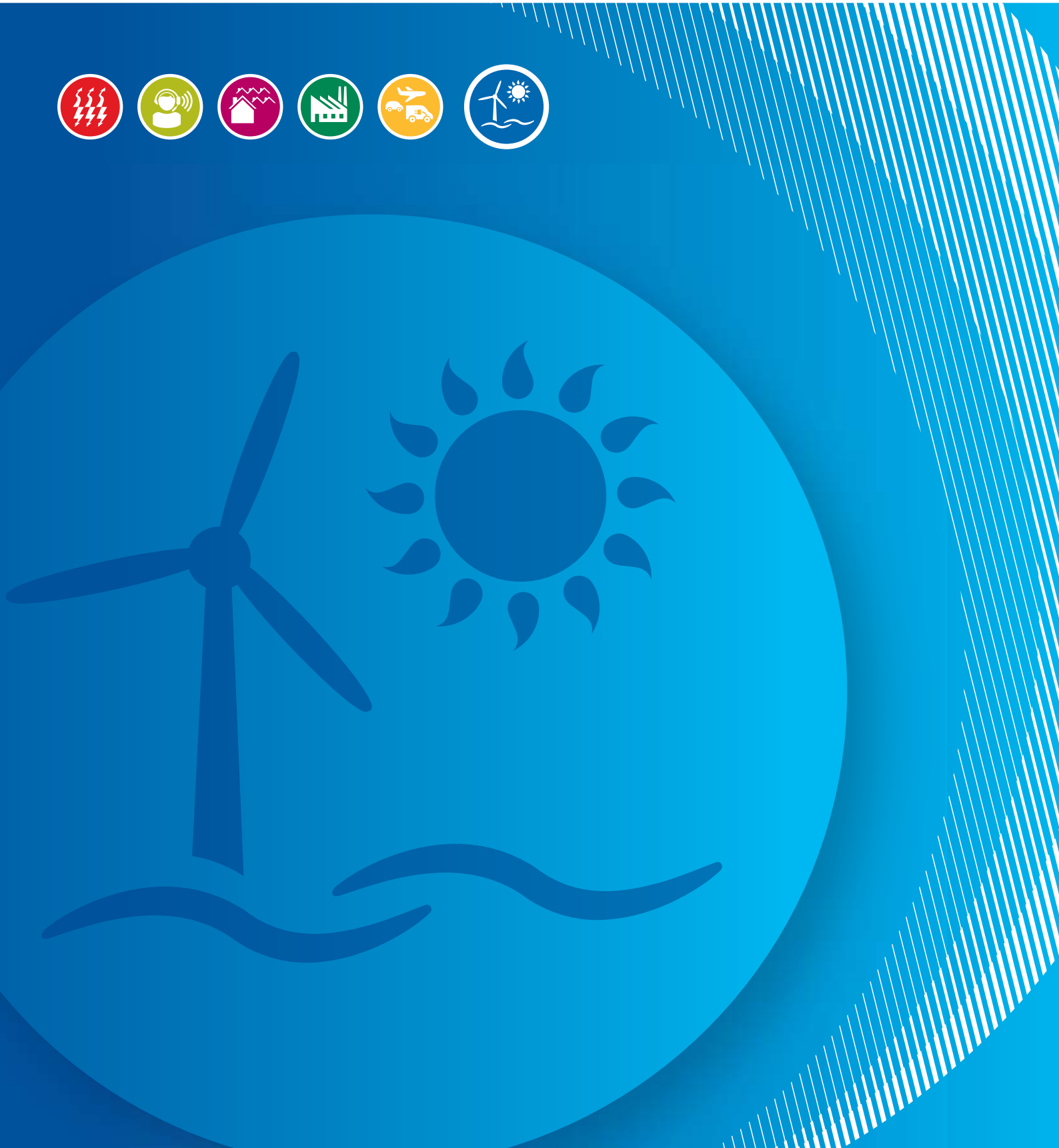
SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Renewable Energy in Ireland 2012

February 2014 Report



Renewable Energy in Ireland 2012

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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 and motivating 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 policymakers 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.

Highlights

Progress towards Overall Renewable Energy Directive Target

- The contribution of renewable energy to overall energy demand rose from 2.3% to 7.1% between 1990 and 2012. Ireland's target is to achieve 16% by 2020 under EU Directive 2009/28/EC.
- In absolute terms the total use of renewables more than trebled between 2003 and 2012 (15% annual average growth) to 838 ktoe, largely due to the increasing contribution from wind energy.
- Renewable electricity contributed 4.1% to the overall energy demand in 2012. Renewable transport energy contributed 0.8% and renewable heat contribution was 2.1% .
- Of the 838 ktoe of renewables used in 2012, most was from wind energy (41%). Renewable electricity was responsible for 63% of the total renewable contribution. Biofuels contributed 10% and renewable heat contributed 28%.
- There was a 0.6% increase in the renewable energy contribution in 2012.

Energy Security

- In absolute terms, the contribution by renewable energy to meeting Ireland's energy needs grew by a factor of five between 1990 and 2012.
- Renewable energy accounted for 58% of indigenous energy production in 2012.

Renewable Electricity (RES-E)

- The share of electricity generated from renewable energy sources (RES-E) has increased fourfold between 1990 and 2012, from 4.9% to 19.6%.
- Wind energy (normalised) accounted for over 15.3% of all electricity generation in 2012, hydro (normalised) accounted for 2.7% and the remaining 1.6% was from bioenergy sources (mainly biomass co-firing and landfill gas).
- Wind power installed generating capacity reached 1,763 MW in 2012.

Renewable Heat Energy (RES-H)

- Renewable heat (RES-H) accounted for 5.2% of all thermal energy in 2012.
- RES-H grew from 2.6% in 1990 to 4.4% in 2010. However 2010 was an exceptionally cold year. In 2011 RES-H reached 5%. Industrial biomass energy use (mostly in the wood, food and cement sectors) accounted for 66% of all thermal renewable energy used in 2012, which corresponds to 3.4% of all thermal energy use in Ireland.
- Industrial biomass energy use increased by 167% (6% average annual growth) between 1990 and 2006. There was a fall of 17% in industrial biomass use between 2006 and 2009. Since then there has been an increase of 10%, with use growing by 2.5% in 2012.
- Residential renewable energy use grew by 18% between 1990 and 2012 (0.8% average annual growth).

Renewable Transport Energy (RES-T)

- Renewable transport energy (biofuels) accounted for 3.8% of road and rail transport (RES-T) in 2012, when calculated according to the definition in EU Directive 2009/28/EC.
- The Government target of 3% RES-T by 2010 was not reached, but the 2010 target was exceeded in 2011.
- The dominant biofuel is biodiesel, representing 61% of biofuel usage in 2012, followed by bioethanol (38%) and pure plant oil (0.5%).
- Indigenous production accounted for 21% of biofuels used or stockpiled in 2012, compared to a peak of 55% in 2007.

Avoided Fuel Imports and CO_2 Emissions

- In 2012 displacement of fossil fuel by renewable energy for electricity generation resulted in an avoidance of between €250 million and €280 million in fossil fuel imports.
- CO_2 avoided through renewable energy use in all sectors totalled 3.2 Mt CO_2 in 2012, with wind energy accounting for 61% of this saving.

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1 Introduction

Developing renewable energy is an integral part of Ireland's sustainable energy objectives and climate change strategy. Renewable energy contributes to meeting all three energy policy goals, namely: energy security, cost competitiveness and protection of the environment through the reduction of greenhouse gas (GHG) emissions. With lower or no net emissions from renewable energy sources compared to fossil fuels, renewable energy sources contribute to the decarbonisation of energy supply and reduction in GHG emissions. They also contribute to energy security, being, for the most part, indigenous energy sources. In a period of increasing and volatile energy costs renewables can also contribute to cost competitiveness by reducing dependence on imported fossil fuels and hedging against further fossil fuel price volatility. There is the potential in the case of some renewable sources for Ireland to become a net exporter of renewable energy and technology.

Further to the European Renewable Energy Directive 2009/28/EC, Ireland's National Renewable Energy Action Plan (NREAP) sets a mandatory target of 16% renewables, comprising 40%, 12% and 10% contributions to electricity, heat and transport respectively. It also sets a national target of 500 MW of ocean energy capacity by 2020.

This report examines the contribution made by renewables to Ireland's energy requirements for the period 1990 to 2012, with a particular focus on production data in 2012. Installed capacity data are available for 2012 and early 2013. This is the sixth in an ongoing series of renewable energy reports and follows the Renewable Energy in Ireland 2011 Report[1]. This report also contains data in relation to energy from waste, drawing on the submission to the IEA/Eurostat annual survey on renewables and waste and the growing contribution of wastes to Ireland's energy supply. The energy from wastes currently used in Ireland (landfill gas, sewage sludge gas, wood wastes, tallow, meat and bone meal and waste oils used for biodiesel) are all classified as renewable sources of energy. Energy from municipal waste, low carbon fuels, tyre derived waste and solid recovered fuel are considered to be partially renewable.

The report discusses the progress towards national and EU renewable targets and provides an overview of the status of all renewables currently used in Ireland. In particular the actual renewable energy used in 2012 is compared to the national targets.

The report is structured as follows:

- Section 2 summarises salient policy measures pertaining to renewable energy in Ireland.
- Section 3 explains the methodologies used to calculate progress towards national and international renewable energy targets.
- Section 4 provides the context for renewable energy deployment, examining the recent trends in primary energy usage.
- Sections 5 to 8 analyse the progress towards the various renewable energy targets.
- Section 9 estimates the extent of avoided carbon dioxide emissions arising from the use of renewables.
- Finally, section 10 looks at the future of renewable energy in Ireland through energy forecasts and the National Renewable Energy Action Plan.

The national energy balance data presented in this report are the most up-to-date at the time of writing. Balance data are updated whenever more accurate information is known. The most up-to-date balance figures are available in the statistics publications section of the Sustainable Energy Authority of Ireland's website. An energy data service is available at http://www.seai.ie/statistics; follow the links for Energy Statistics Databank. This service is hosted by the Central Statistics Office (CSO) with data provided by SEAI. The 2012 national energy balance data used were published on 8th October 2013.

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.

1 Available from http://www.seai.ie/Publications/Statistics_Publications/EPSSU_Publications/

2 Renewable Energy – the Policy Context

Irish renewable energy policy is framed in the context of European legal obligations specified in various Directives and Regulations, as well as other international and national targets. This section outlines the key policy targets relevant to renewable energy use in Ireland and any new policy developments since the publication of the Renewable Energy in Ireland 2012 Report[2]. Existing policy measures which relate to renewable energy are listed in Appendix 2, as well as recent regulatory and technical measures introduced to facilitate more renewable energy sources.

2.1 EU Directive 2009/28/EC and Statutory Instruments 147 & 148 of 2011

The European Union Directive 2009/28/EC[3] on the promotion of the use of energy from renewable sources and amending and subsequently repealed Directives 2001/77/EC[4] and 2003/30/EC[5] are still the most important legislation influencing the growth of renewables in Europe and Ireland. Statutory Instrument (SI) 147 gives effect to the Directive in Irish law and SI 148 of 2011[6] conferred additional functions to SEAI relating to the requirements under the Directive concerning renewable energy-related information and training, promotion and encouragement of renewable energy use by public bodies and promotion of certain renewable energy technologies.

The EU Directive 2009/28/EC specifies that:

- Mandatory national targets should be established consistent with a 20% share of energy from renewable sources in Community energy consumption by 2020. This is consistent with the renewable energy target contained in the EU Climate and Energy package[7] renewables target. Ireland's overall target is to ensure that at least 16% of gross final energy consumption is from renewable sources by 2020 (compared with 2.8% in 2005).
- Each Member State must submit a national renewable energy action plan (NREAP) by June 2010. Each Member State must also submit a report to the Commission on progress in the promotion and use of energy from renewable sources by 31 December 2011 and every two years thereafter.
- A mandatory national target should be established consistent with a 10% share of energy from renewable sources in transport[8] (RES-T) in Community energy consumption by 2020. The 10% target for energy from renewable sources in transport is set at the same level for each Member State. This renewable energy can be from biofuels or the renewable portion of electricity used for transport. The Directive 2009/28/EC also establishes the sustainability criteria for biofuels and bioliquids. Transport energy contributions from wastes, second generation biofuels and electric vehicles (EVs) are given higher weightings than first generation biofuels for the EU RES-T target.

2.1.1 National Renewable Energy Action Plan (NREAP)

In the NREAP each Member State sets out national targets for renewable electricity, transport and heat (RES-E, RES-T and RES-H respectively) and the steps envisaged to meet the state's mandatory EU 2020 overall renewable energy target. The forecasts document on which the first NREAP[9] was based was submitted in December 2009. The finalised NREAP[10] text was submitted to the European Commission on 30 June 2010.

The first progress report[11] on the NREAP was submitted in January 2012. This reported on the progress towards the targets in 2009 and 2010 and based on this progress projected a renewables trajectory to 2020.

2.2 EU Effort Sharing Decision 2009/406/EC on Greenhouse Gas Emissions

Decision No. 406 of 2009, on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's GHG emission reduction commitments up to 2020, requires Ireland to reduce GHG emissions from non-ETS sectors (i.e. sectors outside of the EU Emissions Trading Scheme) by 20% below 2005 levels by 2020.

2 SEAI, 2012. Available from http://www.seai.ie/Publications/Statistics_Publications/Renewable_Energy_in_Ireland_2011.pdf
3 Available from http://eur-lex.europa.eu/en/index.htm
4 Ibid
5 Ibid.
6 Statutory Instrument No.147 & 148 of 2011. Available from http://www.irishstatutebook.ie/home.html
7 http://ec.europa.eu/environment/climat/climate_action.htm
8 Only petrol, diesel, biofuels consumed in road and rail transport, and electricity used by electric road vehicles shall be taken into account.
9 http://ec.europa.eu/energy/renewables/transparency_platform/doc/ireland_forecast_english.pdf
10 http://www.dcenr.gov.ie/NR/rdonlyres/03DBA6CF-AD04-4ED3-B443-B9F63DF7FC07/0/IrelandNREAPv11Oct2010.pdf
11 http://www.dcenr.gov.ie/NR/rdonlyres/B611ADDD-6937-4340-BCD6-7C85EAE10E8F/0/IrelandfirstreportonNREAPJan2012.pdf

2.3 Biofuels Obligation and Statutory Instrument No. 33 of 2012

The Biofuels Obligation introduced in the Energy (Biofuel Obligation and Miscellaneous Provisions) Act 2010[12] came into effect in July 2010, following a commencement order in Statutory Instrument 322 of 2010[13]. The scheme to promote the use of biofuels came into effect after the completion of the Mineral Oil Tax Relief (MOTR) scheme for biofuel producers, which was in operation between 2006 and 2010.

The biofuels obligation requires every oil company and oil consumer liable to pay the National Oil Reserves Agency (NORA) Levy (the 'Obligated Parties') to ensure that, in each obligation period, not less than 4 litres in every 100 litres of road transport fuel is biofuel. This ratio equates to 4.166% by volume of petroleum-based motor fuel placed on the market. The first obligation period ran from 1st July to 31st December 2010; and since then the obligation period is based on the calendar year.

The Minister may, from time to time, review the percentage rate. In December 2012 the Minister signed Statutory Instrument No. 562 of 2012 – National Oil Reserves Agency Act 2007 (Biofuel Obligation Rate) Order 2012 which increased the rate to 6.383%. In energy terms this equates to 5.3% with allowance made for double certificates and 3.4% without the double allowance.

The scheme is administered by the National Oil Reserve Agency (NORA). Since the introduction of Biofuel Sustainability Criteria Regulations in February 2012 (SI No. 33 of 2012[14]) NORA issues one certificate for each litre of biofuel provided that the fuel meets the compliance requirements on sustainability and two certificates per litre are issued for biofuels produced from biodegradable waste, residue, non-food cellulosic material, ligno-cellulosic material or algae. In 2010 the Commission issued a communication on the practical implementation of the EU biofuels and bioliquids sustainability scheme and on counting rules for biofuels (2010/C 160/02).

2.4 Electric Vehicles

The Minister for Communications, Energy and Natural Resources announced in April 2009 the introduction of grant support of up to €5,000 for a Battery Electric Vehicle (BEV) or a Plug-in Hybrid Electric Vehicle (PHEV) purchased and registered before the end of December 2013. In addition to the grant, a BEV qualifies for Vehicle Registration Tax relief of up to €5,000 whereas a PHEV qualifies for up to €2,500 VRT relief. This provides a maximum combined subsidy (grant + VRT relief) of €10,000 in the case of a BEV and €7,500 for a PHEV. The grant is accessed via the dealer and is administered by SEAI.

ESB has been providing free connection points in the home of each of the first 2,000 vehicles purchased. In addition, ESB has a target to install 1,500 public street charging points and 30 fast charging points nationwide. In May 2013 there were 670 AC public charge points installed and 40 DC fast charging points.

2.5 Renewable Energy Feed-In Tariff (REFIT)

REFIT stands for 'Renewable Energy Feed in Tariff' and is the primary means through which electricity from renewable sources is supported in Ireland. The first REFIT scheme (REFIT 1) was announced in 2006 and state aid approval was obtained in September 2007 and was open for applications until the end of 2009.

REFIT 2 is designed to incentivise the addition of 4,000 MW of new renewable electricity capacity to the Irish grid from onshore wind, hydro and biomass landfill gas technologies. Plants must be new plants in all cases, neither built nor under construction on 1/1/2010. Projects must be operational by end 2015. The support for any particular project cannot exceed 15 years and may not extend beyond 31/12/2030.

REFIT 3 is designed to incentivise the addition of 310 MW of renewable electricity capacity to the Irish grid. Of this, 150 MW will be High Efficiency CHP (HE CHP), using both anaerobic digestion and the thermo-chemical conversion of solid biomass, while 160 MW will be reserved for biomass combustion and biomass co-firing.

Renewable generator applications are processed in a 'Gate' system, whereby all applications deemed complete by a given date are processed in one batch. There is also a policy that facilitates small scale renewables by providing grid connections outside the 'Gate' process for small bio-energy, wave and tidal generators.

2.6 Draft Offshore Renewable Energy Development Plan (OREDP)

A draft Offshore Renewable Energy Development Plan (OREDP)[15] was issued for public consultation by the Department of Communications, Energy and Natural Resources (DCENR) in November 2010. The Minister asked the Sustainable Energy Authority of Ireland for a Strategic Environmental Assessment (SEA) on low, medium and

12 Statutory Instrument No.322 of 2010. Available from http://www.irishstatutebook.ie/home.html
13 Public Act No.11 of 2010. Available from http://www.irishstatutebook.ie/home.html
14 Statutory Instrument No.33 of 2012. Available from http://www.irishstatutebook.ie/home.html
15 Available from http://www.dcenr.gov.ie/NR/rdonlyres/2990B205-534E-486E-8586-346A6770D4B6/0/Draft_13_OREDPWebversion.pdf

higher marine renewable energy development scenarios, set out in the draft OREDP, to inform policy decisions on developing this new industry. The SEA reports on these scenarios have informed the draft plan. A Natura Impact Statement on the draft plan was also prepared. The draft OREDP has been reviewed in light of the environmental findings and the public consultation, prior to finalisation. The final version of the OREDP, including the Appropriate Assessment decision, is anticipated shortly and will be published together with a Ministerial SEA Statement which will set out how environmental considerations have been integrated into the plan and how feedback from the public consultation has been considered.

2.7 Draft Geothermal Energy Development Bill of 2010

In July 2010, the Government gave its approval for the submission of a draft general scheme for the Geothermal Energy Development Bill to the Office of the Attorney General for detailed drafting and for the publication of both the general scheme[16] and the Regulatory Impact Assessment[17]. The bill is going through the legislative process, prior to enactment.

2.8 Strategy for Renewable Energy: 2012-2020

The *Strategy for Renewable Energy: 2012 - 2020*[18] of the Department of Communications, Energy and Natural Resources, states the ambition that "Ireland can also become a global leader in research and development in renewable energy and related technologies". The strategy identified five strategic goals: increasing both on- and offshore wind; building a sustainable bioenergy sector; fostering R&D in renewables such as wave and tidal; growing sustainable transport; and building robust and efficient electricity networks.

2.9 Building Regulations (Part L)

Since 2008 there is a requirement in the Building Regulations that a reasonable proportion of the energy consumption to meet the energy performance of new dwellings is provided by renewable energy sources. Renewable energy sources can be solar energy (thermal and photovoltaic), wind, hydropower, biomass, geothermal, wave, tidal, landfill gas, sewage treatment plant gas and bio-gases. Also the portion of thermal output of a heat pump above a coefficient of performance (COP) of 2.5 is considered renewable.

The Regulation gives guidance on what represents a reasonable minimum level of energy provision from renewable energy technologies in order to satisfy the Regulation. These are:

- 10 kWh/m^2/annum contributing to energy use for domestic hot water heating, space heating or cooling; or
- 4 kWh/m^2/annum of electrical energy; or
- a combination of these which would have equivalent effect.

2.10 Energy Export Policy and Development Framework

The Department of Communications, Energy and Natural Resources is developing a Renewable Energy Export Policy and Development Framework for renewable export opportunities from Ireland. The process will include the undertaking of relevant environmental assessments and several public consultations. An initial public consultation was launched in October 2013.

In January 2013, Government signed a Memorandum of Understanding with the UK Government on energy cooperation, which signalled the joint interest of both parties to develop renewable energy trading opportunities between the two jurisdictions. Analysis is currently underway to determine the feasibility and potential benefits of exporting renewable energy to the UK. The outcome of the analysis could lead to the signing of an Inter-Governmental Agreement in 2014.

16 Available from http://www.dcenr.gov.ie/Natural/Exploration+and+Mining+Division/Geothermal+Energy+Legislation/
17 Ibid
18 Available from http://www.dcenr.gov.ie/NR/rdonlyres/9472D68A-40F4-41B8-B8FD-F5F788D4207A/0/RenewableEnergyStrategy2012_2020.pdf

3 Methodology for Calculating Renewable Energy Shares

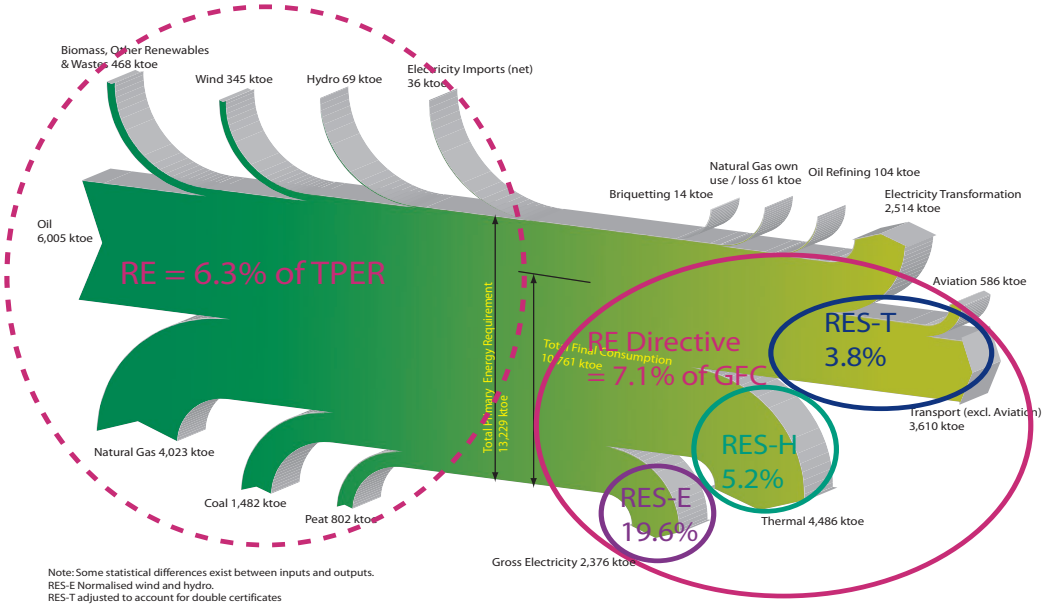
There are many different ways to calculate the share of renewable energy, which can lead to confusion when the question is raised 'How much of Ireland's energy comes from renewable sources?' A variety of indicators has emerged to measure progress against various different measures and targets — national, EU and global. This section tries to clarify the issues by explaining some of the calculation methods.

3.1 Renewables Share of TPER and TFC

Traditionally, energy trends are considered in terms of total primary energy requirement (TPER) and total final consumption (TFC). TPER is a measure of all energy used and TFC is a measure of the energy used by final customers only, i.e. excluding the losses in useful energy during transformation. The contribution from renewable energy can be captured in terms of its percentage share of either TPER or TFC.

The Sankey diagram for Ireland in Figure 1 illustrates where the various renewable targets fit within overall energy use in Ireland and the position with regard to progress towards those targets in 2012. Towards the right of the figure the transport, heat and electricity targets' current percentages are shown relative to the respective amount of final energy that they refer to. Also shown is how these relate to the EU Renewables Directive target. Towards the left of Figure 1 the overall contribution of renewable energy to total primary energy requirement (TPER) is shown at 6.3%. Whilst there is no specific target for this measure it does help to illustrate the position of renewables in the overall energy use in Ireland.

Figure 1 *Renewable Energy Status in Ireland (2012)*



Source: SEAI

Gross final consumption (GFC) of energy is an alternative to TFC that was developed recently and is the denominator used by the EU to track progress towards the targets in Directive 2009/28/EC. The Directive defines GFC 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. The renewable energy contribution includes electricity generation, transport energy and thermal energy from renewable sources. This builds on the definition for gross final consumption of electricity used in Directive 2001/77/EC (to track progress in renewable generated electricity) and adds gross final consumption of heat and transport.

3.2 Total Primary Energy Equivalent - TPEE

Both the primary and final energy consumption of non-combustible renewable energy sources such as wind and hydro are very similar when expressed as a share of TPER. However, this is not the case for most combustible fuels, due to the energy conversion losses associated with electricity generation. Depending on the efficiency of electricity generation, typically between 25% and 55% of the energy content of the fuel input into power plants is output in the form of electricity. As a result, the contribution of non-combustible renewable sources to TPER is not adequately accounted for.

The total primary energy equivalent (TPEE) is an alternative approach to TPER in which the primary energy of the renewable energy is considered to be equivalent to the primary energy of the fuel that would have been required to produce the equivalent amount of electricity. The effective contribution of renewable energy to Ireland's primary energy use is captured more completely in the renewable energy share of TPEE than the renewable energy share of TPER.

The principle adopted by the International Energy Agency (IEA) for primary energy is that it is the first energy form downstream in the production process for which multiple energy uses are practical. The primary energy forms are usually chemical (eg solid fuel, oil or gas) or electricity. Where the primary energy form is the electricity output from hydro power, wind or solar PV generation, the primary energy equivalent is the physical energy content of the electricity generated in the plant, i.e. assume 100% efficiency. For most fuels this is not the case, due to the energy conversion losses associated with electricity generation. The primary energy equivalent approach equates the primary energy of the renewable energy with the primary energy of the fuel that would have been required to produce the equivalent amount of electricity. A detailed description of the methodology used for calculating the Primary Energy Equivalent (PEE) is provided in Appendix 1.

The renewables share of Total Primary Energy Equivalent can be used as a metric to track the penetration of renewables. While there are not any targets associated with this metric, it provides an insight into the reduction of primary energy demand by substituting fossil fuel generated electricity with non-combustible renewables.

3.3 Renewable Energy Directive 2009/28/EC

The target for Ireland in the European Renewable Energy Directive 2009/28/EC for 2020 is for renewable sources to account for 16% of gross final energy consumption (GFC).

There are also differing methodologies in the way the overall share of energy from renewables and the individual share of renewables by each mode of energy application, namely heat, transport and electricity (termed RES-E, RES-T and RES-H respectively), are calculated. These individual targets have separate denominators and in some cases weighting factors; therefore, the individual target percentages cannot be simply added together to get the overall share of renewables.

The main difference arises in transport energy consumption. In the overall RES target all transport energy is included, including aviation and marine, whereas the RES-T target relates only to road and rail energy use (i.e. land transport). There are also weighting factors used in the RES-T calculation for some individual renewable sources (namely biofuels from waste, second generation biofuels and renewable generated electricity powering electric vehicles) but in the calculation of the overall renewable energy target (RES) weighting factors are not applied.

3.3.1 Gross Final Consumption

The definition of gross final consumption of energy (GFC) is the energy delivered for energy purposes 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.

- GFC = TFC (Transport) + GFC (Elec) + GFC (Heat)

In the case of electricity for example, the difference between total final consumption (TFC) and gross final energy consumption (GFC) is that TFC equates to all electricity demand used by customers, whereas GFC includes the transmission and distribution losses and the in-house use of electricity by electricity generators.

3.3.2 Overall Renewables Target — RES

In order to facilitate international comparisons of renewable energy it is necessary to set transparent and unambiguous rules for calculating the share of energy from renewable sources and for defining those sources across all countries. In the EU Renewable Energy Directive 2009/28/EC the renewable energy share is calculated from the gross final consumption of energy. No weighting factors are applied to renewable energy sources for the calculation of the overall renewable energy share. There is a legally binding European target for Ireland to achieve a 16% share of energy from renewable energy sources in gross final consumption of energy by 2020, specified in Annex 1 of the Renewable Energy Directive.

Numerator: The numerator here is the sum of the individual renewable sources.

- Electricity – This is the total renewable electricity generation, with normalisation for climatic variations applied to the hydro and wind contributions.
- Heat – This is the total renewable energy used for heat purposes excluding renewable generated electricity that is used for heating to avoid double counting.
- Transport – This is the total renewable energy used for transport excluding renewable generated electricity that is used for transport to avoid double counting.

Denominator: The denominator is the gross final consumption adjusted for aviation being limited to 6.18% of gross final consumption (as prescribed in Article 5.6 of the Renewable Energy Directive 2009/28/EC).

3.3.3 Renewable Electricity — RES-E

Prior to the EU Renewable Energy Directive 2009/28/EC there was a target and strategy for the contribution of renewable energy to the electricity market established in the EU Directive 2001/77/EC[19]. This Directive set indicative targets for each Member State for the contribution of renewable generated electricity relative to gross electricity consumption for the year 2010. Ireland's 2020 national target in regard to renewable electricity is 40% by 2020, but there is not a specified mandatory RES-E European target for 2020.

Numerator: The total renewable electricity for RES-E calculation is the same as the amount calculated for the overall target, i.e. the sum of the individual renewable electricity sources. No multiplication factors are applied in the calculation of the renewable electricity target, but the wind and hydro portions of renewable electricity are normalised for climatic variations when reporting progress towards international renewable energy targets.

Denominator: The denominator here is the gross electricity consumption which is defined as gross electricity generated plus net imports. No account is taken of the renewables content of imports.

It is important to note the gross electricity generated is different (more than) the total electricity requirement, as gross electricity includes electricity used within power stations and also transmission system and distribution system losses whereas the total electricity requirement is the gross electricity requirement minus the in-house load of power plants. Note that EirGrid, the transmission system operator (TSO), often quotes the Total Electricity Requirement metric.

3.3.3.1 Normalisation

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 normalisation rules. The normalisation rules are specified in Annex II of the Directive and different rules apply for hydro and for wind. The normalised renewable hydro contribution is calculated as the installed capacity of the latest year for hydro multiplied by the sum of electricity generated divided by the installed capacity for the last 15 years for hydro energy. As shown in Equation 1, where N is the reference year; $Q_{N(Norm)}$ is the normalised electricity generated by all hydropower plants in year N for reporting progress towards Renewable Energy Directive 2009/28/EC; Q_i is the actual quantity of electricity generated in year i by all hydropower plants measured in GWh, excluding production from pumped storage units, using water that has previously been pumped uphill; and C_i is the total installed capacity net of pumped storage of all hydropower plants at the end of year i measured in MW.

Equation 1 *Hydro Normalisation Equation*

Source: European Commission

$$Q_{N(norm)} = \frac{C_N \times \left[\sum_{i=N-14}^{N} \frac{Q_i}{C_i}\right]}{15}$$

The normalised wind electricity contribution is calculated as the average installed capacity of the latest two years multiplied by the sum of electricity generated divided by the average end year installed capacity over the last 5 years.

Equation 2 *Wind Normalisation Equation*

Source: European Commission

$$Q_{N(norm)} = \frac{C_N + C_{N-1}}{2} \times \frac{\sum_{i=N-n}^{N} Q_i}{\sum_{j=N-n}^{N} \left(\frac{C_j + C_{j-1}}{2}\right)}$$

19 European Union, 2001. Directive 2001/77/EC. Available from http://europa.eu/legislation_summaries/energy/renewable_energy/l27035_en.htm

As shown in Equation 2, where N is the reference year; $Q_{N(Norm)}$ is the normalised electricity generated by all wind power plants in year N for reporting progress towards Renewable Energy Directive 2009/28/EC; Q_i is the actual quantity of electricity generated in year i by all wind power plants measured in GWh; C_i is the total installed capacity of wind power plants at the end of year i measured in MW; and n is 4 or the number of years preceding year N for which capacity and production data are available, whichever is the lower.

3.3.4 Renewable Heat — RES-H

In order to meet the 2020 national RES target, renewable thermal energy (RES-H) is required to be around 12% in 2020, but there is not a specified mandatory RES-H target for 2020 in the EU Directive.

Numerator: Total renewables for RES-H is the same as the overall target, i.e. the total renewables used for heat purposes. The share of renewable electricity used for heating is not included as it would lead to double counting.

Denominator: In the absence of district heating, thermal GFC is equal to thermal TFC. Hence thermal gross final consumption is calculated as TFC minus TFC (electricity) minus TFC (transport less electricity used in transport) i.e. the heat demand is calculated as a remainder when electricity and transport demands are subtracted from the overall final consumption.

3.3.5 Renewable Transport — RES-T

There is a mandatory obligation for all Member States to meet the 10% RES-T target by 2020 as well as achieving the overall RES target specified for each Member State.

Numerator: Total renewables for RES-T is the sum of biofuel used for road and rail transport plus the renewable portion of electricity used for road vehicles multiplied by a weighting factor of 2.5. A weighting factor of two is applied to second generation biofuels or biofuels from wastes. These weighting factors are used for the calculation of RES-T only and do not apply when calculating the transport contribution to the overall RES share.

Denominator: The denominator here is the sum of petrol, diesel, biofuels and electricity used for road and rail transport. The multiplication factors used in the numerator are not applied in the denominator. Consumption of aviation (kerosene and/or biofuels) and marine are not included in the denominator.

The EU Directive 2009/28/EC attaches an important condition to biofuels: that they must come from sustainable sources. Sustainable sources as defined by Article 17 of the Directive 2009/28/EC are:

- The greenhouse gas emission saving from the use of biofuels and bioliquids shall be at least 35%, in accordance with the methodology prescribed in the Directive. This percentage increases to 50% from 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.

3.3.6 Co-operating Mechanisms and Short-Term Statistical Transfers

If a country is unable to meet the target with indigenous renewable energy sources, there are flexible mechanisms outlined in the Directive which could assist in meeting the EU target[20].

There are three main cooperation mechanisms. "Statistical transfers", where Member States agree to attribute renewable energy produced in one Member State to another in their statistical accounting for target compliance. There is no specific plant or physical energy involved.

"Joint projects", where the renewable energy from a particular project is shared between the parties, with or without a physical flow of the energy produced. Under Article 9 of the Directive joint projects with physical flows can also be arranged with third countries.

The third mechanism is a joint support scheme, where Member States co-finance their new renewable energy production independent of its location (within their territories).

20 Commission Staff Working Document, *Guidance on the use of renewable energy cooperation mechanisms* http://ec.europa.eu/energy/gas_electricity/doc/com_2013_government_intervention_en.pdf

4 Context for Renewable Energy Deployment

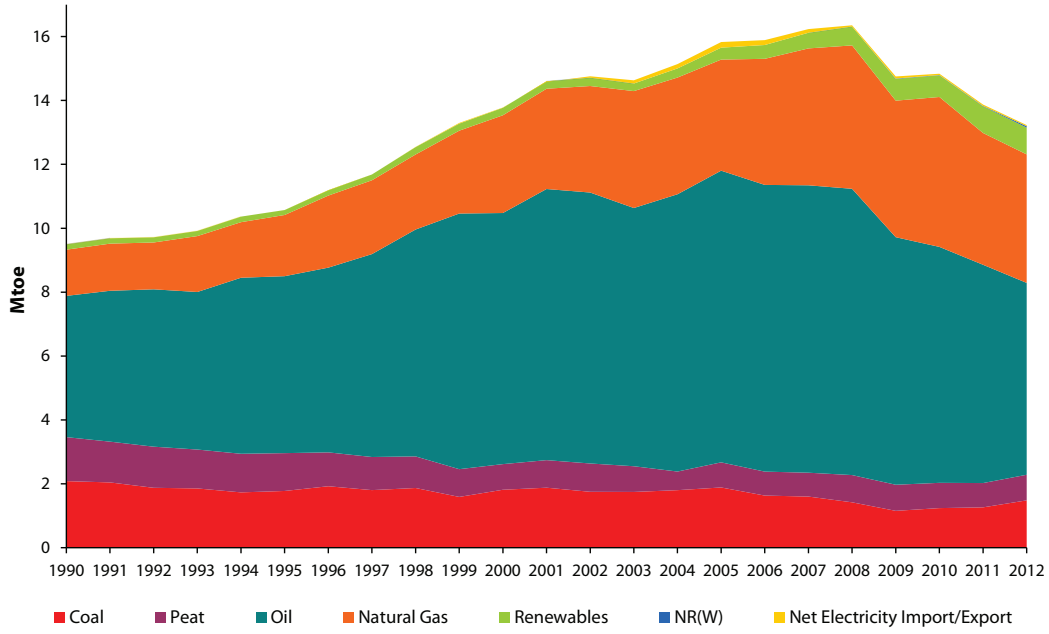
4.1 Primary Energy

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

Figure 2 illustrates the trend in energy supply over the period 1990 to 2012, emphasising changes in the fuel mix. Primary energy requirement in Ireland in 2012 was 13.2 million tonnes of oil equivalent (Mtoe). Over the period 1990 – 2012 Ireland's total annual primary energy requirement grew in absolute terms by 39% (average annual growth rate of 1.5%). The individual fuel growth rates and shares are shown in Table 1. A more detailed discussion on the trends in TPER between 1990 and 2012 is contained in SEAI's Energy in Ireland 2013 report[21].

The 2012 data show a further 4.4% reduction in primary energy requirement to 13.2 Mtoe. The most significant reduction was in transport with petrol consumption falling by 5.9% while there were increases in coal and peat of 17% and 5.4% respectively, primarily in electricity generation.

Figure 2 *Total Primary Energy Requirement 1990 to 2012*



Source: SEAI

Figure 2 shows the significant increase in overall TPER over the period 1990 - 2012 and also the considerable growth in renewable energy since the mid 1990s. Total renewable energy grew from 168 ktoe to 838 ktoe between 1990 and 2012, an increase of 400% (7.6% per annum on average) over the period. 2012 figures show a 0.6% increase over the previous year in the contribution of renewables to the total primary energy requirement.

21 SEAI, 2012, Energy in Ireland 1990 to 2012 - 2013 Report. Available from http://www.seai.ie/

Table 1 *Growth Rates and Shares of TPER Fuels 1990 – 2012*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2012	'90 – '12	'00 – '05	'05 – '10	'10 – '12	2012	1990	2012	1990	2012
Fossil Fuels (Total)	32.0	1.3	2.5	-1.6	-6.6	-5.2	9,330	12,312	98.2	93.1
Coal	-28.9	-1.5	0.8	-8.0	9.3	17.3	2,085	1,482	22.0	11.2
Peat	-41.8	-2.4	-0.4	0.1	0.7	5.4	1,377	802	14.5	6.1
Oil	35.8	1.4	3.0	-4.2	-9.8	-12.1	4,422	6,005	46.6	45.4
Natural Gas	178.1	4.8	2.6	6.2	-7.4	-2.5	1,446	4,023	15.2	30.4
Renewables (Total)	399.7	7.6	9.7	12.7	11.1	0.6	168	838	1.8	6.3
Hydro	15.1	0.6	-5.7	-1.0	15.7	13.5	60	69	0.6	0.5
Wind	-	-	35.4	20.4	19.4	-8.4	0	345	0.0	2.6
Biomass	142.7	4.1	9.8	3.1	10.2	20.1	105	256	1.1	1.9
Other Renewables	7024.2	21.4	9.0	32.3	-1.9	-8.0	2	168	0.0	1.3
Non-Renewable (Wastes)	-	-	-	-	126.4	209.1	0	44	0.0	0.3
Electricity Imports	-	-	64.7	-18.0	1.5	7.1	0	36	0.0	0.5
Total	**39.3**	**1.5**	**2.8**	**-1.3**	**-5.6**	**-4.6**	**9,497**	**13,229**		

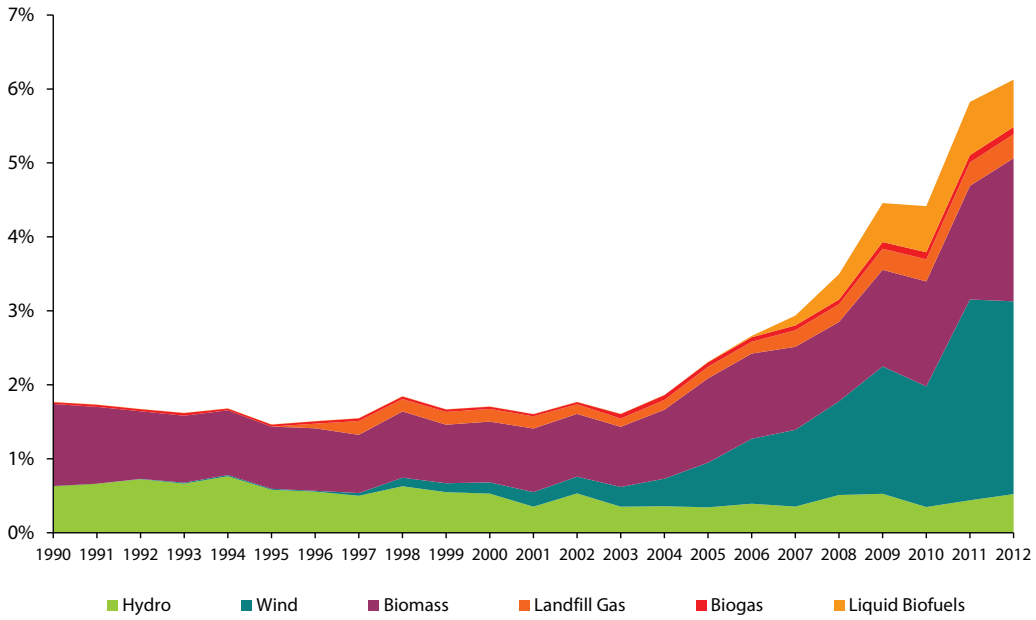
Source: SEAI

Figure 3 shows that renewable energy had been contributing nearly 2% of Ireland's total primary energy requirement (TPER) between 1990 and 2004. In 2004 the contribution stood at 1.9% and this increased to 6.3% in 2012.

There are many different indicators outlined in Section 3 in relation to the share of renewables in energy use and the figure of 6.3% renewable contribution to primary energy in 2012 should not be confused with others that relate to specific targets or measures, which have different specific methodologies in order to calculate the progress towards that target or measure.

The renewable contribution to TPER is less than the contribution to the overall renewable Directive target as the denominator of the target is adjusted to limit aviation to 6.18% of TPER, while other energy transformation losses, such as those which occur when briquetting, oil refining or transporting natural gas, are excluded from the denominator for the Directive calculation.

Figure 3 *Renewable Energy Contribution to TPER 1990 – 2012*



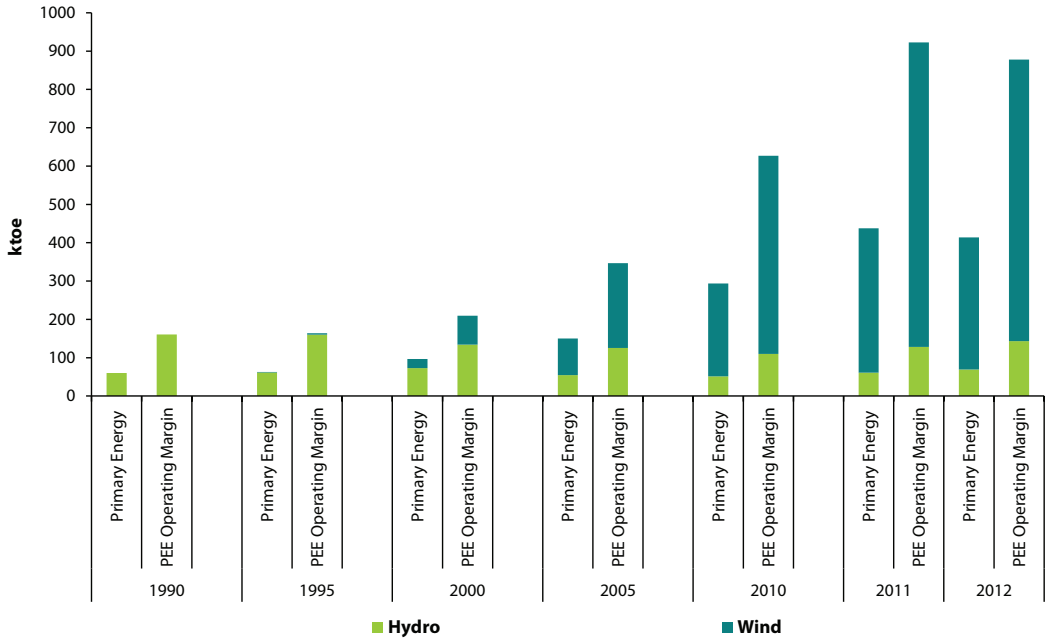
Source: SEAI

4.2 Primary Energy Equivalent

The primary energy equivalent approach equates the primary energy of the renewable energy with the primary energy of the fuel that would have been required to produce the equivalent amount of electricity. The methodology for calculating the Primary Energy Equivalent (PEE) based on the Operating Margin approach is outlined in

Appendix 1. Based on this analysis the PEE for non-combustible renewable energy (wind and hydro) is compared with the primary energy requirement (PE) values in Figure 4 at five-year intervals between 1990 and 2010. Figure 4 also includes 2011 and 2012 data. The difference between the PE and PEE is particularly noticeable and also the increasing importance of wind. Focusing on the year 2010, the PEE for wind and hydro was almost 2.3 times larger (133%) than their primary energy.

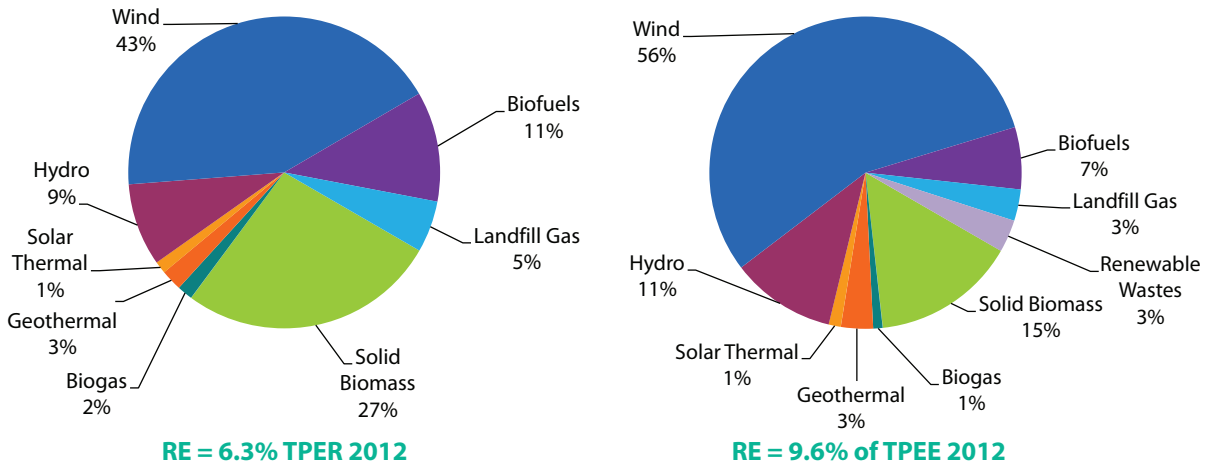
Figure 4 *Primary Energy (PE) and Primary Energy Equivalent (PEE) for Wind and Hydro*[22]



Source: SEAI

The TPEE for renewable energy is then calculated by adding the primary energy for combustible renewable sources to the calculated TPEE for non-combustible renewables. This provides a new measure of renewable energy's contribution to energy supply. The TPEE for renewable energy increased from 269 ktoe in 1990 to 1,336 ktoe in 2011, an increase of 397% (8.3% per annum on average), but fell back to 1,320 ktoe in 2012. There was a 1.2% decrease in the TPEE in 2012 relative to the previous year, primarily due to reduced wind output. Figure 5 compares the contribution of renewable energy to TPER using the traditional PE approach and the TPEE approach. Renewable energy accounted for 6.3% of TPER in 2012 (first pie chart in Figure 5) and 9.6% of TPEE (second pie chart in Figure 5).

Figure 5 *Renewable Energy Shares of TPER and TPEE in 2012*



Source: SEAI

22 See Appendix 1 for description of Primary Energy Equivalent (PEE) and operation margin methodology.

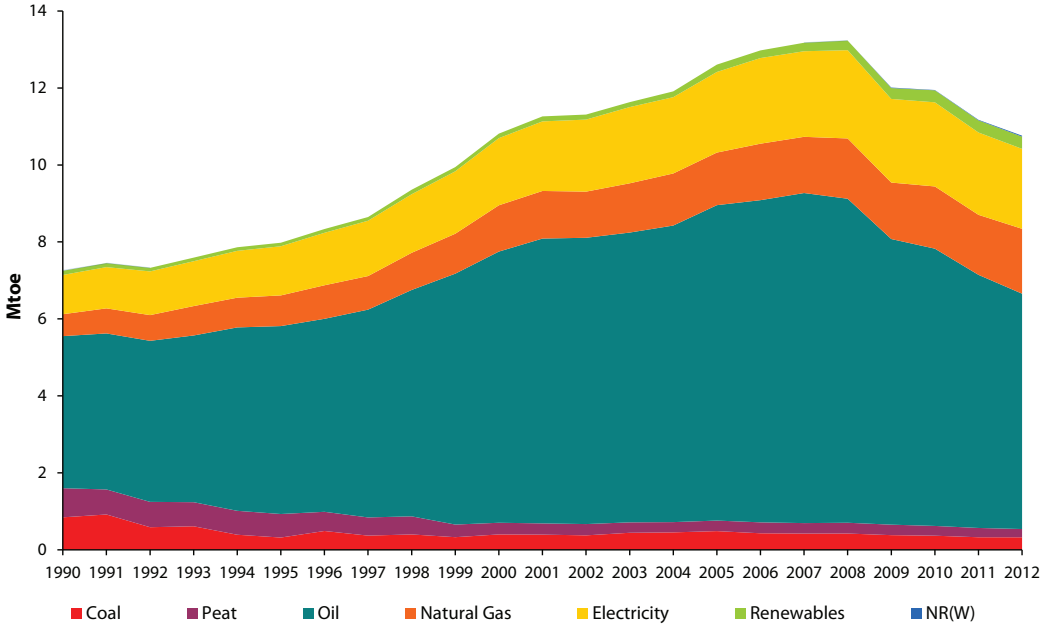
4.3 Energy Demand

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

Figure 6 and Table 2 shows the shift in the pattern of final energy demand by fuel over the period 1990 to 2012. Ireland's TFC in 2012 was 10.8 Mtoe, a fall of 3.7% on 2011 and 48% above 1990 levels (representing an average growth rate of 1.8% per annum). Final consumption of renewable energy increased by 194% (5% per annum on average) from 1990 to 2012.

Final consumption of renewable energy sources grew by 0.4% to 317 ktoe in 2012. The share of renewables in final consumption was 2.9% in 2012.

Figure 6 *Total Final Consumption by Fuel 1990 – 2012*



Source: SEAI

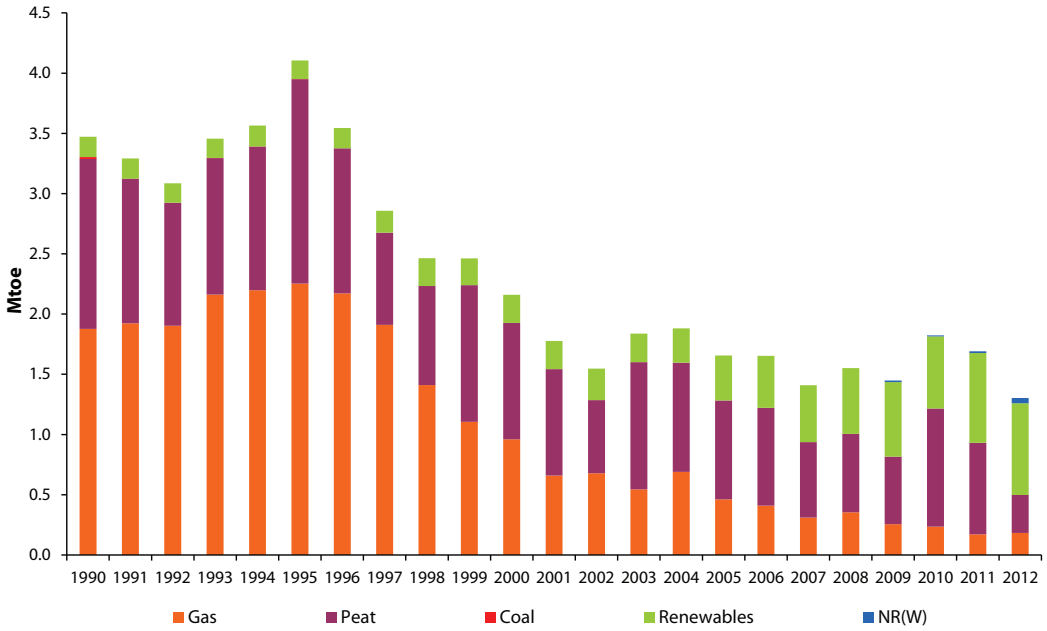
Table 2 *Growth Rates, Quantities and Shares of TFC Fuels*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2012	'90 – '12	'00 – '05	'05 – '10	'10 – '12	2012	1990	2012	1990	2012
Fossil Fuels (Total)	36.3	1.4	2.9	-1.8	-6.0	-4.2	6,121	8,340	84.4	77.5
Coal	-61.6	-4.3	4.0	-5.5	-5.9	-0.4	843	323	11.6	3.0
Peat	-71.6	-5.6	-2.0	-1.5	-7.9	-10.9	757	215	10.4	2.0
Oil	54.8	2.0	3.1	-2.5	-7.9	-7.0	3,952	6,116	54.5	56.8
Natural Gas	196.0	5.1	2.6	3.4	2.1	8.1	570	1,686	7.9	15.7
Renewables	193.9	5.0	10.2	10.2	0.8	0.4	108	317	1.5	2.9
Non-Renewable (Wastes)	-	-	-	-	72.6	79.7	0	25	0.0	0.2
Combustible Fuels (Total)	39.0	1.5	3.0	-1.5	-5.7	-3.9	6,229	8,655	85.9	80.4
Electricity	103.6	3.3	3.7	0.9	-2.5	-2.9	1,021	2,078	14.1	19.3
Total	**48.4**	**1.8**	**3.1**	**-1.1**	**-5.1**	**-3.7**	**7,249**	**10,761**		
Total Climate Corrected	**43.5**	**1.7**	**3.3**	**-2.1**	**-3.2**	**-4.2**	**7,423**	**10,653**		

4.4 Indigenous Energy Sources

Ireland is not endowed with significant indigenous fossil fuel resources and has over past decades not harnessed significant quantities of renewable resources. Although there has been strong growth in renewables in recent years it is from a small base. Figure 7 shows the indigenous energy fuel mix for Ireland over the period 1990 to 2012. 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 fell by 90% over the period since 1990, to 183 ktoe, and peat production fell by 78% to 315 ktoe. Renewable energy in contrast increased by 354% to 761 ktoe. Indigenous production peaked in 1995 at 4,105 ktoe and there has been a 68% reduction since then to 1,304 ktoe.

Figure 7 *Indigenous Energy Sources by Fuel as a Share of TPER 1990 – 2012*



Source: SEAI

Increasing the deployment of renewables is part of the strategy to improve energy security for Ireland. The decline in indigenous sources of energy has been compensated for by the use of renewables. Of the indigenous energy production in 2012 renewable energy accounted for 58%, peat for 24% and natural gas for 14%. There was also a small contribution of 3% from non-renewable wastes.

5 Renewable Generated Electricity (RES-E)

5.1 Fuel Inputs to Electricity Generation and Electricity Demand

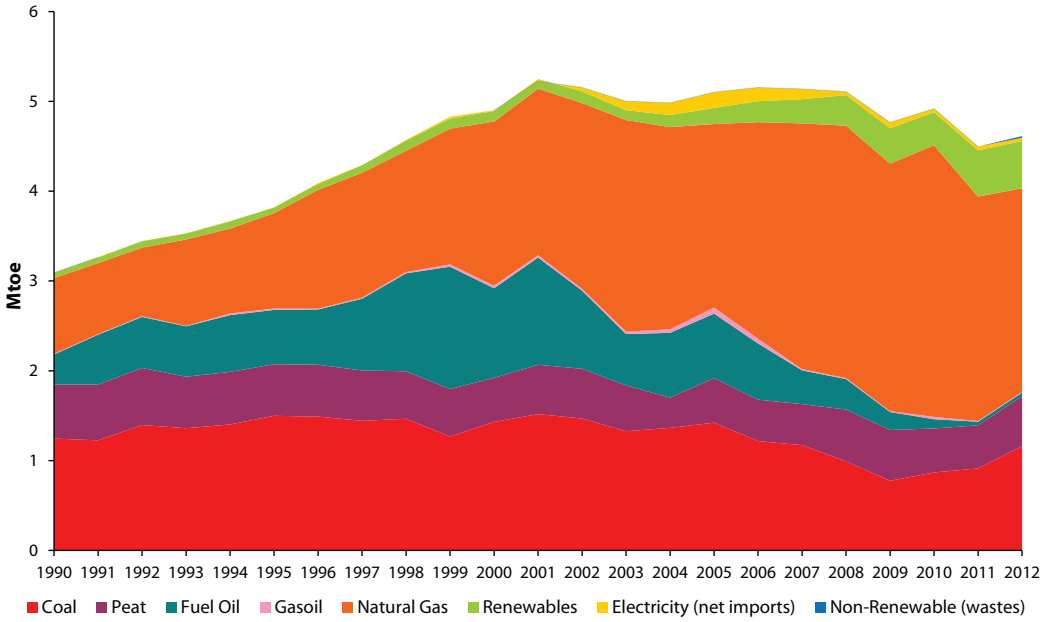
Electricity demand has consistently remained between 15% and 20% of total final consumption for the last 20 years and was approximately 24 TWh in 2012. For some sectors there is a higher reliance on electricity, in particular industry and services, both with an electricity share of 35% and 40% respectively in the sector total final energy demand. The share in the residential sector is lower at 26%.

Fuel inputs to electricity generation are responsible for approximately one third of the total primary energy demand in Ireland (4.6 Mtoe in 2012). When sectoral energy consumption is considered in terms of primary energy and CO_2 emissions, the upstream energy use and related emissions from electricity use in the residential, industry and services sectors are significant.

There are two broad categories of renewable electricity source: combustible and non-combustible. Non-combustible sources of renewable energy contribute to an overall reduction in primary energy demand as they do not have the transformation losses associated with fuel combustion for electricity generation.

The fuel inputs to electricity generation from 1990 to 2012 are shown in Figure 8. The fuel inputs to electricity generation almost doubled between 1990 and 2001. However a switch away from oil to more efficient natural gas generation resulted in a reduction in fossil fuel inputs since the peak of 2001. Overall energy inputs to electricity generation remained relatively constant for the last decade and more recently the fossil fuel inputs have fallen due to the growing contribution of renewables.

Figure 8 *Inputs to Electricity Generation by Fuel Source 1990 – 2012*



Source: SEAI

Table 3 shows the growth rates, quantities and shares of the primary fuel mix for electricity generation over the period 1990 – 2012.

The primary fuel requirement for electricity generation grew by 69% from 3,094 ktoe in 1990 to a high of 5,237 ktoe in 2001. Between 2001 and 2004 the requirement reduced by 4.7%, while at the same time the final consumption of electricity increased by 10%. In 2012, 4,622 ktoe of energy was used to generate electricity, 2.2% more than in 2011 and 12% lower than peak levels in 2001. The fuel inputs to electricity generation were one third (35%) of the total primary energy requirement in 2012. Electricity consumption as a share of total final consumption increased from 14% to 19% between 1990 and 2012.

Table 3 *Growth Rates, Quantities and Shares of Electricity Generation Fuel Mix (primary fuel inputs)*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2012	'90 – '12	'00 – '05	'05 – '10	'10 – '12	2012	1990	2012	1990	2012
Fossil Fuels (Total)	33.2	1.3	-0.1	-1.0	-5.4	2.4	3,034	4,042	98.1	87.5
Coal	-6.8	-0.3	-0.1	-9.4	15.6	27.1	1,245	1,160	40.2	25.1
Peat	-7.7	-0.4	0.2	-0.3	6.6	16.1	604	557	19.5	12.0
Oil	-83.7	-7.9	-5.2	-29.6	-36.1	2.0	343	56	11.1	1.2
Gas	169.3	4.6	2.3	8.2	-13.4	-9.2	843	2,269	27.2	49.1
Renewables (Total)	777.7	10.4	8.9	15.4	19.6	2.0	60	526	1.9	11.4
Hydro	15.1	0.6	-5.7	-1.0	15.7	13.5	60	69	1.9	1.5
Wind	-	-	35.4	20.4	19.4	-8.4	-	345	-	7.5
Other Renewables	-	-	4.8	20.1	22.8	42.9	-	112	-	2.4
Non-Renewable (Wastes)	-	-	-	-	-	-	-	18	-	0.4
Combustible Fuels (Total)	37.5	1.5	-0.1	-0.8	-4.7	3.7	3,034	4,173	98.1	90.3
Electricity Imports (net)	-	-	83.6	-25.5	-6.2	-15.6	-	36	-	0.8
Total	**49.4**	**1.8**	**0.8**	**-0.7**	**-3.1**	**2.6**	**3,094**	**4,622**		

Source: SEAI

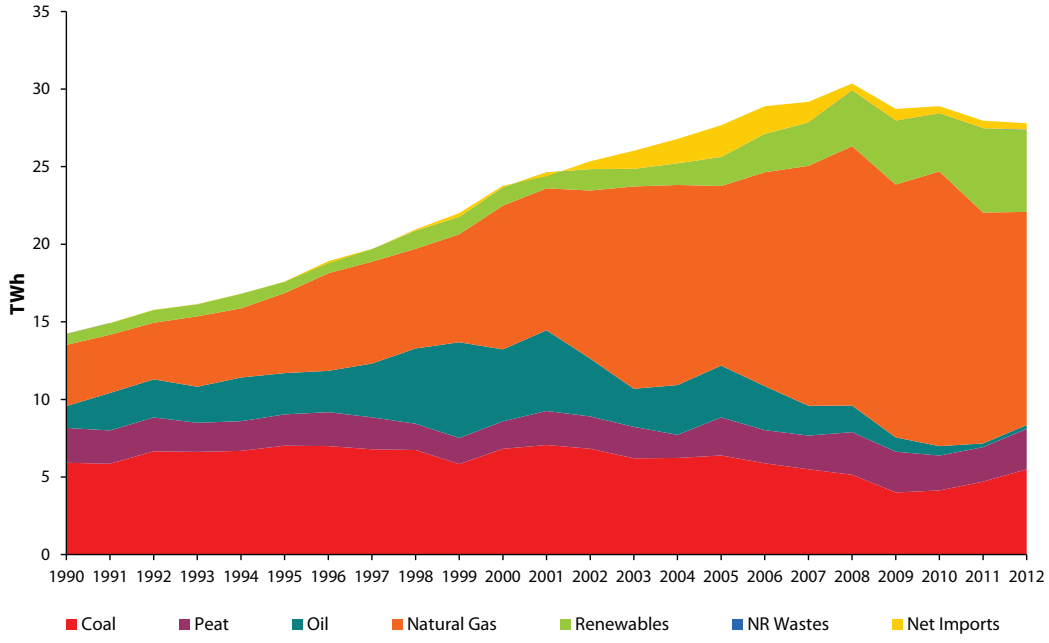
Figure 9 shows the trend in Gross Final Consumption (GFC) of electricity for Ireland over the period 1990 – 2012. It illustrates the changing shares of each fuel/energy source. The doubling of gross electricity consumption over the period 1990 to 2008 is striking, as is the growth in gas generated electricity. It is interesting to compare Figure 8 and Figure 9 and see that even though demand continued to increase between 2001 and 2008 the inputs to electricity generation decreased. As already mentioned, this is the result of higher efficiency electricity generation from natural gas Combined Cycle Gas Turbines (CCGT) and the increasing contribution from renewables.

Due to the impact of the economic recession there has been a reduction in the gross electricity consumption since 2008, as shown in Figure 9. As detailed in Table 4, the share of gas generation increased from 31% in 1990 to 61% in 2010 but has fallen back to 49% in 2012. These changes provide a context against which the growth in RES-E can be assessed. Total Gross Final Consumption of electricity was 27.8 TWh in 2012.

Electricity from renewable energy sources more than trebled its share over the period, going from 4.9% of gross final electricity consumption in 1990 to 19.6% in 2012. During this time the absolute amount of electricity from renewables increased from 697 GWh to 5,256 GWh, a 7.5 fold increase.

Gas-generated electricity grew by 248% over the period 1990 to 2012, an annual average growth rate of 5.8% per annum. In contrast, oil generated electricity has almost been eliminated, falling from a 10% share of all generation in 1990 to 0.9% in 2012.

Figure 9 *Gross Electricity Consumption by Fuel Source 1990 – 2012*



Source: SEAI

Table 4 *Gross Electricity Consumption Percentage by Fuel Source 1990 – 2012*

% of Gross	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Coal	41.6	39.9	28.7	23.1	20.4	18.8	16.9	13.9	14.3	16.8	19.8
Peat	15.8	11.5	7.4	8.9	7.4	7.4	9.0	9.1	7.8	8.0	9.4
Oil	9.9	15.1	19.5	12.1	9.8	6.6	5.6	3.2	2.1	0.9	0.9
Gas	27.7	29.4	39.0	41.8	47.7	53.0	55.1	56.7	61.3	53.2	49.4
Renewables	4.9	4.1	5.0	6.8	8.6	9.6	11.8	14.3	12.9	19.4	18.9
NR Wastes	-	-	-	-	-	-	-	-	-	-	0.2
Net Imports	0.0	-0.1	0.4	7.4	6.2	4.6	1.5	2.7	1.6	1.8	1.5

Source: SEAI

5.2 Sources of Renewable Electricity

5.2.1 Hydro Energy

There are 14 large hydroelectric[23] generators connected to the power transmission system, each having a maximum export capacity (MEC) of over 4 MW. The total hydro connected to the transmission system is 212 MW. This is 2.8% of the total connected generation capacity.

There are a further 58 micro[24] (< 1 MW) hydroelectric generators connected to the distribution system with an installed capacity of 25.5 MW. There are four micro generation projects of 1 MW capacity contracted for power distribution system connections.

5.2.1.1 Pumped Hydro Storage

Electricity produced by pumped storage from water that has previously been pumped uphill is not classified as being from a renewable energy source and is not included in either the numerator or the denominator of the renewable electricity (RES-E) calculation. While it is not a renewable electricity source, pumped hydro storage has attributes relevant to renewable energy deployment. It is a means of electricity storage for load balancing in an electricity system. Significantly for renewables, pumped hydro storage can be used to facilitate wind energy integration into the electricity grid.

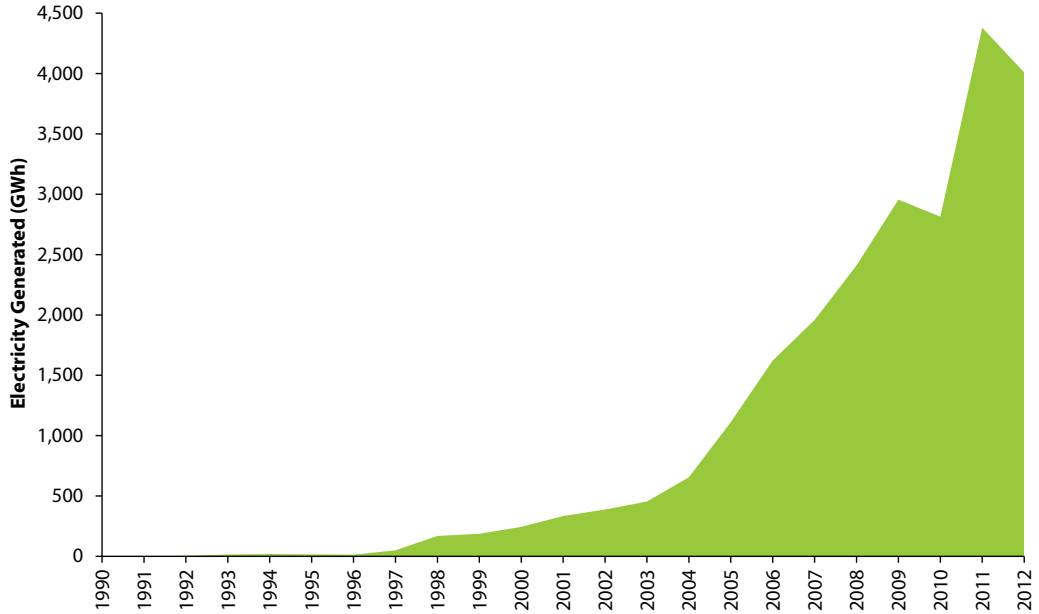
There is currently only one pumped hydro station in Ireland, at Turlough Hill. The station comprises four 73 MW generators to give a total capacity of 292 MW. It was not in operation from August 2010 to February 2012 due to scheduled maintenance works. There is also a 35 MW pumped storage project in the grid connection application queue[25].

5.2.2 Wind – On-shore and Off-shore

Figure 10 and Table 5 show the electricity generated from wind and illustrate the rapid rise in electrical output since 1997 when the first of the wind farms supported by the Alternative Energy Requirement (AER) programme came online. Total electrical output from wind in 2012 was 4,010[26] gigawatt hours (GWh) representing a fall of 8.4% on 2011 due to the wind resource being lower (less wind blew) than in 2011. Wind was responsible for 14.4% of gross electrical consumption in 2012 or 15.3% on a normalised basis. The historic peak recorded wind power output[27] was 1,564 MW, delivered on Wednesday 20th November 2013.

23 EirGrid *TSO Non-Wind Generators - Connected (11 January 2012)*. Available from http://www.eirgrid.com/customers/connectedandcontractedgenerators/
24 ESB Networks Distribution Connected Non-Wind Farms (DSO). Available at http://www.esb.ie/esbnetworks/en/generator-connections/
25 See http://www.eirgrid.com/customers/gridconnections/completedgenerationapplications/
26 Output from both grid connected wind farms and large auto-producer turbines.
27 System records are updated on the EirGrid website, as well as 15 minutes average data on wind power. www.eirgrid.com/operations/

Figure 10 *Electricity Generated by Wind (GWh) 1990 – 2012*



Source: EirGrid

Table 5 *Renewable Electricity Production – Wind*

	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Wind (GWh)	0	16	244	1,112	1,622	1,958	2,410	2,955	2,815	4,380	4,010

Source: EirGrid

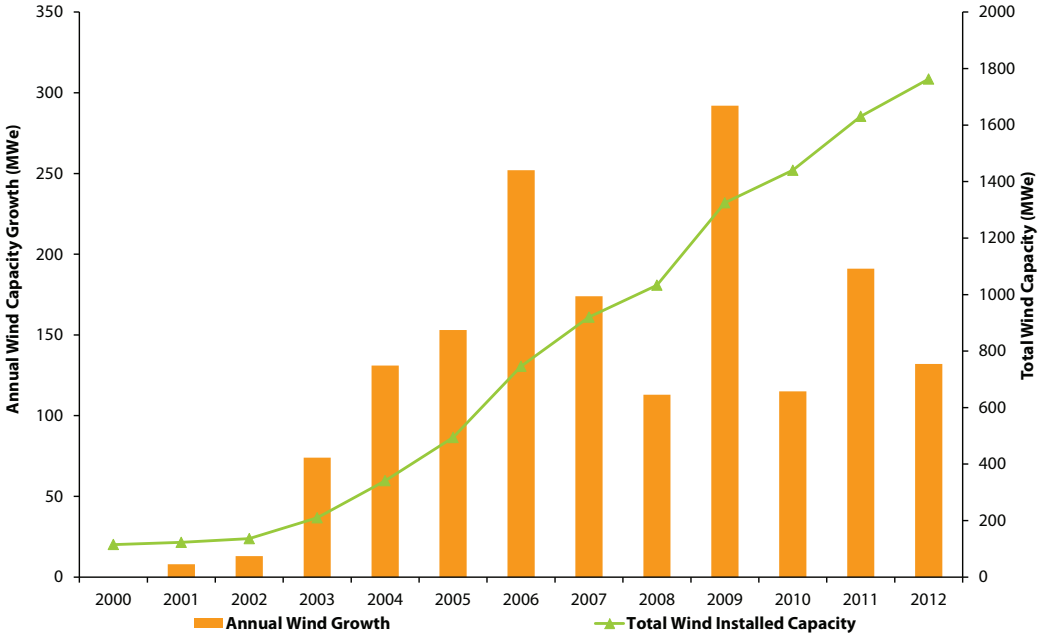
Figure 11 traces the evolution in installed wind capacity from 2000 to 2012 (the first wind farms came on line in 1992). It shows the annual incremental capacity added and the cumulative capacity on the Irish transmission and distribution networks.

There was a slowdown in wind farm development in 2007 and 2008 due to a number of factors including uncertainty regarding the renewable energy feed-in tariff (REFIT) scheme (which was waiting on EU approval until September 2007) and uncertainty about access to finance for wind farm development. The rate of development increased during 2009 but decreased again in 2010. In 2011 an additional capacity of 191 MW was installed, similar to the 5-year average installation rate of approximately 180 MW per annum. The rate of installation fell back again in 2012 with just 132 MW coming on stream.

The total installed capacity of transmission and distribution system connected wind farms reached 1,763 MW by the end of 2012. Onshore wind farms with an additional combined Maximum Export Capacity (MEC) of 295.7 MW had target connection dates during 2013[28].

28 EirGrid (July 2013), *All Island Renewable Connection Report 36 Month Forecast (Q1 2013)*, http://www.eirgrid.com/media/All-Island_Renewable_Connection_Report_-_36-Month_Forecast_(Q1_2013).pdf.

Figure 11 *Installed Wind Generating Capacity 2000 – 2012*



Source: EirGrid

The contribution of wind energy from small turbines for auto production in industry was 11 GWh or just 0.27% of all wind energy generated in 2012. The contribution from grid connected domestic installations was less than a tenth of the industry auto production of wind energy in 2012. A domestic micro-generation rate is available from ESB Customer Services as discussed in Appendix 2 section A2.2.9. While there may also be some non-grid connected domestic turbines, their contribution is currently considered negligible.

5.2.2.1 Capacity Factors

The capacity factor (CF) of wind power is the ratio of average delivered power to theoretical maximum power. It can be computed for a single turbine, a wind farm consisting of dozens of turbines or at the national level consisting of hundreds of farms. At the national level, the rate of capacity increase each year can significantly impact on the capacity factor in periods of large annual capacity increases. For instance, if a significant amount of capacity is installed in the last months of the year then the aggregated capacity factor for the year will appear low as this additional capacity only generated for a fraction of the year.

Annual estimates of the annual average capacity factor for installed wind capacity in Ireland since 2000 are shown in Table 6. In this calculation the total wind generated electricity produced per annum is divided by the mid-year installed capacity. However, as already mentioned, this method can underestimate the annual capacity factor if the bulk of new capacity is installed and becomes operational in the second half of the year.

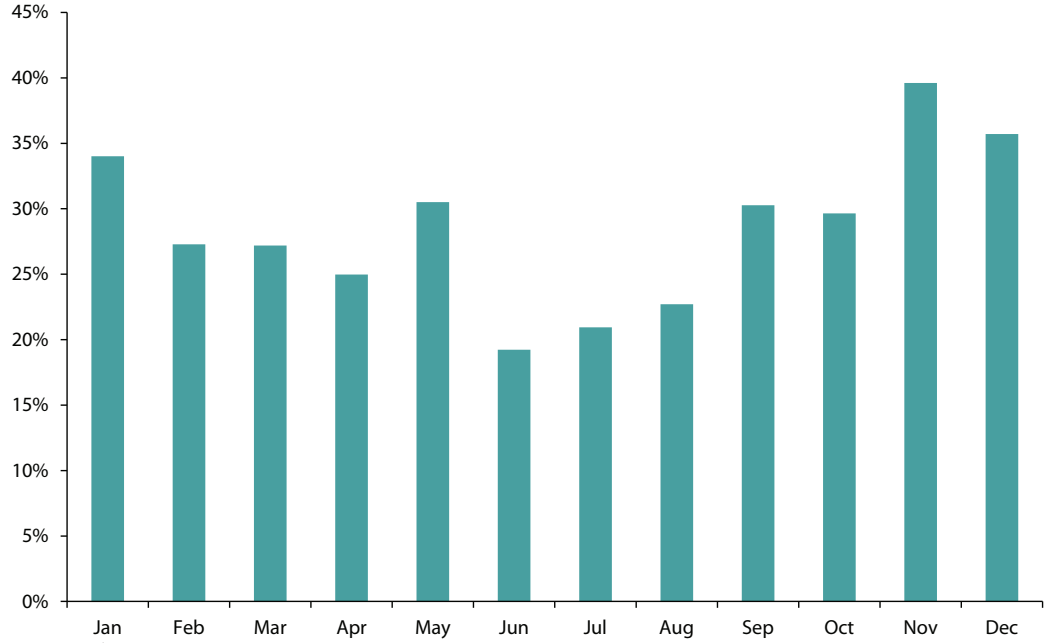
Table 6 *Annual Capacity Factor for Wind Power Generation in Ireland 2000 – 2012*

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Capacity Factor	30%	32%	34%	30%	27%	30%	30%	28%	29%	29%	24%	33%	27%

Source: EirGrid and SEAI

A more accurate calculation of the capacity factor for Ireland using monthly installed capacities and wind generated electricity was also calculated for 2009 to 2012 and is shown in Figure 12. The graph shows a general tendency for the highest capacity factors to be at the start and end of the year, with lower wind generated outputs during the summer months.

Figure 12 *Wind Generation Capacity – Average Monthly Capacity Factors 2009 – 2012*

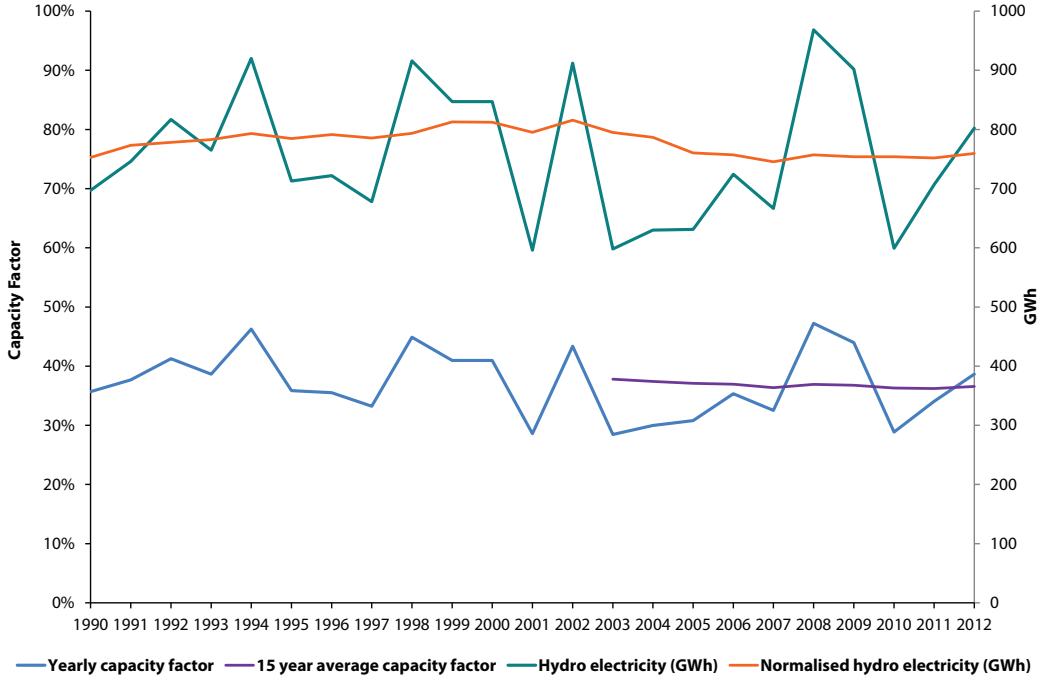


Source: EirGrid & SEAI

5.3 Normalisation of Hydro and 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 under Directive 2009/28/EC, the effects of climatic variation are smoothed through use of a normalisation rule, as described in section 3.3.3.1. The normalisation rule for hydro uses the average capacity factor of the previous 15 years and the installed capacity of the reporting year to calculate the normalised hydro contribution towards the renewable energy targets. Figure 13 shows the individual and normalised data over the 23 years 1990 – 2012.

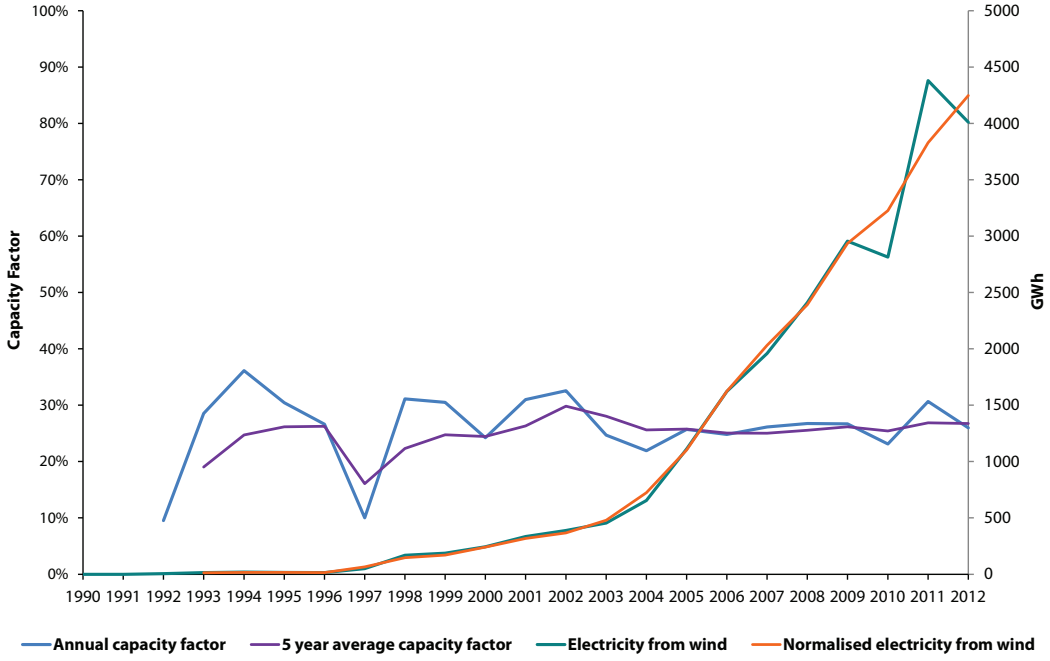
Figure 13 *Normalised Hydro Energy Contribution 1990 – 2012*



Source: SEAI and EirGrid

The normalisation rule for wind uses the average installed capacity of the reporting year and the previous year multiplied and the average capacity factor of the previous five years. The average 5 year capacity factor is shown in Figure 14.

Figure 14 *Normalised Wind Energy Contribution 1990 – 2012*



Source: SEAI and EirGrid

5.3.1 Combustible Renewables

5.3.1.1 Solid Biomass

Solid biomass covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation. It is primarily wood, wood wastes (firewood, wood chips, barks, sawdust, shavings, chips, black liquor[29] etc.), other solid wastes (straw, oat hulls, nut shells, tallow, meat and bone meal etc.). Most of the solid biomass used in Ireland is for thermal energy purposes only. In electricity generation biomass is used in co-firing with fossil fuels in existing power plants. Only a small amount of biomass is currently used in Combined Heat and Power (CHP) plants (1.1% in 2011). In the Government's 2007 Energy White Paper there is a target to have 30% biomass co-firing with peat in the three stated-owned peat-generation stations by 2015. There is also REFIT support for electricity generation from bioenergy, as detailed in Appendix 2.

5.3.1.2 Waste to Energy

There is currently one municipal waste-to-energy plant in Ireland. The facility operated by Indaver is based in Duleek, Co. Meath and became operational in 2011, managing 200,000 tonnes of residual waste per annum and with a capacity of 15 MW. There are currently plans for two further waste-to-energy plants, one in Ringaskiddy, Co. Cork and another in Poolbeg, Dublin. Incineration of municipal and hazardous waste is exempt from the emissions trading scheme.

5.3.1.2.1 Renewable Municipal Solid Waste (MSW)

The biodegradable part of municipal waste produced by households, industry, hospitals and the tertiary sector is considered to be 'renewable biomass'.[30] The quantities used as fuel are reported on a net calorific value basis. If the renewable portion of MSW is not known then a default value of 50% is used.

5.3.1.2.2 Municipal Solid Waste (MSW) - Non-Renewable

This covers the non-biodegradable part of municipal waste produced by households, industry, hospitals and the tertiary sector that is incinerated at specific locations. The quantities used as fuel are reported on a net calorific value basis. If the non-renewable portion of MSW is not known then a default value of 50% is used.

29 This is a recycled by-product formed during the pulping of wood in the paper-making industry.
30 Article 2 (e) of Directive 2009/28/EC. See footnote on page 18.

5.3.1.3 Biogas

Biogas consists of landfill gas, sewage sludge gas and other biogas produced by anaerobic digestion. Landfill gas is reported separately to biogas in the Irish national energy balance. In 2012 the biogas figure in the Irish national energy balance consisted largely of estimates of energy generated in waste water treatment plants and other biogas installations in industry; these are estimates only, due to poor response rates to the SEAI annual surveys.

5.3.1.3.1 Landfill Gas

Although produced from waste, landfill gas (LFG) is regarded as a renewable or sustainable energy source for the purpose of EU renewable energy targets. Landfill gas in Ireland is only used for electricity generation or is flared directly to the atmosphere. There are 22 landfill gas generators connected to the distribution grid with an MEC of 45 MW, with a further 9.8 MW contracted for connection to the electricity grid. Landfill gas is unlikely to have significant growth as an energy source due to limitations on how much future waste can be sent to landfills. In 2012 174 GWh was produced from landfill gas, representing 0.63% of the gross electricity generated.

5.3.1.3.2 Sewage Sludge Gas

Sewage sludge gas is produced in sewage treatment facilities and used on site in CHP plants for own use electricity and for heat treatment of the sewage. The current installed capacity is just less than 4.8 MW and produced approximately 21 GWh in 2012 or 0.08% of gross electricity generated.

5.3.1.3.3 Other Biogas

Biogas is produced from the anaerobic digestion of animal slurries, wastes in abattoirs, breweries and other agri-food industries. Anaerobic digestion is a cost effective method of producing heat/electricity and reducing harmful wastes. Biogas is used in CHP plants to generate electricity either for own use or for exporting to the grid. There is currently 4 MW installed capacity connected to the electricity distribution network with a further 21 MW contracted or in the queue for connection. In 2012 approximately 3.7 GWh was generated from biogas or 0.01% of total electricity generated in 2012.

5.3.2 Ocean Energy – Tidal & Wave

5.3.2.1 Tidal Energy

The tidal accessible resource in Ireland is determined by the availability of suitable sites with appropriate depth and tidal stream speeds and also by commercial constraints. The resource is estimated at 0.92 TWh[31] per annum. To put this figure in context this equates to 3.3% of the total electricity demand for 2012.

An Irish company (Open Hydro) was the first company to install a tidal energy device in the European Marine Energy Centre (EMEC) off the Scottish coast in 2006. The world's first commercial tidal energy device was connected to the grid in Northern Ireland in April 2008. The device, 'Sea-Gen', a 1.2 MW tidal current energy converter device developed by a UK company (Marine Current Turbines), is located in Strangford Lough.

5.3.2.2 Wave Energy

It is estimated that an accessible wave energy resource of 21 TWh per annum[32] exists within the total limit of Irish waters. This equates to just over three quarters (76%) of Ireland's total electricity demand in 2012. The Government has a target of 500 MW of installed wave energy capacity by 2020 and an ambition for Ireland to be a world leader in the development of wave energy. Since 2008 a REFIT payment of 22 cents per kWh is available for electricity from wave energy. The Government also announced the development of a full scale test site for wave energy devices off the west coast of Ireland, at Belmullet, Co. Mayo, in 2008. In February 2010 a weather buoy was deployed off the coast of North Mayo to monitor wave and weather conditions.

There are currently a number of wave energy devices being tested in a test site for quarter scale devices located in Galway Bay. A number of devices designed by Irish companies are being tested in the Galway Bay site and at other locations around the world. While there are several different wave energy device prototypes in development, a commercial wave energy device does not yet exist.

31 *Tidal and Current Energy Resource in Ireland, SEAI,* available from http://www.seai.ie/Renewables/Ocean_Energy/Irelands_Tidal_Energy_Resource/
32 http://www.seai.ie/Renewables/Ocean_Energy/Ireland's_Wave_Energy_Resource

5.3.3 Solar Electricity (Photovoltaic)

There are few grid connected photovoltaic (PV) installations in Ireland. The cost of PV has been falling dramatically in recent years[33]. Over the period 2000 – 2011, solar PV was the fastest-growing renewable power technology worldwide[34] and in installations using certified products installed by competent personnel it performs reliably to provide viable contributions to renewable electricity generation.

The Government has indicated that the manner of providing Government support for the uptake of solar PV installations will be through the provision of a feed-in tariff rather than through grant aid. The intention to provide such a tariff is stated in the Programme for Government and SEAI has provided analysis of tariff options to the Department of Communications, Energy and Natural Resources. A single electricity supplier has voluntarily offered a mico-generation feed-in tariff since 2009 which includes solar PV. See appendix A2.2.9.

The Government has not yet announced the launch of a feed-in tariff for solar PV but official recognition that solar PV is a viable renewable energy generation option includes the following:

- The energy contribution of a solar PV array may be included in the calculation of the renewable energy contribution within a building to comply with Part L of the building regulations for new buildings. It is now generally recognised that solar PV may, in many cases, represent the least cost option for meeting the Part L renewable energy contribution requirement.
- The contribution of a solar PV array to reducing a building's annual electricity demand and CO_2 emissions is included in the Building Energy Rating and a calculation routine for the estimation of this is included within the associated DEAP software.
- Solar PV products meeting the required European and international standards are listed on the SEAI Triple E Register for accredited energy efficient equipment. Listed solar PV products qualify for a favourable depreciation regime for corporation tax under the Accelerated Capital Allowances scheme and for VAT refunds when installed for agricultural use by farmers. Public bodies are also obliged to purchase Triple E listed products when procuring relevant equipment items.
- SEAI recommends solar PV panels as an option for consideration in its literature and publications on renewable energy and on low carbon buildings.
- Solar PV arrays have been provided with exemption to the requirement for planning permission for a range of typical installations. SEAI contributed to the development of these planning exemptions by the DECLG.
- SEAI formed a Standards Development Group (SDG) to develop FETAC micro-generation award standards for installer training courses, including courses for solar PV installers. Final award specifications were provided to FETAC for training awards, which are now FETAC accredited, for the following courses.
  - Implementation of micro solar PV systems
  - Electrical Installation of micro-generators

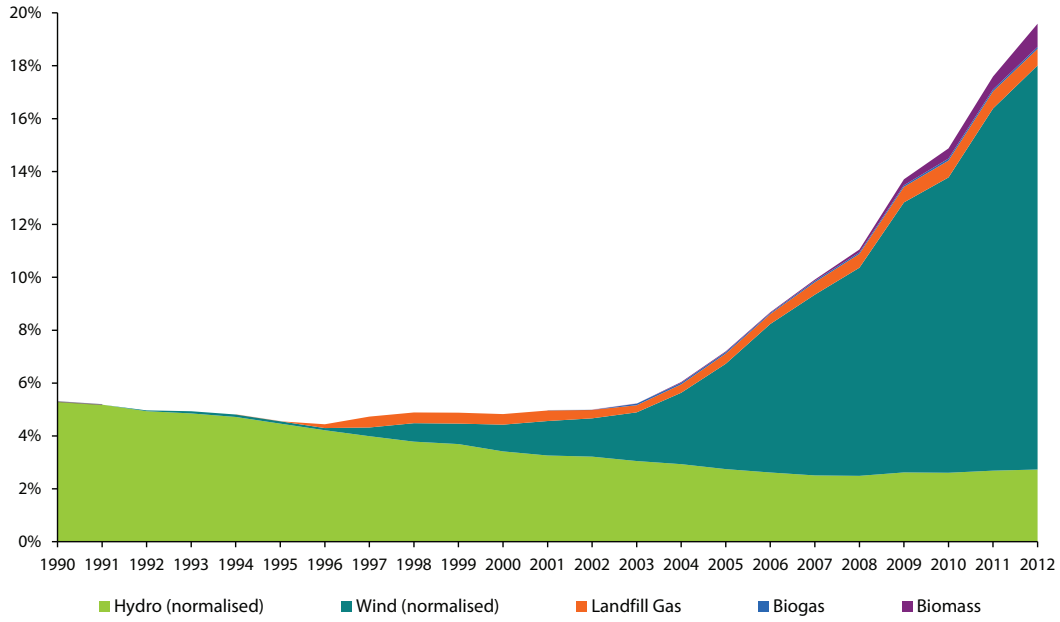
While there are also some existing standalone commercial and domestic installations, statistics are not available for these installations. There were 49 micro-generation grid connected PV installations connected at the end of 2012, with a total installed capacity of 151 kW.

5.4 Contribution of Renewable Electricity Sources

Figure 15 shows the contribution of all renewables as a percentage of gross electricity consumption. While the share from hydro has declined, Figure 15 and Table 7 show how the electricity production contribution from wind energy has grown. There has also been a small contribution from waste water biogas since 2003 and from solid biomass CHP since 2004. Normalised wind and hydro energy in 2012 accounted for 15.3% (13.7% in 2011) and 2.7% (2.7% in 2011), respectively, of Ireland's gross electrical consumption. Solid biomass was responsible for 0.9% (0.5% in 2011), while landfill gas was responsible for 0.6%. The remaining 0.1% in 2012 was from biogas.

33 Bazillian et.al., 2012, Reconsidering the Economics of Photovoltaic Power. Available from http://www.bnef.com/WhitePapers/download/82
34 International Energy Agency, Photo Voltaic Power System – Annual report 2011. Available from http://www.iea-pvps.org/index.php?id=6

Figure 15 *Renewable Energy (%) Contribution to Gross Electricity Consumption by Source 1990 – 2012*



Source: SEAI and EirGrid

Table 7 *Renewable Electricity as Percentage of Gross Electricity Consumption 1990 – 2012*

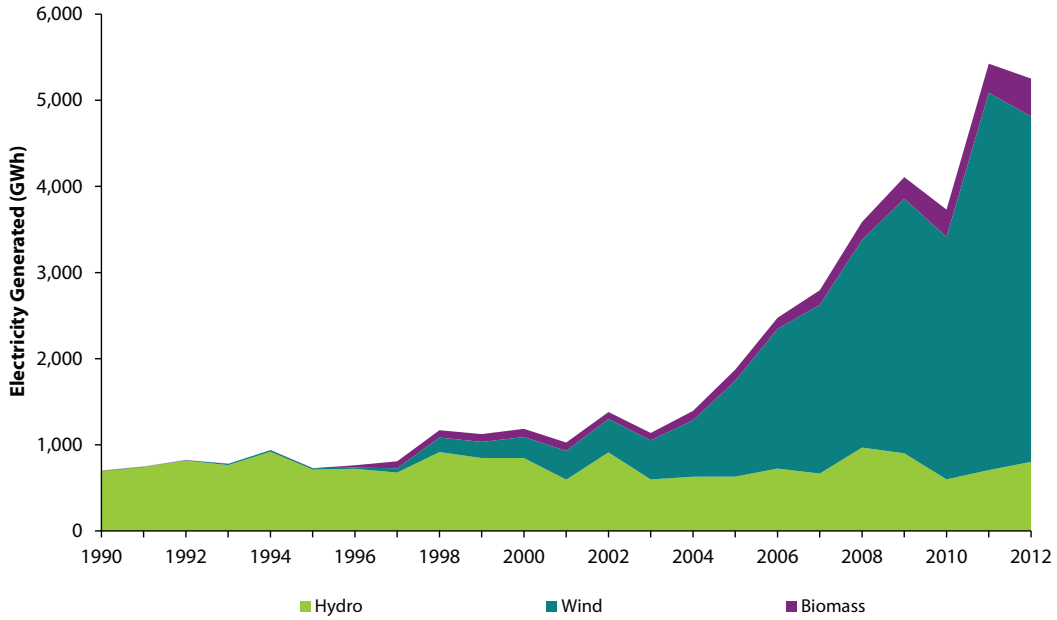
	1990	2000	2005	2006	2007	2008	2009	2010	2011	2012
Renewables % of Gross Electricity	**5.3**	**4.8**	**7.2**	**8.7**	**9.9**	**11.1**	**13.7**	**14.9**	**17.6**	**19.6**
Hydro (normalised)	5.3	3.4	2.7	2.6	2.5	2.5	2.6	2.6	2.7	2.7
Wind (normalised)	-	1.0	4.0	5.6	6.8	7.9	10.2	11.2	13.7	15.3
Biomass	-	-	-	-	-	0.1	0.2	0.4	0.5	0.9
Landfill gas	-	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0.6
Biogas	-	-	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1

Source: SEAI

The share of electricity generated from renewable energy sources (RES-E) in 2009 was 13.7% (normalised) which meant that Ireland surpassed the EU interim target of 13.2% RES-E by 2010. While it appeared that Ireland would also meet the national target of 15% in 2010, the target was missed due to reduced levels of wind speed and rainfall and other constraining factors in 2010. Hydro electricity in 2010 was 34% less than in 2009 and electricity from wind was 5% less than 2009 in spite of a 10% increase in installed capacity. The normalised RES-E contribution in 2010 was 14.9%. The normalised RES-E contribution in 2012 was 19.6%.

Figure 16 shows the contribution from each renewable energy source to the overall RES-E mix in GWh before the normalisation rules are applied. Biomass here is a collective term comprising electricity generation from solid biomass, landfill gas and biogas, where landfill gas provides the most significant input. The almost eightfold increase in electricity generation from renewable energy between 1990 and 2011 is clearly visible in Figure 16, dominated by the growth in wind energy. The total electricity generated from renewable energy reached 5,256 GWh in 2012, a decrease of 3.1% from 2011.

Figure 16 *Renewable Energy Contribution (GWh) to Gross Electricity Consumption by Source 1990 – 2012*



Source: SEAI and EirGrid

The absolute electricity generated from renewable energy sources is detailed in Table 8.

Table 8 *Renewable Electricity Produced in GWh 1990 – 2012*

	1990	2000	2005	2006	2007	2008	2009	2010	2011	2012
Total Renewable Electricity	**753**	**1,148**	**1,993**	**2,509**	**2,946**	**3,357**	**3,941**	**4,298**	**4,920**	**5,446**
Hydro (normalised)	753	812	760	757	745	757	754	754	752	759
Wind (normalised)	-	240	1,102	1,624	2,031	2,391	2,936	3,227	3,830	4,247
Biomass	-	0	8	8	14	33	65	111	137	244
Landfill gas	-	95	106	108	139	159	169	184	181	175
Biogas	-	-	16	12	17	17	17	22	21	21

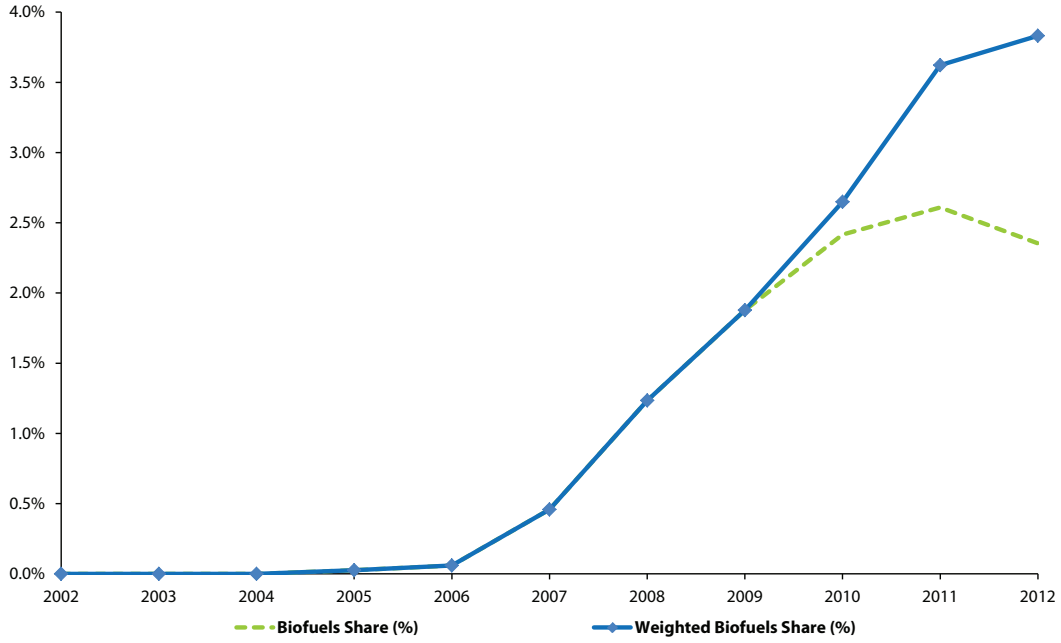
Source: SEAI

6 Renewable Transport Energy (RES-T)

Transportation is the energy consuming sector that is most difficult to decarbonise – and the most exposed to volatile oil prices. The Renewable Energy Directive 2009/28/EC established a mandatory minimum 10% target for the contribution of renewable energy as a share of all petrol, diesel, biofuels and electricity consumed in road and rail transport energy by 2020. According to the Directive for this target a weighting of 2.5 is applied to the electricity from renewable energy sources consumed by electric road vehicles, where the contribution is calculated as the energy content of the input of electricity from renewable energy sources, measured two years before the year in question. Also supported through a weighting factor of 2 are advanced biofuels, and biofuels from waste; that is, biofuels that diversify the range of feedstocks used to become commercially viable receive an extra weighting compared to first generation biofuels.

Under the Biofuels Obligation Act 2010 suppliers of fuel for road transport were required to include an average of 4% biofuels by volume (approximately 3% in energy terms) in their sales between 1st July 2010 and the end of 2012. From the start of 2013 the requirement is 6.383%[35]. Figure 17 illustrates the dramatic recent growth in renewable energy used for transport (biofuels), albeit from a low base. It shows the ratio of renewable energy used in Ireland as a share of road transport energy, in accordance with the definition in the EU Biofuels Directive (2003/30/EC), both with and without the weighting specified in the Renewable Energy Directive 2009/28/EC.

Figure 17 *Renewable Energy as a Proportion of Road and Rail Transport Energy (RES-T) 2002 – 2012*



Source: SEA

It is evident from Figure 17 that the growth coincided with the introduction of tax relief support for biofuels, with slow growth from 2004 to 0.06% in 2006 followed by an increase to 1.2% in 2008 and 2.6% in 2010. The Mineral Oil Tax Relief scheme (MOTR II) ended in 2010 with the introduction of the Biofuels Obligation Scheme. The figure for renewables in transport energy (RES-T) in 2012 is 3.8%. The EU Directive 2003/30/EC target for RES-T of 2% by 2008 was not met. In addition, the Government target of 3% RES-T by 2010 was not met but was surpassed in 2011. Table 9 shows the data behind Figure 17 in absolute terms.

35 Office of the Attorney General, (Dec. 2012), *S.I. No. 562/2012 - National Oil Reserves Agency Act 2007 (Biofuel Obligation Rate) Order 2012*, http://www.irishstatutebook.ie/2012/en/si/0562.html

Table 9 *Biofuels Growth in ktoe and as a Proportion of Road and Rail Transport Energy 2005 – 2012*

ktoe	2005	2006	2007	2008	2009	2010	2011	2012
Petrol	1,822	1,883	1,920	1,830	1,666	1,505	1,425	1,296
Diesel	2,378	2,590	2,758	2,615	2,378	2,236	2,221	2,225
Biofuels (ktoe)	1	3	22	56	77	93	98	85
Biofuel Penetration	***0.0%***	***0.1%***	***0.5%***	***1.2%***	***1.9%***	***2.4%***	***2.6%***	***2.4%***
Weighted biofuels (ktoe)	1	3	22	56	77	102	137	140
Weighted biofuels share	***0.0%***	***0.1%***	***0.5%***	***1.2%***	***1.9%***	***2.7%***	***3.7%***	***3.8%***

Source: SEAI

The top section of Table 9 shows, in energy terms, the amounts of petrol, diesel and biofuel used in transport for the purposes of calculating the RES-T percentage. Beneath these, in bold, is the biofuel penetration rate calculated without reference to double certifications of second generation biofuels and biofuels from waste. The bottom section of the table shows the energy value of the biofuels taking into account the weighting allowed for the double certification and below this, in bold, the subsequent calculation of the RES-T percentage arising from this. Both the biofuel share (penetration) and the weighted biofuel share are shown in Figure 17.

Table 10 gives a breakdown of the weightings applied to the renewable transport energy sources in accordance with the Biofuel Obligation Scheme Act. The European Union (Biofuel Sustainability Criteria) Regulations (SI 33 of 2012) referred to as the Sustainability Regulations, were introduced in February 2012. These Regulations gave effect to Section 44 G (4) of the Biofuels Acts 2010. The Regulations require that biofuel which is placed on the market must satisfy the carbon and sustainability criteria [36] of the Renewable Energy Directive 2009/28/EC in order to be counted towards the biofuel obligation. However, a Transitional Provision in the Sustainability Regulations essentially waived this obligation until mid July 2012. Prior to that, that is in 2010 and 2011, as long as it could be demonstrated that biofuel was being placed on the market, it could be counted towards the annual obligation.

The EU Commission is currently preparing to amend the Renewable Energy Directive. One of the goals for the amended Directive will be to further incentivise the production of advanced biofuels. One of the proposed methods of achieving this is to cap the contribution of first generation biofuels.

Table 10 *Proportion of Individual Biofuel with Multiple Credits*

	2010	2011	2012	2020 projected
Bioethanol	0%	0%	0%	100%
Biodiesel	18%	58%	99%	100%
Pure plant oil	0%	0%	0%	

Source: NORA & SEAI

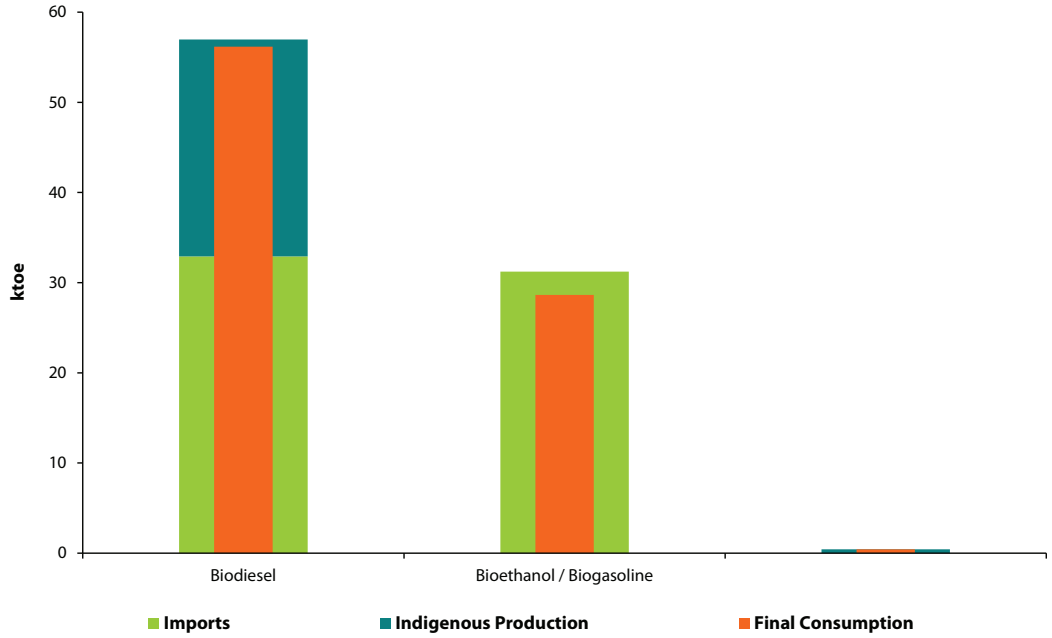
In 2010 less than one fifth of biodiesel attracted double certification compared to almost 100% in 2012.

6.1 Biofuels

Figure 18 shows the contribution of different biofuels to Ireland's transport energy supply in 2012. The graph distinguishes between the amount of biofuels produced and imported (the thicker green bars) and the amount used (the thinner orange bar) in 2012. The difference between the amounts produced and imported versus the final consumption is accounted for by stock changes.

36 There are essentially three criteria:
- Biofuel placed on the market must achieve a minimum Greenhouse Gas Saving. This was 35% in 2012. The percentage will increase to 50% in 2017, and for installations where production started after 2017, it will increase to 60% in 2018;
- Biofuels shall not be made from raw material obtained from land with high biodiversity value;
- Biofuels shall not be made from raw material obtained from land with high carbon stock.

Figure 18 *Biofuels Production, Imports and Usage (2012)*



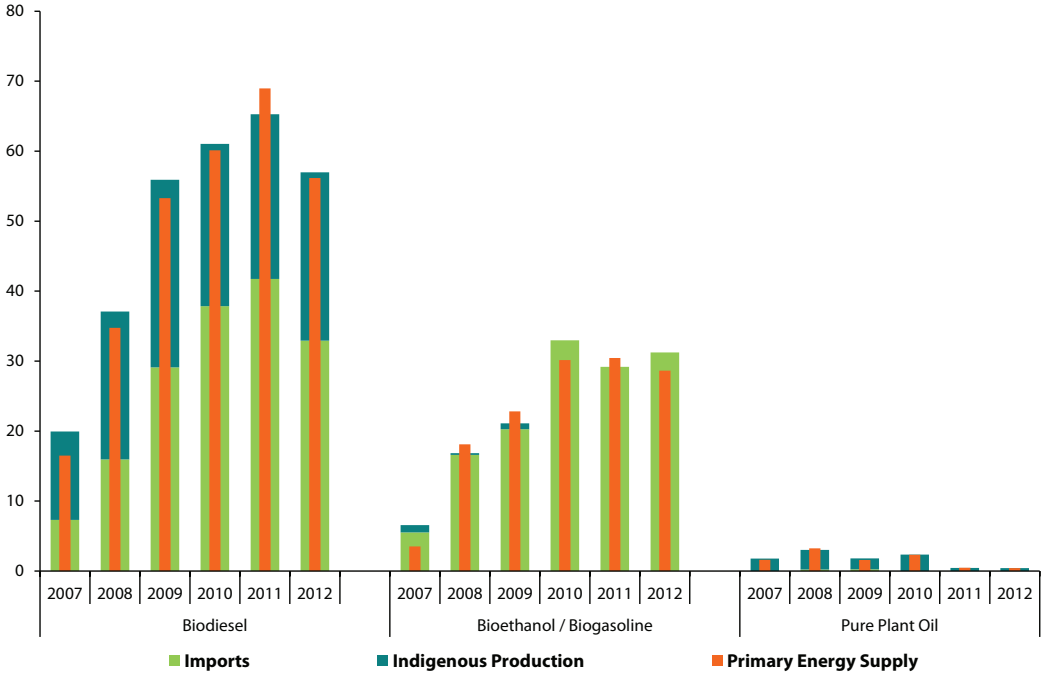
Source: SEAI

The dominant biofuel is biodiesel, representing 66% of consumption in 2012. The remaining 34% was from bioethanol. It is also apparent from Figure 18 that during 2012 there were more biofuels imported than produced indigenously. Indigenous production retained in Ireland accounted for 21% of biofuels supply (on an energy basis) in 2012.

The proportion of indigenous production compared to imports varies according to the biofuel. All bioethanol used in Ireland since 2010 was imported, i.e. no indigenous bioethanol production, whereas pure plant oil used for transport purposes was all produced in Ireland. There is some indigenous production of biodiesel from waste oil and from rape seed but 66% of all biodiesel consumed in 2012 was imported. The sources of biofuels are likely to come under increased scrutiny with the focus on the sustainability criteria for biofuels in Directive 2009/28/EC and the double weighting in the RES-T calculation for biofuels from wastes, residues, non-food cellulosic material, ligno-cellulosic material or algae. An additional constraint in terms of biofuel production in the EU arises due to agricultural cross-compliance policy that limits the amount of land that can be transferred to tillage[37]. A short time series of biofuel consumption trends in Ireland is shown in Figure 19.

37 Singh A, Smyth BM, Murphy JD (2009). "A biofuel strategy for Ireland with an emphasis on production of bio-methane and minimization of land take," *Renewable and Sustainable Energy Reviews* (2009), doi:10.1016/j.rser.2009.07.004

Figure 19 *Biofuels Production, Imports and Consumption 2007 – 2012*



Source: SEAI

Two primary factors caused the noticeable drop in biofuel imports, production and usage between 2011 and 2012:

- The amount of road transport fuel consumed in Ireland fell by 3.8% in energy terms. This consisted of a 9.1% fall in petrol and a 0.1% increase in diesel consumption.
- The amount of biodiesel which was eligible for double certification, by virtue of being produced from waste, increased from 58% in 2011 to 99% in 2012. This reduced substantially the actual amount of biodiesel required to be placed on the market in order to satisfy the biofuel obligation.

With the increase in the obligation from 4% to 6% in 2013, it would be expected that the data for 2013 will show a significant increase in the amount of biofuel placed on the market in Ireland.

6.2 Electric Vehicles

Renewable electricity can contribute to fuel transport systems when they are converted to electricity. Electric vehicles are inherently energy efficient and when supplied with renewable electricity can lead to substantial reductions in imported fossil fuels for transport. Ireland has set a target of converting 10% of its passenger and light commercial vehicle stock to electric vehicles (equivalent to 230,000 vehicles) by 2020.

In April 2011 a grant programme was launched together with VRT relief of up to €5,000 per vehicle to support M1 and N1 category electric vehicles meeting minimum specified performance criteria in order to generate the critical mass necessary to assist in the development of an electric vehicles market in Ireland. In parallel a nationwide programme to roll out electric vehicle charging points was begun to provide the necessary charging infrastructure to encourage market growth of electric vehicles.

According to the Vehicle Registration Unit of the Department of Transport, at the end of 2012 there were 230 passenger electric vehicles, 54 freight electric vehicles, 62 electric motorcycles and 302 other electric vehicles (taxi, island vehicle, forklift etc).

6.3 Other Renewable Fuels for Transport

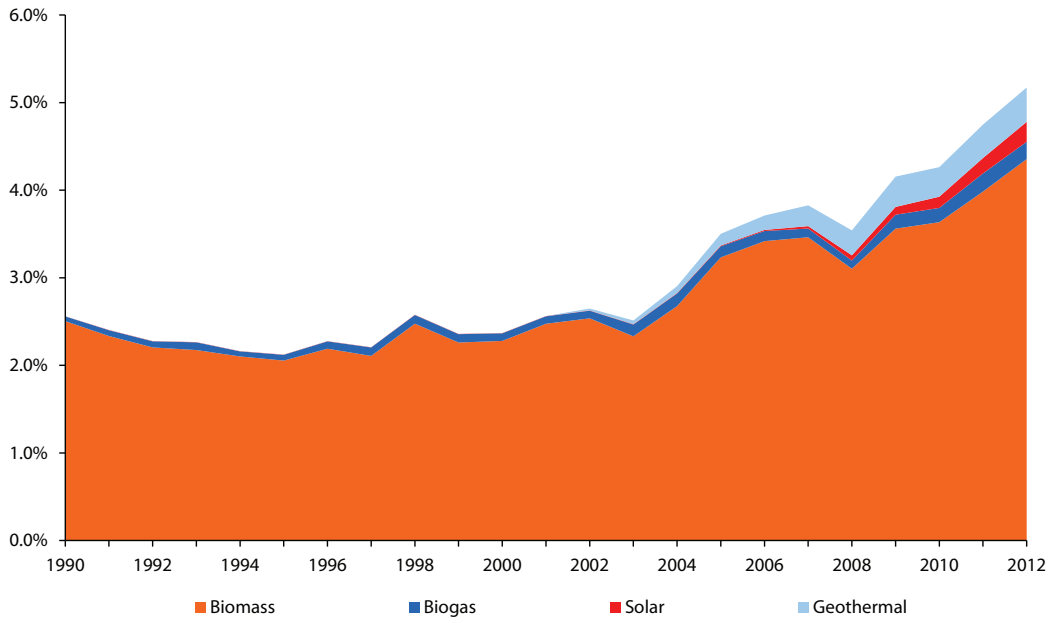
The double weighting in the RES-T calculation for biofuels from wastes, residues, non-food cellulosic material, ligno-cellulosic material or algae encourages the development of biofuels from these sources. There is scope in Ireland to use other renewable fuels in transport such as compressed natural gas derived from bio-methane, and recent analysis points to this as one option for Ireland to meet the RES-T target using indigenous energy sources.[38]

38 Smyth B.M., Ó Gallachóir B. P., Korres N. E. and Murphy J. D. (2010). Can we meet targets for biofuels and renewable energy in transport given the constraints imposed by policy in agriculture and energy? *Journal of Cleaner Production*, Volume 18, Issues 16 - 17, pp 1671 - 1685. .

7 Renewable Thermal (Heating and Cooling) - RES-H

The thermal energy market in Ireland is defined as the energy used for space, process and water heating, cooking etc. It is calculated as the residual energy requirement when energy use from transport and electricity generation are subtracted from the total final energy consumption. The calculation of RES-H thus excludes electricity used for heating and cooling in order to avoid double counting. Energy use for thermal purposes accounted for 33% of the total primary energy consumption in 2012. The residential sector accounts for the largest share of final thermal energy use (45% in 2012), followed by industry (33% in 2012), services (18% in 2012) and agriculture (5% in 2012). Oil is the dominant fuel in the thermal energy market, accounting for 44% of the primary energy used for thermal purposes in 2012. Figure 20 shows the contribution of renewable thermal energy between 1990 and 2012.

Figure 20 *Renewable Thermal Energy as a Share of Total Thermal Energy (RES-H) 1990 – 2012*



Source: SEAI

Renewable energy contributing to Ireland's thermal energy requirements is dominated by industrial biomass use, in particular the use of waste wood to produce heat in fibre board manufacture, joineries and wood processing plants and the use of tallow from rendering plants for heat. In addition there is a small contribution in the industry data of biogas from anaerobic digestion of food processing waste products. Wastes, which are partly renewable, have been used in the non-metallic mineral products sub-sector by cement manufacturers since 2009.

The absolute consumption (in ktoe) of renewables for thermal energy in all sectors is detailed in Table 11. As shown, the increasing activity in these sub-sectors of industry led to industrial biomass use increasing from 63 ktoe in 1990 to 164 ktoe in 2006, but this has dropped back since the peak to 153 ktoe.

Table 11 *Renewable and Waste Thermal Energy (RES-H) by Sector 1990 – 2012*

Renewable & Waste Heat (ktoe)	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012
Overall	**108**	**92**	**118**	**190**	**196**	**199**	**193**	**205**	**219**	**218**	**232**
Industry total	63	62	100	163	164	153	139	139	152	150	153
Food and beverage	*2*	*3*	*4*	*54*	*58*	*59*	*41*	*39*	*40*	*41*	*36*
Wood & wood products	*61*	*59*	*96*	*109*	*106*	*94*	*88*	*85*	*100*	*93*	*96*
Non-metallic minerals	*0*	*0*	*0*	*0*	*0*	*0*	*10*	*15*	*12*	*16*	*22*
Residential	45	30	17	23	25	35	37	46	48	46	53
Commercial/Public Services	0	0	0	4	8	11	17	20	18	22	26

Source: SEAI

Renewable heat in industry has remained relatively static since 2005 while use in the residential and services sectors has increased by 122% and 400% respectively, albeit from quite low bases. Overall use of renewable heat grew by 108% between 1990 and 2012 as shown in Table 12. Growth in 2012 relative to the previous year was 2.7% with the residential use growing by 10.6% (not weather corrected).

Table 12 summaries the trends in renewable thermal consumption and market shares for all sectors.

Table 12 *Trends in Renewable Thermal Energy (RES-H) by Sector 1990 – 2012*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2012	'90 – '12	'00 – '05	'05 – '10	'10 – '12	2012	1990	2012	1990	2012
Overall	115.3	3.5	10.1	2.9	2.9	6.6	108	232	2.6	5.2
Industry Total	143.5	4.1	10.3	-1.4	0.3	2.5	63	153	1.5	3.4
Wood & wood products	57.2	2.1	2.6	-1.8	-2.2	2.8	61	96	1.4	2.1
Other industry	2453.9	15.9	65.9	-0.5	5.0	2.1	2	58	0.1	1.3
Residential	18.2	0.8	5.6	16.3	4.5	15.6	45	53	1.1	1.2
Commercial/Public Services	-	-	-	34.8	19.2	15.2	0	26	0.0	0.6

Source: SEAI

Renewable energy use in the residential sector is mainly accounted for by solid biomass (wood) but also includes recently added geothermal and solar thermal energy. The growth in biomass in households recently can be attributed to the increasing penetration of biomass boilers and stoves and the use of wood pellets and wood chips as fuel sources. These technologies have been stimulated by the Greener Homes Scheme[39] of grant assistance plus the introduction of renewable energy requirements in the 2008 revision to the Building Regulations Part L for dwellings. The result of this has been to reverse the overall declining trend in RES-H in households. Renewable energy use in the residential sector was 53 ktoe in 2012, 16% higher than in the previous year.

During the period of operation of the Greener Homes Scheme between 2006 and 2010 renewable energy use in homes increased from 25 ktoe to 48 ktoe.

Some growth in RES-H has also been observed in the services sector, also supported by a grant scheme, the Renewable Energy Heat Deployment (ReHeat) scheme, which supported wood chip and pellet boilers, solar thermal and heat pump installations. The ReHeat scheme closed in 2011. Renewable energy use in the services sector has, since 2006, grown by 240% to 26 ktoe in 2012.

7.1 Combustible Renewables

7.1.1 Solid Biomass & Renewable Wastes

Solid biomass covers organic, non-fossil material of biological origin which may be used as fuel for heat production. It is primarily wood, wood wastes (firewood, wood chips, barks, sawdust, shavings, chips, black liquor[40] etc.) and other solid wastes (straw, oat hulls, nut shells, tallow, meat and bone meal etc.) and the renewable portion of industrial and municipal wastes. Most of the solid biomass is used for thermal energy in the industrial sector where it is burnt directly for heat or used in CHP units; the rest is consumed in the residential and commercial sectors.

In 2012, the final energy consumption of solid biomass and renewable wastes was 195 ktoe. Industry consumed 149 ktoe (76%) with the wood and wood products sub-sector accounting for 64% of this followed by the food and drinks sector at 21% and cement at 15%.

The residential sector accounted for 27 ktoe or 14% of the final consumption of solid biomas, and renewables wastes and services 19 ktoe (10%).

7.1.2 Non-Renewable Wastes

Non-renewable wastes such as low carbon fuels (LCF) derived from hospital wastes and solid recovered fuels derived from municipal solid wastes are currently burnt by cement manufacturers for heat and more recently as a fuel in a waste to energy installation. The quantities used as fuels are reported on a net calorific value basis as part of the Emissions Trading Scheme.

Final energy consumption of non-renewable wastes amounted to 25 ktoe in 2012, all of which was used in the cement sector of industry.

39 Greener Homes is a capital grant support scheme administered by SEAI for home renewable energy heating systems. See http://www.seai.ie/greenerhomes for details.

40 This is a recycled by-product formed during the pulping of wood in the paper-making industry.

7.1.3 Biogas

Biogas is produced from the anaerobic digestion of sewage, animal slurries and wastes in abattoirs, breweries and other agri-food industries. Anaerobic digestion is a cost effective method of producing biogas which can be used directly in boilers to provide heat only or in CHP units to provide heat only or both heat and electricity while reducing harmful wastes. In 2012 the biogas figure in the Irish energy balance consisted of an estimate of energy generated in waste water treatment plants and other biogas installations in industry which in total amounted to 9 ktoe.

7.2 Geothermal Energy and Heat Pumps

The geothermal energy statistics in Ireland currently cover installations which were grant aided by SEAI plus an estimate of additional units by heat pump suppliers. A coefficient of performance of 3.5 is assumed for accounting purposes for all installations. This means that for every 1 unit of electricity used by geothermal heat pumps 3.5 units of heat energy are produced. The heat produced minus the primary energy used to generate the electricity driving the heat pumps is the figure used for geothermal energy in the balance. Geothermal installations include horizontal and vertical ground source heat pumps.

While existing geothermal energy installations primarily involve individual sites, an investigation has confirmed the feasibility of creating a geothermal district heating system using a deep geothermal aquifer in the Dublin basin.[41]

In 2012 the estimated contribution from geothermal and heat pumps to the final consumption of renewable energy was 18 ktoe.

7.3 Solar - Thermal

The amount of solar energy contribution to heating in Ireland is estimated from applications to the SEAI-administered Greener Homes Scheme[42] and the Renewable Energy Heat Deployment (ReHeat)[43] scheme for the commercial sector, which both operated from 2006 to 2011. Since 2008, under the Building Regulations Part L, all new domestic buildings are required to install renewable energy sources to provide at least 10 kWh/m^2/yr so any solar installations contributing to meeting this requirement are also included. In 2012, 0.4% of the total residential sector energy requirements were met by solar thermal energy.

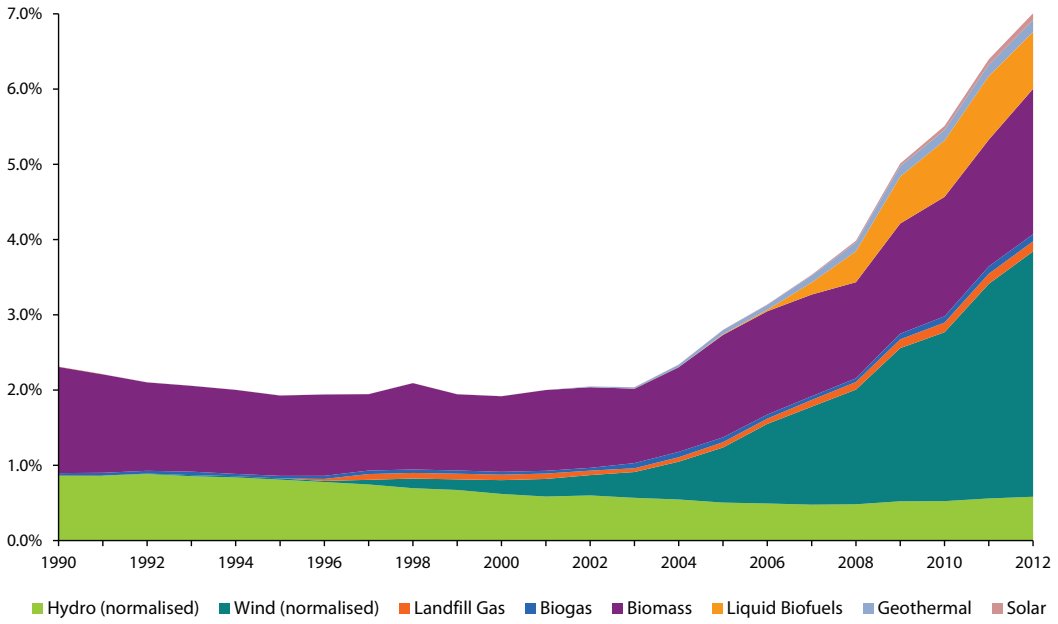
In 2012 the estimated contribution from solar thermal installations to the final consumption of renewable energy was 10 ktoe.

41 More information available from GT Energy. http://www.gtenergy.net
42 Under the Greener Homes Scheme 22,903 dwellings installed solar panels.
43 The Renewable Heat (ReHeat) Deployment Programme, administered by SEAI, provides assistance for the deployment of renewable heating systems in industrial, commercial, public & community premises. http://www.seai.ie/Grants/Renewable_Heat_Deployment_Programme/

8 Progress towards Targets

The contribution of renewable energy from various sources to gross final consumption according to the definition in Directive 2009/28/EC is shown in Figure 21. Biomass here consists largely of wood and wood waste as thermal energy, with smaller contributions from electricity generated from biomass and biogas along with transport liquid biofuels. The contribution in 1990 was 2.3% and remained fairly constant until 2004. The contribution then started to rise annually, reaching 7.1% in 2012.

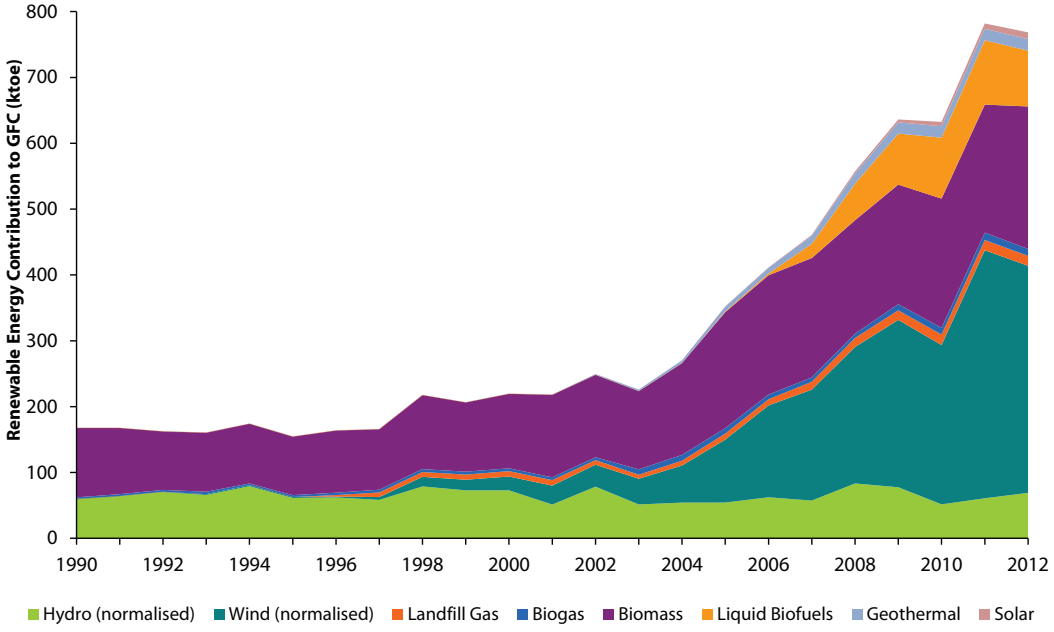
Figure 21 *Renewable Energy (%) Contribution to Gross Final Consumption (Directive 2009/28/EC) 1990 – 2012*



Source: SEAI

Figure 22 shows the renewable energy contributions in absolute energy terms, to illustrate the growth in each source independently of GFC growth.

Figure 22 *Renewable Energy (ktoe) Contribution to GFC (Directive 2009/28/EC) 1990 – 2012*

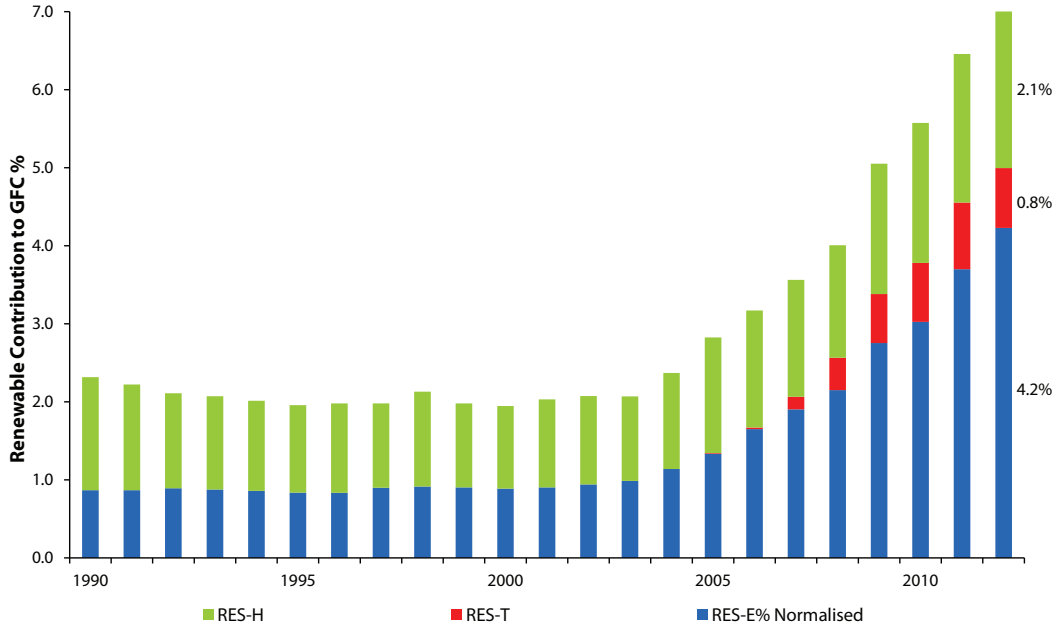


Source: SEAI

The more than tripling of renewable energy (from 226 ktoe to 768 ktoe[44]) between 2003 and 2012 (14.6% annual average growth) is striking, due largely to the increasing contribution from wind energy.

Figure 23 shows the same information as presented in Figure 21 but here the renewable contributions are distinguished in terms of each energy mode, i.e. indicating separately the contribution in energy terms to electricity, transport and thermal energy.

Figure 23 *Renewable Energy (%) Contribution to GFC by Mode 1990 – 2012*



Source: SEAI

Examining renewable energy data in terms of quantities of energy produced provides a different perspective than focusing on the proportions of renewable energy in each energy market, i.e. when energy use is classified into three distinct modes of application (markets), namely; mobility (transport), thermal uses (space or process heating) and electricity. Table 13 shows the contribution of renewable energy to each energy mode, presented in absolute energy terms (ktoe) rather than as a percentage of the energy consumption for those modes. The growth in wind energy noted in Figure 21 is clearly visible here in the growth in RES-E, electricity generation from renewables – as is the recent growth in biofuels, both of which are the result of policy measures.

Table 13 *Renewable Energy (ktoe) Contribution to GFC by Mode 1990 – 2012*[45]

ktoe	1990	2000	2005	2006	2007	2008	2009	2010	2011	2012
Renewable Electricity (normalised)	65	99	171	216	253	289	339	370	423	468
Biofuels in Transport	0	0	1	3	22	56	78	93	98	85
Renewable Heat	108	118	190	196	199	193	205	219	218	232
Total	**173**	**216**	**363**	**414**	**474**	**538**	**622**	**681**	**739**	**785**

Source: SEAI

Table 13 shows that in 2012 renewable energy contributed 468 ktoe in the form of electricity, 232 ktoe in the form of thermal energy and 85 ktoe to transport energy. The contribution from renewable energy to electricity was more than double the renewable contribution to the thermal energy market and more than five times the contribution to the transport energy market. This contrasts significantly with the situation in 2000, when the renewable energy contribution to thermal energy was higher than from renewable electricity.

The contributions from each mode are important because, in addition to the EU Directive 2009/28/EC mandatory targets for overall renewable energy and renewable energy in transport, Ireland has national targets for 2020 that are specified (and subsequently revised upwards in the case of RES-E) in the 2007 Government White Paper on Energy for each individual mode of energy, as follows:

44 These figures are unadjusted for the normalisation of wind and hydro. Normalisation is required for the calculation of the Renewable Directive targets. Normalised figures are presented in Table 13.

45 Figures presented in this table are adjusted for the normalisation of wind and hydro. These are the figures used in the numerator for the calculation of the renewable energy percentage of gross final consumption. The renewable electricity (normalised) figure is also the numerator used in calculation of RES-E.

- RES-E 40% – electricity from renewable sources to contribute 40% to gross electricity consumption by 2020, with an interim target of 15% by 2010.
- RES-H 12% – 12% of thermal energy to come from renewable sources by 2020, with an interim target of 5% by 2010.
- RES-T 10% – 10% of petrol, diesel, biofuels and electricity consumed in road and rail transport to come from renewable energy sources by 2020 (mandatory Directive target), with interim national targets (biofuels penetration) of 2% by 2008 and 3% by 2010. Weighting factors are used in the calculation of the RES-T target only and not for the transport contribution to the overall renewable target.

Table 14 tabulates progress towards the individual modal targets and to the overall TFC target for the period 1990 – 2012. Here the percentages in each row, for RES-E, RES-T and RES-H, relate to the specific modal targets and the percentages in the final row relate to the overall target, using the definition in the EU Renewable Energy Directive. Note that the individual targets cannot be added to get the overall renewables contribution. The last two columns show the targets for 2010 and 2020. This provides a sense of the scale of challenge to meet each target, and an indication of the significance of progress to date, when placed within the context of these targets.

Table 14 *Renewable Energy Progress to Targets*[46] *1990 – 2012*

											Targets	
% of each target	**1990**	**2000**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2010**	**2020**
RES-E	4.9	5.0	6.8	8.6	9.4	11.1	13.7	14.8	17.6	19.6	15	40
RES-T	0.0	0.0	0.0	0.1	0.5	1.2	1.9	2.7	3.7	3.8	3	10
RES-H	2.6	2.4	3.5%	3.7	3.8	3.5	4.2	4.3	4.7	5.2	5	12
Directive (2009/28/EC)	2.3	1.9	2.8	3.2	3.6	4.0	5.1	5.6	6.5	7.1		16

Source: SEAI

In 2012 the overall renewable energy contribution to gross final consumption was 7.1%. The Renewable Directive (2009/28/EC) target is 20% in 2020.

In the case of RES-E, the share of electricity from renewable energy has increased fourfold between 1990 and 2012, from 4.9% to 19.6%. Most of this increase took place since 2000.

There was a significant increase in the share of transport energy from biofuels between 2007 and 2012, albeit from a low base. Biofuels accounted for 2.4% (in energy terms) of road transport energy in 2012, growing from 0.1% in 2006. The short term national targets of 2% by 2008 and 3% by 2010 contained in the 2007 Government Energy White Paper were not achieved despite that considerable recent growth. The penetration of renewable energy in transport was accelerated by the commencement of the Biofuels Obligation Scheme in July 2010. It specified a requirement of a 4.2% by volume (equivalent to approximately 3% in energy terms) biofuels share of all petroleum products sold for road transport energy use for the period 2010 to 2012. The obligation has been increased to 6.4% by volume for 2013 – 2014.

The contribution from renewable energy to thermal energy grew from 2.6% in the early 1990s to 5.2% in 2012. This growth was dominated by increased biomass use and is mostly due to increased activity in the industrial sub-sectors where the biomass is mostly used (wood and food sectors). There has also been recent growth in renewable energy use in the residential and services sectors with the introduction of grant support schemes and revised provisions in the Building Regulations, but the increases here have been small in volume relative to overall thermal renewable energy consumption. The target of achieving a 5% renewable energy contribution to Ireland's thermal energy by 2010 was missed; as already discussed the cold weather of 2010 may have been a factor in this.

It is interesting to compare the absolute contributions of renewable energy to each market and then to re-examine Table 13 from this perspective. Table 14 shows that, over the period 1990 – 2012, the renewable energy share in electricity was, in each year, significantly higher than the renewable share of the thermal energy market.

46 Note individual target percentages are not additive

9 Displacement of Fuel Imports and CO_2 Emissions

One of the benefits of determining the PEE associated with non-combustible renewables is that it can be used to calculate the amount of fossil fuel displaced and CO_2 avoided through the use of renewable energy. The primary energy equivalent (PEE) of renewable energy sources is described in section 3.2. The methodology used to calculate the PEE is included in Appendix 1. The caveats associated with the results for primary energy equivalent apply equally to the calculated CO_2 avoided.

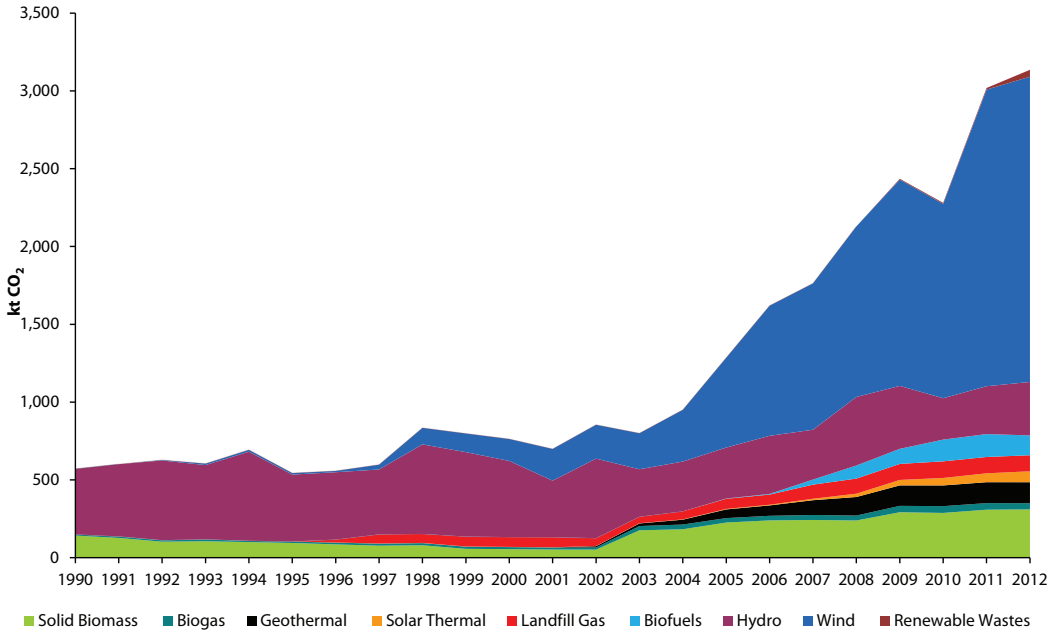
As outlined in Appendix 1, renewable electricity generation resulted in an avoidance of between €250 million and €280 million in fossil fuel imports in 2012.

Figure 24 shows the trend in avoided CO_2 emissions from renewable energy across all sectors for the period 1990 – 2012. It is assumed the electricity from renewables (wind, hydro, landfill gas, biogas and renewable waste) avoids the amount of CO_2 that would have been produced by the marginal plant considered in Appendix 1.

It is further assumed that the thermal energy from renewable energy (solid biomass, biogas, geothermal, solar, biogas and renewable waste) displaces thermal energy from oil-fired boilers. The CO_2 avoided from thermal renewable energy is equated with the CO_2 emissions that would have arisen from this oil consumption.

The avoided CO_2 emissions associated with biofuels usage in transport are calculated on the basis of assumed 100% displacement of emissions from conventional fuels. The emissions from biofuels production are accounted for in this analysis in accordance with the UNFCCC reporting guidelines[47]. Thus the CO_2 avoided from bioethanol in transport is equated with CO_2 emissions that would have arisen from the petrol consumption displaced, and CO_2 avoided from biodiesel and pure plant oil is determined from diesel consumption displaced.

Figure 24 *Avoided CO_2 from Renewable Energy in all Sectors 1990 to 2012*



Source: SEAI

Based on this methodology the estimated amount of CO_2 avoided from renewable energy increased by 301% (7.2% per annum on average) over the period 1990 to 2010, reaching 3,199 kt CO_2 in 2012, as illustrated in Figure 24. The emissions avoided from wind energy deployment have increased considerably since 2004. It is estimated that in 2012 wind energy resulted in the avoidance of 1,962 kt CO_2 (61%), followed by hydro (343 kt CO_2) and solid biomass (310 kt CO_2).

It is worth noting that most of the emissions (2,448 kt CO_2, or 77%) avoided are in electricity generation, and accordingly contribute to the targets of companies in the EU Emissions Trading Scheme (ETS), while most of the emissions avoided in thermal and all in transport energy contribute to Ireland's target to achieve a 20% reduction in greenhouse gas (GHG) emissions in non-ETS sectors relative to 2005 levels.

47 Emissions from fossil fuels used in the production of biofuels in Ireland are captured separately in the transformation section of the energy balance.

10 The Future of Renewables in Ireland

In order to inform policy formulation, the SEAI Energy Modelling Group (EMG), in conjunction with ESRI, produced forecasts which examine energy usage scenarios for 2020. Three sets of forecast scenarios were prepared in 2012. The first, the Baseline scenario, is not intended to represent a realistic outcome, but is useful in presenting a base case against which other forecasts may be compared. The second, the National Energy Efficiency Action Plan (NEEAP) and National Renewable Energy Action Plan (NREAP) scenario, builds on the Baseline forecast, with additional assumptions introduced to incorporate the details published in both the NEEAP and NREAP. The third scenario, Risk, looks at alternative outcomes in 2020 when some of the key assumptions in the forecasts are changed.

10.1 Forecasts for Renewable Electricity (RES-E)

The national 2020 target for RES-E is 40% of gross electricity consumption. Forecasts estimate an overall electricity demand of 31,104 GWh in 2020 according to the NEEAP/NREAP scenario. To reach 40%, equating to 11,193 GWh of renewable electricity in 2020, an average annual growth rate of 7.2% is required. Renewable electricity had an average growth rate of over 19% per annum between 2010 and 2012.

Assuming an installed capacity of 25 MW for ocean energy, 285 MW for biomass and 234 MW for hydro energy by 2020, an installed wind energy capacity of 3,628 MW would be required in order to achieve the 2020 RES-E target, requiring an average annual growth rate of 10.3% per annum. The increase in wind capacity has been approximately 20% per annum since 2005. The 40% RES-E target requires 4,172 MWe of installed renewable energy capacity, more than double the current capacity.

10.2 Forecasts for Renewable Energy in Transport (RES-T)

The transport demand in 2020 under the NEEAP/ NREAP scenario is projected to be 5,380 ktoe (46% of the projected total final demand). The target for 2020 is to achieve a 10% contribution of road and rail transport. Projected demand from road and rail transport is estimated to be 4,499 ktoe. A mixture of biofuels and a renewable electricity contribution from electric vehicles is projected to meet the renewable requirements for RES-T.

It is projected that the target of 10% electric vehicles share of the vehicle stock by 2020 will contribute 33 ktoe of renewable electricity towards the 10% RES-T target in 2020. It is also projected that the balance of renewable contribution (406 ktoe) to RES-T will come from biofuels.

If all of the biofuels are produced from wastes, residues, non-food cellulosic material and ligno-cellulosic material, then the contribution can be doubled. This would require only 203 ktoe to come from biofuels. However, as the multiplication factor cannot be applied for the overall target, the overall renewable share of gross final consumption may not be met in that case.

10.3 Forecasts for Renewable Thermal Energy (RES-H)

Forecasts to 2020 estimate a total thermal consumption of 3,762 ktoe in 2020 in the NEEAP/NREAP scenario, requiring 457 ktoe of renewable energy in order to meet the RES-H target of 12% by 2020. This corresponds to an average annual growth rate of 8.9% over the period 2012 to 2020, against the background of growth at 3.4% per annum on average between 1990 and 2010 and 2.9% between 2010 and 2012. This indicates the scale of the challenge in the thermal energy sector to meet the renewables target.

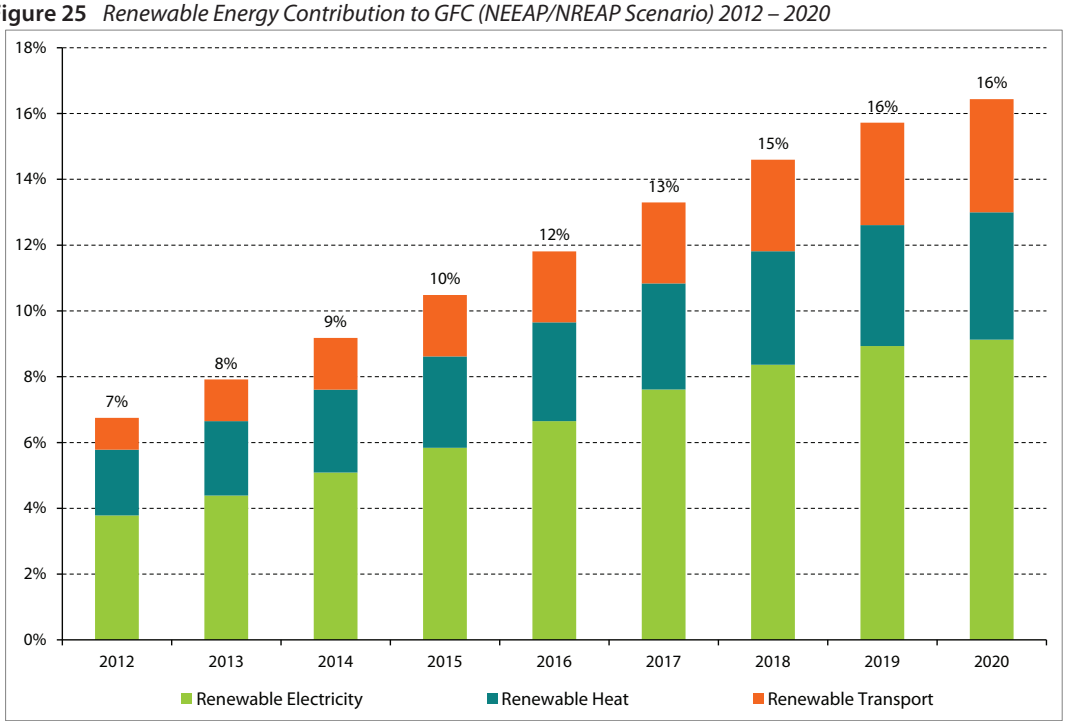
10.4 Overall Renewable Energy Forecasts to 2020

Figure 25 presents the 2012 forecast of the renewable energy contribution to GFC[48] (according to the definitions in the Directive) for the NEEAP/NREAP scenario, indicating separately the contribution to electricity (RES-E), transport (RES-T) and thermal energy (RES-H).

As part of Ireland's NREAP, the least-cost trajectory toward achieving overall renewable energy targets which will be achieved from indigenous resources needs to be identified. Energy efficiency savings are accounted for within the forecasts. Since the renewable energy targets are expressed as percentages of energy consumption, any decrease in energy efficiency savings, or increase in energy demand due to other factors, will increase the amount of renewable energy production required to meet the renewable energy targets.

48 GFC (Directive) = TFC (Transport) + GFC (electricity) + GFC (heat)

Figure 25 *Renewable Energy Contribution to GFC (NEEAP/NREAP Scenario) 2012 – 2020*



Source: SEAI

The combined effect of the three modal targets, coupled with Ireland's energy efficiency targets, are projected (according to the 2012 Energy Forecasts for Ireland to 2020[49]) to deliver a 16% renewable energy contribution to GFC, i.e. to deliver the proposed EU Directive target for Ireland, as detailed in Table 15.

Table 15 *Renewable Energy as a % of Gross Final Demand 2012 – 2020*

	Gross Final Demand (ktoe)			Growth %	Contribution to Modal RES %			Contribution to Overall RES %		
Renewable Energy	**2012**	**2016**	**2020**	**'12-'20**	**2012**	**2016**	**2020**	**2012**	**2016**	**2020**
Renewable Electricity	452	818	963	113	19.6	33	40	4.2	6.7	9.1
Renewable Heat	232	347	457	97	5.2	8.6	12	2.1	3.0	3.9
Renewable Transport	85	265	439	416	3.8	6.5	10	0.8	2.2	3.4
Total Renewable Energy	**768**	**1,429**	**1,859**	**142**						
RES								**7.1**	**12**	**16**

Source: SEAI

49 SEAI, 2012. http://www.seai.ie/

Glossary of Terms

Biodiesel: Includes biodiesel, biodimethylether (DME), Fischer-Tropsch diesel, cold-pressed bio-oil and all other liquid biofuels which are added to or blended with or used straight as transport diesel.

Biofuels: Liquid fuels derived from biomass crops or by-products that are suitable for use in vehicle engines or heating systems. They can be considered as potential replacements or extenders for mineral fuels such as diesel or petrol. They can be sub-divided into a number of categories, the principal two being:

Vegetable oils / animal fats which can be used in unprocessed form or converted to biodiesel.

Bioethanol produced from the fermentation of organic materials such as sugar beet, cereals, etc.

Bioenergy: Bioenergy is energy from biomass.

Biogas: A gas composed principally of methane and carbon dioxide produced by anaerobic digestion of biomass, comprising: Sewage sludge gas, produced from the anaerobic fermentation of sewage sludge, and other biogas, such as biogas produced from the anaerobic fermentation of animal slurries and of wastes in abattoirs, breweries and other agro-food industries.

Biogasoline: Includes bioethanol, biomethanol, bio-ethyl-ter-butyl ether (bioETBE) and bio-methyl-tertio-butyl-ether (bioMTBE).

Biomass: The biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

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

Combined Heat & Power (CHP) 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.

Concentrating solar power (CSP): CSP devices concentrate energy from the sun's rays to heat a receiver to high temperatures. This heat is transformed first into mechanical energy (by turbines or other engines) and then into electricity – solar thermal electricity (STE).

Geothermal energy: Geothermal energy refers to heat energy stored in the ground. Heat is supplied to the ground from two sources – the hot core of the planet and the sun. It can be classified as either 'deep' or 'shallow' depending on the depths involved.

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

Gross 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.

Heat Pump: A heat pump is a device that moves heat from one location (the source) to another (the sink). Heat pumps are used for space heating and cooling, as well as water heating. Geothermal heat pumps operate on the fact that the earth beneath the surface remains at a constant temperature throughout the year, and that the ground acts as a heat source in winter and a heat sink in summer. They can be used in both residential and commercial or institutional buildings. Other heat pump types are available such as air and water source. These operate on the same principle indoors but the method of collecting heat is different for each type.

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.

Hydro-Power: Potential and kinetic energy of water converted into electricity in hydroelectric plants. Pumped storage is treated separately in the national energy balance. The Renewable Energy Directive 2009/28/EC states that electricity produced in pumped storage units from water that has previously been pumped uphill should not be considered to be electricity produced from renewable energy sources.

Kilowatt Hour (kWh): The conventional unit of energy whereby electricity is measured and charged for commercially. Related units are megawatt hour (MWh) and gigawatt hour (GWh) which are one thousand and one million kWhs respectively.

Landfill Gas (LFG): A gas composed principally of methane and carbon dioxide produced by anaerobic digestion landfill wastes.

Meat and Bone meal: Produced when offal and carcass and butchers wastes are processed at rendering plants.

Microgeneration: A microgenerator might use any one of the following technologies to generate electricity: Wind turbine, Photovoltaic panels (also known as solar electric panels), Micro-hydro (scaled down version of hydro-electricity station), Micro-CHP (fuelled by bio or fossil fuels). In Ireland microgeneration is classified by ESB Networks as grid-connected electricity generation up to a maximum rating of 11 kW when connected to the three-phase grid (400 V). The vast majority of domestic and agricultural customers are connected at single phase (230V) and for these customers to be classified as microgenerators the maximum rating permitted is 5.75 kW. These ratings are in line with Irish conditions prescribed in European standard EN50438.

Photovoltaic Energy: Energy from solar electric panels. Solar radiation is exploited for electricity generation by photovoltaic cells which convert the solar radiation into DC current.

Refuse derived fuels (RDF): Fuels produced from waste through a number of different processes such as mechanical separation, blending and compressing to increase the fuel value of the waste. Such waste derived fuels can be comprised of paper, plastic and other combustible wastes and can be combusted in a waste-to-energy plant, cement kiln or industrial furnace.

RES-E: Renewable energy sources in electricity.

RES-H : Renewable energy sources of heat/thermal energy.

RES-T: Renewable energy sources used for transportation.

Solar photovoltaic (PV): directly converts solar energy into electricity using a PhotoVoltaic (PV) cell made of a semiconductor material.

Solar Thermal Electricity (STE): This heat is transformed first into mechanical energy (by turbines or other engines) and then into electricity

Solid Biomass: Covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation. It comprises: (a) Charcoal, covering the solid residue of the destructive distillation and pyrolysis of wood and other vegetal material and (b) Wood, wood wastes and other solid wastes, covering purpose-grown energy crops (poplar, willow etc.), a multitude of woody materials generated by an industrial process (wood/paper industry in particular) or provided directly by forestry and agriculture (firewood, wood chips, bark, sawdust, shavings, chips, black liquor etc.) as well as (c) wastes such as tallow, straw, rice husks, nut shells, poultry litter, crushed grape dregs etc. Combustion is the preferred technology for these solid wastes. The quantity of fuel used is reported on a net calorific value basis.

Solid recovered fuels (SRF): Fuels refined from crude refuse derived fuels (RDF). To be defined as SRF a fuel must meet minimum standards for moisture content, particle size, metals, chloride and chlorine content and calorific value.

Tallow: The fatty tissue or suet of animals.

Tonne of Oil Equivalent (toe): This is a conventional standardized unit of energy and is defined on the basis of a tonne of oil having a net calorific value of 41686 kJ/kg.

Total Final Consumption (TFC): This is the energy used by the final consuming sectors of industry, transport, residential, agriculture and tertiary. 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.

Wind Energy: Kinetic energy of wind exploited for electricity generation in wind turbines.

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Appendix 1 Primary Energy Equivalence Methodology

The primary and final energy consumption for non-combustible renewable energy sources such as wind and hydro is very similar. For most combustible fuels this is not the case, due to the energy conversion losses associated with electricity generation. Depending on the efficiency of electricity generation, typically between 25% and 55% of the energy content of the fuel input into power plants is output in the form of electricity.

The primary energy of fossil fuels and combustible renewables is defined as the calorific content of the fuel, according to internationally agreed methodologies for presenting energy statistics[50]. For non-combustible renewable sources (wind and hydro) the primary energy is considered to be equivalent to the quantity of electricity generated. This follows the IEA principle that the primary energy should be the first energy form downstream in the production process for which multiple energy uses are practical. This allows for harmonised international comparisons, but it does not accurately represent how fossil fuels used for electricity generation are displaced by non-combustible renewable energy. This is because, in primary energy terms, the fuel input into a fossil fuel plant is currently considered to be equivalent to the electricity output from a non-combustible renewable energy plant, such as a wind farm or hydro-power plant. An alternative approach is to consider the primary energy of the renewable energy to be equivalent to the primary energy of the fuel that would have been required to produce the same amount of electricity.

This is the principle behind the primary energy equivalent (PEE) based on the partial substitution method. It requires an assumption to be made about the efficiency of the combustible fuel-based electricity generation being substituted by the non-combustible renewable generated electricity. The contribution from the renewable energy source is, in this approach, equated to the combustible fuel energy input that it displaces. The PEE for non-combustible renewable energy essentially represents the thermal combustible fuel energy avoided through the generation of non-combustible renewable-based electricity. By quantifying the combustible fuel displacement achieved by renewable energy, the environmental benefits and indeed the security of supply benefits may be quantified and used to inform policy decisions.

This raises a key question, however – what electricity generation is being displaced by renewable energy-generated electricity? In a previous report[51], the calculation of PEE was based on a theoretical displacement by each kWh from renewable energy of a kWh generated from the entire fossil fuel plant mix. The methodology used now draws on approaches that have been developed for use in baselining studies in credit-based emissions trading systems[52,53].

Renewable energy plants are primarily displacing electricity from the last fossil fuel plant dispatched to meet electricity demand. In 2012 the latter comprised primarily gas-fired plant and some coal-fired plant. Calculating the PEE based on such plant provides a more accurate estimate than using the entire plant mix and the approach is known as the Operating Margin Approach. There are clear limitations in this analysis but it does provide useful indicative results.

On this basis, in the Republic of Ireland, with combined cycle gas turbines and coal fired generation comprising the prevailing marginal generating plant, renewable electricity generation is estimated to have avoided between €250 million and €280 million in fossil fuel imports and approximately 2.5 million tonnes of CO_2 emissions.

The limitations and caveats associated with this methodology include that it ignores plant used to meet the associated reserve requirements of renewables. These open cycle plants will typically have lower efficiency and generate increased CO_2 and NO_x emissions compared with combined cycle gas turbines (CCGT). The method does not account for such cycling effects or cross border trade with Northern Ireland within the all island electricity system.

The purpose of presenting a simplified analysis here is to provide initial insights into the amount of fossil fuels that are displaced by renewables and the amount of emissions thereby avoided. It is worth noting, however, that the results emerging from a forthcoming detailed electricity system modelling analysis by SEAI of the impact of renewable energy for year 2012 broadly supports the above estimation.

50 International Energy Agency (2007), *Energy Balances of OECD Countries 2004 – 2005.* Available from http://www.iea.org

51 SEAI (2004), *Renewable Energy in Ireland – Trends and Issues 1990 – 2002.* Available from http://www.seai.ie/Publications/Statistics_Publications/EPSSU_Publications/

52 Kartha S., Lazarus M. and Bosi M, 2004. *Baseline recommendations for greenhouse gas mitigation projects in the electric power sector, Energy Policy 32,* 545-566.

53 For further information on Ireland see Ó Gallachóir B. P., O'Leary F., Bazilian M., Howley M. & McKeogh E. J. Comparing Primary Energy Attributed to Renewable Energy with Primary Energy Equivalent to Determine Carbon Abatement in a National Context. *Journal of Environmental Science and Health* Part A: Toxic /Hazardous Substances and Environmental Engineering, Vol.41, No. 5.

Appendix 2 Policy Measures

This appendix lists existing policy measures that influence the development of renewable energy sources in Ireland.

A2.1 General Policy Measures

A2.1.1 Renewable Energy Research, Development and Demonstration

In August 2002, SEAI launched the Renewable Energy RD&D programme[54]. The focus of the programme is to stimulate the application and further deployment of renewable energy technologies, particularly those close to market viability. The programme was allocated an indicative budget of €16 million.

A2.1.2 Irish Energy Research Council — An Energy Research Strategy for Ireland

The Energy Research Strategy 2008-2013[55] focuses on the approach that should be taken towards basic and applied research to underpin new energy conversion, distribution and end use technologies. The strategy describes the rationale and proposed strategic actions for major areas of research activity including Ocean Energy and Sustainable Bioenergy.

A2.1.3 Science Foundation Ireland

It was announced in May 2008 that the Government was formally extending the remit of the Science Foundation Ireland (SFI) to incorporate the areas of sustainable energy and energy-efficient technologies. SFI's role is to build a capacity of highly-skilled researchers in the area of research underpinning sustainable energy and energy-efficient technologies and integrate with the research strategy prepared by the Irish Energy Research Council.

A2.1.4 Charles Parsons Energy Research Awards

The Minister for Communications, Marine and Natural Resources announced the establishment of the awards[56] in 2006. The awards are designed to develop and stimulate overall energy research capacity, particularly in certain priority areas. They provide funding for research groups active in energy research and research training; in particular, full-time researchers, PhD scholarships for engineering graduates and summer student placements.

A2.1.5 Corporate Tax Relief for Investment in Renewable Energy Generation

Section 486 Corporate Tax Relief came into effect in 1999. Corporate equity investments in certain renewable energy projects are eligible for tax relief[57] in the form of deduction from a company's profits for an investment in new ordinary shares in a qualifying company. Budget 2007 announced that the qualifying period for the scheme of tax relief for corporate investment in certain renewable energy projects was being extended from 31 December 2006 to 31 December 2011.

Statutory Instrument 98 of 2009[58] brings into operation the provisions of section 51 of the Finance Act 2007. This section extends the qualifying period for relief under section 486 B of the Taxes Consolidation Act 1997 to 31 December 2011. To qualify for the relief the energy project must be in the solar, wind, hydro or biomass technology categories, and be approved by the Minister for Public Enterprise (now the Minister for Communications, Marine and Natural Resources). The investment in respect of which relief can be given is capped at the lesser of 50% of all capital expenditure or €9.525 million for a single project. Investment by a company or group is capped at €12.7 million per annum and unless the shares are held for at least five years by the company the relief will be withdrawn.

A2.1.6 Business Expansion Scheme (BES)

Business Expansion Tax Relief[59] is a tax relief incentive scheme that provides tax relief for investment in certain corporate trades. Investments in renewable energy qualify for BES relief. Budget 2007[60] announced that the scheme was being renewed from 1st January 2007 for a seven year period to 31st December 2013. Individual investors holding a BES equity investment for a minimum period of five years can benefit from tax relief, at their marginal rate, in respect of investments of up to a maximum of €150,000 per year.

There is no tax advantage for the company in receipt of the BES but securing funding may enhance the ability to attract other external funding.

54 Details available from http://www.seai.ie/Renewables/Renewable_Energy_Policy/Policy_Support_Mechanisms/13_RERDD-Overview.pdf
55 Details http://www.dcenr.gov.ie/Energy/Office+of+the+Chief+Technical+Advisor/Irish+Energy+Research+Council.htm
56 Details available from http://www.dcenr.gov.ie/Energy/Parsons_Awards_Advert.htm
57 Details available from http://www.revenue.ie/en/business/incentives/renewable-energy-generation-taxrelief.html
58 Available from http://www.irishstatutebook.ie/home.html
59 Details available from http://www.revenue.ie/en/business/reliefs-incentives.html
60 Details available from http://www.budget.gov.ie/Budgets/2007/2007.aspx

A2.1.7 Triple E Register & Accelerated Capital Allowance (ACA)

The Triple E product register is a list of energy efficient and renewable energy equipment that meets certain minimum criteria set out by SEAI. Typically, the products on the register are among the top 10-15% most efficient in their class.

The accelerated capital allowance (ACA) is a tax incentive scheme incorporated within the Triple E framework. It encourages companies that pay corporation tax to invest in energy efficient equipment by enabling them to write off 100% of the purchase value of qualifying equipment against profit in the year of purchase. The ACA was introduced in the Finance Act 2008 for a trial period of three years and was subsequently extended until 31st December 2014 via the Finance Act 2011. The scheme includes ten different equipment categories and a growing list of over fifty technologies, including electric vehicles and micro-generators such as wind turbines >5kW, solar PV and biomass boilers.

A2.1.8 Carbon Tax

A carbon tax at a rate of €15 per tonne of carbon dioxide (CO_2) was introduced on fossil fuels in the 2010 budget[61]. The tax was applied to petrol and auto-diesel with effect from midnight, 9th December 2009; and from 1st May 2010 applies to Kerosene, Marked Gas Oil, Liquid Petroleum Gas (LPG), Fuel Oil and Natural Gas. The application of the tax to Coal and Commercial Peat came into force on the 1st May 2013 at a rate of €10 per tonne of carbon dioxide emitted and will rise to €20 per tonne in May 2014. Exemption from the tax will apply only to participants in the EU Emissions Trading Scheme (ETS) in respect of fuels so covered. On that basis, electricity is not subject to the carbon tax. One of the consequences of the carbon tax on fossil fuels is to improve the cost competitiveness of renewables. The carbon tax was increased to a rate of €20 per tonne of carbon dioxide produced in the 2012 budget. The carbon tax liability per unit of energy is detailed in Table 16.

Table 16 *Carbon Tax*

Fossil Fuel	Unit	€	Effective
Petrol	litres	0.046	07 December 2011
Auto-diesel	litres	0.053	07 December 2011
Kerosene	litres	0.051	1 May 2012
Marked Gas Oil	litres	0.055	1 May 2012
LPG	litres	0.033	1 May 2012
Fuel Oil	litres	0.062	1 May 2012
Natural Gas (NCV)	MWh	4.1	1 May 2012 (€3.7/MWh GCV)
Peat Briquettes	tonne	18.33	1 May 2013 rising to €36.67 May 2014
Milled Peat	tonne	8.99	1 May 2013 rising to €17.99 May 2014
Other Peat	tonne	13.62	1 May 2013 rising to €27.25 May 2014
Coal	tonne	26.33	1 May 2013 rising to €52.67 May 2014

Source: Department of Finance

A2.1.9 Emissions Trading

The EU Emissions Trading Scheme (ETS) is a 'cap and trade' scheme for 11,000 large emitters of greenhouse gases throughout Europe. Upon its commencement, emitters were allocated free allowances, with each allowance giving the holder the right to emit one tonne of CO_2 or the equivalent amount of another greenhouse gas. The scheme ran for an initial pilot phase (2005-2007) followed by a second phase between 2008 and 2012. Over this period, the price of allowances fluctuated widely – from ~€30 per tonne at its peak to near zero on occasions.

The scheme's third phase, which runs from 2013 to 2020, introduces significant changes. Whereas allocations for Irish sites for the first two phases were decided by the Environmental Protection Agency (EPA) – in accordance with methodologies specified by the European Commission – the allocations for the third phase have been set by the Commission. Furthermore, from 2013 participants in the industrial sector are facing significant reductions in their free allowances and, for all industries, the number of free allowances will reduce progressively each year from 2013 to 2020. Participants in the power generation sector are now obliged to purchase all of their allowances.

A2.1.10 Renewable Energy Information

Sustainable Energy Authority of Ireland provides information on renewable energy, through its website, hosting workshops and training events and also through dealing with queries from the public.

61 Details available from http://www.budget.gov.ie/Budgets/2010/2010.aspx and http://www.environ.ie/en/Publications/Environment/Atmosphere/

A2.1.11 Local Energy Agencies

The network of local energy agencies' collective goal is to support the development and implementation of energy policy. Information, advice and skills provided through the local agencies can enhance knowledge on options for increased renewable energy at a local level. For more information see the Association of Irish Energy Agencies (http://aiea.ie/home)

A2.1.12 Energy Efficiency Fund (EEF)

In February 2013, the Minster for Communications, Energy & Natural Resources announced a €70 million Energy Efficiency Fund (EEF), which is a key deliverable of the Government's Action Plan for Jobs. While the majority of the funds will be used for energy efficiency projects, the fund manager can invest up to 20% of the funds in energy-related projects that deliver monetary or CO2 savings, such as biomass or CHP.

A2.2 Renewable Electricity Policy Measures

A2.2.1 Renewable Energy Feed-in Tariff (REFIT) for Electricity Generation

REFIT stands for 'Renewable Energy Feed in Tariff' and is the primary means through which electricity from renewable sources is supported in Ireland. The first REFIT scheme (REFIT 1) was announced in 2006 and state aid approval was obtained in September 2007.

The REFIT 1 scheme was open for applications until 31/12/09 and since that date no new applications have been accepted, although projects accepted into the scheme before that date, which under the relevant legislation were granted an extension of time to become operational, continue to be developed.

There is 1,380 MW of REFIT renewable generation capacity supported in the 2012/2013 PSO decision: 55 MW of REFIT 2 projects, 2 MW of REFIT 3 projects, with the remainder in REFIT 1.

The REFIT 2 scheme for onshore wind, small hydro and landfill gas was opened in March 2012 and the REFIT 3 (biomass technologies) scheme opened in February 2012. Both schemes are for projects built and operational between 1st October 2010 and 31st December 2015. For more details see http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/REFIT.htm.

A2.2.2 Renewable Electricity Grid Connections

The Commission for Energy Regulation[62] (CER) decides on the methodology for electricity grid connection offers. Since December 2004 renewable electricity generators wishing to connect to the transmission or distribution systems have been subject to group processing of connection applications through a series of successive "Gates". The current system in operation is termed the "Gate 3" process. This system ensures priority grid access for renewable generators. Exemptions are available for "public good" projects, subject to approval by the CER.

A2.2.3 Gate 3

It is envisaged that the completion and roll-out of Gate 3 offers and connections will ensure that Ireland meets the RES-E 40% target.

A2.2.4 Electricity Transmission System Upgrade Plan — Grid 25[63]

The development of the electricity transmission system is critical in order to achieve the Government RES-E target of 40%. EirGrid, the Irish transmission system operator, calculates that to facilitate the necessary increase in renewable generation and to adequately meet the demands of the electricity customer, the capacity of the bulk transmission system will need to be doubled by 2025. The full strategy for developing the transmission system is presented in EirGrid's Grid 25 document.

A2.2.5 Interconnection

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 exporting renewable electricity. The East-West interconnector between Ireland and Britain started commercial operation on 21st December 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. Ireland is also being considered for inclusion in an off-shore supergrid along with other northern EU countries and Norway.

62 Commission for Energy Regulation website: http://www.cer.ie/
63 Available from http://www.eirgrid.com/media/Grid%2025.pdf

A2.2.6 Facilitation of Renewables Study

A Facilitation of Renewables study was carried out by EirGrid, the transmission system operator. The study on the operational implications of managing high levels of variable renewables generation on the electricity power system was published in 2010. For more information see http://www.eirgrid.com/renewables/facilitationofrenewables/.

A2.2.7 Delivering a Secure and Sustainable Power System (DS3)

The DS3 programme (http://www.eirgrid.com/operations/ds3/) was set up as a follow-on from the Facilitation of Renewables Study. There are three major work areas within this programme: system policy, system tools and system performance. The different aspects of this programme are fundamental to ensuring the continued security of electricity supply on the island of Ireland and are required to deliver on the 2020 renewable electricity targets.

A2.2.8 Combined Heat and Power (CHP) Deployment Programme

The CHP Deployment Programme[64], which ran over the period 2006 to 2010, provided grant support to assist the deployment of small-scale (<1 MWe) biomass CHP systems. The programme provided funding for CHP systems (including anaerobic digestion and wood residues) and included funding for feasibility studies for micro-CHP generation. The objective of the trial was to assess the available technology and identify possible barriers, risks and benefits associated with its deployment.

A2.2.9 Small and Micro Scale Electricity Generation Programme

In April 2008, a new small and micro scale electricity generation programme[65] was initiated. The programme assessed technical, financial and regulatory issues surrounding the deployment of small and micro generation technologies in Ireland. This included a review of market arrangements required to encourage small and micro scale generation uptake, the definition of quality standards for products and installers, and a pilot trial and monitoring of 42 installations.

Electric Ireland offers a domestic micro-generation rate[66] of €0.09 per kWh for micro generation exported to the grid for domestic wind, PV, micro CHP and hydro generators until the end of 2014, which is paid over a five-year period from the start of their contract date.

A2.2.10 Smart Metering

Smart meters can facilitate improving energy efficiency by empowering consumers with more detailed, accurate, and timely information regarding their energy consumption and costs, thus helping consumers reduce any unnecessary energy usage and shift any discretionary electricity usage away from peak consumption times.

The Commission for Energy Regulation established the Smart Metering Project Phase 1 in late 2007 with the objective of setting up and running smart metering trials and assessing their costs and benefits, which will inform decisions relating to the full rollout of an optimally designed universal National Smart Metering Plan. On the 17th December 2013 the CER published a Proposed Decision on the Smart Metering High Level Design. This paper covered: the Core design of the Smart Metering solution, time of use tariffs, the Pay As You Go processes and the presentation of energy usage.

A2.2.11 Guidelines for Planning Authorities on Wind Energy Development

The Department of Environment, Community and Local Government published guidelines[67] for planning authorities on wind energy in order to facilitate a consistent approach by planning authorities both in identifying areas for development of renewable energy and having regard to potential impacts.

A2.2.12 Planning Permission Exemptions for Renewable Energy Technologies

Planning exemptions for micro-generation renewable energy technologies were introduced for domestic[68] purposes in 2007 and other buildings[69] in 2008. The exemptions apply to wind turbines, solar panels, heat pumps and biomass subject to certain conditions in each case.

A2.2.13 Strategic Environmental and Natura Assessment (SEA)

A Strategic Environmental Assessment and Natura Impact Statement on offshore wind, wave and tidal energy development were published in 2011.

64 The CHP deployment programme is a grant support scheme administered by SEAI. See http://www.seai.ie/Grants/CHP for details.
65 The small and micro scale electricity generation programme is a grant support scheme administered by SEAI. See http://www.seai.ie/Grants/Microgenpilot for details.
66 Details available from https://www.esb.ie/esbcustomersupply/residential/energy_efficiency/micro_generation_tariff.jsp
67 http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownLoad,1633,en.pdf
68 Statutory Instrument No.83 of 2007. Available from http://www.irishstatutebook.ie/home.html
69 Statutory Instrument No.235 of 2008. Available from http://www.irishstatutebook.ie/home.html

A2.2.14 The Ocean Energy Prototype Development Fund

The Ocean Energy Prototype Development Fund, which provides grants to the ocean energy industry, aims to stimulate the development of ocean energy devices and systems. The fund has been in operation since 2009.

A2.2.15 Offshore Grid Research

EirGrid published a study[70] into the design and architecture of a future offshore energy grid. The Irish Government are also involved in the Irish Scottish Links on Energy Study[71] (ISLES) examining issues around an offshore grid between Ireland, Northern Ireland and Scotland. The results of the ISLES Feasibility Study[72], carried out by RPS Group, were disseminated at a conference in Glasgow on 23rd November 2011. Ireland is also a participant in the North Seas Offshore Grid Initiative.

A2.2.16 Birds and Habitat Regulations SI 477 of 2011

This legislation[73] published in September 2011 introduced new regulations to ensure adequate protection of birds and habitats.

A2.2.17 Report of the Research Prioritisation Steering Group

In March 2012, Forfás published its report from the Research Prioritisation Steering Group. This report, which has been adopted by Government, identifies fourteen priority areas that will become the focus of future State investment in research and innovation. The proposed areas were selected from all fields of science on the basis of their potential to deliver a sustainable economic return to Ireland, including through enterprise development. Two of the fourteen priority areas are:

- Marine renewable energy, for which the report states that the focus should be "to position Ireland as a research, development and innovation hub for the deployment of marine renewable energy technologies and services".
- Smart grids (and smart cities), which comprise a suite of ICT technologies that enable the better management of electricity networks and can facilitate the increased deployment of renewable energy generators.

A2.3 Renewable Thermal Energy Policy Measures

A2.3.1 Building Regulations (Part L Amendment) Regulations 2008 and 2011[74]

Since July 2008, all new domestic buildings are required to have the following contribution from renewable energy:

- 10 kWh/m^2/annum contributing to energy use for domestic hot water heating, space heating or cooling, **or**
- 4 kWh/m^2/annum of electrical energy, **or**
- a combination of these which would have the equivalent effect.

A requirement for a quantified amount of energy from renewable for non-domestic building is not specified in the 2008 building regulations Part L - buildings other than dwellings. However it is stated that consideration should be given to the use of renewable energy, e.g. solar water heating, and to heat recovery from other processes, where applicable.

A2.3.2 Planning and Development Legislation

Statutory Instrument (SI) 666 of 2006 on alternative energy systems is building legislation that indicates the renewable energy requirement needs to be established prior to building work commencing. SI 83 of 2007 and SI 235 of 2008 allow for conditional planning exemptions for renewable energy technologies.

A2.3.3 Greener Homes Scheme Phase II

Phase II of the Greener Homes Scheme was launched on 1st October 2007. The intention of the scheme was to stimulate consumer investment in renewable heating solutions and to develop the market for renewable technologies and fuels, thereby reducing CO_2 emissions in the domestic sector. Phase II included a range of new objectives including heightened product standards and improved training standards across the industry. The Greener Homes Scheme provided assistance to homeowners who intended to purchase a new renewable energy heating system for an existing house, which was first occupied prior to 30th June 2008. The Greener Homes Scheme closed to new applicants since May 2011.

70 http://www.eirgrid.com/media/EirGrid%20Offshore%20Grid%20Study.pdf
71 http://www.islesproject.eu/
72 http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Action/leading/iles/IslesReports
73 http://www.irishstatutebook.ie/home.html
74 Available from http://www.environ.ie/en/DevelopmentandHousing/BuildingStandards/

A2.3.4 Better Energy Homes Scheme

The Irish Government, through SEAI, encourages people to improve the energy performance of their homes by incentivising the cost of installing various upgrade measures. Though aimed at improving the energy efficiency of the housing stock, solar heating is included as part of the scheme when combined with other energy efficiency measures. The incentive is in the form of a cash grant. Cash grants are fixed, irrespective of home size, though where actual expenditure is lower than the grant value only the lower amount will be paid. See http://www.seai.ie/Grants/Better_energy_homes/ for more details.

A2.3.5 Better Energy Warmer Homes Scheme

The Better Energy Warmer Homes scheme (BEWH), administered by SEAI, funds energy efficiency improvements in the homes of the elderly and vulnerable, making the homes more comfortable, healthier and more cost effective to run. The service involves the installation of standard energy efficiency measures appropriate to the eligible household subject to SEAI survey, budget allocation and available capacity. The service is provided at no cost to the household.

A2.3.6 Better Energy Communities

The purpose of this scheme is to test new and innovative approaches to achieving high quality and efficient delivery of improvements in energy efficiency within Irish communities. Communities can be a collective term connecting one or many organisations wishing to develop a single project in one location or across multiple locations, in rural or urban areas. The scheme specifically seeks to test innovative and pioneering partnerships for delivery between for example, the public and private sectors, domestic and non-domestic sectors, commercial and not-for-profit organisations. The scheme is open to projects and related initiatives in the community spanning multiple sectors and focusing on energy efficiency in buildings, business, facilities and transport sectors, and allowing for additional installation of integrated renewable energy technologies and infrastructure. It allows for a mix of technologies and a blend of domestic and non-domestic elements. See http://www.seai.ie/Grants/Better_Energy_Communities/ for more details.

A2.3.7 Better Energy Workplaces Scheme

This fund is designed for implementing a wide range of qualifying sustainable energy upgrading projects in the public, commercial, industrial and community sectors. Though not the focus of the scheme, renewable energy systems such as wind turbines and PV panels can be included but only when accompanied by a suite of energy efficiency upgrade measures.

A2.3.8 Renewable Heat Deployment Programme (ReHeat)

In order to facilitate meeting the national target specified in the Government White Paper of 5% of all heat to come from renewable energy sources by 2010 and 12% by 2020 a Renewable Heat (ReHeat) Deployment Programme[75] was launched in March 2007. The programme provides assistance for the deployment of renewable heating systems in industrial, commercial, public and community premises in Ireland. The heating systems covered by this grant scheme are boilers fuelled by wood chip or wood pellets, solar thermal systems and heat pumps.

A2.3.9 Bioenergy Establishment Scheme[76]

This scheme provides establishment grants to farmers to plant willow and miscanthus to produce biomass suitable for use as a renewable source of heat and energy. The scheme provides establishment grants of up to €1,300 per hectare or 50% of the cost. The scheme was initially launched on a pilot basis in 2007 and supported the planting of 2,500 hectares by the end of 2009. €1 million was made available to support the planting of a further 1,000 hectares in 2010.

A2.3.10 Wood Biomass Harvesting Machinery Scheme[77]

The Department of Agriculture and Food has introduced a scheme of support grants to assist the development of the supply chain required to process and supply wood biomass to end-users.

75 See http://www.seai.ie/index.asp?locID=1114&docID=-1 for details.

76 Dept. of Agriculture and Food (2007), BioEnergy Scheme for Willow and Miscanthus. Available from http://www.agriculture.gov.ie/farmerschemespayments/otherfarmersschemes/bioenergyscheme/

77 Dept. of Agriculture and Food (2007), Wood Biomass Harvesting Machinery Scheme. Available from http://www.agriculture.gov.ie/contentarchive/forestry/woodbiomassharvestingmachineryscheme/

A2.4 Renewable Transport Policy Measures

A2.4.1 Bioenergy Action Plan

The Bioenergy Action Plan[78] was launched in March 2007, based on the work of a ministerial task force in which six government departments were represented, as well as the Office of Public Works (OPW). The plan contains 50 action items to help develop Ireland's bioenergy resource. Specific tasks were identified for each department and the OPW to promote bioenergy in the transport, heat and electricity sectors as well as bioenergy research and development.

A Bioenergy Roadmap[79] for Ireland was published in 2010 to outline the growth potential of bioenergy in Ireland to 2050 such as:

- Annual abatement of over 11Mt of CO_2.
- Bioenergy is highly suitable for inclusion in a national distributed energy network.
- Over 3,500 ktoe of indigenous resources are available for the bioenergy supply chain by 2050 .

A2.4.2 Biofuels Mineral Oil Tax Relief (MOTR)

The Biofuels MOTR Scheme II[80] was designed as an interim measure to increase the level of biofuels in the fuel mix and to encourage the development of an indigenous biofuels industry. It was introduced in the 2006 Budget as a five-year scheme. There are four categories in this scheme: Biodiesel (EN590), Pure Plant Oil, Bioethanol and biofuels in captive fleets. Since the start of Scheme II there has been a steady increase in biofuels used in Ireland.

A2.4.3 Biofuels Obligation Scheme

The Energy (Biofuel Obligation and Miscellaneous Provisions) Act 2010[81] came into effect from June 2010. The Bill places an obligation on fuel suppliers to ensure that biofuels comprise 4% of the volume of their supplies, equivalent to approximately 3% in energy terms. This rate was increased to 6.383% from the start of 2013. The scheme is administered by the National Oil Reserves Agency (NORA) at no cost to the Exchequer. It will be a key component in achieving the EU target of 10% penetration of renewable energy in transport by 2020.

Article 17 of the Renewable Energy Directive 2009/28/EC specifies that biofuels must come from sustainable sources. Statutory Instrument (SI) 33 of 2012 gave effect to this provision. The SI came into effect in 2013. From 1st January 2013, in order to claim Biofuel Obligation Scheme (BOS) Certificates, the biofuel placed on the market must be deemed to be sustainable. Prior to 1st January 2013, it was sufficient to demonstrate that the biofuel placed on the market was simply biofuel. There was also transitional provision which essentially waived the provision until 1st July 2012.

Compliance with the biofuels obligation scheme can be met with tradable certificates. Biofuels produced from biodegradable or residue will be issued with two certificates per litre whereas all other biofuels will receive one certificate per litre.

A2.4.4 Electric & Hybrid Vehicles

The Minister for Communications, Energy and Natural Resources announced in April 2009 the introduction of grant support of up to €5,000 for a Battery Electric Vehicle (BEV) or a Plug-in Hybrid Electric Vehicle (PHEV) purchased and registered before the end of December 2013. In addition to the grant, a BEV qualifies for Vehicle Registration Tax relief of up to €5,000 whereas a PHEV qualifies for up to €2,500 VRT relief. This provides a maximum combined subsidy (grant + VRT relief) of €10,000 in the case of a BEV and €7,500 for a PHEV. The grant is accessed via the dealer and is administered by SEAI.

ESB has been providing free connection points in the home of each of the first 2,000 vehicles purchased. In addition, ESB has a target to install 1,500 public street charging points and 30 fast charging points nationwide. In May 2013 there were 670 AC public charge points installed and 40 DC fast charging points.

78 Available from http://www.nora.ie/_fileupload/File/Energy%20(Biofuel%20Obligation%20and%20Miscellaneous%20Provisions)%20Act%202010.pdf
79 Available from http://www.seai.ie/Renewables/Bioenergy_Roadmap.pdf
80 Details available from http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels+Scheme+II/
81 Details available from http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels+Obligation+Scheme.htm

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