Offshore Renewable Energy Catapult

Driving innovation and knowledge

GENERATING ENERGY AND PROSPERITY:

Economic Impact Study of the offshore renewable energy industry in the UK

March 2014

Technology Strategy Board
Driving Innovation

CATAPULT

Foreword

March 2014

It is my pleasure to introduce 'Generating Energy and Prosperity', the Offshore Renewable Energy Catapult's Economic Impact Study, analysing the potential value of the UK's offshore wind, wave and tidal energy.

There have been a number of detailed and valuable reports over the past couple of years considering the costs of delivering offshore renewable energy and how they might be addressed. The Offshore Wind Cost Reduction Task Force, which I chaired, and The Crown Estate's Offshore Wind Cost Reduction Pathways Study, both reported in June 2012, providing detailed and widely accepted analysis of how cost targets can be achieved. These remain current and it is not our intention to reiterate their findings.

However, what is less up-to-date is the understanding of the potential economic value of offshore renewables to the UK and why it is worth the investment now to develop and grow sustainable industries delivering energy from our offshore natural resources.

Our report quantifies the potential economic benefits against differing capacity scenarios and identifies the specific areas of the supply chain that hold the highest potential value.

Key to unlocking this value is driving cost reductions to ensure economic success for the industry. Technology innovation will play a major role in delivering this opportunity. It can reduce the cost of offshore renewable energy and enhance the competitiveness of UK businesses, in so doing creating an industry with the skills, services and know-how to not only create extensive economic benefit and employment but also to export our capabilities around the world for decades to come.

I firmly believe that we have the opportunity to make the UK the strategic knowledge base for the global offshore renewables industry. At ORE Catapult, we are working with UK industry, academia, supply chain, government and SMEs to drive forward innovation, joining up the excellent work already underway, focusing innovation on the UK's strengths and where the economic opportunity is greatest, in order to realise that goal.

Andrew Jamieson, *Chief Executive*

Executive Summary

The UK leads the world today in both deployment and ambition for offshore renewable energy. It has more than double the installed offshore wind capacity of any other nation and has ambitious targets for both offshore wind and marine energy. Together, the UK's global leadership in current deployment and strong future targets are supporting the development of an indigenous industry that is set to provide substantial economic benefits through the first half of the 21st century and beyond.

Working with the Fraser of Allander Institute (FAI) at Strathclyde University and BVG Associates, the ORE Catapult has quantified the economic opportunity that offshore renewables can deliver out to 2020, identified the biggest opportunity areas and has sought to understand how the UK's offshore potential can be made a reality.

In its December 2013 Electricity Market Reform Delivery Plan, the Department of Energy and Climate Change (DECC) published two scenarios for offshore wind in which installed capacity reached 8GW and 15GW by the end of 2020. In DECC's marine energy scenario installed capacity reached around 100MW by the end of 2020.

For each offshore wind scenario, we built a "gradual growth" path that reflects existing market conditions. Recognising that industry and government have the potential to achieve much more, we have also considered an "accelerated growth" path which assumes a series of public sector interventions which support the UK's ambitions, driving cost reduction and quality improvements through greater innovation and investment.

For marine energy, we considered a single scenario against DECC's anticipated 100MW deployment by 2020.

We considered each part of the supply chain, how much new investment was likely in each scenario and how much of the expenditure would be in the UK. Using established economic tools, we modelled the resulting economy-wide Gross Value Add (GVA) and job creation.

Figure 1 shows that in the 15GW accelerated growth path scenario for offshore wind, where UK companies seize the opportunity and innovate collaboratively, GVA can reach almost £6.7bn in 2020, supporting 34,000 direct jobs and 150,000 jobs in total.

With the gradual growth path to 8GW installed in 2020, GVA can reach £2.3bn in 2020, with just under 12,000 direct jobs and 50,000 jobs supported in total.

Figure 1 8GW/15GW offshore wind gradual/accelerated growth

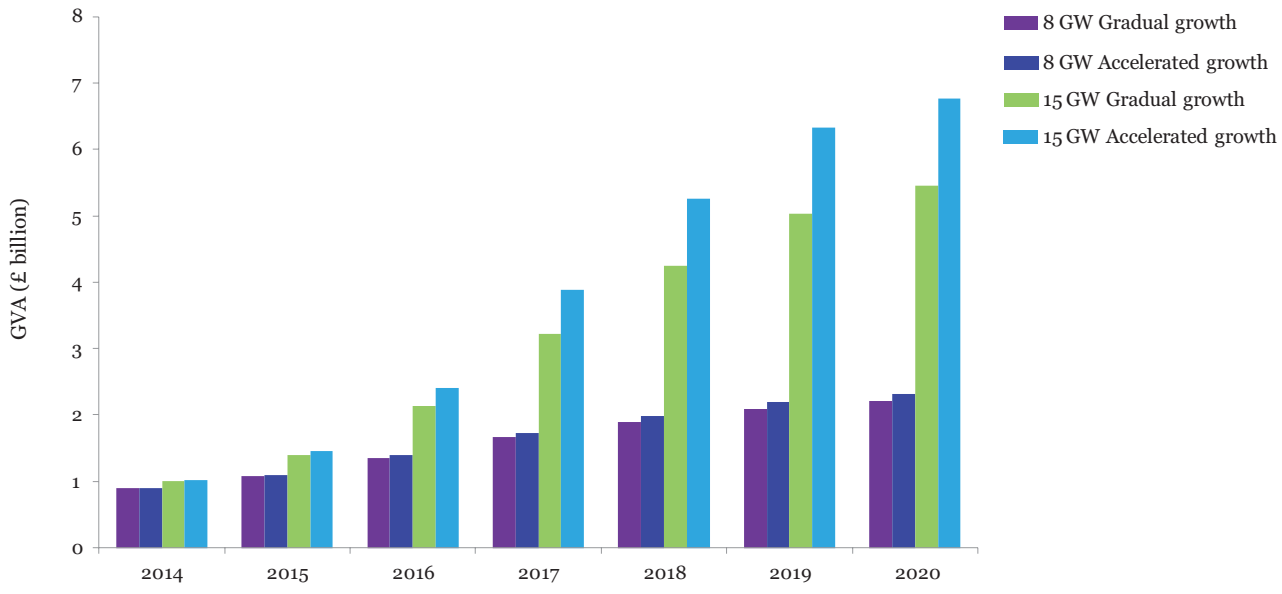


Figure 1 UK gross value added in the offshore wind sector to 2020 under the 8GW and 15GW capacity scenarios under the gradual and accelerated growth paths.

Considering the areas of greatest opportunity, turbine manufacturing provides the single biggest contribution to GVA by 2020, with some £2.1bn in the accelerated 15GW scenario. The next biggest contributor is in the area of operations and maintenance, with £1.4bn at the upper end.

The accumulation of know-how in the effective operation and maintenance of assets will provide an exportable service industry similar to that achieved by the oil and gas industry over recent decades. It is this area that we believe will make the biggest long-term contribution to offshore wind GVA, as when the growth in new installed capacity ultimately slows, an increasing proportion of total expenditure will be operational.

The figures for marine energy up to 2020 are naturally smaller than for offshore wind, reflecting the relative immaturity of tidal and wave technologies. We do not anticipate large scale commercial wave technology deployment by 2020 but recognise a potential £110m GVA principally from tidal stream demonstration projects.

However, the UK leads the world in the design, deployment and early project development of wave and tidal energy technology and this advantage, combined with significant synergies with the development of offshore wind, can lead to the industrialisation of marine energy technology in the following decade, delivering significant economic benefits as a result, from this emerging global market.

The offshore wind supply chain today

The UK has been a driving force in European offshore wind deployment. Offshore wind represented 3.6% of the UK's electricity supply in 2013, and the industry contributed circa £1bn to the UK economy and supported 20,000 jobs in total, of which 5,000 were direct jobs. Only about 40% of the lifetime costs of currently operational UK offshore wind farms will be spent domestically, however, since most large components are imported. By supporting the development of the UK's supply chain, the share of value retained in the country could be significantly enhanced (see box).

The UK supply chain today

The offshore wind technology supply chain consists of six major segments: turbines; foundations; cables; electrical systems; installation, and operations and maintenance. The UK's strengths are mainly in the latter four segments of the supply chain, with European and other international suppliers leading in the first two.

Companies that have enjoyed long term and stable industrial support for wind energy, in countries like Germany and Denmark, have benefited early from growth in offshore wind. They have maintained leadership in the wind turbine supply chain, while only a small proportion of turbine components are manufactured in the UK.

Although the UK has residual capacity in heavy engineering, it is starting from a lower base than some of its competitors and steel foundations have been mostly imported.

The UK has a strong high voltage power sector, however, and while there is a global supply base for large electrical components such as switchgear, transformers and reactors, most offshore substations have been built in the UK, partly because of its experience of building offshore oil and gas platforms.

The UK has considerable strength in the offshore construction sector, in the operation of installation vessels and in engineering the tools for installation such as component handling equipment and remotely operated vehicles.

Operation and maintenance makes up about a third of offshore wind farm lifetime costs. For UK wind farms, about three quarters of this is spent domestically and much of this is local to the wind farm.

The offshore wind supply chain to 2020

Figure 2 to Figure 5 show the growth in GVA for each area of the supply chain for each scenario and growth path. At 15GW, a tipping point will have been surpassed. This tipping point is where economic value to the UK begins to increase at a much greater rate and we begin to see relatively more substantial returns on our investment. The Catapult believes that this tipping point will be reached at a capacity of between 10 and 15GW.

Supply chain growth is maximised in the 15GW accelerated growth scenario, where new UK investments in turbine and foundation manufacturing facilities in particular lead to a steep growth in GVA.

Figure 2 15GW offshore wind, gradual growth

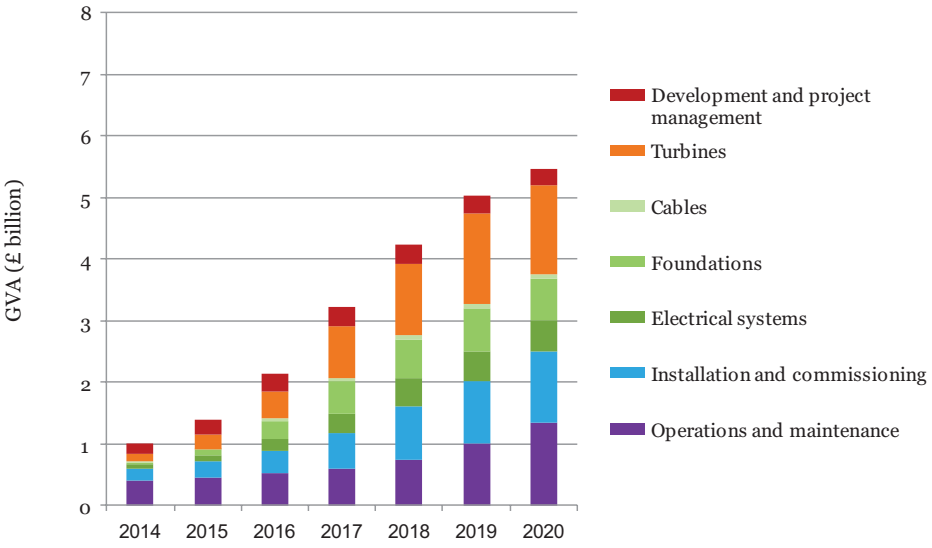


Figure 3 15GW offshore wind, accelerated growth

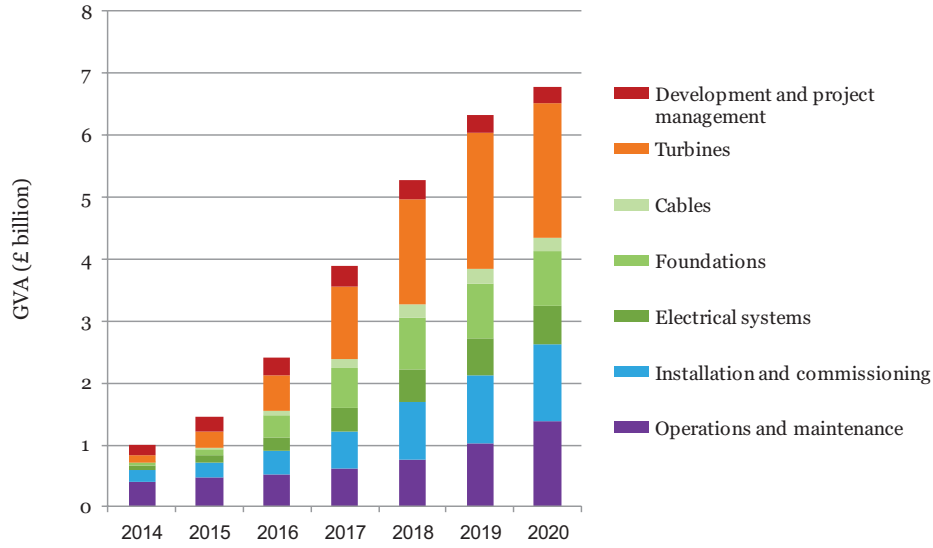


Figure 4 8GW offshore wind, gradual growth

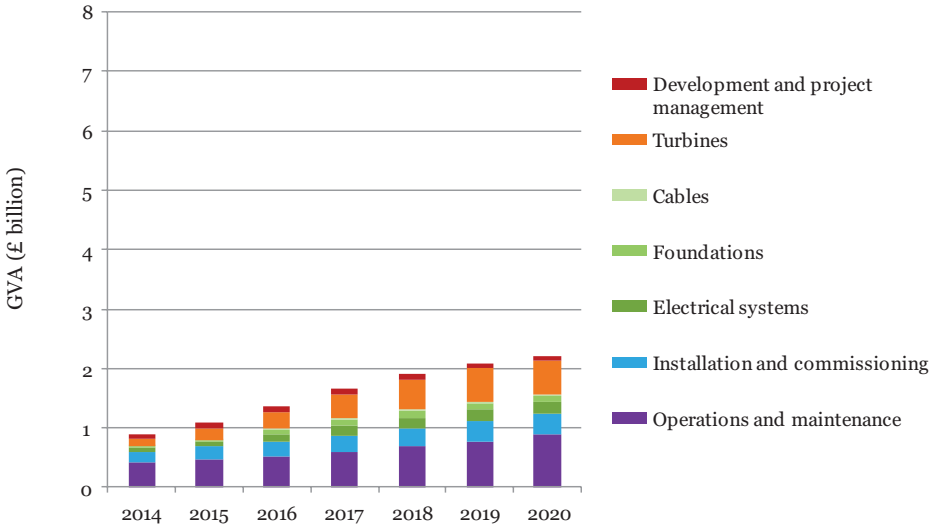
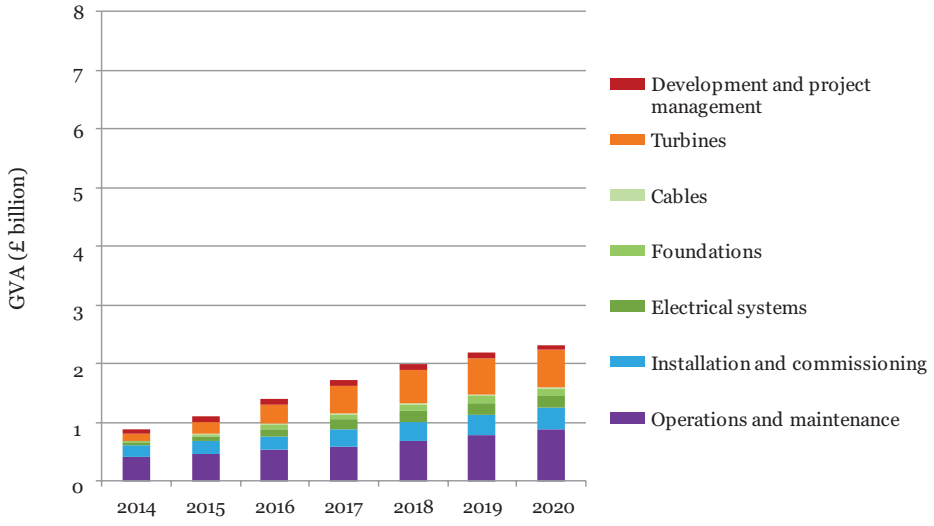


Figure 5 8GW offshore wind, accelerated growth



Turbines

There are no integrated European manufacturing and installation facilities for offshore wind turbines, which are needed to optimise logistics and reduce costs. The UK has the largest pipeline of offshore wind projects and it is natural for turbine manufacturers to invest in the market into which they are selling. Nacelle assembly is a high profile but relatively small part of the cost. The biggest prizes for the UK are tower and blade manufacture which, when integrated with nacelle assembly, provide opportunities for cost reduction.

Investment decisions will depend on the size of the available market that can be supplied from the new facility.

In the 8GW scenario, we expect an investment in one UK turbine assembly facility to supply both domestic and export markets. Some of the towers will be made here, and on the accelerated growth path, a greater proportion of the towers will be made in the UK.

In the 15GW scenario, in addition, a significant proportion of blades for UK projects are made in the UK and in the accelerated growth path a second turbine manufacturer invests in a nacelle assembly facility. Through this, GVA from turbine supply can increase from £130m to £2.1bn and much of this benefit will be felt in the areas around industrial ports on the east coast where there is good access to many offshore wind development areas in northern Europe.

The ORE Catapult will play a role in turning these scenarios into reality. We will facilitate and promote accelerated lifetime testing programmes in laboratory facilities to ensure that the technology being developed in the UK supply chain is robust before companies approach their customers. This will help with next generation turbine designs, which are well advanced, with several at the prototype stage. Turbine manufacturers also have a pressing need for offshore test sites and the ORE Catapult will work to coordinate the UK's offering. We will also work in the areas of blade materials and manufacturing processes, drawing in new expertise from the High Value Manufacturing Catapult and its partners.

Foundations

There is likely to be a demand for UK manufactured foundations, provided that suppliers can compete on cost and quality. If so, they represent a significant win for the UK supply chain. Several companies have already developed UK investment plans, mostly to upgrade facilities previously used to support offshore oil and gas, which are awaiting firm orders before investment is committed. In the 8GW scenario, one third of foundations (a mixture of large monopiles and jackets) are made in the UK from 2018.

In the 15GW scenario, the UK market share remains the same but investment, either at new or existing facilities, is brought forward to 2017. In the accelerated growth path, concrete gravity-base foundations demonstrate cost reduction on some sites enabling investment in a new UK factory. Combined, all foundation manufacturing opportunities are forecast to generate £900m UK GVA in 2020 in the accelerated growth path.

Several innovative foundation designs have been developed and there have been significant marginal gains to conventional designs. The ORE Catapult will play a key role in unlocking the opportunity through supporting design, testing and demonstration of new foundations concepts, and by supporting standardisation and development of new manufacturing techniques. We will also work with colleagues in the Department for Business, Innovation and Skills, the Technology Strategy Board and enterprise agencies to help build the knowledge base required to unlock strategic investment in facilities. This could, for instance, be in alternative foundation types such as gravity bases, which have the potential to provide both cost savings and increased UK benefit.

Cables

In the 8GW scenario, the UK continues to maintain its healthy share of the array cable market. Existing facilities for both array and export cables are likely to be sufficient to meet demand. In the 15GW scenario, however, the supply of export cables is constrained. With long lead times for new factories, new capacity is most likely to be added at existing factories, as it is less of a risk, but on the accelerated growth path efforts to lower the risk of UK investment lead to a new export cable facility in the UK. As a result, the UK GVA from cable supply rises to over £200m in 2020 under this scenario.

The ORE Catapult is already working to support the standardisation of cable designs and facilitate R&D in polymeric cables rated above 400kV for both offshore wind and interconnector HVDC projects. We are also supporting the development of fault detection and condition monitoring equipment specifically for the offshore wind sector.

Electrical Systems

In the 8GW scenario, most substations continue to be supplied from the UK but using imported large components. There are no HVDC projects in the UK before 2020 in this scenario but there will be some export of equipment from a UK centre of excellence. In the 15GW scenario, UK-based companies maintain their share of the market and in the accelerated growth path, an HVDC platform, with a mass over 10,000 tonnes, is built in the UK for the domestic market contributing to a £600m GVA in 2020.

Power transmission is a significant area of cost reduction that is often overlooked. The ORE Catapult will support the standardisation of electrical systems and substation design whilst promoting innovation in HVDC networks.

Installation

Large vessel operators with modern fleets and strong track records are already prevalent in the UK and they have made significant new investments in vessels, particularly for turbine installation. New vessels lower installation costs but there has been significant investment in this area in recent years with a potential over-supply, which makes it more difficult for UK-based companies to increase their market share through further investment. Therefore, under both the gradual growth paths, UK companies maintain their market share, but under the accelerated growth paths, enhanced capability enables UK companies to grow their market share. This results in £1.2bn UK GVA from installation under the 15GW scenario is. This GVA will mainly be delivered by companies supplying services at or

near the main wind farm installation base or where there is a strong offshore engineering capability. This is primarily based around the UK east coast in East Anglia, north-east England and Scotland, but there are also significant facilities in other UK industrial ports. The ORE Catapult aims to maximise the technological competitiveness of UK engineering companies, through new or standardised strategies for component handling and installation. This may range from simple items such as sea-fastenings to the most advanced installation techniques which improve installation times, reduce weather downtime and minimise external impacts. UK companies are already making a difference here and the ORE Catapult can further enhance their competitiveness.

Operations and maintenance

Much of the operations and maintenance (O&M) for UK projects will continue to be based locally, providing long-term jobs in the area local to the wind farm. With the growth of the UK turbine supply chain, replacements will increasingly be supplied from the UK but the impact will mainly come after 2020, when UK companies will have a role to play in refurbishing and remanufacturing older turbine fleets. For projects further from shore than those in operation in the UK, O&M logistics can be shaped by UK companies' experience of working offshore. The GVA from O&M in the accelerated growth path of the 15GW scenario increases to £1.4bn in 2020 compared with £900m in the 8GW scenario.

The ORE Catapult is working to increase the range of working conditions offshore, improve the efficiency of crew access for maintenance and standardise strategies for component replacement and turbine access. We will facilitate the move to condition-based (rather than time-based) maintenance of turbines though the introduction of new sensor technologies, many of which will be developed by UK SMEs. We will also facilitate collaborative research programmes such as our SPARTA platform.

SPARTA Case study

Our SPARTA data platform will capture and structure vital operational turbine data, an industry first already being driven by the Catapult. This will help inform development across the whole supply chain from vessel operations to the development of next generation turbines and their critical components.

Industrial competitiveness and the UK economy

The UK's ambitions in offshore renewable energy are the largest in Europe and they create a significant opportunity for UK companies to gain competitive advantage through innovation. The ORE Catapult will play a significant role in helping companies to achieve this. UK companies can look forward to exporting their products, services, skills and know-how around the globe.

By developing an internationally competitive offshore renewable energy industry, the UK will benefit from investment in strategically important technologies and markets, economic diversification, increased international trade and greater economic competitiveness.

The UK economic benefits generated in terms of wealth and employment creation will not be concentrated in one or two regions but will be dispersed across many local

economies in the UK. This distribution of economic benefits will promote regional growth and greater economic parity across regions.

The offshore wind supply chain beyond 2020

The DECC scenarios show that 41 GW of installed capacity can be reached by 2030 if annual installation rates remain at about 2.5GW per annum and if 15GW was achieved by the end of 2020. In this scenario, the UK remains the largest European market and will increasingly reap the economic rewards from sustained innovation and growth in services. Although there will likely be sufficient capacity in the supply chain, new investments are likely as suppliers seek to grow market share in domestic and export markets. The UK will benefit most by following the accelerated growth path.

All industries take time to evolve and achieve their potential. This research indicates that the offshore renewable energy industry has the potential to catalyse significant economic growth and job creation in the UK. Should this sustained growth be achieved, the industry will emulate the oil and gas industry, whose success in the UK was built over a number of decades. Offshore renewables will be a UK industry that competes on the global stage based on a dynamic innovation system and unique, embedded expertise. The industry will have significant international competitive advantage in both products and services, driven by the successful interaction of the UK's SMEs, its corporate base and research community.

The marine energy supply chain to 2020

The UK marine energy supply chain starts from a more advanced position than offshore wind, reflecting the UK's pioneer status. The challenge is to ensure that today's suppliers of prototype and demonstration projects remain as part of the industrialised supply chain beyond 2020.

The marine energy sector, primarily through tidal stream demonstration projects, could be worth £110m in 2020, supporting about 2,500 jobs. These projects will lay the foundation for the industrialisation of marine energy in the next decade. With the UK at the forefront of technology development, most of the devices installed in UK waters will have been designed and built in the UK.

As the industry grows, UK companies will increasingly face competition from overseas companies with the capacity to fabricate large structures in volume and supply bespoke wave and tidal device installation vessels. The ORE Catapult can support UK manufacturers as they grow from small to large volume manufacture. Just as offshore wind has stimulated investment in bespoke installation vessels, the same will be needed in marine energy and the ORE Catapult can play a role in supporting innovation and standardisation.

Marine energy deployment poses many new technical challenges but the approach to industrial support shares many characteristics with offshore wind. Much of the UK's offshore wind expertise can be harnessed to support the growth and cost reduction challenges of marine energy globally.

Next steps

This analysis illustrates the significant UK business opportunity that offshore renewables represent, but much depends on industry and public bodies working together to reduce the cost of energy and to enhance the competitive advantage of UK suppliers through innovation in products and processes. The ORE Catapult will play a leading role in helping the industry develop standards and good practice guidelines for a range of components and processes.

UK know-how will play a key role in realising this opportunity and the ORE Catapult will be a driving force in generating this expertise. By identifying priority areas, we can ensure that work is focused on where the greatest opportunities for cost reduction intersect with the greatest opportunities for UK economic development. We can add value by linking and supporting the excellent and innovative work being undertaken by many UK organisations.

With this collective action, the UK can reach a tipping point whereby investment in the supply chain to 2020 generates significant economic benefits and creates an internationally competitive industry beyond 2020.

Methodology

BVG Associates

BVGA provided the input data for the analysis which was based on the total annual expenditure. Using typical project cost breakdowns per MW and taking the annual installed capacity, the total expenditure for UK and non-UK projects completed in a given year was calculated. Using the assumptions about the development of the UK supply chain described in this document, UK content estimates for UK and non-UK projects were made for each main sub-element of the wind farm supply chain. From this, the UK expenditure for projects completed in a given year between 2014 and 2020 was derived. Since expenditure on an offshore wind farm takes place over several years, figures for each sub-element have been offset. The aggregated annual figures (or the "demand shock") were supplied to the Fraser of Allander Institute.

Fraser of Allander Institute

The UK economic impact was estimated using an input-output (IO) model analysis, which is the most widely employed method of assessing the impact of major new expenditures on regional and national economies. The IO approach allows us to determine the macroeconomic impact of a change in final demand on the rest of the economy. The analysis in this report is conducted under the general IO assumption of passive supply. Under this assumption, there are no supply-side constraints on factors of production. Furthermore, the IO model assumes no substitution between inputs. The price of commodities is fixed and technical coefficients do not change over time.

The analysis was performed using the UK IO table for the year 2004, which was the most up to date symmetric IO table for the UK economy. This study analysed the impact of development of the offshore renewable energy for the UK for the period 2014-2020 and it was assumed that the economic structure of the UK economy has remained unchanged until now.

The GVA figures reported refer to the sum of capital and labour income. Therefore, this does not account for net indirect tax. GVA figures using Type II multipliers include direct, indirect and induced values.

The employment impact is reported in full time equivalent jobs. The total production (output) is given by intermediate sales and final demand. The latter includes also export of goods and services to the rest of the World.

Consultation

The assumptions about the development of the UK supply chain were circulated for feedback with the following organisations. However, the assumptions used reflect the views of the authors and are not Government projections:

UK Government, Department for Business, Innovation and Skills

UK Trade & Industry

Technology Strategy Board

Scottish Government

Scottish Development International

Scottish Enterprise

Highlands & Islands Enterprise

Invest Northern Ireland

Welsh Government, Department for Economy, Science and Transport

ORE Catapult, BVG Associates and Fraser of Allander

ORE Catapult

ORE Catapult is a technology innovation and knowledge centre established by the Technology Strategy Board for the identification, development and rapid commercialisation of innovative technology to deliver affordable, offshore renewable energy. The ORE Catapult works in collaboration with policy makers, industry large and small, utilities, asset owners and the UK's research organisations.

In the production of this report, the ORE Catapult has worked with the Fraser of Allander Institute to analyse extensive supply chain data supplied by BVG Associates. The commentary reflects the views of the Catapult and not necessarily those of the contributing organisations.

Fraser of Allander Institute

The Fraser of Allander Institute is a research unit of the University of Strathclyde in Glasgow and is formally part of the Department of Economics and the Strathclyde Business School. The Institute carries out research on regional issues generally and the Scottish economy in particular, including forecasting and the analysis of short-term and medium-term movements in Scottish economic activity.

Its researchers have an international reputation in modelling regional economies and in regional development. The Institute publishes an Economic Commentary on the Scottish economy, and the quarterly Scottish Chambers' Business Survey. The Institute also undertakes individually tailored research projects commissioned by private and public sector clients.

BVG Associates

BVG Associates is an independent consultancy with expertise in the technology, implementation and economics of wind and marine energy generation systems. Its purpose is to help its clients establish renewable energy generation as a major, responsible and cost-effective part of a sustainable global energy mix.

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