

Working for a Green Britain: Vol 2

Future Employment and Skills in the UK Wind & Marine Industries

July 2011





energy&utilityskills

RenewableUK is the trade and professional body for the UK wind and marine renewables industries. Formed in 1978, and with over 660 corporate members, RenewableUK is the leading renewable energy trade association in the UK. Wind has been the world's fastest growing renewable energy source for the last seven years, and this trend is expected to continue with falling costs of wind energy and the urgent international need to tackle CO₂ emissions to prevent climate change.

In 2004, RenewableUK expanded its mission to champion wave and tidal energy and use the Association's experience to guide these technologies along the same path to commercialisation.

Our primary purpose is to promote the use of wind, wave and tidal power in and around the UK. We act as a central point for information for our membership and as a lobbying group to promote wind energy and marine renewables to government, industry, the media and the public. We research and find solutions to current issues and generally act as the forum for the UK wind, wave and tidal industry, and have an annual turnover in excess of five million pounds.

Energy & Utility Skills (EU Skills) is the Sector Skills Council (SSC) for the gas, power, waste management and water industries, licensed by Government and working under the guidance of the UK Commission for Employment and Skills (UKCES). Employer-led, our purpose is to ensure that our industries have the skills they need now and in the future.

The energy and utilities sector is fundamental to the success of the UK economy and is crucial to the way modern society functions. It is critical to facilitate an adequate supply of competent people to develop, maintain and enhance the sector.

A skilled workforce is vital for meeting the challenges of an increasingly competitive global economy and particularly during this tough economic climate, where skills are the key lever for successful competition.

Our commitment is to raise employer engagement, demand and investment in skills, to ensure that we have authoritative labour market information for all of our industries and to develop National Occupational Standards (NOS) to ensure that qualifications meet employer needs.

Working Together

Since 2009 EU Skills have been working with RenewableUK on developing a clearer understanding of the skills issues related in the wind and marine energy industries.

By combining the resources of the two organisations we have been able to explore skills from the perspectives of both the large asset owners and the wider supply chain. The open relationship has allowed both organisations to expand their

understand of the industries' skills needs, with two significant outcomes: first the creation of the Wind Turbine O&M Technician qualifications and the associated Modern Apprenticeship and secondly the joint commissioning of this research in to employment in the wind and marine industries. We hope to develop this working relationship further during 2011 to enhance the value added to the stakeholders of both organisations.

Contents

Executive Summary	2
Introduction	5
Detailed Results – Employment Projections	6
Onshore Wind	6
Offshore Wind	10
Small-scale Wind	15
Marine Energy	19
Key Findings	23
The Implications of Rapid Growth for Skills Delivery and Acquisition	26
Conclusions	30
Appendix	32
Key Definitions	
Methodology	
References & Endnotes	36

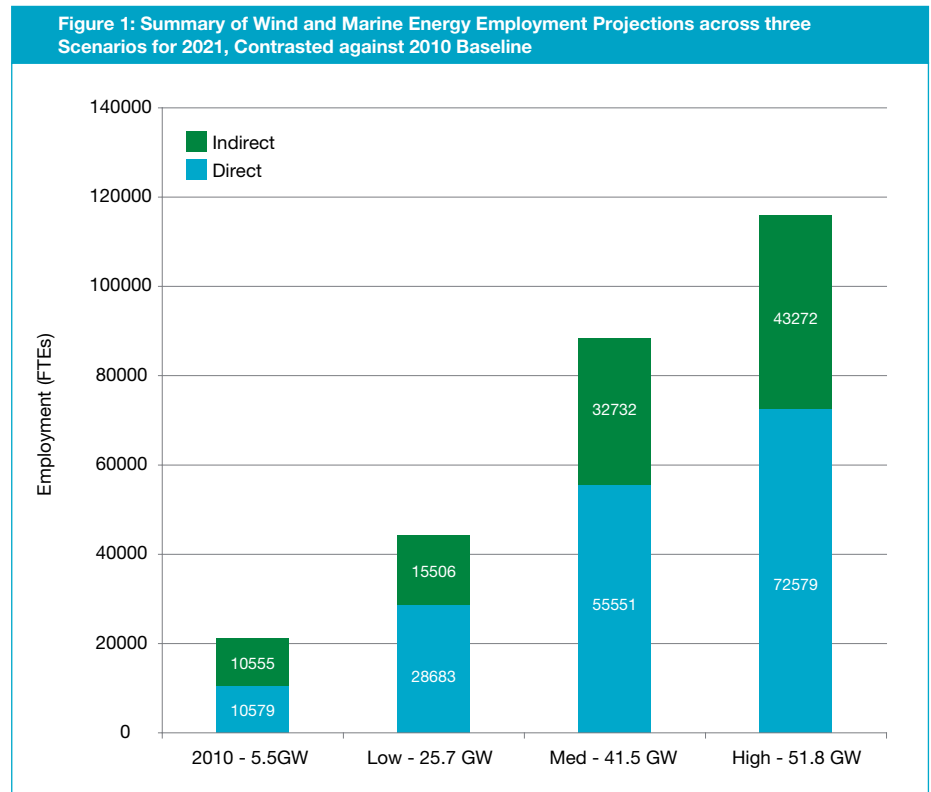
Executive Summary

Driven by the UK Government's commitment to reduce carbon emissions, the wind and marine energy sector has seen unprecedented growth over the past few years. The UK is at the forefront of deploying offshore wind turbines, is a global centre for small wind technology design and manufacture and leads in the research and development of marine energy. Onshore wind technology has been deployed commercially in the UK since the early 1990s and the industry currently provides the most substantial share of renewable energy to UK consumers. *Working for a Green Britain* reported that for April 2010 the wind and marine energy industry directly employed 10,600 full-time equivalent (FTE) employees.^{1/1} It also revealed that between 2007 and 2010 the large-scale on- and offshore wind energy sector experienced stellar growth recruiting 4,400 FTEs in just three years. The wind energy workforce near doubled to 9,200 direct FTE employees in a time of worldwide recession. With this recent rapid expansion the demand for highly skilled and often specialist technical personnel has increased. Skills gaps are already acting as a barrier to the growth of firms.

This Report examines:

- What the future may hold for wind and marine energy market development
- How many recruits will be needed across the sector
- What the key risks are to UK based wind and marine jobs coming through

The prospects for future wind and marine energy deployment depend on a range of key factors such as innovation, access to finance, revenue incentives, planning policy, access to grid and political decision making. Literature review reveals a plethora of views from different analysts on how deployment trends are to develop. This Report presents a High, a Medium and a Low scenario for the



deployment and UK content associated with onshore wind, offshore wind, small wind and marine energy. The scenarios are based on secondary sources from Government, independent consultants and RenewableUK reports. Each scenario was developed through literature research and industry consultation. Cambridge Econometrics have modelled projections of forward looking employment opportunities under differing assumptions of sector growth, allowing for variable domestic deployment, export markets and the impact of productivity gains over time. The key question asked is what difference the sectors fate means in terms of UK based job creation and whether the UK skills system and talent pool can support growth at all.

Figure 1 illustrates that for 2021 there is a stark difference between the employment projections associated with three possible scenarios for wind and marine energy sector development.

The sponsors of this research, RenewableUK and Energy & Utility Skills recommend that policy makers, industry and training providers should at bare minimum aim to ensure the delivery of the Medium Scenario is secured for the UK. The High Scenario is presented to illustrate the maximum potential employment and skills needs of the sector, whilst a Low Scenario is modelled to showcase how the socio-economic benefits of wind and marine energy could well be missed if efforts are not focused to unlock sector growth. An overview of each of the three scenarios is provided on page 3.

Ultimately, the realisation of either of the scenarios is heavily dependent on whether an effective and stable policy and legislative framework emerges and is sustained; the ability of politicians and developers to overcome current barriers to deployment; and the willingness of all parties to invest in the skills base required to underpin growth.

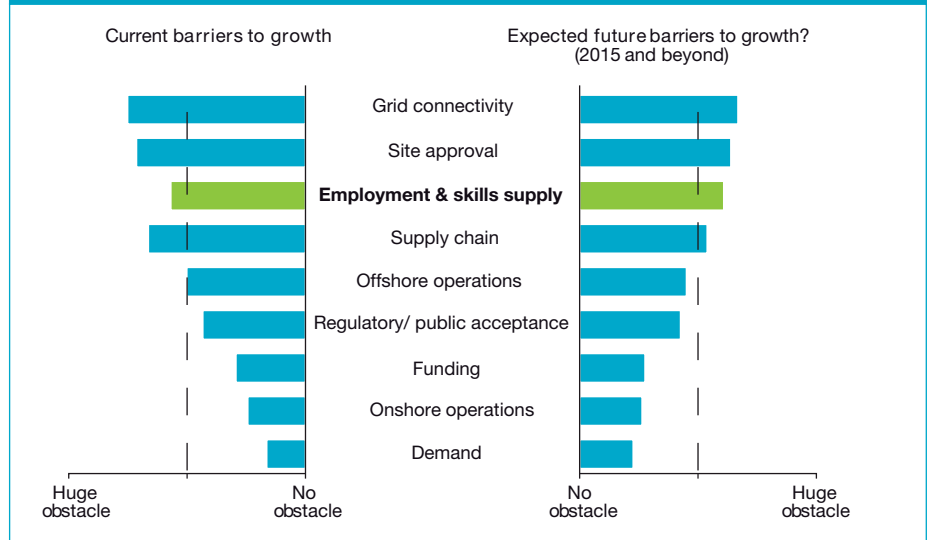
High Scenario

The High Scenario represents a very ambitious but achievable outcome. If Government provides clear, positive long term policy signals, confidence in the markets will come through and will draw in private investment into the sector. The rapid deployment of wind and marine technologies and the subsequent large expansion of design and manufacturing activities will create a huge opportunity for UK employment. The scenario assumes a particularly rapid roll-out of new offshore wind farms, the UK can both contribute to meeting its renewable energy and carbon targets for 2021 and also create a new world-leading export industry. The largest demand will come for design and manufacturing skills in offshore, small wind and marine energy but across the board recruitment rates and training demand will be substantial. An overall 10-fold increase in the deployment of wind and marine technologies (51.8GW) could support over 115,000 FTEs. 73,000 of these employees would be working directly in the sector and the rest in the supply of manufacturing inputs, raw materials and business-to-business support services.

Medium Scenario

The Medium Scenario, anticipates strong general growth across the sector but the deployment trends factor in various barriers that are likely to effect market development for wind and marine technologies. Deployed capacity grows to 41.5GW by 2021 from around 5.5GW in 2010. In this scenario a total of over 88,300 employees are projected be involved in wind and marine energy, 55,600 of whom will be directly specialising in the sector. The greatest potential is in the development of offshore wind, which alone may need near 30,000 direct FTEs by 2021. The skills system needs to enable around 45,000 individuals to train, upskill and reskill, so that they may be eligible to take advantage of the recruitment drive

Figure 2: Employment & skills supply is expected to become more critical over time
Source: Bain & Co 2008²



that is to come. The greatest increase in volume of demand for training will be for manufacturing skills and in Operations and Maintenance. Other occupational areas will also be critical to the healthy development of the sector.

Low Scenario

In contrast to the above two, the Low Scenario represents a failure of the UK wind and marine energy sector. In the absence of strategic support for the sector this deployment trajectory is more likely to occur. It is based on sources that provide unambitious trends for small wind and marine energy, and scenarios that project the onshore and offshore wind industries to stall in the rate of capacity deployment. The scenario is viewed by industry members as a failure. In total only 25.7GW is anticipated to be installed by 2021 and the opportunities for the UK to become a major centre for design and manufacture are assumed to be foregone. UK wind and marine energy projects could be largely reliant on imported technologies. In this case only 44,000 FTEs would be employed in total across the sector supply chain. A mere doubling of employment numbers from 2010 will be seen as a failure for the UK economy to have harnessed the potential

socio-economic benefits that the wind and marine energy sector holds.

Wind and marine energy could support the creation of tens of thousands of jobs, but the supply of skills itself could act as a barrier to sector development

Whilst the opportunity for UK employment is significant, one of the key findings of a seminal report by Bain & Company in 2008 was that the supply of skills is already acting as a key constraint to the scale of economic benefits that the UK can capitalise on from wind and marine energy.²ⁱⁱ Figure 2 summarises the views of 80 industry members polled in 2008. Sector employers viewed skills shortages as the fourth greatest restriction at the time. They anticipated skills shortages to become even more acute in the near future. *Working for a Green Britain* demonstrated that far from being resolved, skills gaps are indeed persisting.

Those working across the skills system need to know whether and how the demand for recruits is set to continue, and what types of training will be in highest demand.

Regardless of which future scenario we consider, tens of thousands of recruits will need to be sourced and trained to support the growth of the sector. Generally a major shift is anticipated in the technology mix with onshore wind employment growing at a slower relative rate compared to the other technologies. In the stronger scenarios manufacturing recruitment will ramp up most significantly, and recruitment in operation and maintenance and construction and installation will also be high. The vast majority of positions in wind and marine energy will be skilled, well-remunerated³ roles that will require either core training in the form of full-time vocational and higher education or transitioning routes for mature entrants. A key problem that is identified by this Report is that it is not clear where skilled, qualified recruits will come from to fill prospective roles.

The greatest concern around current and future skills supply is related to those occupational areas that require power sector and more specifically wind and marine energy focused expertise. The skills system is failing to ensure an adequate supply of Science Technology, Engineering and Mathematics qualified entrants to the labour market. Whilst some companies are providing opportunities for young people more can always be done in the way of bringing apprentices and graduates into firms. One of the critical issues is the shortage of high quality, industry recognised short courses available for training mature entrants looking to switch careers into the sector.

It is clear that the key to achieving any level of industry growth, in a way that supports UK plc more widely, will be in having a skills system and training infrastructure that delivers the right skills, at the right time, for a reasonable cost. Failure in this area could result in operations and jobs being “offshored” or being carried out by non- UK companies and workers.

The message for government, training providers and employers is clear. If the projected employment opportunities are to be realised, training delivery needs to ramp up rapidly in general – with a particular focus on offshore wind, manufacturing skills, and renewable technology-specific Operations and Maintenance.

Introduction

This report is based on a study commissioned by RenewableUK and EU Skills, and written by Cambridge Econometrics, the University of Warwick Institute for Employment Research (IER) and IFF Research. The study looks at current and future employment and skills associated with the development of the UK wind and marine energy industries over the period 2010 to 2021.

The first phase of research focused on a snapshot of employment and skills in 2010 and was published in February 2011. *Working for a Green Britain* reported that for April 2010 the wind and marine energy industry directly employed 10,600 full-time equivalent (FTE) employees.¹ It also revealed that in the three years between 2007 and 2010 the large-scale on- and offshore wind energy sector experienced stellar growth, adding 4,400 FTEs, thus near doubling the wind energy workforce to 9,200.

This follow-up report investigates the future potential employment opportunity and the scale of the resourcing challenge in the UK wind and marine energy sector between April 2010 and April 2021. The scope of the study covers UK onshore, offshore, and small wind and marine energy.

A bespoke Wind and Marine Energy Employment Model was built by Cambridge Econometrics for the purposes of this study. The empirical findings of the 2010 survey, involving over 250 employers, are used to provide a robust starting point for future employment projections.

Three market scenarios with High, Medium and Low trajectories for deployment and UK content are modelled for each of the four technologies to provide us with a range of employment projections over the next decade. As noted, deployment scenarios

are taken from literature review and assumptions around manufacturing and other variables from a combination of secondary sources and consultation of technology specific industry consultation groups.

The Results section analyses projections for each technology on an individual basis.

For each technology:

- Direct employment (inclusive of all those employed in renewable-specific activities) is modelled based on various assumptions made around sector growth, allowing for domestic renewable energy capacity deployment, export markets and the impact of productivity gains through learning rates.
- Indirect employment (those jobs created because of increases in output in the sectors that supply the renewable energy sector) is modelled using an input-output methodology.

The model breaks down employment trends by broad 'occupational domain':

- Manufacturing and Design
- Planning and Development of sites
- Construction and Installation
- Operations and Maintenance
- Specialist Support Services

This should help professionals within the skills system have a vision of demand for different types of training by broad occupational area.

Details of how both aspects of the model work and a list of all Key Definitions for technical terms are presented in the Appendix of this report.

Detailed Results: Breakdown of Employment Projections by Technology 2010-2021

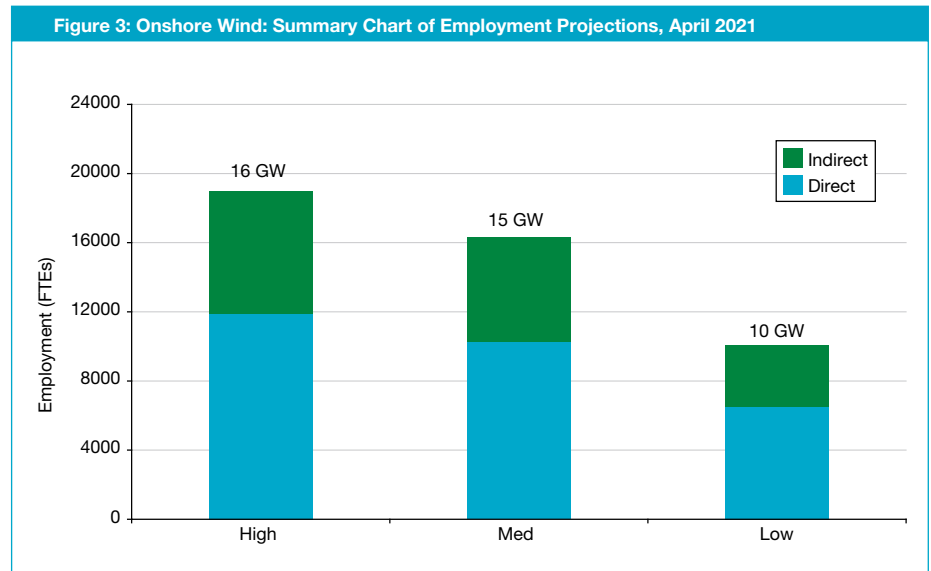
Onshore Wind: Results

Three scenarios have been modelled for onshore wind, with the following outputs:

- **High Scenario 16GW projection:**
~11,900 direct FTEs, 7,100 indirect FTEs
- **Medium Scenario 15GW projection:**
~10,300 direct FTEs, 6,100 indirect FTEs
- **Low Scenario 10GW projection:**
~6,500 direct FTEs, 3,500 indirect FTEs

The onshore wind industry is expected to experience more modest growth than other renewable energy sectors because future deployment rates are anticipated to be slower. This is explained by the relative maturity of the industry and is a consequence of on-going planning and grid issues acting as a barrier to more rapid expansion.

The technology, economics and policy environment for the onshore wind energy industry are well understood, but the rate of expansion over the next decade remains dependent on a variety of unpredictable factors, ranging from the state of the economy to adverse weather windows for construction and potential changes to the policy environment arising from the Government's Electricity Market Reforms. As a result, there is considerable variation in the three projected employment scenarios (See Figure 3), ranging from only a very small increase of around 500 FTEs in total direct employment under the worst case scenario to an increase of around 5,900 in the High Scenario. The High and Medium Scenarios analysed show relatively similar deployment trend lines. The main difference between these is in the assumptions we used for the export of specialist onshore manufactured goods. The Low Scenario on the other hand aims for a third less generation capacity than the Medium case for 2021.



The Low Scenario would represent a failure of the UK's energy policy, and would put the nation at risk of missing its EU renewable energy and carbon emissions targets. The overall direct workforce in 2021 would remain the same as it is in 2010 under the Low Scenario. This is because, based on the deployment trend, in most occupational roles the workforce would decline, aside from in Operations and Maintenance, where a threefold increase in employment would still be feasible.

Under either of the more optimistic scenarios the workforce will grow significantly and, as a result, policy-makers, investors and wind energy firms need to move swiftly to ensure the UK has access to a suitable skills pool.

Starting assumptions for modelling onshore wind scenarios and employment

Onshore wind is the most commercially mature of the markets being investigated in this study. The first onshore wind farm in the UK became operational in 1991, and the industry has since expanded to draw in hundreds of businesses, supported by an average increase in year-on-year deployment of around 190MW/year.^{4/iii} In April 2010, 3.4GW

of onshore wind was installed and the industry directly employed 6,000 FTEs.^{5/i}

The European onshore wind market is well established with The European Wind Energy Association (EWEA) reporting over 70GW of installed capacity for 2010.⁶ The UK missed the opportunity to become an exporter of onshore wind devices in the 1980s. Instead, the UK industry relies on imports from manufacturing bases in Germany, Denmark and Spain. The three scenarios mapped out for the onshore wind sector all assume that the potential for the UK market share in onshore wind-specific manufacturing remains small (5% of domestic market share, 1% of European export market share in 2010) because of the continued strength of European exports.⁷ (By 2021 EWEA project the European onshore wind market, excluding the UK, to be 190GW in size).⁸

Labour productivity gains in the sector are based on a learning rate of 7%, which leads to increases in labour productivity of 11–16% between 2010 and 2021.⁹

Employment outputs based on High, Medium and Low Scenarios

High Scenario for Onshore Wind: (16GW projection: ~11,900 direct FTEs)

This scenario is based on Ofgem's analysis of energy supplies, which predicts that high levels of investment in the onshore wind market could lead to a total capacity of around 16GW by 2021.¹⁰ Whilst this is a relatively high-growth scenario, compared to the anticipated growth in deployment of the other wind and marine technologies, it does not appear to be overly ambitious. This is because onshore wind is already a mature market where the deployment rate is approaching its peak.

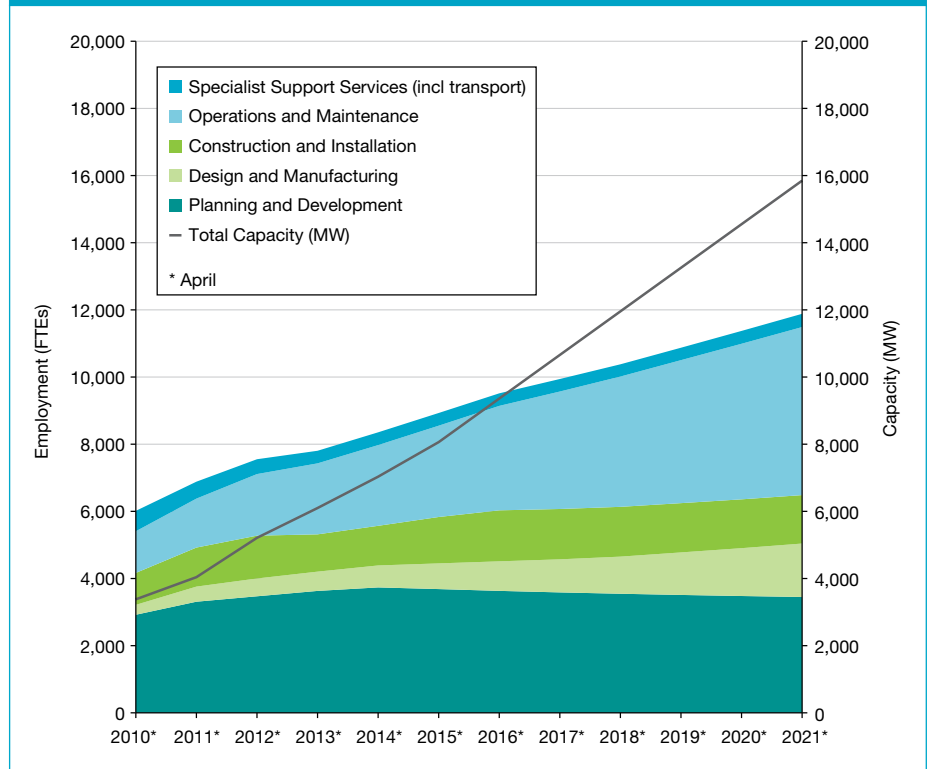
Under this scenario, a modest revival in domestic turbine manufacturing ensures that around 12% of the domestic market is supplied by UK manufacturers, whilst a modest export market develops – with the UK supplying 5% of direct onshore wind components to the European market. This is possible, provided domestic demand is sufficient and a piggyback effect is created off the back of the growth of the UK's offshore wind manufacturing base.⁷

Figure 4 illustrates how the High Onshore Scenario will require over 11,900 FTEs by 2021, close to doubling the level of employment in 2010.

The largest absolute growth in employment in onshore wind is attributed to Operations and Maintenance activities, which rise from around 1,200 FTEs in 2010 to 5,000 in 2021. This is because of the increase in the number of turbines in operation over the time period (see Figure 6).

Employment growth in Planning and Development remains slow across the period – rising from 2,900 FTEs in 2010 to 3,500 FTEs in 2021 (30% of the total direct workforce). As a proportion of overall employment, Planning and Development actually becomes less

Figure 4: Onshore Wind Employment Projections: High Scenario



significant on the grounds that the rate of growth in other employment domains is far higher over the next decade.

Employment in Manufacturing and Design is set to increase to 1,600 FTEs by 2021, up from 300 in 2010. Although the rate of recruitment is high in Manufacturing and Design, by 2021 just 13% of the total direct onshore workforce would be involved in this type of activity.

A small increase in jobs is expected in the Construction and Installation sector (1,000 in 2010 to 1,400 in 2021) reflecting a slight pick-up in annual deployment rates.

Around 400 FTEs are expected in Specialist Support Services in 2021.

Medium Scenario for Onshore Wind (15GW projection: ~10,300 direct FTEs)

For the medium growth scenario for large onshore wind the projection is based on the National Renewable

Energy Action Plan, which estimates that onshore wind capacity could be close to 15GW by 2021.¹¹

The scenario assumes a slightly slower roll-out of new onshore wind farms and a more modest recovery for domestic turbine manufacturing. Whilst it is assumed that the share of the domestic market for specialist onshore manufactured goods may still double to 10%, the big difference between this scenario and the high one is that the UK's export share remains the same as today's at 1%.⁷

Figure 5 shows that in this scenario, employment reaches a slightly lower level of 10,300 FTEs compared to 11,900 in the High Scenario.

1GW less delivery comes through than in the high projection. Nonetheless, the largest growth in employment numbers in onshore wind will be in Operations and Maintenance. By 2021 employment in Operations and Maintenance will

grow to 4,700 FTEs – therefore, close to half of the overall workforce will be professionals in this occupational domain.

Modest growth is projected for Planning and Development, with 280 more employees in this field by the end of the period compared to 2010.

The major difference in employment between this and the High Scenario is in Manufacturing and Design, where lower assumed export market penetration means the number of FTEs in Manufacturing and Design will only increase to around 500 in 2021 (1,000 less than in the High Scenario). Whereas in the High Scenario around 13% of the 2021 direct workforce is projected to be in Manufacturing and Design, this will only be 5% in the Medium Scenario. Notably, this is the same as the percentage in 2010.

The Construction and Installation workforce in the Medium Scenario is very similar to that needed in the High Scenario, owing to the relatively small difference in installed capacity (1GW) between the two cases. It increases from 950 to 1,400 FTEs by 2021.

In this scenario we anticipate only slightly fewer Specialist Support Services jobs than in the High Scenario (under 400), reflecting the slightly lower levels of deployment.

Low Scenario for Onshore Wind (10GW projection: ~6,500 direct FTEs)

The third scenario projection follows an analysis for the Department for Business, Enterprise and Regulatory Reform, which suggested that just over 10GW of large onshore wind capacity could be built by 2021.¹² The scenario assumes the continuation of severe planning constraints and a slowdown in annual deployment rate for onshore wind, requiring just under 7GW to be built in 11 years.

Figure 5: Onshore Wind Employment Projections: Medium Scenario

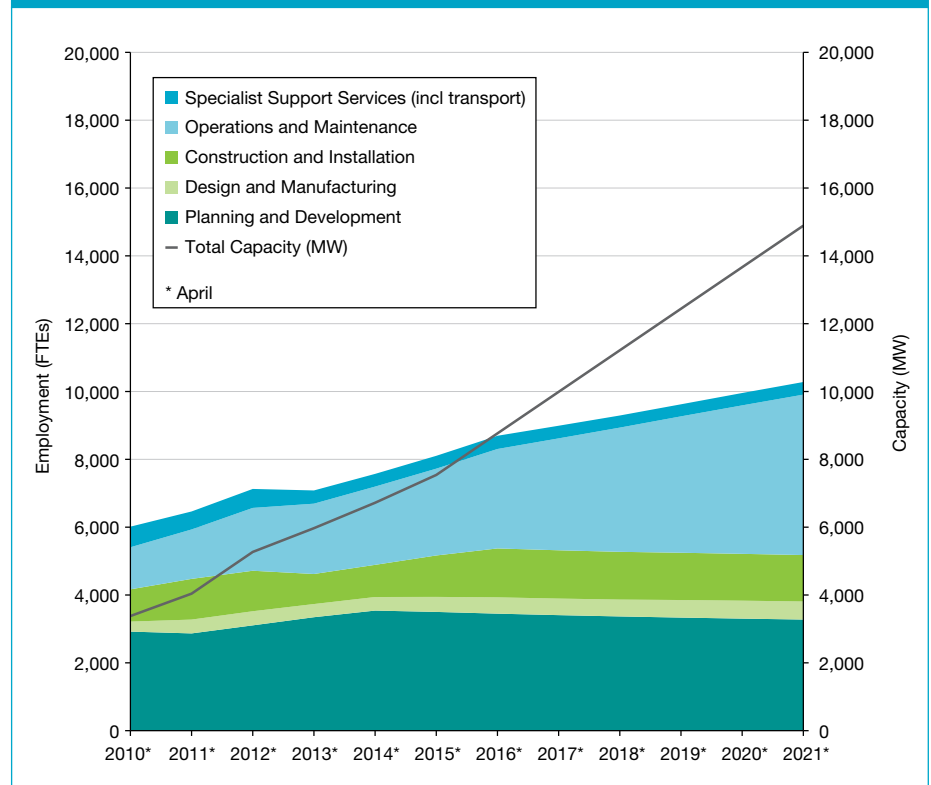


Figure 6 illustrates that in the low scenario, total direct employment remains fairly stagnant across the period – 6,000 FTEs in 2010 compared to 6,500 FTEs in 2021.

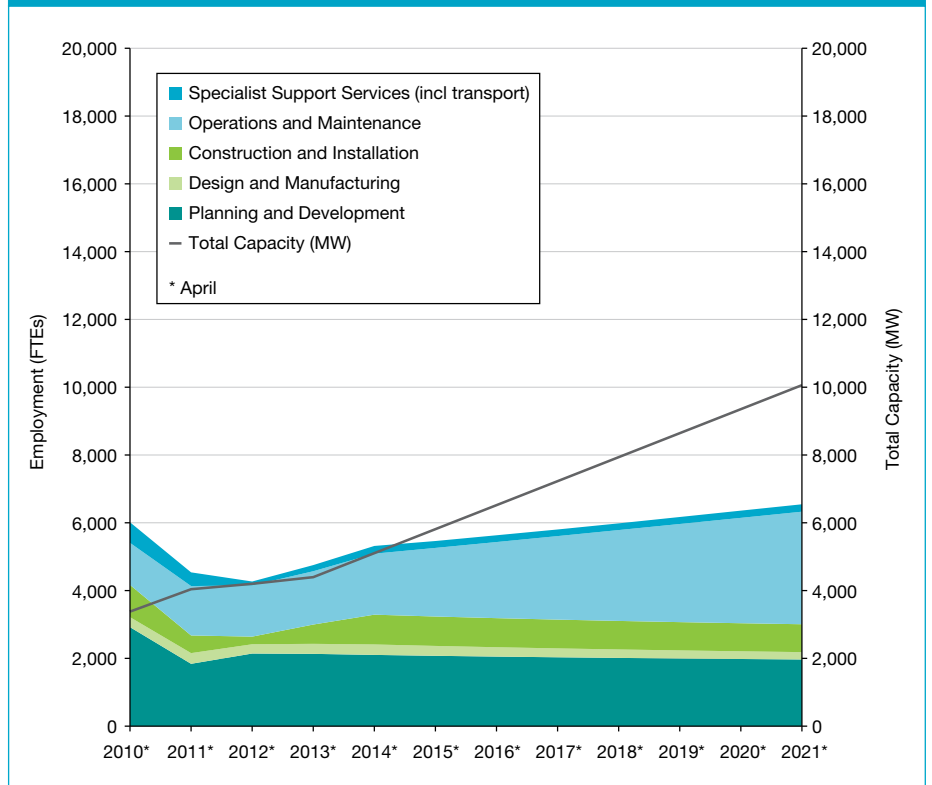
Clearly, in this scenario, in which less than two-thirds of the High Scenario capacity comes through, fewer UK jobs will be created. Although this will place less demand on the training system, it will clearly be a loss to communities in terms of job creation. Even though overall capacity increases, the overall employment figures are anticipated to remain stagnant. The scenario predicts a fairly sudden fall in employment between 2010 and 2012, due to the slow anticipated deployment rates, followed by some recovery thereafter.

The only projected growth in employment is anticipated to be in Operations and Maintenance, as this type of employment is related to the cumulative increase in the number of sites and turbines that

need to be serviced. Operations and Maintenance employment increases to 3,300 FTEs by 2021, representing around a threefold increase in employment over the course of the decade. Operation and Maintenance employees will make up 50% of the workforce in 2021, compared to just 21% in 2010.

In all other employment domains jobs would actually be lost over the course of the decade in this Low Scenario. The most marked and immediate effect of this will be for Planning and Development employment. By 2021 the number of FTEs in Planning and Development is expected to be around 2,000 compared to 2,900 in 2010/11. Many of the Specialist Support Services in onshore wind are affiliated with planning, and thus a sharp fall is expected in direct employment here too. The slowdown in deployment will also reduce the demand for the Construction and Installation-related workforce. The UK demand for manufactured goods is also assumed to be too low to support any increase in the UK onshore wind manufacture-related workforce.

Figure 6: Onshore Wind Employment Projections: Low Scenario



Offshore Wind: Results

Three scenarios have been modelled for offshore wind, with the following outputs:

- **High Scenario 31GW projection:** ~42,400 direct FTEs, 25,300 indirect FTEs
- **Medium Scenario 23GW projection:** ~29,700 direct FTEs, 17,500 indirect FTEs
- **Low Scenario 13GW projection:** ~11,800 direct FTEs, 6,400 indirect FTEs

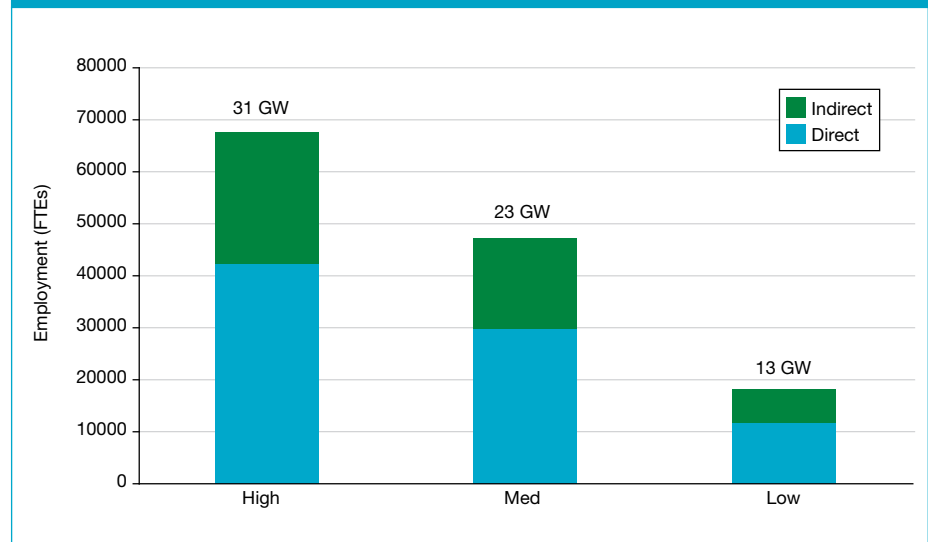
The first commercial-scale offshore wind farm was commissioned in 2003. As a relatively novel adaptation of onshore technologies, offshore systems are still going through innovation and cost reduction. The UK recently seized the title as the world's largest producer of offshore wind energy and is now poised to become the dominant force in this fast-growing global market.

UK offshore wind capacity has increased threefold between 2007 and 2010.⁵ The industry already quadrupled its direct workforce to around 3,200 full-time people in this three-year period.¹ With a raft of new projects either under construction or in planning we project that between 11,800 and 42,400 direct FTE opportunities could be supported by 2021. Between 6,400 and 25,300 full-time roles could also be supported indirectly through increased demands on supply chains. A summary illustration is shown in Figure 7.

The socioeconomic benefits of offshore wind hinge heavily on the strategic vision and strength of policy support from government, in combination with the investment appetite and perceptions of market risk on the part of private sector investors and manufacturers.

Across all three scenarios 2014–2015 represents a step change in the development sector. This is the

Figure 7: Offshore Wind Summary Chart of Employment Projections, April 2021



period during which the planned UK manufacturing centres are expected to become operational. The expansion in Operations and Maintenance employment is anticipated to boom post 2016.

The High Scenario demonstrates that, with the right policy environment and the rapid roll-out of new offshore wind farms, the UK can both contribute to meeting its renewable energy and carbon targets for 2021 and also create a new world-leading export industry. Assuming a thirtyfold increase in deployment over the course of the decade, it projects a fourteenfold increase in direct employment opportunities. This new industry has the potential to be as economically strategic as the onshore wind industry is to Denmark.

Overall, the Medium Scenario assumes that planning, investment and technical barriers take longer to overcome than in the more optimistic High Scenario. But it again highlights how a stable policy environment can deliver a significant new offshore wind industry that creates up to 29,700 direct jobs (a near tenfold increase on 2010); secures a sizeable supply chain for direct manufacture; and exploits sizeable export opportunities.

The high degree of variation between the job creation projections is driven by the market scenarios used for the model. These have been selected from the literature, and the range of assumptions reflects the degree of continued uncertainty over the policy framework for offshore wind, the subsequent pace at which new deep-water offshore wind farms will be built, and the extent to which the UK can attract turbine manufacturers to locate here.

Although the track record of UK offshore wind shows strong growth to date, not all forecasts for future deployment are particularly ambitious.

The low offshore wind market development scenario is based on the Government's 2009 National Renewable Energy Action Plan.¹¹ Offshore industry experts view the indicated target of 13GW for 2021 as insufficient for realising significant UK content. In this Low Scenario, the UK will struggle to attract manufacturers and will become an importer of turbines – job creation is focused on construction and support services. Only a third of the jobs projected in the High Scenario would be gained under these assumptions. This Low Scenario is perceived to be one of significant failure to keep the UK at the

helm of global offshore wind expansion. It will mean that the socio-economic benefits of the sector will be substantially curtailed.

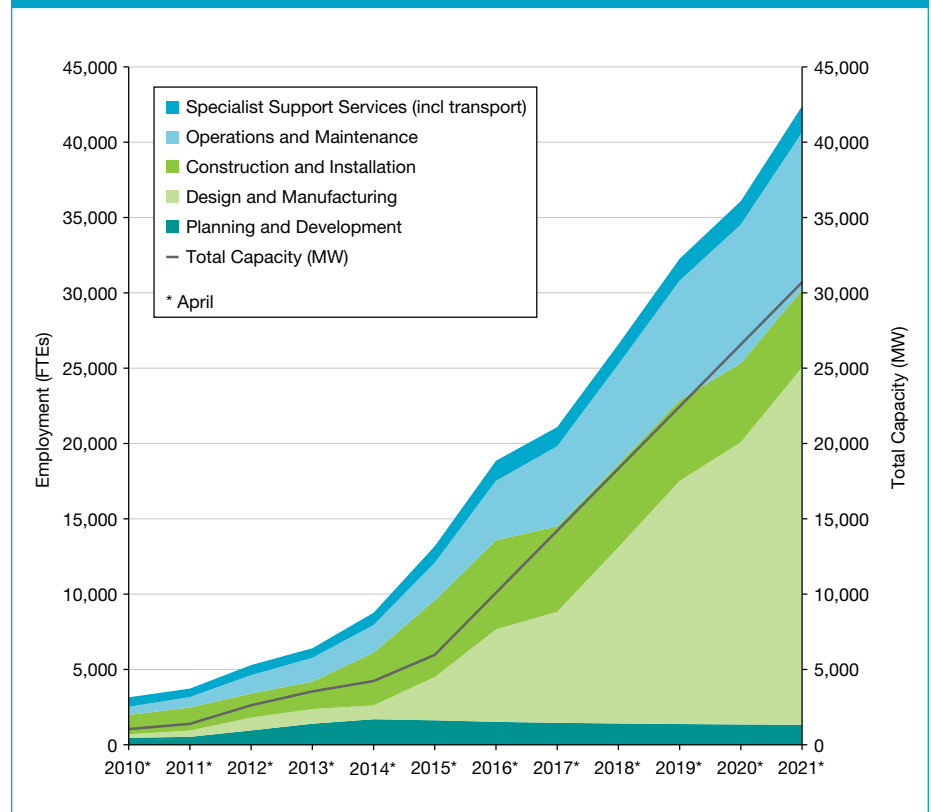
Industry investors are currently wary of the large amount of uncertainty posed by on-going policy changes, such as the Electricity Market Reform, ROC banding review, the Localism Bill and Project TransmiT. Unless well managed, these issues could limit the ability of the UK to secure the industrial base for offshore wind that would deliver tens of thousands of jobs and help the UK Government reach its legally binding target of generating 15% of energy from renewable sources by 2020.

Starting assumptions for modelling offshore wind scenarios and employment

The starting point for the model is based on data records from the UK Wind Energy Database, which show 1.04GW of offshore wind capacity was operational across twelve projects at the end of April 2010.⁵ At that time our survey of firms revealed that 3,200 FTEs were directly involved in this UK offshore wind sector.¹

The UK leads the world in offshore wind technology deployment; an analysis by the European Wind Energy Association mapped out just 1.35GW of offshore capacity for the whole of the rest of Europe in 2010.⁶ However, the starting base for UK manufacturing activity for direct industry-specific components, such as foundations for offshore turbines, was reported through industry consultation to be relatively low (3% of domestic supply and 2% of European market share for 2010).¹³ This is because, at present, the European wind industry has already developed a manufacturing base in Denmark, Germany and Spain. The wind turbines installed to date in the UK offshore wind projects are marine versions of existing onshore turbines. However, the next generation of offshore wind turbines will be larger and

Figure 8: Offshore Wind Employment Projections: High Scenario



offshore specific, and will require new supply chains. Brought forward by the announcement of Round Three leases and the confirmation that funding will be made available for the upgrade of ports infrastructure, several manufacturers have announced their intent to locate production facilities in the UK. Siemens, General Electric, Gamesa, Vestas, Mitsubishi and Doosan have announced plans for prospective manufacturing or research and development facilities in the UK that could create thousands of direct new jobs and many more in the resulting supply chains. In addition, in other areas of the supply chain, such as cabling and foundations, companies such as TAG Energy and JDR Cables are making investments in new manufacturing facilities.¹⁴ The question, however, remains as to how many of the planned employment opportunities will be located the UK? This depends on the domestic and export demand for products from the planned facilities (and therefore the

market size for UK offshore wind), and also on the ability of the UK skills system to supply qualified and skilled recruits.

The industry view is that, as long as the UK can consistently deliver at least 3GW of new offshore wind capacity a year from 2016, there will be sufficient turbine demand to convince manufacturers to locate here.¹³ This prediction is based on a consultation with RenewableUK members. There is a risk that weak policy support could hold back industry ambitions.

We assume a learning rate of 9% for offshore wind, leading to an increase in employment productivity of between 37 and 52%, depending on the scenario.⁹

Employment outputs based on High, Medium and Low Scenarios

High Scenario for Offshore Wind (30.7GW projection: ~42,400 direct FTEs)

The detailed assumptions are based on Douglas Westwood's dynamic growth scenario in which 30.7GW of offshore wind capacity is in operation by 2021.^{15a} It predicts a strong development scenario in which all planned Rounds One, Two and 2.5 projects are completed by the end of the decade, and a significant proportion of Round Three projects and a series of wind farms in Scottish Territorial Waters are also fully constructed.

The industry is confident that if this rapid roll-out is completed, strong domestic demand for turbines and related technologies and services will convince a sizeable direct manufacturing and supply chain base to locate in the UK (55% by 2021), opening the gateway for UK-based suppliers of direct components for offshore wind to take a large share of the European export market (30% by 2021).¹³

Figure 8 shows that the high market growth scenario predicts that the offshore wind sector could support around 42,400 direct jobs by 2021.

The substantial growth in annual deployment rates and total capacity is expected to lead to considerable opportunities in offshore wind, particularly in design and manufacturing. UK OEMs could both dominate the domestic market and supply large numbers of turbines and components to Germany, France, Scandinavia and other parts of Europe. Under this High Scenario, by 2021 56% of all employment would be in Manufacturing and Design. Two-thirds of the total 23,700 Manufacturing and Design employees will be working to supply the domestic market. The modelling anticipates an overall hundredfold increase in Manufacturing and Design employment from 2010

levels. (This growth in economic activity and job creation would make offshore wind turbine manufacturing comparable to the size of the Danish onshore wind industry in 2010).¹⁶

The growth in Planning and Development jobs is expected to be more modest, with the number of full-time employees potentially peaking at 1,700 FTEs in 2014, as the Round Three developments that will be built during the second half of the decade move past the current ramp-up phase. By 2021, around 1,300 people are still expected to be employed in offshore wind Planning and Development jobs, a near threefold increase on the fewer than 500 people employed in 2010.

Employment in Construction and Installation is projected to quadruple, but is expected to peak before the end of the projection period. Construction and Installation work peaks in 2015/16, requiring 5,900 direct FTEs as annual deployment rates peak. By 2021, the model suggests there will still be over 5,000 FTEs in Construction and Installation as deployment rates continue, albeit at a declining annual pace.

A twentyfold increase in offshore wind capacity means that a significant expansion of the direct workforce in Operations and Maintenance will be required. The related direct workforce is expected to grow to over 10,400 FTEs by 2021, roughly equivalent to the total number of FTEs that were employed by the entire wind and marine sector in 2010.

Nearly 1,800 FTEs could also be created in Specialist Support Services by 2021. For offshore wind this is likely to be driven by growth in specialist water transport services, but also in activities related to grid build and connection, and in specialist environmental and technical consultancy.

Medium Scenario for Offshore Wind (23GW projection: ~29,700 direct FTEs)

The Medium Scenario for offshore wind is based on Douglas Westwood's analysis of developers' commitments as part of the Round Three developments, including adjustments for the possibility of project delays, attrition from reductions in project sizes and withdrawals of projects.^{15b}

Assuming this 23GW of project delivery, and that all companies that have announced their intent to set up R&D, manufacturing and assembly facilities bring their proposed sites into full operation from 2014 onwards, then industry representatives are confident a relatively high proportion of the UK and European market opportunity could be captured by UK-based suppliers of specialist manufactured goods.

Industry leaders regard the delivery of 3GW of new capacity per annum as sufficient for securing an industrial base for offshore wind. We use the assumption that this rate of delivery provides a sustainable demand base for the industry. As a result of slower market growth relative to the High Scenario, industry experts expect slightly less manufacturing activity will move to the UK, but they still predict UK-based offshore wind manufacturers can meet a sizeable 40% of domestic market and account for a quarter of the wider European market.¹³

In total, we predict that under these assumptions around 29,700 FTEs could be supported, slightly over half of which would be in Manufacturing and Design (see Figure 9).

Under the Medium Scenario the major employment gains are again driven by Manufacturing and Design activity. However, it is also where the greatest gap exists between the employment projections. In the Medium Scenario, Manufacturing and Design-related direct employment rises by 66 times compared

to the hundredfold expansion reported for the High Scenario. In this Medium Scenario, around 15,500 FTEs will be needed in Manufacturing and Design, with a fairly even split between those servicing the domestic market and those servicing the export market. This represents a substantial drop from the 23,700 projected in the High Scenario, in which the domestic demand for turbines is 7GW-worth higher and a greater market share is assumed to be captured by the UK.

In Planning and Development, employment is once again anticipated to peak in 2013/14 at 1,200 FTEs, double the 2010 level. This reflects the peak in annual deployment anticipated in around 2016/17 and the high levels of deployment sustained through to 2021.

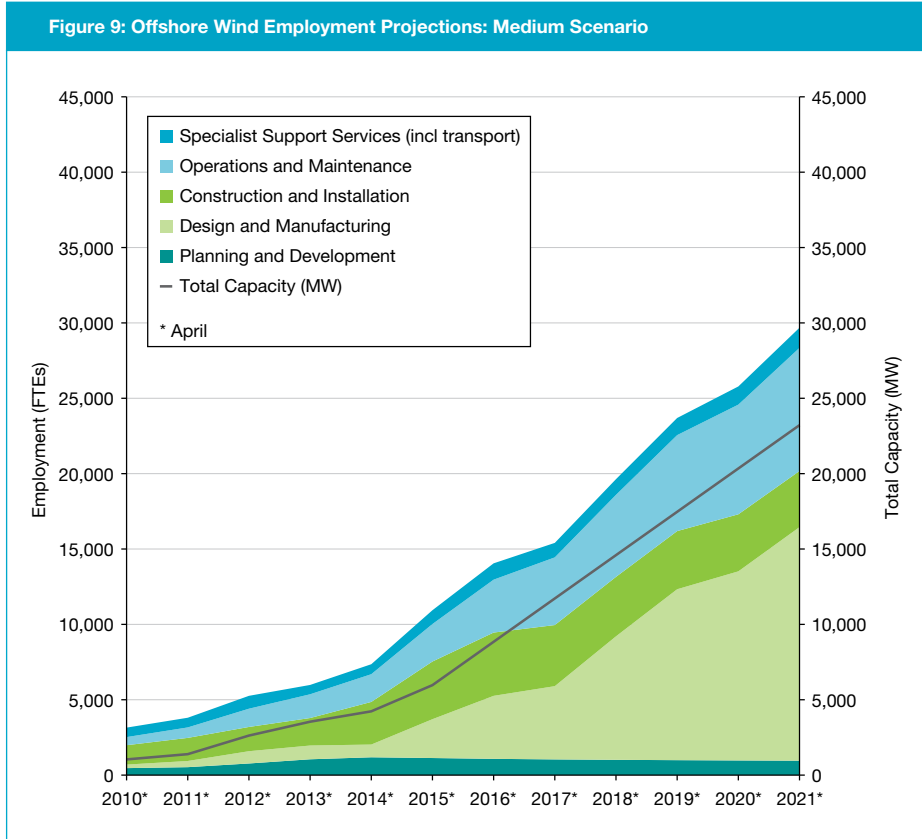
Similarly, employment in Construction and Installation is expected to peak in 2015/16 at around 4,200 FTEs, up from 1,300 in 2010.

In addition, employment growth in Operations and Maintenance is likely to be substantial. In 2010, 1GW of capacity supported 540 FTEs, but by 2021, under this scenario, 23GW of capacity could support nearly 8,200 FTEs. An additional 1,300 FTEs could also be created in Specialist Support Services, such as transport and specialist consultancy services, by 2021.

Low Scenario for Offshore Wind (13GW projection: ~11,800 direct FTEs)

The Low Scenario sets out a worst case, whereby continued policy uncertainty and a weak investment climate mean the development of the UK's domestic offshore wind industry stalls and as such it fails to secure the export opportunities currently on offer.

The National Renewable Energy Action Plan provides the basis for this scenario, modelling a growth path that leads to just 13GW of offshore wind capacity being



installed by 2021.¹¹ This development path is widely regarded by industry representatives as being a failure scenario, with industry slowly building up to an annual output of just 1.7GW per year by 2021.

Having achieved a tripling of offshore wind capacity between 2005 and 2009, and a sevenfold increase between 2005 and 2010, such modest expansion could only result from policies that fail to address well-documented planning and investment barriers.⁵

Intelligence gathered by RenewableUK's in-house expert on supply chain and manufacturing suggests that such a small domestic market would fail to entice businesses to establish large-scale R&D and manufacturing bases in the UK, with companies potentially favouring other European countries such as Germany and Denmark. Under this scenario, small-scale assembly facilities may be viable and some export opportunities to

European markets may still be possible. The assumption voiced by the sector is that, with insufficient local demand, the domestic output would only amount to 6% and an export share of 4% would be reasonable.¹³ With European and global offshore wind markets expected to take off over the course of the next decade, the UK will miss an opportunity to secure a world-leading manufacturing industry.

We estimate that 11,800 FTEs would be created under these conditions by 2021 – just around a quarter of the potential employment projected for the High Scenario. Although this still represents a near fourfold increase from current levels, it remains a failure scenario given the scale of the global offshore wind opportunity.

The major difference between this and the Medium or High Scenarios is in the projection for manufacturing jobs. Under this Low Scenario, the domestic capacity growth is thought insufficient

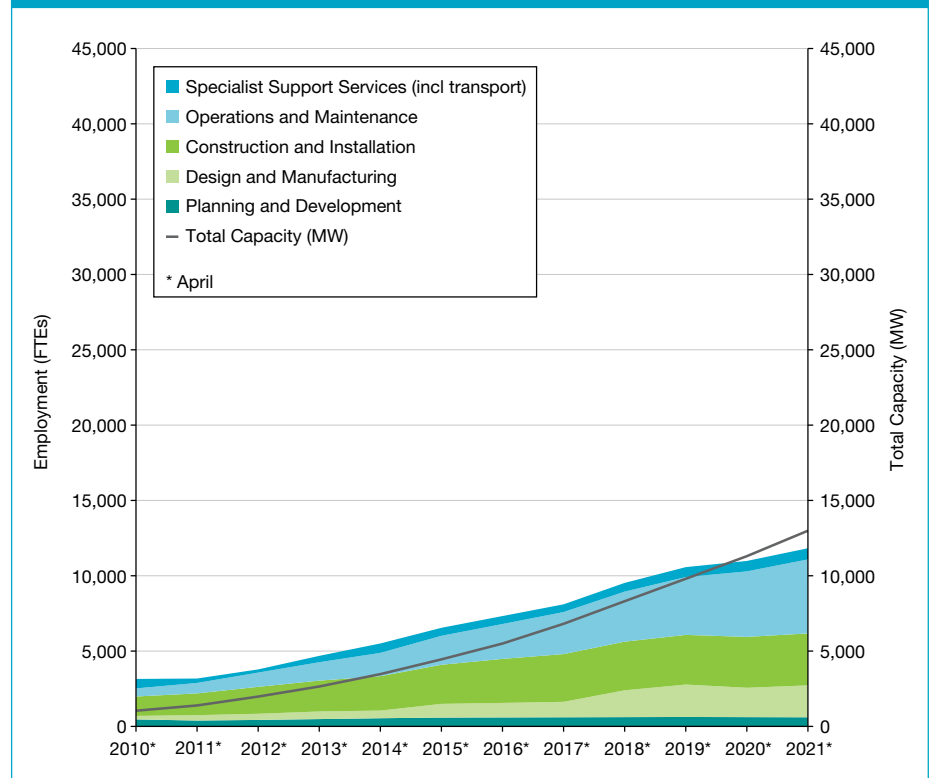
to attract major manufacturers to the UK, and as a result there are only 2,100 FTEs in Manufacturing and Design – less than a tenth of the potential for job creation in the High Scenario. This is still a substantial increase from 2010 levels, in which just 230 people are employed in Manufacturing and Design, but the projections remain very low compared to the two more ambitious scenarios.

The projected tenfold increase in offshore wind capacity by 2021, which results as the Round Two, Round 2.5 and potentially some early Round Three projects come online, means that there will still be job creation opportunities (see Figure 10).

For example, the number of FTEs in Operations and Maintenance sees a ninefold increase and is expected to rise to nearly 5,000 FTEs. Construction and Installation jobs steadily rise threefold to 3,400 direct FTEs. Planning and Development will experience more modest gains, with just 140 new FTEs employed in 2021 compared to 2010. In this Low Scenario, there are far fewer Specialist Support Service jobs projected (700) than in the Medium Scenario (1,300), primarily because of the lower manufacturing activity, but also because of lower deployment and lower demand for maintenance support services.

Overall this scenario represents a sizeable failure for the offshore wind industry and the UK's wider low-carbon economy. The failure to deliver a rapid roll-out of new offshore wind farms results in only modest employment gains, and, significantly, the failure to attract manufacturing plants to Britain means the development of offshore wind farms over the next twenty years will be largely reliant on imported technologies and skills.

Figure 10: Offshore Wind Employment Projections: Low Scenario



Small-scale Wind: Results

Three scenarios have been modelled for small-scale wind, with the following outputs:

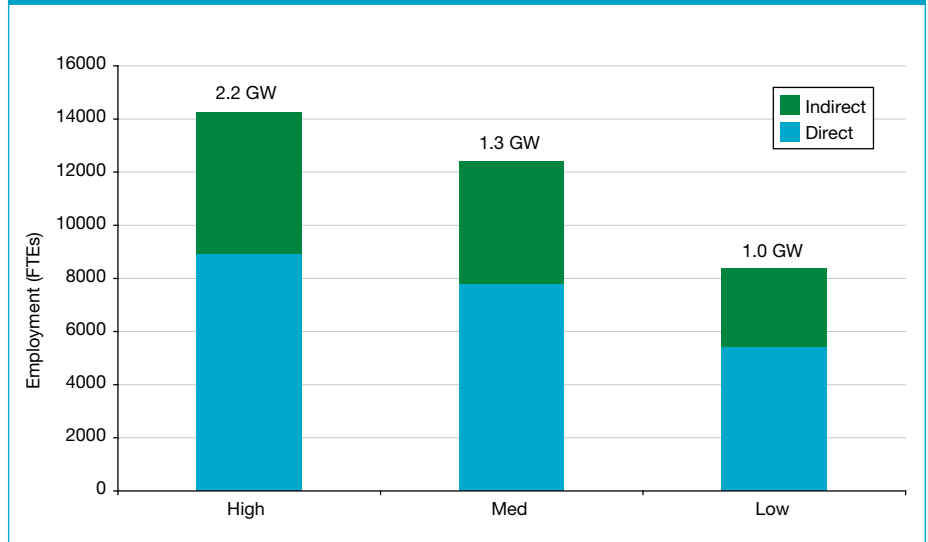
- **High Scenario 2.2GW projection:** ~8,900 direct FTEs, 5,300 indirect FTEs
- **Medium Scenario 1.3GW projection:** ~7,800 direct FTEs, 4,600 indirect FTEs
- **Low Scenario 1GW projection:** ~5,400 direct FTEs, 2,900 indirect FTEs

By way of clarification, the small-scale wind systems industry is taken to cover economic activity associated with wind turbines of capacity in the range 0–100kW.

The UK is one of the global leaders for small wind and has potential to cement its position as one of the world's largest manufacturing centres for small turbines. Domestic demand for small on-site turbines is increasing as households and businesses seek to take advantage of the guaranteed returns offered by the Government's Feed-in Tariff scheme, cut their carbon emissions and insulate themselves against rising energy prices.

Literature review reveals that anticipated deployment scenarios for small wind are all strong, considering installed capacity for the UK industry today (34MW baseline). The High Scenario requires very strong deployment rates, particularly over the next three years. Nonetheless, as a technology that is just entering a phase of rapid deployment – stimulated by the introduction of the Feed-in Tariff in April 2010 – and in the absence of historical data on the long-term effects of this policy, the prospects for the domestic market for small-scale wind systems are not certain. As a result, the differences between our three scenarios for domestic installation trends and employment prospects are quite wide (see Figure 11).

Figure 11: Small Wind Systems: Summary Employment Projections, April 2021



We project direct employment to rise from around 600 FTEs currently to between 5,400 and 8,900 FTEs by 2021. In addition, a further 2,900 to 5,300 FTEs could be supported indirectly in the manufacturing supply chains and the various service activities needed to support the retailing and installation of small turbines.

The rate of employment demand increase is perhaps lower than would be expected when glancing at the significant rate of ramp-up in capacity. This is because the industry looks set to be transformed from a cottage-style sector over the course of the next decade. The expected learning rate for small wind manufacture is much higher than that of other wind energy technologies. Across all three market scenarios the projection for small wind Planning and Development employment remains negligible (and is therefore not visible on the graphs). The Planning and Development of sites for small turbines is far less complex and labour-intensive compared to the other technologies that are subject to an array of planning policy restrictions owing to their size and the necessity of being connected to the grid.

Starting assumptions for modelling small-scale wind scenarios and employment

The small wind market is already relatively well established. Since 2005, almost 14,000 small wind systems have been deployed in the UK accounting for an estimated 34.5MW of installed capacity at the start of the 2010 financial year.¹⁷ This served as the starting point for the model.

Consultation with small wind system OEMs suggests that, in 2010, 75% of the specialist components for small wind turbines supplied to the UK consumer base were manufactured and designed domestically.¹⁸ The volume of exports exceeds domestic demand – the scope for UK OEMs is truly international due to the small size of the units to be shipped. For 2010, 22,200 small turbines were reported to make up the export market, and 20% of all direct turbine components for the year were supplied from the UK.¹⁷

600 FTEs are assumed to have been directly employed by small wind firms in 2010.¹

Due to the simpler work requirements associated with small-scale turbines, the labour intensity per turbine unit for small

systems is much lower compared to that of the other technologies covered by this study.

Please note that for this section of the report Construction and Installation and Operation and Maintenance jobs are drawn into one category based on the observation that these activities are performed by the same individual in small wind.

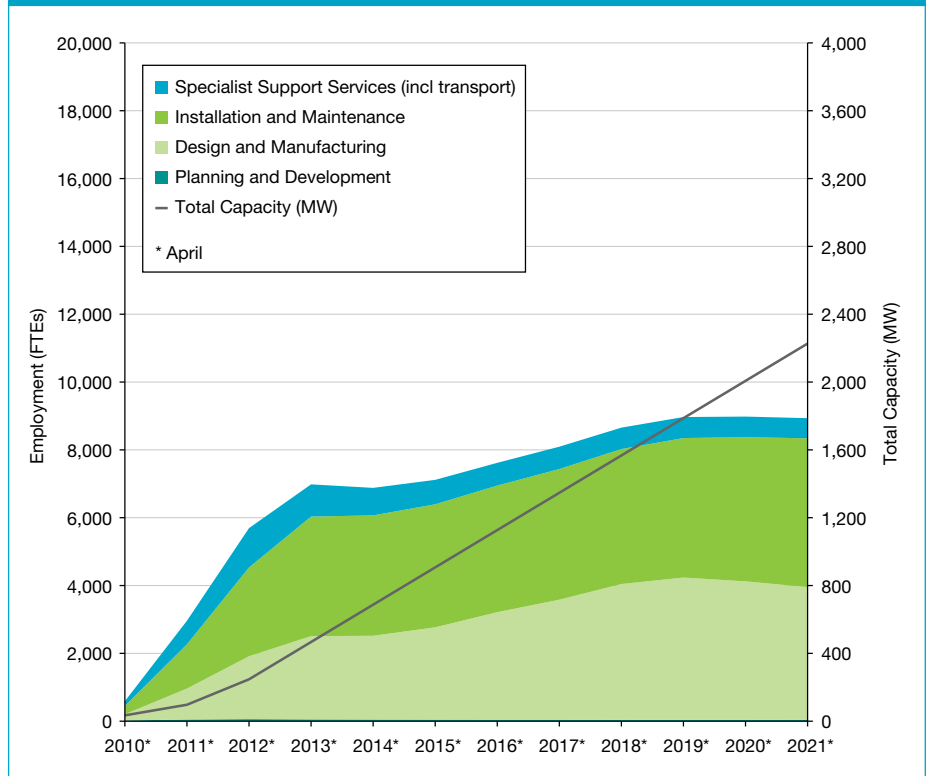
Looking ahead, the assumption used for export potential is that 4,800,000 units will have been put to the global market by 2021.¹⁷ The assumption of 15% regarding the learning rate used in all three scenarios is drawn from Mott MacDonald's supporting evidence to the Committee on Climate Change, Renewable Review.¹⁹ In the case of small wind, this corresponds to a productivity gain of 15% for every doubling of capacity.

Employment outputs based on High, Medium and Low Scenarios

High Scenario for Small Wind (2.2GW projection: ~8,900 direct FTEs)

Deployment trends under the High Scenario are based on Renewables Advisory Board (RAB) assumptions, which see a steady increase of approximately 220MW per annum in small-scale wind capacity between 2008 and 2021, resulting in a 65 times increase in overall capacity to reach 2.2GW by 2021.²⁰ Whilst UK OEMs have an excellent prospect to take advantage of such strong local market demand, the maturation of the market and likely entry of international competitors will inevitably lead to some erosion of UK manufacturers' market dominance (65%, down from 75%). There is also likely to be a marginal easing of UK manufacturers' hold on export markets from 20% to 15%.¹⁸ For the High Scenario, presented in Figure 12, the number of people employed in the small-scale wind industry is expected to rise fifteenfold from 600 last year to 8,900 by 2021.

Figure 12: Small Wind Systems Employment Projections: High Scenario



The highest rate of employment growth relative to 2010 will be in Manufacturing and Design. The number of people employed in these positions is expected to increase to around 3,900 FTEs by 2021. There is a plateau effect and a slight decline in later years, as significant efficiency gains kick in through learning. As the sector matures, and OEMs consolidate and increase their output, it is likely that they will move to leaner manufacturing techniques.

Yet in absolute numbers the greatest requirement will be for new recruits for Installation and Maintenance. Around 4,400 FTEs in total will be required in this type of role – up from 240 in 2010.

Employment in Specialist Support Services, such as retail, financial support and transport, will climb at a far more modest rate (a fourfold increase over the course of the decade) to support up to 600 FTEs.

**Medium Scenario for Small Wind
(1.3GW projection: ~7,800 direct FTEs)**

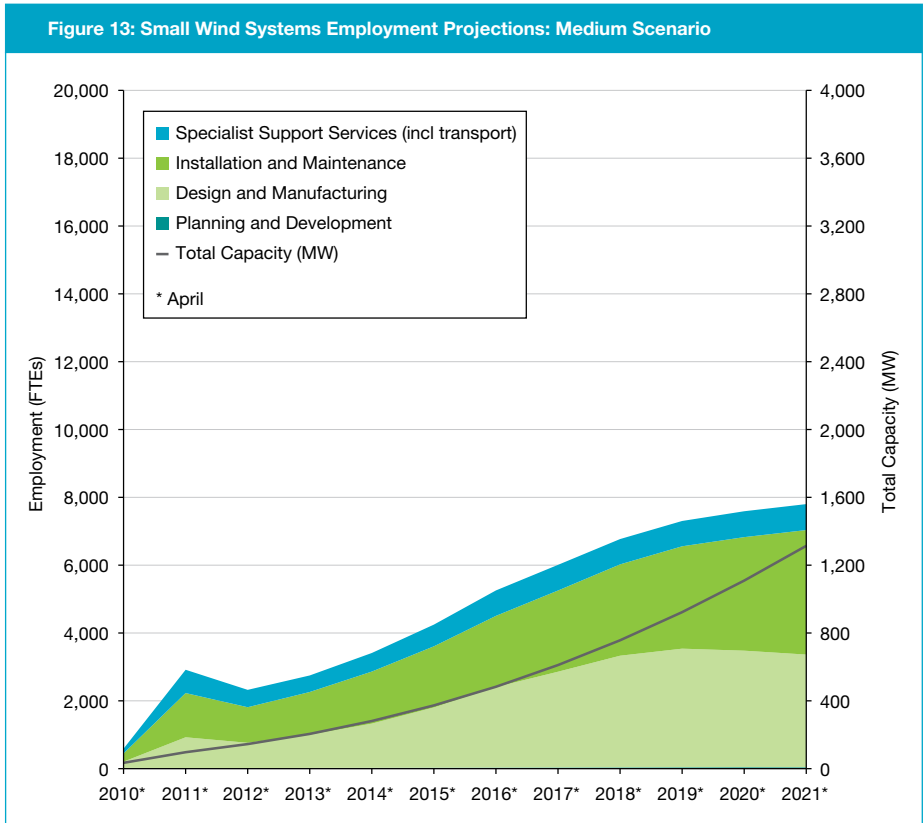
The medium growth scenario is based on RenewableUK estimates, which indicate that the installation of 600,000 small wind systems would contribute to an overall small-scale wind capacity of 1.3GW by 2021.²¹ Industry consultation suggests that under this scenario OEMs are confident of retaining a 65% share of the domestic market in 2021, although the UK share of the international market is expected to halve over the next decade, in the face of increased competition.¹⁸

As a result, total employment across the sector is expected to rise from 600 FTE employees in 2010/11 to around 7,800 FTE employees in 2021 (see Figure 13).

Employment prospects under this scenario are still very strong, but weaker than that anticipated in the High Scenario as a result of relatively smaller market shares, both domestically and in export markets, and slower UK market growth.

Again the rapid expansion in design and manufacturing dictates that the expansion of the Manufacturing and Design workforce will be at the highest rate relative to 2010 (an eighteenfold increase). The projection is that 3,300 FTEs will be employed in this role by the start of the next decade. Total numbers in Installation and Maintenance will nonetheless be higher – the workforce is projected to expand fifteenfold to 3,700 FTEs.

Employment in specialist services is actually projected to be higher than for the High Scenario (around 800 in 2021). This is because of the fast learning rates that occur in the early part of the High Scenario, which impact on productivity, combined with the fact that the main driver of demand for Specialist Support Services is from manufacturing and installation activity, which in turn is a function of deployment rates; these are similar between the High and Medium Scenarios at the end of the period.



**Low Scenario for Small Wind
(1GW projection: ~5,400 direct FTEs)**

This scenario is based on two reports from The Former Department for Business, Enterprise and Regulatory Reform (BERR), which estimate potential small-scale wind capacity of approximately 1GW by 2021.^{22/23} OEMs still have confidence they will retain a 65% share of the domestic market in 2021 under this scenario. However, the failure to deliver the large increases in domestic capacity envisaged in the previous scenarios will make it harder for UK manufacturers to take advantage of the anticipated growth in the international market, and as such the UK's share is expected to fall from 20% in 2010 to just 5% in 2021.¹⁸

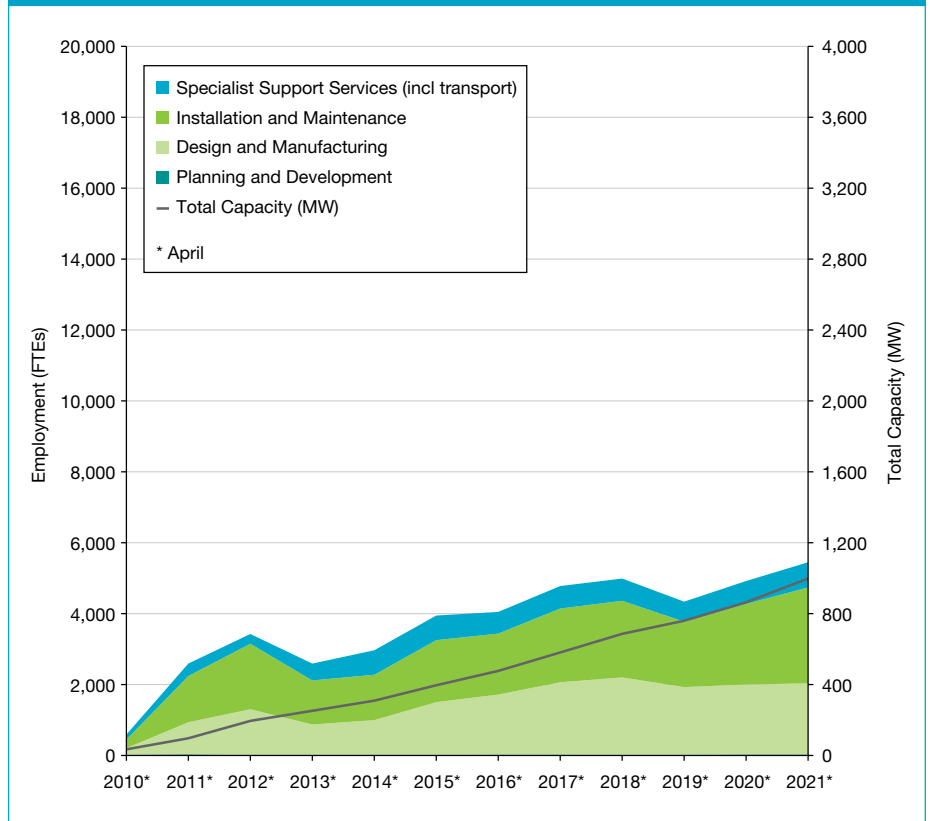
As shown in Figure 14, the modelling suggests 1GW of capacity is sufficient to support around 5,400 FTEs by 2021.

The total number of FTEs is significantly lower than for the more optimistic scenarios. Overall direct employment is projected to expand ninefold compared to thirteen- and fifteenfold increases in the Medium and High Scenarios.

Driven by the more limited success of UK manufacturers in the global market, the most significant drop in potential employment is in Manufacturing and Design – in this occupational area only 2,000 FTEs could be supported in this Low Scenario.

Manufacturing and Design and Installation and Maintenance employment would both expand at the same rate over the decade (an elevenfold increase). Because this scenario leads to 0.3GW less being installed compared to the Medium Scenario, nearly 1,000 fewer FTEs will be required for Installation and Maintenance. As a direct consequence of this, there is also a slightly lower demand for Specialist Support Services compared to that of the Medium Scenario.

Figure 14: Small Wind Systems Employment Projections: Low Scenario



Marine Energy: Results

Three scenarios have been modelled for marine energy, with the following outputs:

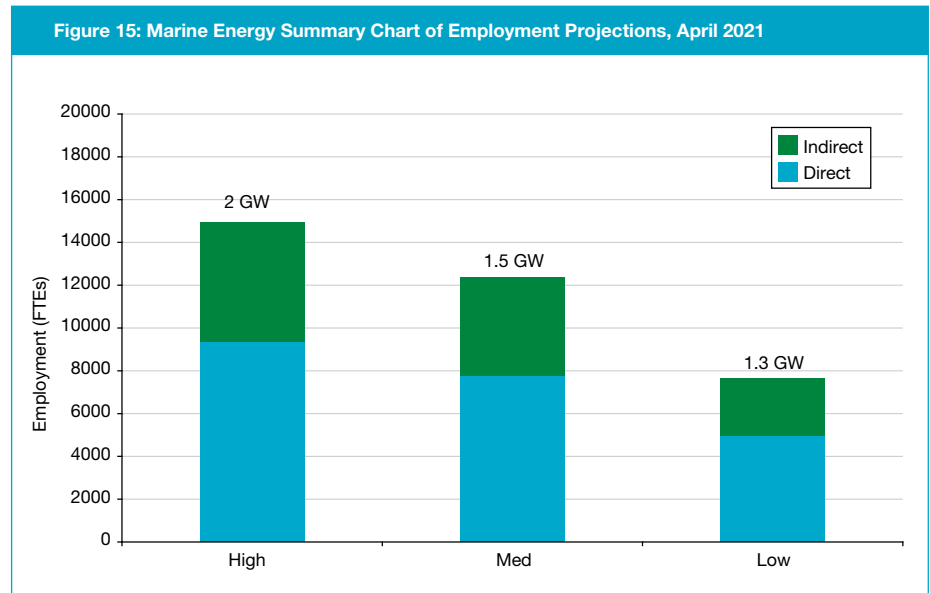
- **High Scenario 2GW projection:** ~9,400 direct FTEs, 5,600 indirect FTEs
- **Medium Scenario 1.5GW projection:** ~7,800 direct FTEs, 4,600 indirect FTEs
- **Low Scenario 1.3GW projection:** ~5,000 direct FTEs, 2,700 indirect FTEs

For the purposes of this study, marine energy refers to wave and tidal stream technologies.

Of the technologies that are the subject of this study, marine energy is considered to be at the earliest stages of commercial development. The industry holds huge long-term potential, and the UK needs to capitalise on its lead in technology R&D to bring forward significant socioeconomic benefits. According to the Carbon Trust, marine energy deployment by 2050 could be over 240GW, and worth £76 billion in value.²⁴

All three technology deployment scenarios show strong growth to 2021, considering a baseline of 2.4MW in 2010.²⁵ Across the board, slow deployment is anticipated up to 2016; thereafter, rapid installation rates are realised as it is assumed that the first small-scale arrays become operational. The real ramp-up in deployment from these technologies is actually anticipated to come post 2021 (outside the scope of this modelling).

Under our range of UK market development scenario assumptions, we estimate that the marine energy sector could directly support between 5,000 and 9,400 direct FTEs by 2021, compared to around 800 in 2010 (see Figure 17). The major difference in employment between scenarios is driven by assumptions regarding how much domestic



Manufacturing and Design activity is retained in the UK over the course of the decade. In the High Scenario, only 10% of specialist goods are imported, and the UK supplies 40% of the European Market – in contrast, whilst the domestic market is still dominated by local OEMs, only 15% of the export market is retained under the Low Scenario.²⁶ Subsequently, less than half the number of direct employees would be supported in the Low Scenario.

Also, whereas in the High Scenario an additional 5,500 FTEs are indirectly supported by the marine sector in 2021, in the Low Scenario only around 2,700 FTEs are supported in indirect (manufacturing supply chain and services) activities. This is predominantly because of the lower growth in Manufacturing and Design, but is also a result of lower service demand across each activity.

The nascent status of the industry means there is uncertainty around the development trajectories for the marine energy market, and thus the three employment projections presented here are also wide ranging. The potential for market growth in the sector will be determined to a large extent by the level of capital grant support available to push

the technology to commercial viability and the generation incentive offered through the Renewables Obligation. Other key barriers and drivers that will affect the success of the marine energy sector are grid availability, consenting and licensing, supporting infrastructure and the supply of skills.

Starting assumptions for modelling marine energy scenarios and employment

Recent years have seen exciting progress in the UK's marine energy industry, with testing of full-scale prototype devices at sea and the installation of the first grid-connected devices. There is significant activity in the R&D of innovative technologies, as well as some devices maturing into the pre-commercial stage. At the start of 2010, the UK had around 2.4MW of marine energy capacity installed. The findings of our survey suggest that just over 800 full-time equivalents were employed directly in marine energy for early 2010.¹

At face value, the employment numbers may seem very high considering deployment figures. This is a simple consequence of the stage at which the industry is in commercial development.

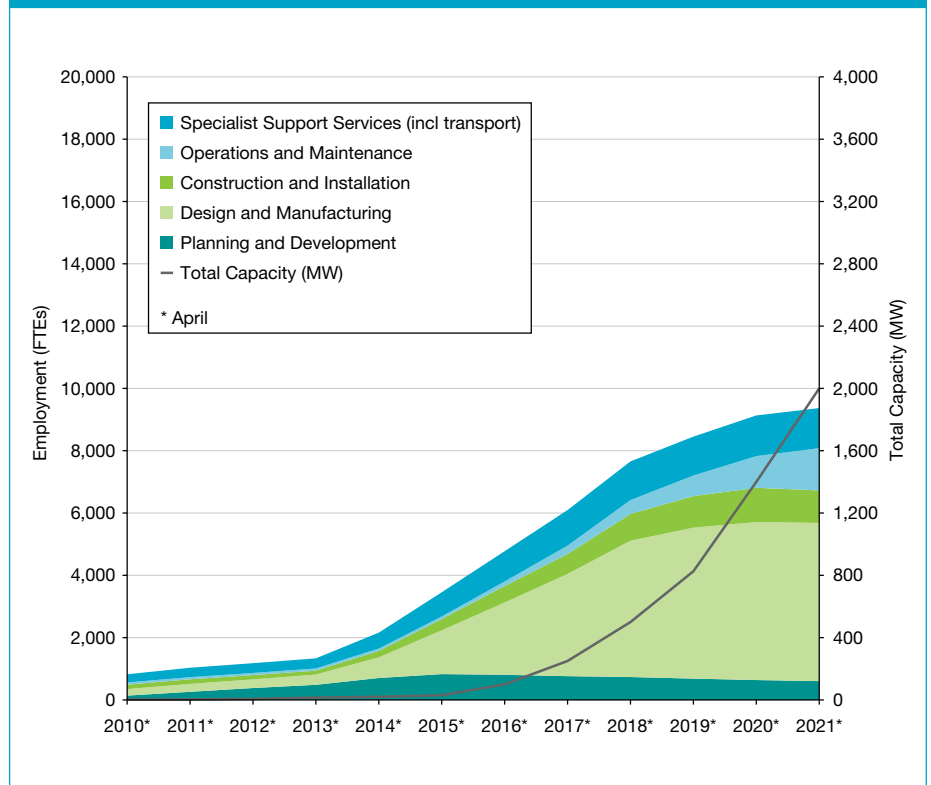
R&D and testing, and the first rounds of consenting for a new technology, are labour intensive. The businesses currently engaged in the marine sector are heavily weighted, in employment terms, towards the activities reflected by fixed costs – these firms do not expect their entire staffing requirements to increase in line with industry growth, but only the variable parts of the company structure. There are likely to be enormous labour productivity gains from future economies of scale in all activities, from manufacturing to maintenance.

In 2010, the majority of devices in UK waters had been designed and manufactured in the UK. We assume that, for 2010, just 10% of specialist components used in devices installed off the UK coast were imported from overseas manufacturers. This is not to say that OEMs have not set up design and manufacturing activities outside of the UK, just that firms are currently concentrating on deploying models off local shores. Industry consultation suggested that the UK holds a 50% market share of design and manufacturing for European marine energy projects.²⁶ In 2010, around 0.5MW of marine technology was operational in Europe outside of the UK.²⁷

We assume that it is unlikely for UK manufacturers to export beyond Europe to any great scale because of the bulkiness of kit. Instead, they are likely to open new branches if demand expands outside of European waters. Our assumptions regarding the future potential for exports of marine technologies are based on a study by the European Ocean Energy Association. Its report suggests that 3.6GW of marine energy could be deployed in Europe by 2021, with 2GW of this stated to come from the UK.²⁷ Therefore, we use a figure of 1.6GW for the potential overseas deployment for 2021.

As the technology is moving from pre-commercial testing to the first arrays,

Figure 16: Marine Energy Employment Projections: High Scenario



over the course of the next decade the learning rate and associated labour productivity gains in the sector are assumed to be high. We assume that for each doubling of total cumulative capacity we will see a 15% improvement in direct labour productivity.²⁸ Given the low starting assumption, this has a strong impact on the scenarios used because of the rapid rate of increase in installed capacity, in ramping up to 2021.

Employment outputs based on High, Medium and Low Scenarios

High Scenario for Marine Energy (2GW projection: ~9,400 direct FTEs)

The High Scenario is based on RenewableUK estimates of developer appetite that state, by 2021 UK marine renewable energy projects could amount to an installed capacity of 2GW.²⁵ Scotland is expected to account for at least 1.6GW of this total, as developers have already received leasing agreements

from The Crown Estate for eleven projects in Scotland’s Pentland Firth and Orkney waters. In this scenario, over half of all European deployment would be in UK waters. With such strong domestic market growth, we assume that UK manufacturers will retain their current share of the market for specialist manufactured goods. The assumption applied for UK export potential is that, whilst competition from European OEMs will strengthen, the UK can still hold a 40% share of the European market for specialist manufactured marine energy goods.²⁶

The High Marine Scenario would see over half of all European marine deployment in UK waters – we project an overall elevenfold increase in the workforce, with extraordinary demand for employees in manufacturing (see Figure 16).

Up from just 2.4MW in 2010, this scenario suggests nearly an 800 times increase in total capacity between 2010

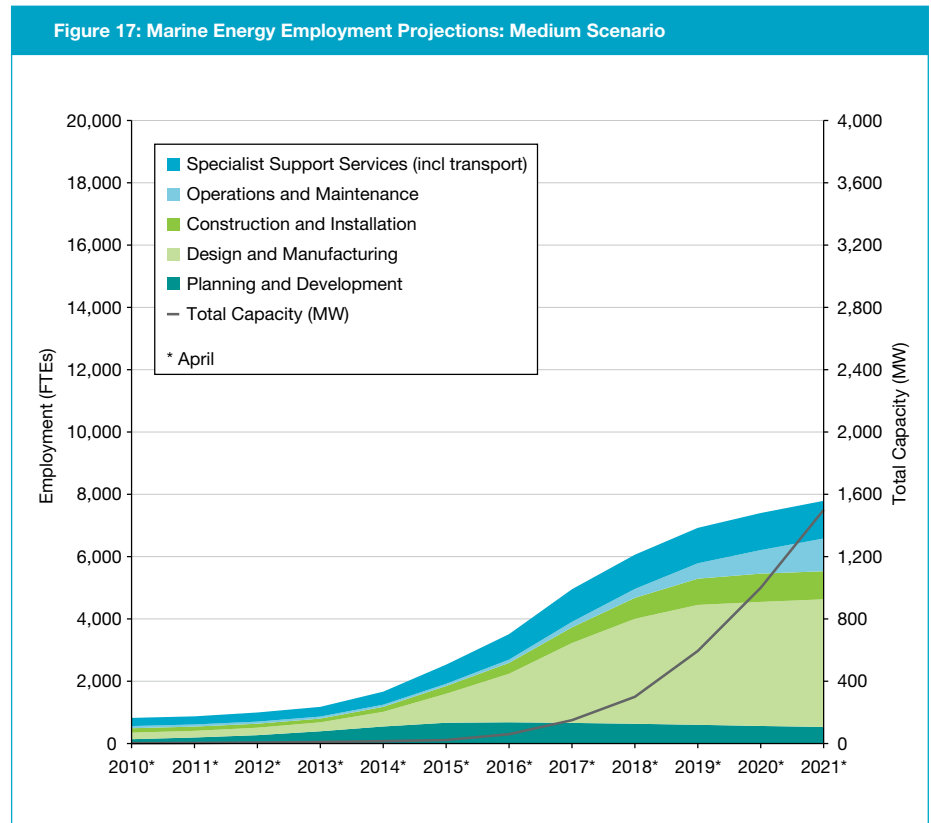
and 2021. However, to assume an 800 times increase in jobs would be incorrect because, as noted, employment intensity for 2010 is very high and there is a very high prospect of productivity gains as companies “learn by doing”.

Employment in 2021 is expected to be heavily dominated by Manufacturing and Design (54% or 5,100 FTEs in 2021); this stellar growth, a 24 times increase from 2010, is driven by the assumed dominance of UK manufacturers.²⁶

Employment in Planning and Development is actually expected to increase at a relatively modest rate, given that, with the first commercial leasing rounds having taken place in 2010, a high number of professionals were already needed at the start of the projection period (20% of total direct employment). The number of sites to be developed will be limited to specific zones, though the complexities of consenting in a marine environment are considerable. The size of the workforce is expected to peak around 2015/16 at around 800 FTEs and fall slightly thereafter because of learning curve effects.

Construction and Installation is projected to be flat in the initial years but will ramp up rapidly from 2013 onwards. Overall, a sevenfold increase in employment in this occupational area is anticipated.

Operations and Maintenance employment will only build up significantly post 2015, as cumulative installed capacity builds up. In the next four years, relatively low amounts of energy are anticipated to be generated from marine arrays, as most models are still in the prototype stages of testing today. Thereafter, demand for marine Operations and Maintenance professionals will ramp up very rapidly. By 2021, with 2GW of capacity installed, we estimate that the marine sector might need as many as 1,400 FTEs in servicing devices, a twentyfold increase on the number of specialists in this role in 2010. This is slightly more than



would be required for a similar amount of offshore wind capacity because of the added complexity of the operational environment.

By 2021, we anticipate that the marine sector will account for around one third of Specialist Support Service jobs (1,300 FTEs), in part because of the services required to support Operations and Maintenance activity, and in part because of the technical consultancy required in Manufacturing and Design, and Construction and Installation of the kit.

Medium Scenario for Marine Energy (1.5GW projection: ~7,800 direct FTEs)

Based on RenewableUK’s ‘Middle Scenario’, trends suggest the Medium Scenario leads to total capacity reaching 1.5GW in 2021, compared to 2GW in the High Scenario.²⁵ Annual deployment rates are, by definition, also slightly lower over the period, and as a result there is lower employment across all activities.

In total, we estimate that, under this scenario, the marine sector could support around 7,800 FTEs, just over half of which would be in Manufacturing and Design (see Figure 17).

Despite assuming lower market shares for UK manufacturers than in the High Scenario, both for domestic market shares (85%) and for export market shares (29%), we expect employment in Manufacturing and Design to continue to dominate total employment, supporting just less than 4,100 FTEs.

Towards the middle of the projection period 600-700 specialists will be involved directly in marine site Planning and Development. Under this scenario of growth, around 400-500MW is built each year post 2013, leading to around 900 FTEs employed in Construction and Installation activities. This represents a sixfold increase in the marine-specific Construction and Installation workforce. The total capacity of 1.5GW is estimated

to require Operations and Maintenance activity sufficient to support around 1,100 FTEs by 2021.

The lower levels of deployment and total capacity are reflected in slightly lower projections for Specialist Support Services: 1,200 FTEs by 2021.

Low Scenario for Marine Energy (1.3GW projection: ~ 5,000 direct FTEs)

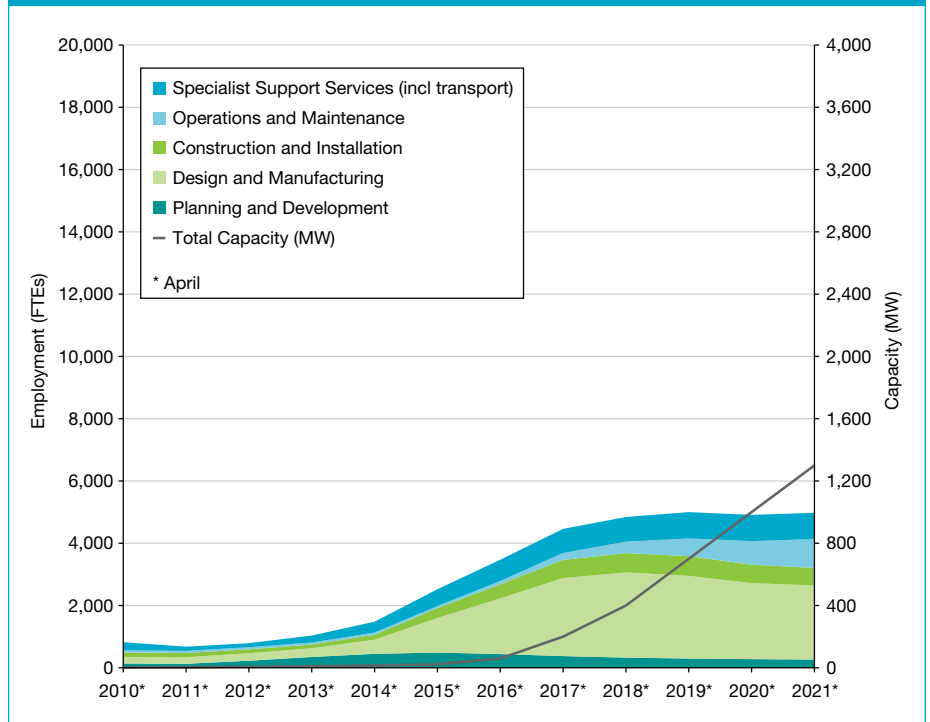
The lowest of the three scenarios follows the National Renewable Energy Action Plan, which assumes that 1.3GW of marine energy capacity is developed by 2021.¹¹ The main difference between this scenario and the previous two is the extent to which UK manufacturers capture both the export (just 15%) and domestic (80%) markets.²⁶ Although the scenario assumes lower annual deployment rates and lower total capacity in 2021, it would still be a positive leap for a fledgling industry and would secure the pathway for entering rapid deployment in the 2020s.

In the Low Scenario, 5,000 FTEs would be supported by 2021, with proportionally fewer FTEs in Manufacturing and Design compared to the other scenarios (see Figure 18). Unsurprisingly, in this scenario, employment is projected to be lower across all the other activities.

The majority of the 2021 workforce will still be in Manufacturing and Design, although we expect only about an elevenfold increase on 2010 employment levels. Only around 2,400 Manufacturing and Design FTEs are projected for 2021, and most of those will be geared towards the domestic market.

In this Low Scenario, the demand for new site planning activity is predicted to wane significantly post 2015. This means that direct Planning and Development employment is expected to peak at around 500 in 2015, then gradually decline to under 300 by 2021 –

Figure 18: Marine Energy Employment Projections: Low Scenario



this is less than double that observed in 2010.

Construction activity undergoes an overall fourfold increase, yet is anticipated to peak in 2018, tapering off slightly towards the end of the decade.

On the other hand, Operations and Maintenance of machines will lead to a thirteen-fold increase in this type of employment. The 1.3GW of total capacity in 2021 supports around 900 FTEs in Operations and Maintenance.

In the Low Scenario, far fewer jobs are projected for Specialist Support Services, since deployment and total capacity are projected to be much lower; as a result we project just 800 FTEs, up from under 300 FTEs as reported in the survey.

Key Findings

The sponsors of this research, RenewableUK and Energy & Utility Skills recommend that policy makers, industry and training providers should at bare minimum aim to ensure the delivery of the Medium Scenario is secured for the UK. Reflecting on recent trends in deployment, developer appetite, supply chain capability and Government targets for renewable energy generation the Medium Scenario is the most likely of the three scenarios. The High Scenario illustrated the maximum potential employment and skills needs of the sector, whilst a Low Scenario was modelled to showcase how the socio-economic benefits of wind and marine energy could well be missed if efforts are not focused to unlock sector growth.

To highlight the key findings of the modelling, the details of the Medium Scenario and associated projections

are as follows. The scenario envisages a near tenfold increase in wind and marine energy capacity to 41.5GW, underpinning an increase in direct full-time employment from 10,600 in 2010¹ to 55,600 by the end of the decade. A further 32,700 indirect roles will also be supported through broader supply of goods and services to the industry. The vast majority of these positions will be skilled, well-remunerated² roles that will require either core training in the form of full-time vocational and higher education courses or specialist training to help mature entrants switch careers into the growth sector. To harness these benefits, onshore wind needs to be rolled out at a steady and strong rate, offshore wind technology needs to be installed at a very rapid rate, the UK small wind industry needs to retain its hold on international export markets and marine energy technologies need to be

pushed to commercial maturity over the 2010-2021 period.

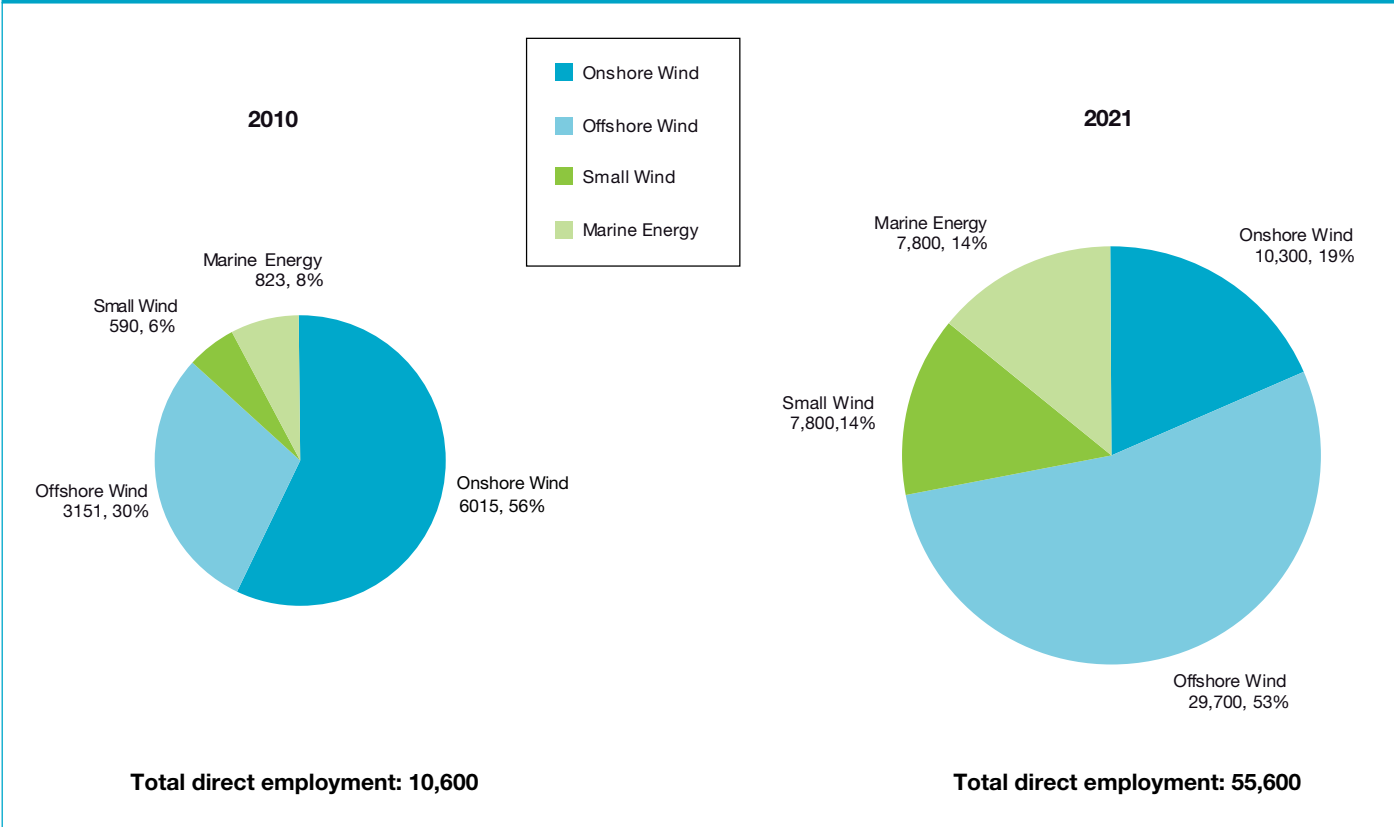
The modelling shows:

- How different technologies will need different numbers of recruits
- How as the sector develops there will be a shift in the types of skills sets that are needed.

Offshore wind is projected to provide the largest share of new renewable energy employment over the next decade if the 23GW offshore industry ambition is realised.

Of the 55,600 direct employees, offshore wind will provide the greatest employment and the most rapid recruitment rate, accounting for 53% of the total wind and marine energy workforce by the end of the decade. In contrast, onshore wind will employ 19%

Figure 19: Direct Employment by Technology: a Comparison of 2010 with 2021



of the 2021 workforce, whilst small wind and marine energy will each employ around 14%.

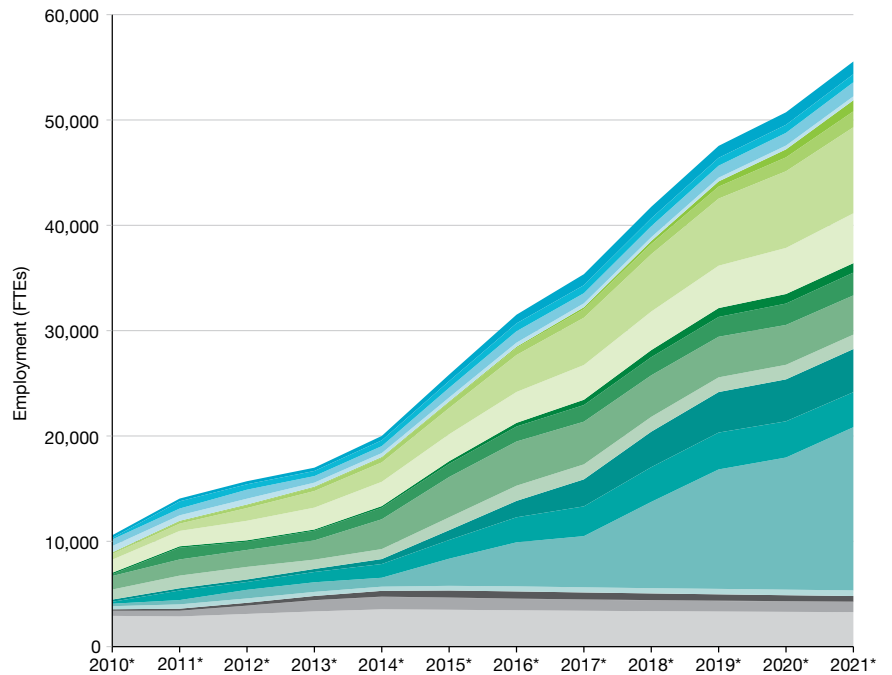
The make-up of the workforce in 2021 contrasts sharply with the current employment mix, which is dominated by onshore wind energy (see pie charts in Figure 19). This drastic change is anticipated because, whilst the onshore wind industry, as a mature sector, will continue steady growth, a real surge is foreseen in the deployment rate for newer renewable energy technologies. According to this medium market scenario, by 2021 the majority of the 41.5GW of total capacity will come from offshore wind (23GW), followed by onshore wind (15GW). Total capacity from marine energy is factored in to continue to lag behind significantly (1.5GW), owing to the relatively lower commercial maturity of this type of technology today. Total installed capacity from small wind is also forecast to be significantly smaller (1.3GW) because of the lower unit size of this technology.

Figure 20 clearly illustrates that the aggregate recruitment rate across the sector is very high over the course of the next ten years. The model breaks down employment trends by broad ‘occupational domain’ for each technology:

- Manufacturing and Design
- Planning and Development of sites
- Construction and Installation
- Operations and Maintenance
- Specialist Support Services

The Medium Scenario would see the UK becoming a major base for offshore, small wind and marine energy. With this, the single largest sector for new employment would be in Manufacturing and Design, compared to the other business domains analysed. Design and manufacture related employment will go up dramatically, from 900 in 2010 to 23,500 FTEs in 2021. (This analysis

Figure 20: Direct Employment Projections for Activity by Technology: Medium Scenario



KEY		
Specialist Support Services	Construction and Installation	Planning and Development
■ Wave and Tidal	■ Wave and Tidal	■ Wave and Tidal
■ Small Wind Systems	■ Small Wind Systems	■ Small Wind Systems
■ Offshore Wind	■ Offshore Wind	■ Offshore Wind
■ Onshore Wind	■ Onshore Wind	■ Onshore Wind
Operations and Maintenance	Manufacturing and Design	
■ Wave and Tidal	■ Wave and Tidal	
■ Small Wind Systems	■ Small Wind Systems	
■ Offshore Wind	■ Offshore Wind	
■ Onshore Wind	■ Onshore Wind	
* April		

excludes those working indirectly in the broad supply chain).

On-going Operations and Maintenance roles build up significantly over time for each of the technologies, leading to an additional 13,500 new FTEs across the sector.

The growth in the number of Construction and Installation roles will be more modest, as the relatively short timeframe for renewable energy installation projects will allow construction workers to move from project to project. Nonetheless, a total of 5,600 new full-time positions will have to be filled in the Construction and Installation sector.

Planning and Development activity is already peaking for some technologies (such as offshore wind that is currently going through Planning and Development for Round Three), so employment in this occupational area is anticipated to increase at the lowest rate, drawing in a modest additional 1,300 FTEs by 2021.

Specialist Support Services shift from being related predominantly to onshore wind to being associated mainly with offshore wind and marine energy (in near-equal proportions). Specialist Support Services are expected to account for around 7% of jobs in the sector by 2021. We anticipate that this will be a combination of transport services, technical and environmental consultancy, and legal and financial firms that provide bespoke services to the sector.

The Implications of Rapid Growth for Skills Delivery and Acquisition

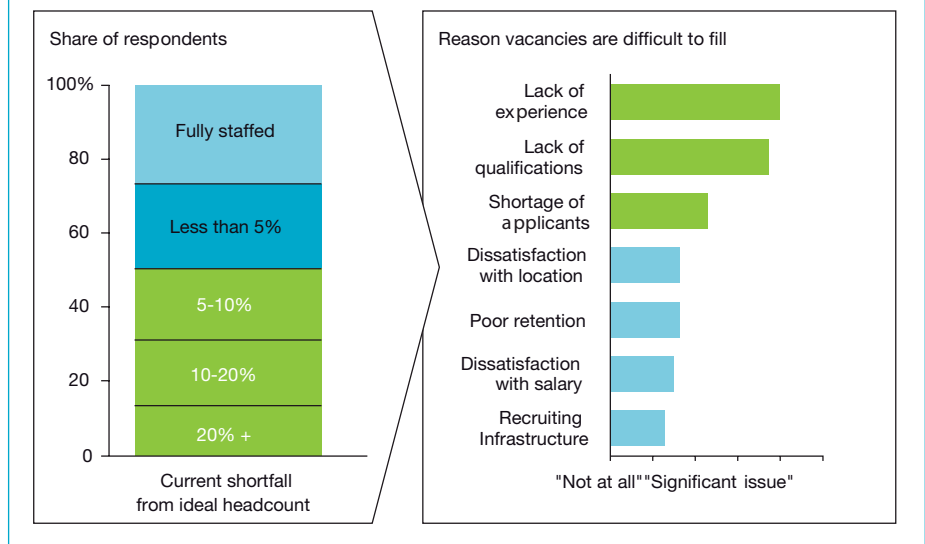
Ultimately, the realisation of any of the scenarios presented for each technology in the Results section is heavily dependent on whether an effective and stable policy and legislative framework emerges and is sustained; the ability of politicians, regulators and firms to overcome current barriers to deployment; and the willingness of all parties to invest in what is required for sustained growth.

Clearly, the more deployment is enabled, the greater the prospects for jobs. Regardless of which scenario we consider, tens of thousands of recruits will need to be sourced and trained to support the growth of the sector. The question of whether the employment benefits are accrued by UK citizens is largely dependent on the quality of the offering the UK talent pool can deliver. Businesses will recruit locally if they have access to skilled, qualified and experienced individuals, and will invest in training people provided they are confident that local providers can meet their needs.

The employment projections detailed in this report suggest strong growth through to 2021. Given the occupational structure of the sector and the prevalence of hard-to-fill vacancies already being reported by employers (particularly at the higher skill levels), skills shortages are a potential constraint on this growth and the further development of the industry within the UK.

In 2008, Bain & Company reported that significant vacancy levels were driven by a lack of experience, a lack of qualifications and a shortage of suitable applicants (see Figure 21).² Research for *Working for a Green Britain* reiterated that factors such as salary levels are not the key cause for unfilled positions.¹ Today, the wind and marine energy sector is characterised by a relatively highly skilled workforce compared to the UK economy as a whole, employing high proportions of people working in

Figure 21: Responses of 100 wind and marine energy firms regarding hard to fill vacancies in 2008²



managerial, professional and associate professional occupations. These are roles typically associated with high-level skills and qualifications (typically HNCs, HNDs, degrees and postgraduate qualifications).¹

Occupations that are already being reported as proving hard to fill include:

Technical Occupations:

Construction Manager, Ecologist, Electrical Engineer, Environmental Consultant, Environmental Impact Assessor, Geophysical Surveyor, Hydro-Dynamic Surveyor, Noise Assessor, Offshore Structural Engineer, Ornithologist, Technical Planner, Power Systems Engineer, Project Engineer, Structural Design Engineer, Operations and Maintenance Technician.

Generic Occupations:

Commercial Manager, Contract Manager, Health & Safety Manager, IT Project Manager, Project Manager, QSHE Manager, Software Engineer, Supervisor, Sales.

An analysis of demand for skills according to our medium projection

As the sector develops in the next decade its skills requirements will also change. The key changes identified for the next decade in the Results section are that:

- as deployment of these technologies into the field increases, increased operation and maintenance of sites is required;
- manufacturing activity across the sector grows rapidly.

Therefore, skilled trades (occupations traditionally associated with levels 3 and 4 vocational and apprenticeship training) will become increasingly in demand. At the same time, demand for higher-level skills will remain significant, driven by the need for continued innovation and development in potentially more technically challenging environments (e.g. further offshore). As such, the challenges in attracting and preparing the required skilled labour are expected to continue.

The key implications of projected growth relate to the ability of the training delivery system to deal with:

- the sheer volume of recruits in demand across a relatively short time period and
- the level of specialisation in training that some critical but relatively niche roles require.

Analysing the results of the Medium Scenario, the nature of the employment opportunity and training challenge becomes apparent.

A 25 times increase in demand for Manufacturing and Design employees across the sector will mean a significant hike in the demand for relevant skills sets. Over 22,500 recruits will be needed across the sector between 2010 and 2021. In order to lead innovation in the design of individual turbine models and entire plant systems there will be continued need for experts with post-doctoral qualifications. The majority of the Manufacturing and Design workforce will need to hold more generic vocational and degree level qualifications. The nature of the qualification needs will be determined by what types of manufacturing centres open up. Current announcements suggest the need for fabrication, steelworks, mechanical and composite technology-related skills will be high. Whilst those moving across from declining sectors within manufacturing will have excellent opportunities, it is also important that young people have access to these roles.

Planning and Development-related employment appears to be relatively flat across the period, as individuals move from one project to the next. However, one must be mindful that this type of work underpins all other activities in the sector. A skills gap in Planning and Development would be particularly detrimental to future deployment. It is of concern that many of the shortage occupations highlighted above are

relevant to this phase of renewables projects. Individuals with degree and postgraduate qualifications are involved with this type of work. There is a significant need to specialise depending on whether the activity is in the marine or terrestrial environment. A lack of clear routes to specialisation may be creating a skills gap.

With Construction and Installation, the skills are more or less a direct transfer of maritime and civil engineering practices. However, the installation of devices requires industry-specific training. Nearly 8,200 FTEs will be expected to be directly involved with this type of activity in 2021. The most significant number will need training for offshore wind.

Wind and marine energy Operations and Maintenance employees referred to in this report are specialists rather than those working on more routine activities necessary to maintain generic infrastructure around wind farms or marine parks. The overall need for 15,500 wind and marine industry specialists in Operations and Maintenance poses a significant challenge for the skills system. This is especially so as over half the new Operations and Maintenance staff will be needed to work offshore. The working environment for these professionals is particularly harsh and hazardous. Apart from in small wind systems, where short transition courses with very short lead times for electricians can fill the gap, all other Operations and Maintenance personnel need to be qualified to level 2, and more often to level 3 or above. The skill sets needed are technology-specific but inevitably build on a blend of electrical and mechanical engineering foundations. Whilst National Occupational Standards for this role are set by EU Skills, and a National Apprenticeship Programme is successfully being rolled out, a large number of mature entrants need to

access shorter routes to competence if the demand is to be met.

Specialist Support Services-type employment is in a wide range of areas, therefore our analysis of the skills and training needs in this domain is restricted.

Opportunities and risks to meeting demand: building on the strengths of the existing UK talent pool

In the case of manufacturing activities, or in indirect roles, the concerns around skills shortages are perhaps not as pronounced, even in the face of such significant ramp-up. These occupations do not necessarily require industry-specific training, just the shift of employees from declining sectors to being active in an emerging sector. The UK's strong skills and industrial capabilities in manufacturing, marine engineering and the process industries, and world-class research and engineering institutes are a real asset that will help UK candidates gain the necessary qualifications to work in the sector.

However, the skills required by the sector as it continues its development over the coming decade are already proving difficult to recruit for from within the UK labour market. EU Skills produced evidence to the Migration Advisory Committee on engineering-related skills shortages in the wider UK power sector and the National Employers Skill Survey reports that skills shortage vacancies are most commonly found in associate professional and skilled trades occupations – precisely those most in demand in wind and marine energy.

The greatest concern around future skills supply is related to those occupational areas that require some form of power sector and indeed renewable technology-specific knowledge.

For example, whilst across the economy as a whole there were 1.8 vacancies per 100 jobs in April 2011, within the utilities it was 3.6 – double the national average and higher than any other individual sector of the economy.²⁹ Clearly there are skills shortages across the electricity industry as a whole, so relying on people to flow in vast numbers from fossil power to renewables is unrealistic.

Many of the roles in technology design, the scientific aspects of Planning and Development, Installation, and Operations and Maintenance rely on individuals to have good Science, Technology, Engineering and Math-related (STEM) core skills that are in short supply across the economy. The current output of STEM students is insufficient to even meet the need to fill vacancies that come about through retirement in traditional sectors, let alone to simultaneously help drive the rise of new innovative industries. Over the last five years, participation in further education for all levels of engineering and technology has fallen by over 25%, whilst the increase in numbers of STEM higher education graduates has been modest (7% since 2002, whilst general graduate numbers have increased 21.7%).³⁰ Simply increasing the number of STEM students will not necessarily alleviate the problem as a high proportion of engineering and technology graduates (41% in 2008/09) do not enter a STEM-related occupation after graduating.³⁰

The output of STEM-qualified individuals needs to rise, and work needs to be done to retain more of those qualified for STEM work.

The industry provides opportunities for young people.

The first renewable energy industry-focused Modern Apprenticeship, the City & Guilds Wind Turbine Operation and Maintenance Programme, is successfully being rolled out by companies and

colleges across the UK. In addition, several larger companies run graduate programmes. Many companies in the supply chain use traditional vocational training to prepare young people. Expecting the majority of recruits to come straight from education overlooks the constraints of small renewable energy teams and their limited capacity to supervise novices (~70% of organisations employ fewer than 24 FTEs).¹ In addition, across the board shifts in demography mean that there will be a restricted flow of young people into the future workforce (by 2018 there will be 12.9% fewer 15–19 year olds than there were in 2008).³⁰

A 2011 survey of RenewableUK's Human Resources Forum members found that, today, around 10–20% of each company's annual recruitment is made up of inexperienced entrants who have just completed formal education. However, even though companies are increasingly investing in apprenticeships and graduate entry programmes, the ratio of new entrants to experienced entrants is only likely to increase marginally in the near future, whilst the sector is still immature. From this we estimate that, of the expected 45,000 new entrants, around 36,000 will be mature candidates. These individuals have very different training needs to successfully cross into the sector, compared to novices.

Many roles require high-quality, short, industry-specific training courses, which are not readily available.

Industry-specific “transition training” in the form of short, very specific courses turning generalists into experts is essential for the sector's success. Yet, this type of training is reported by industry members to be in low and inadequate supply today. This could create a significant bottleneck in employee supply over the next decade.

The importance of “sideways movement” of individuals from related industries is recognised in the literature as a key strategy for the sector in coping with the demand for technical competence, combined with transferable experience. Research by Card Group also backs the observation that “it can take...several months before [sideways entrants] can become effective in their roles”.³¹ This brings inefficiency and risk for businesses. Experienced workers, even people who have the core skills that the wind industry needs, are slow to “hit the ground running”.

In the face of rapid expansion, transition training cannot be delivered purely in-house within individual renewable energy businesses, because of the low volume of training demand within individual companies, lack of internal training capacity and lack of industry benchmarking. The costs of developing solutions on a company-by-company basis are prohibitively high, and the perceived risks of competitors poaching trained staff also act as a barrier. In the meantime, owing to the relatively small head count per company, market signals from individual businesses are too weak to make it sensible for private sector training providers to react to the local need for delivering courses. In combination, this is leading to inaction, and represents a skills market failure in the renewable energy sector.

Government needs to take on the responsibility for providing a robust strategy to incentivise action on the part of businesses and providers.

The industry's ability to attract the required skills will obviously have implications for the extent to which the potential growth of the sector can be realised. It is not simply an issue of increasing skills supply, given that the skills in greatest need are also being demanded in other sectors of the economy, but of putting in place policies and practices that will allow the sector to retain and upskill its highly skilled workers.

Risks of failure

Should the sector develop as rapidly as we anticipate, recruitment problems and skills shortages could become even more manifest if urgent action is not taken now to address the supply of skills to the sector. It is essential that the skills system deliver the right skills at the right time. Failure to act in this area now could permanently damage the prospects for UK renewable energy employment growth for years to come.

In order to achieve this in a way that limits the impact of skills deficiencies, and to cope with the evolution of skills requirements as technologies move through the product life cycle, a number of things need to occur:

1. Policy makers and the providers of learning need continued robust labour market intelligence, stating how workforce requirements will develop over time, on which to base their plans. This has to come direct from employers and drawn together into an industry-wide picture of what skills will be required, by when.
2. Employers and the providers of learning need to collaborate more in order to ensure that the outputs of learning (i.e. skills) are in line with employers' needs.
3. Government needs to ensure that the UK's skills system is flexible enough accommodate the needs of a very rapidly changing industry, this including a funding regime that is flexible enough to meet the needs of all employers.
4. All parties need to collaborate to identify and promote the career opportunities and pathways that are available within the industry to young people and mature entrants alike.

If insufficient skills are available from within the UK labour market, the sector, if it is to meet its installed capacity targets, may have to resort to Europe to supply essential goods and services (for example, the "offshoring" of design and manufacturing jobs to European competitors). Similarly, European contractors could be brought in to install, operate and maintain UK facilities. This will be expensive for the sector and ultimately for consumers. This outcome would see the UK fail to secure the domestic socioeconomic benefits that the sector has to offer.

Conclusions

This report has presented three scenarios for four technologies in the wind and marine energy sector and the modelling has yielded corresponding employment projections.

The High Scenario represents a very ambitious but achievable outcome. If Government provides clear, positive long term policy signals, confidence in the markets will come through and will draw in private investment into the sector. An overall 10-fold increase in the deployment of wind and marine technologies (51.8GW) could support over 115,000 FTEs, 73,000 of these would be working directly in the sector and the rest in the supply of wind and marine energy related goods and support services.

The Medium Scenario, anticipates strong general growth across the sector but the deployment trends factor in various barriers that are likely to effect market development for wind and marine technologies. Deployed capacity grows to 41.5GW by 2021 from just under 5GW in 2010. In this scenario a total of over 88,300 employees are projected be involved in the wind and marine sector, 55,600 of whom will be directly specialising in the sector.

In the absence of strategic support for the sector the Low Scenario deployment trajectory is likely to occur. It is based on sources that provide unambitious trends for small wind and marine energy, and scenarios that project the onshore and offshore wind industries to stall in the rate of capacity deployment. The scenario is viewed by industry members as a failure. In total only 25.7GW is anticipated to be installed by 2021 and the opportunities for the UK to become a major centre for design and manufacture are assumed to be foregone. UK wind and marine energy projects could be largely reliant on imported technologies. In this case only 44,000 FTEs would be employed in total across the sector supply chain. A mere doubling of employment numbers from 2010 will be seen as a failure for the UK economy to have harnessed the potential socio-economic benefits that the wind and marine energy sector holds.

The range of scenarios available demonstrates that the UK wind and marine energy sector's development is at risk from various factors such as uncertainty around:

- Energy policy
- Planning policy
- Revenue support
- Access to finance
- Access to grid
- Technology risks

Ultimately, the realisation of any of the scenarios presented for each technology in the Results section is heavily dependent on whether an effective and stable policy and legislative framework emerges and is sustained; the ability of politicians, regulators and firms to overcome current barriers to deployment; and the willingness of all parties to invest in what is required for sustained growth.

In order to unlock growth in employment a clear and ambitious strategy must be set out and pursued by UK Government and businesses across the sector. Tens of thousands of recruits will need to be sourced and trained to support the growth of the sector. To ensure that the employment benefits are accrued locally the skills system must proactively support training people to make the most of the new job openings. As it currently stands the skills system and training infrastructure is not providing sufficient support.

Appendix

Key Definitions

Technologies:

The “*wind and marine energy sector*” in this study refers to four technology groups:

Onshore wind:

“Large-scale” onshore wind turbines over 100kW.

Small-scale wind systems:

wind turbines less than 100kW.

Offshore wind:

wind turbines deployed in a marine environment.

Marine energy:

wave and tidal energy technologies.

Types of employment:

Full-Time Equivalent employees (FTEs):

are employees that regularly work more than 30 hours a week. To account for part-time employees, the total number of people who work less than 30 hours a week has been tallied up and their numbers have been halved.

Direct employees:

are those spending the majority of their working day on specifically wind and marine energy-related activities. In relating this to the survey responses, this meant including all employment in companies that responded that their main activity was in the wind and marine energy sector.

Indirect employees:

are individuals whose jobs have been created because of increases in the demand from the wind and marine energy sector for non-sector-specific goods and services.

Industrial activities and occupational domains that sector employees are engaged in:

Following on from the Bain & Company approach, we have sought to disaggregate the wind and marine energy sector into five activities:

Planning and Development:

refers to all economic activity related directly to the planning and development of wind and marine energy sites.

Manufacturing and Design:

refers to all economic activity related directly to the design and manufacture of wind and marine energy equipment. The definition excludes the design and manufacture of generic components such as ball-bearings. Thus the following are included:

- Technology R&D Assembly and retail of complete devices (complete wind, tidal and wave power generation units)
- Manufacture of specialist key components (nacelle cover, nacelle, blade, rotor hub, tower etc.)
- Manufacture and assembly of main units related to “balance of plant” (foundation, substation, cables, etc.).

Construction and Installation:

“Construction” refers to the construction of civil/maritime industry-specific components of wind/marine farms, including “balance of plant” (excluding general infrastructure such as roads leading to sites). “Installation” covers the installation of wind and marine devices and electrical components of industry-specific “balance of plant” units.

Operations and Maintenance:

This covers all direct activities related to the operation and running of wind and marine sites. Maintenance refers to the sector-specific servicing activities that are carried out for devices, electrical components and “balance of plant”.

Specialist Support Services and Other:

This category includes a wide range of wind and marine energy-focused specialist services:

- Technical consultancy
- Environmental consultancy
- Specialist legal services
- Specialist financial services
- Specialist transport services
- Specialist insurance services

Other terminology:

Learning rates:

Learning rates typically refer to the changing relationship between the costs

of developing and operating a particular technology, and the scale to which it is deployed. Learning rates are expressed as percentages, where the figure reported indicates the cost saving for each doubling of capacity. In this study we have translated learning rates to expected changes in labour productivity, making the assumption that labour costs are the same as other business costs and subject to the same gains from learning.

Original Equipment Manufacturer (OEM):

The standard definition for OEM refers to a company that supplies equipment to other companies to resell or incorporate into other products using the resellers’ brand names.

Methodology

Our approach seeks to translate the employment impacts that result from the expansion of the wind and marine energy sector into changes in the number of direct and indirect jobs.

The sector is not easily identified within the Standard Industrial Classification, the classification system used in the UK to distinguish different kinds of economic activity. For example, the Standard Industrial Classification system currently does not explicitly separate the manufacture of wind turbine components from other types of engineering manufacturing. But following on from the Bain & Company approach, we have sought to disaggregate the wind and marine sector into five activities:

1. Planning and Development (of sites)
2. Manufacturing and Design (of wind and marine energy equipment, but not generic components such as ball-bearings)
3. Construction and Installation
4. Operations and Maintenance
5. Specialist Support Services and Other.

There is a wide flux in estimates of renewable energy employment in the literature. A review of papers shows that a wide variation of techniques has been applied in the past, across similar

sectors in differing regions, to estimate the employment impact of renewable energy industries. These methods include various types of model-based analyses. Many use meta-analysis of the literature and case studies as their starting points (Burguillo et al., 2009 and Williams et al., 2008), and some have used surveys (Blanco et al., 2009 and Lehr et al., 2008).^{32/33/34/35} However, significant inconsistencies have resulted, largely from the lack of continuity and clarity in the definitions used by different authors.

Survey

Our approach builds on the most comprehensive employment and skills survey of companies in the wind and/or marine energy sector to date. The survey focused on UK employers and captured the largest sample of renewable businesses compared to previous attempts. The data from the survey was used to develop a projections model designed to analyse annual employment effects of alternative scenarios for UK and global wind and marine energy deployment through to 2021.

The purpose of the survey was:

- to measure employment for April 2010 to identify the total number of people employed overall in the sector and the mix of roles in the industry;
- to gain an indication of the skills demand and supply in the sector; and
- to obtain the detailed information required to construct the projection model.

The survey was undertaken by IFF Research with employers operating in the wind and marine energy sector, between 30 September and 27 October 2010.

The respondents were requested to supply data for April 2010 (the start of the financial year). The sample of employers was provided by RenewableUK and 561 companies were emailed informing them of the survey and its purpose. 253 companies supplied data via telephone interview and their responses were used to

estimate employment for the full population of companies directly involved in wind and marine energy.

The results of the survey are reported in *Working for a Green Britain*.

Overview of modelling approach

The second part of the approach saw the development of a model to project UK employment into the future, covering both employment arising in the wind and marine energy industries as well as indirect employment to support the additional renewables activity.

Three market development scenarios (High, Medium and Low) were fed into the model for each technology, to generate projections for direct and indirect employment.

Modelling Direct Employment

Direct employment is modelled separately for each activity based on the specifics of that activity, the industry drivers identified and the characteristics of each technology. The key drivers for projections always relate to the input assumptions on total cumulative capacity, but other variables are also critical.

These are discussed on a case-by-case basis below.

Planning and Development (for each technology)

For Planning and Development, current levels of output and employment are calibrated to expectations of future rates of annual deployment. As an example, large onshore wind projects that are expected to be built between 2011 and 2015 will contribute to 2010 levels of activity in Planning and Development in onshore wind.

The lead times to consent vary by technology. For example, for large onshore wind and marine energy technologies the lead times are two

to five years, whilst for offshore wind they are two to four years. In contrast, a lead time of a few days/weeks is assumed for Planning and Development of small-scale wind systems (this is not represented in the annual model).

Manufacturing and Design (for each technology)

For Manufacturing and Design, output and employment are related to the following factors:

- Annual domestic deployment combined with domestic market share
- Annual export market capacity deployment – combined with export market share
- Export market based on the Global Wind Energy Council (GWEC) Scenarios for Europe for large onshore and offshore wind
- Export market for small-scale wind systems based on Small-scale Wind Systems Report (export market is global rather than European)
- Export for marine from EMEA
- Export market shares based on assumptions, both in the history – which is key to calibration – and the forward-looking rates
- Learning rates.
- The changes in each of these factors, compared to the current market situation, are used to estimate turnover and employment in future years.

Construction and Installation (for each technology)

For Construction and Installation, current levels of output and employment are calibrated to both current levels and expectations of future levels of annual deployment.

As an example, large onshore wind projects that are expected to be deployed between 2010 and 2011/12 will contribute to 2010 levels of activity in Construction and Installation in onshore wind. The lead times vary by technology, and there are no assumed lead times for Construction and Installation of small-scale wind systems, which are simply linked to current installation rates.

As deployment rates increase, so too do employment and output in Construction and Installation activity, but they are reduced by the effect of the learning rate, which introduces effective productivity gains (through learning) as capacity deployment increases.

Operations and Maintenance (for each technology)

Output and employment in Operations and Maintenance activities are driven by the growth in total capacity and therefore assume constant average annual load factors over time.

This is a valid assumption since we are trying to estimate employment, rather than output, and employment is unlikely to be substantially affected by above, or below, average load factors between years. A learning curve is also introduced to reflect expected gains in productivity as the various technologies are deployed.

Specialist Support Services

The projections for Specialist Support Services are based on the growth of each of the above activities and the “I–O” relationship identified from the survey between each activity for each technology and the support services purchased. This is described more fully in the next section, when considering indirect employment, where the model mechanics are the same; the only difference is that Specialist Support Services have been classified as direct, whilst other “non-specialist” suppliers to the UK wind and marine industry have been classified as indirect.

Modelling Indirect Employment

The model for indirect employment is based around the concept of an input–output table. This framework provides a coherent representation of UK economic statistics (specifically, the national accounts) and was considered to be the most suitable method for analysing the UK wind and marine energy industry in the context of the wider economy. The model combines official UK economic data (produced by the UK Office for National Statistics, ONS) with data taken

from the survey conducted specifically for this project. Once combined with assumptions on future renewables uptake and production trends in the industry (such as learning rates), the model is able to generate projections of indirect employment that can be attributed to increased wind and marine energy industry activity (see Figure 1).

An input–output table embodies an accounting framework that defines an economy’s industrial structure in terms of sectors (sometimes referred to as institutions) such as households, corporations and government, and transactions (purchases/flows) between pairs of sectors (their linkages). The transactions are normally reported in monetary units. In this way, the table depicts the chain of purchases made by, say, households on consumer goods. In turn, the table tracks purchases of inputs by the consumer goods industry on other sectors further up the supply chain and these upstream sectors’ purchases on their suppliers, etc. An input–output table, of the kind used in the model, is a matrix in which the columns represent industries and the rows represent these same industries’ products. The matrix elements thus report the purchases made by industries of other industries’ products.

In the input–output framework, the demand for a particular class of final output, for example, household demand for consumer goods, can be traced back through to manufacturers and on to their suppliers. Industry-to-industry flows, such as manufacturing’s purchases from other suppliers, constitute what is termed intermediate demand, whilst final demand refers to demand for end-products, the final good sold to households.

The implication in this kind of framework is that a one-unit increase in demand for goods entails a more-than-one-unit increase in economy-wide output, because the additional demand is transmitted up the supply chain, necessitating purchases of inputs elsewhere.

Analysis of this kind, to assess the impacts of changes in demand on the wider economy, is termed multiplier analysis, and yields estimates of the

amount of output required across the economy to support a given increase in final demand. The application of productivity figures can then be used to convert this into an equivalent measure in terms of employment: the number of economy-wide (full-time equivalent) jobs required to support an increase in demand in a sector sufficient to require one more employee in that sector.

The most common forms of multiplier are Type I and Type II output multipliers. Type I multipliers measure the direct and indirect impacts, allowing us to calculate indirect job impacts; they are calculated from considering the linkages between the domestic industry sectors only (i.e. only intermediate demand effects). Type II multipliers include the induced impact; their calculation takes the additional step of endogenising the household sector, by including the compensation paid in exchange for labour inputs and how this flows into household incomes, which generates further final demand for products. The calculation of the induced impact allows us to estimate induced employment impacts based on the productivity of the sectors impacted. Households are effectively treated as another industry in the economy, supplying labour and purchasing final goods and services. Type II employment effects are calculated in the model but are not reported here.

The input–output tables produced by national and international statistics agencies typically record purchases for a single year, which is suitable for our needs. The level of disaggregation (i.e. the sectoral detail) in the data is relatively high, but does not separately identify elements of the renewables industry that are of interest in this study. It is necessary to construct a modified input–output table that reduces the detail in some areas (other UK sectors are aggregated up to much broader categories as these are not the focus of the analysis and serve to reduce the overall complexity of the final model) and adds detail elsewhere (the wind and marine energy sectors).

If the wind and marine energy industries can be represented in terms of its transactions (i.e. we can add the

appropriate columns to the input–output table), then multiplier analysis can be carried out. To preserve the accounting framework that underpins the original input–output table used as the starting point, values in the matrix are re-allocated, away from industries not involved in renewables, to the wind and marine energy sectors.

The level of wind and marine energy industries detail added to the input–output table, and by extension included in the model, covers a number of activities for each technology: Construction and Installation Operations and Maintenance Planning and Site Development Manufacturing and Design (of renewable energy technologies relating to marine energy) Specialist Support Services.

Activities classified as “indirect” in the survey include:

- Research
- Technical and environmental consultancy services
- Professional business services
- Training
- Other

The data collected from the survey serve as the starting point for the construction of the new input–output table, identifying the approximate sizes of the various sectors in terms of turnover (and their wage bills), as well as, for the Planning and Development, Manufacturing and Design, Construction and Installation, and Operations and Maintenance sectors, details regarding their expenditures on inputs from Specialist Support Services and other indirect activities. These expenditures, wage bills and turnover figures were used as the basis to carry out the re-allocation. For the other direct and indirect activities, in the absence of more detailed information on their expenditures, the intermediate demands from their parent sectors (i.e. from the original table) were assumed to be reflective of the proportions in the wind and marine energy activities and accordingly shared out by their gross output/turnover figures.

From the survey data alone (which were themselves adjusted to attempt

to account for missing data and non-responses), the construction exercise above led to a first estimate of the input–output table that is incorporated into the final model. Some adjustments were made at this point for the purposes of modelling. Uncertainty in some survey figures manifested itself in implausible input requirements when the total output from some sectors was considered – intermediate demand as a proportion of gross output exceeded 100%, which gives rise to implausibly large multipliers and is, in accounting terms, somewhat unlikely. In such cases, the decision was made to allocate additional gross output to these sectors (to more closely resemble their parent sectors) in order for more sensible multiplier effects to be calculated.

Having constructed an input–output table (and the associated multipliers) that separately identifies wind and marine energy industries from the rest of the UK economy, projections of future employment can be generated as follows (which is a broad description of the steps implemented in the model):

For each technology, calculate the amount of new capacity to be planned, manufactured and built (not deployed – in other words accounting for lead times, and domestic and export market shares) in the UK in the current year, and convert this new capacity into the equivalent amount of output required (based on the survey data on capacity and value of construction); this will be applied to the relevant technology’s Planning and Development, Manufacturing and Design, and Construction and Installation sectors.

For each technology, take the total amount of capacity operating in the UK in the current year, and for a number of lead years (the number of lead years varying across technology) convert into the equivalent amount of output (based on the survey data on the value of Operations and Maintenance, and the capacity it currently supports); this will be applied to the relevant technology’s Operations and Maintenance sector.

Having calculated the required demand in terms of output, apply the multipliers to obtain the output impacts by indirect

sector and for Specialist Support Services.

Apply productivity figures to the output impacts to derive the employment impacts (which are calibrated back to the data in the case of direct activities); the productivity figures may evolve over time according to an assumed learning rate.

Caveats of modelling

Uncertainty around the employment projections has been mitigated as far as possible: the dataset is based on the most comprehensive survey of the entire sector and its companies’ employment, turnover and purchasing characteristics to date; where data was not available it was supplemented through estimates based on stakeholder engagement; capacity projections were taken from the literature and scrutinised by the project team and third-party stakeholders; and finally, we present a range of projections to highlight the impact of different, but plausible, assumptions on the projections.

However, the projections depend entirely on the starting data and the assumptions, both on the current state of the markets and the scenario assumptions for future capacity deployment and market development. There is little more that can be done to remove the inherent uncertainty around how the wind and marine energy sectors might develop over the next ten years in terms of electrical capacity and market demand for UK manufactured technologies.

References & Endnotes

1. University of Warwick Institute for Employment Research, Cambridge Econometrics, IFF Research (2011), *Working for a Green Britain*
 2. Bain & Company (2008), *Employment Opportunities and Challenges in the Context of Rapid Industry Growth*
 3. Hay Group (2009, & 2010) Renewables Reward Survey, www.haygroup.com/uk/
 4. Department of Energy and Climate Change (June 2010) *Digest of UK Energy Statistics 2010*
 5. RenewableUK (live online), UK Wind Energy Database (referenced for April 2010), www.bwea.com/ukwed/index.asp
 6. European Wind Energy Association (April 2010), EWEA Annual Report
 7. RenewableUK onshore wind member consultation meeting (01/03/2011)
 8. European Wind Energy Association (2009) *Pure Power 2009 Update*, www.ewea.org/fileadmin/ewea_documents/documents/publications/reports/Pure_Power_Full_Report.pdf,
 9. International Energy Association (November 2010), *Global Energy Outlook*
 10. Ofgem, (October 2009), *Project Discovery: Energy Market Scenarios*
 11. Department of Energy and Climate Change (2009), *National Renewable Action Plan*
 12. Sinclair Knight Merz for BERR, (June 2008), *Quantification of Constraints on the Growth of UK Renewable Generating Capacity* ('Medium Growth Scenario')
 13. RenewableUK offshore wind member consultation meeting (01/03/2011)
 14. RenewableUK (2010 & 2011), *Rebirth of Manufacturing Volumes 1 & 2*
 15. a) Douglas Westwood for RenewableUK (2010), *UK Offshore Wind: Building an Industry* ('Aggregate Developer Appetite scenario')
b) Douglas Westwood for RenewableUK (2010), *UK Offshore Wind: Building an Industry* ('Healthy Industry scenario')
 16. Aquamarine Power (2010), *Danish wind 1980-2010: lessons for the British marine energy industry*
 17. RenewableUK (April 2010), *Small Wind Systems: UK Market Report*, and DECC, RESTATS (visited: 10/01/2011) <https://restats.decc.gov.uk/cms/welcome-to-the-restats-web-site/>
 18. RenewableUK small wind systems member consultation meeting (07/03/2011)
 19. Mott MacDonald (May 2011), *Costs of Low Carbon Generation Technologies*
 20. Renewables Advisory Board (June 2008) 2020 VISION – How the UK can meet its target of 15% renewable energy
 21. BWEA response to the Renewable Energy Strategy Consultation
 22. Department for Business Enterprise and Regulatory Reform (2008), *The Growth Potential for Micro-generation in England, Wales and Scotland*
 23. Element Energy for BERR (2008), *The Growth Potential for Onsite Renewable Electricity Generation in the Non-Domestic Sector in England, Wales and Scotland*
 24. Carbon Trust (2011), *Marine Renewables Green Growth Paper*
 25. RenewableUK (2010), *Marine Renewable Energy, State of the Industry Report*
 26. RenewableUK Marine Energy Member Consultation (01/03/2011)
 27. EU Ocean Energy Association (2010), *Oceans of Energy: European Ocean Energy Roadmap 2010-2050*, www.eu-oea.com/index.asp?bid=436
 28. Carbon Trust (2006), *Future Marine Energy*
 29. Office for National Statistics (May 2011), *National Vacancy Survey*
 30. www.statistics.gov.uk/pdfdir/lmsuk0511.pdf
 31. Card Group (2010), *Training Provision in Large Scale Wind Renewables*
 32. EngineeringUK (2010), *EngineeringUK 2011: State of Engineering*
 33. Burguillo, M and P del Rio (2009), *An Empirical Analysis of the Impact of Renewable Energy Deployment on Local Sustainability*, Renewable and Sustainable Energy Reviews Volume 13
 34. Williams, S.K., Acker T., Goldberg M., and Greve M. (2008), *Estimating the Economic Benefits of Wind Energy Projects Using Monte Carlo Simulation with Economic Input/Output Analysis*, Wind Energy
 35. Blanco & Rodriguez (2009), *Direct employment in the wind energy sector: An EU study*, Energy Policy Volume 37 Lehr, U., Nitsch J., Kratzat M, Lutz C., Edler D., (2008) Renewable Energy and Employment in Germany, Energy Policy Volume 36
- i. 10,800 direct FTEs were reported by IER in February 2011. This figure has been revised down to 10,600FTEs – it was detected that small wind employees were double counted in Installation and Maintenance because the question asked was misinterpreted.
 - ii. BWEA (former trade name for RenewableUK) commissioned Bain & Company to publish 'Employment Opportunities and Challenges in the Context of Rapid Industry Growth'.
 - iii. Estimated from DUKES data. The first UK onshore wind project was in 1991, there is now 3.4 GW – that's an average of around 190 MW installed per annum over 18 years.

About the authors



Cambridge Econometrics (CE) specialises in the application of economic modelling and data analysis techniques to the needs of clients in business and government. It is a leading independent economic consultancy, with a full portfolio of economic intelligence services. CE was established in 1978 to provide commercial access to research in the University of Cambridge, in particular to the work carried out in developing the Cambridge Multisectoral Dynamic Model of the British economy (MDM).

Since its founding, CE has provided one of the most detailed industrial forecasting services available for the UK economy. The work of the company has now expanded to cover regional and local forecasts for the UK, forecasts for Europe, and energy-economy-environment analysis and forecasts for the UK and Europe, as well as modelling work for individual clients. Our clients represent a wide variety of businesses, and central and regional government bodies and our expertise has been employed over a wide range of economic modelling issues.

Over the past years a significant proportion of the company's work has been in the area of European economic modelling. This has come about through the development of the E3ME model, a sectoral-based econometric input-output model for Europe, with economy-energy-environment (E3) interactions, which has been used in a wide array of projects for Commission Services.

More information can be found at
www.camecon.com
info@camecon.com
 01223 533100



The Institute for Employment Research (IER) was established by the University of Warwick in 1981. The IER is one of Europe's leading centres for research in the labour market field. Its work focuses upon the operation of labour markets and socio-economic processes related to employment and unemployment in the UK at national, regional and local levels. It includes comparative European research on employment and training. The IER's research fields involve addressing major issues of socioeconomic behaviour and policy in their local, national and international setting. The work of the IER covers a wide range of research-related activities; basic and strategic research; labour market assessment and evaluation; household and employer surveys; technical assistance and consultancy; and an advanced study programme.

The IER provides a range of research and analytical services to customers in both the public and private sectors. It has conducted major research projects for all the main UK government departments as well as for various international organisations, including the ILO, OECD, European Commission, Cedefop, etc.

More information can be found at
www2.warwick.ac.uk/fac/soc/ier
ier@warwick.ac.uk
 02476 523283



IFF Research is a long-standing full-service research agency set up in 1965, and employing 55 staff. It specialises in studies on employment, learning and skills, working regularly for government departments and agencies including BIS, DWP, Sector Skills Councils, Skills Development Scotland, the Skills Funding Agency, and the UK Commission for Employment and Skills (UKCES). IFF undertakes studies employing the full spectrum of research methodologies, from qualitative studies involving depth interviews and focus groups, to large quantitative surveys using online, postal, telephone, and face-to-face approaches.

More information can be found at
www.iffresearch.com
dirts@iffresearch.com
 020 7250 3035

RenewableUK

Greencoat House, Francis Street
London SW1P 1DH, United Kingdom

Tel: +44 (0)20 7901 3000

Fax: +44 (0)20 7901 3001

Web: www.renewable-uk.com

Email: info@renewable-uk.com