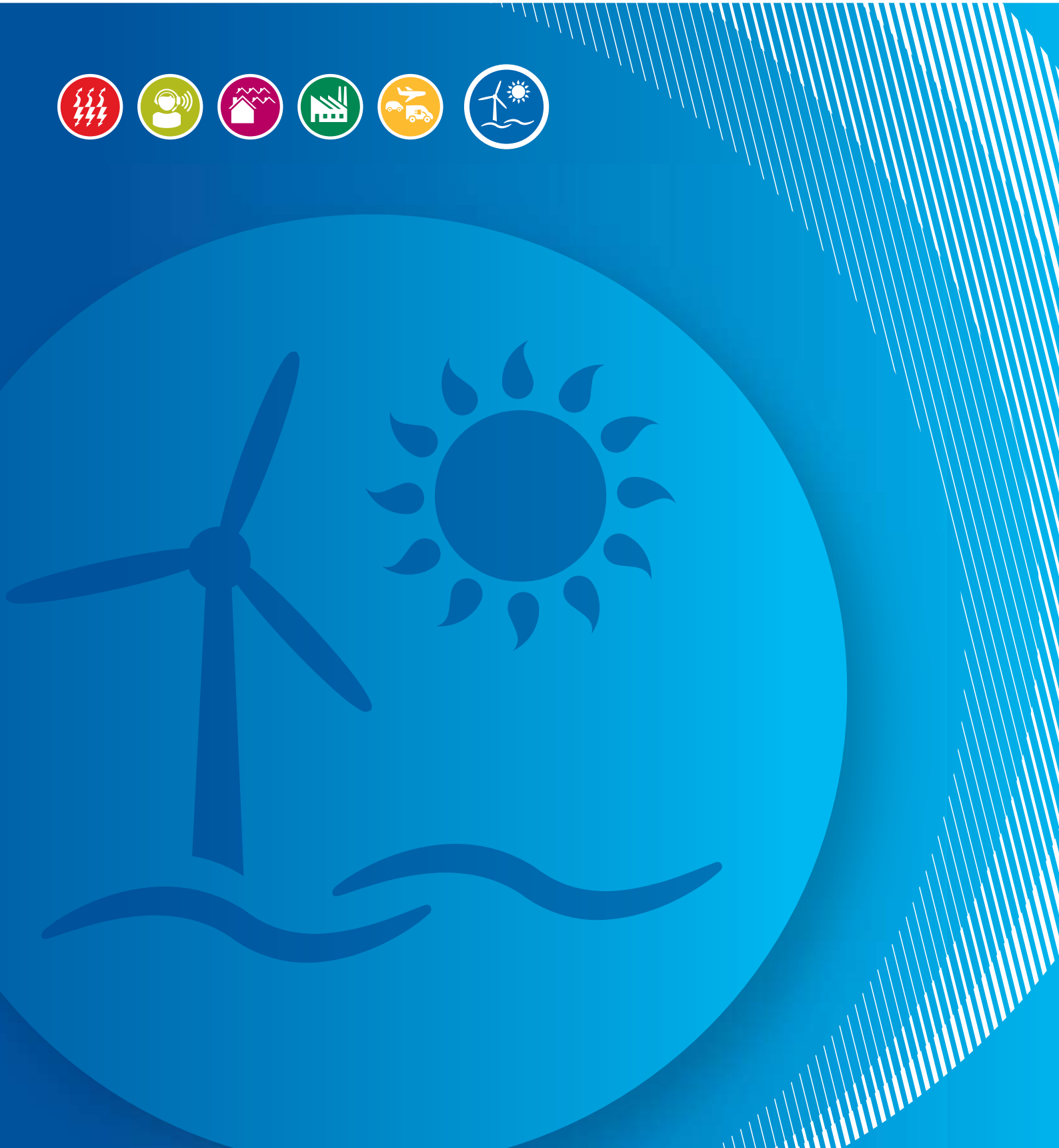
SUSTAINABLE ENERGY AUTHORITY OF IRELAND

# Renewable Energy in Ireland 2011

2012 Report



# Renewable Energy in Ireland 2011


Report prepared by
**Emer Dennehy, Martin Howley, Dr. Brian Ó Gallachóir and Mary Holland**

**Energy Policy Statistical Support Unit**

*June 2012*

## Sustainable Energy Authority of Ireland

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

SEAI's key strategic objectives are:

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

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

## Energy Policy Statistical Support Unit (EPSSU)

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

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

# Highlights

## Progress Towards Overall Renewable Energy Directive Target

- The contribution of renewable energy to overall energy demand rose from 2.3% to 5.6% between 1990 and 2010, and reached 6.5% in 2011. Ireland's target is to achieve 16% by 2020 under EU Directive 2009/28/EC.
- In absolute terms the total use of renewables nearly trebled between 2003 and 2011 (16% annual average growth) to 747 ktoe, largely due to the increasing contribution from wind energy.
- Renewable electricity contributed 3% to the overall energy demand in 2010 and grew to 3.7% in 2011. Renewable transport energy contributed 0.7% in 2010 and grew to 0.8% in 2011. The renewable heat contribution was 1.8% in 2010 and grew to 2% in 2011.
- Of the 747 ktoe of renewables used in 2011, most was from wind energy (44%). Renewable electricity was responsible for 57% of the total renewable contribution. Biofuels contributed 12% and renewable heat contributed 31%.
- There was a 20% increase in the renewable energy contribution in 2011, but part of this was due to the low wind speeds and rainfall in 2010.
- Final consumption of all fuels decreased in 2011 with the exception of renewables, which increased by 1.9% and non-renewable wastes which increased by 122% from a very low base.

## Energy Security

- Renewable energy accounted for 41% of indigenous energy production in 2011.

## Renewable Electricity (RES-E)

- The share of electricity generated from renewable energy sources (RES-E) in 2011 was 17.6%.
- Wind energy accounted for over 13% of all electricity generation in 2011, hydro accounted for 2.6% and the remaining 2% was from bioenergy sources (mainly biomass cofiring and landfill gas).
- Wind power installed generating capacity reached 1,631 MW in 2011.
- The EU Directive 2001/77/EC target for Ireland of 13.2% RES-E by 2010 was exceeded with RES-E at 14.8% in 2010.
- The national target of 15% RES-E by 2010 was narrowly missed, due to lower than average wind speeds and rainfall levels in that year.

## Renewable Heat Energy (RES-H)

- Renewable heat (RES-H) provisionally accounted for 5% of all thermal energy in 2011 and was one year late in meeting the national target of 5% RES-H for 2010.
- RES-H grew from 2.6% in 1990 to 4.4% in 2010. However 2010 was an exceptionally cold year. In 2011 RES-H reached 5% .
- Industrial biomass energy use (mostly in the wood, food and cement sectors) accounted for 68% of all thermal renewable energy used in 2011, which corresponds to 2.9% of all thermal energy use in Ireland.
- Industrial biomass energy use increased by 167% (6% average annual growth) between 1990 and 2006. However there has been a decrease in industrial RES-H recently with an average annual reduction of 2% since 2006. The industrial biomass demand in 2011 remained unchanged at the 2010 demand level.
- Residential biomass energy use increased by 9.5% between 1990 and 2011 (0.5% average annual growth). However the average annual growth rate increased in recent years to 18% between 2005 and 2010.

## Renewable Transport Energy (RES-T)

- Renewable transport energy (biofuels) accounted for 2.6% of road and rail transport (RES-T) in 2010 and 3.6% in 2011, when calculated according to the definition in EU Directive 2009/28/EC.
- The Government target of 3% RES-T by 2010 was not reached, but the 2010 target was exceeded in 2011.
- The dominant biofuel is biodiesel, representing 64% of biofuel usage in 2011, followed by bioethanol (34%) and pure plant oil (2%).
- Indigenous production accounted for 24% of biofuels used or stockpiled in 2011, compared to a peak of 55% in 2007.

## Avoided $CO_2$ Emissions

- $CO_2$ avoided through renewable energy use increased by 267% (6.7% per annum on average) over the period 1990 to 2010 reaching 2.8 Mt $CO_2$ in 2010 and provisionally 3.6 Mt $CO_2$ in 2011.
- Wind energy use gave rise to the largest avoidance of emissions in 2010 (60%) followed by solid biomass and hydro.

# 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 to fossil fuels, renewable energy sources contribute to the decarbonisation of energy supply and reduction in GHG emissions. They also contribute to energy security, being, for the most part, indigenous energy sources. In a period of increasing and volatile energy costs renewables can also contribute to cost competitiveness by reducing dependence on imported fossil fuels and hedging against further fossil fuel price volatility. There is the potential in the case of some renewable sources for Ireland to become a net exporter of renewable energy and technology.

The recently published *Strategy for Renewable Energy: 2012 - 2020*[1] by the Department of Communications, Energy and Natural Resources, states the ambition that "Ireland can also become a global leader in research and development in renewable energy and related technologies". The strategy identified five strategic goals: increasing both on- and offshore wind; building a sustainable bioenergy sector; fostering R&D in renewables such as wave and tidal; growing sustainable transport; and building robust and efficient electricity networks.

Further to European Renewable Energy Directive 2009/28/EC, Ireland National Renewable Energy Action Plan (NREAP) sets a mandatory target of a 16% renewables, comprising 40%, 12% and 10% contributions from electricity, heat and transport respectively.

This report examines the contribution made by renewables to Ireland's energy requirements for the period 1990 to 2011, with a particular focus on production data in 2010, and introduces provisional 2011 data. Installed capacity data are available for 2011 and early 2012. This is the fifth in an ongoing series of renewable energy reports and follows the Renewable Energy in Ireland 2010 Report[2]. This report also contains data in relation to energy from waste, drawing on the submission to the IEA/Eurostat annual survey on renewables and waste and the growing contribution of wastes to Ireland's energy supply. The energy from wastes currently used in Ireland (landfill gas, sewage sludge gas, wood wastes, tallow, meat and bone meal and waste oils used for biodiesel) are all classified as renewable sources of energy. Energy from municipal waste, low carbon fuels and solid recovered fuel are considered to be partially renewable.

The report discusses the progress towards national and EU renewable targets and provides an overview of the status of all renewables currently used in Ireland. In particular the actual renewable energy used in 2010 is compared to the national short term targets for that year as stated in the 2007 White Paper on Renewable Energy. There are however other targets that are likely to require a greater contribution from renewable energy, notably the EU Effort Sharing Decision 2009/406/EC[3] on greenhouse gas emissions reduction in the non emissions trading sectors.

The report is structured as follows:

- Section 2 summarises the policy measures which have been announced since the last Renewable Energy in Ireland 2010 update to increase renewable energy penetration.
- Section 3 explains the methodologies used to calculate progress towards national and international renewable energy targets.
- Section 4 provides the context for renewable energy deployment, examining the recent trends in primary energy usage.
- Sections 5 to 8 analyse the progress towards the various renewable energy targets.
- Section 9 estimates the extent of avoided carbon dioxide emissions arising from the use of renewables.
- Finally, section  looks at the future of renewable energy in Ireland through energy forecasts and the National Renewable Energy Action Plan.

The national energy balance data presented in this report are the most up-to-date at the time of writing. Balance data are updated whenever more accurate information is known. The most up-to-date balance figures are available in the statistics publications section of the Sustainable Energy Authority of Ireland's website. An energy data service is available at http://www.seai.ie/statistics; follow the links for Energy Statistics Databank. This service is hosted by the Central Statistics Office with data provided by SEAI. The 2011 balance data used are from the provisional balance as released on 18 April 2012.

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.dcenr.gov.ie/NR/rdonlyres/9472D68A-40F4-41B8-B8FD-F5F788D4207A/0/RenewableEnergyStrategy2012_2020.pdf
2 Available from http://www.seai.ie/Publications/Statistics_Publications/EPSSU_Publications/
3 Available from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0136:0148:EN:PDF

# 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 2010 Update[4]. Existing policy measures which relate to renewable energy are listed in Appendix 2, as well as recent regulatory and technical measures introduced to facilitate more renewable energy sources.



## 2.1 EU Directive 2009/28/EC and Statutory Instruments No's.147 and 148 of 2011

The European Union Directive 2009/28/EC[5] on the promotion of the use of energy from renewable sources and amending and subsequently repealed Directives 2001/77/EC[6] and 2003/30/EC[7] is still the most important legislation influencing the growth of renewables in Europe and Ireland. Statutory Instrument (SI) 147 gives effect to the Directive in Irish law and SI 148 of 2011[8] conferred additional functions to SEAI relating to the requirements under the Directive concerning renewable energy-related information and training, promotion and encouragement of renewable energy use by public bodies and promotion of certain renewable energy technologies.

The EU Directive 2009/28/EC specifies that:

- Mandatory national targets should be established consistent with a 20% share of energy from renewable sources in Community energy consumption by 2020. This is consistent with the renewable energy target contained in the EU Climate and Energy package[9] renewables target. Ireland's overall target is to ensure that at least 16% of gross final energy consumption from renewable sources by 2020 (compared with 3.1% 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 Conmmission 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[10] (RES-T) in Community energy consumption by 2020. The 10% target for energy from renewable sources in transport is set at the same level for each Member State. This renewable energy can be from biofuels or the renewable portion of electricity used for transport. The Directive 2009/28/EC also establishes the sustainability criteria for biofuels and bioliquids. Transport energy from wastes, second generation biofuels and electric vehicles (EVs) is given a higher weighting than first generation biofuels for the EU RES-T target.

### 2.1.1 National Renewable Energy Action Plan (NREAP)

In the NREAP each Member State sets out national targets for renewable electricity, transport and heat (RES-E, RES-T and RES-H respectively) and the steps envisaged to meet the state's mandatory EU 2020 overall renewable energy target. The forecasts document on which the first NREAP[11] was based was submitted in December 2009. The finalised NREAP[12] text was submitted on 30 June 2010.

The first progress report[13] on the NREAP was submitted in January 2012. This reported on the progress towards the targets in 2009 and 2010 and based on this progress projected a renewables trajectory to 2020.

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

Decision No. 406 of 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's GHG emission reduction commitments up to 2020, requires Ireland to reduce GHG emissions from non-ETS sectors (i.e. sectors outside of the EU Emissions Trading Scheme) by 20% below 2005 levels by 2020. Recent research[14] suggests that this target is likely to require a greater contribution from renewable energy than the 16% share of energy demand required by the EU Renewable Energy Directive 2009/28/EC.

4 SEAI, 2010. Available from http://www.seai.ie/Publications/Statistics_Publications/SEI_Renewable_Energy_2010_Update/RE_in_Ire_2010update.pdf
5 Available from http://eur-lex.europa.eu/en/index.htm
6 Ibid
7 Ibid.
8 Statutory Instrument No.147 & 148 of 2011. Available from http://www.irishstatutebook.ie/home.html
9 http://ec.europa.eu/environment/climat/climate_action.htm
10 Only petrol, diesel, biofuels consumed in road and rail transport, and electricity used by electric road vehicles shall be taken into account.
11 http://ec.europa.eu/energy/renewables/transparency_platform/doc/ireland_forecast_english.pdf
12 http://www.dcenr.gov.ie/NR/rdonlyres/03DBA6CF-AD04-4ED3-B443-B9F63DF7FC07/0/IrelandNREAPv11Oct2010.pdf
13 http://www.dcenr.gov.ie/NR/rdonlyres/B611ADDD-6937-4340-BCD6-7C85EAE10E8F/0/IrelandfirstreportonNREAPJan2012.pdf
14 Ó Gallachóir B. P., Rout U. K., Lavigne D., Chiodi A. and Gargiulo M. 2010 Modelling Ambitious CO2 Reduction Targets for Non-ETS Sectors. Proceedings International Energy Workshop 2010 June 20 – 23 2010, Stockholm.

## 2.3 Biofuels Obligation and Statutory Instrument No. 33 of 2012

The Biofuels Obligation introduced in the Energy (Biofuel Obligation and Miscellaneous Provisions) Act 2010[15] came into effect in July 2010, following a commencement order in Statutory Instrument 322 of 2010[16]. The scheme to promote the use of biofuels came into effect after the completion of the Mineral Oil Tax Relief (MOTR) scheme for biofuel producers, which was in operation between 2006 and 2010.

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

The scheme is administered by the National Oil Reserve Agency (NORA). NORA issues one certificate for each litre of biofuel provided that fuel meets the compliance requirements on sustainability, as stated in SI No. 33 of 2012[17]. Two certificates per litre are issued for biofuels from biodegradable waste, residue, non-food cellulosic material, ligno-cellulosic material or algae.

## 2.4 Electric Vehicles

The Minister for Communications, Energy and Natural Resources approved grant support of up to €5,000 for the purchase of Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs) (cars with $CO_2$ emissions of less than 75g $CO_2$ per km) available from 2011 to 2012. This support is in addition to the Vehicle Registration Tax (VRT) relief of up to €1,500 for BEVs and PHEVs as included in the 2011 Finance Act. Annual motor tax for both BEVs and PHEVS is at the lowest $CO_2$ emissions (band A) rate (€160 in 2012). The ambition is to have 2000 electric road vehicles in the stock by the end of 2012 in order to meet the overall target of 10% of the stock by 2020 (approximately 230,000 electric vehicles).

## 2.5 Renewable Energy Feed-In Tariff (REFIT)

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

REFIT 3 is designed to incentivise the addition of 310MW of renewable electricity capacity to the Irish grid. Of this, 150MW will be High Efficiency CHP (HE CHP), using both anaerobic digestion and the thermo-chemical conversion of solid biomass, while 160MW 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 renewable by providing grid connections outside the 'Gate' process for small bio-energy, wave and tidal generators.

## 2.6 Draft Offshore Renewable Energy Development Plan (OREDP)

A draft Offshore Renewable Energy Development Plan (OREDP)[18] was issued for public consultation by the Department of Communications, Energy and Natural Resources (DCENR) in November 2010. The Minister asked the Sustainable Energy Authority of Ireland for a Strategic Environmental Assessment (SEA) on low, medium and higher marine renewable energy development scenarios, set out in the draft OREDP, to inform policy decisions on developing this new industry. The SEA Reports on these scenarios have informed the draft plan. A Natura Impact Statement on the draft plan was also prepared. A finalised OREDP is due to be published by the DCENR in 2012.

## 2.7 Draft Geothermal Energy Development Bill of 2010

In July 2010, the Government gave its approval for the submission of a draft general scheme for the Geothermal Energy Development Bill to the Office of the Attorney General for detailed drafting and to the publication of both the general scheme[19] and the Regulatory Impact Assessment[20]. The bill is going through the legislative process, prior to enactment.

15 Statutory Instrument No.322 of 2010. Available from http://www.irishstatutebook.ie/home.html
16 Public Act No.11 of 2010. Available from http://www.irishstatutebook.ie/home.html
17 Statutory Instrument No.33 of 2012. Available from http://www.irishstatutebook.ie/home.html
18 Available from http://www.dcenr.gov.ie/NR/rdonlyres/2990B205-534E-486E-8586-346A6770D4B6/0/Draft_13_OREDPWebversion.pdf
19 Available from http://www.dcenr.gov.ie/Natural/Exploration+and+Mining+Division/Geothermal+Energy+Legislation/
20 ibid

# 3 Methodology for calculating Renewable Energy Shares

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

## 3.1 Renewables Share of TPER and TFC

Traditionally, energy trends are considered in terms of total primary energy requirement (TPER) and total final consumption (TFC). TPER is a measure of all energy used and TFC is a measure of the energy used by final customers only, i.e. excluding the loss in useful energy during transformation. The contribution from renewable energy can be captured in terms of its percentage share of TPER or TFC. However both are problematic in capturing the full contribution from renewable energy. Electricity is one of the end use 'fuels' within TFC, so the renewable share of TFC does not capture the contribution of renewable energy to electricity.

The Sankey diagram in Figure 1 illustrates where the various renewable targets fit within overall energy use in Ireland, indicating in particular the different denominators used. The full span of the sankey (indicated by the arrow to the left of the centre of the sankey) provides a measure of primary energy, used in quantifying the renewable energy share of TPER. This was used previously by the EU in the White Paper on Renewable Energy, which established the EU target to double the contribution of renewable energy to overall energy supply by 2020 (from 6% of TPER in 2995 to 12% by 2010.). The denominator used to calculated the share of renewables in TFC is similarly indicated by the arrow just to the right of centre of the sankey diagram. These shares are not subject to any specific national or European targets, but are nonetheless useful to gauge the contribution of renewables. Also highlighted in Figure 1 is the EU Renewable Directive target and towards the right of the figure the transport, heat and electricity targets relative to the respective amounts of final energy to which they refer.

Regarding share of TPER, the primary and final energy consumption for non-combustible renewable energy sources such as wind and hydro are very similar. For most 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. This means that the contribution of non-combustible renewable sources to TPER is not adequately captured in that the electricity they displace is greater than that accounted for.

In this report the contribution of renewable energy to both TPER and TFC is reported but in addition two other methodologies are also used that address these shortcomings and provide a more complete picture.

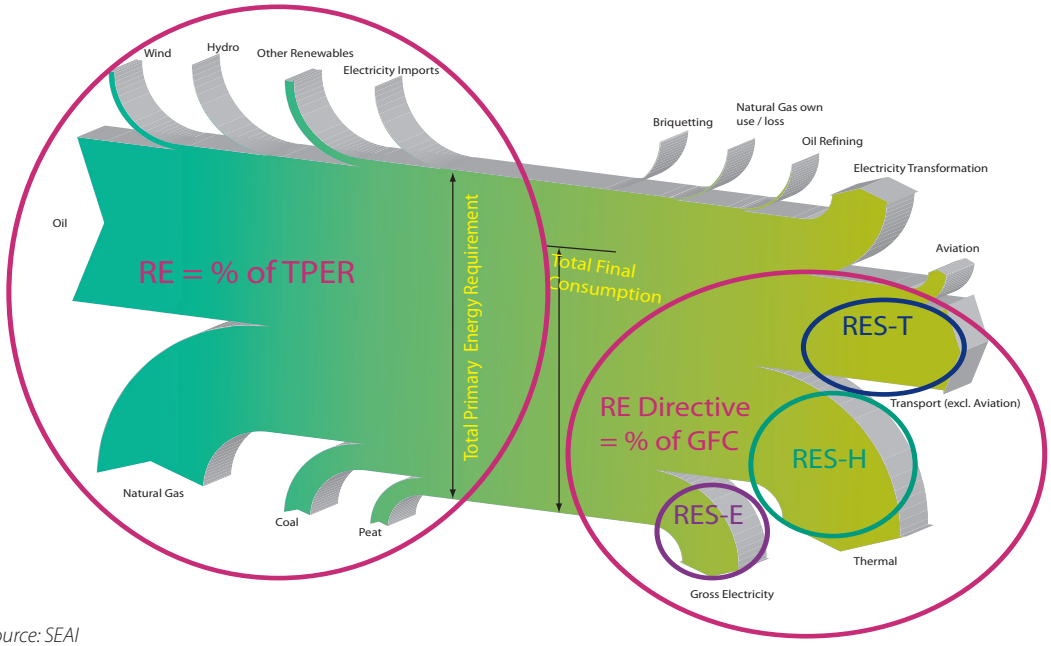
- The total primary energy equivalent (TPEE) is an alternative approach to TPER in which the primary energy of the renewable energy is equated with the primary energy of the fuel that would have been required to produce the equivalent amount of electricity. The contribution of renewable energy to Ireland's primary energy use is captured more completely in the renewable energy share of TPEE than the renewable energy share of TPER.
- Gross final consumption (GFC) of energy is an alternative to TFC that was developed recently and is the denominator used by the EU to track progress towards the targets in Directive 2009/28/EC. The Directive defines GFC as the energy commodities delivered for energy purposes to manufacturing industry, transport, households, services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution. The renewable energy contribution includes electricity generation, transport energy and thermal energy from renewable sources. This builds on the definition for gross final consumption of electricity used in Directive 2001/77/EC (to track progress in renewable generated electricity) and adds gross final consumption of heat and transport.

## 3.2 Total Primary Energy Equivalent - TPEE

The principle adopted by the International Energy Agency (IEA) is that the primary energy form should be the first form downstream in the production process for which multiple energy uses are practical. The primary energy forms are usually heat or electricity. Where electricity is selected as the primary energy form - for example, hydro power, wind, solar PV - the primary energy equivalent is the physical energy content of the electricity generated in the plant, i.e. assume 100% efficiency. For most fuels this is not the case, due to the energy conversion losses associated with electricity generation. The primary energy equivalent approach equates the primary energy of the renewable energy with the primary energy of the fuel that would have been required to produce the equivalent amount of

electricity. A detailed description of the methodology used for calculating the Primary Energy Equivalent (PEE) is provided in Appendix 1. Another metric used to track the penetration of renewables is the renewables share of Total Primary Energy Equivalent. 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.

**Figure 1** *Renewable Energy Targets*




*Source: SEAI*

## 3.3 Renewable Energy Directive 2009/28/EC

The target for Ireland in the European Renewable Energy Directive 2009/28/EC for 2020 is for renewable sources to account for 16% of gross final energy consumption (GFC). The Directive 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. The renewable energy contribution includes electricity generation, transport energy and thermal energy from renewable sources.

There are also differing methodologies in the way the overall share of energy from renewables and the individual share of renewables by each mode of energy application, namely heat, transport and electricity (termed RES-E, RES-T and RES-H respectively), are calculated. These individual targets have separate denominators and in some cases weighting factors and cannot be added 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 EVs) but in the calculation of the overall renewable energy target (RES) weighting factors are not applied.

### 3.3.1 Gross Final Consumption

The definition of gross final consumption of energy (GFC) is the energy delivered for energy purposes including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution.

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

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

### 3.3.2 Co-operating Mechanisms and Short-Term Statistical Transfers

If a country is unable to meet the target with indigenous renewable energy sources, there are flexible mechanisms outlined in the Directive which could assist in meeting the EU target. The flexible mechanisms outlined in the Directive are co-operating mechanisms and short-term statistical transfers. The "co-operating mechanisms" enable trading of compliance with other Member States and also enable purchase from outside the EU with matching physical import.

The Directive also outlines "short-term statistical transfers", where Member States may agree on and may make arrangements for the statistical transfer of a specified amount of energy from renewable sources from one Member State to another Member State.

### 3.3.3 Overall Renewables Target — RES

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

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

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

**Denominator:** The denominator is the gross final consumption adjusted for aviation being limited to 6.18% of gross final consumption (as prescribed in Article 5.6 of the Renewable Energy Directive 2009/28/EC). Marine bunkers are also added. For Ireland, GFC is calculated by subtracting electricity use from total final consumption and adding gross electricity consumption.

### 3.3.4 Renewable Electricity — RES-E

Prior to the EU Renewable Energy Directive 2009/28/EC there was a target and strategy for the contribution of renewable energy to the electricity market established in the EU Directive 2001/77/EC[21]. This Directive set indicative targets for each Member State for the contribution of renewable generated electricity relative to gross electricity consumption for the year 2010. Ireland's 2020 national target in regard to renewable electricity is 40% by 2020, but there is not a specified mandatory RES-E European target for 2020.

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

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

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

#### 3.3.4.1 Normalisation

In calculating the contribution of hydro and wind energy for the purpose of the overall 16% target for renewable energy in Ireland by 2020 in Directive 2009/28/EC the effects of climatic variation are smoothed through use of normalisation rules. The normalisation rules are specified in Annex II of the Directive and different rules apply for hydro and for wind. The normalised renewable hydro contribution is calculated as the installed capacity of the latest year for hydro multiplied by the sum of electricity generated divided by the installed capacity for the last 15

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

years for hydro energy. As shown in Equation 1, where N is the reference year; $Q_{N(Norm)}$ is the normalised electricity generated by all hydropower plants in year N for reporting progress towards Renewable Energy Directive 2009/28/EC; $Q_i$ is the actual quantity of electricity generated in year i by all hydropower plants measured in GWh, excluding production from pumped storage units, using water that has previously been pumped uphill; and $C_i$ is the total installed capacity net of pumped storage of all hydropower plants at the end of year i measured in MW.

**Equation 1** *Hydro Normalisation Equation*

*Source: European Commission*

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

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

**Equation 2** *Wind Normalisation Equation*

*Source: European Commission*

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

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

### 3.3.5 Renewable Heat — RES-H

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

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

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

### 3.3.6 Renewable Transport — RES-T

There is a mandatory obligation for all Member States to meet the 10% RES-T target by 2020 Directive 2008/32/EC 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. The use of the multiplication targets in RES-T results in a different figure to that of the renewable transport energy used for the transport contribution to total renewable energy. These weighting factors are used for the calculation of RES-T only and do not apply when calculating the transport contribution to the overall RES share.

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

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

- The greenhouse gas emission saving from the use of biofuels and bioliquids shall be at least 35%. This percentage increases to 50% by 2017 and (for new biofuel plants that start production from 1 January 2017) 60% from 2018.
- Biofuels and bioliquids shall not be made from raw material obtained from land with high biodiversity value.
- Biofuels and bioliquids shall not be made from raw material obtained from land with high carbon stock.

Agricultural raw materials cultivated in the Community and used for the production of biofuels and bioliquids shall be obtained in accordance with the requirements and standards under the provisions referred to under the heading 'Environment' in part A and in point 9 of Annex II to Council Regulation (EC) No 73/2009.

# 4 Context for Renewable Energy Deployment

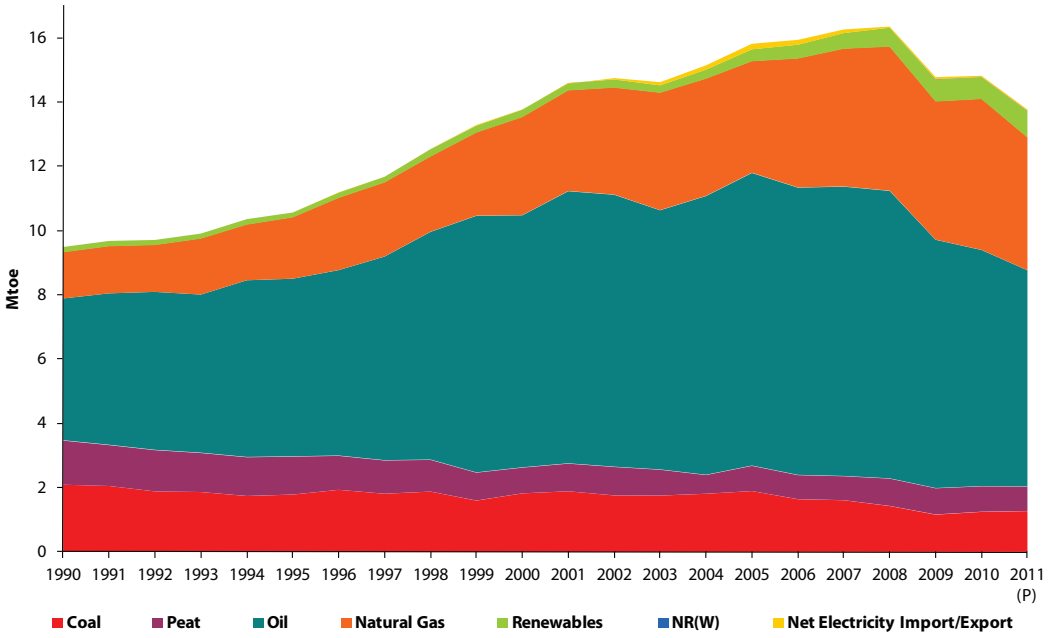
## 4.1 Primary Energy

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

Figure 2 illustrates the trend in energy supply over the period 1990 to 2011 (provisional 2011 data), emphasising changes in the fuel mix. Primary energy requirement in Ireland in 2010 was 14.8 million tonnes of oil equivalent (Mtoe). Over the period 1990 – 2010 Ireland's total annual primary energy requirement grew in absolute terms by 55.4% (average annual growth rate of 2.2%). The individual fuel growth rates and shares are shown in Table 1. A more detailed discussion on the trends in TPER between 1990 and 2010 is contained in SEAI's Energy in Ireland 2011 report[22].

Provisional 2011 data show a further 6.3% reduction in primary energy requirement to just under 13.8 Mtoe. All fuels experienced a reduction with the exception of coal which increased by 1.7%, renewables increased by 20% and non renewable wastes increased by 122% from a very low base.

**Figure 2** *Total Primary Energy Requirement 1990 to 2011(Provisional)*




*Source: SEAI*

Figure 2 shows the significant increase in overall TPER over the period 1990 - 2010 and this masks the considerable growth in renewable energy since the mid 1990s. Total renewable energy grew, from 168 ktoe to 680 ktoe between 1990 and 2010, an increase of 305% (7.2% per annum on average) over the period. The increase in 2009 was 15% but in 2010 there was a decrease of 0.8%. Provisional 2011 figures show a 20% increase in the contribution of renewables to the total primary energy requirement, to 747 ktoe.

22 SEAI, 2011, Energy in Ireland 1990 to 2010 - 2011 Report. Available from http://www.seai.ie/Publications/Statistics_Publications/Energy_in_Ireland/

**Table 1** *Growth Rates and Shares of TPER Fuels 1990 - 2010*

| | Growth % | Average annual growth rates % | | | | | | Shares % | |
|---|---|---|---|---|---|---|---|---|---|
| | 1990 – '10 | 1990 – '10 | 1990 – '95 | 1995 – '00 | 2000 – '05 | 2005 – '10 | 2010 | 1990 | 2010 |
| Fossil Fuels (Total) | 50.4 | 2.1 | 2.2 | 5.4 | 2.4 | -1.6 | -0.1 | 98.2 | 95.1 |
| Coal | -44.0 | -2.9 | -3.1 | 0.4 | 0.4 | -8.9 | -1.3 | 22.0 | 7.9 |
| Peat | -42.6 | -2.7 | -3.0 | -7.5 | -0.4 | 0.1 | -3.1 | 14.5 | 5.4 |
| Oil | 66.7 | 2.6 | 4.6 | 7.3 | 3.0 | -4.2 | -4.8 | 46.6 | 49.9 |
| Natural Gas | 225.3 | 6.1 | 5.8 | 9.8 | 2.6 | 6.2 | 9.2 | 15.2 | 31.9 |
| Renewables (Total) | 304.6 | 7.2 | -1.6 | 8.7 | 9.8 | 12.6 | -0.8 | 1.8 | 4.6 |
| Hydro | -14.0 | -0.8 | 0.5 | 3.5 | -5.7 | -1.0 | -33.5 | 0.6 | 0.3 |
| Wind | - | - | - | 72.4 | 35.4 | 20.4 | -4.6 | 0.0 | 1.6 |
| Biomass | 96.3 | 3.4 | -3.3 | 4.9 | 9.8 | 2.8 | 6.8 | 1.1 | 1.4 |
| Other Renewables | 7423.6 | 24.1 | 4.8 | 56.5 | 10.1 | 31.4 | 12.2 | 0.0 | 1.2 |
| Wastes | - | - | - | - | - | - | -29.4 | 0.0 | 0.1 |
| Electricity Imports | - | - | - | 53.2 | 64.7 | -18.0 | -19.1 | 0.0 | 0.4 |
| **Total** | **55.4** | **2.2** | **2.2** | **5.4** | **2.8** | **-1.3** | **-0.3** | | |

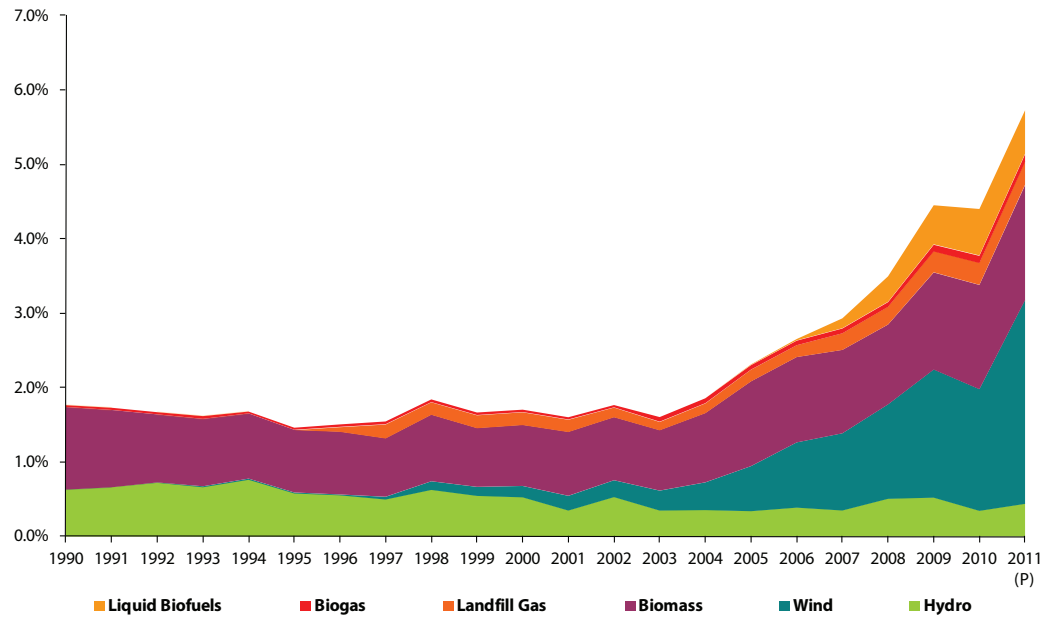
*Source: SEAI*

Figure 3 shows that renewable energy has been contributing nearly 2% of Ireland's total primary energy requirement (TPER) between 1990 and 2004. In 2004 the contribution stood at 1.9% and this increased to 4.6% in 2010. The provisional 2011 data point to a renewable contribution to TPER of 5.9%.

There are many different indicators outlined in Section 3 in relation to the share of renewables in energy use and the figure of 5.9% renewable contribution to primary energy in 2011 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 4.12% of TPER, while other energy transformation losses, such as those which occur when briquetting, oil refining or transporting natural gas, are excluded from the denominator for the Directive calculation.

**Figure 3** *Renewable Energy Contribution to TPER 1990 - 2011 (Provisional)*

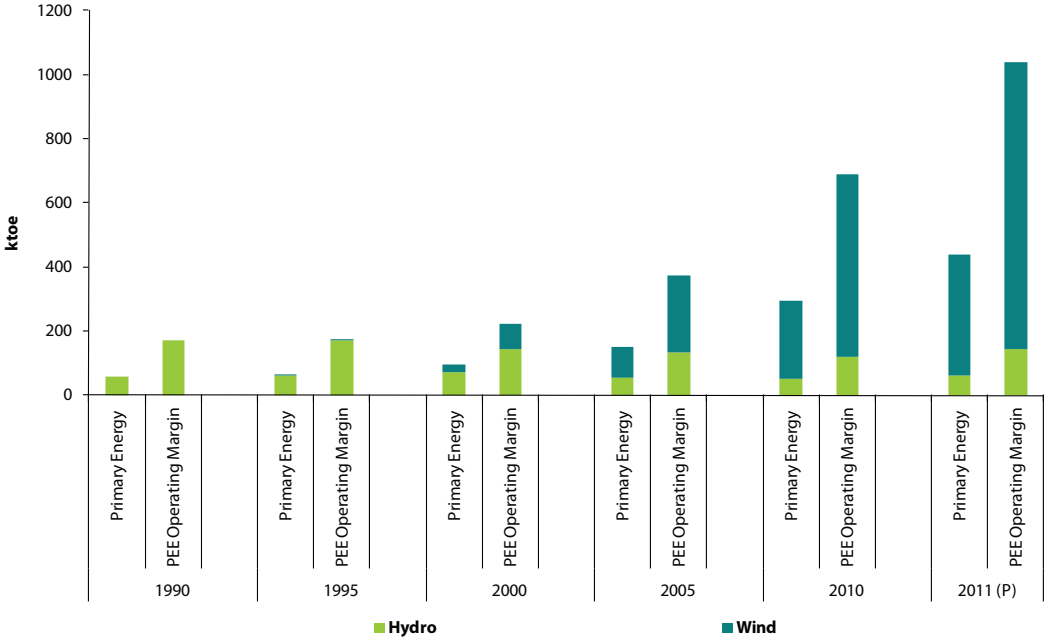



*Source: SEAI*

## 4.2 Primary Energy Equivalent

The primary energy equivalent approach equates the primary energy of the renewable energy with the primary energy of the fuel that would have been required to produce the equivalent amount of electricity. The methodology for calculating the Primary Energy Equivalent (PEE) is outlined in Appendix 1. Based on this analysis the PEE for non-combustible renewable energy (wind and hydro) is compared with the primary energy requirement (PE) values in Figure 4 at five-year intervals between 1990 and 2010. Figure 4 also includes provisional 2011 data. The difference between the PE and PEE is particularly noticeable and also the increasing importance of wind. Focusing on the year 2010, the PEE for wind and hydro was almost 2.4 times larger (135%) than their primary energy.

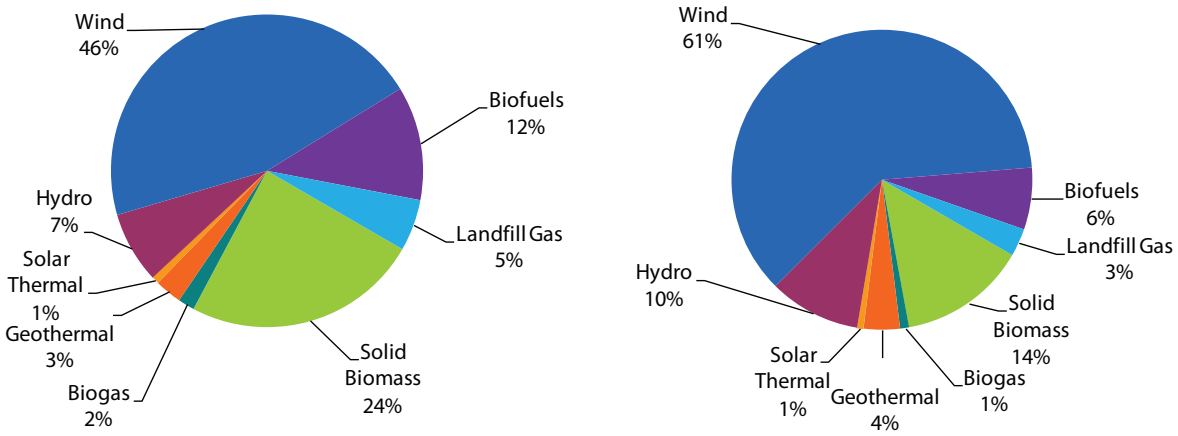
**Figure 4** *Primary Energy (PE) and Primary Energy Equivalent (PEE) for Wind and Hydro*




*Source: SEAI*

The total PEE 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 total PEE for renewable energy increased from 281 ktoe in 1990 to 1104 ktoe in 2010, an increase of 293% (7.1% per annum on average). There was an increase of 30% in the total PEE during 2011. Figure 5 compares the contribution of renewable energy to TPER using the traditional PE approach and the PEE approach. Renewable energy accounted for 5.9% of TPER in 2011 (1st pie chart in Figure 5) and 10% of TPEE (2nd pie chart in Figure 5).

**Figure 5** *Renewable Energy Share of TPER and TPEE in 2011 (Provisional)*

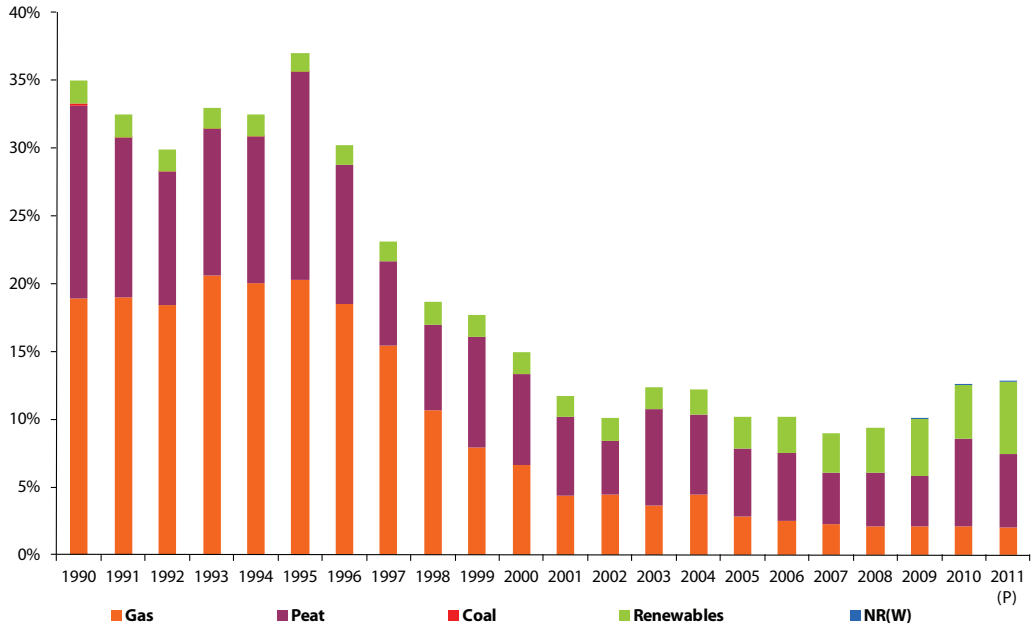



*Source: SEAI*

## 4.3 Indigenous Energy Sources

Ireland is not endowed with significant indigenous fossil fuel resources and has to date not harnessed significant quantities of renewable resources. Although there has been strong growth in renewables in recent years it is from a small base. Figure 6 shows the indigenous energy fuel mix for Ireland over the period 1990 to 2011. The reduction in indigenous supply of natural gas is clearly evident from the graph as is the switch away from peat since the mid 1990's. Indigenous production peaked in 1995 at 4.1 Mtoe and there has been a 56% reduction since then to 1.8 Mtoe. Production of indigenous gas decreased by 85% over the period since 1990, and peat by 46%, while renewable energy in contrast increased by 346%.

**Figure 6** *Indigenous Energy Sources by Fuel as a Share of TPER 1990 - 2011 (Provisional)*




*Source: SEAI*

Increasing the deployment of renewables is part of the strategy to improve energy security for Ireland. Of the indigenous energy production in 2011 renewable energy was responsible for 41%. Therefore the decline in indigenous sources of energy has been halted by the use of renewables. Peat accounted for 42% of all indigenous energy in 2011 and natural gas accounted for 16% of indigenous energy. There was also a small contribution from non-renewable wastes.

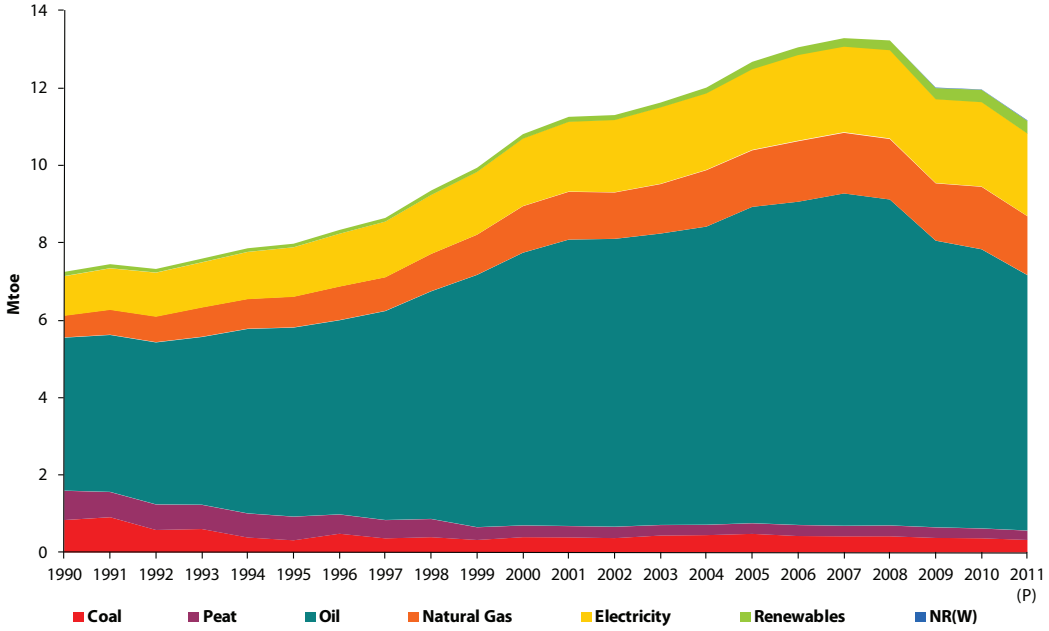
## 4.4 Energy Demand

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

Figure 7 shows the shift in the pattern of final energy demand by fuel over the period 1990 to 2010, along with provisional 2011 data. Ireland's TFC in 2011 was almost 12 Mtoe, a decrease of 6.5% on 2010 and 54% above 1990 levels (representing an average growth rate of 2.1% per annum). Final consumption of renewable energy increased by 204% (5.4% per annum on average) from 1990 to 2011.

Renewable energy sources experienced the highest growth in final consumption of all fuels in 2010, growing by 10.8%. There was a further decrease in final energy consumption in 2011 of 6.7%. Final consumption of all fuels decreased with the exception of renewable energy, which increased by 1.9% and non-renewable wastes which increased by 122% but from a very low base.

**Figure 7** *Total Final Consumption by Fuel 1990 - 2011 (Provisional)*




*Source: SEAI*

# 5 Renewable Generated Electricity (RES-E)

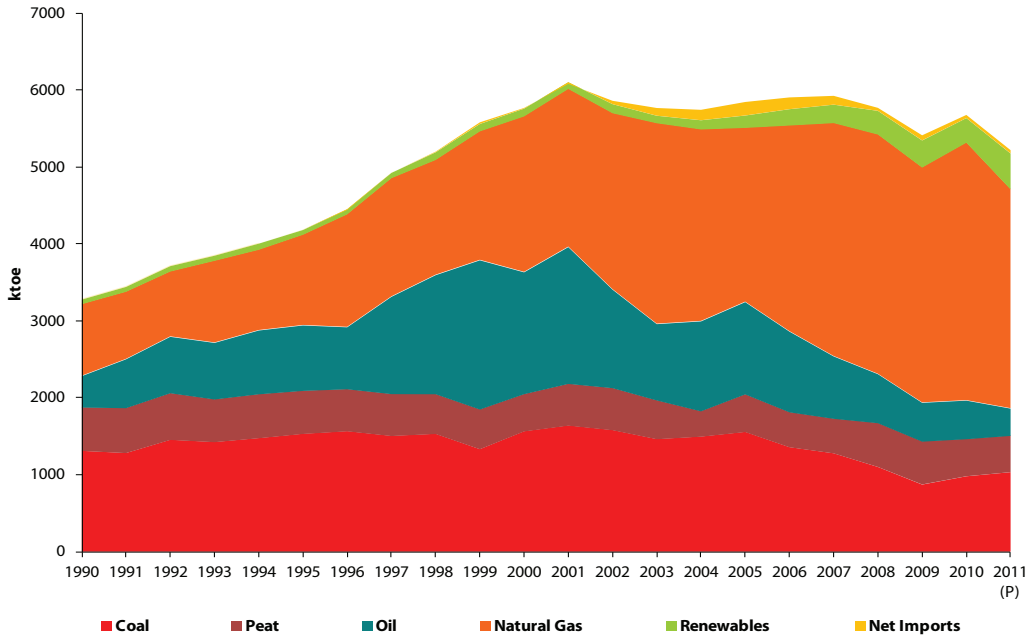
## 5.1 Fuel Inputs to Electricity Generation and Electricity Demand

Electricity demand has consistently remained between 15% to 20% of total final consumption for the last 20 years and was just under 25 TWh in 2011. For some sectors there is a higher reliance on electricity, in particular industry and services both with an electricity share of approximately 40% in the sector total final energy demand. Fuel inputs to electricity generation in Ireland are responsible for approximately a third of the total primary energy demand (all energy demand) in Ireland (~5 Mtoe in 2011). When sectoral energy consumption is considered in terms of primary energy and $CO_2$ emissions, the electricity use in the residential, industry and services sectors is significant.

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

The fuel inputs to electricity generation from 1990 to 2011 are shown in Figure 8. The fuel inputs to electricity generation almost doubled between 1990 and 2001. However a switch away from oil to more efficient natural gas generation resulted in a reduction in fossil fuel inputs since the peak of 2001. Overall energy inputs to electricity generation remained relatively constant for the last decade and more recently the fossil fuel inputs have decreased due to the growth in the contribution of renewables.

**Figure 8** *Inputs to Electricity Generation by Fuel Source 1990 - 2011 (Provisional)*



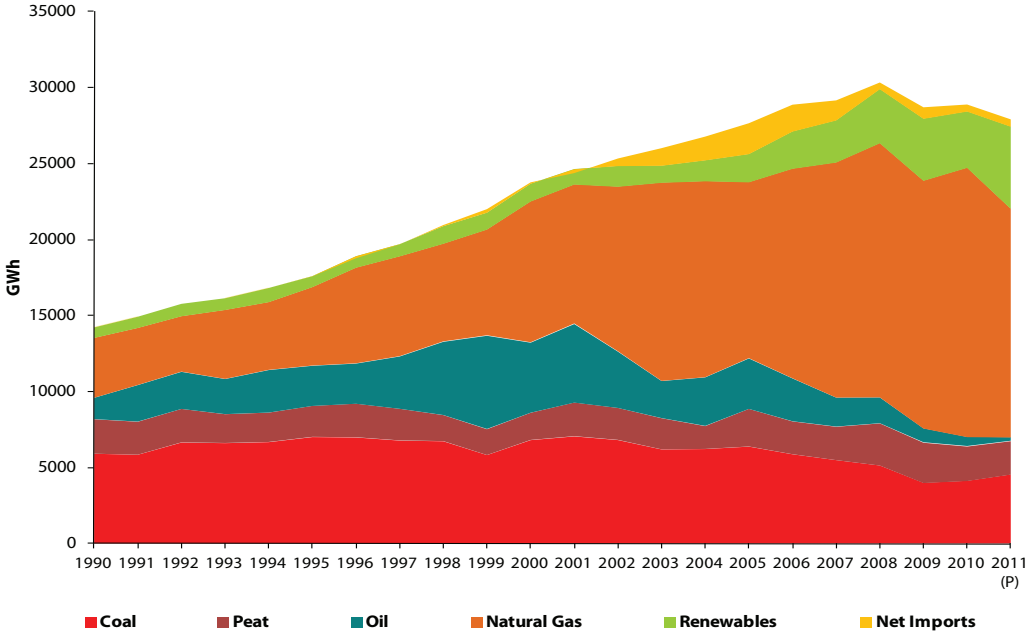

*Source: SEAI*

Figure 8 shows the growing trend in Gross Final Consumption (GFC) of electricity for Ireland over the period 1990 – 2011. It illustrates the changing shares of each fuel/energy source. The doubling of gross electricity consumption over the period 1990 to 2008 is striking, as is the growth in gas generated electricity. It is interesting to compare Figure 8 and Figure 9 and see that even though demand continued to increase between 2001 and 2008 the inputs to electricity generation decreased. As already mentioned, this is the result of more efficiency electricity generation from natural gas Combined Cycle Gas Turbines (CCGT) and the increasing contribution from renewables.

Due to the impact of the economic recession there has been a reduction in the gross electricity consumption since 2008, as shown in Figure 9. As detailed in Table 2, the share of gas generation increased from 28% in 1990 to 55% in 2011. These changes provide a context against which the growth in RES-E can be assessed. Total Gross Final Consumption of electricity was 27 TWh in 2011. Electricity from renewable energy sources nearly trebled its share, in the context of this doubling of overall gross electricity consumption to 5.4 TWh in 2011.

Gas-generated electricity grew by 205% over the period 1990 to 2011, an annual average growth rate of 5.5% per annum. In contrast, oil generated electricity has reduced significantly from a 11% share of all generation in 1990 to just over 1% in 2011.

**Figure 9** *Gross Electricity Consumption by Fuel Source 1990 - 2011 (Provisional)*




*Source: SEAI*

**Table 2** *Gross Electricity Consumption Percentage by Fuel Source 1990 - 2011 (Provisional)*

| % of Gross | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 (P) |
|---|---|---|---|---|---|---|---|---|---|---|
| Coal | 39.8 | 36.5 | 27.0 | 26.5 | 22.9 | 21.5 | 19.0 | 16.0 | 17.2 | 19.7 |
| Peat | 17.4 | 13.5 | 8.5 | 8.5 | 7.8 | 7.7 | 10.0 | 10.4 | 8.6 | 9.2 |
| Oil | 12.5 | 20.3 | 27.5 | 20.5 | 17.8 | 13.7 | 11.0 | 9.3 | 8.8 | 6.8 |
| Gas | 28.5 | 28.1 | 35.1 | 38.7 | 45.3 | 51.1 | 53.9 | 56.5 | 59.0 | 54.6 |
| Renewables | 1.8 | 1.5 | 1.8 | 2.8 | 3.6 | 4.1 | 5.3 | 6.5 | 5.6 | 8.9 |
| Net Imports | 0.0 | 0.0 | 0.1 | 3.0 | 2.6 | 1.9 | 0.7 | 1.2 | 0.7 | 0.8 |

*Source: SEAI*



## 5.2 Sources of Renewable Electricity

### 5.2.1 Hydro Energy

There are 14 large hydroelectric[23] generators connected to the transmission system (maximum export capacity {MEC} of > 4 MW). The total hydro connected to the transmission system is 212 MW. This is 2.8% of the total connected generation capacity. There are a further 58 micro[24] (< 1 MW) hydroelectric generators connected to the distribution system with an installed capacity of 25.5 MW. Further growth in large scale hydro projects is not currently planned. However there are 4 micro generation projects of 1 MW capacity contracted for distribution system connections.

#### 5.2.1.1 Pumped Hydro Storage

Electricity produced by pumped storage from water that has previously been pumped uphill is not classified to be from a renewable energy source and is not included in either the nominator or the denominator of the renewable electricity (RES-E) calculation. While it is not a renewable electricity source, pumped hydro storage has many notable attributes. 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.

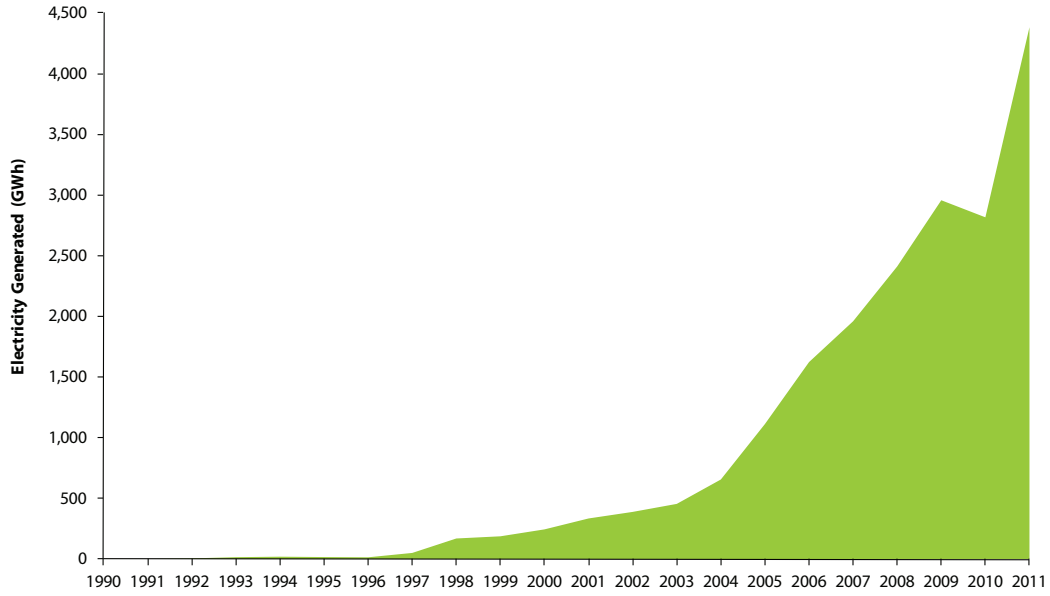
There is currently only one pumped hydro station in Ireland. The station comprises four 73 MW generators to give a total capacity of 292 MW. It was not in operation from August 2010 to February 2012 due to scheduled maintenance works. There is one other pumped hydro generator which is contracted for connection in 2012 with a capacity of 70 MW. There are further planned projects to increase pumped storage in the grid connection queue.

23 EirGrid *TSO Non-Wind Generators - Connected (11 January 2012).* Available from http://www.eirgrid.com/customers/connectedandcontractedgenerators/
24 ESB Networks Distribution Connected Non-Wind Farms (DSO). Available at http://www.esb.ie/esbnetworks/en/generator-connections/

### 5.2.2 Wind – On-shore and Off-shore

Figure 10 and Table 3 show the electricity generated from wind and illustrate the rapid rise in electrical output since 1997 when the first of the wind farms supported by the Alternative Energy Requirement (AER) programme came online. Total electrical output from wind in 2011 was 4,380[25] gigawatt hours (GWh) representing an increase of 56% on 2010, but it should be noted that in 2010 the wind resource was poor (less wind blew). Wind was responsible for 15.7% of gross electrical consumption in 2011 (9.72% in 2010). The peak recorded wind power output[26] was 1,474 MW delivered on Saturday 26th November 2011.

**Figure 10** *Electricity Generated by Wind (GWh) 1990 - 2011*




*Source: EirGrid*

**Table 3** *Renewable Electricity Production – Wind*

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

*Source: EirGrid*

Figure 11 traces the evolution in installed wind capacity from 2000 to 2011 (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. The surge in wind farm construction activity in the period 2003 – 2006 is very clear and resulted in Ireland (the All-Island network) reaching the highest level of wind power penetration in the world[27]. While total installed wind capacity in Ireland is low compared with Germany, Spain and Denmark, wind power penetration is higher in the Irish system than in either the British, UCTE or NORDEL synchronous power systems.

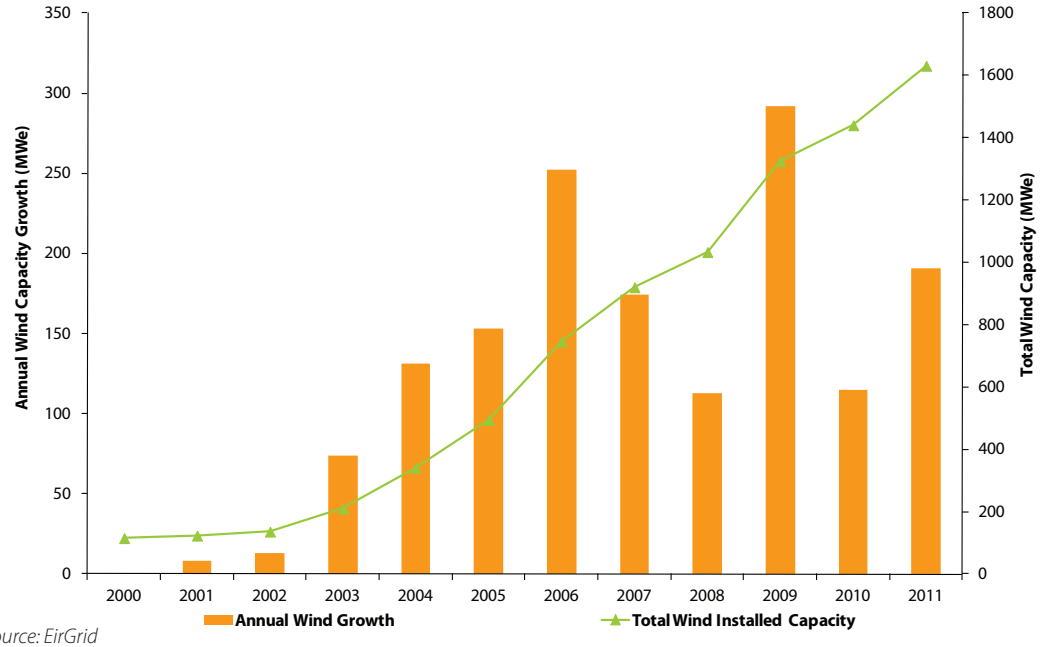
There was a slowdown in wind farm development in 2007 and 2008 due to a number of factors including uncertainty regarding the renewable energy feed-in tarriff (REFIT) scheme (which was waiting on EU approval until September 2007) and uncertainty about access to finance for wind farm development. The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

The total installed capacity of transmission and distribution system connected wind farms reached 1,631 MW by December 31st 2011[28]. Onshore wind farms with an additional combined Maximum Export Capacity (MEC) of 323.5 MW have target connection dates during 2012 (34.5 MW[29] for connection to the transmission system and 283 MW[30] for connection to the distribution system).



25 Output from both grid connected wind farms and large auto-producer turbines.
26 System records are updated on the Eirgrid website, as well as 15 minutes average data on wind power. www.eirgrid.com/operations/
27 Measured as the ratio between installed wind generation capacity and overall generating capacity for a synchronous power system. For more detail see Ó Gallachóir B. P., Gardner P., Snodin H. & McKeogh E. J. Wind Energy Systems Security - The Grid Connection Moratorium in Ireland. *International Journal of Energy Technology and Policy (IJETP)* 5 633 - 647
28 EirGrid Installed Wind Report (31st Dec 2011). Available from www.eirgrid.com/media/Connected%20Wind%20Farms%20-%2031%20Dec%202011.pdf
29 Transmission system contracted wind farm list from EirGrid. Available from www.eirgrid.com/media/TSO_Wind_Contracted_080612.pdf
30 ESB Networks distribution system contracted wind farm list. Available from www.esb.ie/esbnetworks/en/downloads/DSO-Contracted-Wind-Farms.pdf

**Figure 11** *Installed Wind Generating Capacity 2000 - 2011*




*Source: EirGrid*

The existing wind data is not currently split between on-shore and off-shore wind energy as there is currently only one off-shore wind farm in Ireland. This is the Arklow Bank with a capacity of 25.2 MW. It is estimated to produce less then 2% of the total wind energy generated in 2011[31]. A renewable energy feed-in tarriff (REFIT) of 14 cents per kWh is available from the Irish government since February 2008. Within the first 8 years of the Gate 3 ITC programme (2010 - 2017) 404 MW[32] of offshore wind is planned to be connected to the grid.

The contribution of wind energy from small turbines for auto production in industry was 10 GWh or just 0.23%of all wind energy generated in 2011. The contribution from grid connected domestic installations was less than a tenth of the industry auto production of wind energy in 2011. A domestic micro-generation rate is available from ESB Customer Services as discussed in Appendix 2 section A2.2.9. While there may also be some non-grid connected domestic turbines, their contribution is currently considered negligible.

### 5.2.2.1 Capacity Factors

The capacity factor (CF) of wind power is the ratio of average delivered power to theoretical maximum power. It can be computed for a single turbine, a wind farm consisting of dozens of turbines or an entire country consisting of hundreds of farms. The more disaggregated the time-period and the installed capacity grouping (eg. at an individual wind farm level as opposed to total national installed capacity), the more accurate the calculation of the overall capacity factor. The rate of capacity increase each year can significantly impact on the capacity factor in periods of large annual capacity increases.

A crude calculation of the annual average capacity factor for installed wind capacity in Ireland since 2000 is shown in Table 4. In this calculation the total wind generated electricity produced per annum is divided by the mid-year installed capacity. However, as not all of the capacity was producing electricity from the start of the year, this method can underestimate the annual capacity factor or overestimate if a lot of capacities is installed and becomes operational in the second half of the year.

**Table 4** *Annual Capacity Factor for Wind Power Generation in Ireland 2000 - 2011*

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

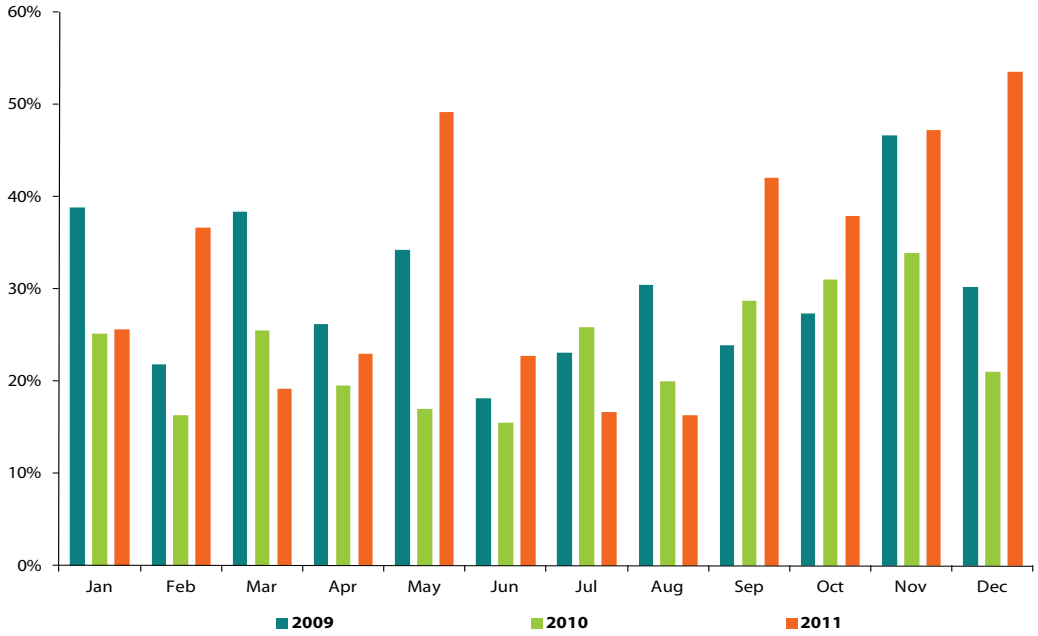
*Source: EirGrid and SEAI*

A more accurate calculation of the capacity factor for Ireland using monthly installed capacities and wind generated electricity was also calculated for 2009 to 2011 and is shown in Figure 12. The graph clearly shows that in general the highest capacity factors are at the start and end of the year with lower wind during the summer months. There was unusually cold weather in January and December of 2010 and very little wind during those cold spells which contributed to the lower than average capacity factor in 2010.

31 Assuming a capacity factor of between 30% and 39% for offshore wind.

32 EirGrid Gate 3 Node Assignment List 24 May 2011. Available from: http://www.eirgrid.com/gate3/nodeassignments/

**Figure 12** *Wind Energy Capacity Factors by Month 2009 - 2011*

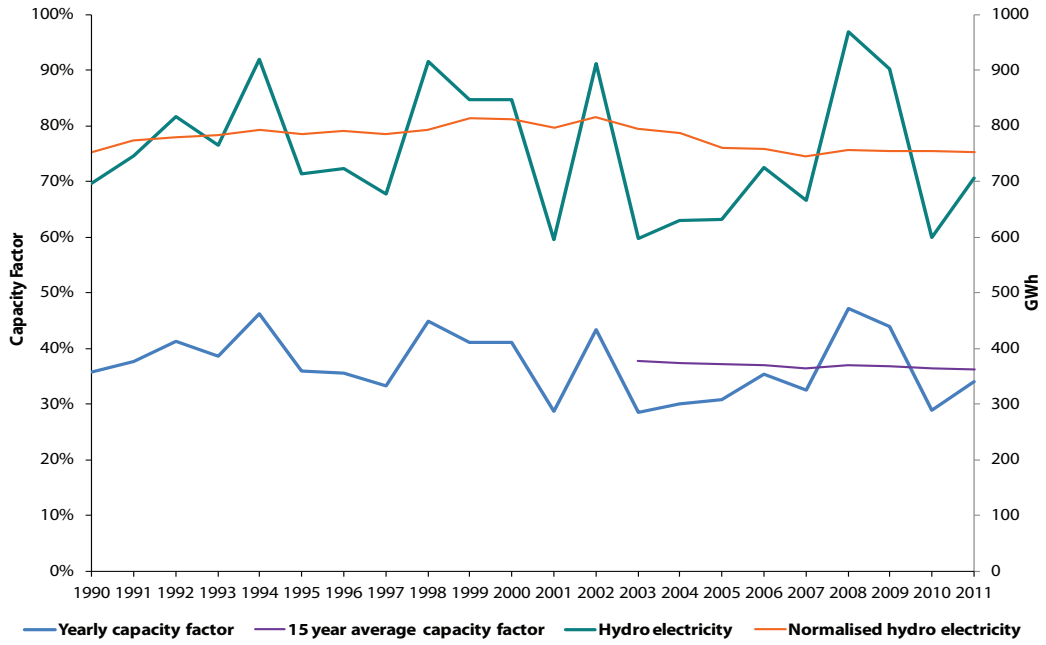



*Source: EirGrid & SEAI*

## 5.3 Normalisation of Hydro and Wind Energy

In calculating the contribution of hydro and wind energy for the purpose of the overall 16% target for renewable energy in Ireland by 2020 in Directive 2009/28/EC, the effects of climatic variation are smoothed through use of a normalisation rule. The normalisation rule is specified in Annex II of the Directive 2009/28/EC. 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 (see Figure 13).

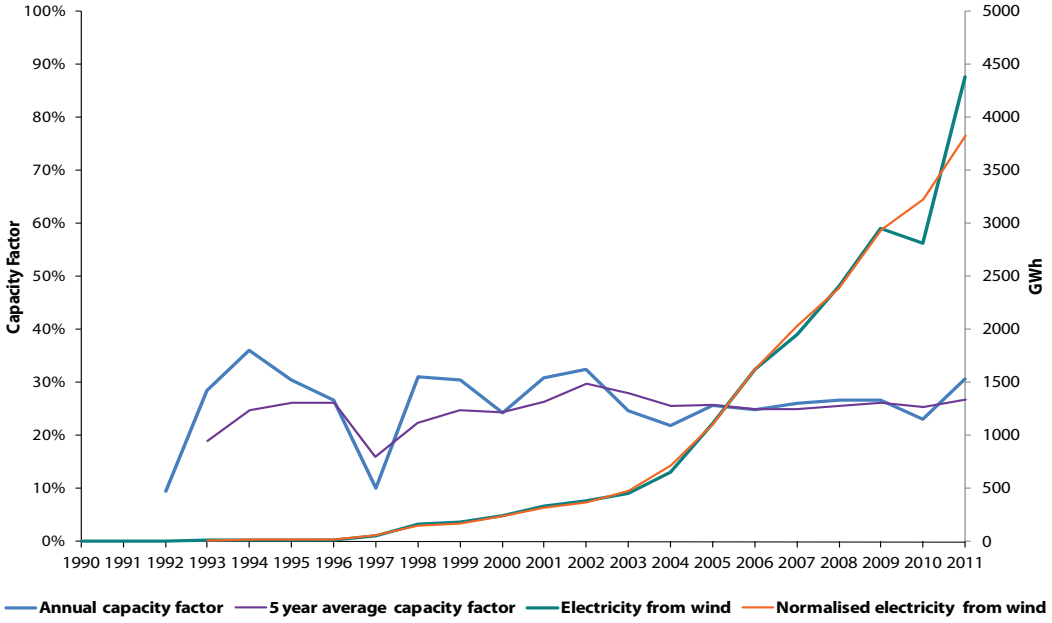
**Figure 13** *Normalised Hydro Energy Contribution 1990 - 2011*




*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 in order to calculate the normalised wind contribution towards the renewable energy target. The 5 year average capacity factor is shown in Figure 14.

**Figure 14** *Normalised Wind Energy Contribution 1990 -2011*




*Source: SEAI and EirGrid*

## 5.3.1 Combustible Renewables

### 5.3.1.1 Solid Biomass

Solid biomass covers organic, non-fossil material of biological origin which may be used as fuel for heat production or electricity generation. It is primarily wood, wood wastes (firewood, wood chips, barks, sawdust, shavings, chips, black liquor[33] etc.), other solid wastes (straw, oat hulls, nut shells, tallow, meat and bone meal etc.). Most of the solid biomass used in Ireland is for thermal energy purposes only. In electricity generation biomass is used in co-firing with fossil fuels in existing power plants. Only a small amount of biomass is currently used in the Combined Heat and Power (CHP) plants (1.1% in 2011). In the Government's 2007 Energy White Paper there is a target to have 30% biomass co-firing with peat in the three stated-owned peat-generation stations by 2015. There is also REFIT support for electricity generation from bioenergy, as detailed in Appendix 2.

### 5.3.1.2 Municipal Waste

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

#### 5.3.1.2.1 Renewable Municipal Waste

The biodegradable part of municipal waste produced by households, industry, hospitals and the tertiary sector is considered to be 'renewable biomass'.[34] The quantities used as fuel are reported on a net calorific value basis. If the renewable portion of MSW is not known then a default value of 50% is used.

#### 5.3.1.2.2 Municipal Solid Waste (MSW) - Non-Renewable

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

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

#### 5.3.1.3 Biogas

Biogas consists of landfill gas, sewage sludge gas and other biogas produced by anaerobic digestion. Landfill gas is reported separately to biogas in the Irish energy balance. In 2011 the biogas figure in the Irish energy balance consisted largely of estimates of energy generated in waste water treatment plants and other biogas installations in industry due to poor response rates to the SEAI annual surveys.

##### 5.3.1.3.1 Landfill Gas

Although produced from waste landfill gas (LFG) is regarded as a renewable or sustainable energy source for the purpose of EU renewable energy targets. Landfill gas in Ireland is only used for electricity generation. There are 15 landfill gas generators connected to the distribution grid with a MEC of 39 MW, with a further 14.5 MW contracted and 19.7 MW in the queue for connection to the electricity grid. Landfill gas is unlikely to have significant growth as an energy source due to limitations on how much waste can be sent to landfills. In 2011 there was 180 GWh produced from landfill gas representing 0.64% of the total electricity generated.

##### 5.3.1.3.2 Sewage Sludge Gas

Sewage sludge gas is produced by county councils in sewage treatment facilities and used on site in CHP plants for own use electricity and for heat treatment of the sewage. The current installed capacity is just less than 4.8 MW and produced approximately 20 GWh in 2011 or 0.07% of total electricity generated in 2011.

##### 5.3.1.3.3 Other Biogas

Biogas is produced from the anaerobic digestion of animal slurries, wastes in abattoirs, breweries and other agri-food industries. Anaerobic digestion is a cost effective method of producing heat/electricity and reducing harmful wastes. Biogas is used in CHP plants to generate electricity either for own use or for exporting to the grid. There is currently 0.9 MW installed capacity connected to the electricity distribution network with a further 21.5 MW contracted or in the queue for connection. In 2011 approximately 3.3 GWh was generated from biogas or 0.07% of total electricity generated in 2011.

### 5.3.2 Ocean Energy – Tidal & Wave

#### 5.3.2.1 Tidal Energy

The tidal accessible resource in Ireland is limited not only by the availability of suitable sites with appropriate depth and tidal stream speeds but also by commercial constraints (including development costs and market reward), policy targets and programmes in place. The resource is estimated at 0.92 TWh[35] per annum. To put this figure in context this equates to 3.3% of the total electricity demand for 2011.

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

#### 5.3.2.2 Wave Energy

It is estimated that an accessible wave energy resource of 21 TWh per annum[36] exists within the total limit of Irish waters. This equates to just over three quarters (75%) of the total electricity demand in 2011. The Government has a target of 500 MW of installed wave energy capacity by 2020 and an ambition for Ireland to be a world leader in the development of wave energy. Since 2008 a REFIT payment of 22 cents per kWh is available for electricity from wave energy. The Government also announced the development of a full scale test site for wave energy devices off the west coast of Ireland, at Belmullet, Co. Mayo, in 2008. In February 2010 a weather buoy was deployed off the coast of North Mayo to monitor wave and weather conditions.

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

### 5.3.3 Solar Electricity (Photovoltaic)

There are not many grid connected photovoltaic installations in Ireland, as it has been an expensive way of producing electricity in Ireland relative to other renewable energy sources. However, the cost of PV has been

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

reducing dramatically in recent years[37]. Over the period 2000 -2011, solar PV was the fastest-growing renewable power technology worldwide[38].

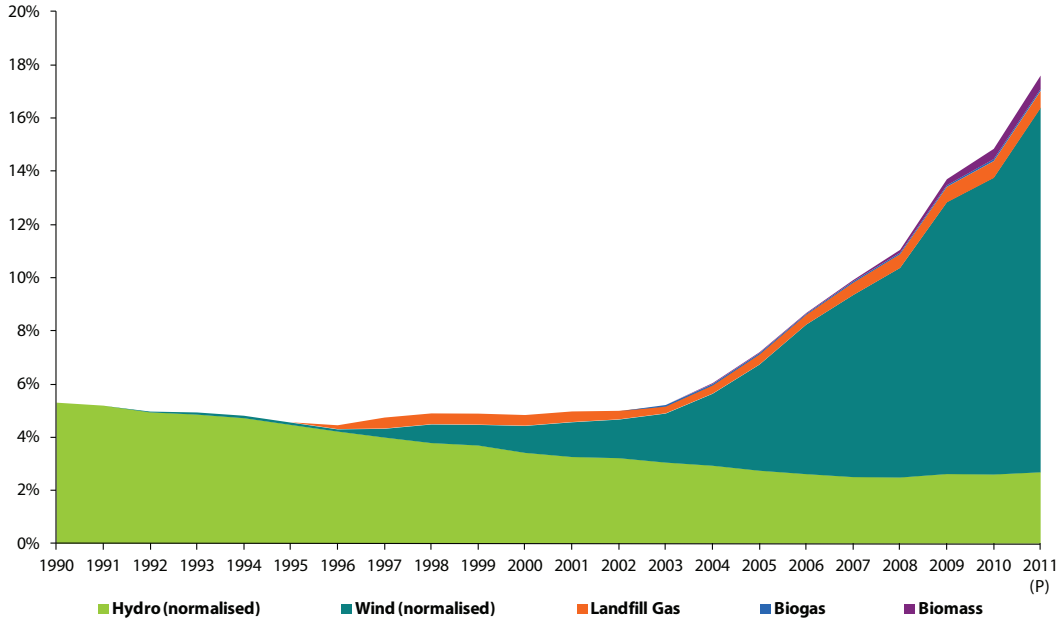
Photovoltaic energy is not supported under the Government REFIT scheme or the Better Energy Homes Scheme administered by SEAI but the domestic micro-generation rate is available from ESB Customer Services as mentioned in section A2.7 on page 19. In addition the 2008 Building Regulations for dwellings have a requirement for a contribution from renewable energy sources.

While there are also some existing standalone commercial and domestic installations, statistics are not available for these installations. There were 15 micro-generation grid connected PV installations connected at the end of 2011, with a total installed capacity of 33.9 kW.

## 5.4 Contribution of Renewable Electricity Sources

Figure 15 shows the contribution of all renewables as a percentage of gross electricity consumption. While the share from hydro has declined, Figure 15 and Table 5 show how the electricity production contribution from wind energy has grown. There has also been a small contribution from waste water biogas since 2003 and from solid biomass CHP since 2004. Normalised wind and hydro energy in 2011 accounted for 13.7% (11.2% in 2010) and 2.7% (2.6% in 2010), respectively, of Ireland's gross electrical consumption. Solid biomass was responsible for 0.5% (0.38% in 2010), while landfill gas was responsible for 0.64% (0.64% in 2010). The remaining 0.07% in 2011 (0.08% in 2010) was from biogas.

**Figure 15** *Renewable Energy (%) Contribution to Gross Electricity Consumption by Source 1990 - 2011 (Provisional)*




*Source: SEAI and EirGrid*

**Table 5** *Renewable Electricity as Percentage of Gross Electricity Consumption 1990 - 2011 (Provisional)*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 (P) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Renewables % of Gross Electricity** | **4.9** | **4.1** | **5.0** | **7.2** | **8.7** | **9.9** | **11.1** | **13.7** | **14.8** | **17.6** |
| Hydro (normalised) | 4.9 | 4.1 | 3.6 | 2.7 | 2.6 | 2.5 | 2.5 | 2.6 | 2.6 | 2.7 |
| Wind (normalised) | - | 0.1 | 1.0 | 4.0 | 5.6 | 6.8 | 7.9 | 10.2 | 11.1 | 13.7 |
| Biomass | - | - | 0.4 | 0.0 | 0.0 | 0.0 | 0.1 | 0.2 | 0.4 | 0.5 |
| Landfill gas | - | - | - | 0.4 | 0.4 | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 |
| Biogas | - | - | - | 0.1 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 | 0.1 |

*Source: SEAI*

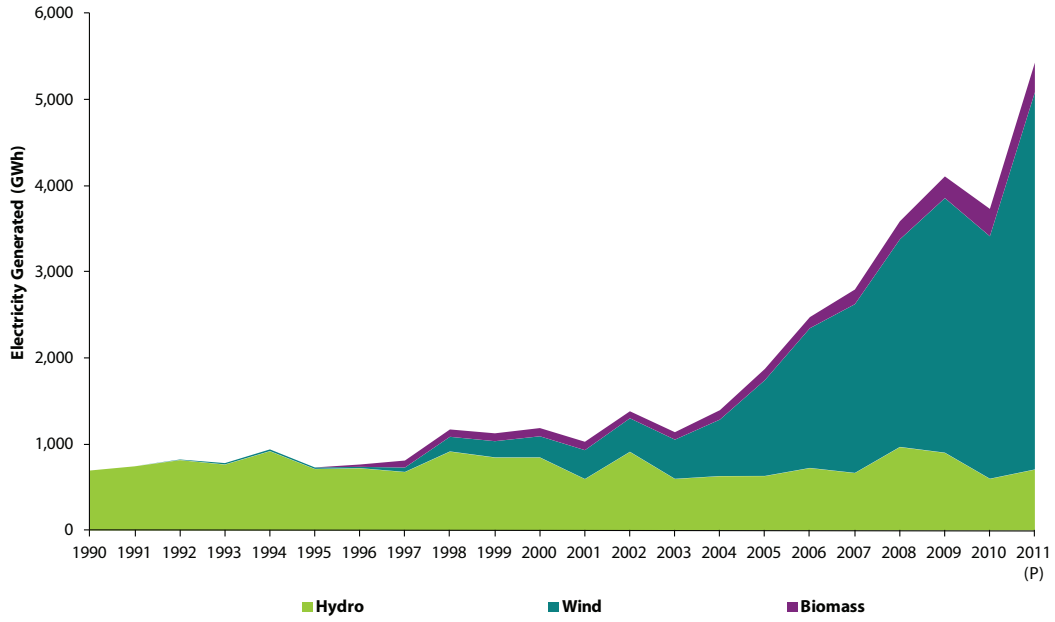
The share of electricity generated from renewable energy sources (RES-E) in 2009 was 14.8% (normalised) which meant that Ireland surpassed the EU interim target of 13.2% RES-E by 2010. While it appeared that Ireland would meet the national target of 15% of electricity generated from renewable energy in 2010, the target was missed due to reduced levels of wind speed and rainfall in 2010. Hydro electricity in 2010 was 34% less than in 2009 and

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

electricity from wind was 5% less than 2009 in spite of a 10% increase in installed capacity. The normalised RES-E contribution in 2010 was 14.8%. Provisional figures for 2011 put the normalised RES-E contribution at 17.6% , in part due to higher than normal wind energy.

Figure 16 shows the contribution from each renewable energy source to the overall RES-E mix in GWh before the normalisation rules are applied. Biomass here is a collective term comprising electricity generation from solid biomass, landfill gas and biogas, where landfill gas provides the most significant input. The more than doubling of electricity generation from renewable energy is clearly visible in Figure 16, dominated by the growth in wind energy. The total electricity generated from renewable energy reached 4,907 GWh in 2011, an increase of 14% from the 4,304 generated in 2010.

**Figure 16** *Renewable Energy Contribution (GWh) to Gross Electricity Consumption by Source 1990 - 2011 (Provisional)*




*Source: SEAI and EirGrid*

The absolute electricity generated from renewable energy sources in detailed in Table 6.

**Table 6** *Renewable Electricity Produced in GWh 1990 - 2011 (Provisional)*

| | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011(P) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Total Renewable Electricity** | **753** | **801** | **1,147** | **1,992** | **2,509** | **2,946** | **3,357** | **3,941** | **4,298** | **4,924** |
| Hydro (normalised) | 753 | 785 | 812 | 760 | 757 | 745 | 757 | 754 | 754 | 752 |
| Wind (normalised) | - | 16 | 240 | 1,102 | 1,624 | 2,031 | 2,391 | 2,936 | 3,227 | 3,830 |
| Biomass | - | - | 0 | 8 | 8 | 14 | 33 | 65 | 111 | 141 |
| Landfill gas | - | - | 95 | 106 | 108 | 139 | 159 | 169 | 184 | 181 |
| Biogas | - | - | - | 16 | 12 | 17 | 17 | 17 | 22 | 20 |

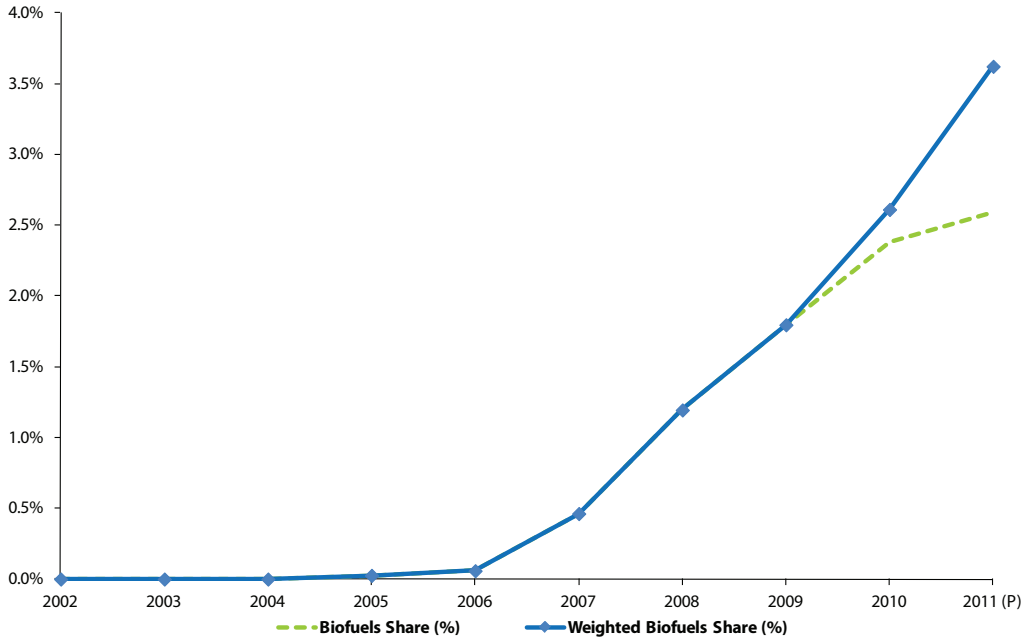
*Source: SEAI*

# 6 Renewable Transport Energy (RES-T)

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

Under the Biofuels Obligation Act 2010 fuel suppliers must include an average of 4% biofuels by volume (approximately 3% in energy terms) in their sales since 1st July 2010. Figure 17 illustrates the dramatic recent growth in renewable energy used for transport (biofuels), albeit from a low base. It shows the ratio of renewable energy used in Ireland as a share of road transport energy, in accordance with the definition in the EU Biofuels Directive (2003/30/EC), both with and without the weightings specified in the Renewable Energy Directive 2009/28/EC.

**Figure 17** *Renewable Energy as a Proportion of Road and Rail Transport Energy (RES-T) 2002 - 2011 (Provisional)*




*Source: SEA*

It is evident from Figure 17 that the growth coincided with the introduction of tax relief support for biofuels, with slow growth from 2004 to 0.06% in 2006 followed by an increase to 1.2% in 2008 and 2.6% in 2010. The Mineral Oil Tax Relief scheme (MOTR II) ended in 2010 with the introduction of the biofuels obligation scheme. The provisional figure for renewables in transport energy (RES-T) in 2011 is 3.6%. The EU Directive 2003/30/EC for RES-T of 2% by 2008 was not met. In addition, the Government target of 3% RES-T by 2010 was not met but was exceeded in 2011. Table 7 shows the data behind Figure 17 and in absolute terms.

**Table 7** *Biofuels Growth in ktoe and as a Proportion of Road and Rail Transport Energy 2002 - 2011 (Provisional)*

| ktoe | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 (P) |
|---|---|---|---|---|---|---|---|---|---|---|
| Petrol | 1,689 | 1,687 | 1,732 | 1,820 | 1,884 | 1,920 | 1,907 | 1,744 | 1,552 | 1,425 |
| Diesel | 1,956 | 2,018 | 2,176 | 2,329 | 2,509 | 2,695 | 2,673 | 2,493 | 2,238 | 2,248 |
| Biofuels (ktoe) | 0 | 0 | 0 | 1.1 | 2.6 | 21.5 | 55.4 | 64.0 | 92.5 | 97.0 |
| Petrol plus Diesel | 3,645 | 3,705 | 3,907 | 4,149 | 4,394 | 4,614 | 4,581 | 4,237 | 3,791 | 3,673 |
| ***Biofuel Penetration*** | ***0%*** | ***0%*** | ***0%*** | ***0.03%*** | ***0.06%*** | ***0.5%*** | ***1.2%*** | ***1.5%*** | ***2.4%*** | ***2.6%*** |
| Weighted biofuels (ktoe) | 0 | 0 | 0 | 1 | 3 | 21 | 55 | 77 | 102 | 137 |
| ***Weighted biofuels share*** | ***0.0%*** | ***0.0%*** | ***0.0%*** | ***0.0%*** | ***0.1%*** | ***0.5%*** | ***1.2%*** | ***1.8%*** | ***2.6%*** | ***3.6%*** |

*Source: SEAI*

Table 8 gives a breakdown of the weightings applied to the renewable transport energy sources in accordance with the Renewable Energy Directive 2009/28/EC. Currently biofuels can only be regarded as sustainable and thus count towards the renewable transport target if they provide a greenhouse gas emissions savings of at least 35% compared to the fuel they are substituting (diesel or petrol). This percentage increases to 50% by 2017 and 60% in 2018. Given the sustainability criteria it is likely that all biofuels used in 2020 will be eligible for double certification, as it will be difficult for first generation energy crop biofuels to meet these criteria.

**Table 8** *Relative Weighting for Renewable Energy Sources of Transport Energy*

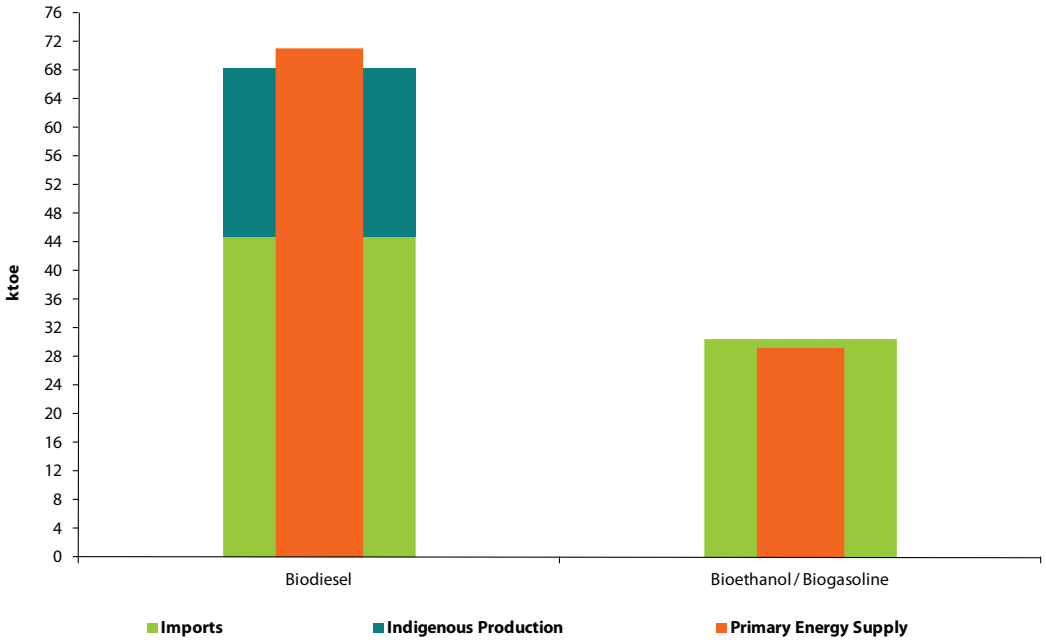
| ktoe | 2010 | 2011 | 2020 |
|---|---|---|---|
| Single credit bioethanol | 100% | 100% | |
| Double credit bioethanol | 0% | 0% | **100%** |
| Single credit biodiesel | 82% | 42% | |
| Double credit biodiesel | 18% | 58% | **100%** |
| Single credit pure plant oil | 100% | 100% | **100%** |
| Double credit pure plant oil | 0% | 0% | |
| Share of renewables in electricity used for transport (2 years prior to submission year) | 11.1% | 13.7% | **40%** |
| Share of renewables in electricity used for electric vehicles | 27.8% | 34.4% | 100% |

*Source: NORA & SEAI*

## 6.1 Biofuels

Figure 18 shows the contribution of different biofuels to Ireland's transport energy supply in 2011. The graph distinguishes between the amount of biofuels produced and imported (the thicker green bars) and the amount used (the thinner orange bar) in 2011. The amount produced and imported need not necessarily sum to the amount used due to stock changes.

**Figure 18** *Biofuels Production, Imports and Usage (2011)*



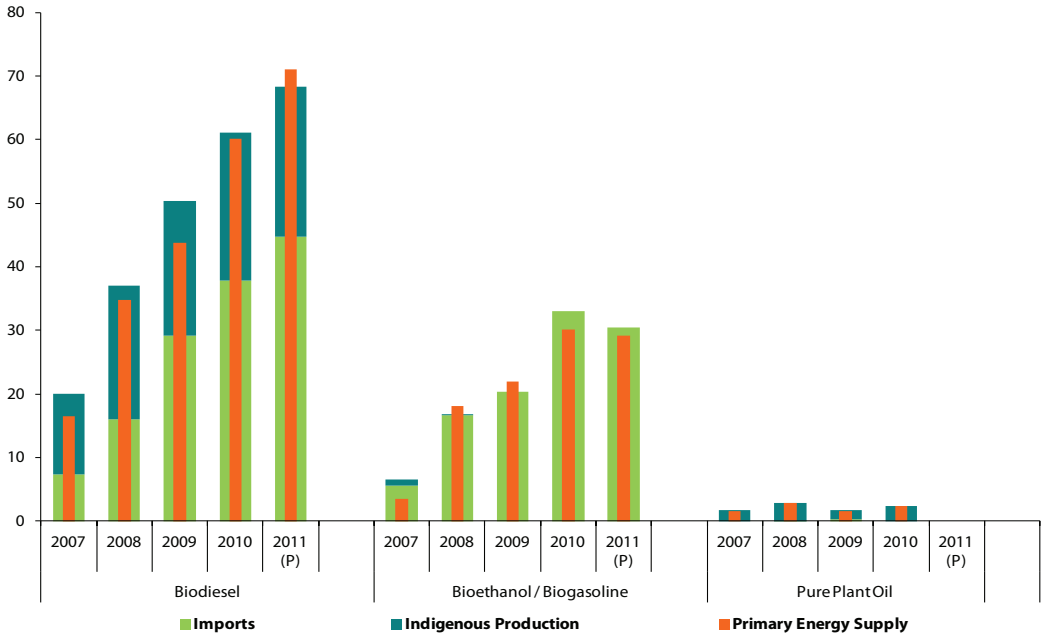

*Source: SEAI*

The dominant fuel is biodiesel, representing 71% of usage in 2011. The remaining 29% was from bioethanol. It is also apparent from Figure 18 that during 2011 there were more biofuels imported than produced indigenously. Indigenous production accounted for 24% of biofuels used or stockpiled in 2011, while imports accounted for 76%.

The proportion of indigenous production compared to imports varies according to the biofuel. All bioethanol used in Ireland in 2010 was imported, i.e. no indigenous bioethanol production, whereas pure plant oil used for transport purposes here was all produced in Ireland. There is some indigenous production of biodiesel from waste oil and from rape seed but 65% of all biodiesel consumed in 2011 was imported. The sources of biofuels are likely to come under increased scrutiny with the focus on the sustainability criteria for biofuels in the Directive 2009/28/EC 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[39]. A short timeseries of biofuel use in Ireland is detailed in Figure 19.

**Figure 19** *Biofuels Production, Imports and Usage 2007 - 2011 (Provisional)*




*Source: SEAI*

## 6.2 Electric Vehicles

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

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

According to the Vehicle Registration Unit of the Department of Transport there were 48 passenger electric vehicles in 2011 and 26 freight electric vehicles.

## 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 Bio-compressed natural gas and recent analysis points to this as one option for Ireland to meet the RES-T target using indigenous energy sources.[40]

There are continuing efforts to try to improve the energy balance (net energy gain) of biofuels. The contribution from biofuels can be enhanced by using solar as the energy source in processing raw biomass. Solar-enhanced biofuels would have a smaller carbon footprint than others[41].



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

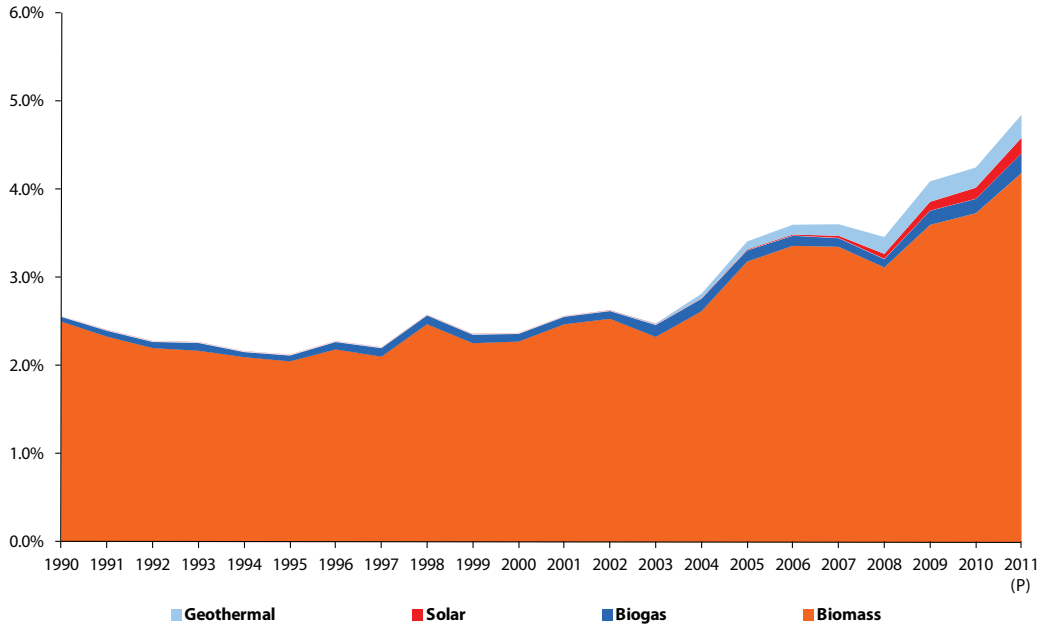
40 Smyth B.M., Ó Gallachóir B. P., Korres N. E. and Murphy J. D. (2010). Can we meet targets for biofuels and renewable energy in transport given the constraints imposed by policy in agriculture and energy? *Journal of Cleaner Production* Volume 18 Issues 16-17 Pages 1671 - 1685. .

41 International Energy Agency, 2011, Solar Energy Perspectives. Available from http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2443

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

The thermal energy market in Ireland is defined as the energy used for space, process and water heating, cooking etc. It is calculated as the residual energy requirement when energy use from transport and electricity generation are subtracted from the total final energy consumption. The calculation thus excludes electricity used for heating and cooling. Energy use for thermal purposes accounted for 34% of the total gross final energy consumption in 2011. The residential sector accounts for the largest share of final thermal energy use (47% in 2011), followed by industry (32% in 2011), services (17% in 2011) and agriculture (5% in 2011). Oil is the dominant fuel in the thermal energy market, accounting for 49% of the primary energy used for thermal purposes in 2011. Figure 20 shows the contribution of renewable thermal energy between 1990 and 2011.

**Figure 20** *Renewable Thermal Energy as a Share of Total Thermal Energy (RES-H) 1990 - 2011 (Provisional)*




*Source: SEAI*

Renewable energy contributing to Ireland's thermal energy requirements is dominated by industrial biomass use, in particular the use of waste wood to produce heat in fibre board manufacture, joineries and wood processing plants and the use of tallow from rendering plants for heat. In addition there is a small contribution in the industry data of biogas from anaerobic digestion of food processing waste products. Wastes, which are partly renewable, have been used in the non metallic mineral products sub-sector by cement manufacturers since 2009. As shown in Table 9, the increasing activity in these sub-sectors of industry led to industrial biomass use increasing from 63 ktoe in 1990 to 164 ktoe in 2007, but this has dropped back since the 2006 peak to 148 ktoe. The absolute consumption (in ktoe) of renewables for thermal energy in all sectors is detailed in Table 10.

**Table 9** *Renewable and Waste Thermal Energy (RES-H) by Sector 1990 - 2011 (Provisional)*

| Renewable & Waste Heat (ktoe) | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 (P) |
|---|---|---|---|---|---|---|---|---|---|---|
| **Overall** | **108** | **92** | **118** | **193** | **197** | **200** | **198** | **196** | **218** | **217** |
| Industry total | 63 | 62 | 100 | 163 | 164 | 152 | 139 | 136 | 148 | 148 |
| *Wood & wood products* | *61* | *59* | *96* | *109* | *106* | *93* | *88* | *85* | *100* | *96* |
| *Other industry* | *2* | *3* | *4* | *54* | *58* | *59* | *51* | *51* | *48* | *52* |
| Residential | 45 | 30 | 17 | 25 | 27 | 37 | 44 | 49 | 52 | 50 |
| Commercial/Public Services | 0 | 0 | 0 | 4 | 6 | 10 | 16 | 20 | 18 | 19 |

*Source: SEAI*

Renewable heat in industry has been decreasing since 2007 and 2009 was the first year that the decrease in industrial renewable heat was not offset by the increases in RES-H in the residential and service sectors. While the overall growth between 1990 and 2011 was 135% (average annual growth of 4.2%), there has been an average annual decrease of 2% since 2006 as detailed in Table 10. The average annual increase of nearly 9% in 2010 and the 2010 rate of consumption has been maintained according to provisional 2011 data. Since 1990 industrial biomass use increased its share from 58% of the total amount of renewable heat in use in all sectors to 68%.

Table 10 summaries the trends in renewable thermal consumption for all sectors.

**Table 10** *Trends in Renewable Thermal Energy (RES-H) by Sector 1990 - 2010*

| | Growth % | Average annual growth rates % | | | | | | Shares % | |
|---|---|---|---|---|---|---|---|---|---|
| **Renewable Heat** | **1990 - 2010** | **'90 - '10** | **'90 - '95** | **'95 - '00** | **'00 - '05** | **'05 - '10** | **2010** | **1990** | **2010** |
| Overall | 82 | 3.2 | -3.1 | 5.1 | 10.4 | 0.4 | -1.2 | 4.7 | 4.0 |
| Industry Total | 106 | 3.9 | -0.3 | 10.1 | 10.3 | -5.6 | -6.4 | 3.3 | 2.8 |
| Wood & wood products | 38 | 1.7 | -0.5 | 10.1 | 2.6 | -6.4 | -4.2 | 2.1 | 1.8 |
| Other industry | 1921 | 17.1 | 4.6 | 8.6 | 65.9 | -4.0 | -10.3 | 1.2 | 1.0 |
| Residential | 10 | 0.5 | -7.8 | -10.4 | 7.9 | 18.1 | 11.2 | 1.0 | 0.9 |
| Commercial/Public Services | - | - | - | - | - | 41.9 | 9.1 | 0.4 | 0.3 |

*Source: SEAI*

There are two notable trends behind the overall trend in renewable energy use in the residential sector, figures for which are also shown in Table 9 and Table 10. This sector's use of renewable energy is also dominated by solid biomass (wood), but it includes as well recently added geothermal and solar thermal energy. Since 1990, there has been a decrease in traditional biomass (firewood) in open fires, in line with the general decline of solid-fuel open fires. Biomass usage decreased from 45 ktoe in 1990 to 15 ktoe in 2003, a drop of 66% (or 4.6% per annum reduction).

In contrast with this is the more recent increasing trend of 'new biomass' in homes, i.e. the use of wood pellets and wood chips as the penetration of biomass boilers and stoves increased, supported under the Greener Homes Scheme[42], augmented by installations of solar energy and heat pump heating systems. The result of this has been to reverse the overall declining trend in RES-H in households. During the period of operation of this grant scheme between 2006 and 2010 renewable energy use in homes increased from 27 ktoe to 52 ktoe (18% per annum). In 2010, the use of renewable energy for heating in homes represented 24% of total renewable energy thermal energy usage in Ireland. Provisional 2011 data shows a small (4%) decline in RES-H in the residential sector compared to 2010, which is likely due to cold weather in 2010.

The recent growth in RES-H in the residential sector has also been observed in the services sector, also supported by an SEAI grant scheme, the Renewable Energy Heat Deployment (ReHeat) scheme. Since 2003, there has been a consistent 2 – 3 ktoe of biogas production from anaerobic waste water treatment in the public services sector. This has been augmented from 6 ktoe in 2006 to 10 ktoe in 2007 and 18ktoe in 2010 by solid biomass heating systems in the commercial services sector and to a lesser extent heat pump and solar thermal systems. The ReHeat scheme closed in 2011.

## 7.1 Combustible Renewables

### 7.1.1 Solid Biomass & Renewable Wastes

Solid biomass covers organic , non-fossil material of biological origin which may be used as fuel for heat production. It is primarily wood, wood wastes (firewood, wood chips, barks, sawdust, shavings, chips, black liquor[43] 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 combusted directly for heat or used in CHP units; the rest is consumed in the residential and commercial sectors.

Approximately half of all solid biomass is consumed in the wood and wood products industry sub-sector where wood wastes or wood residues of that sector are being combusted for heat. Similarly tallow, a by-product or output of the food sector is combusted for heat in that sector. Tallow accounts for 20% of all solid biomass. A further 4% in 2010 (6% provisionally in 2011) of solid biomass is accounted for in the industry sub-sector of other non-metallic mineral products where the renewable portion of solid wastes is consumed by cement manufacturers.

Wood chips, pellets and briquettes make up approximately 20% of all solid biomass consumed in Ireland. The remaining 7% is an estimate of the non-traded wood logs which are being used in open fires or stoves. The non-traded wood is estimated in the absence of available data. Estimates of the non-trade wood consumption vary with different methodologies. However, as this non-traded wood is only a small part of the total solid biomass consumption, the relative variation in estimates is negligible relative to the overall total solid biomass consumption and for the calculation of RES-H.



42 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.

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

### 7.1.2 Non-Renewable Wastes

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

### 7.1.3 Biogas

Biogas is produced from the anaerobic digestion of sewage, animal slurries, 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 both heat only or both and electricity while reducing harmful wastes. In 2010 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.

## 7.2 Geothermal Energy and Heat Pumps

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

While existing geothermal energy installations primarily involve individual sites, an investigation is being carried out into a geothermal district heating system using a deep geothermal aquifer in the Dublin basin.[44]

## 7.3 Solar - Thermal

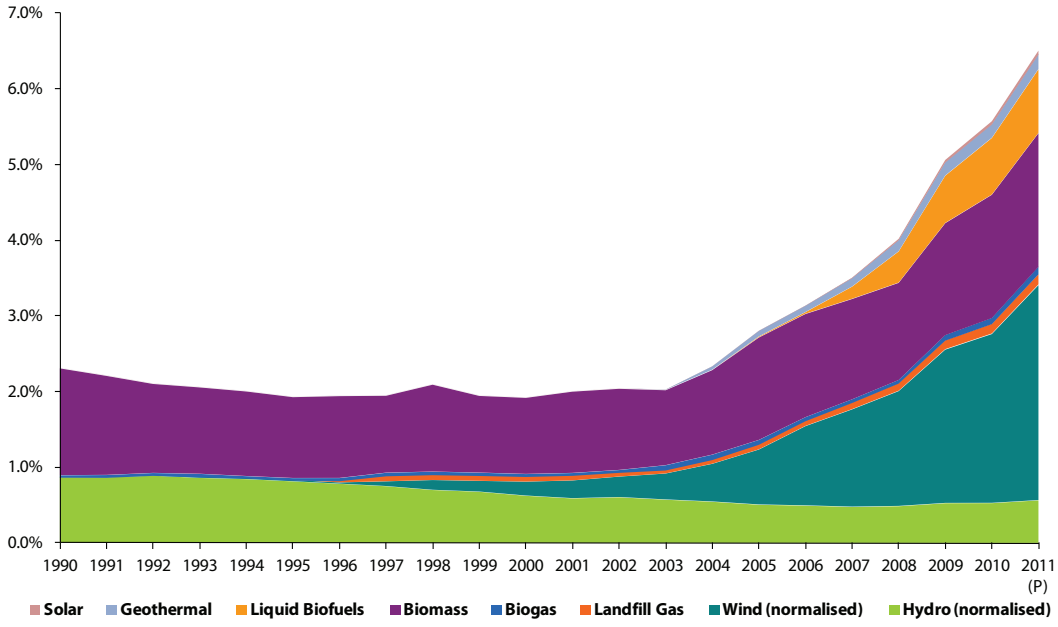
The average annual solar radiation on a longitudinal surface in Ireland is 1,000 kWh/m$^2$. The amount of solar energy used in Ireland is estimated from applications to the SEAI-administered Greener Homes Scheme[45] and the Renewable Energy Heat Deployment (ReHeat)[46] scheme for the commercial sector , which both operated from 2006 - 2011. Since 2008 all new domestic buildings are required to install renewable energy sources to provide at least 10 kWh/m$^2$/yr so any solar installations contributing to meeting this requirement of the 2008 domestic building regulations are also included. In 2010, 0.2% of the total residential sector energy requirements were met by solar thermal energy.

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

# 8 Progress Towards Targets

The contribution of renewable energy from various sources to gross final consumption according to the definition in the Directive 2009/28/EC is shown in Figure 21. Biomass here consists largely of wood and wood waste as thermal energy, with smaller contributions from electricity generated from biomass and biogas along with transport liquid biofuels. The contribution in 1990 was 2.3% and remained fairly constant until 2004. The contribution then started to rise annually, reaching 5.6% in 2010. Provisional 2011 data puts the renewable energy contribution at 6.45%.

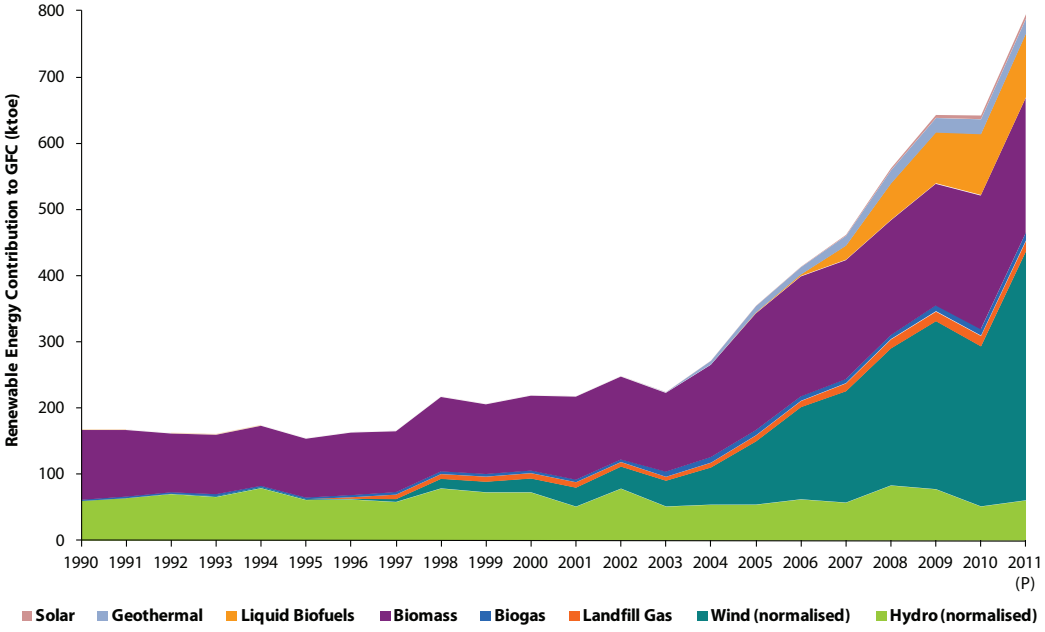
**Figure 21** *Renewable Energy (%) Contribution to Gross Final Consumption (Directive 2009) 1990 - 2011 (Provisional)*




*Source: SEAI*

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

**Figure 22** *Renewable Energy (ktoe) Contribution to GFC (Directive 2009) 1990 - 2011 (Provisional)*

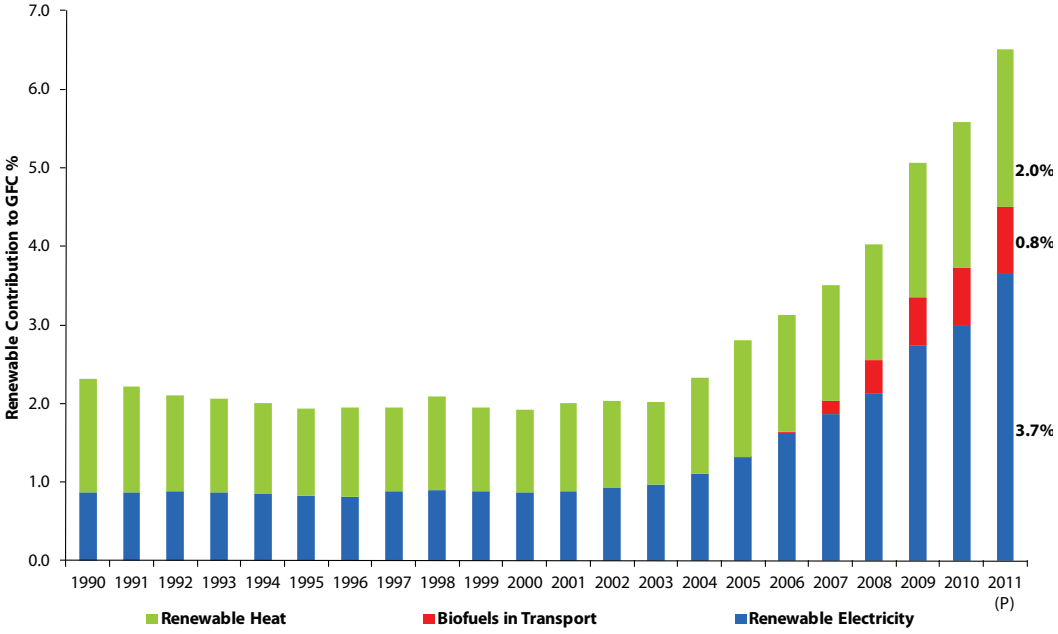



*Source: SEAI*

The more than doubling of renewable energy (from 224 ktoe to 691 ktoe) between 2003 and 2010 (17% annual average growth) is striking, due largely to the increasing contribution from wind energy. The provisional total figure for 2011 is 747 ktoe.

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

**Figure 23** *Renewable Energy (%) Contribution to GFC by Mode 1990 - 2011 (Provisional)*




*Source: SEAI*

Examining renewable energy data in terms of quantities of energy produced provides a different perspective than focusing on the proportions of renewable energy in each energy market i.e when energy use is classified into three distinct modes of application (markets), namely; mobility (transport), thermal uses (space or process heating) and electricity. Table 11 shows the contribution of renewable energy to each energy mode, presented in absolute energy terms (ktoe) rather than as a percentage of the energy consumption for those modes. The growth in wind energy noted in Figure 21 is clearly visible here in the growth in RES-E, electricity generation from renewables – as is the recent growth in biofuels, both of which are the result of policy measures.

**Table 11** *Renewable Energy (ktoe) Contribution to GFC by Mode 1990 - 2011 (Provisional)*

| ktoe | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011(P) |
|---|---|---|---|---|---|---|---|---|---|---|
| Renewable Electricity (normalised) | 60 | 64 | 102 | 161 | 213 | 237 | 304 | 347 | 370 | 423 |
| Biofuels in Transport | 0 | 0 | 0 | 1 | 3 | 21 | 55 | 64 | 92 | 97 |
| Renewable Heat | 108 | 92 | 118 | 193 | 197 | 200 | 198 | 196 | 229 | 227 |

*Source: SEAI*

Table 11 shows that renewable energy contributed 423 ktoe to Ireland in the form of electricity in 2008 and 227 ktoe in the form of thermal energy and 97 ktoe to transport energy. The contribution from renewable energy to electricity was thus 86% higher than the renewable contribution to the thermal energy market and more than three times the contribution to the transport energy market. This contrasts significantly with the situation in 2000, when the renewable energy contribution to thermal energy was close to the renewable contribution to electricity.

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

- RES-E 40% – electricity from renewable sources to contribute 40% to gross electricity consumption by 2020, with an interim target of 15% by 2010.
- RES-H 12% – 12% of thermal energy to come from renewable sources by 2020, with an interim target of 5% by 2010.

- RES-T 10% – 10% of petrol, diesel, biofuels and electricity consumed in road and rail transport to come from renewable energy sources by 2020 (mandatory Directive target), with interim national targets (biofuels penetration) of 2% by 2008 and 3% by 2010. Weighting factors are utilised in the calculation of the RES-T target only and not for the transport contribution to the overall renewable target.

Table 12 tabulates progress towards the individual modal targets and to the overall TFC target for the period 1990 – 2011 (2011 provisional). 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 proposed EU Renewable Energy Directive. Note that the individual targets cannot be added to get the overall renewables contribution. The last two columns show the targets for 2010 and 2020. This provides a sense of the scale of challenge to meet each target, and an indication of the significance of progress to date, when placed within the context of these targets.

**Table 12** *Renewable Energy progress to targets[47] 1990 - 2011 (Provisional)*

| | | | | | | | | | | | Targets | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % of each target | 1990 | 1995 | 2000 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011(P) | 2010 | 2020 |
| RES-E | 4.9 | 4.1 | 5.0 | 6.8 | 8.6 | 9.4 | 11.1 | 13.7 | 14.8 | 17.6 | 15 | 40 |
| RES-T | 0.0 | 0.0 | 0.0 | 0.0 | 0.1 | 0.5 | 1.2 | 1.5 | 2.6 | 3.6 | 3 | 10 |
| RES-H | 2.6 | 2.1 | 2.4 | 3.5 | 3.7 | 3.8 | 3.6 | 4.3 | 4.4 | 5.0 | 5 | 12 |
| Directive (2008) | 2.3 | 1.9 | 2.0 | 2.8 | 3.1 | 3.5 | 4.0 | 5.1 | 5.6 | 6.5 | | 16 |

*Source: SEAI*

In the case of RES-E, the share of electricity from renewable energy has trebled between 1990 and 2010 from 4.9% to 14.8%, an increase of 10 percentage points over 20 years. Most of this increase took place in the past ten years since 2000. However, as discussed earlier the national RES-E target of 15% by 2010 was not met as there was less wind and rain in 2010 than usually.

There was a significant increase in the share of transport energy from biofuels in 2007 and 2011, albeit from a low base. Biofuels accounted for 2.6% (in energy terms) of road transport energy in 2010, growing from 0.1% in 2006. The short term national targets of 2% by 2008 and 3% by 2010 contained in the 2007 Government Energy White Paper were not achieved despite that considerable recent growth. The penetration of renewable energy in transport was accelerated by the commencement of the Biofuels Obligation Scheme in July 2010. It specifies a requirement of a 4.2% by volume (equivalent to approximately 3% in energy terms) biofuels share of all petroleum products sold for road transport energy use.

Regarding RES-H, there was a decline in the contribution from renewable energy to thermal energy in the early 1990s, from 2.6% in 1990 to 2.1% in 1995. Between 2000 and 2007 RES-H grew from 2.4% to 4.4% in 2010. This growth in renewable energy (dominated by biomass) that has occurred is mostly due to increased activity in the industrial sub-sectors where the biomass is mostly used (wood and food sectors). There has also been recent growth in renewable energy use in the residential and services sectors with the introduction of grant support schemes, but the increases here have to date been small in volume with respect to overall thermal renewable energy consumption. The short term target of achieving a 5% renewable energy contribution to Ireland's thermal energy by 2010 was missed; as already discussed the cold weather of 2010 could have negatively impacted on this target. Provisional figures for 2011 show RES-H on or above 5%.

It is interesting to compare the absolute contributions of renewable energy to each market and then to re-examine Table 11 from this perspective. According to Table 12, over the period 1990 – 2010, the renewable energy share in electricity was, in each year, significantly higher than the renewable share of the thermal energy market. Table 11 shows, however ,that the quantity of renewable energy produced in the form of electricity was less than that in the form of thermal energy over the period 1990 – 2005. While electricity has the largest percentage share of renewable energy, it is important to highlight that electricity is the smallest energy market (19% of gross final consumption in 2011).



47 Note individual target percentages are not additive

# 9 $CO_2$ Displacement

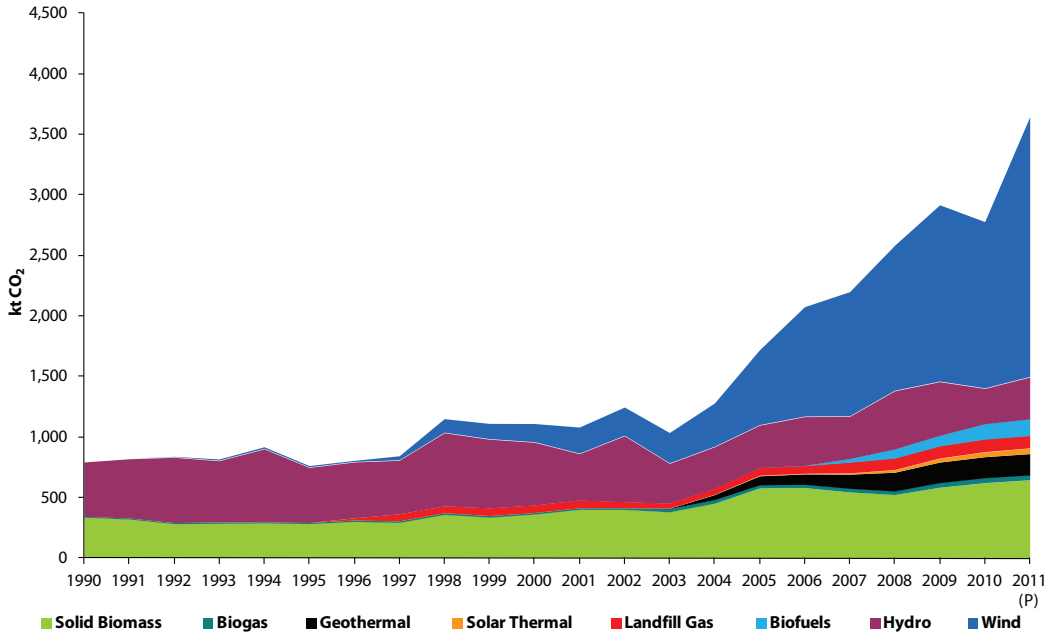
One of the benefits of determining the PEE associated with non-combustible renewables is that it can be used to calculate the amount of $CO_2$ avoided through the use of renewable energy. The primary energy equivalent (PEE) of renewable energy sources is described in section 3.2. The methodology used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

Figure 24 shows the trend in avoided $CO_2$ emissions from renewable energy for the period 1990 – 2011. It is assumed the electricity from renewables (wind, hydro, landfill gas and the electricity portion of waste water biogas) avoids the amount of $CO_2$ produced by the weighted average electricity production from the same marginal plant considered in Appendix 1 – i.e. oil and single cycle gas plant.

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

The avoided $CO_2$ emissions associated with biofuels usage in transport assumes 100% displacement of emissions from conventional fuels. The emissions from biofuels production are accounted for in this analysis in accordance with the UNFCCC reporting guidelines[48]. Thus the $CO_2$ avoided from bioethanol in transport is equated with $CO_2$ emissions that would have arisen from the petrol consumption displaced and $CO_2$ avoided from biodiesel and pure plant oil is equated with diesel consumption.

**Figure 24** *Avoided $CO_2$ from Renewable Energy 1990 to 2011 (Provisional)*




*Source: SEAI*

Based on this methodology the estimated amount of $CO_2$ avoided from renewable energy increased by 257% (7.3% per annum on average) over the period 1990 to 2010, reaching 2,774 kt $CO_2$ in 2010 and provisionally 3,640 kt $CO_2$ in 2011, illustrated in Figure 24. The emissions avoided from wind have been most significant since 2004. In 2011 wind energy avoided 2,144 kt $CO_2$ (60%), followed by solid biomass 633 kt $CO_2$ and hydro 346 kt $CO_2$.

It is worth noting that most of the emissions (75%) avoided (those in electricity generation) contribute to the targets of companies in the EU Emission Trading Scheme (ETS), while the emissions avoided in thermal and transport energy contribute to Ireland's target to achieve a 20% reduction in greenhouse gas (GHG) emissions in non-ETS sectors relative to 2005 levels.

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

# 10 The Future of Renewables in Ireland

In order to inform policy formulation, the SEAI Energy Modelling Group (EMG), in conjunction with ESRI, produced forecasts which examine energy usage in 2020. Three sets of forecast scenarios were prepared in 2011. The first, the Baseline scenario, is not anticipated to represent a realistic outcome, but is useful in presenting a base case against which other forecasts may be compared. The second, the National Energy Efficiency Action Plan (NEEAP) and National Renewable Energy Action Plan (NREAP) scenario, builds on the Baseline forecast, with additional assumptions introduced to incorporate the details published in both the NEEAP and NREAP. The third scenario, Exploratory scenarios - Potential and Risk, looks at two alternative outcomes in 2020 when some of the key assumptions in the forecasts are changed.

## 10.1 Forecast for Renewable Electricity (RES-E)

In accordance with the amended White Paper target, the new national 2020 target for RES-E is 40% of gross electricity consumption. Forecasts estimate an overall electricity demand of 27,354 MWh in 2020 according to the NEEAP/NREAP scenario. To reach 10,942 MWh of renewable electricity in 2020, an average annual growth rate of 9.2% is required. Renewable electricity had an average growth rate of over 15% per annum between 2005 and 2010 but due to the lack of wind and rain in 2010 declined by almost 7% in that year.

Assuming an installed capacity of 75 MW for ocean energy, 274 MW for biomass and 234 MW for hydro energy by 2020, an installed wind energy capacity of 3,521 MW would be required in order to achieve the 2020 RES-E target, requiring an average annual growth rate of 10% per annum. The increase in wind capacity was been approximately 20% per annum since 2006 The 40% RES-E target requires 3,968 MWe of installed renewable energy capacity, more than double the current capacity or an annual average increase of the order of 9% per annum.

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

The transport demand in 2020 under the NEEAP/ NREAP scenario is projected to be 5,375 ktoe (45% of the projected total final demand). The target for 2020 is to achieve a 10% contribution of road and rail transport, projected to be 4,011 ktoe, from renewables by a mixture of biofuels and a renewable electricity contribution from electric vehicles.

Assuming that the target of 10% electric vehicles share of the vehicle stock is achieved by 2020, this will contribute 1.7 percentage points (there is no European Commission decision yet on whether this also includes the contribution from the LUAS and DART electric rail systems) towards the 10% RES-T target in 2020. The remaining 8.3 percentage points or 333 ktoe is anticipated to be delivered by biofuels. Average annual growth rates of 15% for biofuels are required in order to meet the RES-T target.

If all of the biofuels are produced from wastes, residues, non-food cellulosic material and ligno-cellulosic material, then the contribution can be doubled. This would require only 167 ktoe to come from biofuels. However, as the multiplication factor cannot be applied for the overall target, the overall renewable share of gross final consumption my not be met in that case.

## 10.3 Forecasts for Renewable Thermal Energy (RES-H)

Forecasts to 2020 estimate a total thermal consumption of 4,126 ktoe in 2020 in the NEEAP/NREAP scenario, requiring 492 ktoe of renewable energy in order to meet the RES-H target of 12% by 2020. This corresponds to an average annual growth rate of 8.5% over the period 2010 to 2020, against the background of growth at 3.2% per annum on average between 1990 and 2010 and an overall RES-H growth rate of -1.2% in 2010. This indicates the scale of the challenge in the thermal energy sector to meet the renewables target.

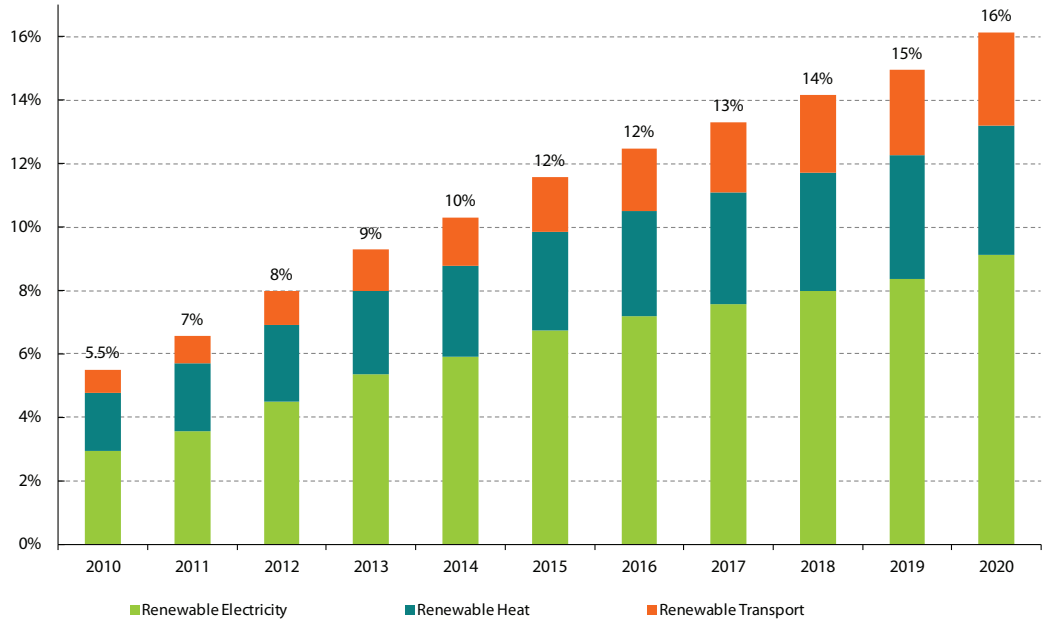
Weather effects may have slowed progress towards the renewable heat target. The demand for heat was high in 2010 as it was a cold year, particularly in January and December. However, since most of the renewable heat is consumed in the industry sector, the use of renewable heat did not increase proportionally with the increase in demand due to the cold weather.

## 10.4 Overall Renewable Energy Forecasts to 2020

Figure 25 presents the forecast of the renewable energy contribution to GFC[49] (according to the definitions in the proposed Directive) for the NEEAP/NREAP scenario, indicating separately the contribution to electricity (RES-E), transport (RES-T) and thermal energy (RES-H).

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

**Figure 25** *Renewable Energy Contribution to GFC (NEEAP/NREAP Scenario) 2010 - 2020*




*Source: SEAI*

The combined effect of the three modal targets, coupled with Ireland's energy efficiency targets, are anticipated (according to forecasts published in the 2011 Energy Forecasts for Ireland to 2020[50]) to deliver a 16% renewable energy contribution to GFC, i.e. to deliver the proposed EU Directive target for Ireland, as detailed in Table 13.

**Table 13** *Renewable Energy as a % of Gross Final Demand 2010 to 2020*

| | Gross Final Demand (ktoe) | | | Growth % | Contribution to Modal RES % | | | Contribution to overall RES % | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Renewable Energy** | **2010** | **2016** | **2020** | **'10-'20** | **2010** | **2016** | **2020** | **2010** | **2016** | **2020** |
| Renewable Electricity | 341 | 839 | 1,080 | 217 | 14.8 | 33 | 40 | 2.95 | 7 | 9 |
| Renewable Heat | 228 | 386 | 477 | 109 | 4.4 | 9 | 12 | 1.8 | 3 | 4 |
| Renewable Transport | 92 | 231 | 345 | 273 | | | | 0.7 | 2 | 3 |
| *for RES-T* | *93* | *239* | *392* | *320* | *3* | *6* | *10* | | | |
| **Total Renewable Energy** | **662** | **1,456** | **1,902** | **204** | | | | | | |
| **RES** | | | | | | | | **5.5** | **12** | **16** |

*Source: SEAI*

The forecasts also predict a 24% decrease in non-emissions trading $CO_2$ emissions compared to 2005 levels if the NEEAP/NREAP scenario targets are achieved, which exceeds the requirement under EU Decision 406/2009/EC to achieve a 20% reduction on 2005 levels by 2020.

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

50 SEAI, 2011. *Energy Forecasts in Ireland to 2020* - 2011 Report available from http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group

# Glossary of Terms

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

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

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

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

**Bioenergy:** Bioenergy is energy from biomass.

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

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

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

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

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

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

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

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

**Gross Final Consumption (GFC):** The Renewable Energy Directive (2008/28/EC) defines gross final consumption of energy as the energy commodities delivered for energy purposes to manufacturing industry, transport, households, services, agriculture, forestry and fisheries, including the consumption of electricity and heat by the energy branch for electricity and heat production and including losses of electricity and heat in distribution.

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

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

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

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

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

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

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

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

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

**RES-E:** Renewable energy sources in electricity.

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

**RES-T:** Renewable energy sources used for transportation.

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

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

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

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

**Tallow:** The fatty tissue or suet of animals.

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

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

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

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

# References


Bazillian et.al., 2012, Reconsidering the Economics of Photovoltaic Power. http://www.bnef.com/WhitePapers/download/82

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

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

Dept. of Communications, Energy and Natural Resources, 2012, Strategy for Renewable Energy: 2012 – 2020. http://www.dcenr.gov.ie/NR/rdonlyres/9472D68A-40F4-41B8-B8FD-F5F788D4207A/0/RenewableEnergyStrategy2012_2020.pdf

Dept. of Communications, Energy and Natural Resources, 2012, Ireland First Progress Report on National Renewable Energy Action Plan. http://www.dcenr.gov.ie/NR/rdonlyres/B611ADDD-6937-4340-BCD6-7C85EAE10E8F/0/IrelandfirstreportonNREAPJan2012.pdf

Dept. of Communications, Energy and Natural Resources, 2010, Draft Offshore Renewable Energy Development Plan (OREDP). http://www.dcenr.gov.ie/NR/rdonlyres/2990B205-534E-486E-8586-346A6770D4B6/0/Draft_13_OREDPWebversion.pdf

Dept .of Communications, Energy and Natural Resources, 2010, Ireland National Renewable Energy Action Plan. http://www.dcenr.gov.ie/NR/rdonlyres/03DBA6CF-AD04-4ED3-B443-B9F63DF7FC07/0/IrelandNREAPv11Oct2010.pdf

Dept. of Communications, Energy and Natural Resources, 2010, Geothermal Energy Development Bill. http://www.dcenr.gov.ie/Natural/Exploration+and+Mining+Division/Geothermal+Energy+Legislation/

Dept. of Communications, Energy & Natural Resources, 2008, Public Consultation on the Biofuels Obligation Scheme - September 2008. http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels+Obligation+Scheme.htm

Dept. of Communications, Energy & Natural Resources, 2008, Renewable Energy Feed-in Tarriffs (REFIT Tarriffs). http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Sustainable+and+Renewable+Energy+Division.htm

Dept. of Communications, Energy & Natural Resources, 2008, Charles Parsons Award Advert, http://www.dcenr.gov.ie/Energy/Parsons_Awards_Advert.htm

Dept. of Communications, Energy & Natural Resources, 2008, Irish Energy Research Council's Energy Research Strategy, http://www.dcenr.gov.ie/Energy/Office+of+the+Chief+Technical+Advisor/Irish+Energy+Research+Council.htm

Dept. of Communications, Energy & Natural Resources, 2007, Bioenergy Action Plan, http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Report+for+website.htm

Dept. of Communications, Energy & Natural Resources, 2007, Energy White Paper 2007 - Delivering a Sustainable Energy Future for Ireland, http://www.dcenr.gov.ie/Energy/Energy+Planning+Division/Energy+White+Paper.htm

Dept. of the Environment (2007), Carbon Budget 2008, http://www.environ.ie

Dept. of the Environment (2007), National Climate Change Strategy 2007-2012, http://www.environ.ie/en/Publications/Environment/Atmosphere/

Dept. of Finance, 2011, 2012 Budget. http://budget.gov.ie/Budgets/2012/2012.aspx

Dept. of Finance, 2009, 2010 Budget. http://budget.gov.ie/Budgets/2010/2010.aspx

EirGrid, 2012, TSO and DSO Non-Wind Generators - Connected. http://www.eirgrid.com/customers/connectedandcontractedgenerators/

EirGrid, 2012, System Records, http://www.eirgrid.com/operations/systemperformancedata/systemrecords/

EirGrid, 2012, Transmission System Contracted Wind Farm List. www.eirgrid.com/media/TSO_Wind_Contracted_080612.pdf

EirGrid, 2012, TSO Non-Wind Generators - Connected (11 January 2012). http://www.eirgrid.com/customers/connectedandcontractedgenerators/

EirGrid, 31st Dec 2011, Installed Wind Report. http://www.eirgrid.com/media/Connected%20Wind%20Farms%20-%2031%20Dec%202011.pdf

EirGrid, 2011, Gate 3 Node Assignment List 24 May 2011. http://www.eirgrid.com/gate3/nodeassignments/

EirGrid, 2009, Grid 25 - A Strategy for the Development of Ireland's Electricity Grid for a Sustainable and Competitive Future, http://www.eirgrid.com

Environmental Protection Agency (2007), National Allocation Plan 2008 - 2012. Available from http://www.epa.ie/downloads/pubs/air/etu/NAP2%20_Final%20_Allocation%20_Decision_040320082.pdf

European Council, 2009, COUNCIL REGULATION (EC) No 73/2009 of 19 January 2009 establishing common rules for direct support schemes for farmers under the common agricultural policy and establishing certain support schemes for farmers, amending Regulations (EC) No 1290/2005, (EC) No 247/2006, (EC) No 378/2007 and repealing Regulation (EC) No 1782/2003. http://eur-lex.europa.eu/en/index.htm

European Parliament and Council, 2009, DECISION No 406/2009/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 23 April 2009 on the effort of Member States to reduce their greenhouse gas emissions to meet the Community's greenhouse gas emission reduction commitments up to 2020. http://eur-lex.europa.eu/en/index.htm

European Parliament and Council, January 2008, Directive of the European Parliament and of the Council on the promotion of the use of energy from renewable sources. http://ec.europa.eu/energy/climate_actions/doc/2008_res_directive_en.pdf.

European Parliament and Council, 2003, DIRECTIVE 2003/30/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 8 May 2003 on the promotion of the use of biofuels or other renewable fuels for transport. http://eur-lex.europa.eu/en/index.htm

European Parliament and Council, 2001, DIRECTIVE 2001/77/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market. http://eur-lex.europa.eu/en/index.htm

European Union, 2009, EU Effort Sharing Decision 2009/406/EC. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0136:0148:EN:PDF

European Union, 2007, EU Climate and Energy package. http://ec.europa.eu/environment/climat/climate_action.htm

International Energy Agency, 2012, Photo Voltaic Power System – Annual report 2011. http://www.iea-pvps.org/index.php?id=6

International Energy Agency, 2011, Solar Energy Perspectives. http://www.iea.org/publications/free_new_Desc.asp?PUBS_ID=2443

Irish Government, 2012, Statutory Instrument (SI) 33 of 2012 European Union (Biofuel Sustainability Criteria) Regulations 2012. http://www.irishstatutebook.ie/home.html

Irish Government, 2011, Statutory Instrument (SI) 477 of 2011 European Communities (Birds and Natural Habitats) Regulations 2011. http://www.irishstatutebook.ie/home.html

Irish Government, 2011, Statutory Instrument (SI) 147 of 2011 European Communities (Renewable Energy) Regulations 2011. http://www.irishstatutebook.ie/home.html

Irish Government, 2011, Statutory Instrument (SI) 148 of 2011 – Sustainable Energy Act 2002 (Section 8(2)) (Conferral of additional functions – Renewable Energy) Order 2011. http://www.irishstatutebook.ie/home.html

Irish Government, 2010, Statutory Instrument No. 322 of 2010 - Biofuel Obligation and Miscellaneous Provisions) Act 2010. http://www.irishstatutebook.ie/home.html

Irish Government, 2009, Statutory Instrument 98 of 2009. http://www.irishstatutebook.ie/home.html

Irish Government, 2008, Statutory Instrument no. 235 of 2008. http://www.irishstatutebook.ie/home.html

Irish Government, 2007, Statutory Instrument no. 83 of 2007. http://www.irishstatutebook.ie/home.html

Irish Government, 2006, Statutory Instrument no. 666 of 2006. http://www.irishstatutebook.ie/home.html

Office of the Revenue Commissioners, 2008, Business Expansion Scheme: Relief for Investments in Corporate Trades. http://www.revenue.ie/en/business/reliefs-incentives.html

Office of the Revenue Commissioners, 2008, Relief for Investment in Renewable Energy Generation. http://www.revenue.ie/en/business/incentives/renewable-energy-generation-taxrelief.html

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.

Ó Gallachóir B. P., Rout U. K., Lavigne D., Chiodi A. and Gargiulo M., 2010, Modelling Ambitious CO2 Reduction Targets for Non-ETS Sectors. *Proceedings International Energy Workshop* 2010 June 20 – 23 2010, Stockholm.

Ó Gallachóir B. P., Gardner P., Snodin H. & McKeogh E. J., 2007, Wind Energy and System Security - The Grid Connection Moratorium in Ireland. *International Journal of Energy Technology and Policy (IJETP)* 5 633 – 647

Ó Gallachóir B. P., O'Leary F., Bazilian M., Howley M. & McKeogh E. J., 2007, 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

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

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*

Sustainable Energy Authority of Ireland (SEAI), 2011, Energy Forecasts in Ireland to 2020 (2011 report). http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group

Sustainable Energy Authority of Ireland, 2011, Energy in Ireland 1990 - 2010 (2011 report). http://www.seai.ie/Publications/Statistic_Publications/EPSSU_publications

Sustainable Energy Authority of Ireland, 2009, Ireland's Wave Energy Resource. http://www.seai.ie/Renewables/Ocean_Energy/Ireland's_Wave_Energy_Resource

Sustainable Energy Authority of Ireland, 2009, Tidal and Marine Current Energy Resource in Ireland. http://www.seai.ie/Renewables/Ocean_Energy/Irelands_Tidal_Energy_Resource/

Sustainable Energy Authority of Ireland, 2007, Renewable Energy Research and Development Document (2007 Report). http://www.seai.ie/Renewables/Renewable_Energy_Policy/Policy_Support_Mechanisms/13_RERDD-Overview.pdf

# Appendix 1 Primary Energy Equivalent Methodology

The primary and final energy consumption for non-combustible renewable energy sources such as wind and hydro is very similar. For most 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[51]. For non-combustible renewable sources (wind and hydro) the primary energy is equated with 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 equated with the electricity output from a non-combustible renewable energy plant, such as a wind farm or hydro-power plant. An alternative approach is to equate 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.

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

This raises a key question however – what electricity generation is being displaced by renewable energy-generated electricity? In a previous report[52], the calculation of PEE was based on a theoretical displacement by each kWh from renewable energy of a kWh generated from the entire fossil fuel plant mix. The methodology used here draws on approaches that have been developed for use in baselining studies in credit-based emissions trading systems[53,54].

Renewable energy plants are not generally displacing electricity from either 'must-run' plants (peat) or from baseload plants (coal fired station at Moneypoint). Calculating the PEE based on the remaining plant provides a more accurate estimate than using the entire plant mix and the approach is known as the Operating Margin Approach. The assumption underpinning this approach is that the renewable plant is displacing the last plants to be dispatched to meet electricity demand, i.e. the marginal oil and gas plants. There are clear limitations in this analysis but it does provide useful indicative results.

The limitations and caveats associated with this methodology include that it ignores any plant used to meet the associated reserve requirements of renewables. These open cycle plants will typically have lower efficiency and generate increased $CO_2$ and $NO_x$ emissions compared with CCGT and these emissions should be incorporated into the analysis. The purpose of presenting a simplified analysis here is to provide initial insights into the amount of fossil fuels that are displaced by renewables and the amount of emissions thereby avoided.

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

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

53 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.

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

# Appendix 2 Policy Measures

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

## A2.1 General Policy Measures

### A2.1.1 Renewable Energy Research, Development and Demonstration

In August 2002, SEAI launched the Renewable Energy RD&D programme[55]. 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[56] 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 awards57 in 2006. The awards are designed to develop and stimulate overall energy research capacity, particularly in certain priority areas. They provide funding for research groups active in energy research and research training; in particular, full-time researchers, PhD scholarships for engineering graduates and summer student placements.

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

Section 486 Corporate Tax Relief came into effect in 1999. Corporate equity investments in certain renewable energy projects are eligible for tax relief58 in the form of deduction from a company's profits for an investment in new ordinary shares in a qualifying company. Budget 2007 announced that the qualifying period for the scheme of tax relief for corporate investment in certain renewable energy projects was being extended from 31 December 2006 to 31 December 2011.

Statutory Instrument 98 of 200959 brings into operation the provisions of section 51 of the Finance Act 2007. This section extends the qualifying period for relief under section 486 B of the Taxes Consolidation Act 1997 to 31 December 2011. To qualify for the relief the energy project must be in the solar, wind, hydro or biomass technology categories, and be approved by the Minister for Public Enterprise (now the Minister for Communications, Marine and Natural Resources). The investment in respect of which relief can be given is capped at the lesser of 50% of all capital expenditure or €9.525 million for a single project. Investment by a company or group is capped at €12.7 million per annum and unless the shares are held for at least five years by the company the relief will be withdrawn.

### A2.1.6 Business Expansion Scheme (BES)

Business Expansion Tax Relief[60] is a tax relief incentive scheme that provides tax relief for investment in certain corporate trades. Investments in renewable energy qualify for BES relief. Budget 2007[61] announced that the scheme was being renewed from 1 January 2007 for a seven year period to 31 December 2013. Individual investors holding a BES equity investment for a minimum period of five years can benefit from tax relief, at their marginal rate, in respect of investments of up to a maximum of €150,000 per year.

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

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

### A2.1.7 Accelerated Capital Allowance Scheme

The Accelerated Capital Allowance Scheme[62] (ACA) was introduced in the Finance Act 2008. The scheme enables businesses to write off the entire cost of a specified set of energy efficient technologies include renewable energy technologies in the first year of purchase (including electric vehicles and micro-generators such as wind turbines >5kW, solar PV and biomass boilers).

### A2.1.8 Carbon Tax

A carbon tax at a rate of €15 per tonne of carbon dioxide ($CO_2$) was introduced on fossil fuels in the 2010 budget[63]. The tax was applied to petrol and auto-diesel with effect from midnight, 9 December 2009; and from 1 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 is subject to a Commencement Order. Exemption from the tax will apply only to participants in the EU Emissions Trading Scheme (ETS) in respect of fuels so covered. On that basis, electricity is not subject to the carbon tax. One of the consequences of the carbon tax on fossil fuels is to improve the cost competitiveness of renewables. The carbon tax was increased to a rate of €20 per tonne of carbon dioxide produced in the 2012 budget. The carbon tax liability per unit of energy is detailed in Table 14.

**Table 14** *Carbon Tax*

| Fossil Fuel | Unit | € | Effective |
|---|---|---|---|
| Petrol | litres | 0.034 | 7 December 2011 |
| Auto-diesel | litres | 0.046 | 7 December 2011 |
| Kerosene | litres | 0.043 | 7 December 2011 |
| Marked Gas Oil | litres | 0.035 | 7 December 2011 |
| LPG | litres | 0.013 | 7 December 2011 |
| Fuel Oil | litres | 0.044 | 7 December 2011 |
| Natural Gas | MWh | 4.1 | 1 May 2012 |
| Peat Briquettes | Bale | | waiting on commencement order |
| Coal | kg | | waiting on commencement order |

*Source: Department of Finance*

### A2.1.9 Emissions Trading

The EU emissions trading scheme came into operation on 1 January 2005. One allowance gives the holder the right to emit one tonne of CO2 or the equivalent amount of another greenhouse gas. The scheme operates on a "cap and trade" basis. EU Governments are required to set an emissions cap for each ins[t]allation in the scheme. The number of allowances allocated to each installation must be set down in the National Allocation Plan (NAP)64 for the period in question, which must be approved by the European Commission. The first trading period ran from Jan 1st 2005 to December 31st 2007. The second trading period began on January 1st 2008 and runs for five years until the end of 2012.

### A2.1.10 Renewable Energy Information

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

### 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.

62 Details available from http://www.seai.ie/Your_Business/Accelerated_Capital_Allowance/
63 Details available from http://www.budget.gov.ie/Budgets/2010/2010.aspx and http://www.environ.ie/en/Publications/Environment/Atmosphere/
64 Available from http://www.epa.ie/downloads/pubs/air/etu/NAP2%20_Final%20_Allocation%20_Decision_040320082.pdf

## A2.2 Renewable Electricity Policy Measures

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

In May 2006 a REFIT[65]. for renewable electricity generation was announced as a successor to the alternative energy requirement scheme (AER) which was based on power purchasing agreements at prices determined by auction. The initial categories supported were large scale wind (>5MW), small scale wind (<5MW), Hydro (<5MW), Biomass landfill gas (LFG) and other Biomass. The renewable energy feed-in tariff (REFIT) scheme was extended to include Offshore Wind, Ocean Energy and Bioenergy Combined Heat and Power (BioEnergy CHP) new plant from 1 June 2008 . This support mechanism is to help meet the national target of 15% of all electricity to come from renewable energy sources by 2010 and 40% by 2020. The support levels are linked to the consumer price index. . The support for any particular project cannot exceed 15 years and may not extend beyond 2030.

### A2.2.2 Renewable Electricity Grid Connections

The Commission for Energy Regulation[66] (CER) decides on the methodology for electricity grid connection offers. Since December 2004 renewable electricity generators wishing to connect to the transmission or distribution systems have been subject to group processing of connection applications through a series of successive "Gates". The current system in operation is termed the "Gate 3" process. This system ensures priority grid access for renewable generators. Exemptions are available for "public good" projects, subject to approval by the CER.

### A2.2.3 Gate 3

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

### A2.2.4 Electricity Transmission System Upgrade Plan — Grid 25[67]

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 is due to be operational by 2012. Investigations are ongoing into other possible interconnectors to either the UK or France. EirGrid states in its Grid 25 development plan that it is likely there will be at least one other interconnector by 2025. Ireland is also being considered for 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.

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

The DS3 programme was setup 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[68], 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

65 See http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Sustainable+and+Renewable+Energy+Division.htm
66 Commission for Energy Regulation website: http://www.cer.ie/
67 Available from http://www.eirgrid.com/media/Grid%2025.pdf
68 The CHP deployment programme is a grant support scheme administered by SEAI. See http://www.seai.ie/Grants/CHP for details.

(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 programme69 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.

ESB Customer Supply offer a domestic micro-generation rate70 of €0.09 per kWh with the addition of €0.10 per kWh available for the first 3000 kWh exported to the grid annually for up to 4000 domestic wind, PV, micro CHP and hydro generators for the next three years (2009 to 2011), which will be paid over a five-year period.

### A2.2.10 Smart Metering

A pilot smart metering scheme will inform on analysis on the feasibility of implementing smart meters throughout Ireland. Smart metres facilitate maximising use of indigenous low carbon renewable energy sources.

### A2.2.11 Guidelines for planning authorities on Wind Energy Development

Guidelines for planning authorities on wind energy were developed in order to facilitate a consistent approach by planning authorities both in identifying areas for development of renewable energy and having regard to potential impacts.

### A2.2.12 Planning Permission Exemptions for Renewable Energy Technologies

Planning exemptions for micro-generation renewable energy technologies were introduced for domestic[71] purposes in 2007 and other buildings[72] in 2008. The exemptions apply to wind turbines, solar panels, heat pumps and biomass subject to certain conditions in each case.

### A2.2.13 Strategic Environmental and Natura Assessment (SEA)

A Strategic Environmental and Natura Assessment on offshore wind, wave and tidal energy development is underway. . A finalised report is due to be published in 2012.

### A2.2.14 The Ocean Energy Prototype Development Fund

The Ocean Energy Prototype Development Fund, which is grant for 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 study73 into the design and architecture of a future offshore energy grid. The Irish Government are also involved in the Irish Scottish Links on Energy Study74 (ISLES) examining issues around offshore grid between Ireland, Northern Ireland and Scotland. The ISLES report is expected to be published in 2012. Ireland is also a participant in the North Seas Offshore Grid Initiative.

### A2.2.16 Birds and Habitat Regulations SI 477 of 2011

This legislation75 published in September 2011 introduced new regulations to ensure adequate protection of birds and habitats.

69 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.
70 Details available from https://www.esb.ie/esbcustomersupply/residential/energy_efficiency/micro_generation_tariff.jsp
71 Statutory Instrument No.83 of 2007. Available from http://www.irishstatutebook.ie/home.html
72 Statutory Instrument No.235 of 2008. Available from http://www.irishstatutebook.ie/home.html
73 http://www.eirgrid.com/media/EirGrid%20Offshore%20Grid%20Study.pdf
74 http://www.islesproject.eu/
75 http://www.irishstatutebook.ie/home.html

## A2.3 Renewable Thermal Energy Policy Measures

### A2.3.1 Building Regulations (Part L Amendment) Regulations 2008[76]

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

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

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

### A2.3.2 Planning and Development Legislation

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

### A2.3.3 Greener Homes Scheme Phase II

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

### 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.

### A2.3.5 Better Energy Workplaces Scheme

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

### A2.3.6 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[77] 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.

### A2.3.7 Bioenergy Establishment Scheme[78]

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 is being made available to support the planting of a further 1,000 hectares in 2010.



76 Available from http://www.environ.ie/en/DevelopmentandHousing/BuildingStandards/

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

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

### A2.3.8 Wood Biomass Harvesting Machinery Scheme[79]

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[80] 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. The Bioenergy Working Group established by the Department of Communications, Energy and Natural Resources (DCENR) will report to the Renewable Energy Development Group (REDG) in 2010 with implementation plans to achieve the targets established in the Bioenergy Action Plan.

### A2.4.2 Biofuels Mineral Oil Tax Relief (MOTR)

The Biofuels MOTR scheme II[81] 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) Bill 2010[82] is currently subject to Oireachtas approval. It is expected to come into effect from July 2010. The Bill will place an obligation on fuel suppliers to ensure that biofuels comprise 4% of the volume of their supplies, equivalent to approximately 3% in energy terms. The scheme will be 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.

The Bill attaches an important condition: that biofuels must come from sustainable sources as defined by Article 17 of the Renewable Energy Directive 2009/28/EC. Compliance with the biofuels obligation scheme can be met with tradable certificates. Biofuels produced from biodegradable or residue will be issued with two certificates per litre whereas all other biofuels will receive one certificate per litre.

### A2.4.4 Electric & Hybrid Vehicles

The 2008 Finance Bill[83] provides relief for hybrid, electric and flexible-fuel vehicles of up to €2,500 for cars registered between 1 July 2008 and 31 December 2010 on the vehicle registration tax (VRT) payable, in addition to the benefit of the 2008 annual motor tax (AMT) $CO_2$ system. Businesses can write off 100% of the cost of purchase against tax under the Accelerated Capital Allowance scheme.

From January 2011 full battery electric cars will qualify for financial support[84] of up to €5,000, and plug in hybrid for up to €2,500, depending on the vehicle cost.

79 Dept. of Agriculture and Food (2007), Wood Biomass Harvesting Machinery Scheme. Available from http://www.agriculture.gov.ie/contentarchive/forestry/woodbiomassharvestingmachineryscheme/
80 Available from http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Report+for+website.htm
81 Details available from http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels+Scheme+II/
82 Details available from http://www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels+Obligation+Scheme.htm
83 Details available from http://www.budget.gov.ie/Budgets/2008/2008.aspx
84 Details available from http://www.seai.ie/News_Events/Press_Releases/Electric_Cars_a_Reality_for_Ireland.html

**Sustainable Energy Authority of Ireland**
**Energy Policy Statistical Support Unit**
Building 2100
Cork Airport Business Park
Co. Cork
Ireland

t +353 1 808 2100
f +353 1 808 2066
e epssu@seai.ie
w www.seai.ie

**Sustainable Energy Authority of Ireland**
Wilton Park House
Wilton Place
Dublin 2
Ireland

t +353 1 808 2100
f +353 1 808 2002
e info@seai.ie
w www.seai.ie

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

EUROPEAN REGIONAL DEVELOPMENT FUND

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