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Accelerating Climate Actions

Socioeconomic impacts and skills development for Indian offshore wind

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Executive summary

India's offshore wind (OSW) sector presents a significant opportunity for clean energy and socioeconomic development. It has a target of 37 GW to be auctioned by the end of 2030, supporting its broader clean energy transition and net-zero commitment by 2070. The sector is expected to generate substantial local gross value added (GVA) and employment across the lifecycle of projects.

This study quantifies the socioeconomic impacts of India's OSW sector and identifies opportunities for skills development for Indian offshore wind. It was conducted by BVG Associates, with support from ClimateHub India Advisors and involved extensive stakeholder engagement.

Economic impacts

The study evaluated the economic and employment impacts of OSW under two scenarios:

- A global value chain scenario (S1), where much of the hardware is imported, and
- An Indian value chain scenario (S2).with a robust domestic value chain with substantial local manufacturing and workforce participation.

Under the global value chain scenario, a single 1 GW offshore wind project in Tamil Nadu generates approximately ₹2,790 crore GVA and 15,000 full-time equivalent (FTE) years of employment. Under the Indian value chain scenario, the same project generates around ₹7,390 crore GVA and 38,800 FTE years of employment, about 77% of total FTE years created by the project, globally.

Similarly, in Gujarat, a single 1 GW project under the global value chain scenario generates about ₹3,220 crore GVA and 17,000 FTE years of employment. Under the Indian value chain scenario, it generates approximately C5,350 crore GVA and 29,700 FTE years, about 59% of total FTE years created by the project, globally.[i]

Figure A illustrates the national employment impacts under the Indian value chain scenario across the 37 GW project pipeline. This results in a total of approximately ₹2,40,400 crore GVA and 1,280,000 FTE years of employment, substantially higher than the ₹1,08,000 crore GVA and 576,000 FTE years estimated under the global value chain scenario.

These impacts cover development, manufacturing, installation, operation, and decommissioning phases, with the operation phase accounting for the largest share due to its long-term nature. Note that the economic impacts are calculated based on a 37 GW project pipeline, with deployment timescales from 2031 to 2043. If additional capacity comes online beyond this period, the impacts are expected to continue beyond 2043, rather than drop off, as shown in Figure A.

[i] Economic impacts should be interpreted with reference to the methodology outlined in Section1.1.1 and Appendix B.

Figure A National employment impacts over project pipeline in the Indian value chain scenario (S2).

The study finds:

- Development and project management activities are high in local content.
- There is much manufacturing potential, facilitated by investment in coastal facilities for nacelle assembly, and manufacture of blades, towers, monopile foundations, and array cables. Such investments offer significant export opportunities due to India's competitive manufacturing base and strong technical workforce, aligned with its *Make In India 2.0* initiative.[1]
- The installation and commissioning phase has significant potential for economic benefit, in using India's expertise in oil and gas and maritime sectors. With sufficient investment and a large enough market, many activities can be localised and carried out in India, supported by global contractors.
- Operation phase activities offer sustained local employment over 30 or more years.

Social impacts

Social impacts are equally important. Case studies from Vietnam, Taiwan, the UK, and the US highlight successful community benefit initiatives, supporting local employment, infrastructure investment, and environmental protection. These examples underscore the importance of inclusive development and stakeholder engagement.

Skills and workforce development

Skills development will be critical to support the OSW sector. The study identifies around 60 key job roles across development, manufacturing, installation, and operations. These roles are generally considered critical as they demand either higher skills, greater responsibility or specialised knowledge specific to OSW, or are in other ways harder to fill, for example due to the volume required. Roles such as mechanical technicians, project managers, and environmental analysts will be in high demand. The selected job roles, when in direct employment, cover about 26% of the total direct and indirect jobs available, with many others indirectly employed deeper into the supply chain.

Universities and industrial training institutes in India already provide a large pool of technically educated staff. A range of training institutes already provide courses relevant to onshore wind and marine operations. It is anticipated that industry, with the help of such providers, will recruit and train a workforce for OSW at the right time, given sufficient confidence to invest.

Route to creating local benefit

The main route to creating local benefit, therefore is to get rational and robust national and state visions, policies and frameworks aligned to give Indian and global OSW industry players confidence to invest, supported by the international finance community. Only after this do actions to support development of the local workforce really impact.

Recommendations

The following actions are recommended.

Increasing confidence in a long-term Indian offshore wind market

1. National and state Government develop clear industrialisation and localisation strategies and policy relating to OSW manufacturing and installation. Alignment of strategy, policy and the frameworks for delivery of OSW maximise the chance of success, as discussed in *Accelerating the Deployment of Offshore Wind in India.*[2]
2. National and state Government build confidence in the Indian OSW industry generally, such that there is increased focus on India as a market to invest in. This is best done through establishing a clear and well-justified volume vision, robust and transparent frameworks, well-resourced institutions with clear responsibilities, and good coordination between national and governments, Indian industry and global wind industry players.
3. National and state Government, including through auction and permitting frameworks, drive good practice in communicating about local content, local gross value added and employment to enable non-ambiguous messaging and drive the desired behaviour of creating local benefit.

Supporting skills development

4. National and state Government implement good practice from other OSW markets and other industries in India to measure and address diversity, gender balance, and equality as the OSW workforce grows.
5. National and state Government support industry to retrain professional staff in skills relevant to OSW through derisking the sector (as described above) and through training or apprenticeship grants.
6. Relevant skill councils communicate clearly about timing and volume of workforce requirements, based on realistic industry growth, and keeping in step with forecast industry need, so that plans are made in good time and workforce is ready, but not trained too early.
7. Relevant skill councils facilitate collaborations between industry, training providers and (where relevant) overseas expertise to accelerate design and delivery of training in areas most wanted by industry, recognising that this will evolve over time as a project pipeline is established.
8. Skill Council for Green Jobs (SCGJ) mobilises and focus the existing training provision on more content relevant to OSW, endorsing relevant courses, including as provided by Global Wind Organisation (GWO) affiliates.
9. Ministry of Education encourages development primary- and secondary-school curriculum content, including projects, with OSW themes, to raise awareness of the sector at an early stage.
10. Indian Institutes of Technology and other universities incorporate OSW content into undergraduate and master's degrees.
11. SCGJ provides online skills and wider information about OSW, for example as done in other European markets through Guide to an Offshore Wind Farm[3] and Building Offshore Wind in Ireland.[4] highlighting the long-term career potential of OSW.
12. SCGJ and industry recognise that recruitment agencies also play an important role in seeking staff with relevant experience in other sectors and providing them with an early understanding of OSW.

Building on existing training capabilities

13. Training institutions develop modular bridge training programs that build on existing onshore wind expertise while introducing offshore-specific modules, enabling staff to train in stages.
14. SCGJ support and encourage existing wind-related training institutions to expand their curricula to include OSW courses, especially those located in coastal regions near where OSW is likely to establish.
15. Industrial skills organisations work sensitively with oil and gas enabling organisations and companies to explore the synergies and benefits of cross-sector working.
16. Ministry of Petroleum and Natural Gas and Ministry of New and Renewable Energy (MNRE) support oil and gas innovators to bring experience to support OSW.

Again, it is noted that staff may working in both sectors across oil and gas and OSW, rather than choosing one sector, exclusively.

Using overseas expertise

To maximise the impact of leveraging overseas expertise, it is recommended that:

17. Industry and training providers Invest in train-the-trainer programs and promote long-term partnerships between overseas experts and local training providers.
18. Industry uses early involvement of overseas experts, for example project directors, to mentor and provide on-the-job training to senior local staff, maximising the chance of success of early projects and enabling positive learning experiences across project teams.

Strengthening health and safety frameworks

To address challenges in health and safety for OSW in India. it is recommended that:

19. Ministry of Labour & Employment updates India's regulatory framework to include OSW-specific safety standards, with cross-agency and industry coordination to ensure clear oversight. It will be important to reflect international best practice and local considerations.
20. Ministry of Labour & Employment and state agencies establish safety audit mechanisms for OSW farms, again with clear, consistent ownership of implementation.
21. Ministry of Labour & Employment drives health and safety-focused behaviours through leadership and culture that are fully embedded in the industry – it is not enough just to have a regulatory framework that is fit for purpose.
22. Ministry of Labour & Employment. with SCGJ implements national training guidelines for wind energy professionals that align with recognised international standards, national and local regulations.

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- Global Wind Organisation
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Contents

List of figures

List of tables

Introduction

India is one of the fastest growing economies in the world and is set to achieve net zero by 2070. The Government of India has shown a strong commitment to clean energy, setting an ambitious target of 500 GW of non-fossil capacity by 2030. Wind energy plays a central role in India's renewable energy landscape, with close to 50 GW of installed capacity, placing the country fourth in the world for onshore wind capacity. Building on this momentum, India also has ambitions to develop an offshore wind (OSW) sector. With its extensive wind resources and a 7,900 km mainland coastline, the country is ready to tap into its OSW potential. Based on preliminary assessments by the National Institute of Wind Energy (NIWE), the states of Gujarat and Tamil Nadu together have 70 GW of OSW potential.

The Ministry of New and Renewable Energy (MNRE), the nodal Ministry for OSW development in India, published the first *National Offshore Wind Energy Policy* in 2015. [5] India has since published various reports aimed at fostering the growth of this sector and promoting investment. In September 2023, MNRE published a strategy paper detailing the areas to be awarded and proposed auction models to allocate sites for the development and construction of OSW projects.[6] The paper stated an ambition to auction 37 GW of OSW leases in India by the end of 2030, putting OSW at the forefront of the country's energy transition plans.

In 2024, in a significant step towards kickstarting India's OSW portfolio, the Government of India announced the development of 4GW of OSW projects off the coast of Tamil Nadu[7] and a 500 MW pilot project Gujarat. Subsequently, processes for the 4 GW tender and the Gujarat demonstration competition were cancelled due to a lack of developer interest, and are pending reformulation.[8] Surveys are underway in Tamil Nadu with a tender process likely to be announced in February 2026.[9] Along with this, the Government of India approved the Viability Gap Funding (VGF) scheme in June 2024 which includes ₹7,453 crore (about US$850 million) for installation and commissioning of 1 GW of OSW energy projects (500 MW each off the coast of Gujarat and Tamil Nadu). Of this, ₹600 crore (US$69 million) is for port upgrades.[ii] [10] In October 2024, the Ministry of Power issued a 25-year waiver on interstate transmission (ISTS) charges for OSW projects beginning operations by December 31, 2032.[11]The Central Electricity Regulatory Commission subsequently updated the regulatory framework.

Besides contributing towards India's net zero targets, India's emerging OSW sector presents significant socio-economic benefits. The development of a burgeoning OSW domestic value chain will have far-reaching economic impacts on the Indian economy, generating significant gross value added (GVA) and full-time equivalent job-years (FTE-years) of employment. To capitalise on these opportunities, the country will need a skilled and specialised workforce. Developing targeted training programmes and partnerships with educational institutions will be essential to ensuring that India's workforce can meet the demands of the OSW industry and support its growth.

To understand the impact of OSW development on India's economy, workforce and society, a socioeconomic impact analysis is critical. Socioeconomic impact analyses provide an understanding of how the OSW sector can influence social and economic development, locally and nationally. This analysis will be beneficial to India by:

- Enabling stakeholders to make informed decisions on policies, incentives, and investments to support OSW growth while maximising national economic benefit.
- Highlighting opportunities for domestic value chain development, guiding policies that encourage local manufacturing, workforce, and infrastructure development. This will help India maximise the local economic benefit of OSW development.
- Developing a clear understanding of socioeconomic benefits to build public support for OSW.

This report analyses the economic impacts of India's OSW pipeline, focusing on how it will contribute to local and national growth. It addresses likely social impacts through relevant case studies from existing projects in other

[ii] Where US$1 is about ₹87 at time of writing.

markets. In addition, the report forecasts demand for key OSW job roles in India, and the skills development necessary to support the sector's expansion.

This project delivers:

- A value chain assessment of India's strengths within various cost categories of the OSW value chain
- A timeline of economic benefits across the value chain for Gujarat, Tamil Nadu, and the rest of India, including development, manufacturing, installation, operations, and decommissioning
- An assessment of skills and training needs in comparison with training provision, and
- Recommendations based on global best practices, and engagements with established international and national stakeholders.

About this report

This report is the output of work undertaken by BVG Associates (BVGA), a global leader in OSW industry building, supported by ClimateHub, an innovative Indian advisory firm focused on renewable energy and climate action. The study was carried out from October 2024 to January 2026, with engagement and input from relevant stakeholders.

The report is structured into two main chapters.

- Chapter 1 presents
  - The methodology and results behind the socioeconomic impact analysis of the Indian OSW sector.
  - A comparison of socioeconomic impacts of OSW with those of other renewable energy technologies.
  - Global examples of social impact case studies.
  - A summary of challenges and opportunities.
  - Specific recommendations to maximise socioeconomic benefits in Indian OSW deployment.
- Chapter 2 presents
  - The methodology and results behind the skills and training analysis of the Indian OSW sector.
  - A review of training programmes in India.
  - A summary of challenges and opportunities, including:
    - Best practice examples on how to leverage overseas expertise
    - Health and safety considerations of the current domestic legislative environment and international standards, and
    - Opportunities for transition of skills from the oil and gas industry.
  - Recommendations on how to support the Indian OSW workforce with the required skills.

1. Socioeconomic impact analysis

A socioeconomic impact analysis is used for assessing the effects of major infrastructure projects, such as OSW development, on a nation's economy, workforce, and society. This analysis provides a comprehensive understanding of how the OSW sector can influence social and economic development, locally and nationally. For the emerging Indian OSW sector, it is important to evaluate both the direct and indirect benefits to ensure that the economic and social advantages are maximised while addressing potential challenges.

Chapter 1 analyses the social and economic impacts of OSW development, with a focus on its implications for India’s emerging OSW industry. This chapter is divided into five sections.

- Section 1.1 Economic impact of Indian offshore wind: Evaluates the economic potential of OSW in India, emphasising how the sector could generate significant local and national GVA and FTE-years of employment while supporting India’s broader energy transition.
- Section 1.2 Offshore wind economic impacts vs other renewable energy technologies: Compares the economic impacts of OSW with those of other renewable energy technologies in India.
- Section 1.3 Social impacts from global offshore wind farms: Illustrates the social impacts of OSW deployment from key markets, offering real-world examples of how OSW projects have impacted local communities, employment, and infrastructure development.
- Section 1.4 Opportunities and challenges: Identifies the challenges and explores potential opportunities for Indian stakeholders to overcome the challenge of shifting from the business as usual to the high localisation scenario.
- Section 1.5 Recommendations: Provides specific recommendations to maximise socioeconomic benefit in Indian OSW deployment.

1.1. The economic impact of Indian offshore wind

Maximising economic impacts is a crucial aspect of OSW development. It ensures that the substantial resources dedicated to these projects generate tangible returns for the local economy, thereby fostering broader social and environmental priorities. In doing so, governments can build strong support among local communities, which is essential for achieving long-term, stable political consensus—an important factor in attracting and sustaining investment in OSW projects.

Economic impacts are typically quantified as GVA and FTE years. GVA is the value generated by any unit engaged in the production of goods and services, and one FTE year is one full-time job for one year. [12,13] One FTE year is the equivalent of one person working full-time for one year. It is also equivalent to two people working for six months. The FTE year unit is the only means of expressing employment in a way that comparisons can be made because the duration of individuals working on the wind farm will vary considerably and, in many cases, their commitment to the project will be less than 100% at any point in time.

It is important to use clear, non-ambiguous language when talking about local benefit and jobs that drives the desired behaviour of creating local benefit. This relates especially to:

- Clarity when talking about employment, so talking about FTE years, not just jobs (where it is not clear how long those jobs last). Some studies, also in different sectors, define employment benefit in terms of the number of people involved, however long they work on a project, which can artificially inflate impact and drive a behaviour of preferring short-term workers.
- Clarity about local content. Again, some studies define local content as when a contract is placed locally (within country), even if the work (value added) is outside the country. Such definitions again can drive a behaviour of using imports and local agents, rather than the desired behaviour of properly creating local employment and value. In 2015, UK introduced a methodology for assessing local content, used for many years by industry and Government to communicate about local content which helped to drive desired behaviour.[14]

This analysis distinguished between direct and indirect impacts, where:

- Direct impacts are associated with the developers and their major contractors,
- Indirect impacts are associated with the non-major suppliers to the project partners and the suppliers to the project's major contractors,

These metrics are modelled at a local level and a national level. In defining what constitutes 'local', the immediate geographic influence of the projects was considered along with the jurisdictions and areas of interest of key stakeholders. Hence, local in this analysis are the states of Gujarat and Tamil Nadu, for projects deploying in waters near these states.

1.1.1 Methodology

The socioeconomic impact analysis was undertaken in the following stages:

1. Deployment projection
2. Value chain assessment
3. Local and national content assessment, and
4. Economic impact assessment.

Deployment projection

The first step was to develop the context for the analysis. To establish the scale of the socioeconomic opportunity, a deployment pipeline projection was established. Based on the OSW targets set by the government, the understanding of the Indian market, and project development lifecycles, a projection of when and where this capacity is likely to be deployed was produced.

Value chain assessment

To establish the socioeconomic opportunity for India associated with the deployment of this pipeline, the Indian value chain's current capability and its likely level of participation were assessed in each of the key areas of the OSW farm project lifecycle. The categories applied in this assessment are presented in Appendix D.

A high-level assessment of the likelihood that each value chain category of the wind farm lifecycle would be conducted using Indian content was conducted for a 1 GW reference project in 2040. These initial screening factors were:

- The capacity of the Indian domestic industry to participate in these activities,
- The benefit of local supply, and
- The amount of inward investment required to allow the activity to be conducted locally.

This included evaluating the number of companies capable of delivering the Indian pipeline, including local firms and non-Indian owned multinational companies with a presence in India. It also included an assessment of where relevant transferable capabilities existed within parallel sectors of the Indian economy, for example, the oil and gas, maritime transport, or civil engineering sectors.

The narrative was informed by publicly available information, including *Capability Assessment of India's Offshore Wind Supply Chain* by MEC+ and OREC, *Supply chain study for Offshore Wind in India* by European Business and Technology Centre (EBTC), and *Tamil Nadu Offshore Wind Manufacturing Supply Chain Investment Study* by OEP and COWI, combined with the team's understanding of how global developers and their main suppliers would seek to deliver projects in India. [15, 16, 17]

Each value chain category was assigned an amber, yellow or green rating depending on how likely significant Indian content would be used. The criteria used to conduct this initial screening are seen in Table 1.1.

Table 1.1 Value chain screening rating criteria.

Rating	Meaning
Amber (A)	Significant local participation is possible (in a reference project)
Yellow (Y)	Significant local participation is probable (in a reference project)
Green (G)	Significant local participation is very likely (in a reference project)

For each value chain category an in-depth triage was then conducted and rated from 1-4 on five different metrics:

- Value chain record and capacity in offshore wind
- Capability in parallel sectors
- The benefit of local supply
- Investment risk, and
- Size of opportunity.

The scoring related to the general capability of the value chain at the national level and was not based on a detailed analysis of individual companies. These criteria were scored using six different categories, as shown in Appendix A.

Local and national content assessment

The assessment of the Indian value chain capability was used to estimate the likely levels of local and national content percentage for each value chain category for Indian OSW projects across two scenarios.

Scenario analysis

- A 'global value chain scenario' (S1) in which India captures a conservative level of local benefit. Here it is assumed that India's current capability will grow organically, but major investments to upgrade India's capability will not occur. Consequently, the majority of manufactured inputs will be sourced from outside India.
- A 'Indian value chain scenario' (S2) in which action is taken to maximise local content and drive investment in the local value chain. This results in investment in Indian manufacturing capability such that the majority of manufactured inputs will be sourced from within India.

Economic impact assessment

The economic impact assessment was based on the methodology developed in-house by BVGA for the OSW sector and is widely used across the sector. The approach was developed because conventional analyses relied on generalised government data that did not map well onto relatively new sectors such as OSW. The methodology is based on content calculations made possible through BVGA's understanding of how costs break down within packages and how the value chain typically sources products and services. Cost break downs for each package are presented in Appendix D and Appendix G.

The economic analysis included all aspects of the development, manufacturing, construction, operation, and decommissioning of an OSW farm, including the electricity export system up to and including the onshore substation. It did not include economic impacts associated with the construction and operation of electricity transmission infrastructure beyond the onshore substation, nor did it include economic impacts associated with the construction of port or manufacturing facilities.

The economic model used the following inputs:

- Project cost data modelled on a representative hypothetical project. All cost data were in 2025 prices. Reference project parameters used for the cost modelling can be found in Appendix C and Appendix F.
- Deployment projection.
- Content percentage estimates – see Appendix E and Appendix H.

- Typical salary levels in the local market, costs of employment, and profit margins were estimated using the process outlined below. It was informed by BVGA's specific sector knowledge and research into typical labour costs associated with each part of the value chain.

Costs and local content for an Indian offshore wind project were determined by first considering their equivalents for a European project, where costs are better known. Adjustments were then made to costs by considering the economic differentiators between the two markets, notably to reflect India's significantly lower cost of labour, lower cost of locally sourced materials, and higher labour intensity of its construction and manufacturing sectors. This approach translated typical European project costs into those expected in the Indian market, with overall cost being reduced due to the lower cost of the Indian portion of content. These adjustments allowed the retained share of expenditure to be contextualised within the Indian economy.

The lower cost of Indian content effectively reduces total local content in relative terms and because of this, the standard GVA-to-cost ratio often used to assess local content is not a reliable indicator of the expected share of work undertaken in India. The share of total FTE-years generated in India compared to the generated globally is a more representative indicator.

The detailed economic impact methodology is presented in Appendix B.

1.1.2 Results

Deployment projection

Based on the OSW targets set by the government, the understanding of the Indian market, and project development lifecycles, a projection of when and where this capacity is likely to be deployed was produced. In 2023, MNRE published the revised *Strategy Paper for Establishment of Offshore Wind Energy Projects* for the establishment of OSW projects. Setting a target of 37 GW of OSW sites to be auctioned by the end of 2030, the paper offered three models for OSW leasing in the country, refer to Table 1.2. [18]

- Model A: Allocates a total of 1 GW, 0.5 GW each in Gujarat and Tamil Nadu. Power Purchase Agreement (PPA) award tender to be supported with VGF.[iii] Based on completed surveys and studies in the Gujarat zone, the Solar Energy Corporation of India (SECI) issued a tender in September 2024 for the development of a 500 MW OSW power project off the coast of Gujarat, which has subsequently been cancelled due to a lack of developer interest. Surveys are underway in Tamil Nadu with data expected in 2026, and it is anticipated that a tender will be announced in February 2026.
- Model B: Allocates a total of 14 GW, with proposed sites in Tamil Nadu. The first tender was launched in February 2024 for 4 GW of OSW projects but was eventually cancelled, again due to limited developer interest. The model provides exclusive site lease tender without VGF support, during the survey period.
- Model C: Allocates a total of 22 GW. Provides non-exclusive site lease tender without VGF support, during the survey period. Can be any site within the EEZ, excluding the sites considered under Model A and Model B.

[iii] The VGF Scheme is administered by the Department of Economic Affairs within the Ministry of Finance and provides financial support in the form of grants, one time or deferred, to economically desirable but commercially unviable infrastructure projects undertaken through Public-Private Partnerships with a view to making them commercially viable.

Table 1.2 India's lease auction trajectory from the strategy paper.

	Lease auction models			
Auction year	A	B	C	Total
2024	0.5	4.0	0.0	4.5
2025	0.5	3.0	0.0	3.5
2026	0.0	3.0	4.0	7
2027	0.0	3.0	4.0	7
2028	0.0	1.0	4.0	5
2029	0.0	0.0	5.0	5
2030	0.0	0.0	5.0	5
Totals	1	14	22	37

The annual and cumulative capacity projection for this analysis was developed based on the overall 37 GW auction trajectory outlined in the strategy paper. The capacity allocation was divided between the two key states of Gujarat and Tamil Nadu, as illustrated in Figure 1.1. These states were selected due to their abundant offshore wind resources, existing infrastructure, and government initiatives supporting offshore wind energy development.

Although India has other coastal states with potential offshore wind resources, no capacity has been allocated to these regions in this analysis. Additionally, no formal studies or detailed assessments have been carried out to evaluate the feasibility and potential of offshore wind projects outside Gujarat and Tamil Nadu. As such, the deployment projections for this analysis remain focused on these two states, which are currently the most viable hubs for offshore wind development in India. Future analyses may expand to include other regions as more data becomes available and as formal studies are conducted to unlock the full potential of offshore wind across the country.

Since the release the strategy paper, the Government of India announced the development of 4GW of OSW projects off the coast of Tamil Nadu and a 500 MW pilot project in each of Gujarat in 2024. Due to limited developer interest, however, the processes for both the 4 GW Tamil Nadu tender and the Gujarat pilot project were cancelled and are pending reformulation.[8] Wind resource surveys are currently underway in Tamil Nadu, with a new tender process expected to be announced around February 2026.[9]

Based on the current progress of seabed leasing, and assuming a gestation period of at least 4 to 5 years between lease award and operation, it is expected that the first project will come online earliest by 2031. For future capacity additions under Models B and C, assuming a gestation period of 8 to 10 years, similar to other international projects, we will likely start seeing these projects from 2032 onwards.

Using this assumption, we see that India will reach its peak offshore wind installation capacity of 4.5 GW each in 2037 to 2040.

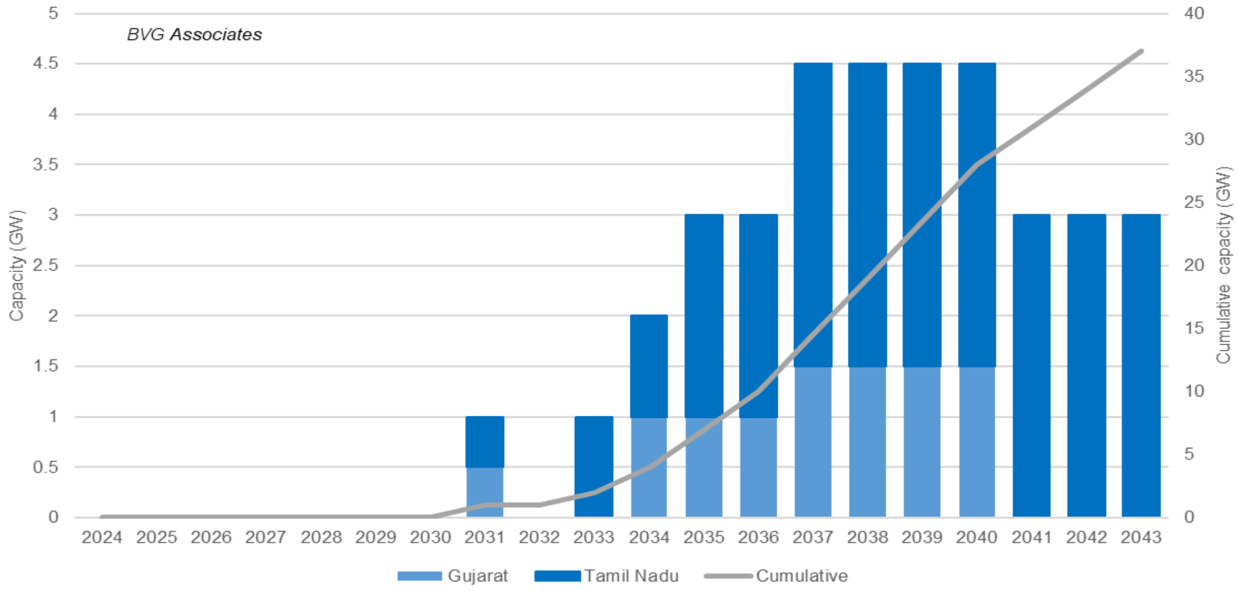


Figure 1.1 Annual and cumulative capacity project forecast for India.

Value chain assessment

India's strong record in onshore wind and oil and gas offers a foundation for developing its OSW sector. With approximately 53.6 GW of installed onshore wind capacity in October 2025[19], the onshore wind sector has created a robust domestic value chain for components like turbines, towers, and blades, involving both local and multinational companies. Similarly, the oil and gas sector along India's coastline has been operational for decades, especially in regions like the Mumbai High and Bassein fields. This sector has cultivated expertise in marine engineering, subsea technology, and large-scale infrastructure management. Several companies operating in this sector have capabilities relevant to OSW, including platform construction, offshore maintenance, and project logistics.

While India has a solid foundation in onshore wind and oil and gas, the transition to OSW, however, will require substantial adaptations, investments in R&D, and targeted government support. OSW has unique technical demands, such as large turbine foundations, subsea cables, and specialized vessels, which are not fully covered by current supply chain capabilities. Developing OSW at scale in India will require mature developers and suppliers to bring their expertise to a new market. These experienced stakeholders will apply their knowledge in design, manufacturing, installation, and operations to gradually reduce costs, making Indian OSW more competitive in the medium and longer term.

The high-level assessment using initial screening results showed that development and project management activities were likely to include significant Indian content. Meanwhile, some manufacturing and installation activities were possible, with some notable exceptions. Most operations activities were expected to contain some Indian content, depending on the activity. The results are provided, along with an explanation and justification for each category.

Note that a amber rating does not mean there will be no value chain activity in India, rather, it indicates that the activities will be limited, at least for early projects.

Table 1.3 Initial value chain category assessment.

	Value chain categories	Rating	Explanation
1	Development and Project Management		
1.1	Development and consenting services	Green	Development and consenting services cover the work needed to secure consent and manage the development process through to financial investment decision. Major onshore developers have offices in India, which means they should be able to develop the capability to deliver such services domestically, using mostly domestic labour and skills. Each country has its approach to OSW deployment, supported by a unique legislative and policy framework. For this reason, project development and consenting services are almost always delivered locally.
1.2	Environmental surveys	Green	Environmental surveys of an OSW farm location and its surroundings determine the environmental impacts. These surveys establish the baseline for the assessment and allow impact modelling to be undertaken. Several Indian companies as well as multinational companies with Indian presence can undertake environmental survey work. Environmental surveys are typically undertaken by companies from the home market, partly because there are sufficient local resources and partly because some of the wildlife impacts are site specific and require detailed local knowledge and expertise.
1.3	Resource and metocean assessment	Green	Resource and metocean assessments provide atmospheric and oceanographic data to inform the engineering design of an OSW farm, the potential future energy production, and to fully describe the likely installation and operating conditions at a proposed OSW farm location. Resource and metocean assessment services are typically delivered locally, due to availability of local assets such as survey vessels close to the project site. There are Indian companies with capability in this space, as well as multinational companies with Indian presence active in this area.
1.4	Geological and hydrographical surveys	Green	Geological and hydrological surveys analyse the seabed of a proposed OSW farm site and export cable route to assess its geological characteristics. Geological and hydrographical surveys are typically delivered locally, due to the availability of local assets such as survey vessels close to the project site. There are Indian companies with capability in this space, as well as multinational companies with Indian presence active in this area.
1.5	Engineering and consultancy	Green	Front-end engineering and design (FEED) studies establish OSW farm system design and develop the concept of the offshore wind farm in advance of procurement, contracting and construction. Beyond cost, there is no strong logic to delivering such services locally, however developers will often choose to do so where the right capabilities exist in the domestic market. India has companies with capability in this space, and multinational companies also have an Indian presence.

	Value chain categories	Rating	Explanation
1.6	Project management	Green	Project management includes managing the collection and interpretation of surveys, submission of planning consents and any design work, and managing the construction of the project through to operations. Project management is predominantly undertaken in-house by wind farm developers. Major onshore developers have offices in India, alongside a few international developers, which means it should have ample capability to deliver such services domestically. Project management is best done locally, with proximity to the project site and key stakeholders is typically seen as advantageous. Staff are highly mobile and experienced OSW project managers will often be recruited internationally, but most will be based in India.
2	Manufacturing		
2.1	Turbine nacelle and hub	Yellow	Nacelles use components sourced by the wind turbine supplier from a range of external suppliers. Nacelles have a complex supply chain, and assembly is a highly technical and capital-intensive activity, requiring significant investment to establish. India does not have any current capability to assemble offshore wind nacelles so they will be imported for the initial projects. For the onshore wind market, India supplies a range of components. With a strong and project pipeline, it is possible that India could capture supply of OSW nacelle components and their assembly, either through inward investment from an established global OSW turbine supplier or an Indian onshore wind turbine supplier, given India's strong industrial base and competitive cost of labour. Establishing coastal Indian manufacturing facilities for components like blades, towers, or monopile foundations will likely come before a nacelle manufacturing owned by an overseas wind turbine supplier facility due to its high technical complexity and intricate supply chain requirements.
2.2	Turbine blade	Yellow	Wind turbine blades are usually designed and supplied by the wind turbine supplier. Blade manufacturing is a highly technical and capital-intensive activity with high barriers to investment. India has some capability in this area from its experience in the onshore wind sector but blades for OSW turbines are typically larger, and investment in new coastal facilities will be required to produce these domestically, though the skills and manufacturing techniques remain the same. India is likely to rely on imports for initial projects. With established international offshore wind turbine manufacturers like GE (through its subsidiary LM Power), Vestas, and Siemens and domestic manufacturers like Inox and already producing blades for onshore turbines locally, there is potential for India to develop this capacity in the future. While India can capitalise on its local expertise and existing manufacturing infrastructure, attracting substantial investments will be crucial to establish offshore wind blade manufacturing domestically. Given India's onshore capabilities, there is some logic for local supply but only with significant investment.

	Value chain categories	Rating	Explanation
2.3	Turbine tower	Yellow	The tower is a tubular steel structure that supports the nacelle. Fabricators manufacture towers based on designs provided by wind turbine suppliers. Relative to manufacture of blades and nacelles, manufacture of towers is less technically complex, therefore barriers to investment and skills requirements are less onerous. India has some capability in this area from its experience in the onshore wind sector, but towers employed for OSW turbines are typically larger, and investment in new facilities will be required to produce these domestically, though the skills and manufacturing techniques remain the same. International manufacturers based in India such as GRI and WINDAR have the experience in manufacturing OSW turbine towers, while local manufacturers do not. With a strong and bankable pipeline, India is likely to capture these activities if it can attract the necessary investment from an established manufacturer given India's existing applicable capabilities and competitive cost of labour. However, it will face competition from established Asia Pacific suppliers such as CS Wind in Vietnam. Given India's onshore capabilities, there is some logic for local supply but with significant investment needed to establish.
2.4	Array cables	Yellow	The network of array cables transfers power from the wind turbines to the offshore substation. They are supplied by specialised manufacturers. There are no local companies with OSW experience in India. India has local and international cable manufacturers with experience in supplying 33kV subsea cables to the offshore oil and gas and telecom sector, which Indian can leverage in the future. There is scope for future potential should the right investments be made. However, there is little logic for local supply as array cables are easily transportable and Indian suppliers will face strong competition from other suppliers in the region.
2.5	Export cables	Amber	The export cable connects the offshore and onshore substations to transmit power from the wind farm to shore. Export cable manufacturing is associated with a high investment requirement and barriers to entry. They are supplied by specialised manufacturers. No companies exist with this capability in India. Investment in local facilities is possible, though barriers to investment are high due to substantial CAPEX investment required. Export cables are easily transportable, therefore there is relatively little logic for local supply.
2.6	Foundation	Amber	The foundation supports the turbine in the water. For fixed offshore wind, this is typically a steel monopile or jacket. India does not currently have the capability to produce monopiles of the required diameter and will potentially import them, at least for the initial projects. India has capability in manufacturing jacket foundations for oil and gas; however, most Indian projects are likely to employ monopiles which represent a lower cost solution in shallower waters. Some jackets may be employed at water depth in excess of 60m. A competitive international market already exists for foundation supply and significant investment would be required in both manufacturing and

	Value chain categories	Rating	Explanation
			port facilities to develop Indian monopile manufacturing capability. The logic for local supply is relatively low, until a stable market establishes.
2.7	Offshore substation	Amber	The offshore substation connects the array cable system to the export cables. The offshore sub-station and beyond transmission infrastructure would be developed by CTU. CTU will likely conduct the electrical engineering activities in-house but will almost certainly outsource the manufacture and fabrication of the substation. Electrical equipment will likely be supplied by a mixture of Indian and specialist overseas contractors. Offshore substation fabrication requires experience in oil and gas topside production or shipbuilding and power electronics. India has major contractors such as Larsen & Toubro, NPCC, Reliance, and others who have supplied the oil and gas sector. Larsen & Toubro has the capability to manufacture substation topsides for the offshore wind sector in India. Any other Indian yards looking to fulfil such contracts will require additional investment. There is little logic for supply as transportation makes up a small portion of overall cost. A competitive international market already exists, with many facilities in the Middle East and Southeast Asia competing for this kind of work, and Indian suppliers will therefore face strong competition from other suppliers in the region.
2.8	Onshore substation	Green	The onshore substation transforms power to grid voltage. They are generally contracted to the same main contractor as the offshore substation. However, they typically contain more local content as the construction methodology is different. Onshore substation construction requires a standard construction skillset. India is well served by construction and power transmission sectors, and there is a strong logic for employing local teams to undertake this work. Therefore, we expect most of this activity to be undertaken locally.
3	Installation and commissioning		
3.1	Offshore substation	Yellow	Offshore substation installation is a heavy lift operation requiring vessels with sufficient crane capacity. It is conducted by specialist, experienced marine contractors with appropriate skills and training. It requires investment from companies to acquire the appropriate cranes and other equipment. India has good experience in oil and gas, telecom, and marine works, which the country can leverage. India has major contractors such as Larsen & Toubro, Reliance and others who have supported the oil and gas sector. However, a competitive international market already exists, and experienced overseas contractors could conduct installation work in India, so the logic for early local supply is low, but local supply is likely to establish in time.
3.2	Offshore cables	Yellow	Offshore cable installation is conducted using dedicated installation vessels by specialist, experienced marine contractors, or in some cases cable manufacturers themselves. It therefore requires investment from

	Value chain categories	Rating	Explanation
			domestic companies to procure the appropriate vessels and other equipment. India has good experience in oil and gas, telecom, and marine works which the country can leverage. India has major contractors such as Larsen & Toubro, Reliance and others who have supported the oil and gas sector. However, a competitive international market already exists, and experienced overseas contractors could conduct installation work in India, so the logic for early local supply is low, but local supply is likely to establish in time.
3.3	Onshore export cables	Green	Onshore cable installation is routine construction work. Before construction, site investigation and environmental work is undertaken to plan the installation and minimise impact on the surroundings. There are also range of local services used before and during the cable installation. India has many construction firms capable of these activities and there is a strong logic for employing local teams to undertake this work. Given strong availability of local construction companies with the required capabilities, India is likely to capture most of the value associated with this activity.
3.4	Turbine installation	Amber	Turbine installation is conducted using dedicated vessels by specialist, experienced marine contractors. No companies exist with this capability in India. India will require further investment from domestic companies to procure the appropriate vessels and other equipment. Experienced overseas contractors could conduct this installation work in India, so are likely to delivery early projects, with local supply following later as the market progresses. Some vessel and crew support services will be provided locally from the start.
3.5	Foundation installation	Amber	As for turbine installation, there is no immediate local capability, but it is likely to establish if a solid pipeline of projects is established.
3.6	Construction port	Green	The construction port is where major components, such as turbines and foundations, are marshalled. There is benefit in having the construction port based locally as it allows for cheaper and quicker installation. The current infrastructure requires investment as there are no ports currently suitable in India. Several studies have been conducted that identifies potential offshore wind ports in India. The GOI has already announced investments for two ports, each in Gujarat and Tamil Nadu. Provided necessary port investments go ahead, India is likely to capture the majority of value associated with this activity. There is a strong logic for local supply.
3.7	Onshore substation	Green	Like onshore cable installation, onshore substation installation is routine construction work and so can be completed by local construction companies, providing they have the required capability and offer a cost-effective service.

	Value chain categories	Rating	Explanation
			India has many construction firms capable of these activities. It is therefore unlikely that investment is required. Given strong availability of local construction companies with the required capabilities, India is likely to capture the majority of value associated with this activity. There is a strong logic for employing local teams to undertake this work.
4	Operations, maintenance, and service (OMS)		
4.1	Operations	Green	There are a wide range of operation activities conducted on wind farms. O&M services are almost always supplied locally as proximity to the project site is critical to keeping cost down. Depending on the operations activities conducted, some investment may be required. Some of these benefit from or require local knowledge and presence, such as operation of vessels and quayside infrastructure, and management of spares and equipment. India can leverage its experience from the onshore wind, oil and gas and marine sectors. India is likely to capture most of the value associated with this activity. The logic for local supply is strong.
4.2	Maintenance	Green	Wind farm maintenance covers a range of activities on a variety of assets, both above and below water. Maintenance activities are provided by a combination of the owner's in-house resources, wind turbine suppliers and third-party service providers. As with operations, routine maintenance activity benefits from a strong logic for local supply, due to cost benefits of proximity to the project site. India is therefore likely to capture most of the value associated with this activity, transferring much experience from onshore wind. The logic for local supply is therefore strong.
4.3	Major repair	Amber	Major repairs are conducted when there is a severe, large-scale failure of a key component or asset in a wind farm. They are most often conducted by the major equipment installers. There are no Indian companies which have this experience now, so for early projects. experienced overseas contractors are likely to supply. In time, however, local supply is likely to establish if the market is of the size modelled.
4.4	OMS port	Green	OMS ports provide facilities from which long-term OMS activities are carried out – such as jetties or quaysides for crew transfer vessels (CTVs) and service operation vessels (SOVs), warehouses, workshops and offices – and which support major and minor repairs. There is a significant cost saving in basing the OMS port near the wind farm. Studies have been conducted that identifies potential offshore wind ports in India. The infrastructure requirements for an OMS port are less onerous than for construction ports. There are several existing ports which may be able to participate, such as Kudankulam and Muttom in Tamil Nadu and Pipavav in Gujarat. With limited additional investments other ports may also participate. The logic for local supply is strong.
5	Decommissioning		

	Value chain categories	Rating	Explanation
5.1	Decommissioning services	Green	Decommissioning services are typically conducted by the major equipment installers. By the time such services are needed, it is very likely that local supply will be available.

Value chain categories were further triaged to assess the capability of the value chain in India and were scored against six different categories, as shown in Appendix A. The analysis showed that while there is limited direct experience, there was some relevant capability in most parts of the value chain. The main opportunities lie where:

- There is a record or capability in parallel sectors
- There is logic in supplying from India, and
- The investment risk is low.

Using these metrics, opportunity was greatest in categories such as development and project management, onshore substation manufacturing and installation, onshore export cables installation, construction port, and the OMS phase as well as decommissioning when it occurs. The OSW industry is highly cost-sensitive and contracting and competition are expected to evolve over time. As the sector matures and the project pipeline develops in India, the opportunities are expected to grow in all phases. Currently, competition takes place on a global basis for many categories of the value chain. This means that local suppliers will need to work hard to learn and compete, with international collaboration a possible route to success. A summary of the results is found in Table 1.4. For a full breakdown of these results, see Appendix I.

Table 1.4 Summary results.

	Value chain category	Record and capacity	Capability in parallel sectors	Benefit of local supply	Investment Risk	Size of Opportunity
1	Development and project management					
1.1	Development and consenting services	3	4	3	3	1
1.2	Environmental surveys	3	4	3	4	1
1.3	Resource and metocean assessment	3	4	3	3	1
1.4	Geological and hydrographical surveys	3	4	3	4	1
1.5	Engineering and consultancy	3	4	1	4	1
1.6	Project management	3	4	3	4	1
2	Manufacturing					
2.1	Turbine nacelle and hub	3	3	2	1	4
2.2	Turbine blade	3	3	2	1	4
2.3	Turbine tower	3	3	2	1	2
2.4	Array cables	3	3	2	2	2
2.5	Export cables	3	3	2	2	3
2.6	Foundation	1	3	2	1	4
2.7	Offshore substation	1	3	2	4	3
2.8	Onshore substation	2	4	4	4	1
3	Installation and commissioning					
3.1	Offshore substation	1	3	2	2	1
3.2	Offshore cables	1	3	2	2	2
3.3	Onshore export cables	2	4	4	4	1
3.4	Turbine	2	3	3	1	3
3.5	Foundation	1	3	3	1	3
3.6	Construction port	1	3	4	2	1
3.7	Onshore substation	2	4	4	4	1
4	Operations, maintenance, and service (OMS)					
4.1	Operations	2	4	4	3	3
4.2	Maintenance	2	4	4	3	3
4.3	Major repair	1	2	2	3	4
4.4	OMS port	1	4	4	2	1
5.	Decommissioning services					
5.1	Decommissioning services	4	3	3	3	4

Local and national content

The assessment of the Indian value chain capability was used to estimate the likely levels of local and national content percentage for each value chain category for Indian OSW projects across two scenarios. Local in this case are the states of Gujarat and Tamil Nadu where the projects are proposed to be commissioned.

Under the global value chain scenario (S1), India captures a conservative level of local benefits. In this scenario, India captures a high level of activity in those areas of the supply chain that have a strong logic for local supply (development and project management, operations, and maintenance). India does not capture significant investment in additional manufacturing capability, aside from two tower manufacturing facilities. Turbine and balance of plant components are imported in general. All major offshore installations (substation, cable, turbine and foundations) and decommissioning activities are carried out by specialist international contractors, supported by Indian contractors. All onshore work and port construction activities are carried out locally.

Under the Indian value chain scenario (S2), action is taken to maximise local content and drive investment in the local value chain. This results in the majority of turbine components and balance of plant for Indian OSW projects being manufactured in India in time. After early projects, all major offshore installation activities are carried out by Indian EPCI contractors, with some support from a mix of Indian companies and international vessel operators.

Development and project management

Development and project management include activities required to secure planning consents, such as the environmental impact assessment, as well as the design, engineering and project management of the wind farm. This phase of wind farm development is typically high in local content. Developers often rely on local planning lawyers, surveyors, and archaeological assessment firms as specific local knowledge is often required. It is assumed that for a 1 GW project, the development and project management phase will occur over seven years.

In S1, a significant portion of the development and project management work is undertaken by developers, with some of their efforts split between their Indian offices and international offices. Majority of these activities accrue to the region local to the project. Local companies are heavily involved in planning and consenting, survey work and site investigations because of their expertise and familiarity with the region.

In S2, India captures a similar level of content as in S1. In both scenarios, it is expected that the local contribution will grow over time. This is consistent with action to develop Indian capability and skills in this space, coupled with an Indian-led value chain which is likely to conduct a greater proportion of development and project management activity locally.

Manufacturing

This phase encompasses the supply of turbines and the balance of plant components. Turbine supply includes the fabrication of towers, nacelles, generators, and blades, while the balance of plant covers all other components necessary for the wind farm, including foundations, cabling, and substations. It is assumed that for a 1 GW project, the manufacturing phase will occur over three years.

India has various companies involved in onshore wind and oil and gas projects which can potentially support the manufacturing and assembly of some OSW components should the right support structures be in place. For example, companies like Suzlon, Adani, Inox, GE, Vestas and Siemens Gamesa manufacture blades for onshore wind. KEC International, Larsen & Toubro, Windar, Suzlon manufacture towers for onshore wind. Major contractors like EIL, Larsen & Toubro, NPCC and Reliance have supplied the oil and gas sector with jacket foundations and offshore substation topsides. Manufacturing OSW components, however, will require additional investment in new facilities, as OSW turbines are typically larger than onshore models.

In S1, turbine components including nacelles, blades and foundations are manufactured by companies located elsewhere in Asia or Europe. Array cables and export cables are imported. A tower manufacturing facility is established in Gujarat and Tamil Nadu in 2033. The onshore substation is manufactured and constructed locally, but the offshore substation is imported. India provides some balance of plant equipment and materials for both onshore and offshore substations. This includes low voltage electrical equipment, lighting, and security systems, building materials, and materials for onshore works. Medium or high-voltage electrical equipment will be supplied from globally established factories.

In S2, India grows its role in the manufacturing and assembly of OSW farm components. A blade manufacturing facility and a monopile foundation manufacturing facility is established in Tamil Nadu in 2033. A nacelle assembly facility is established in Tamil Nadu in 2035. These assumptions are based on Tamil Nadu's established onshore wind manufacturing base, existing infrastructure and larger concentration of planned offshore wind capacity. As in S1, S2 sees tower manufacturing facilities in Gujarat and Tamil Nadu.

The nacelle assembly facility uses Indian-manufactured gearboxes (if present in the design), castings, and forgings and a range of other components. Array cables are also supplied locally. India will have a subsea array cable factory based out of Gujarat, established in 2031. This reflects the state's industrial strengths in steel and heavy manufacturing, and existing onshore cable production capabilities. Both onshore substation and offshore substation are manufactured and constructed locally. Export cables are imported.

The above narrative is reflective of the current industrial capabilities and potential for cross sector knowledge transfer in Tamil Nadu and Gujarat. These remain dependent on sufficient industry appetite for investment, dependent on government support and industry confidence of a substantial market. Table 1.5 provides an overview of local manufacturing capability assumptions in S1 and S2.

Table 1.5 Local manufacturing facility assumptions in S1 and S2.

Component	Factory location(s)	Expected start year	Scenario
Tower	Tamil Nadu	2033	S1 and S2
	Gujarat	2033	S1 and S2
Blade	Tamil Nadu	2033	S2 only
Nacelle assembly	Tamil Nadu	2035	S2 only
Monopile foundation	Tamil Nadu	2033	S2 only
Array cable	Gujarat	2031	S2 only

In each scenario, we assume that there is a cap on the number of components per year one factory can produce. Each factory services first demand for componentry in its home region, before allocating any leftover capacity to service demand in the other region. Any additional component demand beyond that met by the manufacturing facility is assumed to be imported. Table 1.6 outlines the annual factory production capacity assumptions for each facility. It is assumed that all facilities will be supplying components suitable for turbines with an 18 - 20 MW turbine rating, in line with the reference project parameters outlined in Appendix D and Appendix G. For towers, blades, nacelles, and turbine foundations, this equates to a production capacity of 1.8 – 2. GW per facility. In the case of array cables, it is assumed that the manufacturing facility will also serves other sectors, with 50% of its output allocated to OSW, which will still be enough to serve over 3 GW of OSW capacity.

Table 1.6 Local manufacturing facility assumptions, annual production capacity.

Component	Annual production capacity
Tower	100 towers
Blade	300 blades
Nacelle assembly	100 nacelles
Monopile foundation	100 monopiles
Array cable	700 km of cable

Installation and commissioning

The installation and commissioning phase involves the transportation of wind farm components from the construction port to the project site, and the on-site works to install turbines and associated electrical equipment, making them ready for generation. It is assumed that for a 1 GW project, the installation and commissioning phase will occur over four years.

Offshore installation services for foundations, cables, and turbines are typically carried out using specialist equipment and skills, including as floating and jack-up vessels with large cranes and cable lay vessels. India has experience in installation and commissioning of oil and gas, telecom, and marine works, which the country can leverage. Major contractors like Larsen & Toubro and Reliance have supported these sectors for many decades.

During construction and installation, there is also a significant need for port space for the pre-assembly, fit, and marshalling of turbines and foundations. The use of ports for these activities provides a significant number of portside jobs in the installation and commissioning phase. Pipavav and Hazira ports in Gujarat and Tuticorin, and Vizhinjam port in Tamil Nadu, have the potential to support the Indian OSW sector with the right infrastructure, though further investment is required to realise this opportunity. The government has announced plans to invest in ports to deliver the required capabilities.[10]

In S1, India uses experienced global contractors from across Asia and Europe for the installation of major components, including offshore substation, offshore cables, turbine, and foundation. These contractors are supported by local firms providing ancillary services with oil and gas and marine sector experience. With the port investments announced by the government of India, the construction port and logistics are captured locally. The greatest contribution from India in installation and commissioning is the provision of local crew and support vessels to support marine activities. Onshore export cables and onshore substation are installed locally. Local civil engineering and electrical firms support projects through activities including excavation, road crossings, cable laying, and the construction of substation buildings, OMS warehouses, and staff facilities.

In S2, the construction port and logistics, are captured locally. Due to the specialist nature of OSW installation vessels, it is assumed that installation will initially be sourced globally. Over time, as domestic vessel capabilities develop, India's contribution is expected to increase. In addition to onshore export cables and onshore substations, offshore cables and offshore substations are also installed by primarily Indian contractors.

Operations, maintenance, and service

Operation, maintenance, and service (OMS) activities support the ongoing operation of the wind turbines, balance of plant, and associated transmission assets. It is assumed that for a 1 GW project, this phase will span over 30 years.

This area of the value chain usually has a high level of local content, and the spending continues over the operational lifetime of the wind farm. For most OSW projects, the operations and maintenance base is located locally. The maintenance base is where the developer manages the control room and asset management of its projects. It includes an associated quayside space used to house service operation vessels (SOVs) or crew transfer vessels (CTVs), which transport technicians and parts to OSW farms to perform routine maintenance tasks on turbines. Unplanned maintenance activities, such as blade replacements, cable repairs, and subsea repairs, are typically carried out by external contractors which may or may not be based locally.

In S1, the majority of OMS spend is captured locally. Local ports are used for operations and maintenance bases. Similar to the installation phase in S1, major repair activities are largely carried out by experienced global contractors with support from local firms providing ancillary services. Under S1, operations and maintenance control centres are located outside India.

In S2, India establishes a more developed supply chain for major repair works, though some support from international contractors and vessel operators is still required for major component replacements. In addition, all operations and maintenance control centres are located within India, leading to higher domestic value capture.

Decommissioning

Decommissioning involves the removal or making safe of offshore infrastructure at the end of its useful life. Turbines, foundations, cables, and substations must be removed and shipped to shore. Decommissioning will involve similar skills and contractors to those used in the installation and commissioning phase of the OSW farm.

Because decommissioning practices could evolve over the operating life of the wind farm, these numbers may change significantly.

In scenario 1, decommissioning is carried out by specialist international contractors, with some support from local firms. In S2, local firms undertake a significant share of work. The vessels undertaking this work are assumed to be based and crewed out of established large ports outside Gujarat and Tamil Nadu.

Economic impact assessment for a single project

Table 1.7 presents the lifetime economic impact in India for a single 1 GW reference project with a lifetime of 30 years deployed in 2040 in Tamil Nadu and Gujarat respectively, under both scenario 1 and 2. It reflects the benefits of a project commissioned in 2040 to capture the economic benefits associated with well-developed supply chain capabilities, as expected in India.

In S1, a single 1 GW reference project deployed in Tamil Nadu will create around ₹2,790 crore GVA and 15,000 FTE years over its lifetime in India, representing about 38% of the total FTE years created globally by the project. Under the same scenario, a single 1 GW reference project deployed in Gujarat will create around ₹3,220 crore GVA and 17,000 FTE years, around 36% of total FTE years created globally.

In S2, a 1 GW reference project in Tamili Nadu will create around ₹7,390 crore GVA and 38,800 FTE years, around 77% of the total FTE years created globally. In Gujarat, it will create around ₹5,350 crore GVA and 29,700 FTE years, around 59% of the FTE years created globally.

Table 1.7 Lifetime economic impact in India for a single 1 GW reference project deployed in Tamil Nadu and Gujarat.[iv]

	GVA (₹ crore)			FTE-years		
	Direct	Indirect	Total	Direct	Indirect	Total
S1, Tamil Nadu project	1,460	1,330	2,790	7,200	7,800	15,000
S2, Tamil Nadu project	3,100	4,290	7,390	15,000	23,800	38,800
S1, Gujarat project	1,660	1,560	3,220	8,000	9,000	17,000
S2, Gujarat project	2,510	2,840	5,350	13,000	16,700	29,700

Tamil Nadu

Below, we explore the economic impacts of a single 1 GW reference project deploying in Tamil Nadu in 2040.

Scenario 1: National impacts

Figure 1.2 shows the lifetime domestic GVA impact of a S1 1 GW reference OSW project in Tamil Nadu, with a commissioning year of 2040, broken down by spend category. The peak annual GVA occurs one year before COD, in 2039, is about ₹220 crore. The total GVA for India over the entire project lifetime is about ₹2,790 crore. 16% of this is in development and project management, 5% in manufacturing, 7% in installation, 71% in operations and maintenance and 1% in decommissioning.

Figure 1.3 shows the FTE years of employment created in India by the same reference project. It follows a similar pattern to GVA, with India's annual employment peaking in 2038 at about 910 FTE years. Total employment generated in India over the project lifetime is about 15,000 FTE years. 15% of this is in development and project management, 4% in manufacturing, 9% in installation, 69% in operations and maintenance, and 3% in decommissioning.

Economic impacts are expected to begin approximately six years before the COD of any project. Therefore, for projects with a COD of before 2040, impacts will occur before 2034, as shown.

The large share of GVA and employment benefits associated with the operations and maintenance phase of this S1 project reflects the high value of the operations and maintenance stage, which stretches over the full lifetime

[iv] Direct and indirect figures are rounded to two significant figures. Totals represent the sum of the direct and indirect.

of the project, and the high Indian content within this phase relative to the manufacturing and installation phases, in which Indian value chain participation is limited in this scenario.

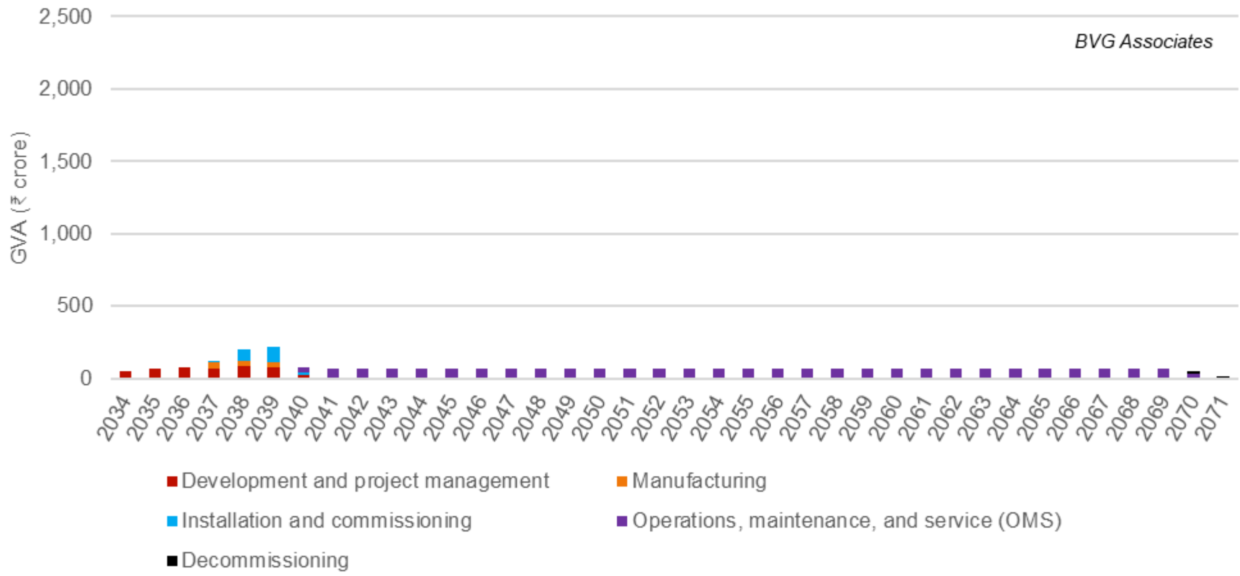


Figure 1.2 National GVA impacts of a single project in Tamil Nadu in S1, split by cost category.

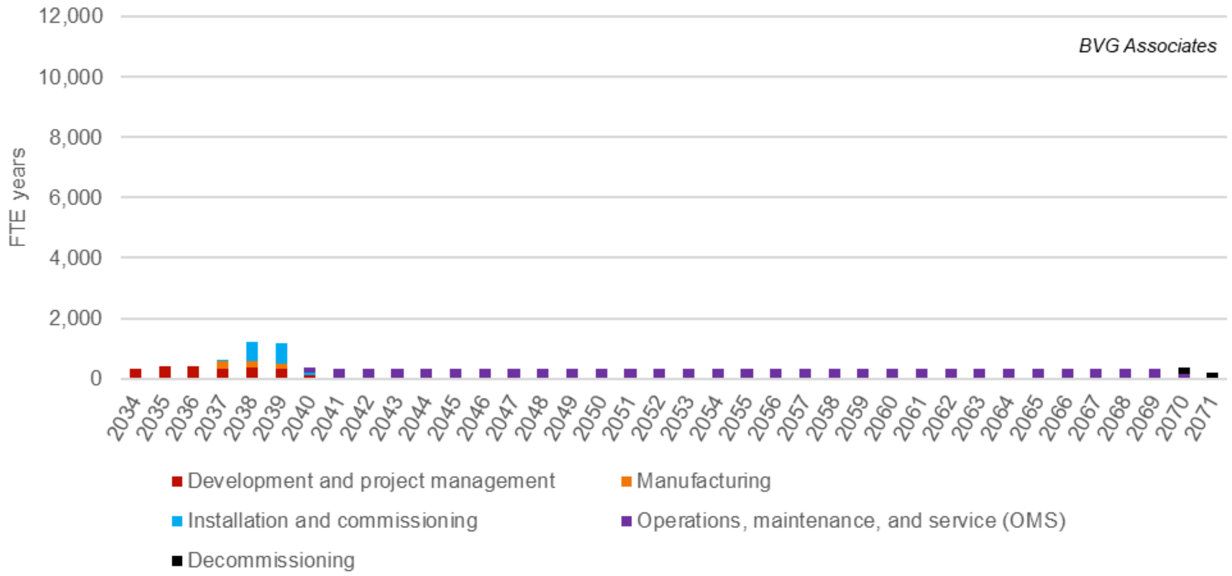


Figure 1.3 National employment impacts of a single project in Tamil Nadu in S1, split by cost category.

Scenario 1: Regional Impacts

Figure 1.4 shows the lifetime GVA impacts of an S1 1 GW reference project in Tamil Nadu, broken down by region. Of the ₹2,790 crore total GVA benefit, Tamil Nadu captures 84%, Gujarat 3% and the rest of India 13%.

Figure 1.5 shows the lifetime employment impacts of the same reference project, broken down by region. This follows a similar pattern to the GVA graph. Of the 15,000 FTE years Indian employment generated by the project, Tamil Nadu captures 84%, Gujarat 3% and the rest of India 13%.

Although there is additional manufacturing capacity assumed in Gujarat for towers, this only has a small impact on GVA and FTE years for a project in Tamil Nadu as the facility's capacity is largely dedicated to servicing demand from Gujarat projects. In addition, turbine towers are a relatively low cost component of an offshore wind farm therefore contributing less GVA and FTE years relative to other components.

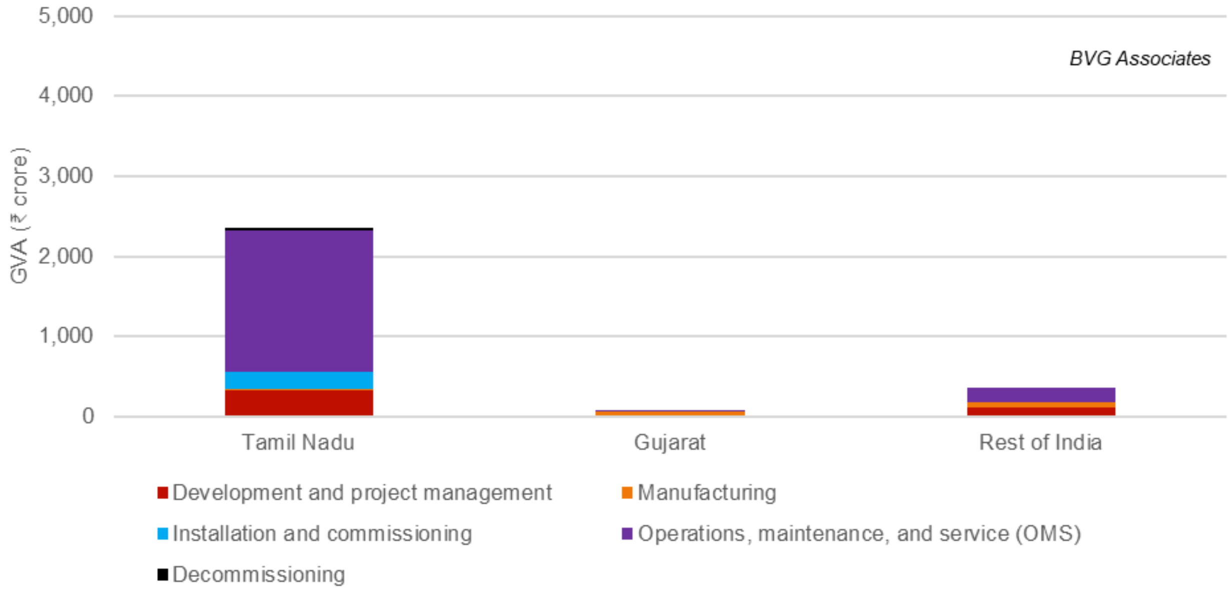


Figure 1.4 GVA impacts of a single project in Tamil Nadu in S1, split by region.

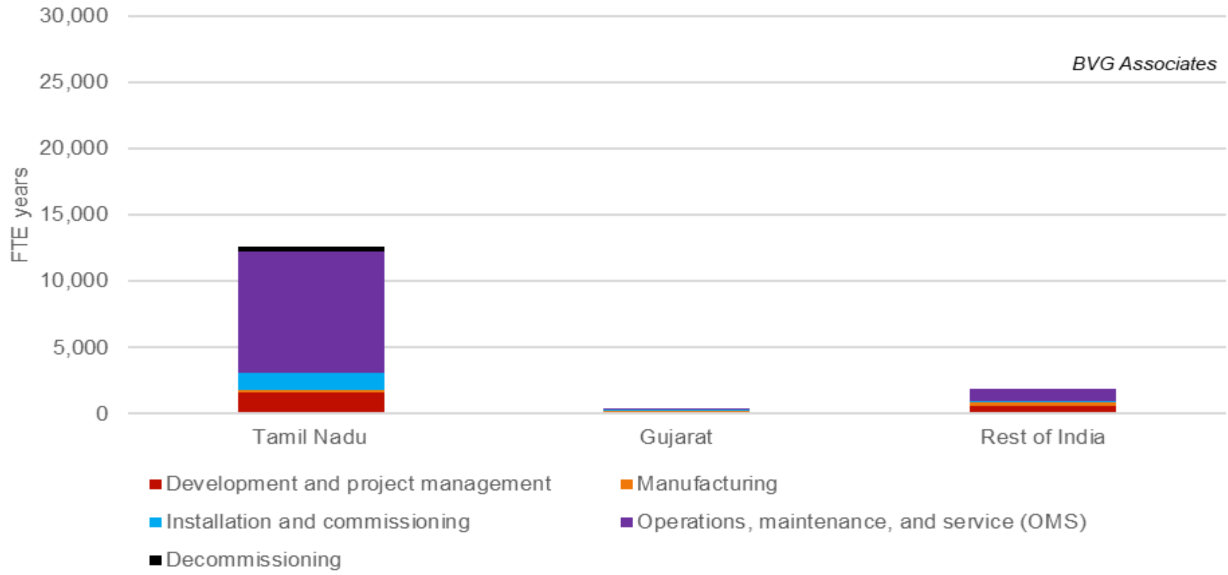


Figure 1.5 Employment impacts of a single project in Tamil Nadu in S1, split by region.

Scenario 2: National impacts

Figure 1.6 shows the lifetime domestic GVA impact in of a S2 1 GW reference OSW project in Tamil Nadu, with a commissioning year of 2040, broken down by spend category. The peak annual GVA occurs one year before COD, in 2039, and is about ₹2,170 crore. The total GVA for India over the entire project lifetime is about ₹7,390 crore. 6% of this is in development and project management, 47% in manufacturing, 13% in installation, 31% in operations and maintenance and 3% in decommissioning.

Figure 1.7 shows the FTE years of employment created in India by the same reference project. It follows a similar pattern to the GVA graph, with India's annual employment peaking in 2039 at about 10,250 FTE years. Total employment generated in India over the project lifetime is about 38,800 FTE years. 6% of this is in development and project management, 43% in manufacturing, 11% in installation, 32% in operations and maintenance, and 8% in decommissioning.

Relative the S1 reference project, the S2 reference project has a higher level of GVA and employment benefit for India. This is driven largely by increased activity within the manufacturing, installation and decommissioning stages which are associated with this scenario.

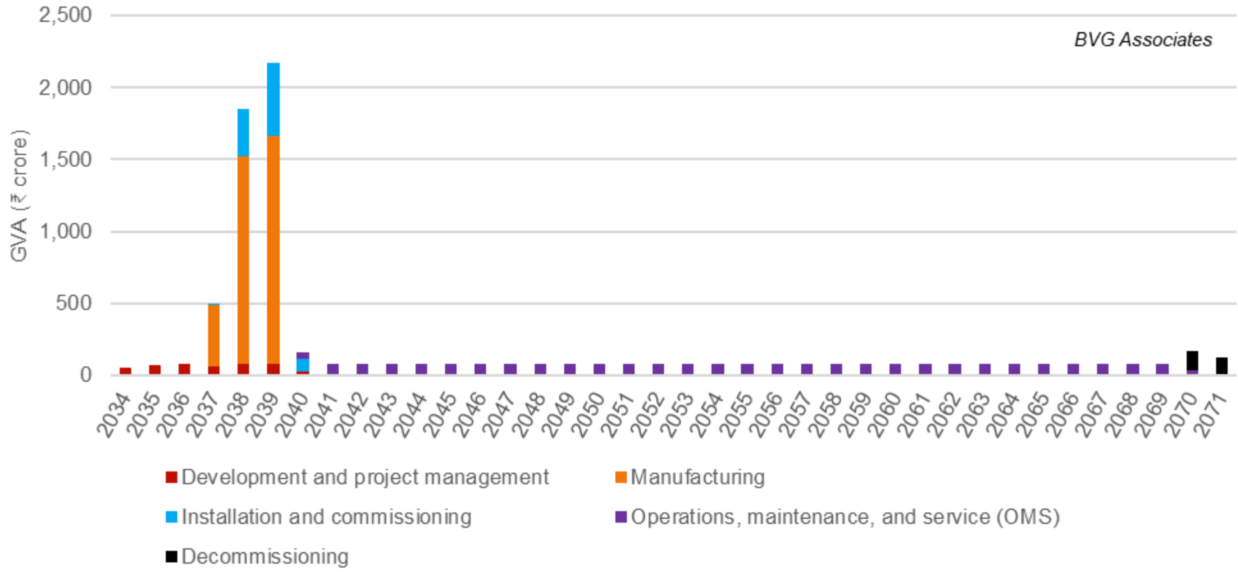


Figure 1.6 National GVA impacts of a single project in Tamil Nadu in S2, split by cost category.

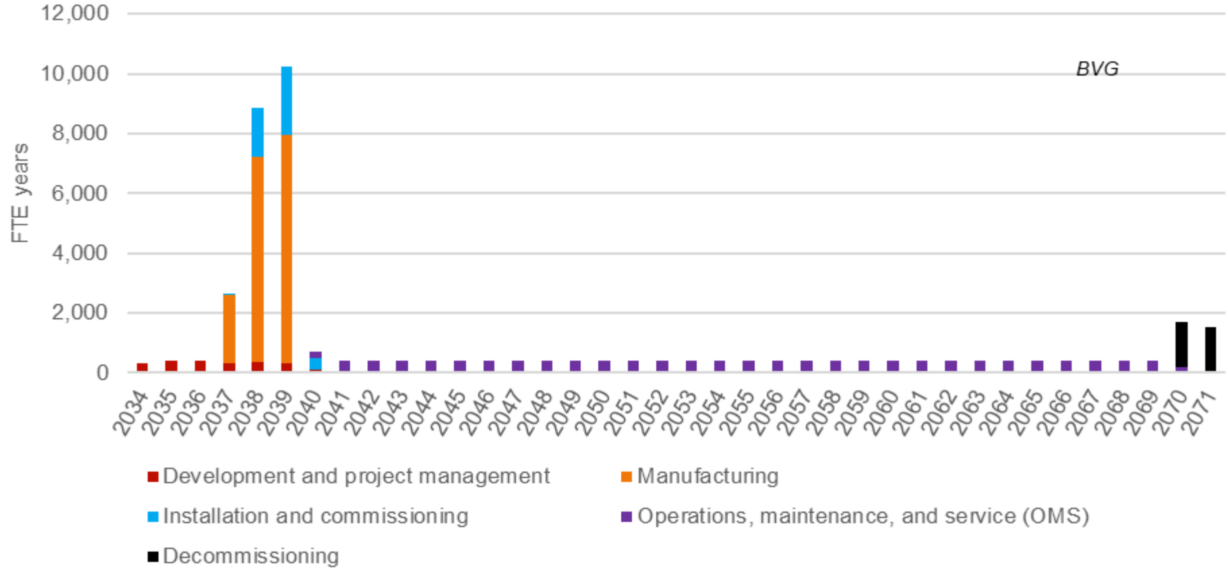


Figure 1.7 National employment impacts of a single project in Tamil Nadu in S2, split by cost category.

Scenario 2: Regional impacts

Figure 1.8 shows the lifetime GVA impacts of a S2 1 GW reference project in Tamil Nadu, broken down by region. Of the ₹7,390 crore total GVA benefit, Tamil Nadu captures 64%, Gujarat 5% and the rest of India 31%.

Figure 1.9 shows the lifetime employment impacts of the same reference project, broken down by region. This follows a similar pattern to the GVA graph. Of the 38,800 FTE years Indian employment generated by the project, Tamil Nadu captures 64%, Gujarat 5% and the rest of India 31%.

Tamil Nadu's capture of the majority of the benefit is driven by its extensive participation in project development and operations and maintenance activity for projects within the local region, coupled with its development of a strong manufacturing supply chain. The rest of India's higher level of benefit relative to S1 is driven by its greater participation of the Indian value chain in supplying materials and second tier inputs to manufacturing facilities, combined with the rest of India's participation in decommissioning activity. As in S1, Gujarat's share of the market remains low for a Tamil Nadu project as Indian manufacturing capacity is assumed in Gujarat for towers and array cables. Both are relatively low cost components of an offshore wind farm therefore contributing less

GVA and FTE years relative to other components. In addition, towers only have a small impact on GVA and FTE years for a project in Tamil Nadu as the facility's capacity is largely dedicated to the Gujarat demand.

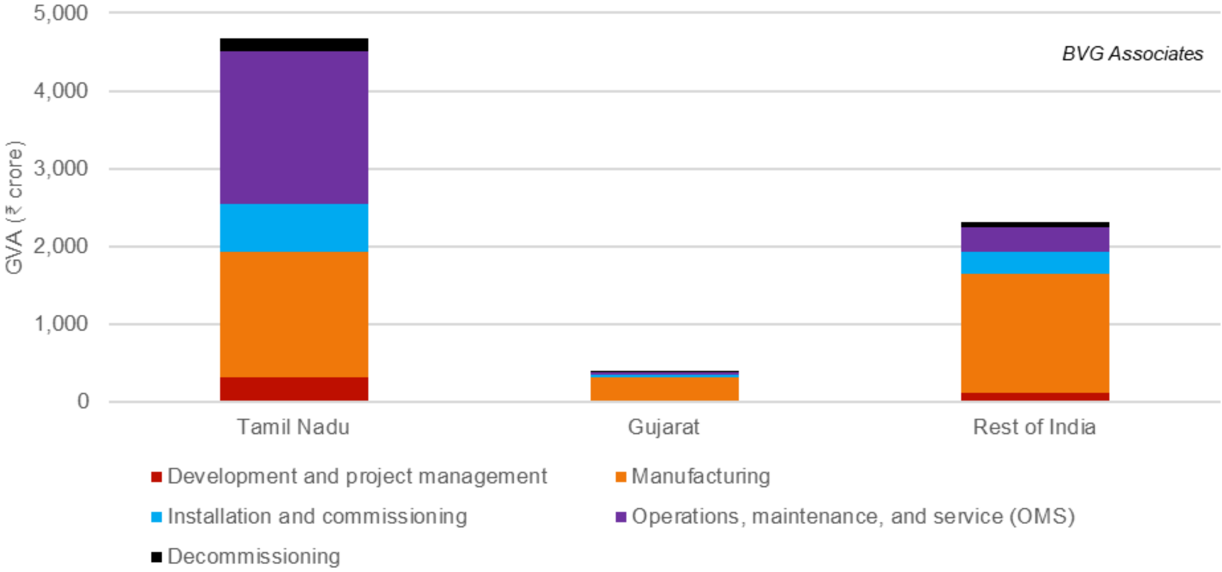


Figure 1.8 GVA impacts of a single project in Tamil Nadu in S2, split by region.

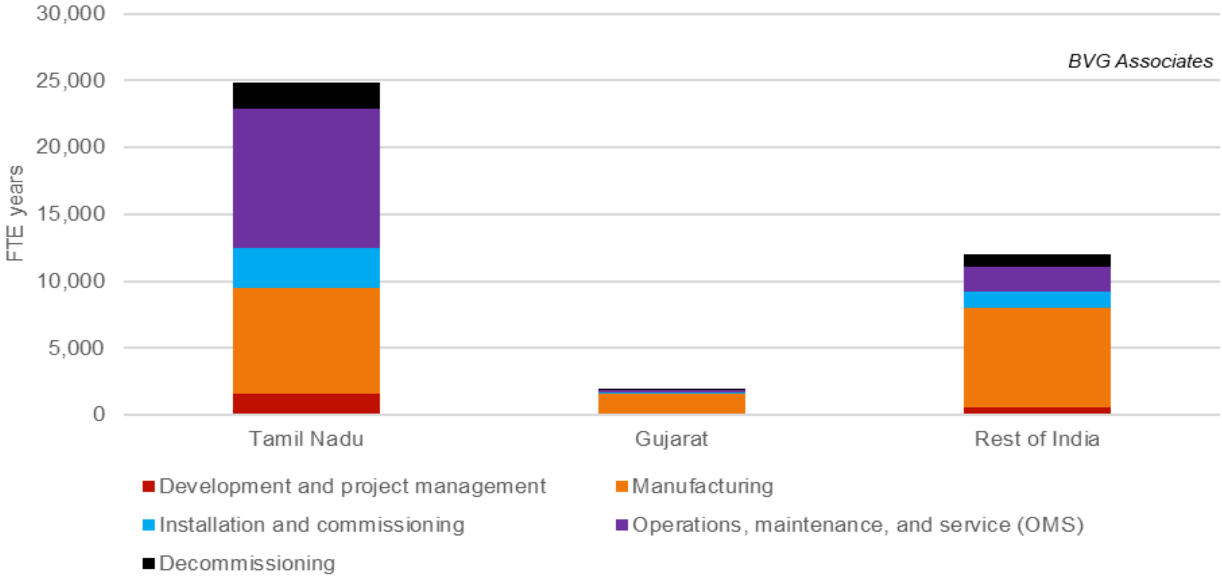


Figure 1.9 Employment impacts of a single project in Tamil Nadu in S2, split by region.

Gujarat

Scenario 1: National impacts

Figure 1.10 shows the lifetime domestic GVA impact of a S1 1 GW reference OSW project in Gujarat with a commissioning year of 2040, broken down by spend category. The peak annual GVA, in 2039, is about ₹420 crore. The total GVA for India over the entire project lifetime is about ₹3,220 crore. 14% of this is in development and project management, 13% in manufacturing, 8% in installation, 64% in operations and maintenance and 1% in decommissioning.

Figure 1.11 shows the FTE years of employment created in India by the same reference project. It follows a similar pattern to the GVA graph, with India's annual employment peaking in 2039 at about 2,080 FTE years. Total employment generated in India over the project lifetime is about 17,000 FTE years. 14% of this is in development and project management, 12% in manufacturing, 9% in installation, 63% in operations and maintenance, and 2% in decommissioning.

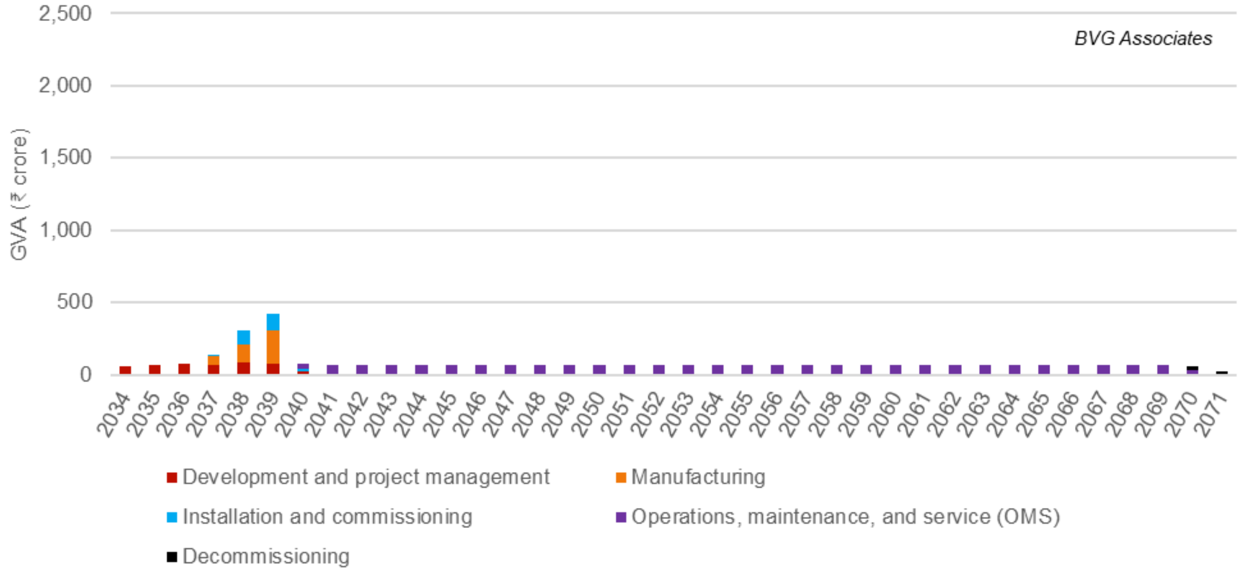


Figure 1.10 National GVA impacts of a single project in Gujarat in S1, split by cost category.

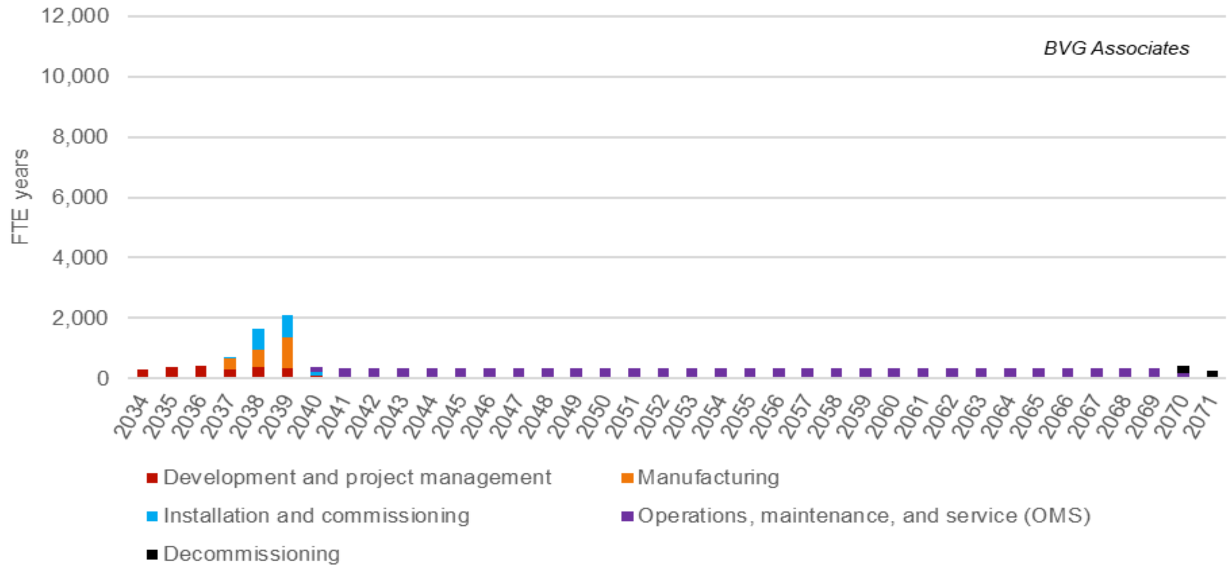


Figure 1.11 National employment impacts of a single project in Gujarat in S1, split by cost category

Scenario 1: Regional impacts

Figure 1.12 shows the lifetime GVA impacts of an S1 1 GW reference project in Gujarat, broken down by region. Of the ₹3,220 crore total GVA benefit, Gujarat captures 84%, Tamil Nadu 1% and the rest of India 15%.

Figure 1.13 shows the lifetime employment impacts of the same reference project, broken down by region. This follows a similar pattern to GVA. Of the 17,000 FTE years Indian employment generated by the project, Gujarat captures 84%, Tamil Nadu 1% and the rest of India 15%.

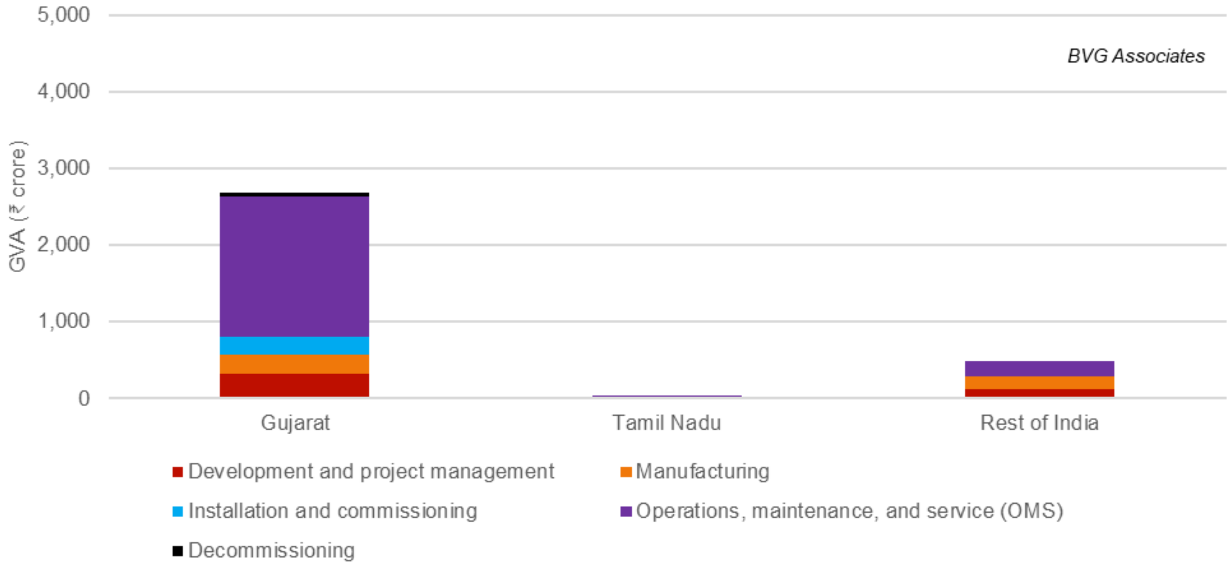


Figure 1.12 GVA impacts of a single project in Gujarat in S1, split by region.

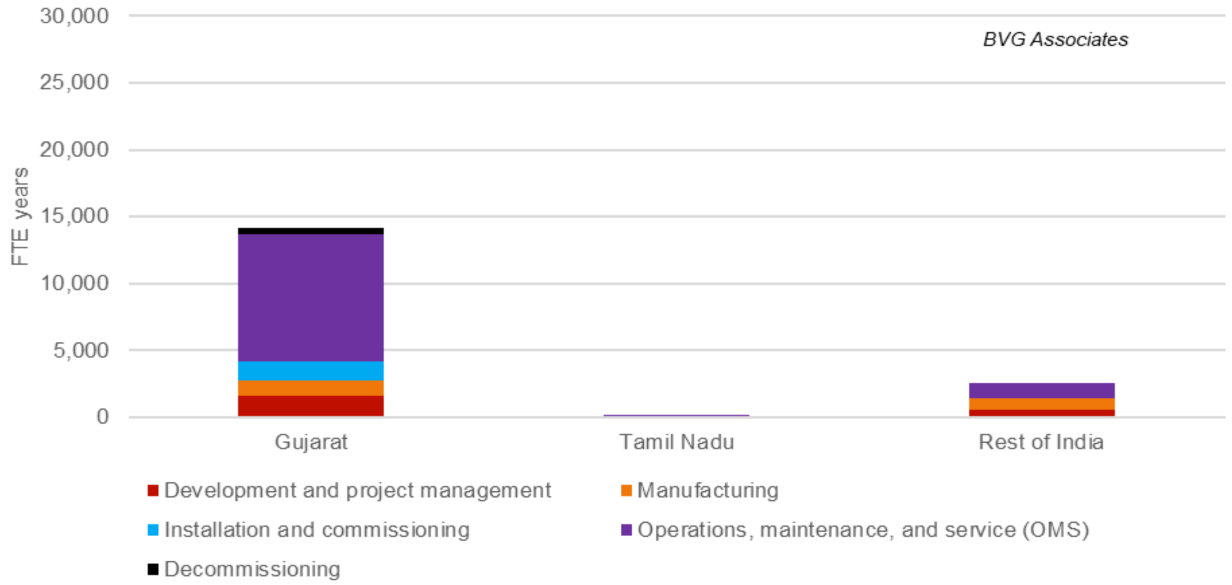


Figure 1.13 Employment impacts of a single project in Gujarat in S1, split by region.

Scenario 2: National impacts

Figure 1.14 shows the lifetime domestic GVA impact of a S2 1 GW reference OSW project in Gujarat with a commissioning year of 2040 , broken down by spend category. The peak annual GVA is one year before COD, in 2039, and is about ₹940 crore. The total GVA for India over the entire project lifetime is about ₹5,350 crore. 8% of this is in development and project management, 22% in manufacturing, 20% in installation, 45% in operations and maintenance and 5% in decommissioning.

Figure 1.15 shows the FTE years of employment created in India by the same reference project. It follows a similar pattern to the GVA graph, with India's annual employment peaking in 2038 at about 4,460 FTE years. Total employment generated in India over the project lifetime is about 29,700 FTE years. 8% of this is in development and project management, 20% in manufacturing, 17% in installation, 44% in operations and maintenance, and 11% in decommissioning.

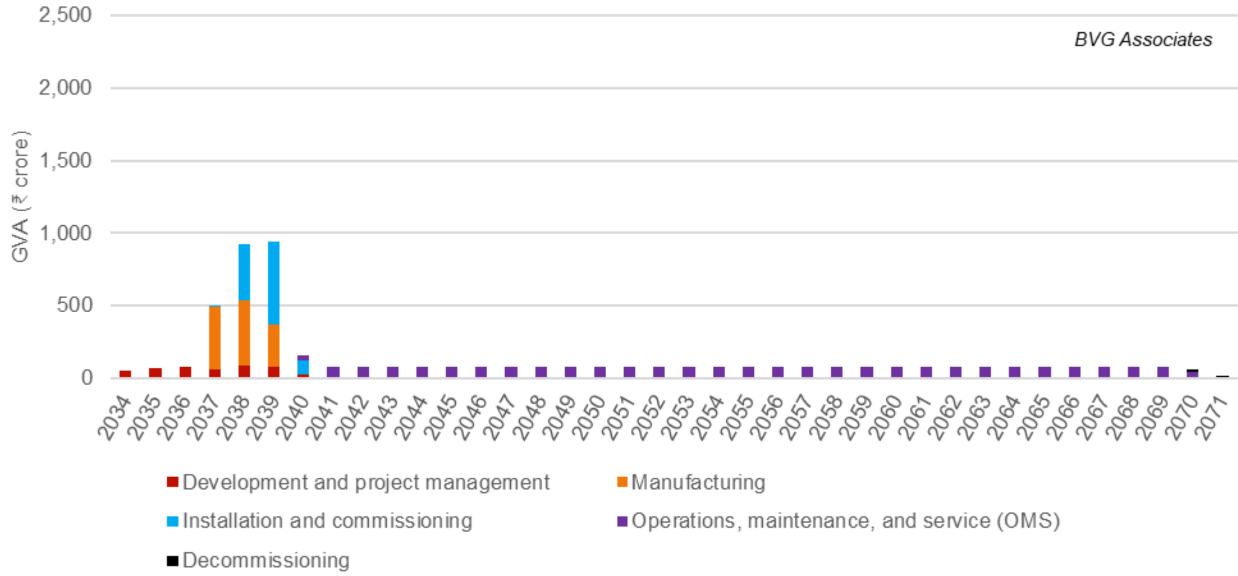


Figure 1.14 National GVA impacts of a single project in Gujarat in S2, split by cost category

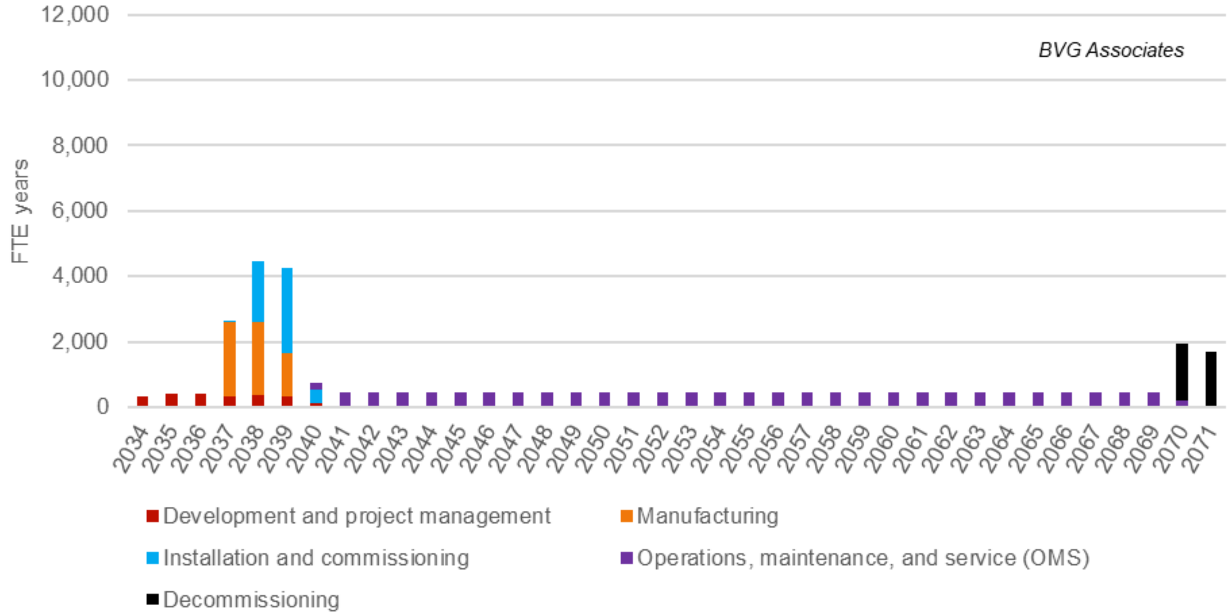


Figure 1.15 National employment impacts of a single project in Gujarat in S2, split by cost category

Scenario 2: Regional impacts

Figure 1.16 shows the lifetime GVA impacts of an S2 1 GW reference project in Gujarat, broken down by region. Of the ₹5,350 crore total GVA benefit, Gujarat captures 73%, Tamil Nadu 3% and the rest of India 24%.

Figure 1.17 shows the lifetime employment impacts of the same reference project, broken down by region. This follows a similar pattern to the GVA graph. Of the 17,400 FTE years Indian employment generated by the project, Gujarat captures 75%, Tamil Nadu 2% and the rest of India 23%.

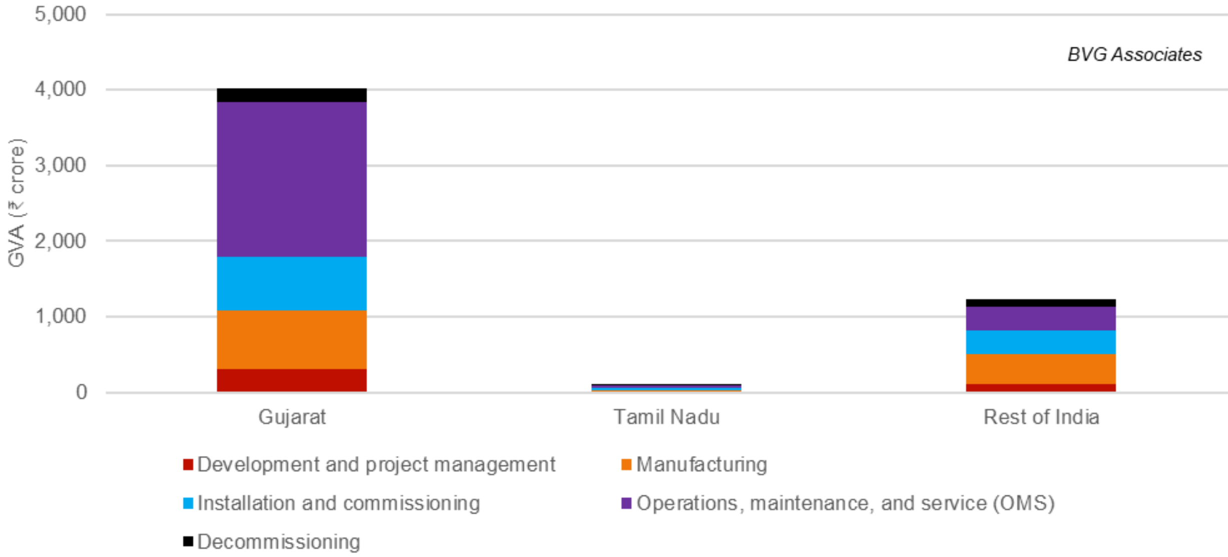


Figure 1.16 GVA impacts of a single project in Gujarat in S2, split by region.

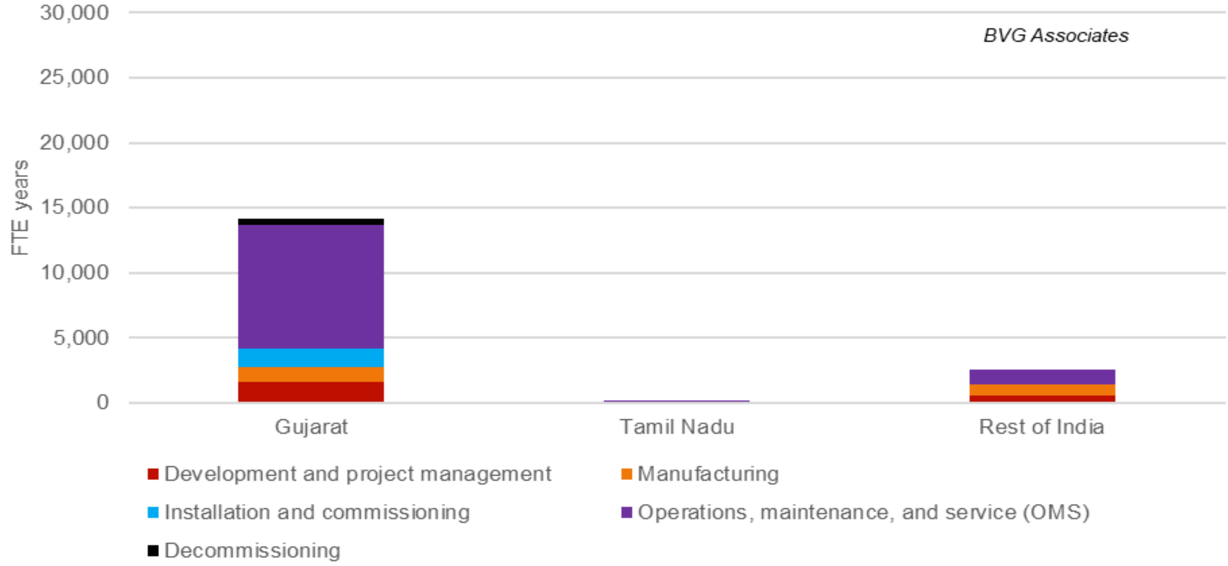


Figure 1.17 Employment impacts of a single project in Gujarat in S2, split by region.

Economic impact assessment for the pipeline of projects

Table 1.8 and Table 1.9 present the lifetime economic impact in India for a 37 GW project pipeline. Under S1, the pipeline will create around ₹1,08,000 crore GVA and 576,000 FTE years over its lifetime in India. Under S2, it will create around ₹2,40,000 crore GVA and 1,280,000 FTE years.

Table 1.8 Lifetime GVA impact in India for a 37 GW project pipeline.[v]

GVA (₹ crore)		Scenario 1	Scenario 2
Tamil Nadu	Direct	35,100	63,000
	Indirect	30,200	63,000
	Total	65,300	1,26,000
Gujarat	Direct	15,900	22,600
	Indirect	12,700	25,100
	Total	28,700	47,600
Rest of India	Direct	5,610	19,600
	Indirect	8,370	47,100
	Total	14,000	66,700
Total India	Direct	56,700	1,05,000
	Indirect	51,300	1,35,000
	Total	1,08,000	2,40,000

Table 1.9 Lifetime employment impact in India for a 37 GW project pipeline.[v]

FTE years		Scenario 1	Scenario 2
Tamil Nadu	Direct	173,000	305,000
	Indirect	178,000	366,000
	Total	351,000	671,000
Gujarat	Direct	77,000	110,000
	Indirect	74,000	146,000
	Total	151,000	256,000
Rest of India	Direct	27,000	99,000
	Indirect	47,000	254,000
	Total	74,000	353,000
Total India	Direct	277,000	514,000
	Indirect	299,000	766,000
	Total	576,000	1,280,000

Scenario 1: National impacts

Figure 1.18 shows the GVA generated in India by the full 37 GW project pipeline. The peak annual GVA, in 2037, is about ₹4,400 crore, as peaking project development and installation activities combine with a growing

[v] Direct and indirect figures for Tamil Nadu, Gujarat and the Rest of India are rounded to two significant figures. All totals represent the sum of the direct and indirect.

operational fleet. The total GVA for India over the entire project pipeline is about ₹1,08,000 crore. 15% of this is in development and project management, 7% in manufacturing, 8% in installation, 69% in operations and maintenance and 1% in decommissioning.

Figure 1.19 shows the FTE years of employment created in India by the full 37 GW project pipeline. It follows a similar pattern to the GVA graph, with India's annual employment peaking in 2037 at about 23,500 FTE years. Total employment generated in India for the project pipeline is about 576,000 FTE years over the lifetime of the projects. 15% of this is in development and project management, 6% in manufacturing, 9% in installation, 67% in operations and maintenance, and 3% in decommissioning.

As in the S1 reference project, the large share of GVA and employment benefits associated with the operations and maintenance phase in S1 reflects the high value of the operations and maintenance stage, which stretches over the full lifetime of the project. It also reflects the high Indian content within this phase relative to the manufacturing and installation phases, in which Indian value chain participation is limited in this scenario.

The economic impacts are calculated based on a 37 GW project pipeline, with deployment timescales through to 2043. This is representative of a one year delay on MNRE's indicative auction schedule published in 2023. If additional capacity comes online beyond this period, the impacts related to development, project management, and installation and commissioning are expected to continue past 2043, rather than drop off, as shown.

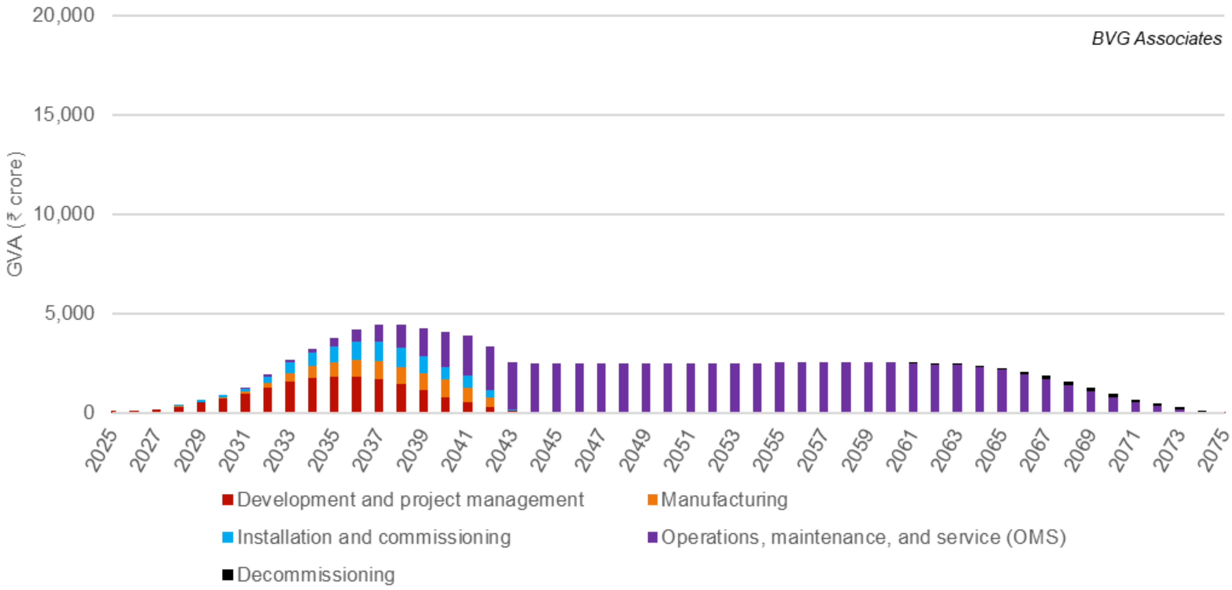


Figure 1.18 National GVA impacts over project pipeline in S1, split by cost category.

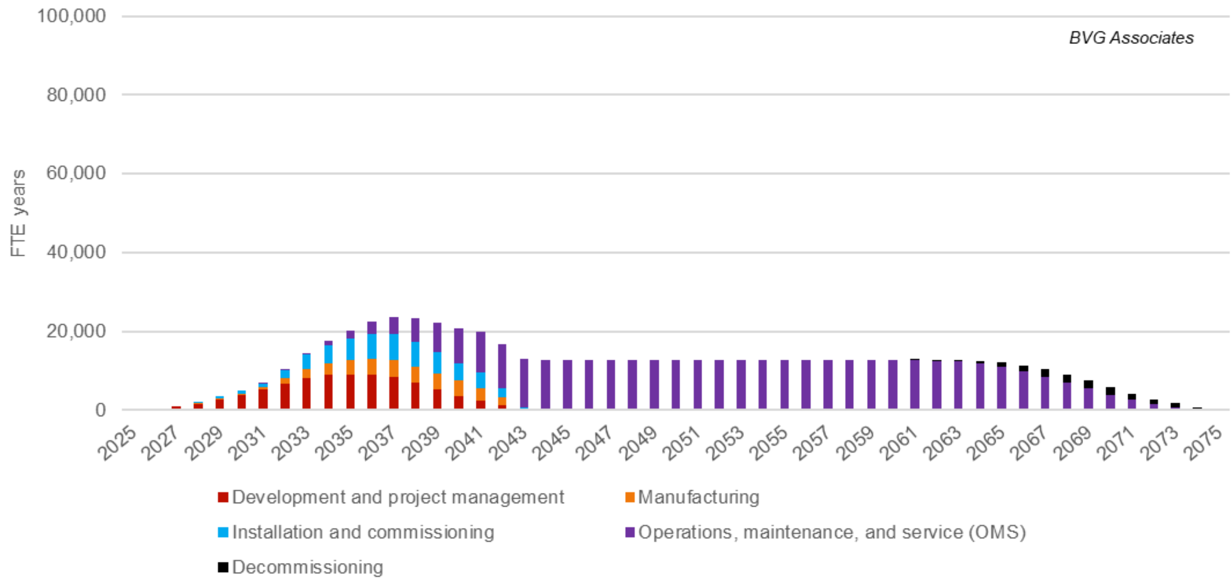


Figure 1.19 National employment impacts over project pipeline in S1, split by cost category.

Scenario 1: Regional impacts

Figure 1.20 shows the profile of GVA benefits to Gujarat and Tamil Nadu associated with the entire project pipeline in scenario 1, split by region. Gujarat's annual benefits peak in 2038 at ₹1,390 crore. Tamil Nadu benefits also peak in 2038 at ₹2,190 crore. The rest of India's annual benefits peak in 2037, at ₹870 crore. Overall, of the ₹1,08,000 crore total GVA benefit, Gujarat captures 27%, Tamil Nadu 60%, and the rest of India 13%.

Figure 1.21 shows the profile of employment benefits to India associated with the entire project pipeline in scenario 1, split by region. Gujarat's annual employment peaks in 2038 at 7,110 FTE years. Tamil Nadu benefits also peak in 2038 at 11,900 FTE years. The rest of India's annual benefits peak in 2037, at 4,540 FTE years. Of the total 576,000 FTE year employment benefit, Gujarat captures 26%, Tamil Nadu 61%, and the rest of India 13%.

The capture of the majority share of GVA and employment benefits by Tamil Nadu reflects the greater volume of projects in the region, with consequent higher levels of, especially, development and project management and operations and maintenance spend. The higher levels of operations and maintenance activity in Tamil Nadu are also reflected in the later peak of GVA and employment activity there, relative to other regions, as the cumulative number of operational projects grows.

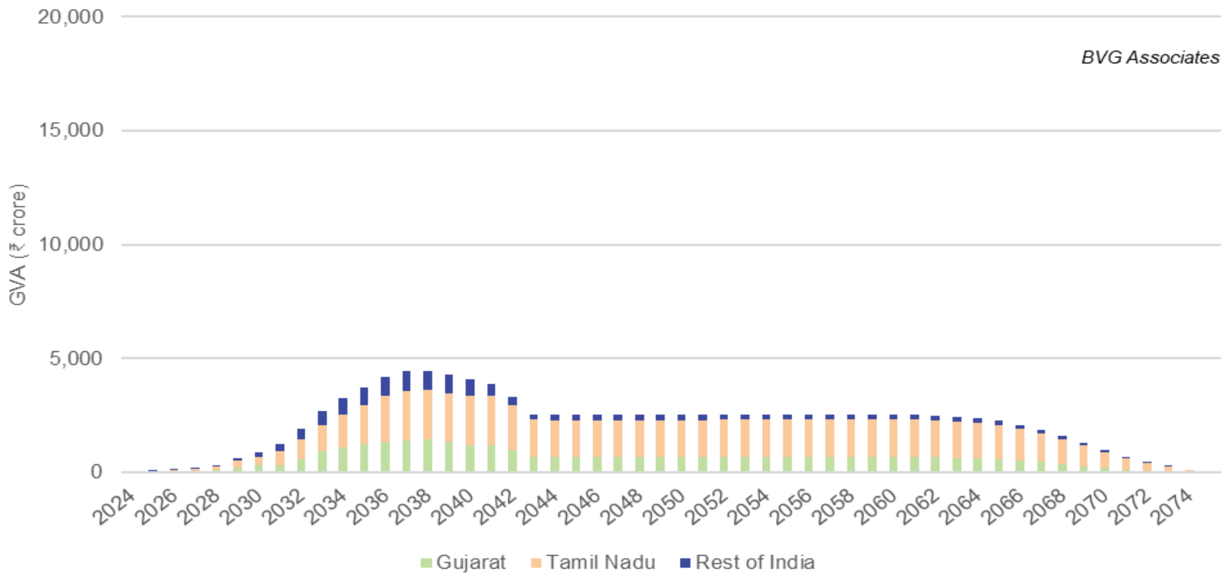


Figure 1.20 GVA impacts of project pipeline in S1, split by region.

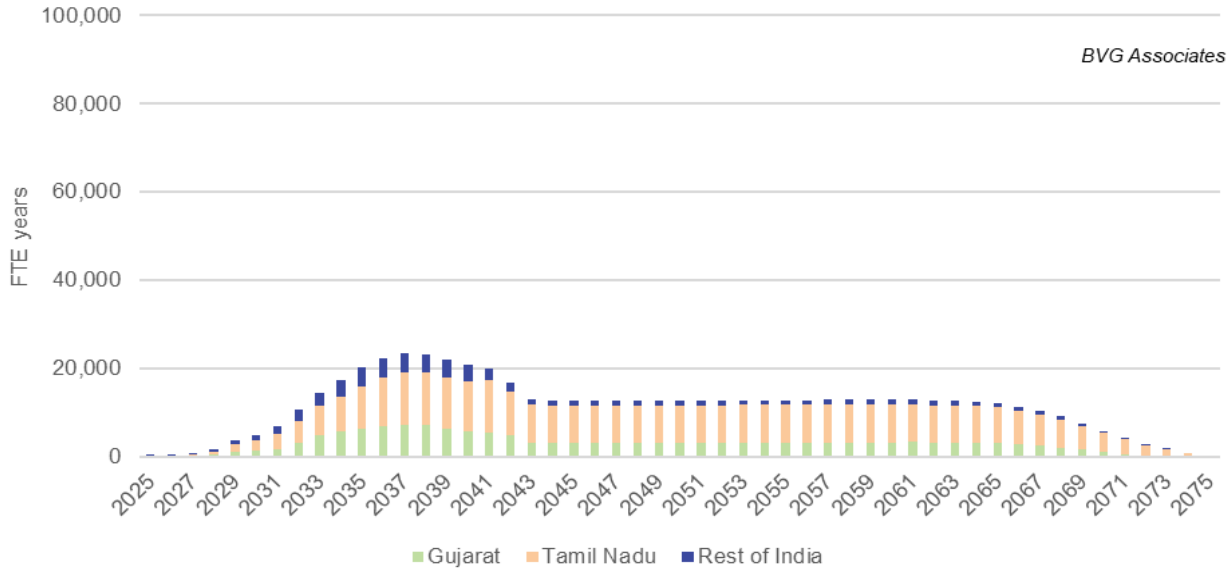


Figure 1.21 Employment impacts of project pipeline in S1, split by region.

Scenario 2: National impacts

Figure 1.22 shows the GVA generated in India by the full 37 GW project pipeline in S2. The peak annual GVA, in 2038, is about ₹18,240 crore, driven by high manufacturing activity, peaking project development activity and a growing operational fleet. The total GVA for India over the entire project pipeline is about ₹2,40,400 crore. 7% of this is in development and project management, 39% in manufacturing, 14% in installation, 36% in operations and maintenance and 4% in decommissioning.

Figure 1.23 shows the FTE years of employment created in India by the full 37 GW project pipeline in S2. It follows a similar pattern to the GVA graph, with India's annual employment peaking in 2037 at about 88,350 FTE years. Total employment generated in India for the project pipeline is about 1,280,000 FTE years over the lifetime of the projects. 6% of this is in development and project management, 36% in manufacturing, 13% in installation, 36% in operations and maintenance, and 9% in decommissioning.

In comparison with S1, S2 sees higher GVA and employment figures, driven to a large extent by increased Indian participation in manufacturing, installation, operation and maintenance and decommissioning. This in turn reduces the relative importance of project development to the overall GVA and employment benefit figures, whose values remain comparable to those in S1.

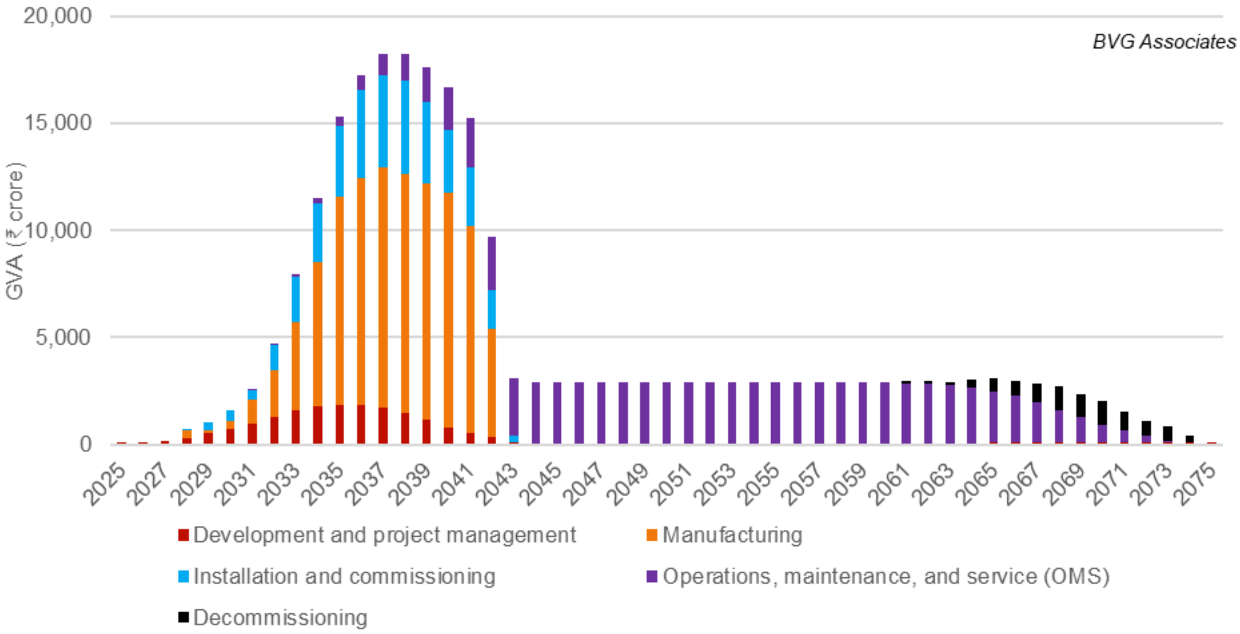


Figure 1.22 National GVA impacts over project pipeline in S2, split by cost category.

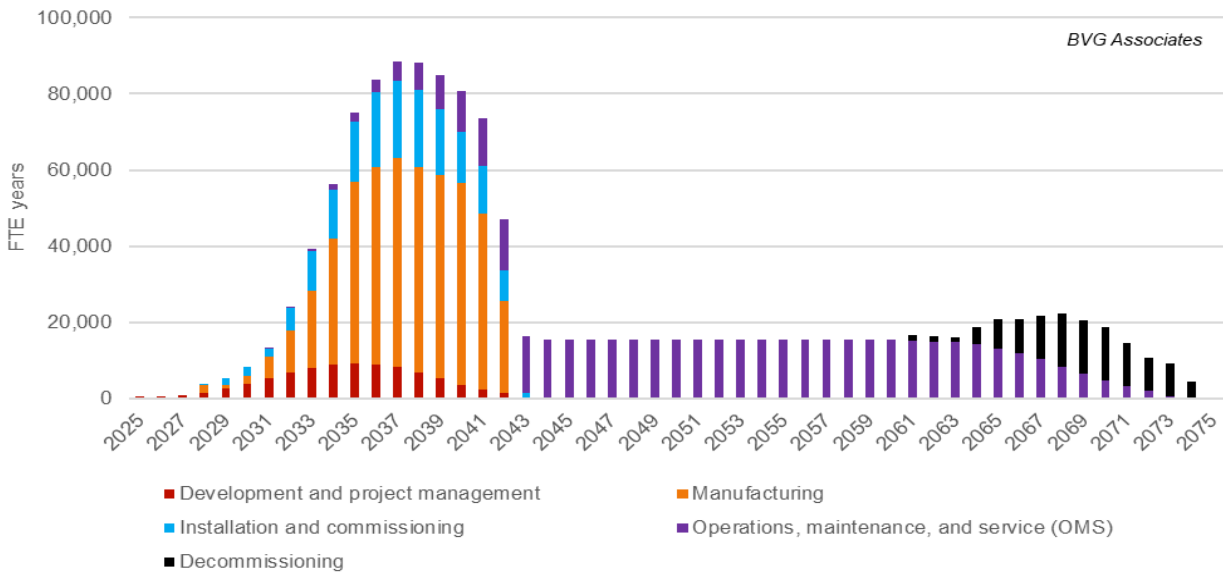


Figure 1.23 National employment impacts over project pipeline in S2, split by cost category.

Scenario 2: Regional impacts

Figure 1.24 shows the profile of GVA benefits to Gujarat and Tamil Nadu associated with the entire project pipeline in S2, split by region. Tamil Nadu annual benefits peak in 2040 at ₹8,410 crore. Gujarat benefits peak in 2037 at ₹1,900 crore. The rest of India's annual benefits peak in 2038, at ₹6,600crore. Overall, of the ₹2,40,000 crore total GVA benefit, Gujarat captures 20%, Tamil Nadu 52%, and the rest of India 28%.

Figure 1.25 shows the profile of employment benefits to India associated with the entire project pipeline in S2, split by region. Gujarat's annual employment peaks in 2037 at 18,100 FTE years. Tamil Nadu benefits peak in 2040 at 41,300 FTE years. The rest of India's annual benefits peak in 2038, at 31,300 FTE years. Of the total FTE year employment benefit, Gujarat captures 20%, Tamil Nadu 52%, and the rest of India 28%.

As in S1, Tamil Nadu captures the largest share of the increased GVA and employment benefits associated with S2. This is due to its larger project pipeline, coupled with its greater share of manufacturing activity, relative to

Gujarat. The rest of India captures a larger share of GVA and employment activity, relative to S1. This is due to the greater participation of the Indian value chain in supplying materials and second tier inputs to manufacturing facilities in Gujarat and Tamil Nadu, combined with the rest of India's participation in decommissioning activity.

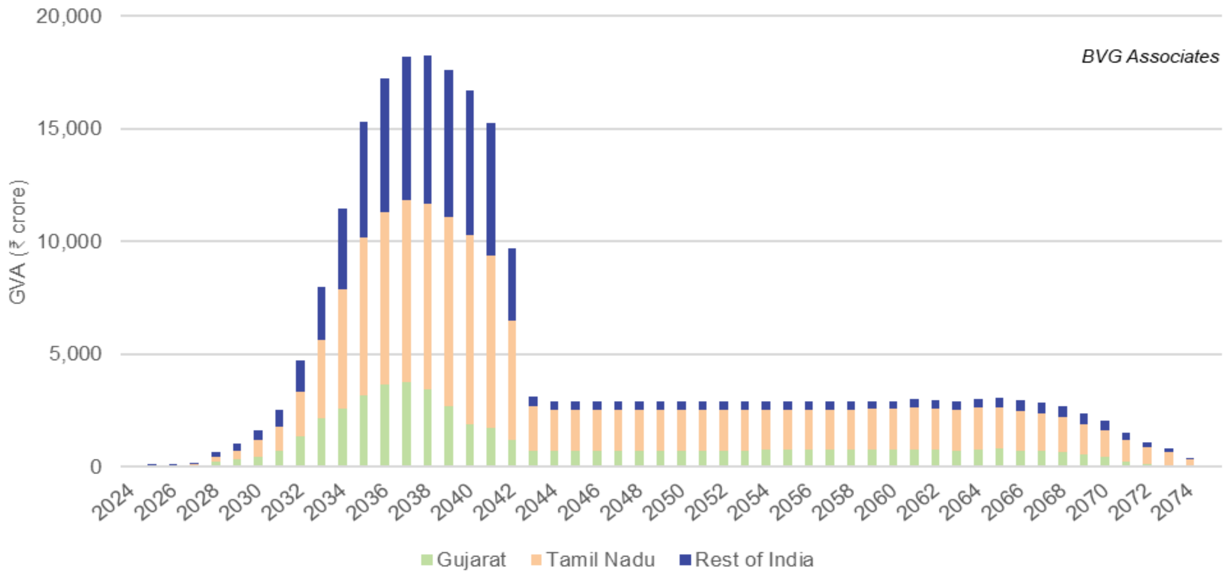


Figure 1.24 GVA impacts of project pipeline in S2, split by region.

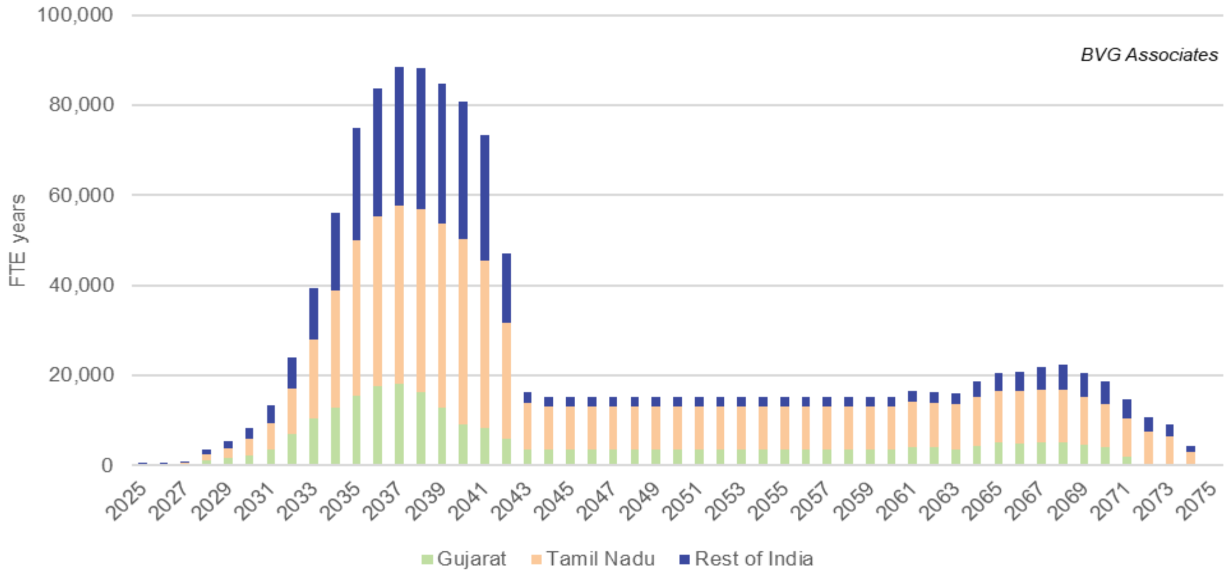


Figure 1.25 Employment impacts of project pipeline in S2, split by region.

1.2. Offshore wind economic impacts vs other renewable technologies

The number of local jobs created by a given project will depend on its specific value chain and location. An analysis of the solar and onshore wind value chain in India is outside the scope of this study. To allow for meaningful comparisons between technologies, this section outlines the typical employment requirements for 1 GW capacity of onshore wind, solar, and OSW.

The following analysis is based on a series of reports published by the International Renewable Energy Agency (IRENA) analysing the global job creation opportunities across various renewable energy technologies, including solar PV[20], onshore wind[21] and OSW[22]. These studies estimate the person-days[vi] required for solar, onshore wind, and OSW projects over their respective lifecycles. The estimates are based on expert interviews, survey responses, and research from leading companies in the solar and onshore and OSW industries. Estimates of person-days are provided as total figures required for typical projects, including a 50 MW solar farm, a 50 MW onshore wind farm, and a 500 MW OSW farm, with a 25-year lifecycle assumed for all technology types. These are estimates of direct positions and do not include indirect or induced employment.

To enable meaningful comparison, direct person-days have been scaled to reflect 1 GW of capacity across technologies. While economies of scale would typically reduce employment for a 1 GW project, these figures are compared based on a pipeline made up of twenty 50 MW solar and onshore wind farms respectively, and two 500 MW OSW farms.

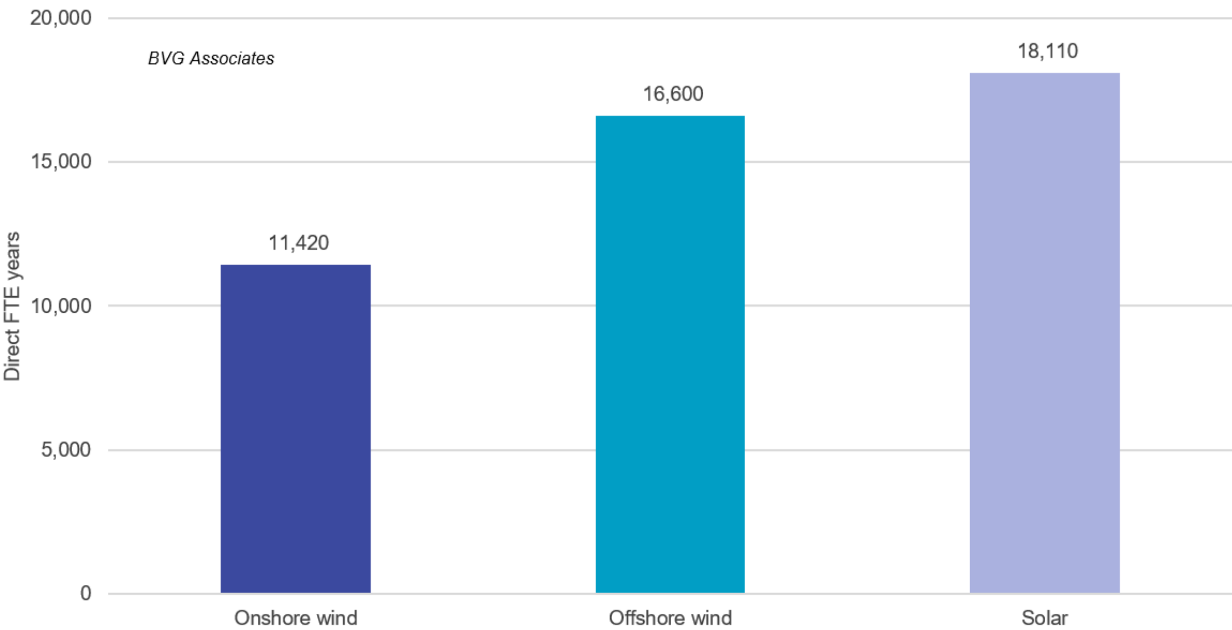


Figure 1.26 Comparison of global direct FTE years required for 1 GW of solar, onshore wind and offshore wind capacity (source: IRENA). [20 21 22]

IRENA's analysis is based on a western OSW development, unlike the employment analysis in this report, which is specific to the Indian context.[vii] As a result, employment figures are not directly comparable but they may provide a helpful benchmark for relative comparison between technologies.

Figure 1.26 shows a comparison of global direct FTE years[viii] required for 1 GW of solar, onshore wind and OSW capacity across a 25-year operational period. Typically, OSW generates approximately 16,600 direct FTE years

[vi] Person-days is a unit of measurement that represents the amount of work one person can complete in a single day.

[vii] The employment analysis in this report reflects India's more labour-intensive economic structure and assumes a large share of work is carried out domestically, which increases the global direct FTE years associated with an Indian OSW project.

[viii] It is assumed one FTE year is equivalent to 252 person-days. This is based on the average working days of a UK FTE position.

for 1 GW of capacity, solar generates 18,100 direct FTE years, and onshore wind generates 11,400 direct FTE years.

Overall employment potential will be higher than presented when indirect and induced jobs are considered. The above studies do not provide specific estimates for these categories.

Due to their larger scale, OSW projects benefit from economies of scale, requiring fewer jobs per unit of capacity compared to multiple smaller projects in other technologies. When evaluating these figures, it is also important to consider the global value chain of each technology. For example, solar panel manufacturing is largely concentrated in China. While these figures provide a general overview of employment requirements, the employment impact of different technologies varies by country and region, depending on value chains, and availability of manufacturing facilities.

1.3. Social impacts from global offshore wind farms

Understanding the social impacts of OSW development is crucial for balancing economic benefits with environmental and community interests, ensuring that these projects contribute to sustainable and inclusive growth. Apart from creating jobs, driving local investment, and supporting skill development, OSW projects can create a wide range of social impacts on local communities and economies.

Across the world, OSW developers have employed various mechanisms to deliver community benefits and share the economic rewards of OSW. These include financial contributions to community funds, local employment initiatives, investment in infrastructure and services, and schemes that allow communities to take part in or directly benefit from OSW revenues. By implementing such measures, governments and developers can ensure that OSW projects not only support national energy and environmental goals but also create meaningful and equitable benefits for the communities hosting them.

Given the nascent stage of India’s OSW industry, accurately assessing the social impacts of OSW development presents a significant challenge. There is considerable uncertainty surrounding the potential social implications, including employment generation, community benefits, displacement concerns, and environmental equity.

To provide meaningful insights and bridge this gap, we have drawn on international experience to illustrate the social impacts of OSW deployment. This report includes four case studies from Vietnam, Taiwan, the UK, and the US that bring real-world perspectives from other OSW markets. Through these case studies, we aim to offer valuable insights that can inform and guide India’s approach to OSW development, helping to mitigate challenges and maximise social benefits.

1.3.1 Case study 1

Vietnam: La Gan

La Gan is a 3.5 GW OSW project currently being developed off the coast of Bình Thuan, Vietnam, and is one of the first large-scale OSW power projects in Vietnam. The project submitted its survey license application and pre-feasibility study report in 2020 and is awaiting approval from the Vietnamese Government. Once operational, the project is expected to be one of Southeast Asia's largest OSW farms.

The project has to date supported various environmental and community initiatives in the development stage, including:

- Community engagement workshop on the prospects of OSW: In August 2023, Copenhagen Infrastructure Partners (CIP), the Union of Science and Technology Associations, and the Department of Natural Resources and Environment of Binh Thuan organised a workshop to introduce opportunities that OSW development will bring to the Binh Thuan region and its ability to coexist with other marine activities. This included socio-economic benefits, local value chain and employment opportunities, and development of the marine economy in parallel with existing activities such as fisheries and recreation.[23]

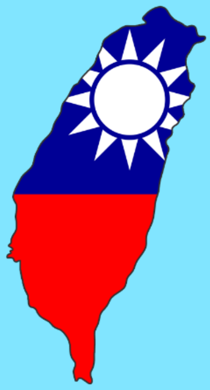
- Disaster relief: The project donated about US$27,000 (about ₹24.4 lakh) to communities affected by floods in the Quang Nam province. The project also sponsored 230 impacted children and their families in the Quang Ngai province. [24]
- Educational support and development: The project donated US$25,000 (about ₹0.24 lakh) to promote education and support underprivileged students.
- Support to disadvantaged households: The project continues to support disadvantaged communities by providing food, school supplies, and welfare bags.
- Solar streetlights: In January 2024, the project inaugurated a solar streetlight system of 400 kW in the Binh Thuan region to improve transportation safety and reduce carbon emissions.[25]

The project further plans to engage with local communities to develop the project responsibly. [26]These include conducting:

- Environmental and social impact assessment to international standards, including surveys and studies on marine and terrestrial ecosystems, cultural heritage, marine traffic, and local fishing practices, and
- Stakeholder engagement with fishing communities and the wider community focuses on vulnerable groups such as low-income households that may be affected by economic changes.

1.3.2 Case study 2

Taiwan: Greater Changhua 1 and 2a



Taiwan has about 1.5 GW of operational OSW capacity and about 3.8 GW under construction or close to construction. The social impacts of OSW projects have remained a significant concern for the fishing industry, leading to project delays. Fishermen across Taiwan have protested OSW developments concerning the lack of community engagement, exclusion of fishing rights, ineffective subsidies of fishery compensation standards, and the protection of sustainable fishing.[27,28] For example, in 2015, fishermen in Changhua protested the construction of a meteorological observation tower for the Fuhai project and cited impacts on fishermen's livelihood. Negotiations between the project and the fishers are ongoing.

In Taiwan, developers are required to compensate fishers holding fishing rights for any losses to their livelihood caused by OSW project development. This is done through a fund which aims to support regional development by funding initiatives in health, welfare, education, infrastructure, cultural activities, employment, fisheries, environmental conservation, and power infrastructure. This is guided by Taiwanese Government standards, with fisheries compensation calculated using a formula often criticised for providing insufficient reimbursement.[29,30] It often leads to disputes as either side deems the terms unfair.

Despite the challenges, OSW projects in Taiwan have created socioeconomic opportunities and enabled local communities to benefit from the development of the renewable energy industry. Ørsted, the developer for the 900 MW Greater Changhua 1 and 2a OSW farms, is committed to developing robust local value chains and creating long-term benefits for local communities. Since establishing their APAC headquarters in Taipei in 2026, they have: [31]

- Set up a community benefit fund that will contribute NT$18 (about ₹50) for every MWh of electricity produced by its Greater Changhua OSW projects. The fund is designated for community livelihood rejuvenation, fishery resources restoration, and other effective coexistence initiatives.
- Introduced the Internship Programme in 2017 to support senior university students in contributing to Taiwan's green energy development. To date, over 30 interns have participated, with 10 securing full-time positions at Ørsted upon completion.
- Launched the Apprenticeship Programme in 2019 in partnership with Da-Yeh University (DYU). The programme supports second-year bachelor students from DYU to enter the OSW industry by providing

classroom courses in engineering, electricity, mechanics, and hydraulics with on-the-job training alongside Ørsted experts at the Greater Changhua projects.

- Launched the Green Energy Scholarship Program (GESP) in 2019 to offer Taiwanese students opportunities to pursue further education. The GESP offers a grant of up to NT$0.4 million (about ₹12 lakh) for tuition, accommodation, and personal living costs. From 2019 to 2022, a total of 25 students were awarded a scholarship. [ix]
- Installed a megawatt-scale energy storage system in 2020 at the National Changhua University of Education (NCUE) to optimise on-campus energy efficiency and smart grid research.
- Inaugurated the Dual-Doppler Radar System in 2021, offering wind and weather observational data to six academic research partners, including National Taiwan University, National Central University, Chinese Culture University, Industrial Technology Research Institute, Technical University of Denmark, and SmartWind Technologies.
- Launched the Green Energy Syllabus initiative in 2022, in partnership with NCUE. This initiative trained teachers from more than 30 elementary schools to share OSW knowledge geared to international standards with more than 750 elementary school children.
- Inaugurated the Ørsted Taiwan OSW Farms Operations and Maintenance Hub in 2022 at the Port of Taichung. The O&M hub is Asia-Pacific's largest green-designed operations facility aimed to support four Greater Changhua OSW farms with a combined capacity of approximately 2.4 GW. The company has also cultivated a local O&M team of technicians and operations professionals and launched the world's first Taiwan flagged customized service operation vessel (SOV) TSS Pioneer.
- Sponsored a Class B seafarer training and certification program in 2023 to recruit fishers and young individuals from the Changhua and Taichung area. 18 trainees have completed a 392-hour course, earning Class B seafarer certification in navigation science and related duties, along with security responsibility and awareness certificates.
- Launched the Sustainable Innovation Accelerator (SIA) in collaboration with the Metal Industries Research & Development Centre (MIRDC) in January 2024. The initiative invites students and professionals to propose innovative solutions for advancing sustainability in the OSW industry. The programme provides a total prize of NT$0.45 million (about ₹13 lakh) to shortlisted teams, and up to NT$0.5 million (about ₹14 lakh) to the winning team.

1.3.3 Case study 3

United Kingdom: Beatrice

Beatrice is a 588 MW OSW project off the coast of Caithness, Scotland. The project reached full commissioning in 2019 and is one of the largest wind farms in Scotland.[32]

The project established the Beatrice Community Fund in 2016-17, to which it contributed almost GB£0.3 million (about ₹330 lakh) per year over five years.[x, 33] By March 2023, the fund had donated around £6 million (about ₹70 crore) to 361 local projects, including community hubs and elderly care centres. [34] Social impact research conducted in 2017 found that every £1 invested from the Beatrice Partnership Fund generated £3.21 in wider value.[35]

The fund had two components:

[ix] Where 1 New Taiwan Dollar (NT$) is about ₹2.64 at time of writing.

[x] Where GB£1 is about ₹113 at time of writing.

- Partnership fund supported regional projects in the highlands aimed at creating opportunities for skills and employment, regenerating infrastructure, landscape and heritages, and driving social and environmental improvements to communities. The funding decisions were made by a regional panel of experts.
- Local funds supported local initiatives in nearby community council areas of Caithness, Sutherland, and Moray. These initiatives included upgrading amenities, restoring buildings, and funding local apprenticeship schemes. The funding decisions were made by panels of local people.

The project also took steps to address environmental and community concerns as required by the Environmental Impact Assessment (EIA), Scotland Regulations 2000, including various geophysical and geotechnical surveys, stakeholder engagement and collaboration, and mitigation strategies.

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Beatrice signed a 25-year agreement with Wick Harbour to use as its operations and maintenance base. It invested about GB£20 million (about ₹200 crore) in Wick, including renovating two harbour front buildings and re-purposing a disused corner of the inner harbour area to facilitate berthing and operation of crew transfer vessels.[36] The building, originally built to support the herring industry, has been sensitively restored to provide a modern state of the art operational facility which includes offices, warehousing, and welfare facilities. [37]

1.3.4 Case study 4

United States: Vineyard Wind 1

Vineyard Wind 1 is an 804 MW OSW project off the coast of Massachusetts, US. It is developed by Vineyard Wind LLC, an OSW development company jointly owned by Copenhagen Infrastructure Partners (CIP) and Avangrid Renewables, with each holding a 50% stake. The project began to produce power in 2024 and is expected to be fully commissioned in 2025. [38]The project has committed US$15 million (about ₹130 crore) in Massachusetts under social development across three initiatives. These include:[39]

- The Windward Workforce Fund was a US$2 million (about ₹17 crore) fund to recruit, mentor, and train residents of Massachusetts for careers in the OSW industry. The programme was undertaken in partnership with vocational schools, community colleges, the Fishing Partnership Support Services, and others, and had two major initiatives. The Building Pathways South (BPS) was a pre-apprenticeship programme that prepared low-income men and women to obtain the requisite qualifications to be considered for union apprenticeship opportunities in OSW. The Turbine Installation Training Initiative supported the Offshore Suitability Experience programme at Massachusetts Maritime Academy to introduce workers to life and work offshore, and the Helicopter Underwater Escape Training (HUET) offered at Survival Systems USA in Groton, Connecticut.

- The Offshore Wind Industry Accelerator Fund invests up to US$10 million (about ₹80 crore) in projects and initiatives to accelerate the development of the OSW value chain, businesses, and infrastructure. This is aimed at attracting investment to upgrade or create new OSW facilities.
- The Marine Mammals and Wind Fund invest up to US$3 million (about ₹26 crore) to develop and demonstrate innovative methods and technologies to enhance protections for marine mammals. The fund will be guided by a steering committee which will include representatives of environmental advocacy groups.

Additionally, the project has also taken steps to support environmental protection. These include:

- Signing an agreement in January 2019 between the Natural Resources Defence Council, National Wildlife Federation, and Conservation Law Foundation, to protect critically endangered North Atlantic right whales. The agreement features restrictions on vessel speeds, construction timelines, and noise, and work-stop measures. Important migration measures were incorporated into the permitting process as a part of this agreement.
- Launching the Fisheries Compensatory Mitigation Program in March 2024, to provide compensation to commercial fishers for economic impacts attributable to the project's construction, operations, and decommissioning activities. This program closed in June 2024. [40]
- Conducting geophysical and geotechnical surveys over several years for sensitive benthic habitats and eelgrass beds to identify the least impactful subsea cable corridor to install subsea cables up to 6 feet beneath the seafloor.
- The Offshore Wind Industry Accelerator Fund invests up to US$10 million (about ₹90 crore) in projects and initiatives to accelerate the development of the OSW value chain, businesses, and infrastructure. This is aimed at attracting investment to upgrade or create new OSW facilities.
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- Conducting geophysical and geotechnical surveys over several years for sensitive benthic habitats and eelgrass beds to identify the least impactful subsea cable corridor to install subsea cables up to 6 feet beneath the seafloor.
- Conducting marine surveys and studies with the UMass Dartmouth School of Marine Science and Technology and the New England Aquarium Anderson Cabot Centre for Ocean Life to gather data on marine species and highly migratory species that may be impacted by the installation and operation of Vineyard Wind 1 project.

[xi] Vineyard Wind, https://vw1fisheriescomp.com/

1.3.5 Key learnings for India

The significant economic and employment benefits associated with the rollout of OSW in India as outlined in Section 1.1.2 represent the cornerstone of the positive impact this initiative is likely to deliver for India, and for the states of Gujarat and Tamil Nadu.

The collected case studies above also demonstrate OSW's potential to deliver additional positive social impacts to host communities through community benefit initiatives. OSW projects represent significant, multibillion dollar investments, and developers are often prepared, and indeed expect, to allocate a portion of actual or expected project revenues to community benefit measures, to build support for their activities and secure social license to operate. In some cases, such initiatives may be mandated as part of leasing, consenting or offtake frameworks, or to meet lenders' social requirements to access finance. In many cases, however, it is voluntary on the part of developers.

The collected case studies in this section demonstrate the wide range of social interventions which are possible and have been successfully implemented as part of the OSW project lifecycle in other markets. Such interventions have included:

- Community engagement
- Community benefit funds
- Disaster relief
- Environmental protection and restoration
- Infrastructure development
- Poverty relief
- Skills and education support, and
- Support for local fishers and other economically impacted communities.

Though most existing examples of operational OSW projects, and hence of their social impact, come from developed markets where the socioeconomic context is quite distinct from India, the evidence from the La Gan project in Vietnam shows that social value initiatives are deliverable and can be impactful in an emerging market context, even during the project development phase.

Nevertheless, bearing in mind the overriding importance of creating an attractive investment environment in India to deliver investment in both OSW projects and value chain, the Government should be cautious in seeking to impose cost-additive social impact requirements, especially at the early stages of projects. Such interventions should be carefully calibrated to be proportionate and are best delivered via a collaborative approach.

Financial measures designed to extract additional community benefit from OSW may have limited net economic impact for India as a whole, as the costs associated with their implementation are likely to be reflected in higher electricity prices.

Despite this, there is likely to be value in pursuing community benefit measures in some form in India. Experience from other markets shows that ambitious deployment programmes can meet with significant public opposition when action is not taken to ensure communities close to projects feel the benefits. In addition, the deployment of OSW in India and the investment associated with it represents an attractive opportunity to address government's wider economic and social priorities, through proportionate measures to encourage appropriate social interventions.

There is no 'one size fits all' approach to social impact, and measures should be carefully considered with regard to the nature of and challenges faced by the specific communities affected. Generally, the success of social interventions in other markets has been when they are rooted in local political cultures and social norms. Extensive community engagement prior to implementing social impact measures is recommended to ensure that interventions are aligned with the needs of the community.

Recommendations to deliver social impacts through Indian OSW deployment are addressed in Section 1.5.

1.4. Opportunities and challenges

As India strives to achieve its ambitious renewable energy and net-zero targets, OSW has emerged as a promising but largely untapped sector. An ambition to tender 37GW by 2030 provides India with the opportunity to enhance its energy security, reduce reliance on fossil fuels, and drive economic growth. However, OSW development comes with its own set of challenges, including policy uncertainty, barriers to investment and, infrastructure limitations.

Based on our findings above, below is an overview of the key opportunities and challenges shaping India's OSW sector.

1.4.1 Opportunities

India as a competitive offshore wind manufacturing hub

India has an opportunity to become a competitive player within the global OSW value chain by leveraging its:

- Vibrant heavy manufacturing sector with expertise in steel, engineering, and fabrication.
- Cost-effective labour market, which can reduce production costs compared to Western countries.
- Existing strengths in parallel sectors such as onshore wind and oil and gas, which provide transferrable skills and infrastructure.

This is reflected in our assessment of India's potential value chain capabilities under an Indian-led model of development, as set out in S2. While both scenarios see India capture a large share of development and project management and OMS spend, in this scenario India establishes a diverse value chain, manufacturing the majority of componentry to serve its OSW rollout.

The key specific manufacturing opportunity areas we identify under S2 are:

- Nacelle assembly
- Blades
- Towers
- Monopile foundations
- Array cables, and
- Offshore substations

With the exception of offshore substations, India currently has no facilities capable of manufacturing these components to the size and specification typically required by OSW projects. India has a record and capability of manufacturing smaller onshore wind componentry. These existing capabilities and skills in the workforce offer an advantage in entering the OSW market, but significant investment in new dedicated facilities will be required for India to capture these activities.

India can further enhance its value chain development through facilitating the development of industrial clusters, centred around OSW focussed ports through supportive policies, funding for business networks, and other initiatives, encourage industry collaboration and investment. Large component manufacturers, which locate in portside locations for logistical reasons, can encourage the development of hubs of interrelated industries and tier-2 suppliers. This clustering effect has been observed in established OSW hubs such as Esbjerg in Denmark, Hamburg in Germany and the Humber region in the UK.

Economic growth and job creation

OSW development presents a significant economic opportunity for India by driving investment, increasing local content, and creating thousands of jobs. This includes:

- High-value engineering and manufacturing jobs.
- Construction and installation jobs related to OSW farm deployment.
- Long-term operations and maintenance roles providing sustained employment opportunities.

- Indirect job creation in related industries, including port development, logistics, and services.

As demonstrated in Section 1.1, OSW deployment has the potential to make a significant contribution to India's economy, both in GVA and employment terms. In S2, we find a potential for ₹2,04,400 crore domestic GVA and 1,280,000 FTE years FTE years of employment associated with the development, construction, operation and decommissioning of India's planned 37 GW OSW fleet.

1.4.2 Challenges

Policy and regulatory uncertainty

To drive significant investment in India's OSW value chain, confidence in OSW in India as an investment environment will be critical. Key challenges include establishing:

- Clear, long-term national and state Government commitments to OSW, providing visibility of long-term substantial OSW deployment.
- Streamlined permitting processes, reducing bureaucratic delays and following good international industry practice captured in lending and other standards.
- Clarity of auction schedules and revenue mechanisms (e.g., tariff structures).
- A good degree of certainty about costs when project developers bid per MWh prices for offtake agreements, which depends on good clarity regarding site conditions and value chain and a short timeline before construction.
- Bankable regulatory frameworks for leasing, permitting, offtake, and grid connection.
- Robust health and safety frameworks.
- Good communication and collaboration between national and state Government, Indian industry and the global OSW industry.

Although this report is focussed on socioeconomic impacts and skills development, there will be little activity in these areas until a viable local market is established, based on these ingredients.

High capital costs and barriers to investment

OSW manufacturing facilities represent major capital investments, typically costing several hundred crore rupees. The business case for major investments in manufacturing and port facilities is rarely made on a single project. Rather, potential investors typically seek markets with robust project pipelines stretching over many years, and with a record of delivery and bankable routes to the market before committing to such investments. India's initial OSW projects alone are unlikely to trigger such investments and are likely to rely mainly on established facilities.

The established global OSW sector has faced headwinds in recent years, with rising costs, driven largely by rising cost of debt and commodity prices, leading to squeezed profit margins, slower than expected deployment and increased caution on the part of investors.

This represents both a challenge and an opportunity for India. While many established western developers and manufacturers are seeking greater market confidence before committing to investments, and in many cases reducing the number of markets in which they operate, India may find it particularly challenging to attract foreign direct investment in its OSW value chain. However, the increased caution of established market participants could present an opportunity for Indian onshore wind manufacturers to enter the market if they have the appetite.

Lack of infrastructure

India currently lacks the necessary port infrastructure to support large-scale OSW deployment Availability of suitable infrastructure is key, as manufacturing facilities for large OSW componentry typically locate in a portside location with ample laydown area and sufficient quayside length, water depth and access channel to accommodate the large vessels which are required to transport and install these components.

In addition, investment in high voltage grid infrastructure to connect OSW projects to demand centres will be needed to support India's OSW rollout. Evidence of progress in this will form another consideration for potential investors.

Specific recommendations to drive investment in the value chain and maximise the economic benefits of Indian OSW deployment, consistent with S2, are addressed in Section 1.5.

1.5. Recommendations

India has the potential to become an established player in the global OSW value chain, leveraging its strong manufacturing base, skilled workforce, and expertise in related industries such as onshore wind and oil and gas. Such potential is fully aligned with its *Make In India 2.0* initiative.[1]Despite these opportunities, several challenges—including policy uncertainty, infrastructure gaps, financial constraints, and a lack of domestic manufacturing capabilities—pose significant barriers to establishing a competitive OSW value chain.

To drive the development of the domestic OSW value chain as set out in S2, and to unlock significant social benefits to be derived both from this economic growth opportunity and additional community benefit measures as explored in Section 1.3, proactive measures are required to create the right environment for investment.

The 2024 BVGA report *Accelerating the deployment of offshore wind in India*[2] provided key recommendations on how India could accelerate its OSW sector. The findings of this detailed and comprehensive roadmap toward the successful deployment of OSW in India still remain relevant to the Government of India and other stakeholders. Here, we include a selection of some of the most important recommendations from this previous report, which should be implemented to create the right investment environment for both OSW projects and value chain, and encouraging development of a vibrant Indian OSW value chain. In addition, we propose new recommendations specifically targeted at industrial development and fostering social value. For more detailed specific recommendations, especially related to the development of robust and bankable frameworks, we recommend this report is read in conjunction with *Accelerating the deployment of OSW in India.*
We recommend:

Establish clear and predictable policies and frameworks

1. MNRE publishes medium- and long-term visions for OSW to 2070 as part of a decarbonised energy mix for India, considering targets for other renewable energy technologies, explaining the case for OSW in terms of cost benefits and long-term contribution to the energy mix, and its role in India's net zero targets, to drive investor confidence in the long term attractiveness of the Indian market.
2. MNRE provides consistent auction schedules to give investors' confidence in market stability.
3. MNRE works with relevant national and subnational stakeholders to establish and solidify clear frameworks for leasing, permitting, offtake and grid connection. These frameworks should provide a clear:
   i. Path to securing seabed exclusivity, for a reasonable timeframe to allow for the long development cycle of OSW projects.
   ii. Framework for permitting which delivers transparent and timely decisions, and which incorporates Good International Industry Practice (GIIP) within Environmental and Social Impact Assessment (ESIA) to facilitate international lending and to enhance projects' social value.
   iii. Route to a long term, bankable power purchase agreement (PPA), backed up by a reliable counterparty, providing revenue certainty and with appropriate escalation mechanisms to protect developers against inflation, currency and commodity price fluctuations.
   iv. Mechanism for securing access to grid which provides long term visibility of grid connection date and protection against delays to that timeline.
4. MNRE reviews the Environmental Social Impact Assessment (ESIA) regulations and process for OSW against international standards, Good International Industry Practice (GIIP) and lender requirements and makes necessary updates and clarifications. To facilitate lending, international funding organisations need to

ensure that projects meet their environmental and social standards. Alignment with these standards will help ensure Indian OSW projects deliver positive social impact.

Develop port infrastructure

5. Ministry of Ports and Shipping develops a long-term multi-phased plan for developing an offshore renewable energy hub within the port facilities of Hazira, Pipavav, Tuticorin, and Vizhinjam. This should sit alongside securing permits for future expansion to keep pace with the growing demand for services within the OSW sector, and a strategy of attracting major anchor tenants around which wider supply-chain businesses and infrastructure can grow.

Value chain development

6. MNRE develops a targeted approach to value chain development, through delivery of offshore wind industrial strategy, focussing on key areas of Indian potential, including:
    i. Development and consenting skills
    ii. Turbine component manufacture
    iii. Foundation manufacture
    iv. Cable manufacture, and
    v. Ports servicing construction and O&M activity.
7. MNRE establishes a long-term official Government of India-industry task force along the lines of UK's Offshore Wind Industry Council (OWIC) involving local and international project developers and key suppliers, to work together to align interests, address gaps, and formulate solutions.
8. Ministry of Finance in partnership with MNRE, Ministry of Heavy Industries, Ministry of Steel, Ministry of Commerce, and Industrial development boards of Gujarat and Tamil Nadu and other states, invests in publicly funded innovation programmes to reduce levelized cost of energy (LCOE) and help increase local supply content.
9. MNRE facilitates investment in local value chain by offering financial incentives such as grants, tax credits, or subsidies to encourage private investment in OSW manufacturing.
10. MNRE develops measures to encourage local value chain investment, including consideration of including non-price factors in leasing and revenue models and the inclusion of value chain plans as part of the bidding criteria, taking care to avoid stringent local content requirements that might add risk and cost to projects and slow deployment.
11. Ministry of Ports and Shipping, Chief Minister offices and Development Authorities of Gujarat and Tamil Nadu, facilitate the development of industrial clusters through supportive policies, funding for business networks, and other initiatives encouraging industry collaboration and investment, such as market entry and business transformation support.
12. MNRE ensures any measures to mandate additional social benefit should be carefully calibrated to ensure proportionality, and developed in consultation with industry, via the government industry taskforce established under recommendation 3, as well as local communities.
13. MNRE Introduces methodologies to ensure robust measurement and reporting against socio-economic impact. Measures should be implemented to ensure visibility of benefits, learning from best practice and continuous improvement of frameworks.

Strengthen research, innovation, and technology transfer

14. MNRE facilitates technology collaborations between Indian firms and experienced international OSW players to accelerate knowledge transfer. Provides financial incentives or tax benefits to encourage joint ventures, partnerships, and knowledge sharing.

2. Skills and training analysis

Developing the necessary skills in the local workforce is important to ensure long term sustainable growth of the OSW sector and to maximise local participation. Skills development is crucial due to the complex and highly technical nature of the OSW sector, requiring expertise across various disciplines including engineering, environmental science, project management, health and safety, and others. This chapter identifies the workforce needs for developing a thriving OSW industry in India.

This chapter is divided into the following sections:

- Section 2.1 Skills and training assessment of the Indian OSW sector: Presents the methodology and the results from identifying key roles and skills required by the Indian OSW sector.
- Section 2.2 Review of training programmes: Presents an overview of skills training provision available in India.
- Section 2.3 Challenges and opportunities: Identifies the challenges and explores potential opportunities for Indian stakeholders to overcome the challenge of shifting from the business as usual to the high localisation scenario. Gives an overview of the current domestic legislative framework in India and how the country can leverage international expertise. Presents examples of skills transfer from parallel sectors, particularly oil and gas, where expertise in some offshore works can be transitioned into OSW roles.
- Section 2.4 Recommendations: Provides specific recommendations on how to promote skills development and address identified skills gaps.

2.1. Skills and training assessment of the Indian offshore wind sector

2.1.1 Methodology

The skills and training assessment models future demand in India based on the Indian value chain scenario (S2) in which action is taken to maximise local content. It following steps were involved:

1. Identify key job roles,
2. Identify FTE year requirements and specific skills, and
3. Review of training provisions

Identify job roles and skills

A bottom-up approach was used to identify key roles and relevant skills within the OSW industry. An OSW project involves a huge variety of roles. Many of these roles, reflected in the top-down overall jobs figure from Section 2.1.2, are generalist roles with non-OSW-specific skills, such as lawyers, accountants, administrative staff, IT support, cooks, security guards, and so on. To keep the report focused and readable, about 60 critical job roles were identified where India is expected to play a role. These roles were based on an assessment of:

- How likely a role is to be undertaken by an Indian worker, and
- How specialist and critical to unlocking Indian OSW deployment the role is.

These roles were informed by the value chain assessment undertaken in Chapter 1, and it is assumed that the roles required in India will remain the same regardless of whether the project is implemented in Tamil Nadu or Gujarat. Building on global OSW industry experience, skill levels and qualifications associated with these roles were provided. Note that the selected job roles cover about 26% of the total jobs available in India, with many others deeper into the supply chain. This is shown in Figure 2.1.

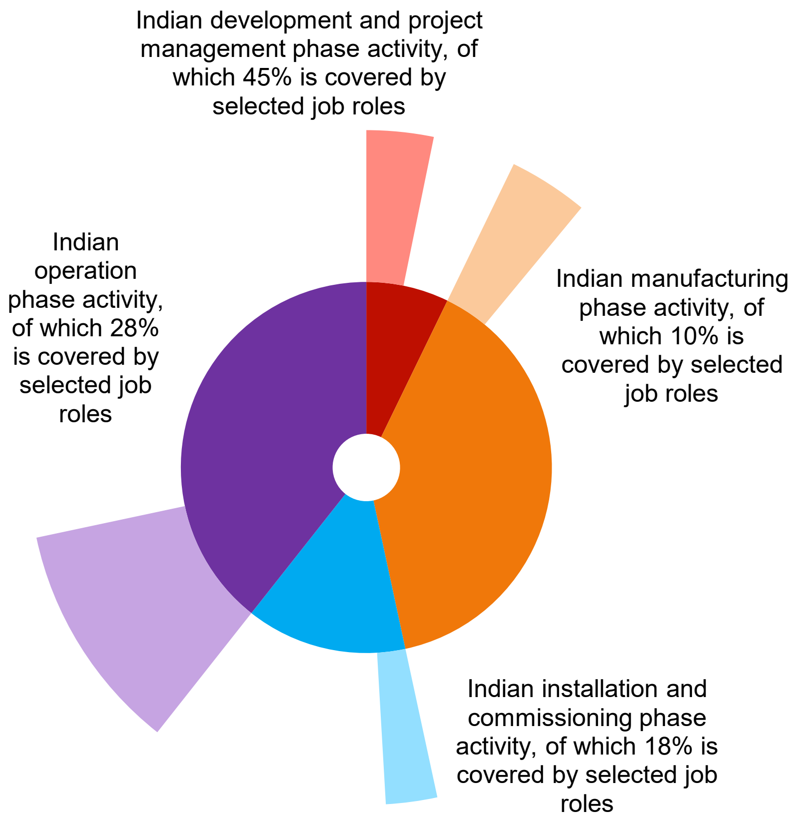

Figure 2.1 Coverage of selected job roles in each phase, compared to scope considered in Chapter 1 (S2).

Although the development and installation phases are well covered, the manufacturing phase is less well covered, as there are many jobs further down the value chain under the manufacturing and assembly facilities considered.

Finalise key job roles and specific skills gaps

A campaign of engagements was then carried out with key stakeholders in the Indian and wider OSW sector, including developers and suppliers, to establish:

- The final list of key roles
- The per-GW FTE-year or per manufacturing facility FTE requirement in India for each of the job roles
- Areas of risk to recruitment, and
- Actions they would like the Indian Government to take to help address these recruitment risks.

Review of training provision

Most training for the OSW industry is undertaken internally ‘on the job’ by developers and their suppliers, building on existing staff experience by adding what needed to deliver value in OSW. A review of training provision was carried out against the training institutes, universities, and research centres in India including oil and gas focused institutions. Engagements with these institutes to understand the alignment of their provision with the key skills and training required was used to validate this process and inform conclusions and recommendations.

Finally, these institutes were encouraged to establish partnerships between them and international institutes, Indian academia, stakeholders, and government bodies to bridge the specific skills gaps identified in the Indian OSW sector.

Key job roles in the Indian value chain

A bottom-up approach was used to identify job roles and skills requirements within the Indian OSW sector. Based on the assessment of Indian value chain capability and opportunities, as well as the expected skills shortages identified by the industry, about 60 job roles were shortlisted which will be key in helping to develop the emerging Indian OSW wind industry. These roles are listed in Table 2.1 and cover a range of value chain categories that will involve Indian workers. They are weighted towards roles in the development phases as these are needed earliest. More details on each job role can be found in Appendix I. In deriving volumes of FTE-years, we have assumed all projects are 1 GW-scale. In reality, some job roles, for example a project director, is a per-project role, rather than a per-GW role. As projects in time are likely to be greater than 1 GW-scale, this may reduce demand in some specialist roles, such as project direction.

For each role, the table provides:

- Category.
    - Data analysis: supports interpreting environmental, geotechnical, and operational data to optimise site selection, delivery and operational performance.
    - Electrical design and management: designs and manages supply of electrical, supervisory control and data acquisition (SCADA) and control systems including within turbines, offshore substations, array cabling, and export system. Supports operational reliability.
    - Electrical practical: focuses on hands-on installation, testing, and maintenance of OSW electrical components like cables and switchgear.
    - Environmental: assesses and monitors marine ecosystems and environmental impacts of OSW projects. Also includes technical aspects of seabed and oceanography.
    - IT and communications: manages and carries out practical work on digital infrastructure, SCADA systems, and communication networks essential for OSW operations.
    - Maritime: covers vessel operations, navigation, and offshore activities critical for transporting equipment and personnel to wind farm sites and installing / maintaining assets.
    - Mechanical design and management: designs and oversees mechanical systems such as turbine components and balance of plant.
    - Mechanical practical: performs physical assembly, maintenance, and repair of OSW turbines and balance of plant.
    - Ports and logistics: coordinates and implements value chain, storage, and transport of OSW components through port facilities and marine routes.
    - Professional: includes legal, financial, quality and health and safety activities that support OSW
    - Project management: oversees offshore wind project timelines, budgets, activities and stakeholder coordination from through the project lifecycle.
- Phase. Which lifecycle phase of the project the role is needed in. Phases are only listed where at least 10% of the lifetime FTE-need is in that phase. Smaller volumes of that role may still be needed in other phases. The skills analysis considered the following four phases development (D), manufacturing (M), installation and commissioning (I&C), and operation (O). The description what is included in each phase, along with the time period for each phase for a 1GW project is presented in Section 1.1.2.

  Decommissioning, removal or making safe of the infrastructure at the end of its useful life, plus disposal of components. is not considered here, as it will happen only after 30 years or more of operation and processes may have evolved significantly in that time.
- Skills availability. This data was sourced from the industry engagement process. The skills availability is assessed using a red, amber, or green (RAG) rating, defined below.
    - Red – recruiting for this role is likely to be hardest due to criticality, specialism/experience needed or volume.

    - Amber – recruiting for this role may be somewhat harder than below.
    - Green – recruiting for this role is likely to be easiest of the roles identified.

  Note that there may always be local considerations that make recruitment harder or easier, for example due to scale of population, local industries and competition.

- Demand for a typical 1 GW project in scenario S2. This was based on BVGA market data gathered over time, adjusted for the Indian market then validated through industry engagement. Demand for roles in the development, installation and commissioning and operation phases have been derived in FTE-years per GW for a 1 GW reference project in 2040. For these phases, it is assumed the FTE demand in India will remain the same regardless weather the project is deployed in Tamil Nadu or Gujarat. We represent demand for a 1 GW reference project in 2040 to illustrate the training and skill required in the Indian value chain scenario. Demand for roles in the manufacturing phase has been derived by scaling the FTE year requirement per year at each facility shown in Table 1.6 what is needed to deliver for a 1 GW project.
- The pipeline demand in India to 2043 for each role in S2.
    - For the development, installation and commissioning and operation phases, this has been calculated by taking the FTE requirement for each role based on the content assumptions for a 1 GW reference project in 2040, distributing that demand over the project lifecycle periods as shown in Figure 2.2, and then scaling it by the capacity projection. In practice, the demand for these roles will start at lower rate per GW and increase over time as the amount of work undertaken in India grows. The apparent decline from 2037 onwards reflects the fact that no new capacity is installed after 2043. In reality, the market in India is likely to continue, thereby providing an ongoing pipeline of development, installation and commissioning and operation phase jobs.
    - For the manufacturing phase, FTE year requirement has been estimated based on the facilities shown in Table 1.6. This considered both facilities in Tamil Nadu and Gujarat. Pipeline impacts are assessed assuming these factories are working at full capacity and therefore do not fluctuate with changes in OSW capacity coming online. For towers blades, nacelles and foundations this means delivering either to Indian OSW projects or exporting to overseas OSW projects. For example, once the blade manufacturing facility comes online in 2033, it produces enough to supply 1.8 – 2 GW of blades per year. In 2033, the demand for blades for Indian projects is less than this, so blades will be exported. From 2034 onwards, the demand for blades for Indian projects is greater than this, so whilst some may still be exported, it is likely that most blades for Indian projects will be made in India and some will be imported. Either way, the benefit of the facility will accrue to India. Likewise, some of the supply from the cable facility will serve OSW in India, some OSW overseas and some, other sectors, but all jobs have been included in the analysis here. This ability of all facilities to serve beyond Indian OSW in means that there is no drop-off in number of FTE's in the manufacturing phase after 2043 (when demand for the 37 GW pipeline ends) because the facilities continue producing to satisfy overseas demand. Indian OSW demand can also be expected to continue beyond the current 37 GW pipeline should projects be delivered successfully.

      Note that pipeline demand starts in 2025, as development and project management activities are assumed to begin six years before COD of the first project in 2031 in S2, though early activity is limited.
- The peak demand in India to 2043 for each role in S2. This was derived by seeking the highest annual demand from analysis presented in the previous bullet.

Note also that an individual with a given skill set may be able to fulfil a number of specified roles, even within an organisation at any time, or over the lifecycle of a project, including as they gain experience. For example, a bid manager at an auction will have a mix of commercial and technical skills that will enable them to take on commercial management roles later in project development.

Note also that FTE demand does not necessarily reflect the physical number of people needed, due to some roles not being full-time and others operating shifts. Numbers should be treated as indicative, as:

- Some organisations go deeper into development activities that others.
- Some suppliers use more or less automation.
- Skills needs continue to evolve and technology (including the scale of wind turbines) evolves.

Available data on FTEs is limited and translating experience in established markets to emerging markets is difficult. For this assessment, FTE demand has been derived based on data from established European markets and then scaled to reflect differences in cost structures and OSW experience in India at each phase of the value chain. These assumptions have been validated through industry engagement process.

2.1.2 Results

Key job roles in the Indian value chain

A summary of the key job roles in Indian offshore wind value chain is shown in Table 2.1.

Table 2.1 Key job roles in the Indian offshore wind value chain.

#	Job role	Category	Phase	Skills availability (RAG)	Demand for 1 GW project (FTE years)[xii]	Pipeline demand to 2043 (FTE years)[xii]	Peak demand (FTEs in year)
1	Project director	Project management	D, O	R	58	860	78
2	Project manager	Project management	D, M, I&C, O	A	290	8,100	860
3	Commercial manager	Project management	D, M, I&C, O	A	200	3,500	340
4	Communications and engagement coordinator	Project management	D, I&C, O	A	80	1,700	160
5	Administrative support manager	Project management	D, M, I&C, O	A	270	4,800	460
6	Consents manager	Project management	D, O	A	74	1,400	140
7	Offshore EIA Manager	Project management	D	A	32	1,200	130
8	Procurement / supply chain manager	Project management	D	A	61	2,100	220
9	Financial analyst	Data analysis	D	G	16	580	63
10	Legal counsel	Professional	D, O	A	53	1,300	130
11	Resource analyst	Data analysis	D	G	32	1,200	130
12	Bid manager	Project management	D	G	16	580	63
13	GIS technician	Data analysis	D	A	79	2,900	320
14	Oceanographer	Environmental	D	A	32	1,200	130
15	Marine ecologist	Environmental	D	A	32	1,200	130

[xii] See explanation above table regarding treatment of manufacturing jobs in per GW and pipeline analysis.

#	Job role	Category	Phase	Skills availability (RAG)	Demand for 1 GW project (FTE years)[xii]	Pipeline demand to 2043 (FTE years)[xii]	Peak demand (FTEs in year)
16	Ornithologist	Environmental	D	A	32	1,200	130
17	Geophysicist	Environmental	D	A	47	1,700	190
18	Hydrographer	Environmental	D	A	16	580	63
19	Electrical engineer	Electrical design and management	D, M, I&C, O	A	150	2,800	290
20	Civil engineer	Mechanical design and management	D, I&C, O	A	210	5,200	550
21	Mechanical engineer	Mechanical design and management	D, M, I&C, O	A	230	5,600	580
22	Geotechnical engineer	Mechanical design and management	D	A	79	2,900	320
23	Structural engineer	Mechanical design and management	D, M	A	52	1,900	200
24	CAD technician	Mechanical design and management	D, M	G	42	1,400	150
25	Manufacturing manager	Mechanical design and management	M	A	20	480	45
26	Production / team supervisor	Mechanical design and management	M, I&C, O	G	210	2,600	280
27	Production operative	Mechanical practical	M	G	700	14,000	1,400
28	Process coordinator	Mechanical practical	M	G	99	2,400	220
29	Equipment service technician	Mechanical practical	M, I&C, O	G	270	4,300	460
30	Machine operator	Mechanical practical	M	G	97	3,200	280
31	Blasting and coating technician	Mechanical practical	M	G	40	1,100	100
32	Quality manager	Professional	M	A	28	900	92
33	Health and safety manager	Professional	D, M, I&C, O	G	120	1,800	200
34	Welder	Mechanical practical	M	A	97	2,700	250
35	Site manager	Project management	I&C, O	G	150	1,500	160
36	Crane operator	Ports and logistics	I&C, O	A	85	2,500	300
37	Crane and rigging inspector	Ports and logistics	I&C, O	G	80	2,600	320

#	Job role	Category	Phase	Skills availability (RAG)	Demand for 1 GW project (FTE years)[xii]	Pipeline demand to 2043 (FTE years)[xii]	Peak demand (FTEs in year)
38	Port / transport operative	Ports and logistics	I&C	G	17	640	78
39	Logistics coordinator and manager	Ports and logistics	I&C, O	G	66	1,100	130
40	Stores / warehouse operative	Mechanical practical	M, I&C, O	A	170	2,300	250
41	Offshore commissioning supervisor	Electrical practical	I&C	R	12	430	52
42	Senior Authorised Person (SAP)	Electrical practical	I&C, O	R	66	1,100	130
43	Electrical technician	Electrical practical	I&C, O	G	380	4,300	460
44	Mechanical technician	Mechanical practical	I&C, O	G	800	7,100	840
45	Jointing and testing engineer	Electrical design and management	I&C	A	22	800	98
46	Communications network technician	IT and communications	I&C, O	G	92	820	96
47	Carousel operator	Maritime	I&C	G	12	430	52
48	Tension operator	Maritime	I&C	G	12	430	52
49	Operations supervisor	Ports and logistics	I&C	G	32	1,200	140
50	Vessel supervisor	Maritime	I&C, O	G	110	1,400	150
51	Control room supervisor	IT and communications	O	G	130	820	110
52	IT manager	IT and communications	D, I&C, O	G	64	1,100	100
53	Rope access and blade repair technician	Mechanical practical	O	G	85	550	73
54	Vessel maintenance technician	Mechanical practical	I&C, O	G	48	490	55
55	ROV technician	Maritime	O	G	43	270	37
56	Vessel master's mate	Maritime	O	G	130	820	110
57	Harbour pilot	Maritime	O	G	85	550	73
58	Data analyst	Data analysis	O	G	85	550	73
59	Marine coordinator	Ports and logistics	I&C, O	G	77	760	91

#	Job role	Category	Phase	Skills availability (RAG)	Demand for 1 GW project (FTE years)[xii]	Pipeline demand to 2043 (FTE years)[xii]	Peak demand (FTEs in year)
60	Stores / warehouse manager	Mechanical design and management	M. O	G	78	740	91
61	Crew manager	Ports and logistics	I&C, O	G	110	1,400	150
62	Asset integrity manager	Mechanical design and management	O	G	85	550	73
Total						126,630	

Skills availability

Roles rated red, indicating potential challenges in fulfilling the role, typically have one or more of the following characteristics:

- Are leadership roles critical to the success of the project, and/or.
- Demand long-term experience or specialised technical knowledge specific to OSW, or
- Are needed in high volumes.

As India currently has no operational OSW projects, filling these roles will require proactive actions to build specialised skills or sufficient expertise. This is particularly true for senior roles, such as Project Director where significant, first-hand OSW experience is necessary.

For roles such as welders, which are required in large numbers and benefit from experience, people may not be readily available sufficient volume to meet needs for timely, high-quality production. Working with local training institutions may be helpful in such circumstances.

Roles such as production operatives are likely to be less challenging to fill. These roles involve skills that are more easily transferable from other industries or require minimal training to bring individuals up to speed. In other markets, such staff have been fully trained as part of setting up new manufacturing facilities.

In general, due to the scale, complexity and offshore environment, OSW projects require an increased level of focus on planning and quality than onshore wind. This means that although there are strong synergies, it should not simply be assumed that staff that have shown good capability in onshore wind can play a similar role offshore, without some level of upskilling.

FTE year requirement for a 1 GW project

The distribution of demand for the different categories of job roles over the lifecycle of a 1 GW project is shown in Figure 2.2.This used the methodology for manufacturing jobs explained above Table 2.1 for a 1 GW project. Development and project management jobs are between years -6 and 0, manufacturing jobs are between years -3 and -1, installation and commissioning jobs are between years -2 and 0 and operation phase jobs are between years 0 and 30, with year 0 being the start of operation.

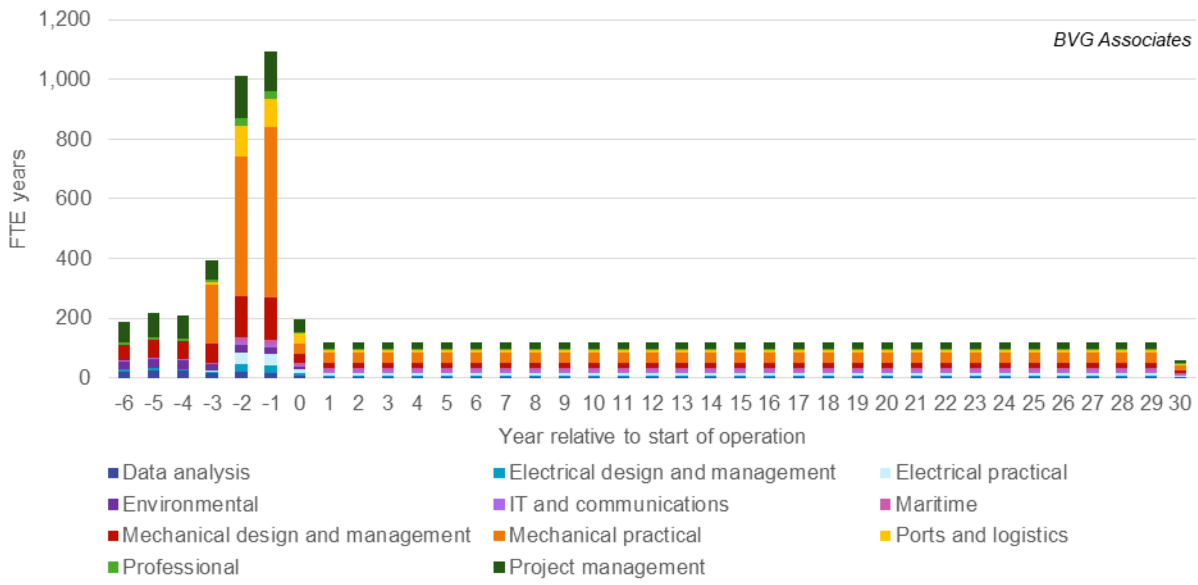

Figure 2.2 Key job roles for a 1 GW project.

This shows about one third of the FTE-years of work is delivered in the two years before the start of operation and about half of the work is delivered by staff in the two mechanical role categories.

FTE year requirement for pipeline of projects under scenario S2

Below, we explore the FTE year requirements for a pipeline of projects under scenario S2, looking at each lifecycle phase in turn.

Beyond the specific job roles assessed that have significant content in each phase, relevant additional roles include:

- Other business / office / facility functions within project developers and suppliers, including:
  - Finance and accounting / enterprise resource planning
  - Human resources, administration, training, and reception
  - IT support
  - Marketing and business development , and
  - Security, cleaning, canteen and facilities management.
- Roles with government, regulators, stakeholders (statutory permitting consultees and others).

Many of these are relevant to each project lifecycle phase. The above roles are considered in the analysis of Chapter 1. Not included are also:

- Roles relating to wider indirect activity, including sub-suppliers.
- Roles relating to induced jobs created by the spend by those with direct and indirect jobs.

Development and project management

The distribution of demand for the different categories of job roles over the pipeline for the development and project management phase is shown in Figure 2.3. The does not consider the gradual growth over time of project management and development activity per GW expected to occur India, since the distribution of pipeline demand has been scaled using the FTE-year demand for a 1 GW reference project in India in 2040. It provides an indication of the overall scale of demand for critical roles in this phase aligned with the capacity expected to come online.

The drop-off from 2036 is as no further capacity is shown in the pipeline from 2044 onwards. In reality, it is likely that further capacity will be developed, thereby at least preserving the same number of jobs. The peak occurs in

2036, reflecting the peak in installation in scenario S2 and the fact that development and project management jobs peak before installation.

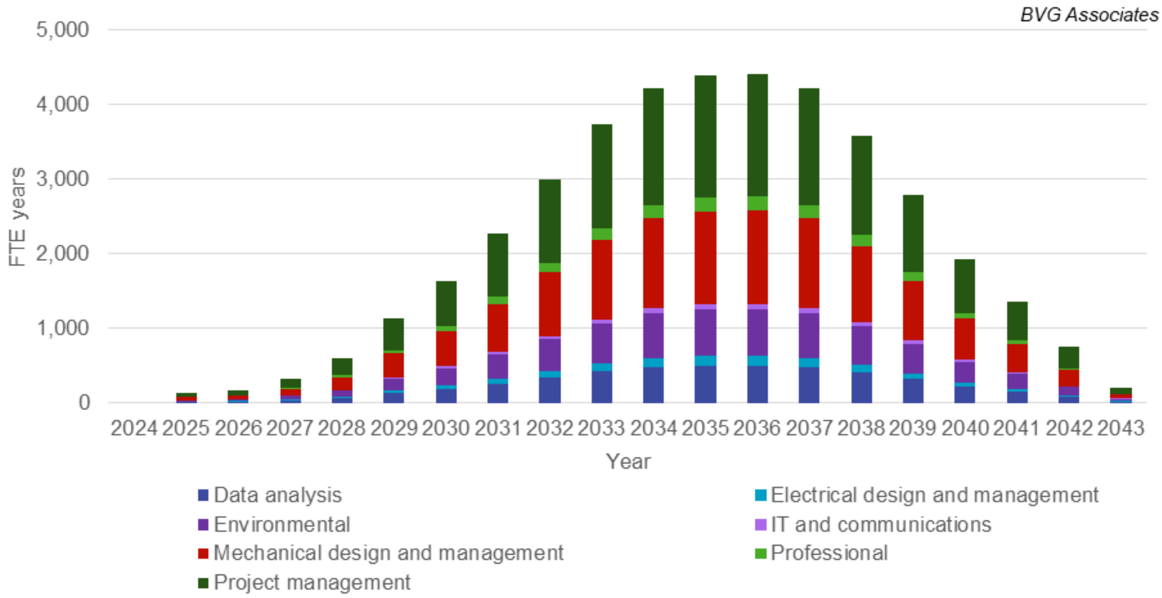

Figure 2.3 Key job roles in the development and project management phase.

The chart shows that jobs start in 2025 as development and project management activities are assumed to begin six years before COD of the first project in 2031 in S2. It also shows the majority of activity in the selected roles is in project management and mechanical design and management.

Manufacturing

The distribution of demand for the different categories of job roles over the pipeline for the manufacturing phase is shown in Figure 2.4. This used the methodology for manufacturing jobs explained above Table 2.1 for the pipeline demand.

The peak is reached in 2035, reflecting when all facilities have been brought online.

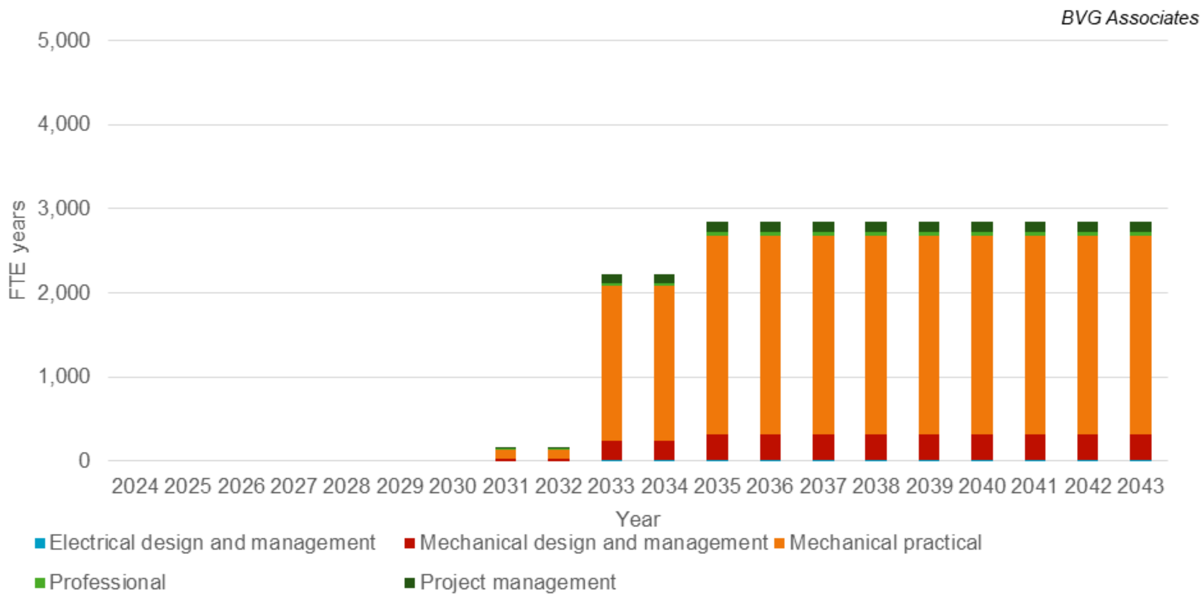

Figure 2.4 Key job roles in the manufacturing phase.

The chart shows the vast majority of activity in the selected roles is in mechanical practical activities, as anticipated in manufacturing large-scale infrastructure.

Installation and commissioning

The distribution of demand for the different categories of job roles over the pipeline for the installation phase is shown in Figure 2.5. The does not consider the gradual growth over time of installation and commissioning activity expected to occur India per GW installed, since the distribution of pipeline demand has been scaled using the FTE-year demand for a 1 GW reference project in India in 2040.

The drop-off from 2038 is again as no further capacity is shown in the pipeline from 2044 onwards. In reality, it is likely that further capacity will be developed, thereby at least preserving the same number of jobs. The peak occurs in 2037, reflecting the peak in installation in S2.

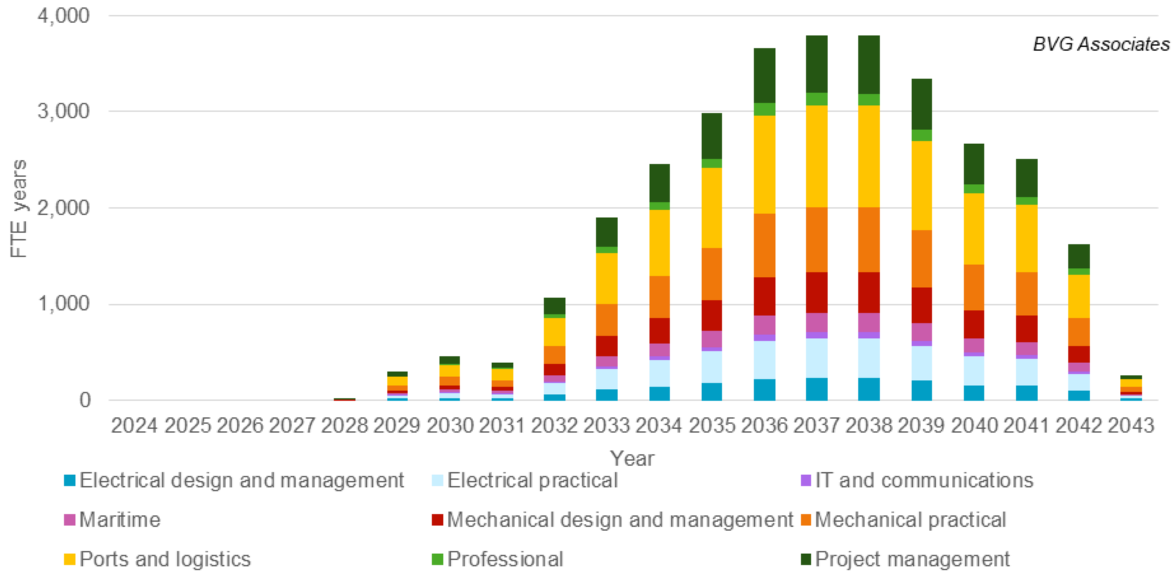

Figure 2.5 Key job roles in the installation and commissioning phase

The chart shows the majority of activity in the selected roles is in ports and logistics and mechanical practical roles. project management and mechanical design and management.

Operation

The distribution of demand for the different categories of job roles over the pipeline for the operation phase is shown in Figure 2.6. The does not consider the gradual growth over time of operational activity expected to occur India per GW operating, since the distribution of pipeline demand has been scaled using the FTE-year demand for a 1 GW reference project in India in 2040.

There is an ongoing increase as each new project comes online, with most job roles lasting through the whole 25 years of the project.

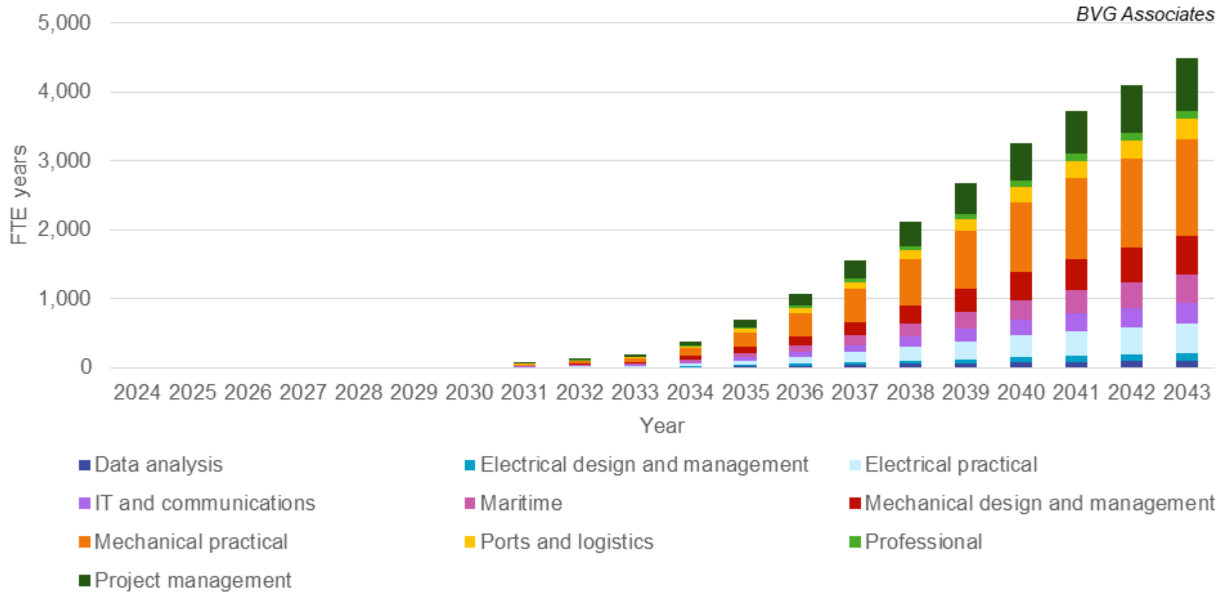

Figure 2.6 Key job roles in the operations phase.

Again, the chart shows the majority of roles are in mechanical practical activities.

2.2. Review of training programmes

Most OSW training in India is expected to be delivered internally by project developers and suppliers. Such companies are used to hiring people with experience from related sectors, such as onshore wind or other industries, and adapting their skills to OSW. Such companies have the technical expertise and motivation to train people for the specific roles and systems they use. Skills and training gaps are usually filled when there is demand, and the industry tends to manage this process itself, working with external providers where needed, given confidence to invest. This approach is likely to continue in India, provided conditions support investment in training and that the education system, including to tertiary level, continues to provide a good volume of people with relevant general engineering and other professional qualifications that are needed in many sectors.

Institutions in India can still play an important role to support the development of the workforce, especially with regard to practical skills relevant to manufacturing and offshore activities. In more developed markets, institutions act as key partners to industry, aligning education and training with market needs. Leading OSW companies often work with technical colleges and training providers to communicate skill requirements. This collaboration helps increase the chance that the right number of people are trained in the right areas at the right time.

Indian institutions can play a similar role by working with industry to identify which skills are needed, in what quantities, and when. Some already offer relevant courses that support workforce development in both onshore and OSW. As the sector grows, stronger coordination and proactive planning between industry and training providers will be important to meet future skills demand effectively.

This section provides an overview of the skills and training covered by the training institutes, universities, and research centres in India as provided in *Gap Assessment of Training and skill building in Offshore Wind Energy Sector in India*.[41] It uses the National Skills Qualifications Framework (NSQF), a competency-based framework developed by the Government to standardise skill development across education and vocational training. It organises qualifications into 10 levels, as summarised in Table 2.2. In detail, each level is defined by specific descriptors related to:

- Process: the nature and complexity of tasks.
- Professional knowledge: the depth of theoretical and practical understanding.
- Professional skill: the ability to apply knowledge in real-world scenarios.

- Core skills: communication, IT, and basic arithmetic.
- Responsibility: the degree of autonomy and accountability.

A detailed table of generic descriptors for each NSQF level is provided in Appendix K. Of course, there are many ways to a given role, so not all staff in a given role will have the qualifications listed. As part of this process, all named institutions were contacted and given the opportunity to contribute, as well as to share their perspectives on developing India's OSW workforce. For further information on the industry engagement process, see Appendix J.

Table 2.2 Overview of National Skills Qualifications Framework.

NSQF level	Generic role	Example offshore wind roles	Generic role description	Generic qualification
1	Helper / assistant labourer	General helper, apprentice office assistant	Performs basic, supervised tasks such as cleaning, fetching tools, or assisting with manual handling in port	No formal qualification; basic literacy and numeracy
2	Assistant	Apprentice port / transport operative, store operative	Supports routine operations like basic material handling or simple assembly under close supervision	Class 10 (Secondary School Certificate (SSC)) education to 15-16 years old or equivalent with informal training
2.5-3	Skilled technician / operator	Machine operator, vessel master's mate	Carries out repetitive tasks such as basic machine operation or inventory handling with limited decision-making	Class 12 (Higher Secondary Certificate (HSC) education to 17-18 years old or Industrial Training Institute (ITI) certificate in relevant trade
3.5-4	Senior technician / supervisor	Welder, electrical technician, rope access technician	Executes skilled tasks like welding, coating, or cable handling with some autonomy and adherence to procedures	ITI or Polytechnic Diploma in trades like welding, electrical, mechanical
4.5-5	Foreman / team leader / junior engineer	Crane operator, production supervisor	Applies practical knowledge and carries responsibility for others	Diploma or advanced certificate
5.5-6	Engineer / senior supervisor	GIS technician, warehouse manager	Manages activities or brings significant technical knowledge	Graduate diploma or bachelor's degree
6.5-7	Senior engineer / technical specialist / manager	Electrical engineer, marine ecologist	Designs and manages systems or processes, or brings significant knowledge to decision making	Bachelor's degree
8	Principal engineer / senior manager	Production manager, offshore EIA manager	Leads teams delivering complex activities	Master's degree or PG diploma

9	Research scientist / technical director	Project director	Overall responsibility for safe, timely delivery of high-value projects	PhD
10	Chief scientist / Industry expert	C-level director	Provides national or global leadership in offshore wind	PhD

2.2.1 Government institutes

There is a range of government institutes that provide public training course relevant to OSW. A non-exhaustive selection is presented below.

National Institute of Wind Energy

NIWE is an autonomous R&D institution established in 1998 by the MNRE, Government of India. Located in Chennai, Tamil Nadu, NIWE serves as the technical focal point for wind energy development in India. It employs a multidisciplinary team of about 100 to 150 scientists, engineers, and administrative staff, though the exact number of employees is not publicly disclosed. NIWE provides services in wind resource assessment, testing and certification of wind turbines, R&D, and skill development. Over the years, it has conducted about 200 national and international training programs, training over 6,000 professionals.

Its training programs, such as the National Training Course on Wind Energy Technology, include modules on OSW, covering aspects like marine resource assessment, turbine installation, and grid integration. These programs are designed to build capacity among engineers, technicians, and policymakers, making NIWE a key institution in preparing India's workforce for OSW deployment. Its technical expertise and policy support are vital as India moves toward large-scale OSW projects. Examples of relevant training courses are provided in Table 2.3.

Table 2.3 Example National Institute of Wind Energy training courses relevant to offshore wind.

Course	NSQF level	Focus area	Duration	Location
Wind Energy Technology (National Course)	Not specified	Wind resource assessment, turbine tech, installation, OMS, OSW basics	3 days	Chennai
Vayumitra Skill Development Programme	Entry-level	Wind energy awareness, basic technical skills, OSW introduction	Varies	Various
Small Wind Turbine Design & Maintenance	4	Design, installation, and maintenance of small wind turbines	5 weeks	Chennai

Skill Council for Green Jobs

SCGJ is a not-for-profit, industry-led organisation established in October 2015 under the Ministry of Skill Development and Entrepreneurship, with support from the MNRE and the Confederation of Indian Industry. Headquartered in New Delhi, SCGJ operates with a network of over 1,200 affiliated teaching partnerships and more than 4,000 trainers and assessors across India. It has trained over 600,000 individuals in green sectors such as renewable energy, waste management, and sustainable development. Its mandate includes developing qualification packs, conducting skills gap analyses, and certifying professionals to meet the workforce needs of India's green economy. It employs 20-30staff.

As India expands its renewable energy portfolio to include OSW, SCGJ's existing frameworks for wind energy training (such as planning, site surveying, installation, and operations can be adapted to meet offshore-specific needs. SCGJ previously developed qualification packs for various roles in onshore wind, some of which are relevant offshore wind. These included courses relevant to such as site surveying, civil and electrical technicians in construction, and mechanical and electrical roles in O&M. SCGJ's wind courses are no longer active. NIWE now handles training and certification for wind energy roles, incorporating the content previously defined by SCGJ through programmes such as Vayumitra Skill Development Programme.

Indian National Centre for Ocean Information Services

The Indian National Centre for Ocean Information Services (INCOIS) is an autonomous institution under the Ministry of Earth Sciences, established in 1998 and located in Hyderabad, Telangana. It operates as part of the Earth System Science Organization and provides ocean data services including tsunami warnings, ocean state forecasts, and potential fishing zone advisories. INCOIS supports marine operations through real-time data from satellites and ocean buoys. It has about 150 to 250 scientists and technical staff.

NCOIS's training arm offers short- and long-term courses in operational oceanography, which are relevant to OSW. These cover ocean modelling, remote sensing, data analysis, and marine forecasting—training is delivered at the Hyderabad campus and includes hands-on experience with oceanographic instruments and data systems. Examples of relevant training courses are provided in Table 2.4.

Table 2.4 Overview of Indian National Centre for Ocean Information Services training courses relevant to offshore wind.

Course	NSQF level	Focus area	Duration	Location
Ocean Remote Sensing & GIS	Not specified	Satellite data, mapping, marine spatial analysis	12 days	Hyderabad
Ocean Numerical Modelling & AI/ML Applications to Earth Sciences	Not specified	Forecasting, modelling, machine learning	12 days	Hyderabad
Wave Modelling & Applications	Not specified	Sea state prediction, wave dynamics	5 days	Hyderabad
Coastal Vulnerability Mapping using QGIS	Not specified	Coastal risk assessment, GIS tools	5 days	Hyderabad
Data Management & Statistical Methods	Not specified	Ocean data processing, QC	12 days	Hyderabad

National Institute of Oceanography

The National Institute of Oceanography (NIO) was established in 1966 and is headquartered in Dona Paula, Goa, with regional centres in Mumbai, Kochi, and Visakhapatnam. It is one of the constituent laboratories of the Council of Scientific & Industrial Research. NIO employs around 170 scientists, supported by 210 technical staff and 120 administrative personnel. The institute conducts research across biological, chemical, geological, and physical oceanography, and operates two research vessels for field studies. Its work includes seabed mapping, EIA's, and coastal zone regulation support.

NIO's training relevance to OSW lies in its expertise in marine geophysics, bathymetry, sediment transport, and ocean modelling, all critical for OSW site selection and environmental planning. While NIO does not run frequent public training programs, it supports doctoral research and offers internships through its School of Oceanography. Examples of relevant training courses are provided in Table 2.5.

Table 2.5 Example National Institute of Oceanography training courses relevant to offshore wind.

Couse	NSQF Level	Focus area	Duration	Location
Doctoral Research in Oceanography	8–10	Marine geology, marine instrumentation, ocean engineering, ocean modelling, sediment study	Multi-year	Goa, Kochi, Mumbai
Internship/Dissertation Program	6–7	Coastal processes, seabed mapping	30–90 days	Goa, Kochi, Vizag
Short-term Research Attachments (project-based)	Varies	Oceanographic data analysis	Varies	Goa

Indian Institute of Technology Madras, Chennai

The Indian Institute of Technology (IIT) Madras is a public technical university established in 1959, located in Chennai, Tamil Nadu. It spans a 620-acre urban campus and is recognised as an Institute of National Importance. It employs over 674 academic staff and supports a student body of more than 10,000, including undergraduates, postgraduates, and doctoral candidates. The institute has a strong focus on engineering, science, and technology, and hosts specialised departments such as Ocean Engineering, which supports research and education in offshore structures, marine systems, and coastal infrastructure.

IIT Madras plays a significant role in offshore wind energy training through its Department of Ocean Engineering, which offers programs in ocean structures, ocean technology, and naval architecture. These courses cover topics such as wave hydrodynamics, offshore platform design, and coastal engineering, skills essential for OSW development. Training is delivered through structured degree programs and short-term workshops, combining theoretical instruction with hands-on lab work and industry-driven projects. Examples of relevant training courses are provided in Table 2.6.

Table 2.6 Example of Indian Institute of Technology Madras, Chennai training courses relevant to offshore wind.

Course	NSQF level	Focus area	Duration	Location
M.Tech in Ocean Structures	8	Offshore platforms, wave dynamics, coastal infrastructure	2 years	Chennai & Zanzibar
M.Tech in Ocean Technology	8	Marine systems, instrumentation, ocean data	2 years	Chennai
B.Tech & M.Tech in Naval Architecture	7–8	Ship design, offshore structures, hydrodynamics	5 years	Chennai
Dynamics of Ocean Structures (short course)	6	Structural response to waves, wind, currents	5–10 days	Chennai
Harnessing Wind Power and Grid Integration	Not specified	Wind energy systems, grid integration		Online

Institute of Drilling Technology

The Institute of Drilling Technology (IDT) was established in 1978 and is located in Dehradun, Uttarakhand, within the Oil and Natural Gas Corporation (ONGC) campus. It is a premier research and training institute in South Asia focused on drilling technologies for oil and gas exploration. IDT supports around 100 companies through applied R&D, technical services, and training. It has a specialised team of 100-150 engineers, scientists, and instructors. It houses advanced simulation and testing facilities for drilling fluids, cementing, and well control.

IDT's training relevance to OSW lies in its expertise in subsurface drilling and marine operations, which are applicable to OSW foundation installation and geotechnical surveys. IDT works in close coordination with ONGC Advanced Training Institute (ATI-ONGC), located in Goa, which specialises in offshore safety, emergency response, and environmental protection training. While IDT focuses on technical competencies in drilling and subsurface engineering, the ATI-ONGC complements this by delivering internationally recognised safety programs. This partnership enables a comprehensive training pathway for offshore wind professionals, combining geotechnical and marine engineering expertise with rigorous safety and survival instruction. Examples of relevant training courses are provided in Table 2.7.

Table 2.7 Example Institute of Drilling Technology training courses relevant to offshore wind.

Course	NSQF Level	Focus area	Duration	Location
Tropical Basic Offshore Safety Induction and Emergency Training	5	Offshore safety, emergency response, helicopter transit	5 days	ATI-ONGC, South Goa
Helicopter Underwater Egress Training	5	Emergency evacuation from offshore helicopters	2 days	ATI-ONGC, South Goa
Marine Aviation and Sea Survival Training	5	Emergency evacuation from offshore helicopters	2 days	ATI-ONGC, South Goa

Institute of Engineering and Ocean Technology

The Institute of Engineering and Ocean Technology (IEOT) is a research and training division of ONGC, established in 1983 and located in Panvel, Navi Mumbai, Maharashtra. It focuses on offshore engineering, subsea systems, and marine geotechnics to support oil and gas exploration and production. IEOT operates within ONGC's technical infrastructure and collaborates with national and international institutions. It is staffed by a specialised team of 100-150 engineers, geoscientists, and technical experts working on offshore technology development and training.

IEOT's relevance to OSW lies in its expertise in marine structures, geotechnical surveys, and subsea engineering, which are directly applicable to OSW foundation design and installation. Though its primary focus is hydrocarbon exploration, IEOT's training programs in offshore safety, drilling logistics, and marine operations can be adapted for offshore wind contexts. It supports knowledge transfer through internal workshops and technical courses, though public course listings are limited.

Areas of capability relevant to OSW, that it could run courses in, include:

- Structural integrity assessment of offshore platforms.
- Soil investigation for offshore installations.
- Risk and reliability engineering, including hazard and operability (HAZOP) and Quantitative Risk Assessment (QRA) studies.
- Materials and corrosion engineering.
- Geotechnical and structural engineering.

2.2.2 Private institutes

There is also a range of private institutes that provide public training course relevant to OSW. Again, non-exhaustive selection is presented below.

Elite Offshore

Elite Offshore is a specialist training provider based in Navi Mumbai, Maharashtra. Established in 2015, the company employs around 15 staff. It focuses on professional training for the offshore, marine, and industrial sectors, offering over 200 courses. Its facilities include simulation equipment and practical training setups tailored to real-world offshore scenarios. The company delivers safety-critical and operational training aligned with international standards such as Offshore Petroleum Industry Training Organization (OPITO), International Maritime Organization (IMO), and Liberian International Ship & Corporate Registry (LISCR).

The academy also offers modules on dynamic positioning, lifting operations, and hazardous materials handling—skills directly applicable to offshore wind logistics, installation, and maintenance. By aligning with global standards and offering practical, scenario-based training, Elite Offshore supports India's growing offshore wind ambitions. Examples of relevant training courses are provided in Table 2.8.

Table 2.8 Example Elite Offshore training courses relevant to offshore wind.

Course	NSQF level	Focus area	Duration	Location
Offshore Installation Manager (OIM)	5	Offshore platform management	5 days	Maharashtra
IMDG HAZMAT Awareness	5	Dangerous goods handling	1 day	
Barge Supervisor / Barge Master (BS)	5	Marine operations	5 days	Maharashtra
Ballast Control Operator (BCO)	5	Stability and ballast systems	5 days	Maharashtra
Personal Survival Techniques (PST)	5	Emergency survival at sea	1 day	Maharashtra
Risk – Human Factor	5	Human behaviour and safety	1 day	Maharashtra

Maersk Training India

Maersk Training India, located in Chennai, has been operational for over a decade and is part of the global Maersk Training network, originally founded in 1978. The centre serves as a hub for maritime, oil and gas, and renewable energy training across South Asia. With a workforce of around 100 employees, it offers both classroom and simulator-based instruction in line with various international standards. Its facility is equipped to scenario-based training, particularly for offshore environments. covering working at heights, sea survival, emergency response, and mechanical systems—all areas covered by Maersk's GWO accredited programs. Examples of relevant training courses are provided in Table 2.9.

Table 2.9 Example Maersk Training India training courses relevant to offshore wind.

Course	NSQF level	Focus area	Duration	Location
Jacking & Rig Move Fundamentals	Not specified	Rig move planning, jacking systems and operations, sea bed conditions and stability, emergency response	5 days	Chennai
Medical Care Supplementary Certificate A	Not specified	Medical assessments and response, medical reporting and radio assistance	5 days	Chennai
Various GWO-certified courses	Not specified	Various	Various	Chennai

Sagar Offshore Maritime Academy

Sagar Offshore Maritime Academy (SOMA), based in Mumbai, has been operational since 2015 and specialises in offshore and maritime training. Located at Ballard Estate in Fort, Mumbai, SOMA is approved by the Directorate General of Shipping, Government of India, and is ISO 9001:2015 certified. The academy employs a multidisciplinary team of about 5. Its primary focus is to deliver practical and safety-oriented training for marine and offshore operations, including crew management and certification support. Examples of relevant training courses are provided in Table 2.10; the full list of courses can be found on its website, with many others being potentially relevant to OSW.[42]

Table 2.10 Example Sagar Offshore Maritime Academy training courses relevant to offshore wind.

Course	NSQF level	Focus area	Duration	Location
Basic Offshore Safety Induction and Emergency Training	4	Offshore safety & emergency response	3 days	Mumbai
Helicopter Underwater Escape Training	4	Helicopter evacuation safety	1 day	Mumbai
Offshore Crane Operator Safety	4	Crane operations on offshore platforms	2 days	Mumbai
Offshore Installation Manager	6	Platform leadership and operations	5 days	Mumbai

2.2.3 Global Wind Organisation

The GWO is a non-profit body established in 2012 by leading wind turbine manufacturers and operators to create standardised safety and technical training for the wind energy sector. Headquartered in Denmark, GWO operates globally with a workforce of approximately 80 employees its Secretariat located in Copenhagen, Denmark. Its mission is to reduce risks and improve safety across the wind industry by ensuring that technicians and support staff meet consistent training standards. GWO collaborates with over 6500 certified training providers providers/centres in more than 55 countries, and its training records are maintained in the WINDA database, a global registry used by employers to verify qualifications. By aligning training across the value chain, GWO helps ensure that personnel can move between projects and regions with minimal retraining. This standardization supports workforce mobility, safety compliance, and operational efficiency in a rapidly expanding global offshore wind market. An overview of its relevant training courses standards is provided in Table 2.11.

Table 2.11 Overview of Global Wind Organisation training standards relevant to offshore wind.

Standard	NSQF Level	Focus area	Typical course duration
Basic Safety Training (BST) Standard	4	Safety fundamentals: first aid, manual handling, fire awareness, working at heights, sea survival	4.5 days
Basic Technical Training (BTT) Standard	5	Technical skills: mechanical, electrical, hydraulic systems, bolt tightening, installation	5–10 days (modular)
Advanced Rescue Training (ART) Standard	6	Rescue operations in nacelle, hub, tower, and blade environments	3–5 days
Enhanced First Aid (EFA) Standard	5	Advanced first aid for remote wind turbine environments	2–3 days
Blade Repair Training (BR) Standard	5	Composite blade inspection and repair techniques	5–10 days
Slinger Signaller (SLS) Standard	4	Safe slinging and signalling for crane operations	2–3 days
Service Lift User & Inspection Training Standard	4	Safe use and inspection of turbine service lifts	1–2 days
Crane & Hoist Basic User Standard	4	Operation of lifting equipment in wind environments	1–2 days
High Voltage Standard	6	Safe working practices on HV systems in wind turbines	3–5 days
Wind Limited Access Training Standard	3	Basic safety awareness for non-technical personnel accessing turbine sites	1 day

There are a range of GWO-certified training providers across India, currently serving the onshore wind industry. The following providers are located in Gujarat or Tamil Nadu, the states where early offshore wind projects are likely to be located, and either:

- Offer courses publicly, or
- Run course only internally for their staff, but as an organisation they are playing an important role in offshore wind.

Backbone Skytech

Backbone Skytech is a private company based in Rajkot, Gujarat, and has been operating since 2022. With a team of approximately 30 employees, the company specialises in infrastructure and energy services. It is a certified provider of GWO training, offering courses in First Aid, Manual Handling, Fire Awareness, and Working at Heights. These programs are designed for both internal staff and external participants, particularly those working in or entering the wind power industry, ensuring they meet global safety and operational standards.

NTC Training Academy

NTC Training Academy is based in Chennai, Tamil Nadu, and has been operating since March 2018. It has a team of about 10 focussed on educational services and is a certified provider of GWO training, which includes installation and maintenance skills for wind turbines.

Oxford Global Training Academy

Oxford Global Training Academy (OGTA), located in Cuddalore, Tamil Nadu, is a training provider specialising in workplace safety and offshore wind industry courses. Operating since 2021, OGTA's team of about 10 offers GWO-certified modules including first aid, manual handling, fire awareness, and working at heights. These courses are designed for external participants, particularly those seeking employment or compliance within the global wind energy sector.

RS Windtech Engineers

RS Windtech Engineers, established in 1996, is headquartered in Aralvaimozhi, Kanyakumari district, Tamil Nadu. With approximately 45 employees, the company has nearly three decades of experience in the wind energy sector, offering comprehensive services such as wind turbine installation, operation and maintenance, repowering, and component repairs. RS Windtech also provides GWO-certified training courses at its facility in Nagercoil. These courses are designed for both internal staff and external professionals.

Siemens Gamesa Renewable Power

Siemens Gamesa Renewable Power has been operating in Tamil Nadu since 2006. The company supplies and operates wind energy systems (including in time, for offshore wind in India) and currently employs around 900 people in India. Siemens Gamesa offers a range of internal wind industry training courses, conducted by certified in-house trainers. These courses, which are DNV ISO 9001 and 14001 certified, focus on technical and safety competencies tailored for personnel working in the wind turbine industry, especially in challenging offshore environments.

Speed Team Infra

Speed Team Infra, established in 2020, is based in Elathur, Tamil Nadu. It employs approximately 120. Speed Team Infra is a leading independent service provider (ISP) in India's wind industry, offering services such as major component replacement (including blades, generators, and gearboxes), project management, installation, logistics, and repowering of wind turbines. The company provides GWO-certified courses delivered in state-of-the-art facilities by skilled instructors and are designed for both internal technicians and external clients.

UGES PowerMax

UGES PowerMax, established in 2016, is headquartered in Vadodara, Gujarat, with a secondary office in Pune, Maharashtra. The company has about 150 employees and specializes in renewable energy services, particularly in wind, solar, and transmission sectors, and has contributed to over 12.5 GW of renewable energy projects. UGES offers wind training courses designed for both internal staff and external professionals, focusing on engineering, automation, project risk assessment, asset management, and diagnostic testing. A range of these are GWO-certified.

Vestas Wind Technology India

Vestas Wind Technology India has been operating in India since 1996 and is headquartered in, Chennai, Tamil Nadu. The company supplies and operates wind energy systems (including in time, for offshore wind in India). The company has a significant presence in the region, including nacelle and hub manufacturing facilities in Kancheepuram, and a training centre in Nelikuppam village. Vestas India employs over 4,000 people nationwide. Vestas India offers a range of GWO-certified training courses. These courses are delivered through onsite facilities and digital platforms for internal staff.

Windcare India

Windcare India, headquartered in Gudimangalam near Coimbatore, Tamil Nadu, has been active in wind turbine maintenance since its founding in 1999 and has a workforce of over 500. It offers GWO-certified courses through its Windcare Training Institute. These courses are designed for both internal technicians and external participants. The institute features hands-on training facilities like a dedicated wind turbine Generator tower and technical labs to simulate real-world conditions.

2.2.4 Universities

Beyond Government and private training institutions, many people that will enter offshore wind will do so having secured bachelors or masters degrees at Indian universities. The supply of places relevant to OSW (and other sectors) is much greater than the demand from OSW, so universities should not act as a bottleneck. Many are now also offering renewable energy courses, combining different disciples and wholly focussed on OSW. An overview of top Indian universities for engineering courses relevant to OSW is provided in Table 2.12. This does not consider other scientific and social courses relevant to OSW, but the same conclusions apply.

Table 2.12 Overview of top Indian universities for engineering courses relevant to offshore wind.

University	Location	Relevant disciplines
IIT Bombay	Mumbai, Maharashtra	Mechanical, electrical, ocean, civil, energy science
IIT Delhi	Delhi NCR	Electrical, mechanical, civil, energy studies, power systems
IIT Madras	Chennai, Tamil Nadu	Ocean, civil, mechanical, electrical, naval architecture
IIT Kharagpur	Kharagpur, West Bengal	Civil, ocean, mechanical, electrical, structural engineering
IIT Kanpur	Kanpur, Uttar Pradesh	Electrical, mechanical, aerospace, materials science, control systems

2.2.5 Summary

Due to the strong onshore wind and oil and gas industries in India, its large workforce and strong technical capabilities, a wide range of providers already offer relevant education and training for OSW. As demand grows and more capacity comes online, the variety and volume of skills required will also increase. While much of this demand is expected to be met through actions led by project developers and suppliers, training institutions will play an important role, especially with regard to practical skills relevant to manufacturing and offshore activities. They can work with industry to understand skill requirements and timing, ensuring that courses are offered when there is real demand. Offering courses prematurely or in skills that are not in demand has the potential to be a drain on resources and move people from useful jobs. Experience from onshore wind and oil & gas shows that Indian institutions and industry have successfully collaborated to develop a skilled workforce. Similar relationships are expected for OSW, with some institutions already active in onshore wind and oil and gas likely to increase their focus on OSW as the sector matures. Although skill gaps may emerge over time as the sector grows, no gaps have been found where urgent activity is needed at this stage.

2.3. Opportunities and challenges

India's OSW sector is poised for significant growth, especially off the coasts of Gujarat and Tamil Nadu. Realising this potential requires a robust and skilled workforce capable of supporting the complex demands of OSW development, manufacturing, installation and operation. While India has a strong foundation in onshore wind and oil and gas, the OSW sector presents unique challenges and opportunities for workforce development.

Despite showing promise for some time, progress in establishing a viable offshore wind market has been slow. Section 1.4.2 considers key policy and regulatory challenges relating to OSW. Only with a stable and competitive OSW market in place will workforce development efforts be fully relevant and effective. The following opportunities and challenges were identified based on feedback from the industry engagement process. For more details on this process, see Appendix K.

2.3.1 Opportunities

Existing capability in onshore wind and oil and gas and other sectors

India's workforce is one of its greatest assets. With over 55% of workers aged between 26 and 35, the country is well-positioned to support a future-focused OSW industry. India has established onshore wind and oil and gas industries, both of which provide a strong foundation for building an OSW workforce. These sectors employ engineers, technicians, project managers, and operations specialists with relevant experience in large-scale energy infrastructure.

Many competencies from onshore wind are directly applicable to OSW, including turbine manufacturing, turbine maintenance activities, and project management. While OSW projects are larger and more complex, these skills provide a strong foundation for developing a skilled workforce. A solid base of experienced onshore wind professionals can help decrease the learning curve in the OSW industry.

Transitioning onshore wind professionals to offshore roles offers several strategic advantages:

- Cost efficiency: retraining existing workers is more economical than recruiting and training entirely new personnel.
- Speed to deployment: leveraging an existing workforce can shorten project timelines and reduce delays.
- Knowledge continuity: onshore wind professionals bring valuable insights into turbine performance, grid integration, and stakeholder engagement that can enhance offshore project outcomes.

India's oil and gas sector also offers a large resource with experience in offshore operations, engineering, and project management. Many of these skills are highly transferable to OSW, including:

- Marine engineering and subsea operations.
- Health and safety management.
- Project planning and logistics.
- Fabrication and installation of offshore structures

Many companies operating in OSW in other markets have transitioned staff (or themselves as a whole company) from oil and gas, demonstrating the feasibility of such transitions. For example, Equinor (Norway) has significantly increased its involvement in OSW, and has used many people from its oil and gas workforce. Equinor has worked with many developers through joint ventures and partnerships on significant OSW projects, like Hywind Scotland, and Dogger Bank offshore wind farms. The Indian Government and oil and gas sector can both play a role in creating structured pathways for applying established expertise to a new sector. OSW should be seen as an additional opportunity for oil and gas companies and staff, not as an alternative.

Staff from other sectors, including the wider manufacturing and service sector, the merchant navy and defence have taken up roles in OSW in other markets.

By building on its strong onshore wind, oil and gas and other relevant sectors, India can create a hybrid workforce capable of supporting both multiple energy sectors, fostering resilience and adaptability in its clean energy transition.

Leveraging overseas expertise

One of the most effective strategies for bridging India's OSW skills gap is leveraging overseas expertise. Countries like Denmark, Germany and the UK have decades of experience in OSW development. Collaborative initiatives such as INNOWIND, a partnership between India and Denmark, have already begun transferring best practices and technical know-how to Indian stakeholders.[43]

Overseas experts can play a vital role in:

- Training Indian professionals through workshops, apprenticeships, and on-the-job mentoring.
- Developing curricula for Indian universities, industrial training and maritime institutes.
- Supporting certification programs (for example, GWO standards) to ensure Indian workers meet international safety and technical benchmarks required by global developers.

- Strengthening institutional capacity by helping create systems, structures and governance needed to support workforce in line with industry demand.

Overseas experts also have an important role to play building capacity within government and regulatory stakeholders, to create clear, timely frameworks that enable OSW projects to progress and attract investment.

2.3.2 Challenges

Health and safety frameworks

Health and safety (H&S) standards are critical in offshore environments, where workers face risks from weather, machinery, and marine operations. India's existing H&S framework, governed by the Petroleum and Natural Gas (Safety in Offshore Operations) Rules, 2008, provides a foundation for offshore safety. These regulations, however, are primarily tailored to oil and gas and require adaptation for OSW projects, which present different technical and operational challenges.

The OSW sector has developed its own standards and accreditation systems to support worker safety and manage competence. Notable examples include the GWO, which provides safety training, and Offshore Energies UK (OEUK), which sets medical and fitness standards for offshore personnel. Workers in offshore environments typically need medical certificates that meet these standards, along with safety and technical certifications for tasks such as turbine maintenance, vessel transfers, and other specialised operations unique to the industry.

Aligning national H&S frameworks with OSW standards will help to create national harmonisation and strengthen workforce quality and safety. It will also enable workforce mobility through mutual recognition across borders and expand energy employment opportunities. A similar exercise has been undertaken in Brazil through the publication of ABEEólica's Guidelines for Safety and Professional Training in the Wind Industry[44], which aim to align international standards and create a standardised set of skills.

At higher level, this alignment will help to protect workers, increase investor confidence, and improve project bankability, thereby supporting the accelerated development of India's OSW market and making the industry attractive to newcomers.

Workforce skill and availability

OSW roles installing and maintaining turbines require higher levels of skill, responsibility, and independence than most jobs in India. Technical and operational positions demand specialised expertise and often involve working in small, unsupervised teams, where the costs of human error can be extremely high due to the costs of accessing turbines offshore, which differs from many other industries.

Most offshore projects are located in coastal regions, where workforce availability can be limited. Educating communities about OSW and promoting OSW as a respected and attractive career path can help address this challenge. It is also important to engage communities in the right way and follow best practices to build trust and long-term support (see Section 1.3).

Workers in onshore wind and the oil and gas sectors may be hesitant to transition to OSW due to unfamiliarity with the environment or perceived risks. It is important to communicate that working in OSW does not require leaving their current industry behind – there will be opportunities to work across sectors..

Industry standards and global competition

The development of India's OSW industry requires alignment with international industry standards and practices. OSW is a global sector that largely communicates in English and relies on international standards. Harmonising Indian standards presents challenges, given the country's unique regulatory environment and institutional frameworks.

India also competes in a dynamic global OSW market, where countries such as Japan, Taiwan, and South Korea have clearer policy frameworks and more developed project pipelines. Uncertainty in any country's route to market reduces confidence among international investors, industry and training providers. To remain competitive, India must provide policy clarity and adopt internationally recognised standards.

2.4. Recommendations

India's OSW sector has great potential. One of the ways to maximise its impact, both in terms of clean energy production and local economic benefit is by developing a skilled and adaptable workforce.

By learning from global best practice and applying experience from onshore wind and oil and gas, India has a clear opportunity to develop a skilled OSW workforce. Strategic partnerships, targeted investments, and policy reforms will be key to unlocking this potential.

Recommendations relevant to all areas then to each of these areas are set out below.

2.4.1 Recommendations

The following actions are recommended.

Increasing confidence in a long-term Indian offshore wind market

1. National and state Government develop clear industrialisation and localisation strategies and policy relating to OSW manufacturing and installation. Alignment of strategy, policy and the frameworks for delivery of OSW maximise the chance of success, as discussed in *Accelerating the Deployment of Offshore Wind in India*.[2]
2. National and state Government build confidence in the Indian OSW industry generally, such that there is increased focus on India as a market to invest in. This is best done through establishing a clear and well-justified volume vision, robust and transparent frameworks, well-resourced institutions with clear responsibilities, and good coordination between national and governments, Indian industry and global wind industry players.
3. National and state Government, including through auction and permitting frameworks, drive good practice in communicating about local content, local gross value added and employment to enable non-ambiguous messaging and drive the desired behaviour of creating local benefit.

Supporting skills development

4. National and state Government implement good practice from other OSW markets and other industries in India to measure and address diversity, gender balance, and equality as the OSW workforce grows.
5. National and state Government support industry to retrain professional staff in skills relevant to OSW through derisking the sector (as described above) and through training or apprenticeship grants.
6. Relevant skill councils communicate clearly about timing and volume of workforce requirements, based on realistic industry growth, and keeping in step with forecast industry need, so that plans are made in good time and workforce is ready, but not trained too early.
7. Relevant skill councils facilitate collaborations between industry, training providers and (where relevant) overseas expertise to accelerate design and delivery of training in areas most wanted by industry, recognising that this will evolve over time as a project pipeline is established.
8. SCGJ mobilises and focus the existing training provision on more content relevant to OSW, endorsing relevant courses, including as provided by GWO affiliates.
9. Ministry of Education encourages development primary- and secondary-school curriculum content, including projects, with OSW themes, to raise awareness of the sector at an early stage.
10. Indian Institutes of Technology and other universities incorporate OSW content into undergraduate and master's degrees.
11. SCGJ provides online skills and wider information about OSW, for example as done in other European markets through Guide to an Offshore Wind Farm[45] and Building Offshore Wind in Ireland[46]. highlighting the long-term career potential of OSW.

12. SCGJ and industry recognise that recruitment agencies also play an important role in seeking staff with relevant experience in other sectors and providing them with an early understanding of OSW.

Building on existing training capabilities

Onshore wind

To enable staff from onshore wind to play a role in OSW it is recommended to:

13. Training institutions develop modular bridge training programs that build on existing onshore wind expertise while introducing offshore-specific modules, enabling staff to train in stages.`
14. SCGJ support and encourage existing wind-related training institutions to expand their curricula to include OSW courses, especially those located in coastal regions near where OSW is likely to establish.

It is noted that staff may smooth workload by working in both of these sectors – there does not need to be a transition from exclusively working in onshore wind to exclusively working in OSW.

Oil and gas sector

To enable oil and gas sector staff to play a role in OSW, it is recommended to:

15. Industrial skills organisations work sensitively with oil and gas enabling organisations and companies to explore the synergies and benefits of cross-sector working.
16. Ministry of Petroleum and Natural Gas and Ministry of New and Renewable Energy support oil and gas innovators to bring experience to support OSW.

Again, it is noted that staff may working in both across both oil and gas and OSW, rather than choosing one sector, exclusively.

Using overseas expertise

To maximise the impact of leveraging overseas expertise, it is recommended to:

17. Industry and training providers Invest in train-the-trainer programs and promote long-term partnerships between overseas experts and local training providers.
18. Industry uses early involvement of overseas experts, for example project directors, to mentor and provide on-the-job training to senior local staff, maximising the chance of success of early projects and enabling positive learning experiences across project teams.

Strengthening health and safety frameworks

To address challenges in health and safety for OSW in India. it is recommended to:

19. Ministry of Labour & Employment updates India's regulatory framework to include OSW-specific safety standards, with cross-agency and industry coordination to ensure clear oversight. It will be important to reflect international best practice and local considerations.
20. Ministry of Labour & Employment and state agencies establish safety audit mechanisms for OSW farms, again with clear, consistent ownership of implementation.
21. Ministry of Labour & Employment drives health and safety-focused behaviours through leadership and culture that are fully embedded in the industry – it is not enough just to have a regulatory framework that is fit for purpose.
22. Ministry of Labour & Employment. with Skill Council for Green Jobs implements national training guidelines for wind energy professionals that align with recognised international standards, national and local regulations.

Appendix A Criteria for value chain assessment

Criterion	Score	Description
Value chain record and capacity in OSW	1	No experience
	2	At least one company with experience in supplying onshore wind farms from India
	3	At least one company with Indian presence and experience of supplying OSW farms from outside India
	4	At least one company with experience of supplying OSW farms from India
Capability in parallel sectors	1	No relevant parallel sectors in India
	2	Relevant sectors with relevant workforce only
	3	Companies in parallel sectors in India that can enter market with high barriers to investment
	4	Companies in parallel sectors in India that can enter market with low barriers to investment
Benefit of local supply	1	No benefits in supplying projects in India from India
	2	Some benefits to supply Indian projects from India but with increased cost and risk
	3	Work for projects in India can be undertaken from outside India but with increased cost and risk
	4	Work for projects in India must be undertaken locally
Investment risk	1	Significant investment with limited opportunity to support other sectors
	2	Significant investment with extensive opportunity to support other sectors
	3	Low investment with limited opportunity to meet demand from other sectors
	4	Low investment with extensive opportunity to meet demand from other sectors
Size of opportunity	1	<2% of wind farm lifetime expenditure
	2	2%≤3.5% of wind farm lifetime expenditure
	3	3.5–5% of wind farm lifetime expenditure
	4	>5% of wind farm lifetime expenditure

Appendix B Economic impact methodology

Conventional modelling of economic impacts for most industrial sectors relies on government statistics, for example, those based on the Ministry of Statistics and Programme Implementation's Central Statistical Office (CSO) and use input-output tables and other production and employment ratios.

National Industrial Classification (NIC) code data can be appropriate for traditional industries at a national level. The development of new codes for a maturing sector, however, takes time. This means that conventional NIC analyses of OSW need to map existing NIC data onto OSW activities, which is not easy and a source of error. Analyses using NIC codes also rely on generalised data.

OSW is ideally suited to a more robust approach that considers the current and future capability of local value chains because:

- Projects tend to be large and have distinct procurement processes from one another, and
- Projects tend to use comparable technologies and share value chains.

This approach enables a realistic analysis of the local and national content of projects even where there are gaps in the data.

In conventional analysis, multipliers are used that are based on statistics of expenditure flows in different sectors. Once the analysis has established what contracts have been awarded to companies in the territory under consideration, the contractors are associated with one of the more sectors used in the NIC. Input-output tables created, for example, by the CSO are used to develop multipliers. These multipliers are used to calculate how demand in each of the NIC sectors leads to direct, indirect, and induced impacts.

The multipliers used in the conventional analysis in effect ignore the value chain in detail, assuming that sector statistics are valid. The BVGA method is based on the principles of *Methodology for measuring UK content for UK offshore wind farms* that seeks to understand the value chain in the lower tiers and produces a figure that is equivalent to direct and indirect GVA.[47] [14]

Calculating a local and national content figure, and understanding profit margins, costs of employment and salaries enable direct and indirect FTEs to be calculated. Induced impacts are calculated using conventional multipliers. The same methodology is followed for local content.

The remaining expenditure is analogous to the direct and indirect gross value added (GVA) created. GVA is the aggregate of labour costs and operational profits. We can therefore model full-time equivalent (FTE) employment from GVA, provided we understand some key variables. In the economic impact methodology, employment impacts are calculated using the following equation:

$$FTE_a = \frac{(GVA - M)}{Y_a + W_a}$$

Where:

FTE_a = Annual FTE employment

GVA = Gross value added

M = Total operating margin

Y_a = Average annual wage, and

W_a = Non-wage average annual cost of employment.

Appendix C Gujarat reference project parameter assumptions

Parameter	Input	Notes
Subzone	B3	
Commercial operation date (COD)	2040	
Water depth	17 m	FOWIND Feasibility Study
Export distance - offshore	35 km	CTUIL ISTS Rolling Plan 2029-30
Export distance - onshore	10 km	
Distance to port - construction	550 km (Kandla)	CoE India OSW Port Study
Distance to port - O&M	28 km (Pipavav)	
Wind speed	7.64 m/s	LiDAR at Subzone B3 Gujarat
		(As per FOWIND Feasibility Study – 7.0 m/s)
Wind speed reference height	120 m	-
Significant wave height	1.1 m	Annual Mean – FOWIND Feasibility Study
Transmission type	HVAC	-
Farm size	1.GW	-
Turbine rating	BVGA internal turbine rating forecast	2030-2032 - 15 MW 2033-2035 - 18 MW 2036-onwards - 20 MW[xiii]
Foundation type	Monopile	-
O&M vessel type	Crew transfer vessel (CTV)	CoE India OSW Port Study
Ground conditions	Soft clay (30-50 kPa)	Undrained shear strength (Su)

[xiii] Wind turbine ratings over time were used to estimate the fraction of demand which could be met by Indian manufacturing facilities. For costs, BVGA's internal LCOE model applies a discount factor over time which considers various elements such as increasing turbine size and advances in efficiency, exact turbine size increases are not considered.

Appendix D Gujarat reference project cost breakdown

Value chain categories	Cost (₹) per MW	
	Scenario 1	Scenario 2
Development and Project management		
Development and consenting services	2,900,000	2,900,000
Environmental surveys	400,000	400,000
Resource and metocean assessment	400,000	400,000
Geological and hydrographical surveys	300,000	300,000
Engineering and consultancy	500,000	500,000
Project management	2,200,000	2,200,000
Manufacturing		
Turbine nacelle and hub	87,200,000	87,200,000
Turbine blade	37,600,000	37,600,000
Turbine tower	6,100,000	6,100,000
Array cables	11,400,000	6,900,000
Export cables	12,100,000	12,100,000
Foundation	34,600,000	34,600,000
Offshore substation	19,700,000	8,800,000
Onshore substation	1,400,000	1,400,000
Installation and commissioning		
Offshore substation installation	1,600,000	1,100,000
Offshore cables installation	18,500,000	12,100,000
Onshore export cables installation	500,000	500,000
Turbine installation	16,300,000	10,600,000
Foundation installation	18,300,000	12,000,000
Construction port	1,600,000	1,600,000
Onshore substation installation	500,000	500,000
Operations, maintenance, and service (OMS)*		
Operations	14,800,000	14,800,000
Maintenance (minor repair)	18,600,000	18,600,000
Maintenance (Major repair)	21,600,000	11,700,000
OMS port	400,000	400,000
Decommissioning		
Decommissioning services	35,500,000	15,200,000

**OMS per MW costs are based on a 30-year lifetime.*

Appendix E Gujarat reference project local content

No content	
Low content (0-5%)	
Medium content (>5%-25%)	
High content (>25%-50%)	
Very high content (>50%)	

Value chain categories	Scenario 1 Gujarat	Scenario 1 Tamil Nadu	Scenario 1 Rest of India	Scenario 2 Gujarat	Scenario 2 Tamil Nadu	Scenario 2 Rest of India
Development and Project management						
Development and consenting services	Very high	Low	Medium	Very high	Low	Medium
Environmental surveys	High	Low	High	High	Low	High
Resource and metocean assessment	High	Medium	Very high	High	Medium	Very high
Geological and hydrographical surveys	Medium	Low	High	Medium	Low	High
Engineering and consultancy	High	Low	High	High	Low	High
Project management	Very high	Low	Medium	Very high	Low	Medium
Manufacturing						
Turbine nacelle and hub	No	No	No	No	No	No
Turbine blade	No	No	No	No	No	No
Turbine tower	Very high	No	High	Very high	No	High
Array cables	No	No	No	High	No	Medium
Export cables	No	No	No	No	No	No
Foundation	No	No	No	No	No	No
Offshore substation	No	No	No	Very high	Low	High
Onshore substation	High	Low	High	High	Low	High
Installation and commissioning						
Offshore substation installation	Medium	No	No	Medium	Low	High
Offshore cables installation	Medium	No	No	High	Low	High
Onshore export cables installation	Very high	Low	Medium	Very high	Low	Medium
Turbine installation	Medium	No	No	High	Low	Medium
Foundation installation	Medium	No	No	High	Low	Medium
Construction port	Very high	No	No	Very high	No	No
Onshore substation installation	Very high	Low	Medium	Very high	Low	Medium
Operations, maintenance, and service (OMS)						
Operations	Very high	Low	Medium	Very high	Low	Medium
Maintenance (minor repair)	Very high	Low	Medium	Very high	Low	Medium
Maintenance (Major repair)	Medium	No	No	Medium	Low	Medium
OMS port	Very high	Low	Medium	Very high	Low	Medium
Decommissioning						
Decommissioning services	Medium	No	No	High	Low	Medium

Appendix F Tamil Nadu reference project parameter assumptions

Parameter	Input	Notes
Subzone	1	Added
COD	2040	
Depth	32 m	FOWIND Feasibility Study
Export distance - offshore	25 km	CTUIL ISTS Rolling Plan 2029-30
Export distance - onshore	10 km	
Distance to port - construction	90 km (Tutikorin)	CoE India OSW Port Study
Distance to port - O&M	16 km (Koodankulam)	
Wind speed	8.1 m/s	FOWIND Feasibility Study
Wind speed reference height	120 m	-
Significant wave height	1.24 m	Annual Mean – FOWIND Feasibility Study
Transmission type	HVAC	-
Farm size	1 GW	-
Turbine rating	BVGA internal turbine rating forecast	2030-2032 - 15 MW 2033-2035 - 18 MW 2036-onwards - 20 MW[xiii]
Foundation type	Monopile	-
O&M vessel type (SOV or CTV)	CTV (COE)	CoE India OSW Port Study
Ground conditions	Sand	

BVGAssociates ClimateHub Accelerating Climate Actions

Appendix G Tamil Nadu reference project cost breakdown

Value chain categories	Cost (₹) per MW	
	Scenario 1	Scenario 2
Development and Project management		
Development and consenting services	2,900,000	2,900,000
Environmental surveys	400,000	400,000
Resource and metocean assessment	400,000	400,000
Geological and hydrographical surveys	300,000	300,000
Engineering and consultancy	500,000	500,000
Project management	2,200,000	2,200,000
Manufacturing		
Turbine nacelle and hub	87,200,000	62,100,000
Turbine blade	37,600,000	26,600,000
Turbine tower	9,800,000	6,800,000
Array cables	11,500,000	7,000,000
Export cables	9,300,000	9,300,000
Foundation	37,800,000	27,100,000
Offshore substation	19,700,000	8,800,000
Onshore substation	1,800,000	1,400,000
Installation and commissioning		
Offshore substation installation	1,600,000	1,100,000
Offshore cables installation	16,600,000	10,800,000
Onshore export cables installation	500,000	500,000
Turbine installation	15,600,000	10,200,000
Foundation installation	14,000,000	9,200,000
Construction port	1,300,000	1,300,000
Onshore substation installation	500,000	500,000
Operations, maintenance, and service (OMS)*		
Operations	14,300,000	14,300,000
Maintenance (minor repair)	17,900,000	17,900,000
Maintenance (Major repair)	20,700,000	11,300,000
OMS port	400,000	400,000
Decommissioning		
Decommissioning services	31,500,000	13,500,000

**OMS per MW costs are based on a 30-year lifetime.*

Appendix H Tamil Nadu reference project local content

No content	
Low content (0-5%)	
Medium content (>5%-25%)	
High content (>25%-50%)	
Very high content (>50%)	

Value chain categories	Scenario 1 Tamil Nadu	Scenario 1 Gujarat	Scenario 1 Rest of India	Scenario 2 Tamil Nadu	Scenario 2 Gujarat	Scenario 2 Rest of India
Development and Project management						
Development and consenting services	Very high	Low	Medium	Very high	Low	Medium
Environmental surveys	Very high	Low	High	Very high	Low	High
Resource and metocean assessment	High	Medium	Very high	High	Medium	Very high
Geological and hydrographical surveys	High	Low	High	High	Low	High
Engineering and consultancy	High	Low	High	High	Low	High
Project management	Very high	Low	Medium	Very high	Low	Medium
Manufacturing						
Turbine nacelle and hub	No	No	No	Very high	Low	High
Turbine blade	No	No	No	Very high	Low	High
Turbine tower	No	Medium	Low	Medium	Medium	High
Array cables	No	No	No	No	High	Medium
Export cables	No	No	No	No	No	No
Foundation	No	No	No	Medium	No	High
Offshore substation	No	No	No	Very high	Low	High
Onshore substation	High	Low	High	High	Low	High
Installation and commissioning						
Offshore substation installation	Medium	No	No	Medium	Low	High
Offshore cables installation	Medium	No	No	High	Low	High
Onshore export cables installation	Very high	Low	Medium	Very high	Low	Medium
Turbine installation	Medium	No	No	High	Low	Medium
Foundation installation	Medium	No	No	High	Low	Medium
Construction port	Very high	No	No	Very high	No	No
Onshore substation installation	Very high	Low	Medium	Very high	Low	Medium
Operations, maintenance, and service (OMS)						
Operations	Very high	Low	Medium	Very high	Low	Medium
Maintenance (minor repair)	Very high	Low	Medium	Very high	Low	Medium
Maintenance (Major repair)	Medium	No	No	High	Low	Medium
OMS port	Very high	Low	Medium	Very high	Low	Medium
Decommissioning						
Decommissioning services	Medium	No	No	High	Low	Medium

Appendix I Findings of value chain assessment

Table I.1 Value chain assessment – development and consenting services.

1.1 Development and consenting services	
Value chain record and capacity in OSW	There are a range of international developers in India with experience in developing international OSW farms from outside India also has both local and international consultants with significant experience in providing development and consenting services in onshore wind. There are no local companies with OSW experience in India.
Capability in parallel sectors	India has a significant onshore wind market which has many parallels with OSW. There will be some crossover with required permits and consenting services, particularly for onshore infrastructure. India also has a strong engineering sector. Companies in parallel sectors can enter the OSW market with low barriers to investment.
Benefit of local supply	The logic for local supply is strong as local knowledge of the legislative and regulatory environment in India is beneficial. Stakeholder and community engagement must be undertaken locally. The work could be undertaken by overseas contractors if local supply is insufficient but with increased cost and risk.
Investment risk	Low investment, as key companies already have a base in India. There will be limited opportunities to meet demand from other sectors while catering to the demand from the OSW sector.
Size of opportunity	Development and consenting services represent a score of 1, at <2% of wind farm lifetime expenditure

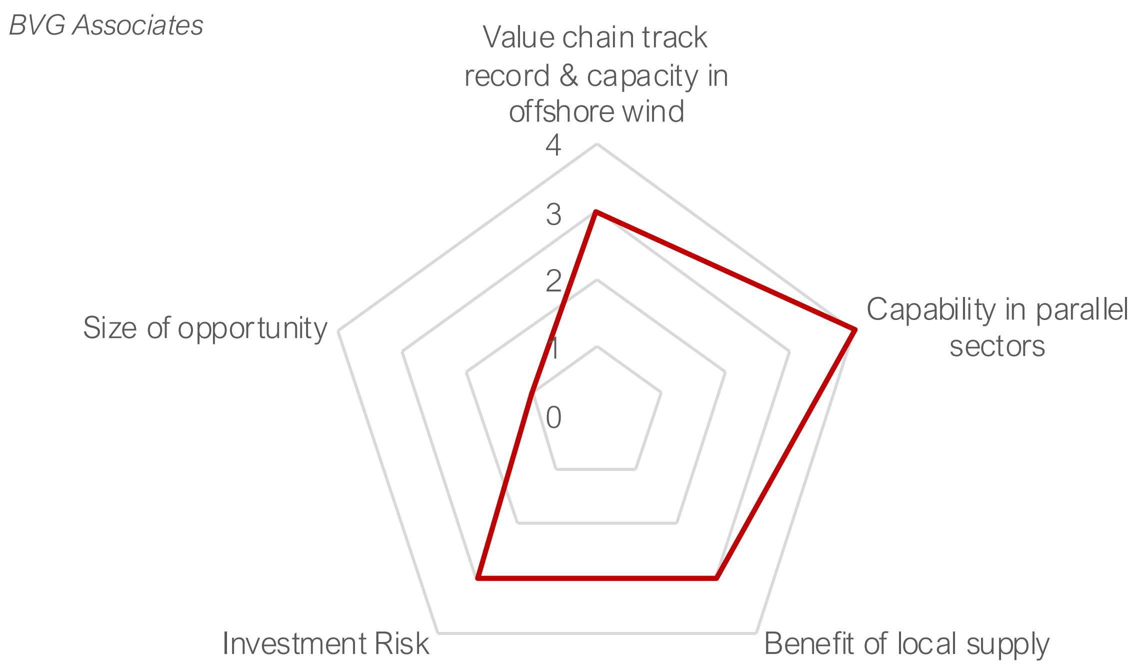

Figure I.1 Development and consenting services assessment.

Table I.2 Value chain assessment – environmental surveys.

1.2 Environmental surveys	
Value chain record and capacity in OSW	Several companies (both local and international) based in India are capable of conducting environmental survey work. Of these, the international companies have experience in supporting OSW developments from outside India. There are no local companies with OSW experience in India.
Capability in parallel sectors	Environmental surveys are required for many kinds of infrastructure projects with which India has significant experience. There are parallels between onshore cabling works for both onshore wind and the power transmission sector. There are also parallels between coastal and marine development such as ports and coastal protection works. Companies in parallel sectors can enter the OSW market with low barriers to investment.
Benefit of local supply	The logic for local supply is strong due to sufficient local resources as well as the requirement for local knowledge of wildlife and site impacts. The work could be undertaken by overseas contractors if local supply is insufficient, but with increased cost and risk.
Investment risk	Low investment risk, as services do not require extensive capex investment and key companies already have a base in India. There will be extensive opportunities to support other sectors.
Size of opportunity	Environmental surveys represent a score of 1, at <2% of wind farm lifetime expenditure

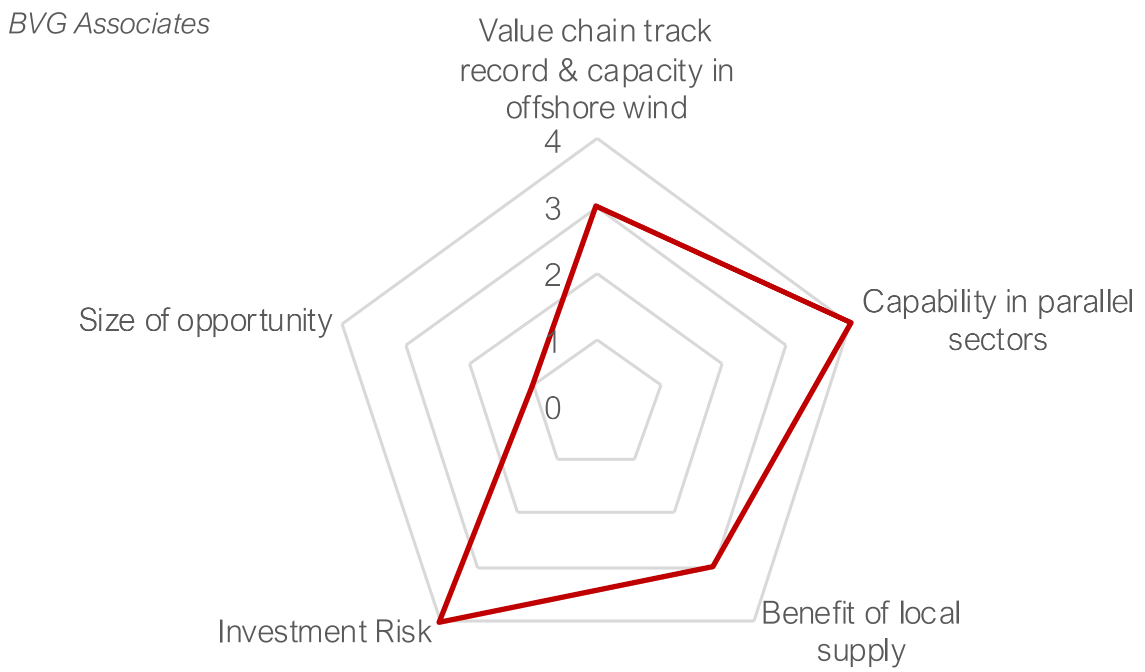

Figure I.2 Environmental surveys assessment.

Table I.3 Value chain assessment – resource and metocean assessment.

1.3 Resource and metocean assessment	
Value chain record and capacity in OSW	Several companies (both local and international) based in India are capable of conducting resource and metocean surveys and assessment work. Of these, the international companies have experience in supporting OSW developments from outside India. There are no local companies with OSW experience in India.
Capability in parallel sectors	India has a well-established onshore wind and oil and gas sector which has parallels with the OSW sector. There are also parallels between coastal and marine development such as ports and coastal protection works. Companies in parallel sectors can enter the OSW market with low barriers to investment.
Benefit of local supply	The logic for local supply is strong as geographical proximity provides an economic advantage. The work could be undertaken by overseas contractors if local supply is insufficient but with increased cost and risk.
Investment risk	Low investment risk, as services do not require extensive capex investment and key companies already have a base in India. There will be limited opportunities to meet demand from other sectors while catering to the demand from the OSW sector.
Size of opportunity	Resource and metocean assessment represent a score of 1, at <2% of wind farm lifetime expenditure

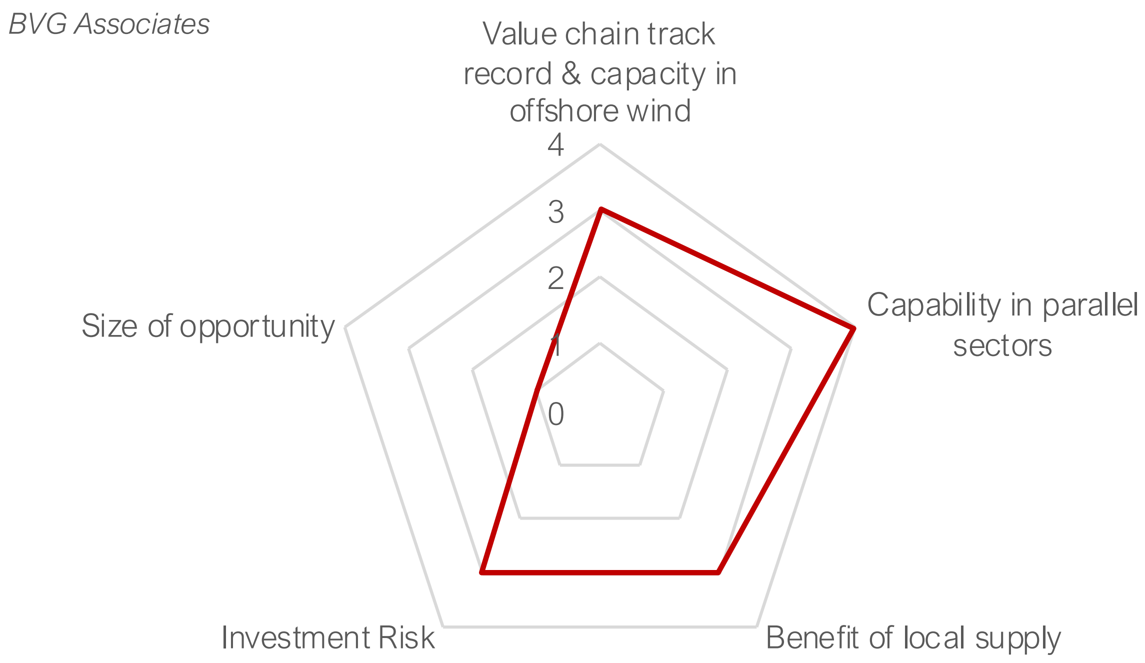

Figure I.3 Resource and metocean assessment.

Table I.4 Value chain assessment – geological and hydrographical surveys.

1.4 Geological and Hydrographical Surveys	
Value chain record and capacity in OSW	Several companies (both local and international) based in India are capable of conducting geological and hydrographical survey work including design and management of surveys and analysis of survey output. Of these, the international companies have experience in supporting OSW developments from outside India. There are no local companies with OSW experience in India.
Capability in parallel sectors	India has a well-established marine and oil and gas sector, which has parallels with the OSW sector. Companies in parallel sectors can enter the OSW market with low barriers to investment.
Benefit of local supply	The logic for local supply is strong as geographical proximity provides an economic advantage. The work could be undertaken by overseas contractors if local supply is insufficient but with increased cost and risk.
Investment risk	Low investment risk, as services do not require extensive capex investment and key companies already have a base in India. There will be extensive opportunities to support other sectors.
Size of opportunity	Geological and hydrographical surveys represent a score of 1, at <2% of wind farm lifetime expenditure.

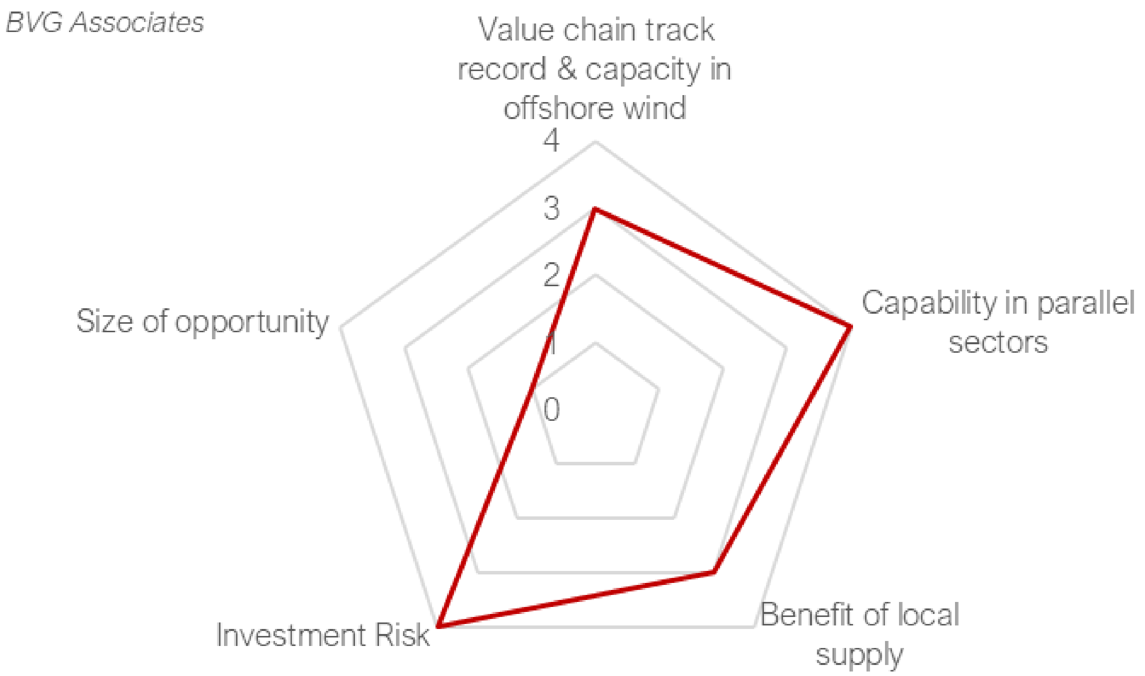

Figure I.4 Geological and hydrographical surveys assessment.

Table I.5 Value chain assessment – engineering and consultancy.

1.5 Engineering and consultancy	
Value chain track record and capacity in OSW	Several companies (both local and international) based in India are capable of conducting engineering and consultancy work. Of these, the international companies have experience in supporting OSW developments from outside India. There are no local companies with OSW experience in India.
Capability in parallel sectors	India has a significant engineering and construction sector that provides designs and technical programmes for civil engineering works including coastal developments such as ports. Its onshore wind sector is also large. There is a significant cross-over with OSW engineering services in both sectors. Companies in parallel sectors can enter the OSW market with low barriers to investment.
Benefit of local supply	The logic for local supply is relatively low as there is little benefit gained from geographical proximity. The work could be undertaken by overseas contractors if local supply is insufficient, so local skill availability is essential.
Investment risk	Low investment risk, as services do not require extensive capex investment and key companies already have a base in India. There will be extensive opportunities to support other sectors.
Size of opportunity	Engineering and consultancy services represent a score of 1, at <2% of wind farm lifetime expenditure.

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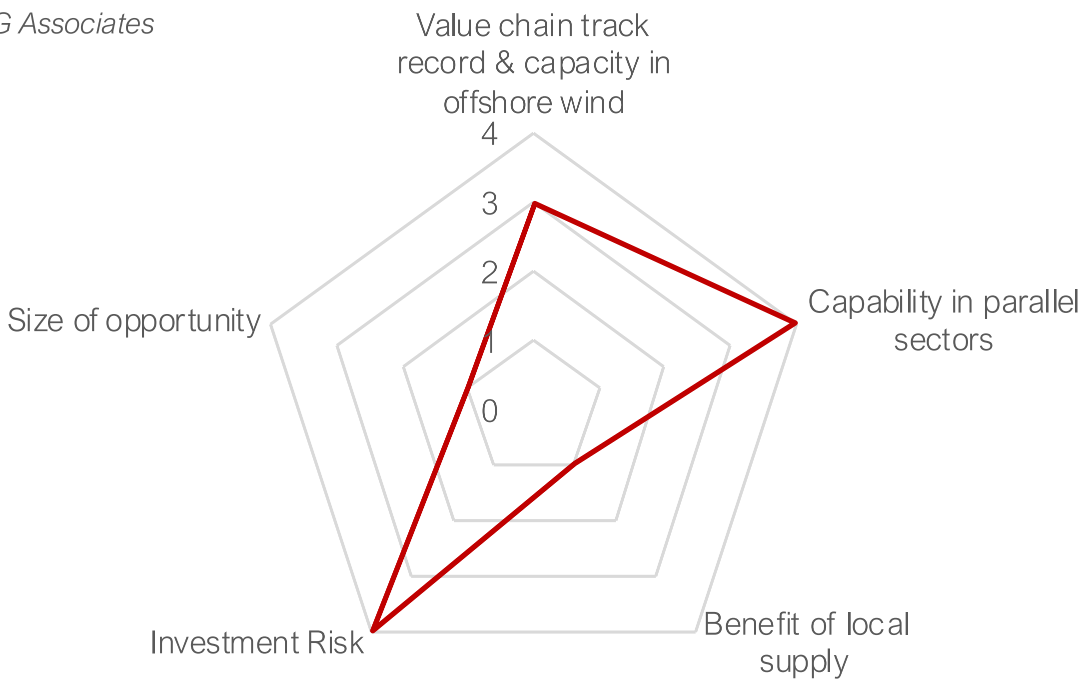

Figure I.5 Engineering and consultancy assessment.

Table I.6 Value chain assessment – project management.

1.6 Project management	
Value chain record and capacity in OSW	Several companies based in India can deliver project management services. Of these, the international companies have experience in supporting OSW developments from outside India. There are no local facilities with experience in supplying OSW projects in India.
Capability in parallel sectors	India has a significant onshore wind and engineering and construction sectors which provide similar project management services. Companies in parallel sectors can enter the OSW market with low barriers to investment.
Benefit of local supply	The logic for local supply is strong as there is benefit gained from the local project site and key stakeholders' proximity. The work could be undertaken by overseas contractors if local supply is insufficient but with increased cost and risk.
Investment risk	Low investment risk, particularly as key companies already have a base in India. However, there will be extensive opportunities to support other sectors.
Size of opportunity	Project management services represent a score of 1, at <2% of wind farm lifetime expenditure.

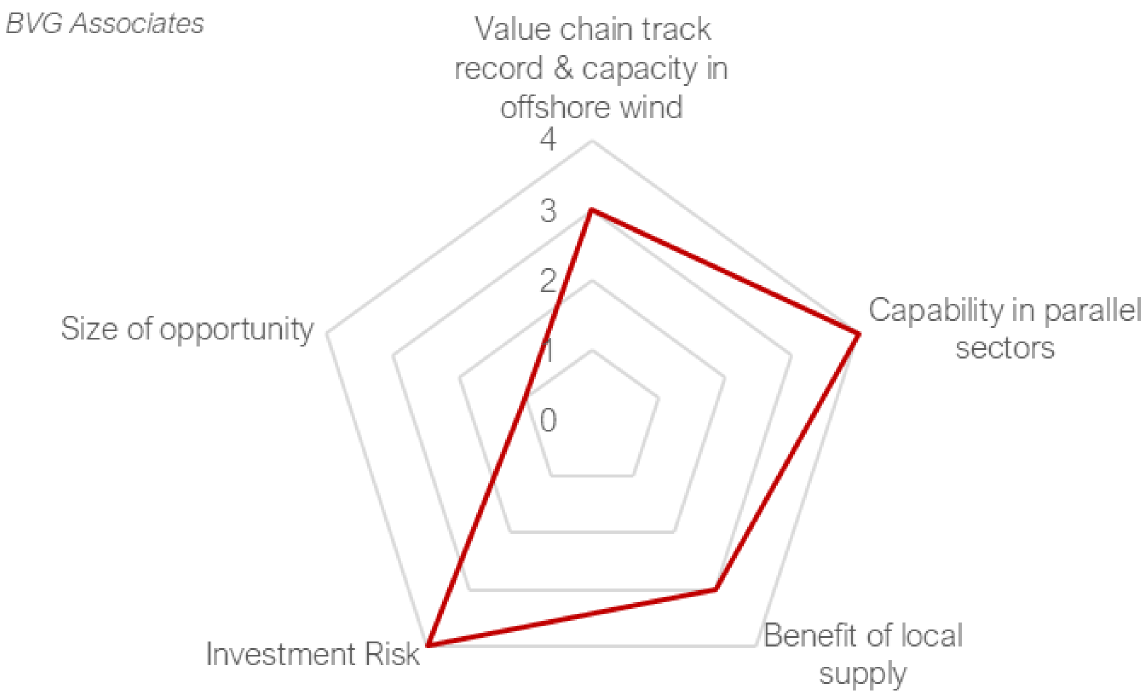

Figure I.6 Project management assessment.

Table I.7 Value chain assessment – manufacturing, turbine nacelle and hub.

2.1 Manufacturing, turbine nacelle and hub	
Value chain record and capacity in OSW	There are a few international turbine manufacturers based in India that have experience in supporting OSW developments from outside India. There are no local facilities with experience in supplying OSW projects in India.
Capability in parallel sectors	India has a well-established onshore wind sector, which has parallels with the OSW sector. Companies in parallel sectors can enter the OSW market but with high barriers to investment, as current facilities are unsuitable for producing the larger nacelles which are typically used in offshore projects
Benefit of local supply	There is little logic for local supply. Nacelle and hub manufacturing is a highly technical and capital-intensive activity. Transport costs are not a key component of overall cost and there is a well-established international value chain.
Investment risk	Turbine nacelle and hub manufacturing has a complex value chain, and is a highly technical and capital-intensive activity, requiring significant investment to establish. Suppliers would also need to be certain of a consistent project pipeline. There will be limited opportunities to service other sectors.
Size of opportunity	Manufacturing, turbine, nacelle and hub represent a score of 4, at >5% of wind farm lifetime expenditure.

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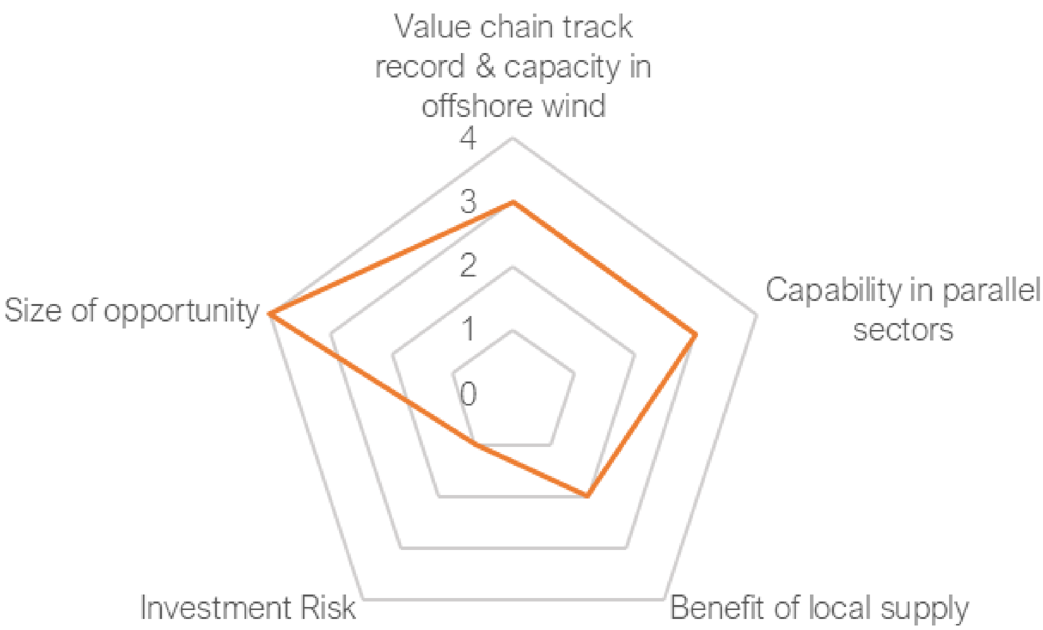

Figure I.7 Manufacturing turbine nacelle and hub assessment.

Table I.8 Value chain assessment – manufacturing, turbine blade.

2.2 Manufacturing, turbine blade	
Value chain record and capacity in OSW	There are a few international turbine blade manufacturers based in India that have experience in supporting OSW developments from outside India. There are no local facilities with experience in supplying OSW projects in India.
Capability in parallel sectors	India has a well-established onshore wind sector, including blade manufacturing capability. Companies in parallel sectors can enter the OSW market but with high barriers to investment.
Benefit of local supply	There is some logic for local supply to avoid transportation costs. However, blade manufacturing a highly technical and capital-intensive activity and there is a well-established international value chain.
Investment risk	Blade manufacturing is a highly technical and capital-intensive activity with high barriers to investment. Current facilities are not capable of producing blades for OSW turbines, which are typically larger than those used in onshore projects. Suppliers would also need to be certain of a consistent project pipeline. There will be limited opportunities to service other sectors.
Size of opportunity	Manufacturing, turbine blade represents a score of 4, at >5% of wind farm lifetime expenditure.

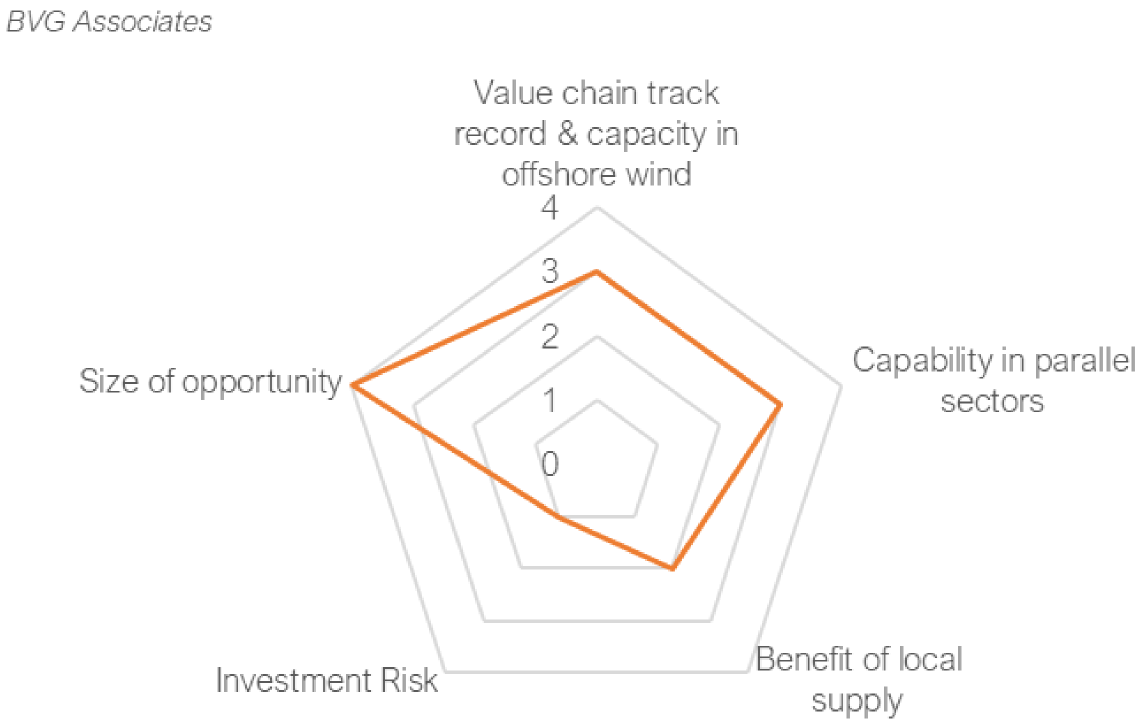

Figure I.8 Manufacturing, turbine blade assessment.

Table I.9 Value chain assessment – manufacturing, turbine tower.

2.3 Manufacturing, turbine tower	
Value chain record and capacity in OSW	There are a few international turbine tower manufacturers based in India that have experience in supporting OSW developments from outside India. There are no local facilities with experience in supplying OSW projects in India.
Capability in parallel sectors	India has an advanced onshore wind sector, including tower manufacture and fabrication capability. Companies in parallel sectors can enter the OSW market but with high barriers to investment
Benefit of local supply	There is some logic for local supply to avoid transportation costs. However, tower manufacturing a capital-intensive activity and there is a well-established international value chain.
Investment risk	Significant investment in new facilities will be required to produce towers domestically. Current facilities are not capable of producing blades for OSW turbines, which are typically larger than those used in onshore projects and suppliers would also need to be certain of a consistent project pipeline. There will be limited opportunities to support other sectors.
Size of opportunity	Manufacturing, turbine tower represents a score of 2, at 2%≤3.5% of wind farm lifetime expenditure..

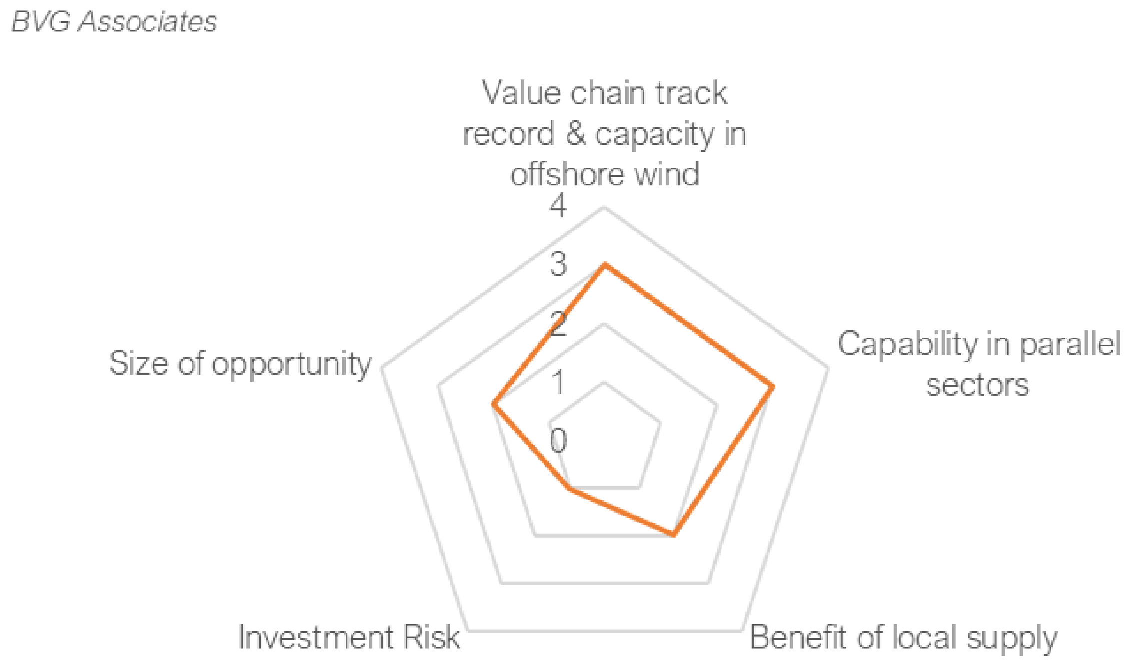

Figure I.9 Manufacturing, turbine tower assessment.

Table I.10 Value chain assessment – manufacturing, array cables.

2.4 Manufacturing, array cables	
Value chain record and capacity in OSW	There are a few international array cable manufacturers with teams (but not large-scale manufacturing facilities) in India that have experience in supporting OSW developments from outside India. There are no local facilities with experience in supplying OSW projects in India.
Capability in parallel sectors	India has cable manufacturers with experience in supplying 33kV and 66 kV cables, but not for subsea use. Companies in parallel sectors could enter the OSW market but with high barriers to investment.
Benefit of local supply	There is logic for local supply but array cables are easily transportable and Indian suppliers will face strong competition from international suppliers.
Investment risk	Significant investment is required because India's existing relevant cable manufacturing capability is not located coastally. There will be opportunity to support other sectors, including oil and gas, from any new facility.
Size of opportunity	Manufacturing, array cables represent a score of 2, at 2-32% of wind farm lifetime expenditure.

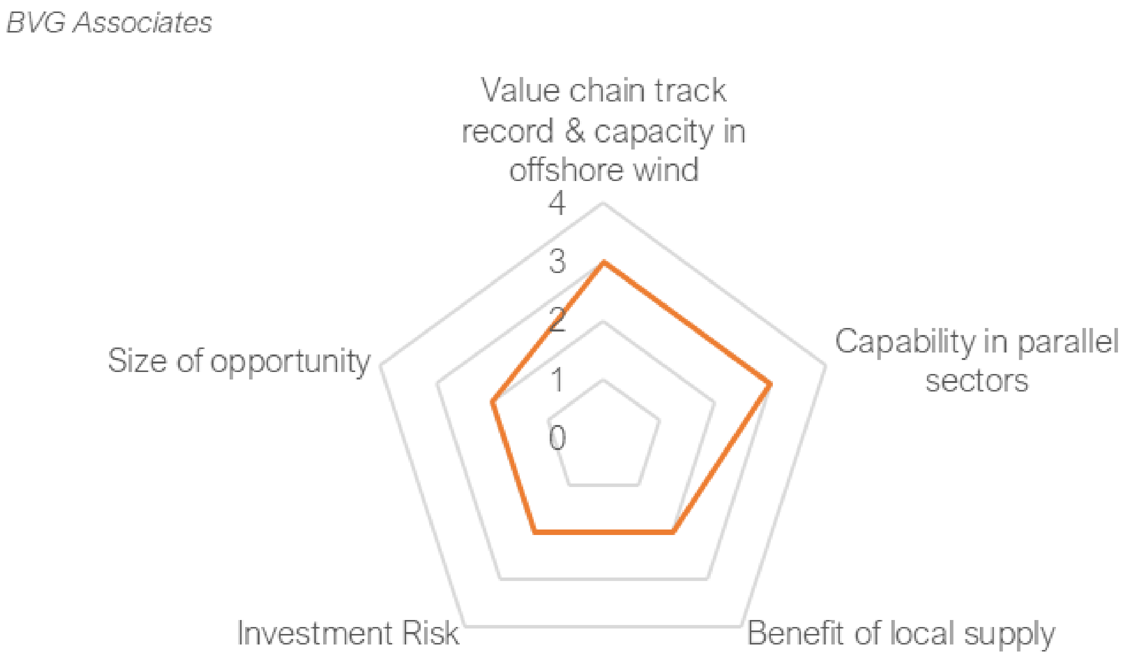

Figure I.10 Manufacturing, array cables assessment.

Table I.11 Value chain assessment – manufacturing, export cables.

2.5 Manufacturing, export cables	
Value chain record and capacity in OSW	There one international export cable manufacturer with a team (but not large-scale manufacturing facilities) in India that has experience in supporting OSW developments from outside India. There are no local facilities with experience in supplying OSW projects in India.
Capability in parallel sectors	India has cable manufacturers with experience in supplying up to 400 kV cables, but not for subsea use. Companies in parallel sectors could enter the OSW market but with high barriers to investment.
Benefit of local supply	There is logic for local supply but export cables are easily transportable and Indian suppliers will face strong competition from international suppliers.
Investment risk	Significant investment is required because India's existing relevant cable manufacturing capability is not located coastally. There will be opportunity to support other sectors, including interconnection, from any new facility.
Size of opportunity	Manufacturing, export cables represent a score of 3, at 3-4% of wind farm lifetime expenditure.

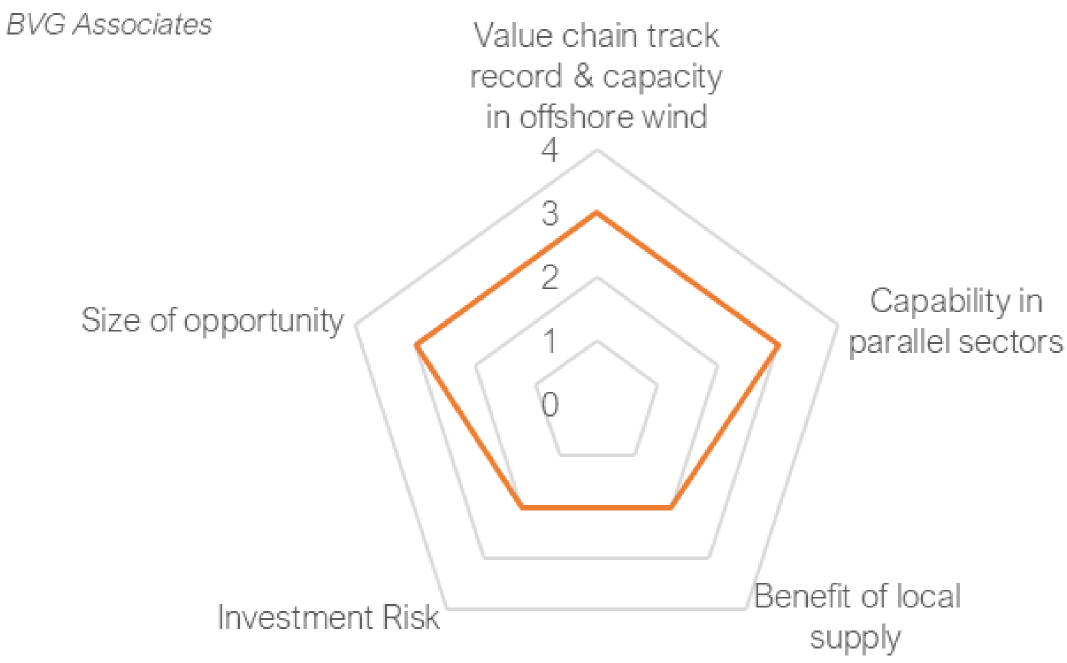

Figure I.11 Manufacturing, export cables assessment.

Table I.12 Value chain assessment –manufacturing, foundation.

2.6 Manufacturing, foundation	
Value chain record and capacity in OSW	There are no companies with OSW experience in India.
Capability in parallel sectors	India can manufacture jacket foundations for oil and gas. Companies in parallel sectors can enter the OSW market but with high barriers to investment.
Benefit of local supply	The logic for local supply is low, as they are relatively straightforward to ship. Indian suppliers will face strong competition from other suppliers in the region.
Investment risk	Significant investment would be required in both manufacturing and port facilities to develop Indian monopile manufacturing capability. Suppliers would also need to be certain of a consistent project pipeline. There will be limited opportunities to service other sectors.
Size of opportunity	Manufacturing, foundations represent a score of 4, at >5% of wind farm lifetime expenditure.

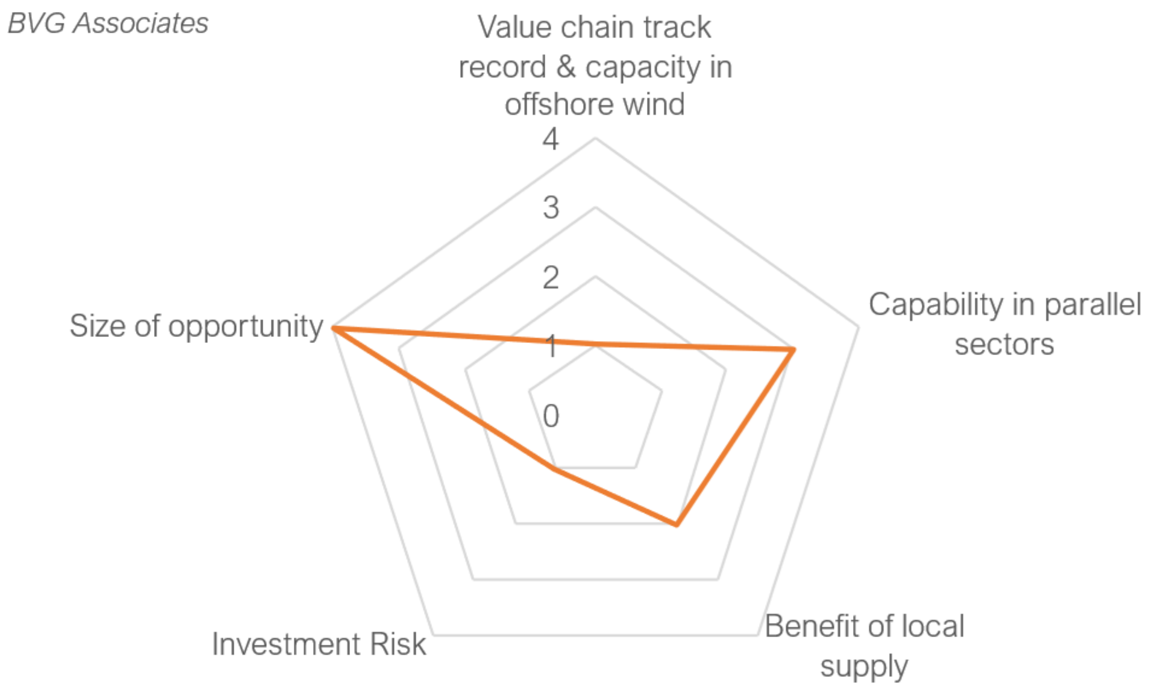

Figure I.12 Manufacturing, foundation assessment.

Table I.13 Value chain assessment –manufacturing, offshore substation.

2.7 Manufacturing, offshore substation	
Value chain record and capacity in OSW	There are no companies with OSW experience in India.
Capability in parallel sectors	India can manufacture topsides for oil and gas. Companies in parallel sectors can enter the OSW market but with high barriers to investment.
Benefit of local supply	There is little logic for supply as transportation makes up a small portion of the overall cost. A competitive international market already exists, and Indian suppliers will therefore face strong competition from other suppliers in the region.
Investment risk	This could be carried out from Larsen & Toubro manufacturing facilities.. Suppliers would however need to be certain of a consistent project pipeline. There will be the opportunity to service other sectors.
Size of opportunity	Manufacturing, offshore substation represents a score of 3, at 3.5-5% of wind farm lifetime expenditure.

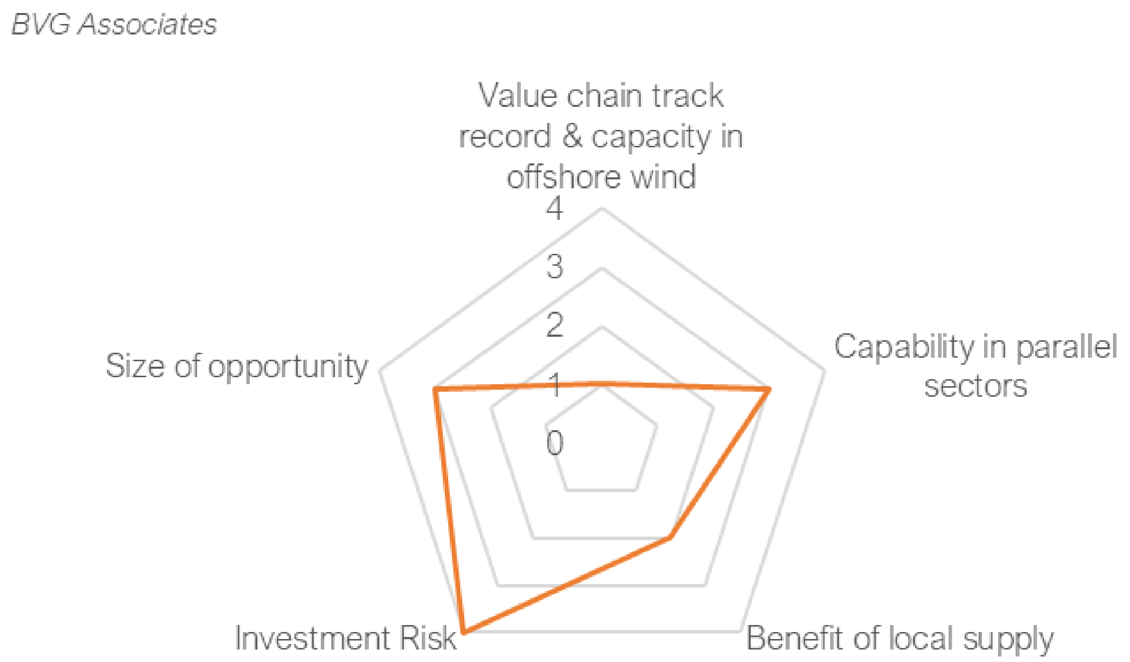

Figure I.13 Manufacturing, offshore substation assessment.

Table I.14 Value chain assessment – manufacturing, onshore substation.

2.8 Manufacturing, onshore substation	
Value chain record and capacity in OSW	There are companies with onshore wind experience in India but no OSW experience.
Capability in parallel sectors	India has sizeable engineering and construction sectors, both of which are highly transferable to onshore substation manufacture as it is mostly standard construction work. Companies in parallel sectors can enter the OSW market with low barriers to investment.
Benefit of local supply	There is a very high logic for employing local teams to undertake this work as it is generally more cost effective to deliver locally and requires a standard construction skillset.
Investment risk	Low investment risks as standard skillsets are required and demand can be met from parallel sectors if given sufficient notice. Extensive opportunity to service other sectors.
Size of opportunity	Manufacturing, onshore substation represents a score of 1, at <2% of wind farm lifetime expenditure.

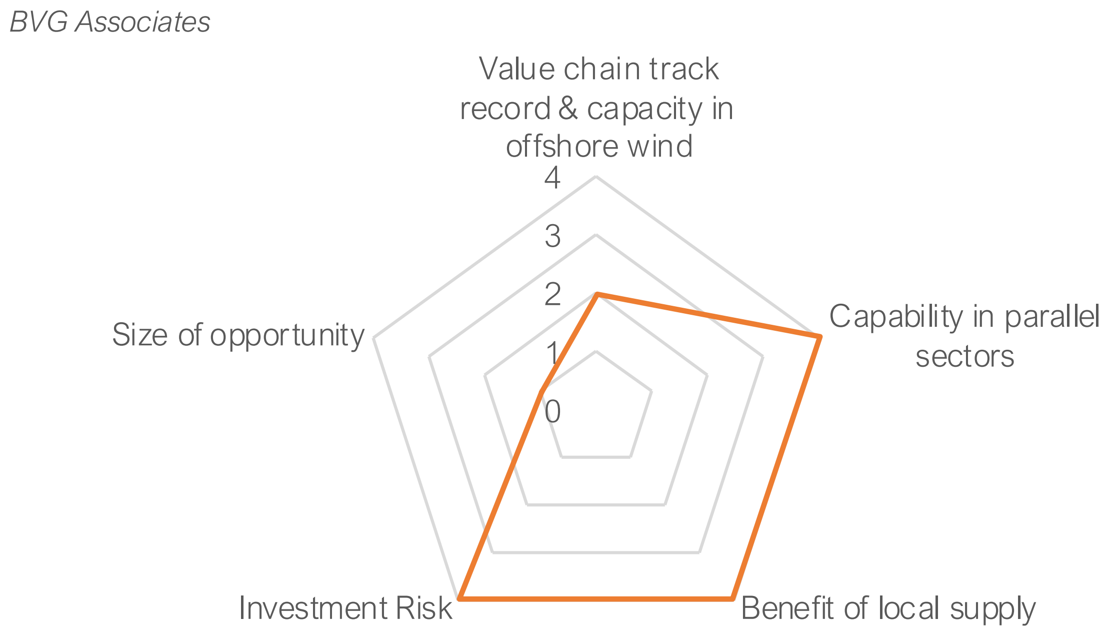

Figure I.14 Manufacturing, onshore substation assessment.

Table I.15 Value chain assessment – installation and commissioning, offshore substation.

3.1 Installation and commissioning, offshore substation	
Value chain record and capacity in OSW	There are no companies with OSW experience in India.
Capability in parallel sectors	India has good experience in oil and gas which the country can leverage. Companies in parallel sectors in India can enter the OSW market but with high barriers to investment.
Benefit of local supply	The logic for local supply is low as a competitive international market already exists, and experienced overseas contractors could conduct installation work in India at a comparable cost to potential local suppliers.
Investment risk	Significant investment would be required in vessels, equipment, and port facilities to develop Indian OSW substation installation and commissioning capability. Suppliers would also need to be certain of a consistent project pipeline. However, there will be opportunities to service other sectors.
Size of opportunity	Installation and commissioning, offshore substation represents a score of 1, at <2% of wind farm lifetime expenditure.

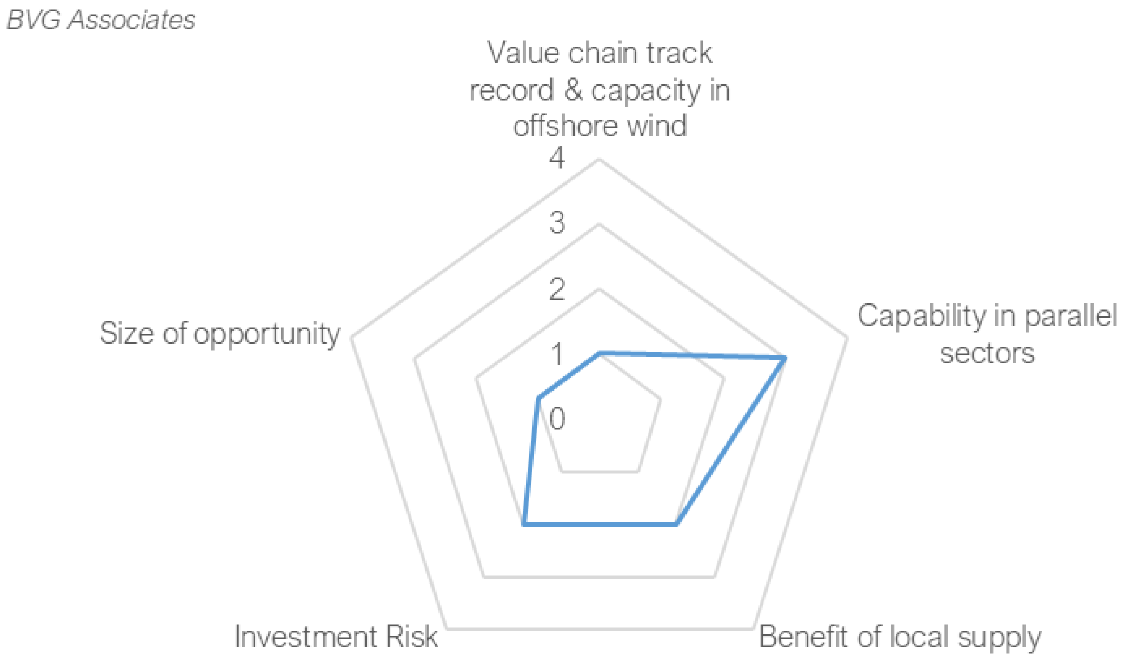

Figure I.15 Installation and commissioning, offshore substation assessment.

Table I.16 Value chain assessment – installation and commissioning, offshore cables.

3.2 Installation and commissioning, offshore cables	
Value chain record and capacity in OSW	There are no companies with OSW experience in India.
Capability in parallel sectors	India has good experience in oil and gas which the country can leverage. Companies in parallel sectors in India can enter the OSW market but with high barriers to investment.
Benefit of local supply	The logic for local supply is low as a competitive international market already exists, and experienced overseas contractors could conduct installation work in India at a comparable cost to local suppliers.
Investment risk	Significant investment would be required in vessels, equipment, and port facilities to develop Indian OSW cable installation and commissioning capability. Suppliers would need confidence of a significant project pipeline. There will, however, be opportunities to service other sectors.
Size of opportunity	Installation and commissioning, offshore substation represents a score of 2, at 2%≤3.5% of wind farm lifetime expenditure.

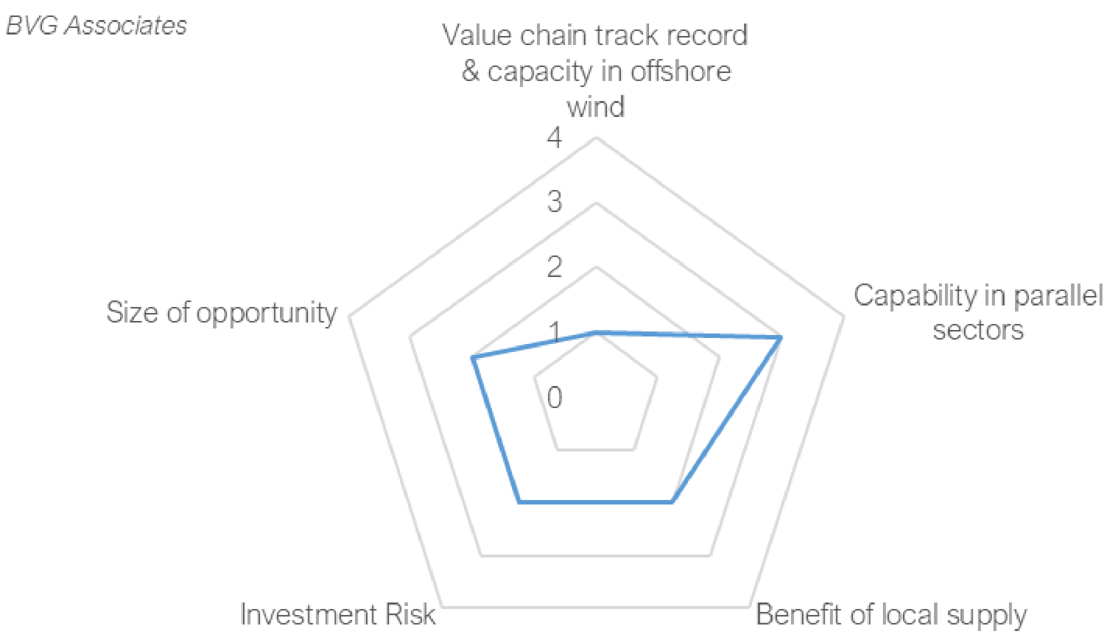

Figure I.16 Installation and commissioning, offshore cables assessment.

Table I.17 Value chain assessment – installation and commissioning, onshore export cables.

3.3 Installation and commissioning, onshore export cables	
Value chain record and capacity in OSW	There are companies with onshore wind experience in India but no OSW experience.
Capability in parallel sectors	India has sizeable onshore wind, telecoms engineering, and construction sectors, all of which are highly transferable to onshore substation manufacture as it is mostly standard construction work. Companies in parallel sectors in India can enter the OSW market with low barriers to investment.
Benefit of local supply	There is a strong logic for employing local teams to undertake this work as it is generally more cost effective to deliver locally and requires a standard construction skillset.
Investment risk	Low investment risk, as limited capex expenditure required to enter market and standard construction skillsets are required. Extensive opportunity to service other sectors.
Size of opportunity	Installation and commissioning, onshore export cables represent a score of 1, at <2% of wind farm lifetime expenditure.

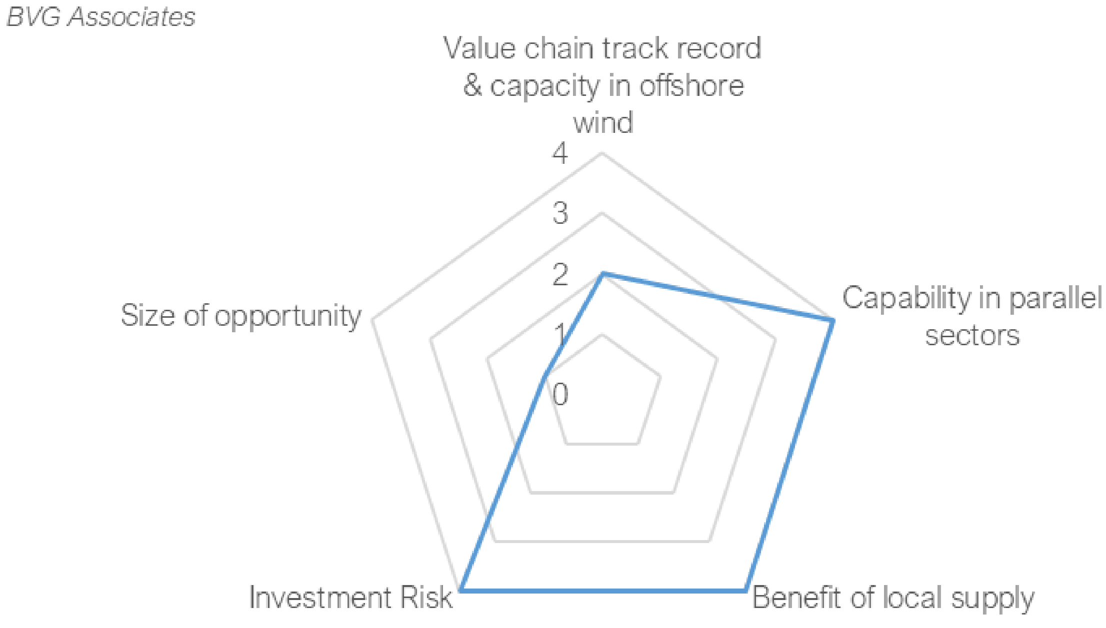

Figure I.17 Installation and commissioning, onshore export cables assessment.

Table I.18 Value chain assessment – installation and commissioning, turbine.

3.4 Installation and commissioning, turbine	
Value chain record and capacity in OSW	There are companies with onshore wind experience in India but no OSW experience.
Capability in parallel sectors	India has a sizeable onshore wind sector and a growing offshore oil and gas construction sector. It is likely that any local supply comes from investment by the offshore construction sector, though may be high barriers to investment and/or require partnerships with overseas contractors.
Benefit of local supply	There is some logic for local supply, which could deliver lower costs and reduce risks associated with installation delays. Experienced overseas contractors could conduct installation work in India, though likely at a somewhat higher cost to local suppliers. There is added risk from local supply early on.
Investment risk	Significant investment would be required in specialist jack-up vessels and equipment to develop Indian OSW turbine installation and commissioning capability. Suppliers would need confidence of a significant project pipeline, as there will be little opportunity to service other sectors.
Size of opportunity	Installation and commissioning, turbine represent a score of 3, at 4-5% of wind farm lifetime expenditure.

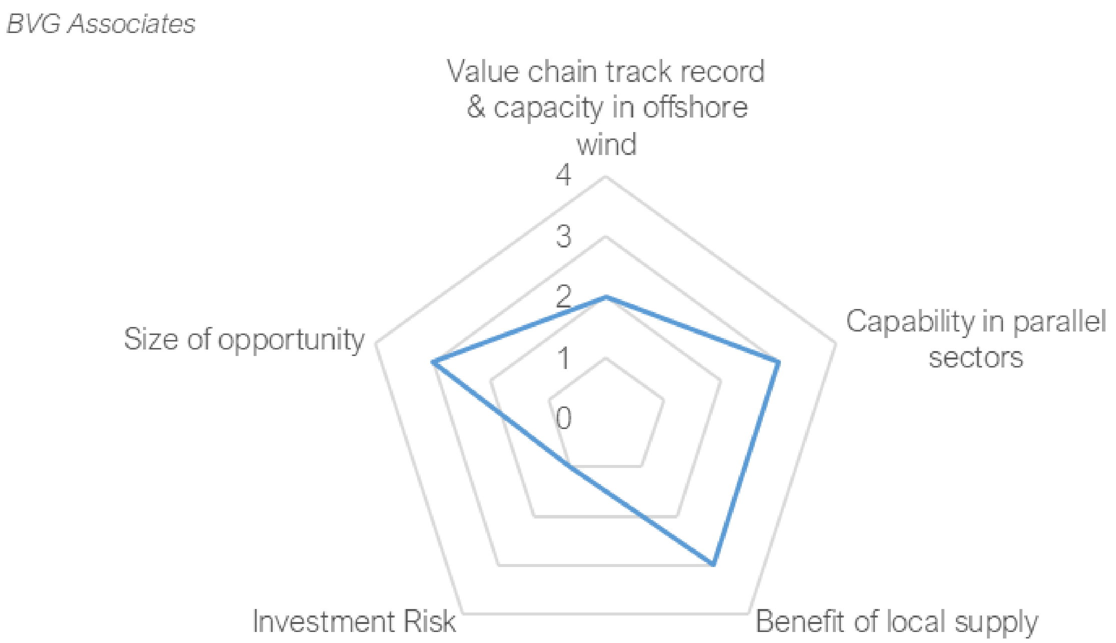

Figure I.18 Installation and commissioning, turbine assessment.

Table I.19 Value chain assessment – installation and commissioning, foundation.

3.5 Installation and commissioning, foundation	
Value chain record and capacity in OSW	There no companies with OSW experience in India.
Capability in parallel sectors	India has several relevant competencies for foundation installation, from its strong offshore oil and gas and marine engineering construction sectors.
Benefit of local supply	There is some logic for local supply, which could deliver lower costs and reduce risks associated with installation delays. Experienced overseas contractors could conduct installation work in India, though likely at a somewhat higher cost to local suppliers. There is added risk from local supply early on.
Investment risk	Significant investment would be required in specialist vessels and equipment to develop Indian OSW foundation installation and commissioning capability. Suppliers would need confidence of a significant project pipeline. There is limited opportunity to service other sectors.
Size of opportunity	Installation and commissioning, foundation represent a score of 3, at 4-5% of wind farm lifetime expenditure.

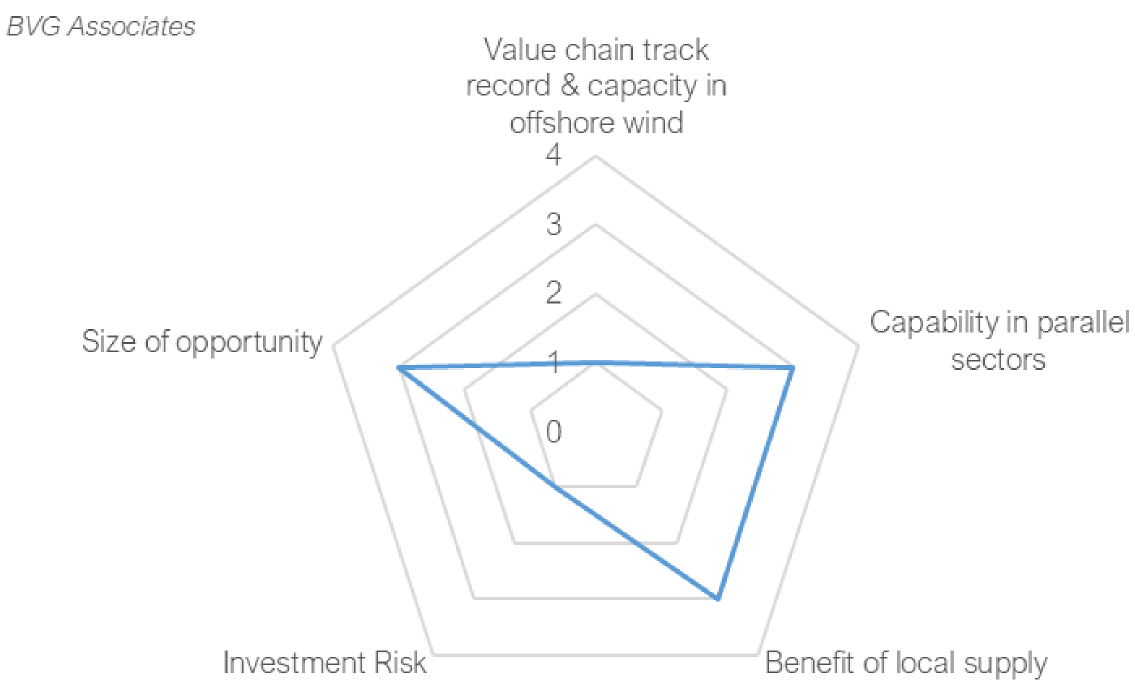

Figure I.19 Installation and commissioning, foundation assessment.

Table I.20 Value chain assessment – installation and commissioning, construction port.

3.6 Installation and commissioning, construction port	
Value chain record and capacity in OSW	There are no companies with OSW experience in India.
Capability in parallel sectors	India has capability in parallel sectors such as marine and civil engineering, as well as the construction sector. Companies in parallel sectors in India can enter the OSW market but with high barriers to investment.
Benefit of local supply	There is high logic in having the construction port based locally as it allows for cheaper and quicker installation. The construction port for a typical project will likely be locally in India.
Investment risk	Barriers to entry are significant as India currently has no suitable ports for large-scale projects such as OSW. Significant investment is therefore needed, which requires market certainty and a strong project pipeline. However, there will be extensive opportunities to service other sectors.
Size of opportunity	Installation and commissioning, construction port represent a score of 1, at <2% of wind farm lifetime expenditure.

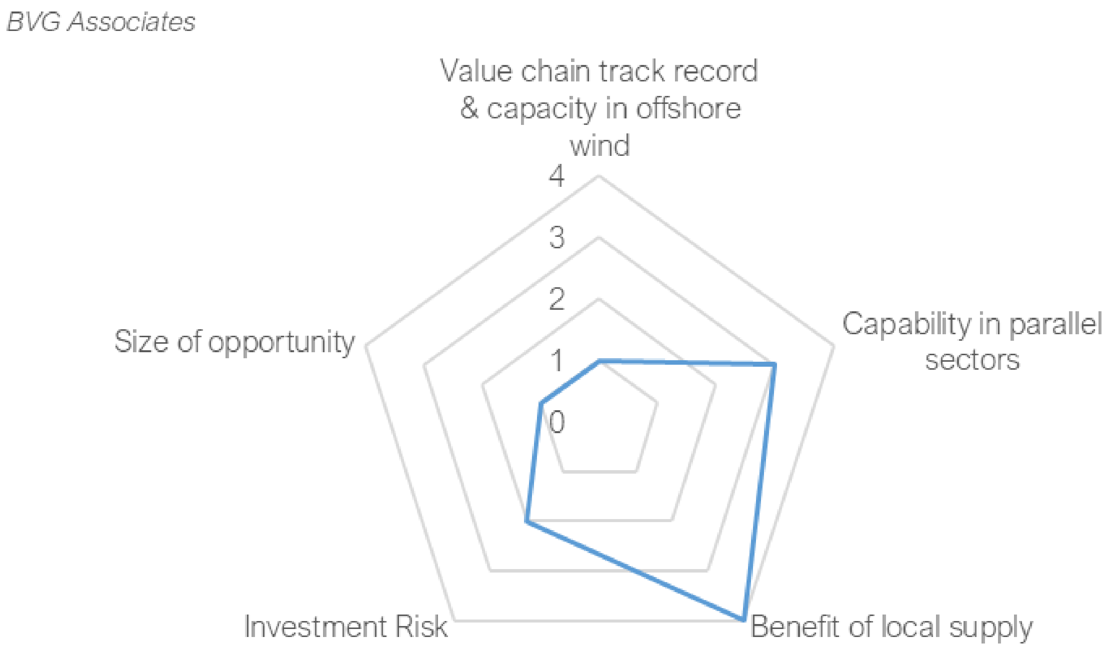

Figure I.20 Installation and commissioning, onshore export cables assessment.

Table I.21 Value chain assessment – installation and commissioning, onshore substation.

3.7 Installation and commissioning, onshore substation	
Value chain record and capacity in OSW	There are companies with onshore wind experience in India but no OSW experience.
Capability in parallel sectors	Onshore substation installation work requires standard construction and electrical engineering skillsets. India has sizeable engineering and construction sectors, which have transferable skills. Companies in parallel sectors in India can enter the OSW market with low barriers to investment.
Benefit of local supply	Onshore substation installation is routine construction work and so is generally contracted to local firms. There is strong logic in local supply.
Investment risk	Low investment risk as limited capex investment required to participate and requires standard electrical and construction skillsets. Extensive opportunity to service other sectors.
Size of opportunity	Installation and commissioning, onshore substation represent a score of 1, at <2% of wind farm lifetime expenditure.

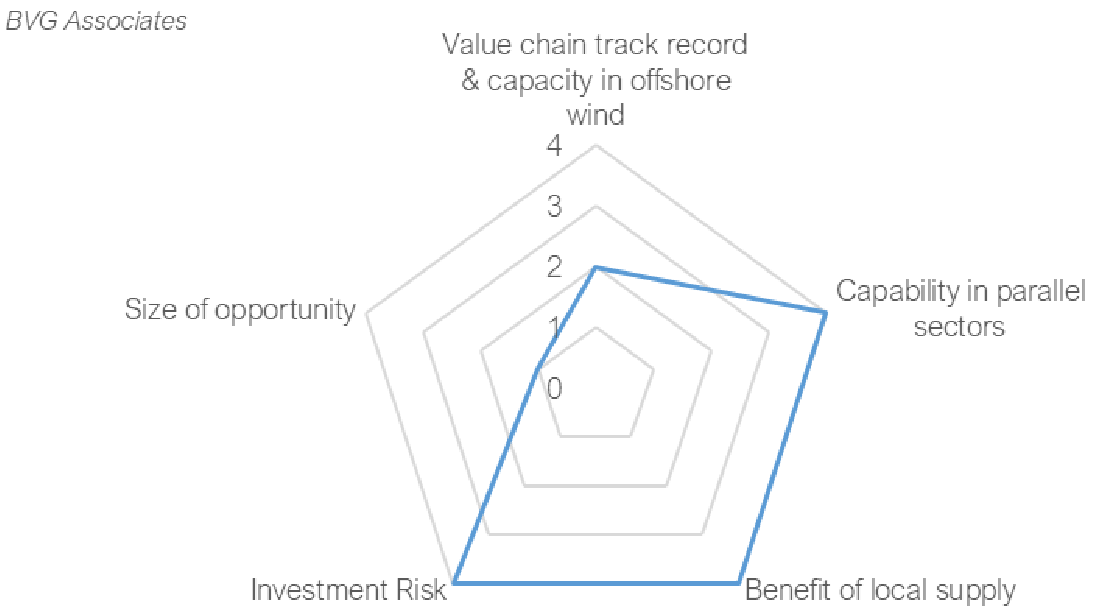

Figure I.21 Installation and commissioning, onshore substation assessment.

Table I.22 Value chain assessment – operations and maintenance, operations.

4.1 Operations and maintenance, operations	
Value chain record and capacity in OSW	There are companies with onshore wind experience in India but no OSW experience.
Capability in parallel sectors	India has large onshore wind and oil and gas sectors which have transferable, complementary capabilities to offshore operations. Companies in parallel sectors in India can enter the OSW market with low barriers to investment.
Benefit of local supply	There is a strong logic for local supply as there is significant cost savings associated with conducting operations activities locally, minimising distance to the project site.
Investment risk	Depending on the operations activities conducted, some investment may be required. Limited opportunity to support other sectors.
Size of opportunity	Operations and maintenance, operations represent a score of 3 at 3.5-5% of wind farm lifetime expenditure.

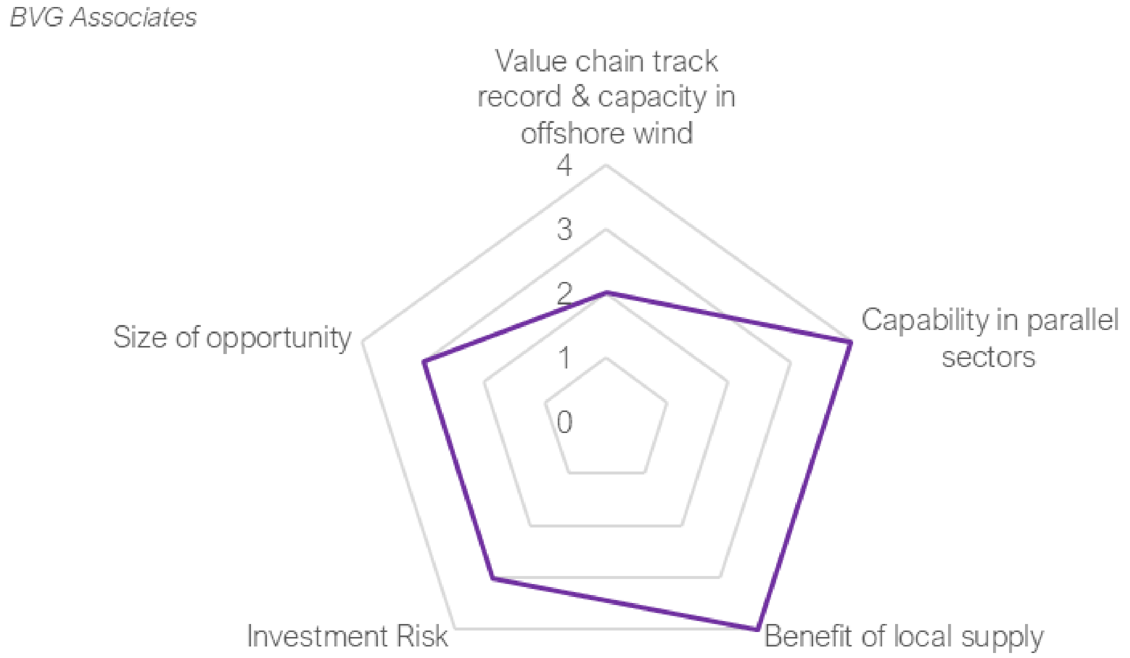

Figure I.22 Operations and maintenance, operations assessment.

Table I.23 Value chain assessment –operations and maintenance, maintenance.

4.2 Operations and maintenance, maintenance	
Value chain record and capacity in OSW	There are companies with onshore wind experience in India but no OSW experience.
Capability in parallel sectors	India has large onshore wind and oil and gas sectors which have transferable, complementary capabilities to OSW maintenance. Companies in parallel sectors in India can enter the OSW market with low barriers to investment.
Benefit of local supply	There is a strong logic for local supply as there is significant cost savings associated with conducting routine maintenance activities locally minimising distance to the project site.
Investment risk	Depending on the maintenance activities conducted, some investment may be required in vessels and equipment. Limited opportunity to support other sectors.
Size of opportunity	Operations and maintenance, maintenance represent a score of 3 at 3.5-5% of wind farm lifetime expenditure.

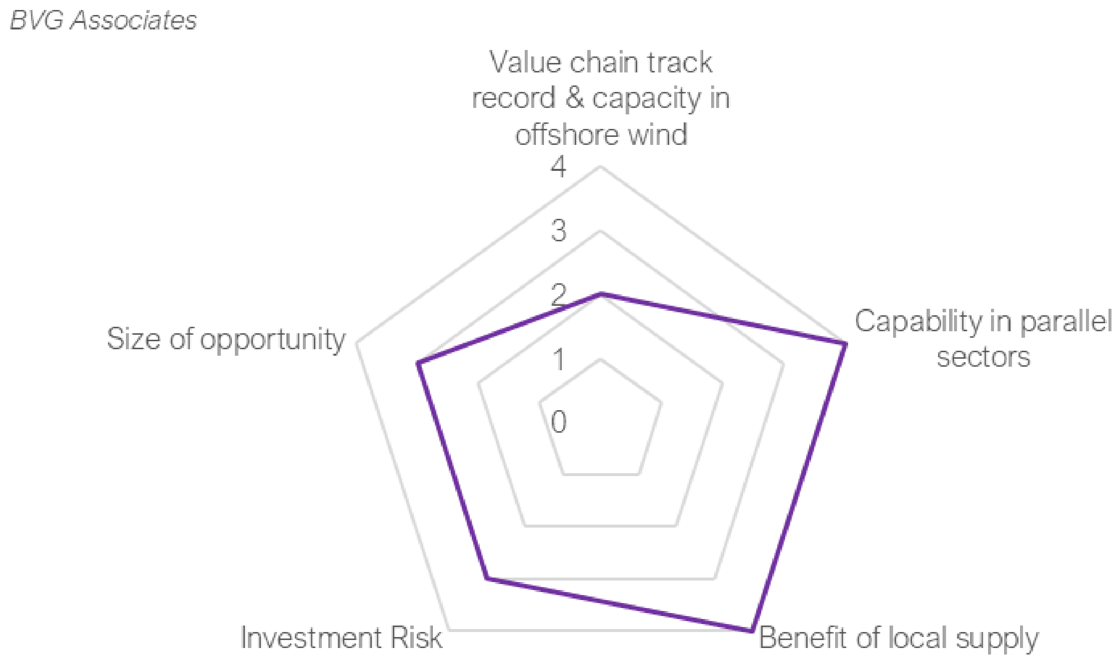

Figure I.23 Operations and maintenance, maintenance assessment.

Table I.24 Value chain assessment – operations and maintenance, major repair

4.3 Operations and maintenance, major repair	
Value chain record and capacity in OSW	There are currently no Indian companies with direct experience in OSW major repair activities, through this will change during the life of projects.
Capability in parallel sectors	India has some relevant offshore industry and onshore wind experience, but undertaking major repairs requires specialised knowledge of OSW turbine components and dedicated vessel operations
Benefit of local supply	There is logic for developing for local supply to reduce response times and lower operational costs and to better use installation vessels by using them for repairs when available, but there is added risk from local supply early on.
Investment risk	Significant investment would be required in specialist repair vessels, lifting equipment, and training to establish a competitive domestic capability, but such investment decisions are likely to have been made in order to serve the turbine installation market already, significantly reducing the risk.
Size of opportunity	Operations and maintenance, major repair represent a score of 4 at >5% of wind farm lifetime expenditure,

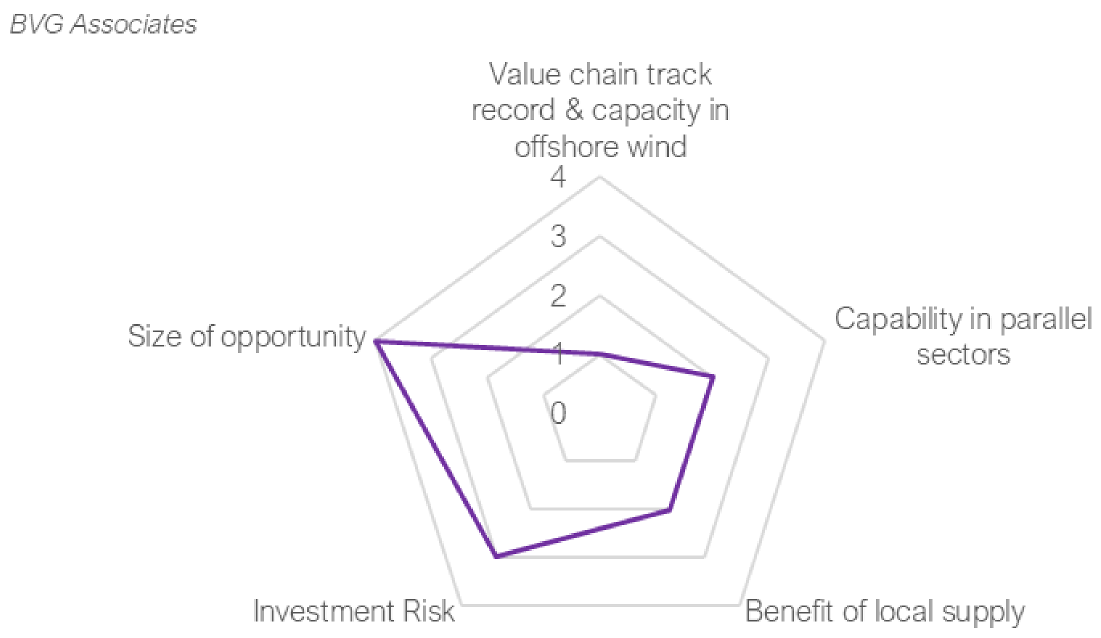

Figure I.24 Operations and maintenance, major repair assessment.

Table I.25 Value chain assessment – operations and maintenance, OMS port.

4.3 Operations and maintenance, OMS port	
Value chain record and capacity in OSW	There are no companies with OSW experience in India.
Capability in parallel sectors	India has active maritime and ports sector which has transferable, complementary capabilities. There are several existing ports and harbours capable of supporting operations and maintenance facilities with varying degrees of upgrade. Companies in parallel sectors in India can enter the OSW market with low barriers to investment.
Benefit of local supply	There is a significant cost efficiency in basing the OMS port near the wind farm. There is therefore strong logic in local supply.
Investment risk	Inward investment will be needed to develop the OMS port to make it suitable for OSW, such as adapting or adding jetties or quaysides for CTVs and SOVs, warehouses, workshops, and offices. Extensive opportunity to support other sectors.
Size of opportunity	Operations and maintenance, OMS port represent a score of 1 at <2% of wind farm lifetime expenditure.

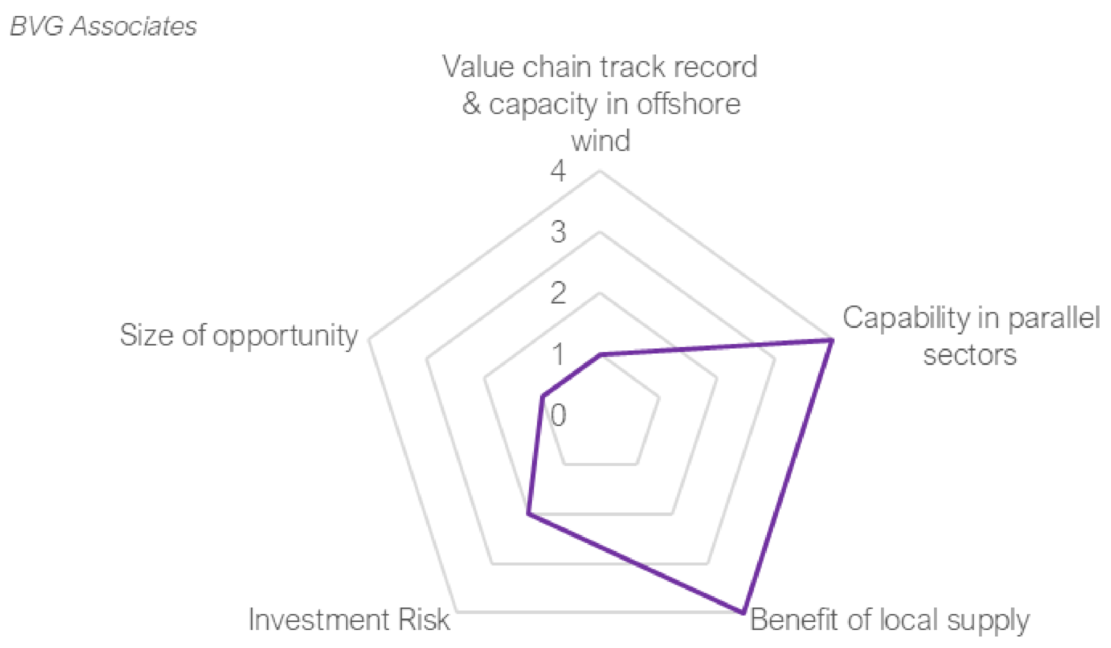

Figure I.25 Operations and maintenance, OMS port assessment.

Table I.26 Value chain assessment –decommissioning services

5.1 Decommissioning services	
Value chain record and capacity in OSW	No Indian companies have experience in OSW decommissioning activities now, but by the time services are required, there will be a mature installation and major repair sector with relevant experience
Capability in parallel sectors	India has some relevant offshore oil and gas decommissioning experience, but entry barriers are high due to the significant investment needed in new vessels, equipment, and OSW specific knowledge.
Benefit of local supply	There is logic for developing local supply to reduce costs.
Investment risk	Significant investment would be required in vessels, lifting equipment, and training to establish a competitive domestic capability, but such investment decisions are likely to have been made in order to serve the installation and major repair markets already, significantly reducing the risk.
Size of opportunity	Decommissioning services represent a score of 4, at 8% of wind farm lifetime expenditure.

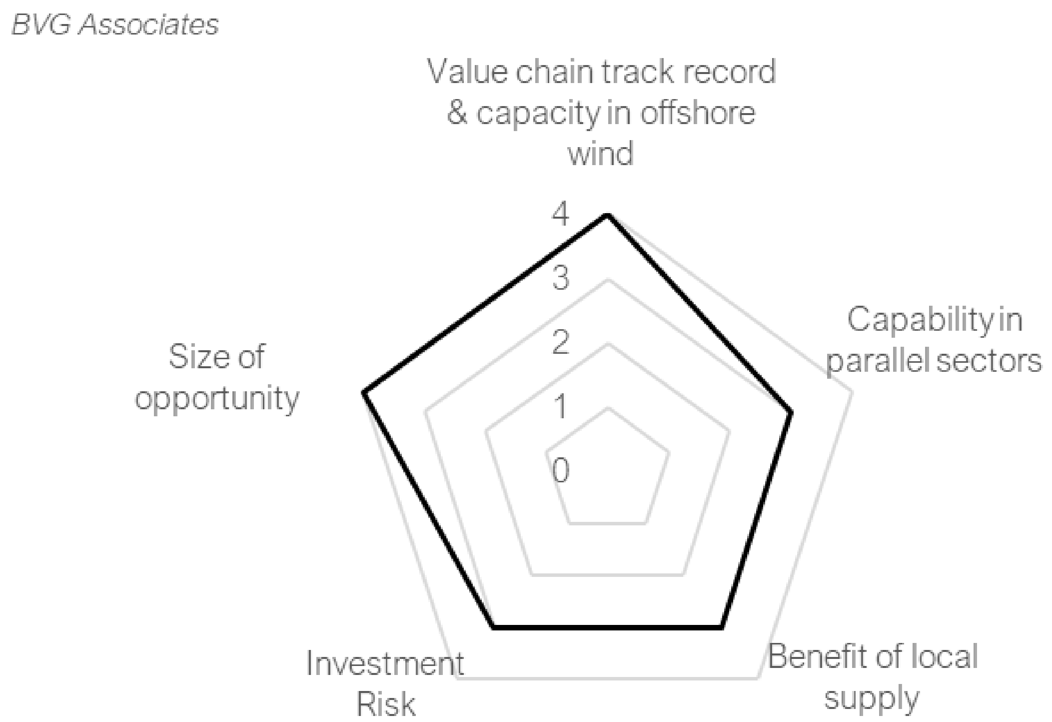

Figure I.26 Decommissioning, decommissioning services assessment.

Appendix J Industry engagement process

The purpose of the stakeholder engagement process was to gather feedback from industry on the development of India's OSW sector and its workforce. This included understanding the challenges and opportunities in preparing a skilled workforce. The engagement ensured that the findings presented in the report reflect jointly developed recommendations from multiple stakeholders in industry.

Engagement approach

Engagement was conducted through workshops, which combined multiple activities:

- Presentation of draft results: BVGA and ClimateHub shared preliminary findings to guide discussions and gather feedback. This covered chapter 1 and chapter 2.
- Panel discussions: training providers and industry representatives shared perspectives on sector challenges, opportunities, and workforce needs. Each session also included a Q&A.
- One-to-one discussions: individual sessions allowed stakeholders to provide detailed feedback on training programmes, regulatory frameworks, and relevant local context-specific items.

All activities were integrated into the workshops to encourage active participation. Two workshops were held:

- Gandhinagar, Gujarat, 23rd September 2025
- Chennai, Tamil Nadu, 25th September 2025.

Stakeholders engaged

Participants included representatives from industry, academia, and development organisations:

- Aban Power Limited
- British High Commission
- Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
- Gujarat Power Corporation Limited (GPCL)
- Gujarat Urja Vikas Nigam Limited (GUVNL)
- Global Wind Energy Council (GWEC)
- Local Governments for Sustainability (ICLEI) South Asia
- Indian Institute of Technology (IIT) Gandhinagar
- Indian Institute of Technology (IIT) Madras
- PwC
- Skills Council for Green Jobs (SCGJ)

Topics of discussion

Key topics discussed included:

- Key job roles in OSW and associated skill requirements
- Current workforce availability and training capacity
- The role of institutions and opportunities for collaboration
- Job creation potential in Tamil Nadu and Gujarat
- Policy and regulatory frameworks influencing sector development.

All feedback and recommendations from these discussions have been documented and are reflected throughout the report.

Appendix K Offshore wind job profiles

Table L.1 provides a detailed description of OSW jobs and associated skills and qualifications. Table L.2 supports by providing detail descriptors related to the NSQF roles. Note that in addition to the qualifications listed, many roles will benefit (or in some cases companies will require) relevant GWO certifications, as listed in Table 2.11.

Table K.1 Detailed description of OSW jobs and associated skills and qualifications.

	Job role	Lifecycle stages	Description	NSQF level	Skills and qualifications typically sought
1	Project director	D, O	Provides strategic leadership, overseeing all aspects of the project from development to decommissioning, ensuring alignment with corporate and national energy objectives.	8–9	NSQF Level 8 competencies and bachelor's degree in engineering (B.Tech/B.E) or related field is required. Level 9 competencies and master's degree (MBA) with PMP certification is strongly desired. Minimum 15 years of project management experience in energy sector.
2	Project manager	D, M, I&C, O	Manages the day-to-day running of the project, including reporting, staff management and financial management. In a manufacturing environment, this includes managing continues improvement or other process development projects.	7	NSQF Level 7 competencies and bachelor's degree in engineering (B.Tech/B.E) or related field is required. Experience: at least 10 years for more senior roles. Preference: Renewable energy.
3	Commercial manager	D, M, I&C, O	Manages commercial and financial aspects of projects and facilities.	7	NSQF Level 7 competencies and bachelor's degree in relevant field related field is required. Experience: at least 10 years for more senior roles.
4	Communications and engagement coordinator	D, I&C, O	Manages public relations and stakeholder engagement, ensuring positive relations with local communities, government agencies, and other stakeholders.	7	NSQF Level 7 competencies and bachelor's degree in in PR/Communications/Journalism or similar relevant field from a reputed institute is required. Should possess a minimum of 5 years' experience handling stakeholder projects independently.
5	Administrative support manager	D, M, I&C, O	Handles office operations, document control, and administrative coordination across project teams and stakeholders	7	NSQF Level 7 competencies and bachelor's degree in Law (LLB) and Company Secretary (CS) is desired.. Completion of Company Secretaryship course (or

					equivalent qualification). 3+ years of experience in corporate secretarial work.
6	Consents manager	D, O	Leads the planning and execution of all permitting and environmental consent processes, coordinating with regulatory bodies to secure the necessary permits and licences, then ensure these are retained.	8	NSQF Level 8 competencies and master's degree (MA, MSc) in environmental science, planning or related field. Extensive experience in either onshore consenting of complex infrastructure projects.
7	Offshore EIA Manager	D	Responsible for managing the EIA process for an offshore wind farm. This includes leading teams to complete the Environmental Impact Assessment Report (EIAR), taking responsibility for the deliverables produced and managing the survey schedule.	8	NSQF Level 8 competencies and master's degree (MA, MSc) in environmental sciences , earth sciences, environmental Engineering or a related environmental discipline. 5 to 10 years of experience on projects experience in the energy sector preferred.
8	Procurement / supply chain manager	D	Manages sourcing and purchasing of equipment and services, ensuring cost efficiency and supplier compliance with project standards.	7	NSQF Level 7 competencies and a bachelor's degree in relevant subject area. A successful record of 10 to 12 years in Procurement / Sourcing / Materials Management with minimum 5 years of experience in handling procurement of wind turbines or other wind industry equipment or services.
9	Financial analyst	D	Assesses the financial viability of projects, monitors costs, and creates financial models to ensure profitability.	7	NSQF Level 7 competencies and a bachelor's degree in finance or related subject is required. 2 years' experience required.
10	Legal counsel	D, O	Provides legal advisory services across all project phases, ensuring compliance with applicable laws and international regulations related to, for example, permitting, contracting and project financing.	7	NSQF Level 7 competencies and a bachelor's degree in Law (LLB) from a reputed institution recognised by the Bar Council of India. At least 10 years of experience.
11	Resource analyst	D	Analyses wind data and models energy production potential to support site selection, financial forecasting, and project optimisation.	7	NSQF Level 7 competencies and bachelor's degree from an accredited university or college in meteorology, atmospheric science, or a closely related field.
12	Bid manager	D	Leads the preparation and submission of developer bids for contracts in development phase.	7	NSQF Level 7 competencies and a bachelor's degree in related subject is required. Minimum 5 years of experience in bid preparation / financial modelling, preferably in the power sector.

13	GIS technician	D	Provides spatial data analysis and mapping support using GIS tools to assist in site selection, environmental assessments, and infrastructure planning.	6	NSQF Level 6 competencies and higher national diploma or bachelors qualification in related subject area. Minimum of 2 years' experience across a broad range of GIS tools, remote sensing techniques, and spatial data management.
14	Oceanographer	D	Assesses ocean currents, wave patterns, and environmental factors to assess the impact of the offshore wind farm on marine environments and its performance.	7	NSQF Level 7 competencies and bachelor's degree in oceanography, marine science or a relevant field. 2 years' experience on field surveys or in a research lab is desirable.
15	Marine ecologist	D	Assesses potential impacts of offshore wind development on marine biodiversity and ecosystems, providing guidance on appropriate mitigation measures.	7	NSQF Level 7 competencies and bachelor's degree in ecology, oceanography, marine science or a relevant field. At least 5 years of experience in the relevant field. Experience in supporting technical assessments for EIA, Habitat Regulation Assessment (HRA) and Water Framework Directives (WFD), planning processes, and ecological assessments.
16	Ornithologist	D	Assesses risks to bird populations, particularly migratory species along India's coast, and supports the design of mitigation practices.	7	NSQF Level 7 competencies and bachelor's degree in ecology, zoology or related subjects. Work experience on field surveys or in a research lab is desirable.
17	Geophysicist	D	Assesses sub-seabed surveys to identify geological risks and inform foundation design and cable routing in offshore zones.	7	NSQF Level 7 competencies and bachelor's degree in a STEM field from a deemed/recognised (AICTE) university or equivalent is required. At least 5 years industry related experience
18	Hydrographer	D	Assesses oceanographic data, including seabed topography and tidal patterns, to support safe and efficient offshore development.	7	NSQF Level 7 competencies and bachelor's degree in marine sciences hydrographic surveying. Minimum 5 years' experience in nearshore and offshore survey covering pre-engineering, pre-construction, post-construction.
19	Electrical engineer	D, M, I&C, O	Designs and manages supply of electrical, SCADA and control systems including within turbines, offshore substations, array cabling, and export system. Supports	7	NSQF Level 7 competencies and bachelor's degree in electrical engineering (B.Tech/B.E) from an AITCTE or UGC recognised university for senior roles. For junior level roles, diploma in electrical engineering is required. A high

			operational reliability. In a manufacturing environment this includes input on facility design and process improvement.		level of experience in Electrical Engineering design environment with lead role in project execution.
20	Civil engineer	D, I&C, O	Manages the design and construction of infrastructure for offshore wind farms, including cable landfall and ports.	7	NSQF Level 7 competencies and bachelor's degree in civil engineering (B.Tech/B.E) from an AITCTE or UGC recognised university for senior roles. For junior level roles, diploma in civil engineering is required. Minimum 5 years of experience.
21	Mechanical engineer	D, M, I&C, O	Responsible for designing and optimising the mechanical systems of an offshore wind farm. They ensure the performance of the wind turbine and foundations are optimised and comply with relevant trade standards. In a manufacturing environment this includes input on facility design and process improvement.	7	NSQF Level 7 competencies and bachelor's degree in mechanical engineering (B.Tech/B.E) from an AITCTE or UGC recognised university for senior roles. For junior level roles, diploma in mechanical engineering is required. Minimum 5 years of experience.
22	Geotechnical engineer	D	Assesses seabed conditions to determine suitable foundation types, designs and installation methods.	7	NSQF Level 7 competencies and bachelor's degree (B.Tech/B.E) in geotechnical engineering or related field from an AITCTE or UGC recognised university for senior roles. A strong foundation in civil engineering and soil mechanics is required and a minimum 5 years of experience.
23	Structural engineer	D, M	Designs turbine towers, foundations, and substation topsides to withstand wind, wave, and operational loads, working with other engineers to ensure structural integrity	7	NSQF Level 7 competencies and bachelor's degree in civil engineering (B.Tech/B.E) from an AITCTE or UGC recognised university for senior roles. Along with master's degree (MTech/M.E) in structural engineering or related field. Minimum 5 years of experience.
24	CAD technician	D, M	Prepares detailed technical drawings and CAD models of turbine and balance of plant components and manufacturing layouts for use by engineering and production teams	6-7	NSQF Level 6-7 competencies and graduate diploma or bachelor's degree in drafting or design engineering, marine engineering, or related field. Software proficiency in AutoCAD, SolidWorks, or similar 3D modelling platforms.
25	Manufacturing manager	M	Leads overall manufacturing operations, overseeing planning of production, resource allocation, and component delivery.	8	NSQF Level 8 competencies and master's degree in a relevant field for example industrial engineering, manufacturing engineering or business management.

					Minimum of 10 years of experience in a manufacturing environment with staff management responsibilities.
26	Production / team supervisor	M, I&C, O	Supervises day-to-day manufacturing and site operations, ensuring welfare and production targets and quality standards are met.	5-6	NSQF Level 5-6 competencies and an advanced certificate, diploma or graduate diploma in relevant subject area. Minimum 2 years' experience in a manufacturing environment.
27	Production operative	M	Performs hands-on manufacturing tasks such as material handling, component preparation and assembly. Role is similar to that of electrical and mechanical technician but based in manufacturing facilities.	3	NSQF Level 3 competencies, and t 2 years' experience working in manufacturing environment is desired and in some cases required.
28	Process coordinator	M	Coordinates and improves manufacturing processes to increase efficiency and ensure consistent product quality. Includes quality control / non-destructive testing under management of quality manager and scheduling under production supervisor / manufacturing manager.	4	NSQF Level 4 competencies, and 2 years' experience working in manufacturing environment is desired and in some cases required.
29	Equipment service technician	M, I&C, O	Conducts routine inspections and repairs on equipment (tooling) used for manufacturing, installation and operation.	4	NSQF Level 4 competencies and ITI or polytechnic diploma or equivalent in a relevant subject area such as electrical or mechanical engineering or science.
30	Machine operator	M	Operates and monitors machines used in the manufacturing facility, following detailed specifications and safety procedures.	3	NSQF Level 3 competencies and 2 years' experience in machine operating activities in a high-quality manufacturing environment.
31	Blasting and coating technician	M	Prepares the surfaces of wind turbine components using abrasive blasting and applies protective coatings (e.g., anti-corrosion paints) to offshore component to ensure durability in harsh marine environments	4	NSQF Level 4 competencies and experience working with wind turbines components within manufacturing environment and/or offshore marine structures from the energy sector.
32	Quality manager	M	Develops and enforces quality assurance protocols throughout the manufacturing process. Includes lead and other supervisory quality staff.	7	NSQF Level 7 competencies and bachelor's degree in related subject area. Knowledge of Integrated Management Systems (IMS), including standards such as ISO 9001 (Quality Management), ISO 14001 (Environmental Management), and ISO 45001 (Occupational Health and Safety Management). Level II

					certification in Non-Destructive Testing, with specialization in Ultrasonic Testing, Magnetic Particle Inspection, Liquid Penetrant Testing, and Visual Testing. More than 10 years of experience in a relevant field such as engineering, safety, wind energy, or manufacturing.
33	Health and safety manager	D, M, I&C, O	Implements and monitors health, safety, and environmental (HSE) protocols, ensuring legal compliance and worker safety.	7	NSQF Level 7 competencies and bachelor's degree in related subject. Post-graduate degree in in Industrial Safety or related subject is desirable. A minimum of 5 years' experience in health, safety, and environmental roles is also required.
34	Welder	M	Joins metal components using various welding techniques to fabricate or repair offshore wind components such as towers, frames, and support structures.	4	NSQF Level 4 competencies and experience working with large structures within a high-quality manufacturing environment.
35	Site manager	I&C, O	Manages on-site activities, ensuring that installation and construction work is completed safely, on time, and according to the project plan.	7	NSQF Level 7 competencies and bachelor's degree in related subject. Minimum 10 years' experience in project and team management in a relevant industry.
36	Crane operator	I&C, O	Operates cranes to move wind turbine and balance of plant components. Also, vessel-based role to install components.	5	NSQF Level 5 competencies, stage 3 offshore crane operator certification and 5 years' experience in marine heavy lift crane operations.
37	Crane and rigging inspector	I&C, O	Inspects cranes and rigging equipment used for installation to ensure safety and functionality.	5	NSQF Level 5 competencies, and 5 years' experience working with associated equipment in a marine industry.
38	Port / transport operative	I&C	Responsible for providing day-to-day component and equipment logistics around the port.	3	NSQF Level 3 competencies and 2 years' experience in heavy goods / port logistics.
39	Logistics coordinator and manager	I&C, O	Organises the transportation of wind turbines, balance of plant, materials, and personnel to the offshore site, ensuring efficient and timely delivery.	6	NSQF Level 6 competencies and higher national diploma or bachelor's degree in related subject area such as engineering, business management, logistics or similar field. Minimum of 5 years of experience.
40	Stores / warehouse operative	M, I&C, O	Oversees storage and inventory of spare parts, tools, and equipment used in construction. Ensures timely dispatch and procurement aligned with maintenance needs.	3	NSQF Level 3 competencies and 2 years' experience of materials. inventory control and logistics. Computer literate especially in EXCEL desired.

41	Offshore commissioning supervisor	I&C	Leads testing and start-up of wind farm components and electrical systems to verify performance before commissioning. Works with OEMs and contractors to resolve issues.	6	NSQF Level 6 competencies and higher national diploma or equivalent in an engineering discipline. Minimum 8 years' experience in the onshore wind or offshore oil or marine industry.
42	Senior Authorised Person (SAP)	I&C, O	Responsible for ensuring the safe operation, maintenance, and management of high-voltage (HV) electrical systems. This includes overseeing and authorising switching operations, isolations, and the safety of personnel working on high-voltage equipment such as substations, transformers, and electrical circuits.	6	NSQF Level 6 competencies and higher national diploma or equivalent in a relevant electrical subject area. HV authorised persons (HVAP) course. Minimum 5 years of experience working with HV switchgear.
43	Electrical technician	I&C, O	Assembles, installs and maintains and repairs electrical components and systems across all offshore wind farm components including turbines and balance of plant equipment.	4	NSQF Level 4 competencies and ITI or polytechnic diploma or equivalent in a relevant subject area such as electrical engineering or science. Experience with onshore wind preferable if role is offshore..
44	Mechanical technician	I&C, O	Assembles, installs, maintains, and repairs mechanical components and systems across all offshore wind farm components including turbines and balance of plant equipment.	4	NSQF Level 4 competencies and ITI or polytechnic diploma or equivalent in a relevant subject area such as mechanical engineering or science. Experience with onshore wind preferable if role is offshore.
45	Jointing and testing engineer	I&C	Responsible for managing electrical jointing and testing of cables during installation.	7	NSQF Level 7 competencies and bachelor's degree in engineering field (B.Tech/B.E) from an AITCTE or UGC recognised university. 5 years 'of experience from testing environment and/or power engineering.
46	Communications network technician	I&C, O	Installs and maintains communication systems that link turbines, substations, and control centres, including SCADA systems. Ensures reliable data and voice connectivity across offshore and onshore assets.	4	NSQF Level 4 competencies and ITI or polytechnic diploma or equivalent in a relevant field such as network infrastructure, systems engineering, computer science is required. 2 years' experience as a communications network technician in a relevant environment preferable.
47	Carousel operator	I&C	Manages and operates the cable carousel system used to store and deploy subsea cables during installation	4	NSQF Level 4 competencies, and 3 years' experience working with associated equipment in a marine industry.
48	Tension operator	I&C	Operates tensioning equipment during cable laying to maintain optimal tension and prevent damage.	4	NSQF Level 4 competencies, and 3 years' experience working with associated equipment in a marine industry.

49	Operations supervisor	I&C	Supervises all heavy lifting operations during installation. Also, vessel-based ole.	5-6	NSQF Level 5-6 competencies and an advanced certificate, diploma or graduate diploma in related subject area such as engineering, business management, logistics or similar field. Minimum of 5 years of experience, ideally in onshore wind.
50	Vessel supervisor	I&C, O	Oversees daily operations on offshore support vessels, ensuring safe transport of personnel and equipment. Coordinates with marine crews and offshore teams to maintain operational schedules	5-6	NSQF Level 5-6 competencies and an advanced certificate, diploma or graduate diploma in relevant discipline. 5 years' experience within ports / vessel logistics.
51	Control room supervisor	O	Manages monitoring of turbine performance and grid connection from the onshore or offshore control room. Responds to faults and coordinate remote troubleshooting and dispatch.	6	NSQF Level 6 competencies and higher national diploma or equivalent in relevant engineering discipline (electronics & communication/ Electrical & electronics. Preferable to have certifications in the field of information security / TSCM. At least 5 years of experience in a leadership role in a similar position for large-sized organization. Onshore wind experiences valuable.
52	IT manager	D, I&C, O	Manages the IT infrastructure for onshore and offshore wind farm operations.	6	NSQF Level 6 competencies and higher national diploma or equivalent in IT or computer related discipline. Minimum 3 years' experience in IT Service Desk role, providing in situ technical support as well as remote support using remote desktop tools. Certifications on Microsoft and Cisco products desired.
53	Rope access and blade repair technician	O	Inspects and repairs wind turbine blades for wear, cracks, and structural damage. Uses specialized tools and resin materials, often working via rope access.	4	NSQF Level 4 competencies ITI or polytechnic diploma in a relevant subject area such as mechanical engineering, science. More than 5 years' of hands-on experience in composites and epoxy blade repairs. GWO and rope access certification. Onshore wind experiences an advantage.
54	Vessel maintenance technician	I&C, O	Maintains offshore transfer vessels and crew boats, including engines, navigation systems, and safety gear.	4	NSQF Level 4 competencies and ITI or polytechnic diploma or equivalent in a relevant subject area such as

			Ensures reliability and seaworthiness for daily operations. This is primarily onshore based role.		mechanical engineering, marine engineering, science or equivalent experience in marine maintenance.
55	ROV technician	O	Operates ROV's to perform tasks like inspection, maintenance, and repair of offshore wind farm structures, cables, and equipment.	5	NSQF Level 5 competencies and higher national certificate or equivalent in a relevant subject area such marine engineering, science or equivalent experience in marine maintenance. Minimum of 6 to 12 months of formal mechanical and hydraulic training, or combination of education and experience.
56	Vessel master's mate	O	Assists the vessel master in navigation, safety, and operations during offshore wind farm activities.	3	NSQF Level 3 competencies and minimum of 5 years of experience working offshore, ideally in oil & gas.
57	Harbour pilot	O	Guides vessels safely into and out of ports, ensuring manoeuvring complies with local marine conditions	5	NSQF Level 5 competencies and higher national certificate or equivalent in a relevant subject area. Licensed by the USCG (or other recognized regulatory body) and be Unlimited Tonnage rated or have prior Navy experience with NEC 0215 qualifications and have had an exemplary record as a Navy Pilot. Shall possess a Special Background Investigation (SBI), secret clearance.
58	Data analyst	O	Analyses turbine performance, weather, and maintenance data to optimize wind farm operations	6-7	NSQF Level 6-7 competencies and higher national diploma, bachelor's degree or equivalent in meteorology, statistics, or engineering - or a closely aligned discipline. Experience in relevant latest industry tools, depending on discipline.
59	Marine coordinator	I&C, O	Manages vessel scheduling, marine traffic, and offshore personnel logistics to ensure smooth operations. Coordinates between marine crews, technicians, and control rooms.	6	NSQF Level 6 competencies and qualification in marine engineering, mechanical engineering, or a related field. 5 years' experience in marine service operations, with leadership experience preferred. Expertise in marine engines, PLC systems, hydraulics, and electrical systems. Certifications: STCW, Marine Engineering licenses, or relevant industry certifications are a plus.

60	Stores / warehouse manager	M. O	Oversees storage and inventory of manufacturing / spare parts, tools, and equipment. Ensures timely provision aligned with needs.	5-6	NSQF Level 5-6 competencies and an advanced certificate, diploma or graduate diploma and minimum of 5 years of experience working warehousing and storage of high-value items..
61	Crew manager	I&C, O	Manages offshore personnel schedules, certifications, and welfare. Ensures proper crew rotation and compliance with labour and safety regulations.	5-6	NSQF Level 5-6 competencies and an advanced certificate, diploma or graduate diploma and 5 years maritime or shipping industry experience.
62	Asset integrity manager	O	Monitors the structural and operational health and reliability of wind farm assets, including turbines, foundations, and cables. Leads inspection programs and long-term maintenance planning.	7	NSQF Level 7 competencies and bachelor's degree in engineering or mathematics field. Experience in the onshore wind valuable.

Table K.2 Detail of generic descriptors for National Skills Qualifications Framework levels.

NSQF level	Generic role	Process	Professional knowledge	Professional skill	Core skills	Responsibility
1	Helper / assistant labourer	Routine and repetitive tasks	Basic awareness; no formal theory	Limited; basic manual tasks	Basic communication and counting	Works under close supervision
2	Semi-skilled worker / junior operator	Simple tasks with some variety	Limited factual knowledge	Uses tools with guidance	Basic literacy and numeracy	Works under supervision with some autonomy
3	Skilled technician / operator	Predictable tasks requiring some judgment	Basic theoretical knowledge	Applies known procedures	Communicates clearly; uses basic IT	Responsible for own work
4	Senior technician / supervisor	Tasks requiring interpretation and choice	Broad factual and theoretical knowledge	Selects and applies procedures	Communicates with clarity; uses IT tools	Works independently with some responsibility for others
5	Foreman / team leader / junior engineer	Tasks requiring problem-solving and planning	Detailed theoretical and practical knowledge	Applies judgment in varied contexts	Presents information; uses digital tools	Supervises others; accountable for outcomes
6	Engineer / senior supervisor	Complex tasks requiring analysis and decision-making	Specialized knowledge in a field	Develops solutions; adapts procedures	Analytical communication; advanced IT use	Manages teams; responsible for quality and safety
7	Senior engineer / technical specialist / manager	Broad range of complex tasks; strategic planning	Advanced theoretical and practical knowledge	Innovates and evaluates solutions	Synthesizes information; professional communication	Full responsibility for projects and teams
8	Principal engineer / senior manager	Highly specialized tasks; research and innovation	Expert knowledge; integrates theory and practice	Designs new approaches; critical evaluation	Research-level communication and analysis	Leads innovation; responsible for strategic outcomes
9	Research scientist / technical director	Original research; highest-level project leadership	High level of theoretical and applied knowledge	Creates new knowledge; sets direction and culture of large teams	Scholarly communication; advanced synthesis; large team motivation and leadership	Leads research; full accountability for project delivery
10	Chief scientist / Industry expert	Groundbreaking research and leadership	Highest level of theoretical and applied knowledge	Develops new paradigms, initiates new markets	Thought leadership; policy-level communication	Leads national/international initiatives; full accountability for market delivery

About BVG Associates

BVG Associates is an independent renewable energy consultancy focussing on wind, wave tidal, and energy systems. Our clients choose us when they want to do new things, think in new ways and solve tough problems. Our expertise covers the business, economics and technology of renewable energy generation systems. We're dedicated to helping our clients establish renewable energy generation as a major, responsible and cost-effective part of a sustainable global energy mix. Our knowledge, hands-on experience and industry understanding enables us to deliver you excellence in guiding your business and technologies to meet market needs.

- BVG Associates was formed in 2006 at the start of the OSW industry.
- We have a global client base, including customers of all sizes in Europe, North America, South America, Asia and Australia.
- Our highly experienced team has an average of over 10 years' experience in renewable energy.
- Most of our work is advising private clients investing in manufacturing, technology and renewable energy projects.
- We've also published many landmark reports on the future of the industry, cost of energy and value chain.

About ClimateHub

ClimateHub India Advisors LLP is an innovative advisory firm focused on renewable energy and climate action, committed to advancing sustainable energy solutions across diverse industries. The company harnesses cutting-edge renewable technologies to assist clients in reducing their environmental footprint. With a team of skilled engineers, scientists, and policy analysts, ClimateHub tailors its services to meet specific energy needs, ensuring compliance with complex regulations while optimizing cost-efficiency. At its core, the firm champions the transition to clean energy, driving sustainability through strategic consulting, research, and project management, underscored by a deep commitment to fostering a sustainable future through renewable energy innovations.

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