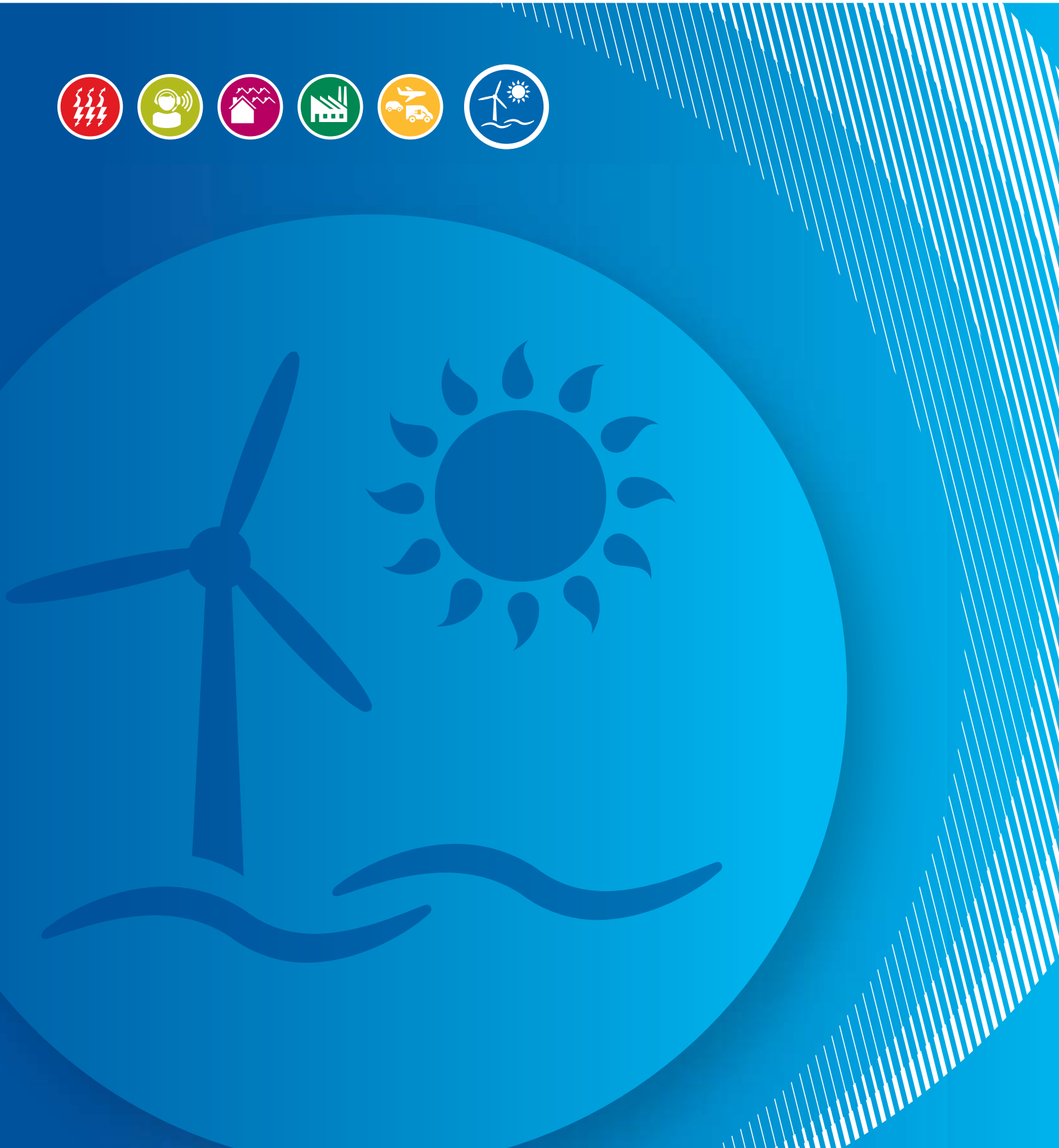
SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Renewable Energy in Ireland 2013

February 2015 Report



Renewable Energy in Ireland 2013

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Energy Policy Statistical Support Unit

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Sustainable Energy Authority of Ireland

The Sustainable Energy Authority of Ireland (SEAI) has a mission 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 to 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.

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. These data are a vital input in meeting international reporting obligations, for advising policy makers and informing investment decisions. Based in Cork, EPSSU is SEAI's specialist statistics team. Its core functions are to:

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

Acknowledgements

SEAI gratefully acknowledges the co-operation of the all the organisations, agencies, energy suppliers and distributors that provided data and responded to questionnaires throughout the year.

Renewable Energy 2013 Highlights

Progress towards overall EU Renewable Energy Directive target

- Renewable energy contributed 7.8% of Gross Final Energy Consumption, almost halfway towards Ireland's binding 2020 target.
- Renewable electricity accounted for 58% of renewable energy, renewable heat 30% and renewable transport fuels 12%.
- Ireland's Gross Final Consumption of renewable energy amounted to 839 thousand tonnes of oil equivalent, five times more than in 1990, largely due to the increasing contribution from wind energy.
- The vast majority of renewable energy came from wind (47%) and bioenergy (42%) with the remainder coming from hydro, geothermal and solar.

Energy Security and Avoided CO_2 Emissions

- Ireland's total indigenous energy production was 2.3 million tonnes of oil equivalent, with renewables accounting for one third of this.
- Renewable electricity generation avoided the combustion of approximately 963 thousand tonnes of oil equivalent of fossil fuels, displacing imports of €300 million.
- 2.9 million tonnes of CO_2 emissions were avoided through renewable energy use in all sectors, of which 60% was due to wind.

Renewable Electricity (RES-E)

- The share of electricity generated from renewable energy sources increased fourfold between 1990 and 2013.
- Renewable energy contributed one fifth of electricity generated, the second largest share behind gas.
- Over 80% of renewable electricity generated came from wind power, with installed generating capacity reaching 1,941 MW.

Renewable Transport Energy (RES-T)

- Renewable energy contributed 4.9% towards the transport renewables target, almost halfway towards the binding target.
- At 72% biodiesel is the dominant biofuel, with the remainder being bioethanol.
- 78% of liquid biofuels used were imported.

Renewable Heat Energy (RES-H)

- Renewable heat share has doubled since 1990, now accounting for 5.7% of all thermal energy.
- Industrial biomass use, mostly in the wood and food sectors, accounted for 60% of all thermal renewable energy used.
- Following significant decline to 2001, renewable heat use in households has since tripled , due to increased use of geothermal, wood and solar.

Table of Contents

Table of Figures

Table of Tables

Table of Equations

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 with 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 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.

The European Renewable Energy Directive 2009/28/EC sets a mandatory target of 16% of gross final energy consumption to come from renewable energy sources by 2020. In response, Ireland's National Renewable Energy Action Plan (NREAP) further sets out targets of 40% 12% and 10% for the contributions renewable energy to electricity generation, heating and transport respectively.

This report examines the contribution made by renewables to Ireland's energy requirements for the period 1990 to 2013, with a particular focus on production data in 2013. Installed capacity data are available for 2013 and early 2014. This is the seventh in an ongoing series of renewable energy reports and follows the Renewable Energy in Ireland 2012 Report[1].

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 2013 is compared with 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 9 analyse the progress towards the various renewable energy targets;
- Finally, section 10 estimates the extent of avoided CO_2 emissions arising from the use of renewables;

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 portal is available at http://www.seai.ie/Energy-Data-Portal/. The 2013 national energy balance data used in this report were published by SEAI in October 2014.

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 Renewable Energy Directive 2009/28/EC

The European Union Directive 2009/28/EC[3] on the promotion of the use of energy from renewable sources, also known as the Renewable Energy Directive (RED), is the most important legislation influencing the growth of renewables in Europe and Ireland. Statutory Instrument (SI) 147 gives effect to the RED in Irish law and SI 148 of 2011[4] conferred additional functions to SEAI relating to the requirements under the RED 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 Renewable Energy Directive specifies that:

- Mandatory national targets should be established consistent with a 20% share of energy from renewable sources in EU energy consumption by 2020. This is consistent with the renewable energy target contained in the EU Climate and Energy package[5] renewables target. Ireland's overall binding 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[6] (RES-T) in EU 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[7] or the renewable portion of electricity used for transport. The RED 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.

Amendments to the RED are being considered at EU level with regard to the use of biofuels towards meeting the RES-T and overall renewable energy targets. The proposed amendments attempt to further encourage the transition towards advanced biofuels in order to reduce competition between biofuels and food production and to mitigate the potential for indirect land-use change emissions resulting from increased biofuels production.

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. Ireland's finalised NREAP[8] was submitted to the European Commission on 30 June 2010. The first progress report[9] on the NREAP was submitted in January 2012 and the second progress report was submitted in February 2014[10]. The former reported on the progress towards the targets in 2009 and 2010 and the latter for 2011 and 2012 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 406 of 2009, on the effort of Member States to reduce their greenhouse gas emissions to meet the EU's GHG emission reduction commitments up to 2020, requires Ireland to reduce GHG emissions from non-ETS sectors

2 SEAI, 2014. Available from http://www.seai.ie/Publications/Statistics_Publications/Renewable_Energy_in_Ireland/Renewable-Energy-in-Ireland-2012.pdf.
3 Available from http://eur-lex.europa.eu/en/index.htm.
4 Statutory Instrument 147 and 148 of 2011. Available from http://www.irishstatutebook.ie/home.html.
5 http://ec.europa.eu/environment/climat/climate_action.htm.
6 Only petrol, diesel and biofuels consumed in road and rail transport, and electricity used by electric road vehicles shall be taken into account.
7 Note that in this report, the term 'Biofuel' refers specifically to liquid biofuels used in transport. See Gloassary for more information.
8 http://www.dcenr.gov.ie/NR/rdonlyres/03DBA6CF-AD04-4ED3-B443-B9F63DF7FC07/0/IrelandNREAPv11Oct2010.pdf.
9 http://www.dcenr.gov.ie/NR/rdonlyres/B611ADDD-6937-4340-BCD6-7C85EAE10E8F/0/IrelandfirstreportonNREAPJan2012.pdf.
10 http://www.dcenr.gov.ie/NR/rdonlyres/007CD508-7235-4E0C-A086-F31B751D71ED/0/IrelandsecondreportonNREAPFebruary.pdf

(i.e. sectors outside of the EU Emissions Trading Scheme) by 20% below 2005 levels by 2020.

2.3 Biofuels Obligation and Statutory Instrument 33 of 2012

The Biofuels Obligation Scheme (BOS) introduced in the Energy (Biofuel Obligation and Miscellaneous Provisions) Act 2010[11] came into effect in July 2010, following a commencement order in Statutory Instrument 322 of 2010[12]. The scheme to promote the use of biofuels came into effect after the completion of the mineral oil tax relief scheme for biofuel producers, which was in operation between 2006 and 2010. The BOS is administered by the National Oil Reserves Agency (NORA)

The first obligation period ran from 1st July to 31st December 2010; and since then the obligation period has been based on the calendar year. From July 2010 to December 2012 the BOS required every oil company and oil consumer liable to pay the NORA levy to ensure that, in each obligation period, not less than 4 in every 100 litres of road transport fuel was biofuel. The Minister may, from time to time, review the percentage rate. In December 2012 the Minister signed Statutory Instrument 562 of 2012 – National Oil Reserves Agency Act 2007 (Biofuel Obligation Rate) Order 2012 which increased the rate to 6 litres of biofuel in every 100 litres of road transport fuel (i.e. 6 litres of biofuel for every 94 litres of conventional fossil fuel). For biodiesel mixed with diesel a 6% share by volume equates to a 5.4% share by energy content, for biogasoline mixed with gasoline (petrol) a 6% share by volume equates to a 3.9% share by energy content.

Since the introduction of Biofuel Sustainability Criteria Regulations in February 2012 (SI 33 of 2012[13]) NORA has issued 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

In April 2009 the Minister for Communications, Energy and Natural Resources announced 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. This was later extended into 2015. 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 homes 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. At the beginning of 2015, over 1,200 public charge points had been installed, including fast chargers along inter–urban routes, with 95% of all major towns and cities having EV recharging infrastructure in place[14].

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. It 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, biomass[15] and landfill gas technologies. Plants must be new plants in all cases, neither built nor under construction on 1st January 2010. Projects must be operational by the end of 2015. The support for any particular project cannot exceed 15 years and may not extend beyond 31st December 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 bioenergy, wave and tidal generators.

11 Statutory Instrument 322 of 2010. Available from http://www.irishstatutebook.ie/home.html
12 Public Act 11 of 2010. Available from http://www.irishstatutebook.ie/home.html
13 Statutory Instrument 33 of 2012. Available from http://www.irishstatutebook.ie/home.html
14 For more information see http://www.esb.ie/electric-cars/electric-car-charging.jsp
15 See Gloassary for explanation of the specific meaning of the terms biomass, biofuels, biogas, bioenergy, etc. in this report.

2.6 Offshore Renewable Energy Development Plan

The offshore renewable energy development plan (OREDP) was published in February 2014[16]. It sets out three high-level goals, based on the concept of sustainable development, as follows:

- to harness market opportunities presented by offshore renewable energy in order to achieve economic development growth and jobs;
- to increase awareness of the value, opportunities and societal benefits of developing offshore renewable energy;
- to ensure that offshore renewable energy developments do not adversely impact Ireland's rich marine environment.

The OREDP acknowledges that given the current state of development and readiness of the various technology options for capturing ocean energy, previously projected levels of installed capacity for 2020 will not now be achieved. Despite this it maintains that the potential identified in those earlier projections remains valid over a longer time-scale, looking out to 2030 and beyond.

Among the many recommendations contained within the OREDP to promote the continued development of ocean energy technology in Ireland is the proposal to introduce a market support scheme for wave and tidal energy equivalent to €260/MWh for the first 30 MW of installed capacity.

An offshore renewable energy steering group has been established to oversee the implementation of the OREDP.

2.7 Draft Bioenergy Plan

The draft bioenergy plan[17] was published by the Department of Communications Energy and Natural Resources (DCENR) in October 2014. The plan will be implemented through 19 policy and enabling actions. The actions fall into five broad, high-level, categories:

- Demand-side measures that contribute directly to delivering renewable energy. The plan proposes to introduce an exchequer-funded renewable heat incentive in 2016. The scheme will be aimed at larger commercial and industrial installations outside of the Emissions Trading System.
- Enabling policies that address the supply-chain challenges faced by domestic producers of biomass. These measures include the establishment of BioEnergy Ireland as a biomass joint venture between Bord na Móna and Coillte, which will create a streamlined commercial state company to procure biomass at market rates in order to optimise the supply chain. Also included is the continued support for the afforestation programme.
- Measures to support research, demonstration and development including conducting an economic assessment of the costs and benefits of biogas and biomethane.
- Further market support and sustainability measures, including the sustainable use of forest material.
- Governance; a bioenergy steering group, chaired by the DCENR, is to be established to coordinate implementation of the finalised plan.

The plan will be subject to a strategic environmental assessment and other appropriate assessments, including undergoing public consultation. The final plan will provide a clear framework for the sustainable development of Ireland's bioenergy resources.

2.8 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 and the Regulatory Impact Assessment[18]. The bill is currently going through the legislative process.

2.9 Strategy for Renewable Energy: 2012 – 2020

The *Strategy for Renewable Energy: 2012 – 2020*[19] of the DCENR states the ambition that 'Ireland can also become a global leader in research and development in renewable energy and related technologies'. The Strategy identifies five goals: increasing both onshore and offshore wind; building a sustainable bioenergy sector; fostering R&D in

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

renewables such as wave and tidal; growing sustainable transport; and building robust and efficient electricity networks.

2.10 Building Regulations Part L

Since 2008 there has been a requirement in the Building Regulations that a reasonable proportion of the energy consumption 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 biogases. 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 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.

2.11 The Energy Efficiency Directive and Ireland's National Energy Efficiency Action Plan

The European Union Directive 2012/27/EU[20] on energy efficiency, also know as the Energy Efficiency Directive (EED), came into force on 25th October 2012. It amends and subsequently repeals the Energy Services Directive 2006/32/EC[21]. The EED places energy efficiency at the core of the EU Energy 2020 strategy. It has been transposed into Irish law through SI 426 of 2014 and SI 131 of 2014.

The EED requires member states to further decouple energy use from economic growth and sets out a common framework of measures for the achievement of the EU's headline 20% energy efficiency target by 2020. It stipulates that Member States shall set an indicative national energy efficiency target and shall report annually on their progress towards the target.

Member states are obliged to submit three National Energy Efficiency Action Plans (NEEAP) to the European Commission over a period of seven years to describe the measures planned to meet targets. Ireland's first NEEAP[22] was published in May 2009 and reaffirmed the target originally introduced in the 2007 White Paper of energy efficiency saving equivalent to 20% of the average primary energy used over the period 2001 – 2005, to be achieved in 2020. Ireland's second NEEAP[23] was launched in February 2013 and the third NEEAP was released in August 2014[24]. All three action plans maintain a commitment to meeting the overall 20% energy savings target in 2020, as well as a 33% reduction in public service energy use. The 2014 report notes that although substantial savings have been made in the last three years "*it is clear that a significant acceleration of effort is required if we are to realise our 2020 targets*".

Apart from contributing to the specific energy efficiency targets discussed briefly above, increased energy efficiency also helps Ireland to meet its renewable energy targets. This is because greater energy efficiency implies that less energy is consumed for a given level of activity, which leads to relatively reduced overall energy demand. As the renewable energy targets are specified as a percentage share of overall energy demand, as is discussed further in section 3, reduced energy demand results in less renewable energy being required to meet the renewable targets.

20 Full details are available at http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2012:315:0001:0056:EN:PDF
21 Directive 2012/27/EU also repealed Directive 2004/8/EC (cogeneration) and amended Directives 2009/125/EC (eco-design of energy-related products) and 2010/30/EU (labelling of energy-related products).
22 Full details are available at http://www.dcenr.gov.ie/NR/rdonlyres/FC3D76AF-7FF1-483F-81CD-52DCB0C73097/0/NEEAP_full_launch_report.pdf
23 Full details are available at http://www.dcenr.gov.ie/NR/rdonlyres/B18E125F-66B1-4715-9B72-70F0284AEE42/0/2013_0206_NEEAP_PublishedversionforWeb.pdf
24 http://www.dcenr.gov.ie/NR/rdonlyres/20F27340-A720-492C-8340-6E3E4B7DE85D/0/DCENRNEEAP2014publishedversion.pdf

3 Methodology for Calculating Renewable Energy Shares

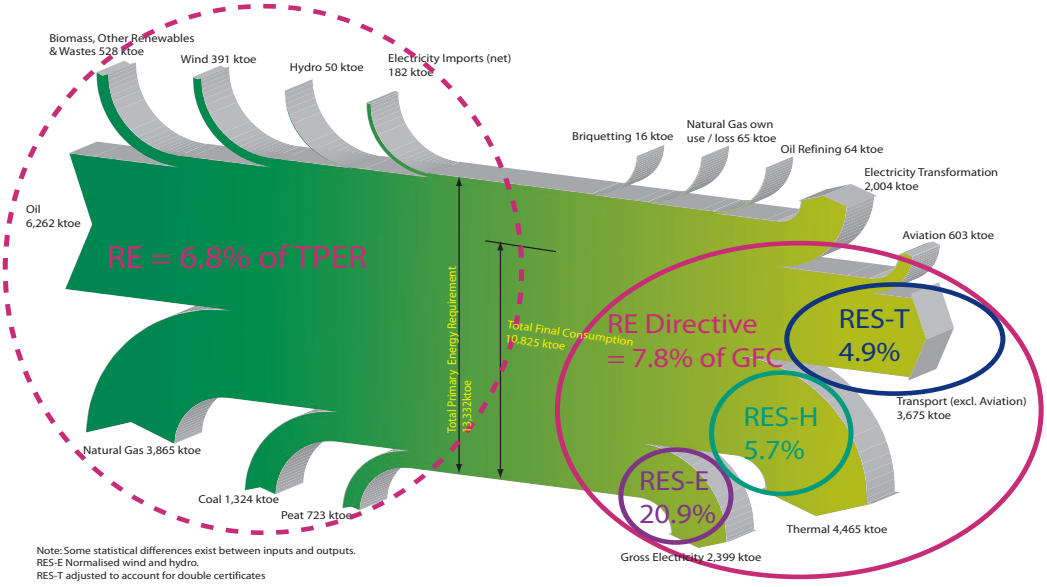
There are many different ways to calculate the share of renewable energy. This can lead to confusion when the question 'How much of Ireland's energy comes from renewable sources?' is raised. A variety of indicators have emerged to measure progress against various different measures and targets — national,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

3.1 Renewables in Context of Overall Energy Use

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. Gross final consumption (GFC) of energy is an alternative to TFC and is the denominator used by the EU to track progress towards the targets in the RED. GFC is explained further in section 3.2.1. The contribution from renewable energy can be captured in terms of its percentage share of either TPER, TFC or GFC.

The Sankey diagram for Ireland in Figure 1 illustrates where the various renewable targets fit within overall energy use in Ireland and the progress towards those targets in 2013. Towards the left of Figure 1 the overall contribution of renewable energy to TPER is shown at 6.8%. Whilst there is no specific target for this measure it does help to illustrate the position of renewables in Ireland's overall energy. Towards the right of Figure 1 the current percentages for renewables in transport, heat and electricity with respect to GFC are shown, as well as the percentage of overall renewables. The scope and calculation for each of the numerators and denominators for each of these percentages are explained in the following sections.

Figure 1 *Renewable Energy Status in Ireland (2013)*



Source: SEAI

3.2 Renewable Energy Directive 2009/28/EC

Ireland's binding target under the RED is for renewable sources to account for 16% of gross final energy consumption (GFC) in 2020. There are differing methodologies for the calculation of 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). 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 weighting factors are not applied.

3.2.1 Gross Final Consumption

The RED defines gross final consumption of energy (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.

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

In the case of electricity for example, the difference between TFC and 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.

3.2.2 Overall Renewables Target

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 RED 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 RED.

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

- Electricity—This is the total renewable electricity generation, with the contribution from wind and hydro normalized to account for climatic variation and in the case of wind to smooth the effect of large annual increases in the installed capacity, as described further in section 3.2.3.1.
- 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 so that aviation is limited to 6.18% of gross final consumption (as prescribed in Article 5.6 of the RED).

3.2.3 Renewable Electricity (RES-E)

Prior to the RED there was a target and strategy for the contribution of renewable energy to the electricity market established in the EU Directive 2001/77/EC[25]. 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 for renewable electricity is 40% of gross electricity consumption, but there is no specified mandatory EU RES-E 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 renewable content of imports.

It is important to note that the gross electricity generated is different to (greater than) both the final electricity consumption and the total electricity requirement, the latter of which is often quoted by EirGrid, the transmission system operator (TSO). 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.

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

3.2.3.1 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 the RED, 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 towards the RED;
- 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 of all hydropower plants, net of pumped storage, at the end of year i measured in MW.

Equation 1 *Hydro Normalisation Equation*

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

Source: European Commission

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 five years, 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 towards the RED;
- 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.

Equation 2 *Wind Normalisation Equation*

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

Source: European Commission

3.2.4 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 renewable heat for the RES-H target is the same as that for the overall target, i.e. the total renewables used for heat purposes. With regard to geothermal energy, the renewable energy contribution is taken to be the total heat produced by the heat pump less the primary energy of the electricity input, i.e. the renewable portion of the heat produced. It is assumed that the coefficient of performance of all heat pumps is 3.5. Geothermal energy is discussed further in section 7.2. In the case of direct electric heating, 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.

3.2.5 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[26]. 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 transport are not included in the denominator.

The RED attaches an important condition to biofuels: that they must come from sustainable sources. Sustainable sources as defined by Article 17 of the Directive 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 EU and used for the production of biofuels and bioliquids shall be obtained in accordance with the requirements and standards set out in 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.

3.2.6 Co-operating Mechanisms and Short-Term Statistical Transfers

If a country is unable to meet the target with indigenous renewable energy sources, there are mechanisms outlined in the Directive that could assist in meeting the EU target[27]. There are three main cooperation mechanisms:

- 'Statistical transfers', where Member States agree to attribute renewable energy produced in one Member 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.
- Joint support schemes, where Member States co-finance their new renewable energy production independent of its location (within their territories).

3.3 Primary Energy Equivalent

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[28]. For non-combustible renewable sources (e.g. wind and hydro) the primary energy can be 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.

When considering the share of non-combustible energy in an energy system one approach is to compare the primary energy of the non-combustible sources (i.e. the electricity produced) directly with the primary energy of combustible sources. This approach compares non-combustible energy in the form of electricity with the total thermal energy content of combustible fuels that are used for electricity production, without considering the energy losses involved in electricity generation processes. Typically between 75% and 45% of the energy content of the combustible fuel input into power plants is lost in the electricity generation process, i.e. the process is 25% – 55% efficient. In contrast non-combustible renewable electricity generation is effectively 100% efficient. Comparing the two on the basis of primary energy thus underestimates the value of non-combustible energy.

An alternative approach is to consider the primary energy of the non-combustible source to be equivalent to the primary energy of the combustible fuel that would have been required to produce that same amount of electricity. This is the principle behind the primary energy equivalent (PEE) approach. A detailed description of the methodology used for calculating the PEE is provided in Appendix 1. The renewables share of total primary energy equivalent (TPEE) 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. The effective contribution of renewable energy to Ireland's primary energy use is captured more completely in the renewable energy share of TPEE than in the renewable energy share of TPER.

26 Renewable Energy Directive, 2009/28/EC; Article 21 (2)

27 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

28 International Energy Agency, *Energy Balances of OECD Countries.* Available from http://www.iea.org

4 Context for Renewable Energy Deployment

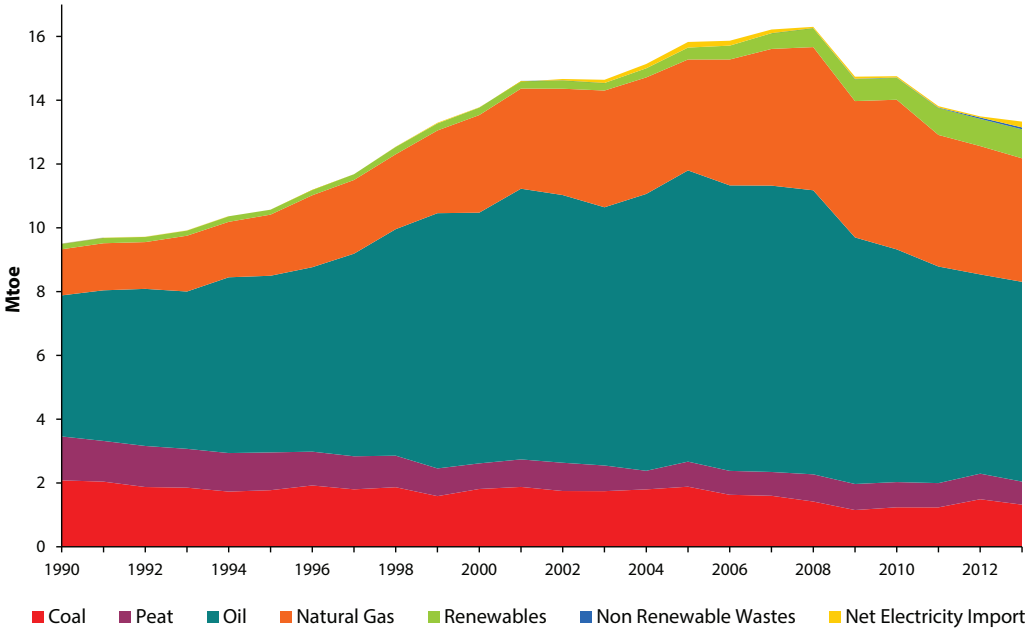
4.1 Primary Energy

Ireland's overall energy supply is discussed in terms of changes to the total primary energy requirement (TPER). 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 2013, emphasising changes in the fuel mix. Primary energy requirement in Ireland in 2013 was 13.3 million tonnes of oil equivalent (Mtoe). Over the period 1990 to 2013 Ireland's total annual primary energy requirement grew in absolute terms by 40% (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 2013 is contained in SEAI's Energy in Ireland 2014 report[29].

The 2013 data show an overall reduction of 1.2% in primary energy requirement relative to 2012. Oil increased slightly by 1.3% due to growth in the transport sector, while coal and peat consumption decreased by 11.3% and 9.8% respectively due to their reduced use in electricity generation.

Figure 2 *Total Primary Energy Requirement 1990 – 2013*



Source: SEAI

Figure 2 shows the significant increase in overall TPER over the period 1990 to 2013 and also the considerable growth in renewable energy since the mid 1990s. Total renewable energy grew from 168 ktoe to 911 ktoe between 1990 and 2013, an increase of 443% (7.6% per annum on average) over the period. 2013 figures show a 6.9% increase over the previous year in the contribution of renewables to the TPER.

29 SEAI, 2014, *Energy in Ireland 1990 to 2013 (2014 Report)*. Available from http://www.seai.ie/

Table 1 *Growth Rates and Shares of TPER Fuels 1990 – 2013*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2013	'90 – '13	'00 – '05	'05 – '10	'10 – '13	2013	1990	2013	1990	2013
Fossil Fuels (Total)	30.6	1.2	2.5	-1.7	-4.6	-3.0	9,330	12,181	98.2	91.4
Coal	-36.5	-2.0	0.8	-8.0	2.2	-11.3	2,085	1,324	22.0	9.9
Peat	-47.5	-2.8	-0.4	0.1	-2.9	-9.8	1,377	723	14.5	5.4
Oil	41.6	1.5	3.0	-4.4	-5.0	0.3	4,422	6,262	46.6	47.0
Natural Gas	167.7	4.4	2.6	6.2	-6.2	-3.7	1,446	3,872	15.2	29.0
Renewables (Total)	443.1	7.6	9.7	13.0	9.8	6.9	168	911	1.8	6.8
Hydro	-17.0	-0.8	-5.7	-1.0	-1.2	-27.9	60	50	0.6	0.4
Wind	-	-	35.4	20.4	17.3	13.2	0	391	0.0	2.9
Biomass	164.3	4.3	9.8	3.1	9.8	8.3	105	279	1.1	2.1
Other Renewables	8022.8	21.1	8.9	33.7	1.4	5.9	2	192	0.0	1.4
Non-Renewable (Wastes)	-	-	-	-	89.0	31.7	0	58	0.0	0.4
Electricity Imports	-	-	83.6	-25.5	65.2	412.5	0	182	0.0	1.4
Total	**40.4**	**1.5**	**2.8**	**-1.4**	**-3.3**	**-1.2**	**9,497**	**13,332**		

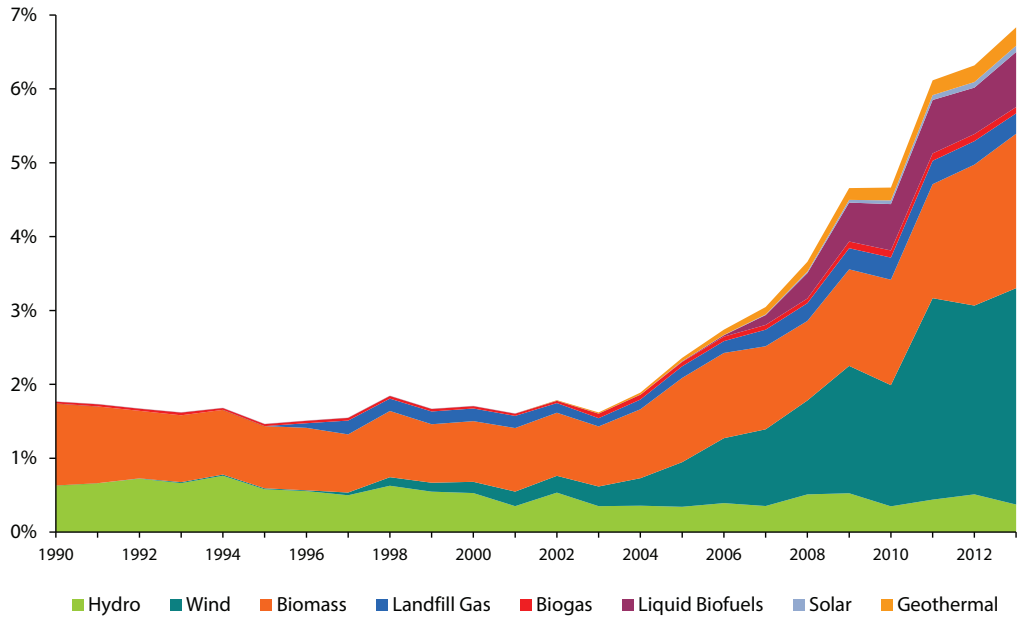
Source: SEAI

Figure 3 shows that renewable energy had been contributing nearly 2% of Ireland's TPER between 1990 and 2004. In 2004 the contribution stood at 1.9% and this increased to 6.8% in 2013.

There are many different indicators outlined in Section 3 in relation to the share of renewables in energy use and the figure of 6.8% renewable contribution to primary energy in 2013 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 RED calculation.

Figure 3 *Renewable Energy Contribution to TPER 1990 – 2013*



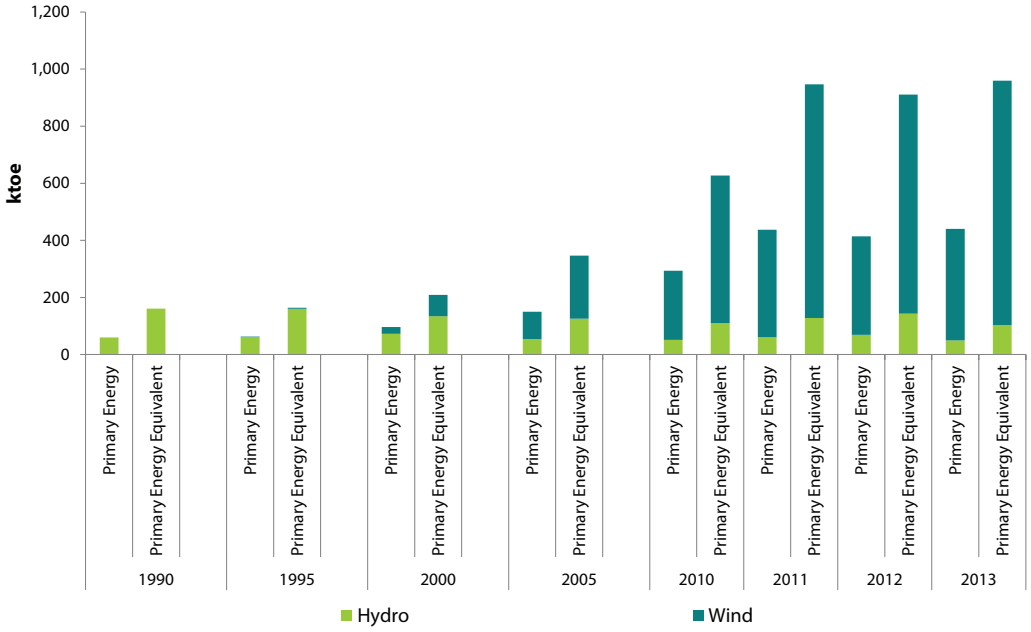
Source: SEAI

4.2 Primary Energy Equivalent of Renewables

As discussed in section 3.3, the primary energy equivalent (PEE) 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 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. Data are shown at five-year intervals between 1990 and 2010, and annually thereafter. The difference between the PE and PEE is particularly noticeable and also the increasing importance of wind. For the year 2013, the PEE for wind and hydro was 2.2 times larger (117%) than their PE.

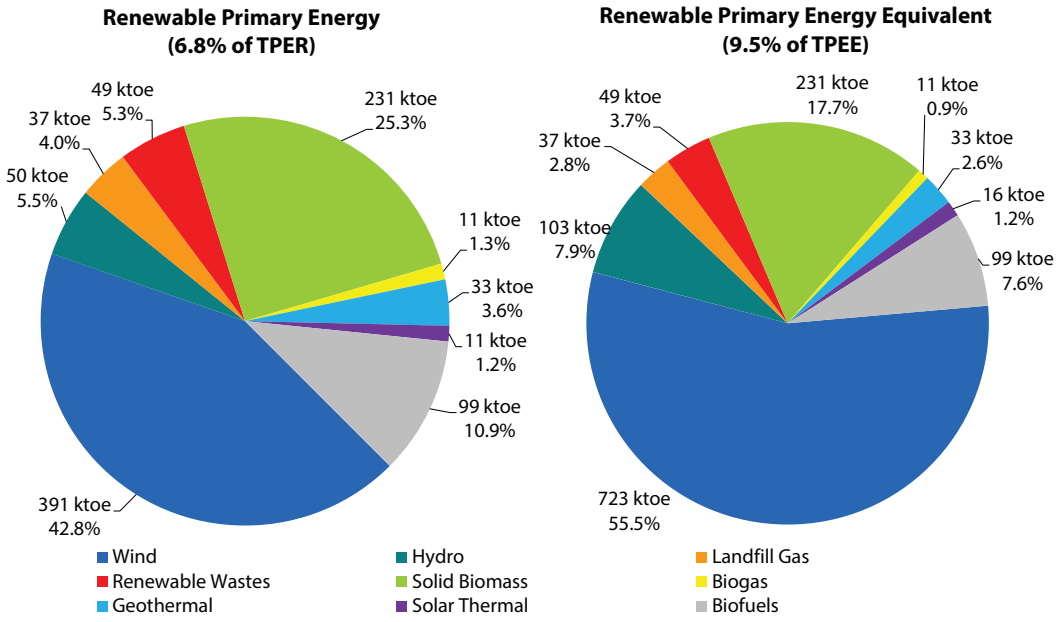
Figure 4 *Primary Energy (PE) and Primary Energy Equivalent (PEE) for Wind and Hydro*[30]



Source: SEAI

The total primary energy equivalent (TPEE) for renewable energy is then calculated by adding the primary energy for combustible renewable sources to the calculated PEE for non-combustible renewables. This provides a new measure of renewable energy's contribution to energy supply. The PEE for renewable energy increased from 269 ktoe in 1990 to 1,302 ktoe in 2013, an increase of 385% (7.1% per annum on average).

Figure 5 *Renewable Energy Shares in terms of Primary Energy and Primary Energy Equivalent in 2013*



Source: SEAI

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

Figure 5 compares the contribution of the different sources of renewable energy using the traditional PE approach and the PEE approach. Renewable energy accounted for 6.8% of the TPER in 2013 and 9.5% of the TPEE, with wind generated electricity accounting for 43% of renewable energy in terms of PE but accounting for 56% of renewable energy using the PEE approach.

4.3 Final Energy Demand

Final energy demand is a measure of the energy that is delivered to 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 users, such as refined oils, electricity, patent fuels etc. Transformation, processing or other losses entailed in delivery to final consumers are known as 'energy overhead'.

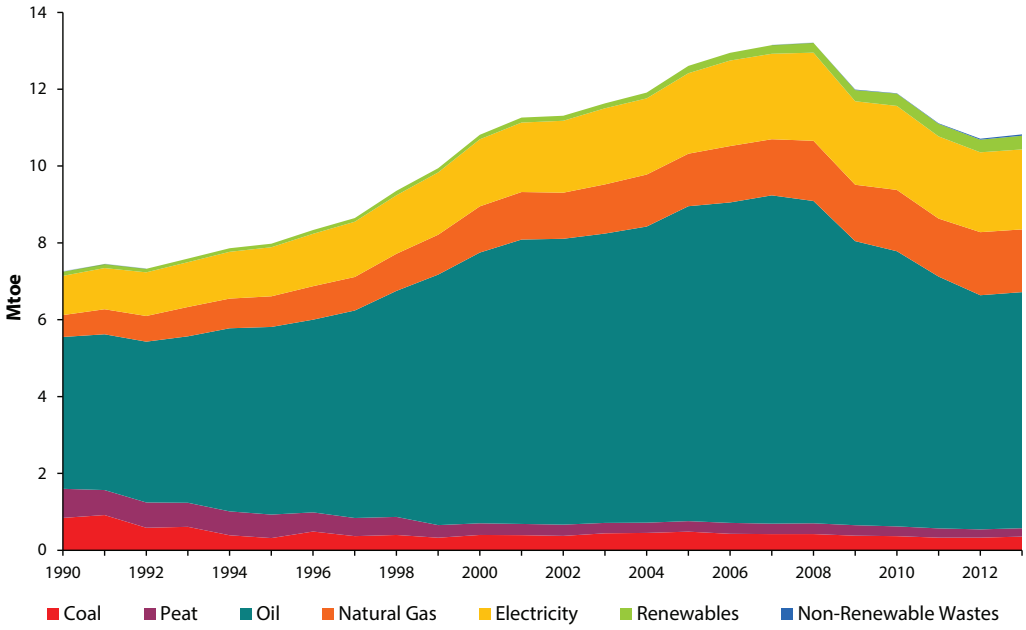
Figure 6 and Table 2 show the shift in the pattern of final energy demand by fuel over the period 1990 to 2013. Ireland's TFC in 2013 was 10.8 Mtoe, an increase of 1.1% on 2012 and 49% above 1990 levels (representing an average growth rate of 1.8% per annum). Note that renewables here accounts only for the direct use of renewables, for example liquid biofuels in the transport sector or biomass in industry; it does not count renewables used to generate electricity, which are counted instead under electricity generation. Final consumption of renewable energy increased by 232% (5.4% per annum on average) from 1990 to 2013. Final consumption of renewable energy sources grew by 8.7% to 358 ktoe in 2013. The share of renewables in final consumption was 3.3% in 2013.

Table 2 *Growth Rates, Quantities and Shares of TFC Fuels*[31]

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2013	'90 – '13	'00 – '05	'05 – '10	'10 – '13	2013	1990	2013	1990	2013
Fossil Fuels (Total)	36.4	1.4	2.9	-2.0	-3.7	0.9	6,121	8,351	84.4	77.2
Coal	-57.8	-3.7	4.0	-5.4	-1.1	8.2	843	355	11.6	3.3
Peat	-71.1	-5.3	-2.0	-1.5	-4.9	1.5	757	218	10.4	2.0
Oil	55.5	1.9	3.1	-2.8	-4.8	0.8	3,952	6,145	54.5	56.8
Natural Gas	186.7	4.7	2.6	3.1	0.8	-0.5	570	1,633	7.9	15.1
Renewables	231.7	5.4	10.2	10.9	3.7	8.7	108	358	1.5	3.3
Non-Renewable (Wastes)	-	-	-	-	59.8	36.9	0	35	0.0	0.3
Combustible Fuels (Total)	39.7	1.5	3.0	-1.7	-3.4	1.2	6,229	8,699	85.9	80.4
Electricity	103.9	3.1	3.7	0.9	-1.6	0.2	1,021	2,081	14.1	19.2
Total	**49.3**	**1.8**	**3.1**	**-1.2**	**-3.0**	**1.1**	**7,249**	**10,825**		
Total Climate Corrected	**43.7**	**1.6**	**3.3**	**-2.3**	**-1.8**	**1.4**	**7,423**	**10,670**		

31 For an explanation of Climate Correction, see the Glossary at the end of this report.

Figure 6 *Total Final Consumption by Fuel 1990 – 2013*



Source: SEAI

4.4 Indigenous Energy Sources

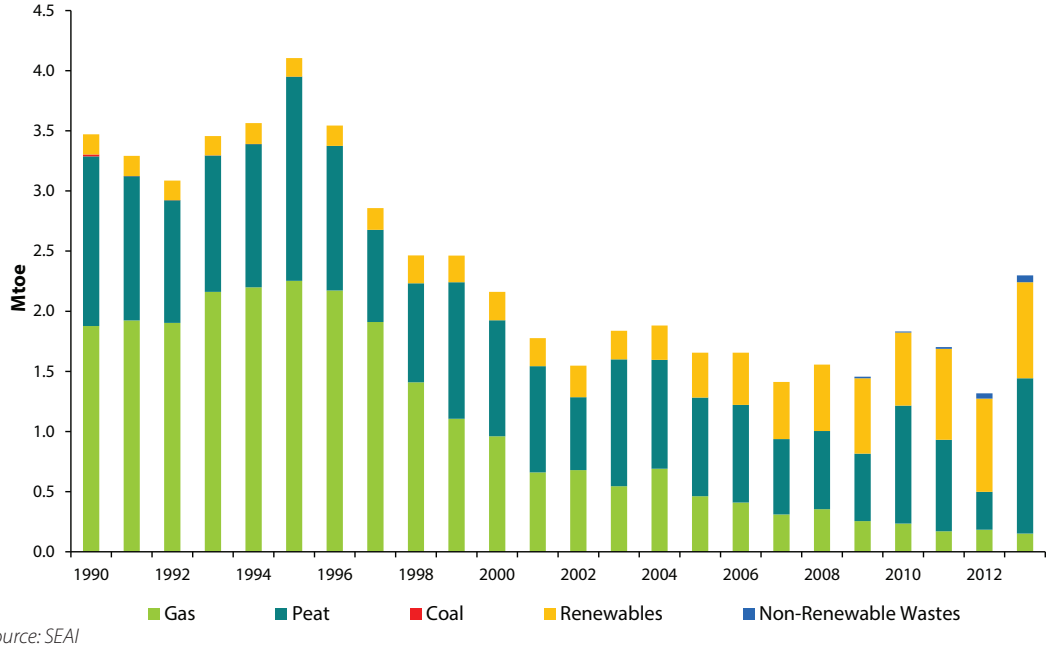
Ireland is not endowed with significant indigenous fossil fuel resources and in past decades did not harness significant quantities of renewable resources. Although there has been strong growth in renewables in recent years, it is from a small base. Figure 7 shows the indigenous energy fuel mix for Ireland over the period 1990 to 2013. The reduction in indigenous supply of natural gas is clearly evident from the graph as is the switch away from peat.

Peat production has fluctuated over the time period, partly due to the fact that the harvesting of peat can be adversely affected by poor weather, although an overall downward trend is evident. The maximum annual peat harvest was 1,697 ktoe in 1995. The lowest recorded harvest was 315 ktoe in 2012. This was 59% below 2011 and 44% below the previous minimum production of 560 ktoe in 2009. The exceptionally low production in 2012 was due to high rainfall in the summer months which prevented much peat from being harvested. Peat production increased significantly in 2013 to 1,292 ktoe, partly in order to replenish stocks that had been depleted the previous year.

Production of indigenous gas fell by 93% from a high of 2,253 ktoe in 1995 to 151 ktoe in 2013. Renewable energy , in contrast, increased by 416%, from a low in 1995 of 155 ktoe to a high in 2013 of 798 ktoe.

Overall indigenous production peaked in 1995 at 4,105 ktoe and had reduced by 68% by 2012 to 1,304 ktoe, but increased by 74% in 2013 to 2,299 ktoe, which remains 44% below 1995 levels.

Figure 7 *Indigenous Energy Sources by Fuel as a Share of TPER 1990 – 2013*



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 partly compensated for by the use of renewables. Of the indigenous energy production in 2013 renewable energy accounted for 35%, peat for 56% and natural gas for 7%. 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

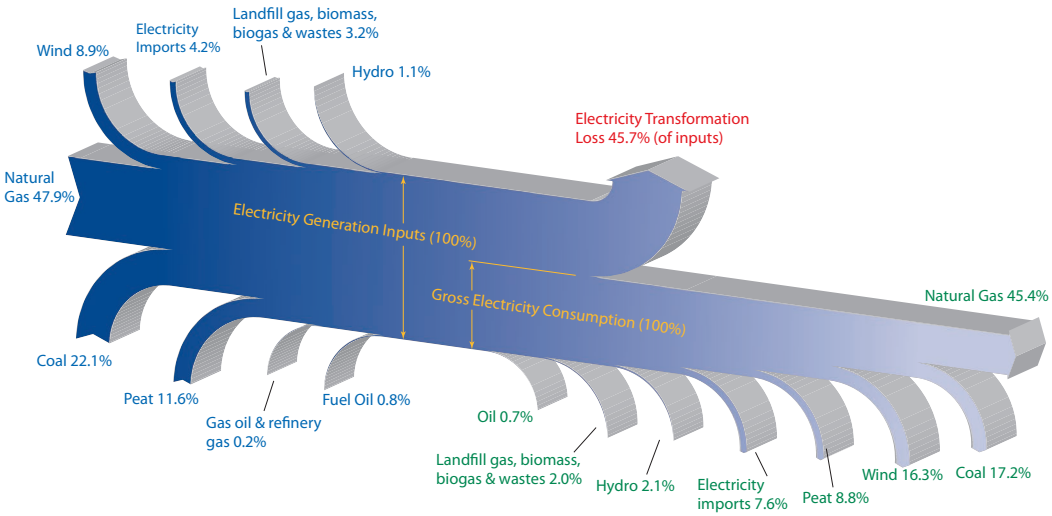
Electricity demand has consistently remained between 15% and 20% of TFC for the last 20 years and was 2,081 ktoe or approximately 24 TWh in 2013 (19% of TFC). For some sectors there is a higher reliance on electricity, in particular industry and services, where electricity accounts for 36% and 42% respectively of the sectoral final energy demand for 2013. The share of electricity in the residential sector was lower in 2013 at 25%.

Fuel inputs to electricity generation are responsible for approximately one third of the total primary energy demand in Ireland (4.4 Mtoe in 2013). 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 electricity contribute to an overall reduction in primary energy demand as they do not have the transformation losses associated with fuel combustion for electricity generation[32].

Figure 8 shows a Sankey diagram for electricity generation in 2013. On the left hand side are shares of primary energy inputs to electricity generation by fuel type. On the right hand side are the shares of gross electricity consumption generated by each fuel type. The difference in shares between the two sides is due to the different conversion efficiencies for different fuel types, as discussed in section 3.3. The scale of transformation losses from the conversion of combustible fuels to electricity can be seen, accounting for 46% of the primary energy input.

Figure 8 *Flow of Energy in Electricity Generation 2013 – Inputs and Outputs by Fuel*



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

Renewables as % of gross electricity consumption = 20.1%
Renewables as % of gross electricity consumption (normalised) = 20.9%
CHP as % of total electricity generation = 7.4%

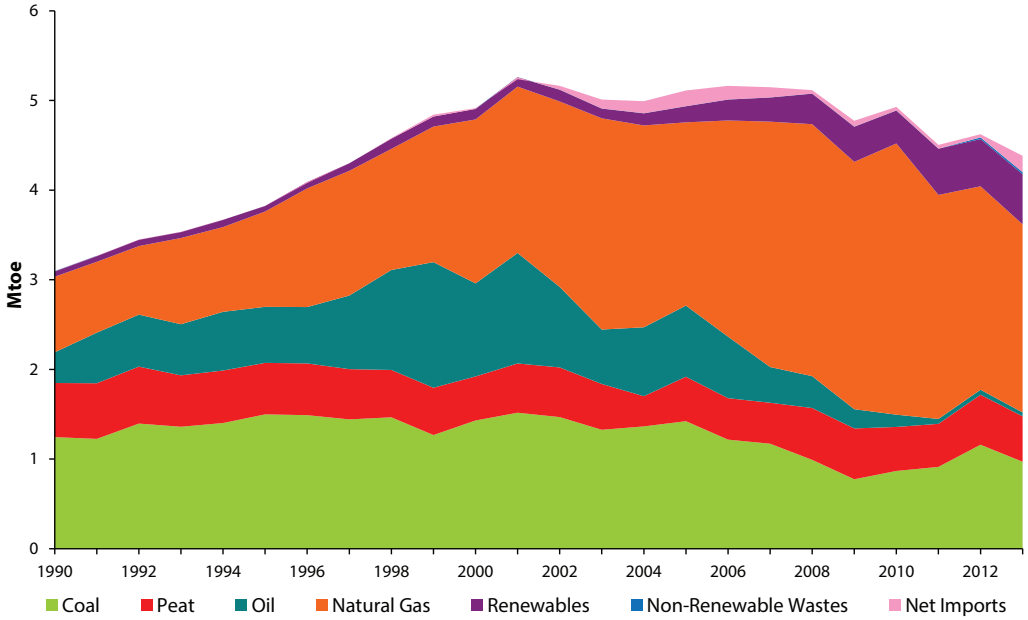
Source: SEAI

The fuel inputs to electricity generation from 1990 to 2013 are shown in Figure 9. Fuel inputs increased steadily 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.

Table 3 shows the growth rates, quantities and shares of the primary fuel mix for electricity generation over the period 1990 – 2013. 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 was reduced by 4.7%, while at the same time the final consumption of electricity increased by 10%. In 2013, 4,382 ktoe of energy was used to generate electricity, 5.2% less than in 2012 and 16% lower than peak levels in 2001. The fuel inputs to electricity generation were one third (33%) of the total primary energy requirement in 2013. Electricity consumption as a share of total final consumption increased from 14% to 19% between 1990 and 2013.

32 Refer to sections 3.3 and 4.2

Figure 9 *Inputs to Electricity Generation by Fuel Source 1990 – 2013*



Source: SEAI

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

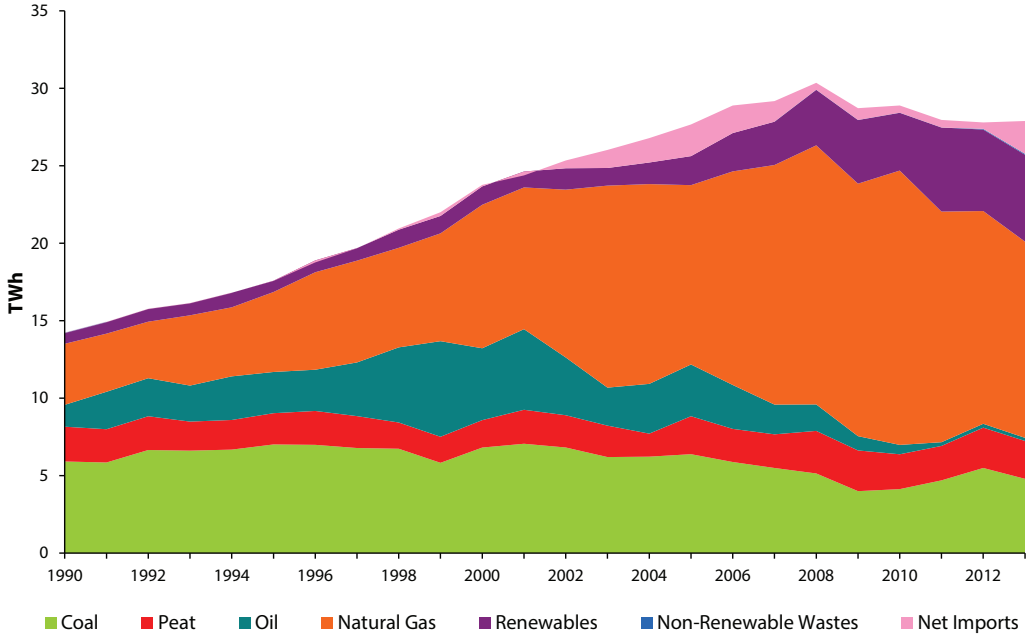
	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2013	'90 – '13	'00 – '05	'05 – '10	'10 – '13	2013	1990	2013	1990	2013
Fossil Fuels (Total)	19.3	0.8	-0.1	-1.0	-7.1	-10.5	3,034	3,619	98.1	82.6
Coal	-22.1	-1.1	-0.1	-9.4	3.8	-16.4	1,245	970	40.2	22.1
Peat	-16.0	-0.8	0.2	-0.2	1.1	-9.0	604	507	19.5	11.6
Oil	-87.3	-8.6	-5.2	-29.6	-31.8	-22.2	343	43	11.1	1.0
Gas	148.9	4.0	2.3	8.2	-11.5	-7.5	843	2,098	27.2	47.9
Renewables (Total)	831.2	10.2	8.9	15.4	14.9	6.1	60	558	1.9	12.7
Hydro	-17.0	-0.8	-5.7	-1.0	-1.2	-27.9	60	50	1.9	1.1
Wind	-	-	35.4	20.4	17.3	13.2	-	391	-	8.9
Other Renewables	-	-	4.8	20.1	16.6	5.1	-	118	-	2.7
Non-Renewable (Wastes)	-	-	-	-	-	24.6	-	23	-	0.5
Combustible Fuels (Total)	23.9	0.9	-0.1	-0.8	-6.5	-9.9	3,034	3,759	98.1	85.8
Electricity Imports (net)	-	-	83.6	-25.5	65.2	412.5	-	182	-	4.2
Total	**41.6**	**1.5**	**0.8**	**-0.7**	**-3.8**	**-5.2**	**3,094**	**4,382**		

Source: SEAI

Figure 10 shows the trend in Gross Final Consumption (GFC) of electricity for Ireland over the period 1990 – 2013. 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 9 with Figure 10 and see that even though demand continued to increase between 2001 and 2008 the inputs to electricity generation decreased. This is the result of higher efficiency electricity generation from natural gas Combined Cycle Gas Turbines (CCGT) and the increasing contribution from renewables.

A further factor is the development of interconnection between the Irish and UK electricity grids. The 500 MW Moyle Interconnector between Scotland and Northern Ireland became operational in 2002, but has been operating at a limited capacity of 250 MW for a number of years due to cable faults. The 500 MW East West Interconnector between Wales and the Republic of Ireland became operational in late 2012 and 2013 was its first full year of operation. This lead to an increase in electricity imports of over 400% in 2013, though from a low base.

Figure 10 *Gross Electricity Consumption by Fuel Source 1990 – 2013*



Source: SEAI

Due to the impact of the economic recession there has been a reduction in the gross electricity consumption since 2008, as shown in Figure 10. As detailed in Table 4, the share of gas generation increased from 28% in 1990 to 61% in 2010 but fell back to 45% in 2013. Gas-generated electricity grew by 222% over the period 1990 to 2013, an annual average growth rate of 5.2% per annum. In contrast, oil generated electricity has almost been eliminated, falling from a 10% share of all generation in 1990 to 0.7% in 2013. GFC of electricity was 27.9 TWh in 2013. These changes provide a context against which the growth in RES-E can be assessed.

Electricity from renewable energy sources more than quadrupled its share of gross electricity generation over the period, going from 4.9% in 1990 to 20.1% in 2013. During this time the absolute amount of electricity from renewables increased eightfold from 697 GWh to 5,606 GWh. Renewable energy surpassed coal to become the second largest source of electricity produced for the first time in 2013.

Table 4 *Gross Electricity Consumption Percentage by Fuel Source 1990 – 2013*

% of Gross	1990	1995	2000	2005	2010	2011	2012	2013
Coal	41.6	39.9	28.7	23.1	14.3	16.8	19.8	17.2
Peat	15.8	11.5	7.4	8.9	7.8	8.0	9.4	8.8
Oil	9.9	15.1	19.5	12.1	2.1	0.9	0.9	0.7
Gas	27.7	29.4	39.0	41.8	61.3	53.2	49.4	45.4
Renewables	4.9	4.1	5.0	6.8	12.9	19.4	18.9	20.1
Non-Renewable Wastes	-	-	-	-	-	-	0.2	0.2
Net Imports	0.0	-0.1	0.4	7.4	1.6	1.8	1.5	7.6

Source: SEAI

5.2 Sources of Renewable Electricity

5.2.1 Hydro Energy

There are 14 large hydroelectric[33] generators connected to the power transmission system, each with 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[34] (< 1 MW) hydroelectric generators connected to the distribution system, with an installed capacity of 25.5 MW. There are a further four micro-generation projects contracted for power distribution system connections. In 2013 hydropower generated 579 GWh of electricity (2.1% of gross electricity) which equates to 736 GWh when normalised (2.6% of gross electricity).

33 EirGrid, *Connected TSO (Non-Wind) Generators*. http://www.eirgrid.com/customers/gridconnections/listofconnectedandcontractedgenerators/

34 ESB Networks, *Distribution Energised Connected Non-Wind*. http://www.esb.ie/esbnetworks/en/generator-connections/Connected-Contracted-Generators.jsp

5.2.1.1 Pumped Hydro Storage

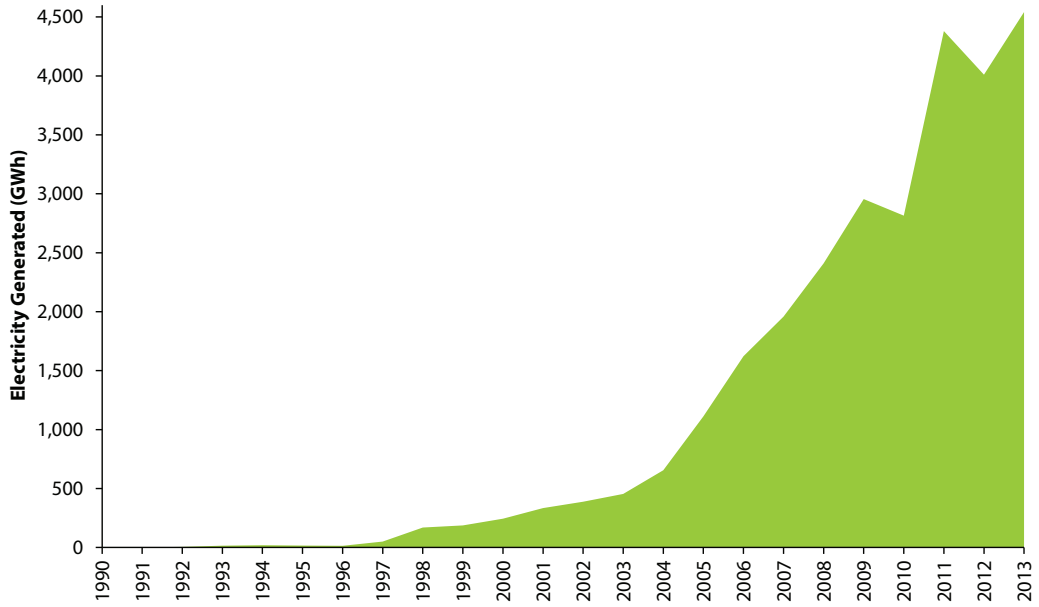
Electricity produced by pumped storage from water that has previously been pumped uphill is not classified as being from a renewable energy source and is not included in either the numerator or the denominator of the renewable electricity (RES-E) calculation. While it is not a renewable electricity source, 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 giving a total capacity of 292 MW. All of the electricity produced from this station is from water that has previously been pumped uphill using electricity and is therefore not classed as renewable. 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[35]. In 2013 245 GWh of electricity was generated at Turlough hill.

5.2.2 Wind Energy

Figure 11 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 on line. Total electrical output from wind in 2013 was 4,542[36] GWh representing an increase of 13.2% on 2012. Total electrical output from wind in 2012 was 4,010 GWh representing a fall of 8.4% on 2011 due to the wind resource being lower (less wind blew). Wind was responsible for 16.3% of gross electrical consumption in 2013 or 16.5% on a normalised basis. The peak recorded wind power output in 2013 was 1,564 MW, delivered on 20th November. At the time of writing the historic peak recorded wind power output[37] was 1,967 MW, delivered on Wednesday, 7th January 2015 at which point wind contributed 52% to the instantaneous system demand.

Figure 11 *Electricity Generated by Wind (GWh) 1990 – 2013*



Source: EirGrid

Table 5 *Renewable Electricity Production from Wind*

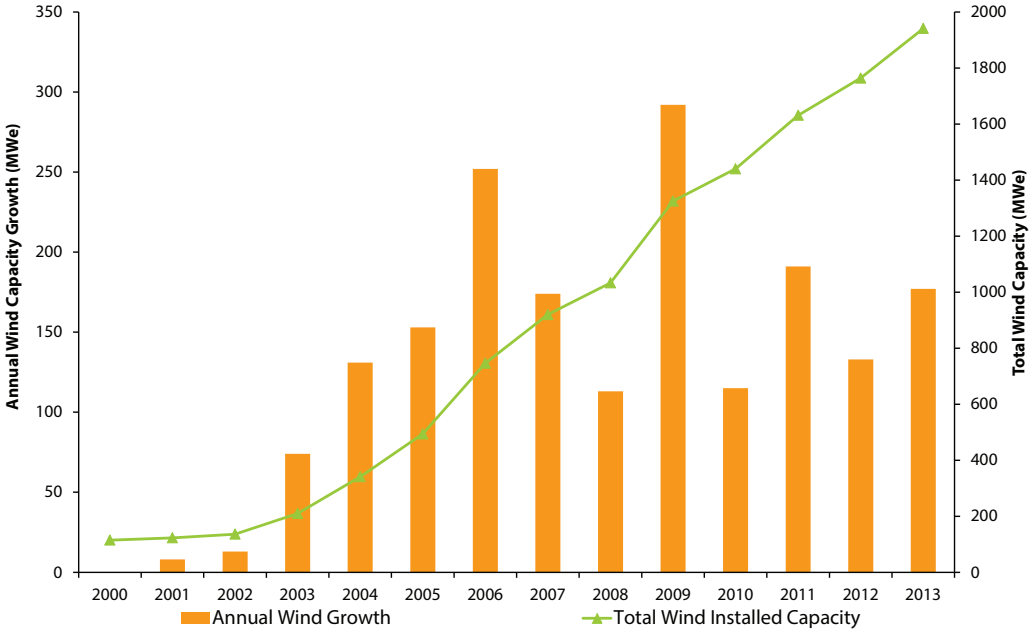
	1990	1995	2000	2005	2010	2011	2012	2013
Wind (GWh)	0	16	244	1,112	2,815	4,380	4,010	4,542

Source: EirGrid

Figure 12 traces the evolution of installed wind capacity from 2000 to 2013 (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.

35 See http://www.eirgrid.com/customers/gridconnections/completedgenerationapplications/
36 Output from both grid-connected wind farms and large auto-producer turbines.
37 System records are updated on the EirGrid website, as well as 15 minute average data on wind power, www.eirgrid.com/operations/

Figure 12 *Installed Wind Generating Capacity 2000 – 2013*



Source: EirGrid

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 for EU approval until September 2007) and uncertainty about access to finance for wind farm development. The rate of development has varied since then with 177 MW added in 2013, bringing the total installed capacity of transmission and distribution system connected wind farms to 1,941 MW by the end of 2013. This compares to an average level of 200 MW/annum estimated to be required in 2020 to deliver 40% RES-E.

According to the latest all-island renewable connection 36 month forecast published by EirGrid at the end of 2013 a further 1,748 MW of wind capacity is contracted to be added to the grid in the period 2014 - 2016, though EirGrid expects only 50% – 75% of this to actually be realised[38].

The contribution of wind energy from small turbines for auto production in industry was 11.8 GWh or just 0.26% of all wind energy generated in 2013. Good data is not available on the contribution from grid-connected domestic installations, but it was estimated that such installations generated less than a tenth of the industry auto production of wind energy in 2012. A domestic micro-generation rate is available from Electric Ireland until the end of 2015, though this scheme is closed to new entrants from 31st December 2014, 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 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 – 2013*

	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013
Capacity Factor	30%	30%	30%	28%	29%	29%	24%	33%	27%	28%

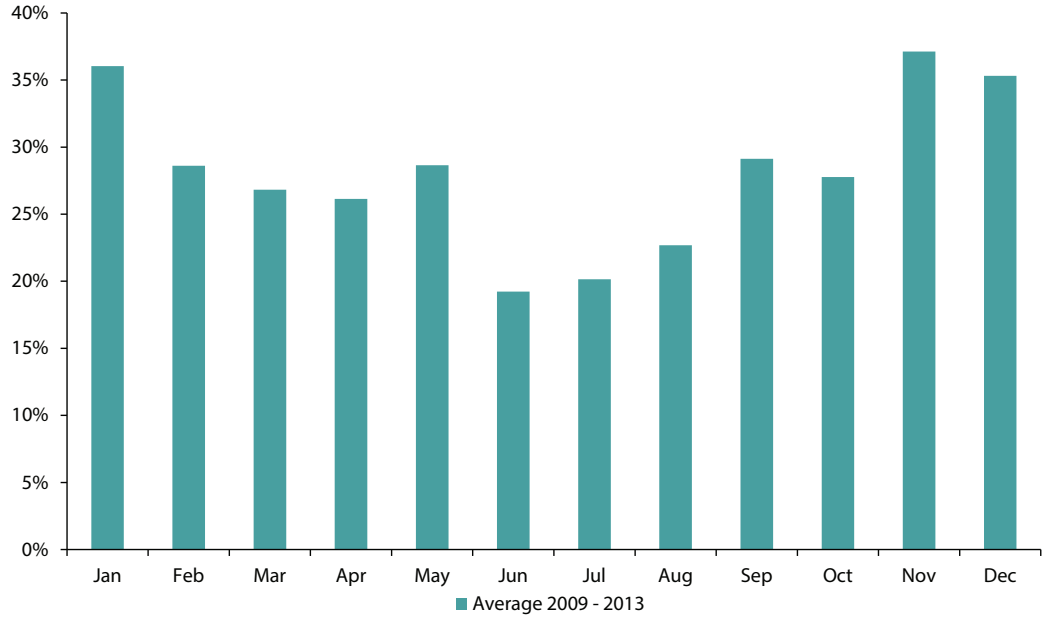
Source: EirGrid and SEAI

A more accurate calculation of the capacity factor for Ireland using monthly installed capacities and wind generated

38 EirGrid, *All Island Renewable Connection Report 36 Month Forecast (Q4 2013)*, July 2013, http://www.eirgrid.com/media/All-Island_Renewable_Connection_Report_-_36-Month_Forecast_(Q1_2013).pdf.

electricity was also calculated for 2009 to 2013 and is shown in Figure 13. 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 13 *Wind Generation Capacity—Average Monthly Capacity Factors 2009 – 2013*

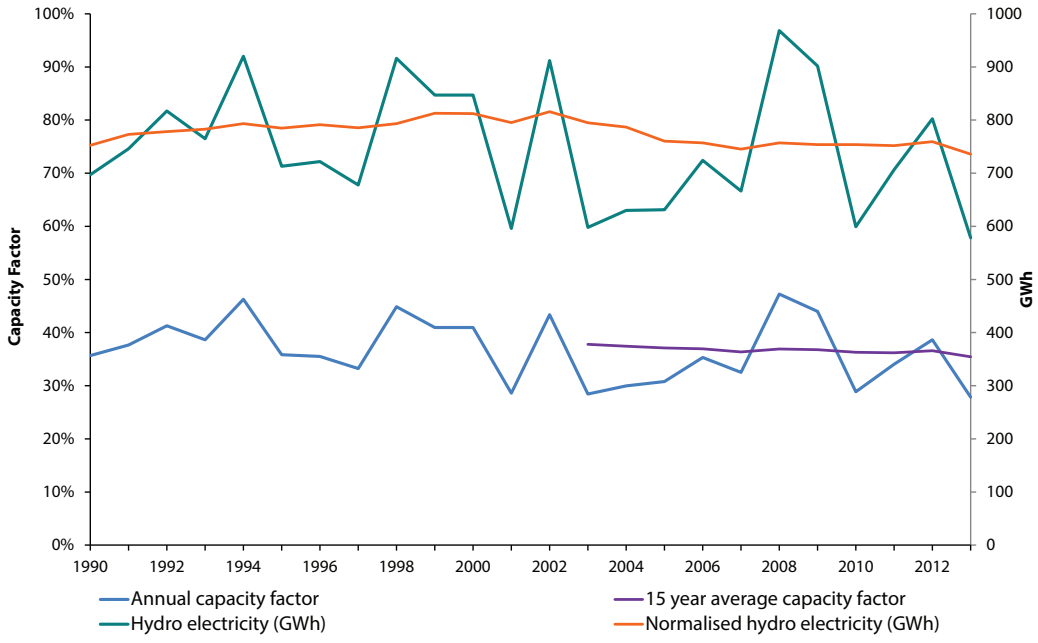


Source: EirGrid & SEAI

5.2.3 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 the RED, the effects of climatic variation are smoothed through use of a normalisation rule, as described in section 3.2.3.1. 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 14 shows the individual and normalised data over the 24 years 1990 – 2013.

Figure 14 *Normalised Hydro Energy Contribution 1990 – 2013*

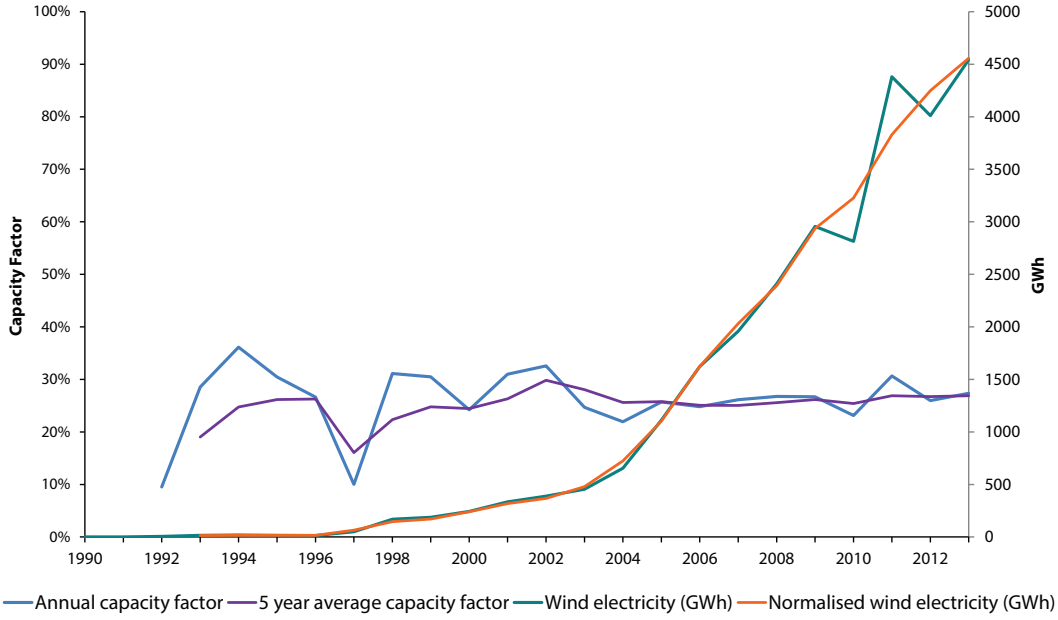


Source: SEAI and EirGrid

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 five year capacity factor is shown in Figure 15.

Figure 15 *Normalised Wind Energy Contribution 1990 – 2013*



Source: SEAI and EirGrid

5.2.4 Combustible Renewables

5.2.4.1 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[39] etc.) and 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 primarily used in co-firing with peat in existing power plants, with a small amount also used in Combined Heat and Power (CHP) plants. In the Government's 2007 Energy White Paper there is a target to have 30% biomass co-firing with peat in the three state-owned peat-generation stations by 2015. There is also REFIT support for electricity generation from bioenergy, as detailed in Appendix 2.

In 2013 215 GWh of electricity was produced from the co-firing of biomass in conventional plant while a further 14 GWh of electricity was produced from biomass CHP.

5.2.4.2 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. In 2013 129 GWh of electricity was produced from waste incineration.

5.2.4.2.1 Renewable Municipal Solid Waste

The biodegradable part of municipal solid waste (MSW) produced by households, industry, hospitals and the tertiary sector is considered to be 'renewable biomass'.[40] 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. In 2013 69 GWh of electricity was produced from the combustion of renewable wastes.

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

5.2.4.2.2 Non-Renewable Municipal Solid Waste

This covers the non-biodegradable part of MSW 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. In 2013 60 GWh of electricity was produced from the combustion of non-renewable wastes.

5.2.4.3 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 2013 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.

5.2.4.3.1 Landfill Gas

Although produced from waste, landfill gas 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 24 landfill gas generators connected to the distribution grid with an MEC of 44 MW, with a further 10 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 2013 158 GWh was produced from landfill gas, representing 0.57% of the gross electricity generated.

5.2.4.3.2 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. In 2013 approximately 24 GWh of electricity was produced from sewage sludge gas CHP units, less than 0.09% of gross electricity generated.

5.2.4.3.3 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 5 MW installed capacity connected to the electricity distribution network with a further 21 MW contracted or in the queue for connection. In 2013 approximately 4.5 GWh was generated from biogas, or 0.02% of total electricity generated in 2012.

5.2.5 Ocean Energy

5.2.5.1 Tidal Energy

The accessible tidal 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[41] per annum. To put this figure in context this equates to 3.3% of the total electricity demand for 2013.

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 developed by a UK company (Marine Current Turbines), is located in Strangford Lough.

5.2.5.2 Wave Energy

It is estimated that an accessible wave energy resource of 21 TWh per annum[42] exists within the total limit of Irish waters. This equates to just over three quarters (75%) of Ireland's total electricity demand in 2013.

The Government has an ambition for Ireland to be a world leader in the development of wave energy[43]. All stages of the development of potential devices are to be facilitated in Ireland through the Marine Renewable Energy Ireland

41 SEAI, *Tidal and Current Energy Resource in Ireland.* http://www.seai.ie/Publications/Renewables_Publications_/Ocean/Tidal_Current_Energy_Resources_in_Ireland_Report.pdf

42 SEAI, 2009, *Accessible Wave Energy Resource Atlas: Ireland: 2005.* http://www.seai.ie/Publications/Renewables_Publications_/Ocean/Wave-Energy-Resource-Atlas-Ireland-2005.63762.shortcut.pdf

43 See Offshore Renewable Energy Development Plan , discussed previously in section 2.6.

(MaREI)[44] project, from the initial stages of drawing board and model testing carried out at the Integrated Maritime Energy Resource Cluster (IMERC) research and enterprise campus at Ringaskiddy in Cork[45], to the quarter scale testing facilities in Galway bay[46], to the full scale, pre-commercial testing facilities being developed at the Atlantic Marine Energy Test Site (AMETS) off of Annagh point in County Mayo[47].

While there are several different wave energy device prototypes in development, a commercial wave energy device does not yet exist.

5.2.6 Solar Electricity (Photovoltaic)

There are few grid-connected photovoltaic (PV) installations in Ireland. The cost of PV has been falling dramatically in recent years, with a recent report by the International Renewable Energy Agency (IRENA) noting that solar PV module prices in 2014 were around 75% lower than at the end of 2009[48,49]. Over the period 2000 – 2011, solar PV was the fastest growing renewable power technology worldwide[50]. For installations using certified products installed by competent personnel it performs reliably to provide viable contributions to renewable electricity generation.

Official recognition that solar PV is a viable renewable energy generation option in Ireland 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 Department of the Environment, Community and Local Government (DECLG).
- SEAI formed a Standards Development Group 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

A single electricity supplier, Electric Ireland, has voluntarily offered a domestic micro-generation rate[51] of €0.09 per kWh for micro-generation exported to the grid, including domestic solar PV, until the end of 2015, though this scheme is closed to new entrants from 31st December 2014. See appendix A2.2.9.

While there are also some existing stand-alone commercial and domestic installations, statistics are not available for these installations. There were 20 new micro-generation grid-connected PV installations connected during 2013, bringing the total number at the end of 2013 to 154, with a total installed capacity of 441 kW. Data is not available on the quantity of electricity generated and it is not included in the national energy balance, though it is estimated to be small, in the order of 300 MWh (~ 0.001% of gross electricity consumption).

5.3 Contribution of Renewable Electricity Sources

Figure 16 and Table 7 show the contribution of all renewables as a percentage of gross electricity consumption, with

44 For more information see http://marei.ie/
45 For more information see http://www.imerc.ie/
46 For more information see http://www.seai.ie/Renewables/Ocean_Energy/Galway_Bay_Test_Site/
47 For more information see http://www.seai.ie/Renewables/Ocean_Energy/Belmullet_Wave_Energy_Test_Site/
48 Available from http://www.irena.org/DocumentDownloads/Publications/IRENA_RE_Power_Costs_Summary.pdf
49 See also Bazillian et. al., 2012, Reconsidering the Economics of Photovoltaic Power. http://www.bnef.com/WhitePapers/download/82
50 International Energy Agency, Photo Voltaic Power System – Annual report 2011. http://www.iea-pvps.org/index.php?id=6
51 Details available from https://www.electricireland.ie/ei/residential/price-plans/micro-generation-scheme.jsp

wind and hydro normalised. Historically, hydro was the largest contributor to renewable electricity in Ireland. While the contribution from hydro has declined in percentage terms since 1990, electricity production from wind energy has increased dramatically to the point where it accounted for 81% of the renewable electricity generated in 2013.

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 2013 accounted for 16.5% (15.2% in 2012) and 2.6% (2.7% in 2012), respectively, of Ireland's gross electrical consumption. Solid biomass was responsible for 1.1% (0.9% in 2012), while landfill gas was responsible for 0.6% (0.6% in 2012). The remaining 0.1% in 2013 was from biogas.

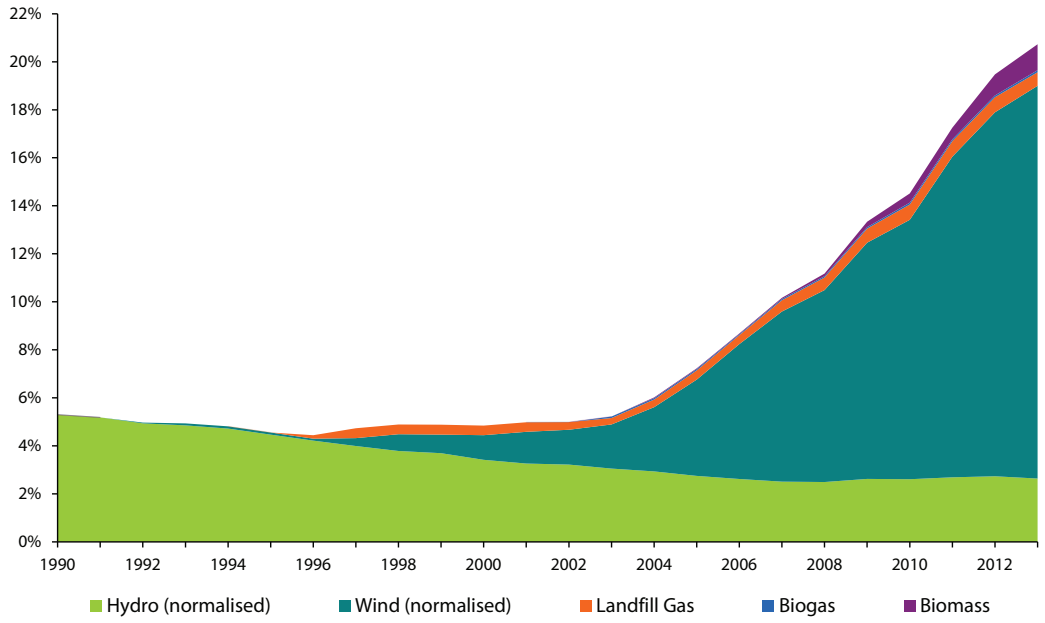
The share of electricity generated from renewable energy sources (RES-E) in 2010 was 14.5% (normalised), which meant that Ireland surpassed the EU interim target of 13.2% RES-E by 2010. While it appeared that Ireland would also meet the national target of 15% RES-E in 2010, it was missed due to reduced levels of wind speed and rainfall, and other constraining factors in that year. 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.

Table 7 *Renewable Electricity (Normalised) as Percentage of Gross Electricity Consumption 1990 – 2013*[52]

% of Gross Electricity	1990	2000	2005	2010	2011	2012	2013
Renewables % of Gross Electricity	5.3	4.8	7.2	14.5	17.3	19.5	20.9
Hydro (normalised)	5.3	3.4	2.7	2.6	2.7	2.7	2.6
Wind (normalised)	-	1.0	4.0	10.8	13.4	15.2	16.5
Biomass	-	-	-	0.4	0.5	0.9	1.1
Landfill gas	-	0.4	0.4	0.6	0.6	0.6	0.6
Biogas	-	-	0.1	0.1	0.1	0.1	0.1

Source: SEAI

Figure 16 *Renewable Energy (Normalised) Contribution (%) to Gross Electricity Consumption by Source 1990 – 2013*



Source: SEAI and EirGrid

The overall share of electricity from renewables increased almost fourfold in the period 1990 to 2013, from 5.3% to 20.9%. As a result of this growth, in 2013, for the first time, renewables were the second largest source of electricity generated in Ireland after gas, contributing more than coal.

Figure 17 and Table 8 show 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. The eightfold increase in electricity generation from renewable energy between 1990 and 2013 is clearly visible in Figure 17, driven predominantly by the growth in wind energy. The total electricity generated from renewable energy reached 5,601 GWh in 2013, an increase of 7.0% from 2012.

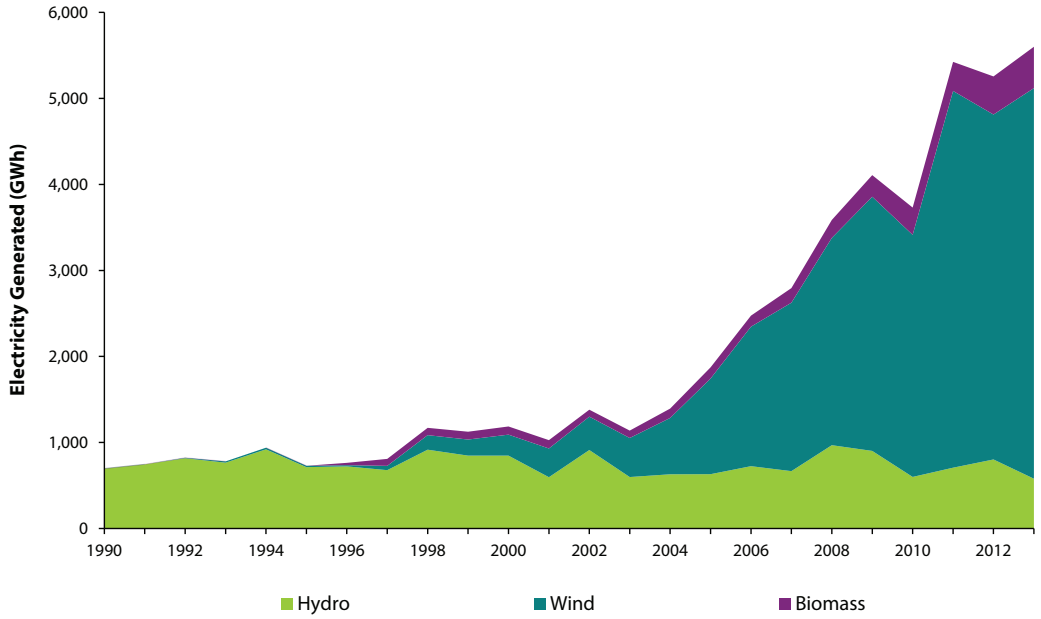
52 Normalised wind figures based on revised historic installed capacities in EirGrid's *All Island Renewable Connection Report 36 Month Forecast (Q4 2013)*. See www.eirgrid.com.

Table 8 *Renewable Electricity Produced in GWh 1990 – 2013*

GWh	1990	2000	2005	2010	2011	2012	2013
Total Renewable Electricity	**697**	**1,186**	**1,873**	**3,731**	**5,425**	**5,256**	**5,601**
Hydro	697	847	631	599	707	802	578
Wind	-	244	1,112	2,815	4,380	4,010	4,542
Biomass	-	-	8	111	137	248	299
Landfill gas	-	95	106	184	181	175	158
Biogas	-	-	16	22	21	21	24

Source: SEAI

Figure 17 *Renewable Energy Contribution (GWh) to Gross Electricity Consumption by Source 1990 – 2013*



Source: SEAI and EirGrid

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. In 2013 97.5% of total fuel usage in the transport sector was supplied by oil-based products, 100% of which were imported. Transport exhibits by far the highest fossil fuel dependency and lowest degree of electrification of any sector of the economy.

The Renewable Energy Directive 2009/28/EC (RED) established a mandatory minimum target of 10% for the share of all petrol, diesel, biofuels and electricity consumed in road and rail transport that is to come from renewable energy by 2020. For this target a weighting factor of 2.0 is applied to advanced biofuels and biofuels from waste. In this way biofuels that are generated from feedstocks that diversify the range of commercially viable biofuels receive an extra weighting compared to first generation biofuels. A weighting of 2.5 is also applied to the electricity from renewable energy sources consumed by electric road vehicles (the share of electricity that comes from renewable sources in a particular year is taken to be the share that was measured two years before the year in question).

The traditional users of electricity for transport in Ireland have been urban rail services, first the DART and subsequently the Luas. The numbers of electric vehicles (EVs) registered remained small in 2013, with just 251 passenger EVs registered out of a total fleet of 1.9 million vehicles, although data for the first half of 2014 shows that there has been a significant increase in the numbers of EVs registered in 2014, with 215 vehicles registered up to the end of August 2014, compared to just 54 in the whole of 2013.

SEAI do not currently have data or a methodology in place to estimate the electricity use of the fleet of electric vehicles in Ireland. In terms of the quantities of renewable energy required to contribute towards meeting the RES-T target, the amount contributed by electric vehicles is currently assumed to be negligible. Considering the overall amount of electricity from renewable sources used by DART and Luas services, the contribution to the renewable energy directive remains very small, accounting for just 0.6% of the weighted share of renewables in 2013, with biofuels accounting for 99.4%.

6.1 Biofuels

Under the Biofuels Obligation Act 2010 suppliers of fuel for road transport were required to include an average of 4% biofuels by volume in their sales between 1st July 2010 and the end of 2012. From the start of 2013 the requirement is 6% by volume[53]. Figure 18 illustrates the dramatic recent growth in renewable biofuel energy used for transport, albeit from a low base. It shows the amount of biofuel 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 RED. Table 9 shows the data behind Figure 18 in absolute terms.

Table 9 *Biofuels Growth in ktoe and as a Proportion of Road and Rail Transport Energy 2005 – 2013*

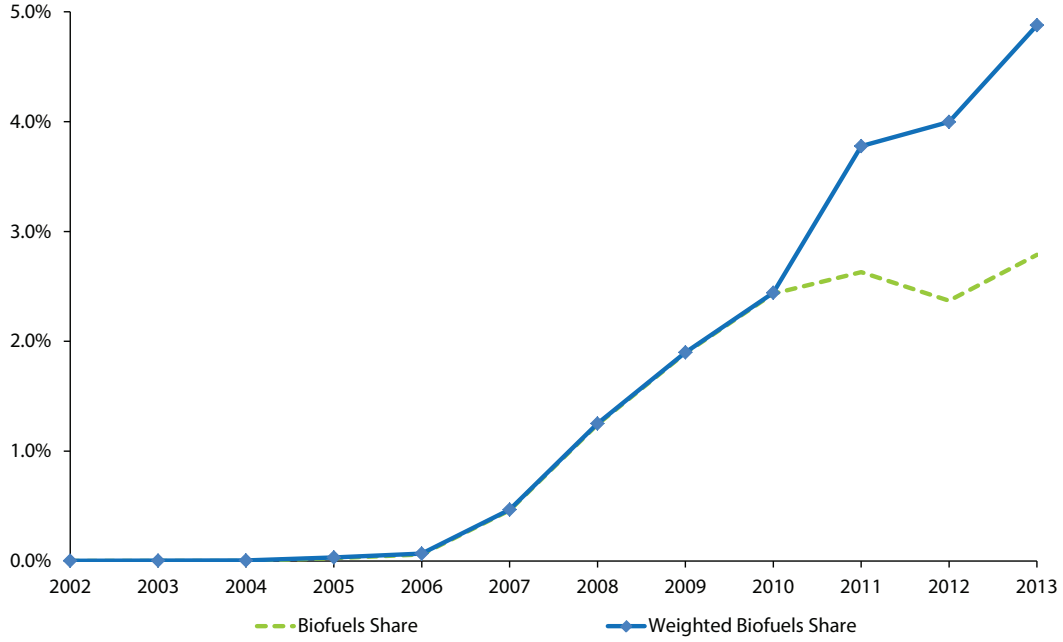
ktoe	2005	2006	2007	2008	2009	2010	2011	2012	2013
RES-T Denominator	4,206	4,447	4,670	4,479	4,079	3,772	3,657	3,524	3,612
Biofuels (ktoe)	1	3	22	56	77	93	98	85	102
Biofuel Penetration	***0.0%***	***0.1%***	***0.5%***	***1.2%***	***1.9%***	***2.5%***	***2.7%***	***1.9%***	***2.8%***
Weighted biofuels share	***0.0%***	***0.1%***	***0.5%***	***1.2%***	***1.9%***	***2.5%***	***3.8%***	***4.0%***	***4.9%***

Source: SEAI

The top section of Table 9 shows, in energy terms, the denominator used in the calculation of the RES-T target, as described in 3.2.5, that is the sum of petrol, diesel, biofuels and electricity used for road and rail transport, without weighting factors. Shown also is the unweighted amount of biofuels used in transport. 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 percentage contribution of biofuels to the RES-T target taking into account the weighting allowed for the double certification. Both the biofuel share (penetration) and the weighted biofuel share are shown in Figure 18.

53 Irish Government, 2012, *Statutory Instrument 562 of 2012 National Oil Reserves Agency Act 2007 (Biofuel Obligation Rate) Order 2012.* http://www.irishstatutebook.ie/home.html

Figure 18 *Biofuel Energy as a Proportion of Road and Rail Transport Energy (RES-T) 2005 – 2013*



Source: SEAI

It is evident from Figure 18 that the growth coincided with the introduction of tax relief support for biofuels, with slow growth prior to 2006 and a share of just 0.06% in that year, 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.

Shown also are the EU and government targets for RES-T set for 2008, 2010 and 2020. Note that these RES-T targets cover all forms of renewable energy in transport, including renewable electricity, but as discussed previously the amount of renewable electricity used to date is almost negligible. The EU Directive 2003/30/EC target for renewables in transport energy (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. The figure for RES-T in 2013 was 4.9%.

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 biofuels placed on the market must satisfy the carbon and sustainability criteria[54] of the RED 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 as long as it could be demonstrated that biofuel was being placed on the market, it could be counted towards the annual obligation.

Table 10 gives the proportion of each type of transport biofuel that is awarded multiple credits. In 2010 less than 20% of biodiesel attracted double certification compared to almost 100% in 2013.

Table 10 *Proportion of Individual Biofuel with Multiple Credits*

	2010	2011	2012	2013	2020 projected
Bioethanol	0%	0%	0%	0%	100%
Biodiesel	18%	58%	99%	99.6%	100%
Pure plant oil	0%	0%	0%	0%	

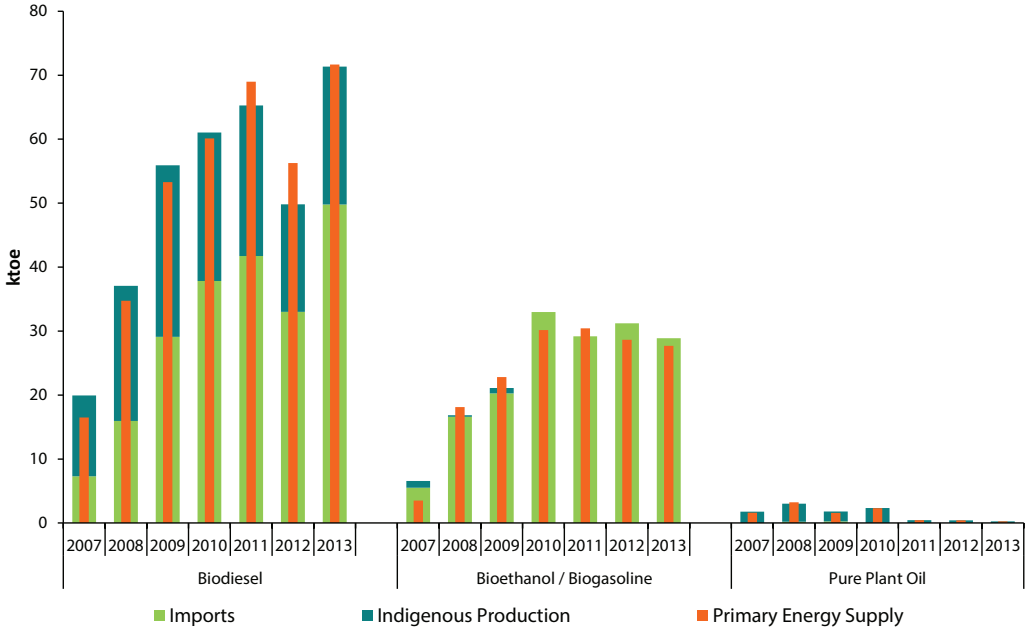
Source: NORA & SEAI

Figure 19 shows the contribution of different biofuels to Ireland's transport energy supply from 2007 to 2013. The graph distinguishes between the amount of biofuels produced and imported (the thicker green bars) and the amount used (the thinner orange bars). The difference between the amounts produced and imported versus the final consumption is accounted for by stock changes. The dominant biofuel is biodiesel, representing 72% of consumption in 2013. The remaining 28% was from bioethanol.

It is also apparent from Figure 19 that during 2013 there were more biofuels imported than produced indigenously. Indigenous production retained in Ireland accounted for just 16% of biofuels supply (on an energy basis) in 2013. The proportion of indigenous production compared to imports varies according to the biofuel.

54 The sustainability criteria are outlined in section 3.2.5.

Figure 19 *Biofuels Production, Imports and Usage 2007 – 2013*



Source: SEAI

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 78% of all biodiesel consumed in 2013 was imported. The sources of biofuels are likely to come under increased scrutiny with the focus on the sustainability criteria for biofuels in the RED 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[55].

There was a noticeable drop in the imports, production and usage of biofuels, particularly biodiesel, between 2011 and 2012. This was caused by two primary factors:

- 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.

The increase in the biofuel obligation from 4% to 6% in 2013 reversed this one year decline, leading to a 20% increase in the unweighted biofuel consumption in 2013 to 102 ktoe.

6.2 Electric Vehicles

Renewable electricity can contribute to fuel transport systems that run on electricity. Electric vehicles (EVs) can lead to substantial reductions in imported fossil fuels for transport when they are supplied with renewable electricity.

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 EVs meeting minimum specified performance criteria in order to generate the critical mass necessary to assist in the development of an EV market in Ireland. In parallel a nationwide programme to roll out EV charging points was begun to provide the necessary charging infrastructure to encourage market growth of EVs. At the beginning of 2015, over 1,200 public charge points had been installed, including fast chargers along inter–urban routes, with 95% of all major towns and cities having EV recharging infrastructure in place[56]

Ireland set an initial target of converting 10% of its passenger and light commercial vehicle stock to EVs by 2020 (roughly equivalent to 230,000 vehicles). According to the Vehicle Registration Unit of the Department of Transport, Tourism and Sport, at the end of 2013 there were a total of 420 EVs licensed in Ireland, including 251 passenger

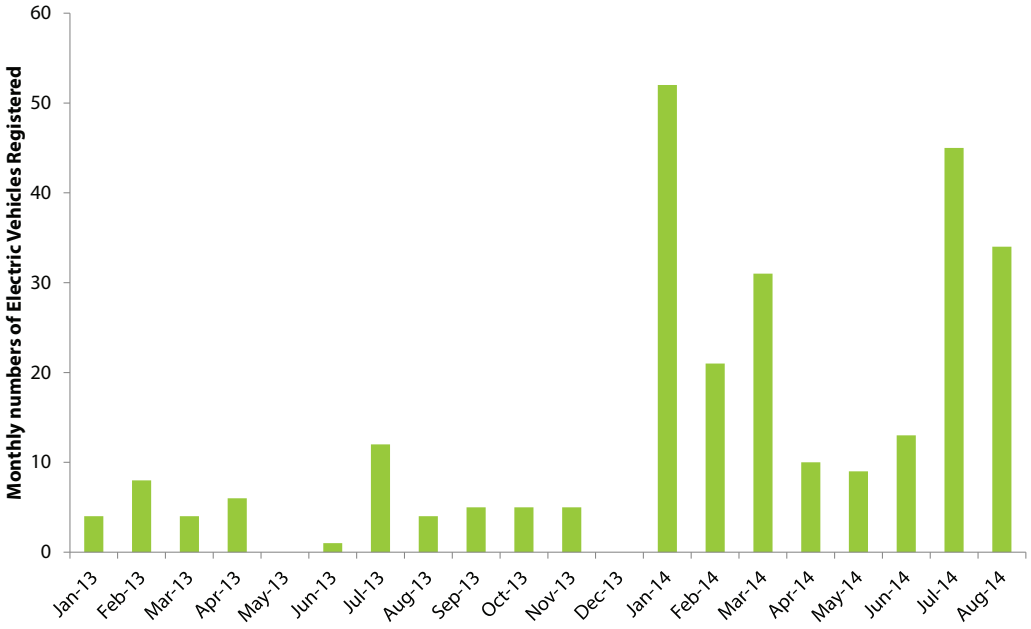
55 Singh A., Smyth B.M., Murphy J.D., 2009. *A biofuel strategy for Ireland with an emphasis on production of bio-methane and minimization of land take.* Renewable and Sustainable Energy Reviews, doi:10.1016/j.rser.2009.07.004

56 For more information see http://www.esb.ie/electric-cars/electric-car-charging.jsp

vehicles, 63 goods vehicles, 53 motorcycles and 53 other EVs (taxis, forklifts, etc.). This number represents less than 0.2% of the initial target for 2020. It is now estimated that approximately 50,000 electric vehicles will form part of the transport fleet in 2020. This figure is based on an adoption rate of 0.5% of new EVs in 2014 rising steadily to an estimated adoption rate of 15% of new EVs in 2020.

Data for 2014 show that there has been a significant increase in the uptake of EVs in the year to date. Figure 20 shows data on the number of EVs registered by month from January 2013 to August 2014. There were 215 vehicles registered up to the end of August 2014, compared to just 54 in the whole of 2013. The upswing in demand for EVs is due in part to the general increase in motor sales and also likely due to the entrance of new manufacturers and car models to the EV market.

Figure 20 *Monthly Registrations of Electric Vehicles January 2013 – August 2014*



Source: SEAI

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 this is a potential option for Ireland to meet the RES-T target using indigenous energy sources.[57]

57 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.

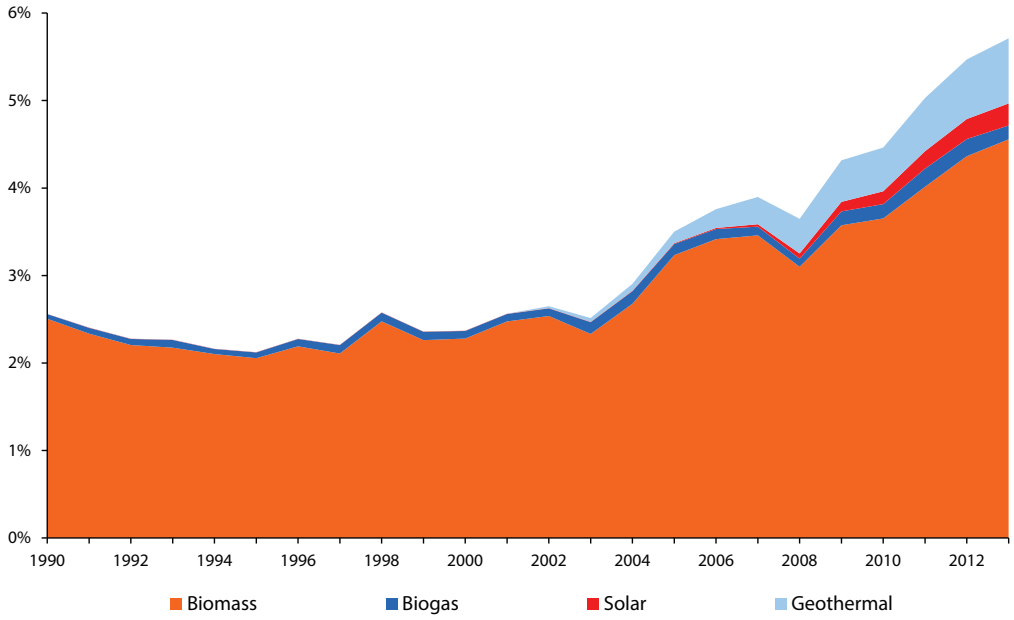
7 Renewable Thermal Energy (RES-H)

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 34% of the total primary energy consumption in 2013. In 2013 the residential sector accounted for the largest share of final thermal energy use (47%), followed by industry (32%), services (17%) and agriculture & fisheries (4%). Oil had the largest fuel share in the thermal energy market in 2013, accounting for 44% of the primary energy used for thermal purposes, followed by gas at 37%.

Figure 21 shows the contribution of renewable thermal energy between 1990 and 2013. Renewable thermal energy 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 use of biomass in the industry sub-sectors discussed above led to industrial biomass use increasing from 63 ktoe in 1990 to 164 ktoe in 2006, but this dropped back to 153 ktoe in 2013. Renewable heat in industry has remained relatively static since 2005 while use in the residential and services sectors has increased by 182% and 852% respectively in the period 2005 to 2013, albeit from quite low bases.

Figure 21 *Renewable Thermal Energy as a Share of Total Thermal Energy (RES-H) 1990 – 2013*



Source: SEAI

Table 11 *Renewable and Waste Thermal Energy (RES-H) by Sector 1990 – 2013*

Renewable & Waste Heat (ktoe)	1990	1995	2000	2005	2010	2011	2012	2013
Overall	**108**	**92**	**118**	**190**	**228**	**229**	**244**	**254**
Industry total	63	62	100	163	152	150	153	153
Food and beverage	*2*	*3*	*4*	*54*	*40*	*41*	*36*	*28*
Wood & wood products	*61*	*59*	*96*	*109*	*100*	*93*	*95*	*100*
Non-metallic minerals	*0*	*0*	*0*	*0*	*12*	*16*	*21*	*25*
Residential	45	30	17	23	54	53	61	64
Commercial/Public Services	0	0	0	4	21	26	31	38

Source: SEAI

Table 12 summaries the trends in renewable thermal consumption and market shares for all sectors. Overall use of renewable heat grew by 136% between 1990 and 2013 as shown in Table 12. Growth in 2013 relative to the previous year was 4.1% with commercial & public sector use growing by 23% (not weather corrected).

Renewable heat use in the residential sector declined by 63% between 1990 and 2001 due to decreased use of solid biomass (wood) in open fires but increased by 287% between 2001 and 2013 (11.9% per annum) due to increased use of geothermal heating, biomass and solar thermal water heating. 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 were stimulated by the Greener Homes Scheme[58] as well as 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. During the period of operation of the Greener Homes Scheme between 2006 and 2010 renewable thermal energy use in homes increased from 27 ktoe to 54 ktoe. Renewable thermal energy use in the residential sector was 64 ktoe in 2013, 5.7% higher than in the previous year.

Table 12 *Trends in Renewable Thermal Energy (RES-H) by Sector 1990 – 2013*

	Growth %	Average annual growth rates %					Quantity (ktoe)		Shares %	
	1990 – 2013	'90 – '13	'00 – '05	'05 – '10	'10 – '13	2013	1990	2013	1990	2013
Overall	136.5	3.8	10.1	3.7	3.8	4.5	108	255	2.6	5.7
Industry Total	142.0	3.9	10.3	-1.4	0.0	-0.2	63	153	1.5	3.4
Food and beverage	-	-	-	-5.7	-11.7	-23.0	2	28	0.1	0.6
Wood & wood products	64.9	2.2	2.6	-1.8	0.0	5.2	61	100	1.4	2.2
Non-metalic minerals	-	-	-	-	27.7	14.2	-	25	0.0	0.6
Residential	43.3	1.6	5.6	19.0	5.7	5.7	45	64	1.1	1.4
Commercial/Public Services	-	-	-	39.6	21.5	25.3	0	38	0.0	0.9

Source: SEAI

Growth in RES-H has also been observed in the services sector where between 2006 and 2013 it grew by 388% to 38 ktoe. It was previously supported by the Renewable Energy Heat Deployment (ReHeat) grant scheme which supported wood chip and pellet boilers, solar thermal and heat pump installations, before it closed in 2011. One proposal contained in the draft Bioenergy Plan[59] is the introduction of a Renewable Heat Incentive scheme (RHI). It would be aimed at large non-ETS industrial and commercial renewable heating installations and would reward participants for each unit of renewable heat produced from sustainable biomass.

7.1 Combustible Renewables

7.1.1 Solid Biomass and Renewable Wastes

Solid biomass covers organic, non-fossil material of biological origin that may be used as fuel for heat production. It is primarily wood, wood wastes (firewood, wood chips, barks, sawdust, shavings, chips, black liquor[60] 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 2013, the final energy consumption of solid biomass and renewable wastes for thermal energy was 202 ktoe. Industry consumed 150 ktoe (74%) with the wood and wood products sub-sector accounting for 100 ktoe of this, followed by the food and drinks sector and cement production, both at 25 ktoe. The residential sector accounted for 28 ktoe or 14% of the final consumption of solid biomass and renewables wastes for thermal energy while the commercial and services sector accounted for 25 ktoe (10%).

7.1.2 Non-Renewable Wastes

Non-renewable wastes such as low carbon fuels 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.

58 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.

59 See section 2.7

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

Final energy consumption of non-renewable wastes for thermal energy amounted to 35 ktoe in 2013, all of which was used in the cement sector of 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 2013 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. Biogas used for thermal energy in 2013 amounted to 7 ktoe.

7.2 Geothermal Energy and Heat Pumps

The geothermal energy statistics in Ireland have been revised from 2005 to 2013 based on industry data. A coefficient of performance of 3.5 is assumed for accounting purposes for all installations. This means that for every 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 renewable 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[61].

In 2013 the estimated contribution from geothermal and heat pumps to the final consumption of renewable energy was 33 ktoe, 25 ktoe of which was in the residential sector.

7.3 Solar Thermal

The contribution of solar energy to heating in Ireland is estimated from applications to the SEAI-administered Better Energy Homes scheme and the Better Energy Workplace scheme. Prior to 2011 estimates were based on data from the Greener Homes Scheme and the Renewable Energy Heat Deployment (ReHeat). 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 . Any solar installations contributing to meeting this requirement are also included.

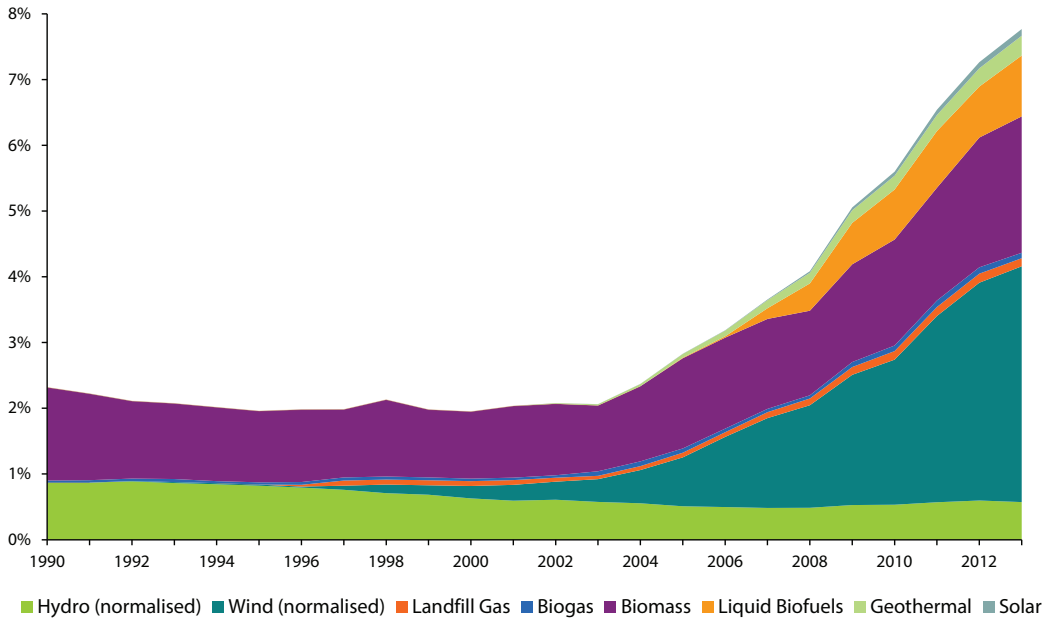
In 2013 the estimated contribution from solar thermal installations to the final consumption of renewable energy was 11 ktoe. All of this was in the residential sector, where it accounted for 0.4% of the total residential sector energy requirement.

61 More information available from GT Energy, http://www.gtenergy.net

8 Overall Renewable Energy

The contribution of renewable energy from various sources to gross final consumption, according to the definition in the RED, is shown in Figure 22. 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 7.8% in 2013.

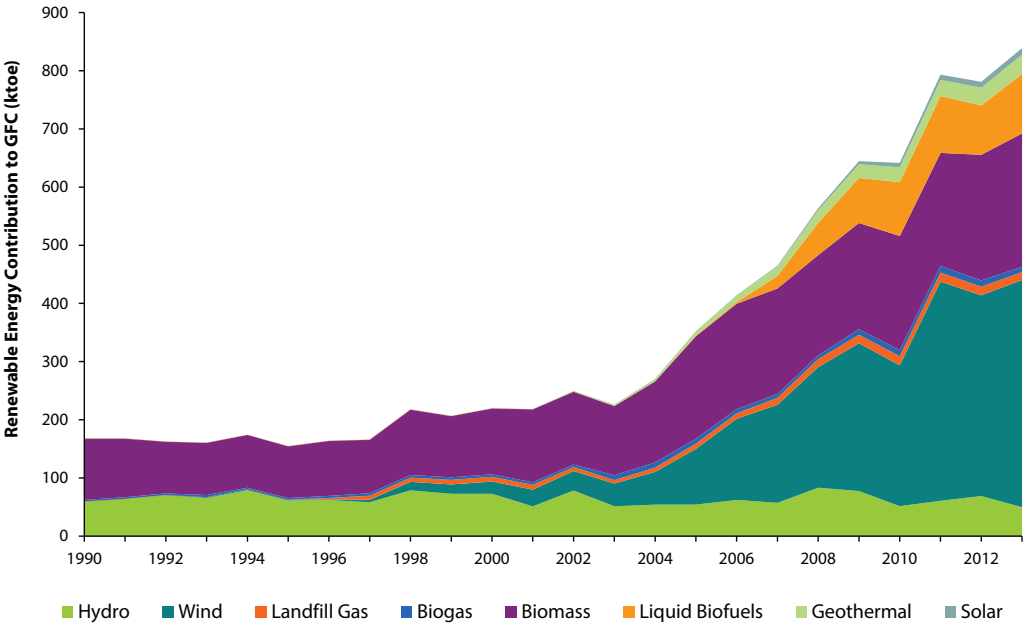
Figure 22 *Renewable Energy (Normalised) Contribution (%) to GFC (Directive 2009/28/EC) 1990 – 2013*



Source: SEAI

Figure 23 shows the renewable energy contributions in absolute energy terms, to illustrate the growth in each source independently of GFC growth.

Figure 23 *Renewable Energy Contribution (ktoe) to GFC 1990 – 2013*

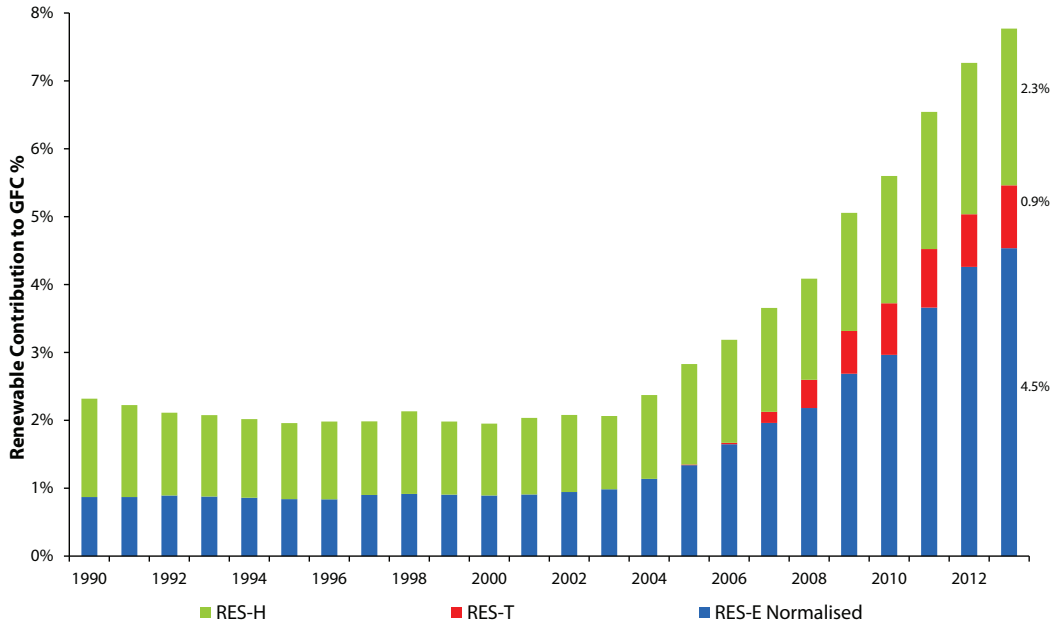


Source: SEAI

The more than tripling of renewable energy between 2003 and 2013 from 226 ktoe to 839 ktoe[62] is striking (14.0% annual average growth). The majority of the growth was due to wind energy (increase of 352 ktoe), with significant growth also in biomass (110 ktoe) and liquid biofuels (102 ktoe). Biomass, liquid biofuels, biogas and landfill gas can be grouped together under the term bioenergy. On this basis the vast majority of renewable energy GFC in 2013 came from wind (47%) and bioenergy (42%), with the remainder coming from hydro, solar and geothermal (11%)[63].

Figure 24 shows the same information as presented in Figure 22 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 24 *Renewable Energy Contribution (%) to GFC by Mode 1990 – 2013*



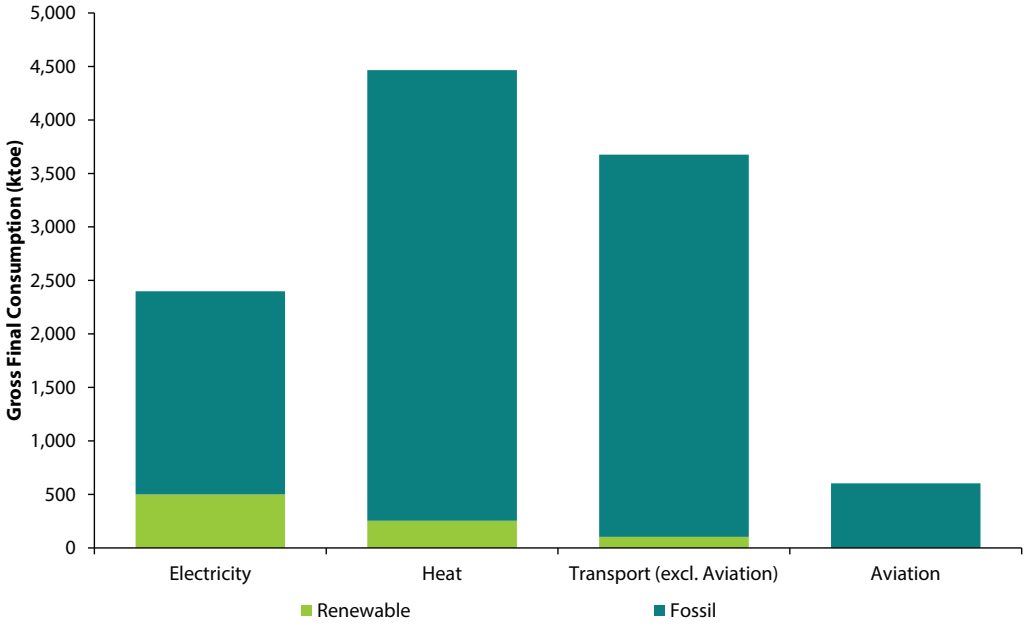
Source: SEAI

It is useful to consider further the renewable GFC for each mode both in relation to the total GFC for that mode and in relation to the renewable GFC from the other modes. This is illustrated in Figure 25. Aviation is separated from transport for RED calculations as discussed in section 3.2.2 and 3.2.5. Electricity accounts for the smallest share of total GFC in 2013 at just 22%, but has the highest penetration of renewables at 21% (with a 2020 target of 40%). This resulted in renewable electricity accounting for 58% of all renewable energy in 2013. In contrast transport, excluding aviation, accounted for 33% of total GFC in 2013, but had the lowest penetration of renewable energy in 2013 at just 2.8% in energy terms (4.9% including weightings, with a 2020 target of 10% including weightings), which resulted in renewable transport accounting for 12% of renewable GFC in 2013. Heating accounted for the largest share of total GFC in 2013 at 40%, with a renewable share of 5.7% (2020 target of 12%) resulting in it accounting for 30% of renewable GFC in 2013.

62 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.

63 In terms of primary energy, wind accounted for 43% of renewable energy, bioenergy 47% and the remainder 10%. See section 4.2

Figure 25 *Renewable and Fossil GFC by Mode in 2013*



Source: SEAI

Examining renewable energy data in terms of the quantities of energy produced provides a different perspective than focusing on the percentage share of renewable energy in each of the three energy modes. 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 shown in Figure 22 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 shows that in 2013 renewable energy contributed 501 ktoe in the form of electricity, 102 ktoe in the form of biofuels in transport and 255 ktoe to thermal energy. The contribution from renewable electricity remains almost double that of renewable thermal and almost five times that of renewable transport energy. This contrasts significantly with the situation in 2000, when the renewable thermal energy was higher than renewable electricity.

Table 13 *Renewable Energy (ktoe) Contribution to GFC by Mode 1990 – 2013*[64]

ktoe	1990	2000	2005	2010	2011	2012	2013
Renewable Electricity (normalised)	65	99	172	361	415	466	501
Biofuels in Transport	0	0	1	93	98	85	102
Renewable Heat	108	118	190	228	229	244	255
Total	**173**	**216**	**363**	**681**	**742**	**795**	**858**

Source: SEAI

64 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 the calculation of RES-E.

9 Progress Towards Targets

The RED sets out two mandatory targets for renewable energy in Ireland to be met by 2020, as follows:

- at least 16% of Ireland's gross final energy consumption to come from renewable sources;
- at least 10% of energy consumed in road and rail transport to come from renewable sources.

In addition to these EU mandatory targets, Ireland has national targets for 2020 that were 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:

- RES-E—40% of gross electricity consumption to come from renewable sources, with an interim target of 15% by 2010;
- RES-H—12% of thermal energy to come from renewable sources, with an interim target of 5% by 2010;
- RES-T—10% of energy consumed in road and rail transport to come from renewable sources by 2020 (as per the mandatory Directive target), with interim national targets for biofuels penetration of 2% by 2008 and 3% by 2010. The weighting factors specified in the RED[65] for electricity and advanced biofuels are used in the calculation of the RES-T target only and not for the transport contribution to the overall renewable target, as per the RED.

Table 14 tabulates progress towards the individual modal targets and to the overall RED target for the period 1990 to 2013. 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. Looking at the contribution of renewables in 2013 it can be seen that in all four cases, Ireland is approximately half way towards meeting the 2020 targets with seven years remaining.

Table 14 *Renewable Energy Progress to Targets[66] 1990 – 2013*

								Targets	
% of each target	**1990**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**	**2010**	**2020**
RES-E (normalised)	5.3	4.8	7.2	14.5	17.3	19.5	20.9	15	40
RES-T (with double certs)	0.0	0.0	0.0	2.5	3.8	4.0	4.9	3	10
RES-H	2.6	2.4	3.5	4.5	5.0	5.5	5.7	5	12
Overall RED	2.3	1.9	2.8	5.6	6.5	7.3	7.8		16

Source: SEAI

In 2013 the overall renewable energy contribution to gross final consumption was 7.8%. The RED target is 16% in 2020.

The share of electricity from renewable energy has increased almost fourfold between 1990 and 2013, from 5.3% to 20.9%. Most of this increase has taken place since 2000. Overall Ireland is broadly in line to meet the 2020 RES-E target. As noted in section 5.2.2, 177 MW of Installed wind capacity was added in 2013 compared with an average of 200 MW/yr required to meet the target, in the period 2014-2016.

The contribution from renewables to thermal energy grew from 2.6% in 1990 to 5.7% in 2013. This growth was dominated by increased biomass use and is mostly due to increased activity in industry, as discussed in section 7.

There was a significant increase in the share of transport energy from biofuels between 2005 and 2013, albeit from a low base as discussed in section 6. The share of biofuels contributing towards the RES-T target, taking into account the weighting allowed for the double certification, was 4.9% in 2013. As the double weighting on advanced biofuels used for the RES-T target does not count towards the overall 16% renewables target, one or more of the modal targets may need to be exceeded in order to achieve the overall target. This will depend on the final split in GFC between the three modes in 2020.

65 Renewable Energy Directive 2009/28/EC Article 3 (4c) and Article 21 (2)
66 Note individual target percentages are not additive

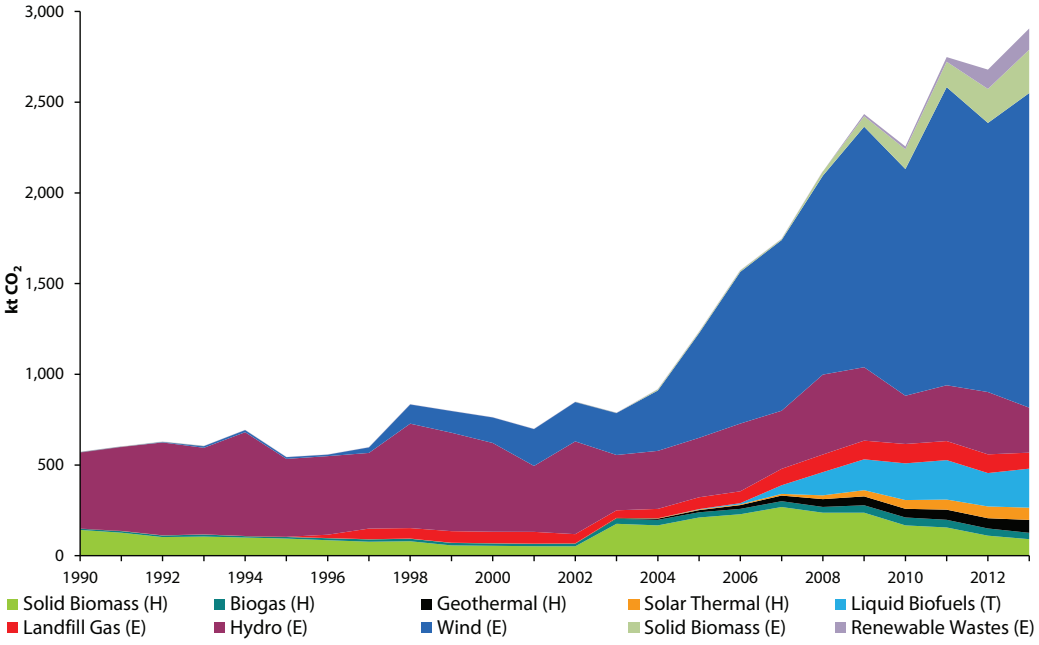
10 Displacement of Fuel Imports and CO_2 Emissions

One of the benefits of determining the primary energy equivalent (PEE) associated with non-combustible renewable energy sources 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 PEE of renewable energy sources is described in section 3.2. The methodology used to calculate the PEE is included in Appendix 1. The assumptions and caveats associated with the results for PEE apply equally to the calculated CO_2 avoided. The results obtained using the PEE methodology have been further refined, using the results of a more detailed dispatch model of the entire all-Island electricity system, developed by SEAI for the year 2012[67], so that the effects of ramping and cycling of fossil fuel plant, though small, are accounted for.

Figure 26 shows the trend in avoided CO_2 emissions from renewable energy across all sectors for the period 1990 – 2013. It is assumed the electricity from renewables (wind, hydro, solid biomass, 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 resulting from the use of biofuels in transport are calculated on the basis of the average litre of biofuels on the Irish market having a carbon intensity of 20 gCO_{2eg}/MJ[68].

Based on this methodology renewable energy is estimated to have displaced 1.3 Mtoe of fossil fuel consumption and avoided GHG emissions of 2,906 $ktCO_2$ in 2013, as illustrated in Figure 26. The emissions avoided from wind energy deployment have increased considerably since 2004. It is estimated that in 2013 wind energy resulted in the avoidance of 1,734 $ktCO_2$ or 60% of the total CO_2 avoided by renewables. This was followed by solid biomass at 330 $ktCO_2$ and hydro at 248 $ktCO_2$.

Figure 26 *Avoided CO_2 from Renewable Energy in all Sectors 1990 – 2013*



Source: SEAI

A large majority of the emissions avoided (2,426 kt CO_2, or 83%) are in electricity generation. This resulted in the avoidance of approximately €300 million in fossil fuel imports for electricity generation in 2013. It is worth noting that carbon emissions savings achieved in electricity generation contribute to the targets of ETS companies, while most of the emissions avoided in thermal and all in transport energy contribute to Ireland's target to achieve a 20% reduction in GHG emissions in non-ETS sectors relative to 2005 levels.

67 See the SEAI report *Quantifying Ireland's Fuel and CO_2 Emissions Savings from Renewable Electricity in 2012* for further details on the methodologies used to calculate the avoided emissions, http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/Quantifying-Ireland%E2%80%99s-Fuel-and-CO2-Emissions-Savings-from-Renewable-Electricity-in-2012.pdf

68 National Oil Reserves Agency (NORA) *The Biofuels Obligation Scheme Annual Report 2013.* See http://www.nora.ie/_fileupload/457-X0120%20-%20Rev_%201%20-%20BOS%20Annual%20Report%20for%202013.pdf

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, liquid biofuels and landfill gas.

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 agri-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 MtCO_2 (mega-tonnes of CO_2 {10^6 tonnes}).

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

Combined Heat and 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).

Degree Days: "Degree Days" is the measure or index used to take account of the severity of the climate when looking at energy use in terms of heating (or cooling) "load" on a building. A degree day is an expression of how cold (or warm) it is outside, relative to a day on which little or no heating (or cooling) would be required. It is thus a measure of cumulative temperature deficit (or surplus) of the outdoor temperature relative to a neutral target temperature (base temperature) at which no heating or cooling would be required.

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 and 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.

Hydropower: 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, carcasses 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 (PV): 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 PV: See Photovoltaic Energy

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 standardised 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 (e.g. 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[69]. 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 hydropower plant.

An alternative approach is to consider the primary energy of the non-combustible renewable source 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) method. 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? This is a critical factor as different fossil fuel types and power plants have significantly different energy efficiencies and carbon intensities. For example displacing generation from an inefficient, CO_2 intensive coal powered plant will lead to significantly greater energy and carbon emissions reductions than displacing generation from a more efficient gas powered plant. Previously[70], the calculation of PEE was based on the assumption that each kWh of electricity generated from non-combustible renewable generation displaced a kWh of electricity from across 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[71,72]. Renewable energy plants are primarily displacing electricity from the last fossil fuel plant dispatched to meet electricity demand. In the Republic of Ireland this comprises primarily of gas-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.

A key limitation of this methodology is that it ignores the interaction between renewable electricity generation and both fossil generation and cross-border trade. A much more detailed and sophisticated analysis of the amount of fossil fuels and carbon emissions that are avoided by renewable energy was carried out by SEAI for a single year (2012) using a detailed dispatch model. This work is presented in the SEAI report *Quantifying Ireland's Fuel and CO_2 Emissions Savings from Renewable Electricity in 2012* which was published in May 2014[73,74]. The advantage of such a model is that it is capable of comprehensively accounting for the extensive range of dynamic factors that influence the interaction of renewable plant and fossil fuel generators and which affect the savings attributed to renewable generation, such as ramping and cycling effects, contingency reserve, network constraints, cross-border electricity trade etc. The disadvantage of dispatch models is that because of the level of detail involved they are very labour intensive to build, update and maintain. For this reason it is not practical to routinely use a dispatch model to estimate the annual avoided fossil fuel usage and carbon emissions from renewable energy. Instead, the results of the single year analysis using the dispatch model have been used to inform and refine the results of the simplified PEE approach, in particular by enabling the emissions resulting from ramping and cycling of fossil fuel plant in response to renewable electricity generation to be estimated and accounted for. There are clear limitations in this analysis but it does provide useful indicative results.

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

70 Sustainable Energy Authority of Ireland, 2004, *Renewable Energy in Ireland—Trends and Issues 1990 – 2002.* Available from http://www.seai.ie/Publications/Statistics_Publications/EPSSU_Publications/

71 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

72 For further information on Ireland see Ó Gallachóir B. P., O'Leary F., Bazilian M., Howley M. and 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

73 See http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/Quantifying-Ireland%E2%80%99s-Fuel-and-CO2-Emissions-Savings-from-Renewable-Electricity-in-2012.pdf

74 See also Di Cosmo V. and Malaguzzi Valeri L., October 2014, *ESRI Working Paper No. 493 – The Effect of Wind on Electricity CO_2 Emissions: The Case of Ireland,* ESRI.

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[75]. 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[76] 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[77] in 2006. The awards were designed to develop and stimulate overall energy research capacity, particularly in certain priority areas. Funding was provided for research groups active in energy research and research training; in particular, full-time researchers, PhD scholarships for engineering graduates and summer student placements. The scheme is now closed to new applicants.

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[78] in the form of deduction from a company's profits for an investment in new ordinary shares in a qualifying company.

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 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 Employment Investment Incentive Scheme (EII)

The Employment Investment Incentive (EII)[79] is a tax relief incentive scheme that provides tax relief to private investors to invest medium-term equity capital in companies which would otherwise find it difficult to raise such funding. The scheme was announced by the Minister for Finance in the Budget 2011 speech to replace the Business Expansion Scheme (BES), and is planned to run until 2020[80]. One of the main changes made from the BES is that under the EII it is easier for companies producing energy from renewable resources to qualify.

Provided an investor holds his or her investment for a minimum period of 3 years, the EII provides individual investors with tax relief of 30% in respect of investments of up to €150,000 per annum. Where it has been proven that additional jobs were created or the company used the capital raised for expenditure on research and development, an additional 11% relief is available at the end of the holding period. 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.

75 Details available from http://www.seai.ie/Renewables/Renewable_Energy_Policy/Policy_Support_Mechanisms/13_RERDD-Overview.pdf
76 Details available from http://www.dcenr.gov.ie/Energy/Office+of+the+Chief+Technical+Advisor/Irish+Energy+Research+Council.htm
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79 Details available from http://www.revenue.ie/en/tax/it/leaflets/it55.html
80 A review of the EII carried out by the Department of Finance was published in October 2014 and outlines potential changes to the scheme to provide additional stimulus to investors. See http://budget.gov.ie/Budgets/2015/Documents/EII_Report_pub.pdf

A2.1.7 Triple E Register and 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 scheme includes ten different equipment categories and a growing list of over fifty technologies, including EVs and micro-generators such as wind turbines (>5kW), solar PV and biomass boilers.

A Review and Cost Benefit Analysis of the scheme was carried out in October 2014. The primary aim of this review was to set out the context and rationale for the scheme, evaluate its overall effectiveness and to make recommendations regarding continuance of the ACA. In his 2015 Budget speech the Minister Finanace announced the continuation of the scheme for a further three years to 31st December 2017.

A2.1.8 Carbon Tax

A carbon tax at a rate of €15 per tonne of CO_2 was introduced on fossil fuels in the 2010 budget[81]. 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 CO_2 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 CO_2 produced in the 2012 budget. The carbon tax liability per unit of energy is detailed in Table 15.

Table 15 *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	01 May 2012
Marked Gas Oil	litres	0.055	01 May 2012
LPG	litres	0.033	01 May 2012
Fuel Oil	litres	0.062	01 May 2012
Natural Gas (NCV)	MWh	4.1	01 May 2012 (€3.7/MWh GCV)
Peat Briquettes	tonne	18.33	01 May 2013 rising to €36.67 May 2014
Milled Peat	tonne	8.99	01 May 2013 rising to €17.99 May 2014
Other Peat	tonne	13.62	01 May 2013 rising to €27.25 May 2014
Coal	tonne	26.33	01 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, introduced 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 were set by the Commission. Furthermore, since 2013 participants in the industrial sector have faced significant reductions in their free allowances and, for all industries, the number of free allowances will continue to 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

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

workshops and training events and also through dealing with queries from the public.

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 and 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 CO_2 emissions 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 31st December 2009 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[82] (CER) decides on the methodology for electricity grid connection offers. Since December 2004 renewable electricity generators wishing to apply to connect to the transmission or distribution systems have been subject to group processing 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[83]

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

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

inclusion in an off-shore supergrid along with other northern EU countries and Norway.

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[84], 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[85] 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[86] 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 2015, though this scheme is closed to new entrants from 31st December 2014.

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 CER 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 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[87] for planning authorities on wind energy in order to facilitate a consistent approach by planning authorities in identifying areas for development of renewable energy, 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[88] purposes in 2007 and other buildings[89] in 2008. The exemptions apply to wind turbines, solar panels, heat pumps and biomass, subject to certain conditions in each case.

84 The CHP deployment programme is a grant support scheme administered by SEAI. See http://www.seai.ie/Grants/CHP for details.
85 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.
86 Details available from https://www.electricireland.ie/ei/residential/price-plans/micro-generation-scheme.jsp
87 http://www.environ.ie/en/Publications/DevelopmentandHousing/Planning/FileDownLoad,1633,en.pdf
88 Statutory Instrument 83 of 2007. Available from http://www.irishstatutebook.ie/home.html
89 Statutory Instrument 235 of 2008. Available from http://www.irishstatutebook.ie/home.html

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.

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[90] 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[91] (ISLES) examining issues around an offshore grid between Ireland, Northern Ireland and Scotland. The results of the ISLES Feasibility Study[92], 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 Statutory Instrument 477 of 2011

This legislation[93] 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 14 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 14 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[94]

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

The EU Energy Performance of Buildings Directive (EPBD), transposed into Irish Law from 2006 onwards, contains a range of provisions to improve the energy performance of new and existing buildings and to promote the use of renewable energy within buildings. From 2013, the EPBD was superseded by the Recast EPBD and Statutory Instrument 666 of 2006 was superseded by Statutory Instrument 243 of 2012.

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

90 http://www.eirgrid.com/media/EirGrid%20Offshore%20Grid%20Study.pdf
91 http://www.islesproject.eu/
92 http://www.scotland.gov.uk/Topics/Business-Industry/Energy/Action/leading/iles/IslesReports
93 http://www.irishstatutebook.ie/home.html
94 Available from http://www.environ.ie/en/DevelopmentandHousing/BuildingStandards/

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 in May 2011.

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 to implement 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[95] 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[96]

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.

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

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

A2.3.10 Wood Biomass Harvesting Machinery Scheme[97]

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.

A2.4 Renewable Transport Policy Measures

A2.4.1 Bioenergy Action Plan

The Bioenergy Action Plan[98] 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[99] 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[100] 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[101] 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 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 a transitional provision which essentially waived the provision until 1st July 2012.

Compliance with the BOS 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 and Hybrid Vehicles

In April 2009 the Minister for Communications, Energy and Natural Resources announced 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. This was later extended to the end of December 2014. 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 homes 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. At the end of January 2014, 819 public charge points had been installed, including 48 DC fast chargers, with 95% of all major towns and cities having EV recharging infrastructure in place.

97 Dept. of Agriculture and Food, 2007, Wood Biomass Harvesting Machinery Scheme. Available from http://www.agriculture.gov.ie/contentarchive/forestry/woodbiomassharvestingmachineryscheme/
98 Available from http://www.nora.ie/_fileupload/File/Energy%20(Biofuel%20Obligation%20and%20Miscellaneous%20Provisions)%20Act%202010.pdf
99 Available from http://www.seai.ie/Renewables/Bioenergy_Roadmap.pdf
100 Available from http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels+Scheme+II/
101 Available from http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels+Obligation+Scheme.htm

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