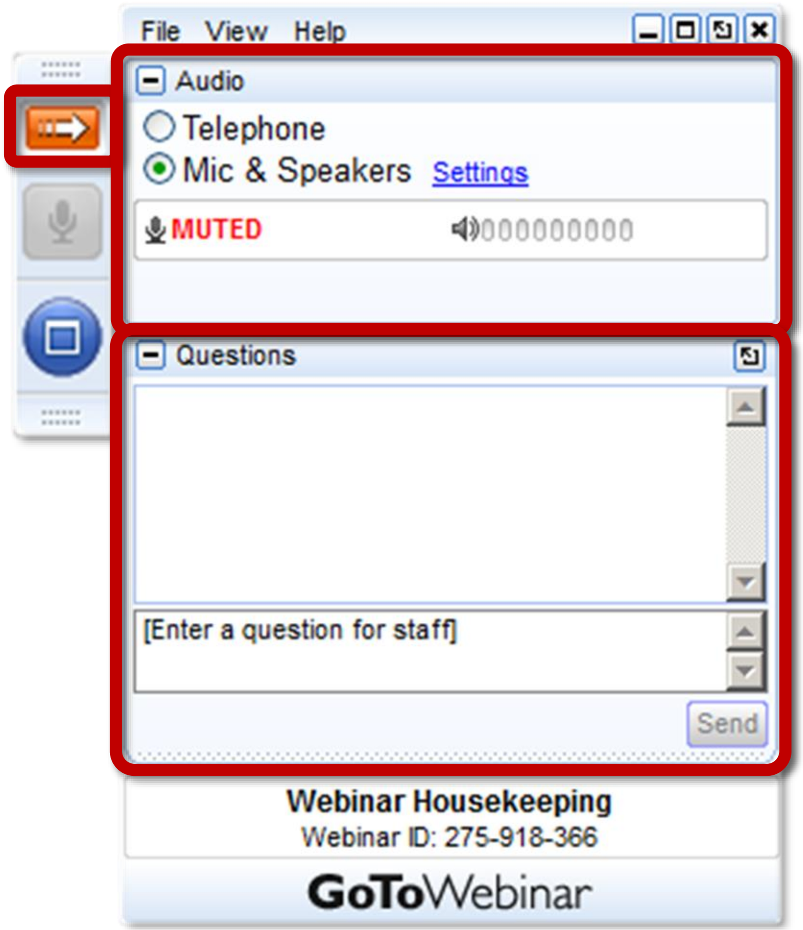
Northeast Wind Resource Center Webinar

U.S. Job Creation in Offshore Wind

Hosted by
Val Stori, Clean Energy Group
December 7, 2017

Housekeeping



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The Northeast Wind Resource Center

The Northeast Wind Resource Center (NWRC) is the regional epicenter for salient, unbiased information on land-based and offshore wind energy in the Northeastern United States. Published research, studies, and analyses associated with the issues impacting public acceptance of wind deployment are available in the NWRC Resource Library.

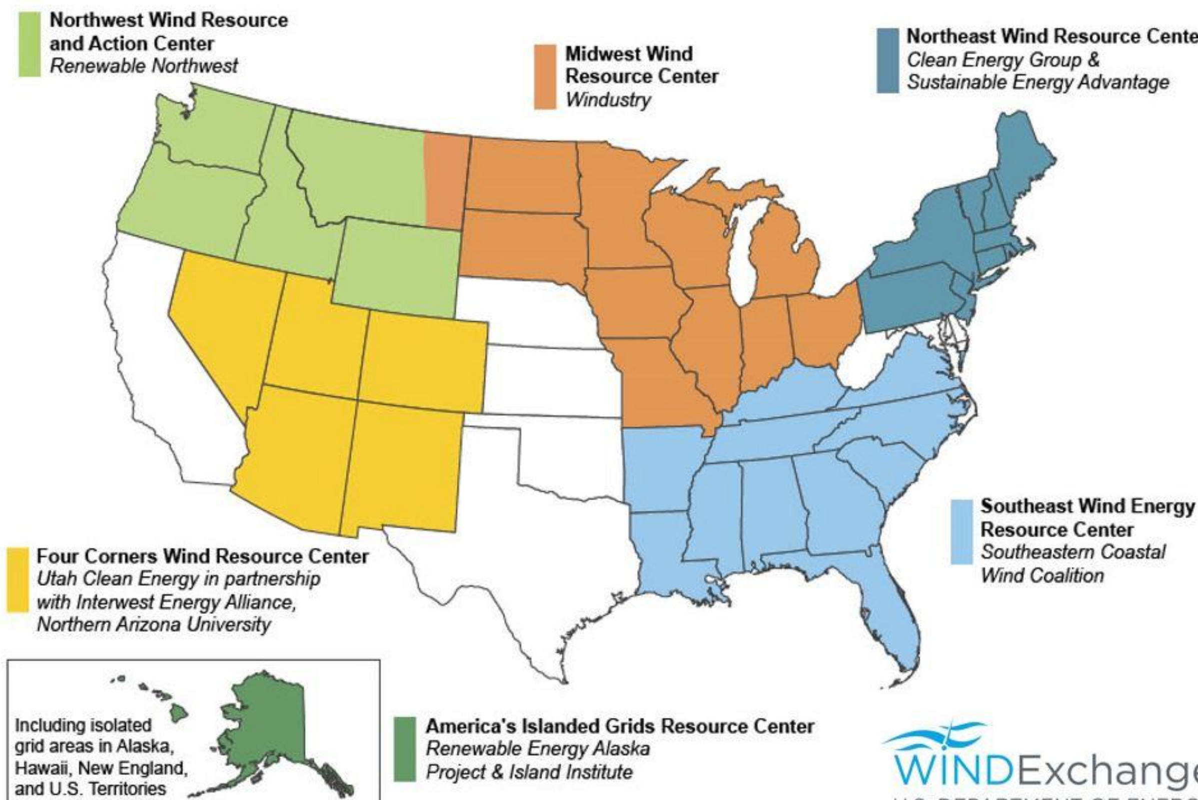
The NWRC is supported in part by a grant from the U.S. Department of Energy's WINDExchange program, and is managed by Clean Energy Group, with participation from Sustainable Energy Advantage and the Maine Ocean & Wind Industry Initiative.

www.northeastwindcenter.org

About WINDExchange

WINDExchange is the U.S. Department of Energy (DOE) Wind Program's platform for disseminating credible information about wind energy. The purpose of WINDExchange is to help communities weigh the benefits and costs of wind energy, understand the deployment process, and make wind development decisions supported by the best available information.

On March 11, 2014, the U.S. Department of Energy (DOE) announced six Wind Energy Regional Resource Centers that were selected through a competitive process administered by the National Renewable Energy Laboratory (NREL).



WINDExchange
U.S. DEPARTMENT OF ENERGY

A Roadmap for Multi-State Cooperation on Offshore Wind

Three reports:

- Northeast Offshore Wind Regional Market Characterization
- U.S. Job Creation in Offshore Wind
- U.S. Jones Act Compliant Offshore Wind Turbine Installation Vessel Study

www.northeastwindcenter.org/offshore-wind/multi-state/#reports

Northeast Wind Resource Center

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State of Rhode Island Office of Energy Resources

CleanEnergy States Alliance

Panelists

- **Alun Roberts**, Associate Director, BVG Associates
- **Val Stori**, Project Director, Clean Energy Group/ Clean Energy States Alliance (moderator)

U.S. Job Creation in Offshore Wind

A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind

Alun Roberts, BVG Associates

Massachusetts Clean Energy Center
Massachusetts Department of Energy Resources
New York State Energy Research and Development Authority
Rhode Island Office of Energy Resources
Clean Energy States Alliance

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Agenda

1. Background and methodology
2. Quantitatively analysis of US offshore wind jobs
3. Occupation analysis of offshore wind jobs
4. Conclusions

Dr Alun Roberts,
Associate Director, BVG Associates
aer@bvgassociates.com
+44 1793 799022

MHI Vestas V164-8.0MW turbines being installed at the Burbo Bank Extension

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Due diligence

Asset management

Technology support

Competitor landscape / Voice of customer / Industry introductions / Value proposition development / communications strategy / M&A / Tendering support

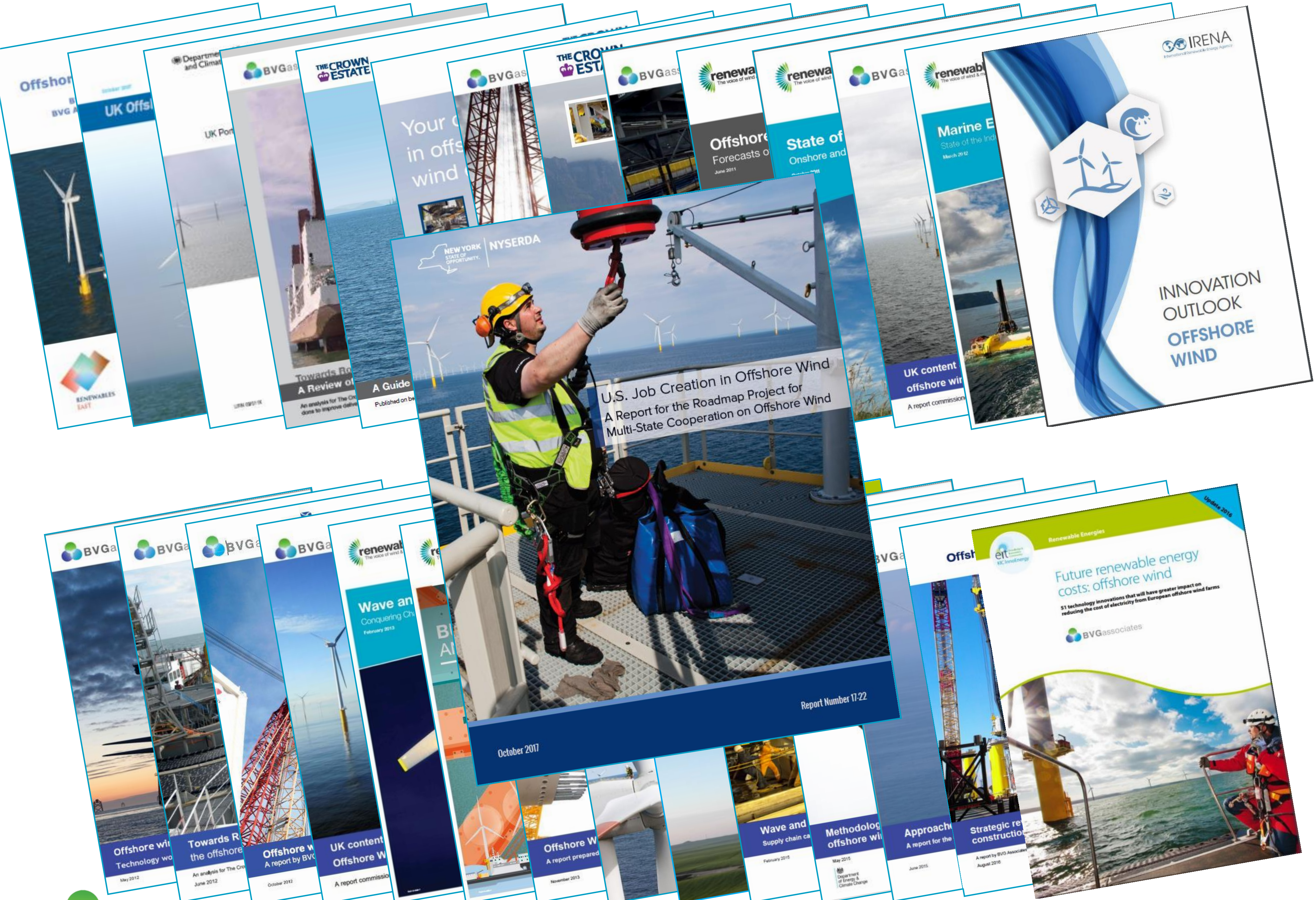
Onshore wind

Offshore wind

Wave and tidal

Energy Systems

Slides indicated pre-read provide relevant, detailed information but will not be covered in detail during the presentation.


NYSERDA
U.S. Job Creation in Offshore Wind
A Report for the Roadmap Project for Multi-State Cooperation on Offshore Wind
Report Number 17-22
October 2017
IRENA
INNOVATION OUTLOOK
OFFSHORE WIND
Update 2016
Renewable Energies
Future renewable energy costs: offshore wind
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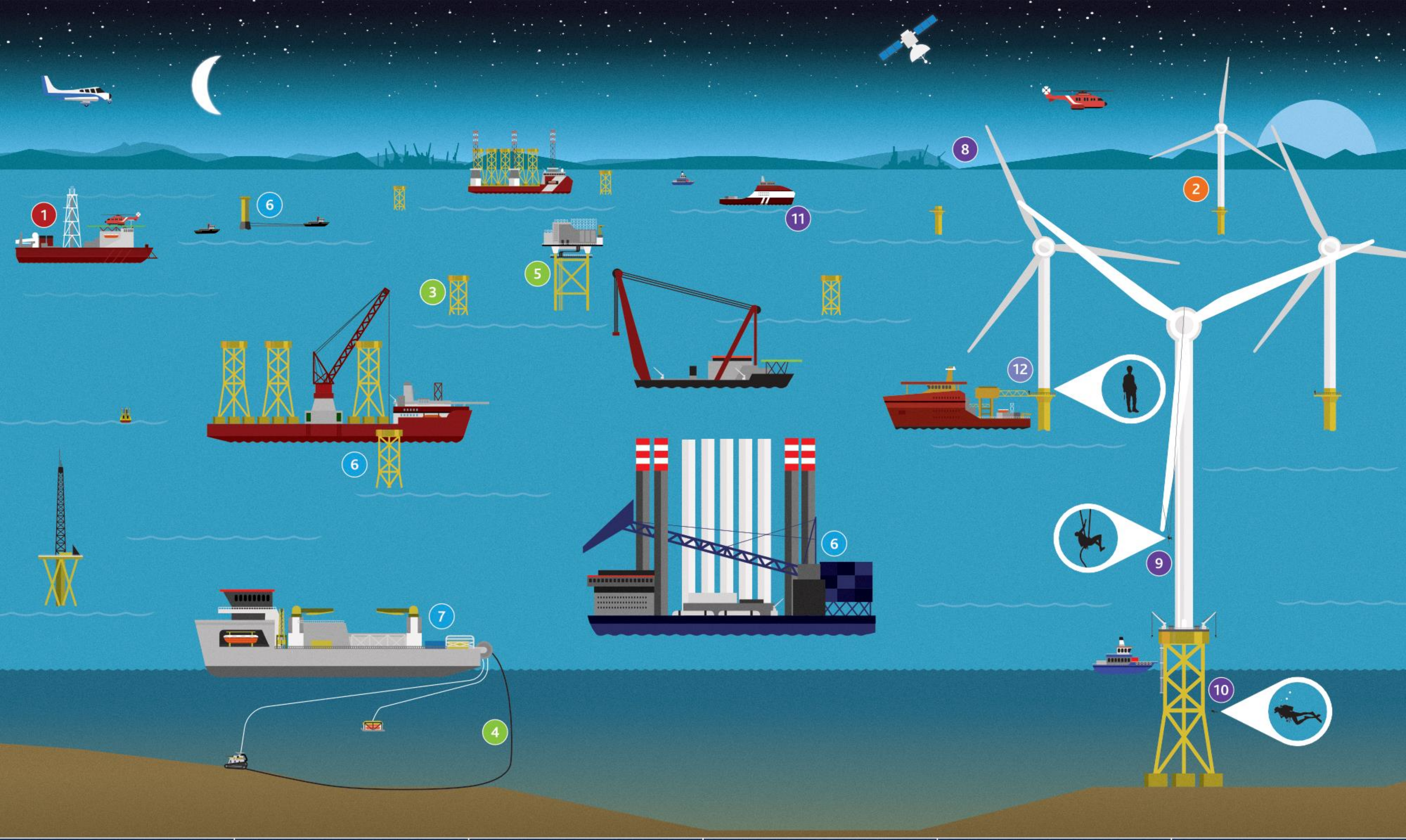

Development	Turbine supply	Balance of plant supply	Installation & commissioning	Operations, maintenance & service	
1 Development surveys and studies	2 Turbine tower supply	3 Foundation supply	6 Turbine and foundation installation	8 Wind farm operations	12 Cross-cutting
		4 Cable supply	7 Cable installation	9 Turbine maintenance	
		5 Substation supply		10 Structural inspect and repair	
				11 Offshore logistics	

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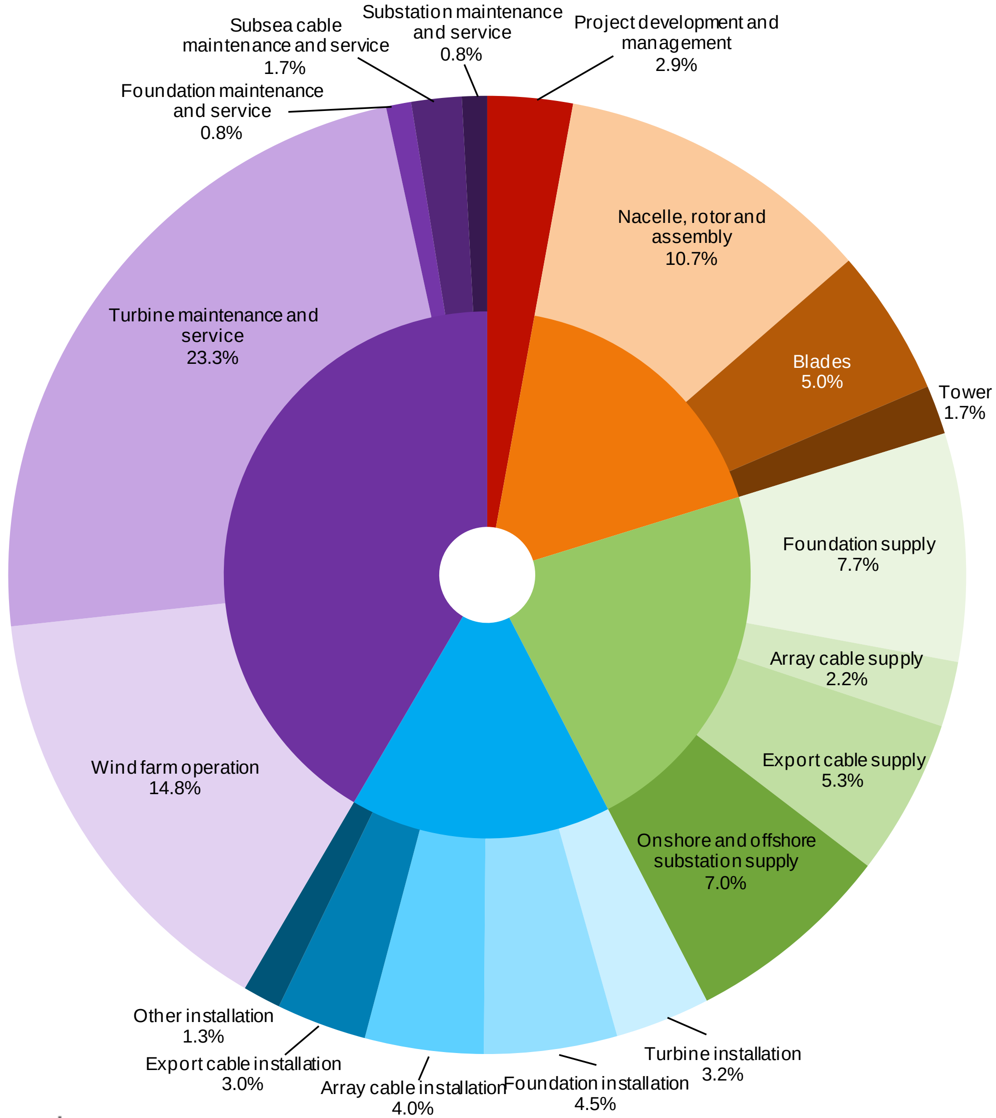
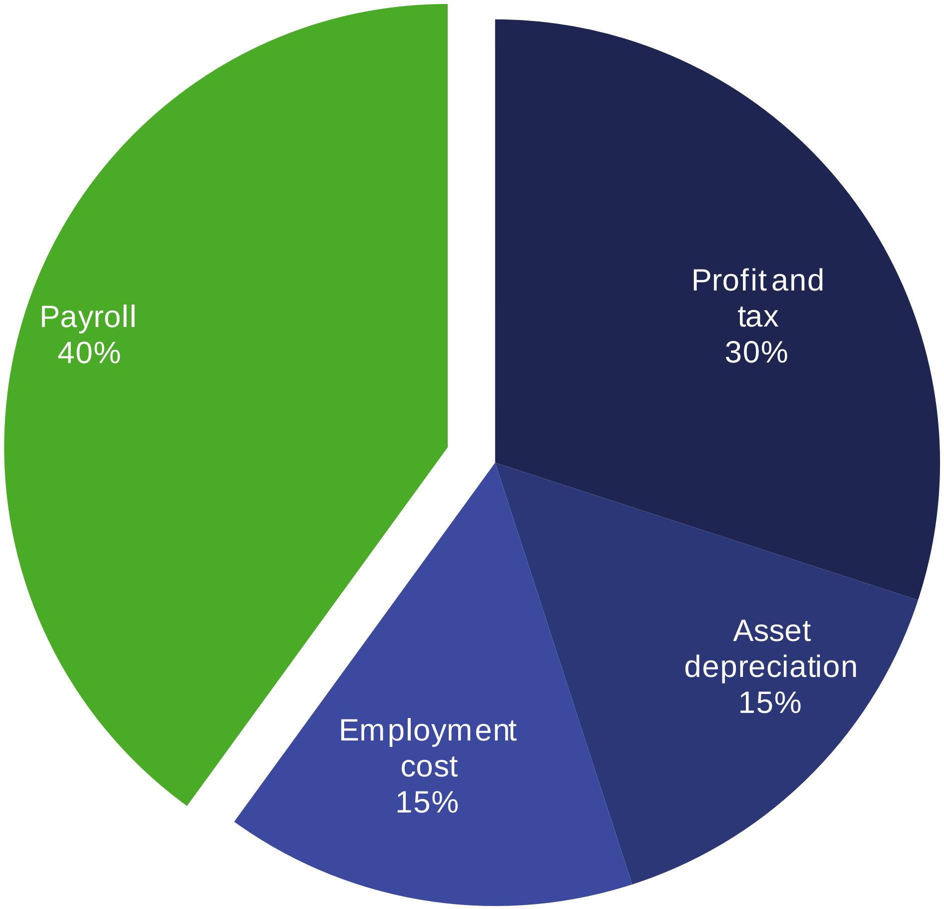
Total offshore wind costs



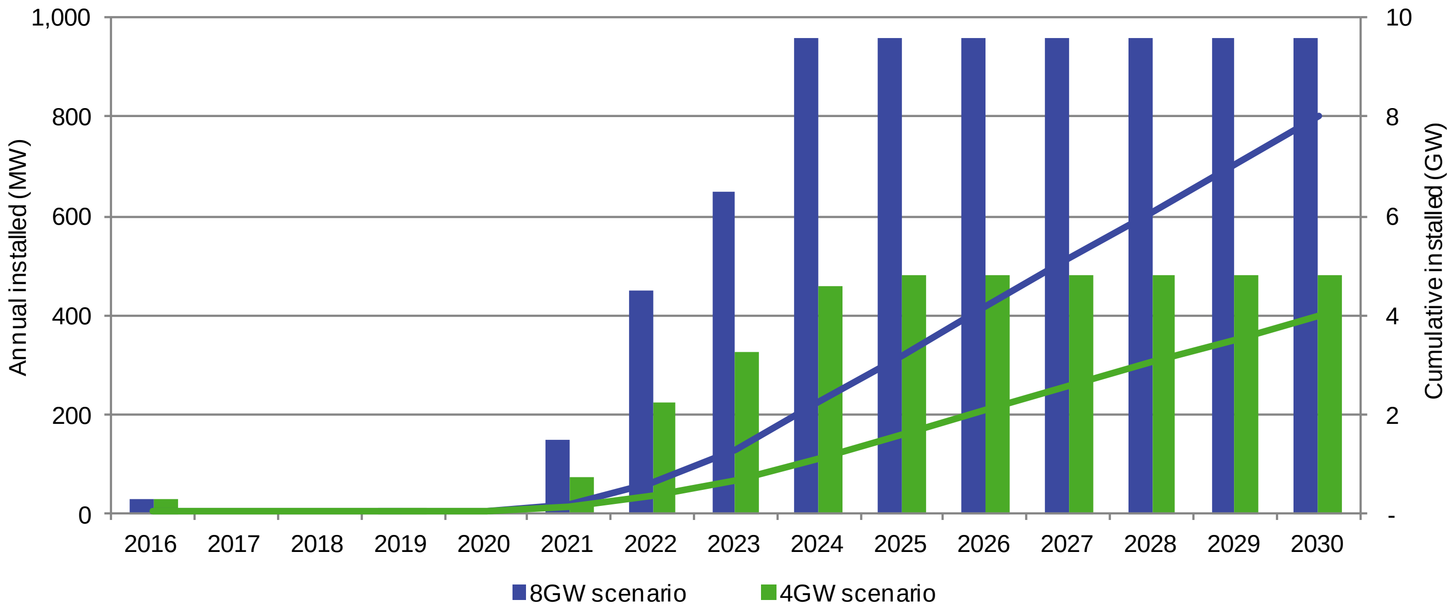
Total offshore wind jobs: methodology



Isolate the payroll

- The aim of the analysis was to understand how much of the expenditure on an offshore wind farm is spent on wages.
- Wind farm costs were based on analysis we undertook with NYSERDA.
- There is no established supply chain in the US, and so we used figures based our understanding of profit and asset depreciation on our experience in Europe.
- Having done this, we researched typical salaries and labor costs in states where we expected offshore wind.
- The methodology differs from conventional approaches that typically use North American Industry Classification System (NAICS) codes. This is the standard used by Federal statistical agencies in classifying business establishments for the purpose of collecting, analyzing, and publishing statistical data related to the U.S. business economy. These codes do not map easily onto the offshore wind sector.

Market scenarios



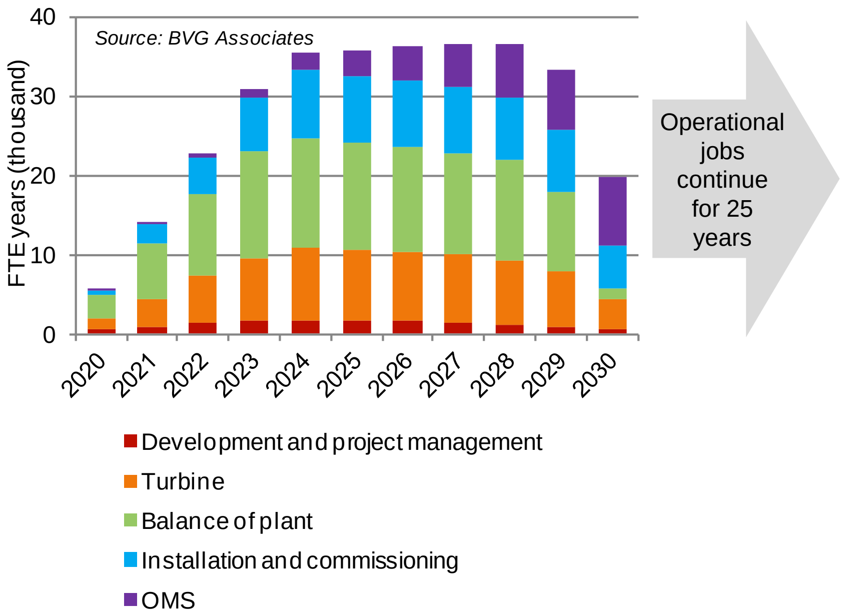
- We agreed a high and low scenarios with the project steering group of 8MW and 4MW built by 2030 along the US east coast .
- These scenarios included Block Island in 2016 and South Fork in 2021 but otherwise were not based on individual projects.
- The key feature was that from 2024 onwards, the annual rate of installation remained the same.

Total job creation

Element of the supply chain		8GW	4GW
Project development and management		14,010	6,980
Turbine supply	Nacelle, rotor and assembly	49,580	24,700
	Blades	18,170	9,000
	Tower	6,140	3,000
Balance of plant	Foundation	36,860	18,400
	Array cables	10,110	5,000
	Export cable	26,440	13,200
	Substation supply and operational infrastructure	37,980	18,900
Installation and commissioning	Turbine	9,790	4,900
	Foundation	19,980	10,000
	Subsea cable	32,060	16,000
	Other installation	7,330	3,700
Operation, maintenance and service	Wind farm operation	64,290	32,000
	Turbine maintenance and service	149,050	74,200
	Foundation maintenance and service	4,890	2,400
	Subsea cable maintenance and service	8,540	4,300
	Substation maintenance and service	3,850	1,900
Total		**499,070**	**248,580**

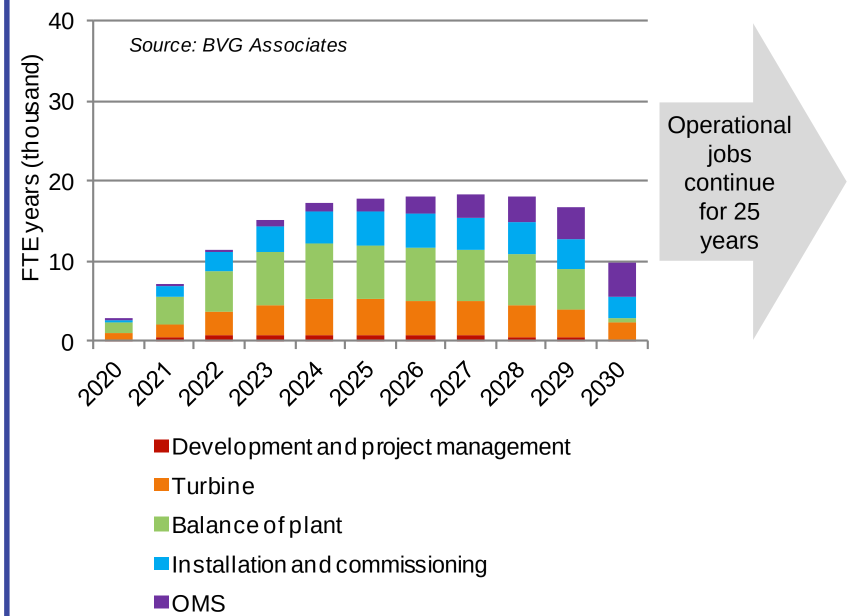
Total job creation

High market scenario



- Annual FTEs peak at about 35,000.
- There is a gradual increase in the proportion of operational jobs.
- There is a gradual decrease in capital phase jobs 2024-2028 because industry learning means lowers costs and fewer jobs.
- The number of jobs starts to fall away in 2029 because no new capacity after 2030 is modelled.

Low market scenario

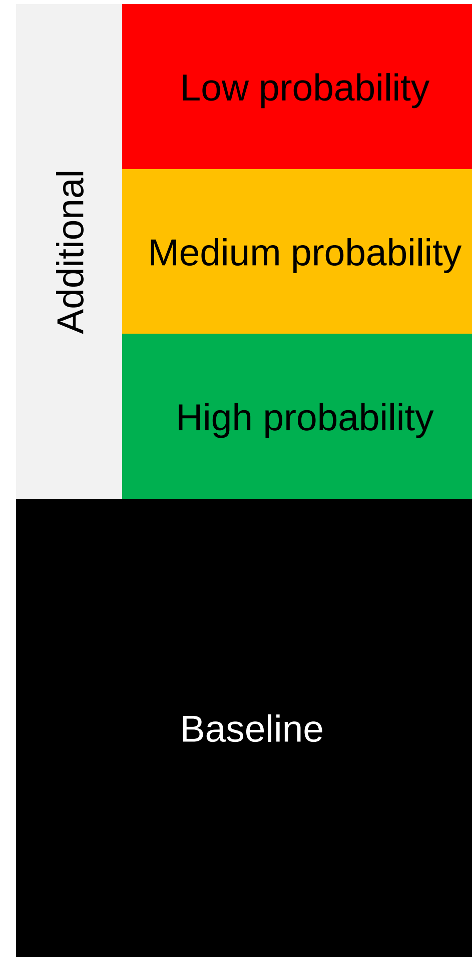


- Annual FTEs peak at about 18,000.
- There is less of a decrease due because a smaller market achieves cost reduction more slowly.

*One full-time equivalent (FTE) year is the equivalent of one person employed full time for a year. It could be, for example, two people employed full time for 6 months or two people employed 50% of the time for a year.

Probability of US jobs

- Baseline jobs are those where there are no compelling reasons why the work would not be undertaken in the US. These baseline jobs are not necessarily undertaken by US nationals.
- Additional jobs may be created in the US by investments in new manufacturing and service facilities. These additional jobs were categorized as high, medium or low probability for each scenario.
- The probability was based on
    - Additional supply chain capacity: the US market may create new demand that cannot be met from existing factories
    - Benefits of local supply: imported components or services from outside the US may have significantly higher costs or risks
    - Local expertise: US companies may have world-class capability that is unlocked by the creation of a local market
    - Market structure: conditions imposed on developers, such as lead times for delivery or local content, may support or hinder investment in local capacity



US offshore wind jobs: turbine

Nacelles

High	Low

- There will be sufficient capacity in European factories to the mid-2020s.
- For nacelles, assembly is ideally close to the wind farm but it is more important for the manufacturer to remain close to its major suppliers.
- There is experience in nacelle and hub component manufacture and assembly in the US from the onshore wind sector, but concentrated in other regions away from the northeast coast.

In the high market scenario, there is a medium probability that the US will secure nacelle and hub components and assembly. In the low market scenario, there is a low probability.

Blades

High	Low

- There will be sufficient capacity in European factories to the mid-2020s.
- Transport and handling of blades is costly and there are few supply chain interfaces. There is therefore a strong benefit of local supply.
- The US has established blade manufacturing skills although this is concentrated in other regions away from the northeast coast.

In the high market scenario, an investment in a US blade manufacturing facility is a high probability. In the low market scenario, there is a medium probability.

Towers

High	Low

- There will be sufficient capacity in European factories to the mid-2020s.
- Transport and handling of towers is costly and there are few supply chain interfaces. There is therefore a strong benefit of local supply.
- The US has tower capability but not in locations suitable for offshore wind.
- Towers are manufactured by third parties and low profit margins are a barrier to investment.

In the high market scenario, an investment in a US blade manufacturing facility is a high probability. In the low market scenario, there is a medium probability.

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US offshore wind jobs: balance of plant

Foundations

High	Low

- There will be sufficient capacity in European factories to the mid-2020s.
- Transport of foundations is costly, there are few supply chain interfaces and suppy chain risk is mitigated by local supply.
- Offshore wind profit margins are narrow and demand is likely to be ‘lumpy’. Efficient manufacture requires significant investment.
- For jackets, high volumes and complex fabrication have meant that several European suppliers have faced financial difficuties.

Foundation and substation supply provides a high probability for additional US jobs in both market scenarios.

Array cables

High	Low

- There will be sufficient capacity in Europe and Asia factories to the mid-2020s.
- Although cable transport and storage is costly, the offshore wind industry has not stimulated significant investment in factories in new markets, mainly because of the high CAPEX and long lead times.
- Array cables are supplied from factories that also meet demand for oil and gas power cables and umbilicals.

In the high market scenario, an investment in a US array cable facility is a high probability. In the low market scenario, there is a medium probability.

Export cables

High	Low

- Capacity has long been an area of concern for offshore wind developers and the growth of the US market in both scenarios will create additional strain on supply.
- There are benefits of local supply but manufaturers have been cautious about building new factories. Most existing factories were built for high capacity interconnectors and there are none in the US.

In the high market scenario, an investment in a US export cable facility is a medium probability. In the low market scenario, there is a low probability.

Offshore wind occupations

Foundations install High Low

- There is limited availability of heavy lift vessels with capacity greater than 1,200t.
- Current Jones-Act compliant vessels are unlikely to be suitable but solutions using US-flagged feeder vessels are viable.
- A CESA-commissioned study showed that a 4GW pipeline could provide a business case for a US-flagged wind farm installation vessel. It would be impractical for a single vessel to support all US offshore wind farm installation.

In the high market scenario, US foundation installation installation is a medium probability. In the low market scenario, there is a low probability.

Subsea cable install High Low

- Jones Act not likely to be applied to cable vessels.
- European vessels could be used, although mobilisation costs may make them uncompetitive.
- There are US-flagged vessels that could be used for oddshore wind cable-laying, although these are likely to be suboptimal because of the specific requirements of offshore wind.

Subsea cable installation jobs have been judged as baseline because there is US capability and no compelling reason to use European contractors.

Turbine installation High Low

- There is limited availability of jack-up vessels with the capability of installing turbines >8MW at 110m.
- Current Jones-Act compliant vessels will not be suitable and feeder solutions are expensive and unproven.
- For early US wind farms at least, creative solutions are likely to be needed.

In the high market scenario, US turbine installation installation is a medium probability. In the low market scenario, there is a low probability.

Offshore wind occupations

Operation

High	Low

- Covers asset management and procurement, and the provision of quayside infrastructure and equipment (including vessels).
- Most administrative functions are provided by a dedicated operating company with some services provided by one of its owners. Most of this work is undertaken locally at the operations base.
- Overseas developers may initially provide some of these services, such as engineering and asset management, from their European teams.

Wind farm operation has been judged as baseline because most functions will need to be in the US, even if they are not local to the wind farm.

Turbine MS

High	Low

- Turbine manufacturers typically negotiate a five-year service agreement with the wind farm owner.
- Most of the jobs are created locally for day-to-day service tasks. Additional labor will be brought in for regular turbine maintenance work but, in a mature US offshore wind industry, this will be done by US technicians.

Turbine maintenance and service has been judged as baseline because most functions will need to be in the US, even if they are not local to the wind farm. Major components will need to be imported if original supply is not US.

Other MS

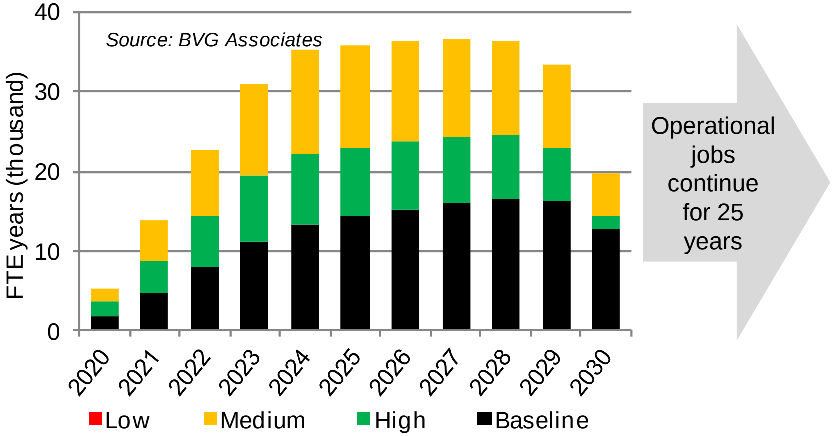
High	Low

- Covers inspection. maintenance and repair to foundations, cables and substations.
- Cable repair is a key area with cables the largest cause of insurance claims in the sector.
- This work is intermittent and very local suppliers are unnecessary. Nevertheless, US suppliers are likely for many aspects of the work.
- In some specialist areas, European suppliers are likely to seek US work and those that are successful are likely to build up US operations.

Other maintenance and service has been judged as baseline.

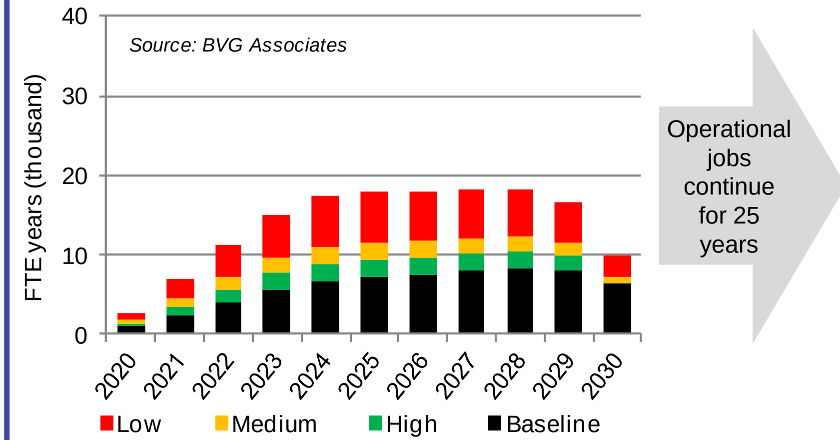
Probability of US jobs

High market scenario



- There is a medium probability that the US can deliver all parts of the offshore wind supply chain.
- A US market of about 1GW is probably smaller than suppliers would like (they would like 1GW for themselves) but the costs of importing from Europe should create a business case for US investment.
- The proportion of baseline jobs increases as operations activity increases and capital phase work decreases in 2029 and 2030.

Low market scenario



- For most of the decade, a third of the supply chain jobs are low probability.
- A US market of 400-500MW a year is insufficient to support a business case for significant new offshore wind investment. It may only be 30 turbines a year, perhaps 10% of European factory output.

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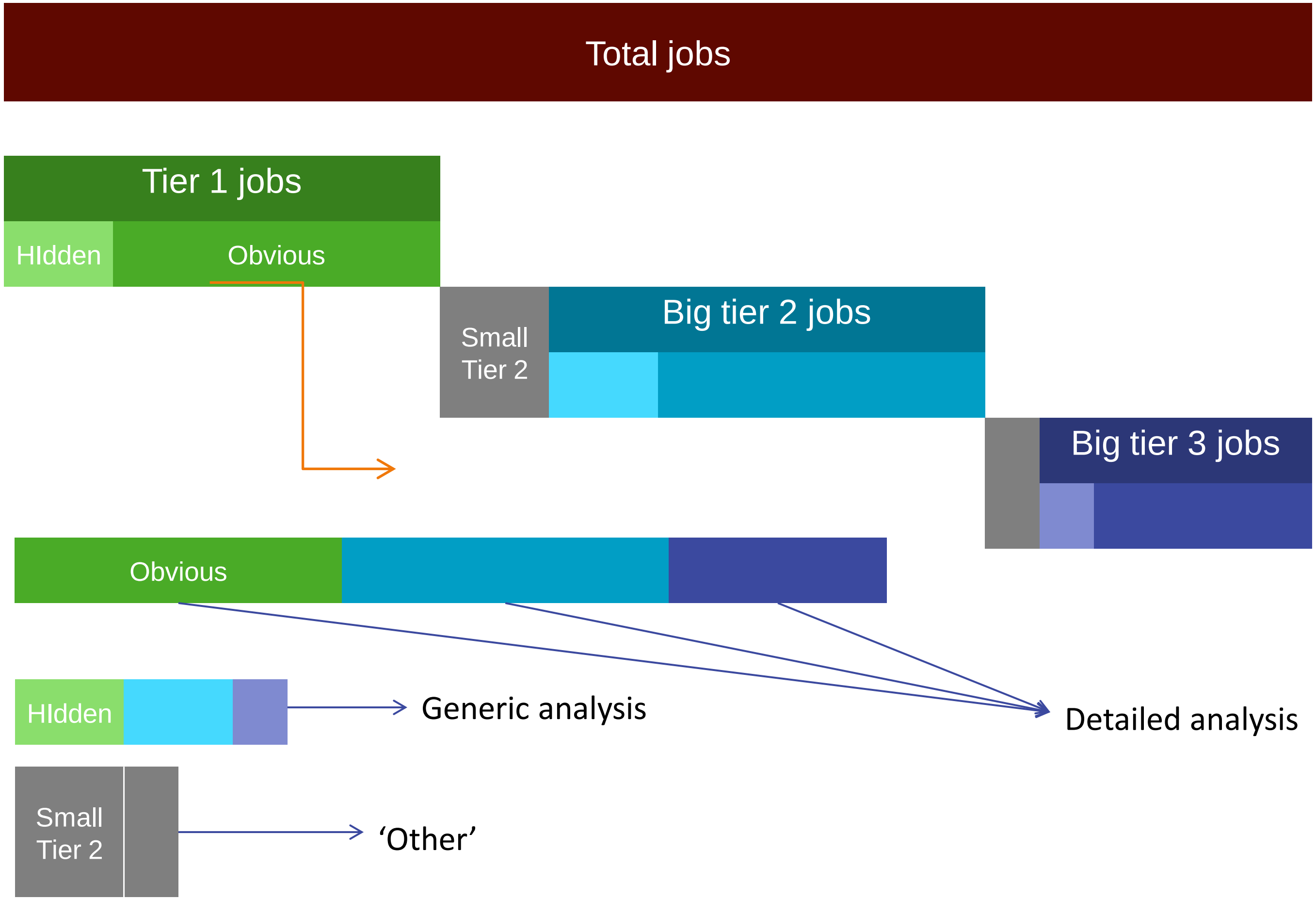
Offshore wind occupations

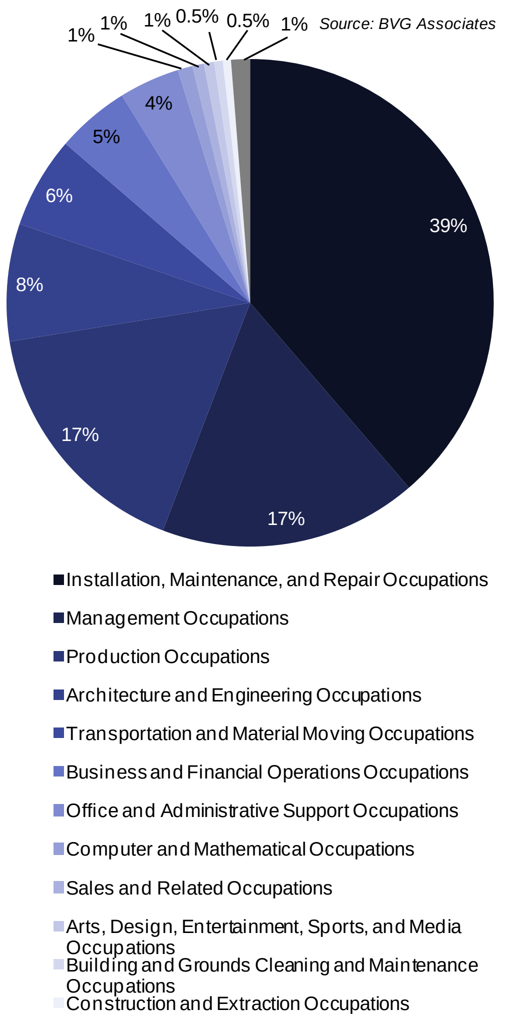
Method

- Department of Labor's Standard Occupational Classification (SOC) system
- Breakdown (%) of roles developed through interviews with established European suppliers.
- The only reasons for differences in the US may be levels of productivity or automation, which are unlikely to be significant

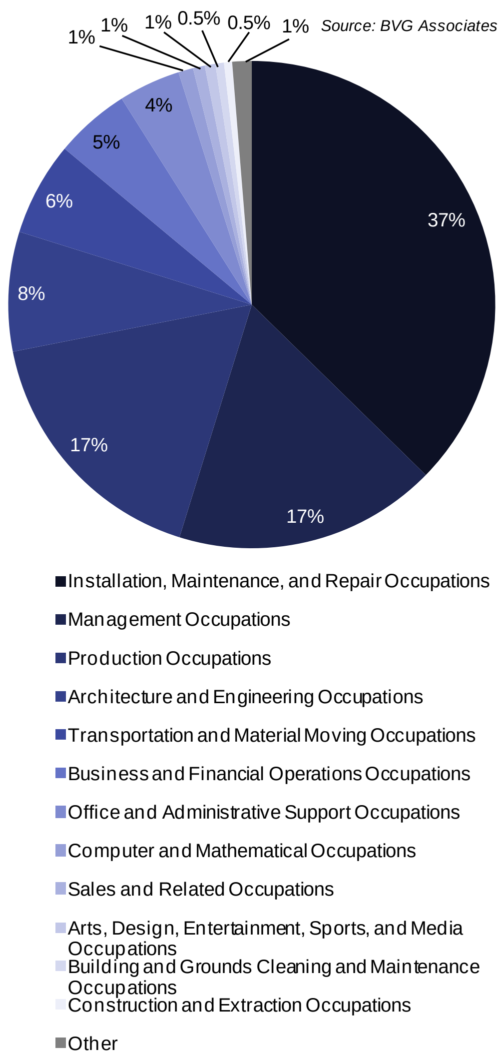


Occupations analysis

Total jobs



Baseline jobs

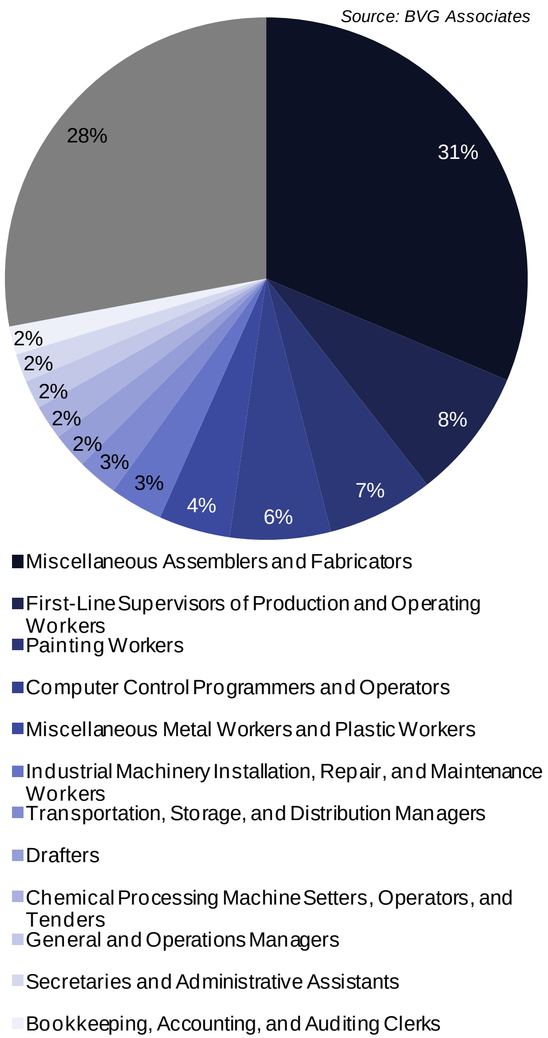


Results at 'major group' category

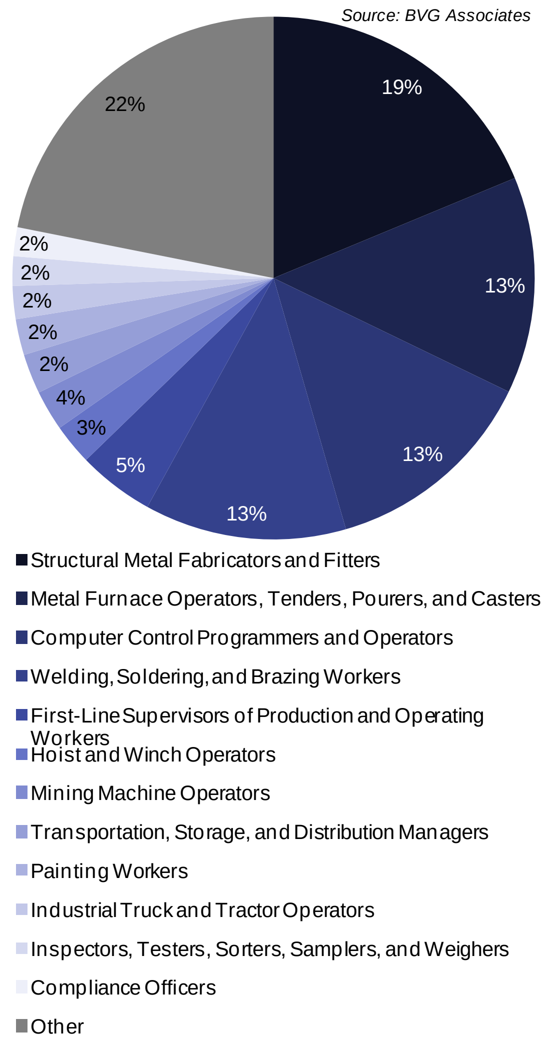
- Major group category is the top level category.
- Unsurprisingly, there is a high proportion of workers engaged in installation and maintenance, production and management
- There are also small but significant numbers of those in general back office occupations, in IT, human resources, sales and marketing, and finance.

Occupations analysis

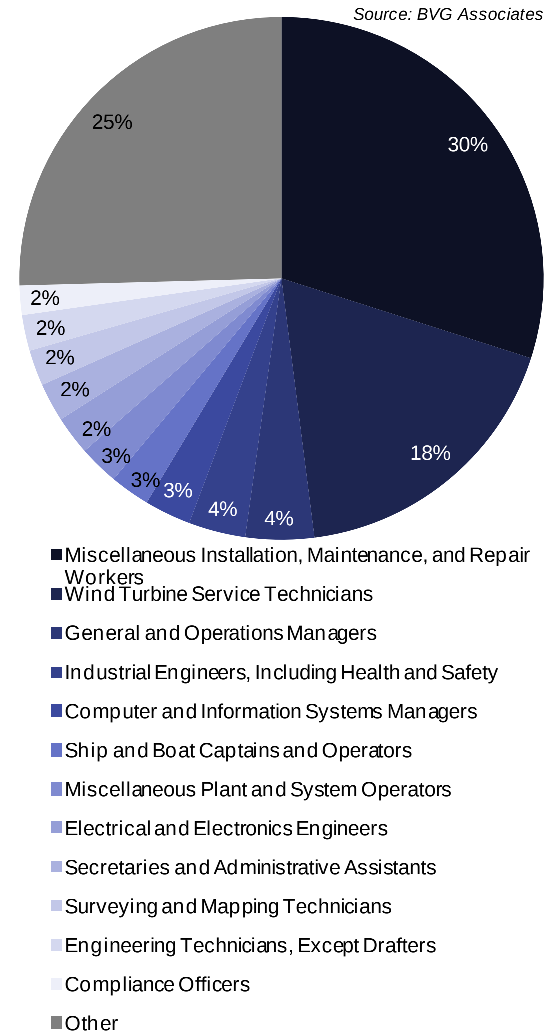
Blades



Foundations



Turbine installation



Conclusions

- The US offshore wind sector will create a significant number of jobs. If the US reaches 8GW by 2030, it should be able to create jobs across all parts of the supply chain.
- In a smaller market, in which the US reaches 4GW by 2030, the case for new offshore wind investments is weak but there are still signifcant 'baseline' jobs, mainly in development and operations. More jobs could be created if local content is demanded but this will limit the US's ability to benefit from European cost reductions.
- The offshore wind sector will support a diverse range of jobs. The key occupations are at technician level, in manufacturing, installation and maintenance. There is a demand for these skills across a range of industrial sectors and offshore wind increases the case for investment to create these skills.
- Suppliers will undertake product-specific training but they will look to public training providers to develop core skills.
- As for all sectors, offshore wind will support employment in back-office functions such as IT, marketing and sales, and finance and in generic business services. These jobs are not 'visible' but they represent a real effect of offshore wind.

Thank you

BVG Associates Ltd
The Blackthorn Centre
Purton Road
Cricklade, Swindon
SN6 6HY UK
tel +44 (0) 1793 752 308

info@bvgassociates.com
@bvgassociates
www.bvgassociates.com

BVG Associates Ltd
Inovo
121 George Street
Glasgow
G1 1 RD UK
tel +44 (0) 44 212 0800

BVG Associates LLC
874 Walker Road
Suite C
Dover
Delaware
19904 USA
tel +1 (313) 462 0673

Andy Geissbuehler
amg@bvgassociates.com
+1 804 405 5156

Thank you for attending our webinar

Val Stori
Clean Energy Group/
Northeast Wind Resource Center
val@cleanegroup.org

Northeast Wind Resource Center: www.northeastwindcenter.org

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