seai SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Energy Security in Ireland: A Statistical Overview

2011 Report

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September 2011

Sustainable Energy Authority of Ireland

The Sustainable Energy Authority of Ireland was established as Ireland's national energy authority under the Sustainable Energy Act 2002. SEAI's mission is to play a leading role in transforming Ireland into a society based on sustainable energy structures, technologies and practices. To fulfil this mission SEAI aims to provide well-timed and informed advice to Government, and deliver a range of programmes efficiently and effectively, while engaging andmotivating a wide range of stakeholders and showing continuing flexibility and innovation in all activities. SEAI's actions will help advance Ireland to the vanguard of the global green technology movement, so that Ireland is recognised as a pioneer in the move to decarbonised energy systems.

SEAI's key strategic objectives are:

- Energy efficiency first – implementing strong energy efficiency actions that radically reduce energy intensity and usage;
- Low carbon energy sources – accelerating the development and adoption of technologies to exploit renewable energy sources;
- Innovation and integration – supporting evidence-based responses that engage all actors, supporting innovation and enterprise for our low-carbon future.

The Sustainable Energy Authority of Ireland is financed by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union.

Energy Policy Statistical Support Unit (EPSSU)

SEAI 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 SEAI'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.

Acknowledgements

The authors wish to express their gratitude to those who provided data and analysis for this report and also to those who commented on previous versions of this report.

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Executive Summary

Ireland's import dependency in 2008 was 89% and 88% in 2009. This compares to an EU average of 55% in 2008. In 1994 Ireland's import dependency was 67% but it increased to 89% by 2001 and has remained at around 90% for the last decade. Increased energy demand, together with the decline of indigenous energy sources, especially in natural gas production at Kinsale since 1995 and decreasing peat production, led to the increase in import dependency.

Notwithstanding this high import dependence, analysis included in this report of Ireland's Supply/Demand index[1] for 2008 concludes that Ireland has the third best score when compared with the index scores of other EU Member States obtained for 2005. This is because most Irish energy imports are sourced within the EU or OECD countries. The results of the analysis of forecasts to 2020 highlight that Ireland's energy security is declining and it is expected to continue to do so due to the diminishing supplies of oil and gas in the EU and OECD.

Reliance on Oil

Oil accounts for just over half of primary energy consumption in Ireland (52% in 2009) and 60% of total energy imports. Ireland's oil dependence (as a proportion of primary energy supply) was fifth highest in the European Union in 2009. Transport is the largest end use of energy in Ireland, accounting for 41% of total final consumption in 2009. There is a 100% import dependence on oil for the transport sector.

Most oil imported into Ireland in 2009 (69%) was in the form of finished oil products (petrol/diesel/kerosene etc.). Oil product imports are primarily (89%) sourced from the United Kingdom. Irish oil product imports account for 23% of total UK refinery production. The UK also imports finished products from a wide variety of sources, with 43% sourced within the EU and 60% from OECD countries.

The remaining 31% of Irish oil imports in 2009 was crude oil for the refinery in Whitegate, Co. Cork. Over 80% of Ireland's crude oil imports were sourced within the EU and Norway in 2009, but there is a growing dependence on Libyan crude oil imports (from just under 1% in 2006 to 20% in 2009 and provisionally 23% in 2010). The UK imports crude oil from a variety of sources, with 65% from Norway, 8% from Russia, 5% from Nigeria and just less than 4% from Libya, in 2009.

Reliance on Natural Gas

The dependence on natural gas has increased from 15% of total primary energy in 1990 to 29% in 2009. Most natural gas used in Ireland is imported (93% in 2009). Electricity generation in Ireland relies heavily on natural gas, with over 60% of electricity generated in 2010 from natural gas. While gas from the Corrib gas field is due to come on stream in the next few years, there will still be a requirement to import gas to meet demand while the Corrib field is producing. The field is expected to decline within six years.

Indigenous Energy Sources

Indigenous production has decreased by 47% since 1990. Production of indigenous gas decreased by 78% over the period since 1990 and peat by 46%, while renewable energy in contrast increased by 150%. Renewable energy was responsible for 40% of indigenous production in 2009, peat was responsible for 38%, natural gas for 21% and the remainder was from non-renewable wastes.

Exploration

The number of wells drilled in the search for oil and gas off the Irish coast is currently very low, reflecting the perceived unattractiveness of Irish waters for mineral exploration. Of the 157 exploration wells that have been drilled since 1970, only 4 discoveries have been commercially exploited to date. In 2011 three on-shore licensing options were awarded in the North West Ireland Carboniferous Basin and in the Clare Basin to explore for shale gas. Further off-shore licensing options are due to be granted in 2011 as part of the Atlantic Margin Licensing Round.

Conclusions

Ireland relies heavily on fossil fuels (95% of total primary energy requirement) and has an 88% import dependence for all fuels. Diminishing supplies of oil and gas in the EU and OECD will impact on Irish energy security. Exploration to find indigenous sources of oil and gas is prudent; however, given to the lack of significant finds to date, there is also a requirement to diversify the fuel mix. Diversifying the fuel mix enhances energy security by reducing demand for imported fossil fuels and also the exposure to their variations in price. Other ways to enhance energy security include improving existing energy infrastructure, for example introducing more gas storage facilities and electricity grid upgrades and interconnection. The contribution from renewables and wastes is the only increasing indigenous energy source and was the most significant indigenous energy source in 2009. Transport energy is the least secure energy sector with almost exclusive dependence on imported oil products.

1 An internationally used energy security metric.

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1 Introduction

This report is the fourth in a series reviewing energy security in Ireland. It comes at a time when energy has become a focal point for governments and businesses alike. The complex interaction and trade-offs between the three pillars of energy policy (energy security, competitiveness and protection of the environment) requires a better understanding of energy security, informed by accessible data and analysis.

This report considers the issue of energy security holistically and allow stakeholders to respond in an informed manner. In aggregating and organising what is sometimes rather eclectic public data into one focused document the report is designed to provide a context for informed action and decision-making in the area of energy security. The complexity of this area of energy policy does not allow for simple solutions or measurement.

For an individual country or region, quantifying energy security is not trivial and there is very little consensus on what metrics should be used. The task is generally reduced to using simple metrics such as import dependency or fuel dominance. Criticism of these metrics includes that they are too narrowly focused and only capture specific aspects of energy security. There have been a number of efforts to carry out more detailed analysis with two useful developments being in portfolio optimisation for the electricity sector and the development of aggregated energy security indicators. In the case of the latter, these include indicators based on the Shannon index that captures diversity in suppliers in addition to fuel diversity, the Herfindahl-Hirschman Index, that incorporates market concentration of suppliers, and the supply demand (S/D) index developed by ECN.

A recent academic overview (Kryut et al., 2009) of energy security indicators distinguished four dimensions of energy security, namely; availability, accessibility, affordability and acceptability of energy, and then proceeded to classify indicators of energy security according to this four-dimensional classification. The paper concluded that there is no one ideal indicator and that applying multiple indicators leads to a broader understanding.

The metrics, or indicators, presented in this report address a wide range of issues relevant to the topic of energy security. They span a range from national to international concerns and across primary fuels and their conversion into energy services. As energy plays a vital role in society, underpinning all areas of economic activity, the economic impact of supply or price fluctuations can therefore be significant and widely felt.

This report is intended to inform debate and provide information to policy makers, energy market participants, investors, and the public. The first half of this report discusses general energy security concepts and reviews policy activity impacting on energy security and recent energy security developments, both international and in Ireland. The report then quantifies security indicators for the overall economy and by fuel. As part of the commitment to develop and improve energy security indicators, SEAI commissioned research for this report to update the supply/demand index of energy security. This analysis, included in the final section of the report, helps to improve our understanding of Ireland's energy security.

Energy data drawn from the national energy balance presented in this report are the most up-to-date at the time of writing. The energy balance is updated whenever more accurate information is known. To obtain the most up-to-date balance figures visit the statistics publications section of the SEAI website (www.seai.ie/statistics). An energy data service is also available at this website, by following the link to Energy Statistics Databank. This service is hosted by the Central Statistics Office with data provided by SEAI.

It should be noted that while SEAI reports on energy metrics and indicators of security, statutory authority for ensuring energy security lies elsewhere. The Commission for Energy Regulation (CER) has the statutory obligation for ensuring electricity and gas energy security in Ireland and the Oil Supply Division of the Department of Communications, Energy and Natural Resources and the National Oil Reserve Agency (NORA) are responsible for oil security and oil stocks respectively. These organisations along with EirGrid and Gaslink publish a number of reports that are important in providing a thorough overview of energy security in Ireland, including:

- Electricity security in Ireland - Commission for Energy Regulation (CER)
- Gas security in Ireland - CER
- GAS joint gas capacity report - CER & Gaslink
- Transmission development statement - Gaslink
- Generation adequacy report - EirGrid
- Transmission Forecast Statement - EirGrid
- Financial Statements - National Oil Reserves Agency (NORA)

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

2 Energy Security Concepts and Policies

Energy security is a varied and complex concept that relates to import dependency, fuel diversity, the capacity and integrity of the supply and distribution infrastructure as well as energy prices, physical risks, emergency and physical disruptions (storms, natural disasters, etc). Energy security is highly context dependent, differing across energy markets and energy market stakeholders, and has a temporal dimension (Chester, 2010). Security of supply is not maximising energy self-sufficiency or minimising dependance but aims to balance the risks linked to such dependence (European Union, 2000). A broad definition of energy security is used in this SEAI report.

The risks to energy security are strongly related to the availability of fuel supply and trends in energy demand. On the supply side, key variables include the size of the physical resources, robustness of infrastructure (electricity networks and gas pipelines), the feasibility (including political), the costs of extraction, geopolitical and weather events. The key variables on the demand side are economic growth, changing economic structure and price.

As already mentioned energy plays a vital role in society with energy prices impacting significantly on economic activity. Sustained high oil and gas prices are putting ever increasing pressure on global economies and their ability to deliver goods and services. This creates an incentive for governments to ensure that secure, reliable and competitively priced energy sources are readily available.

Figure 1 is an attempt to capture the multifaceted nature of energy security. At its simplest, energy security is supply meeting demand. However, there are many factors which can impact on both the supply and demand and thus energy security. The risks to physical energy availability are depicted on the supply side (see Fig 1) but can also impact on the demand for fuels if the access, or perceived access, to fuels is interrupted. Regulatory and policy decisions as well as management of natural resources also impact upon energy security.

Risks to energy security include uncontrollable risks such as natural disasters. The Japanese earthquake in March 2011 which ultimately led to the meltdown of a number of nuclear reactors is a recent example of this risk. Extreme weather events such as hurricane Katrina in August 2005, are also uncontrollable. Other risks such as terrorism (e.g. oil tanker hijacking), geopolitical tension (e.g. the conflict in Libya) and political tensions, which can lead to strikes, can all be mitigated through strategic alliances and negotiations. All risks to the components impacting the supply/demand energy balance eventually manifest in price. Price in turn affects demand and changes the investment climate.

Mitigation measures aimed at catastrophic accidents and environmental destruction can reduce related risks but due to costs they are often not implemented. Other risks include capacity constraints which may be an issue if there was a sudden increase in demand or when insufficient capacity has been developed to meet the demand. The investment climate is also significant; the recent global economic recession has impacted on investment in renewables for example and thus is slowing down the shift from fossil fuel dependence and the diversification of fuel sources.

One approach to examining energy security is to study the different energy sources (coal, oil, gas, and renewables), means of transformation (electricity, refineries) and transportation modes (grids, pipelines, ports, ships). All of these have risks of supply interruptions or failures, challenging the security of undisturbed energy supply. Examining energy security by fuel is the approach followed in section 5.

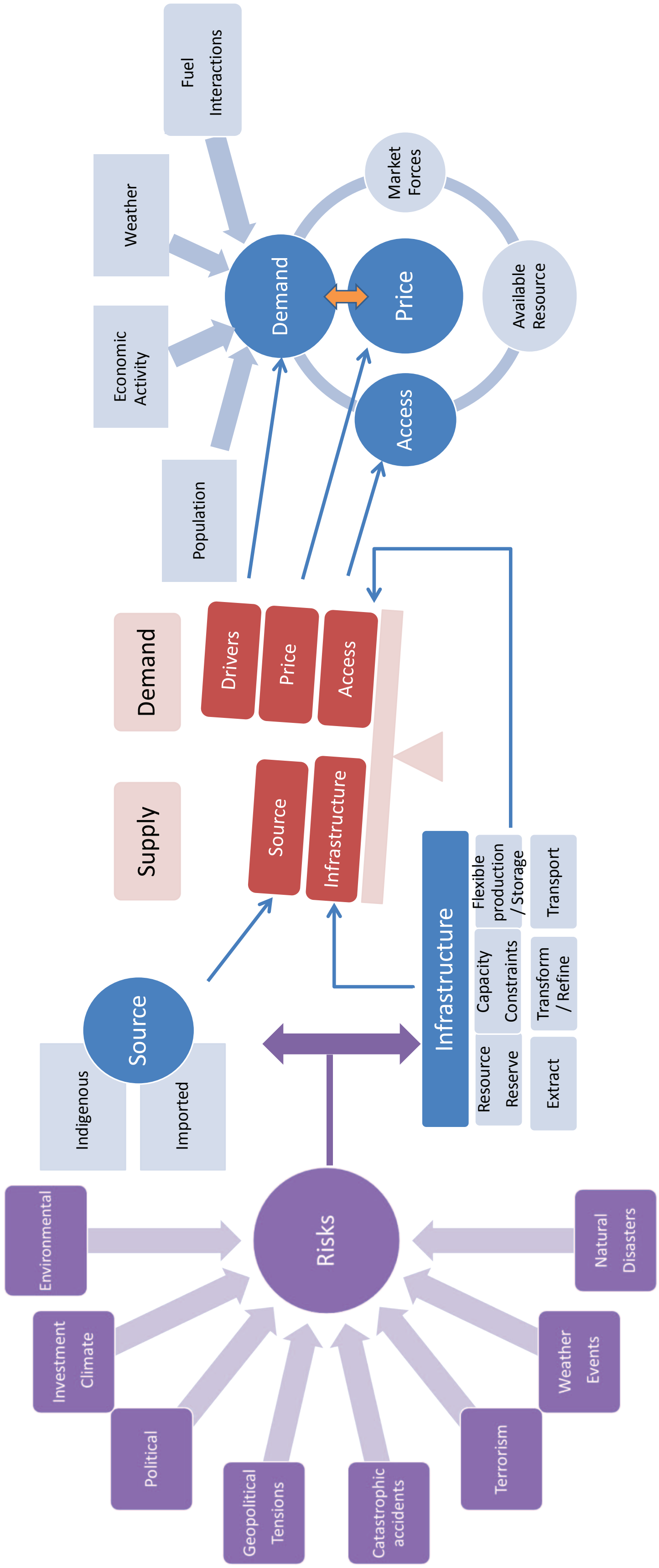
2.1 International Cooperation

The International Energy Agency was founded during the oil crisis of 1973-1974 with an initial role to coordinate response measures in times of oil supply emergencies. Ireland was a founding member of the IEA. Energy Security is described by the International Energy Agency (IEA)[1] as "the uninterrupted physical availability at a price which is affordable, while respecting environment concerns". The IEA expands on this definition saying "Energy Security has many aspects: long-term energy security is mainly linked to timely investments to supply energy in line with economic developments and environmental needs. On the other hand, short-term energy security is the ability of the energy system to react promptly to sudden changes in supply and demand." The IEA works towards improving energy security by:

- promoting diversity, efficiency and flexibility within the energy sectors of the IEA member countries
- remaining prepared collectively to respond to energy emergencies
- expanding international co-operation with all global players in the energy markets

1 http://www.iea.org

Figure 1 *Representation of energy security*



Source: SEAI

The International Energy Program (I.E.P. Agreement) requires IEA member countries to hold oil stocks equivalent to at least 90 days of net oil imports and to release stocks, restrain demand, switch to other fuels, and increase domestic production or share of available oil in the event of a major oil supply disruption. The IEA ranks energy security risks to oil with physical supply interruption due to extreme weather and unforeseen technical problems as the most common.

The IEA also works to ensure an affordable and clean energy future. It maintains that renewable energy sources will have a central role to play in moving the world onto a more secure, reliable and sustainable energy path and that energy efficiency offers a powerful and cost-effective tool for achieving a sustainable energy future. Both renewables and energy efficiency decrease reliance on imported fossil fuels, thus enhancing energy security.

2.1.1 European Union

While each member state is responsible for its own energy security, solidarity between Member States is a basic feature of European Union membership. European Union (EU) understanding of energy security can be garnered from various energy policy publication[2]. The EU underlines that energy efficiency and renewable energy sources are key priorities of EU energy policy, both for environmental and for security of supply reasons.

Member States must maintain a total level of oil stocks corresponding, at the very least, to 90 days of average daily net imports or 61 days of average daily inland consumption (2009/119/EC), whichever of the two quantities is greater. As oil is one of the European Union's main energy resources the purpose of this directive is to enhance oil security of supply in order to avoid or mitigate a crisis in this sector.

The EU published legislation on gas energy security (Regulation No. 994/2010) in December 2010 in an attempt to safeguard the security of the gas supply following lessons learned from the Russian-Ukrainian gas crises. The highest priorities are to diversify the supply routes and sources and to provide adequate liquid natural gas (LNG) supplies for Europe.

EU legislation on electricity (Directive 2005/89/EC) published in January 2006 establishes measures aimed at safeguarding security of electricity supply so as to ensure the proper functioning of the EU internal market for electricity, an adequate level of interconnection between Member States, an adequate level of generation capacity and balance between supply and demand.

Other recent EU policy documents such as *Europe 2020 initiative - Energy infrastructure priorities for 2020 and beyond: A Blueprint for an integrated European energy network* and *Towards a new energy strategy for Europe 2011 - 2020*[3], state that the increase in renewable energy sources and the improvement of energy efficiency are key policy aims as methods of enhancing energy security.

2.2 National Policy

The National Oil Reserves Agency Act 2007[4] established NORA as a State Agency under the aegis of the Department of Communications Energy and Natural Resources (DCENR) with responsibility for the holding of national strategic oil stocks. This Act came into effect on 1st August 2007.

The Commission for Energy Regulation (CER) holds the statutory obligation for electricity security of supply in Ireland. The legal basis for this is founded in Statutory Instrument (S.I.) 60 of the 2005 – European Communities (Internal Market in Electricity) Regulations 2005[5].

S.I. no. 697 of 2007, transposition of European Communities (Security of Natural Gas Supply) Regulation 2007, assigns overall responsibility to the Commission for Energy Regulation for monitoring and protecting the security of the Republic of Ireland natural gas supply.

The CER chairs the Task Force on Emergency Procedures (TFEP), which also includes representatives from the Department of Communications, Energy and Natural Resources (DCENR), Gaslink, Bord Gáis Networks (BGN), EirGrid and ESB Networks. This task force is responsible for ensuring that coordinated procedures are in place to manage a supply emergency on the gas and electricity systems, and that an emergency on one system does not lead to an emergency on the other.

2 European Union legislation is available at: http://eur-lex.europa.eu/en/index.htm
3 Available at: http://ec.europa.eu/energy/infrastructure/strategy/2020_en.htm
4 Acts of the Oireachtas are available at: http://www.irishstatutebook.ie/home.html
5 Statutory Instruments are available at: http://www.irishstatutebook.ie/home.html

The first TFEP report[6] (CER/07/195) was published in 2007 and included recommendations to enhance the existing arrangements and procedures, including:

- Giving EirGrid a role in the curtailment of gas supplies to power stations during a natural gas supply emergency, in order to mitigate as far as possible the impact on electricity supplies; and
- Requiring power stations to hold adequate stocks of secondary fuels and testing their ability to switch over to these secondary fuels in an emergency.

The Secondary Fuel Obligations Decision (CER/10/104) issued by the CER for power stations requires all baseload gas-fired power stations to hold five days of secondary back-up fuel and non-baseload gas-fired stations to hold 3 days of secondary back-up fuel . The Decision also gives EirGrid the power to regularly test the ability of gas-fired power stations to switch over to their secondary back-up fuel, and to inspect the level of secondary back-up fuel held on site (CER, 2010b).

The CER has formal monitoring and reporting arrangements in place with EirGrid as Transmission System Operator to examine the electricity security of supply in the short, medium and long term. The main components of this are monitoring fuel and other power sources, the balance between supply and demand and the electricity network.

Generation adequacy[7] is the capability of the power production capacity to supply the electricity demand on the system. The balance between the supply and the demand of electricity is quantified using a statistical indicator called the loss of load expectation (LOLE). The accepted generation adequacy standard for Ireland is eight hours' loss of load expectation per year.

Irish Government energy policy, as stated in the Energy White Paper published by the DCENR in 2007, seeks to increase energy efficiency and the use of renewables in line with EU and IEA energy policies, as a method of reducing dependence on imported fossil fuels and to diversify the fuel mix in Ireland.

2.3 Interaction with Environmental Objectives

Climate change mitigation objectives in energy policy are complementary with energy security objectives. Both seek increased fuel diversity and slow fossil fuel depletion rates. The Copenhagen Accord[8] (UNFCC, 2009), which was the outcome of the landmark UN conference on climate change held in Copenhagen in December 2009 (Conference of Parties COP15), set a non-binding objective of limiting the increase in global temperature to two degrees Celsius above pre-industrial levels.

Signals of climate change impacts are evident in Ireland. The Environmental Protection Agency (EPA) 2009 report *'A Summary of the State of Knowledge on Climate Change Impacts for Ireland'* (Desmond et al., 2009) states that the changes are in line with changes that are occurring at regional and global levels. They are expected to continue to increase in the coming decades and up to at least the end of this century. These include changes to key meteorological parameters such as average temperature, rainfall intensity and patterns, as well as ecosystem changes.

While the impact of climate change on energy use in Ireland requires more detailed analysis it is likely that the changes will impact on the generation and demand for energy. Seasonal changes will impact on the energy demand (for example an increase of use of air conditioning) and there may also be a change in resource availability for renewable generation (especially wind and hydro generation). An increase in storm intensity could also make supply interruptions, especially to electricity, more likely.

The EU Emissions Trading System (EU ETS), launched in 2005, effectively put a price on carbon emissions and demonstrated the possibility of capping and trading greenhouse gas emissions. It is a cornerstone of the EU's policy to combat climate change and a key tool for reducing industrial greenhouse gas emissions cost-effectively. Reducing greenhouse gas emissions is the best way to mitigate the worst consequences of climate change

6 Commission for Energy Regulation decision documents are available at http://www.cer.ie
7 EirGrid publishes an annual Generation Adequacy Report. Available at: http://www.eirgrid.com/aboutus/publications/
8 Available at: http://unfccc.int/documentation/documents/advanced_search/items/3594.php?rec=j&priref=600005735#beg

3 Recent Developments

Energy security is the focus of considerable current attention from governments and the media. The most recent developments affecting energy security are the global recovery in energy demand (as the world emerges from economic recession) that has occurred simultaneously with a tightening in oil supply due to political events in the Middle East and North Africa (MENA). These two factors resulted in a 36% increase in Brent crude oil prices from $80 / barrel in 2010 to $108 / barrel in January – April 2011. A second significant recent development was the increased growth of liquefied natural gas (LNG) capacity and unconventional gas supply from the USA that resulted in a decoupling of oil and gas prices in a number of regional gas markets, particularly America, but also the United Kingdom and Ireland.

Another development affecting energy security is the accident at the Fukushima nuclear plant in Japan following the earthquake and tsunami in March 2011. This has led to renewed debate surrounding the future role of nuclear power in the global energy mix. The IEA has expressed concern about the implications for the development of nuclear energy stating that *"investment in nuclear capacity may be delayed or deferred at least in the short-term and plants may be retired early due to the introduction of more stringent safety regulations... any slowdown in the development of nuclear capacity will have implications for energy prices, the overall fuel mix, climate change and investment."* (Tanaka, 2011). One of the visible impacts has been Germany's announcement at the end of May 2011 of its intention to phase out all nuclear power plants by 2022. Another nuclear energy development that impacts on discussion in Ireland is the cancellation in 2010 (Bazilian *et al.*, 2011) of the programme to develop a novel Generation IV Pebble Bed Modular Reactor in South Africa. Most nuclear power plants are too large to be readily incorporated into Ireland's relatively small power system. These modular reactors, however, were envisaged to be available at a scale more suited to the Irish power system.

There are important distinctions worth noting with respect to oil market and gas market development on the demand side also. As the global economy emerges from recession, oil and gas markets are starting to show important signs of recovery, but the impact of the recession was different on the two energy sources. Gas demand fell by more than 3% in 2009, double the pace of decline seen for oil. This highlights the use of oil primarily as a transport fuel, where consumption is relatively inelastic. Gas on the other hand, as a major industrial and power generation fuel, was fully exposed to the decline in industrial production seen in the recession. But common to both oil and gas is the dichotomy between OECD and non-OECD markets, with continuing growth in non-OECD regions, notably China, India and the Middle East, contrasting with weaker demand in OECD and Russia (IEA, 2011b).

3.1 Oil

Oil demand is driven by economic growth and as shown in Figure 2, the economic recession caused an overall reduction in global demand in 2008 and 2009. Demand increased, however, in non-OECD countries, driven by continued growth in transport activity. Total oil demand in 2010 increased to 86.7 million barrels per day (Mb/d)[9], surpassing the previous record of 86.3 Mb/d set in 2007 (U.S.E.I.A., 2011 a). Global growth continued in early 2011 and is anticipated to reach 89.2 Mb/d for the full year, corresponding to a projected GDP growth of 4.3% (IEA, 2011d).

Analysis from the IEA suggests that crude oil production from currently producing oil fields reached a peak in 2008 and will see a 75% decline in output by 2035 relative to 2009 levels[10]. Replacing this supply implies a need to produce over 50 million barrels per day from new oil fields (including those found but not developed and those yet to be found). This is equivalent to about four times the production capacity of Saudi Arabia, the world's largest oil producer (Tanaka, 2011). It would require rapid and significant investment and ambitious production rates to achieve this ambition. The rates of oil production required[11] have been challenged by oil depletion analysts in Uppsala University (Aleklett *et al.*, 2010; Höök *et al.*, 2009), and the Oil Depletion Analysis Centre in London (Miller, 2011).

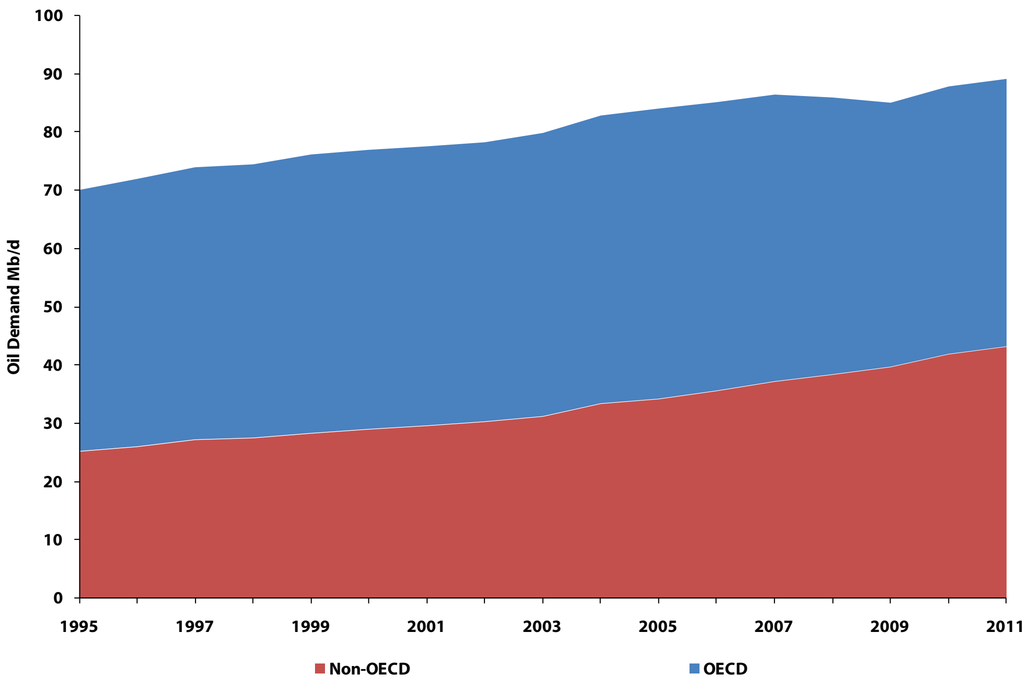
Another concern regarding future oil supply is that more than half of the new oil that has been discovered since the year 2000 is in deep water (IEA, 2010b). The disastrous events that took place at the Macondo well in the Gulf of Mexico in April 2010 have raised questions regarding the suitability of both procedures and technology associated with deep offshore drilling, which will certainly impact on timeframes and costs of oil production. This poses a challenge to the IEA projection in the 2010 World Energy Outlook of oil from deepwater fields growing from 5 Mb/d in 2009 to 9 Mb/d in 2035.

9 Mb/d = million barrels per day, calculated as the average daily oil demand (or supply). 1 barrel = 159 ℓ = 0.159 m^3 = 42 US gallons
10 See figure 3.19, page 122 of International Energy Agency, World Energy Outlook 2010
11 Measured in terms of oil field depletion rates, defined as the percentage of remaining reserves produced each year.

In addition to the required new 50 Mb/d of conventional oil supply, the IEA anticipates that a further 17 Mb/d of oil will come from unconventional oil (mainly from Alberta tar sands in Canada but also some coal to liquids, gas to liquids and oil shales) to meet growing demand[12] to 2035, anticipated to reach 96 Mb/d.

All of these projections require careful incorporation of geopolitical events that can have a significant impact on supply. Taking one country as an example, Libya exported 1.2 Mb/d in 2010. Since the outbreak of civil war in mid-February 2011, oil and gas production in that country has fallen by an estimated 60% to 90% (U.S.E.I.A., 2011b). Placing this in a global context, global oil demand grew by 2.8 Mb/d in 2010 and is anticipated to grow by 1.3 Mb/d in 2011. In terms of implications for Ireland, Libya's exports in 2010 included 14 kb/d to Ireland, which accounted for 23% of Ireland's crude oil imports (IEA, 2011a). For reference Ireland's total oil consumption in 2009 was 167 kb/d.

Figure 2 *Global oil demand 1995 - 2011*



Source: International Energy Agency

3.2 Gas

The major recent developments in gas supply are a) the notable expansion of unconventional North American gas and b) the growth of liquefied natural gas (LNG) gas capacity. Unconventional gas includes shale gas, coalbed methane, tight gas (from low permeability reservoirs) and methane hydrates (IEA, 2010b). Figure 3 shows where the different types of gas resources are found. Methane hydrates, not shown in Figure 3, are solid compounds containing methane trapped within water crystals found under sediments on the ocean floor.

The IEA estimates (IEA, 2010b) that proven resources amounted to 184 Tm^3 by the end of 2008[13] and that cumulative production (since gas production first started) by the end of 2009 amounted to about 90 Tm^3. Estimates for remaining recoverable resources of conventional gas amount to 404 Tm^3. The majority of these resources (both proven and remaining recoverable) are in the Middle East and Russia. Unconventional gas estimates (IEA, 2009), excluding methane hydrates, are estimated to be 900 Tm^3.

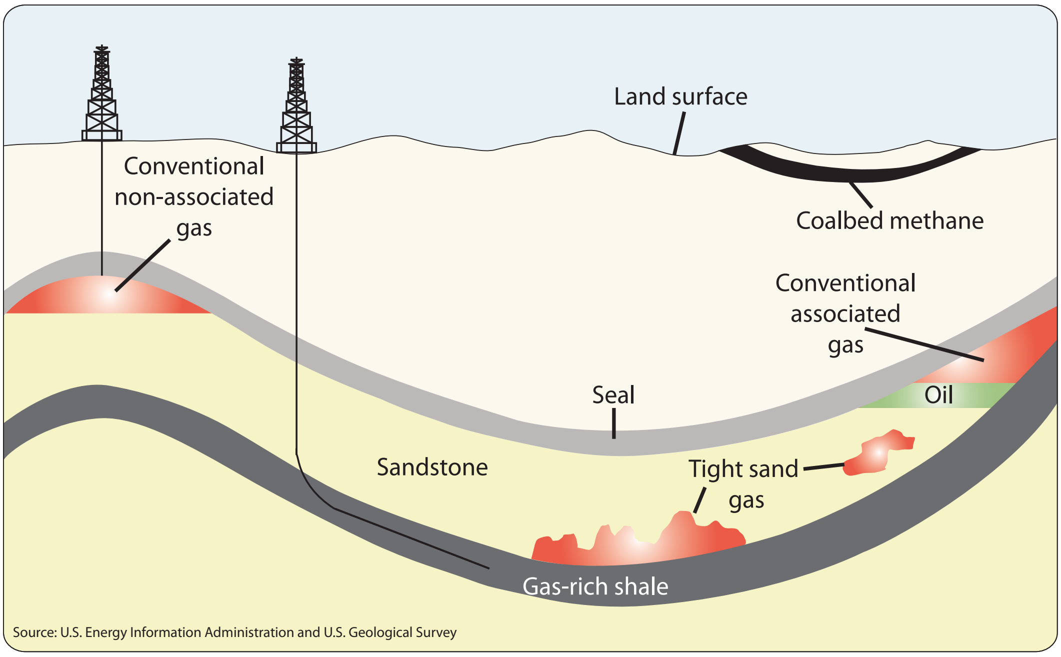
The production of shale gas in the USA rose from 12 Gm^3 in the year 2000 to 45 Gm^3 in 2009 (IEA, 2010b), reversing the downward trend on overall gas output. This largely eliminated the requirement for LNG imports into the USA and along with the global recession, contributed to a global surplus gas supply.

12 The projected 96 Mb/d demand is contained in a *New Policies Scenario*. This scenario takes account of the broad policy commitments that have already been announced by governments

13 Natural gas is generally discussed in volumetric terms as multiples of cubic metres and typically has a calorific value of 36 MJ/m^3

The other key development impacting on gas security is the increase in capacity and production of LNG, which has the distinct advantage of being readily transportable by ship, removing some of the constraints of pipeline gas. Preliminary figures (IEA, 2011e) show that global trade shot up to 220 million tonnes (300 Gm³) in 2010, a 20% increase from 2009. The main supplier of LNG is Qatar, while demand is primarily coming from Asia and Europe. As well as trade increasing last year, a number of new LNG projects were under construction everywhere from Angola to Algeria, but most notably in Australia, which will start producing significant supplies over the medium term.

Figure 3 *Schematic geology of natural gas resources*



Source: U.S. Energy Information Administration and the U.S. Geological Survey

The EU faced its 'worst ever gas-supply crisis' (IEA, 2009) in January 2009 when Russia interrupted gas flows through Ukraine during a dispute about the price of gas, transit fees and outstanding debts. The disruption was initially 110 million cubic metres per day (Mm³/d) and increased over the first week in January. On January 7, all gas transit through Ukraine was halted, causing the loss of 300 – 350 Mm³/d to the rest of Europe, at a time of very high demand, as it happened during the coldest weather conditions in two decades in Western and Central Europe. European gas companies drew down gas from commercial storage, secured supplies from Russia via alternative pipeline routes and from LNG. Cross-border flows within Europe were severely disrupted (except those from the UK) and countries with low resilience (poorly equipped with storage and other emergency arrangements, notably in Eastern Europe) were severely affected. The Nord Stream gas pipeline that will connect Russia directly to Germany (bypassing Ukraine) is currently under construction with the first pipeline due to be completed in 2011 and the second in 2012.

3.2.1 Corrib Gas Field

According to the IEA (IEA, 2011c), the Corrib gas field is expected to start commercial production in 2012/13. Corrib gas production is anticipated to meet 73% of Ireland's annual demand in this first year. The production profile is quite short, however, and is expected to decline within 6 years of its commencement. Initial peak production of Corrib is forecast to be 9.5 Mm³/d in 2013 but production is expected to decline to 4.2 Mm³/d by 2018/19. This compares with 2009 annual demand of 14 Mm³/d.

3.2.2 Gas Storage

Ireland has one gas storage facility - off the south west coast at Kinsale. This facility has the capacity (depending on the levels of gas held in storage at any given time) to supply 48% of protected customers for up to 50 days, which equates to 10% of annual demand. The Kinsale facility currently has a working volume of circa 218 million cubic metres (Mm³), which is equivalent to approximately 4.2% of Ireland's annual gas consumption in 2009. It has a maximum withdrawal rate of 2.5 Mm³/day and a maximum injection rate of 1.6 Mm³/day. Gas imports from Great Britain are used to refill the storage facility at Kinsale in addition to site production. The operator of the facility is currently examining the feasibility of developing additional storage at the site.

Islandmagee Storage Limited (formerly Portland Gas NI Ltd) proposes to develop a 500 Mm^3 salt cavity storage facility under Larne Lough (CER *et al.*, 2010). The company has completed seismic testing and successfully submitted a planning application to the relevant authorities in Northern Ireland. Islandmagee Storage plans gas operations to commence in 2015.

BGE (NI), a subsidiary of Bord Gáis and Storengy, have established the North East Storage project[14], to determine if there are subterranean salt layers present to the southwest of Larne, which could potentially be used for underground natural gas storage. A seismic survey and analysis of survey data were completed in early 2010 and a test drill was carried out in early 2011 to complete the technical feasibility stage of the project. The initial results have indicated that suitable subterranean salt layers are present approximately 1500m (one mile) below the surface.

3.2.3 Shannon LNG

Shannon LNG (IEA, 2011c) proposes to construct the country's first LNG terminal in the Shannon estuary. This project has received full planning permission. In December 2009, the terminal developers received the authorisation from the Commission for Energy Regulation (CER) to construct a gas pipeline, which will connect the proposed LNG terminal to the national gas grid. This project is expected to be developed on a phased basis. The facility is expected initially to have a maximum output of 10.7 Mm^3/day with output reaching 26.8 Mm^3/day at maximum production. Phase 1 of commercial operations is expected to commence in 2015/16. The LNG project has the potential to add diversity to Irish gas supplies.

3.3 Energy Prices

According to the IEA, 'the age of cheap energy is over' (Tanaka, 2011) and the oil price changes over the past 10 years as shown in Figure 4 illustrate this point. Since 2000, oil prices grew steadily and since 2004 have not returned to the cheap $30 per barrel. Oil prices post 2005 were driven by rapid economic growth in China and India in particular, without an accompanying rise in supply, and then peaked in July 2008 at more than $140 per barrel. The extent to which the oil price rise contributed to the global economic recession in 2008 and 2009 has not been quantified. The effect of the recession on oil prices is, on the other hand, clearly visible in Figure 4, with the dramatic reduction in price (to as low as $34 per barrel in December 2008) due to falling oil demand. From mid 2009 to mid 2010, oil prices were relatively stable at $70 - $80 per barrel.

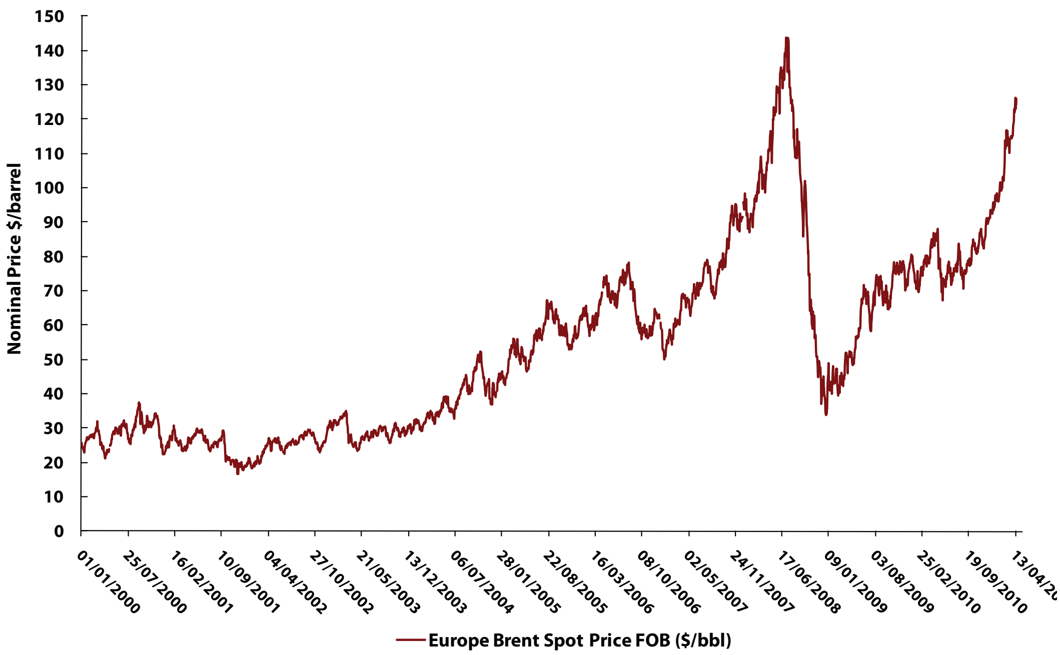
As previously mentioned, economic recovery, together with tightening of oil supply, have led to a significant price increase since October 2010 and oil has remained above $100 per barrel since February 2011. This increase in oil prices now poses a threat to a fragile global economy. The IEA maintains that spikes in the price of oil have played a role in each global recession since the early 1970's (Birol, 2011).

Another factor that contributes to oil price trends is financial market speculation. The debate regarding its role vis-à-vis the role of market fundamentals (i.e. supply and demand) can be polarised at times. The IEA view is that the key determinant of oil prices over time is the fundamentals, while clearly other factors (including speculation but also government policies, geopolitical events, etc.) can play a role in influencing short term price trends (IEA, 2011b).

There is evidence from other research to support this view. Kaufmann and Ullman (2009) conclude (from analysis of a causal relationship between the prices for the ten crude oils) that the rise in oil prices towards the end of the sample period (March 2008) was generated by both changes in market fundamentals and speculation. They were not surprised by this result. Increasing demand along with stagnant levels of non-OPEC production changed the supply/demand balance in a way that required higher prices to clear the market. This change in market fundamentals was recognized by speculators, who felt that ongoing changes in fundamentals would raise prices further, and took positions accordingly. The increase anticipated by prices set on the futures market was eventually transmitted to the spot market, which drove prices beyond levels justified by the existing supply/demand balance.

14 North East Storage project website http://www.northeaststorage.com/web/index.php

Figure 4 *European crude oil spot prices 2000 - 2011*



Source: U.S Energy Information Agency 2011

Traditionally gas prices have been coupled to oil prices and even now nearly half of OECD gas demand is priced directly off oil, with varying time lags and linkages. In 2009, as oil prices increased, these markets, including Japan, Korea, and most of continental Europe saw prices averaging about $9/Mbtu[15]. In North America and the United Kingdom (and hence also Ireland), prices averaged less than half this level, on an energy basis around one-third that of oil (IEA, 2011b). This resulted in gas prices in Ireland being lower than the EU average during 2009 (SEAI, 2010b). In 2010, this situation changed however, as gas prices in the USA and UK decoupled, with USA prices remaining low and UK prices increasing and realigning with European prices, as LNG imports into Europe increased steadily (EC, 2010c).

Looking ahead, the number of rigs drilling for natural gas in 2011 in the USA is lower than in 2010, due to more rigs being directed to oil because of the large price disparity between the two fuels on an energy equivalent basis. In addition, Japan is expected to have a higher demand for LNG as a replacement fuel for electricity generation due to the reduction in nuclear power production. Both of these factors will force upward pressure on global LNG prices and hence on the price of gas in Europe (U.S.E.I.A., 2011a). In the UK, LNG accounted for 48% of gas imports in 2010 (UK DECC, 2011) indicating that gas prices are set to increase in Ireland also.

Energy prices are also affected by carbon prices, depending on their carbon content (coal prices per kWh are affected more than gas). To date carbon prices have remained too low to impact significantly on energy prices and fuel choices but are providing a signal of what may come. Ireland's carbon tax of €15/t CO_2 that was introduced in 2010 increased petrol prices by 4.2c per litre (≈ 3%). This compares with a price increase due to crude oil price changes of approx 40% over the two year period from April 2009 – April 2011.

Emissons prices in turn have been affected by the economic recession. The EU and New Zealand currently have cap and trade systems in place, in which a carbon dioxide (CO_2) emissions cap is set for a particular period and trading of CO_2 emissions allowances is established. More than 12,000 power plants and manufacturing sites are involved within the EU emissions trading scheme (ETS) 2008 – 2012. In 2010 the verified emissions from these sites were 3% higher than 2009 levels, but still remained below pre-recession levels (in 2009 there was an 11.6% reduction in ETS emissions due to the economic downturn) (EC, 2011). The impact on prices has been strong, reducing from €25/t to €8/t CO_2 in early 2009 (EC, 2010a) and remaining low (in the range €10/t - €15/t CO_2) between March 2009 and April 2011 (ICE Futures Europe, 2011). This means the costs associated with meeting the EU 20% emissions reduction target have fallen, with projections of EU ETS carbon prices of €16/t CO_2 by 2020. This weakened price signal is unlikely to deliver the objective of transforming the EU to a low-carbon economy, prompting discussions to increase to a 30% emissions reduction target by 2020 relative to 1990 levels. This is anticipated to increase the price of carbon to €30/t CO_2 by 2020 (UK Climate Change Commission, 2011).

15 1 Mbtu (million British Thermal Units) = 293 kWh

Looking further ahead, the IEA estimates that in order to achieve emissions reduction consistent with a 450 ppm CO_{2equiv} scenario, the ambition required is greater and the price of carbon in the power sector should reach \$45/t CO_2 by 2020 and \$120/t CO_2 in 2035 (IEA, 2010b). In this scenario oil demand in 2035 is dampened to 81 million barrels per day (Mb/d), compared with 96Mb/d in the New Policies Scenario. The price of crude oil as a consequence of this lower demand is projected to be \$90/barrel in 2035 compared with \$113/barrel in the New Policies Scenario. This is not the full story however, as the impact in 2035 of the \$120/t CO2 carbon price is to add a further \$44 (Tanaka, 2010) to each barrel of oil, raising the effective price of crude oil to \$134/barrel, which is now higher than in the New Policies Scenario. In this way climate change policies can reduce the demand for oil, hence increasing security of energy supply and at the same time increase the price. If a clear climate policy is in place however, the price signal is quantifiable and not as volatile as the oil price dynamic.

4 Energy Security and Competitiveness in a Rapidly Changing World

The Sustainable Energy Authority of Ireland co-hosted a seminar on energy security and competitiveness on June 13th 2011. The seminar was jointly organised with the Association for the Study of Peak Oil (ASPO), with assistance from Forfás and the Chief Scientific Adviser to the Government. The objective was to refresh analysis on the interplay between energy supply and price prompted by the rise in oil prices, a reflection of profound geo-political changes arising from increased energy demand in China and India, as well as threats on the supply side caused by the on-going turmoil in the Middle East.

The speakers included:

- Pat Rabbitte T.D., Minister for Communications, Energy and Natural Resources
- Richard O'Rourke, Association for the Study of Peak Oil and Gas (ASPO)
- Katrina Polaski, Head of Low Carbon Technology, Sustainable Energy Authority of Ireland (SEAI)
- Fergus Cahill, Irish Offshore Operators Association
- Peter Clinch, Professor of Environmental Economics, University College Dublin

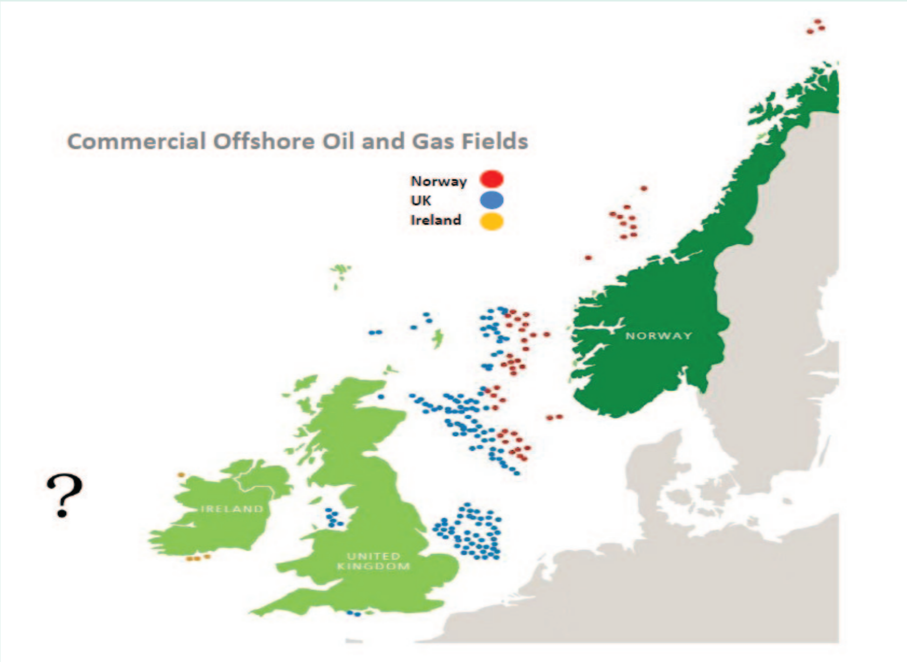
The analysis in this Energy Security 2011 report was presented at the conference by Katrina Polaski of SEAI. The following are summaries of the presentations by the invited speakers at the conference. The entire proceedings are available as video presentations on the SEAI website[16].

4.1 Exploration and Production Offshore Ireland: Are We Competitive?

Fergus Cahill, Irish Offshore Operators Association (IOOA)

The ultimate in energy security is to have indigenous production of major primary energy sources. For Ireland, these are oil and gas. However, we have no oil and very little gas production. We should therefore be striving to accelerate discovery and production of oil and gas off our coasts. To attract exploration our approach must be competitive. So far that has not been the case. Exploration has been at a very low level for the past thirty years. Only one significant commercial find, Corrib, has been made. A licensing round in 2009 attracted only two applications. Membership of IOOA has fallen from 17 companies to 8 over the period.

Figure 5 *Commercial offshore oil and gas fields*



Source: Irish Offshore Operators Association

16 http://www.seai.ie/News_Events/Previous_SEAI_events/Energy_Security_and_Competitiveness_June_13_2011/

Only 3% of Ireland's offshore area is under licence, with many licences being returned to the Government. This is despite relatively favourable fiscal terms and estimates of potential for substantial reserves by the DCENR. Our fiscal terms are often compared negatively with those of Norway. This comparison is invalid. The North Sea has been a prolific petroleum province for 50 years, with thousands of exploration wells and hundreds of producing fields (see Figure 5). We should compare ourselves with areas of low success, such as France, Spain and Portugal, which in fact have fiscal terms quite similar to ours.

The low level of exploration in Ireland results from a number of factors. Firstly, the discoveries expected following the award of licences under the 1975 terms did not materialize, nor have they done so since then. This has significantly weakened interest in the area. Secondly, because of lack of infrastructure, deep water and harsh weather, costs offshore Ireland are high. Thirdly, the difficulties encountered by the Corrib project have not gone unnoticed.

What is to be done?

Much is being done at this time. The Department of Communications, Energy and Natural Resources (DCENR) has devoted considerable efforts towards promoting the Irish offshore internationally. A large area has been released for licensing and a new "option" licence has been introduced, designed to attract new entrants, particularly smaller companies. Recent statements have shown that the importance of developing our oil and gas resources is fully appreciated. All of the above is reflected in the success of the recent Atlantic Margin Round, which attracted 15 applications, a marked improvement on previous rounds.

However, if we are to maintain the momentum, we must learn from the Corrib experience. Corrib will not be in production before 2013; that is 17 years from discovery. The giant Ekofisk Field, which transformed Norway's situation, was discovered in 1969 and came on stream in 1972, three years later. Ireland needs a transparent, robust and legally binding regime for field development, so that all stakeholders have a clear understanding of the issues involved and how they are to be addressed. A single well offshore the west coast can cost up to €50 million, with no guarantee of success. If the industry is to risk these large sums, there must be the assurance of a reasonably predictable field development process.

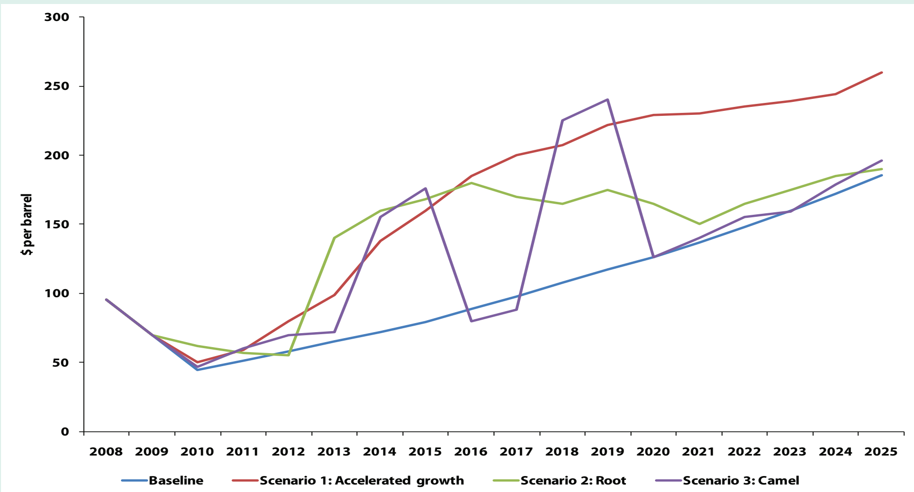
Success offshore would deliver tax revenues measured in billions, increased employment and economic development. The signs are that we are now on the road to competitiveness. The members of IOOA are intensifying their exploration efforts and, with the new licensees, a great deal of hard work, substantial investment, and no little luck , will deliver the results for which we are all hoping.

4.2 The Economic Impacts for Ireland of High Oil and Gas Prices

Dr. Andrew Kelly, AP EnvEcon and Prof. Peter Clinch, University College Dublin

The macroeconomic impacts for Ireland of three oil and gas price scenarios for the period from 2010 to 2025 were examined against a steady baseline scenario of more moderate change. It is important to point out that scenarios rather than forecasts are modelled, although our extreme scenarios are generally in line with the upper bounds of defined international forecast ranges. The scenarios modelled are shown in Figure 6.

Figure 6 *Oil price growth scenarios modelled*

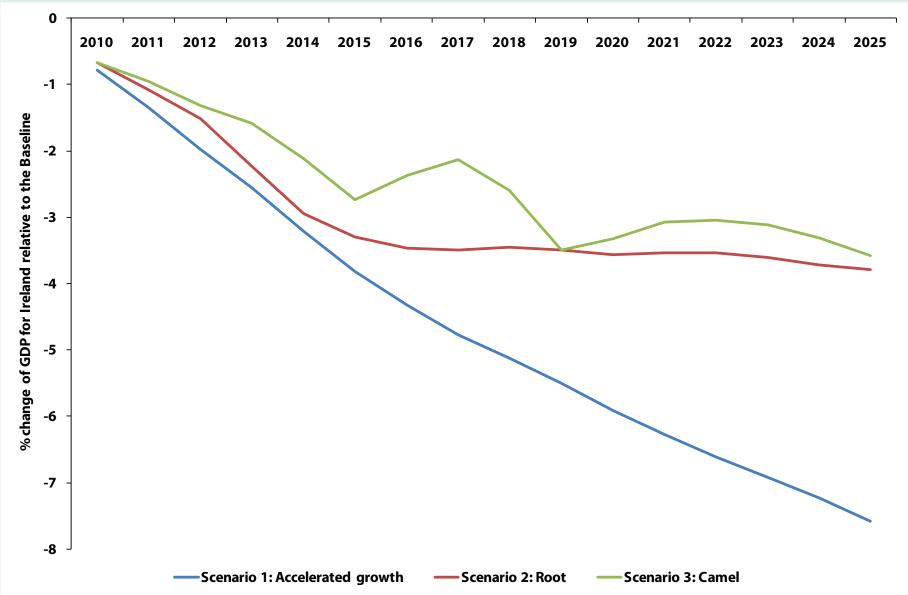


Under the baseline scenario, real oil and gas prices rise slowly to a real price of $\$100_{2008}$ in 2025. In contrast, under the three analytical scenarios used for this study, real prices take alternative paths to more rapid highs of as much as $\$175_{2008}$ in 2019. Thus we have considered the challenges Ireland may face should oil and gas prices evolve on more aggressive pathways with rapid sustained increases or a variety of other severe shocks.

By way of a methodological overview, the approach taken was to model and quantify the impacts of high oil and gas prices on an international scale, and then to feed these outcomes and conditions into a national scale modelling exercise to determine comparable impacts in an Irish-specific context. The outcomes of this part of the study included quantified macro-economic modelling results of the impact of the scenario price levels at an Irish and international scale – specifically focused on indicators such as GDP, employment and inflation.

The economic impacts of high oil and gas prices for Ireland are particularly unfavourable, with GDP falling between 3.5% and 7.5% below the baseline growth level in 2025 under the scenarios (see Figure 7). These impacts on growth levels are derived indirectly from associated changes in inflation and interest rates, and unfavourable changes in demand and international trade. These events have a large impact on Ireland as a small open economy that relies strongly on international trade and investment. For this reason also, we would not expect these impacts to be ameliorated by national action alone, as, even if Ireland could somehow avoid high domestic energy prices, it is the depressed growth and consequently reduced demand from our trading partners that would impact most negatively on the Irish economy. The results suggest that actions and efforts to mitigate exposure to high oil and gas prices at the international level, and not just domestically, are of significant importance to Ireland. This lends further weight to the merits of international actions to reduce energy intensity and diversify energy mix and associated exposures.

Figure 7 *Impact on GDP of high oil and gas prices for Ireland*



The modelled results are supplemented by a qualitative analysis of additional impacts and outcomes that could be expected in the Irish case but were not explicitly or implicitly captured in the macroeconomic modelling exercise, including:

- Distributional impacts
- Energy & fuel poverty
- Mobility reduction
- Price volatility
- Competitiveness
- Energy import Cost

In summary the report highlights a significant and costly exposure within Ireland and our trading partners to oil and gas price shocks of the nature evaluated. Certain national costs and societal impacts may be mitigated where energy provision is diversified to allow for power generation from a reliable and comparatively lower-cost mix of alternatives. The principal question to be addressed, however, remains the specific strategy taken for future energy needs and the appropriate speed and scale of investment. Note: This contribution is based on work led by AP EnvEcon Limited in cooperation with the ESRI and funded by Siemens Ireland. The original report, commissioned by Siemens Ireland, is available at:

http://www.siemens.ie/_documents/siemens_oilgas_report.pdf

4.3 Energy Security and Competitiveness: The International Context

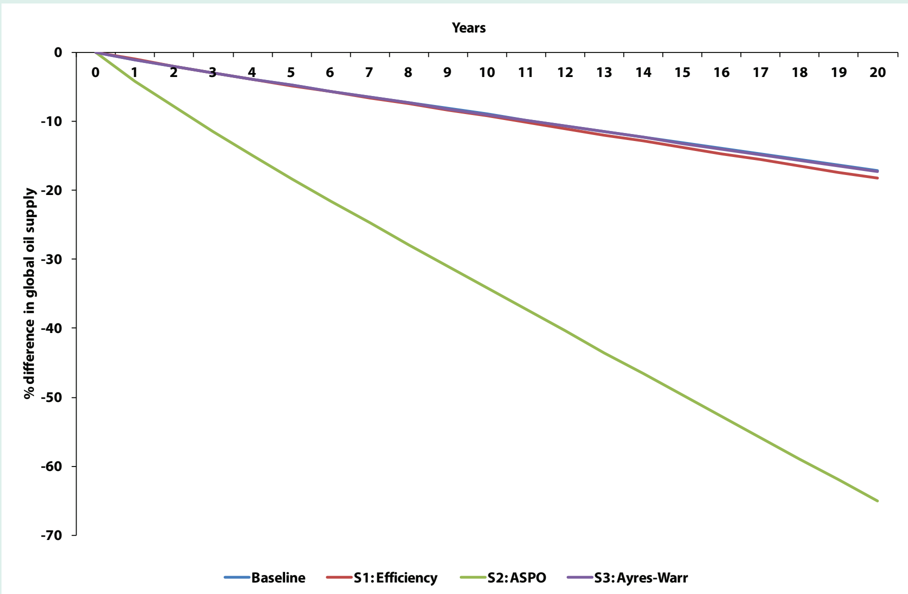
Richard O'Rourke, Director, The Association for the Study of Peak Oil and Gas (ASPO) Ireland

Interest in the subject of energy security tends to rise and fall with the price of oil, and is traditionally thought of in terms of strategic storage as a buffer to the ill-winds of geo-politics. Dr. Colin Campbell's publication in 1997 of his book, *The Coming Oil Crisis*, re-ignited a heated debate kicked off by M. King Hubbert in the Fifties and that surfaced again during the oil crises of the Seventies, on when a peak in global oil production might occur, and whether it would be determined by a maximum in supply or demand. While Dr. Campbell[17] argued that a supply-driven peak could occur within a decade, others argued that it wouldn't happen before 2030, and then would be due to a demand-side transformation away from oil. That the Chief Economist at the International Energy Agency, Dr. Fatih Birol, has publicly stated (April 2011, ABC interview) that conventional oil production peaked in 2006 and national governments should have started preparing a decade ago suggests that once again (as also happened with the climate change crisis and the bank asset bubble) in the face of an enormous risk management challenge, we have mis-spent far too much effort on waiting for greater certainty and not enough managing the down-side risk.

It is timely then, if a decade tardy, that the International Monetary Fund (IMF) published a chapter in the April 2011 edition of its World Economic Outlook (WEO) dedicated to considering different oil supply scenarios and their impact on the global economy. The IMF took their standard economic model (GIMF) and considered a baseline scenario in which oil supply grows by only 0.8% per annum versus Business-As-Usual (BAU) of 1.8% per annum. It then considers 3 additional scenarios (as shown in Figure 8):

1. Greater substution away from oil: the economy gets more efficient faster, dampening demand in the face of tighter supplies (Scenario 1: Efficiency)
2. Greater decline in oil production: production drops by 2% pa (-3.8% vs BAU) (Scenario 2: ASPO)
3. Greater economic role for oil: oil is far more important to the economy than conventional neo-classical models assume (Warr and Ayres, 2010) (Scenario 3: Ayres-Warr)

Figure 8 *Global oil supply (% difference)*

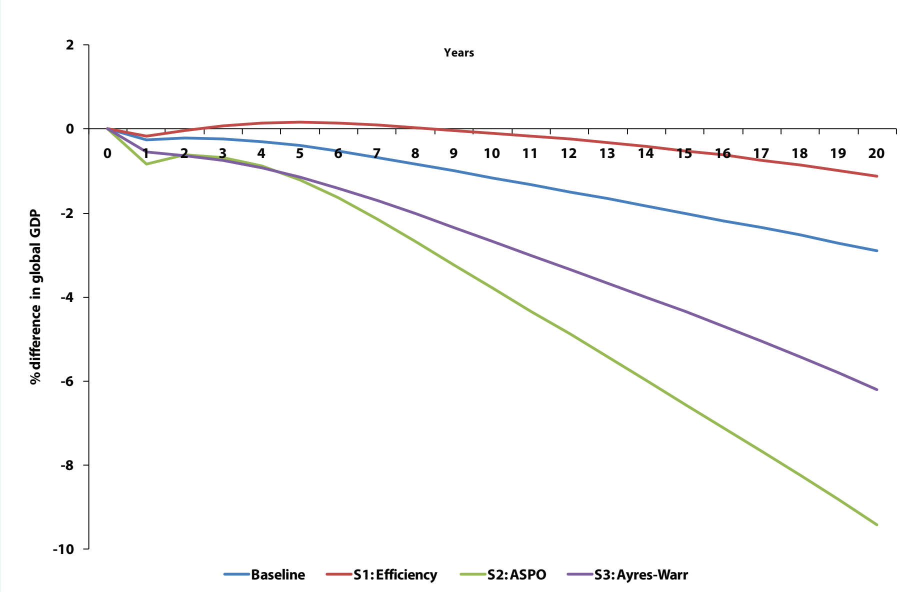


Source: IMF, World Economic Outlook, 2011

The IMF did not consider the scenario which combines 2 and 3, which is also very possible. Scenario 2 is, as expected, highly damaging to the global economy. In all scenarios, reflecting the very inelastic nature of oil demand, even a small shortage causes a spike in oil price and depresses economic activity (see Figure 9). It is worth adding that a report commissioned by Siemens into the impact of higher oil prices on the Irish economy (Siemens, 2010) found that Ireland is more exposed than most to these risks.

17 Dr. Colin Cambell is the founder of the Association for the Study of Peak Oil (ASPO)

Figure 9 *Global real GDP (% difference)*



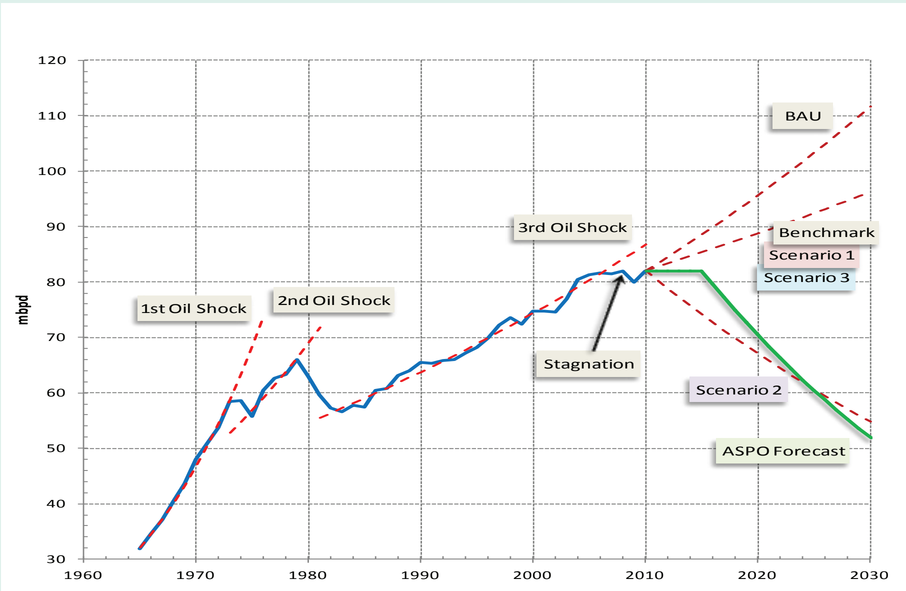
Source: IMF, World Economic Outlook, 2011

The IMF make two broad policy recommendations, one short term, the other long term:

- Develop policies to deal with the risk of an early onset of decline (resilience)
- Develop policies to reduce dependence (transformation)

While a considerable amount of work has been and is being done on the latter, largely driven by the response to climate change, virtually nothing is being done about the former, which therefore represents an enormous risk and challenge to achieving the latter. Somewhat counter-intuitively, at greatest risk in the short term is our already precarious banking system. Having a system resilient enough to withstand further shocks, should they arise, needs to be the focus of attention. We've already lost a decade, we've little time to prepare the risk management plan necessary, we cannot start soon enough.

Figure 10 *Global oil market developments - world oil production (million barrels per day)*



Source: IMF, World Economic Outlook, 2011 & ASPO, 2011

5 Energy Security Metrics

In this report energy security metrics are evaluated in the following categories:

- Overall Economy
- Fuel
- Exploration

Many of the metrics are included in the annual Energy in Ireland reports but are repeated here for their specific relevance to energy security.

5.1 Energy Security Metrics - Overall Economy

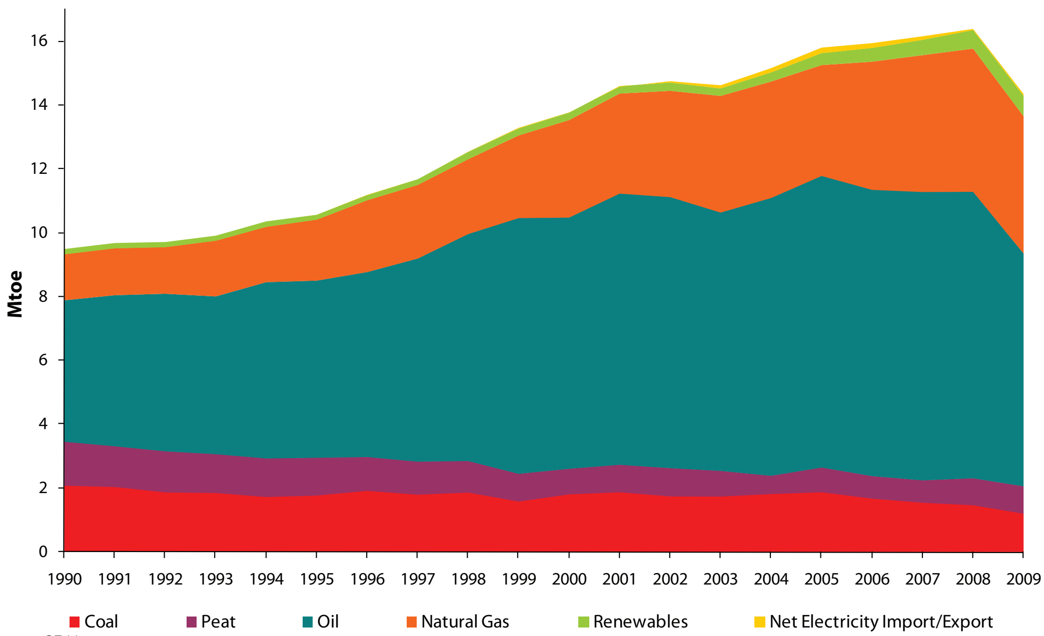
5.1.1 Supply

Total Primary Energy Requirement (TPER) is the barometer used to gauge movements in energy supply. Ireland's total energy supply (gross energy consumption) is examined in Figure 11. TPER is defined as the total amount of energy used within Ireland in any given year. In Ireland the TPER is largely driven by demand as a result of economic growth. The reduction from 2008 to 2009 reflects reduced demand due to the recession.

TPER 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. Greater efficiency of transformation will improve energy security as the requirement for energy products is reduced.

Figure 11 illustrates the trend in energy supply over the period 1990 to 2009, emphasising changes in the fuel mix. Primary energy requirement in Ireland in 2009 was 14.9 million tonnes of oil equivalent (Mtoe). Over the period 1990 – 2009 Ireland's total annual primary energy requirement grew in absolute terms by 57% (average annual growth rate of 2.4%). In 2009 Ireland's primary energy requirement decreased by 9.3%.

Figure 11 *Total Primary Energy Requirement (TPER) 1990 - 2009*

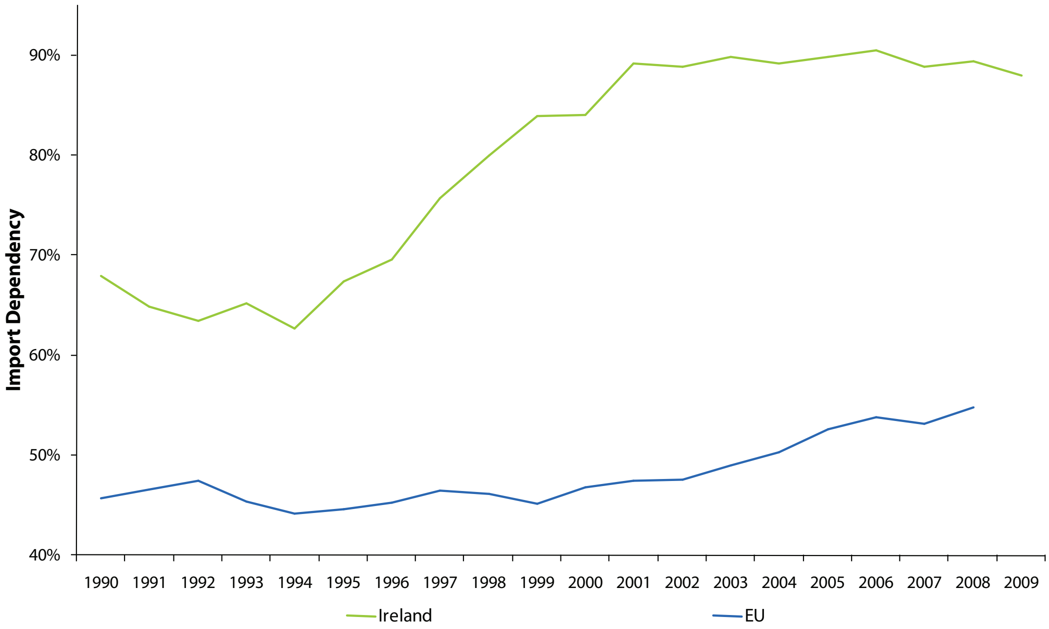


Source: SEAI

5.1.1.1 Import Dependency

Since the mid-1990s import dependency has grown significantly, due to the increase in energy use across all sectors but particularly in transport. This increase in demand together with the decline in indigenous natural gas production at Kinsale since 1995 and decreasing peat production has led to the increase in import dependency. Figure 12 illustrates the trend in import dependency since 1990 compared to that of the European Union. Domestic production accounted for 32% of Ireland's energy requirements in 1990 but in 2009 that had reduced to 11%, resulting in Ireland's import dependency being at 89% in 2009.

Figure 12 *Import dependency of Ireland and the EU 1990 - 2009*

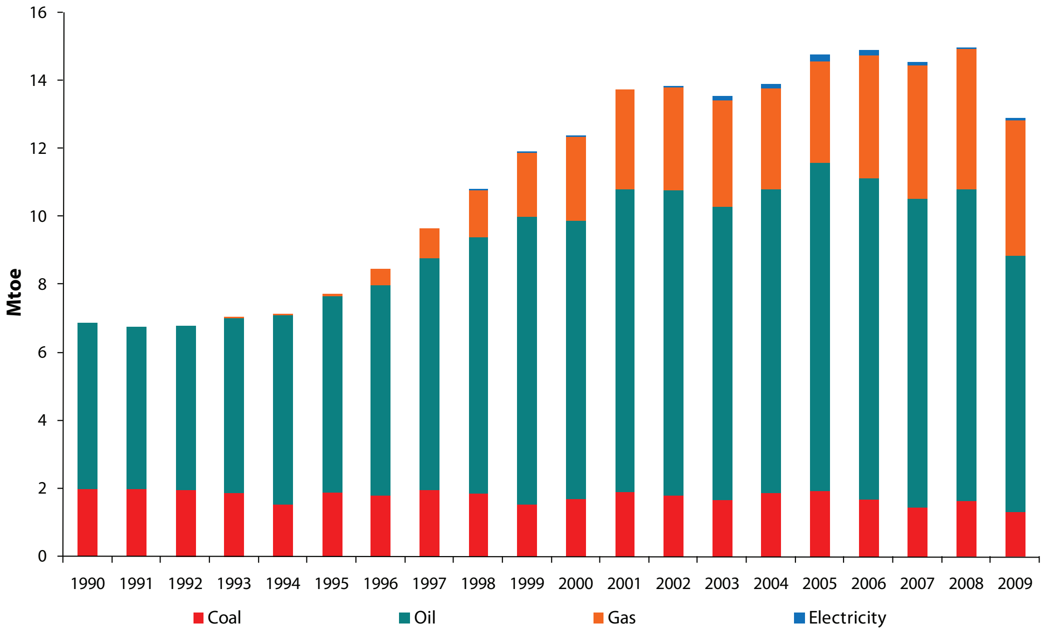


Source: SEAI

Figure 13 shows the trend for net fuel imports (imports minus exports) over the period 1990 to 2009. Imports peaked in 2008 and there was an 11% decrease in 2009. The growing dependence on oil due largely to increased energy use in transport is the most striking feature. Total net imports nearly doubled (96%) over the period with a 86% increase in net imports of oil to 2008. Oil imports fell by 12% in 2009.

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. This is largely the result of increased usage of gas in electricity generation. Coal imports have remained stable over the period reflecting the base load operation of Moneypoint electricity generating plant although they fell by 19% in 2009. In 2009, oil, gas and coal accounted for 60%, 30% and 9% of net imports respectively while electricity and renewables (biofuels and wood pellets) accounted for the remaining 1% of net imports in 2009.

Figure 13 *Imported energy by fuel*

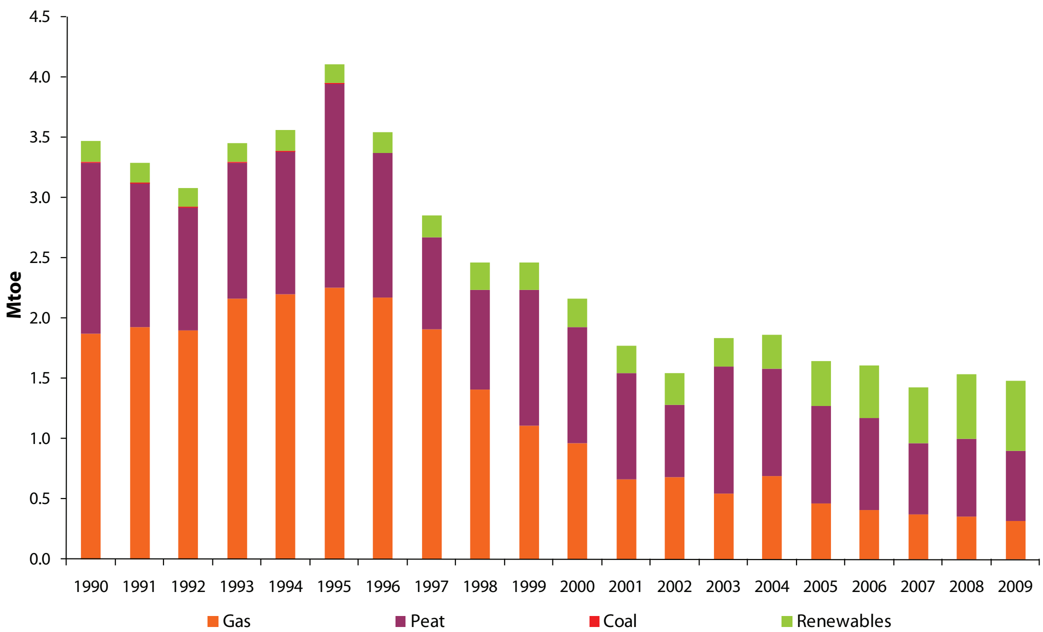


Source: SEAI

5.1.1.2 Indigenous Energy Sources

Ireland is not endowed with significant indigenous fossil fuel resources and has to date not harnessed significant quantities of renewable resources, although there has been strong growth in renewables in recent years from a small base. Figure 14 shows the indigenous energy fuel mix for Ireland over the period 1990 to 2009. 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 83% over the period since 1990, peat by 59% while renewable energy in contrast increased by 261%. Indigenous production peaked in 1995 at 4.1 Mtoe and there has been a 63% reduction since then.

Figure 14 *Indigenous energy sources by fuel 1990 - 2009*



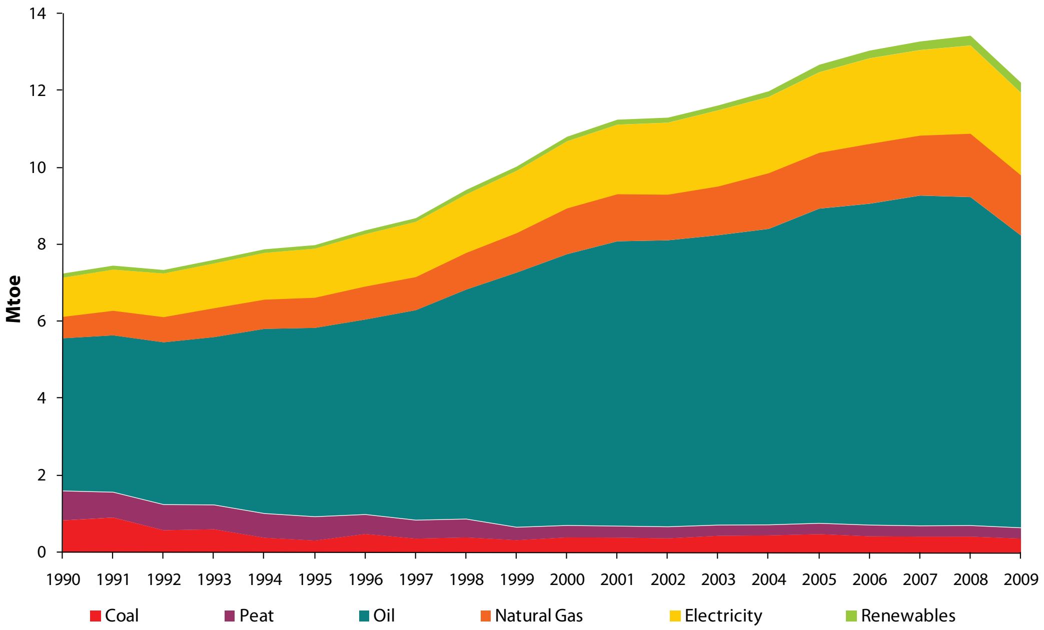
Source: SEAI

Increasing the deployment of renewables is part of the strategy to improve energy security for Ireland. Of the indigenous energy production in 2009 renewable energy was responsible for 40%. Therefore the decline in indigenous sources of energy has been halted by the use of renewables. Peat accounted for 38% of all indigenous energy in 2009 and natural gas accounted for 21% of indigenous energy. There was also a small contribution from non-renewable wastes.

5.1.2 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 and/or other losses entailed in delivery to final consumers are known as "energy overhead".) Trends in final energy demand, i.e. the amount of energy used directly by final consumers, are assessed both in terms of the mix of fuels used and consumption by individual sectors. Figure 15 shows the shift in the pattern of final energy demand by fuel over the period 1990 to 2009.

Figure 15 *Total final consumption by fuel 1990 - 2009*

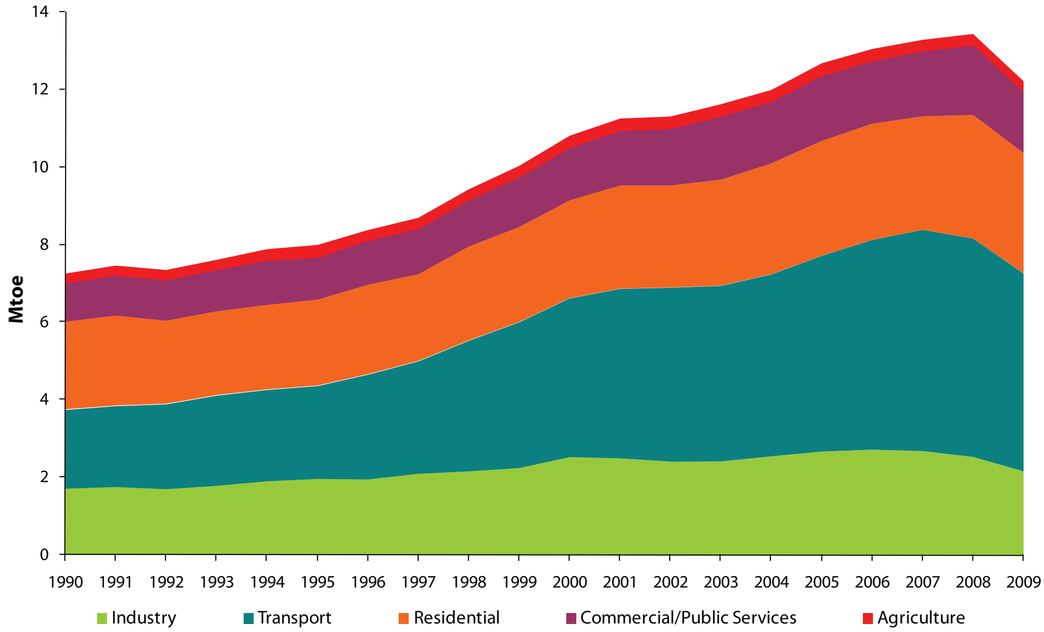


Source: SEAI

Ireland's TFC in 2009 was 12.2 Mtoe, a decrease of 8.9% on 2008 and 69% above 1990 levels (representing an average growth rate of 2.8% per annum). Final consumption of renewable energy increased by 169% (5.3% per annum on average) from 1990 to 2009. Final consumption of all fuels decreased in 2009 with the exception of renewable energy which grew by 14%.

It is also interesting to examine TFC by sector to see where most of the energy is being used (see Figure 16). Over the period 1990 to 2009 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 41% in 2009, while the share of industry and residential has decreased.

Figure 16 *Total Final Consumption (TFC) by sector from 1990 - 2009*



Source: SEAI

The EU uses the PRIMES modelling tool for energy forecasting. The PRIMES model simulates a market equilibrium solution for energy supply and demand in the EU-27 and its Member States. It is used for projections to the future, scenario building and policy impact analysis and covers a medium to long-term horizon. The model determines the equilibrium by finding the prices of each energy form such that the quantity producers will chose to supply matches the quantity consumers wish to use. The model is behavioural but also reflects in an explicit and detailed way the available energy demand and supply technologies and pollution abatement technologies. The model considers market economics, industry structure, energy/environmental policies and regulation, which have been or may in future be developed to influence market behaviour of energy system agents (European Union, 2009).

Table 1 presents the results of EU PRIMES forecasts to 2020. The EU-27 import dependence is forecast to deteriorate due to declining energy production. Ireland's import dependency shows a slight improvement due to increased production of natural gas over the period as well as an increased use of renewable energy sources.

Table 1 *Import dependency forecasts to 2020*

%	2010	2015	2020
EU-27	55	58	60
Ireland	90	89	88

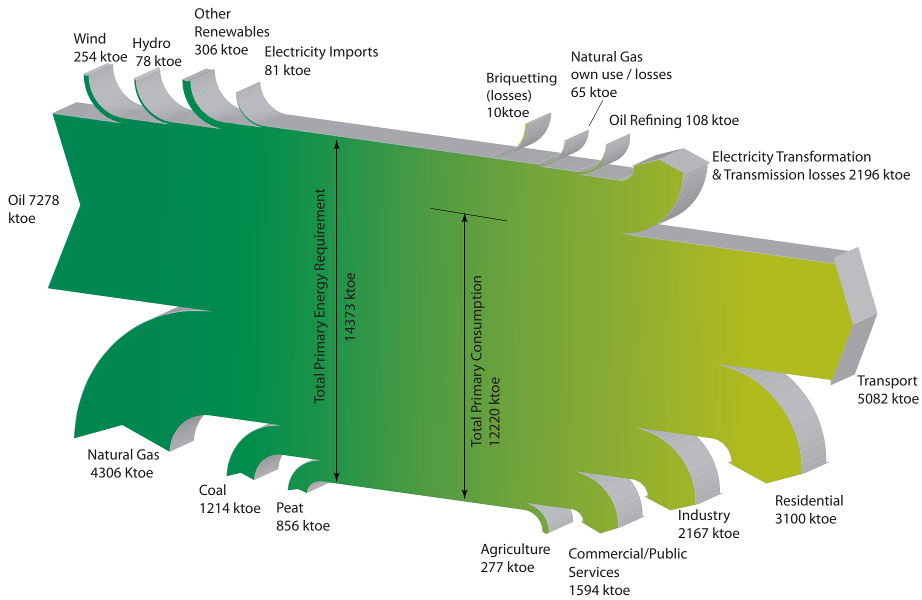
Source: PRIMES (2009)

5.1.3 Supply and Demand

Figure 17 shows the energy balance for Ireland in 2009 as a flow diagram. This provides a useful overview of the energy landscape, illustrating clearly the significance of each of the fuel inputs (by relevant thickness), energy lost in transformation and final energy demand to each of the end use markets, electricity, thermal and transport.

The main point to note is the dominant role that oil occupies as a fuel of choice, which is primarily due to demand in the transport sector. The size of the transport and thermal markets (41% and 40% of TFC respectively) as compared to the electricity market is also significant. Other points of relevance include the relatively small overall contribution of renewables and the fact that electricity transformation losses still account for a significant proportion of primary energy supply (16%).

Figure 17 *Energy flow in Ireland in 2009*



Source: SEAI

5.1.3.1 Supply/Demand Index

The Supply/Demand Index (S/D Index) is based on a country's energy system covering not only the supply of primary energy sources but also the conversion and transport of secondary energy carriers and the final energy demands. The S/D Index is suited for assessing current energy security as well as energy security in the medium and longer term. The index differs from other energy security metrics as it covers both supply and demand.

The S/D Index is based largely on objective information contained in energy balances combined with weighting factors and scoring rules, using existing indicators to the extent possible. The most important uncertainties are addressed by sensitivity analyses. The S/D Index for Ireland is discussed in section 8. The results of the analysis highlight that Ireland's energy security is declining and it is expected to continue to do so due to the diminishing supplies of oil and gas in the EU and OECD.

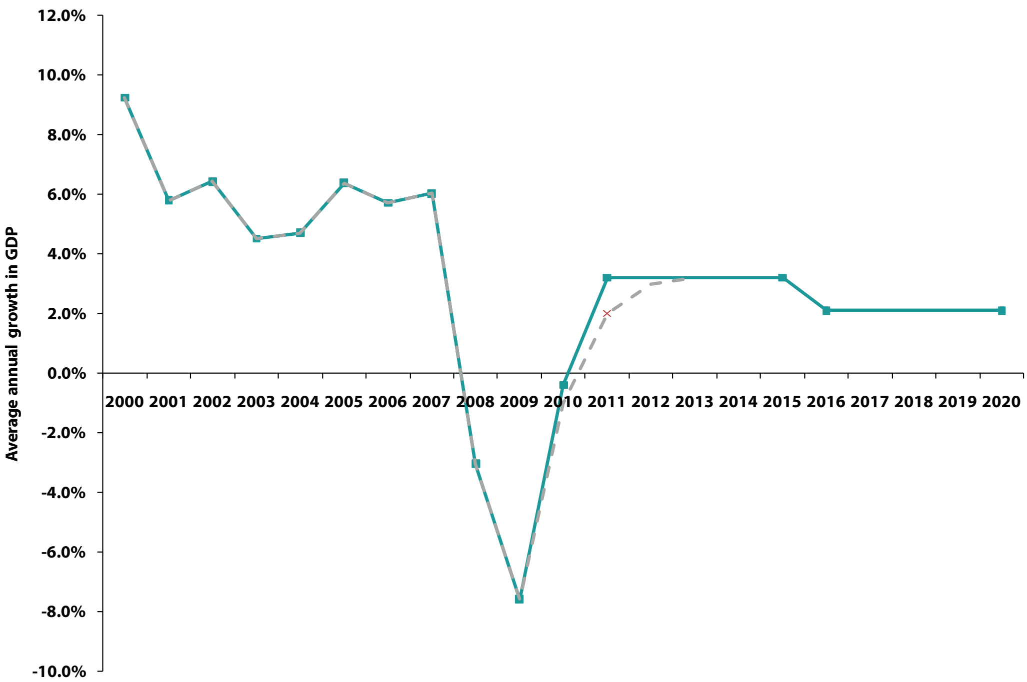
Based on this new analysis, the result for the year 2008 shows a minor decrease to 72, compared to the previous scores for the years 2005 (75) and 2006 (76) as obtained from the analysis in 2007 (SEAI, 2007). Ireland's Supply/ Demand index for 2008 is the third best score when compared with the index scores of other EU Member States obtained for 2005.

5.1.4 Market Signals

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. Projections for economic growth in the current economic climate are being redefined frequently. Energy projections depend on macro-economic forecasts and fuel-price projections, as well as incorporating envisaged energy policy plans.

The data in Figure 18 is from the Economic and Social Research Institute (ESRI) low growth scenario macro-economic projections for Ireland as published in the July 2010 report entitled 'Recovery Scenarios for Ireland: An Update'. The dashed line indicates updated projections from the quarterly economic commentary of Spring 2011.

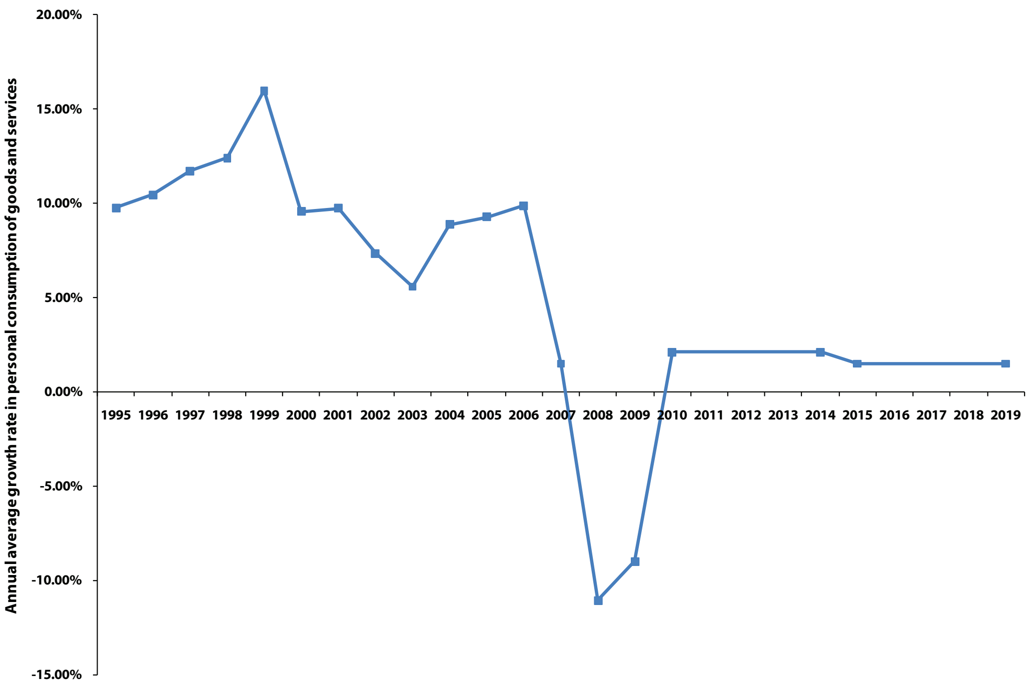
Figure 18 *Projected growth in Gross Domestic Product (GDP) to 2020*



Source: ESRI

Growth in disposable income in Ireland has historically been directly comparable to growth in private car sales and private car energy use. Figure 19 shows historical and projected growth in personal consumption of goods and services. There was a sharp decline in disposable income in 2008, due to the recession in Ireland, and growth is projected to be approximately 2% per annum for the next decade.

Figure 19 *Projected growth in personal consumption of goods and services*



Source: ESRI

5.1.5 Energy Prices

The most significant factor affecting energy prices in Ireland is recent dramatic changes in global oil prices. This has particular effect in Ireland due to Ireland's high dependence on oil. In addition there is the knock-on impact oil prices have on other energy prices, in particular natural gas (as discussed in section 3.3). As a consequence of the increase in natural gas prices and because of Ireland's reliance on natural gas for electricity generation, electricity prices have increased.

A carbon tax of €15 per tonne was introduced on fossil fuels in the 2010 Budget with the aim of encouraging innovation into alternative low carbon technologies. The tax was applied to petrol and auto-diesel with effect from midnight, 9 December 2009; and from 1 May 2010 to kerosene, marked gas oil, liquid petroleum gas (LPG), fuel oil and natural gas. The application of the tax to coal and commercial peat is subject to a Commencement Order. Exemption from the tax applies only to participants in the EU Emissions Trading Scheme (ETS) in respect of fuels so covered.

While the carbon tax of €15 per tonne is not applied to electricity at the point of purchase, generators in the Single Electricity Market (SEM) are subject to a 'Carbon Revenue Levy'[18] proportional to the carbon emissions of their generation portfolio. All electricity consumers are subject to a public service obligation levy (PSO) to support the use of indigenous fuels and renewables. There is also a small level of excise duty levied on non-household use of electricity since October 2008, called the electricity tax.

SEAI publishes a biannual report on Electricity and Gas Prices in Ireland[19] based on the methodology for the revised EU Gas & Electricity Price Transparency Directive[20] which came into effect on the 1st January 2008. These reports 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.

In the following sections on price, real prices are used for any price comparisons over time. Real prices are where the effects of inflation have been factored in, so essentially they are a constant price.

5.1.5.1 Oil Prices

Oil is a commodity traded on the international market and crude oil prices are dependent on market forces. The market forces that principally influence oil prices are supply and demand, with global growth patterns and political stability factors that may impact on the supply or demand, as discussed in section 3.1. As Ireland is neither a producer nor a significant world player in terms of demand, it cannot influence the price of oil, in spite of significant import dependence.

Crude oil prices, as shown in Figure 4, increased from $30 per barrel in 2004 to a peak of $144 per barrel on July 11th 2008, doubling 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 2008. Average oil prices during the second half of 2009 were 71 $/barrel and 97 $/barrel for the whole of 2008. During 2009 as a whole, the average oil price was 62 $/barrel and in 2010 this increased to 80 $/barrel. Oil prices have increased again in 2011 with the average price between January and mid-April at 108 $/barrel.

Oil prices to households in Ireland were 27% higher in real terms in the first quarter (Q1) of 2011 than in the year 2005. Petrol prices in Ireland were 18% higher in real terms in the second quarter (Q2) of 2010 than in the year 2005. Diesel prices in Ireland were 4% higher in real terms in the second quarter (Q2) of 2010 than in the year 2005.

5.1.5.2 Natural Gas Prices

Natural gas prices to industry in Ireland were 17% higher in real terms in the fourth quarter (Q4) of 2010 than in the year 2005. Natural gas prices to households in Ireland were 3% lower in real terms in the fourth quarter (Q4) of 2010 than in the year 2005.

The UK end-user gas price forecast at the National Balancing Point (NBP - a virtual trading location for UK gas) is given in Figure 20. The price forecasts are from the UK National Grid Ten Year statement. It predicts a doubling in

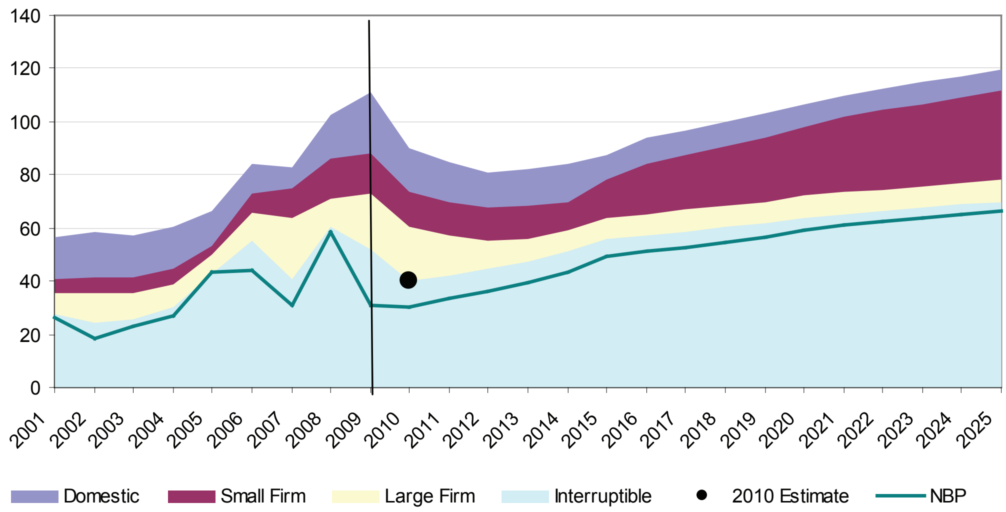
18 Electricity Regulation (Amendment) (Carbon Revenue Levy) ACT 2010. Available at: www.irishstatutebook.ie

19 Sustainable Energy Ireland (various dates), *Understanding Electricity and Gas Prices in Ireland*, www.seai.ie

20 http://europa.eu/legislation_summaries/energy/internal_energy_market/l27002_en.htm

the NBP price between 2009 and 2025. While the exact price may not be realised, the trend of a constant increase in gas prices is significant. Similar to oil prices the price of gas is predicted to continue rising in the foreseeable future. Ireland currently relies on the UK for all natural gas imports.

Figure 20 *UK end-user gas price forecast*



Source: UK Transmission National Grid (Gas)

5.1.5.3 Electricity Prices

There are a number of components which determine the price of electricity. The generation mix, which is mostly made up of fossil fuels in Ireland, is a critical component. Over 60% of Ireland's electricity is generated from natural gas, therefore the variability in the price of natural gas significantly impacts on the price of electricity in Ireland.

The wholesale cost of electricity is established by the Single Electricity Market (SEM) and reflects the generators fuel and short term operating costs. A Carbon Revenue Levy is imposed on all generators in the SEM which is proportional to the emissions of their generating portfolio. Capacity Payments are made to generators based on a measure of their availability, thus adding long term costs of generation to the electricity price. According to CER[21] the capacity payment is required to ensure the expected demand of the system is met even under situations of unexpected failure of generation during system peak demand or unusual or unanticipated increases in demand.

There are charges for the use of the transmission and distribution systems know as use of system charges (TUoS - Transmission Use of System and DUoS - Distribution Use of System). These use of system charges are regulated by the CER and are used to invest in the electricity infrastructure. There are also supplier administration costs. There are a number of taxes and levies on electricity in Ireland. Value Added Tax (VAT) is applied to the base price of electricity at a rate of 13.5%. VAT can be recovered by businesses.

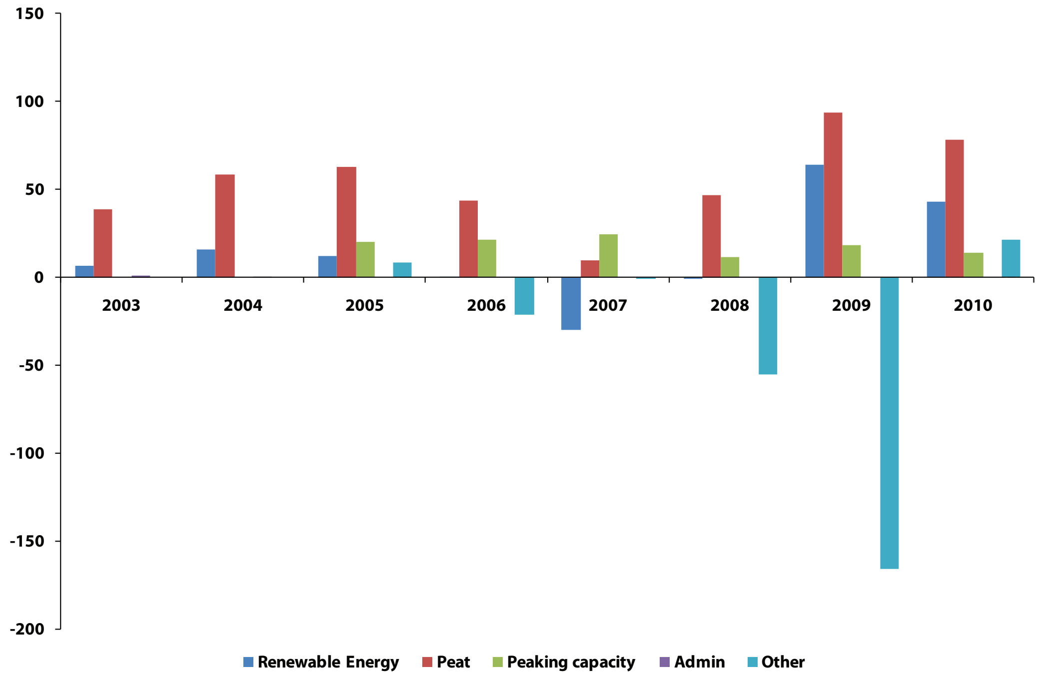
In accordance with the EU Energy Tax Directive, the Finance Act 2008 introduced excise duty, called electricity tax, on supplies of electricity made on or after 1 October 2008. There are two tax rates: €0.50 per megawatt hour (MWh), for electricity supplied for business use; and €1 per MWh, for electricity supplied for non-business use. This is not applied to electricity for residential use.

The public service obligation (PSO) levy is charged to all electricity customers. It is designed to support the national policy objectives of security of energy supply, the use of indigenous fuels (i.e. peat) and the use of renewable energy sources in electricity generation. Specifically, the proceeds of the levy are used to recoup the additional costs incurred by all suppliers in having to source a proportion of their electricity supplies from such generators.

The levy, which is calculated by the CER in accordance with the relevant legislation and particular terms of the various PSO schemes, is recoverable from all final customers of electricity, based on the proportion of maximum demand attributed to each category of accounts (Domestic, Small/Medium, and Large). Figure 21 shows the cost breakdown for the PSO from 2003 to 2010.

21 http://www.cer.ie/en/electricity-retail-market-regulated-revenues-and-tariffs.aspx?article=ac3a4e3c-b360-4d45-ad21-81d9ddf010d7

Figure 21 *PSO cost breakdown 2003 to 2010*



Source: Commission for Energy Regulation (CER)

In the four years prior to the 1st October 2010 the effective PSO levy was set at zero for various reasons (CER, 2010a). However from the 1st October 2010 domestic electricity consumers were charged a flat rate of €2.73 per month, small business consumers were charged a flat rate of €8.25 per month and medium and large business consumers (>30 kVA maximum import capacity) were charged at a rate of €1.15 per kVA of maximum import capacity.

SEAI and EirGrid conducted a joint modelling exercise to investigate the impact of increased wind generation on electricity generation costs in 2011 (SEAI and EirGrid, 2010). The study concluded that while capital costs of wind energy plants are higher than conventional generation wind energy can act as a hedge against high fuel costs by depressing the wholesale cost of electricity.

Electricity prices to industry in Ireland were 43% higher in real terms in the fourth quarter (Q4) of 2010 than in the year 2005. Real prices are where the effects of inflation have been removed, essentially a constant price. Electricity prices to households in Ireland were 2% higher in real terms in Q4 of 2010 than in the year 2005.

6 Energy Security Examination by Fuel

6.1 Oil

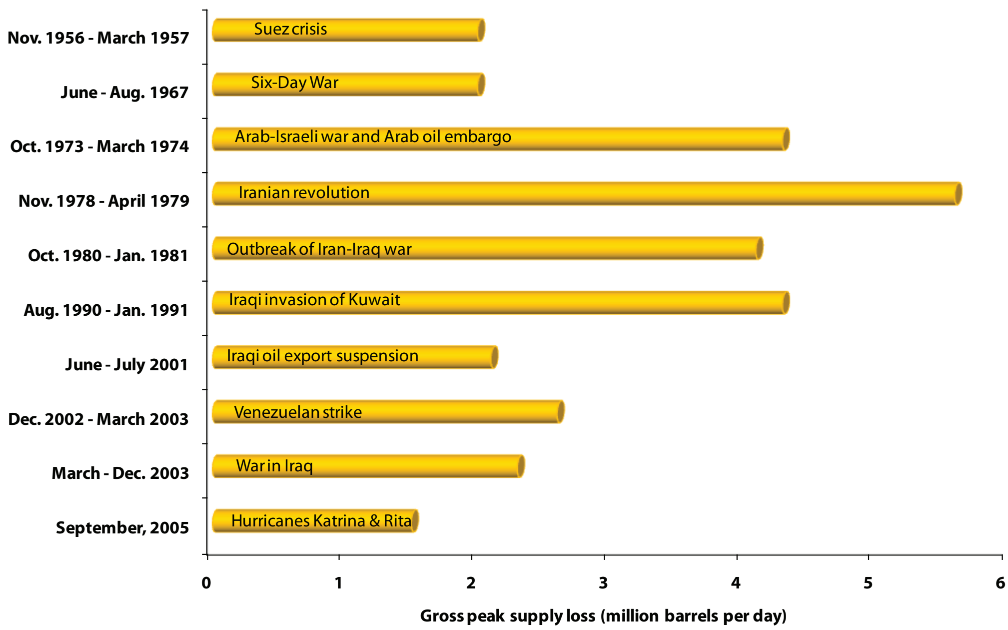
The International Energy Agency lists the following as the global threats to oil energy security:

- Capacity constraints both in production and refining
- Uncertain investment climates
- Geopolitical tensions and terrorism
- Natural disasters such as extreme weather conditions
- ... the unexpected event

Figure 22 details the oil supply loss during major world supply disruptions. The disruption to global oil supply due to the Libya conflict, which began in the first quarter of 2011, is estimated as a gross peak loss of 1.5 million barrels per day. As mentioned in section 3.1, global oil demand was 86.7 million barrels per day in 2010 and is anticipated to reach 89.2 million barrels per day for 2011. Therefore the loss due to the Libya conflict represents approximately 2% of the total global demand.

On 23 June 2011, the IEA announced a release of 60 million barrels of oil in response to the ongoing supply disruption of Libyan light sweet crude, an anticipated oil demand increase in the third quarter, and to act as a bridge to incremental supplies from major producers. The International Energy Agency has released stocks three times; in the build up to the Gulf War in 1991; after Hurricanes Katrina and Rita damaged offshore oil rigs, pipelines and oil refineries in the Gulf of Mexico in 2005; and in response to the ongoing disruption of oil supplies from Libya in 2011.

Figure 22 *Major World Oil Supply Disruptions chart*



Source: International Energy Agency (IEA)

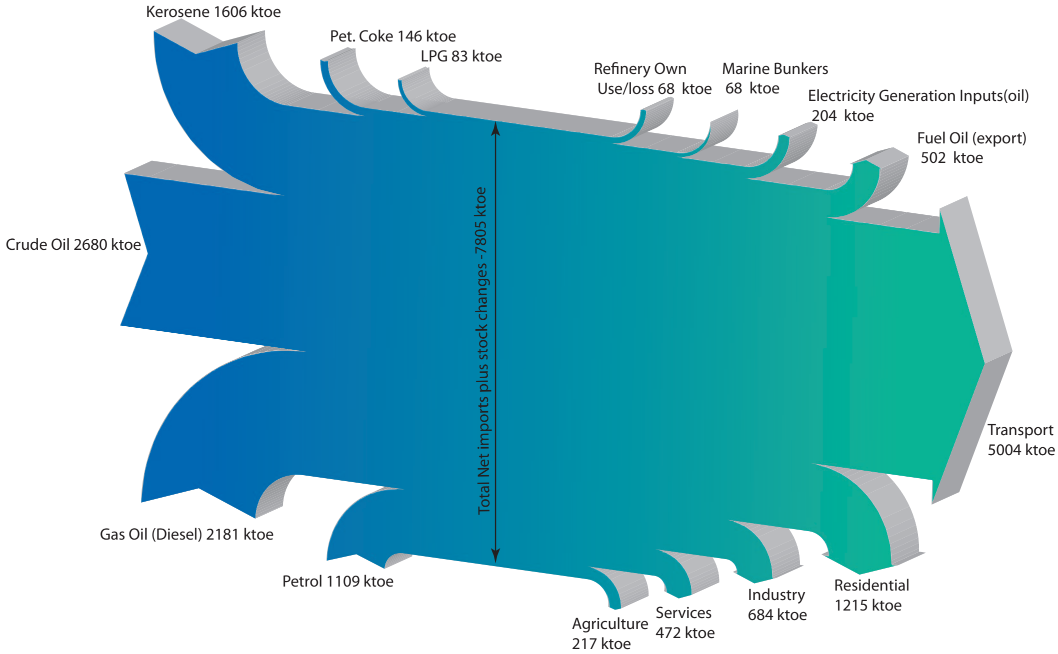
Ireland was responsible for 0.21% of global oil consumption in 2009 and 1.2% of total European consumption. According to EU statistics[22], Ireland's oil dependence (as a proportion of primary energy supply) is fifth highest in the European Union (52% primary energy in 2009).

22 Eurostat Database

6.2 Oil Usage in Ireland

Oil is the dominant fuel used in Ireland at 52% of the total primary energy requirement in 2009. This is an increase from the share of 47% in 1990 but a decrease from the peak dependence on oil of 60% of the total primary energy requirement in 1999. Transport is the largest end use of oil, but there is also significant use in residential heating and in the industrial sector. Figure 23 shows the oil balance for Ireland as a flow diagram.

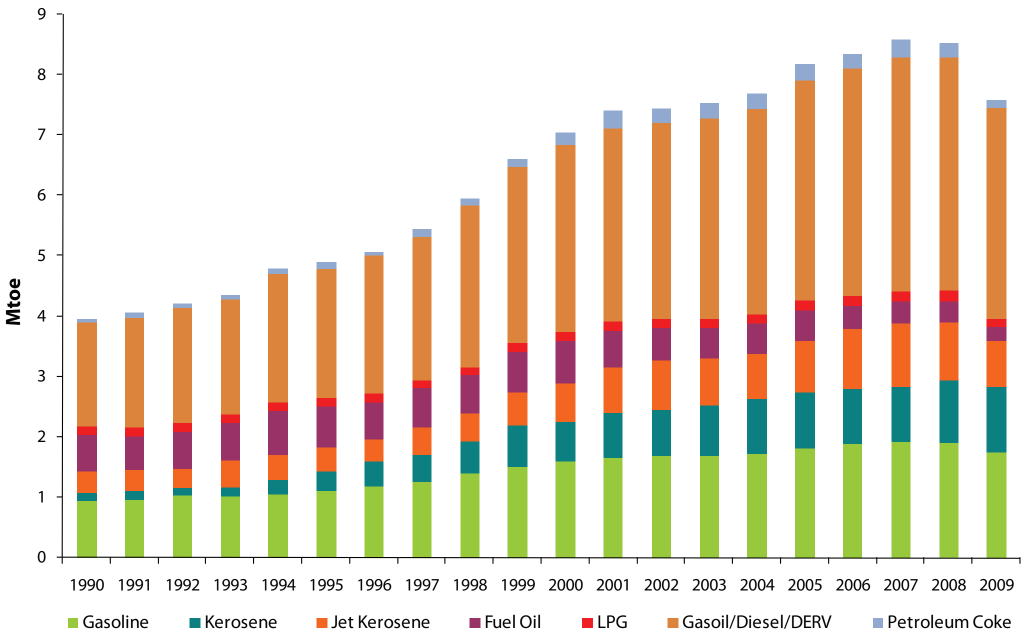
Figure 23 *Oil energy flow - 2009*



Source: SEAI

Final consumption of oil fell by 11% in 2009 as can be seen in Figure 24 after average annual growth rates of over 4.4% between 1990 and 2008.

Figure 24 *Final consumption of oil from 1990 to 2009*



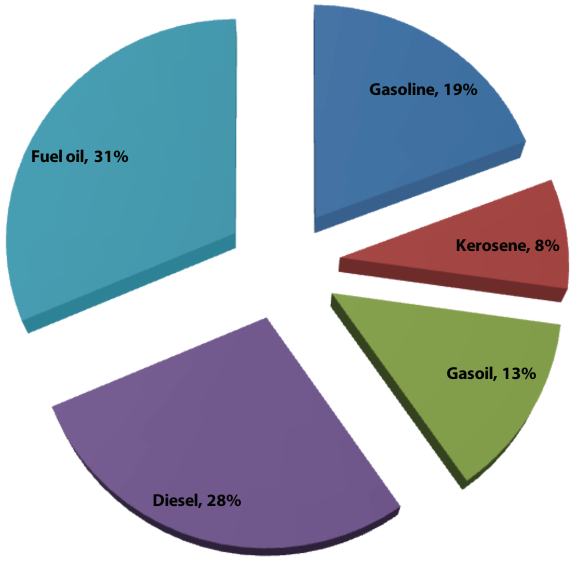
Source: DCENR (Oil Division)

6.2.1 Oil Market

The oil market in Ireland is served by a number of companies, both multi-national and domestic independents. Ireland has one oil refinery, located at Whitegate, Co. Cork, which was operated by the Irish National Petroleum Corporation (INPC), a State-owned company, until July 2001 when it was sold to private owners. The refinery is now operated by the Irish Petroleum Company Limited (IPCL), a ConocoPhillips subsidiary which also operates the storage terminal at Whiddy Island, within Bantry Bay, on the southwest coast of Ireland.

The capacity of the Whitegate facility is 75 kilo-barrels per day (27.4 million barrels per year). There was 19 million barrels of crude oil imported in 2010. The latest available production figures indicate that over 18.5 million barrels were refined in 2010. Figure 25 provides a breakdown of production by fuel type.

Figure 25 *Whitegate refinery production 2009*



Source: ConocoPhillips

Table 2 illustrates where the crude oil used in Ireland is sourced. Most of the crude oil is sourced in Norway. Over 80% of Ireland's crude oil imports were sourced within the EU and Norway in 2009, butthere is a growing dependence on Libya for crude oil imports (from just under 1% in 2006 to 20% in 2009 and provisionally 23% in 2010).

Table 2 *Irish crude oil imports by country of origin 2009*[23]

Country	000's metric tonnes	Percentage share (%)
Norway	1075	**41.3**
Denmark	580	**22.3**
Libya	514	**19.8**
United Kingdom	248	**9.5**
Netherlands	161	**6.2**
Nigeria	24	**0.9**

Source: DCENR

It is important to note that crude oil only accounts for 31% of the total oil imported into Ireland in 2009, meaning that 69% of the oil imported into Ireland is in its final product form (petrol/diesel/kerosene etc.). The United Kingdom is the source of 89% of oil product imports as documented in Table 3. Inland distribution of oil products within Ireland is by road from a number of marine terminals and the road loading facility located at the Whitegate oil refinery.

23 Only provisional data for 2010 was available at the time of publication so 2009 has the most up-to-date reliable data available at the time of publication

Table 3 *Oil product imports by country of origin 2009*

Country	000's metric tonnes	Percentage share (%)
United Kingdom	5169	**89**
Other (not specified)	636	**11**

Source: DCENR

Examining the UK petroleum industry more closely in Table 4 reveals that most of the crude oil used in the UK in 2009 was sourced from Norway (over 65%). There are currently nine active oil refineries in the UK.

Table 4 *UK crude oil imports by country of origin 2009*

Country	000's metric tonnes	Share (%)
Norway	30,665	**65.1**
Russia	3,831	**8.1**
Nigeria	2,367	**5.0**
Libya	1,845	**3.9**
Venezeula	1,201	**2.6**
Others	7,195	**14.6**

Source: IEA

The share of the Irish imports represented 23% of the total UK petroleum product production in 2009. UK exports in 2009 were mainly made up of petrol, gas/diesel oil and fuel oil, whereas imports consisted of aviation turbine fuel, petrol and gas/diesel oil. For gas/diesel oil, exports from the UK tend to be of lower grades for use as heating fuels, while imports tend to be of higher-grade gas/diesel oil with a low sulphur content. Nearly half (49%) of all UK finished product imports are sourced within the EU and 60% are from within the Organisation for Economic Co-operation and Development (OECD) member countries.

Table 5 *UK finished oil products imports by country of origin 2009*

Country	000's metric tonnes	Share (%)
Netherlands	3666	16%
Belgium	2319	10%
Russian Federation	2020	9%
United States	1455	6%
France	1451	6%
Singapore	1406	6%
Kuwait	1354	6%
Venezuela	1304	6%
Sweden	1275	6%
Germany	1201	5%
Norway	620	3%
Saudi Arabia	620	3%
Denmark	524	2%
Qatar	497	2%
India	350	2%
Others	2397	11%

Source: IEA

6.2.2 National Oil Reserves

Ireland's oil stock policy has evolved in response to its international commitments arising from membership of the EU and the International Energy Agency. Currently, the EU requires the holding of 61 days' stocks based on the previous year's consumption, while the IEA requires 90 days' stocks based on the previous year's net imports of oil. Following the "European Communities (Minimum Stocks of Petroleum Oils) Regulations, 1995" responsibility for the management of Ireland's oil stocks was vested in the National Oil Reserves Agency (NORA). This body acts as an agent on behalf of the Minister for Communications, Energy and Natural Resources (DCENR).

Stock holdings are held either directly by the Agency itself or on its behalf by third parties, either within Ireland or within countries with which Ireland has concluded a Government-to-Government Oil Stockholding Agreement. Oil stocks may be either wholly owned by NORA or held on NORA's behalf under what, in the industry, is termed "stock tickets" - the latter is a mechanism whereby NORA has the option to purchase, under commercial contracts and at market prices, volumes of oil in the event of an oil emergency being declared.

Table 6 shows the situation as of end of May 2010. A total of 107 days (based on IEA methodology) worth of stocks were held, of which 72 days were held within Ireland. Ireland's IEA stockholding requirement for 2010 amounts to approximately 1626 kilo – tonnes of oil equivalent or 20% of the total annual demand in 2009.

Table 6 *Number of days' oil stocks held by Ireland at the end of May 2010*

MW_e	In Ireland (days)	Abroad (days) *	Total days
NORA stocks wholly owned	33	7	40
Ticketed (stock tickets)**	0	28	28
Industry / Consumer stocks ***	39	0	39
Total	72	35	107

Source: NORA

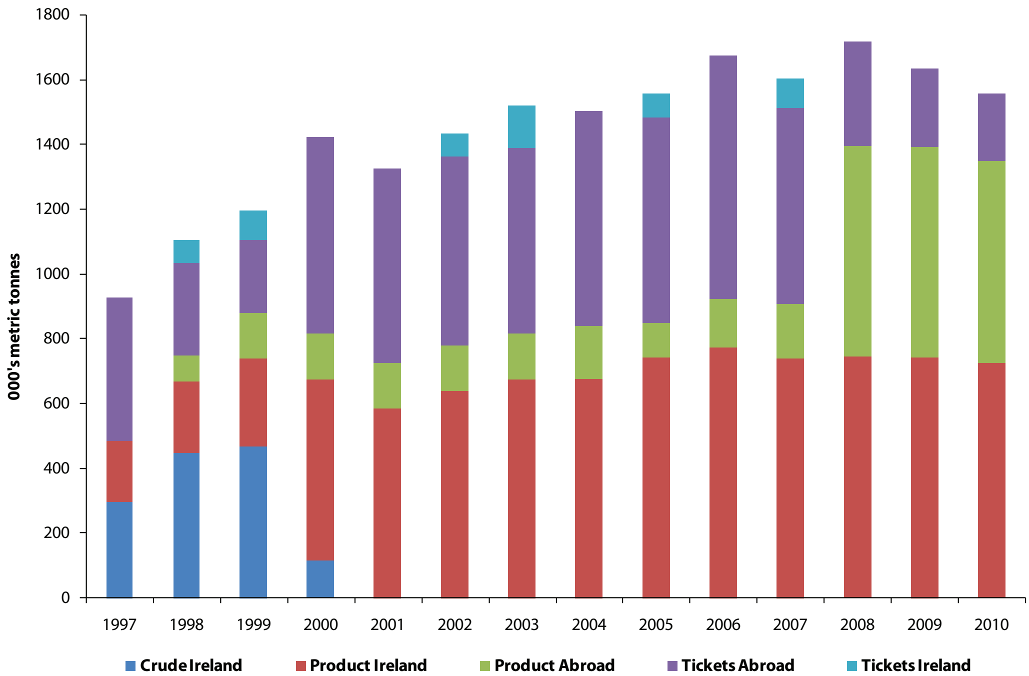
** These are stocks held in other EU countries under cover of Bilateral Agreements whereby the host country guarantees that it would not oppose the transfer of the oil in question to Ireland in the event of an emergency.*

*** Surplus (i.e. over and above operational stocks) private sector stocks which NORA rents with an option to purchase (during the period of the contract) in the event of an emergency.*

**** These are operational stocks held at major ports, the Whitegate refinery and by large consumer companies such as the ESB which would be legally and physically amenable to the government control in the event of an emergency under the Fuels Acts 1971 and 1982. Industry stocks that have already been delivered to filling stations etc. are not included.*

Figure 26 illustrates Ireland's oil stock levels during the period 1997 to 2010. Product refers to holdings of oil products (petrol, diesel, etc) that are held either in Ireland or in other jurisdictions covered by a relevant Oil Stockholding Agreement. NORA has been steadily increasing the volume of physical stocks held, and is seeking to maximise the volumes held in Ireland, in line with Government policy, to strengthen Ireland's security of supply. The Minister for Communications, Energy and Natural Resources has overall responsibility in Ireland for the maintenance of oil supplies during adverse circumstances (DCENR, 2008).

Figure 26 *NORA oil stocks from 1997 to 2010*



Source: NORA

Reserve Stocks in the Japan Earthquake

In the aftermath of the Japanese earthquake on March 11 2011 there were severe oil shortages in northern Japan. Six oil refineries were initially closed, representing 30% of Japan's total refining capacity. On March 14th stockholding obligations on industry were lowered by three days. However as a state of emergency was not declared immediately it took 10 days (March 21st) before the oil companies were allowed to release the stocks, due to a reduction of the obligated stock by 22 days to a 45 day stock holding requirement[1]. During those ten days lorries of supplies were unable to get petrol to travel up the empty expressway north as the supplies were reserved for emergency vehicles only.[2] This provides an example of the importance of holding reserve stocks, and highlights the critical role emergency management plans have in ensuring appropriate access to reserves.

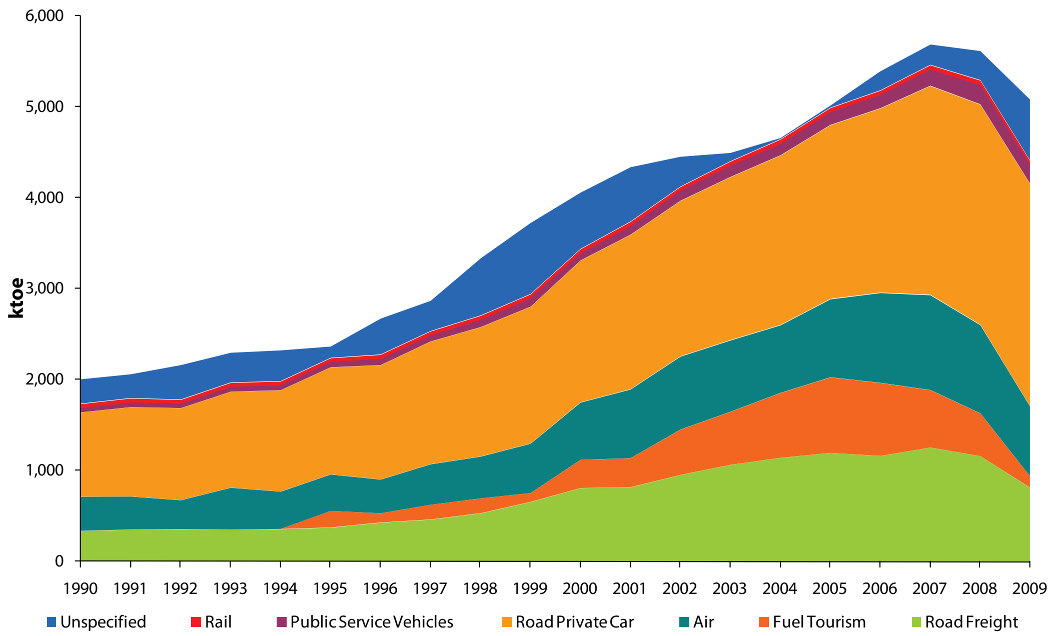
1 International Energy Agency, Energy facts about Japan following the March 11th earthquake, 25th March 2011
2 The Economist March 26th - April 1st 2011.

6.2.3 Transport Energy

Transport or mobility is a key area to consider from an energy security perspective as it is almost exclusively oil based and thus entirely in Ireland's case import dependent. Figure 27 shows the breakdown of transport energy fuel consumption by mode of transport. It also highlights the significant growth in transport energy demand since 1990.

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 is consumed by the Dublin Area Rapid Transport (DART) system and Luas light rail since 2004. Petrol is almost exclusively used for road transport, as is liquefied petroleum gas (LPG). 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 but the bulk is used for road transport. This diesel road transport 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. Diversification of transport energy is a major need which most commentators suggest is not being addressed with sufficient urgency. In terms of energy security biofuels and electric vehicles offer an alternative to the dependence on oil in the transport sector.

Figure 27 *Transport energy modal split, 1990 to 2009*



Source: SEAI

6.2.3.1 Biofuels

The IEA World Energy Outlook 2010 projects that the use of biofuels (transport fuels derived from biomass feedstocks) will increase rapidly up to 2035 due to both rising oil prices and government support. The Renewable Energy Directive 2009/28/EC mandates a 10% share of renewable energy in total transport demand by 2020. There are strict sustainability criteria attached to biofuels in the Renewable Energy Directive. These conditions are:

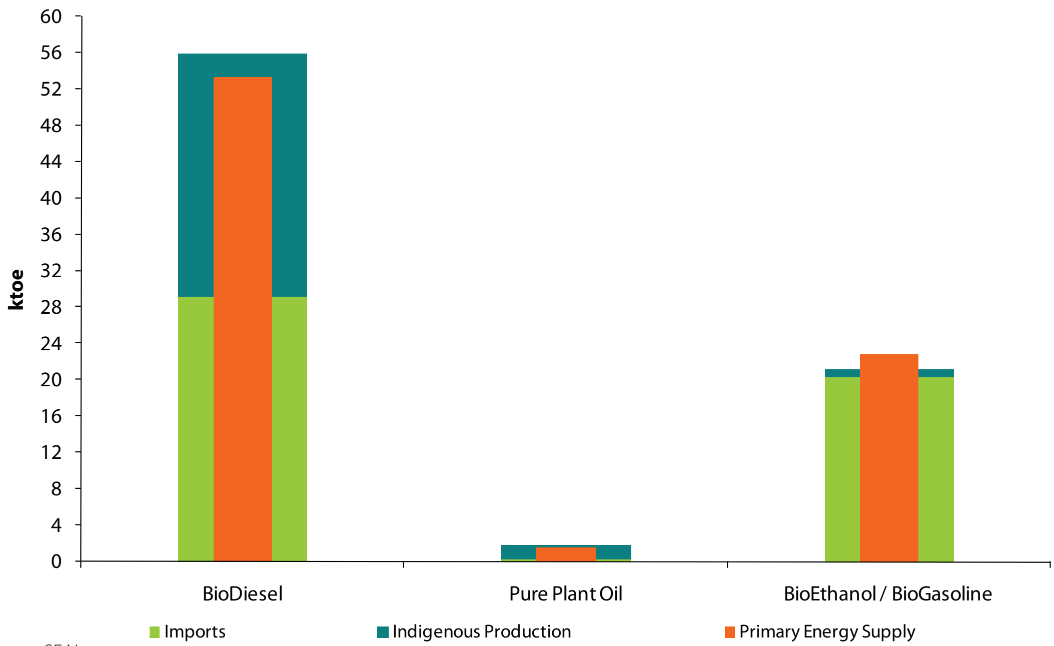
- The greenhouse gas emission saving from the use of biofuels and bioliquids shall be at least 35%. This percentage increases to 50% by 2017 and (for new biofuel plants that start production from 1 January 2017) 60% from 2018.
- Biofuels and bioliquids shall not be made from raw material obtained from land with high biodiversity value.
- Biofuels and bioliquids shall not be made from raw material obtained from land with high carbon stock.
- Agricultural raw materials cultivated in the Community and used for the production of biofuels and bioliquids shall be obtained in accordance with the requirements and standards under the provisions referred to under the heading 'Environment' in part A and in point 9 of Annex II to Council Regulation (EC) No 73/2009.

The Irish government lowered the 2010 biofuels target for Ireland from 5.75% to 3%[24] in October 2008 due to concerns regarding the impact of global biofuels development on food prices, food security and sensitive ecosystems coupled with low greenhouse gas emissions benefits from some energy intensive biofuel production processes.

Over the last few years, there has been a vigorous debate about the extent to which biofuels lead to GHG reductions, particularly given new research about the emissions associated with direct and indirect land-use changes (ILUC) caused by biofuel production (Edwards et al., 2010; Tyner et al., 2010; E4tech, 2010). While virtually all bioenergy systems can offer big greenhouse gas reductions when replacing high-emissions fossil-based alternatives, the question gets complicated when there are changes in the use of land. It becomes yet more complicated when effects of those changes can be both direct and indirect (IEA, 2010a).

There has also been a public debate over whether conventional biofuels can harm food security, following a peak in agricultural commodity prices in 2007-08. Although the latest analyses suggest that a combination of high oil prices, poor harvests and use of commodities by financial investors probably had a considerably higher impact on food prices than biofuel production (World Bank, 2010), food security remains a critical topic for the design of sound biofuel policies.

Figure 28 *Biofuels production, imports and usage (2009)*



Source: SEAI

Figure 28 shows the contribution of different biofuels to Ireland's transport energy supply in 2009. The graph

24 Announcement by the Minister for Communications, Energy and Natural Resources on 29th September 2008. http://www.dcenr.gov.ie/Press+Releases/2008/Minister+Ryan+proposes+new+target+for+biofuels+in+Ireland.htm

distinguishes between the amount of biofuels produced and imported (the thicker green bars) and the amount used (the thinner orange bar) in 2009. The amount produced and imported need not necessarily sum to the amount used due to stock changes. During 2009, there were more biofuels imported than produced indigenously. Indigenous production accounted for 43% of biofuels used or stockpiled in 2009, while imports accounted for 57%.

The proportion of indigenous production compared to imports varies according to the biofuel. In bioethanol, imports represent almost seventy times the amount produced in Ireland. There was 25% more biodiesel produced indigenously than was imported in 2008 (i.e. 57% produced indigenously and 43% imported) and pure plant oil used for transport purposes here was all produced in Ireland. The sources of biofuels are likely to come under increased scrutiny with the focus on the sustainability criteria for biofuels in the Directive 2009/28/EC.

6.2.3.2 Electric Vehicles

For the Renewable Energy Directive (2009/28/EC) 10% transport target, the calculation of the electricity from renewable energy sources consumed by electric road vehicles will be considered to be 2.5 times the energy content of the input of electricity from renewable energy sources. Ireland has substantial resources of wind and ocean energy accessible to it. In contrast, only modest reserves of gas and oil have so far been identified in Irish waters. By storing the intermittent renewable electricity, from wind and waves, highly efficient electric vehicles therefore offer Ireland the opportunity to supply a significant proportion of its transport energy needs from its own energy resources while substantially reducing the associated CO_2 footprint.

In November 2008, the Government set out its plans for the mass deployment of electric vehicles in Ireland. A target of 10% of all vehicles in the transport fleet to be powered by electricity by 2020 was set. In April 2009 the Minister for Communications, Energy and Natural Resources announced the introduction of grant support of up to €5,000 for the purchase of Battery Electric Vehicles (BEVs) and up to €2,500 for the purchase of Plug-in Hybrid Electric Vehicles (PHEVs), available from 2011 to 2012. In addition the Minister for Finance in his Budget Speech of December 2009 announced zero Vehicle Registration Tax (VRT) on BEVs and VRT relief of up to €2,500 for PHEVs. Initial modelling suggests that meeting a 10% electric vehicle target will deliver 1.0% – 1.5% of transport energy from renewable energy sources (including the multiplier factor) and would represent some 250,000 – 300,000 cars on Irish roads over the next 12 years (Foley et al., 2009).

There is an interim target to achieve 6,000 passenger electric vehicles in operation in Ireland by 2012. This target has been set in order to generate the critical mass necessary to assist Ireland in achieving its overall goal of ensuring that 10% of all vehicles are electric by 2020. There are also tax incentives for businesses to purchase electric vehicles. Businesses can write off 100% of the cost of purchase against tax in the year purchased under the Accelerated Capital Allowance Scheme.

6.3 Natural Gas

Natural gas is the lowest carbon emitting fossil fuel. According to the IEA natural gas is set to play a central role in meeting the world's energy needs for the next two-and-a-half decades. The IEA World Energy Outlook (IEA, 2010b) forecasts that growth in demand for natural gas far surpasses that of any other fossil fuel due to its more favourable environmental and practical attributes and constraints on how quickly low carbon technologies can be deployed. Final energy use of natural gas globally grew faster than any other fuel over the period 1990 to 2009 and natural gas was second only to renewables in terms of growth of primary energy demand over the same period.

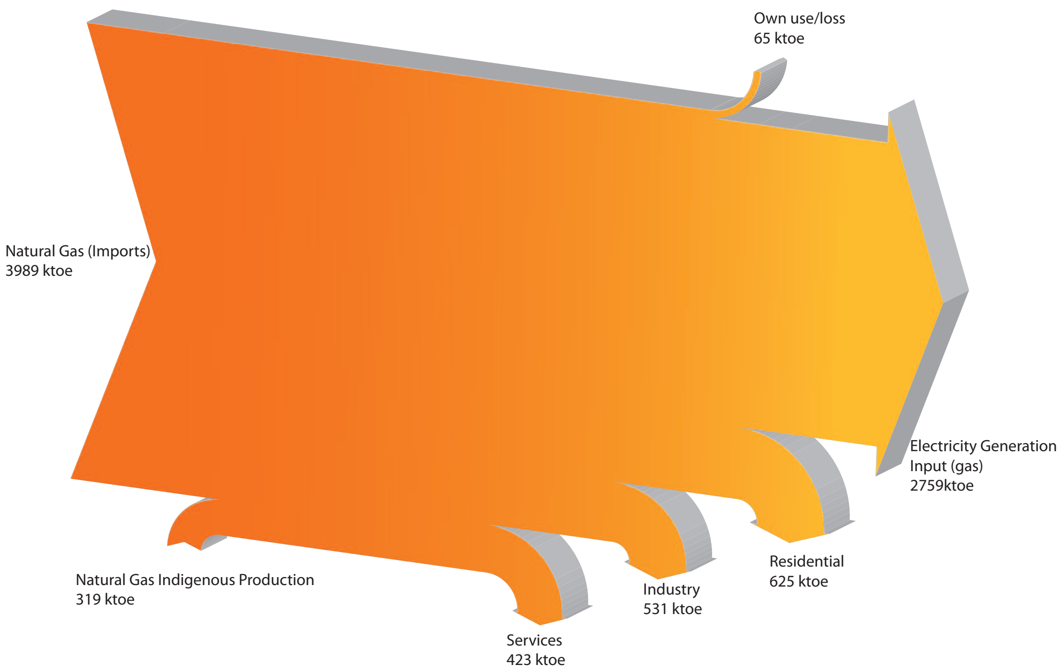
Natural gas makes up a quarter of the European primary energy supply. The European Union has a 38% import dependence for natural gas.

Ireland was responsible for 0.16% of global gas consumption in 2009 and 1% of OECD Europe consumption (at approximately 5 billion cubic metres per annum). While Ireland has some indigenous natural gas, 93% of natural gas used in Ireland in 2009 was imported. All of Ireland's imported natural gas is sourced from the United Kingdom. Ireland's imports made up 37% of the total UK natural gas exports in 2009 and 7.4% of the total UK production in 2009.

6.3.1 Natural Gas Usage

Figure 29 presents an energy flow diagram for gas usage in 2009. The total input, categorised by imported and indigenous, is shown on the left while outputs on the right are categorised by sector. This illustrates that the majority of gas is imported (93%) and electricity generation is responsible for the largest share of output (63%).

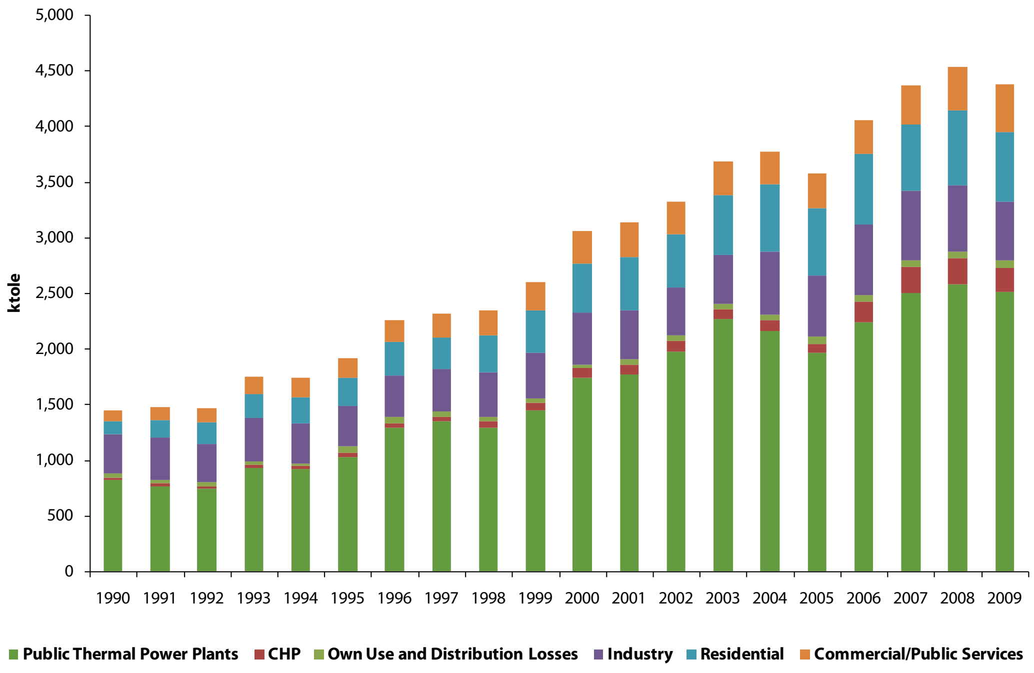
Figure 29 *Natural gas energy flow in Ireland in 2009*



Source: SEAI

The growth in natural gas demand is shown in Figure 30. Natural gas had a 24% share in industrial energy consumption, a 20% share in residential energy use and a 26% share in the services sector in 2009. Total gas demand has increased over the period 1990 to 2009 by an average of 7.5% per annum (for a total increase of 198%). Use of gas in the power generation sector in particular has been strong and growth over the period was 227% or 6.4% per annum over the period. By the end of 2009, 64% of total gas was used for power generation. Natural gas use decreased in 2009 by 4% due largely to the fall in electricity demand.

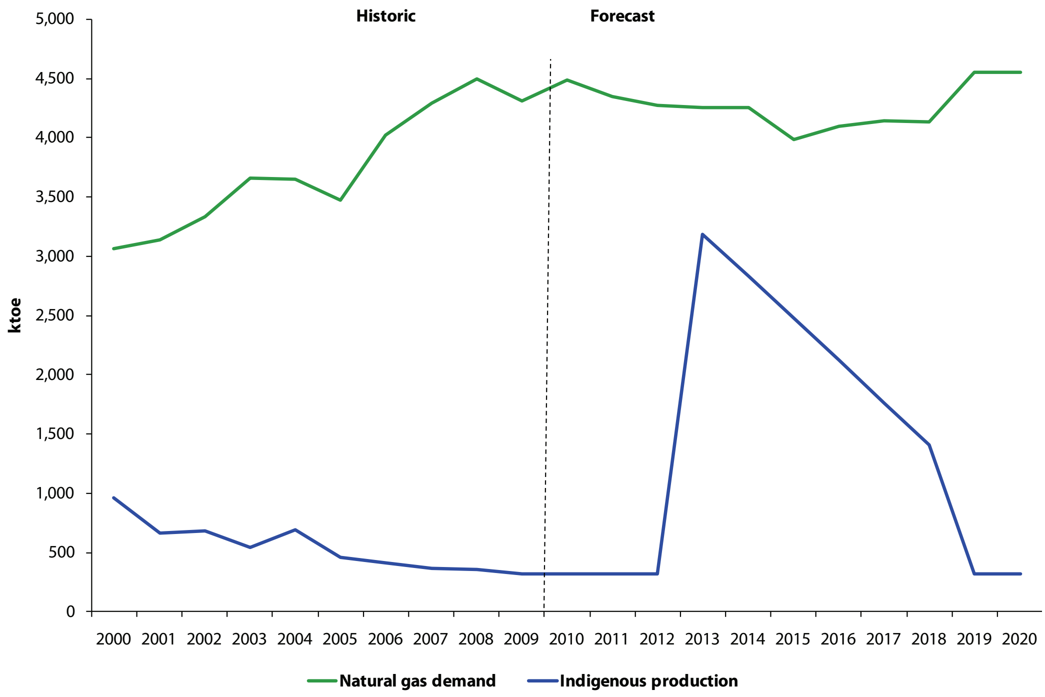
Figure 30 *Gas demand 1990 to 2009*



Source: SEAI

Forecast data for indigenous production of natural gas are available from the SEAI modelling team's annual national energy forecasts. Data presented in Figure 31 for the period to 2020 shows that the forecasted demand is far in excess of what will be available from indigenous sources. Indigenous gas from the Corrib gas field is assumed to be available from 2012/13 as estimated by the IEA and discussed in the recent developments section (3.2.1).

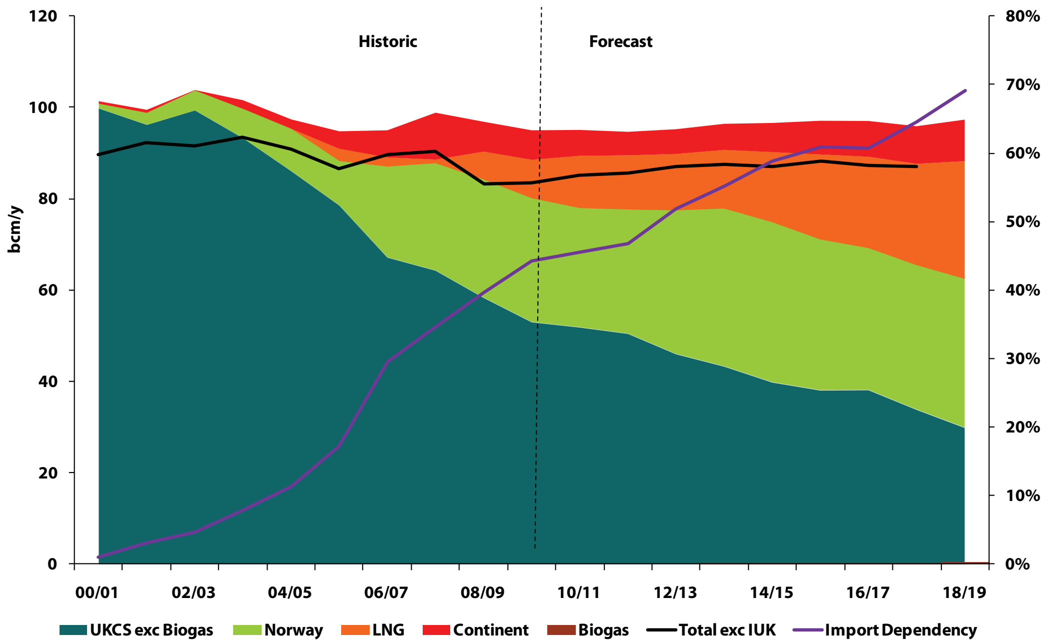
Figure 31 *Forecast of gas supply and demand to 2020*



Source: SEAI and IEA

Currently all gas imported into Ireland comes from the UK so it is relevant to examine the situation in the UK. It is anticipated that the UK will have a 70% import dependence on natural gas by 2020 (UK National Grid, 2010) as shown in Figure 32. This is due to the anticipated depletion of production from the UK continental shelf (UKCS) at a rate of 4% per annum. However the UK is also investing in liquid natural gas (LNG) terminals which transform gas in a liquid state into a gaseous state. Their primary contribution is diversity away from pipeline gas. The UK LNG capacity was approximately 5 bcm at the end of 2009 and is expected to rise to 23 bcm by 2020. The UK natural gas demand in 2009 was approximately 91 bcm, this excludes exports to Ireland through the UK interconnector (IUK).

Figure 32 *Annual UK demand and potential supply 2000 to 2019*



Source: UK National Grid

6.3.2 Natural Gas Infrastructure

Ireland's natural gas infrastructure is presented in Figure 33. The natural gas transmission network in Ireland is operated by Gaslink since 2008. The total transmission network length at the end of 2010 was 2,373 km while that of the distribution networks was 10,856km (Bord Gáis Éireann, 2011). The high pressure transmission network conveys gas from two entry points (at Inch and Moffat) to directly connected customers and distribution networks throughout Ireland, as well as to connected systems at exit points in Scotland (the Scotland-Northern Ireland Pipeline) and the Isle of Man.

The Moffat entry point, located onshore in Scotland, connects the Irish natural gas system to that of Transco in the UK, and allows for the importation of UK gas to Ireland but not exportation of gas from Ireland to the UK. The Inch entry point, located in Cork, connects the Kinsale and Seven Heads gas fields and the Kinsale storage facility to the onshore network. The Irish system has three compressor stations, Beattock and Brighouse Bay in southwest Scotland, and Midleton near Cork.

The maximum import capacity for the interconnectors is imposed by the capability of the compressor stations to deliver high pressure flows into the pipelines. This current limit is 1.24 million cubic metres per hour. Further compression power and/or onshore pipeline reinforcement in Scotland could enable the interconnectors to increase this limit. However according to the latest forecasts from Bord Gáis Éireann's annual report, Ireland's transmission network infrastructure has the capacity to transport the anticipated gas demand to all end consumers in 2010 and beyond.

In the long term there will be an increasing reliance on the interconnectors to access European gas sources. The traditional sources of the Dutch and UK sectors of the North Sea are in decline and future gas supplies are projected as being delivered from more distant fields such as the northern Norwegian sector or via LNG from outside the EU.

Figure 33 *Map of the gas grid*

Source: Bord Gáis Éireann

6.3.3 Natural Gas Storage

Increasing gas storage will enhance gas energy security due to a diversification from the dependence on the UK market. Ireland's first storage facility commenced operations in 2001 in the Southwest Kinsale Field. The facility enables gas to be injected (stored) on minimum demand days during the summer months and delivered to the Irish market in the winter when demand is higher. The CER has licensed the facility and it was made available to third parties from 1st June 2006. As detailed in section 3.2 there are also plans for LNG storage in Shannon and two salt cavity gas storage projects in Larne Lough in Northern Ireland.

6.3.4 Biogas

Biogas is a mixture of methane (50-75%), carbon dioxide (25-45%) and small amounts of water (2-7%), as well as trace gases such as sulphur hydrogen, oxygen, nitrogen, ammonia and hydrogen. Farm, municipal or industrial-based anaerobic digestion plants convert waste material into biogas. Waste/feedstock is pumped into a closed vessel (digester) which has been inoculated with suitable bacteria. Anaerobic (0% oxygen) conditions are then maintained in the vessel and the temperature is held at a constant value (typically 40°C). The biogas produced can be upgraded to fossil ('natural') gas quality. Bord Gáis has a conservative estimate that the potential biomethane resource in Ireland is 0.4 bcm/a or 7.5% of the national gas demand requirement in 2009 or the equivalent of heating approximately 300,000 homes each year (Bord Gáis Éireann, 2011). Biogas could also be used as a transport fuel, diversifying the fuel mix used for transport. However there are obstacles to making biogas commercially viable, not least of all cost.

6.4 Electricity

The Commission for Energy Regulation (CER) holds the statutory obligation to monitor electricity security of supply in Ireland and work closely with all market players to ensure long term electricity security. The legal basis for this is founded in Regulation 28 of Statutory Instrument (SI) 60 of the 2005 – 'European Communities (Internal Market in Electricity) Regulations 2005'. This monitoring includes:

- the balance between supply and demand,
- the level of expected future demand,
- the envisaged additional capacity being planned or under construction,
- the quality and level of maintenance of the transmission networks,
- the measures to cover peak demand, and
- the measures to deal with a shortfall of capacity by one or more suppliers.

In the short term electricity energy security is dependent on operational security only. In the longer term the issue is more complex and the security of electricity supply is dependent on access to primary fuels, market adequacy and system adequacy which in turn is reliant upon generation adequacy and network adequacy.

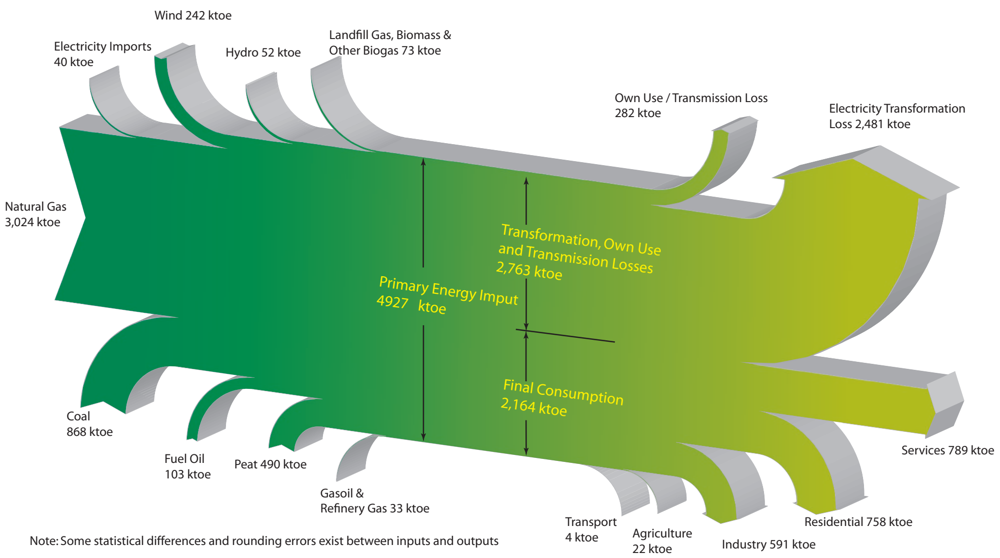
6.4.1 Electricity Generation

Figure 34 shows graphically the flow of energy in electricity generation and supply. The relative size of the final electricity consumption and the energy lost in transformation and transmission is striking. These losses represent 55% of the energy inputs. The dependence on natural gas in electricity generation in 2010 was 61% . The small, but growing, contribution from renewables is also notable as is the dominance of gas in the generation fuel mix.

In terms of energy security the dominance of gas is a significant risk both to the physical security of supply and also of exposure to price variation. Increasing the share of renewable electricity is a way to reduce the reliance on imported fossil fuels for electricity generation and to reduce the dominance of natural gas in electricity generation.

In 2010, renewables accounted for 7.4% of the energy inputs to generate electricity with wind contributing 4.9% of total inputs. Wind accounted for 66% of the renewable energy used for electricity generation in 2010. However it should be noted that variable renewable electricity sources, in particular wind, introduce short term risks to the security of the electricity supply.

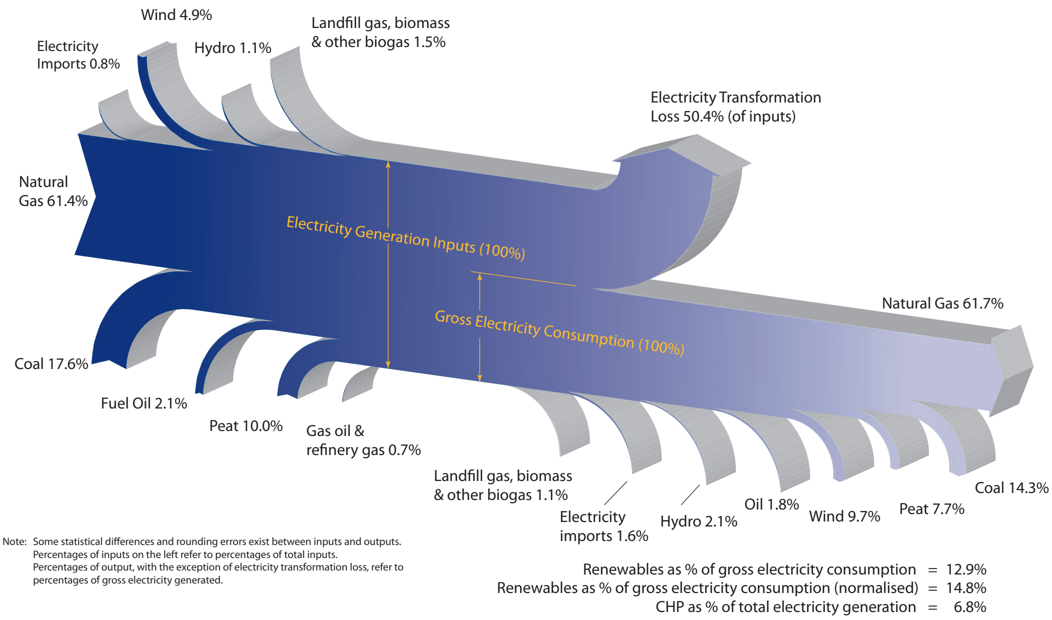
Figure 34 *Energy flow in electricity generation and supply*



Source: SEAI

Figure 35 shows a similar picture to *Figure 34* except that the electricity outputs are shown by fuel used to generate the electricity and as percentages for the purposes of comparison with the various targets. Renewable generation makes use of wind, hydro, landfill gas, biomass and other biogas and in 2005 accounted for 6.8% of gross electricity consumption. This increased to 14.3% in 2009 but dropped back to 12.9% in 2010. When normalisation is applied to the wind and hydro contributions, to smooth the effects of climatic variation, the renewable generation as a percentage of gross electricity generation was 13.7% in 2009 and 14.8% in 2010. The national target was 15% by 2010 and is 40% by 2020. Normalised figures will be reported as the progress towards the national targets.

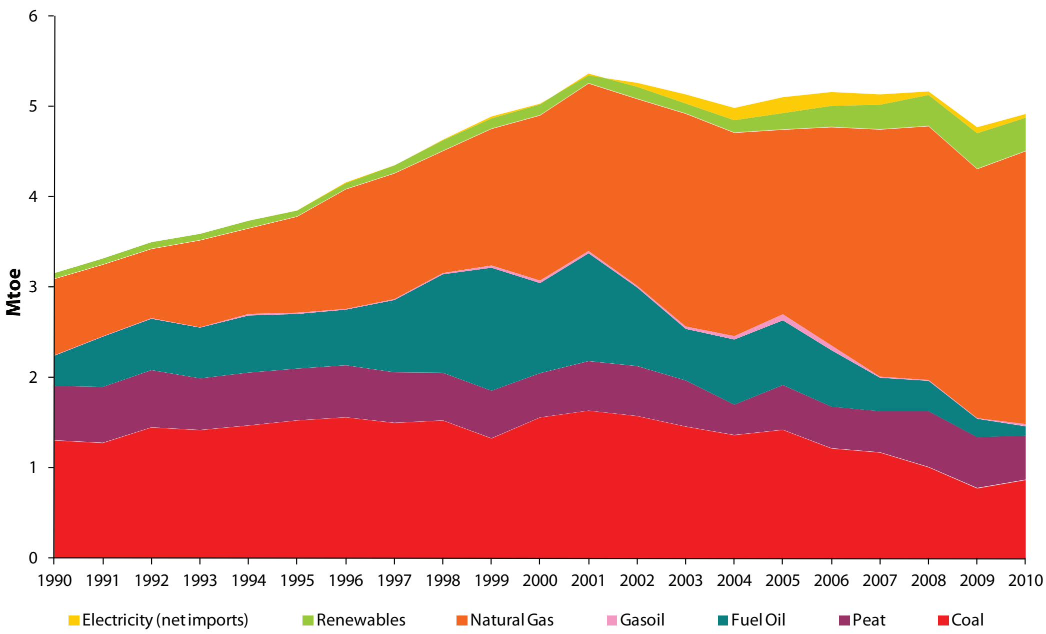
Figure 35 *Flow of energy in electricity generation - fuel inputs/electricity outputs 2010*



Source: SEAI

Figure 36 shows the growing trend in gross electricity consumption for Ireland over the period 1990 – 2010. It illustrates the changing shares of each fuel/energy source. The doubling of gross electricity consumption over the period is striking, as is the growth in gas-generated electricity.

Figure 36 *Gross electricity consumption by fuel source*



Source: SEAI

As shown in Table 7, the share of gas generation increased from 28% in 1990 to 61% in 2010. Renewable energy nearly trebled its share, in the context of a doubling of overall gross electricity consumption. Note that the renewable contribution in Table 7 is not normalised for the installed capacity and weather variations; normalised values are detailed in Table 9.

Table 7 *Gross electricity consumption percentage by fuel source*

% of Gross	1990	1995	2000	2005	2006	2007	2008	2009	2010
Coal	41.6	39.9	28.7	23.1	20.4	18.8	17.3	14.5	14.3
Peat	15.8	11.5	7.4	8.9	7.4	7.4	9.1	9.5	7.7
Oil	9.9	15.1	19.5	12.1	9.4	6.8	7.3	3.3	1.8
Gas	27.7	29.3	38.9	41.8	48.1	52.9	53.1	55.6	61.8
Renewables	5.0	4.2	5.0	6.8	8.6	9.4	11.9	14.4	12.9
Imports	0.0	-0.1	0.4	7.4	6.2	4.6	1.5	2.7	1.6

Source: SEAI

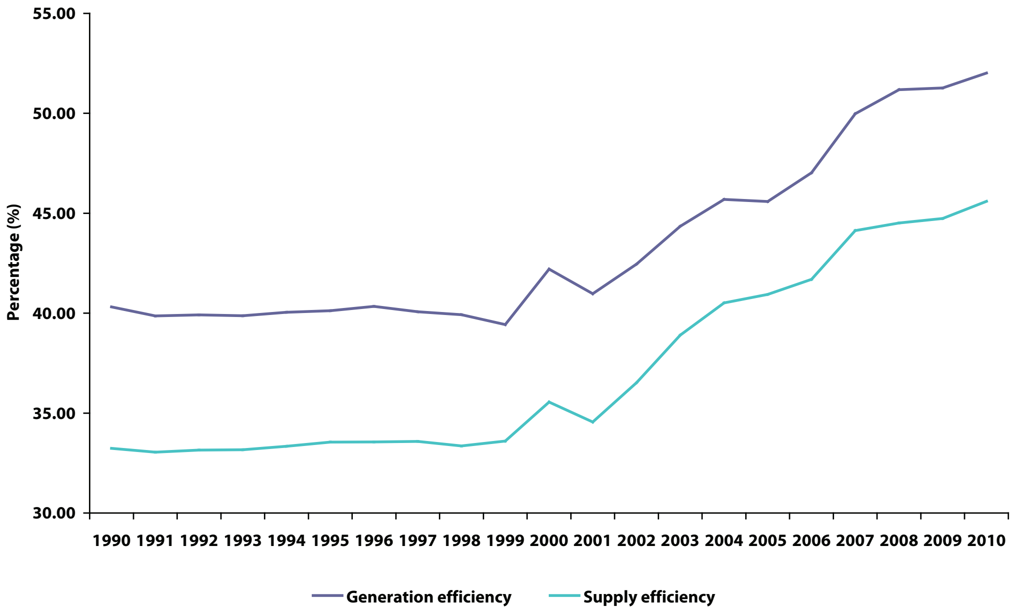
The efficiency of electricity generation and supply are shown in Figure 37. Generation efficiency is defined as the electricity produced from both thermal and renewable generators divided by the fuel inputs and expressed as a percentage. Supply efficiency is defined as final consumption of electricity, excluding the generation plants' "own use" of electricity and transmission and distribution losses, divided by the fuel inputs required to generate this electricity and expressed as a percentage. Thus, by definition generation efficiency is always going to be greater than the supply efficiency as the electricity generators' "own use", transmission and distribution losses are not considered as losses in the calculation of generation efficiency. Another difference in the calculations is that imports are excluded from the generation efficiency calculation.

From the mid 1990s onwards the influence of the use of higher efficiency natural gas plants and the increase in production from renewable sources are evident. The sharp rise between 2002 and 2004 (from 35% to 40%) is accounted for, principally, by the introduction of new Combined Cycle Gas Turbine (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.

Improvements in efficiency in 2007 were due largely to the commissioning of two further CCGT plants, Tynagh (384 MW) in 2006 and Huntstown 2 (401 MW), and the increase in renewable electricity. In 2010 two new combined cycle gas turbine units (CCGTs) were connected in Cork with a combined capacity of 877 MW. The steam turbine in Marina was also decommissioned and Marina is now operating as an open-cycle gas turbine (OCGT). While OCGT plants are not as efficient as CCGT plants, in this case there was an improvement in efficiency through the installation of a new generator. Two open-cycle distillate peaking units in Edenderry, with a total generating capacity of 114 MW, became operational in 2010. These new peaker plants are also an improvement in efficiency compared to reliance on older oil based peakers. ESB Power Generation decommissioned two units at Poolbeg in March 2010, giving a reduction in capacity of 219 MW. This is in addition to a third 242 MW unit at Poolbeg which was decommissioned in 2007.

As well as the change to more efficient gas plants the increase of renewables in the system has contributed to the overall efficiency improvement. At the end of 2010 the installed wind capacity was 1448 MW. Due to low wind speeds in 2010, resulting in a capacity factor of only 24% as opposed to an average of over 30% for the previous eight years, there was a deterioration in efficiency. As 2010 was also a relatively dry year, the hydro contribution was the lowest in twenty years, which also contributed to the efficiency deterioration.

Figure 37 *Efficiency of electricity generation and supply 1990 to 2010*

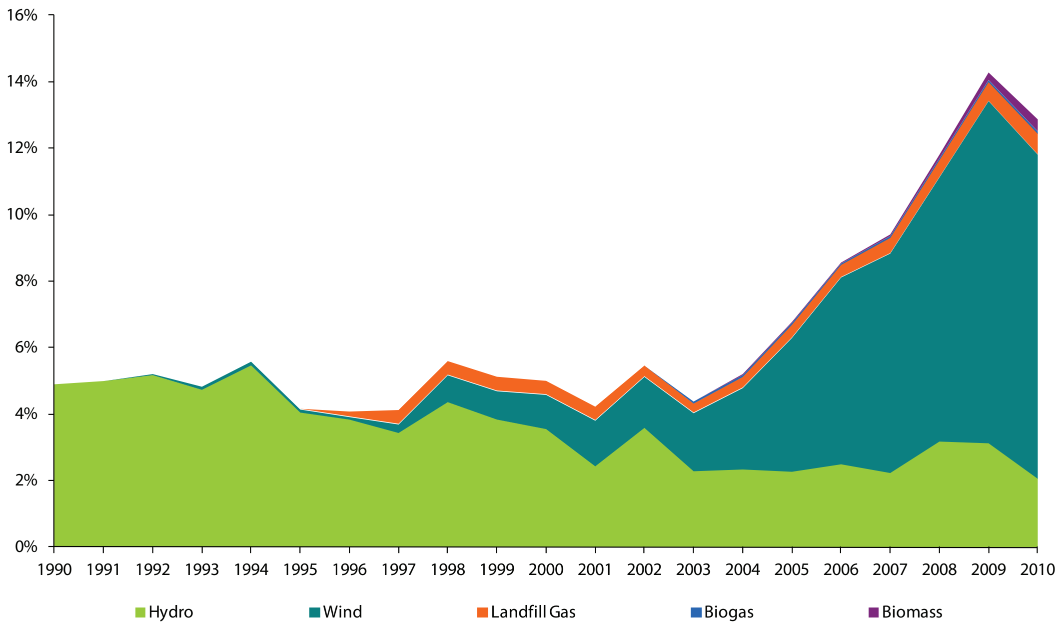


Source: SEAI

6.4.2 Electricity from Renewables

The contribution from renewable energy sources to electricity generation is plotted in Figure 37. Because of the variability of renewables in the short term conventional plant with flexibility is required for short term energy security in order to integrate more renewables on the grid.

Figure 38 *Renewable energy (%) contribution to gross electricity consumption by source*



Source: SEAI and EirGrid

Table 8 *Renewable electricity as percentage of gross electricity consumption*

	1990	1995	2000	2005	2006	2007	2008	2009	2010
Renewables % of Gross Electricity	4.9	4.1	5.0	6.8	8.6	9.4	11.8	14.3	12.9
Hydro	4.9	4.1	3.6	2.3	2.5	2.2	3.2	3.1	2.1
Wind	-	0.1	1.0	4.0	5.6	6.6	7.9	10.3	9.7
Biomass	-	-	0.4	0.5	0.4	0.6	0.7	0.9	1.1

Source: SEAI and EirGrid

Table 8 shows the share of electricity generated from renewable energy sources (RES-E) in 2010 was 12.9%. A significant milestone in 2009 was that wind energy accounted for over 10% of all electricity generation. Biomass is a collective term comprising electricity generation from solid biomass, landfill gas and biogas, where landfill gas provides the most significant input. The more than doubling of electricity generation from renewable energy is clearly visible in Figure 37 and is dominated by the growth in wind energy.

In calculating the contribution of hydro and wind energy for the purpose of the overall 16% target for renewable energy in Ireland by 2020 in Directive (2009/28/EC) the effects of climatic variation are smoothed through use of a normalisation rule. The normalisation rule is specified in Annex II of the Directive (2009/28/EC). When normalisation is applied to hydro and wind the renewable energy as a percentage of gross electricity consumption changes as detailed in Table 9.

Table 9 *Normalised renewable electricity as percentage of gross electricity consumption*

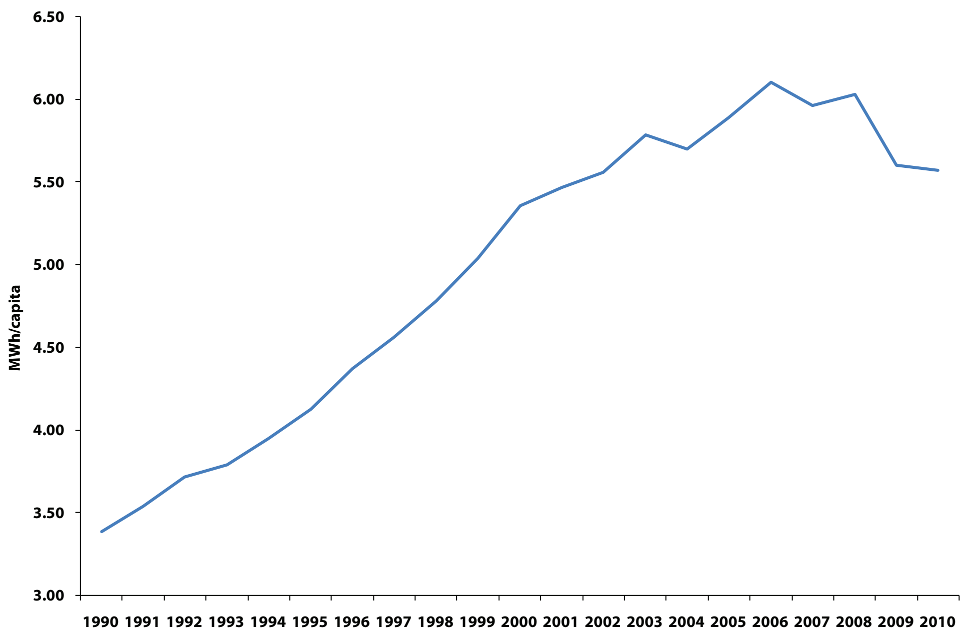
	1990	1995	2000	2005	2006	2007	2008	2009	2010
Renewables % of Gross Electricity	5.3	4.6	4.8	7.2	8.7	9.9	11.1	13.7	14.8
Hydro (normalised)	5.3	4.5	3.4	2.7	2.6	2.5	2.5	2.6	2.6
Wind (normalised)	-	0.1	1.0	4.0	5.6	6.8	7.9	10.2	11.2
Biomass	-	-	0.4	0.5	0.4	0.6	0.7	0.9	1.1

Source: SEAI and EirGrid

6.4.3 Electricity Demand

Electricity demand per capita increased by 65% over the period (2.6% per annum), as shown in Figure 39. The impact of the recession can be seen in the significant drop (4%) in consumption per capita between 2008 and 2009 .

Figure 39 *Electricity demand per capita*



Source: SEAI

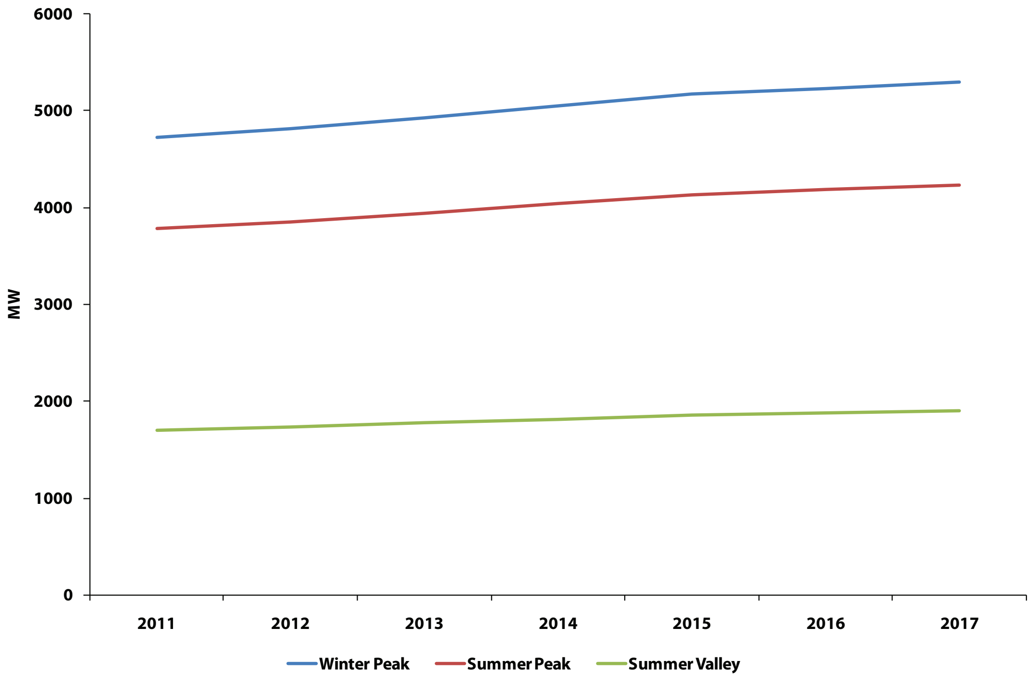
The winter peak figures represent the expected annual peak demands that are forecast to occur in the October to February winter period of each year; for example the 2010 forecast of 4,950 MW is the maximum demand projected to occur in winter 2010/11. The peak for 2010 was 5,090 MW, which occurred on December 21st. These peak forecasts take account of the influence of demand-side management (DSM) schemes, such as EirGrid's winter peak demand reduction scheme (WPDRS).

EirGrid (the Transmission System Operator) forecast the transmission demand in an annual publication called "Transmission Forecast Statement" (TFS) for three different scenarios, namely: the winter peak demand, the summer peak demand and the summer valley or summer minimum demand. The summer minimum demand is relevant for variable renewable energy as minimum demand periods that occur when the renewable resource is abundant could mean not all the renewable power is required to meet demand. The summer peak refers to the average peak value between March and September. This is typically 20% lower than the winter peak. While the overall grid power flow may be lower in summer than in winter, this may not be the case for flows on all circuits. In addition, the capacity of overhead lines is lower because of higher ambient temperatures, while network maintenance, normally carried out in the March to September period, can weaken the network, further reducing its capability to transport power.

The annual minimum is referred to as the summer valley. Summer valley cases examine the impact of less demand and less generation dispatched. This minimum condition is of particular interest when assessing the capability to connect new generation. With local demand at a minimum, the connecting generator must export more of its power across the grid than at peak times. In preparing the forecasts EirGrid reviewed historical summer valley demand data and the analysis showed a trend over recent years of increasing summer valley demand.

Figure 40 presents the forecasts of transmission demand for the period 2011 to 2017 from EirGrid's latest Transmission Forecast Statement. While it is difficult to accurately predict a peak demand figure for a particular year, the forecasts in Figure 40 may be taken as indicative of a general trend in demand growth. Three demand values are presented for each year: the winter peak, the summer peak and the summer valley. It can be seen that winter peak and summer peak demand are both projected to increase by 12% over the course of the period, which is an average annual increase of 1.9%.

Figure 40 *Transmission peak and valley demand forecast 2010 to 2016*



Source: EirGrid

6 Energy Security Examination by Fuel

6.4.4 Electricity Infrastructure and Investment

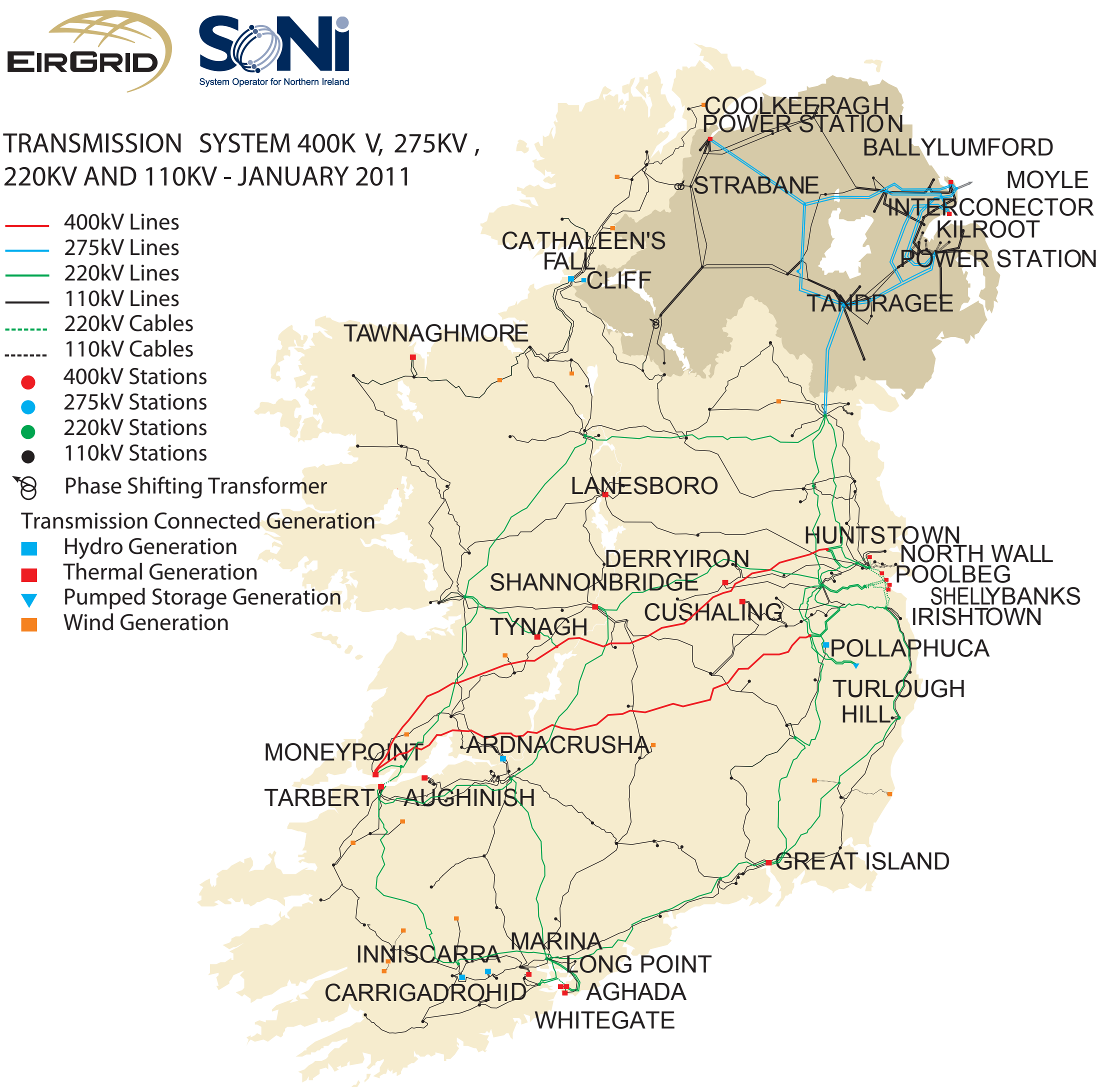
In terms of electricity infrastructure, Ireland relies on an extensive high-voltage transmission network and a medium- and low-voltage distribution network to transport electricity domestically, detailed in Figure 41. The transmission network , a meshed network of high voltage lines and cables for the transmission of bulk electricity, forms the backbone of the electricity supply system in Ireland. EirGrid is the transmission system operator, responsible for planning and operating the transmission system. The main features of EirGrid's transmission development plan are:

- Completion of the 220 kV expansion project to Srananagh in the Sligo area to meet demand in the North West and provide an essential route for power flows from future wind generation.
- Expansion of the 400 kV system to provide necessary bulk transfer capacity out of Dublin and Moneypoint, and between this system and the Northern Ireland system.
- The strengthening of the networks in and around Athlone, Castlebar, Cavan, Cork City, Dunmanway, Galway, Letterkenny, Meath Hill, Newbridge, Tullamore, and Wexford to meet demand.
- Establishment of four new 220/110 kV stations in Kerry, three of which are required to connect renewable generation.
- Connection of nine new DSO stations and connection of nine new thermal generators to the transmission system.
- Facilitating the connection of 1,424 MW of renewable energy from the Gate 2 process and 3,995 MW Gate 3 wind applications.

EirGrid also has a longer term strategy for the development of the transmission system out to 2025, described in the publication titled GRID 25.

ESB Networks Ltd. is the licensed operator of the electricity distribution system in the Republic of Ireland. They are responsible for building, operating, maintaining and developing the electricity network and serving all electricity customers in the Republic of Ireland. As Meter Operator, they also install, maintain and read all electricity meters. A recent network upgrading project saw all of Ireland's MV (Medium Voltage) overhead electricity network converted to 20kV or refurbished. A comprehensive programme of asset replacement was also carried out in 2010 based on asset condition, performance and system risk. This programme covered a wide range of network assets including: overhead lines, underground cables, medium and low voltage substations.

Figure 41 *Electricity transmission and distribution system*

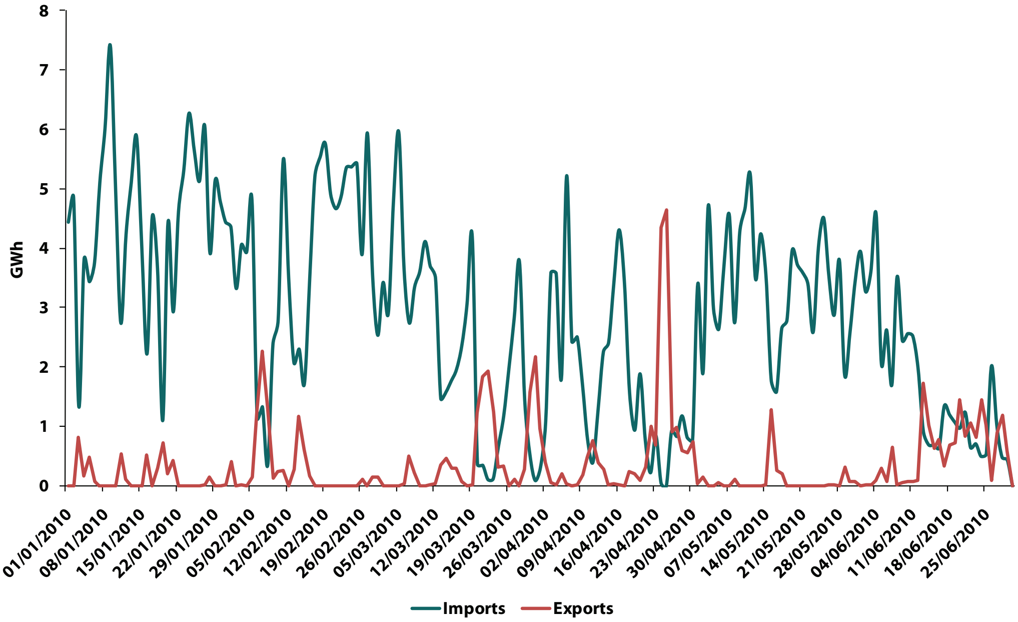


Source: EirGrid

6.4.5 Interconnection

The electricity network in the Republic of Ireland is interconnected with Northern Ireland. The main interconnector is at the Louth 220 kV station. The flows on this interconnector between January to June 2010 are shown in Figure 42. In addition there are 110 kV connections at Letterkenny in Co. Donegal and Corraclassy in Co. Cavan. The two Transmission System Operators (TSOs) in the Republic of Ireland and Northern Ireland are jointly progressing plans to develop an additional North/South interconnector. This interconnector is due to be completed between 2015 and 2017 (EirGrid and SONI, 2010).

Figure 42 *Flows on the North-South interconnector (Louth-Tandragee 275kV lines)*



Source: EirGrid

The development of interconnection between the All-Island Electricity Grid system and other grids, for example Great Britain and Europe, is considered necessary in order to facilitate greater amounts of renewable electricity. The East-West interconnector between Ireland and Britain is due to be operational by 2012. Investigations are ongoing into other possible interconnectors to either the UK or France. EirGrid states in its Grid 25 development plan that it is likely there will be at least one other interconnector by 2025. However the likelihood of another interconnector has been questioned given the reduction in electricity demand along with the new economic climate, both due to the recession.

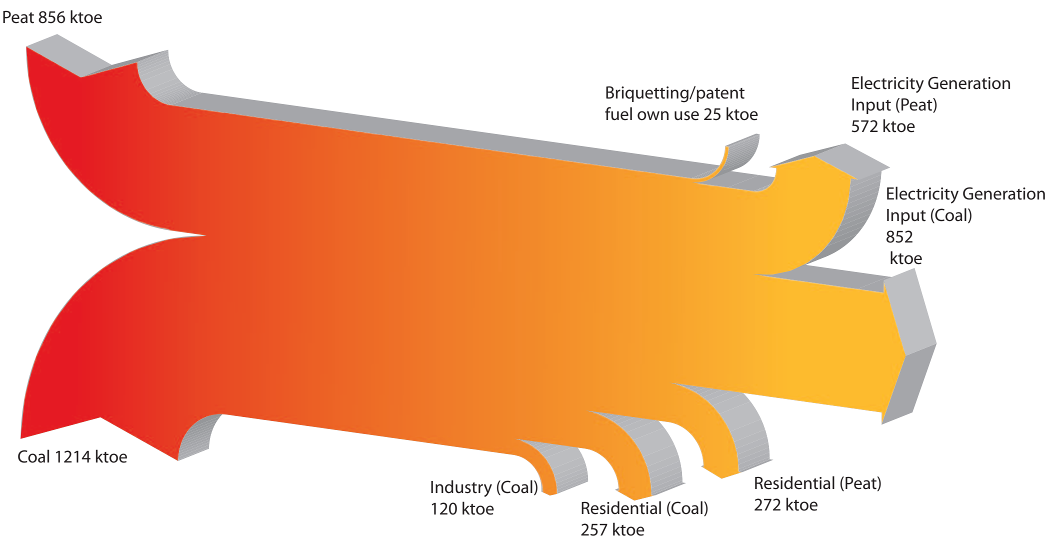
Ireland is also being considered for inclusion in an off-shore supergrid along with other northern EU countries and Norway. The envisaged grid would integrate and connect renewable energy production capacities in the Northern Seas with consumption centres in Northern and Central Europe and hydro storage facilities in the Alpine region and in Nordic countries (European Commission, 2010b).

6.5 Solid Fossil Fuels

6.5.1 Coal and Peat Consumption

Figure 43 presents an energy flow diagram for solid fuels in 2006. Coal and peat inputs are shown on the left while outputs on the right are categorised by sector. It can be seen from *Figure 43* that coal is the dominant solid fuel and electricity generation accounts for the largest share of solid fossil fuel usage.

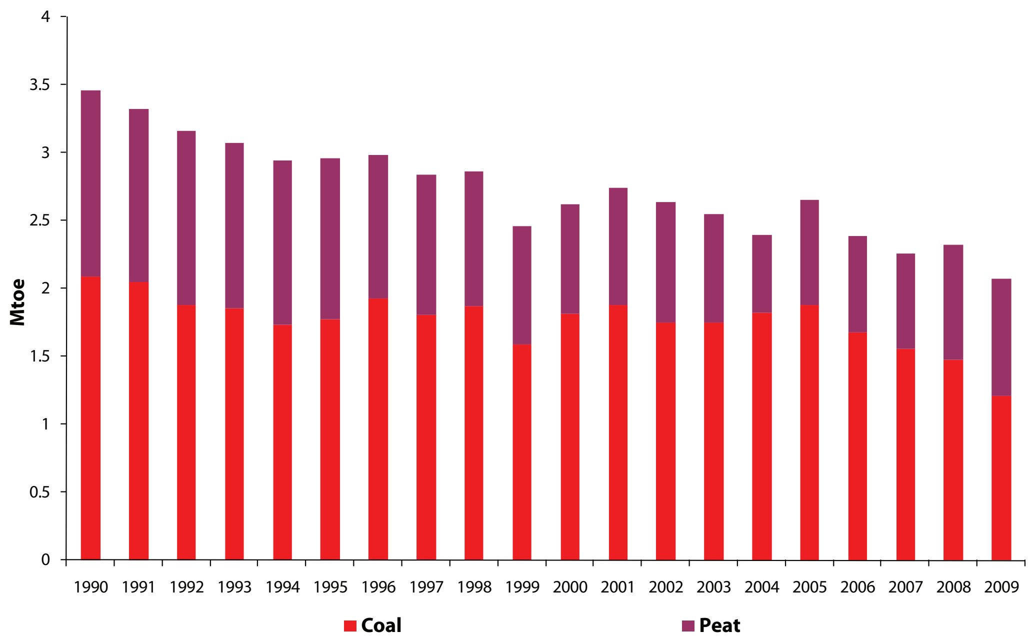
Figure 43 *Energy flow 2009 - solid fuels*



Source: SEAI

The primary energy demand for coal and peat over the period 1990 to 2009 is illustrated in Figure 44. Over the period consumption of coal and peat declined by 22% and 49% respectively. This is in part reflecting energy and climate policies directed at diversifying away from carbon intensive fossil fuels. However, both coal and peat are important sources of fuel diversity from a supply security perspective.

Figure 44 *Coal and peat consumption 1990 to 2009*

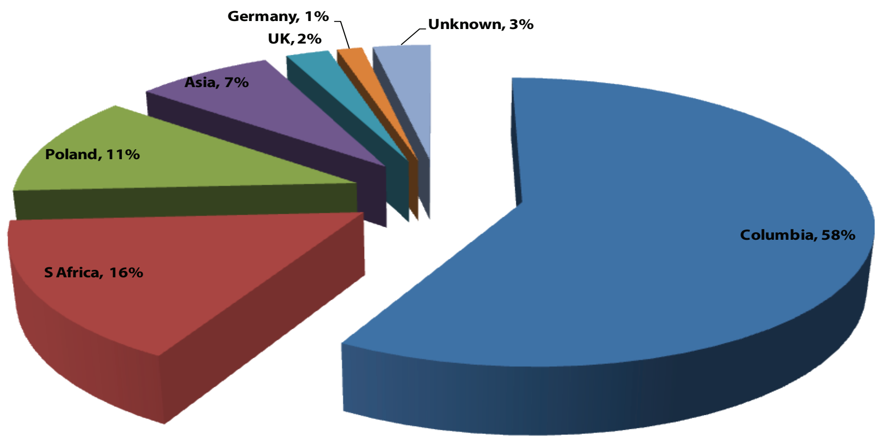


Source: SEAI

6.5.1.1 Coal Imports

In 2009 coal (which in this case includes lignite, bituminous coal, manufactured ovoids and anthracite) imports into Ireland totalled 2.2 million tonnes. *Figure 45* illustrates the type and origin of the coal used in 2009. The largest share of Ireland's imports of coal came from Columbia (42%).

Figure 45 *Coal imports by country of origin in 2009*

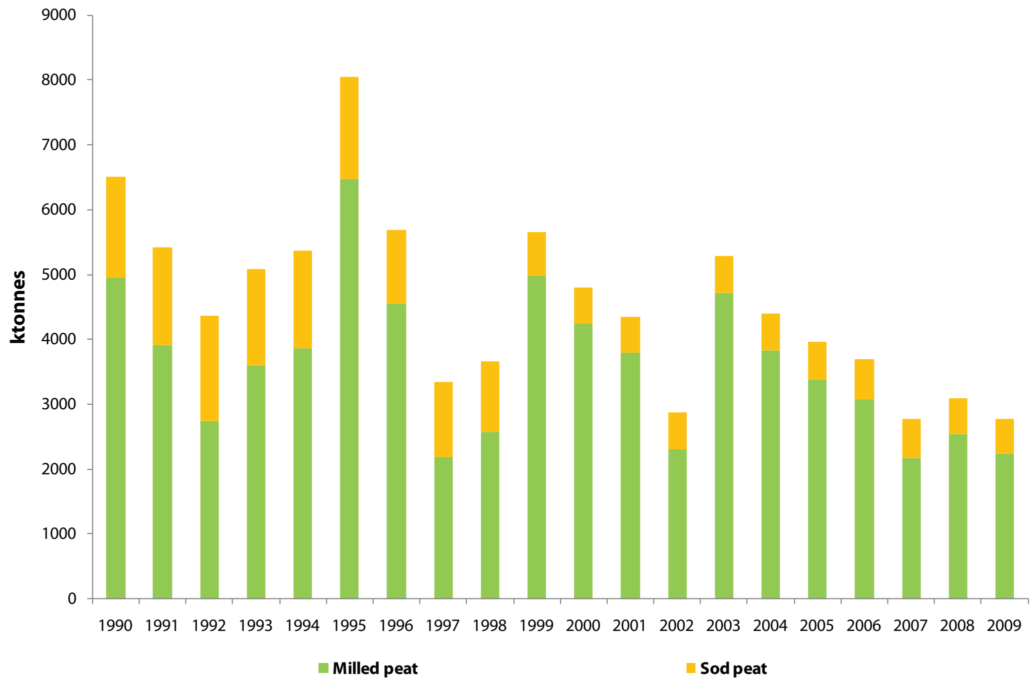


Source: SEAI

6.5.2 Peat Production

Figure 46 shows the production of peat over the period 1990 to 2009. Milled peat is produced by Bord na Móna while sod peat is produced by the private sector. Total peat production peaked in 1995 at 8 million tonnes. Total production in 2009 was 2.8 million tonnes, 81% of which was milled peat.

Figure 46 *Peat production 1990 to 2009*



Source: Bord na Móna

6 Energy Security Examination by Fuel

There is a public service obligation to use peat in electricity generation; see section 5.1.5.3. This is government policy in order to maintain the use of an indigenous fuel source in electricity generation for energy security reasons and in order to maintain employment in the relatively scarcely populated Irish midlands region. However a recent study (Tuohy et al., 2009) suggests the current ''must-run'' mode of operation adopted for peat generation appears sub-optimal. It shows that while peat is beneficial for one pillar of energy policy (security), the current usage of peat is not optimal from a competitiveness or environmental perspective.

6.6 Solid Renewables and Wastes

The significant renewable energy sources in use in the electricity sector, biogas and renewables in transport have already been discussed. Solid renewables and wastes are mainly used for generating heat, with just a small portion used for co-firing of electricity generating stations with fossil fuels and for small combined heat and power units (CHP). Renewables, which are mostly indigenous sources of energy, enhance energy security by reducing demand for imported fossil fuels and also the exposure to their variations in price. They also contribute to diversification of the fuel mix.

Approximately 34% of all primary energy was used for thermal energy, i.e. space or process heating, in 2009. Renewable energy sources in the heat sector include solid biomass – mainly wood and wood wastes, geothermal and solar thermal energy. There is a government target of 12% of thermal energy to come from renewable energy sources by 2020. In 2009 share of renewables in the heat sector was at 4.2%.

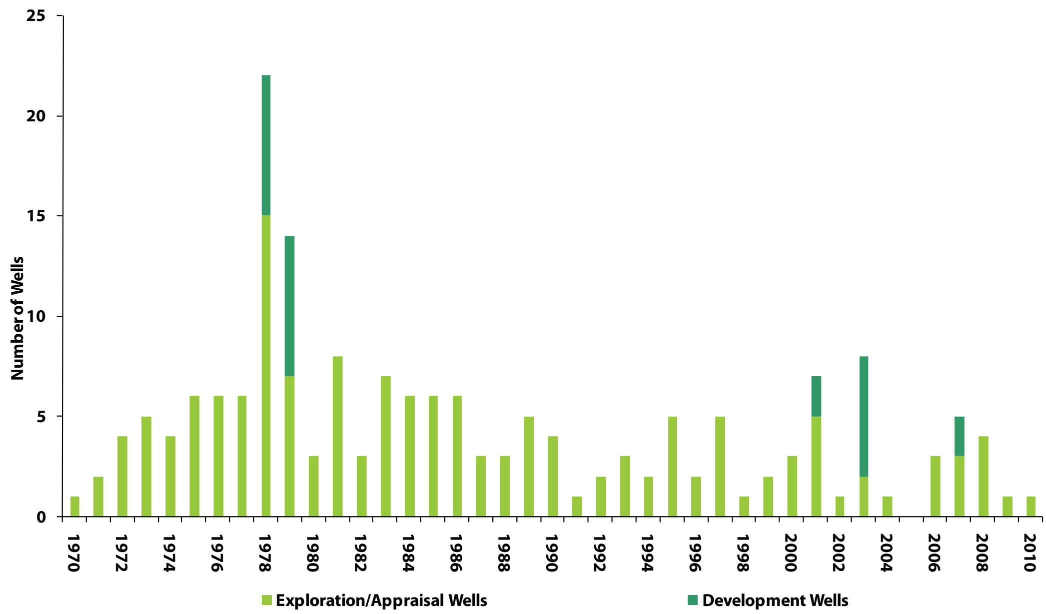
While landfill gas first appeared in the national energy balance in 1996 and the biogas category including biogas from waste water treatment plants has been used as an energy source since 2003, in 2009 a new category for solid wastes to energy was added to the energy balance. Using wastes for energy not only enhances energy security by diversifying the energy fuel mix but also contributes to waste management targets by diverting from landfills.

7 Exploration Metrics

7.1 Oil and Gas Exploration

Figure 47 shows the amount of exploration for oil and gas taking place in Irish waters. The number of wells drilled is currently very low, reflecting the perceived unattractiveness of Irish waters for mineral exploration. It should be noted that among the 157 exploration wells that have been drilled since 1970, only 5 discoveries have been exploited. They are: Kinsale Head, Southwest Kinsale, Ballycotton, Seven Heads and Corrib gas field which is currently under development. The primary gas field in Ireland over the last decade, Kinsale, is in decline.

Figure 47 *Wells spudded and drilled in Ireland for exploration 1970 to 2010*



Source: DCENR (PAD)

An explanation of the graph legend is as follows:

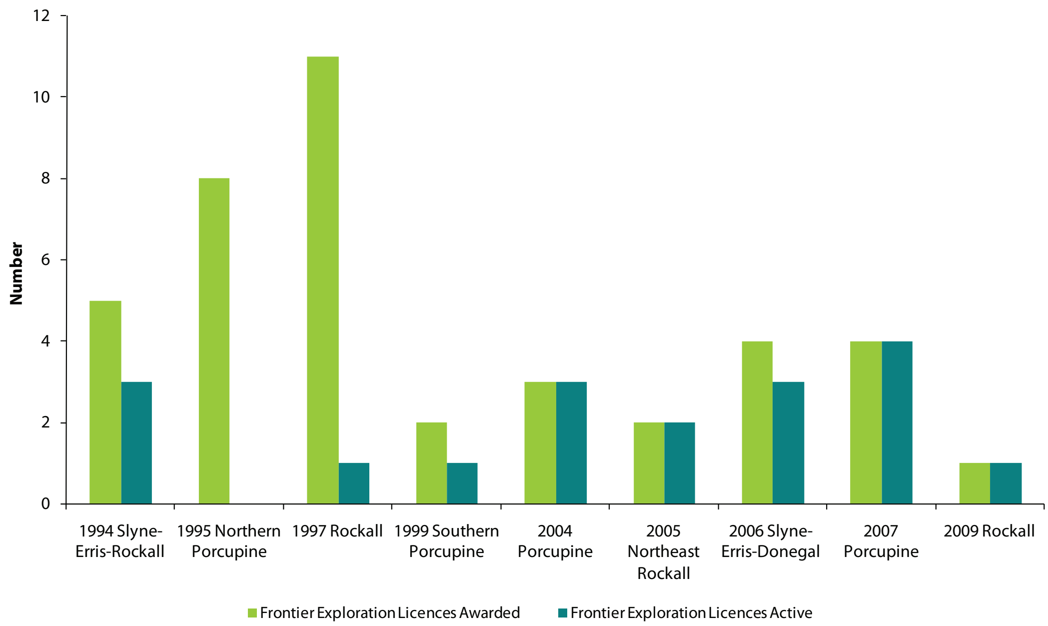
- Exploration wells are drilled on valid prospects outside the interpreted limits of commercial or potentially commercial discovered hydrocarbons.
- Appraisal wells are drilled subsequent to establishing the location of hydrocarbon accumulations, within the interpreted limits of commercial or potentially commercial discovered hydrocarbons, for the purpose of delineating the size and productive capacity of the reservoir(s), and
- Development wells are drilled for the purpose of production, injection, observation or disposal of fluid to or from known fields.

The number of licences to explore that have been granted since 1992 and the number that are currently active are shown in Figure 48. In October 2007 the terms were announced for a new oil and gas exploration licensing round in the Porcupine Basin. From this round profitable fields will pay up to 40% in taxation to the Exchequer, an increase of 15% for the oil and gas companies involved. The acreage on offer in the Porcupine Basin to the west of Ireland covers unlicensed blocks in an area of approximately 63,500 square kilometres. The acreage on offer for Rockall Basin off the west coast covered unlicensed blocks in an area of approximately 117,200 square kilometres.

In the most recent licensing round, the 2011 Atlantic Margin Licensing Round, 15 separate applications were received, the largest number received in any round. The round was different from previous licensing rounds and is designed to boost the level of exploration activity off the Irish coast. For the first time ever the area covered in the 2011 Round includes all of Ireland's Atlantic sedimentary basins. The area on offer extends from about 30-380 km from shore with water depths typically ranging from 200m, or less, to over 3000m[25].

25 Details available from the Petroleum Affairs Division of the Department of Communications, Energy and Natural Resources.

Figure 48 *Number of licences 1994 to 2009*



Source: DCENR (PAD)

7.2 Shale Gas

Three companies were awarded exploration licensing options in early 2011 for on-shore gas in the Lough Allen Basin, also known as the North West Ireland Carboniferous Basin, and in the Clare Basin, targeting the natural gas resource potential of the two basins, which had been identified in earlier exploration. The Licensing Options are valid for a period of up to a maximum of 24 months and may not be extended. Option-holders are required to hold a Petroleum Prospecting Licence for the full duration of the Licensing Option. The Licensing Options are subject to the Licensing Terms for Offshore Oil and Gas Exploration, Development and Production 2007[26]. By late 2012 or early 2013, an assessment of the petroleum resource potential for the area must be provided to the Department of Communications, Energy and Natural Resources (DCENR), along with costed plans for further exploration or exploitation. Prior to commercial exploitation an exploration licence is required and also a Petroleum Lease.

Shale gas is extracted using a process known as hydraulic fracturing. In the past, the oil and gas industry considered gas locked in tight, impermeable shale (shale gas) uneconomic to produce. However, advances in directional well drilling and reservoir stimulation have dramatically increased gas production from unconventional shales (Andrews, et al., 2009). Hydraulic fracturing will not take place in the basins North West Ireland Carboniferous and the Clare during the period covered by the Licensing Options (2011 to end of 2012/early 2013). There are concerns about the environmental impacts of hydraulic fracting which would need to be addressed prior to the issuing of exploration licences.

7.3 Coal

There may also be reserves of coal. For example, the Kish Bank Basin, offshore of Dublin, is thought to contain significant quantities of bituminous coal. However, an extensive programme of exploration is required to quantify resources. A Geological Survey of Ireland report in 1986 considered the potential for exploiting this coal. Currently, however, there are no exploration licences covering the area.

7.4 Peat

Peatlands cover 1.03 million hectares of the Republic of Ireland and approximately 25,000 hectares, or 8% of the area once classified as raised bogs is currently actively harvested. There has not been any new bogs acquired in the last 20 years by the state agency responsible for peat harvesting (Bord na Mona). Under the EU Habitats Directive Ireland is obliged under Articles 2 and 4 to protect and, where possible, restore raised boglands.

26 Available at: http://www.dcenr.gov.ie

8 Supply/Demand (S/D) Index

As part of the continuing commitment to develop and improve energy security indicators, SEAI commissioned the following research in 2010 which updates and examines the supply/demand index of Security of Supply for Ireland. The S/D Index is a Security of Supply indicator developed by the Energy Research Centre of the Netherlands (ECN) and Clingendael International Energy Programme (CIEP). The first version of the index was published in 2006 (Scheepers et al., 2006). In 2006, SEAI commissioned ECN to calculate the S/D Index for Ireland for the years 2005 and 2020 (SEAI, 2006). The S/D Index was updated in 2007 and then proposed to be one of the three components of an 'EU standard' for the security of energy supply (Scheepers et al., 2007). Following this update, SEAI requested ECN to calculate the S/D Index for Ireland again, based on Irish national energy balances for 2005 and 2006, and a national forecast.

This section describes the results of quantifying the S/D Index for Ireland for the years 2008 and 2020. The results are presented in Section 8.3. The quantification is based on 2008 data for Ireland, the most recent available when the update was commissioned. The results for the EU-27 Member States can be used to establish the relative position of Ireland. The PRIMES based quantifications, as reported in Scheepers et al. (2007), have been used for this purpose. Section 8.2 provides more details on the data assumptions for Ireland.

The 2008 quantification is based on a combination of data sources:

- The 2008 national energy balance provided by SEAI,
- Eurostat data[27] or PRIMES model result (EC, 2006) from supplemented with information from other sources (IEA, 2006). These sources are used to supplement the data that are not available from the SEAI energy balances.

In addition, ECN has quantified the S/D index for the year 2020 based on four scenarios:

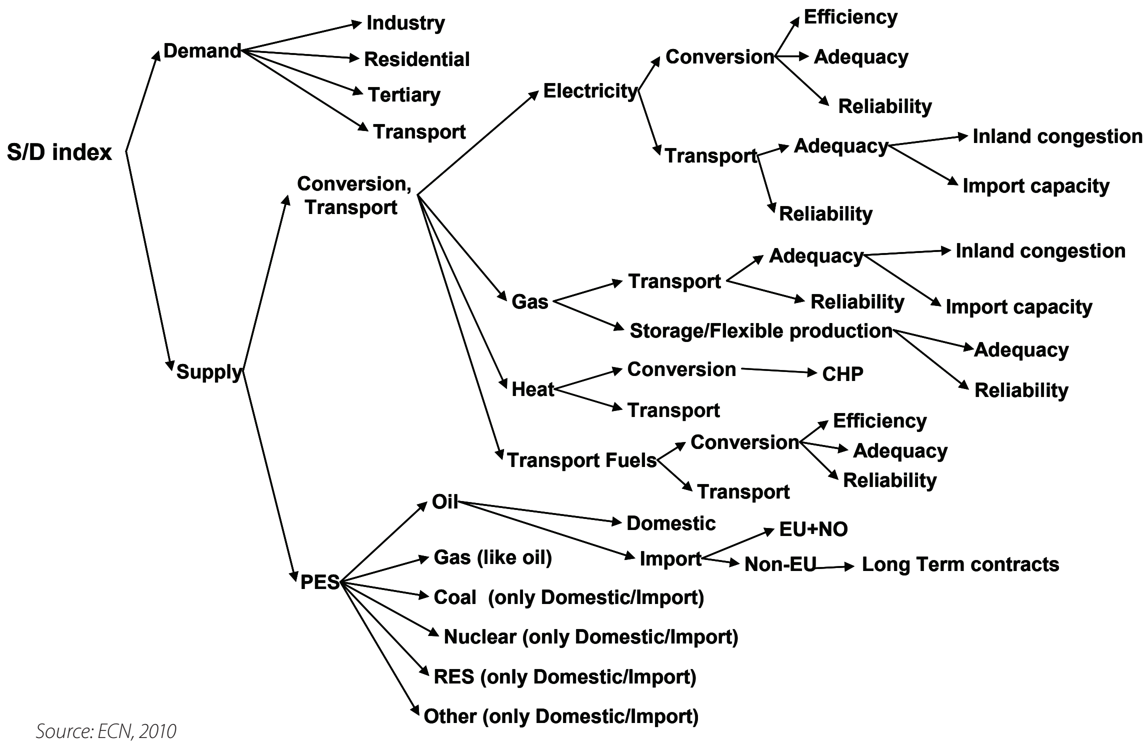
- SEAI forecast for 2020, 'SEAI Baseline' scenario. This scenario does not constitute an expected outcome, but is the counterfactual scenario against which the expected impact of various policy measures can be compared.
- SEAI forecast for 2020, 'SEAI White Paper plus' scenario. This scenario shows that Ireland will almost achieve the 16% RES target of the EU Renewables Directive as well as fully achieve the national targets.
- The 'EU Trends to 2030 - Update 2009' Baseline and Energy Efficiency scenarios (EU, 2010a). These scenarios provide the most recent European Commission estimates for the year 2020, based on quantification by the PRIMES model. The results of this quantification are summarised in Section 5.1.3.1, mainly to compare them with the SEAI 2020 scenarios.

8.1 Description of the Supply/Demand Index

The S/D index aims at reviewing and assessing energy security of supply in the medium and longer run. The S/D Index covers final energy demand, energy conversion and transport and primary energy sources supply (PES). It uses four types of inputs; two objective types and two types of a more subjective nature. The objective inputs concern the shares of different supply and demand types (i.e. for demand: industrial use, residential use, tertiary use and transport use; for supply: oil, gas, coal, nuclear, RES and other) and the values characterizing capacity and reliability in conversion and transport based on the secondary energy carriers (electricity, gas , heat and transport fuels). Figure 49 displays the conceptual model of the elements considered in the overall S/D Index.

27 Eurostat 2008

Figure 49 *The S/D Index Model Structure*



Source: ECN, 2010

The subjective inputs concern the weights which determine the relative contribution of the different components in the Index (such as the relation between supply and demand outputs in the Index, or the relation between EU imports and non-EU imports) and the scoring rules for determining various Index values reflecting different degrees of perceived vulnerabilities.

Six cases have been quantified for Ireland:

- IE-2008s-base — Quantification of the S/D index for 2008 based on the energy balances provided by SEAI, supplemented with data from Eurostat and the European Commission.
- IE-2020-base — Quantification of the year 2020 based on the SEAI Baseline forecast, supplemented with data from Eurostat and the European Commission.
- IE-2020-base2 — As IE-2020-base, but with alternative assumptions on the origins of imports of oil and gas.
- IE-2020WP — Quantification of the year 2020 based on the SEAI White Paper Plus (WP+) forecast.
- IE-2020-Primbase — Quantification of the year 2020 based on the PRIMES Baseline (EU, 2010a).
- IE-2020-Primref — Quantification of the year 2020 based on the PRIMES Reference scenario (EU, 2010a).

The results are summarised in Figure 50 and Table 11. In addition to the overall S/D index, Table 11 provides the sub-scores and the weighing factors with which the sub-scores are combined into the overall S/D index. Results should be assessed with consideration of the data assumptions laid down in the next section.

8.2 Data Assumptions – Ireland

This section provides a brief overview of the main data assumptions for the cases quantified.

8.2.1 2008 Assumptions

For the 2008 quantifications, the SEAI energy balances were used to the best possible extent, resulting in estimates for:

- Final energy demand shares (weights for demand scores).
- Shares of primary energy sources (weights for PES scores).
- Import dependencies (used in scoring PES).

Other information provided by SEAI includes:

- CHP share in electricity production (used in scoring C+T heat share).
- Average efficiency of thermal electricity production (used in scoring electricity).

Eurostat data have been used for the import origin of oil and gas, in particular the share of the imports coming from outside the EU and Norway. In 2008, these shares amounted to 16% and 0% respectively. Oil imports from outside the EU originate from Libya.

European Commission benchmarking reports have been used to establish the electricity reserve margin and import capacity share, resulting in 10.4% (domestic capacity in relation to peak demand) and 6% (import capacity as fraction of domestic capacity), respectively. The CHP shares were estimated by SEAI (SEAI, 2010a) and equal 6.3%, for 2008. According to the most recent PRIMES results, the CHP share in 2005 was equal to 2.6%.

The efficiency of electricity generation equalled 46.6% in 2008 (ECN calculations based on figures provided by SEAI).

8.2.2 2020 Assumptions

The following parameters have been adopted from the SEAI forecasts for the year 2020[31]:

- Final energy demand shares.
- Shares of primary energy sources.
- Average efficiency of thermal electricity production, 44.9% and 50% from the SEAI Baseline & SEAI WP+ scenarios respectively.
- Interconnection capacity increase to 900 and 1400 MW_e for the Baseline and WP+ scenarios, respectively.
- The CHP share was assumed to be equal to the 2008 energy balance value (6.3%).

The same parameters have been calculated or adopted from the PRIMES 'EU Energy Trends to 2030 - Update 2009' forecast for the year 2020:

- Final energy demand shares.
- Shares of primary energy sources.
- Average efficiency of thermal electricity production 46.9% and 45.7% for the baseline and reference scenarios respectively.
- The interconnection capacity increases by 500 MW from 2012 onwards due to the new interconnector linking Wales to the Republic of Ireland. This capacity increase adds to the existing Moyle 400 MW link between Northern Ireland and Scotland. This equals the assumption in the SEAI Baseline scenario.
- CHP shares of 4.6% and 4.5% for Baseline and Reference scenarios (EU, 2010a) respectively. These shares are lower than in SEAI's own forecasts for 2020.

The SEAI 2020 forecasts do not provide figures for the import dependencies, therefore they are assumed to be equal to the SEAI 2008 energy balance figures. The PRIMES forecasts provide specific values for the import dependencies in the year 2020. Crude oil and natural gas import shares coming from within the EU and Norway are mainly based on SEAI input to Eurostat.

8.3 Results

8.3.1 2008 Results

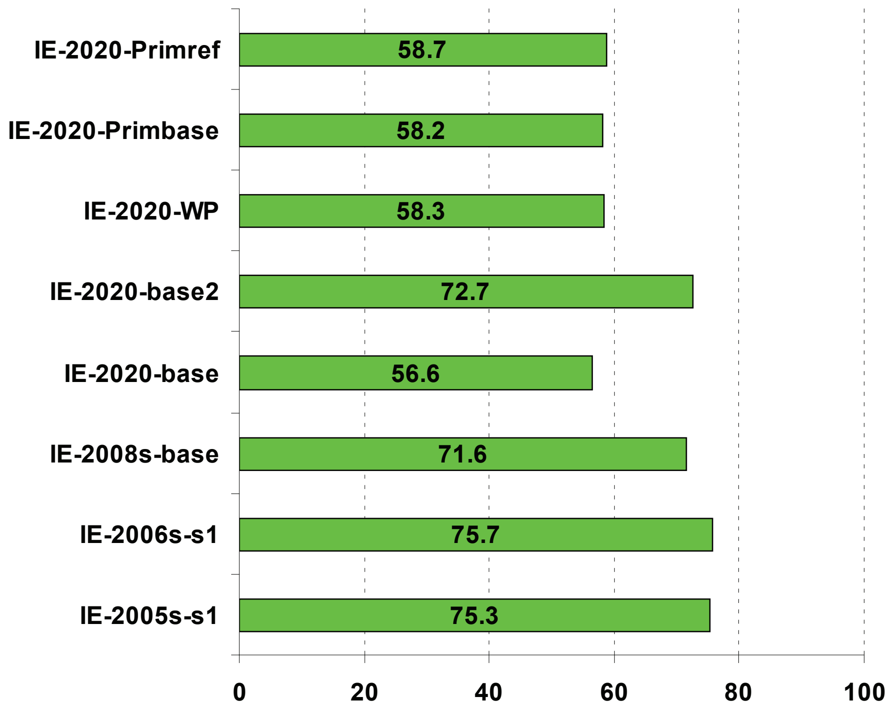
Based on this new analysis, the result for the year 2008 shows a minor decrease to about 72, compared to the previous scores for the years 2006 and 2007 as obtained from the analysis in 2007 (SEAI, 2007). All of these scores compare well to the other EU-27 Member State (MS) cases as scored for the year 2005 (SEAI, 2007; Scheepers *et al.*, 2007; Jansen and Seegregts, 2010).

Ireland's S/D index for 2008 is the third best score when compared with the index scores of other EU Member States obtained for 2005.

These relatively high scores for Ireland are caused by high sub-scores in the PES (primary energy sources). The PES sub-scores were quite high (96-97) in 2005 and 2006, due to oil and gas import from within the EU and Norway. The oil and gas scores are therefore 100 (IE-2005s and IE-2006s). In 2008, the PES sub-score dropped to 88, which was mainly due to the import of 16% of the oil from outside the EU/Norway (Libya).

The C+T (Conversion and Transport) scores are moderate (52 to 56, increasing from 2006 to 2008). This is mainly due to the relatively low CHP share in the electricity production (2.2% in 2005, in 2008 increased to 6.3%: SEAI, 2010).

Figure 50 *The S/D Index results for Ireland, 2005-2008, and 2020 scenarios*



Source: ECN, 2010

8.3.2 2020 Results

Origins of oil and natural gas imports are the main relevant factors

From the S/D index scores it can be concluded that Ireland's S/D Index is largely determined by the origin of the imported oil and gas, given the large share of oil and gas in the primary energy mix (82% in 2008 and still 78% in the two 2020 SEAI forecasts). Changes in the origins of these oil and gas imports could cause the S/D Index to deteriorate in the medium and longer term.

As the origin of imported oil and gas cannot be derived from the scenarios, an assumption has to be taken. Different assumptions are possible. When in 2020 the origins of the imports of oil and gas are assumed to remain the same as in 2008 (IE-2020-base2), the 2020 S/D Index score continues to increase to 72.7 in the SEAI Baseline scenario case. If the depletion of oil and gas fields in North-West Europe is taken into account, it is likely that countries like Ireland and the UK will import more from outside the EU/Norway in 2020 compared to 2005. The import dependency of the UK is also of relevance, since Ireland imports oil and gas mainly from the UK. A large part of the gas imported by Ireland from the UK will no longer be largely produced in the UK, but increasingly be imported by the UK. The UK predicts an import dependency of around 69% in 2019 (UK National Grid, 2010). For both reasons, as in the 2007 analysis, a 50/50 division for the origin of imports of oil and gas can be assumed for the year 2020. In this case the S/D Index drops to 56.6 and 58.3 for the SEAI Baseline and White Paper Plus scenarios, respectively. If the shares imported from outside EU and Norway increase even more substantially, a significantly larger drop in the S/D Index can be expected. Such a drop in the S/D index value would indicate a considerable increase in exposure to potential security of supply disruptions.

One of the possible measures to mitigate such exposure could be to decrease the share of oil in the PES mix (54-59% in 2020 SEAI Baseline and White Paper forecasts) by reducing demand and fuel switching. The latter could be achieved by increasing the share from renewable energy sources. Another possibility would be to increase the share of renewable sources in the transport sector, e.g. by biofuels, currently amounting to 3.0% and 8.0% in the SEAI Baseline and White Paper Plus scenarios respectively (SEAI, 2009) at the expense of fossil fuels.

Electricity interconnection capacity increase enhances security of supply

Additional interconnection capacity between Ireland and the United Kingdom improves the C+T electricity sub-score. In 2020 the sub-score will increase to 76 (SEAI Baseline) or 83 (SEAI WP+).

The interconnection capacity increases from 500 MW today (2010) to 900 and 1400 MW in the SEAI Baseline and White Paper Plus scenarios, respectively. The 500 MW East/West interconnector comes online in 2013. A third interconnector of 500 MW is included in the White Paper Plus scenario. The interconnector assumptions modelled are detailed in Table 10.

Table 10 *Electricity interconnection and generation capacity*

		2010	2020 Baseline[31]	2020 WP+[31]	Remarks
Interconnection capacity	MW_e	400 (Moyle)	900 (East/West, from 2013)	1,400	The third interconnector from the WP+ is not very likely.
Generation capacity	MW_e	9600	9,972	11,208	
Relative share	%	5.2	9.0	12.5	

Source: SEAI

A measure of the enhancement of security of supply in Ireland through increase of electricity interconnection capacity can be provided by computing the relative share of the latter in the Irish total generation capacity. The relative share is expected to increase from about 5% in 2010 to 9-12.5% in 2020.

Table 11 *S/D Index Ireland, 2005-2008 Statistics, 2020 SEAI and EU Energy Trends to 2030 scenarios*

	Statistics, Energy Balances						SEAI Baseline and White Paper Plus Scenarios						Primes, EU Energy Trends			
	2005		2006		2008		2020 Baseline		2020 Baseline 2		2020 WP+		2020 Primes Base		2020 Primes Ref	
S/D Index		75.3		75.7		71.6		56.6		72.7		58.3		58.2		58.7
Demand	***0.3***	***57***	***0.3***	***55.8***	***0.3***	***55.8***	***0.3***	***56.1***	***0.3***	***56.1***	***0.3***	***52.9***	***0.3***	***56.1***	***0.3***	***56.1***
Industry	0.21	100	0.19	100	0.19	100	0.19	100	0.19	100	0.20	100	0.19	100	0.19	100
Residential	0.23	44	0.23	44	0.24	44	0.22	40	0.22	40	0.20	46	0.25	40	0.25	40
Tertiary	0.16	62	0.15	62	0.16	62	0.15	66	0.15	66	0.13	48	0.16	66	0.15	66
Transport	0.40	40	0.42	40	0.42	40	0.45	42	0.45	42	0.47	37	0.40	42	0.41	42
Supply	***0.7***	***83.1***	***0.7***	***84.2***	***0.7***	***78.3***	***0.7***	***56.8***	***0.7***	***79.8***	***0.7***	***60.6***	***0.7***	***59.0***	***0.7***	***59.9***
C+T	**0.3**	**52.2**	**0.3**	**55**	**0.3**	**55.7**	**0.3**	**57.6**	**0.3**	**57.6**	**0.3**	**60.1**	**0.3**	**58.3**	**0.3**	**57.1**
Electricity	0.3	67	0.3	68	0.3	68	0.3	76	0.3	76	0.3	82	0.3	79	0.3	77
Gas	0.3	71	0.3	71	0.3	71	0.3	71	0.3	71	0.3	71	0.3	71	0.3	71
Heat	0.2	9	0.2	22	0.2	25	0.2	22	0.2	22	0.2	25	0.2	22	0.2	18
Transport Fuels	0.2	45	0.2	45	0.2	45	0.2	45	0.2	45	0.2	45	0.2	45	0.2	45
Primary Energy Supply	**0.7**	**96.3**	**0.7**	**96.7**	**0.7**	**88.0**	**0.7**	**56.4**	**0.7**	**89.3**	**0.7**	**60.9**	**0.7**	**59.4**	**0.7**	**61.0**
Oil	0.58	100	0.54	100	0.56	84	0.59	50	0.59	84	0.54	50	0.52	50	0.52	50
Gas	0.23	100	0.27	100	0.27	100	0.29	55	0.29	100	0.24	55	0.25	55	0.20	50
Coal	0.17	78	0.16	79	0.14	79	0.05	77	0.05	77	0.07	78	0.14	77	0.13	78
Nuclear	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100
Renewable Energy Sources	0.02	100	0.03	100	0.03	100	0.07	100	0.07	100	0.15	100	0.07	100	0.14	100
Other	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100	0.00	100	0.01	100	0.01	100

Source : ECN

9 Data Sources

Bord Gáis Éireann

Bord Na Móna

Central Statistics Office

Commission for Energy Regulation

Department of Communications, Energy and Natural Resources

Department of Trade and Industry (UK)

Economic and Social Research Institute

EirGrid

Environmental Protection Agency

ESB Networks

European Commission DG TREN

Eurostat

International Energy Agency

Joint Energy Security of Supply Working Group (UK)

National Oil Reserves Agency

Petroleum Affairs Division - Department of Communications, Energy and Natural Resources

UK Transmission National Grid (Gas)

US Geological Society

US Energy Information Administration

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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 (103 tonnes) and Mt CO_2 – mega-tonnes of CO_2 (106 tonnes).

Combined Heat & Power Plants: Combined heat and power (CHP) refers to plants which are designed to produce both heat and electricity. CHP plants may be autoproducer (generating for own use only) or third-party owned selling electricity and heat on-site as well as exporting electricity to the grid.

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

Gross Final Consumption (GFC): The Renewable Energy Directive (2008/28/EC) defines gross 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.

Gross Electrical Consumption: Gross electricity production is measured at the terminals of all alternator sets in a station; it therefore includes the energy taken by station auxiliaries and losses in transformers that are considered integral parts of the station. The difference between gross and net production is the amount of own use of electricity in the generation plants.

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.

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Ireland's EU Structural Funds Programmes 2007 - 2013
Co-funded by the Irish Government and the European Union

EUROPEAN REGIONAL DEVELOPMENT FUND

The Sustainable Energy Authority of Ireland is partly financed by Ireland's EU Structural Funds Programme co-funded by the Irish Government and the European Union