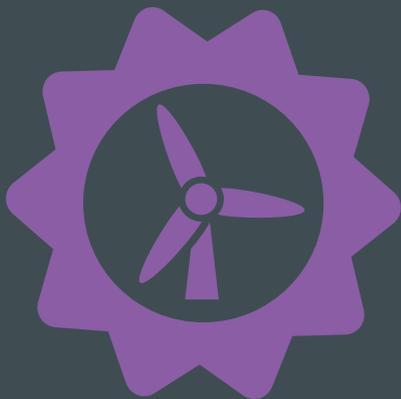


# Introduction to the Wind Energy Roadmap to 2050

The development of renewable energy, including both offshore and onshore wind, is central to our energy policy.



Energy derived from our indigenous renewable sources improves the security of our supply and provides a hedge against volatile imported energy prices. This benefits all society through a reduced dependence on fossil fuels and achievement of a cleaner, more sustainable environment where employment and national competitiveness can be strengthened, and our low carbon energy makes us an attractive place to do business.

With the goal of a more secure, cleaner and affordable energy future in mind, SEAI has developed a suite of roadmaps that consider possible scenarios moving from the present to the longer term horizon of 2050. This involves considering resource availability, technology and supply chain development paths, transmission and system integration requirements and our existing and future regulatory environment. A roadmap considers these issues, maps a potential path to a future deployment scenario, and estimates some of the benefits of achieving that scenario.

This roadmap considers an accelerated deployment path for onshore and offshore wind to 2050, and was developed alongside roadmaps for

Smart Grids and Electric Vehicles, with consistent assumptions applied, including a significant increase in Irish electricity demand to 2050 driven by population growth, increased electrification of the residential and services sectors, the delivery of a smarter grid, and policies to encourage electric vehicle adoption. The wind roadmap builds on the work of the International Energy Agency and identifies possible barriers and constraints to increased deployment, and estimates CO<sub>2</sub> reduction, value of generation, and job creation benefits.

Ireland's wind resource potential is vast. Onshore, it represents some of the most cost effective renewable resource in Europe, and offshore it benefits from Ireland's extensive area of offshore territory in the Atlantic and the Irish Sea. With reference to the most recent assessments of wind energy potential onshore and offshore, this roadmap shows low, medium and high scenarios for deployment, generating many times more than Ireland's own electricity demand, and as much as 2.5% of total projected European electricity demand by 2050.

The scenarios recognize that wind turbine technology, as well as technology for integrating wind energy into electricity systems designed for conventional power, will continue to advance in the coming decades. Thus sites being developed today have the potential to repower with more efficient technology or larger capacity turbines. Repowering drives onshore wind capacity growth from 2030 onwards in this roadmap. Ireland has the potential to become a major exporter of renewable

electricity to the European market, and, in doing so, can reap the benefits of job creation as well as revenues recognising clean energy. The deployment scenarios envisaged could produce an estimated 20,000 jobs, initially in installation but also driven by a continuing employment market in operations and maintenance.

The impediments to greater deployment of wind energy are not trivial. They range from the rate of infrastructure development and access to finance, to difficulties in getting or retaining planning permission and social acceptance. A number of required near term policy and infrastructure related actions are identified in the roadmap. Many actions have already begun, and are responding to well articulated calls for a more coherent and coordinated approach to addressing existing barriers to deployment. The development of such an approach will enable us to meet our near term targets, and put us on the path to achieving, and reaping the benefits of, the long term deployment scenarios envisaged in this roadmap.

I want to thank the many stakeholders who have contributed their time and their views to the development of this roadmap, and to invite comments from other interested parties to [roadmaps@seai.ie](mailto:roadmaps@seai.ie).

**Prof. J Owen Lewis**  
Chief Executive, SEAI

# Wind Energy Key Points

## Technology innovation remains a crucial driver for the potential level of deployment of wind energy

Onshore and offshore wind could create 20,000 direct installation and O&M jobs by 2040



The potential economic value of electricity generated by wind could reach almost €15 billion by 2050

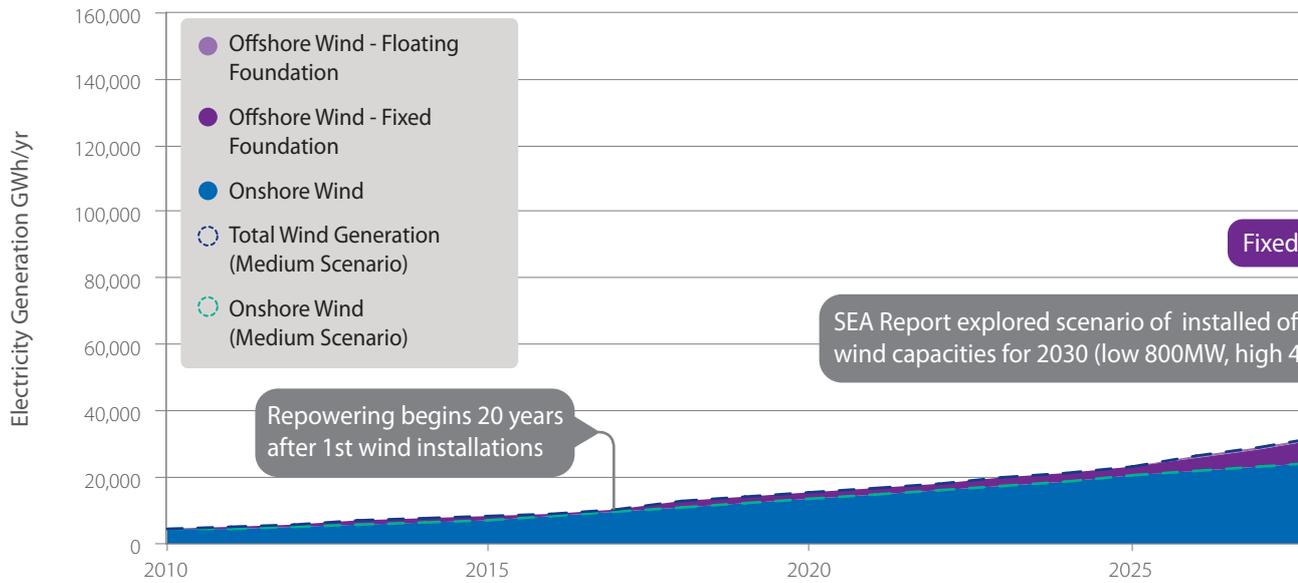


Wind energy is currently the largest contributing resource of renewable energy in Ireland. The primary objective of this roadmap is to identify the actions that are required to accelerate the deployment of wind energy, both on and offshore, in Ireland, so that it becomes the largest source of energy; to aid policy makers, and industry and power system actors in their efforts to successfully implement large amounts of wind energy in Ireland. It lists the actions and milestones that could be incorporated in a deployment framework. The resulting 2050 deployment pathway is based on assumptions of the potential for, and timing of, technology breakthroughs in the onshore and offshore sector as well as assumptions about the development of legislative, economic, technical and infrastructural conditions. It considers aspects such as grid reliability, the role of smart grid for improved system balancing and the structural and operational requirements for successful system integration of wind energy.

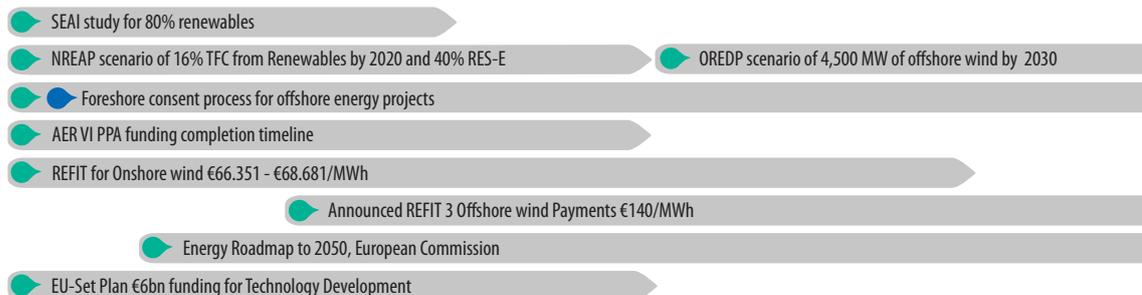
## Key Findings

- Given favorable developments in policy and infrastructure, Ireland can achieve deployment of between 11GW - 16GW of onshore wind and 30GW of offshore wind by 2050
- Wind energy has the potential to generate enough electricity to exceed domestic demand by 2030
- A comparison of electricity demand and wind generation potential shows the capacity for Ireland's wind market to become export driven in the 2020–2030 timeframe
- As the onshore and offshore wind markets mature, re-powering and operation and maintenance will become key to the retention of a sustainable industry: preparation for this eventuality will increase our benefit from this opportunity
- The repowering of onshore and offshore wind turbines will contribute over 15GW to 2050
- The potential economic value of electricity generated by wind could reach almost €15 billion by 2050
- Onshore and offshore wind could create 20,000 direct installation and O&M jobs by 2040. Offshore wind represents a significantly greater employment opportunity than onshore wind post-2025
- The wind industry is expected to hit a peak annual investment of between €6 billion and €12 billion by 2040. Wind has a cumulative Investment potential of €100 - €200 billion in 2050
- By 2050 Irish wind could contribute 2.5% to EU Electricity Demand and just over 5% of EU wind energy generation could come from Ireland
- Onshore and Offshore wind represent a significant carbon abatement opportunity - Wind could abate between 400 and 450 Mt of CO<sub>2</sub> by 2050

# Wind energy - onshore and offshore wind energy generation



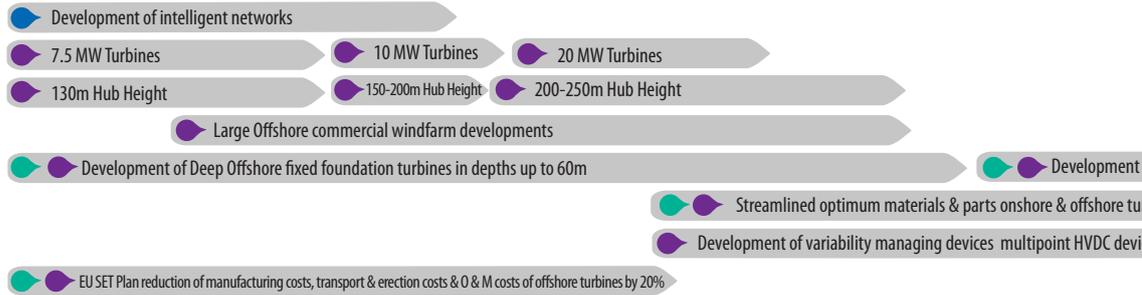
## POLICY FRAMEWORK, SUPPORTS AND TECHNOLOGY SUPPORT MECHANISMS



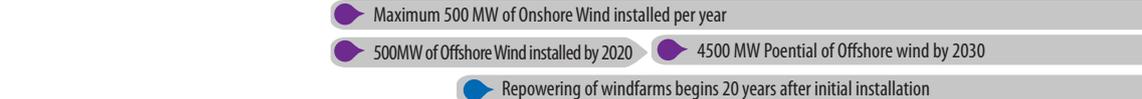
## PUBLIC ENGAGEMENT & ENVIRONMENT



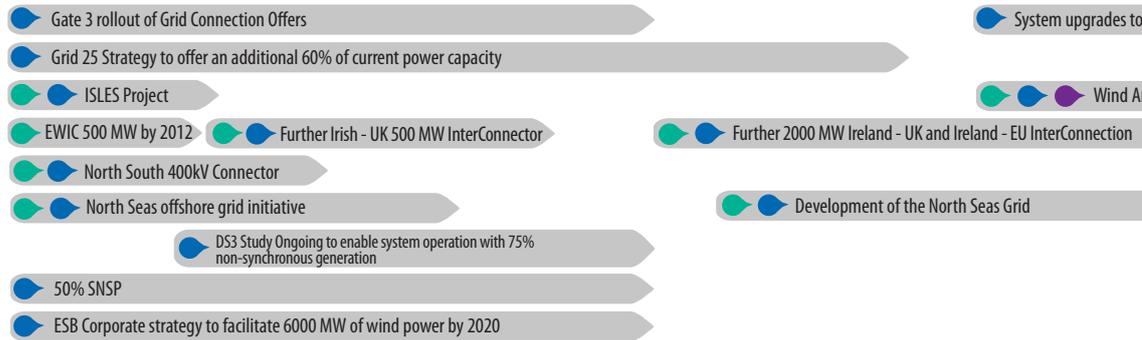
## DEVICE TECHNOLOGY



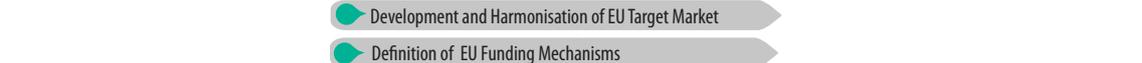
## INDUSTRY



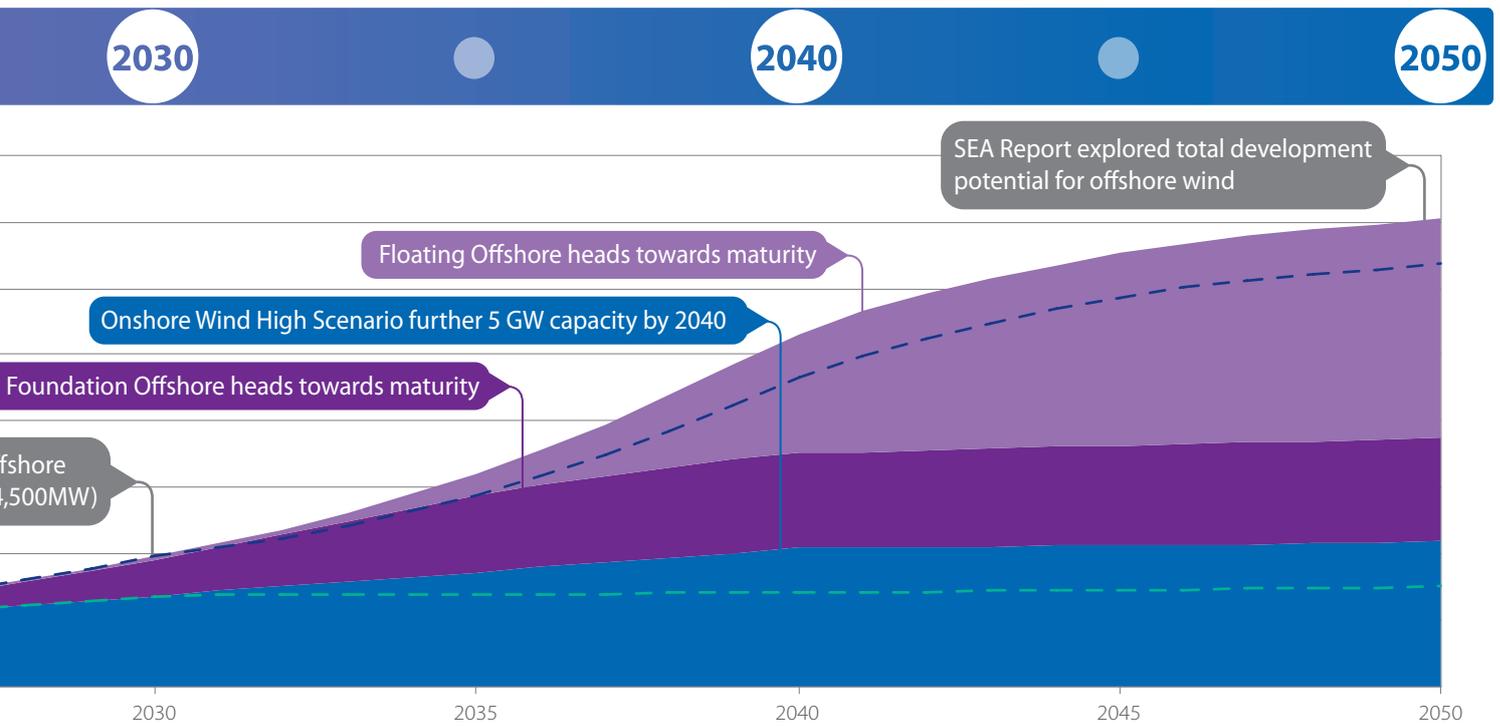
## INFRASTRUCTURE



## MARKET DEVELOPMENT



# Generation scenarios



OREDP high scenario of 39,500 MW of offshore wind by 2050

Financial supports for on and offshore wind begin to decline as industry matures

Possible development of a transnational planning process

of Offshore Floating Turbines in depths >100m

turbines (minimising manufacture, construction and operating & maintenance costs)

ces

onshore connections to accommodate repowering

Annual Output reaches 50% of domestic demand Major need for Interconnection

Further need for infrastructure as capacity outweighs demand

Ireland can achieve deployment of 11GW - 16GW of onshore wind and 30GW of offshore wind by 2050

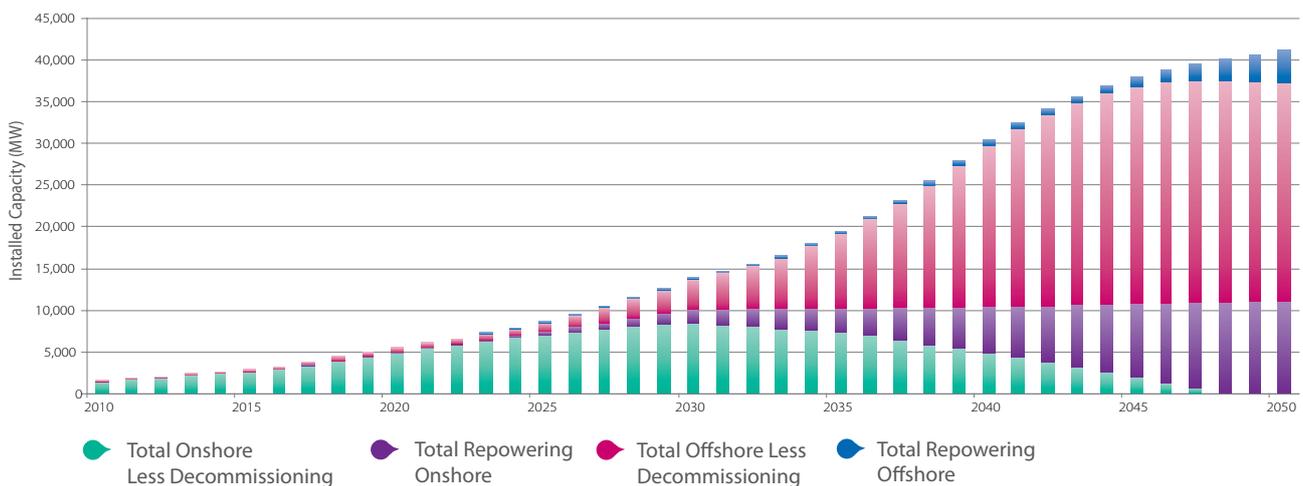
## KEY

- Government and governing bodies
- Power systems and regulators
- Industry

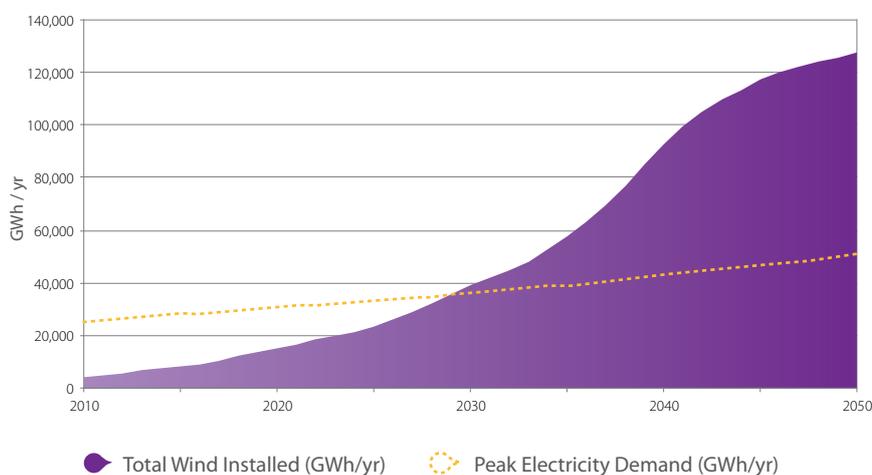
# Wind Energy to 2050

Our assessment shows that the wind energy resource represents a significant value to Ireland by 2050. This value is presented in terms of its ability to contribute to our indigenous energy needs, the benefits of enhanced employment creation and investment potential, and the ability to significantly abate carbon emissions to 2050. Furthermore, a comparison of electricity demand and wind electricity generation shows a great capacity for Ireland to export excess wind energy in the 2020 – 2030 timeframe.

## Cumulative Capacity with Repowering of Onshore and Offshore Wind Installations to 2050

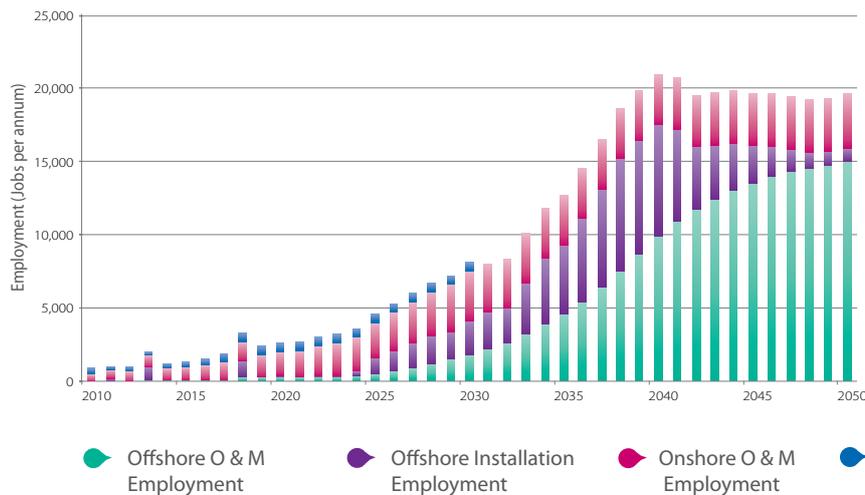


## Annual Electricity Demand vs. Wind Generation



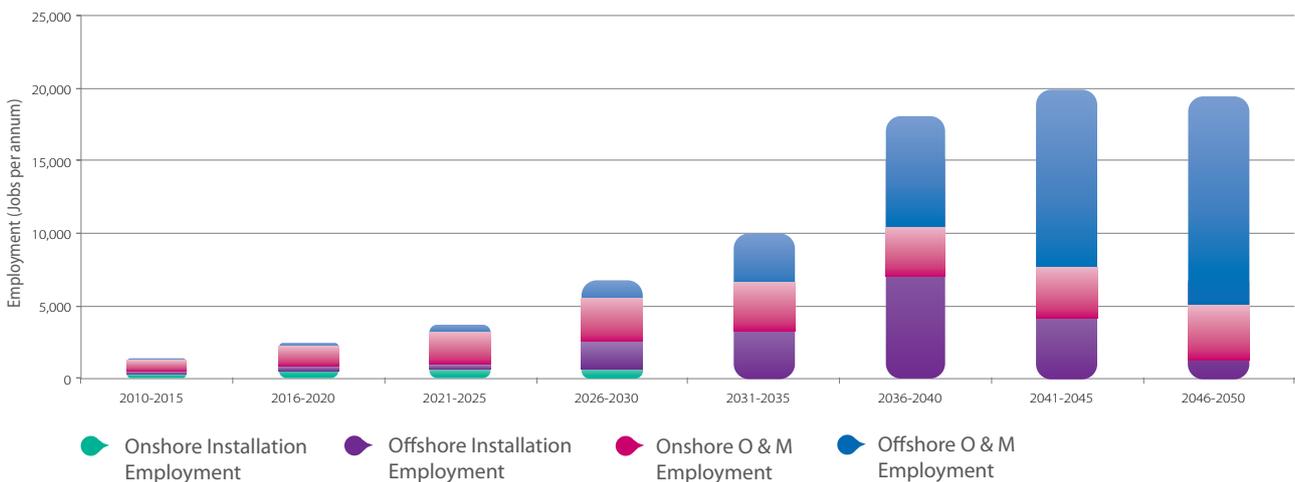
**Key Point:** Ireland has the potential to generate enough electricity to exceed domestic demand by 2030.

## Annual Onshore and Offshore Wind Employment Figures to 2050

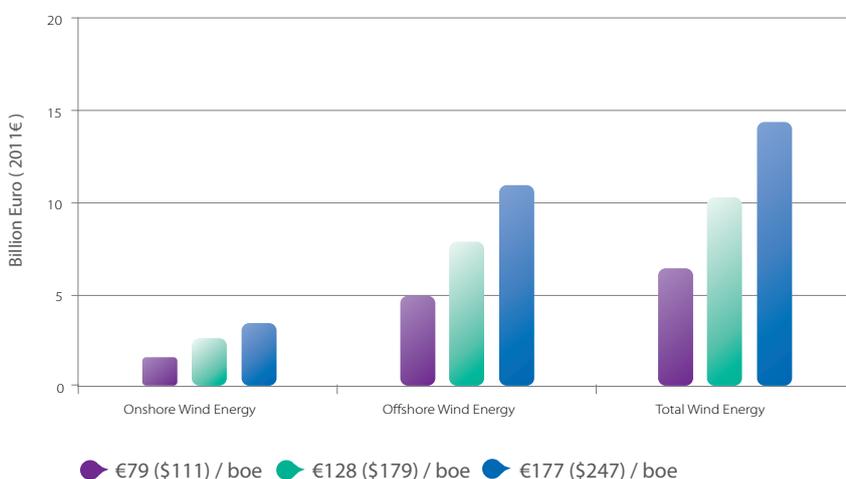


**Key Point:** Onshore and offshore wind generation could create 20,000 direct installation and operation and maintenance jobs by 2040

## 5 Year Average Onshore and Offshore Wind Employment Figures to 2050

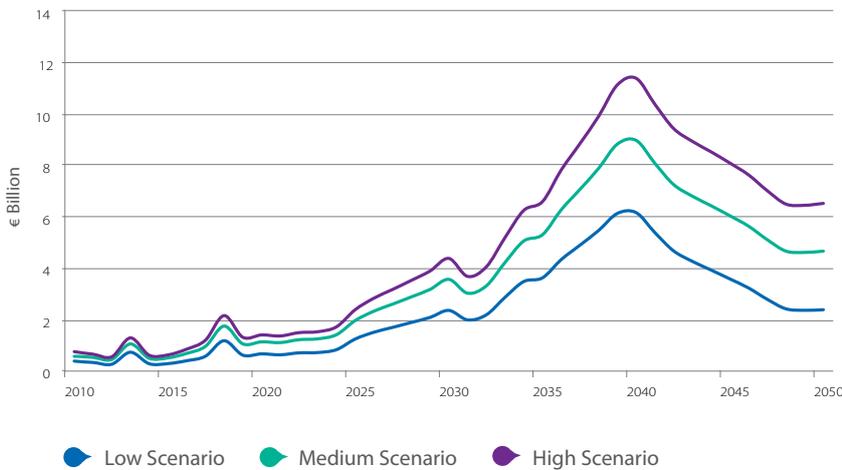


## Wind Energy Resource Value Expressed in Cost Per Barrel of Oil Equivalent in 2050



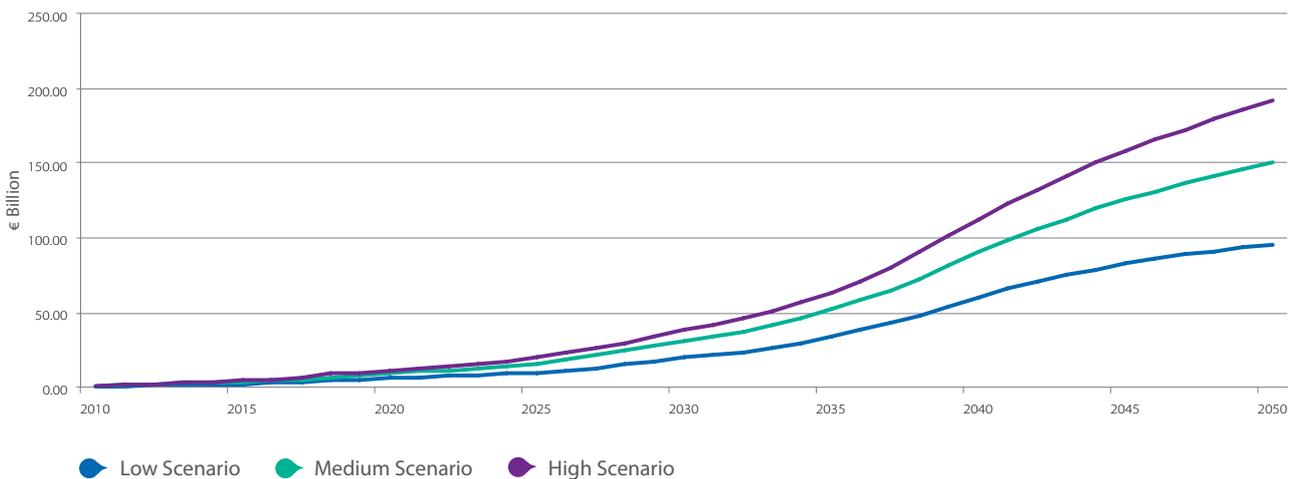
**Key Point:** The potential economic value of electricity generated by wind could reach €15 billion by 2050 on the basis of fuel substitution. While financial support may be required in the early years of this deployment scenario, as technologies mature and market structures evolve from those designed for conventional generation, providing incentives for benefits not currently priced, supports for wind should no longer be necessary.

## Annual Investment in Onshore and Offshore Wind

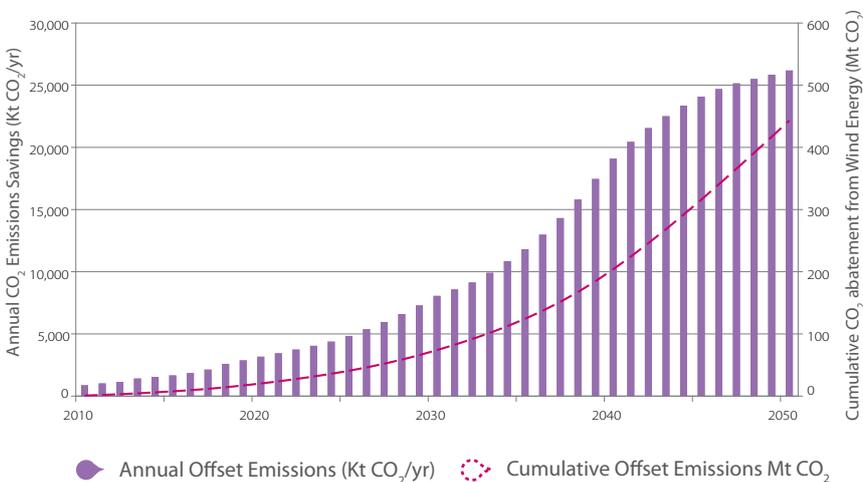


**Key Point:** The Irish wind industry is expected to hit a peak annual investment of between €6 - €12 billion by 2040. Wind has a cumulative investment potential of €100 - €200 billion in 2050.

## Cumulative Investment in Onshore and Offshore Wind

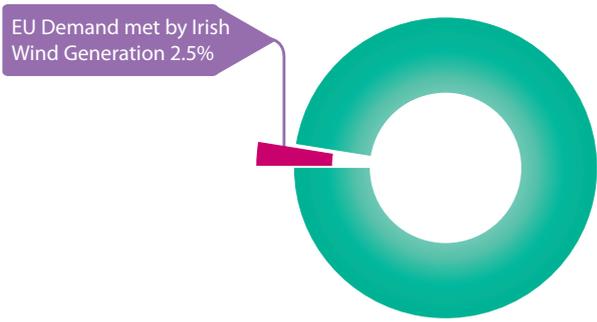


## Estimated Annual and Cumulative CO<sub>2</sub> Emissions Offset from Natural Gas Power Generation to 2050



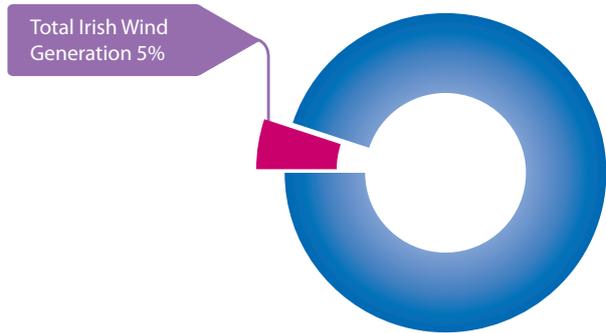
**Key Point:** This calculation assumes a carbon content for gas fired generation of 205.6 grams CO<sub>2</sub> per kWh for the generation displaced by wind. While base load gas-fired generation may increase in efficiency and become less carbon intensive over time, the operation of gas-fired generation may change to mitigate against this (i.e. increased use as peaking plant). For this reason the factor of 205.6 grams of CO<sub>2</sub> per kWh was applied consistently through to 2050.

Irish Contribution to EU Electricity Demand in 2050



Rest of EU Demand Total Irish Wind Generation

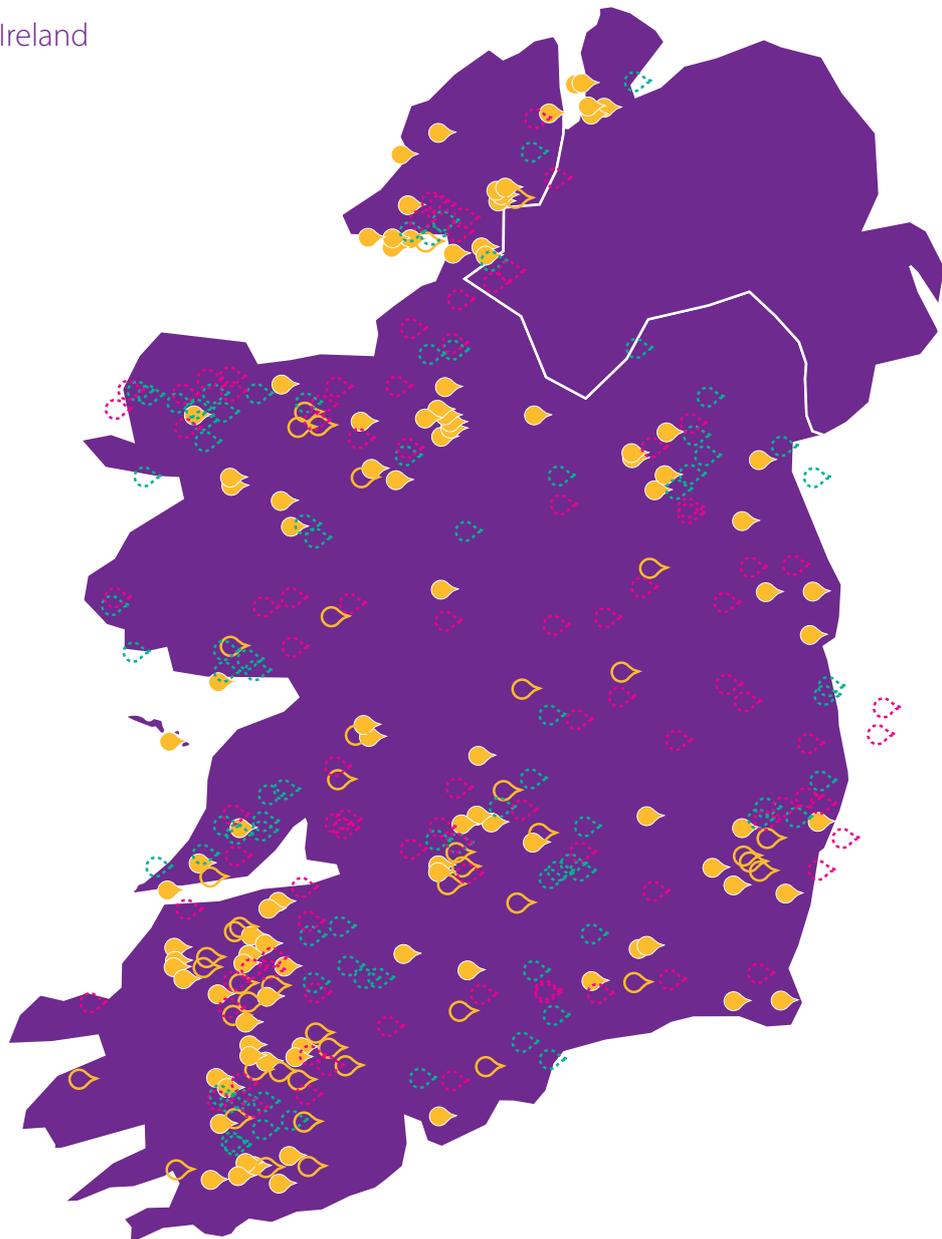
Irish Contribution to EU Wind Generation in 2050



Rest of EU Wind Generation Total Irish Wind Generation

Map of Windfarms in Ireland

- Connected
- Contracted
- Gate 3 Live Offer
- Grid Applicant





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