

Energy Forecasts for Ireland to 2020

2009 REPORT



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Report prepared by

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Energy
Modelling Group

Sustainable Energy Ireland

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

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

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

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

Energy Modelling Group

There are growing demands for SEI to support evidence-based policy formation in the area of energy efficiency and renewable energy. This includes *ex ante* assessments of the impact of different policy measures against baseline energy forecasts. Such assessments involve modelling a range of short-term and medium-term scenarios for energy demand and supply growth.

SEI's Energy Modelling Group (EMG), established in 2009 specifically to meet this need, provides high-quality analysis and policy advice on a range of energy-climate issues at the national and European level. Along with EPSSU, it operates within SEI's Strategy and Innovation Division.

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Executive Summary

This report from SEI's Energy Modelling Group, which presents forecasts of energy supply and demand for the Irish Republic over the period to 2020, is intended to inform future policy on energy efficiency, renewable energy, climate change and security of supply.

Three scenarios are analysed. Each of these is based on recent ESRI economic projections which take account of the current economic shock but which assume a recovery starting in 2011. The base year figures are all calibrated against SEI's 2008 National Energy Balance, but the projections for 2009 onwards have been adjusted in different ways to take account of assumptions about the implementation of efficiency measures and renewable energy investments.

For the **Baseline** scenario (which incorporates policy measures that were in place prior to the end of 2008 but which does not include the introduction of any new measures) the primary energy requirement reaches 17,052 ktoe by 2020. This represents an increase of 4.3% compared to the 2008 reference period. The fastest growing sectors are projected to be transport and services. Oil remains the dominant fuel, reflecting its continued use in road transport and residential heating. Final energy consumption increases to 15,002 ktoe in 2020, an increase of 12.0% compared to 2008. The contribution of renewable energy towards final consumption grows to 7.2% over the first three years, but it levels off thereafter. The electricity generation sector becomes increasingly dependent on natural gas-fired plants and Ireland remains a net importer of electricity.

The *Baseline* is not an expected outcome, but rather a counterfactual against which alternative policy scenarios can be compared. Compared to last year's *Baseline* energy forecast (which was based on ESRI's 'credit crunch' scenario) the final consumption in 2020 is 9% lower. More than half of this is attributable to efficiency measures being incorporated, with the remainder being due to lower economic growth.

The **White Paper Plus** scenario incorporates additional efficiency savings as described in Ireland's National Energy Efficiency Action Plan. It also assumes the achievement of renewables targets (including biomass co-firing) and power generation fuel diversity targets in the 2007 *Energy White Paper*, as well as subsequent Government targets for the contribution of renewable electricity (RES-E) and the market share of electric vehicles by 2020. Compared to the *Baseline*, Ireland's primary energy requirement in 2020 is reduced by 5.7% and its final energy consumption is reduced by 8.1%. Much of this reduction is achieved in the services and residential sectors, with relatively little occurring in the transport sector. The contribution of renewable energy towards total final consumption reaches 15.4% by 2020. This reflects a weighted average of the national targets for electricity, heating and transport, which are respectively 40% RES-E, 12% RES-H and 10% RES-T. Compared to *Baseline*, the growth in renewable electricity generation is attributable to a mixture of wind, ocean and biomass. Despite a significant drop in coal-fired and peat-fired electricity generation, the fuel share of gas-fired plants falls below 60%. Ireland becomes a net exporter of electricity (1475 GWh in 2020).

The *White Paper Plus* scenario assumptions pre-date the EU Renewables Directive, but it nevertheless shows Ireland nearly achieving the 16% RES target from that Directive. Given that the amount of wind capacity currently being processed for connections (Gate 3) is well above what is assumed in this scenario, it suggests a clear path to meeting both the pre-existing national targets and the new overall EU target of 16%.

This is illustrated in the **Exploratory** scenario is a variant of the *White Paper Plus* in that it assumes the same efficiency savings and the same contribution to RES-H and RES-T. It also assumes the same level of interconnection to Great Britain (1400MW) but the generation mix includes additional Onshore and Offshore wind capacity, resulting in 52% RES-E and an overall RES of 17.5%. Net exports of electricity reach 3,475 GWh in 2020. The scenario represents an initial exploration by SEI of the possible consequences of high penetration levels of variable renewable generation that may arise on foot of the Gate 3 connection process.

Thus the *White Paper Plus* and *Exploratory* scenarios illustrate that a range of options exist to meeting both the national and EU renewable energy targets. Analysis suggests, however, the choice of path will also be important for the delivery of greenhouse gas targets. This is because the new EU targets for greenhouse gas abatement treats emissions in the EU Emissions Trading Scheme (EU ETS) differently from those outside. Ireland's domestic target for greenhouse gases focuses on the non-ETS sectors, which means that delivery of this target must be driven by renewable penetration in heat and transport, or by a shift from these modes to renewable electricity.

The report concludes by outlining a programme of further work with the objective of improving SEI's modelling and forecasting capability. In this regard, SEI looks forward to continued co-operation with other stakeholders.

1. Introduction

Under the Sustainable Energy Act 2002, SEI has a national role in compiling and disseminating projections of energy production and use. This report by SEI's Energy Modelling Group (EMG) presents a range of energy supply and demand forecasts for the Republic of Ireland over the period to 2020.

The main purpose of the report is to inform debate on future energy trends, particularly as they relate to EU policies on energy efficiency, renewable energy, climate change, air quality and security of energy supply. This includes providing information for use by Ireland's Environmental Protection Agency (EPA) in preparing energy-related projections of greenhouse and trans-boundary gas emissions.

The tables summarising the data and growth rates relating to the energy forecast in this report are grouped in time periods relevant to policy discussions, i.e. the period 2008–2012, representing:

- the period covered by the Kyoto Protocol targets for greenhouse-gas emissions
- the period to 2020 representing the period covered by Ireland's *White Paper on Energy* and EU Directive targets for renewable energy and greenhouse-gas emissions

Our methodology builds on four years of work previously undertaken in association with the Economic and Social Research Institute (ESRI). A common goal of the ongoing development work undertaken by SEI is the improved availability of disaggregated data to underpin its modelling and forecasting capability. This report can be read in conjunction with the recent SEI publication *Energy in Ireland 1990–2008*, which provides the context of historical trends in energy supply and energy use.

The remainder of the report is structured as follows:

Section 2 describes the methodology by which the projections have been prepared. It also sets out the key assumptions along with a number of caveats.

Section 3 presents a *Baseline* energy projection for the Republic of Ireland. This scenario does *not* constitute an expected outcome. Rather, it is a reference against which the expected impact of various policy measures can be compared.

Section 4 presents energy forecasts corresponding to two feasible policy scenarios.

Section 5 discusses the implications of the *Baseline* and policy scenarios, particularly as they relate to the achievement of Ireland's EU obligations on the promotion of renewable energy and reduction of greenhouse-gas emissions.

Section 6 concludes with a discussion of the further work which is planned to improve the quality and expand the scope of future modelling work.

2. Methodology and Assumptions

SEI's energy forecasts are grounded in economic forecasts, principally GDP by sector. Last year's energy forecasts¹ were based on a 'credit crunch' macroeconomic scenario contained in ESRI's 2008 Medium Term Review, using the HERMES model. The assumptions were amended somewhat to take account of analysis reported in the autumn 2008 Quarterly Economic Commentary. These macroeconomic projections took into account the downturn in construction activity and, in a limited way, the reduction of credit availability arising from the collapse of Lehman Brothers Holdings Inc.

The 2009 forecast is consistent with ESRI's 'World Recovery' scenario² in which Ireland experiences a sharp economic decline during 2009, a further small decline during 2010, and modest growth in 2011–20. The macroeconomic trends are summarised in *Table 1*.

Table 1 Key macroeconomic assumptions

	Growth Rate (% per annum)			Average Annual % Growth	
	2008	2009	2010	2010-15	2015-20
GDP	-3.0%	-7.8%	-2.3%	5.2%	3.3%
GNP	-2.7%	-9.0%	-1.9%	5.5%	3.3%
Personal Consumption	-1.0%	-6.9%	-2.9%	2.8%	4.0%
	2008	2009	2010	2015	2020
Number of Households (thousands)	1,560	1,585	1,606	1,756	1,931
Average No. per Household	2.8	2.8	2.8	2.6	2.5

CO₂ prices (*Table 2*) are required as inputs to the HERMES model. For the period 2009–12, they are based on the EU Allowance futures market prices prevailing in Q4 2009. For the period 2013 onwards, they are based on shadow carbon prices in the current Department of Finance guidelines. Oil and coal prices projected to 2020 (*Table 2*) are also required as inputs to the energy forecasting model. These are broadly in line with the price assumptions underpinning EU DG-TREN's most recent forecast for EU-27, based on the PRIMES model. This is in contrast to last year's forecast, which instead used International Energy Agency (IEA) forecast data.

Table 2 Fuel and CO₂ price assumptions

Carbon Price	2008	2009	2010	2015	2020
€/tCO ₂	23.84	13.83	14.54	20.74	30.74
Fuel Prices	2008		2010	2015	2020
	€ ₂₀₀₈ / (MWh)		€ ₂₀₀₈ / (MWh)	€ ₂₀₀₈ / (MWh)	€ ₂₀₀₈ / (MWh)
Coal	8.10		7.20	8.70	10.20
Oil	56.40		26.50	41.50	51.60
Gas (GCV)	25.80		17.70	21.30	26.20
Peat	12.00		12.0	12.0	12.0

Whereas last year's energy forecasting exercise comprised just two sets of supply/demand projections (*Baseline* and *White Paper*), this year's exercise considers three: *Baseline*, *White Paper Plus* and *Exploratory*. The *White Paper Plus* scenario this year includes policies agreed since the *White Paper*³ was finalised. The *Exploratory* scenario is essentially a variant on the *White Paper Plus* that takes into account additional installed wind power. The base-year energy data for all three scenarios is calibrated against EPSSU's 2008 National Energy Balance.

The rationale for these choices (which were made by SEI in consultation with DCENR, ESRI, EPA and other interested parties) is as follows.

¹ SEI 2008 *Energy in Ireland 1990–2007*. Available from www.sei.ie/statistics

² This is one of two scenarios analysed in ESRI Research Series 007 'Recovery Scenarios for Ireland', published May 2009. The alternative scenario is slightly more pessimistic, assuming global recovery in 2012 rather than 2011. See www.esri.ie/UserFiles/publications/20090513115638/RS007.pdf. The economic indicators in *Table 1* differ slightly from those in the May 2009 paper, reflecting a more recent analysis.

³ Delivering a Sustainable Energy Future for Ireland, DCMNR, March 2007.

- In line with previous guidance from DG-TREN, our *Baseline* scenario to 2020 incorporates the expected impact of policies and measures that were in place by the end of the prior calendar year (2008). It excludes a number of policy targets which do not yet have measures in place to deliver them. The *Baseline* energy projection can therefore be regarded as a yardstick against which we measure the impact of recent and forthcoming policies. It also forms the energy basis for EPA's *With Measures* projections of energy-related greenhouse-gas emissions. The *Baseline* differs from last year's in that the macroeconomic projections are significantly different, the forecasts are calibrated to a further year's historical data, and new energy efficiency measures introduced in the last year have led to energy savings – notably, the 2008 Building Regulations, private-car taxation changing to an emissions-based system and the Home Energy Savings Scheme.
- The *White Paper Plus* scenario presents an alternative view to 2020 which assumes the achievement of key policy targets for 2020 that are contained in the 2007 *White Paper on Energy*, along with those subsequently agreed in the Programme for Government. These include:
 - a 20% improvement in energy efficiency across all sectors
 - a 33% energy end-use efficiency savings target for the public sector
 - 400MW installed CHP by 2010 and 800MW by 2020
 - renewable electricity (RES-E) reaching 40% market share
 - 500MW of installed ocean energy generation capacity
 - renewable heat (RES-H) reaching 12% market share
 - renewable energy in transport (RES-T) reaching 10% market share⁴ (including the 10% electric vehicles penetration target
 - the market share of natural gas-fired electricity generation not exceeding 50%
- It is noted that not all of these targets have measures associated with them at this stage. As such, the *White Paper Plus* set of forecasts inherently assumes that additional measures will be devised to bridge any remaining gap to meeting these targets, that such measures will be implemented on a timely basis, and that they will have the intended effect. The *White Paper Plus* projections can be regarded as a basis for analysing the implications of existing national energy policy targets, particularly in respect of our EU emissions reduction and renewables obligations. They form the energy basis of EPA's *With Additional Measures* projections of greenhouse-gas emissions.
- The *Exploratory* scenario, which differs from *White Paper Plus* in the assumed level of renewable electricity generation, is one of many possible future policy scenarios. The ongoing work is prompted partly by a desire to explore the relationship between national and EU targets for renewables penetration. The chosen scenario also enables a preliminary exploration of the possible implications of high wind penetration, reflecting the level of successful applications under the recent Gate 3 process. The assumed penetration of variable renewables is broadly consistent with the *High Renewables* (53% RES-E) variant scenario in EirGrid's recent economic study of interconnection between the All-Island grid and Great Britain.⁵

The underlying econometric analysis for all the national energy forecasts is derived from the ESRI's HERMES macroeconomic model. The procedure for generating the national energy forecasts is as follows:

1. Within ESRI's HERMES Energy Sub-Model, fuel and electricity demand projections are calculated based on the macroeconomic projections for Ireland using historical econometric time-series relationships.
2. In the *Baseline* scenario projections, SEI amends the HERMES Energy Sub-Model output to take account of the expected impact of energy efficiency measures put in place before the end of 2008 but which are considered too recent to be detectable in any time-series analysis.⁶
3. SEI then generates the *White Paper Plus* scenario demand projections incorporating the additional targeted energy savings to be delivered by Ireland's National Energy Efficiency Action Plan 2009–20.
4. SEI also generates the *White Paper Plus* scenario supply projections taking into account the *White Paper* targets for renewable thermal energy and renewable transport energy. In the case of transport, the more recent target for electric vehicles is also taken into account.

⁴ Transport market in this case excludes aviation and international shipping.

⁵ www.eirgrid.com/media/Executive_Summary_Interconnection_Economic_Feasibility_Report.pdf

⁶ This includes legislation such as the 2008 Building Regulations and changes to the motor tax regime in 2009.

5. ESRI uses the IDEM electricity dispatch model⁷ to generate the *Baseline* scenario supply projections for electricity based on SEI-specified renewable contributions. The *White Paper Plus* and *Exploratory* supply scenarios are also generated in this way, using progressively higher installed renewable generation capacity.

Although SEI regards the resulting projections as the best ones currently available for the Republic of Ireland, there are some important limitations to our current methodology. First, it entails iterating between two separate models which operate on different mathematical principles. The sectoral detail is more limited than that available for historical data, particularly with respect to transport and industry. The preparation of Baseline figures requires a degree of subjective judgment by SEI to reconcile ‘bottom-up’ policy measures with ESRI’s HERMES Energy Sub-Model.⁸ Last, but not least, we assume that effective measures can be designed and implemented to satisfy each policy target. It seems likely that a more robust approach will be needed to satisfy the European Commission regarding Ireland’s progress towards the targets specified in its National Energy Efficiency Action Plan and the forthcoming National Renewable Energy Action Plan.

7 ESRI’s IDEM model produces half-hourly dispatch data for each type of generation (plus imports and exports) participating in the All-Island market.

8 For simplicity, we assume that efficiency measures implemented prior to the end of 2006 are fully captured in the ESRI’s econometric equations, but that those implemented after 2006 are not captured at all. Possible alternative modelling approaches are discussed in Section 6.

3. Baseline Forecast to 2020

The *Baseline* projections are intended to act as a reference case or as counterfactual to the two policy scenarios outlined in Section 4. As such, the *Baseline* does not represent a realistic outcome. A further purpose of the *Baseline* is in comparing the policy assumptions and corresponding results from forecasts generated in a given year with those generated in previous years in order to track progress. If the *Baseline* changes significantly (separately from changes due to changed macro-economic assumptions), this indicates a transition from an aspiration, expressed in terms of targets, to policy action, expressed in terms of measures implemented to deliver targets.

Implicit in the *Baseline* projection are the effects of those policy measures, concerning both energy efficiency and renewable energy. Those legislated for and in place by the end of 2008 are as follows:

Energy Efficiency

- SEI Public Sector Building Demonstration Projects
- Non-residential Building Regulation 2005
- SEI Large Industry programmes⁹
- Existing ESB demand-side management initiatives
- Residential Building Regulations 2002
- SEI House of Tomorrow Programme
- SEI Warmer Homes Scheme
- Transmission and distribution efficiency improvements
- Winter Peak Demand Reduction Scheme
- Current installed capacity of CHP¹⁰.

Additional measures that were more recently implemented and hence reflect a change from the *Baseline* forecasts generated in 2008, are as follows:

- SEI Small Business (SME) Supports
- Accelerated Capital Allowance Scheme
- Residential Building Regulations 2008
- SEI Home Energy Saving scheme
- Efficient Boiler Standards
- Improved economy of private-car fleet
- VRT/motor tax changes

Renewable Energy

- Renewable electricity generation that has secured grid connection agreement and can avail of support under the Renewable Energy Feed-in Tariff (REFIT)¹¹
- Biofuels supported by the Biofuel Mineral Oil Tax Relief scheme¹² and Biofuels Obligation Scheme to 2010.

3.1 Primary Energy Supply Forecasts (*Baseline*)

Figure 1 shows the historical and forecast trend for primary energy supply for the period 1990–2020. The trend assumes significantly lower levels of growth in the period 2008–2020 (4.3% or 0.3% per annum) than those experienced since 1990 (3.1% per annum 1990–2008).

Primary demand in 2008 (16.3 Mtoe) is expected to grow to 17 Mtoe by 2020. This trend includes a 1.2% average annual reduction in primary energy requirement to 2012 and a 1.2% average annual growth thereafter to 2020.

⁹ Due to the long-running nature of the Large Industry programme, it is assumed that 25% of programme effect is already accounted for in *Baseline*. The remaining 75% of savings are subtracted in the base case, given future ramp-up of programme impact over time.

¹⁰ A 5% growth rate has also been incorporated in the base case to reflect historic deployment.

¹¹ See <http://www.dcenr.gov.ie/NR/rdonlyres/3B13ECAA-9351-41E0-8B44-7C02E98E4F50/0/AdditionalREFITcategories.pdf>

¹² See: [http://www.dcenr.gov.ie/Energy/Latest+News/Mineral+Oil+Tax+\(MOT\)+Relief.htm](http://www.dcenr.gov.ie/Energy/Latest+News/Mineral+Oil+Tax+(MOT)+Relief.htm)

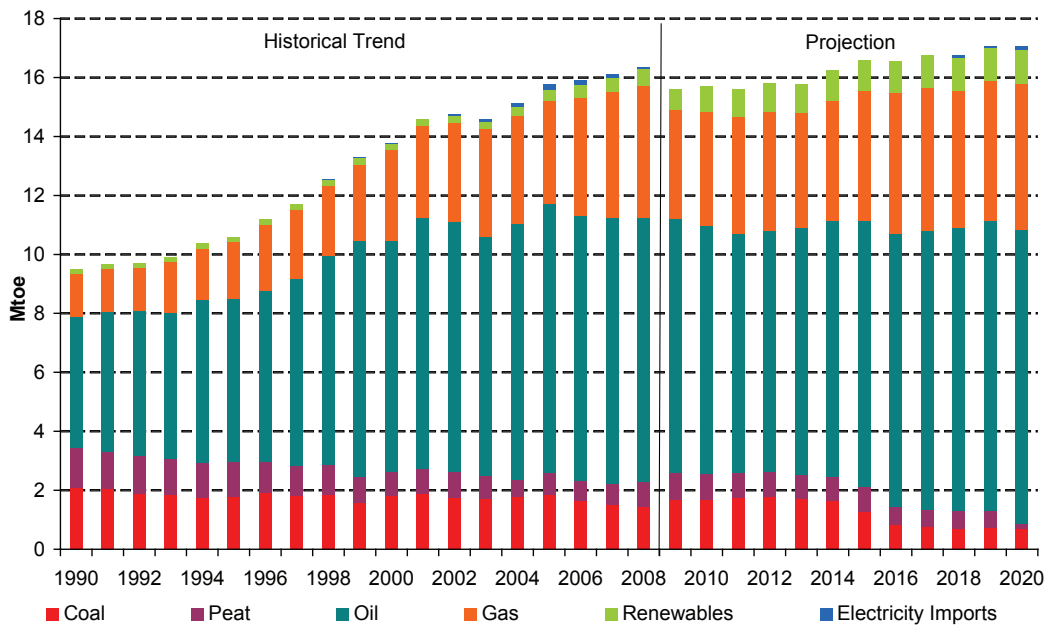
Figure 1 Total Primary Energy Requirement (TPER) 1990–2020 (Baseline)

Table 3 presents the projections for individual fuels, growth rates and fuel shares in 2008, 2012 and 2020.

Table 3 Total Primary Energy Requirement by Fuel 2008–2020 (Baseline)¹³

Fuel	Total Primary Energy Supply (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Coal	1,436	1,773	705	-50.9	-5.8	5.4	-10.9	9	11	4
Oil	8,964	8,181	9,952	11.0	0.9	-2.3	2.5	55	53	58
Gas	4,491	4,048	4,947	10.1	0.8	-2.6	2.5	27	26	29
Peat	845	848	174	-79.4	-12.3	0.1	-18.0	5	5	1
Renewables	581	954	1,169	101.1	6.0	13.2	2.6	4	6	7
Electricity Imports	39	-243	106					0	-2	1
Total	16,356	15,561	17,052	4.3	0.3	-1.2	1.2			

In this scenario, oil is projected to remain the dominant fuel, accounting for 58% of energy supply in 2020. An increase in gas is also expected, bringing its share of TPER to 29% in 2020. The contribution from coal and peat continues to decline over the period, to lows of 4% and 1% shares of TPER in 2020 respectively.

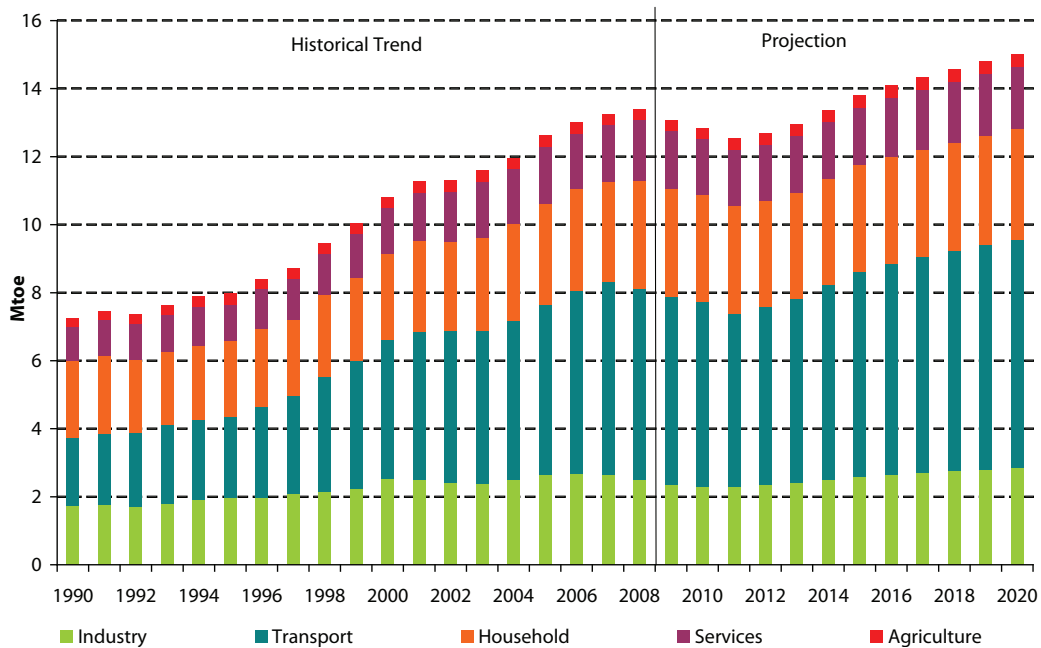
Renewable energy is anticipated to grow significantly in the short term (over 13% per annum) between 2008 and 2012, in providing additional electricity and transport energy, according to the targets specified in the input assumptions. Renewables are thus projected to contribute 6% of energy supply by 2012, but with little progress thereafter.

Electricity trading with the UK increases with the arrival of the new 500MW East-West Interconnector, leading to Ireland becoming a net exporter of electricity in 2012, reflecting increased amounts of variable wind energy on the system, but returning to a position of net imports by 2020.

3.2 Final Energy Demand Forecasts (Baseline)

Figure 2 shows the historical trend and projections in final energy demand attributed to the individual sectors. Energy demand grows at 0.9% per annum on average over the period 2008–2020, compared with 3.5% per annum on average from 1990 to 2008. A number of factors underpin this, in particular the changed economic circumstances and the impact of energy efficiency measures.

¹³ Net imports represented. A negative number represents net exports.

Figure 2 Total Final Demand by Sector 1990–2020 (Baseline)

This year's *Baseline* demand forecast in 2020 is 9% lower than that produced last year. More than half of this reduction (4.8%) is due to expected energy savings from existing energy efficiency measures now included in the *Baseline* in 2009. The remaining (4.2%) reduction is due to macroeconomic effects.

Table 4 shows the *Baseline* forecast changes in final energy demand and resulting sectoral shares to 2020. Over the period 2008–2020, transport demand grows by almost 20%, raising its share of final demand to 45%.

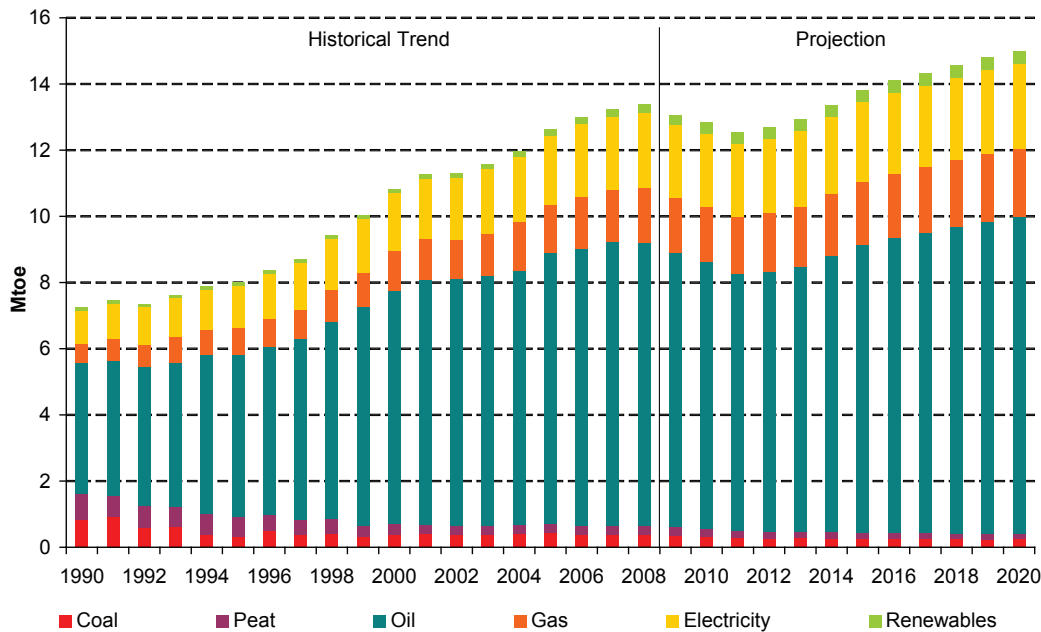
By contrast, energy in domestic dwellings shows modest growth rates (1.8% for residential and 0.7% for services) and the combined share of these two sectors falls to 34% by 2020.

Industry energy demand grows by 14% over the period, reflecting economic growth rates in industry during the economic recovery period (post-2010).

Table 4 Final Energy Demand by Sector 2008–2020 (Baseline)

Sector	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Sectoral Shares %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Household	3,185	3,112	3,242	1.8	0.1	-0.6	0.5	24	25	22
Industry	2,496	2,348	2,854	14.3	1.1	-1.5	2.5	19	18	19
Services	1,807	1,656	1,821	0.7	0.1	-2.2	1.2	13	13	12
Agriculture	300	343	373	24.6	1.8	3.5	1.1	2	3	2
Transport	5,612	5,237	6,713	19.6	1.5	-1.7	3.2	42	41	45
Total	13,400	12,697	15,002	12.0	0.9	-1.3	2.1			

These changes in final energy demand by sector are reflected in the changes in the fuel mix contributing to energy demand, which are shown in *Figure 3*. The increasing dominance of oil since 1990 is evident: from a share of 55% in 1990 to 64% in 2020. The decline of solid fuels is also clear over the entire period. The renewable energy contribution to final demand shown here excludes electricity generated from renewables; this forms part of the electricity share of demand.

Figure 3 Total Final Consumption by Fuel 1990–2020 (Baseline)

The growth rates and shares of individual fuels are shown in *Table 5*. All fuels, with the exception of natural gas and renewable energy, are expected to decline for the period 2008 to 2012. Over the period 2012 to 2020, the biggest factors driving renewed energy demand growth are:

- increasing demand within the transport sector, primarily for motor fuel
- increasing gas and oil consumption in the industry sector
- the growth in electricity demand in the services sector

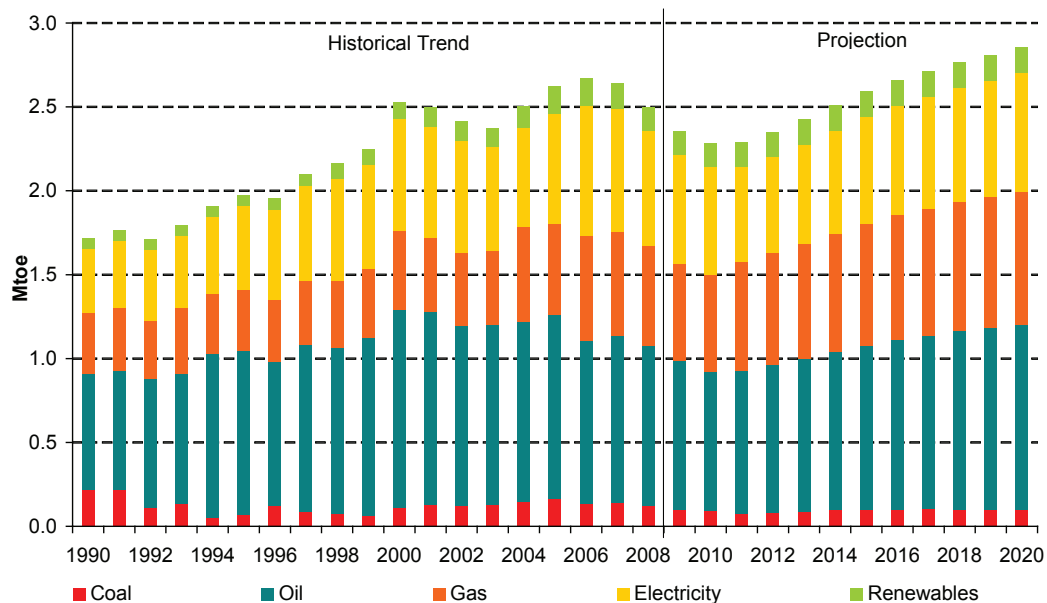
There are no significant changes in the shares of fuels in final energy demand in 2020 relative to 2008, where oil continues to dominate (64%) followed by electricity (17%) and gas (14%). Renewable energy remains small, with some growth anticipated from biofuels in transport. The historic decline in solid fossil fuels (coal and peat) continues, to shares of 2% and 4% respectively.

Table 5 Final Energy Demand by Fuel 2008–2020 (Baseline)

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Coal	380	271	238	-37.3	-3.8	-8.1	-1.6	3	2	2
Oil	8,534	7,835	9,607	12.6	1.0	-2.1	2.6	64	62	64
Gas	1,659	1,778	2,056	24.0	1.8	1.8	1.8	12	14	14
Peat	280	214	147	-47.4	-5.2	-6.5	-4.6	2	2	1
Renewables	254	348	381	50.4	3.5	8.2	1.2	2	3	3
Electricity	2,294	2,249	2,569	12.0	0.9	-0.5	1.7	17	18	17
Total	13,401	12,695	15,000	11.9	0.9	-1.3	2.1			

3.2.1 Industrial Final Energy Demand

Final energy use in industry by fuel is shown in *Figure 4*. Historic demand in this sector increased at the rate of 2.1% per annum (1990–2008). A decline in demand began in 2007 and is expected to continue until 2010. A growth averaging 2.5% per annum is projected for 2012–2020.

Figure 4 Industry Final Energy Demand by Fuel 1990–2020 (Baseline)

Comparing this trend to the 2008 *Baseline* suggests a 3.7% increase in the projected 2020 energy demand. This increase is due to the current recession prompting cost-cutting (wages, materials, etc), resulting in increased international competitiveness, and hence allowing for stronger growth during economic recovery.

The effect of these macro assumptions (a 9% increase on the 2008 *Baseline* projection for 2020) is offset by a 5.2% reduction in demand based on energy savings from measures¹⁴ included in this 2009 *Baseline*.

Table 6 Industry Final Energy Demand by Fuel 2008–2020 (Baseline)

Industry	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Coal	125	80	100	-20.4	-1.9	-10.5	2.7	5%	3%	3%
Oil	950	882	1,104	16.2	1.3	-1.8	2.8	38%	38%	39%
Gas	596	667	793	33.1	2.4	2.8	2.2	24%	28%	28%
Renewables	139	148	150	7.9	0.6	1.5	0.2	6%	6%	5%
Electricity	686	571	707	3.1	0.3	-4.5	2.7	27%	24%	25%
Total	2,496	2,348	2,854	14.3	1.1	-1.5	2.5			

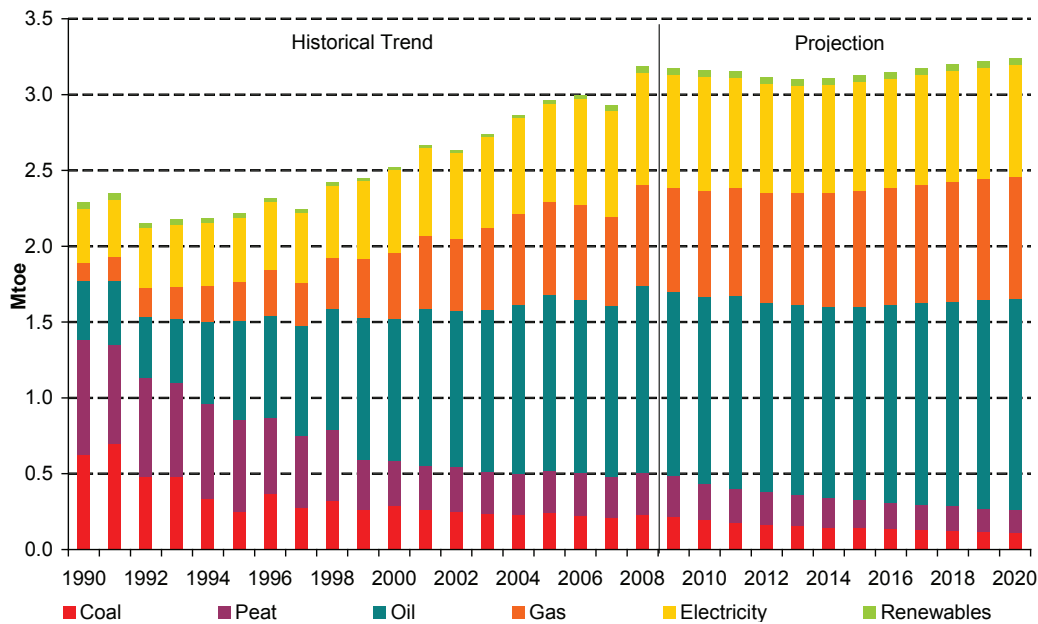
Appendix 1 provides a description of key assumptions relating to the treatment of savings from NEEAP measures in 2020 in the industry sector (and all other sectors).

3.2.2 Residential Final Energy Demand

Figure 5 shows the *Baseline* trend for the residential sector beyond 2008. The reduced demand followed by recovery (to just above 2008 levels in 2020) arises due to a reduction in the rate of new build dwellings over the period and the effect of energy-saving measures incorporated in this *Baseline* for residential energy demand.

Following growth over the period 1990–2008 of 1.8% per annum, a period of reducing demand is expected for the period 2008–2012 (averaging 0.6% per annum), followed by a return to growth at 0.5% per annum from 2012 to 2020.

¹⁴ SEI Large Industry programmes; Accelerated Capital Allowance Scheme (rolled out in 2008); Deployment of CHP in the industry sector.

Figure 5 Residential Final Energy Demand by Fuel 1990–2020 (Baseline)

As shown in *Table 7*, solid fuels continue to decline (coal by 5.7% per annum, peat by 5.2% per annum) and are forecast to represent 8% of final demand in 2020 compared with 15% in 2008. Gas and oil demand grows over the period (by 20% and 13% respectively). Oil remains the dominant fuel in 2020 at 43% share of final consumption, followed by gas at 25% and electricity, stable over the period at 23%.

Table 7 Residential Final Energy Demand by Fuel 2008–2020 (Baseline)

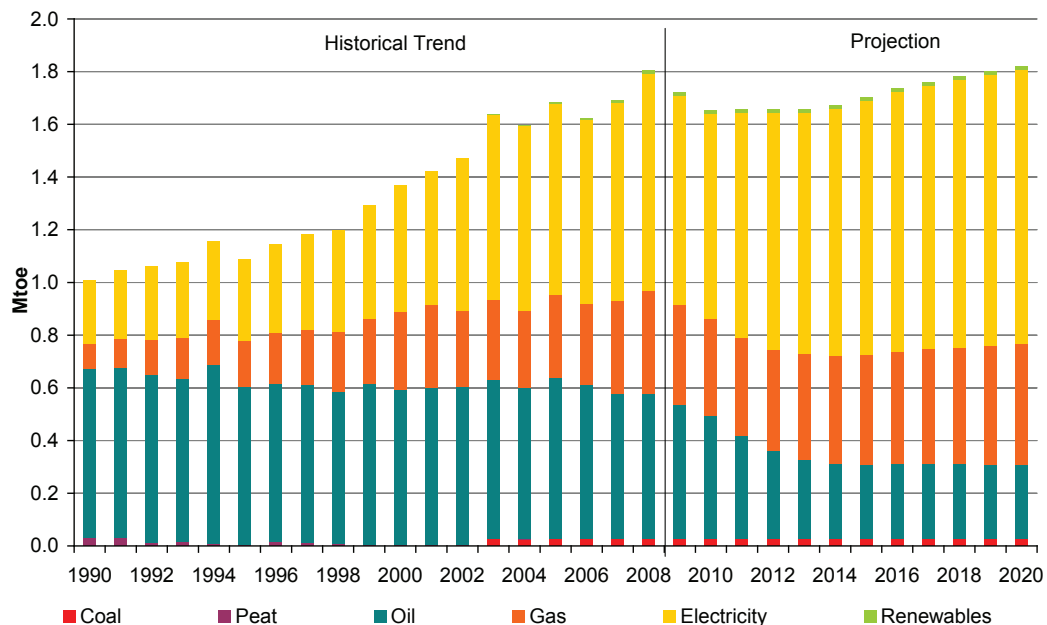
Residential	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08-20	08-20	08-12	12-20	2008	2012	2020
Coal	228	164	113	-50.7	-5.7	-7.9	-4.6	7	5	3
Oil	1,231	1,249	1,395	13.3	1.0	0.4	1.4	39	40	43
Gas	669	728	805	20.4	1.6	2.1	1.3	21	23	25
Peat	280	214	147	-47.4	-5.2	-6.5	-4.6	9	7	5
Biofuels	44	43	41	-6.1	-0.5	-0.5	-0.5	1	1	1
Electricity	733	714	741	1.0	0.1	-0.7	0.5	23	23	23
Total	3,185	3,112	3,242	1.8	0.1	-0.6	0.5			

The levelling-off of demand growth in this sector has been caused in part by the effects of efficiency measures implemented over the last few years. Revisions to building regulations in 2002 and 2008 contribute significantly to the expected reduction in demand, affecting oil and gas consumption in particular. The expected impact of minimum efficiency standards for replacement residential boilers, implemented in 2008, and the Home Energy Saving scheme, launched in 2009, have also been incorporated.

The effect of new measures introduced during 2008 is a 12.2% reduction in 2020 final demand compared with the corresponding *Baseline* figure generated in last year's projection. This, combined with an expected further reduction due to macro-economic assumptions (3.2%) leads to a *Baseline* 2020 projection in 2009 that is 15.5% lower than the previous estimate.

3.2.3 Services Final Energy Demand

The services sector is second only to transport in terms of the fastest-growing historic demand (3.3% per annum for 1990–2008). The projections feature a reduction of 2.2% per annum on average over the 2008–12 period, with growth levels of 1.2% per annum thereafter. As illustrated in *Figure 6*, historic electricity growth in the services sector was 7% per annum over the period 1990–2008. Electricity is expected to remain the fastest-growing fuel over the period 2008–2020 albeit at the lower rate of 2% per annum. The contribution of renewable electricity is discussed in Section 3.3.

Figure 6 Services Final Energy Demand by Fuel 1990–2020 (Baseline)

As shown in *Table 8*, the fastest-growing fuels in the services sector over the period 2008–2020 will be gas and electricity, with average annual growth rates of 1.3% per annum and 2.0% per annum respectively. (These rates are substantially lower than those observed over the period 1990–2008).

Overall oil use in this scenario falls markedly from a share of 30% in 2008 to 15% in 2020. This is balanced by increasing demand shares for electricity (from 45% to 57%) and gas (from 22% to 25%) consumption in 2020, continuing the fuel-mix changes that have occurred since 1990.

Table 8 Services Final Energy Demand by Fuel 2008–2020 (Baseline)

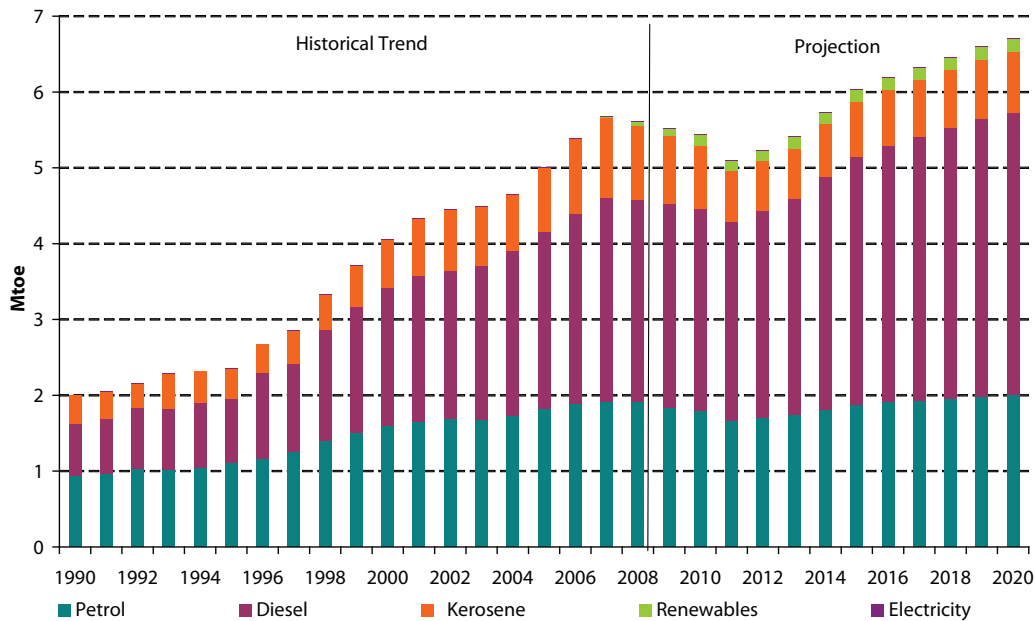
Services	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Coal	26	26	26	0.0	0.0	0.0	0.0	1	2	1
Oil	550	337	282	-48.7	-5.4	-11.6	-2.2	30	20	15
Gas	394	384	458	16.2	1.3	-0.7	2.2	22	23	25
Renewables	15	14	14	-5.9	-0.5	-1.0	-0.2	1	1	1
Electricity	822	896	1040	26.6	2.0	2.2	1.9	45	54	57
Total	1,807	1,656	1,821	0.7	0.1	-2.2	1.2			

The expected effects of recently implemented NEEAP efficiency measures (namely, SEI's small-business supports and a portion of the expected savings from the ACA scheme¹⁵) are incorporated in the *Baseline* figures. Both these programmes dampen electricity demand growth and account for a 1.5% reduction in 2020 final consumption in the services sector, compared with the projection generated in 2008. Including the expected macroeconomic effect of the current recession (8.8% reduction), there is a 10.2% overall reduction compared to last year's projection.

3.2.4 Transport Final Energy Demand

Transport energy demand is anticipated to grow at a rate of 1.5% per annum over the period 2008 to 2020 compared with 5.9% per annum in the period 1990–2008. Despite this reduced growth rate, transport continues to increase its dominance as the highest-energy-using sector of the economy by 2020 (45% share of total demand).

¹⁵ 60% of expected Accelerated Capital Allowance savings are attributed to the services sector.

Figure 7 Transport Final Energy Demand by Fuel 1990–2020 (Baseline)

As shown in *Table 9*, the largest absolute growth in the period 2008–2020 is expected for diesel (747 ktoe or nearly 40% over the period). This is due to current policy measures, such as those relating to vehicle registration tax (VRT) and annual motor tax,¹⁶ prompting a switch to diesel cars, and a resumption of freight transport growth as economic recovery emerges. These factors outweigh the efficiency impact of EU Regulation 443/2009 on the minimum share of cars with specific emissions less than or equal to 130 g CO₂/km from 2010 (and 95 g CO₂/km from 2019).

Oil products are set to grow over the 2008–20 period by 1.4% per annum, reflecting a decline of 2.2% per annum in the period 2008–2012, followed by annual growth of 3.2% thereafter.

Table 9 Transport Final Energy Demand by Fuel 2008–2020 (Baseline)

Transport	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Oil	5,552	5,088	6,530	17.6	1.4	-2.2	3.2	99%	97%	97%
Kerosene	970	659	800	-17.5	-1.6	-9.2	2.5	17%	13%	12%
Petrol	1,907	1,704	2,003	5.0	0.4	-2.8	2.0	34%	33%	30%
Diesel	2,673	2,724	3,727	39.4	2.8	0.5	4.0	48%	52%	56%
Biofuels	56	143	176	217.4	10.1	26.7	2.7	1%	3%	3%
Electricity	5	5	5	0.0	0.0	0.0	0.0	0.1%	0.1%	0.1%
Total	5,611	5,235	6,711	19.6	1.5	-1.7	3.2			

Despite the current recession, renewables (i.e. transport biofuels) exhibit 10.1% average annual growth over the period 2008–2020 (albeit from a very low base). This is attributable to the biofuels obligation on suppliers to achieve a 4% share of biofuels (by volume of fuel, equivalent to 3% in energy terms) by 2010.

The *Baseline* projections for transport energy in 2020 are 10.2% lower than those generated last year. This is due in part to energy savings through policies implemented (2%), but mainly to the effect of the current recession (8.8%).

3.3 Renewable Energy (Baseline)

Renewable energy forecasts are presented in three categories that focus separately on the contribution of renewables to

¹⁶ Further analysis of these measures' impact is available in *Energy in Transport – 2009 report (SEI, EPSSU)*.

Ireland's electricity demand (RES-E), transport energy demand (RES-T) and heating and cooling (thermal energy) demand (RES-H). These represent distinct energy markets or energy modes and also align with national targets for renewable energy contained in the *White Paper*.

The share of renewable energy as a proportion of overall energy demand is also discussed, in order to track progress towards Ireland's binding targets under Directive 2009/28/EC on renewable energy¹⁷ – 16% RES penetration of overall demand and 10% penetration of (road and rail) transport energy demand.

3.3.1 Renewable Contribution to Overall Energy Demand (RES)

Figure 8 shows the final consumption of energy in the Republic of Ireland split by mode of application. The thermal and transport applications account for most final demand, with electricity accounting for the remainder. Electricity here is measured in terms of gross electricity consumption (electricity generation plus net imports) as per Directive 2009/28/EC rather than final electricity demand; hence the shares here differ slightly from those used in previous sections.

In the *Baseline* by 2020 the electricity market accounts for 18% of overall demand while transport accounts for 44% and the thermal market 38%. These different market sizes affect how Ireland's individual national targets contribute to meeting the overall 16% Directive target for 2020. In energy terms, meeting the 40% RES-E target is thus not equivalent to four times the 10% RES-T target.

Figure 8 Energy Consumption by Mode of Application (Baseline)

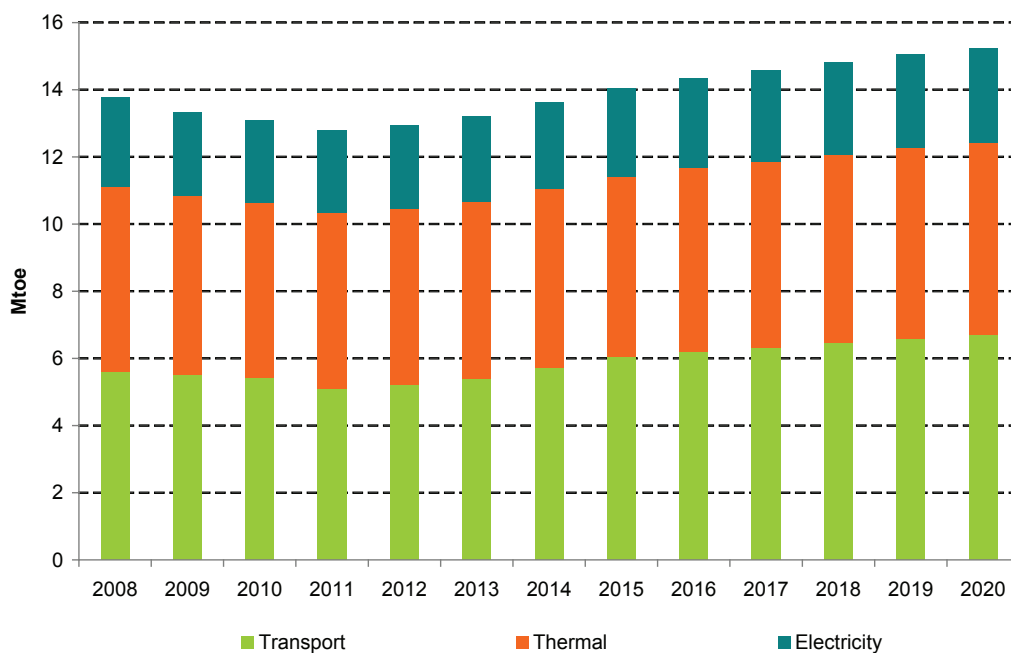


Table 10 details the data and growth rates in electricity, thermal and transport from the *Baseline* projection. The largest final use of energy occurs in transport. With growth of 20% over the period 2008–2020, transport also contributes most to the overall upward demand trend.

Electricity grows by 6% but does not influence the overall trend as strongly, due to the smaller proportion of final energy consumption. The thermal energy market grows by 4% over the period, slower than the other two markets, thus continuing the trend since 1990.

17 Commission of the European Communities, 2009, Directive of the European Parliament and of the Council on the Promotion of the Use of Energy from Renewable Sources, (2009/28/EC): <http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0016:0062:EN:PDF>

Table 10 Energy Consumption by mode of application 2008–2020 (Baseline)

Fuel	Final Consumption (ktoe)			Growth %	Average Annual Growth Rate %			Energy Application Shares %		
	2008	2012	2020		08–20	08–20	08–12	12–20	2008	2012
Electricity	2,665	2,500	2,813	5.6	0.5	-1.6	1.5	19	19	18
Thermal	5,502	5,209	5,718	4.0	0.3	-1.3	1.2	40	40	38
Transport	5,612	5,237	6,713	19.6	1.5	-1.7	3.2	41	40	44
Total	13,779	12,946	15,243	10.6	0.8	-1.5	2.1			

The total renewable energy contribution to final energy demand, RES, is calculated by dividing the *energy from renewable sources* (i.e. total electricity generated from renewable sources plus total renewable energy used directly for transport and heat) by *total final consumption of energy* (defined as total final demand plus in-house electricity and heat use plus transmission and distribution losses for electricity and heat).

Figure 9 shows the *Baseline* projection of the renewable energy contribution to total final consumption. Its contribution towards each end use of energy, electricity, thermal and transport is presented as a proportion of overall energy demand. The scale of the graph is set to highlight the distance of the *Baseline* projection to the EU RES target of 16%.

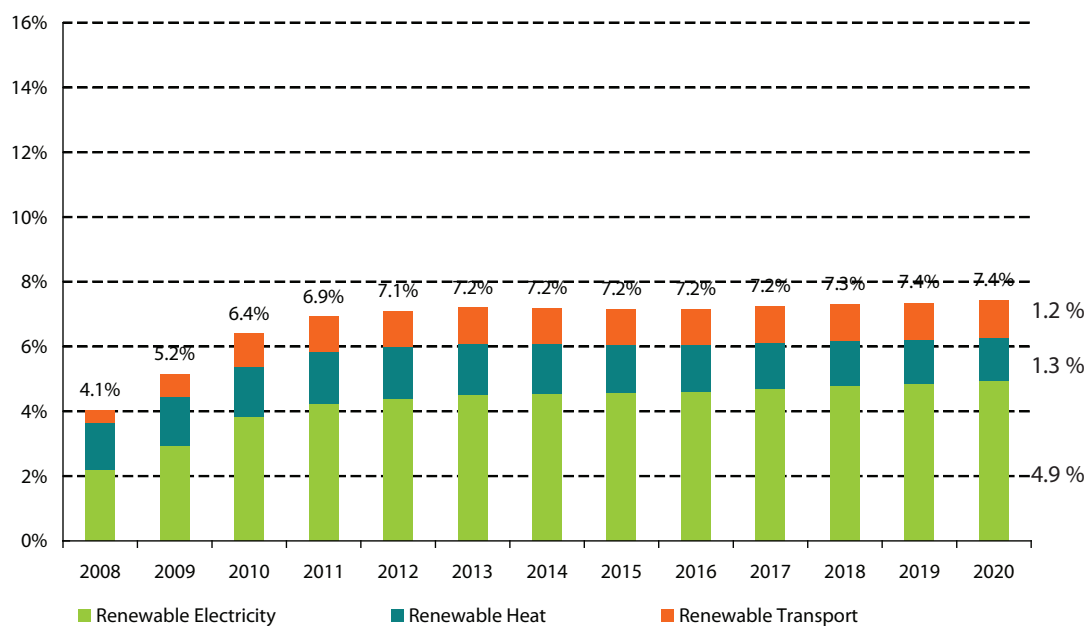
Figure 9 Renewable Energy Contribution to Final Consumption (Baseline)

Table 11 provides details of the renewable energy trends projected in the *Baseline*. Initially, there is a rise of three percentage points, from 4% in 2008 to 7.1% in 2012, before the growth flattens off, showing just a one percentage point growth for the remainder of the period to 2020.

Renewable electricity in the *Baseline* projection contributes 5% to the overall RES in 2020, having experienced a growth rate of 17% per annum over the period 2008–2012 and a slower annual rate of growth from there to 2020.

Renewable transport grows from a low base – by 27% per annum in the period to 2012, with slower growth of 2.6% per year from 2012 to 2020. Renewable thermal energy remains relatively constant throughout the period. Growth in the electricity sector is principally driven by the effects of the existing REFIT support scheme while growth in transport can be accounted for by the impact of biofuel support. This shows that the policy measures included in the *Baseline* projection have had their full effect by 2012.

Table 11 Renewable Energy as a % of Final Consumption (Baseline)

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Sectoral Contribution %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
RES-E	304	570	752	146.9	7.8	17.0	3.5	2.2	4.4	4.9
RES-H	198	202	202	2.0	0.2	0.5	0.0	1.4	1.6	1.3
RES-T	57	143	176	215.4	10.0	26.5	2.6	0.4	0.7	1.2
Total Renewables	558	915	1130	102.5	6.1	13.2	2.7			
RES								4.1	7.1	7.4

The following sub-sections describe in more detail the particular segments of *Figure 9* for RES-E, RES-T and RES-H and the individual renewable energy fuels.

3.3.2 Renewable Contribution to Electricity Generation (RES-E)

While no explicit EU target exists for Ireland in the electricity area, the amended 2007 *White Paper* target of 40% RES-E includes some specific objectives for individual technologies, including Ocean, Biomass and Co-firing.

Figure 10 splits renewable-electricity generation by fuel; the general trend shows an increase in the total amount of renewable electricity generated. Hydro and biomass generation remains relatively static over the period, with close to zero annual growth rates. Wind generation grows quickly between 2008 and 2012, at 8.3%, reflecting the increased capacity, but slows to 4.2% following this period in line with the conclusion of Gate 2.

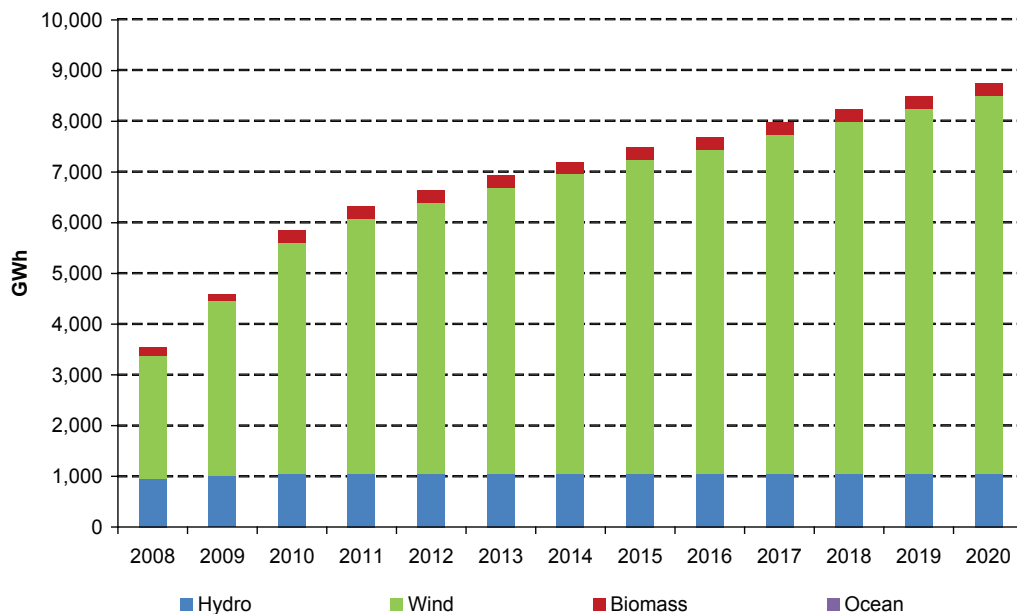
Figure 10 Renewable Contribution to RES-E (Baseline)

Table 12 shows the growth rates and energy contribution of each of the renewable electricity generation fuel sources. Wind contributes most renewable electricity (85% in 2020), growing from a 68% share of renewable electricity generated in 2008. Hydro and biomass increase their absolute amounts of energy generated between 2008 and 2012 but remain constant for the remainder of the period.

Table 12 Renewable Electricity Generation Fuels Contribution to RES-E (Baseline)¹⁸

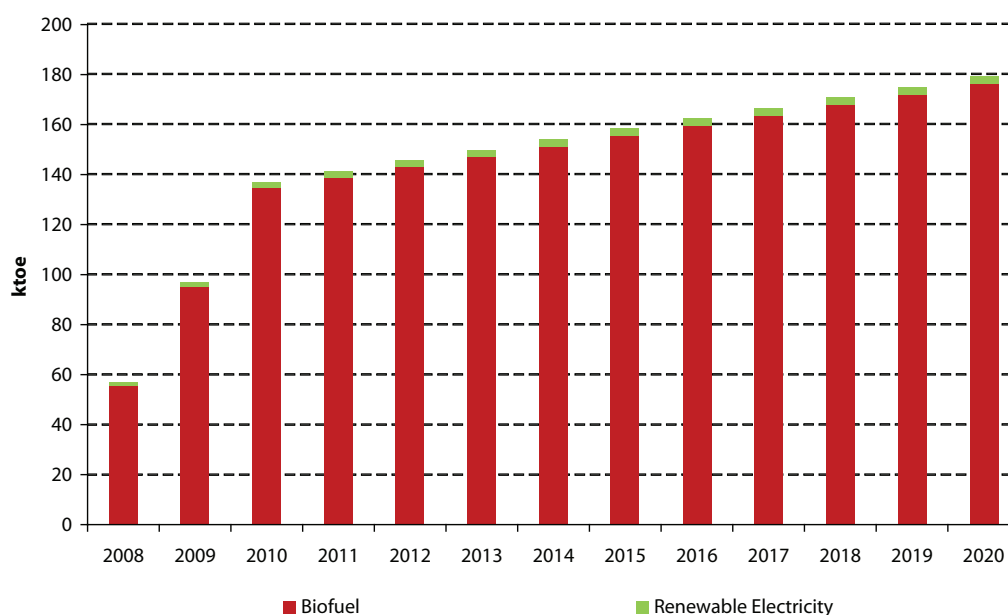
Fuel	Total Generation (GWh)			Growth %	Average Annual Growth Rate %			Fuel Shares of Total Renewable Generation %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Biomass	160	238	238	48.1	3.3	10.3	0.0	0.5	0.8	0.7
Hydro	968	1,053	1,053	8.7	0.7	2.1	0.0	3.1	3.6	3.2
Ocean	0	0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	2,410	5,342	7,449	209.0	9.9	22.0	4.2	7.8	18.4	22.8
Total Generation	3,539	6,632	8,740	146.9	0.0	6.5	0.0			
Gross Cons.	30,994	29,073	32,717	5.6	0.0	-0.6	0.0			
RES-E								11.4	22.8	26.7

3.3.3 Renewable Contribution to Transport (RES-T)

In addition to the overall RES target, the EU renewable energy Directive sets down a binding target for Ireland of 10% of final consumption in the transport sector to come from renewable energy in 2020 (RES-T). The directive also sets out a methodology for calculating this transport target that gives extra weightings to renewable electricity used in electric vehicles and to second-generation biofuels.¹⁹ However, for the calculation of the overall RES target, renewable transport fuels do not receive any extra weighting.

Renewable electricity used in transport is determined by extracting the proportion of the electricity consumption consistent with the proportion of renewable energy in the electricity sector. For example, in 2020 RES-E is 28% and the final consumption of electricity in transport is 5 ktoe, giving a renewable energy proportion of 1.3 ktoe. Applying the weighting methodology gives a figure of (2.5 x 1.3), i.e. 3.25 ktoe for inclusion in the RES-T calculation.

Figure 11 shows the trajectory of consumption of renewable energy in the transport sector, calculated according to the RES-T methodology. Biofuels make the largest contribution, while renewable electricity with the weightings shows a relatively small impact. Renewable fuels in the transport sector reach 197 ktoe in 2020, which corresponds to a RES-T of 3%.

Figure 11 Renewable Energy Contribution to RES-T (Baseline)

¹⁸ No REFIT tariff for ocean energy was included in the baseline projection because it was introduced after the end of 2008.

¹⁹ See Article 3(4) of Directive 2009/28/EC.

Table 13 shows the data and growth of renewable fuels in the transport sector between 2008 and 2012. The demand for electricity for electric vehicles remains constant over the period but the amount that can be counted towards the RES target grows in line with the increasing RES-E. Biofuel use increases at an annual rate of 19% between 2008 and 2012, before returning to the more moderate growth of 3% per annum for the remainder of the projected period. In the *Baseline* projection, biofuels are expected to account for 98% of the renewable energy used in the transport sector.

Table 13 Renewable Energy Contribution to RES-T (Baseline)

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares of RES-T %		
	2008	2012	2020		08-20	08-12	12-20	2008	2012	2020
Renewable Electricity	1	3	3	133.9	7.3	18.9	2.0	0.03	0.06	0.05
Biofuels	56	143	176	217.4	10.1	26.7	2.7	1.2	3.12	2.98
Total Renewables	57	146	179	215.4	10.0	26.5	2.6			
Total Cons.	4,642	4,578	5,913	27.4	2.0	-0.3	3.2			
RES-T								1.2	3.2	3.03

3.3.4 RES-H Renewable Contribution to Heat

While no explicit EU target for Ireland exists in the Thermal area, a national target of 12% RES-H was set down in the 2007 *Energy White Paper*.

The renewable energy consumed in thermal applications is generally generated either from biomass, solar, geothermal or ground-source heat pumps.²⁰ Renewable electricity used for thermal purposes is included in the renewable electricity numbers and as such is not considered in this section.²¹

Energy consumed in heating applications is generally un-metered, which makes direct estimation of consumption difficult. Final energy consumption of heat is determined in the *Baseline* projection by calculating the residual energy consumption of the total after energy used in the electricity and the transport sectors has been evaluated. It is therefore difficult to give a disaggregated breakdown of the renewable energy fuel sources.

Figure 12 shows the penetration of renewable energy for thermal applications in each of the economic sectors. In line with the absence of recent measures for renewable energy in the *Baseline* projection, no increase in the consumption of renewable energy is evident over the period. Final consumption of renewable energy in 2020 amounts to 205 ktoe, which represents 3.5% RES-H in 2020.

²⁰ The term ground-source heat pump can be used interchangeably with air source and hydro source.

²¹ However, the promotion of electric heating based on renewable generation would contribute towards the RES-H target.

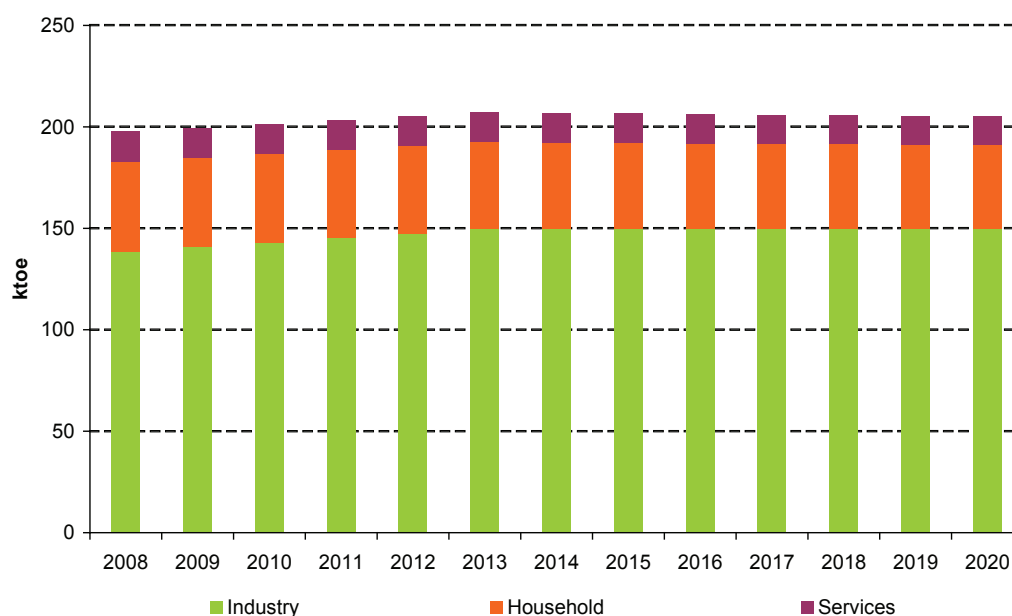
Figure 12 Thermal Energy Consumption by Sector 1990–2020 (Baseline)

Table 14 details the data for renewable energy use for thermal applications. All sectors show little growth over the period, with the overall share of renewable energy dropping to less than 3.5% in 2020. These *Baseline* projections highlight the scope for expansion of renewable energy for thermal application.

Table 14 Thermal Energy Consumption by Sector 2008–2020 (Baseline)

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Sectoral Shares %		
	2008	2012	2020		08–20	08–20	08–12	12–20	2008	2012
Industry	139	148	150	7.9	0.6	1.5	0.2	2.5	2.8	2.6
Household	44	43	41	-6.1	-0.5	-0.5	-0.5	0.8	0.8	0.7
Services	15	14	14	-5.9	-0.5	-1.0	-0.2	0.3	0.3	0.2
Total Renewable Energy	198	205	205	3.7	0.3	0.9	0.0			
Total Consumption	5,502	5,209	5,718	4.0	0.3	-1.3	1.2			
RES-H								3.6	3.9	3.6

3.4 Electricity Generation Fuel Mix (Baseline)

Fuel inputs to the electricity sector are influenced by several interacting factors. Domestic demand changes together with the level of interconnection determine the quantity and type of generation capacity required to ensure security of supply. The *Baseline* projects electricity consumption to rise over the period, with the level of interconnection also to increase in line with known investment. This section outlines the IDEM model outcome for the *Baseline* projection of electricity generation fuel mix.

Power-generation plant commissioning and decommissioning expectations in these forecasts are in line with announcements from the power-generation industry.

- Combined Cycle Gas Turbines (CCGTs) are expected to be commercially operational at Aghada and Whitegate in Co. Cork by 2010, with a combined generation capacity of 876MW, while up to 1100MW is expected to be decommissioned by the end of 2012.²²

²² See <http://www.eirgrid.com/media/GAR%202009-2015.pdf>

- Heavy Fuel Oil (HFO) plant at Tarbert and Great Island as well as the steam units at Poolbeg are expected to account for most retiring capacity, dropping out of the model calculations at the end of 2010 along with the North Wall Open Cycle Gas Turbine (OCGT) and Marina steam turbine.
- The Public Service Obligation (PSO) supports for the peat-burning power stations runs out for Edenderry in 2015 and for the ESB plant in 2019, which impacts on their dispatch merit, resulting in a lighter running duty.
- From 2012 onwards, 500MW of new interconnector capacity, linking Wales to the Republic of Ireland, is included in model calculations, augmenting the existing 400MW link from Northern Ireland to Scotland.

In addition to these considerations, further expansion in power-generation capacity is represented as follows:

- Total wind capacity grows to 1500MW in 2010 before increasing further to 2700MW by 2020.
- Biomass installed capacity is comprised of Biomass Combined Heat and Power (CHP) landfill gas and the co-firing capacity of the country's peat power stations. In the *Baseline* forecast this capacity is assumed to reach 61MW by 2010.

The findings on dispatch merit order and annual load factor are derived from the ESRI's IDEM economic dispatch model, which determines which plants need to generate electricity to meet expected demand at the lowest possible short-run cost. Policy considerations may impose constraints on this dispatch (or through longer-term signals) in order to change the fuel mix for security-of-supply reasons.

The changes in fuel inputs to electricity generation are shown in *Figure 13*. Growth in fossil-fuel output drops across all fossil fuels, with the exception of natural gas which sees significant growth over the period, driven by the relative economic advantage of gas²³ used in gas turbines, particularly CCGTs. Oil makes a small but steady contribution, reflecting its application as a start-up fuel in coal and peat plant as well as a fuel for smaller peaking units. Coal use decreases over the period, reflecting the differential between gas and coal prices coupled with the impact of rising carbon prices on the marginal cost of operation for coal units; this moves the existing coal units up the economic merit order towards a mid-merit running duty. In line with the expiration of the PSO, peat use drops steadily – down to zero in 2020. Renewable electricity generation increases in every year over the period, reflecting the steady increase in wind capacity.

Figure 13 Primary Fuel Mix for Electricity Generation 1990–2020 (Baseline)

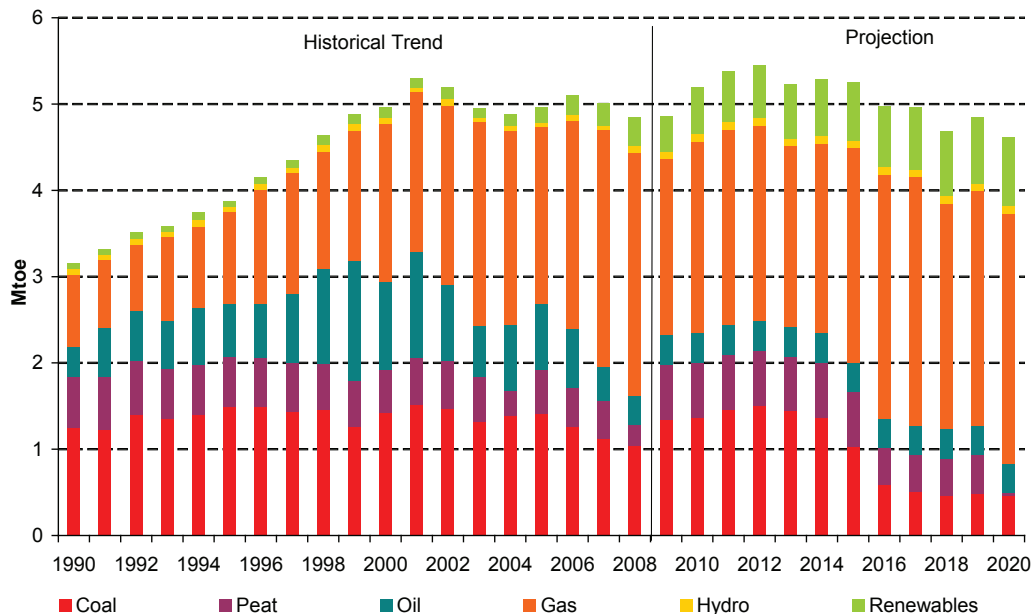


Table 15 shows a summary of the shares in electricity generation fuel mix over time. Overall, the energy inputs for electricity generation fall by 5.2%, reflecting the increased efficiency and growing share of renewable energy (where for wind and hydro the fuel input is equated with the electricity output).

²³ Assumed fossil-fuel related prices in 2020: Gas €27/MWh; Oil €54/MWh; Coal €9.5/MWh; Carbon €31/Tonne. Source: ESRI 2009.

Table 15 Primary Electricity Generation Fuel Mix 2008–2020 (Baseline)

Fuel	Elec Gen Fuel Inputs (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020		08–20	08–20	08–12	12–20	2008	2012
Coal	1,046	1,502	467	-55.4	-6.5	9.5	-13.6	21	28	10
Oil	345	345	345	0.0	0.0	0.0	0.0	7	6	8
Gas	2,811	2,270	2,890	2.8	0.2	-5.2	3.1	55	42	64
Peat	558	634	27	-88.5	-16.5	28.4	-32.6	11	12	1
Renewables	329	606	788	139.6	7.6	16.5	3.3	6	11	17
Total	5,089	5,357	4,516	-5.2	-0.4	3.0	-2.1			

Figure 14 deals with the outputs of electricity (in TWh) by fuel. Electricity generation plants that operate at higher efficiency capture a proportionately larger share of output than is the case for the primary fuel input graph (Figure 13). Renewable electricity generation such as wind & hydro has an effective conversion efficiency of 100%, resulting in a 28% share of generated electricity in 2020, from a 17% share of fuel inputs.

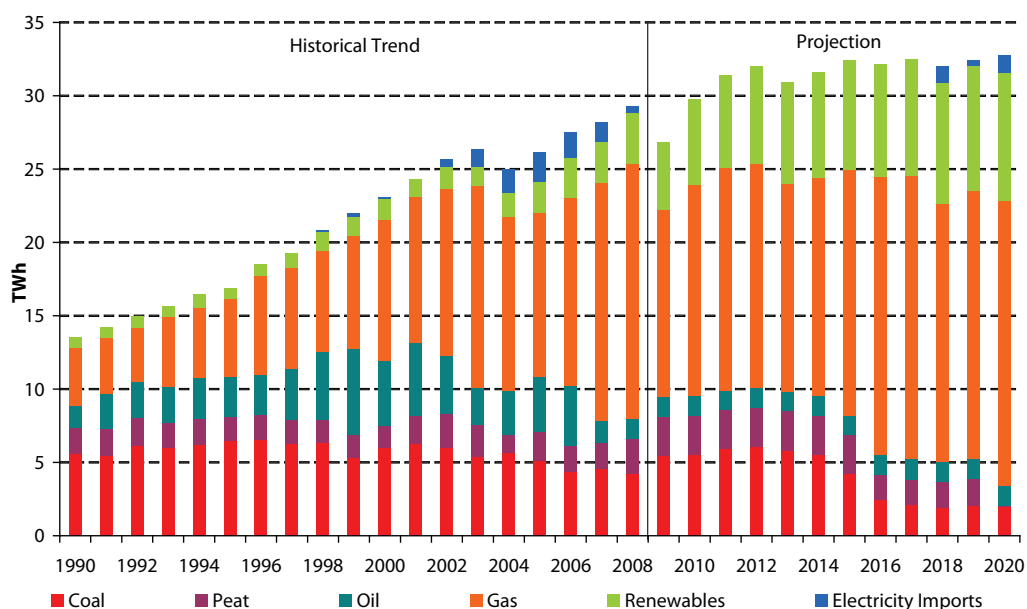
Figure 14 Electricity Generation by Fuel 1990–2020 (Baseline)

Table 16 summarises the data that underpins Figure 14. It also shows the growth rates and shares of electricity generation by fuel. Overall, electricity generation increases over the projected period but at a lower rate than electricity demand growth. This divergence is reconciled when electricity imports are accounted for. Electricity imports are a feature in 2008, switching to exports from then until 2018 before returning to net imports in 2019 and 2020.

The extra volumes of trade after 2012 are a function of the increased interconnector capacity from that year. Gas accounts for 62% of electricity generation in 2020, compared with a *White Paper* target limiting it to 50%.

Table 16 Electricity Generation by Fuel 2008–2020 (Baseline)²⁴

Fuel	Gross Electricity Consumption (MWh)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020		08–20	08–20	08–12	12–20	2008	2012
Coal	4,259	6,060	1,966	-53.8	-6.2	9.2	-13.1	15	19	6
Oil	1,367	1,367	1,367	0.0	0.0	0.0	0.0	5	4	4
Gas	17,363	15,275	19,448	12.0	0.9	-3.2	3.1	60	48	62
Peat	2,338	2,661	61	-97.4	-26.2	3.3	-37.6	8	8	0
Renewables	3,539	6,631	8,738	146.9	7.8	17.0	3.5	12	21	28
Electricity Imports	450	-2,822	1,230					2	-9	4
Total Generation	28,865	31,994	31,581	9.4	0.8	2.6	-0.2			

²⁴ Note: Only electricity exports count towards the total generation

4. Policy Scenarios to 2020

Two policy scenarios (*White Paper Plus* and *Exploratory*) are presented in this section. These scenarios build on the *Baseline* projections, with additional assumptions introduced that account for key national energy efficiency and renewable energy targets and measures. The scenarios are structured such that the energy efficiency measures and targets are applied first and then the renewable energy targets, to meet the remaining energy demand requirements.

With respect to energy *efficiency*, the same assumptions are applied to both the *White Paper Plus* and *Exploratory* Gate 3 scenarios:

- EE 20% – the scenarios assume the *White Paper* energy efficiency target of 20% will be achieved by 2020. This includes expected energy savings as outlined in the National Energy Efficiency Action Plan (NEEAP).²⁵

Wherever the data analysis applies equally to the *Baseline* and *White Paper Plus* scenarios in this section, they are referred to collectively as *Policy* scenarios. Specifically, savings from the following proposed and committed measures are included in both *Policy* scenarios, as per the NEEAP (May, 2009):

- Residential Building Regulations 2010
- Low Carbon Homes 2013 (a further revision to residential building regulations)
- Smart meter roll-out
- Ecodesign for energy-using appliances²⁶
- Non-residential building regulations 2010
- Efficient driving measures
- Electric vehicle deployment
- Transport mobility management (travel plans)
- E-working
- More sustainable transport fleets
- Meeting the CHP target of 800MW of installed capacity by 2020

Total savings from these measures, and those assumed implicit in the *Baseline*, account for three-quarters of the national 2020 savings target (20% or 31,925 GWh based on historic consumption²⁷). New measures, such as the proposed Energy Demand Reduction Target (EDRT), expanded business supports and additional transport initiatives will be required to achieve the full national target. *Table 17* outlines the assumptions of savings included. It should be noted that the actual mix of savings achieved to bridge the gap to the target is likely to change (eg, the full potential could be met through retrofits of residential dwellings); however, some potential has been incorporated in each sector as a proxy, on the basis described below.

Table 17 Additional Savings Potential Assumed Achieved in Policy Scenarios

Sector	Savings contribution assumed GWh (PEE)
Industry	500
Residential	3,000
Services	3,800
Transport	700
Total	8,000

The services sector includes achievement of the 33% energy savings target for the public sector as described in the NEEAP. In addition to the savings achieved through existing measures, a further 3100 GWh is required for this purpose.²⁸ Additional potential in the residential sector represents a proportion of the significant opportunity that exists for energy savings through residential retrofit measures. It is estimated that over one million homes could benefit from efficiency upgrades. On the basis of a HES-scheme-style intervention, 3,000 GWh represents improvements to about 330,000 homes.

²⁵ 'Maximising Ireland's Energy Efficiency – The National Energy Efficiency Action Plan 2009–2020', Department of Communications, Energy and Natural Resources (May, 2009).

²⁶ Residential lighting savings only.

²⁷ Calculated as 20% of average energy use over the period 2001–2005. Further detail in the NEEAP (May, 2009).

²⁸ A description of the programme to deliver these savings can be found at: http://www.sei.ie/Your_Business/Public_Sector/

The remaining savings required are split between industry and transport. For industry, it is expected that significantly more potential exists for further savings than that assumed here, in order to simulate reaching the 2020 target. For example, *Demand Side Management in Ireland – Evaluating the Efficiency Opportunities* (SEI, January 2008) estimated potential savings using currently available technologies at 5,220 GWh for this sector.

A conservative level of additional savings is assigned to transport in acknowledgement of additional measures outlined in the Sustainable Transport Action Plan (STP) that do not yet have associated policies or measures, but have been identified as opportunities.

With respect to renewable energy, the *White Paper Plus* scenario and the *Exploratory* scenario differ with respect to the amount of wind power assumed installed over the period to 2020:

White Paper Plus scenario

- RES-E 40% – In accordance with the amended national target (the *White Paper* target was originally 33%), renewable generation is assumed here to contribute 40% of gross electricity consumption (total electricity generated plus net imports) in 2020. It is assumed that sufficient measures are introduced to deliver the ocean-energy target of 500 MW by 2020, that the Bioenergy Strategy Group Report is implemented (delivering approx. 400 MW of biomass) and that the remaining renewable electricity to deliver an overall 40% contribution comes from wind power (3,100 MW by end 2020).
- RES-H 12% – As set down in the *Energy White Paper*, 12% of final thermal energy demand is to come from renewable sources by 2020. A range of policies are under consideration.
- RES-T 10% – As set down in the *Energy White Paper*: initially, 10% penetration of biofuels but this was subsequently amended to a 10% contribution by biofuels plus renewable electricity used in electric vehicles, calculated in accordance with EU renewable Directive 2009/28/EC.²⁹ The Biofuels Obligation³⁰ has set a target for 2010 and this, combined with measures to stimulate the uptake of electric vehicles,³¹ is assumed in the policy scenarios to drive the expansion of renewable energy in transport.

Exploratory scenario

- Energy efficiency, RES-H, RES-T measures and targets are the same as in the *White Paper Plus* scenario.
- For renewable electricity, this scenario explores the impact of a greater deployment of wind power. It is assumed that 5,000 MW of wind power will be installed by 2020, of which 500 MW is offshore wind power. (It is worth noting, though, that if all the Gate 3 applications were connected, there would be approximately 6700MW of wind). The 500 MW target for ocean energy and the 400 MW of biomass are also assumed, in line with the assumptions for the *White Paper Plus* scenario.

4.1 Primary Energy Supply Forecasts (*Policy Scenarios*)

The following sections shed light on the impacts of the *White Paper Plus* scenario assumptions on future energy trends energy in Ireland, starting with energy supply (TPER). *Figure 15* shows the trend in primary energy supply; in this scenario, Ireland's energy requirements are 1.7% lower in 2020 than in 2008. Comparing these *White Paper Plus* forecasts to the *Baseline* projection (*Figure 1*), Ireland's energy requirements in 2020 are reduced by 5.7% due to the achievement of the energy efficiency and renewable energy targets. The penetration by renewable energy (of TPER) is 15% compared with 7% in the *Baseline*.

29 See Section 3.3.2 for details of this calculation.

30 See www.dcenr.gov.ie/Energy/Sustainable+and+Renewable+Energy+Division/Biofuels+Obligation+Scheme.htm

31 See <http://www.transport.ie/transport/Sustainable/index.asp?lang=ENG&loc=1913>

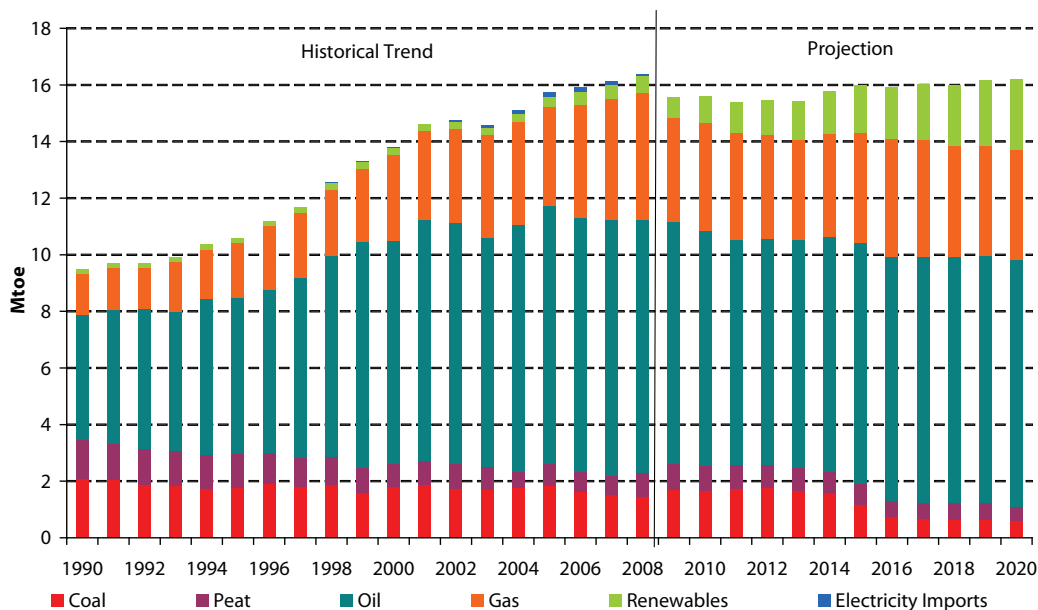
Figure 15 Total Primary Energy Requirement 1990–2020 (White Paper Plus scenario)

Table 18 provides the detailed data, growth rates and fuel shares for primary energy in the *White Paper Plus* scenario forecasts. Ireland's primary energy supply is set to reduce marginally (0.1% per annum) over the period 2008–2020 (compared with 0.3% per annum growth in the *Baseline* forecasts).

Table 18 Total Primary Energy Supply by Fuel 2008–2020 (White Paper Plus)³²

Fuel	Total Primary Energy Supply (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Coal	1,436	1,766	606	-57.8	-6.9	5.3	-12.5	9%	12%	4%
Oil	8,964	7,960	8,721	-2.7	-0.2	-2.9	1.1	55%	52%	54%
Gas	4,491	3,690	3,916	-12.8	-1.1	-4.8	0.7	27%	24%	24%
Peat	845	828	483	-42.8	-4.5	-0.5	-6.5	5%	5%	3%
Renewables	581	1,218	2,481	326.8	12.9	20.3	9.3	4%	8%	15%
Electricity Imports	39	-244	-127					0%	-2%	-1%
Total	16,356	15,218	16,080	-1.7	-0.1	-1.8	0.7			

Table 18 shows net electricity exports in the *White Paper Plus* scenario for 2020 (in contrast to net imports in the *Baseline* case).

Total Primary Energy Requirement by fuel data presented here relates to the *White Paper Plus* scenario. Two differences in TPER occur in the *Exploratory* scenario. These are:

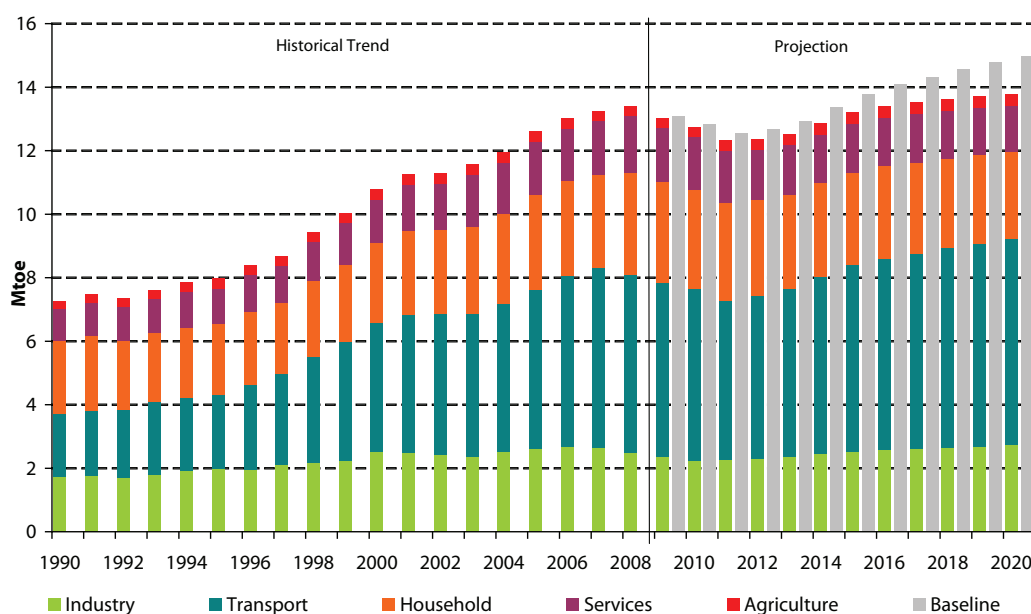
- An increase in renewable supply of 284 ktoe (to a total of 2,765 ktoe in 2020)
- An increase in net electricity exports to 299 ktoe in 2020 (compared with 127 ktoe in the *White Paper Plus* scenario)

Final Energy Demand Forecasts (Policy)

Figure 16 shows the final demand forecasts by sector for the *White Paper Plus* forecasts.³³ The overall projection for final demand from the *Baseline* forecasts is also included for comparison.

³² Net imports represented. A negative number represents net exports.

³³ These final demand results also apply to the *Exploratory* scenario.

Figure 16 Total Final Demand by Sector 1990–2020 (Policy)

It is evident from *Figure 16* and *Table 19* that most of the efficiency gains required to reach the national 20% savings target are expected to be made during the period 2012–2020. Overall growth over the period 2008–2020 is 2.8% in this policy scenario compared to 12.3% in the *Baseline*. Total final demand in 2020 here is 8.1% lower than in the *Baseline* scenario.

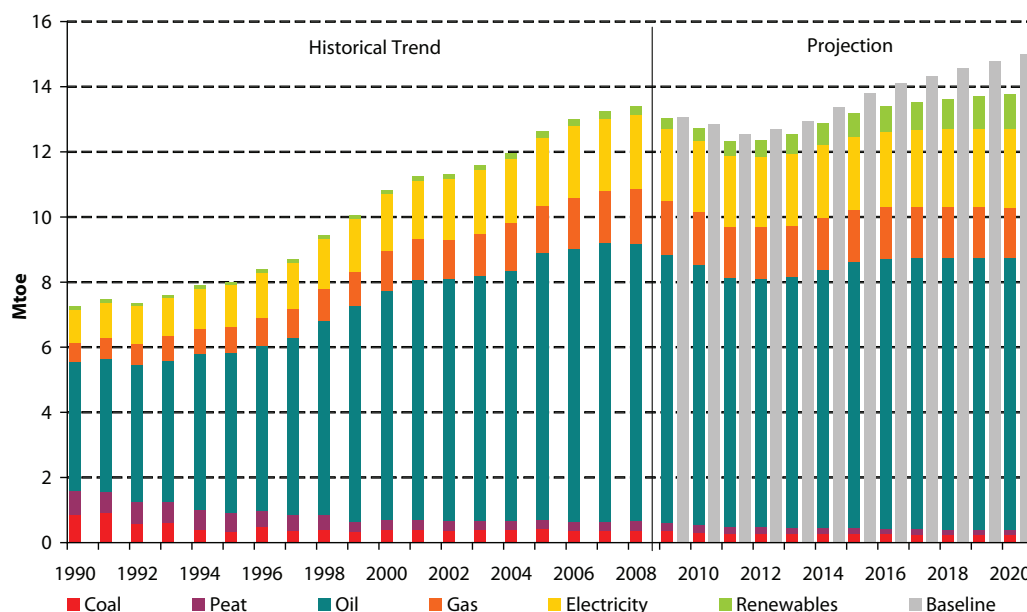
Table 19 Final Energy Demand by Sector 2008–2020 (Policy)

Sector	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Sectoral Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Household	3,185	3,013	2,734	-14.1	-1.3	-1.4	-1.2	24	24	20
Industry	2,496	2,296	2,728	9.3	0.7	-2.1	2.2	19	19	20
Services	1,807	1,583	1,448	-19.9	-1.8	-3.3	-1.1	13	13	11
Agriculture	300	343	373	24.6	1.8	3.5	1.1	2	3	3
Transport	5,612	5,140	6,492	15.7	1.2	-2.2	3.0	42	42	47
Total	13,400	12,375	13,776	2.8	0.2	-2.0	1.3			

The biggest reductions in energy demand are forecast for the services (20%) and residential (14%) sectors. This is underpinned by the assumption that the 33% energy savings target for the public sector will be met along with the additional potential expected from the residential sector (3,000 GWh, 258 ktoe), for example, through retrofit of existing dwellings.

The transport sector's share of final demand continues to increase, reaching 47% of final demand by 2020. Energy efficiency measures identified in the NEEAP reduce expected growth in this sector from 19.7% (2008–2020) to 15.7%.

Figure 17 and *Table 20* show the split of total final demand by fuels for the policy scenarios.

Figure 17 Total Final Demand by Fuel 1990–2020 (Policy)

The most significant change in absolute terms, compared with the *Baseline*, is the reduced demand for oil: 1,226 ktoe (13%) lower in 2020 in the policy scenarios. Despite this, oil remains dominant, accounting for 61% of final demand in 2020.

Gas demand is expected to grow by 25% in the *Baseline* projection (2008–2020); however, due to the impact of energy savings measures applied in the policy scenarios, an overall reduction of 8.2% is expected compared with the *Baseline* over the period 2008–2020. This means that by 2020 gas final demand in the policy scenarios is 26% lower than in the *Baseline*.

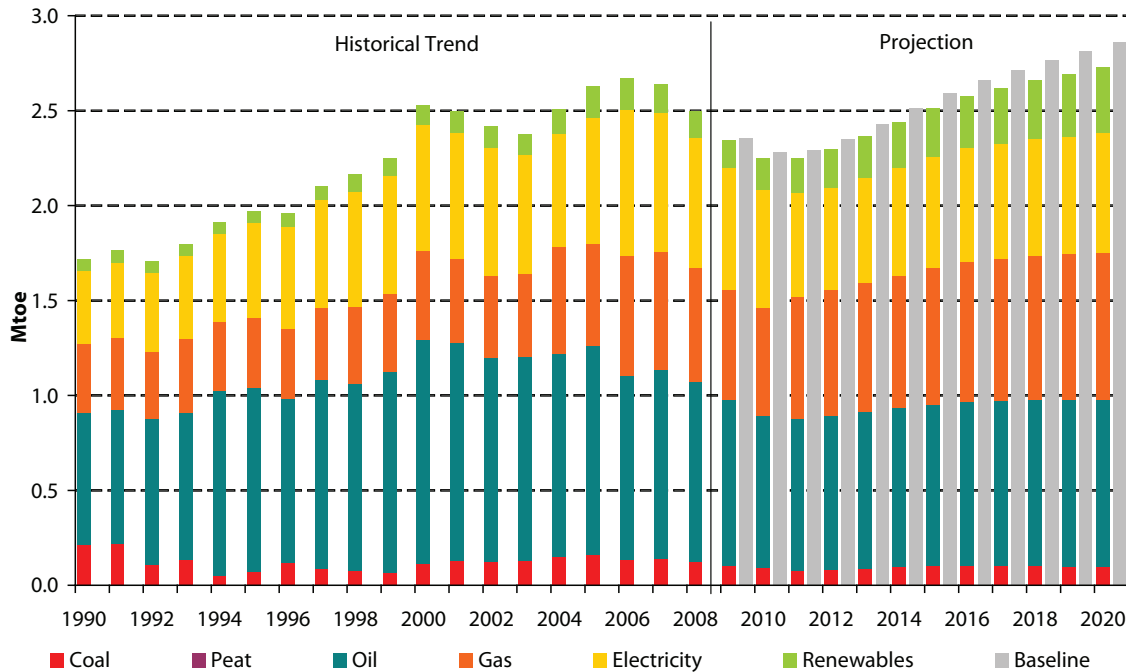
The contribution from renewable energy to final demand (i.e. the renewable energy contributions to the transport and heat markets) in 2020 is significantly higher (1,055 ktoe) in the policy scenarios compared with the *Baseline* (381 ktoe).

Table 20 Final Energy Demand by Fuel 2008–2020 (Policy)

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Coal	380	269	233	-38.7	-4.0	-8.3	-1.8	3%	2%	2%
Oil	8,534	7,614	8,376	-1.9	-0.2	-2.8	1.2	64%	62%	61%
Gas	1,659	1,584	1,519	-8.5	-0.7	-1.1	-0.5	12%	13%	11%
Peat	280	213	146	-47.9	-5.3	-6.6	-4.6	2%	2%	1%
Renewables	254	520	1,055	316.2	12.6	19.7	9.2	2%	4%	8%
Electricity	2,294	2,174	2,447	6.7	0.5	-1.3	1.5	17%	18%	18%
Total	13,401	12,375	13,776	2.8	0.2	-2.0	1.3			

4.1.1 Industry Final Energy Demand

The policy forecasts for final energy demand in industry by individual fuel are shown in *Figure 18*. Total final demand from the *Baseline* forecast is also shown for comparison. Energy demand for industry in 2020 is 4.6% lower than the *Baseline* forecast. The growth in renewable energy uptake by industry shown in *Figure 18* reflects the industry allocation of the 12% RES-H target.

Figure 18 Industry Final Energy Demand by Fuel 1990–2020 (Policy)

The data underpinning *Figure 18* is presented in *Table 21*. Energy demand over the period 2008–2020 is expected to increase by 0.7% per annum on average. This includes a period of continuing demand reduction, 2008–2012 (2.1% per annum), followed by a period of resumed growth at 2.2% per annum.

Table 21 Industry Final Energy Demand by Fuel 2008–2020 (Policy)

Industry	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Coal	125	80	98	-21.3	-2.0	-10.5	2.6	5	3	4
Oil	950	814	877	-7.7	-0.7	-3.8	0.9	38	35	32
Gas	596	662	778	30.5	2.2	2.6	2.0	24	29	29
Renewables	139	202	345	148.5	7.9	9.8	6.9	6	9	13
Electricity	686	538	630	-8.2	-0.7	-5.9	2.0	27	23	23
Total	2,496	2,296	2,728	9.3	0.7	-2.1	2.2			

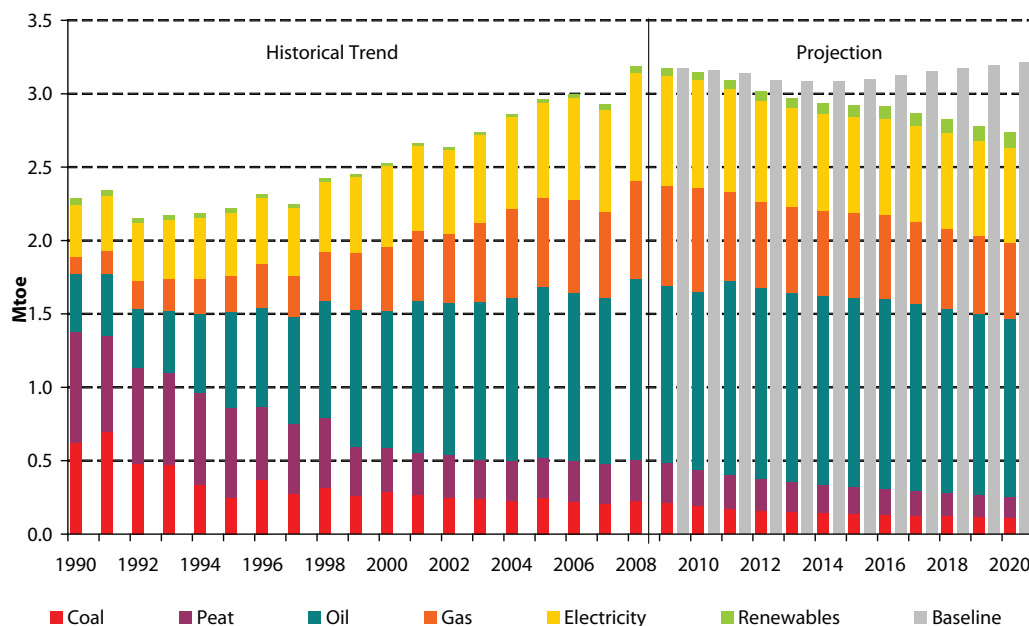
In terms of the fuels, the largest reduction in the policy forecasts, compared with the *Baseline*, is for oil, which shows growth at 0.9% in the *White Paper* forecasts between 2012 and 2020 and 3.0% annual growth in the *Baseline*. This results in an overall reduction in oil demand for industry of 73 ktoe in the policy scenario, compared with an expected increase in demand of 175 ktoe in the *Baseline* forecast, i.e. a 20% reduction.

This change can be linked to assumptions on the impact of expanded energy savings programmes for large industry together with further deployment of CHP in industry. A net 8.2% decrease in electricity demand in industry is anticipated over the period 2008–2020 in the policy scenario, compared with an increase of 3.2% in the *Baseline* scenario.

The allocated share of renewable energy increased from 6% in 2008 to 13% in 2020.

4.1.2 Residential Final Energy Demand

The *White Paper Plus* forecast for the residential sector is shown in *Figure 19*. Energy demand is projected to be 14% lower than 2008 levels in 2020; this represents a 16% reduction relative to the *Baseline* forecast.

Figure 19 Residential Final Energy Demand by Fuel 1990–2020 (Policy)

As shown in *Table 22*, oil demand is projected to return approximately to 2008 levels in 2020, in the policy scenarios. This compares to expected growth of 29% (355 ktoe) in the *Baseline* forecasts for the period 2008–2020. Gas demand in the policy forecasts will drop by 2.1% per annum between 2008 and 2020, compared with no expected change in the *Baseline*.

A combination of planned future building regulation revisions in 2010 and 2013, transitioning to a low-carbon-homes standard, together with savings expected from a phase-out of low-efficiency (incandescent) lighting, and widescale retrofit of existing dwellings, have a significant impact on demand reduction in the policy scenario.

Table 22 Residential Final Energy Demand by Fuel 2008–2020 (Policy)

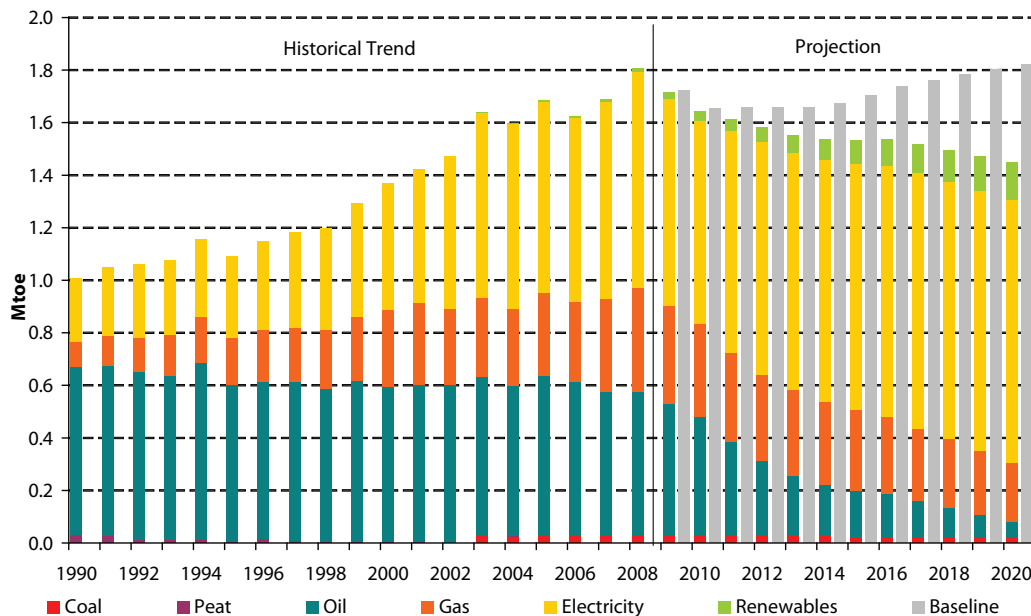
Residential	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Coal	228	163	112	-51.0	-5.8	-8.1	-4.6	7	5	4
Oil	1,231	1,300	1,210	-1.7	-0.1	1.4	-0.9	39	43	44
Gas	669	592	516	-22.9	-2.1	-3.0	-1.7	21	20	19
Peat	280	213	146	-47.9	-5.3	-6.6	-4.6	9	7	5
Biofuels	44	61	103	135.4	7.4	8.7	6.7	1	2	4
Electricity	733	684	648	-11.7	-1.0	-1.7	-0.7	23	23	24
Total	3,185	3,013	2,734	-14.1	-1.3	-1.4	-1.2			

Renewable energy heating will grow by 7.4% per annum but from a low base, reaching a 4% penetration of residential energy demand in 2020.

4.1.3 Services Final Energy Demand

Figure 20 shows the *White Paper Plus* forecasts for the services sector. A significant reduction in expected demand (20%) is evident in the policy scenario compared to the *Baseline*.

The impact of the renewable energy heat target is evident, with it supplying 10% of overall energy demand in the sector by 2020.

Figure 20 Services Final Energy Demand by Fuel 1990–2020 (Policy)

As shown in Table 23, demand in the policy forecasts for the services sector is declining at -1.8% per annum on average over the period 2008 to 2020, compared with an upward trend of 2.0% per annum in the *Baseline*.

Despite the significant demand reduction expected, electricity is expected to continue its historic growth trend, increasing its share of total energy demand in the sector to 69% by 2020.

The *White Paper Plus* forecast shows a 17% per annum reduction in oil demand over the period 2008–2020 compared with a 5.4% per annum reduction in the *Baseline*. This reduces its share of demand in 2020 to 4% in the policy forecasts compared to 15% in the *Baseline*.

Gas accounts for 16% in 2020, compared with 25% in the *Baseline*, shifting from an increasing trend of 1.3% per annum over the period 2008–2020 to a downward trend of 4.6% in the forecast scenario over the same period.

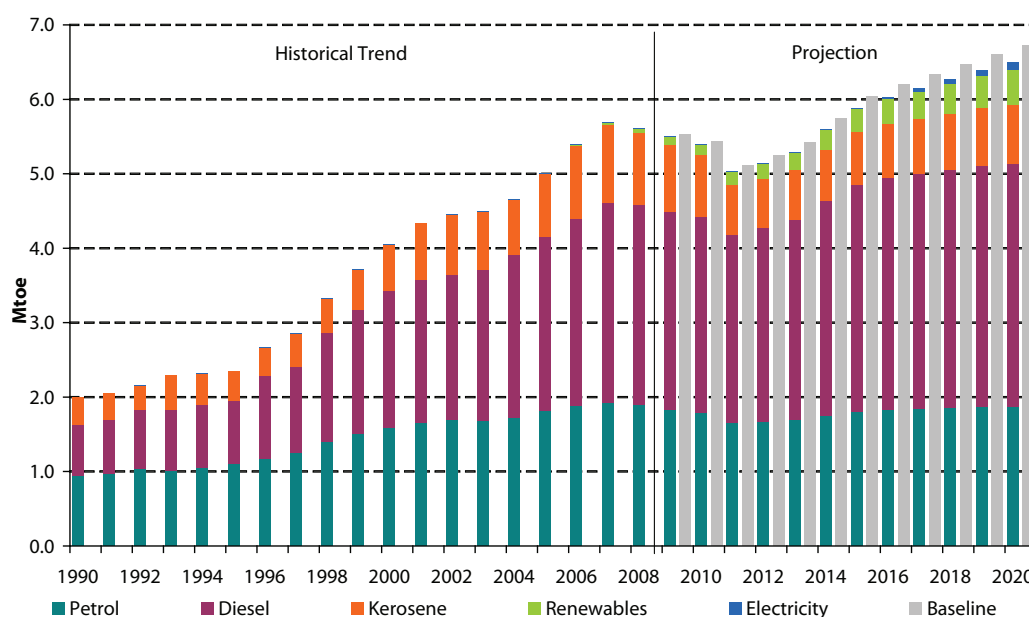
Table 23 Services Final Energy Demand by Fuel 2008–2020 (Policy)

Services	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Coal	26	26	23	-13.5	-1.2	-0.5	-1.5	1%	2%	2%
Oil	550	285	60	-89.1	-16.9	-15.1	-17.7	30%	18%	4%
Gas	394	330	225	-42.9	-4.6	-4.3	-4.7	22%	21%	16%
Renewables	15	57	143	848.6	20.6	39.2	12.3	1%	4%	10%
Electricity	822	885	998	21.5	1.6	1.9	1.5	45%	56%	69%
Total	1,807	1,583	1,448	-19.9	-1.8	-3.3	-1.1			

The significant reduction in demand expected in the sector is linked to achievement of the public sector's 33% energy savings target, as defined in the NEEAP. This provides 3100 GWh (267 ktoe) of expected savings in 2020. This target, coupled with additional business supports for small and medium-sized enterprises (SMEs), leads to a reduction of 3800 GWh (327 ktoe) in 2020, in addition to the savings already incorporated in the *Baseline* trend.

4.1.4 Transport Final Energy Demand

Figure 21 shows the fuel mix for transport in the policy forecasts. Continued growth in the sector is expected following the recessionary period, with average annual growth of 3.1% per annum for 2012–2020 – only a slight reduction on that expected for the *Baseline* (3.2% per annum) over the same period.

Figure 21 Transport Final Energy Demand by Fuel 1990–2020 (Policy)

The share of petrol is forecast to drop from 34% to 29%, while diesel is anticipated to slightly increase its share from 48% to 50% over the period 2008–2020. Overall, the share of oil in the sector is reduced from 99% in 2008 to 91% in 2020 on the basis of increased penetration of biofuels (7% in 2020) and to a lesser extent electricity (1.5% in 2020).

A simplified assumption applied here is that biofuels will displace petrol and diesel in accordance with their respective shares of final demand. In addition, fuel tourism is excluded from the analysis.

Table 24 Transport Final Energy Demand by Fuel 2008–2020 (Policy)

Transport	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Oil	5,552	4,935	5,933	6.9	0.6	-2.9	2.3	99	96	91
Kerosene	970	659	800	-17.5	-1.6	-9.2	2.5	17	13	12
Petrol	1,907	1,670	1,873	-1.8	-0.2	-3.3	1.4	34	32	29
Diesel	2,673	2,606	3,259	21.9	1.7	-0.6	2.8	48	51	50
Biofuels	56	201	464	729.1	19.3	37.6	11.1	1	4	7
Electricity	5	5	95	1,917.2	28.4	0.0	45.6	0.1	0.1	1.5
Total	5,612	5,140	6,492	15.7	1.2	-2.2	3.0			

A range of measures affecting the efficiency of transport are applied in the policy scenarios. These include efficient-driving measures, electric-vehicle deployment, mobility-management plans, e-working³⁴ and more sustainable public transport fleets. Further detail on these measures can be found in the Department of Transport's Sustainable Travel and Transport Action Plan (February, 2009).

As per the *Baseline* scenario, the shift from petrol to diesel is in part explained by changes to VRT and motor tax introduced in 2008 that incentivise the purchase of lower-CO₂-emitting vehicles.

It is clear that these measures alone are not sufficient to offset a return to moderately fast demand growth expected after 2012. This sector remains a focus for further policy development.

³⁴ Promoting of working from home, leading to reduced car use.

4.2 Renewable Energy (Policy Scenario)

The *White Paper Plus* and *Exploratory* scenarios include the same assumptions on RES-T and RES-H contributions to renewable energy supply. The *Exploratory* scenario considers a significantly higher contribution from renewable electricity (RES-E) than the *White Paper Plus* scenario. This affects the difference between the two policy scenarios in terms of the overall renewable energy contribution, RES, and the renewable energy in transport, RES-T; the latter shows a difference in the magnitude of renewable electricity used in electric vehicles. With regard to the renewable-heat contribution, RES-H, the policy scenarios are considered as being essentially the same and as such are considered together.

Figure 22 shows graphically the forecast for final consumption by energy mode, or energy market, in the policy scenarios. As in the *Baseline* projection, the largest sector, transport, is the main driver of the overall trend of consumption growth. The effect of the energy efficiency measures has been to reduce the overall consumption by 8.2% as compared to the *Baseline* projection for these modes.

Figure 22 Energy Consumption by Mode of Application 2008–2020 (Policy Scenarios)

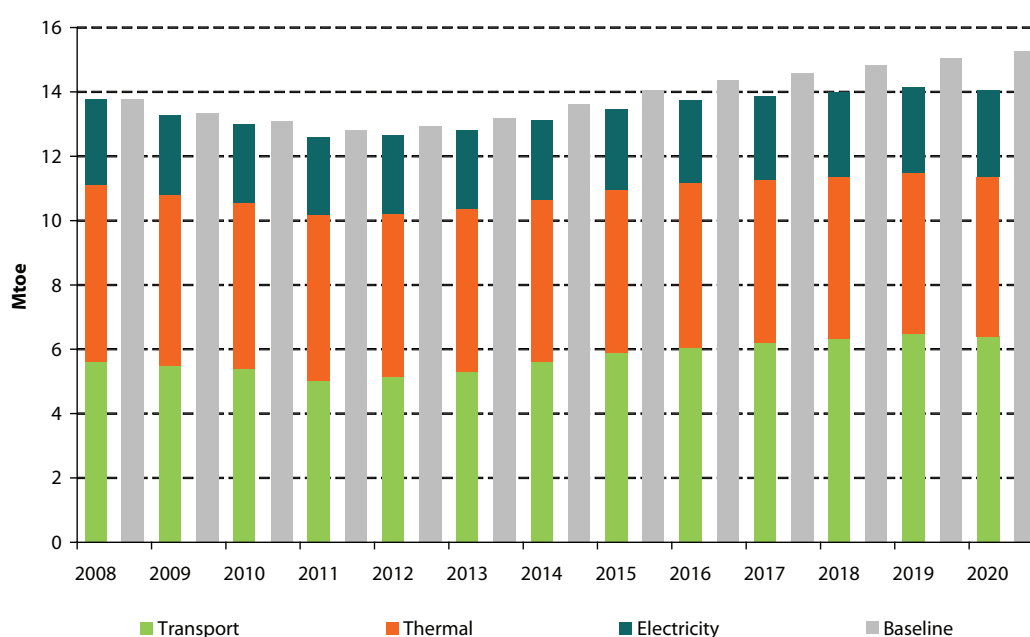


Table 25 indicates a reduction in thermal demand of 10% over the period, with electricity consumption showing only a slight increase of 1%. Transport grows by almost 16%, two percentage points less compared with the *Baseline*.

Table 25 Energy Consumption by Mode of Application (Policy Scenarios)

Fuel	Final Consumption (ktoe)			Growth %	Average Annual Growth Rate %			Final Application Shares %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Electricity	2665	2426	2689	0.9	0.1	-2.3	1.3	19	19	19
Thermal	5502	5060	4836	-12.1	-1.1	-2.1	-0.6	40	40	35
Transport	5611	5140	6492	15.7	1.2	-2.2	3.0	41	41	46
Final Cons.	13779	12626	14018	1.7	0.1	-2.2	1.3			

4.2.1 Renewable Contribution to Overall Energy Demand

White Paper Plus Scenario

Figure 23 shows the combined renewable energy contributions to overall energy demand. Where the *Baseline* projection showed a growth trend halting in 2012, the *White Paper Plus* scenario continues to grow up to 2020. This highlights the impacts of future anticipated renewable energy policy measures required to reach the *White Paper* targets. The RES contribution in 2020 achieves 15.4%, which is close to Ireland's 16% EU target.

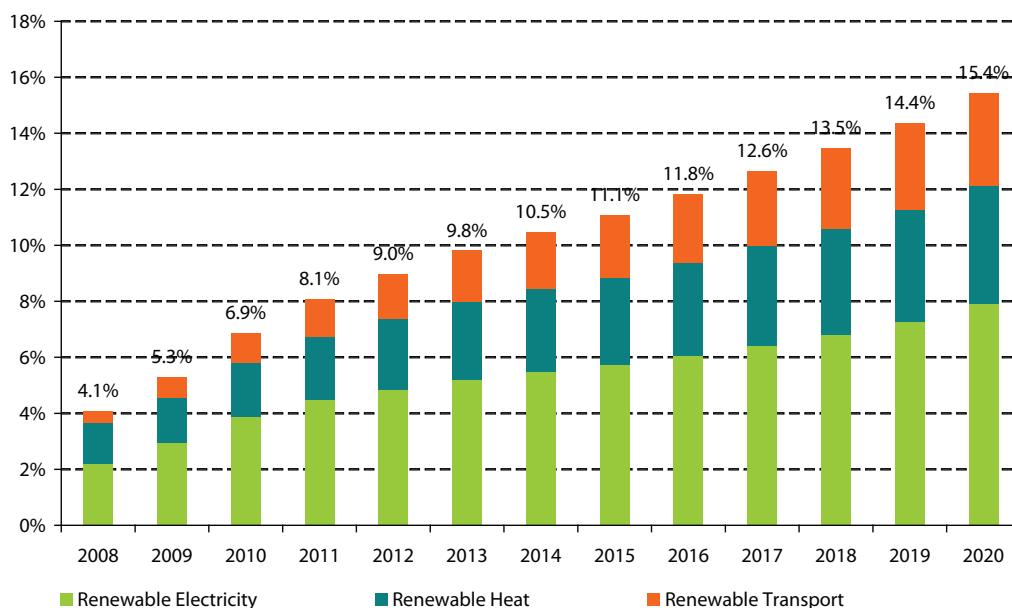
Figure 23 Renewable Energy Contribution to Final Consumption (White Paper Plus)

Table 26 outlines the trends illustrated by the graph. Each energy mode sees a large increase in renewable energy on current levels, with a close to fourfold increase overall. Renewable energy consumption in transport is forecast to grow at a rate of 21% per annum, contributing 3.3% of the overall 15.4% RES in 2020. This reflects the growth of transport demand, but it also assumes that measures are put in place to achieve 10% RES-T.

Renewable electricity generation grows by 265% over the period. It accounts for 40% of gross electricity consumption in 2020, but contributes just 8% to overall energy demand due to the low share of electricity in overall energy demand. Renewable thermal energy contributes the remaining 4.2% to the overall demand.

It is important to stress that energy efficiency savings are also contained within these forecasts. Given that the renewable energy targets are expressed as percentages of energy consumption, any shortfall in efficiency savings or increase in demand due to other factors would increase the amount of renewable energy production required to meet the renewable energy targets.

Table 26 Renewable Energy as a % of Final Consumption (White Paper Plus)

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Sectoral Contribution %		
	2008	2012	2020		08-20	08-20	08-12	12-20	2008	2012
RES-E	304	612	1109	264.4	11.4	19.1	7.7	2.2	4.8	7.9
RES-H	198	383	593	199.2	9.6	18.0	5.6	1.4	3.0	4.2
RES-T	57	204	563	881.1	21.0	37.3	13.6	0.4	1.6	3.3
Total Renewables	558	1195	2164	288.0	12.0	21.0	7.7			
Total Cons.	13,779	12,626	14,018	1.7	0.1	-2.2	1.3			
RES								4.1	9.5	15.4

Exploratory Scenario

Including the extra renewable electricity generation in the *Exploratory* scenario sees the overall RES contribution increase from 15.4% to 17.5%, which would represent an over-achievement of the EU target.

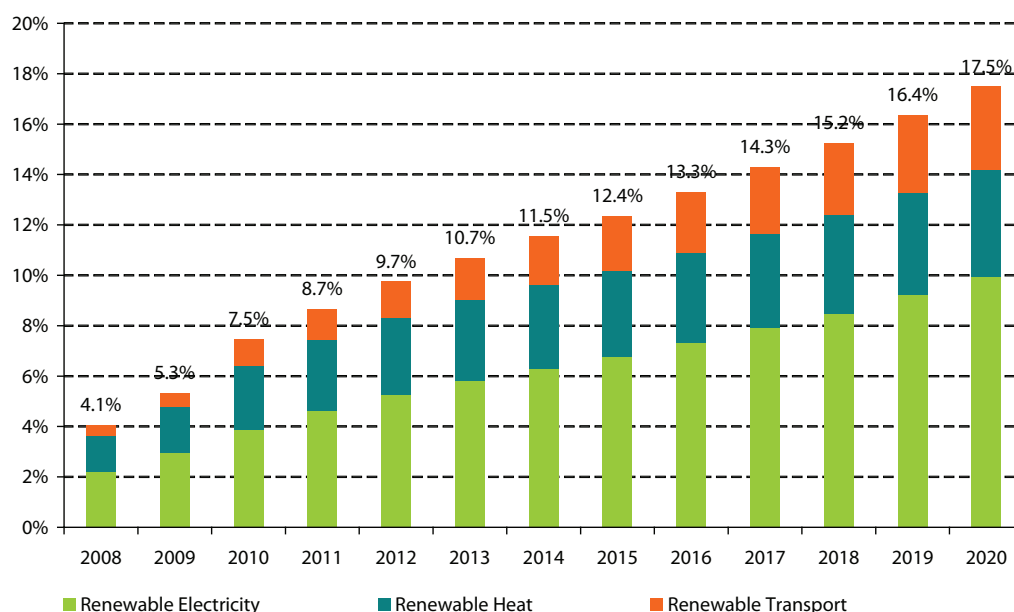
Figure 24 Renewable Energy Contribution to Final Consumption (Exploratory)

Table 27 summarises the data and trends apparent in Figure 24. Electricity generation from renewable now increases at the higher growth rate of 13.5% per annum, which delivers 25% more renewable electricity in 2020 than in the *White Paper Plus*. This equates to 1,395 ktoe (16,221 GWh) in 2020.

Surpassing the EU target, as in this scenario, is contingent on an annual growth rate in renewable energy of 13%. The increase in RES as a result of the increased wind-generated electricity included has a positive impact on achievement of the EU target in the modelling exercise. However, achieving this depends on, *inter alia*, overcoming the technical challenges of incorporating such a high level of renewable electricity in the electricity grid; building the infrastructure and policy support measures required for electric vehicles, and overcoming the significant challenges associated with delivering the level of biofuels required and renewable energy in the heat sector.

Table 27 Renewable Energy as a % of Final Consumption (Exploratory)

Sector	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate%			Sectoral Contribution %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
RES-E	304	666	1395	358.5	13.5	21.6	9.7	2.4	5.0	9.9
RES-H	198	384	593	200.5	9.6	18.0	5.6	1.6	2.9	4.2
RES-T	57	185	588	933.8	21.5	34.2	15.6	0.4	1.4	3.3
Total Renewables	558	1231	2455	340.0	13.1	21.9	9.0			
Total Cons.	13,779	12,626	14,018	1.7	0.1	-2.2	1.3			
RES								4.1	9.7	17.5

Thus the two policy scenarios straddle the delivery of EU renewable energy targets. Whereas the *White Paper Plus* scenario is based on the minimum wind energy capacity required to meet national sectoral targets, the Exploratory scenario shows that additional wind capacity well below what is now being processed for connection will meet and indeed exceed the EU renewable energy target.

4.2.2 Renewable Contribution to Electricity (RES-E)

White Paper Plus Scenario

Figure 25 shows the trends evident in achieving the 40% RES-E. Hydro capacity, and thus hydro output, is assumed to expand at a slow rate over the forecast period – 0.7% per annum.

Biomass production increases steadily at an annual growth rate of 24%, to contribute 7% to RES-E by 2020.

Ocean energy is assumed to start commercial production in 2016, propelled by an expansion in the capacity of wave electricity-generation technology. Renewable energy harnessed from the ocean is envisaged to contribute over 4% to RES-E by 2020.

Wind renewable electricity generation increases at 11% per annum over the period, supplying an extra 511 ktoe in 2020 above 2008 levels. This represents the largest contribution of all the renewable electricity fuels towards RES-E, standing at 27% of gross electricity consumption.

Figure 25 Renewable Contribution to RES-E (White Paper Plus)

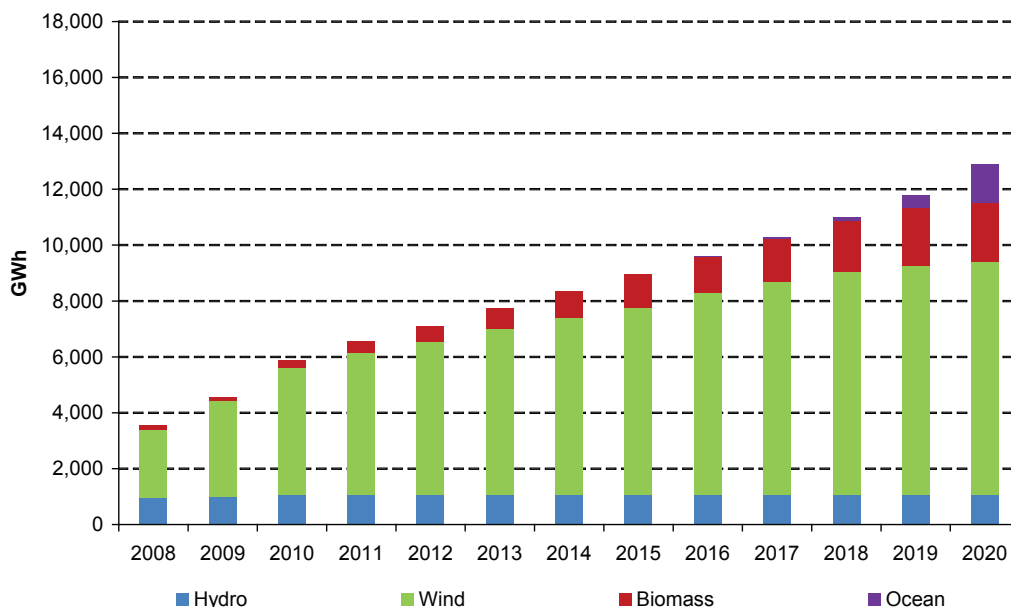


Table 28 shows the growth trends across all the renewable energy fuels over the period. Overall renewable electricity generation grows by 11% per annum and is anticipated to reach 12,899 GWh in 2020. Wind energy is the largest contributor, accounting for over 60% of total renewable generation throughout the period. Biomass displays the fastest growth of all the renewable fuels over the period, growing at 24% per annum to contribute 2,132 GWh to renewable generation by 2020.

Table 28 Renewable Electricity Generation Fuels Contribution to RES-E (White Paper Plus)

Sector	Total Final Demand (GWh)			Growth %	Average Annual Growth Rate %			Fuel Contribution to RES-E %		
	2008	2012	2020		08-20	08-12	12-20	2008	2012	2020
Biomass	160	570	2132	1228.8	24.1	37.3	17.9	0.5	2.0	6.8
Hydro	968	1053	1053	8.7	0.7	2.1	0.0	3.1	3.7	3.4
Ocean	0	0	1367	0.0	0.0	0.0	0.0	0.0	0.0	4.4
Wind	2410	5495	8347	246.3	10.9	22.9	5.4	7.8	19.5	26.7
Total Gen.	3,539	7,119	12,899	264.4	11.4	19.1	7.7			
Gross Cons.	30,994	28,209	31,276	0.9	0.1	-2.3	1.3			
RES-E								11	25	41

Exploratory Scenario

Figure 26 shows the effect on RES-E of 5,000 MW of wind (500 MW of which is offshore) rather than the figure of 3,100 MW in the *White Paper Plus*. The total amount of renewable generation grows to 16,221 GWh, which represents a 26% increase in renewable electricity production over the *White Paper Plus* scenario. Wind electricity generation is seen to increase more steeply than in the previous scenario, while biomass, ocean and hydro remain on a similar trajectory.

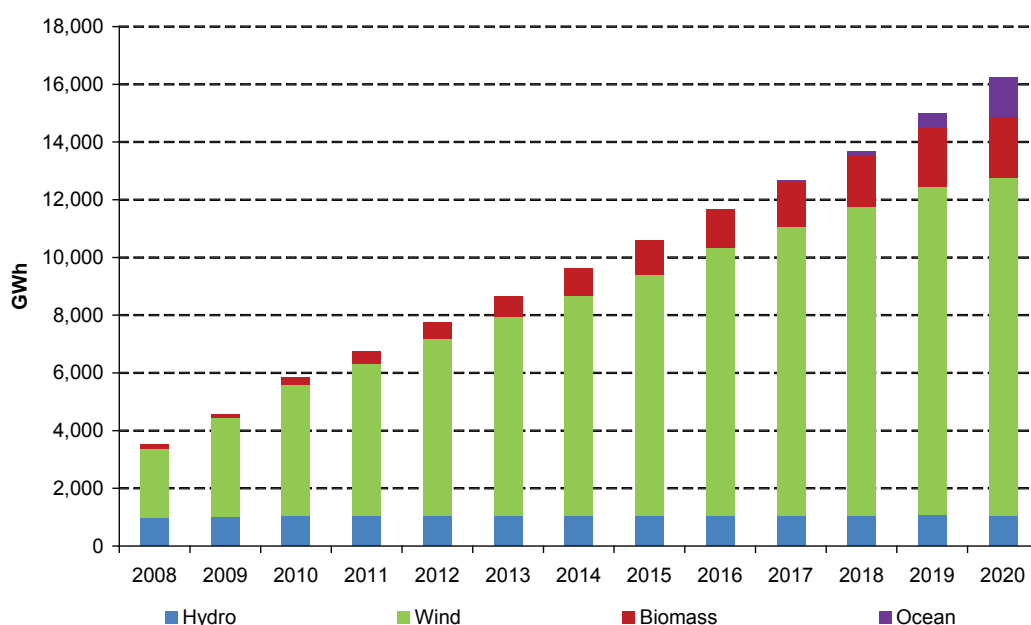
Figure 26 Renewable Contribution to RES-E (Exploratory)

Table 29 shows wind generation growing at 14% per annum between 2008 and 2020, three percentage points more than in the *White Paper Plus*. This expansion raises the RES-E to 52%, which is in excess of the 40% national target.

Table 29 Renewable Electricity Generation Fuels Contribution to RES-E (Exploratory)

Sector	Total Final Demand (GWh)			Growth %	Average Annual Growth Rate %			Fuel Contribution to RES-E %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Biomass	160	570	2088	1201.8	23.8	37.3	17.6	0.5	2.0	6.7
Hydro	968	1053	1053	8.7	0.7	2.1	0.0	3.1	3.7	3.4
Ocean	0	0	1367	0.0	0.0	0.0	0.0	0.0	0.0	4.4
Wind	2410	6123	11720	386.2	14.1	26.2	8.5	7.8	21.7	37.5
Total Gen	3539	7746	16228	358.5	13.5	21.6	9.7			
Gross Cons	30994	28209	31276	0.9	0.1	-2.3	1.3			
RES-E								11	27	52

4.2.3 Renewable Contribution to Transport (RES-T)

Both policy scenarios deal with the same total final consumption for each of the fuels used in transport, but differ in the way electricity used in electric vehicles is counted towards the target. The scenarios assume that the target for electric-vehicles penetration is achieved and that measures are put in place to deliver 8.5% of road and rail transport energy from biofuels by 2020.

Here the EU Directive 2009/28/EC calculation methodology for RES-T is used for both policy scenarios, leading to two slightly different overall renewable transport energy numbers, but both meet the target of 10%. The difference in renewable electricity for the two scenarios is the root cause and this is further amplified when the weighting³⁵ is applied.

³⁵ The 2.5 multiplier for renewable electricity used in transport is prescribed by the EU renewable directive 2009/28/EC. A brief overview of this methodology is presented in Section 3.

White Paper Plus Scenario

Figure 27 illustrates the relative contributions of biofuels and renewable electricity towards the RES-T target. Biofuels are expected to provide the bulk of renewable energy, with renewable electricity becoming more prominent towards 2020.

Figure 27 Renewable Energy Contribution to RES-T (White Paper Plus)

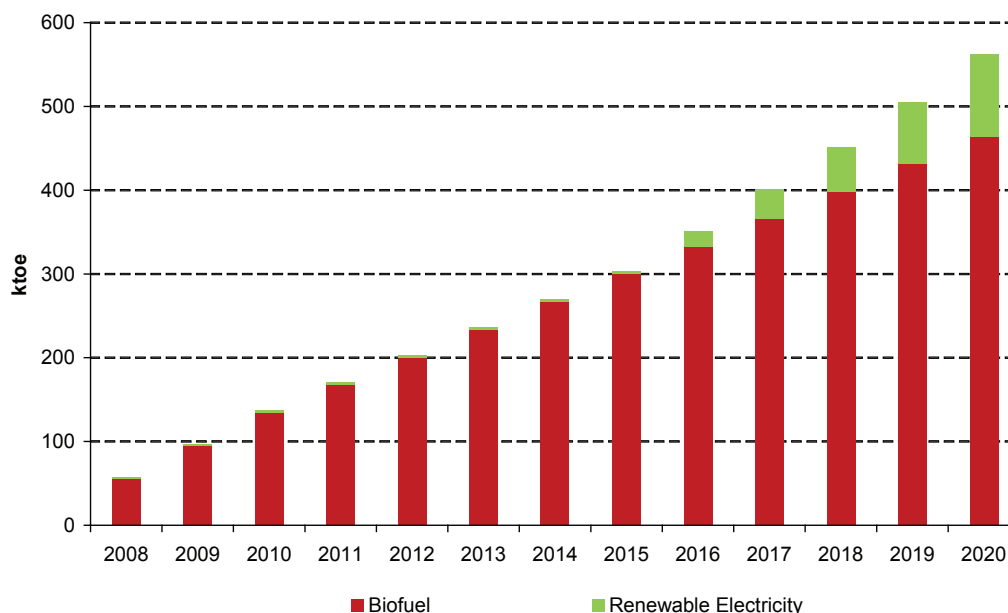


Table 30 outlines the trends evident in the graph. Total consumption of electricity in transport grows at an annual rate of 46% from 2012 to 2020, but the proportion that can be considered renewable grows at 55% per annum, reflecting the increasing RES-E along the trajectory to 2020. With the weighting applied, renewable electricity accounts for 1.7% of consumption in 2020. Biofuels expand at the rate of 19% per annum between 2008 and 2020, reaching 464 ktoe in 2020 which contributes 8% to RES-T.

Table 30 Renewable Energy Contribution to RES-T (White Paper Plus)³⁶

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Contribution to RES-T %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Renewable Electricity	1	3	98	7185	43.0	21.9	54.8	0.0	0.1	1.7
Biofuels	56	135	464	729	19.3	24.5	16.7	1.2	3.0	8.0
Total Renewables	57	138	563	881.1	21.0	24.5	19.3			
Total Cons.	4,642	4,484	5,790	24.7	1.9	-0.9	3.2			
RES-T								1.2	3.1	9.7

Exploratory Scenario

A higher RES-E in each year to 2020 in the *Exploratory* forecast results in a greater proportion of the electricity use in transport being eligible for consideration in RES-T. Given that the final consumption of the fuels is identical in both policy scenarios, the *Exploratory* shows a slightly higher RES-T in the final calculation due to the RES-E difference. In spite of this, little difference can be detected between Figure 27 and Figure 28, highlighting the fact that increased renewable electricity in the *Exploratory* has little impact over and above the *White Paper Plus* scenario.

³⁶ Note: Total Consumption includes weighting for renewable electricity

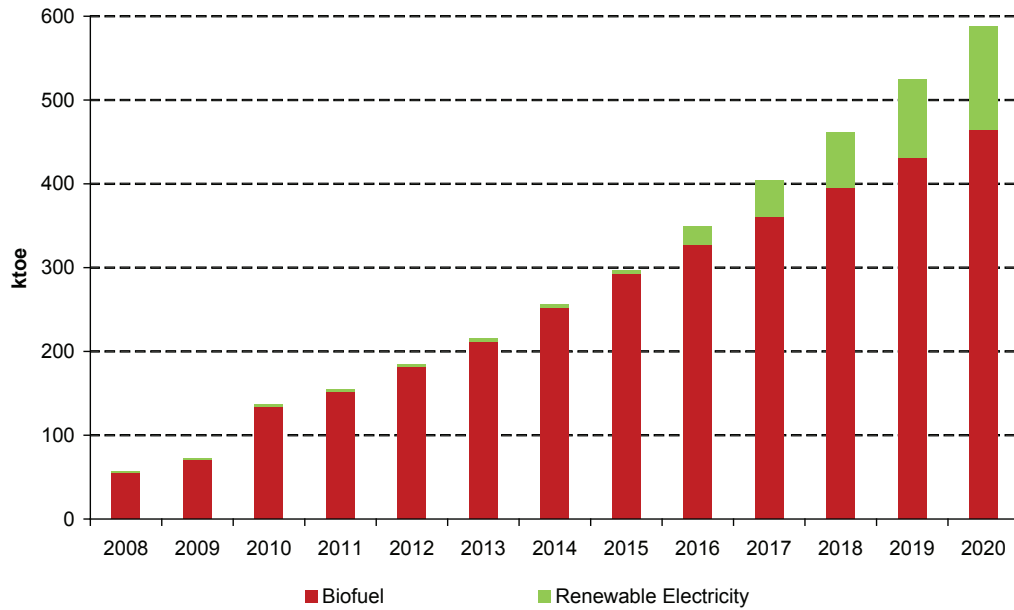
Figure 28 Renewable Energy Contribution to RES-T (Exploratory)

Table 31 summarises the data from Figure 28. Again, electricity consumption grows at 46% per annum but the renewable proportion grows at an annual rate of 58%; a three percentage point increase from the previous scenario. The *Exploratory* scenario shows a 25 ktoe increase in renewable energy use in transport from the *White Paper Plus*, which results from the combination of the increased RES-E in the *Exploratory* and the weighting applied. When the final RES-T number is again rounded to the nearest whole number, the contribution of renewable energy in transport is 10%.

Table 31 Renewable Energy Contribution to RES-T (Exploratory)

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Contribution to RES-T Generation %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Renewable Electricity	1	3	124	9065.6	45.7	24.5	57.6	0.0	0.1	2.1
Biofuels	56	181	464	736.1	19.4	34.4	12.5	1.2	4.0	8.0
Total Renewables	57	185	588	933.8	21.5	34.2	15.6			
Total Cons	4,642	4,479	5,810	25.2	1.9	-0.9	3.3			
RES-T								1.2	4.1	10.1

4.2.4 Renewable Contribution to Heat (RES-H)

Figure 29 shows the renewable thermal energy penetration in industry, services and households consistent with the *White Paper* target of 12% RES-H.

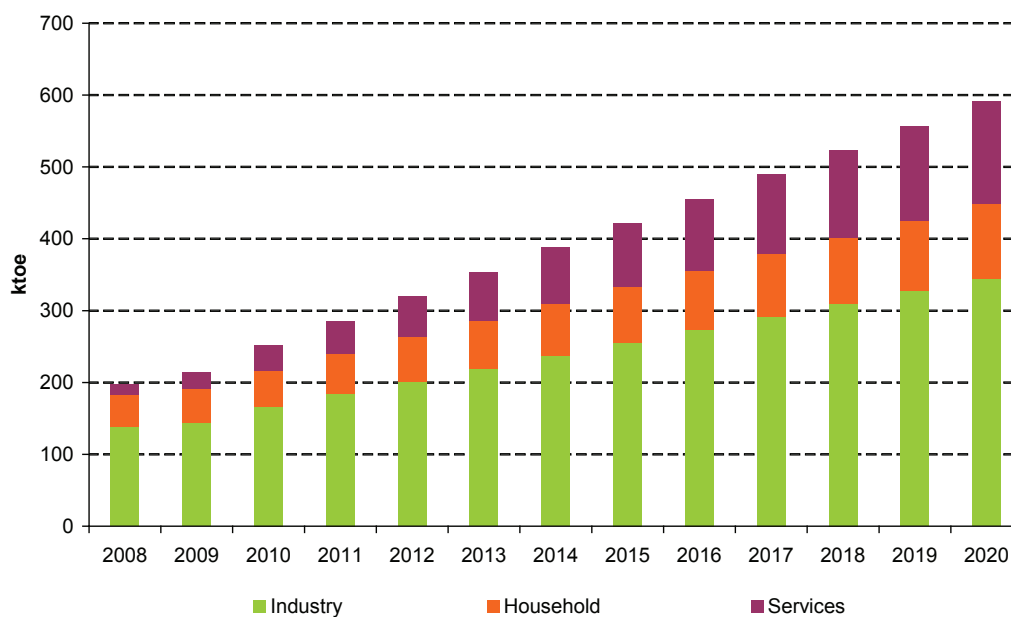
Figure 29 Thermal Energy Consumption by Sector 1990-2020 (Policy Scenarios)

Table 32 shows that renewable heat must grow at an annual rate of nearly 10% in order to achieve the *White Paper* target, during a period in which overall thermal energy consumption is projected to fall. This highlights the challenge that the RES-H target presents.

Table 32 Thermal Energy Consumption by Sector 2008–2020 (Policy Scenarios)

Fuel	Total Final Demand (ktoe)			Growth %	Average Annual Growth Rate %			Sectoral Shares %		
	2008	2012	2020		08–20	08–20	08–12	12–20	2008	2012
Industry	139	202	345	148.5	7.9	9.8	6.9	70.2	63.1	58.3
Household	44	61	103	135.4	7.4	8.7	6.7	22.2	19.2	17.5
Services	15	57	143	848.6	20.6	39.2	12.3	7.6	17.7	24.2
Total Renewables	198	320	591	198.9	9.6	12.8	8.0			
Total Consumption	5,502	5,060	4,836	-12.1	-1.1	-2.1	-0.6			
RES-H								3.6	6.3	12.0

4.3 Electricity Generation Fuel Mix (Policy Scenario)

In both the *Policy* scenarios, fossil-fuel power plants follow the same schedule in terms of commissioning and decommissioning as that outlined in Section 3.4, dealing with the electricity generation mix in the *Baseline* projection.

Table 33 outlines the capacity assumption for renewable electricity and the levels of interconnection in the *White Paper Plus* and the *Exploratory* scenarios as well as the *Baseline*.

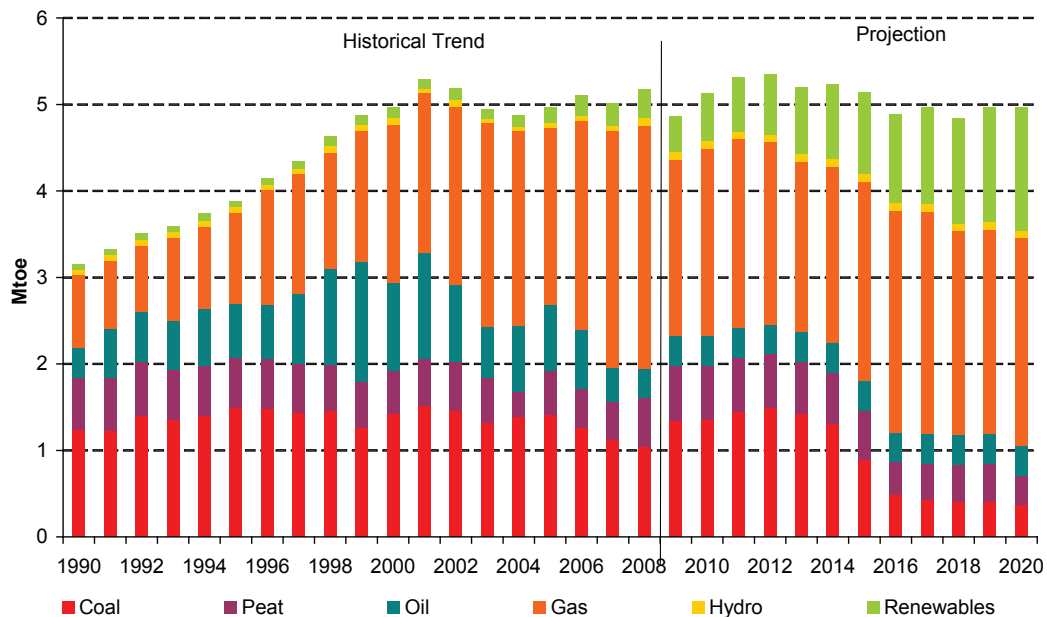
Table 33 Renewable Electricity Capacity Assumption in Policy Scenarios

Technology	All Scenarios (MW)	Baseline (MW)	White Paper Plus (MW)	Exploratory (MW)
	2010	2020	2020	2020
Biomass	64	64	400	400
Hydro	260	260	260	260
Offshore Wind	0	0	0	500
Onshore Wind	1,500	2,700	3,100	4,500
Tidal	0	0	0	0
Wave	0	0	500	500
Interconnection	500	900	1400	1400

In addition to the capacity inputs outlined, extra constraints are imposed on the model that may not necessarily align with the economic dispatch but are required for overriding reasons such as ensuring security of supply. To that end, peat plants are supported by a public service obligation (PSO) which reduces their wholesale price bids. The PSO for the ESB-owned peat units runs out in 2019 while the PSO held by Edenderry Power runs out in 2015.

White Paper Plus Scenario

Figure 30 shows the trend for the primary fuel mix in electricity generation up to 2020. It is noteworthy that, in spite of a reduction in total final consumption between 2008 and 2012, the total energy used in electricity generation increases. This is largely due to the extra interconnection coming on line in this period and the move from being a net electricity importer to a net electricity exporter.

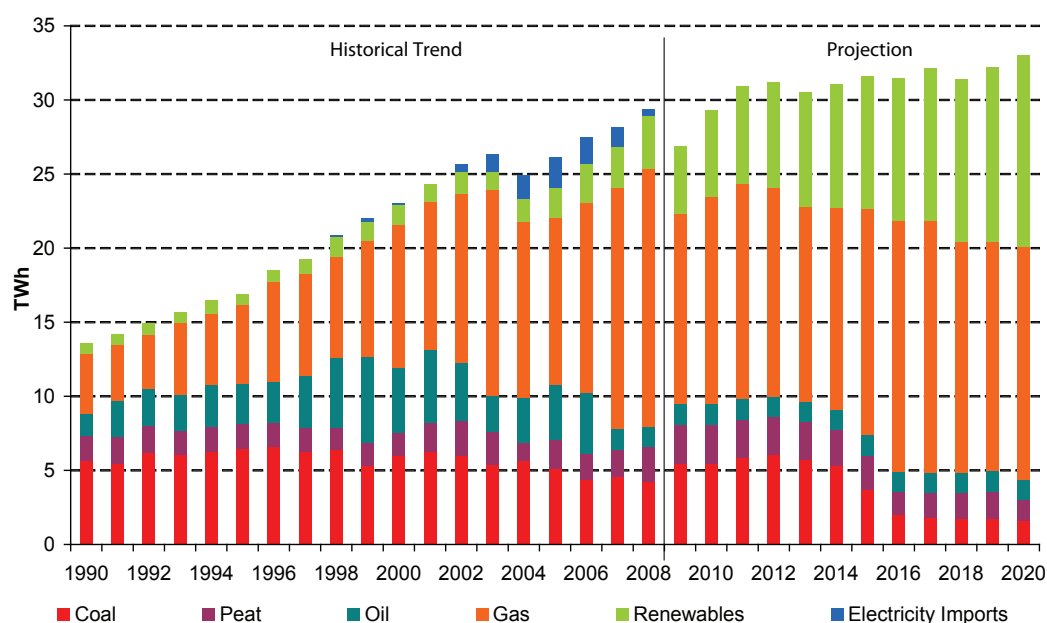
Figure 30 Primary Fuel Mix for Electricity Generation 1990–2020 (White Paper Plus)

In terms of the fuels used to generate electricity, renewable fuel sources are the only fuels expected to see an absolute increase over the entire period. Gas falls in the 2008 to 2012 period, despite the additional plants, reflecting the impact of growth in wind generation. Gas rises then, at 1.6% per annum, in the 2012 to 2020 period, accounting for 49% of the primary fuel inputs, staying within the *White Paper* target of limiting its share to 50%.

Table 34 Electricity Generation Primary Fuel Inputs 2008–2020 (White Paper Plus)

Fuel	Elec Gen Fuel Inputs (ktoe)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020		08–20	08–20	08–12	12–20	2008	2012
Coal	1,046	1,497	373	-64.4	-8.2	9.4	-16.0	20.6	28.5	7.6
Oil	345	345	345	0.0	0.0	0.0	0.0	6.8	6.6	7.1
Gas	2,811	2,106	2,397	-14.7	-1.3	-7.0	1.6	55.2	40.0	49.1
Peat	558	615	338	44.9	3.1	27.5	-7.2	11.0	11.7	6.9
Renewables	329	698	1,426	333.7	13.0	20.7	9.3	6.5	13.3	29.2
Total	5,089	5,262	4,879	2.4	0.2	2.5	-0.9			

The total level of electricity demand in each half-hour period is met by the least cost plant dispatch subject to system security constraints. *Figure 31* shows the annual electricity generation mix.

Figure 31 Electricity Generation by Fuel 2008–2020 (White Paper Plus)

Overall, the amount of electricity generated grows 14% over the period, which is almost double the amount required by the growth in domestic demand. The much greater role of exports in the forecast accounts for this difference between actual electricity generated and domestic electricity consumption.

Exports are driven by an increase in the interconnection capacity in 2012 combined with the expansion of renewable electricity generation. In the initial period following the commissioning of the new interconnection capacity, export flows are expected to rise substantially in 2012 before falling back slightly in 2020. The overall growth in exports over the period is predicted to be in the region of 84% per annum, accounting for almost 5% of electricity generation in 2020.

Table 35 summarises the data underpinning *Figure 31*. Coal generation sees a 62% reduction over the period, due to the evolving coal/gas price differential coupled with rising carbon prices. Renewable electricity generation grows in line with the expansion in wind, wave and biomass capacity, to reach the RES-E target of 40% in 2020. This RES-E number does not correspond to the share renewable electricity has of overall generation, the former is calculated using gross electricity consumption (total generation plus net imports) whereas the latter uses total electricity generation in the calculation. As a proportion of primary energy input, renewable electricity captures a 29% share but, as a share of final electricity generated, renewable electricity generated attains a 39% share.

Table 35 Electricity Generation by Fuel 2008–2020 (White Paper Plus)³⁷

Fuel	Gross Electricity Consumption (GWh)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020		08–20	08–12	12–20	2008	2012	2020
Coal	4,259	6,041	1,596	-62.5	-7.9	9.1	-15.3	14.7	19.4	4.8
Oil	1,367	1,367	1,367	0.0	0.0	0.0	0.0	4.7	4.4	4.1
Gas	17,401	14,077	15,773	-9.4	-0.8	-5.2	1.4	60.2	45.1	47.8
Peat	2,338	2,580	1,398	-40.2	-4.2	2.5	-7.4	8.1	8.3	4.2
Renewables	3,539	7,117	12,897	264.4	11.4	19.1	7.7	12.2	22.8	39.0
Electricity Imports (Net)	(450)	0	0	-100	0.0	0.0	0.0	(1.7)	0	0
Electricity Exports (Net)	0	2,835	1,478	147700	0	629.7	-7.8	0.0	9.1	4.5
Total Gen.	28,904	34,017	34,508	14.3	1.1	1.9	0.7			

Exploratory Scenario

The general overall trend relating to the primary energy requirement for electricity generation follows a similar path to that in the *White Paper Plus*. A difference in the total energy requirement is apparent as well as differences in the individual fuel shares, with the *Exploratory* showing slightly more fuel inputs than is the case in the *White Paper Plus* in 2020. This reflects the higher level of renewable electricity generation in the *Exploratory* together with a higher level of exports.

Gas, coal and peat all have reduced shares as compared to the *White Paper Plus*, with renewable inputs being five percentage points higher. *Figure 32* illustrates these expected trends for the *Exploratory* scenario. The trends underlying the profiles of the fossil fuels are as described in the *White Paper Plus* scenario, with the trend in renewable electricity being driven by the expansion in renewable electricity capacity.

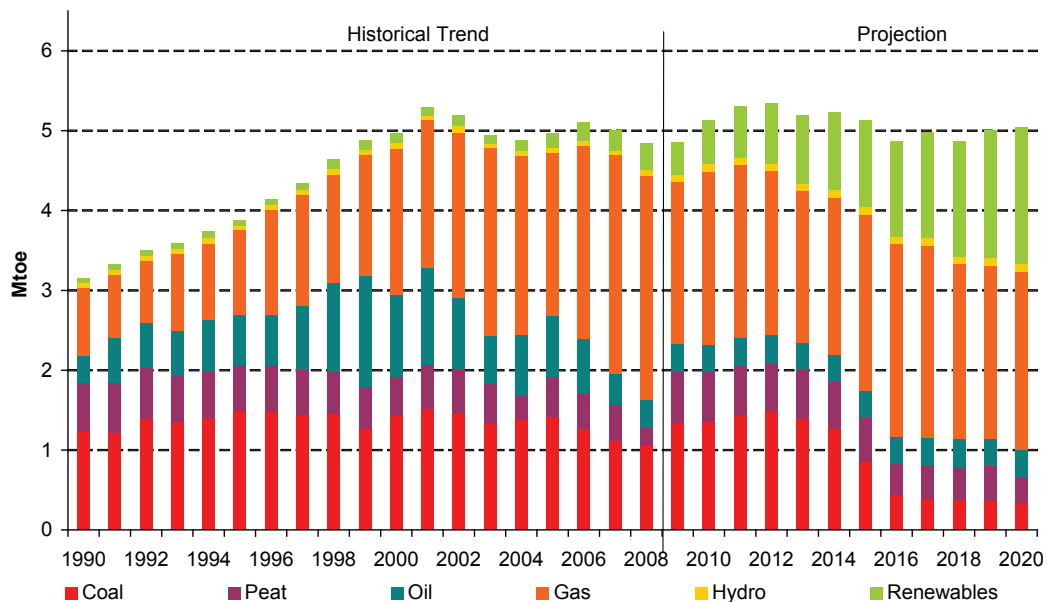
Figure 32 Primary Fuel Mix for Electricity Generation 1900–2020 (Exploratory)

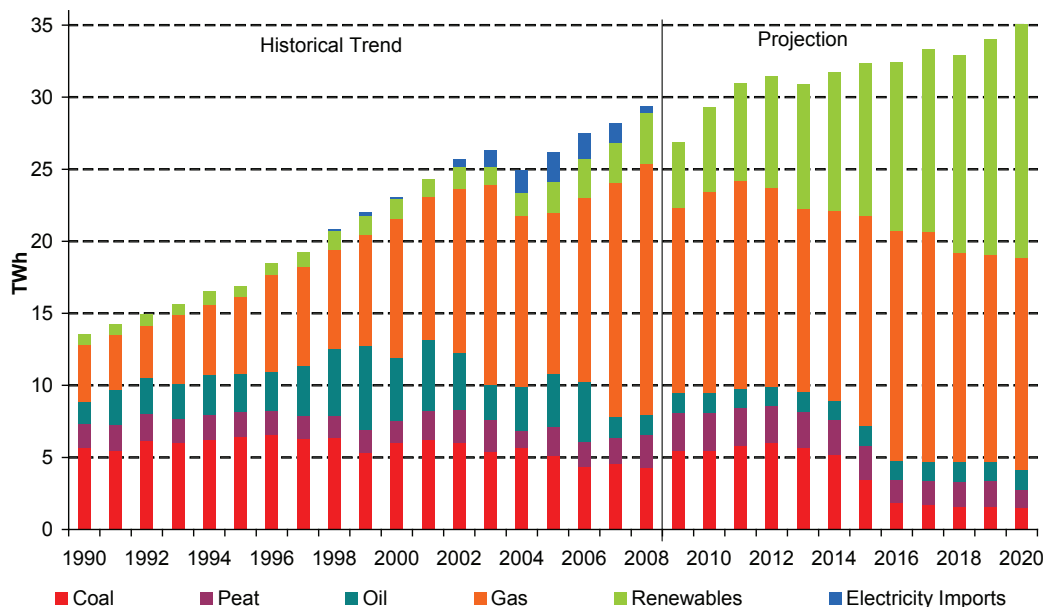
Table 36 outlines the data for the primary fuel inputs in the *Exploratory* scenario. Renewable fuel inputs are predicted to grow at 15% per annum, to reach a 34% share of primary energy required in 2020. The remaining primary fuel inputs have either experienced an absolute reduction below current (2008) levels or remained static up to 2020.

³⁷ Note: Only electricity exports count towards the total generation

Table 36 Electricity Generation Primary Fuel Inputs 2008–2020 (Exploratory)

Fuel	Elec Gen Fuel Inputs (ktoe)			Growth %	Average Annual Growth Rate %				Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020	
Coal	1,046	1,484	339	-67.6	-9.0	9.1	-16.8	22	28	7	
Oil	345	345	345	0.0	0.0	0.0	0.0	7	7	7	
Gas	2,811	2,062	2,249	-20.0	-1.8	-7.4	1.1	59	39	45	
Peat	558	614	315	35.1	2.5	27.4	-8.0	5	12	6	
Renewables	329	752	1,706	418.9	14.7	23.0	10.8	7	14	34	
Total	5,089	5,258	4,954	4.0	0.3	2.5	-0.7				

The estimation of required fuel inputs is based on a forecast of the total electricity generation expected over the period 2008 to 2020, which in turn is determined by modelling the Irish electricity market and its interaction with interconnected markets. *Figure 33* shows the *Exploratory* expected trajectory of electricity generation to 2020. The increasing prominence of renewable electricity generation in the portfolio is clearly evident, while the increase in overall electricity also stands out.

Figure 33 Electricity Generation by Fuel 1990–2020 (Exploratory)

As shown in *Table 37*, overall generation grows by 22% over the period to reach over 35 TWh in 2020. Electricity generated for export accounts for a significant proportion of this generation, reaching almost 10% in 2020.

It should be noted that the 46% generation share of renewable electricity does not correspond with the RES-E number as the generation share is calculated using total generation whereas RES-E uses gross electricity consumption.

All fossil-fuel sources see a reduction in the share of electricity generated. Gas shows the lowest reduction, 15%, over the period.

Table 37 Electricity Generation by Fuel 2008–2020 (Exploratory)

Fuel	Gross Electricity Consumption (GWh)			Growth %	Average Annual Growth Rate %			Fuel Shares %		
	2008	2012	2020	08–20	08–20	08–12	12–20	2008	2012	2020
Coal	4,259	5,990	1,464	-65.6	-8.5	8.9	-16.1	14.7	19.0	4.2
Oil	1,367	1,367	1,367	0.0	0.0	0.0	0.0	4.7	4.4	3.9
Gas	17,401	13,779	14,749	-15.2	-1.4	-5.7	0.9	60.2	43.8	42.0
Peat	2,338	2,575	1,299	-44.4	-4.8	2.4	-8.2	8.1	8.2	3.7
Renewables	3,539	7,745	16,225	358.5	13.5	21.6	9.7	12.2	24.6	46.2
Electricity Imports (Net)	(450)	0	0	-100.0	0.0	0.0	0.0	(1.6)		
Electricity Exports (Net)	0	3,098	3,475	347397	97.3	646.1	1.4	0.0	9.9	9.9
Total Gen.	28,903	31,455	35,104	21.5	1.6	2.1	1.4			

5. Discussion

The purpose of this section is to draw out a selection of themes and issues arising from the modelling work conducted for this year's forecasts. Key issues include:

- The expected impact of energy efficiency policy measures (both existing and planned) on the forecast energy demand in each sector
- The implications of the updated forecasts for renewables policy, particularly with regard to investment in renewable electricity generation required to meet the RES-E target
- The ongoing challenge to meet Ireland's greenhouse-gas targets for 2020 in the Non-Emissions Trading sector

The projected total final consumption for 2020 (15,002 ktoe) in the *Baseline* scenario is 9.0% lower than the corresponding figure in last year's forecast. Two factors have contributed to this change. First, the 2009 *Baseline* figures are derived from an updated macroeconomic outlook, reflecting the current economic shock, with recovery expected in 2011. This accounts for 4.2% of the reduction, and is mainly attributable to reduced activity in the transport and services sectors. However, more than half of the reduction (4.8%) results from energy savings reflecting the expected impact of policy measures³⁸ that were implemented during 2008. Efficiency measures in domestic dwellings contributed roughly three-fifths of these projected energy savings; industry- and transport-related measures accounted for the balance.

A more detailed analysis of the efficiency measures underlying these adjustments to the 2020 *Baseline* figures is provided in *Appendix 1*.

For the purpose of estimating year-on-year *Baseline* consumption, we also make the simplifying assumption that annual efficiency savings ramp up in a linear fashion between 2009 and 2020 as illustrated by the blue columns in *Figure 34*. This same assumption also applies to the additional efficiency savings incorporated in the *Policy* scenarios, as represented by the red columns.

Figure 34 Energy Savings Applied per Scenario

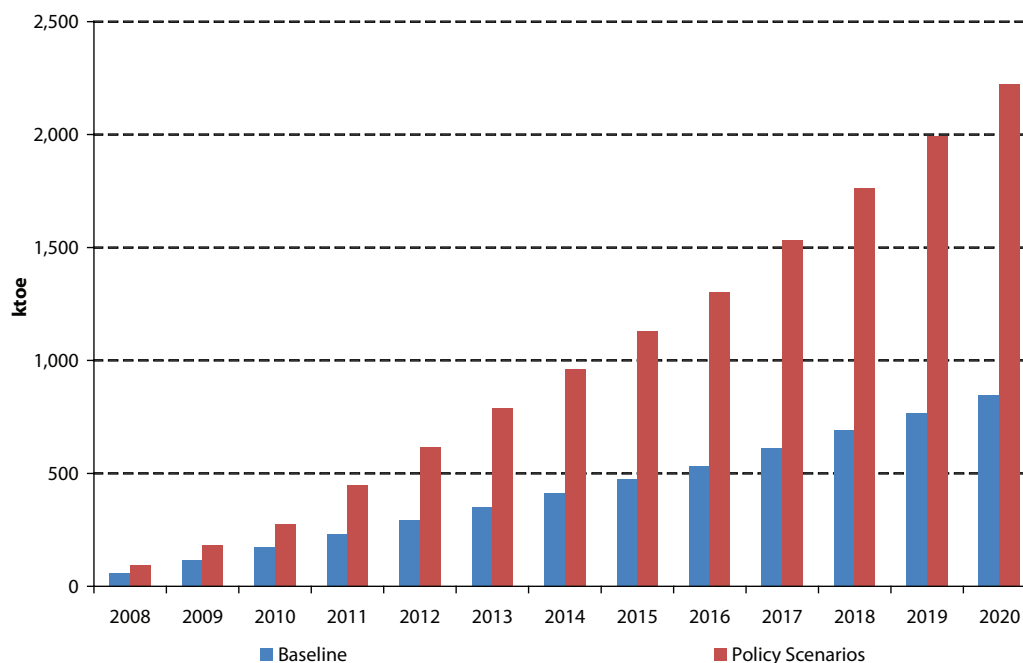
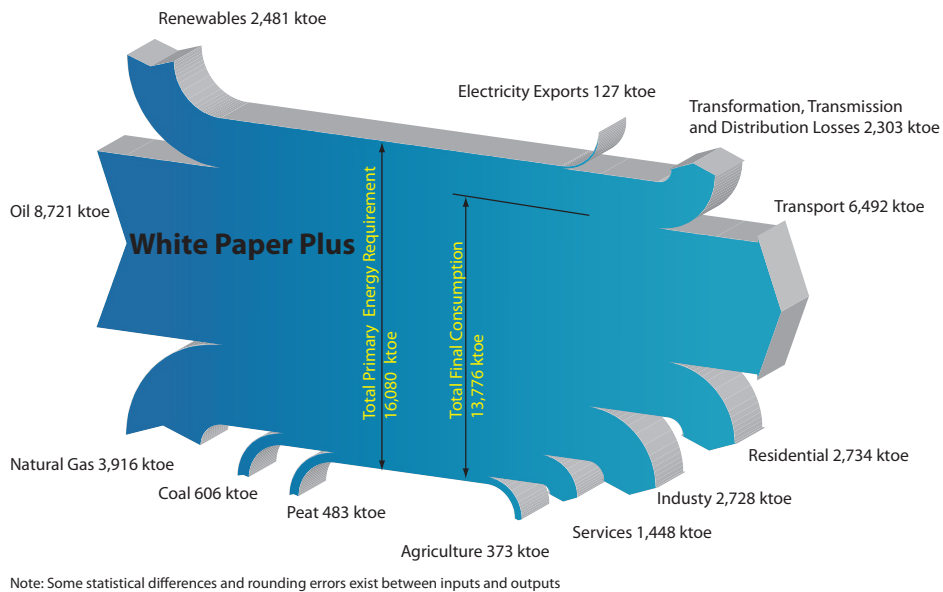
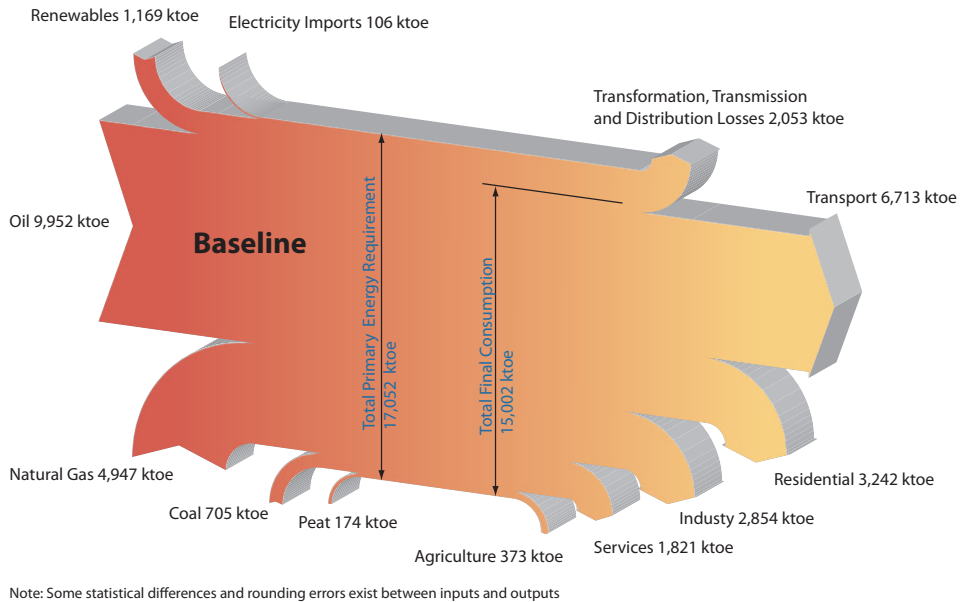


Figure 35, which compares the projected 2020 energy flows for the *Baseline* and *White Paper Plus* scenarios, highlights a number of structural differences. Compared to *Baseline*, primary energy use is reduced by 5.7%, while fossil-fuel use is reduced by 14.5% even though the country moves from being a net importer to a net exporter of electricity. Meanwhile, final energy consumption is reduced by 8.2%, reflecting efficiency gains in all sectors other than agriculture.

³⁸ In last year's forecast, the impact of these measures on energy demand appeared in the *White Paper* policy scenario rather than the *Baseline*.

Figure 35 Projected Energy Flow in Ireland in 2020 – Baseline and White Paper Plus Scenarios



The two policy scenarios, *White Paper Plus* and *Exploratory*, illustrate the path to meeting Irish and EU renewable energy targets for 2020. If anything, the *White Paper Plus* scenario, based as it is on meeting the separate national targets for renewable electricity, heat and transport, represents a lower bound of the likely wind energy capacity in 2020. The extent of applications being processed now within Gate 3 suggest that it is likely to be higher than this. Given this, it is notable that this scenario effectively meets the more recently introduced EU target of 16% overall RES. The *Exploratory* scenario demonstrates that just a small additional capacity of wind energy, much less than is likely to be connected in Gate 3, will deliver and indeed exceed the EU 16% target.

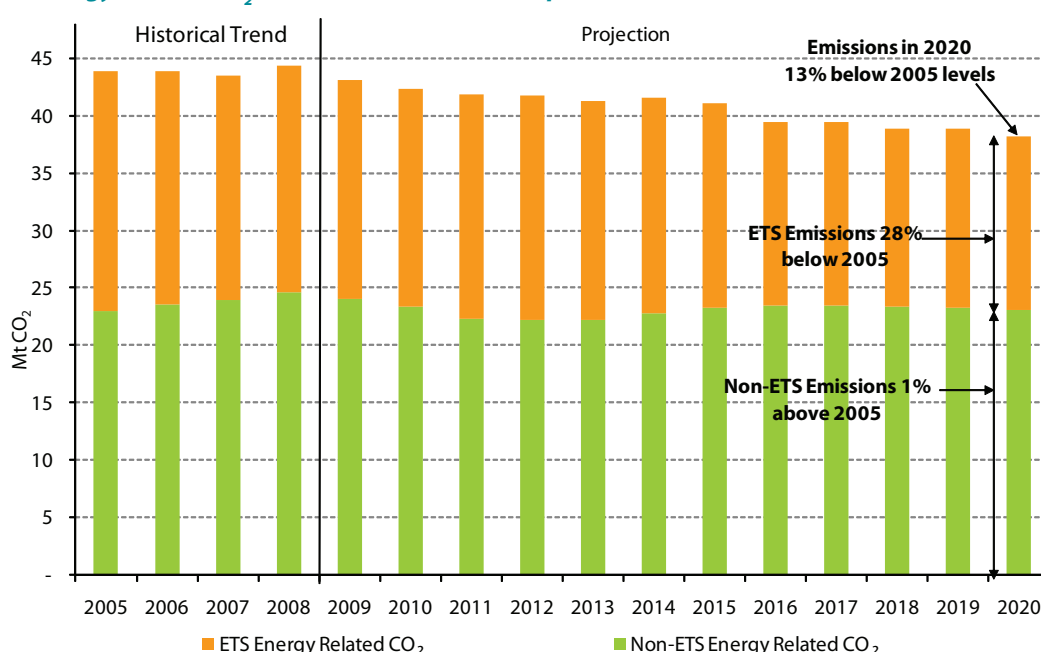
Thus these two scenarios demonstrate the important finding that there are a number of plausible paths to meeting the EU 16% target, with different relative contributions from heat, transport, electricity, and from the various contributors to renewable electricity.

Given the level of applications in the Gate 3 process, it seems quite feasible that the aggregate amount of wind and wave capacity installed by 2020 will be substantially greater than that envisaged in the *White Paper Plus* scenario (3,100 MW). However, despite the assumption of 1,400 MW of Interconnector capacity, the ESRI's IDEM analysis of this scenario suggests the possibility of curtailment for both wind and wave generation, primarily during periods of low electricity demand.³⁹

As illustrated in *Figure 36*, the *White Paper Plus* scenario would be consistent with an overall reduction of 13% in energy-related greenhouse-gas emissions by 2020, compared to 2005. Most of the reductions, however, are forecast to take place in the Emissions Trading sector, for which EU-wide rather than national targets will apply after 2012.

The non-Emissions Trading sector faces the prospect of a 1% increase in energy-related emissions compared to 2005 (compared with a 20% reduction target for Ireland), despite the impact of energy efficiency policies and of the current economic shock. This illustrates the need for future energy policy to take explicit account of the structure of EU greenhouse gas targets.

Figure 36 Energy-related CO₂ Emissions in the *White Paper Plus* Scenario



This challenge can be approached in two ways: first, by targeting reductions in the non-ETS sectors (i.e. further energy efficiency and renewable energy ambition in thermal energy use in buildings and transport) and, secondly, by 'shifting' from non-ETS emissions to ETS emissions. An example of the latter is the Government's 10% target for penetration of electric vehicles (included in the *White Paper Plus* scenario); it effectively shifts a portion of transport energy demand from the Non-Trading sector into the Emissions Trading Sector. The same advantage would attach to any future policies designed to switch heating demand from oil and gas into renewable electricity. Both approaches need to be carefully considered in terms of efficacy, cost and implications for other dimensions of energy policy, such as security of energy supply.

³⁹ The average curtailment of available wind and wave energy for the *Exploratory* scenario in 2020 is 6.3%. However, from a societal perspective, the marginal curtailment rate for the 1,330 MW of capacity which is over and above that in *White Paper Plus* would be substantially higher (possibly up to 29%).

6. Further Work

The Energy Modelling Group continually seeks to improve the quality and robustness of its analysis. A number of areas have been identified for further work during 2010.

First, it is considered desirable to develop a greater degree of sectoral disaggregation in the *Baseline* projections. The ESRI may be able to provide some additional sectoral detail by running the HERMES energy sub-model in conjunction with its environmental emission model ISus.⁴⁰ However, it may also be necessary to calibrate the *Baseline* projection by reference to empirical data. The improved sourcing of data will involve close co-operation with the EPSSU. Existing published data sources will be used more effectively and new data-collection methods will be developed where appropriate. For the residential and commercial buildings sector, for example, these could include analysis of utility billing data and the commissioning of surveys, possibly in conjunction with some of SEI's programmes.

Related to this issue, one of the limitations of the analytical approach adopted in this report is the potential incompatibility of macro-economic assumptions (top-down or sectoral level) underpinning the *Baseline* data with those underpinning 'bottom-up' savings estimates from individual policies.⁴¹ A degree of subjective judgment is involved in estimating the extent to which historical energy efficiency measures that are ongoing programmes are impacting on the *Baseline*. It is also possible that recent structural changes in the economy may not be fully reflected. For example, the *Baseline* projection of transport sector energy demand is partly derived from econometric coefficients that correlate road-freight transport statistics to economic activity. This historical data relates to a period in which the construction sector was a disproportionately large part of GDP and freight volume.

SEI therefore aims to complement the existing approach with an empirically based energy demand model for Ireland that has the potential to address these issues. It entails building a *Baseline* energy demand projection from the bottom up for energy end use in each sector, based on existing and future stock data (e.g. type, size and energy performance of houses; size, fuel and efficiency of cars, etc) and macro drivers for these (e.g. no. of houses, GVA in industry, etc). Scenario analysis could then be undertaken within the model, adjusting the new *Baseline* on the basis of the expected impacts of individual (or groups of) policies and measures. Using this method, the assumptions underpinning the *Baseline* projection with those underpinning scenario analysis would be automatically aligned.

The software tool selected to support the new bottom-up energy demand modelling is the Long Range Energy Alternatives Planning (LEAP) system.⁴² A hierarchical branch structure for energy demand will be created within LEAP, disaggregating first at a sectoral level, then by sub-sector, and finally by technologies and fuels at the end-use level.

By comparing the results from each approach, SEI also aims to garner a better understanding of the expected impacts of planned policies and measures. Outputs will include a key input of energy service demand input to the Irish TIMES model currently under development.⁴³ This model may then be used to optimise entire energy system configurations (including both energy efficiency and energy supply) and explore, for example:

- the optimal modal configuration (RES-E, RES-T and RES-H contributions to deliver the 16% RES target, for example)
- the optimal energy system configurations to deliver the 20% emissions reduction target for the non-ETS targets
- energy system configurations for Ireland beyond 2020 out to 2050, to deliver longer-term targets for efficiency, renewable energy and emissions reduction.

Secondly, SEI aims to develop an improved capability for supply-side modelling. This includes participation in the International Energy Agency's ETSAP programme, and entails providing support for whole-energy-system analysis in University College Cork, using the MARKAL-TIMES linear optimisation model. SEI has also commissioned the development of a bio-energy resource cost model in order to support the development of Ireland's National Renewable Energy Action Plan.

Thirdly, it is envisaged that power dispatch modelling work will be conducted to extend the analysis previously carried out in the All-Island Grid Study. In particular, we aim for an improved understanding of the interaction between high renewables penetration and electricity exports. It is also hoped to model the impact of renewables penetration, consistent with the *Exploratory* scenario, on the operability and economics of conventional plant needed to provide system security.

40 See http://www.esri.ie/research/research_areas/environment/isus/

41 Bottom up here refers to starting with individual energy-using units such as houses for the residential sector, or cars in transport, their activity level (numbers) and changes in their energy intensities, in order to estimate energy savings.

42 <http://www.energycommunity.org/default.asp?action=47>

43 See <http://www.ucc.ie/en/serg/energypolicy/projects/irishtimes/> for more information.

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Department of Transport (DOT)

EirGrid

Appendix 1 – Energy Savings Adjustments

The following table summarizes the assumptions made for incorporating energy savings for policies and measures as described in the National Energy Efficiency Action Plan (DCENR, May, 2009) in to the baseline and policy scenarios. In general, actions assumed implicit in the baseline where in place prior to 2007; hence their impact is assumed to already be incorporated in the forecasted trends. Actions and measures implemented during 2007 and 2008 have also been incorporated in the baseline. Adjustments are made for future (committed) measures are incorporated in the policy scenarios.

Measure	Estimated energy savings in 2020		Baseline assumptions	Policy (White Paper Plus and Exploratory) scenario assumptions
	GWh (PEE)	ktoe		
Business and Public Sectors				
SEI Public Sector Building Demonstration Project	140	12	Assumed implicit in baseline.	-
Building Regulations 2005	560	48	Assumed implicit in baseline.	-
Building Regulations 2010	1,360	117	-	Estimated impact from measure applied to both scenarios
SEI Large Industry programmes	4,070	350	75% of expected impact from measures incorporated in to baseline. Remainder assumed implicit.	-
SEI Small Business Support	565	49	Estimated impact of measures incorporated in to baseline. Measure introduced prior to end 2008.	-
Existing ESB demand side management initiatives	435	37	Assumed implicit in baseline.	-
Accelerated Capital Allowance for Energy	800	69	Estimated impact of measures incorporated in to baseline. Measure introduced in the Finance Act, 2008.	-

Measure	Estimated energy savings in 2020		Baseline assumptions	Policy (White Paper Plus and Exploratory) scenario assumptions
Residential Sector				
Building Regulations 2002	1,015	87	Assumed implicit in baseline.	-
Building Regulations 2008	2,490	214	Estimated impact of measures incorporated in to baseline. Measure introduced in 2008.	-
Buildings Regulations 2010	1,100	95	-	Estimated impact from measure applied to both scenarios.
Low Carbon Homes 2013	395	34	-	Estimated impact from measure applied to both scenarios.
House of Tomorrow Programme	30	3	Assumed implicit in baseline.	-
Warmer Homes Scheme	170	15	Assumed implicit in baseline.	-
Home Energy Savings Scheme	600	52	Estimated impact of measures incorporated in to baseline. Pilot launched in 2008, full programme launched in 2009.	-
Smart meter installation	690	59	-	Estimated impact from measure applied to both scenarios.
Ecodesign for Energy-Using Appliances	1,200	103	-	Estimated impact from measure applied to both scenarios
Efficient Boiler Standard	2,400	206	Estimated impact of measures incorporated in to baseline. Measure launched prior to end 2008.	-

Measure	Estimated energy savings in 2020		Baseline assumptions	Policy (White Paper Plus and Exploratory) scenario assumptions
	GWh (PEE)	ktoe		
Transport Sector				
Improved fuel economy of private car fleets	1530	132	Estimated impact of measures incorporated in to baseline. Measure announced in 2008.	-
Efficient Driving Measures	655	56	-	Estimated impact from measure applied to both scenarios. Measure committed to in the <i>Sustainable Travel and Transport Action Plan (Department of Transport, 2009)</i> .
Electric Vehicle Deployment	955	82	-	Estimated impact from measure applied to both scenarios. Commitment announced in 2009.
Mobility management – travel plans	1090	94	-	Estimated impact from measure applied to both scenarios. Measure detailed in the <i>Sustainable Travel and Transport Action Plan</i> .
VRT/Motor tax changes	200	17	Estimated impact of measures incorporated in to baseline. Measure introduced in 2008.	-
E-working	150	13	-	Estimated impact from measure applied to both scenarios. Measure committed to in the <i>Sustainable Travel and Transport Action Plan</i> .
More sustainable public transport fleets	90	8	-	Estimated impact from measure applied to both scenarios. Measure committed to in the <i>Sustainable Travel and Transport Action Plan</i> .
Energy Supply Sector	310			
Transmission and distribution efficiencies improvement	310	27	Assumed implicit in baseline.	-
Winter Peak Demand Reduction Scheme	55	5	Assumed implicit in baseline.	-

The impact of achievement of the public sector 33% energy savings target and targets for installed capacity of CHP are incorporated in to the scenarios as below

Target	Estimated energy savings in 2020		Baseline assumptions	Policy (White Paper Plus and Exploratory) scenario assumptions
	GWh (PEE)	ktoe		
Public sector target				
33% energy savings for the public sector	3100	267	n/a	Additional savings required to meet the target applied to both scenarios.
Installed CHP capacity				
White Paper targets for installed capacity of CHP	435	37	Currently installed capacity (to 2008) assumed implicit (including a growth rate of 5% per annum)	Additional installed capacity required to meet the 2020 target of 800MW CHP installed applied to both scenarios.

Additional savings required to achieve the 20% national energy savings targets are assigned to individual sectors as below.

Additional savings	Estimated energy savings in 2020		Baseline assumptions	Policy (White Paper Plus and Exploratory) scenario assumptions
	GWh (PEE)	ktoe		
Industry	500	43	n/a	Additional savings applied to both scenarios
Residential	3000	258	n/a	Additional savings applied to both scenarios
Transport	700	60	n/a	Additional savings applied to both scenarios
Services	700	60	n/a	Additional savings applied to both scenarios







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