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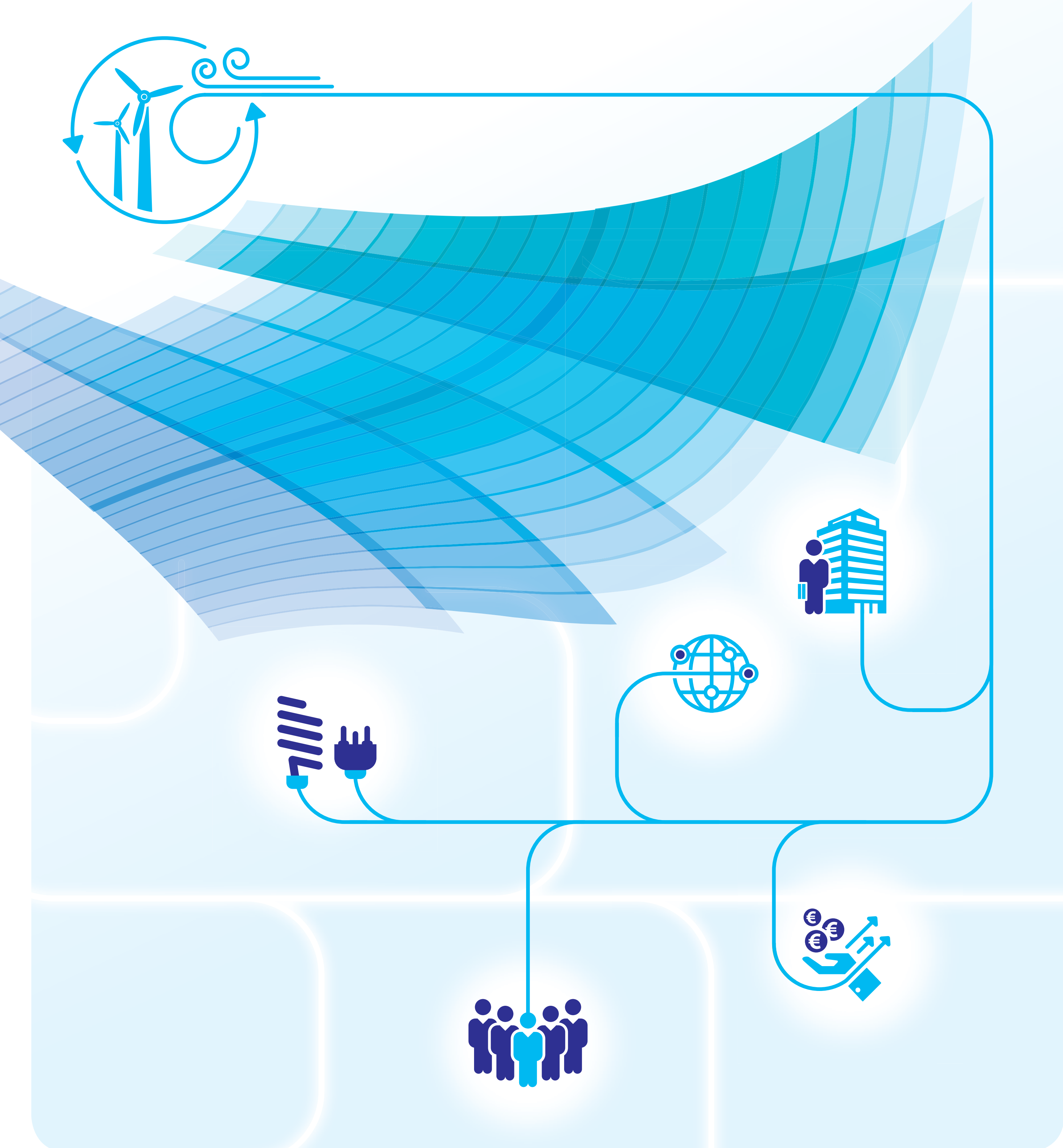
A Macroeconomic Analysis of Onshore Wind Deployment to 2020

An analysis using the Sustainable Energy Economy Model



A Macroeconomic Analysis of Onshore Wind Deployment to 2020

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SUSTAINABLE ENERGY AUTHORITY OF IRELAND

Report prepared by
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Sustainable Energy Authority of Ireland

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

SEAI's key strategic objectives are:

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

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

Key insights

Investment resulting in increased deployment of onshore wind in Ireland will contribute to Ireland's binding EU renewable energy targets for 2020, reduce our reliance on imported fossil fuels, and reduce Ireland's greenhouse gas emissions. The analysis presented in this report indicates that in addition to contributing to these principal aims of energy policy, there are also positive macroeconomic and net employment benefits available.

Results are provided for the single year 2020 to give an indication of the potential macro and employment impacts in that year. It is expected that the benefits will extend beyond 2020 with the extent of these benefits determined by Government policy, European policy initiatives and investment in the transition to a low-carbon energy system.

In summary:

- Anticipated wind deployment, sufficient to reach the 40% renewable electricity target in Ireland by 2020, has a positive impact on the Irish economy and net employment.

- Between 2,880 and 6,000 net jobs could be created in 2020. The extent of the increase depends on how wind deployment impacts on future electricity prices.

- Around 2,000 of the new jobs are anticipated to be created directly in the construction sector. The extent to which these levels of new jobs persist post-2020 will depend on future deployment and repowering of existing sites. Around 500 ongoing direct jobs in operations and maintenance of existing turbines are created.

- Employment benefits are maximised in the case that savings accrue to consumers due to increased wind deployment. Any savings lead to increased indirect employment in sectors supporting wind deployment and from induced employment created by increased expenditure in the economy.

- In the event of a future electricity price rise due to increased wind deployment, fewer indirect jobs and induced jobs are created in the economy – however, the total economy wide employment impacts remain positive.

- The employment impacts stem from the anticipated total capital investment of approximately €270 million in 2020 in wind turbines, plus the associated investment in the transmission grid to facilitate renewable sources of electricity.

- In terms of wider macroeconomic impacts in 2020, GDP could increase by €305–585 million (2012 prices). The additional employment drives increases in average income per capita and real disposable income in 2020 (where electricity cost savings are made).

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1 Introduction

In 2013 Ireland had 1.8 GW of installed wind generation capacity, which supplied 16.3% of the country's electricity requirements. Comparatively, Ireland has the twelfth highest level of installed wind capacity in Europe, and on the basis of contribution to national electricity demand, ranks fourth in Europe (and the world), on par with Spain and ahead of Germany and Scandinavia.[1]

The recent growth in onshore wind capacity in Ireland reflects Europe-wide ambitions for long-term sustainability and energy security, underpinned by National Renewable Energy Action Plans (NREAPs) under the European Union's Renewable Energy Directive (2009/28/EC). National energy efficiency and renewable energy action plans (NREAP/NEEAP) set individual targets for Member States to reduce CO_2 emissions, increase energy efficiency, and move towards a larger share of renewable energy.

Although designed to ensure sustainable economic growth in the future, a transition to clean energy also has immediate implications for:

1. Private investment;
2. Electricity and fuel prices;
3. Redirection of financial support;
4. Employment;
5. Competitiveness.

This report examines the net impact on employment of greater deployment of onshore wind in line with 2020 targets, taking into account changes in investment and how potential changes in the electricity price affect consumption, industrial competitiveness and trade.

To estimate the macroeconomic and employment impact of achieving Ireland's onshore wind ambitions, we use SEAI's macro-econometric Sustainable Energy Economy Model (SEEM). SEEM is based on a leading regional policy analysis tool in the United States, Regional Economic Models, Inc (REMI), which has been adapted to the Irish economy by SEAI. Rather than gross employment figures, or the total employment generated, SEEM estimates total *net* employment, taking into account any loss of employment due to changes in prices or displacement of existing activity. As a simulation model, the current trajectory of the Irish economy with existing and planned onshore wind capacity in 2020 is compared to a scenario where capital investment and supports continue to increase up to 2020 to reach NREAP/NEEAP targets. Thus, net employment figures should be interpreted as the jobs in the year 2020 that could be generated on top of existing employment by meeting NREAP and NEEAP targets rather than an estimation of total cumulative jobs in the sector.

This report first gives a brief overview of the methodology and the data inputs into the model in Chapter 2 (capital investment, sales of wind energy, displacement of the transport and storage of fossil fuels, and support mechanisms). Chapter 3 presents the net employment results from investment in onshore wind and/or the transmission grid under two electricity price scenarios: a 2% increase or a 2% decrease in electricity prices by 2020. Chapter 4 contains a more detailed analysis of the impact on the construction, manufacturing, and electricity supply sectors. The conclusion follows in Chapter 5.

[1] IEA, 2013. Available at:
http://www.iea.org/publications/freepublications/publication/Wind_2013_Roadmap.pdf

2 SEEM outputs, structure and inputs

2.1 Gross/net analysis

SEEM provides an insight into both the gross and net impacts on employment and the macroeconomy (i.e. aggregate effects on economic activity linked to changes in spending, consumption and/or production in a given region).

Gross impacts refer to the economic activity and/or employment created to construct and maintain new wind farms, including supporting activity from manufacturers, professional services, and suppliers of goods and services.

Net impacts consider the subsequent expansion or contraction of all economic actors, taking into account displacement as a result of crowding out (where increased public spending replaces, or drives down, private spending), or changing factor costs (such as higher labour costs or commodity prices), or changing electricity prices. Changes in prices or incomes as a result of renewable energy feed-in tariffs to incentivise investment or a higher demand for labour within a scarce labour supply are captured by SEEM, as is their impact upon wider employment. For instance, a change in the price of electricity affects the cost of production, with a knock-on effect on sales, productivity and employment to varying degrees across different industries in the economy. Net employment analysis is also defined by offering a future counterfactual or 'baseline' scenario of what would have happened without a given programme compared to an alternative scenario with policy action.

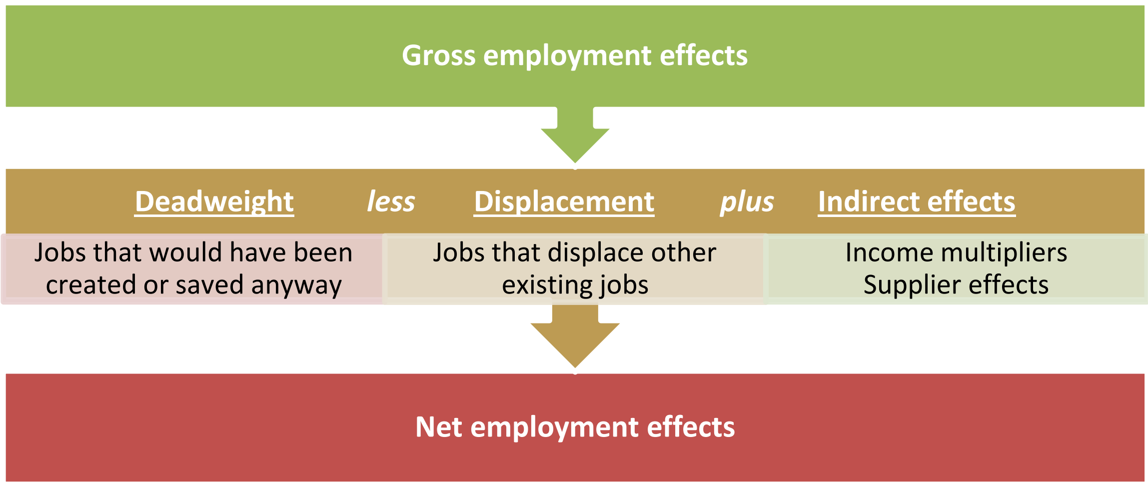


Figure 1: Gross and net employment

Most European studies on the employment impact of renewable energy deployment rely on basic employment multipliers, supply chain analysis, or input–output (I–O) modelling to produce gross effects from investment in renewable energy.[2] Only a few have used more complex computable general equilibrium or macroeconometric models such as SEEM to estimate the real net employment impact of renewable energy, two of which are briefly described in the text box below.[34]

[2] 'Review of approaches for employment impact assessment of renewable energy deployment', available at: http://iea-retd.org/wp-content/uploads/2011/11/EMPLOY-task-1.pdf
[3]Bohringer, C., Keller, A., Van der Werf, E., 2013. 'Are green hopes too rosy? Employment and welfare impacts of renewable energy promotion', *Energy Economics 36*: 277–85

Bohringer et al. (2013) undertake computable general equilibrium analysis to derive the net employment effect of an increase in the share of renewable electricity in Germany supported by a range of green subsidy options. The authors conclude that positive employment benefits hinge upon the subsidy scheme, with thresholds advised for electricity feed-in tariffs to maximise employment benefits.

Lehr et al. (2012) consider the net economic impacts of renewable energy investment up to 2030 in Germany under different generation costs, installation, fossil fuel price, and international trade scenarios. In gross terms, employment increases from 340,000 in 2009 to up to 600,000 in 2030. Excluding a scenario with lower renewable energy exports, positive long-term net employment is also observed across all scenarios. Under medium assumptions, net employment reaches around 150,000 in 2030.

2.2 Direct, indirect and induced impacts

Employment figures using SEEM are presented in terms of direct, indirect, induced, and induced investment, shown in Figure 2.

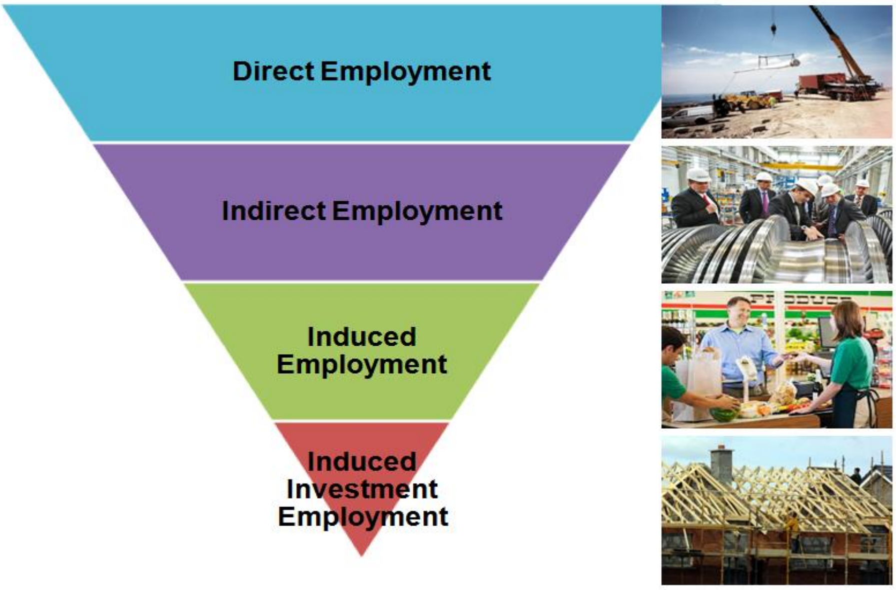


Figure 2: Net employment by category – direct, indirect, induced, and induced investment

Direct impacts encompass the additional output and employment created during the development and ongoing operations of a wind energy plant, such as the contractors and crews hired to build the plant, as well as longer-term onsite maintenance staff.

Indirect impacts refer to indirect employment in the supply chain, including manufacturing jobs at the plants that build turbines, towers and blades, as well as other sectors which supplement the construction and maintenance of the plant, such as specialist engineering and legal services. Indirect employment also encompasses the net impact of a change in production costs or displacement of industries in the supply chain.

[4] Lehr, U., Lutz, C., Edler, D., 2012. 'Green jobs? Economic impacts of renewable energy in Germany', *Energy Policy 47*: 358–64

Induced impacts capture the net employment created to satisfy local demand for goods and services, generally in the retail and consumer services sectors. This reflects changes in consumption as a result of higher (or lower) employment, or how a change in prices, such as electricity prices, affects overall consumption-related employment.

Induced investment impacts refer to investment in residential capital stock (i.e. housing), non-residential capital stock (non-residential buildings) and purchasers' equipment as a knock-on result of an economic stimulus or shock. The greatest impact is on the housing and commercial construction industry.

The text box below summarises the attributes of the Sustainable Energy Economy Model in the context of traditional macro-analysis. For more information on macroeconomic and energy modelling, a detailed overview of the REMI model, and how REMI was adapted into the Sustainable Energy Economy Model for the Irish economy, please refer to a background document available on the SEAI website.[5]

SEEM (Sustainable Energy Economy Model)

Benefits:

- Produces net employment impacts with 'Type III' multipliers (i.e. encompasses direct, indirect, and induced employment with varied consumption functions across different cohorts and goods and services);
- Forecast simulations not possible with a basic input–output model;
- High level of industrial disaggregation (20 industries);
- Substitution effects (e.g. between labour and capital);
- Scarce resources act as constraints to economic expansion;
- Dynamic incomes, prices and costs relative to changes in regional demand and supply;
- Labour and commodity access indices drive agglomeration effects based on New Economic Geography concepts (e.g. accessibility and/or lower costs attract industrial activity).

Limitations:

- Fixed intermediate input proportions in estimates of production;
- No financial or energy price module (changes in prices and costs as a result of renewables calculated externally and input manually);
- Estimated regional industrial activity based on employment data;
- Parameters derived from USA data. As Ireland has a small, open economy, the model may underestimate sensitivity to changes in the labour market and international competitiveness. However, Irish consumption elasticities are applied;
- The global economy is exogenous. International migration and economic growth are based on CSO and ESRI projections respectively.

[5]SEAI, 2014. Sustainable Energy Economy Model Background Document, available at (in 2015): http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/

2.3 Model structure

The basic configuration in SEEM takes a hypothetical 'control' scenario of the current Irish economy and compares this to an 'alternative' scenario. The control scenario reflects the current state of the Irish economy with existing wind capacity and no further policy support measures beyond the lifetime of Alternative Energy Requirement (AER) power purchasing agreements or current renewable energy feed-in tariff (REFIT) schemes. The alternative scenario simulates the current economy with additional installed capacity and policy measures to meet a target of 32% wind-generated electricity in 2020, in line with Ireland's National Renewable Energy Action Plan (NREAP). Figure 3 illustrates the control scenario and the inputs in the alternative scenario.

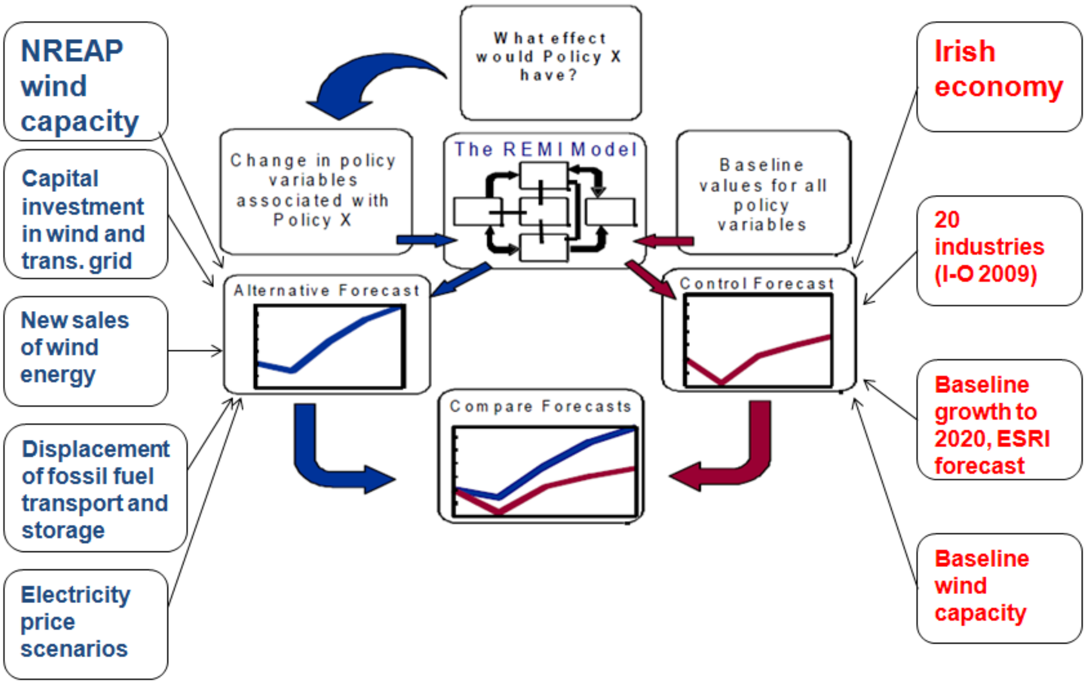


Figure 3: SEEM model configuration

2.4 SEEM control (baseline) and alternative (NREAP)forecasts

The control (baseline) forecast in SEEM contains detailed data on the Irish economy from 2009 to 2050, including industrial output, employment, demographic statistics, prices, consumption and income. The industrial breakdown is divided between two regions in Ireland – the Southern and Eastern Region, and the Border, Midlands and Western Region[6] – and 20 broad industry sectors (NACE code Rev. 2) taken from the 2009 Supply and Use tables for Ireland, published by the Irish Central Statistics Office.[7]

Supply and Use tables are combined to produce an input–output table that displays industrial (up to 62 industries in the national I–O table), household, government and net

[6] NUTS II Regional Assemblies originally designated for the purposes of EU Structural Funds, see http://www.iro.ie/regional_assemblies.html
[7] http://www.cso.ie/en/newsandevents/pressreleases/2013pressreleases/pressreleasesupplyandusetablesforireland2009/

export production and purchasing flows for a given year. Since official I–O tables split by region are not yet available in Ireland, inter-industry regional trade flows in SEEM are based on the interaction between industry-specific demand and supply estimates in each region.

The Economic and Social Research Institute's (ESRI) economic forecast is used to chart overall growth in the Irish economy up to 2020 in the control forecast.

Production activity surrounding 1.4 GW of wind capacity in Ireland in 2010 is assumed to be encompassed within the 2009 I–O table (where investment is assumed to occur one year prior to capacity coming online).

Electricity generation in the control forecast follows overall growth trends, which adequately captures SEAI's projected baseline growth in wind capacity up to 2020.

The alternate forecast includes the additional investment, sales, displacement and costs required on top of the baseline to reach 3.56 GW of capacity by 2020.

2.5 Onshore wind forecast to 2020

SEAI's Energy Forecast estimates the annual wind-energy generation needed each year up to 2020 in order to reach the 40% renewable electricity target after biomass and other renewable electricity sources have been accounted for, and assuming the energy efficiency targets encompassed in the National Energy Efficiency Action Plan (NREEP) are achieved.

The 'baseline' scenario in Figure 4 plots current installed wind capacity and future projects with a connection date agreement before the end of 2013, with an assumption that ageing wind turbines go offline after 2017 without further investment. The 'NREAP/NEEAP' scenario charts the gradual growth in capacity beyond the baseline, whereby onshore wind capacity is 1.2 GW higher by 2020, compared with the 'baseline' scenario, with the potential to provide 32% of Ireland's electricity. The 'new' line shows the additional capacity required, used to estimate the net employment impacts up to 2020 in SEEM.

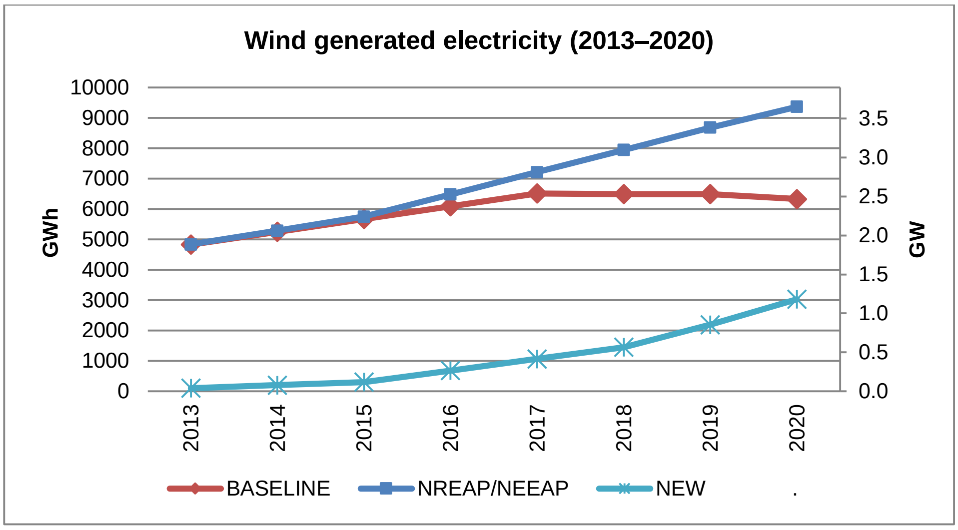


Figure 4: Installed onshore wind capacity (2013–2020), baseline and NREAP/NEEAP scenarios

2.6 Inputs in alternative forecast

Table 1: Control and alternative forecast figures

	Control forecast (no further policy incentives)	NREAP/NEEAP
Total projected wind capacity 2020	2.4 GW	3.6 GW
Average additional wind capacity each year (2013–20)	93 MW	241 MW
Share of total electricity consumption 2020	22%	32%
Wind investment cost per MW	€1.3 million	€1.3 million
Average wind investment per year (2013–20)	€121 million	€313 million
Total projected wind output 2020	6,330 GWh	9,360 GWh
Average additional wind output per year (2013–20)	290 GWh	670 GWh
REFIT price onshore wind c/kWh (2012 price)	6.84	6.84
Average value of additional wind output per year (2013–20)	€19 million	€45 million
Average no. turbines per year (if 2MW with 30% load factor)	55	127
Average transmission grid capital investment cost per year (2013–25)	–	€145 million
Average transmission grid O&M cost per year	–	€6 million

Capital investment

Reaching a total installed capacity of 3.56 GW of onshore wind energy, which is required to meet the 2020 onshore renewable electricity target, requires capital investment in new wind power plants, labour and materials, and ongoing operation costs.

At an average investment cost of €1.3 million per MW (based on cost estimates used in the calculation of REFIT prices), an additional 1.2 GW of wind capacity requires a total €1.53 billion capital investment in wind farm development in the years leading up to 2020, with another €1.6 billion investment in expanding the transmission grid up to 2025.[8]

Improvements in the grid connection and planning application mechanisms, including the group processing of generation applications via the Gate process and targeted tax reliefs, facilitate increased deployment of onshore wind in Ireland.

On average, €192 million investment in onshore wind is required annually from now until 2020; however, investment is expected to be weighted towards the end of the decade. Investment in grid connection to wind farms is planned to take place from 2015 onwards.

Sales and displacement

A cumulative 3.56 GW of onshore wind capacity in 2020 would contribute to significant domestic sales of onshore wind-generated electricity (valued at ~€640 million in 2020 based on REFIT, 2012 prices) and a corresponding displaced demand for fossil fuels (Figure 5).

[8] Assuming overland investment and 50% of Eirgrid's projected investment in grid infrastructure is to accommodate greater wind capacity on the system.

Given Ireland's high dependence on fossil fuel imports (85%, 2013[9]) and preferential use of domestically sourced electricity, all displaced fossil fuels are assumed to be imported. As a result, the macroeconomic and employment effects of avoided fossil fuel extraction and sales are external. A lack of displacement of indigenous coal and gas mining minimises the national cost and distinguishes Ireland from many other countries making the transition towards renewable energy.

A recent report by the SEAI estimates that onshore wind on the system averted spending on imported fossil fuels to the value of €177 million in 2012.[10] While this also reduces traditional generators' running time, capacity or employment in generation plants is not expected to fall perceptibly since capacity payments provide the necessary revenue for plants to remain operational. Thus, rather than modelling displacement of employment in the fossil fuel generation plants, SEEM assumes a relative loss of employment in the transport and storage sector due to a lower throughput of fossil fuels in the country.

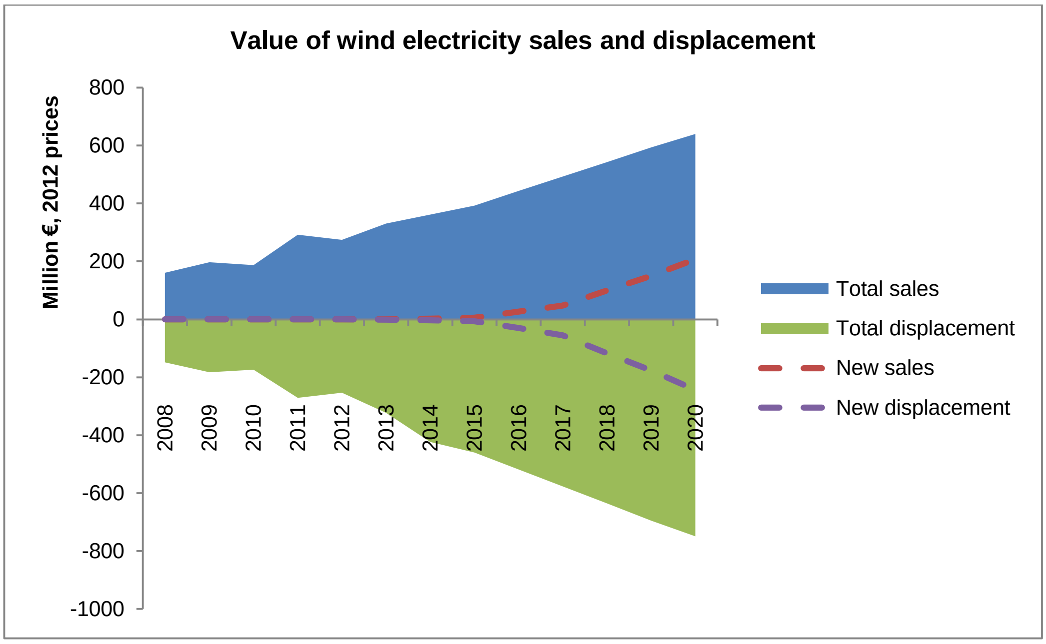


Figure 5: Value of wind electricity sales and displacement

[9] SEAI, 2012. 'Energy in Ireland', available at:
http://www.seai.ie/Publications/Statistics_Publications/Energy_in_Ireland/Energy_in_Ireland_1990_-_2012_Report.pdf

[10] SEAI, 2014. 'Quantifying Ireland's Fuel and CO_2 Emissions Savings from Renewable Electricity in 2012', available at:
http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/Quantifying-Ireland%E2%80%99s-Fuel-and-CO2-Emissions-Savings-from-Renewable-Electricity-in-2012.pdf (Accessed 23 July 2014)

SEAI has researched the flow of investment and sales revenue from onshore wind and the transmission grid through the different industrial sectors in the supply chain required for input–output macro-analysis (capital investment supply chain illustrated in Figure 6 and Fugure 7).

In terms of its capacity to capture capital investment domestically, Ireland has strong indigenous feasibility, planning, foundations and engineering expertise, with the skills and knowledge base to potentially supply niche markets in controls and instrumentation, albeit the bulk of heavy manufacturing (blades, towers) is imported at present.

Similarly, the Irish supply chain is very well positioned in all of the preliminary design and operational aspects of the electricity grid, providing a significant boost to local employment. However, some manufactured materials such as cables, underground pipes, insulators and conductors are sourced from abroad. Import intensities in the model are derived from aggregate import intensities by sector from the national I–O table, which fall broadly in line with estimated self-supply of manufactured goods and services in the Irish renewable energy industry (discussed further in Chapter 4).[11]

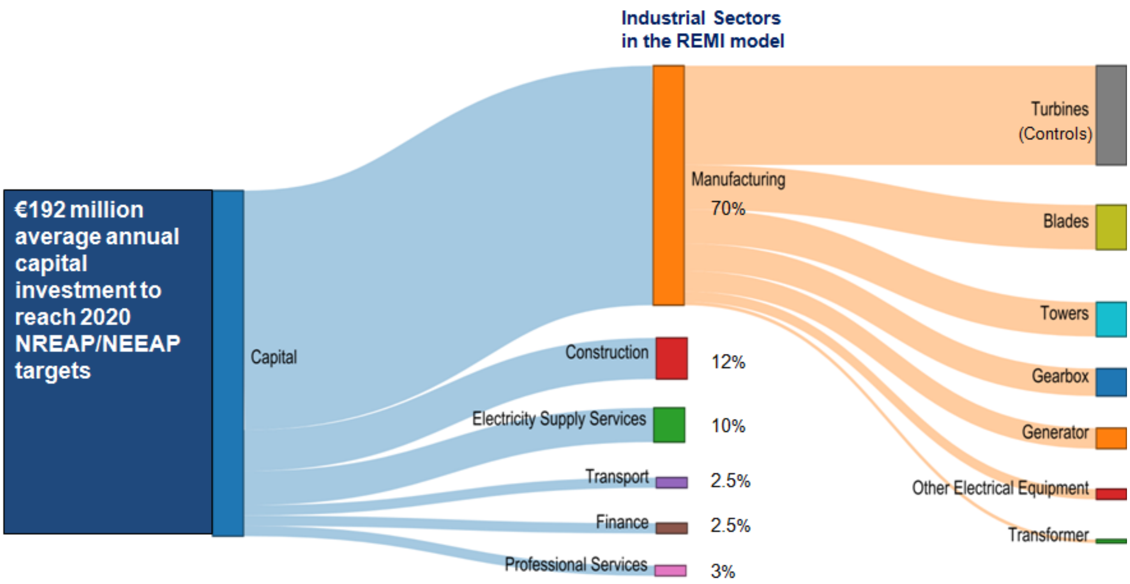


Figure 6: Onshore wind supply chain

[11] See SEAI, 2014, 'Ireland's Sustainable Energy Supply Chain Opportunity' for further information.

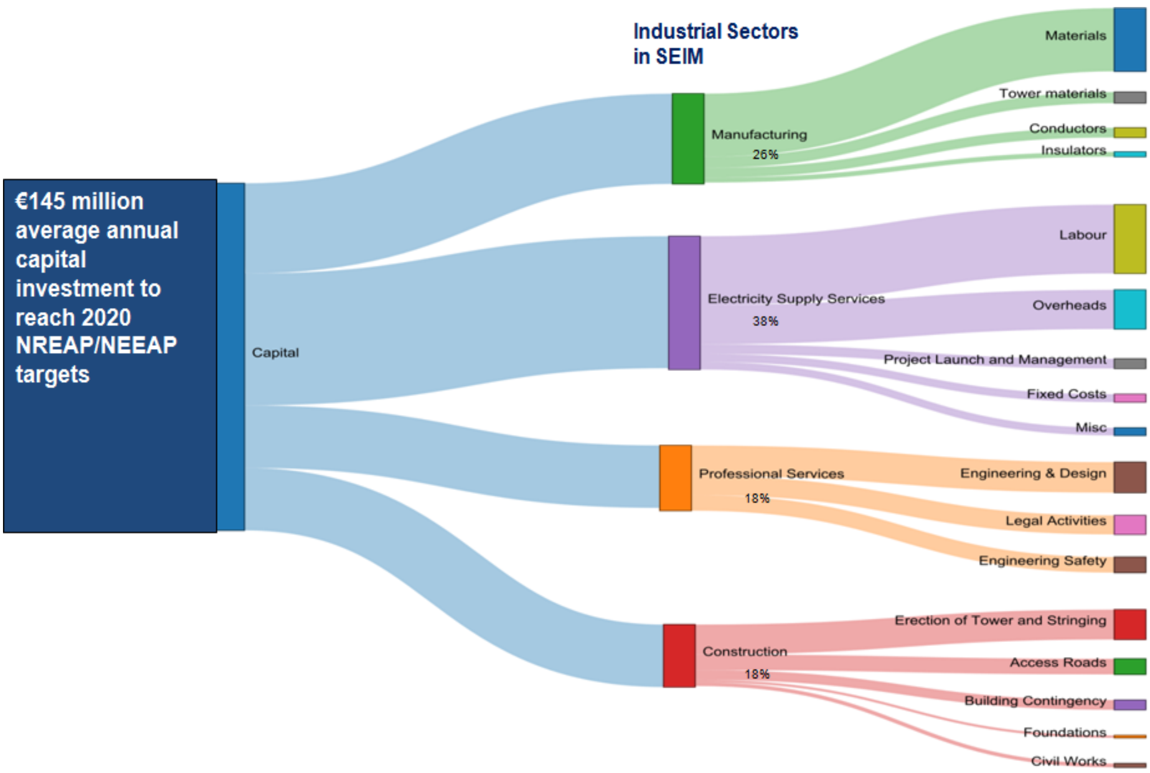


Figure 7: Transmission grid supply chain

Support mechanisms

Investment in onshore wind is incentivised by a renewable energy feed-in tariff (REFIT) which guarantees a balancing payment[12] and a minimum price per megawatt-hour of renewable electricity generated, this is funded through the Public Service Obligation (PSO) levied on all electricity consumers. The REFIT mechanism provides suppliers of renewable energy with a payment when the market price for electricity falls below the REFIT tariff plus the balancing payment. Grid network improvements, expansion and maintenance are also supported via surcharges on electricity bills, determined by the Commission for Energy Regulation.

The future cost of the REFIT to electricity consumers is greatly dependent upon the amount of renewables in the system and the market price for electricity, which is in turn determined by the global price of fossil fuel and CO_2 (85% energy import intensity in Ireland). Since wind generators do not consume fuel they have no short term costs which tend to put a downward pressure on electricity prices. Depending on the relative price of fossil fuel, the cost savings from onshore wind generation may be greater or less than the subsidy received from the REFIT for wind-generated electricity.[13]

In 2011, studies estimated that the two balanced out and electricity prices were neither positively nor negatively affected by the wind capacity in the system.[14] [15] Going forward,

[12] The balancing payment is an additional payment for electricity suppliers who contract with renewable electricity generators.
[13] SEAI/Eirgrid, 2011: 'Impact of Wind Generation on Wholesale Electricity Costs in 2011'. Available at: http://www.eirgrid.com/media/ImpactofWind.pdf
[14] O'Mahoney, A., Denny, E., 2011, 'The Merit Order Effect of Wind Generation in the Irish Electricity Market'. Available at: http://www.usaee.org/usaee2011/submissions/OnlineProceedings/USAEE%20Washington%20Paper.pdf

the basic assumption is that if fossil fuel prices increase over time, onshore wind produced at the REFIT price would serve to reduce the wholesale price of electricity in Ireland. Conversely, if gas and coal prices decline, the difference between the market price for fossil fuel generated electricity and the REFIT may exceed potential savings on fuel costs. Given the inherent uncertainty over future fossil fuel prices, the potential impact of renewables on electricity prices is difficult to predict. In addition, the investment in expanding Ireland's electricity infrastructure also must be taken into account.

To compensate for this uncertainty, a number of electricity price scenarios have been modelled:

Scenario 1, called Wind Only, outlines the impact of building and maintaining new wind farms to consider the net employment benefits associated with greater deployment of onshore wind alone (evenly split between the Border, Midlands and West, and the Southern and Eastern regions, consistent with Grid 25 plans for expansion).

Scenario 2 – Wind and Transmission Grid – covers those assumptions in Scenario 1 and also includes the necessary investment and employment associated with expanding the electricity grid overland to accommodate more wind.

In scenarios 1 and 2, wind deployment has a neutral effect on electricity prices.

Scenario 3 – Electricity price increase of 2% in 2020 – uses the same assumptions as scenario 2 but assumes a 2% rise in the price of electricity by 2020.

Scenario 4 – Electricity price decrease of 2% in 2020 – assumes that the greater wind capacity depresses the wholesale price of electricity by 2% in 2020.

Scenario 1	Scenario 2	Scenario 3	Scenario 4
• Capital investment in wind • Sales of electricity from wind • Displacement of transport and storage fossil fuels	• Capital investment in wind • Sales of electricity from wind • Displacement of transport and storage of fossil fuels • Capital investment in the grid • Transmission grid O&M	• Scenario 2 • 2% increase in electricity prices by 2020	• Scenario 2 • 2% decline in electricity prices by 2020

Figure 8: Investment and electricity price scenarios

Additional benefits and costs

As with any economic model, every aspect of the economy is not captured and simplifying assumptions have been made. SEEM provides a valuable insight into the net employment effects of investment, with transparent cause and effects in terms of inputs and outputs integrating Ireland's national accounts, production, labour indicators and price indices. However, the budget deficit and financial indicators are not captured.

[15] Di Cosmo, V., Malaguzzi Valeri, L., 2012. 'Relation between wind and electricity prices in a deregulated market: the case of Ireland', Available at: http://www.usaee.org/usaee2012/submissions/OnlineProceedings/MalaguzziValeri_proceedings.pdf

Studies which have attempted to integrate these considerations with respect to onshore wind investment can be referred to in the footnotes. Broadly, whether funding is raised internally or from abroad has an impact upon domestic liquidity, with the possible crowding out of indigenous private investment on one hand, or implies some repatriation of profits on the other. In terms of government receipts and expenditure, private investment in expanding the Irish renewable energy supply adds to government finances via tax revenue, which may be used to reduce the government's budget deficit or lower taxes, with various implications for the macroeconomy depending on how the additional revenue is used.[16] [17]

Development of an indigenous energy supply also affects the balance of payments: energy imports are replaced with greater reliance on domestic energy capacity improving the country's current account in the long term, while the manufactured imports required over the investment period would increase the deficit in the short term. Overall, however, greater investment in national capital stock, increasing economic resilience to changes in global fossil fuel prices and the reduction of a significant energy import cost from the country's balance sheet would have positive implications for the country's credit rating in the long run.[18]

We have also not attempted to model the impact that a higher number of wind farms in Ireland would have on the amenity values of surrounding areas, local house prices, or tourism (be these positive or negative) given their tenuous link with employment. There is a lack of conclusive evidence in the literature and there is an implicit variation in estimates depending on factors such as location, planning, and the prevailing attitudes at the time. The potential penalty costs of not meeting targets are also not included in the control scenario. While the cost of failing to meet the 2020 target is not yet known, analysis carried out for the Department of Communications Energy and Natural Resources indicates that a shortfall in the range of 1% to 4% on the overall target could result in costs to the exchequer of between €140 million and €600 million.[19] Depending on the magnitude of the penalty, greater renewable energy deployment to meet obligatory targets would prevent an equivalent loss of public expenditure in other areas of the economy.

Finally, reducing fossil fuel dependence has invaluable benefits for reducing emissions and contributing to environmental sustainability, potentially averting substantial future costs to both the national and global economies. While it is not possible to capture the long-term benefits of sustainable energy investment in short-to-medium term analysis, economic analysis of the impact of renewable energy investment should be considered in the wider context of transitioning toward a clean energy supply versus the future environmental and social costs of a business-as-usual scenario. Research is active in this area, which will contribute to complementary analysis on the long-term socio-economic impacts of conventional energy systems.

3 Model results

[16] Siemens/IWEA, 2013, 'An Enterprising Wind – An economic analysis of the job creation potential of the wind sector in Ireland'. Available online at: http://www.siemens.ie/pool/news-events/press_releases/an-enterprising-wind.pdf

[17] Ernst and Young, 2012, 'Analysis of the value creation potential of wind energy policies'. Available online at: http://www.ey.com/Publication/vwLUAssets/Informe_wind/$FILE/Value_creation_wind_policies.pdf

[18] Poyry/Cambridge Econometrics, 2014, 'The Value of Wind Energy to Ireland – A report to the Irish Wind Energy Association'. Available online at: file:///C:/Users/Sarah/Downloads/EconomicBenefitsOfWind_41X187872__Final.pdf

[19] http://igees.gov.ie/wp-content/uploads/2013/10/Future-Expenditure-Risks-associated-with-Climate-Change-Climate-Finance1.pdf

3.1 Net employment impact from additional investment to meet 2020 targets under four scenarios

Table 2: Key findings (nationwide)

	Scenario 1: Additional 1.2 GW of wind	**Scenario 2:** Wind and grid (no change in electricity price)	**Scenario 3:** Scenario 2 with 2% rise in electricity prices	**Scenario 4:** Scenario 2 with 2% decline in electricity prices
Total net employment	2,900	4,400	2,880	6,000
Change in total employment	+0.14%	+0.21%	+0.14%	+0.28%
Direct employment	1,670	2,450	2,450	2,450
Indirect employment	475	770	210	1,330
Induced employment	320	470	8	950
Induced investment employment	550	800	550	1,090
Change in GDP (2012 €)	+307 million	+446 million	+306 million	+586 million
Change in personal income	+0.13%	+0.19%	+0.13%	+0.25%
Change in the price index (2009 = 100)	+0.03%	+0.06%	+0.14%	–0.03%
Change in real disposable personal income	+0.08%	+0.12%	–0.01%	+0.26%

Scenario 1: Wind only

Developing an additional 1.2 GW of onshore wind capacity from 2013 to 2020 would have a significant impact on the Irish economy. By 2020, GDP increases by €307 million (2012 prices) with 2,900 net new jobs that year. Since in this scenario wind energy depresses the wholesale cost of electricity equivalent to the value of subsidies (no change in electricity prices), onshore wind-generated electricity is effectively paying for itself, with only negligible negative implications for the wider economy via lower demand for the transport and storage of fossil fuels (–81 net jobs).

The majority of employment is in the construction sector (~2,000), almost two thirds of which is directly employed to construct new onshore wind farms. The other third is a result of induced investment in new residential and non-residential buildings and equipment to facilitate increased economic activity. Direct construction employment lasts for the duration of the building activity (~one year), with the potential for ongoing construction employment subject to the level of future deployment.

There are approximately another 450 new long-term jobs directly created to support the operations and maintenance of new wind turbines and in the wider electricity supply sector, translating to 0.34 jobs per MW, which falls in line with European Wind Energy Association (EWEA) estimates for direct O&M employment in Europe.

Figure 9 displays net jobs per MW in Ireland as a whole across the different employment categories, assuming an additional 1,181 MW by 2020.[20]

[20] Construction jobs are divided by 1,181 MW for comparison purposes. Note, however, that this downwardly distorts construction jobs per MW since investment in 2020 is not cumulative and only reflects the capacity increase for that year.

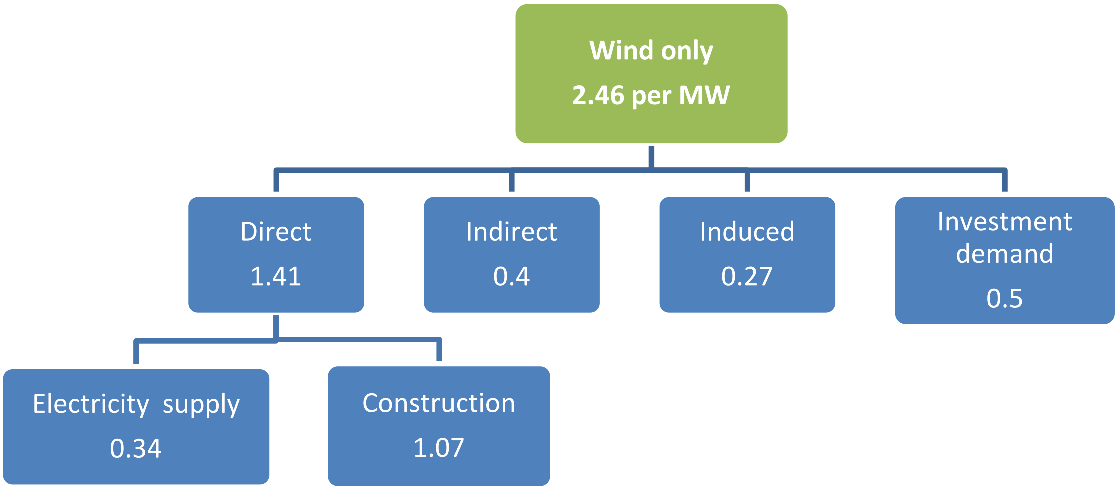


Figure 9: Scenario 1: Wind only – direct, indirect, induced and investment demand jobs per MW

Most manufactured materials like towers, blades and subcomponents are assumed to be imported (import intensity of 66% derived from Irish I–O tables) so fewer indirect manufacturing jobs are generated domestically (~100).

Overall, the additional employment in the country is expected to boost average personal income per capita by around 0.13%. Higher wages and general inflationary pressures have a slight upward impact on prices, which are projected to rise by 0.04%. However, a higher difference in real incomes (+0.18%) could lead to approximately 300 additional jobs via induced employment to meet greater demand in consumption of goods and services, mainly in the health, retail, and food sectors.

Figure 10 displays net jobs per MW, split by industry and by region. The model suggests there are around 100 more jobs created in the construction sector in the Border, Midlands and West due to lower average construction wages in that region, resulting in slightly more employment being sourced from that area. Conversely, since the majority of transport and storage activity is concentrated in the South and East of Ireland, this region experiences a greater loss of jobs in that sector.

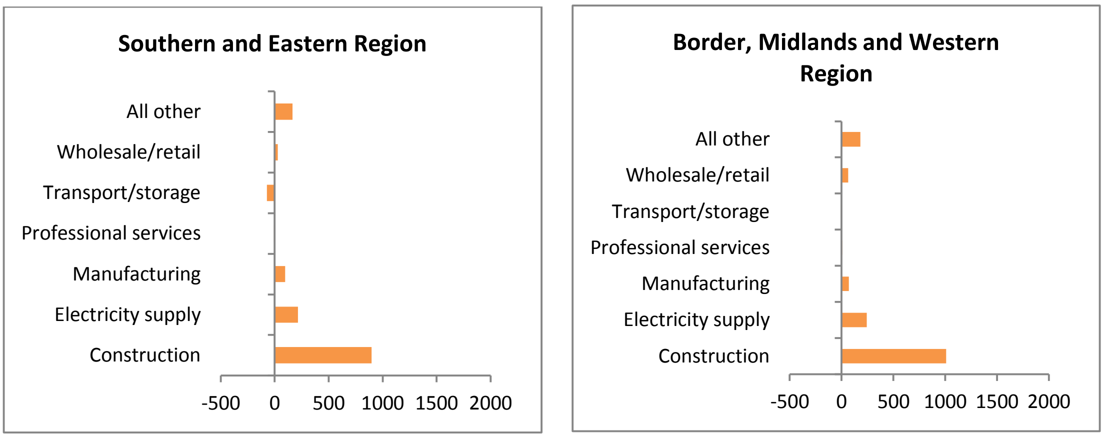


Figure 10: Scenario 1: Wind only – net jobs by industry and by region

Scenario 2: Wind and transmission grid

Including the necessary investment and maintenance of the transmission grid as well as wind farm development, 1,500 additional jobs are generated, reaching net figures of around 4,400 in 2020, approximately 2,000 of which are direct jobs in the construction sector (in job-years). Almost 500 direct longer-term jobs are generated in the electricity, gas and steam industry, with the remainder as a result of indirect employment in the supply chain (~770) and increased spending generally in the economy, both on construction of capital stock and the purchasing of goods and services (~1,250).

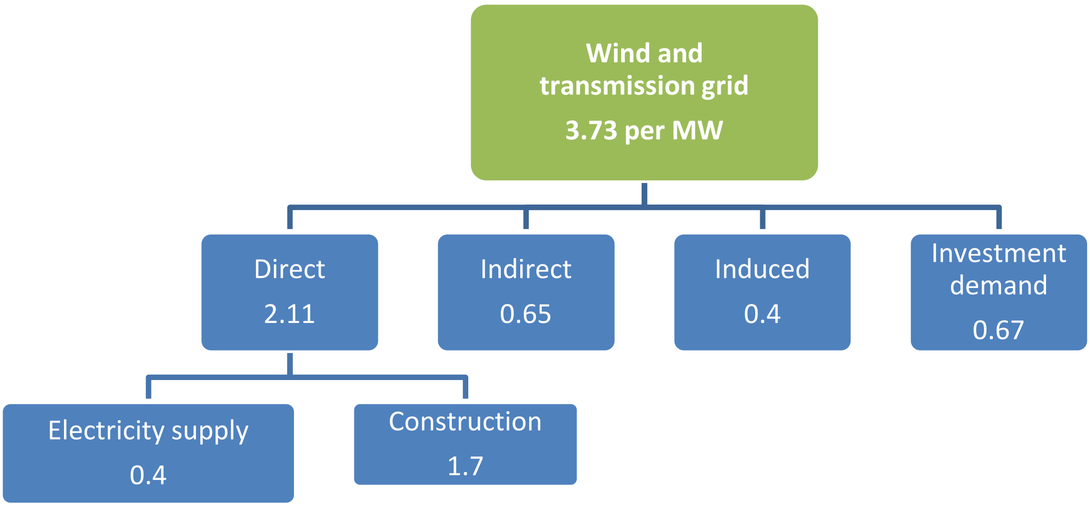


Figure11: Scenario 2: Wind and transmission grid only – direct, indirect, induced and investment demand jobs per MW

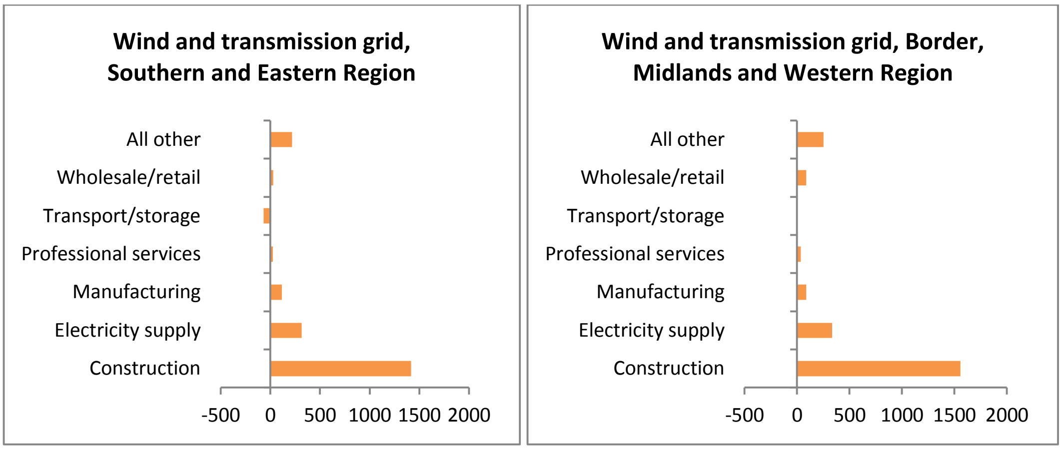


Figure 12: Scenario 2: Wind and transmission grid only – net jobs by industry and by region

Figure 13 presents the share of net new employment by occupational group in 2020, with broadly similar breakdowns observed across all four scenarios. The majority of new employment is in the 'other' category (unskilled occupations), followed by craft and related trades, plant and machine operators, and clerical support. The 'other' category represents the bulk of non-skilled new construction activity.

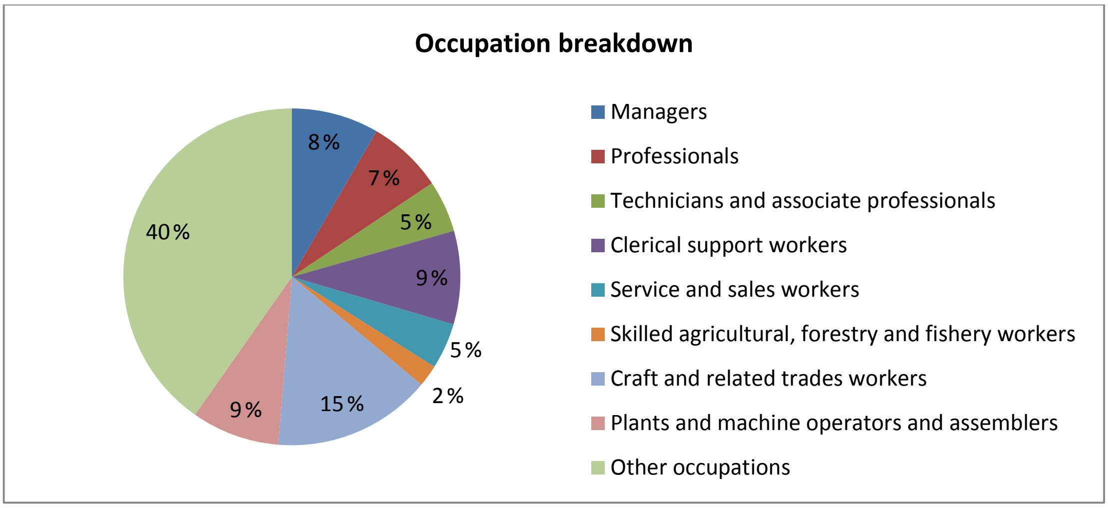


Figure 13: Scenario 2: Occupation pie chart

Scenario 3: Electricity price increase of 2% in 2020

A 2% increase in electricity prices does not impact on direct employment but has a small dampening effect on employment generally as output in some sectors declines due to higher production costs. The aggregate price index (2009 = 100) rises by 0.14% primarily because of higher electricity costs. As a result, despite an increase in personal income from higher employment opportunities in the wind sector and a limited labour supply, real disposable income falls by 0.01% due to relatively higher price increases. Fuel and power is treated as a necessary good in SEEM, with an inelastic price elasticity of demand. Thus consumption of electricity only drops by 0.85% due to the 2% increase in price.

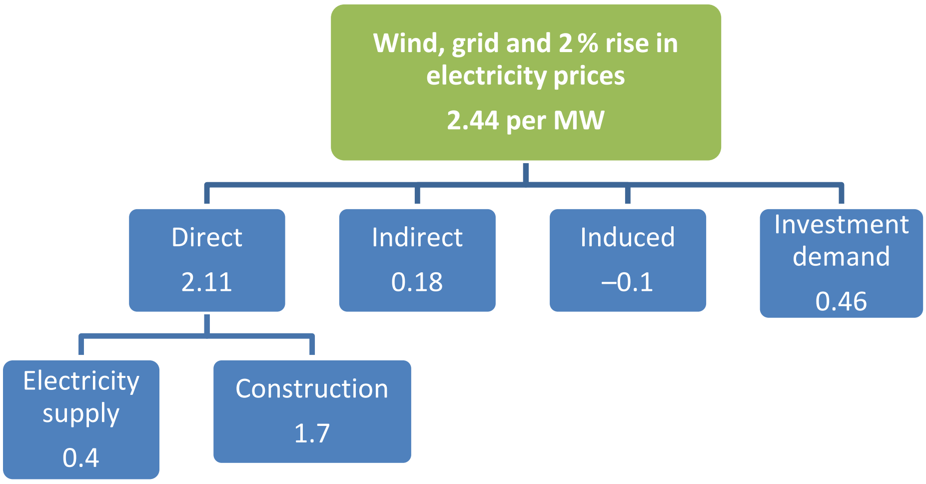


Figure 14: Scenario 3: Wind, transmission grid and 2% rise in electricity prices – direct, indirect, induced and investment demand jobs per MW

There is a net gain in output across sectors linked to onshore wind and transmission grid development (construction, electricity, and manufacturing), with other sectors experiencing an overall reduction in output and employment from a combination of induced income and price effects, particularly in the Southern and Eastern region.

Exports to the rest of the world in all industries experience a small decline (between 0 and 0.15%) substituted with a similar rise in imports and resulting in export employment falling by 0.07%.

In terms of occupation, the wholesale/retail and skilled agriculture workers are the most sensitive to price increases with negative net employment (–0.03% and –0.02% compared to the baseline), but positive net employment is observed across all other categories. Overall, however, despite a 2% increase in electricity prices, net employment, average labour productivity, output, intermediate demand and value-added all increase.

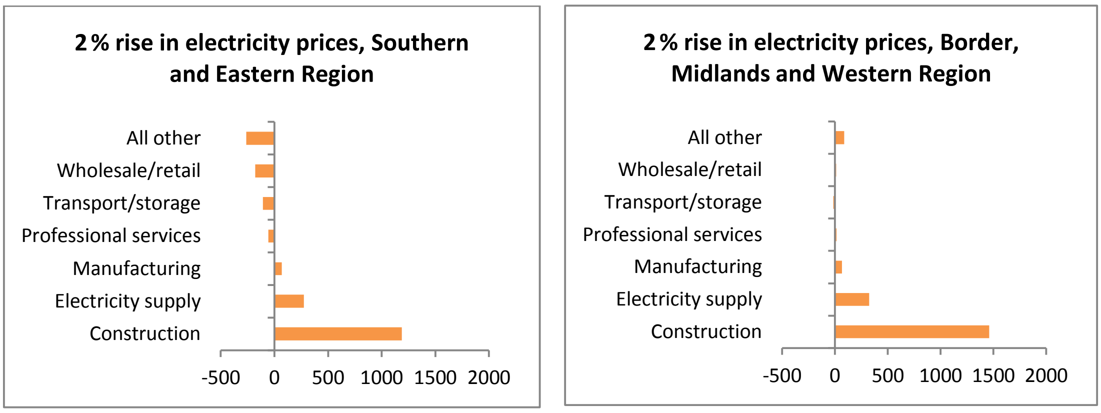


Figure 15: Scenario 3: Wind, transmission grid and 2% rise in electricity prices – net jobs by industry and by region

In terms of the additional rather than cumulative sales of wind-generated electricity, electricity prices need to increase by 6% (to support the additional 1.2 GW of wind capacity and investment in the transmission grid) before net employment starts to suffer and aggregate value-added in the Southern and Eastern region falls by 0.06%. However, even at a 6% increase in the price of electricity, the net impact on the national economy in terms of output and GDP remains positive, with a close-to-zero change in net employment.

Table 3: Scenario 3 – summary economic statistics, % change from baseline

% change from baseline (nationwide)	Net employment	Average productivity	Output	Intermediate demand	Value-added
2% increase in electricity prices	+0.14	+0.04	+0.17	+0.20	+0.15
6% increase in electricity prices	–0.01	+0.05	+0.04	+0.07	+0.01

Scenario 4: Electricity price fall of 2% in 2020

There are significant net employment and macroeconomic benefits for Ireland if increased onshore wind reduces the long-term costs of electricity. In addition to the direct employment in the renewable sector, lower electricity costs enhance competitiveness among producers and stimulate greater household consumption. The Southern and Eastern Region in particular experiences higher output in manufacturing, professional and scientific activities and financial/insurance services (~350 extra jobs in the SE Region and ~200 in the BMW Region in these sectors). Additional disposable income via lower energy bills fuels higher consumption of health, retail and accommodation/food services in particular, supporting over 400 net new jobs in the SE Region and 250 jobs in the BMW Region.

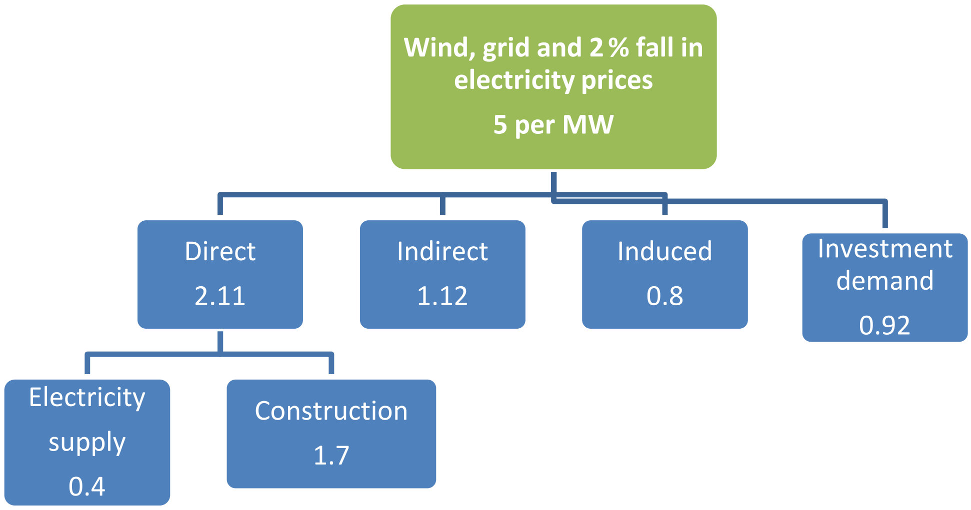
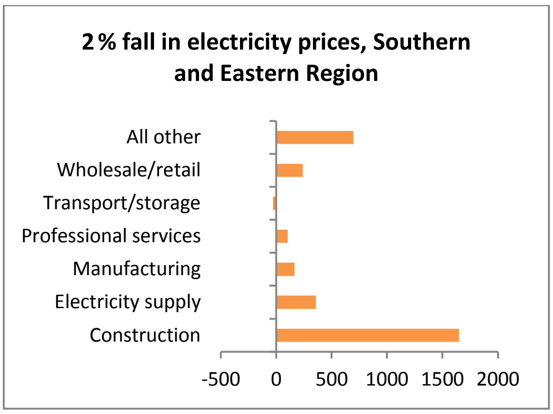


Figure 16: Scenario 4: Wind, transmission grid and 2% fall in electricity prices – direct, indirect, induced and investment demand jobs per MW



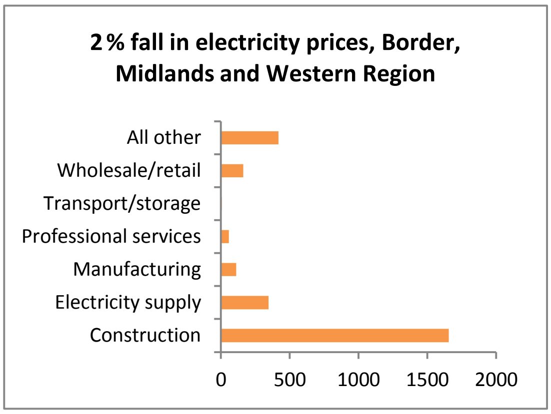


Figure 17: Scenario 4: Wind, transmission grid and 2% fall in electricity prices – net jobs by industry and by region

4 Sectoral analysis

The three main areas which benefit from greater wind deployment in the Irish energy portfolio are manufacturing, construction, and the electricity supply sector (i.e. operations and maintenance of wind farms and the electricity grid).

4.1 Manufacturing sector

SEEM assumes that 66% of manufactured products are imported, reflecting the aggregate import intensity for manufacturing in Ireland in 2009 (CSO I–O Table, 2009). In reality the import intensity for manufactured wind components at present in Ireland may be higher; however, approximately 34% self-supply of manufactured components falls broadly in line with Ireland's potential capacity to capture supply chain activity in the onshore wind sector in 2020, given appropriate scale and policy initiatives (see 'Ireland's sustainable energy supply chain opportunity' for further discussion[21]). Ireland has a strong capacity to provide foundations and develop electronic and control components for the wind sector to meet demand in Ireland as well as Europe and the rest of the world. Figure illustrates an estimate of Ireland's current capacity to capture anticipated investment in wind energy. Green indicates that Ireland is very well placed to capture investment (given the existing skills base, infrastructure, procurement policies, intellectual property rights and critical mass) and red represents no existing supply chain and a low domestic capacity to capture investment.

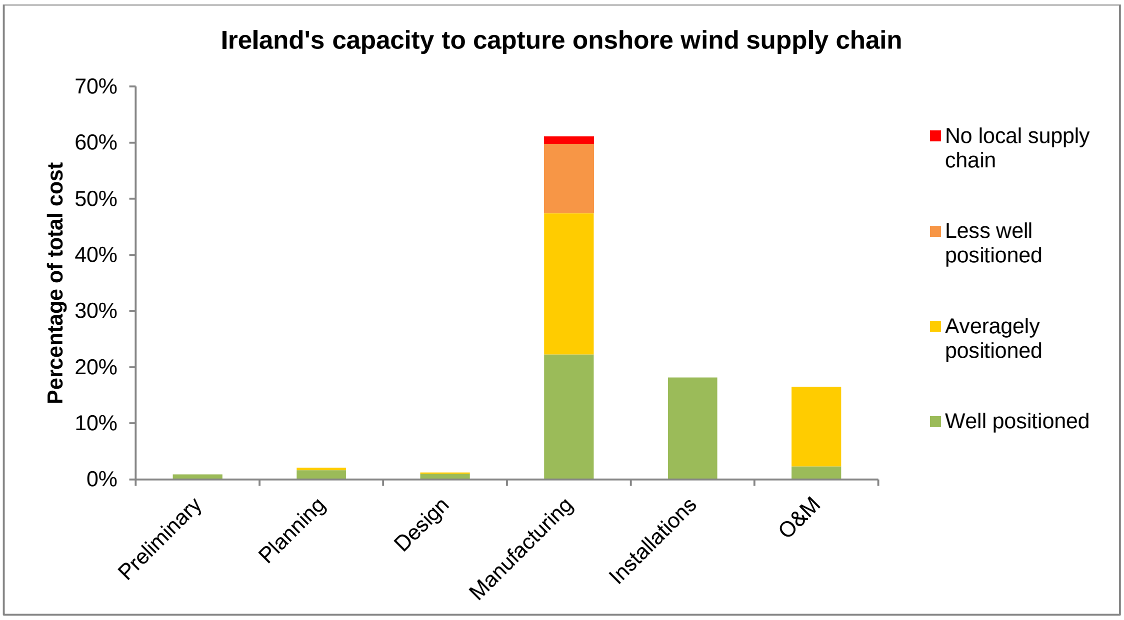


Figure 18: Ireland's capacity to capture onshore wind supply chain

Most of the components in the manufacturing tree face either slight (in yellow) or stronger barriers (in orange and red) to domestic production, for example: the nascent heavy manufacturing industry in Ireland; the restrictive procurement policies of existing suppliers; and the maturity of the onshore wind manufacturing market in Europe. The planning and installation phases of development are currently where the highest amount of investment is likely to be captured in Ireland; they have the strong potential to capture the yellow share of O&M and manufacturing given appropriate scale and policy actions.

4.2 Construction sector

Between 2007 and 2011, the Irish construction sector in general fell by 27% in the residential market and by 40% in the non-residential market.[22] If NREAP targets for onshore wind are achieved, the largest increase in net jobs in 2020 is in construction-related activity, which could provide a valuable short-term boost to the sector. The years 2019 and 2020 represent the height of the wind plant construction period in our model, with approximately 300 MW of additional wind capacity assumed to take place in each of those years. In 2020, to build the new wind farms and expand the transmission grid could

[21] SEAI, 2014. 'Ireland's sustainable energy supply chain opportunity', available at: http://www.seai.ie/Publications/Statistics_Publications/Energy_Modelling_Group_Publications/Ireland%E2%80%99s-Sustainable-Energy-Supply-Chain-Opportunity.pdf
[22] http://www.forfas.ie/media/19072013-Irelands_Construction_Sector-Publication.pdf

require over 2,000 construction workers directly onsite. This number increases to almost 2,800 when induced investment from readjusting the level of optimal capital stock is included. Construction jobs would be dispersed throughout the country as grid improvements and expansions to cater for wind extend to all regions. This would have a particularly beneficial impact in the Border, Midlands and Western Region.

4.3 Electricity supply sector (O&M)

SEEM estimates that the operations and maintenance of an additional 1,181 MW of wind capacity in 2020 will directly support almost 500 jobs in the electricity supply sector; this number increases to around 1,300 when the maintenance of existing wind facilities is included. In contrast to capital investment, where employment only lasts for as long as the construction dictates, operations jobs last the lifetime of the wind farm which, according to a recent report by Siemens and IWEA, is estimated at around 15 years.[23] Indirectly, the ongoing operations and maintenance of existing and potential onshore wind energy supports a similar number of jobs in construction, buoyed by induced capital investment. Approximately 150 jobs are also created in the manufacturing sector to cater for repairs and maintenance (assuming around 30% of wind farms and grid maintenance are serviced locally in 2020) and over 400 jobs are generated through higher incomes and induced demand for local goods and services. In contrast to the initial job creation from capital investment in wind farms, the development of local expertise required for the long-term operations and maintenance of onshore wind would have structural importance for Ireland and provide an opportunity to capitalise both domestically and internationally on the renewable electricity sector.

[23] Siemens/IWEA, 2013. 'An enterprising wind' – an economic analysis of the job creation potential of the wind sector in Ireland' (p. 10).

5 Conclusion and summary

The findings in this economic impact assessment suggest that continued onshore wind deployment to meet Irish renewable energy targets has a consistently positive impact on net employment and the Irish economy in 2020 based on a range of scenarios.

By 2020, 4,400 net jobs are estimated to be created in the Irish economy as a result of building new wind farms and expanding the electricity network (central scenario).

The majority of these, up to 2,450 jobs, are from direct employment in the onshore wind and electricity supply sector.

Another 770 jobs are created in the Irish supply chain due to additional industrial demand in the economy: 470 jobs are created in the goods and services industries to serve greater household expenditure as a result of higher average disposable incomes per capita; and 800 jobs are created due to higher investment in buildings and equipment (capital stock).

In these scenarios wind energy depresses the wholesale cost of electricity equivalent to the value of subsidies (no change in electricity prices), so onshore wind-generated electricity is effectively paying for itself. Unlike many other forms of infrastructure development, crowding out of private sector investment or reallocation of resources does not occur.

There are significant net employment and macroeconomic benefits for Ireland if increased onshore wind reduces the long-term costs of electricity. In addition to the direct employment in the renewable sector, lower electricity costs enhance competitiveness among producers and stimulate greater household consumption. Additional disposable income via lower energy bills fuels higher consumption of health, retail and accommodation/food services in particular, supporting over 400 net new jobs in the SE Region and 250 jobs in the BMW Region.

If a greater share of onshore wind capacity in the Irish energy system leads to an electricity price increase above and beyond projected electricity price forecasts, it would have to be 6% higher than the forecast price in 2020 before positive net employment is no longer observed.

The three main areas which benefit from greater wind deployment in the Irish energy portfolio are manufacturing, construction, and the electricity supply sector (i.e. operations and maintenance of wind farms and the electricity grid). Ireland has a strong capacity to provide foundations and develop electronic and control components for the wind sector to meet demand in Ireland as well as Europe and the rest of the world. In contrast to the initial job creation from capital investment in wind farms, the development of the local expertise required for the long-term operations and maintenance of onshore wind would have structural importance for Ireland and provide an opportunity to capitalise both domestically and internationally on the renewable electricity sector.

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