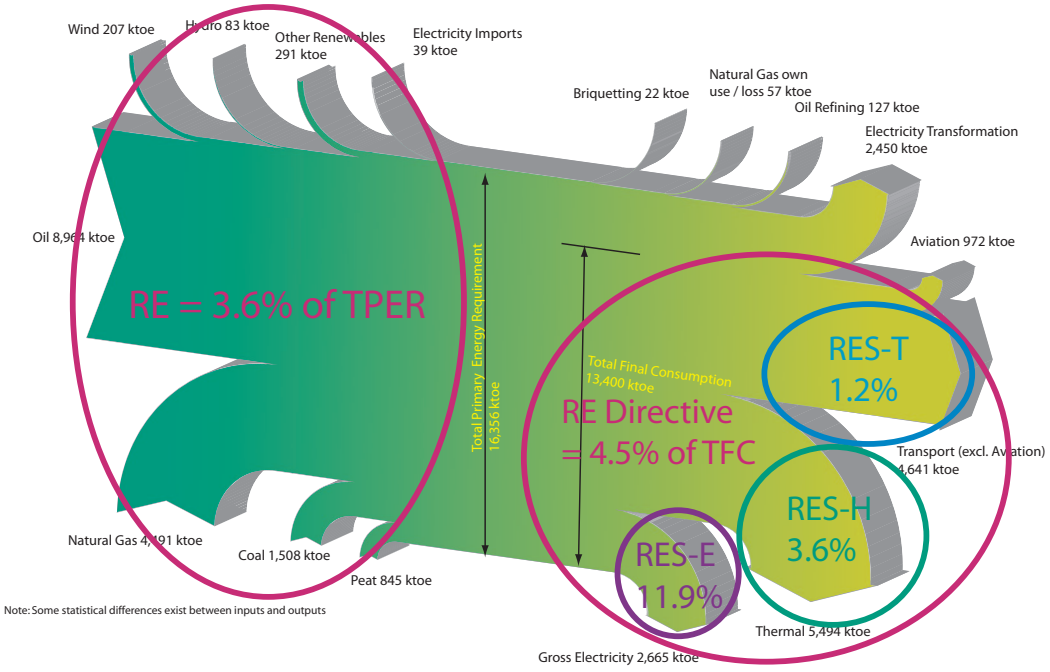


There was a significant increase in the share of transport energy from biofuels since 2006, albeit from a low base. In absolute terms, biofuels in transport increased from 1 ktoe in 2005 (0.03%) to 3 ktoe in 2006 (0.06%), 21 ktoe in 2007 (0.5%) and 56 ktoe in 2008 (1.2%). The 2% target for 2008 contained in the White Paper was not achieved notwithstanding considerable recent growth.

3.1.4 Progress towards renewable energy targets

Figure 27 illustrates where the various renewable targets fit within overall energy use in Ireland and the position with regard to progress towards those targets in 2008. Towards the right of the figure the transport, heat and electricity targets current percentages are shown relative to the respective amount of final energy that they refer to. Also shown is how these relate to the proposed 2008 Directive target.

Figure 27 Progress to Targets 2008



Towards the left of *Figure 27* the overall contribution of renewable energy to total primary energy requirement (TPER) is shown at 3.6%. Whilst there is no specific target for this measure it does help to illustrate the position of renewables in the overall energy use in Ireland.

Table 10 Renewable Energy Progress to Targets[30]

% of each target	1990	1995	2000	2005	2006	2007	2008		*2010*	*2020*
RES-E	4.9	4.1	5.0	6.8	8.6	9.4	11.9		*15*	*40*
RES-T	0.0	0.0	0.0	0.0	0.1	0.5	1.2		*3*	*10*
RES-H	2.6	2.1	2.4	3.5	3.6	3.7	3.6		*5*	*12*
Directive (2009/29/EC)	**2.3**	**2.0**	**2.0**	**3.1%**	**3.6%**	**4.1%**	**4.5%**			***16***

Source: SEI

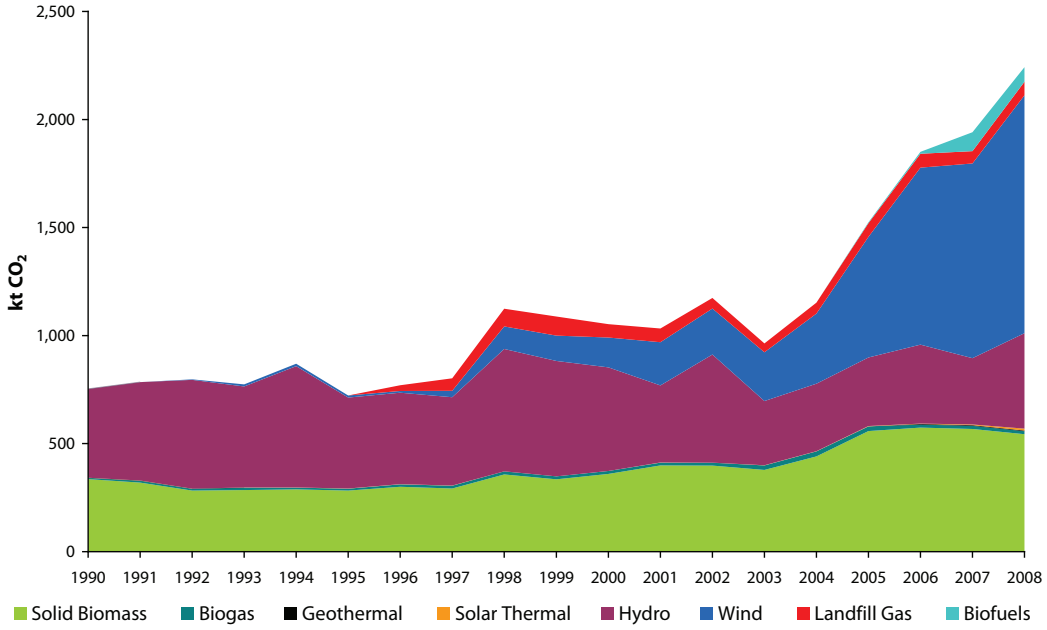
Table 10 tabulates progress towards the individual national modal targets and to the overall Directive target for the period 1990 – 2008. Here the percentages in each row (RES-E, RES-T and RES-H) relate to the specific modal targets and the percentages in the final row relate to the overall target using the definition in the EU RE Directive 2009/29/EC. The latter two columns show the targets for 2010 and 2020.

3.1.5 CO_2 Displacement

Figure 28 shows the trend in avoided CO_2 emissions from renewable energy for the period 1990 – 2008. See *Renewable Energy in Ireland – 2008 Report* for details on the methodology used to calculate the avoided emissions.

30 Note: Individual target percentages are not additive.

Figure 28 Avoided CO_2 from Renewable Energy 1990 to 2008



The estimated amount of CO_2 avoided from renewable energy increased by 197% (6.2% per annum on average) over the period 1990 to 2008 reaching 2,242 kt CO_2 in 2008, illustrated in *Figure 28*. The emissions avoided from wind were most significant in 2008, 1,101 kt CO_2, followed by solid biomass 544 kt CO_2 and hydro 441 kt CO_2.

3.1.6 Combined Heat and Power

Combined Heat and Power (CHP) is the simultaneous generation of usable heat and electricity in a single process. In conventional electricity generation much of the input energy is lost to the atmosphere as waste heat. Typically 60% of the input energy is lost with just 40% being transformed into electricity. Combined Heat and Power (CHP) systems channel this extra heat to useful purposes so that usable heat and electricity are generated in a single process. The efficiency of a CHP plant can typically be 20% to 25% more efficient than the combined efficiency of heat-only boilers and conventional power stations. Also, if embedded in the network close to the point of electrical consumption, CHP can avoid some of the transmission losses incurred by centralised generation. Therefore in the right circumstances CHP can be an economic means of improving the efficiency of energy use and achieving environmental targets for emissions reduction.

The European Commission published a strategy document on CHP in 1997[31] with the aim of doubling the 1994 CHP penetration by 2010 (from 9% to 18%). This target refers to the EU–15 and in 2007 (the latest year data are available) the proportion of total electrical output that was generated from CHP was 10.3% (10.9% for EU-27), indicating the scale of the challenge for the remaining years.

The European Union CHP Directive[32], approved in February 2004, seeks to create a favourable environment for CHP installations. The Energy (Miscellaneous Provisions) Act of 2006 transposes the EU CHP Directive into Irish law. In 2009 two statutory instruments SI 298 and SI 299 of 2009 were published. SI298 brought into law section 6 of the 2006 act which relates to CHP. SI299 gives the Commission for Energy Regulation (CER) the responsibility of calculating Power to Heat Ratio's for CHP units in Ireland.

In the Irish Government 2006 Budget an indicative allocation of €11M was made for a CHP programme to run in the 2006 to 2010 time frame. The Budget allocation led to the SEI CHP Deployment Programme which provides grant support to assist the deployment of small-scale (<1MW_e) fossil fuel fired CHP and biomass (anaerobic digestion and wood residue) CHP systems. The

31 Commission of the European Communities (1997), *A Community Strategy to Promote Combined Heat and Power and to Dismantle Barriers to its Development*.

32 European Union, 2004. Directive 2004/8/EC of the European Parliament and of the Council of 11 February 2004 on the promotion of cogeneration based on a useful heat demand in the internal energy market. Available from: http://europa.eu.int/eur-lex/pri/en/oj/dat/2004/l_052/l_05220040221en00500060.pdf

CHP Deployment Programme also includes funding for feasibility studies for micro-CHP generation. The objective of the trial is to assess current technology and identify possible barriers, risks and benefits associated with its deployment. This was put in place to inform future policy consideration of micro-generation and the opportunities for further efficiency gains through distributed small scale generation[33].

The *Government's Energy White Paper*[34] published in 2007 set out the energy policy directions and targets for Ireland to 2020. The *White Paper* states that "*growth in combined heat and power deployment is an important objective to 2020*" and targets of a total of 400 MW_e of installed CHP capacity by 2010, and 800 MW_e by 2020 have been set. The Programme for Government was published in June 2007 and includes a commitment to remove any regulatory barriers to CHP and district heating systems. The National Climate Change Strategy (NCCS)[35] 2007 to 2012, published on the 2nd April 2007 states that 0.162 Mt CO_2 equivalent will be saved by 2010, as a result of the CHP deployment programme. The final National Energy Efficiency Action Plan[36] published in May 2009 also reflects the targets set out in the Government White Paper.

The installed capacity[37] of CHP in Ireland at the end of 2008 was 289 MW_e (195 units[38]) – up from 287 MW_e (178 units) in 2007, an increase of 1%. Comparing operational installed capacity, there was a 2.5% increase from 2007 to 2008, that is, an increase of 7MW_e of installed capacity. The installed capacity at the end of 2008 was 72% of the Government 2010 target. Natural gas was the fuel of choice for 271 MW_e (185 units) in 2008. It is worth noting that there is one single 160MW gas plant which dominates. Oil products[39] made up the next most significant share with 8.1 MW_e (6 units) while solid fuels accounted for 5.2 MW_e (2 units), the remainder being biomass at 5.35 MW_e (2 units).

Figure 29 illustrates the contribution from CHP to Ireland's energy requirements in the period 1994 – 2008[40]. Fuel inputs have increased by 155% (7% per annum) while the thermal and electrical outputs increased by 246% (9% per annum) and 613% (15% per annum) respectively over the period. This suggests that the overall stock of CHP installations has become more efficient over the period. In 2008 fuel input decreased by 1%, thermal output increased by 16% while electricity increased by 35%. The large increase in 2006 is accounted for by the Aughinish Alumina plant which came online in that year.

33 Details of the trial are available from http://www.sei.ie/index.asp?locID=1091&docID=-1.
34 The full text of the White Paper is available at http://www.dcmnr.gov.ie/Energy/Energy+Planning+Division/Energy+White+Paper.htm.
35 Available from http://www.environ.ie/.
36 Available from http://www.dcmnr.gov.ie/.
37 Megawatt electrical or MWe is the unit by which the installed electricity generating capacity or size of a CHP plant is quantified, representing the maximum electrical power output of the plant. The figures above include a number of units that were not operational (5.7 MWe, 7 units) and a number whose status is currently unknown (4 MWe 6 units).
38 Note that units are distinct from CHP plants or schemes and that there may be more than one CHP unit at a site.
39 Oil products are comprised of LPG and heavy fuel oil and refinery gas.
40 CHP in Ireland is examined in more detail in a separate SEI publication: Sustainable Energy Ireland (2009), *Combined Heat and Power in Ireland: Trends and Issues – 2009 Update,* available from www.sei.ie.

Figure 29 CHP Fuel Input and Thermal/Electricity Output 1994 – 2008

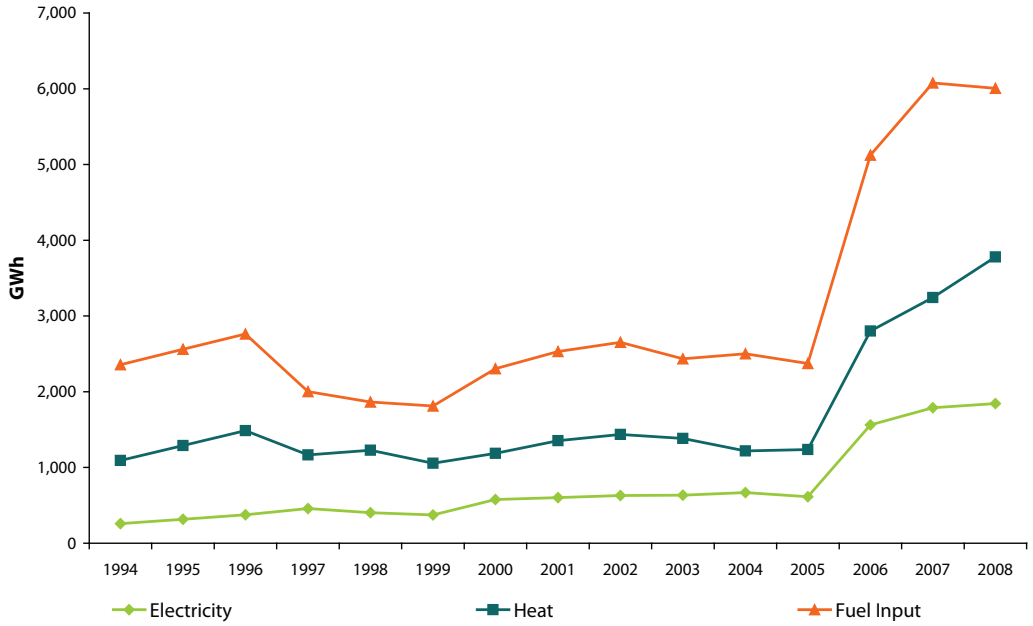
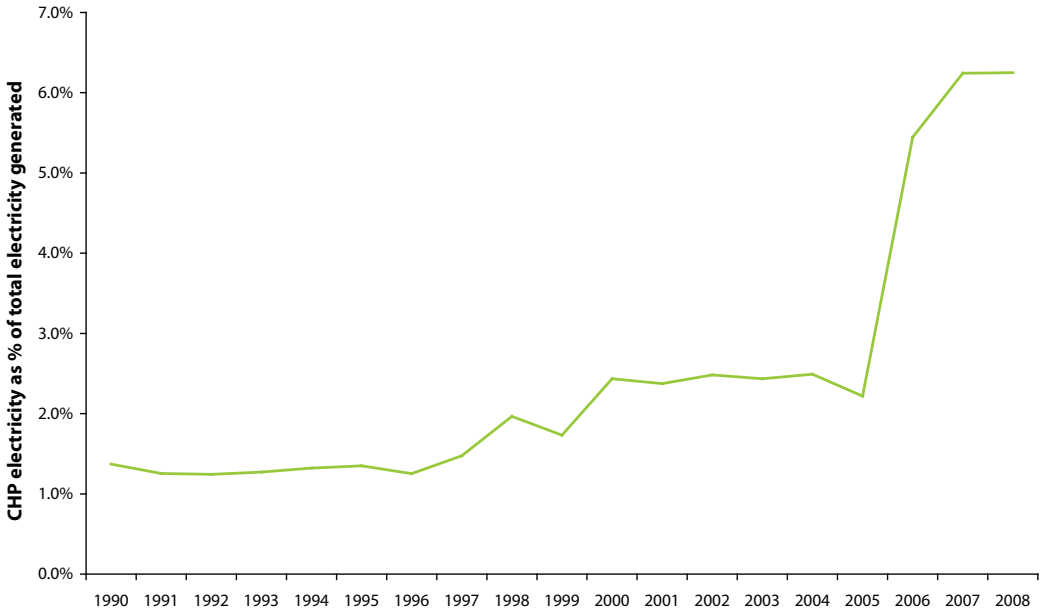


Figure 30 focuses on CHP generated electricity in Ireland as a proportion of gross electricity consumption (i.e. electricity generation plus net imports) in the period 1990 to 2008. In 2008, 6.3% of total electricity generation was generated in CHP installations compared with 6.2% in 2007 and 5.4% in 2006.

Some CHP units export electricity to the national grid. In 2008 there were 11 units exporting electricity to the grid. These units exported 1,013 GWh of electricity in 2008, an increase of 8.9% on 2007.

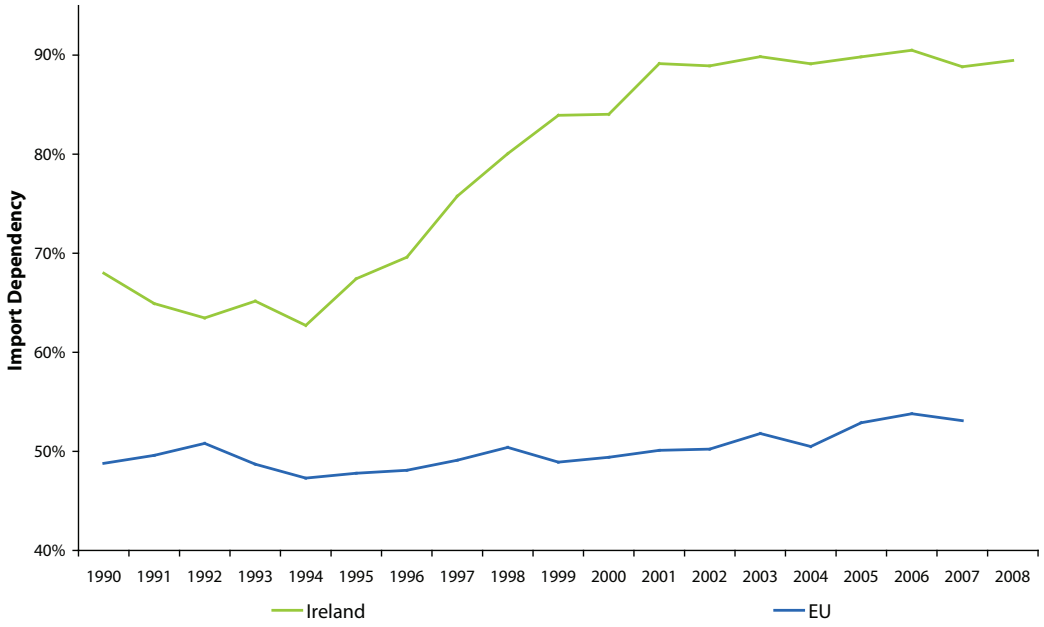
Figure 30 CHP Electricity as percentage of Total Electricity Generation 1990 – 2008



3.2 Security of Supply

Security of energy supply relates to import dependency, fuel diversity and the capacity and integrity of the supply and distribution infrastructure. Ireland's security of supply is closely linked to EU security of supply, but import dependency is examined here for Ireland in its own right. Security of supply is treated in more detail in a separate SEI publication[41]. *Figure 31* illustrates the trend since 1990, comparing it with the EU.

Figure 31 Import Dependency of Ireland and EU



Source: SEI and Eurostat

Domestic production accounted for 32% of Ireland's energy requirements in 1990. However, since the mid-1990s import dependency has grown significantly, due to the increase in energy use together with the decline in indigenous natural gas production at Kinsale since 1995 and decreasing peat production. Imported oil and gas accounted for 81% of TPER in 2008, compared with 50% in 1990. Ireland's overall import dependency reached 91% in 2006 and has decreased slightly to 89% in 2008.

This trend reflects the fact that Ireland is not endowed with significant indigenous fossil fuel resources and has to date not harnessed significant quantities of renewable resources. *Figure 32* shows the indigenous energy fuel mix for Ireland over the period. The reduction in indigenous supply of natural gas is clearly evident from the graph as is the switch away from peat. Production of indigenous gas decreased by 81% over the period since 1990, peat by 54% and renewable energy in contrast increased by 221%. Indigenous production peaked in 1995 at 4.1 Mtoe and there has been a 63% reduction since then.

The share of native gas within the indigenous fuels contribution was 23% in 2008, compared with 54% in 1990. The share of peat increased from 41% in 1990 to 42% in 2008 but in absolute terms peat consumption declined by 54%. Renewable energy accounted for 35% of indigenous produced fuels in 2008.

Some proposed developments are likely to impact on this trend including the plans to extract and utilise gas at the Corrib Gas Field and the targets for increasing the deployment of renewable energy to be achieved by 2010 and 2020.

41 Sustainable Energy Ireland (2007), *Security of Supply in Ireland – 2007 Report*, www.sei.ie.

Figure 32 Indigenous Energy by Fuel

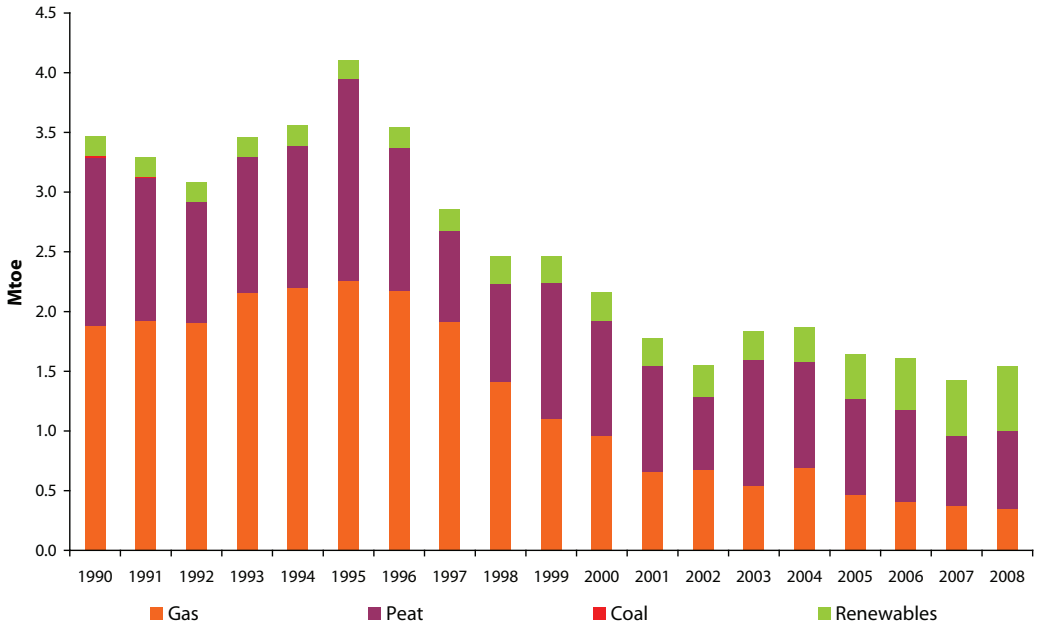
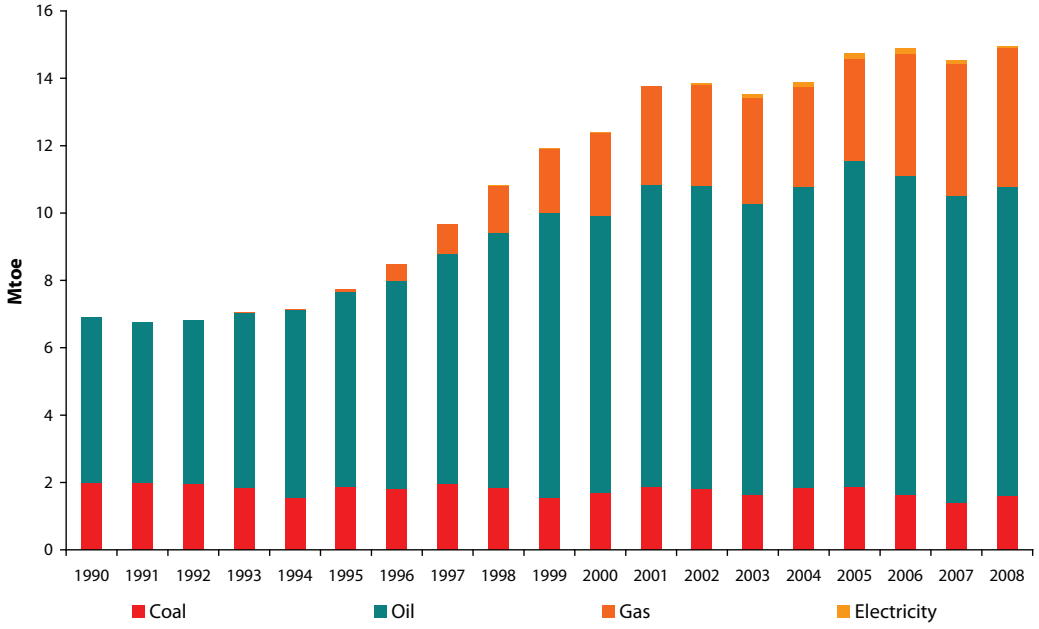


Figure 33 shows the trend for net fuel imports (imports minus exports) over the period 1990 – 2008. The growing dependence on oil due largely to increase in energy use in transport is the most striking feature. There was more than a doubling (113%) of total net imports over the period with an 86% increase in net imports of oil. The decline of indigenous natural gas reserves at Kinsale is also indicated by the growth in imported natural gas in the latter part of the decade. Coal imports have remained stable over the period reflecting the base load operation of Moneypoint electricity generating plant. In 2007, oil, gas and coal accounted for 64%, 25% and 10% of net imports respectively.

Figure 33 Imported Energy by Fuel



3.3 Cost Competitiveness

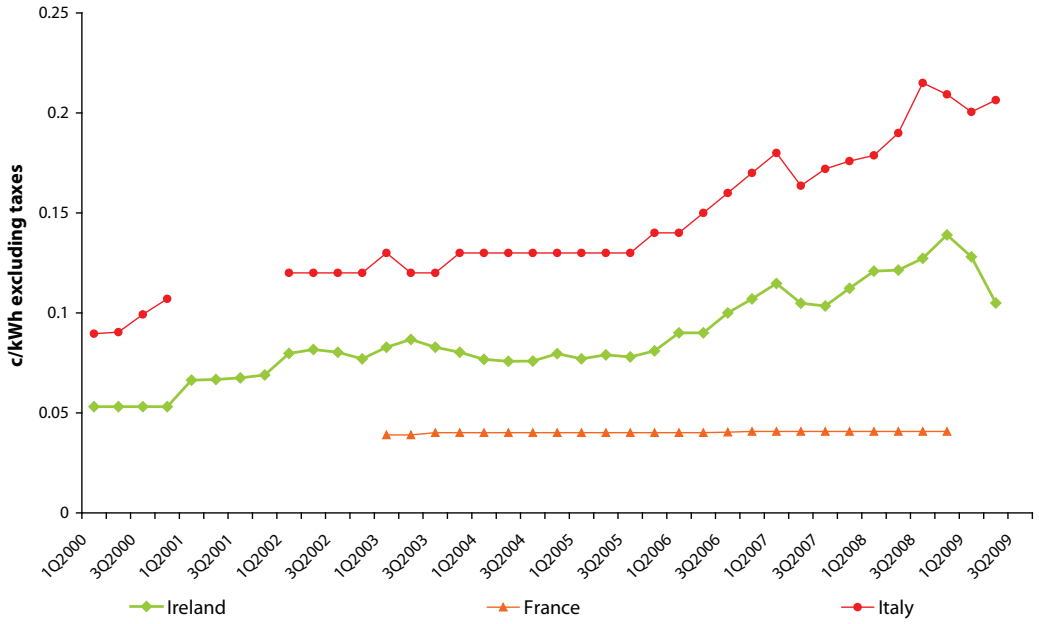
Energy use is an important part of economic activity and therefore the price paid for this energy is a determining factor in the competitiveness of the economy. The EU has introduced competition into the electricity and gas markets through the liberalisation process in order to reduce energy costs to final consumers.

This section presents comparisons of the cost of energy in various forms in Ireland with that in selected EU countries. The source of the data presented here is the International Energy Agency (IEA) *Energy Prices and Taxes*. This data source was chosen because it is produced quarterly and the latest complete data is available for the second quarter of 2009. Prices shown are in current (nominal) money. Graphical comparisons with other countries in money terms are restricted to euro-zone countries (subject to data availability) to avoid difficulties in adjusting for exchange rates. To avoid confusion in the graphs, only data for Ireland and the highest and lowest price countries (as of the 2nd quarter 2009) are presented. Relative price increases since 2000 however are tabulated for all the EU-15 countries in index format in both nominal and real terms.

SEI has also published a number of reports titled *Understanding Electricity and Gas Prices in Ireland*[42] based on the new methodology for the revised EU *Gas & Electricity Price Transparency Directive*[43] which came into effect on the 1st January 2008. These reports focus specifically on gas and electricity prices and are a useful reference for this section on cost-competitiveness. When produced annually these reports should help in understanding the key contributing factors and the precise impact of energy price increases. The new methodology reflects more accurately the actual cost of gas and electricity to final consumers as it incorporates all the factors in the cost of their use. When a sufficient time series of data are collected under the Directive these will be used here for assessment of gas and electricity prices for business and households.

3.3.1 Energy Prices in Industry

Figure 34 Electricity Prices to Industry



Source: Energy Prices & Taxes © OECD/IEA, 2009.

42 Sustainable Energy Ireland (various dates), *Understanding Electricity and Gas Prices in Ireland*, www.sei.ie.
43 *European Commission Decision 2007/394/EC* amending *Directive 90/377/EEC*.

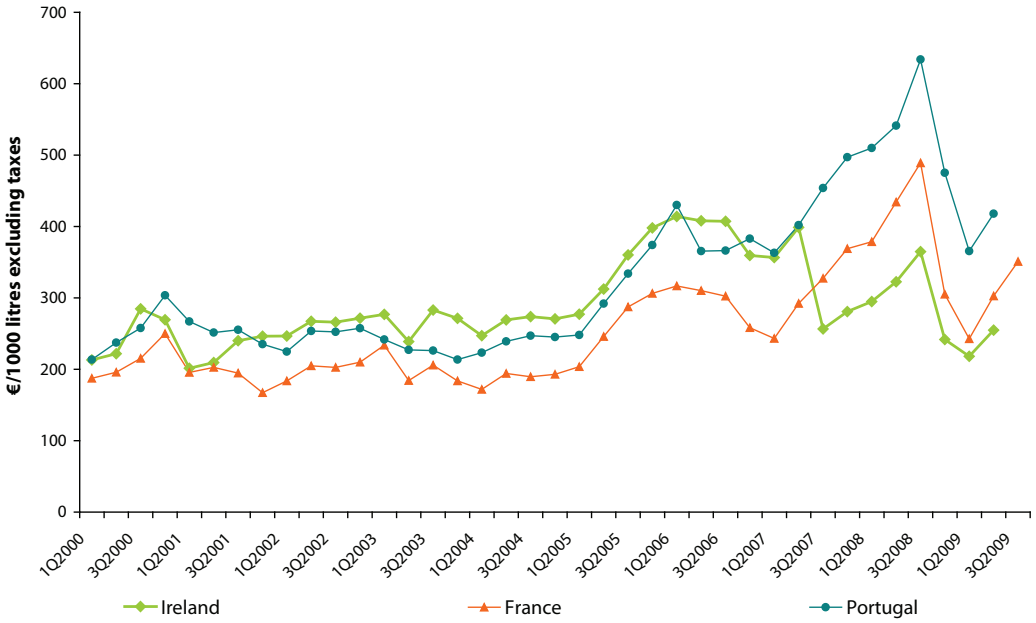
Table 11 Electricity Price to Industry Increase since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2009 (nominal)	194	249	134	112	167	100	178	151	**198**	214	172		124	192	153	258
2nd qtr 2009 (real)	151	224	114	95	152	90	161	113	**223**	183	137		107	157	131	212

Source: Energy Prices & Taxes © OECD/IEA, 2009.

Electricity prices to Irish industry have risen by 123% in real terms between 2000 and 2009, the second largest increase of the EU-15 countries, behind Austria. The fuel mix for electricity generation is one factor that has a key bearing on the variation in the price of electricity. Ireland has the highest overall dependency of electricity generation on fossil fuels in the OECD EU-15 countries. Ireland and Italy have 62% and 66% respectively of electricity generated by gas and oil.

Figure 35 Fuel Oil Prices to Industry



Source: Energy Prices & Taxes © OECD/IEA, 2009.

Table 12 Oil Price to Industry Increase since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2009 (nominal)	148	106	128	111	119	117	135	138	**119**	120	121	115	150	126	142	134
2nd qtr 2009 (real)	109	95	109	93	108	105	122	103	**135**	103	96	99	130	103	121	110

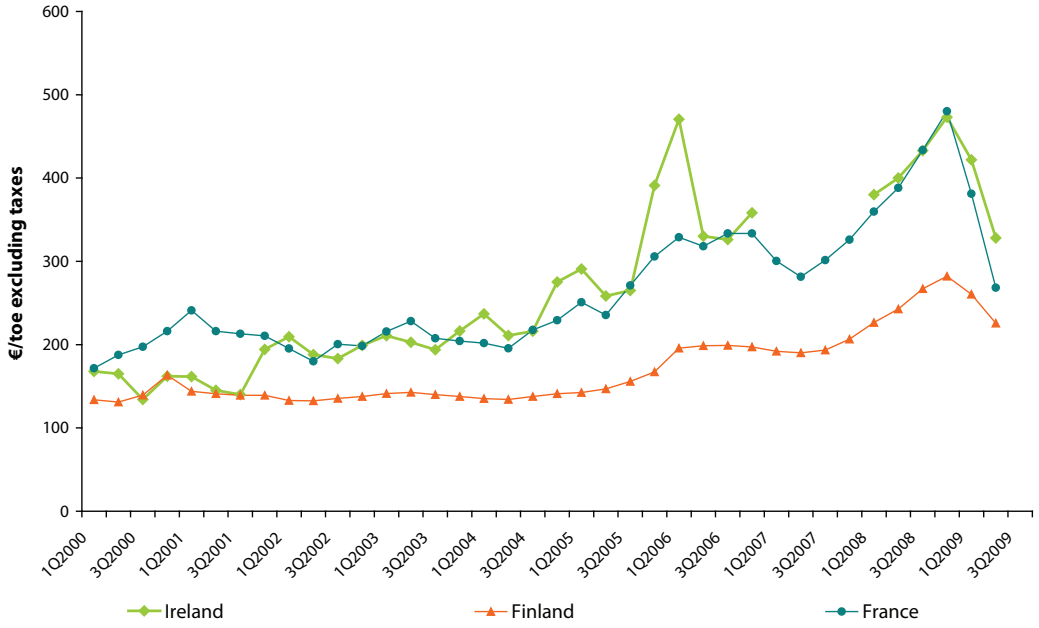
Source: Energy Prices & Taxes © OECD/IEA, 2009.

Oil prices to industry in Ireland were 35% higher in real terms in mid 2009 than in the year 2000. This was the largest increase

experienced within the EU-15. Interestingly however, Ireland has one of the lowest fuel oil price to industry in the Euro Area since late 2007.

Crude oil prices doubled between July 2007 and July 2008. During the first semester (S1) of 2008, nominal crude oil prices increased by 39%. After July 2008, there was a sharp decline in the price of crude oil to a low of around $34/barrel in late December. Prices during the first semester 2009 rose to around the $70/barrel level.

Figure 36 Natural Gas Prices to Industry



Source: Energy Prices & Taxes © OECD/IEA, 2009.

Table 13 Natural Gas Price to Industry Increase since 2000

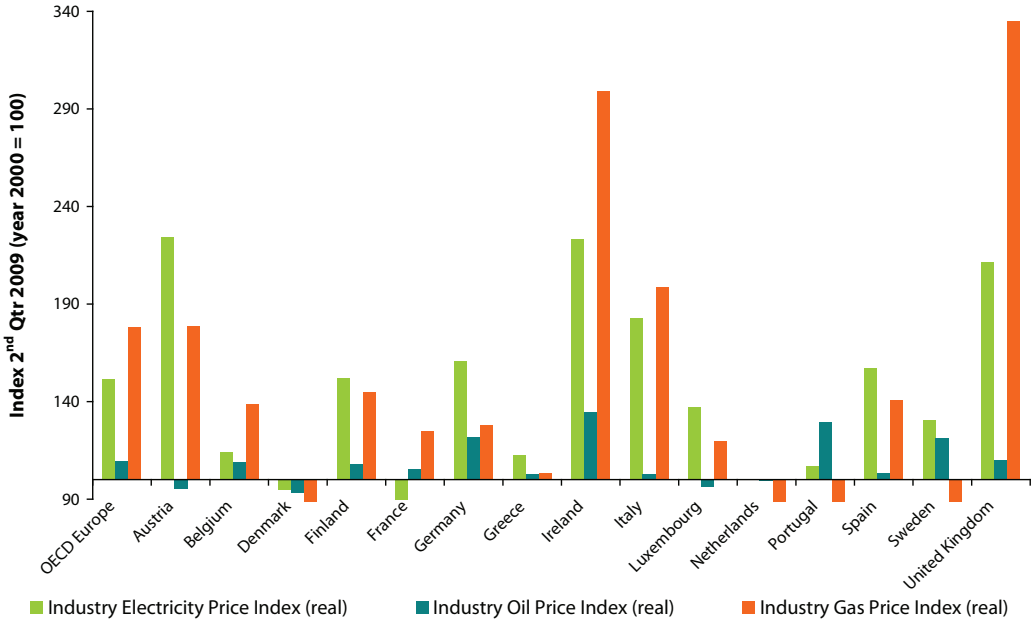
Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2009 (nominal)	225	198	163	-	159	139	141	139	**265**	232	150	-	-	172	-	408
2nd qtr 2009 (real)	178	179	139	-	145	125	128	104	**299**	199	120	-	-	141	-	335

Source: Energy Prices & Taxes © OECD/IEA, 2009.

With reference to *Figure 36*, natural gas prices to Irish industry were three times higher in mid 2009 than in 2000 in real terms. The UK was the only other EU-15 country to experience higher growth.

Figure 36 also shows the dramatic increase in gas prices to industry during 2008 linked to increased global energy prices and the subsequent fall from the start of 2009.

Figure 37 Real Energy Price Change to Industry since 2000 in EU-15 (index)

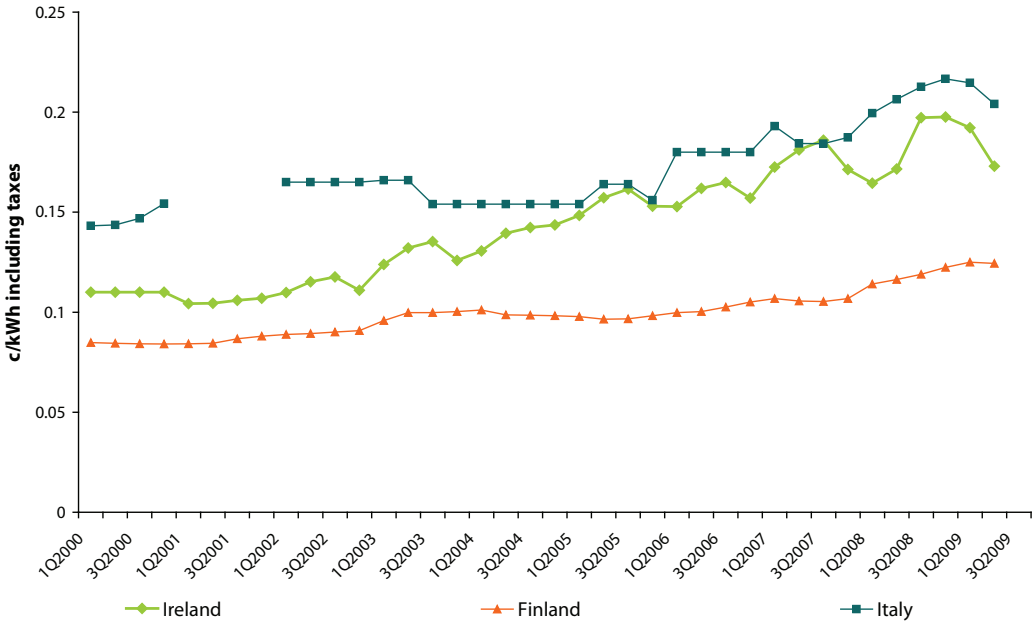


Source: Energy Prices & Taxes © OECD/IEA, 2009.

Figure 37 summarises the data presented in tables 11, 12 and 13. It emphasises the unique problems experienced by Ireland and the UK with respect to gas prices in industry. The IEA publishes an overall energy price index (real) for industry which shows that overall energy costs for Irish industry increased by 54% compared with 27% for OECD Europe. This also has to be taken in the context of the weighting of energy in the cost base of Irish industry[44].

3.3.2 Household Energy Prices

Figure 38 Household Electricity Prices



Source: Energy Prices & Taxes © OECD/IEA, 2009.

44 See Sustainable Energy Ireland (2007), *Energy in Industry 2007 Report*, available from www.sei.ie.

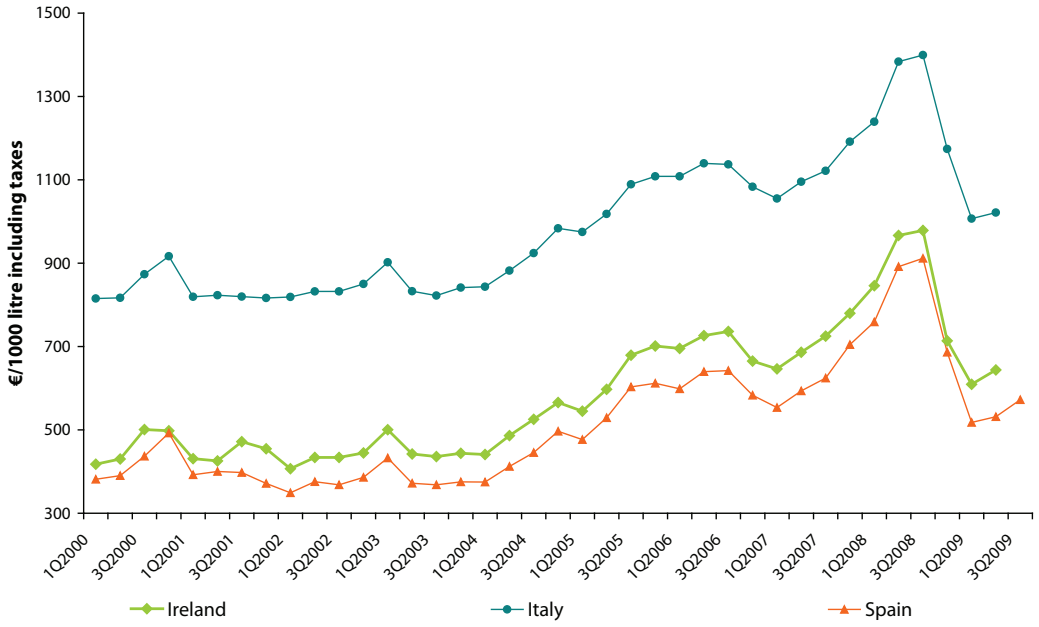
Table 14 Electricity Price to Households Increase since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2009 (nominal)	159	139	118	121	147	105	149	148	**157**	139	172	133	118	122	180	185
2nd qtr 2009 (real)	119	117	99	101	128	90	129	112	**122**	114	141	109	93	94	157	148

Source: Energy Prices & Taxes © OECD/IEA, 2009.

Electricity prices to Irish householders increased by 22% in real terms since 2000. Finland, Germany, Luxembourg, Sweden and the UK experienced higher real growth in household electricity prices.

Figure 39 Household Heating Oil Prices



Source: Energy Prices & Taxes © OECD/IEA, 2009.

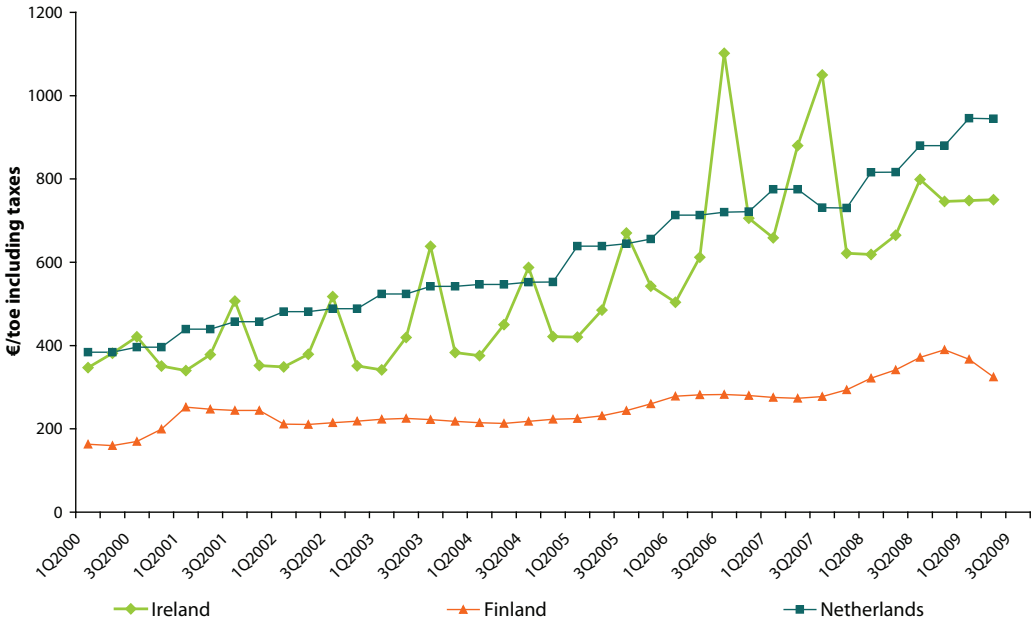
Table 15 Oil Price to Households Increase since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2009 (nominal)	130	117	131	117	117	113	134	130	**121**	115	128	117	143	121	132	122
2nd qtr 2009 (real)	102	98	109	97	102	97	116	98	**94**	94	105	96	114	93	115	98

Source: Energy Prices & Taxes © OECD/IEA, 2009.

Heating oil prices to Irish householders increased in nominal terms by 21% since 2000, lower than the OECD Europe average of 30% increase. In real terms this represented a decrease of 6%, and well below the OECD Europe which experienced an increase of 2%. With reference to *Figure 39* heating oil prices to households in Ireland remain in the lower end of the price range among the euro-zone countries.

Figure 40 Household Natural Gas Prices



Source: Energy Prices & Taxes © OECD/IEA, 2009.

Note that the peaks shown in the Irish gas price in *Figure 40* reflect fixed standing charges and low consumption during summer months resulting in higher unit prices. From October 2007 onwards this trend has flattened out as a result of the new standard rate tariff which has a low annual standing charge.

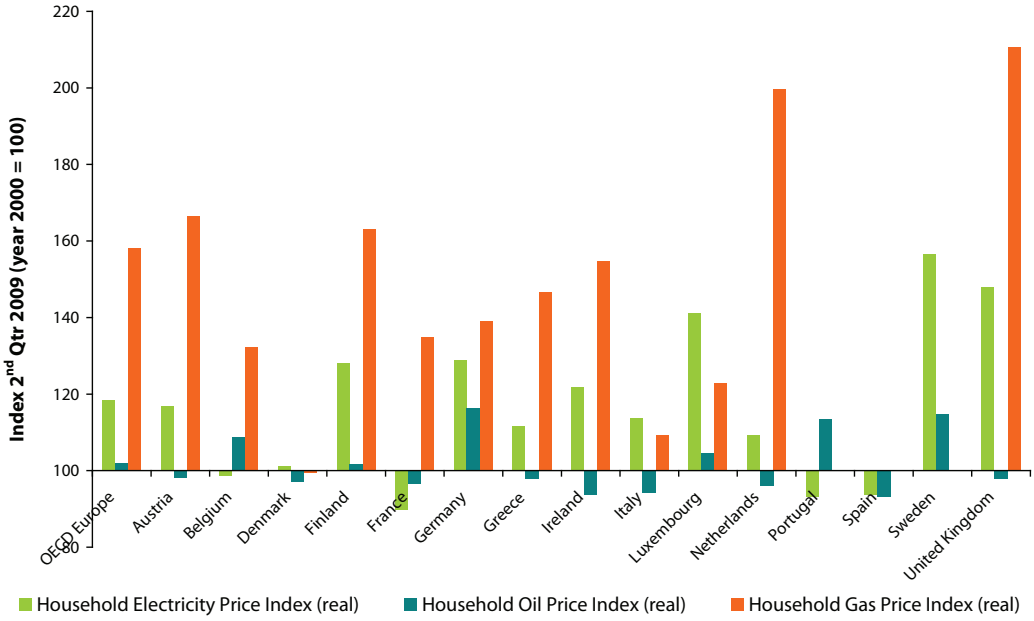
Table 16 Natural Gas Price to Households Increase since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2009 (nominal)	218	198	159	119	188	158	160	194	**200**	133	150	242		..		263
2nd qtr 2009 (real)	158	166	132	99	163	135	139	147	**155**	109	123	200		..		211

Source: Energy Prices & Taxes © OECD/IEA, 2009.

Figure 40 shows that the gas price to Irish households was close to the average increase since 2000 experienced in the Euro Area countries. Gas prices have doubled in nominal terms since 2000. However, in real terms, the increase was 55%. This was the situation as of the 2nd quarter of 2009.

Figure 41 Real Energy Price Change to Households since 2000 in EU-15 (index)



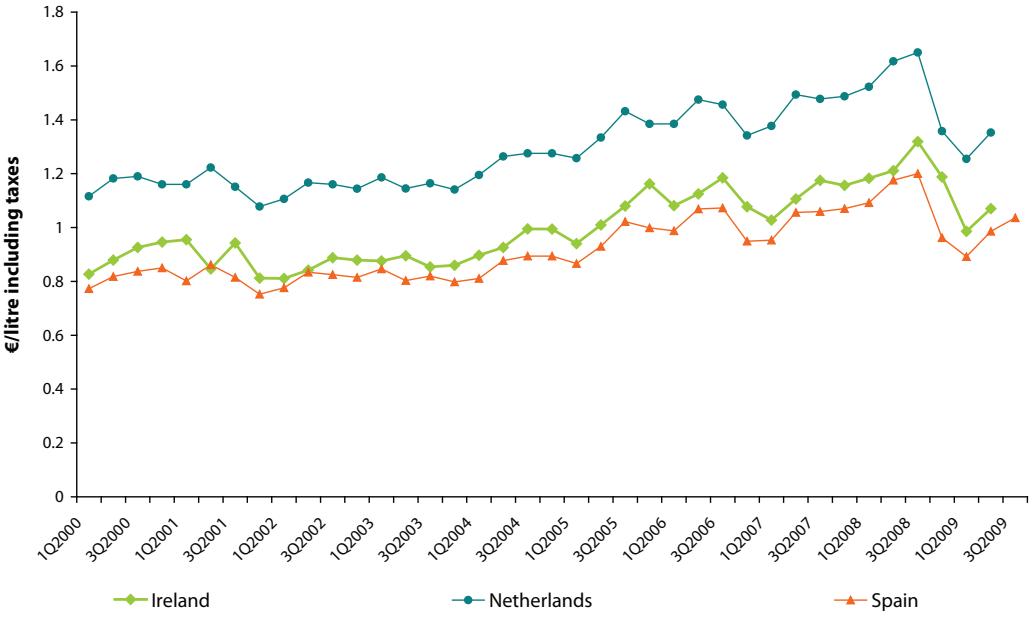
Source: Energy Prices & Taxes © OECD/IEA, 2009.

Figure 41 summarises the data presented in tables 14, 15 and 16. The IEA publishes an overall energy index (real) for households which shows that overall energy costs for Irish households increased by 6% compared with 15% for OECD Europe.

3.3.3 Transport Energy Prices

Petrol and diesel prices shown here are inclusive of both excise and VAT.

Figure 42 Retail Unleaded Petrol Prices (95 RON[45])



Source: Energy Prices & Taxes © OECD/IEA, 2009.

45 RON is the research octane number used in Europe to rate the characteristics of petrol.

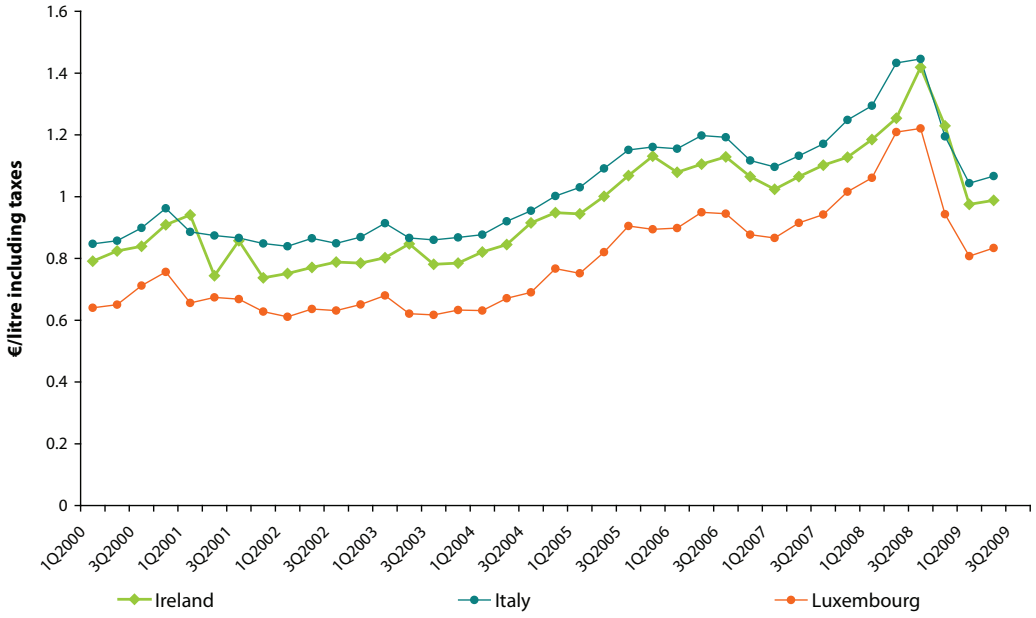
Table 17 Petrol Price Increase since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2009 (nominal)	131	112	127	115	115	111	134	132	**120**	114	128	117	143	120	131	122
2nd qtr 2009 (real)	101	94	106	96	100	95	116	100	**93**	94	105	96	114	93	114	98

Source: Energy Prices & Taxes © OECD/IEA, 2009.

Figure 42 shows that petrol prices in Ireland are in the lowest range in the euro-zone countries (for clarity only highest and lowest of the euro-zone countries are shown). Petrol prices in Ireland in the 2nd quarter of 2009 were 7% below in real terms the level in 2000. Petrol prices fell between the 3rd quarter of 2008 and the 2nd quarter of 2009 when they started to rise again.

Figure 43 Retail Road Diesel Prices



Source: Energy Prices & Taxes © OECD/IEA, 2009.

Table 18 Auto Diesel Price Increase since 2000

Index 2000 = 100	OECD Europe	Austria	Belgium	Denmark	Finland	France	Germany	Greece	**Ireland**	Italy	Luxembourg	Netherlands	Portugal	Spain	Sweden	United Kingdom
2nd qtr 2009 (nominal)	146	124	124	109	115	116	137	142	**117**	120	121	116	151	126	136	127
2nd qtr 2009 (real)	104	104	104	91	100	100	119	107	**91**	98	99	96	120	97	119	102

Source: Energy Prices & Taxes © OECD/IEA, 2009.

Figure 43 shows that diesel prices in Ireland are in the upper range for the euro-zone countries. Diesel prices in Ireland fell by 9% in real terms since 2000 which is below the 4% average increase for OECD Europe countries. Again diesel prices fell

between the 3rd quarter of 2008 and the 2nd quarter of 2009 when they started to rise again.

Figure 44 Real Energy Price Change in Transport since 2000 in EU-15 (index)

Source: Energy Prices & Taxes © OECD/IEA, 2009.

Figure 44 summarises the data presented in *Table 17* and *Table 18*.

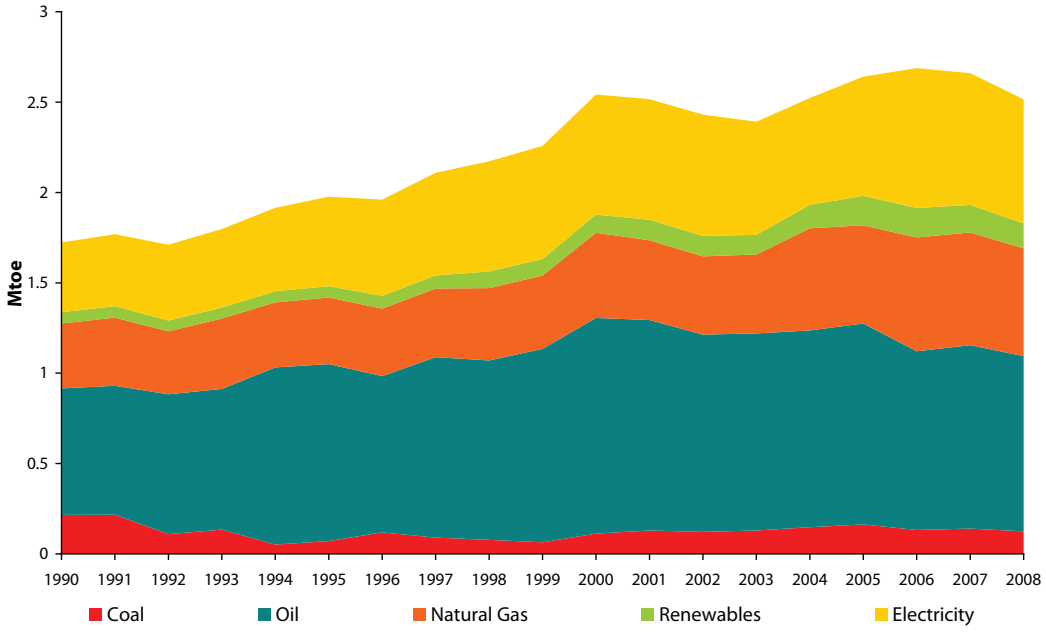
4. Sectoral Indicators

This section explores the changes in energy trends that are taking place at a sectoral level to deepen our understanding of energy use patterns generally and to assist in assessing the likely impacts of policies and measures to achieve a particular target.

4.1 Industry

Final energy use in industry has grown by 45% (2.1% per annum) to 2.5 Mtoe over the period 1990 – 2008. Within that period only electricity, natural gas and renewables have increased their share. The share of electricity has risen from 22% to 27%, natural gas from 21% to 24% and renewables from 3.7% to 5.6%. The increase in renewables is mainly due to the use of biomass in the wood processing industry and the use of tallow in the rendering industry.

Figure 45 Industry Final Energy Use by Fuel



Electricity is the second most dominant energy form in industry at 27% behind oil at 38%. Growth of electricity use in industry averaged 3.3% per annum over the period 1990 – 2008. In 2008 the consumption of electricity in industry fell by 5.9% (following a 5.7% decrease in 2007), which contrasts with the period 2005 – 2008, when electricity use in industry increased by 1.3% per annum.

Table 19 Growth Rates and Shares of Final Consumption in Industry

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Fossil Fuels (Total)	31.5	1.5	2.1	4.5	0.4	-2.5	-5.0	73.9	67.0
Coal	-42.1	-3.0	-19.9	9.6	7.7	-8.5	-10.7	12.6	5.0
Oil	36.4	1.7	6.9	3.9	-1.5	-4.6	-4.4	40.5	38.1
Gas	66.3	2.9	0.6	5.0	2.9	3.2	-4.5	20.8	23.9
Renewables	120.0	4.5	-0.3	10.1	10.3	-5.3	-8.8	3.7	5.6
Combustible Fuels (Total)	35.7	1.7	2.0	4.8	1.1	-2.7	-5.3	77.6	72.5
Electricity	77.9	3.3	5.2	6.0	-0.1	1.3	-5.9	22.4	27.5
Total	**45.1**	**2.1**	**2.8**	**5.1**	**0.7**	**-1.7**	**-5.4**		

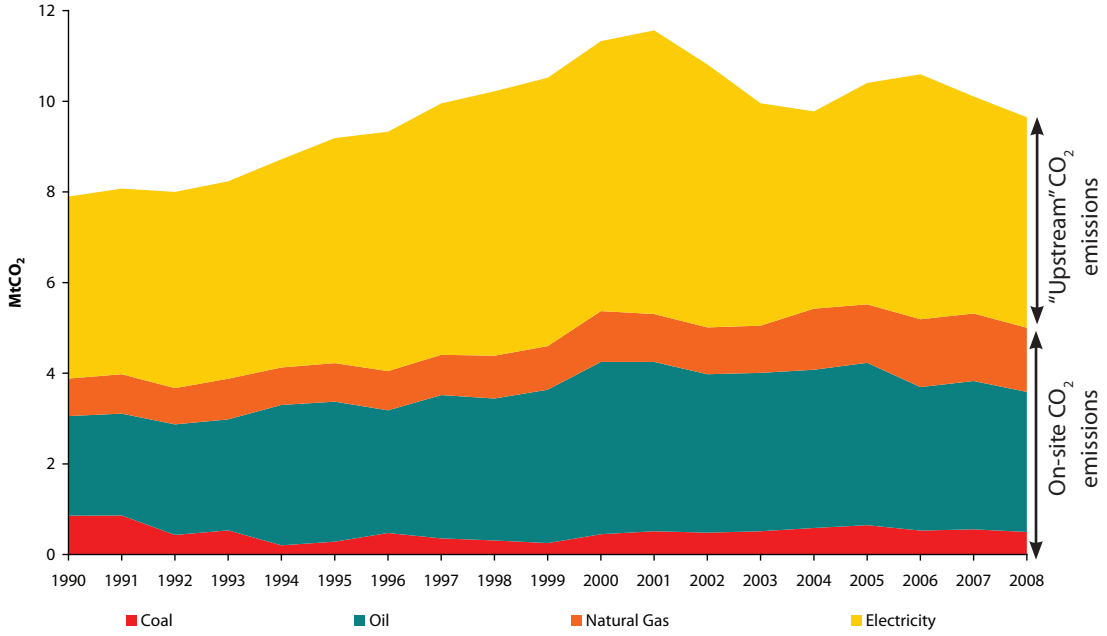
Overall final energy use in industry decreased by just 5.4% in 2008 relative to the previous year, with all fuels experiencing reductions. Coal use experienced the largest decrease (11%) but had the smallest share of fuel use at 5% in 2008. Oil with the largest share (38%) experienced a drop of 4.4% in 2008. Interestingly, renewable energy use in industry fell by 8.8% in 2008.

Renewable energy use in industry is predominantly the use of biomass in the wood processing industry.

In order to determine industry's total energy-related CO_2 emissions it is necessary to view electricity on a primary energy basis, i.e. the fuels required to generate the electricity consumed by industry. In 2008 electricity represented 47% of energy used in industry, when calculated on a primary energy basis, compared to 27% on a final energy basis.

Figure 46 shows the primary energy-related CO_2 emissions of industry, distinguishing between the *on-site* CO_2 emissions associated with direct fuel use and the *upstream emissions* associated with electricity consumption.

Figure 46 Industry Energy-Related CO_2 Emissions by Fuel



As detailed in *Table 20*, industrial energy-related CO_2 emissions fell by 4.6% in 2008 following a 5.4% fall in 2007. Electricity consumption was responsible for 48% of industry's energy related emissions in 2008. Electricity is indirectly responsible for almost half of CO_2 emissions in industry, almost as much as all the other fuels used by industry combined.

Table 20 tabulates the growth rates and relative shares of energy related CO_2 emissions in industry.

Table 20 Growth Rates and Shares of Energy-related CO_2 Emissions in Industry

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Coal	-42.0	-3.0	-19.9	9.6	7.7	-8.5	-10.6	10.8	5.1
Oil Total	40.4	1.9	7.0	4.2	-1.2	-4.8	-5.6	27.8	32.0
Kerosene	723.0	12.4	20.1	16.3	6.8	3.7	12.4	0.6	4.3
Fuel Oil	-21.5	-1.3	6.7	2.9	-6.8	-11.2	-8.0	17.0	10.9
LPG	33.1	1.6	-0.4	1.8	1.9	4.2	17.9	2.1	2.3
Gas Oil	20.1	1.0	7.3	-1.9	0.8	-3.6	-0.5	5.7	5.7
Petroleum Coke	361.0	8.9	10.2	16.0	7.5	-1.9	-16.5	2.3	8.8
Natural Gas	72.2	3.1	0.6	5.7	2.8	3.2	-4.9	10.4	14.7
Total Combustible Fuels	29.0	1.4	1.7	4.9	0.6	-3.2	-5.9	49.1	51.9
Electricity	15.5	0.8	4.3	3.7	-3.9	-1.7	-3.1	50.9	48.1
Overall Total	**22.1**	**1.1**	**3.1**	**4.3**	**-1.7**	**-2.5**	**-4.6**		

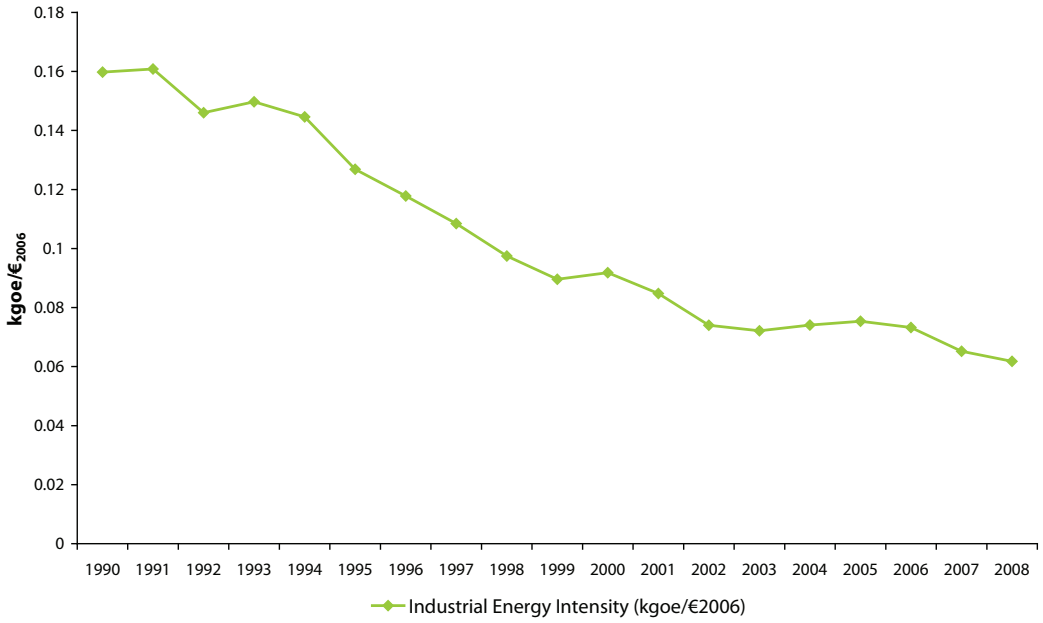
If upstream electricity-related emissions are omitted then there was a 5.9% decrease in CO_2 emissions from combustible fuels used on-site in industry in 2008.

4.1.1 Industry Energy Intensity

Industrial energy intensity is the amount of energy required to produce a unit of value added, measured in constant money values. *Figure 47* shows the industrial energy intensity between 1990 and 2008 in kilograms of oil equivalent per euro of industrial value added (in 2006 values) (kgoe/€2006). Over the period, industrial energy consumption increased by 56% while value added increased by 277% resulting in a reduction in intensity of 61%. In other words it takes less than half the amount of energy in 2008 to generate a euro of value added than it did in 1990. It should be noted that a downward trend in energy intensity signifies an improvement.

Value added output from industry fell by 0.3% in 2008, a lower rate than the 3% fall in the economy overall, while energy use fell by 5.5% resulting in a 5.1% decrease in energy intensity in industry.

Figure 47 Industry Energy Intensity



As mentioned in section *2.5*, energy intensity in this form is a crude indicator and variation may be the result of many factors. To eliminate the effects of structural changes an index of energy intensity at constant structure [46] is also shown, in *Figure 48*.

This indicator measures the impact of structural changes in industry by comparing the variations of the actual intensity with that of a fictitious or notional intensity at constant structure (using 1995 structure as a reference). It can be seen that structural changes have had a significant effect but other factors are also responsible for the improvement in energy productivity.

The green line in *Figure 48* is the trend in energy intensity in industry. The red line represents the evolution of industrial energy intensity had the structure not changed over time. Over the period 1995 to 2008, the intensity of industry declined by 51% (5.4% per annum). However, if this structural change had not occurred, the intensity decline would have been 18% (1.5% per annum).

These structural changes were brought about by global economic influences and Irish industrial policy. Over the period, industrial policy concentrated on moving the sector up the value chain to manufacture high-value goods such as pharmaceuticals, electronics and value-added foodstuffs. This resulted in increased economic efficiencies, contributing to the further reduction in intensity, shown in *Figure 48*.

46 This section draws on methodology developed under the ODYSSEE project. See Bosseboeuf D. et al, 1999, *Energy Efficiency Indicators – The European Experience* and Bosseboeuf D. et al, 2005, *Energy Efficiency Monitoring in the EU-15,* both published by ADEME and the European Commission. http://www.odyssee-indicators.org/

Figure 48 Index of Energy Intensity of Industry 1995 - 2008

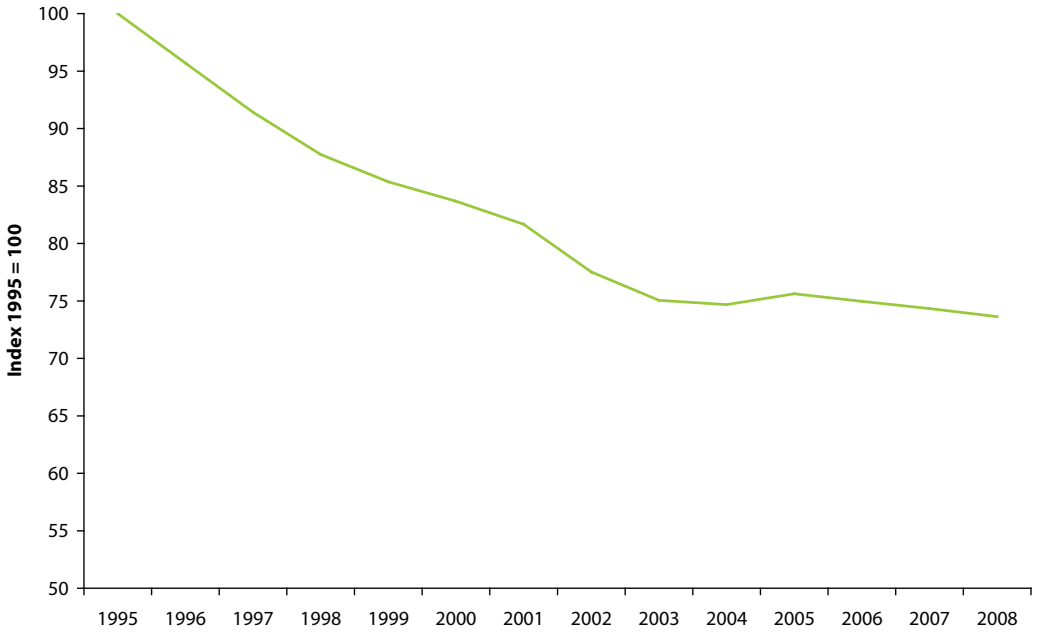
To further remove non-efficiency effects from the energy intensity at constant structure an ODEX indicator for industry in Ireland has been constructed over the period 1995 to 2008, shown in *Figure 49*. Again here, as with intensity, a downward trend signifies improvement, this time in efficiency.

The graph clearly shows improvements in energy efficiency over the period.

The ODEX indicator is based on unit consumption expressed in terms of energy used per unit of physical output (where data are available) and production indices for the other sub-sectors relative to that in the base year (in this case 1995). It is important to note that, for some sub-sectors, the trends also include some non-technical changes, especially in the chemical industry as a result of the shift to light chemicals. Data for this sector are currently not available at a sufficiently disaggregated level.

The index decreased from 100 in 1995 to 74 in 2008 indicating a 26% improvement in energy efficiency. There has been a change in the calculation methodology for the industry ODEX presented here. The change relates to the number of industrial sub-sectors used in addition to updates on energy consumption shares of the sub-sectors and gross value-added generated.

Figure 49 Industry ODEX 1995 - 2008

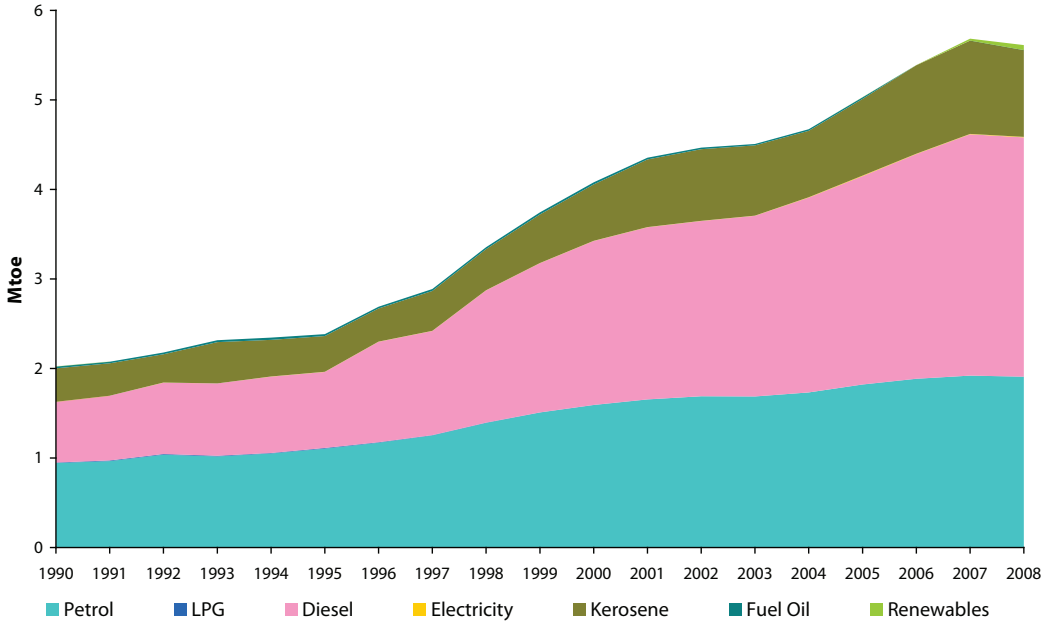


There is a significant difference between the estimated energy-efficiency improvement calculated using energy intensity at constant structure (19%) and using the ODEX methodology (26%). This issue is currently the subject of academic investigation, on behalf of SEI. Initial analysis suggests that, for the industrial sector in Ireland, energy intensity at constant structure is a better measure of efficiency. This is the metric used for energy efficiency of industry in creating the overall energy-efficiency index in this report.

4.2 Transport

Transport energy use decreased for the first time since 1990, by 1.3% to 5.6 Mtoe, in 2008.

Figure 50 Transport Final Energy Use by Fuel[47]



The growth rates for the different transport fuels over the period are shown in *Table 21*. Overall energy use in transport fell in 2008 by 1.3%. Renewables in the form of biofuels increased by 159% in 2008 compared with 2007 albeit from a small base. Only renewables, LPG and electricity experienced growth in transport in 2008. Of the oil based fuels, kerosene consumption experienced the largest decline at 7%. Kerosene in transport is exclusively used for aviation. The share of diesel in transport energy has risen from 34% to 48% over the period 1990 – 2008 while conversely the share of petrol has declined from 47% to 34%.

Table 21 Growth Rates and Shares of Final Consumption in Transport

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Fossil Fuels (Total)	174.8	5.8	3.4	11.3	4.3	3.4	-1.9	99.9	98.9
Total Oil	174.8	5.8	3.4	11.3	4.3	3.4	-1.9	99.9	98.9
Petrol	102.2	4.0	3.2	7.6	2.7	1.6	-0.6	46.7	34.0
Diesel	295.1	7.9	4.7	16.6	4.9	4.7	-0.8	33.5	47.6
Kerosene	159.4	5.4	1.4	9.5	6.4	4.2	-7.0	18.5	17.3
LPG	-82.5	-9.2	-2.8	-18.4	-13.2	4.2	17.9	0.3	0.0
Renewables	-	-	-	-	-	272.0	158.9	0.0	0.99
Combustible Fuels (Total)	177.5	5.8	3.4	11.3	4.3	3.7	-1.3	99.9	99.9
Electricity	243.6	7.1	2.4	7.6	17.8	-2.3	7.8	0.1	0.1
Total	**177.6**	**5.8**	**3.4**	**11.3**	**4.3**	**3.7**	**-1.3**		

Petrol consumption in transport was at 1.9 Mtoe in 2008, a small decrease of 0.6% on the previous year. Petrol consumption in 2008 was a little more than double that in 1990.

Diesel consumption in transport was 2.7 Mtoe in 2008, a small decrease of 0.8% on the previous year. Diesel consumption grew

47 This is based on data of fuel sales in Ireland rather than fuels consumed in Ireland. As a result the effect of cross border trade (fuel tourism) or smuggling is not taken into account in the figures presented here. SEI's report *Energy in Transport (2009)* presents estimates of fuel tourism and these are shown in *Figure 51*.

by 295% reaching almost four times the 1990 level.

The growth rates and shares of the energy-related CO_2 emissions from the different transport fuels are tabulated in *Table 22*. Transport experienced for the first time a decrease in primary energy-related CO_2 emissions (-1.9%) during 2008.

Table 22 Growth Rates and Shares of Energy-Related CO_2 Emissions in Transport

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Total Oil Products	176.4	5.8	3.4	11.4	4.3	3.4	-1.9	99.8	99.8
Petrol	102.2	4.0	3.2	7.6	2.7	1.6	-0.6	45.7	33.4
Diesel	295.1	7.9	4.7	16.6	4.9	4.7	-0.8	34.3	49.1
Kerosene	159.4	5.4	1.4	9.5	6.4	4.2	-7.0	18.5	17.3
LPG	-82.5	-9.2	-2.8	-18.4	-13.2	4.2	17.9	0.3	0.0
Electricity	123.1	4.6	1.6	5.3	13.3	-5.2	11.1	0.2	0.2
Total	**176.3**	**5.8**	**3.4**	**11.4**	**4.3**	**3.4**	**-1.9**		

4.2.1 Transport Energy Demand by Mode

Fuel consumption in transport is closely aligned to the mode of transport used: kerosene is almost all used for air transport, fuel oil for shipping and electricity currently is consumed by the Dublin Area Rapid Transport (DART) system and, since 2004, by LUAS. Liquefied petroleum gas (LPG) is almost exclusively used for road transport, as is petrol. The bulk of petrol consumption for road transport can be assumed to be for private car use although there is a significant number of petrol-driven taxis in operation. Diesel consumption is used for navigation, rail and road purposes. This diesel consumption is used for freight transportation, public transport in buses and taxis, private car transport and other applications such as agricultural, construction and other machines.

SEI's report on *Energy in Transport*[48] presents an estimation of the energy use in transport by different mode. The contribution from each mode of transport to energy demand is shown in *Figure 51* and detailed in *Table 23*. The road freight category recorded the second largest growth over the period, of 247% (7.2% per annum) reaching 21% share of all transport energy use. This is significant because the focus of attention in the sector is often the private car mode, which increased by 135%. The share of energy use in transport by private cars in 2008 was 39%, down from 46% in 1990.

Table 23 Growth rates and shares of transport final energy demand by mode, 1990 – 2008

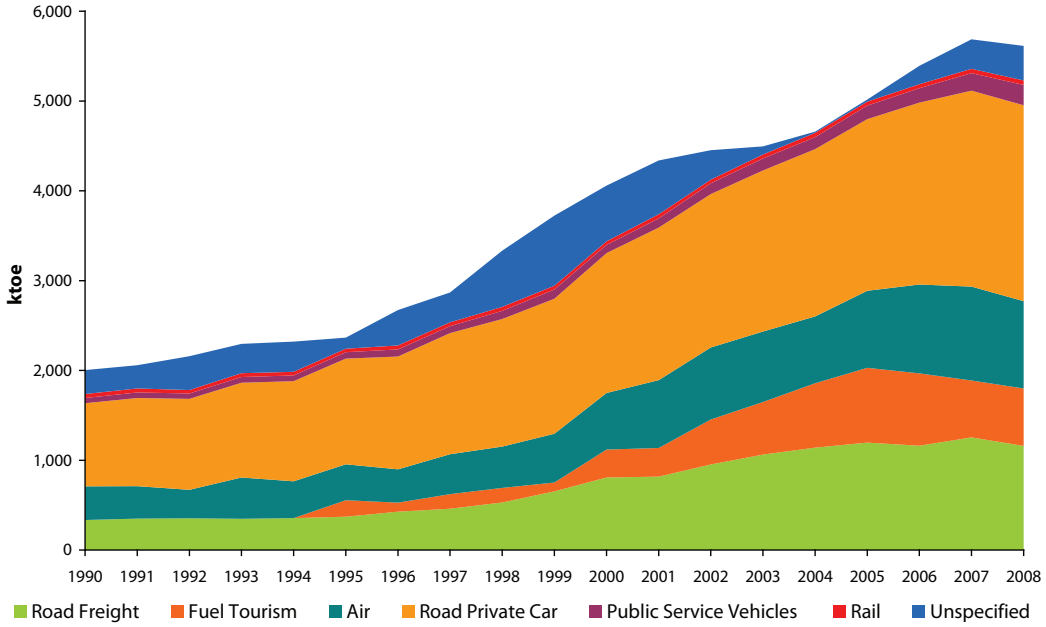
	Growth %	Average annual growth rates %						Shares %	
Mode	**1990 - 08**	**'90 – '08**	**'90 – '95**	**'95 – '00**	**'00 – '05**	**'05 – '08**	**2008**	**1990**	**2008**
Road freight	247.1	7.2	2.1	16.8	8.2	-1.0	-7.6	16.7	20.7
Fuel tourism	-	-	-	11.3	21.8	-8.5	1.0	0.0	11.4
Air	159.2	5.4	1.4	9.5	6.4	4.2	-7.0	18.7	17.3
Road private car	135.5	4.9	4.9	5.8	4.2	4.5	0.0	46.2	38.8
Public-service vehicles	298.3	8.0	4.8	4.6	11.0	14.5	15.4	2.8	4.0
Rail	12.4	0.7	-3.3	2.3	1.1	3.9	6.2	2.2	0.9
Unspecified	44.6	2.1	-14.2	38.0	-48.1	154.9	17.4	13.3	6.9
Total	**180.2**	**5.9**	**3.4**	**11.4**	**4.3**	**3.8**	**-1.3**		

The mode with the largest increase was public service vehicles which grew by 298% (8% per annum) but its share stood at just 4% in 2008. Air grew by 159% (5.4% per annum) with its share standing at 17% and rail consumption increased by 12.4% (0.7% per annum) with a share of less than 1%.

Combined petrol and diesel fuel tourism is also included in *Figure 51*. Only fuel tourism out of the Republic of Ireland (ROI) is included in this graph i.e. fuel which is purchased in ROI but consumed elsewhere. Before 1995 the trend was negative i.e. fuel was purchased outside and consumed within the State.

48 Sustainable Energy Ireland (2009), *Energy in Transport – 2009 Report*, http://www.sei.ie/statistics.

Figure 51 Transport Energy Demand by Mode 1990 - 2008



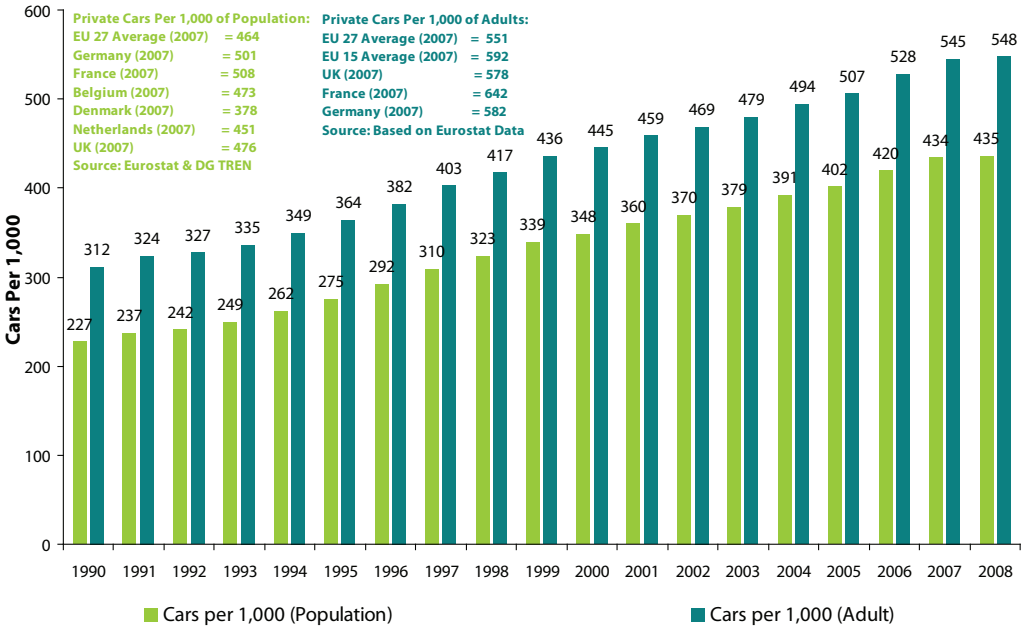
Energy use in transport was 5.6 Mtoe in the year 2008. Road transport accounted for 64% of this (72% if fuel tourism is excluded). SEI's *Energy in Transport* report estimates that private car transport was responsible for 2.2 Mtoe of energy use in 2008. This represents 61% of road transport energy use and 39% of all transport energy use. *Figure 51* also illustrates the relative weighting of private car transport compared to road passenger services (bus) and rail travel.

4.2.2 Private Car Transport

The number of vehicles on Irish roads exceeded two million[49] for the first time in 2004, reaching 2,497,568 vehicles by the end of 2008, 2% more than in 2007. Of these there were 1.92 million private cars or 77% of the total. Private car numbers increased by 2.2% in 2008. This resulted in an increase in car density as shown in *Figure 52* to 548 cars per 1000 adults, compared to an EU-27 average of 551 and a UK average of 578 (both in 2007). There is now more than one car for every two adults in Ireland.

49 Source: Vehicle Registration Unit, Department of Transport (various years) *Irish Bulletin of Vehicle and Driver Statistics.*

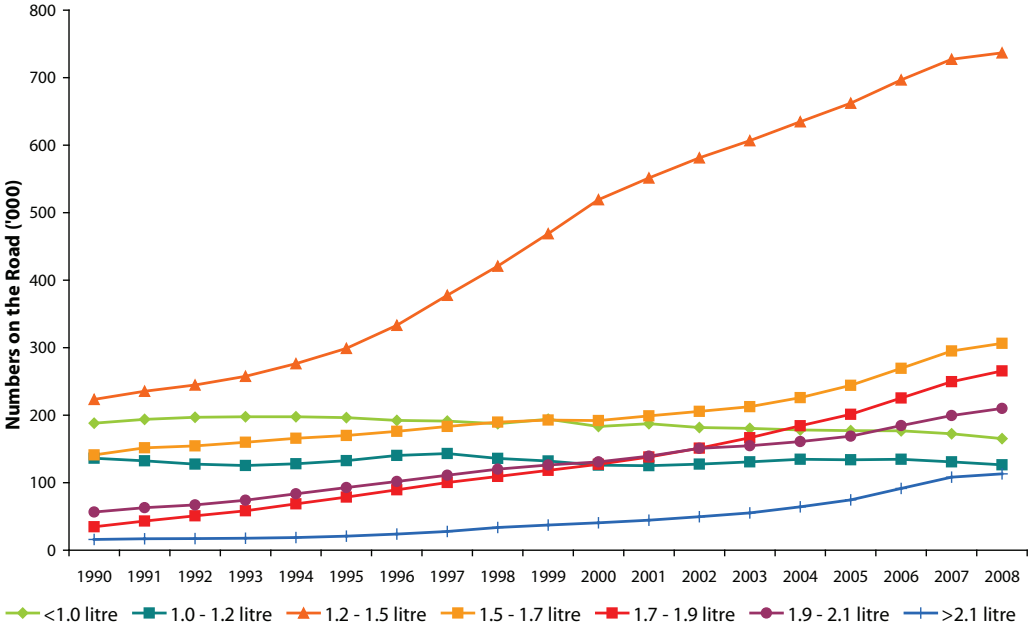
Figure 52 Private Cars per 1000 of Population



Source: Based on Vehicle Registration Unit and CSO data.

The number of cars per permanently occupied dwelling was 1.25 in 2008, representing a 59% increase on the figure of 0.8 in 1990. In 1998 the number of private cars exceeded the number of permanently occupied dwellings for the first time.

Figure 53 Change in Car Engine Size



Source: Based on Vehicle Registration Unit data.

Figure 53 shows how purchasing patterns with respect to engine size have changed over time. Cars with an engine size of 1.2 litres or less are showing declining numbers, whereas the numbers of cars with engine size of larger than 1.2 litres are all showing increasing trends.

The 1.2 to 1.5 litre engine size has the largest share of private cars – 38% of the total in 2008. This was over twice the share of the second most popular class, the 1.5 to 1.7 litre band, which accounted for 16% of the total. In 1990 the less than 1.0 litre engine size had the second largest share of private cars, 24% of the total. This share fell to 8.6% in 2008.

It is also interesting to note that cars with an engine size of greater than 1.9 litres have increased their share of the total, from 9.1% in 1990 to 17% in 2008. Indeed, cars with engines greater than 1.7 litres have increased their share from 13.5% in 1990 to 31% in 2008.

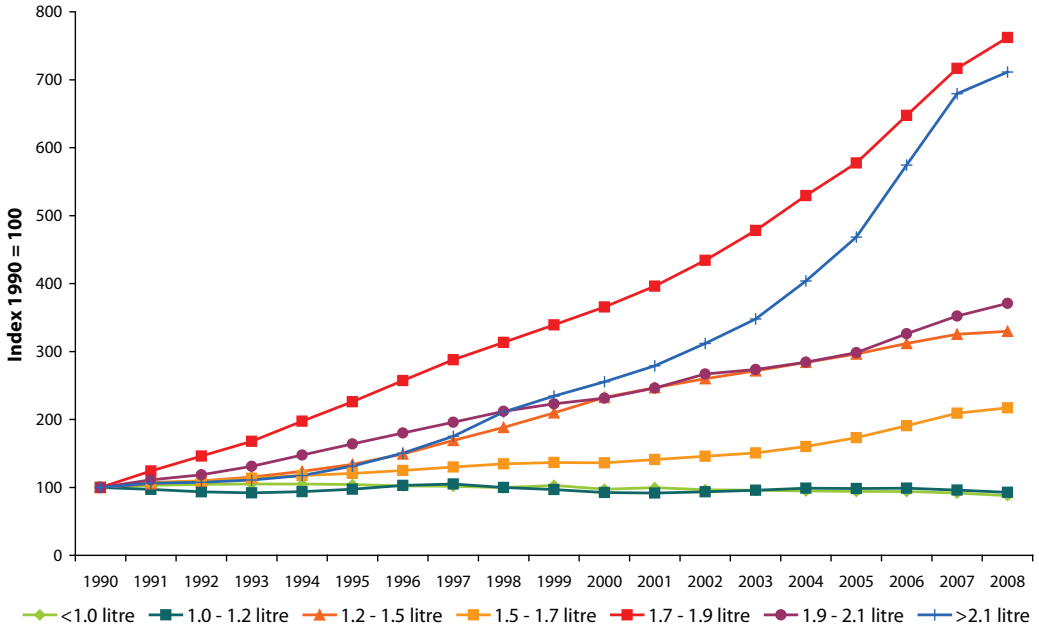
Table 24 Growth Rates & Shares of Private Cars by Engine Size Band 1990 to 2008

	Growth %	Average annual growth rates %						Shares %	
CC Bands	**1990 – 2008**	**'90 – '08**	**'90 – '95**	**'95 – '00**	**'00 – '05**	**'05 – '08**	**2008**	**1990**	**2008**
<1.0 litre	-12.2	-0.7	0.9	-1.4	-0.7	-2.3	-4.2	23.6	8.6
1.0 - 1.2 litre	-7.2	-0.4	-0.6	-1.0	1.2	-1.9	-3.4	17.1	6.6
1.2 - 1.5 litre	229.7	6.9	6.0	11.7	5.0	3.6	1.3	28.1	38.3
1.5 - 1.7 litre	117.1	4.4	3.8	2.5	4.9	7.8	3.8	17.7	15.9
1.7 - 1.9 litre	662.2	11.9	17.7	10.1	9.6	9.7	6.4	4.4	13.8
1.9 - 2.1 litre	270.9	7.6	10.4	7.1	5.2	7.5	5.3	7.1	10.9
>2.1 litre	611.4	11.5	5.6	14.2	12.9	14.9	4.7	2.0	5.9
Total	**141.5**	**5.0**	**4.5**	**5.9**	**4.7**	**5.0**	**2.2**		

Source: Based on Dept. of Transport Data.

Figure 54 presents change in car engine size over time expressed as an index, with 1990 as the reference year. This gives a clearer indication of the rate of increase of the differing size classes. Cars with engines less than 1.2 litre are showing declining numbers. The other classes are showing an increase.

Figure 54 Change in Car Engine Size (Index)



Source: Based on Vehicle Registration Unit data.

The fastest-growing range is the 1.7 to 1.9 litre category. The greater than 2.1 litre is the second fastest-growing. This clearly shows, together with a combined increase in share from 9.1% to 16.8%, a changing preference towards larger cars. The number of cars in the 1.7 to 1.9 litre range grew by 662% since 1990 and those in the greater than 2.1 litre range grew by 611%.

4.2.3 New CO_2 based Vehicle Registration and Road Tax Bands

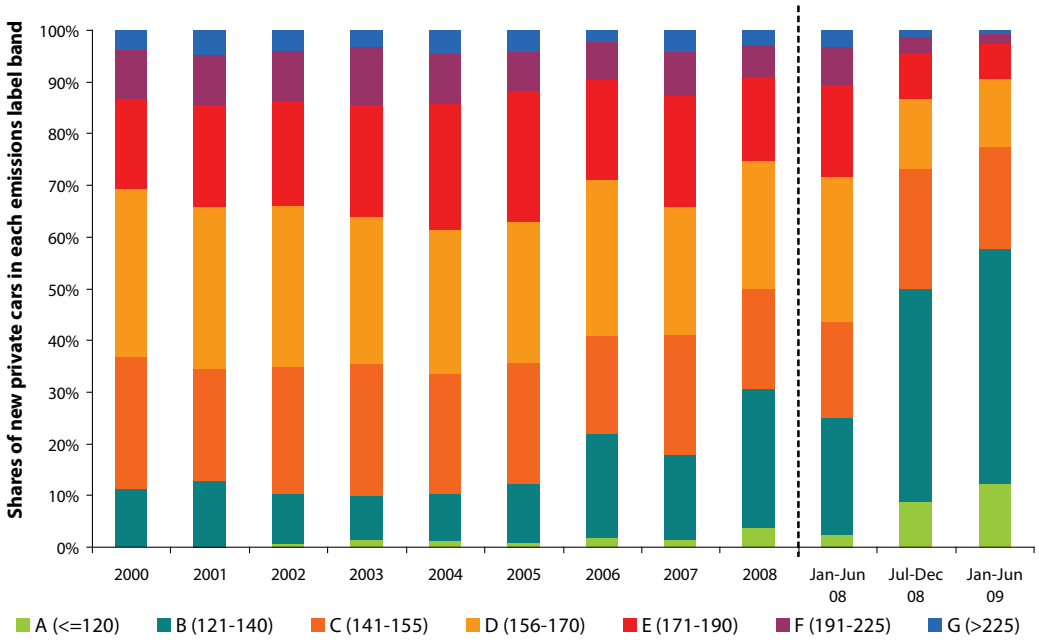
A new system of assessing private cars for Vehicle Registration Tax (VRT) and annual motor (AMT) tax came into effect from July 2008. This was signalled in the December 2007 Budget. The new system has moved away from assessing vehicles based on engine size to one that is based solely on the CO_2 emissions per kilometre. Seven tax bands are used for the assessment with the bands corresponding to the EU labelling system. The bands are shown in *Table 25*.

Table 25 CO_2 based Vehicle Registration and Road Tax Bands

Band	CO_2 Emissions (CO_2 g/km)
Band A	less than 120
Band B	greater than 120 and less than or equal to 140
Band C	greater than 140 and less than or equal to 155
Band D	greater than 155 and less than or equal to 170
Band E	greater than 170 and less than or equal to 190
Band F	greater than 190 and less than or equal to 225
Band G	greater than 225

Since the change in VRT and AMT, SEI has been monitoring the impact of the changes by tracking the sales of new private cars and comparing sales by emissions band before and after the change on 1st July 2008.

Figure 55 Shares of new private cars in each emission band 2000 – 2008 (+2009 S1)



Source: Based on Vehicle Registration Unit data.

Figure 55 shows the shares of new-car sales[50] between 2000 and June 2009 classified by emissions label band. Between 2000 and 2005 the share of label bands A, B & C was on average 35% while in 2006/07 it rose to 41%. For the first half of 2008, before the new taxes came into effect, the share of these three bands was 44%. In the period after the introduction of the change, July to December, the share of these bands rose to 73%. In the first six months of 2009 it increased again to 78%. This is a significant shift in purchasing patterns towards lower-emissions vehicles. This has to be tempered by the fact that the motor industry experienced a severe downturn during 2008/'09 and that most car purchases took place in the first semester of the year, before the introduction of the new taxation system.

Table 26 tabulates the data shown in *Figure 55*. The largest increase in share was in the B label band, rising from 23% in the first

50 Licensed as private cars.

semester of 2007 to 41% in the second semester. More than half of all cars registered after July were in bands A or B. The largest reduction in share was in the D labels, falling from 28% to 14%. The A label band more than tripled its share, from 2.4% to 8.8%, while the G labels fell to 1.3% share in the second half of 2008 and further to 0.6% in the first half of 2009.

Into the first half of 2009 the shares of labels A and B strengthened to 12% and 45% respectively (from 9% and 41%) with the shares of all higher emitting labels declining.

Table 26 Shares of new private cars in each emissions band, 2000 – 2008 (+2009 - S1)

CO_2 band	2000	2001	2002	2003	2004	2005	2006	2007	2008	Jan - Jun 2008	July - Dec 2008	Jan - Jun 2009
A	0.0%	0.0%	0.7%	1.5%	1.2%	0.9%	1.8%	1.5%	3.8%	2.4%	8.8%	12.3%
B	11.3%	12.8%	9.6%	8.5%	9.1%	11.4%	20.3%	16.3%	26.8%	22.8%	41.3%	45.4%
C	25.6%	21.7%	24.7%	25.3%	23.1%	23.2%	18.8%	23.4%	19.3%	18.3%	22.9%	19.8%
D	32.4%	31.4%	31.0%	28.7%	27.9%	27.6%	30.2%	24.7%	25.0%	28.1%	13.8%	13.0%
E	17.5%	19.5%	20.4%	21.5%	24.4%	25.1%	19.3%	21.6%	15.9%	17.9%	8.5%	6.9%
F	9.5%	9.7%	9.6%	11.3%	9.7%	7.5%	7.2%	8.4%	6.4%	7.3%	3.3%	2.1%
G	3.7%	4.9%	4.0%	3.2%	4.5%	4.2%	2.3%	4.2%	2.8%	3.2%	1.3%	0.6%

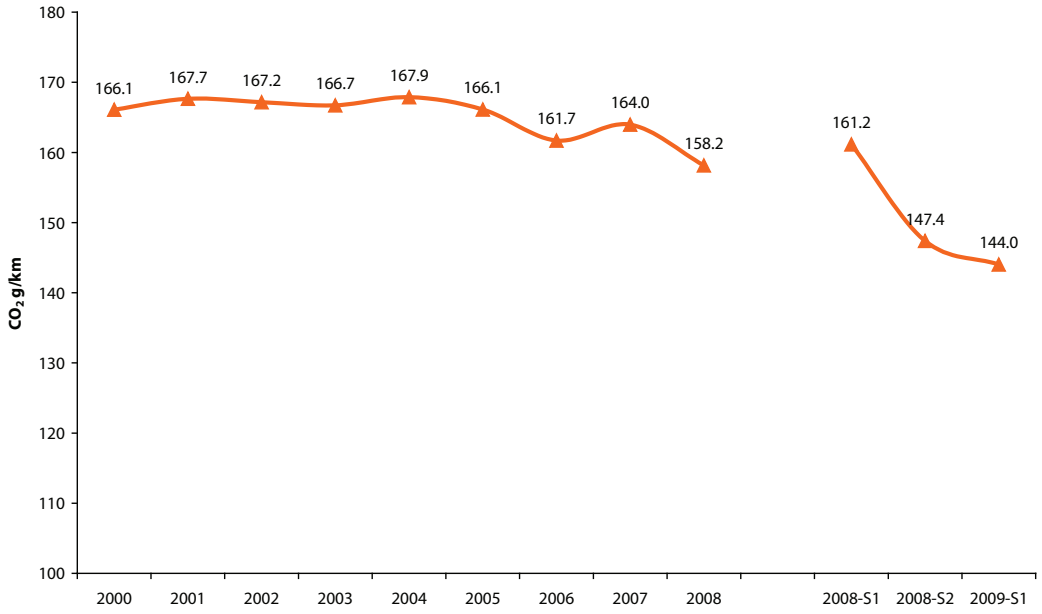
Source: Based on Vehicle Registration Unit data.

The average weighted emissions per car in 2007 were approximately 164 g CO_2/km which is encompassed within band D. Bands A, B & C are all below the current average; between 2000 and 2007 they collectively ranged from a 37% share of new cars to 41%. During the first half of 2008, before the application of the new registration and road taxes, the share grew slightly to 43%, but, after the introduction of the new tax regime, the share increased to a remarkable 73% and further to 78% in the first half of 2009. Conversely, the combined share of bands E, F & G fell from 29% in early 2008 to 6.2% after the change. This resulted in the weighted average going from 161 g CO_2/km before July 2008 to 147 g CO_2/km afterwards (11% reduction). The overall weighted average for 2008 was 158 g CO_2/km, a 3.5% reduction on 2007.

Figure 56 shows the evolution of the weighted average specific CO_2 emissions of new cars between 2000 and the first semester of 2009. It also shows the effect during 2008 of the change to the CO_2 taxation. Between 2000 and 2007 the average CO_2 emissions were approximately 166 CO_2 g/km for both petrol and diesel. For 2008 as a whole, there was a 3.5% reduction and a further 9% in the first semester of 2009.

However, if 2008 is taken in isolation, it can be seen that, over the first six months before the changeover, the average emissions for both petrol and diesel cars were approximately at the 2006 level. After the changeover in July, the average emissions fell by 8.6% with a further drop in the first semester of 2009 of 2.3%.

Figure 56 Specific CO_2 emissions of new cars, 2000 – 2009 (S1)



Source: Based on Vehicle Registration Unit & VCA data.

In label terms and with reference to *Figure 56*, the average new petrol and diesel car before the change would have been a D whereas after July the average new petrol car was a low C and the average new diesel a B.

4.2.4 Fuel Efficiency of New Cars in Ireland

New cars entering the Irish fleet exhibit the efficiency benefits over time of improved engine design by car manufacturers. The purchasing trend towards larger engine sizes shown in *Figure 54* is negating the efficiency benefits. In order to assess energy policy decisions regarding VRT and / or annual road tax change, it is important to assess the extent to which the purchasing trends have offset the efficiency gains. This may be achieved using an approach adopted by SEI[51], which measures the overall efficiency of new cars entering the fleet.

All new cars have fuel consumption figures (measured under test conditions) quoted for urban, extra-urban and combined driving. It is possible to arrive at an average test efficiency figure for new cars entering the national fleet weighted by the sales figures for each individual model.

The weighted average of the fuel consumption of new cars first registered in the years 2000 – 2008 was calculated by SEI using an extract from the Vehicle Registration Unit's national database and data on fuel consumption of individual models. The detailed results of this and other analysis were presented in SEI's *Energy in Transport – 2009 Report* and are also presented here.

51 Sustainable Energy Ireland (2007), *Energy in Transport – 2007 Report*, www.sei.ie/statistics. .

Figure 57 Weighted Average Specific Fuel Consumption of New Cars 2000 – 2008

Source: Based on Vehicle Registration Unit & VCA data.

The specific fuel consumption for new petrol cars on the road in Ireland in 2005 was 7.02 litres/100km (40 miles per gallon, mpg). This represented an increase of 1.6% (decrease in fuel efficiency) on the average consumption in 2000. In 2006 there was a step change improvement in the weighted average fuel efficiency of petrol cars with the specific fuel consumption improving by 4% to 6.74 litres/100km on 2005 figures. However, in 2007 these rebounded to 6.82 litres/100km before falling to 6.68 litres/100km (-2%) in 2008, helped by the change in taxation.

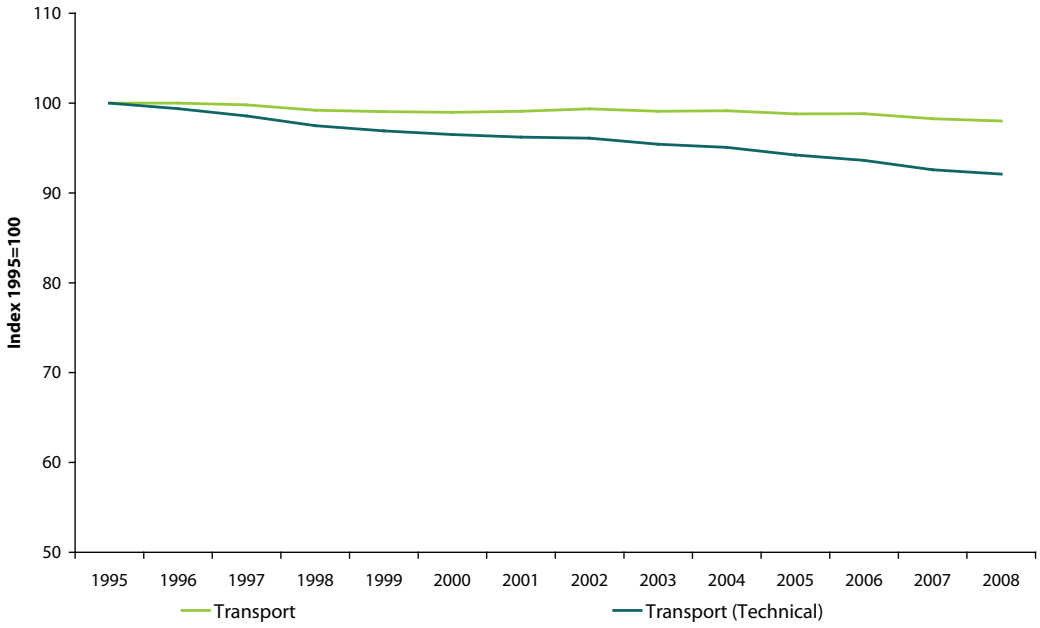
For diesel cars the average fuel efficiency improved slightly over the period 2000 - 2006 by 0.2% to 6.18 litres/100km. There was an improvement in 2006 over 2005 figures of 2%. As with petrol there was a rebound in 2007 with the average fuel efficiency of diesel cars decreasing by 2.4% to 6.3 litres/100km. In 2008 the taxation change had more of an effect on new diesel cars when the average fuel efficiency fell to 5.87 litres/100km, an improvement of 7.3%.

Generally, until 2005 the decrease in fuel efficiency suggests that the purchasing trend towards large cars over the period did outweigh the efficiency benefits of engine improvements. This appears to have changed during 2008 following the introduction of the new car tax systems.

4.2.5 Transport Sector Energy Efficiency

Two ODEX indicators examine efficiency for the transport sector as a whole in *Figure 58*. Note that air transport is not included as per the Energy Services Directive 2006/32/EC.

Figure 58 Transport ODEX 1995 - 2008



The transport observed ODEX fell by 2%[52] over the period 1995 – 2008 while the technical ODEX decreased by 8% (0.6% per annum). Additional efficiency gains would have been made if not for behavioural effects, for example the purchase of larger cars.

4.2.6 Private Car Average Annual Mileage

SEI's report *Energy in Transport - 2007 Report*[53] first profiled private car average annual mileage, based on results from an analysis of over three million National Car Test (NCT) tests.

Figure 59 presents the results of the NCT analysis for the period 2000 – 2008. The combined average mileage for petrol and diesel cars in 2008 was 16,708 kilometres (10,382 miles). Diesel cars had an average mileage of 24,227 km (15,054 miles) with the average for petrol being 15,266 km (9,486 miles). These figures differ slightly from those reported in the 2007 report due to a recalculation of the average as more cars are tested. The trend from year to year is more important than the absolute values.

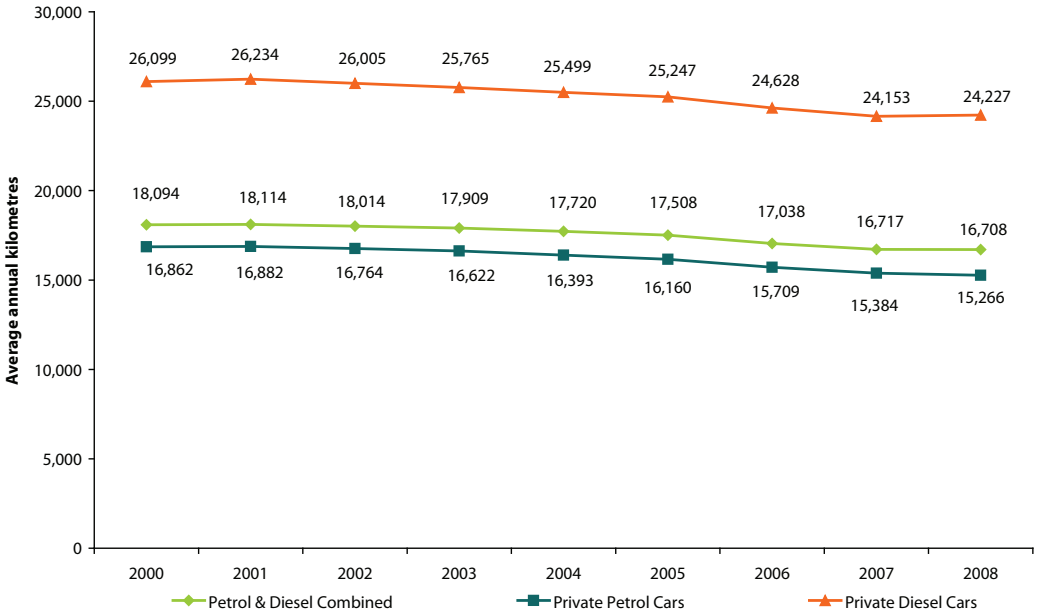
Overall average annual mileage per private car decreased by 0.1% in 2008 compared to 2007. Petrol car mileage decreased by 4% and diesel cars mileage increased by 0.1%.

Average mileage for all private cars has fallen by 7.7% (1% per annum on average) over the period 2000 to 2008. Petrol car annual mileage fell by 9.6% (1.3% per annum) while diesel car average mileage fell by 7.2% (0.9% per annum).

The data suggests that average annual mileage has been decreasing in Ireland while section *4.2.2* showed that ownership rates are increasing.

52 2% improvement in transport sector energy efficiency
53 Sustainable Energy Ireland (2007), *Energy in Transport – 2007 Report*, www.sei.ie/statistics.

Figure 59 Private Car Average Annual Mileage 2000 – 2008

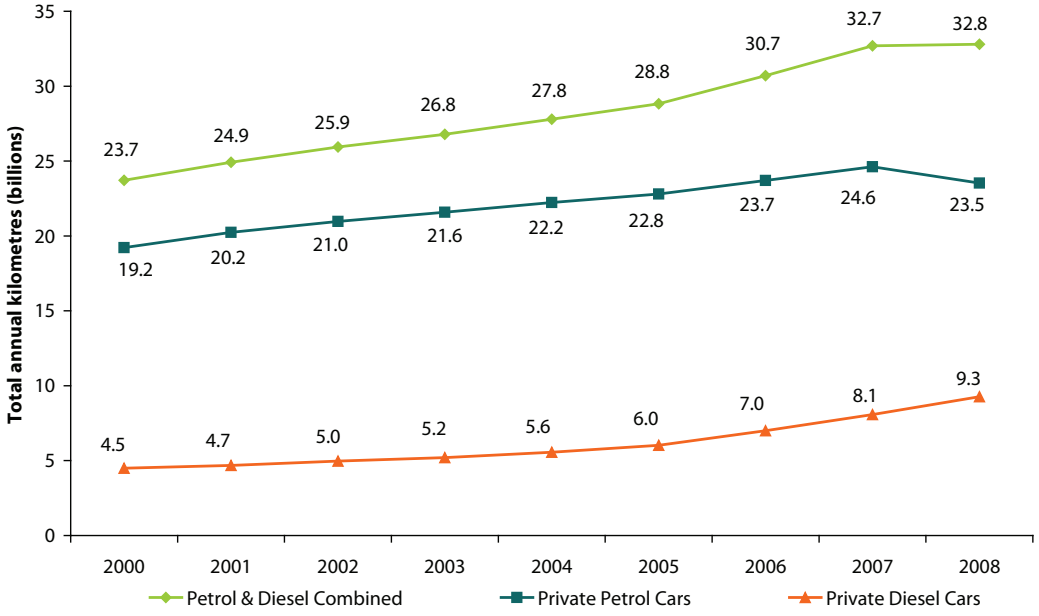


Source: Based on NCT Data

Section 4

Many households now own two cars. This will typically increase the transport energy usage per household but will also reduce the per car average mileage. Overall, the total number of kilometres travelled has increased which in turn has led to increased private car fuel consumption, as detailed in section *4.2.1*. Total mileage by all private cars increased by 38% over the period 2000 to 2008 (see *Figure 60*). Total mileage by petrol cars increased by 22% and diesel cars by 106%.

Figure 60 Total Private Car Annual Mileage 2000 – 2008



Source: Based on NCT Data

During 2008, overall private car mileage increased by 0.3%, but, as seen in *Figure 60* overall travel in petrol cars fell for the first time by, 4.4%, while travel by diesel cars continued to rise, at a rate of 15%. The reduction in overall mileage of petrol cars is due to a 0.5% reduction in the numbers of privately registered petrol cars on the road in 2008. Conversely there was a 13.5% increase in the number of privately registered diesel cars.

4.3 Residential

Residential final energy use grew by 41% (1.9% per annum) over the period 1990 – 2008 to a figure of 2.9 Mtoe in real terms. Corrected for climate the growth was also 41%. During this time the number of households[54] in the State increased by 53% from approximately 1.01 million to 1.5 million at the end of 2008[55]. Residential energy use increased by 8.8% during 2008. When corrections for climate effects[56] are taken into account the increase was 3.3% (see *Table 27*).

Figure 61 Residential Final Energy Use by Fuel

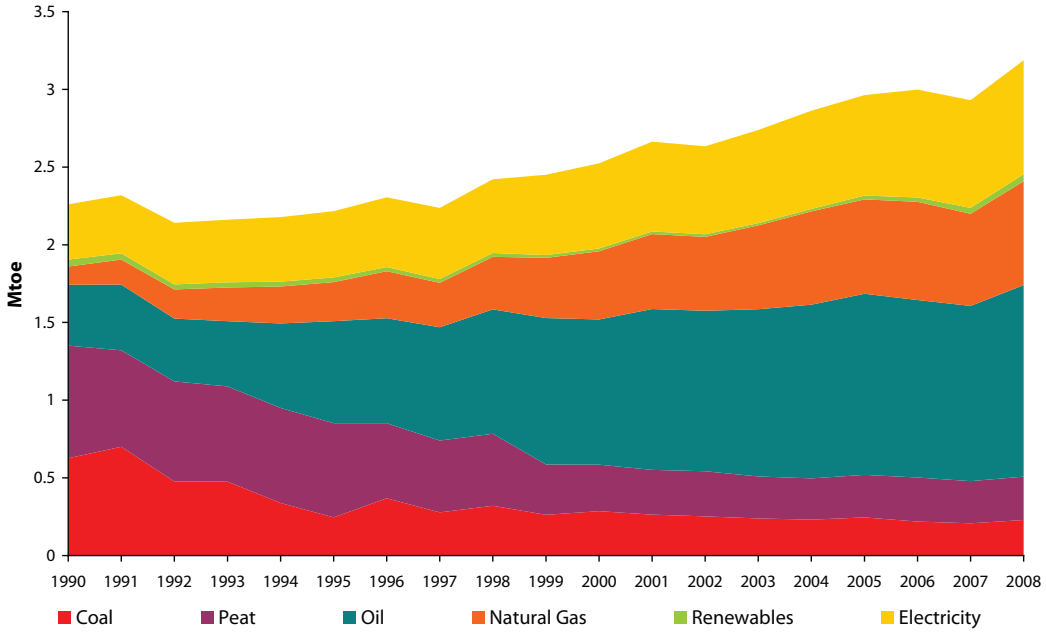


Figure 61 shows significant changes in the mix of fuels that have been consumed in the residential sector over the period. This can largely be explained by the move away from the use of open fires and solid fuel fired back-boiler heating systems that were popular in the 1970s and 1980s. New houses built in the 1990s predominantly had oil or gas-fired central heating or perhaps even electric storage heating and there has also been a trend to convert existing back-boiler systems to either oil or gas.

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 may result in greater usage.

The revisions of building regulations also had an impact on residential final energy use. Revisions were introduced in 1992, 2002, May 2006 and July 2008, all which had the effect of reducing the energy requirements of the new housing stock.

The increase in electricity usage in households can be explained by an increase in the use of appliances, such as washing machines, driers, dishwashers, microwave ovens, computers, televisions, games consoles etc. in the home.

As can be seen from *Figure 61*, oil has become the dominant fuel in the residential sector, more than doubling its share from 17% in 1990 to almost 39% in 2008. Electricity is the second most dominant fuel in the sector at 23%. Natural gas usage increased by a factor of almost six over the period to become the third fuel of choice at 21% share. The renewables share of energy used in households in 2008 was just 1.4%.

54 Defined as the number of private households in permanent housing units.
55 Central Statistics Office (2007), *Census 2006 Volume 3 – Household Composition, Family Units and Fertility.*
56 Annual variations in climate affect the space heating requirements of occupied buildings. Climate correction involves adjusting the energy used for space heating by benchmarking the climate in a particular year with that of a long-term average measured in terms of number of degree days.

The growth rates and shares are tabulated in *Table 27*.

Table 27 Growth Rates and Shares of Final Consumption in Residential Sector

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Fossil Fuels (Total)	29.6	1.4	-1.1	2.2	3.2	1.7	9.6	82.3	75.6
Coal	-63.5	-5.4	-17.0	3.0	-3.0	-2.4	9.7	27.7	7.2
Peat	-61.4	-5.2	-3.5	-13.2	-1.8	0.8	3.1	32.1	8.8
Briquettes	-31.7	-2.1	-5.0	0.0	-5.5	5.4	24.5	6.9	3.3
Oil	215.5	6.6	10.9	7.3	4.6	1.9	9.4	17.3	38.6
Gas	470.4	10.2	16.5	11.8	6.7	3.3	12.8	5.2	21.0
Renewables	-1.6	-0.1	-7.8	-10.4	7.9	20.5	18.0	2.0	1.4
Combustible Fuels (Total)	27.7	1.4	-1.2	2.0	3.2	1.8	9.5	84.2	76.3
Electricity	105.8	4.1	3.7	5.1	3.3	4.3	5.7	15.8	23.0
Total	**41.0**	**1.9**	**-0.4**	**2.6**	**3.3**	**2.5**	**8.8**		
Total Climate Corrected	**41.0**	**1.9**	**0.2**	**2.1**	**4.0**	**1.2**	**3.3**		

The salient trends in energy use in the residential sector are as follows:

- Direct renewables usage in households increased by 18% in 2008 to 44 ktoe but its share dropped from 2% to 1.4% since 1990.
- Oil usage increased considerably by 215% over the period 1990 – 2008 to 1.2 Mtoe and its share in the residential sector grew from 17% to 39%. There was a 9.4% increase in oil consumption in households in 2008.
- Electricity consumption increased by 5.7% in 2008 and its share of residential final consumption now stands at 23%.
- Natural gas usage increased by 13% in 2008 to 669 ktoe.
- Coal usage increased by 9.7% in 2008 to 228 ktoe.
- Sod peat usage increased by 3.1% in 2008 while peat briquette usage increased by 25% – the largest increase of all the fuels used in the residential sector in 2008.
- Fossil fuel use in households increased by 9.6% in 2008.
- 2008 was colder than 2007 with 11% more heating degree days. This contributed to the increased energy use in 2008 in this sector.

In 2008 residential sector energy-related CO_2 emissions were 12,352 kt CO_2 representing 26% of the total (energy-related). The residential sector total was the second largest after transport (35%).

Over the period 1990 to 2008 energy-related CO_2 emissions from the residential sector increased by 14.7% (0.8% on average per annum) while those in transport, services, industry and agriculture increased, respectively, by 176% (5.8% per annum), 71% (3% per annum), 22% (1.1% per annum) and 5% (0.3% per annum).

The residential sector is specifically examined in more detail with respect to energy-related CO_2 emissions in *Figure 62* and the relatively constant or flat, overall trend can be seen. While final energy use in the sector increased by 41% over the period, its energy-related CO_2 emissions increased by 15%, illustrating the effect of the changing fuel mix on energy related emissions.

Figure 62 Residential Energy-related CO_2 by Fuel

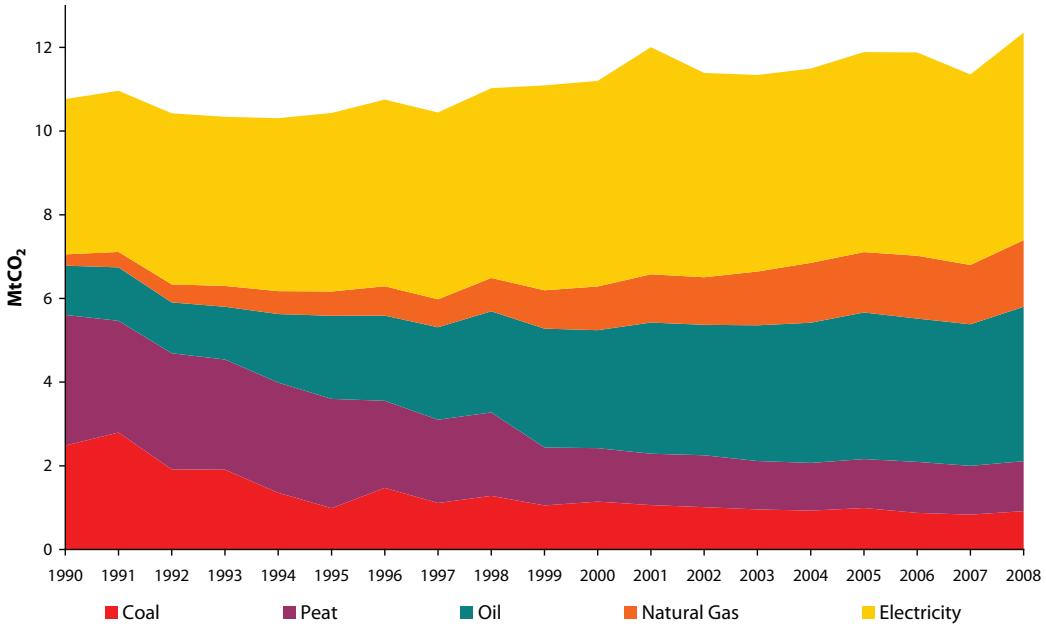


Table 28 Growth Rates and Shares of Energy-Related CO_2 Emissions in Residential Sector

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Coal	-63.1	-5.4	-16.8	3.0	-2.9	-2.6	9.6	23.1	7.4
Peat	-61.7	-5.2	-3.5	-13.3	-1.7	0.7	2.7	29.0	9.7
Briquettes	-31.7	-2.1	-5.0	0.0	-5.5	5.4	24.5	6.0	3.5
Oil	213.3	6.6	11.0	7.3	4.4	1.7	9.1	10.9	29.9
Gas	490.4	10.4	16.5	12.5	6.7	3.3	12.3	2.5	12.9
Renewables	-	-	-	-	-	-	-	0.0	0.0
Combustible Fuels (Total)	4.8	0.3	-2.7	0.4	2.5	1.3	8.7	65.5	59.8
Electricity	33.6	1.6	2.8	2.8	-0.5	1.2	8.9	34.5	40.2
Total	**14.7**	**0.8**	**-0.6**	**1.4**	**1.2**	**1.3**	**8.8**		

4.3.1 Unit Consumption of the Residential Sector

The unit consumption of the residential sector is typically defined in terms of the unit consumption of energy or the energy consumed per dwelling. *Figure 63* shows the trend in unit consumption per dwelling, which decreased by 7.7% during the period 1990 – 2008.

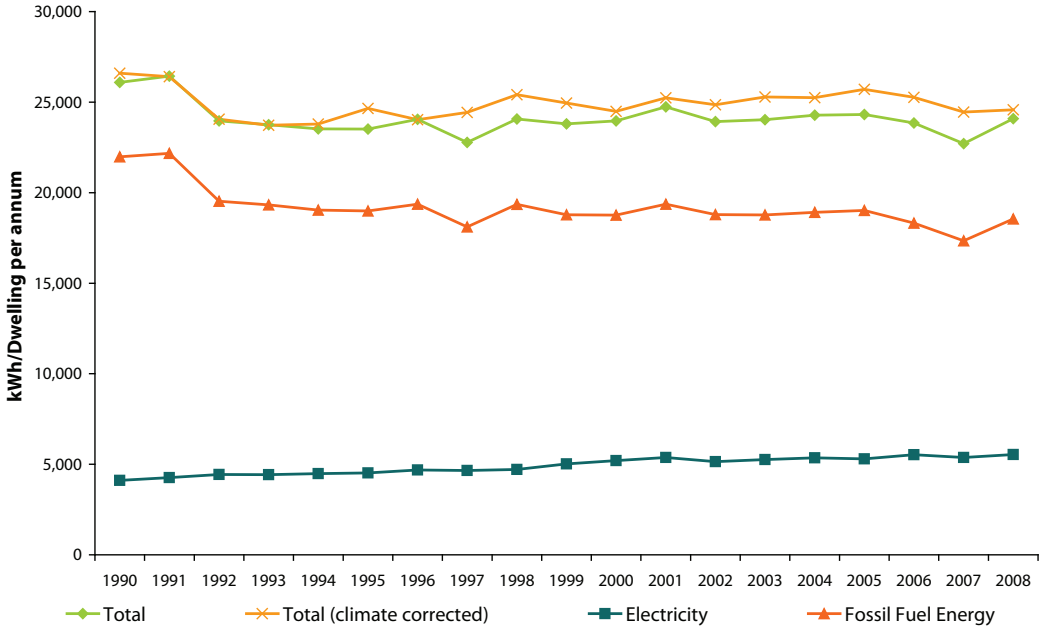
While overall unit energy use per dwelling has decreased, *Figure 63* also shows an increasing trend in electricity consumption per dwelling. This has increased by 35% since 1990. The increasing penetration of household electrical appliances such as washing machines, dishwashers, clothes driers, computers and multiple televisions as well as convenience appliances is believed to have contributed to this increase. In contrast, fossil fuel consumption per dwelling has decreased by 16% over the period.

In 2008 the "average" dwelling consumed a total of 24,444 kWh of energy based on climate corrected data. This was comprised of 18,882 kWh (77%) in the form of direct fossil fuels and the remainder (5,557 kWh) as electricity.

Figure 63 also shows overall unit energy use per dwelling, corrected for climate variations. Looking at this and in conjunction with *Table 31*, it can be seen that the decrease in climate corrected energy use per dwelling over the period was 7.7% while the uncorrected energy use decrease was also 7.7%. It can be seen that most of the improvement in unit use occurred during the

early 1990s and again from 2001 onwards with the increasing penetration of new housing stock.

Figure 63 Unit Consumption of Energy per Dwelling (permanently occupied)



Source: Based on SEI, CSO and Met Éireann data

One reason for the slowing trend in the late 1990s may be the trend towards larger houses as shown in *Figure 64*. Larger houses have higher space-heat requirements and they also have proportionally greater surface area and therefore higher heat losses. *Table 29* shows that the largest rate of growth in the floor area of new houses and flats occurred in the 2005 – 2008 period.

Table 29 Growth Rates in Residential Floor Areas per New Dwelling[57]

	Growth %	Average annual growth rates %					
	1990 – 2008	1990 – '08	1990 – '95	1995 – '00	2000 – '05	2005 – '08	2008
New Houses	29.4	1.4	-0.1	2.0	0.9	4.1	2.5
New Flats	32.9	1.6	0.3	3.1	0.5	3.0	0.2

Average floor areas of new houses grew from 130 square metres in 1990 to 168 square metres in 2008 (an increase of 29%). The average declined slightly in the early 1990s and then grew at a rate of 2% per annum in the latter half of the decade. Average floor areas of houses increased by 2.5% in 2008. Average floor areas of new flats showed a stronger growth over the period from 64 square metres to 85 square metres (33%). The average floor area of flats increased by 0.2% in 2008.

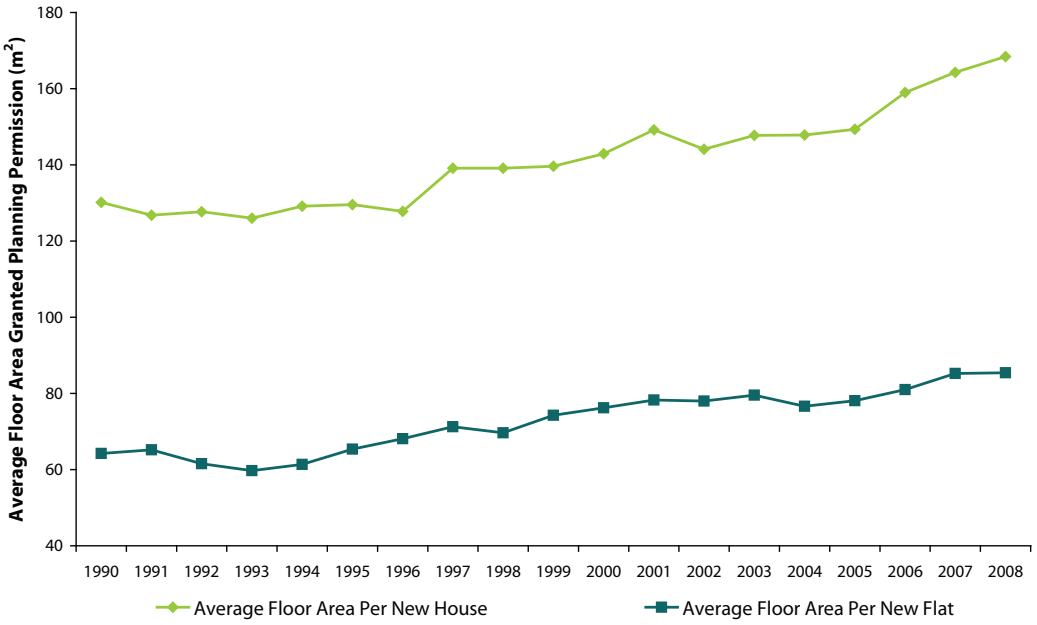
The ratio of new houses to new flats granted planning permission in 1990 was approximately 9 to 1 whereas in 2008 it was more than 2.4 to 1.

The 2006 Census[58] notes that in 1991, 6.5% of the housing stock consisted of apartments or flats whereas in 2006 the portion was 10%.

57 Note that the figures used in *Table 29* and *Figure 64*, are for the average floor area of new houses that were granted planning permission. It is not known if all those granted permission were actually built but the figures provide a plausible proxy for the trend in new house size.

58 CSO (2007), *2006 Census of Population – Volume 6 – Housing*.

Figure 64 Floor Areas of New Houses and New Flats



Source: CSO

While the above only refers to new dwellings it is also possible to estimate the trend in the stock[59] 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[60]. Data from this model is updated incrementally, using planning permission data and estimates of the number of permanently occupied dwellings. The results are presented in *Figure 65*. *Table 30* summarises the growth rates during the period. Over the period 1990 to 2008 the estimated average floor area of the stock of dwellings increased from 100 square metres in 1990 to 118 square metres in 2008.

Table 30 Growth in Average Floor Area -Stock

	Growth %	Average annual growth rates %					
	1990 – 2008	1990 – '08	1990 – '95	1995– '00	2000 – '05	2005 – '08	2008
Average Floor Area	18.0	0.9	0.3	1.2	1.1	1.2	1.0

Average floor area has increased steadily over the period as larger dwellings are added to the stock. Growth of 1.2% was recorded in 2008. 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 second quarter of 2009, the average floor area of non estate houses granted permission was 253 square metres (247m^2 in 2nd qtr 2008) compared to 128 square metres for houses in estates (146m^2 in 2nd qtr 2008) and 92 square metres for flats (86m^2 in 2nd qtr 2008)[61].

The evidence suggests that there has been a trend towards larger dwellings (although estate houses floor area has started to fall since 3rd quarter 2008). 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.

59 This section draws on data first presented in a separate SEI report entitled *Energy Consumption and CO_2 Emissions in the Residential Sector 1990 to 2004*. The report is available at www.sei.ie.
60 Kevin O' Rourke (2005), *Personal Communication*.
61 CSO (2009), *Planning Permissions – Quarter 4 2008*. Available at www.cso.ie.

Figure 65 Average Floor Area of the Housing Stock 1990 – 2008

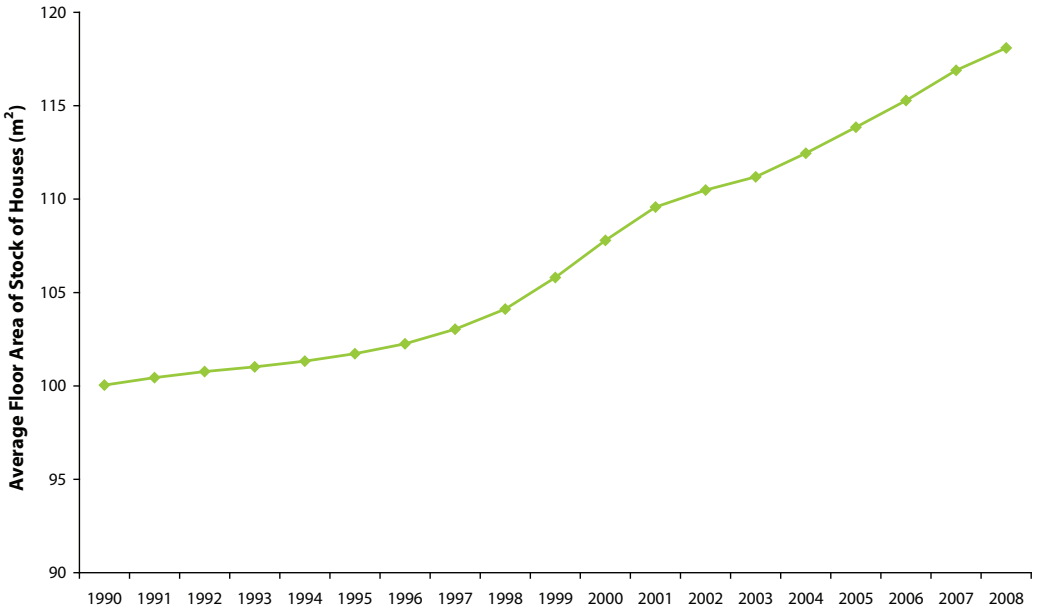


Table 31 Growth Rates of Residential Unit Energy Consumption and Unit CO_2 Emissions

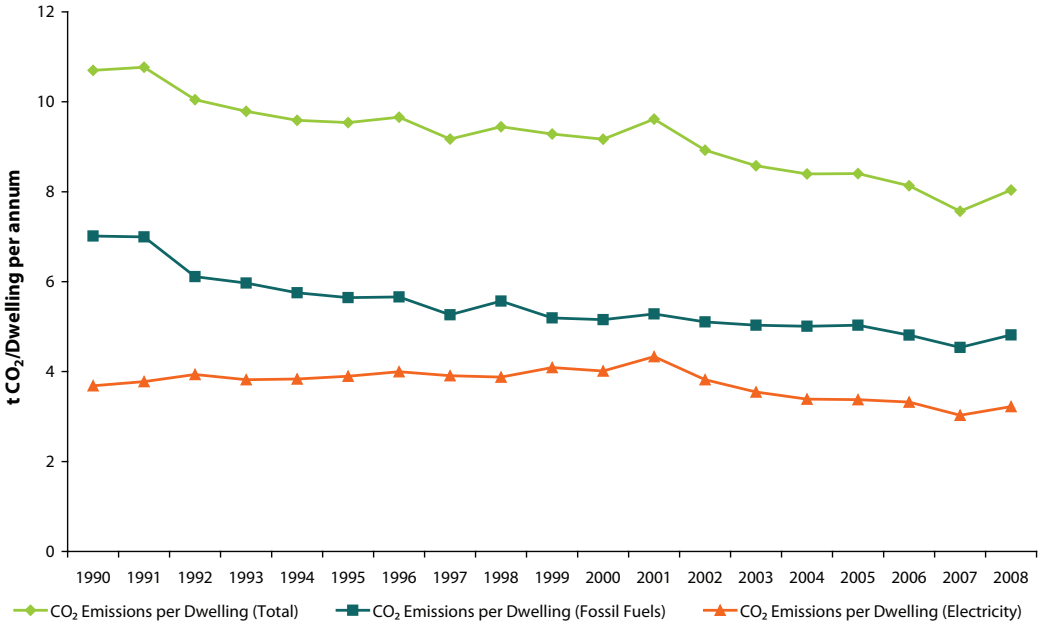
	Growth %	Average annual growth rates %					
Unit Energy Consumption	**1990 – 2008**	**'90 – '08**	**'90 – '95**	**'95 – '00**	**'00 – '05**	**'05 – '08**	**2008**
Total Energy	-7.7	-0.4	-2.1	0.4	0.3	-0.3	6.1
Fossil Fuel Energy	-15.6	-0.9	-2.9	-0.2	0.3	-0.8	7.0
Electrical Energy	34.8	1.7	1.9	2.8	0.4	1.5	3.1
Unit Energy Consumption Climate Corrected							
Total Energy Climate Corrected	-7.7	-0.4	-1.5	-0.2	1.0	-1.5	0.7
Fossil Fuel Energy Climate Corrected	-15.5	-0.9	-2.2	-0.9	1.2	-2.3	0.3
Electrical Energy Climate Corrected	34.8	1.7	2.0	2.7	0.5	1.3	2.1
Unit Energy-Related CO_2 Emissions							
Total Energy CO_2	-24.9	-1.6	-2.3	-0.8	-1.7	-1.5	6.1
Fossil Fuel CO_2	-31.4	-2.1	-4.3	-1.8	-0.5	-1.4	6.0
Electricity CO_2	-12.5	-0.7	1.1	0.6	-3.4	-1.5	6.2

Examining *Table 31* and *Figure 66* over the period 1990 to 2008 the emissions of energy-related CO_2 per dwelling decreased by 7.7% while the reduction for unit energy use was also 7.7%. The 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. However, the downward trend was reversed in 2008 when the energy use per household increased by 6.1% and total energy-related CO_2 emissions also rose by 6.1%. This was as a result of 2008 being much colder than 2007. Climate corrected, the unit energy consumption per household was just 0.7% higher in 2008 than in 2007 compared with an uncorrected increase of 6.1%.

Emissions associated with the use of electricity per dwelling fell by 12.5% over the period, despite the 35% increase in electricity consumption per dwelling. 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 and because of the growing contribution of renewables in electricity generation. The increasing use of electrical appliances will, however, have offset some of the gains.

In 2008 the "average" dwelling was responsible for emitting approximately 8 tonnes of CO_2. A total of 4.8 tonnes CO_2 (61%) came from direct fuel use and the remainder indirectly from electricity use.

Figure 66 Unit Energy-Related CO_2 Emissions per Dwelling



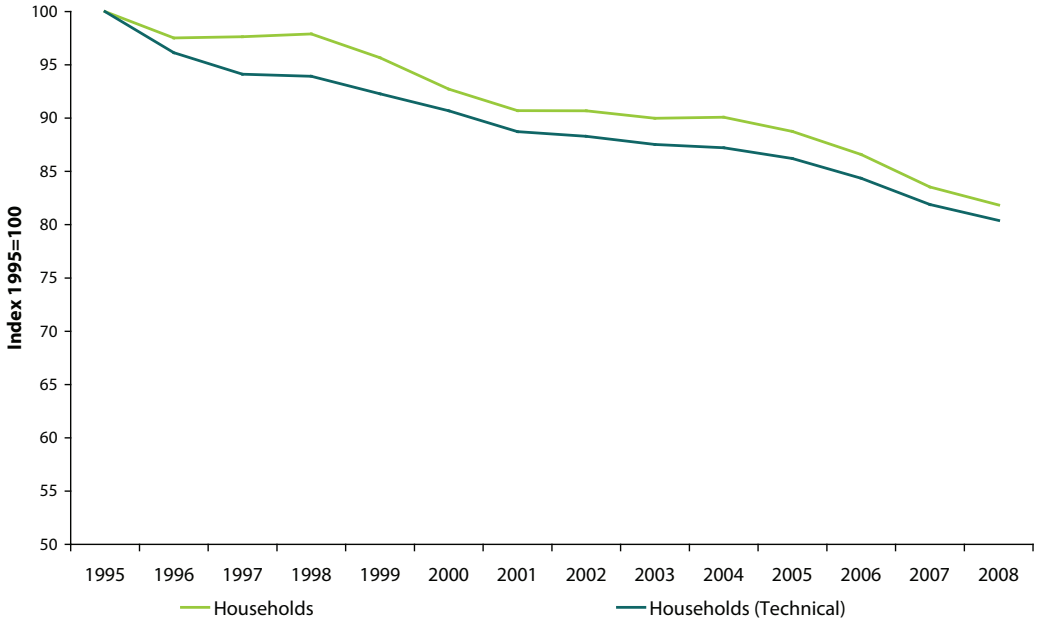
4.3.2 Residential Sector Energy Efficiency

Two ODEX indicators are shown in *Figure 67* for the household sector. The observed ODEX decreased (indicating an improvement in energy efficiency) by 18% over the period (1.3% per annum). To remove the influence of behavioural or lifestyle factors a technical ODEX is also calculated. Technical efficiency gains arise from the use of more energy efficient technologies whereas behavioural gains are the result of how technologies (for example, heating systems and appliances) are used.

The technical ODEX decreased by 20% (1.7% per annum)[62]. This implies that additional efficiency gains would have been made if not for the change in behaviour, i.e. efficiency gains were made but rebound effects negated some of the gains. Rebound effects are the result of increased energy usage through higher comfort levels, the move towards whole house heating, larger dwellings, use of power showers etc.

62 The technical ODEX is different to the technical ODEX published in *Energy in Ireland 1990 - 2007* and *Energy Efficiency in Ireland 2009 Report* due to data and methodological updates.

Figure 67 Household ODEX 1995 - 2008



4.4 Commercial and Public Services

Final energy use in the commercial and public services sector grew by 80% (3.3% per annum) over the period 1990 – 2008 to a figure of 1.8 Mtoe. Growth was 79% if climate corrected energy use is considered. During this period the value added generated by the sector grew by 157% while the numbers employed more than doubled (128% increase).

Figure 68 Commercial and Public Services Final Energy Use by Fuel

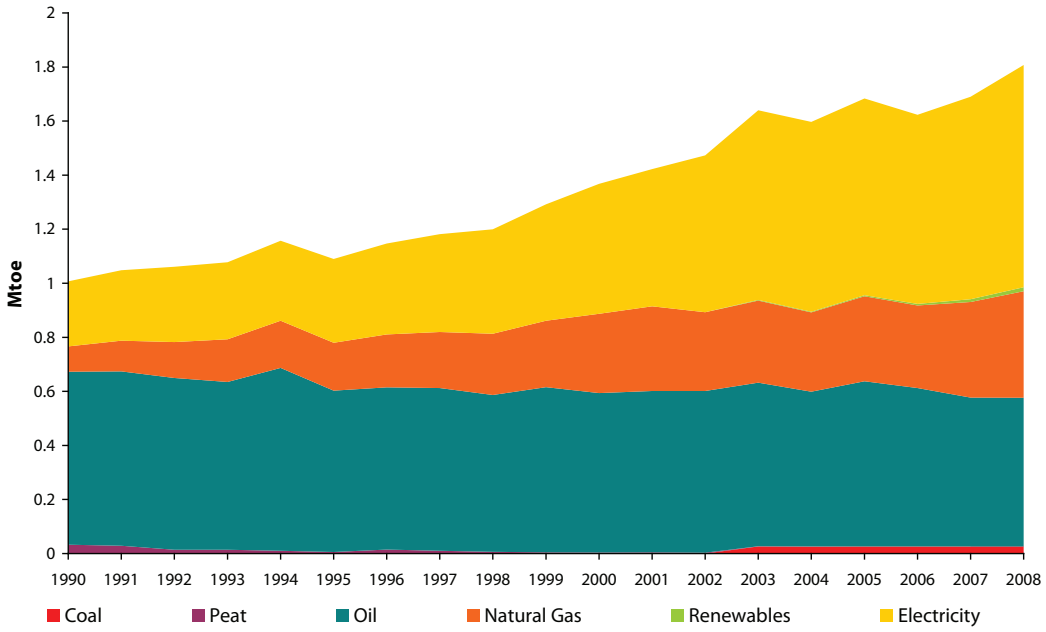


Figure 68 shows the changes in the fuel mix in the services sector over the period. One interesting feature is the small range of fuels utilised in this sector – essentially oil, gas and electricity accounting for 98% of the energy use. Oil and gas are used predominantly for space-heating purposes but also for water heating, cooking and, in some subsectors, laundry. Gas consumption increased by 319% although this was from a low base.

Electricity consumption in services increased by 242% (7.1% per annum) between 1990 and 2008 and has a higher share at 45% than any other individual fuel in services, up from 24% in 1990. This growth is fuelled by the changing structure of this sector and the general increase in the use of information and communication technology (ICT) and air conditioning.

Growth rates and shares are tabulated in *Table 32*.

Table 32 Growth Rates and Shares of Final Consumption in the Commercial & Public Services Sector

	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Fossil Fuels (Total)	26.6	1.3	0.3	2.6	1.4	0.7	4.2	76.1	53.7
Coal	-	22.8	-100.0	-	-	0.0	0.0	0.1	1.4
Oil	-14.0	-0.8	-1.4	-0.2	0.7	-3.4	-0.1	63.6	30.5
Natural Gas	319.3	8.3	13.5	10.6	1.4	7.8	11.2	9.3	21.8
Renewables	-	-	-	-	-	54.9	50.2	0.0	0.8
Combustible Fuels (Total)	28.3	1.4	0.3	2.6	1.5	1.0	4.7	76.1	54.4
Electricity	241.9	7.1	5.2	9.2	8.7	4.1	9.7	23.9	45.5
Total	**79.5**	**3.3**	**1.6**	**4.6**	**4.2**	**2.4**	**6.9**		
Total Climate Corrected	**79.2**	**3.3**	**2.2**	**4.1**	**4.9**	**1.2**	**1.9**		

The key trends are as follows:

- Final energy use grew by 80% over the period 1990 – 2009 (3.3% per annum). The increase was 79% when corrected

for climate. Overall energy use in this sector increased by 6.9% in 2008 but this was just 1.9% on a climated corrected basis.

- Oil, gas and electricity make up 98% of energy consumed in the services sector. The small contributions from coal and peat in the early 1990s are now negligible.
- Electricity became the dominant "fuel" in this sector in 2005 – the only sector where electricity has a higher share of final consumption than any other fuel. Consumption of electricity increased by 242% over the period 1990 – 2008 and its share went from 24% to 45%. Electricity consumption in services increased by 9.7% in 2008 to 822 ktoe.
- Oil consumption fell by 0.1% in 2008 to 551 ktoe, the only fuel to experience a reduction. This followed a 6% fall in 2007. The share of oil in final consumption of the sector fell from almost 64% in 1990 to 30% in 2008.
- Natural gas consumption grew by 319% (8.3% per annum) over the period to 394 ktoe. Its share has grown from 9.3% in 1990 to 22% in 2008. In 2008 gas consumption increased by 11%.
- Overall fossil fuel use in services increased by 4.2% in 2008.

Figure 69 shows the primary energy-related CO_2 emissions of the services sector, distinguishing between the *on-site* CO_2 emissions associated with direct fuel use and the *upstream* emissions associated with electricity consumption. Emissions from non-electrical energy increased by 17% over the period whereas the emissions associated with electricity consumption increased by 122%. In 2008 the non-electricity emissions increased by 3.4% and the electricity associated emissions in services increased by 13%. Overall energy-related CO_2 emissions in this sector increased by 9.7% in 2008 to 8.3 Mt CO_2.

In the services sector, the share of emissions associated with electricity demand in 2008 was approximately two thirds (67%) compared to the combustion of oil and gas. In 1990 the proportion was closer to half and half respectively (52% electricity and 48% fuels).

Figure 69 Commercial and Public Services Sector CO_2 Emissions by Fuel

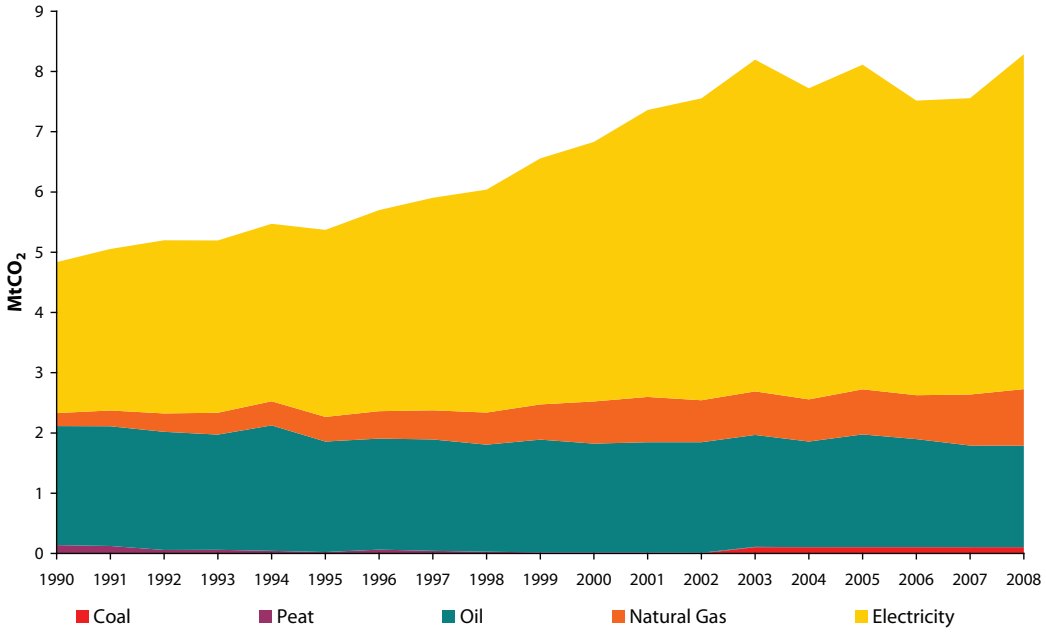


Table 33 Growth Rates and Shares of CO_2 Emissions in Commercial/Public Services

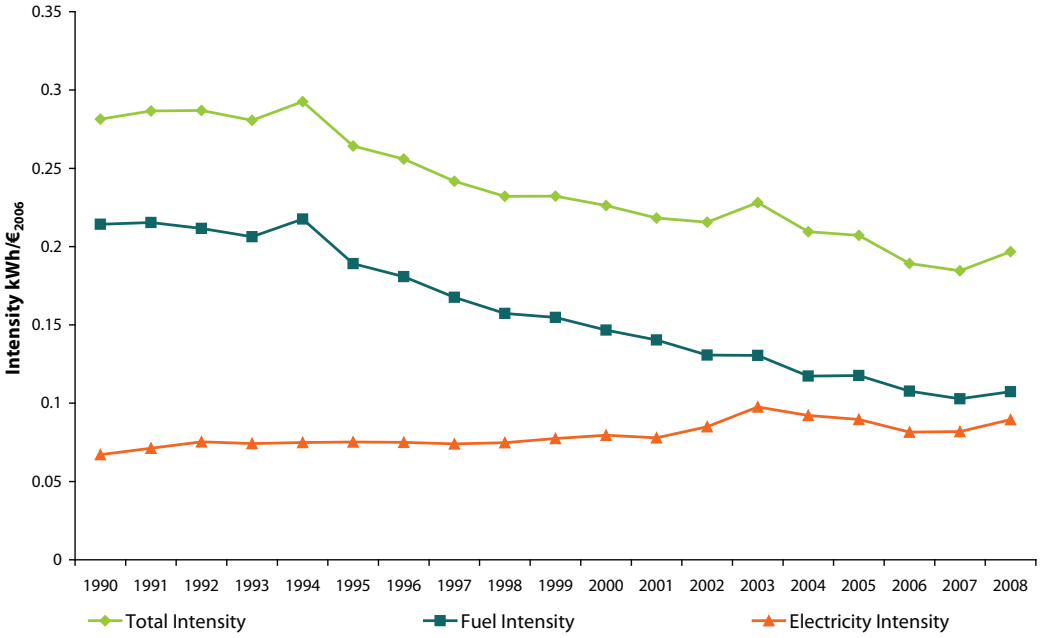
	Growth %	Average annual growth rates %						Shares %	
	1990 – 2008	'90 – '08	'90 – '95	'95 – '00	'00 – '05	'05 – '08	2008	1990	2008
Combustible Fuels	17.0	0.9	-0.6	2.2	1.5	0.0	3.4	48.2	32.9
Electricity	122.0	4.5	4.4	6.8	4.6	1.0	13.0	51.8	67.1
Total	**71.4**	**3.0**	**2.1**	**4.9**	**3.5**	**0.7**	**9.7**		

4.4.1 Energy Intensity of the Services Sector

The energy intensity of the services sector is generally measured with respect to the value added generated by services activities. As shown in *Figure 70*, this intensity is much flatter than that of industry although it is showing a declining trend since 1994. The overall energy intensity of the services sector was 35% lower in 2007 than it was in 1990, principally because of the rapid growth in the value added in the sector. The downward trend was reversed in 2003 but continued downwards from 2004 onwards. A reversal also occurred in 2008 when the overall intensity increased by 6.6% resulting in services intensity being 30% lower in 2008 than in 1990.

Electricity intensity increased by 56% up to 2003, decreased by 16% up to 2007 but has since increased by 9.4% in 2008. Services electricity intensity was 33% below 1990 levels in 2008.

Figure 70 Energy Intensity of Commercial and Public Services Sector



Two other measures in this sector are energy use per unit of floor area and per employee. The consumption of oil and gas is mainly for heating purposes and is related to the floor area heated, not directly related to the number of people occupying a building at a given time. Due to an absence of data on floor area in the services sector it is not currently possible to calculate the consumption per unit of floor area.

Unit consumption of electricity per employee is used as an indicator of energy use in the services sector because in the main, there is a correlation between electricity use and the number of employees. With reference to *Figure 71* it can be seen that unit consumption of electricity was rising steadily since 1990. By 2003 it was 58% higher than in 1990 but it had fallen back to 41% in 2007. 2008 saw the electricity use per employee increase by 8.2%

By contrast, the fuel consumption per employee declined by 46% between 1994 and 2007 but increased by 3.2% in 2008 leaving it at 44% below 1990 levels.

Figure 71 Unit Consumption of Energy & Electricity per Employee in the Services Sector

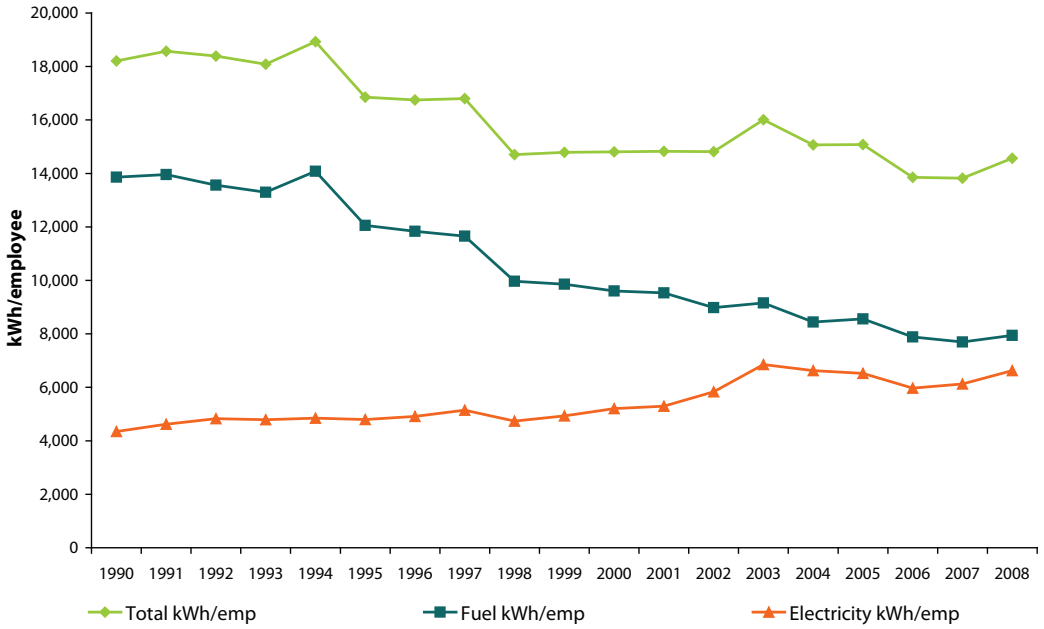


Table 34 Growth Rates and Shares of Unit Consumption per Employee in Commercial/Public Services

	Growth %	Average annual growth rates %					
	1990 – 2008	1990 – '08	1990 – '95	1995 – '00	2000 – '05	2005 – '08	2008
Total kWh/employee	-21.3	-1.3	-1.5	-2.6	0.4	-1.7	5.5
Fuel kWh/employee	-43.6	-3.1	-2.7	-4.5	-2.3	-3.0	3.3
Electricity kWh/employee	49.9	2.3	2.0	1.7	4.6	0.0	8.2

As a result of the heterogeneous nature of the services sector it is difficult to assess the amount of energy that is consumed in this sector. Energy statistics relating to fuel consumption for the services sector in Ireland are calculated as a residual. This approach is unsatisfactory, not least because the energy use in the services sector is affected by uncertainties in all other sectors. As a result, there is only limited information available to policy-makers with which to formulate and target energy efficiency policies and measures for the sector.

The increasing number of energy suppliers in the liberalised market makes this task all the more difficult. Thus, the data does not allow for ODEX indicators to be formulated at this point. Work is on-going, however, within the ODYSSEE project to address this situation.

Glossary of Terms

Carbon Dioxide (CO_2): A compound of carbon and oxygen formed when carbon is burned. Carbon dioxide is one of the main greenhouse gases. Units used in this report are *t* CO_2 – tonnes of CO_2, *kt* CO_2 – kilo-tonnes of CO_2 (10^3 tonnes) and *Mt* CO_2 – mega-tonnes of CO_2 (10^6 tonnes).

Carbon Intensity (kg CO_2/kWh): This is the amount of carbon dioxide that will be released per kWh of energy of a given fuel. For most fossil fuels the value of this is almost constant, but in the case of electricity it will depend on the fuel mix used to generate the electricity and also on the efficiency of the technology employed. Renewable sources of electricity generation, such as hydro and wind, have zero carbon intensity.

Climate Correction: Annual variations in climate affect the space heating requirements of occupied buildings. Climate correction involves adjusting the energy used for space heating by benchmarking the climate in a particular year with that of a long-term average measured in terms of number of degree days.

Energy Intensity: The amount of energy used per unit of activity. Examples of activity used in this report are gross domestic product (GDP), value added, number of households, employees etc. Where possible, the monetary values used are in constant prices.

Gross and Net Calorific Value (GCV & NCV): The gross calorific value (GCV) gives the maximum theoretical heat release during combustion, including the heat of condensation of the water vapour produced during combustion. This water is produced by the combustion of the hydrogen in the fuel with oxygen to give H_2O (water). The net calorific value (NCV) excludes this heat of condensation because it cannot be recovered in conventional boilers. For natural gas, the difference between GCV and NCV is about 10%, for oil it is approximately 5%.

Gross Domestic Product: The gross domestic product represents the total output of the economy over a period.

Heating Degree Days: "Degree Days" is the measure or index used to take account of the severity of the weather when looking at energy use 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.

Structural Effect: As it affects energy intensity, structural change is a change in the shares of activity accounted for by the energy consuming sub-sectors within a sector. For instance, in industry the structural effect caused by the change in emphasis of individual sub-sectors such as pharmaceuticals, electronics, textiles, steel etc in their contribution to gross domestic product.

Total Final Consumption (TFC): This is the energy used by the final consuming sectors of industry, transport, residential, agriculture and services. It excludes the energy sector such as electricity generation and oil refining etc.

Total Primary Energy Requirement (TPER): This is the total requirement for all uses of energy, including energy used to transform one energy form to another (eg burning fossil fuel to generate electricity) and energy used by the final consumer.

Value Added: Value added is an economic measure of output. The value added of industry, for instance, is the additional value created by the production process through the application of labour and capital. It is defined as the value of industry's output of goods and services less the value of the intermediate consumptions of goods (raw materials, fuel, etc) and services.

Energy Conversion Factors

To : / *From :*	**toe**	**MWh**	**GJ**
	Multiply by		
toe	1	11.63	41.868
MWh	0.086	1	3.6
GJ	0.02388	0.2778	1

Energy Units:

joule (J): Joule is the international (S.I.) unit of energy.

kilowatt hour (kWh): The conventional unit of energy that electricity is measured by and charged for commercially.

tonne of Oil Equivalent (toe): This is a conventional standardized unit of energy and is defined on the basis of a tonne of oil having a net calorific value of 41686 kJ/kg. A related unit is the *kilogram of oil equivalent (kgoe)*, where 1 kgoe = 10^{-3} toe.

Decimal Prefixes

deca (da)	10^{1}	deci (d)	10^{-1}
hecto (h)	10^{2}	centi (c)	10^{-2}
kilo (k)	10^{3}	milli (m)	10^{-3}
mega (M)	10^{6}	micro (μ)	10^{-6}
giga (G)	10^{9}	nano (n)	10^{-9}
tera (T)	10^{12}	pico (p)	10^{-12}
peta (P)	10^{15}	femto (f)	10^{-15}
exa (E)	10^{18}	atto (a)	10^{-18}

Calorific Values

Fuel	Net Calorific Value toe/t	Net Calorific Value MJ/t
Crude Oil	1.0226	42,814
Gasoline (petrol)	1.0650	44,589
Kerosene	1.0556	44,196
Jet Kerosene	1.0533	44,100
Gasoil / Diesel	1.0344	43,308
Residual Fuel Oil (heavy oil)	0.9849	41,236
Milled Peat	0.1860	7,787
Sod Peat	0.3130	13,105
Peat Briquettes	0.4430	18,548
Coal	0.6650	27,842
Liquefied Petroleum Gas (LPG)	1.1263	47,156
Petroleum Coke	0.7663	32,084
	Conversion Factor	**Conversion Factor**
Electricity	86 toe/GWh	3.6 TJ/GWh

Emission Factors

	t CO_2/TJ (NCV)	g CO_2/kWh (NCV)
Liquid Fuels		
Motor Spirit (Gasoline)	70.0	251.9
Jet Kerosene	71.4	257.0
Other Kerosene	71.4	257.0
Gas/Diesel Oil	73.3	263.9
Residual Oil	76.0	273.6
LPG	63.7	229.3
Naphta	73.3	264.0
Petroleum Coke	92.93	334.5
Solid Fuels and Derivatives		
Coal	94.6	340. 6
Milled Peat	116.7	420.0
Sod Peat	104.0	374.4
Peat Briquettes	98.9	355.9
Gas		
Natural Gas	56.9	204.7
Electricity		
(2008)	161.5	581.8

Sources

Central Statistics Office

Department of Communications, Energy and Natural Resources

Department of Environment, Heritage and Local Government

Department of Transport

Eirgrid

Environmental Protection Agency

European Commission DG TREN

EU funded SAVE II ODYSSEE Project

Eurostat

International Energy Agency

Met Éireann

SGS (National Car Test)

Vehicle Registration Unit

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Energy Balance 2008

kilo tonnes of oil equivalent (ktoe)	Coal	Peat	Oil	Natural Gas	Renewables	Electricity	Total
Indigenous Production	-	645	-	355	538	-	1,538
Imports	1,600	-	10,386	4,135	44	65	16,229
Exports	4	10	1,216	-	2	26	1,258
Mar. Bunkers	-	-	70	-	-	-	70
Stock Change	-160	210	144	1	2	-	197
Primary Energy Supply (incl non-energy)	**1,436**	**845**	**9,243**	**4,491**	**581**	**39**	**16,635**
Primary Energy Requirement (excl. non-energy)	**1,436**	**845**	**8,964**	**4,491**	581	**39**	**16,356**
Transformation Input	**1,046**	**674**	**3,615**	**2,811**	**38**	**58**	**8,242**
Public Thermal Power Plants	1,046	558	345	2,577	29	-	4,557
Combined Heat and Power Plants	-	7	6	233	9	-	255
Pumped Storage Consumption	-	-	-	-	-	45	45
Briquetting Plants	-	108	-	-	-	-	108
Oil Refineries & other energy sector	-	-	3,264	-	-	13	3,277
Transformation Output	**-**	**92**	**3,411**	**-**	**14**	**2,250**	**5,767**
Public Thermal Power Plants	-	-	-	-	11	2,061	2,072
Combined Heat and Power Plants - Electricity	-	-	-	-	3	160	163
Combined Heat and Power Plants - Heat	-	-	-	-	-	-	-
Pumped Storage Generation	-	-	-	-	-	28	28
Briquetting Plants	-	92	-	-	-	-	92
Oil Refineries	-	-	3,411	-	-	-	3,411
Exchanges and transfers	**12**	**-**	**-12**	**-**	**-304**	**304**	1
Electricity	-	-	-	-	-304	304	-
Heat	-	-	-	-	-	-	-
Other	12	-	-12	-	-	-	1
Own Use and Distribution Losses	**-**	**22**	**127**	**63**	**-**	**371**	583
Available Final Energy Consumption	**401**	**241**	**8,900**	**1,617**	**253**	**2,165**	**13,577**
Non-Energy Consumption	**-**	**-**	**279**	**-**	**-**	**-**	**279**
Final non-Energy Consumption	-	-	279	-	-	-	279
Total Final Energy Consumption	**380**	**280**	**8,534**	**1,659**	**253**	**2,294**	**13,400**
Industry	**125**	**-**	**950**	**596**	**139**	**686**	**2,496**
Non-Energy Mining	-	-	94	20	-	49	163
Food, beverages and tobacco	18	-	148	169	41	137	513
Textiles and textile products	-	-	7	0	-	7	14
Wood and wood products	-	-	3	4	88	28	122
Pulp, paper, publishing and printing	-	-	5	7	-	22	33
Chemicals & man-made fibres	-	-	37	101	-	104	243
Rubber and plastic products	1	-	11	5	-	34	51
Other non-metallic mineral products	106	-	250	54	10	73	493
Basic metals & fabricated metal products	-	-	300	184	-	47	531
Machinery and equipment n.e.c.	-	-	7	9	-	16	33
Electrical and optical equipment	-	-	75	34	-	130	239
Transport equipment manufacture	-	-	3	8	-	10	21
Other manufacturing	-	-	9	2	-	29	40
Transport	**-**	**-**	**5,552**	**-**	**56**	**5**	**5,612**
Road Freight	-	-	1,160	-	-	-	1,160
Road Private Car	-	-	2,126	-	56	-	2,181
Public Passenger Services	-	-	226	-	-	-	226
Rail	-	-	46	-	-	5	50
Domestic Aviation	-	-	43	-	-	-	43
International Aviation	-	-	929	-	-	-	929
Fuel Tourism	-	-	640	-	-	-	640
Unspecified	-	-	384	-	-	-	384
Residential	**228**	**280**	**1,231**	**669**	**44**	**733**	**3,185**
Commercial/Public Services	**26**	**-**	**550**	**394**	**15**	**822**	**1,807**
Commercial Services	26	-	359	173	12	589	1,159
Public Services	-	-	191	221	3	233	648
Agricultural	-	-	251	-	0	48	300
Statistical Difference	**22**	**-39**	**86**	**-42**	**-1**	**-129**	**-103**

Note: This is the "short" version of the energy balance. A more detailed "expanded" balance showing detailed sub-fuel data is available on the SEI website at http://www.sei.ie/statistics.

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