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Economic impact of the La Gan offshore wind Project

A report for Copenhagen Offshore Partners (extract version)

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BVGassociates

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- BVG Associates was formed in 2006 at the start of the offshore wind 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 supply chain.

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Executive summary

The La Gan project is a 3.5GW offshore wind project currently in development off the coast of the Binh Thuan province of Vietnam. The project development is being led by Copenhagen Offshore Partners (COP) on behalf of Copenhagen Infrastructure Partners and the project owners.

The project will provide significant benefits to Vietnam. For the baseline scenario examined, which assumes some additional investment into the Vietnamese offshore wind industry, the La Gan project is projected to provide the following benefits:

- Contribution of over US$9 billion to the Vietnamese economy over the project lifetime. The most significant contributions are from the development of the wind farm, foundations supply, onshore transmission supply and operations and maintenance. In all these areas Vietnam has strong expertise, meaning that local suppliers can be utilised more heavily.
- The project is expected to create over 130,000 Full time equivalent (FTE) jobs including 45,880 direct FTE jobs in Vietnam. 1 FTE is defined as a full time equivalent job over 1 year
- The total Vietnamese content is projected to be 44.1% across the full supply chain.
- About 250 TWh of energy will be generated over the project lifetime. The fully constructed 3.5GW wind farm could power about 7 million households per year.[1]
- 130 million tonnes of CO_2 emissions avoided over the project lifetime.[2]

The market associated with this scenario and level of investment is about equivalent to 25GW of Vietnamese offshore wind projects by 2035.

This report examines the economic impact of the project, investigating the benefit that the project could deliver to the Vietnamese economy.

To strengthen our analysis, we interviewed 13 companies active in the Vietnamese offshore wind supply chain, who were chosen for their expertise and track record. These companies, categorised according to their main area of expertise, are shown in Figure 1.

From these interviews and our previous work in this area we built up a narrative of which goods and services in the supply chain could be supplied by Vietnamese companies. We then calculated the following economic metrics over the full project lifecycle:

- Vietnamese content: the proportion of the offshore wind goods and services supplied by Vietnamese companies.
- Gross-value added (GVA): a measure of the contribution of the La Gan project to the gross domestic product (GDP) of Vietnam.
- Full time equivalent (FTE) year jobs: One FTE year is defined as a full-time equivalent job for one year, with part-time or part-year work considered as appropriate.

The metrics included:

- Direct impacts: those associated with the activity of developers and their major contractors
- Indirect impacts: those associated with the suppliers to the developer or its major contractors, and
- Induced: those associated with the personal spending of the direct and indirect workforce.

We examined a “business as usual” scenario, assuming minimal additional investment in Vietnam and a “baseline” scenario which assumed a higher level of investment into the offshore wind industry.

Table 1 and Table 2 show the results for the baseline scenario. These are also presented across the full project lifecycle in Figure 2 and Figure 3 for the type of impact (direct, indirect or induced). We calculated that the La Gan project could provide over $9 billion GVA for the Vietnamese economy through the creation of over 130,000 FTE years.

[1] Assuming 45% net capacity factor and 2,000 kWh consumed per year per home in Vietnam in 2033.

[2] Assuming 500 tonnes/GWh is produced by the equivalent capacity of fossil fuels

Figure 1 The suppliers that participated in the study, categorised according to their main area of expertise in offshore wind.

Table 1 **Vietnamese gross-value added (GVA) and number of full time equivalent (FTE) jobs for the La Gan project baseline scenario, categorised by type of impact (direct, indirect and induced).**

Impact	GVA	Number of FTE jobs
Direct	$4,459 million	45,880
Indirect	$2,803 million	49,950
Induced	$1,932 million	38,790
Total	**$9,194 million**	**134,620**

Table 2 Vietnamese GVA and number of FTE years for the La Gan project baseline scenario, categorised by supply chain category).

Supply chain category	GVA	Number of FTE years
Development and project management	$880 million	13,260
Turbine	$442 million	7,960
Foundation supply	$646 million	12,250
Array cable supply	$0 million	0
Export cable supply	$83 million	1,470
Onshore and offshore substation supply	$1,232 million	22,440
Operational infrastructure	$185 million	4,050
Installation and commissioning	$943 million	18,550
Operations, maintenance and service	$4,134 million	46,410
Decommissioning	$651 million	8,220
Total	**$9,194 million**	**134,620**

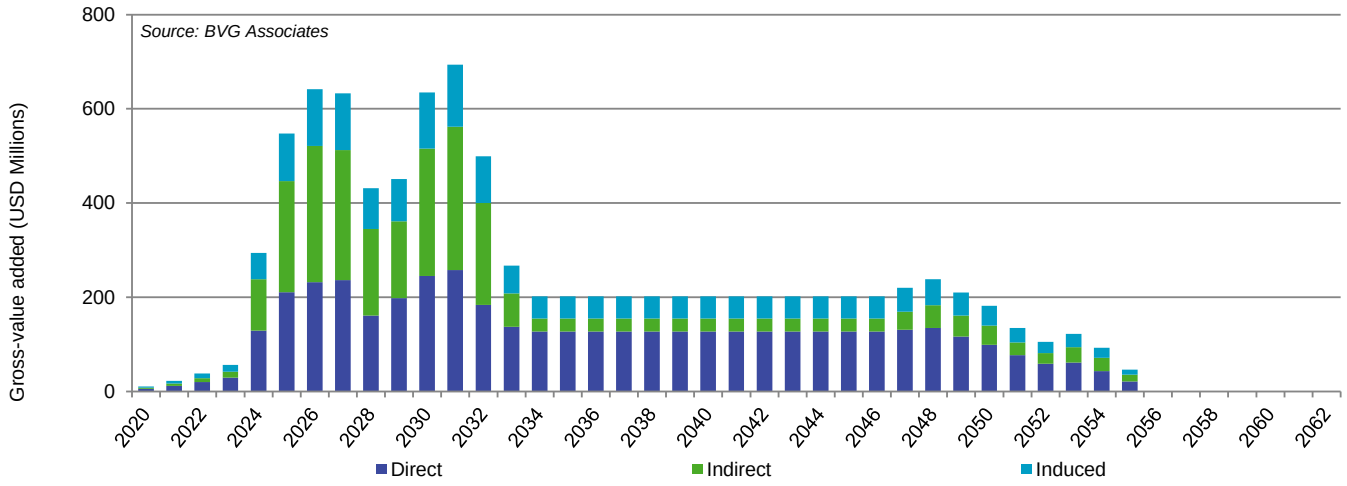

Figure 2 Vietnamese gross-value added (GVA) for the baseline scenario, split into direct, indirect and induced jobs.

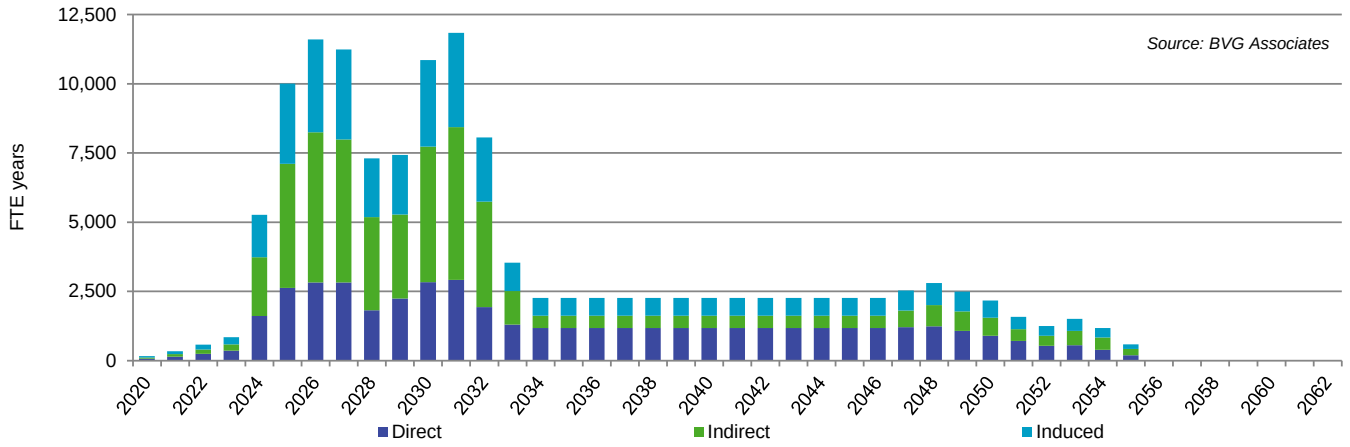

Figure 3 Vietnamese full-time equivalent (FTE) jobs for the baseline scenario, split into direct, indirect and induced jobs. 1 FTE is defined as a full time equivalent job over 1 year.

1. Introduction

The La Gan project is an offshore wind project currently being developed in Vietnam. It is anticipated to be one of the first large scale offshore wind farms in the country, with a potential capacity of 3.5GW that will be constructed in several phases. Copenhagen Offshore Partners (COP) is leading the development of the project on behalf of Copenhagen Infrastructure Partners (CIP) and the project owners.

COP invited BVG Associates (BVGA) to undertake an economic impact analysis. The La Gan project is attracting political attention, and a key challenge for the project partners will be communicating the employment impacts of the project. It is important to demonstrate the benefits to encourage and maintain positive discussions between the project partners and La Gan stakeholders (for example the Vietnamese government).

The aim of this study is to assess the economic impact of the project by calculating the following indicators:

- Annual and total employment created by all phases of the project, from project development to decommissioning, and
- Annual and total gross value added (GVA) for all project phases.

By sharing these results with relevant stakeholders, the project owners will be able to hold positive discussions and build the healthy relationships that are key for streamlining the project.

2. Methodology

Given the uncertainties concerning industrialisation of offshore wind in Vietnam, we analysed two market scenarios:

- A baseline scenario, in which there is significant, but realistic, expansion of offshore wind and new investment in Vietnam. Investment will be in building new facilities as well as upgrading existing ones. In this scenario, a total of 25GW of offshore wind capacity would be installed by 2035, accounting for 12% of the Vietnamese electricity needs.
- A business as usual scenario, in which there is moderate expansion of offshore wind and limited new investment in the Vietnamese offshore supply chain. Investment will be in upgrading existing facilities with little, if any, new facilities constructed. In this scenario, a total of 11GW of offshore wind capacity would be installed in Vietnam by 2035, accounting for 5% of the Vietnamese electricity needs.

The were devised by BVG Associates, based on a forecast of the Vietnamese offshore wind industry. They align with the market growth predicted by the World Bank and Danish Energy Authority, which believe that Vietnam could install up to 10GW of offshore wind capacity by 2030.[3] In April 2020, the Ministry of Industry and Trade announced plans to install 11.6GW by 2025, significantly more than the 2GW stated in the current power development plan.[4] Soon it is expected that the government will launch its new power development plan (Power Development Master Plan 8) which will provide clarity on this issue.

In both scenarios, other Asian countries will be seeking to develop their supply chains and have first-mover advantage for some components. They consider the timing of the La Gan project and the lead times for investment.

The study was split into four tasks:

1. Model set up and data gathering
2. Interviews with Vietnamese suppliers and global suppliers with an ambition to supply the Vietnamese market
3. Supply chain narrative, which defined the potential for Vietnamese suppliers to contribute to the project for each scenario, and
4. Economic impact analysis, including calculation of Vietnamese local content proportion, GVA and Vietnamese jobs created by the project.

2.1. Model development and data gathering

The project owners envisage the La Gan project being made up of two procurement phases, with capacity built out over seven years.

Messages on socioeconomic impacts are most powerful if they include where in the supply chain the money is spent and the jobs are created. Hence, the supply chain was broken into 19 categories covering the full lifecycle: from development to decommissioning. The project partners provided cost estimates for each year of the project for each category.

Initial estimates of Vietnamese salary levels and jobs created across the supply chain were informed by a previous study for the World Bank in 2020, which examined the Vietnamese offshore wind market and provided a strategic vision outlining how it would develop in the future.[5]

2.2. Industry engagement

The aim of this task was to improve on existing data and knowledge of the Vietnamese supply chain and reduce uncertainty by interviewing relevant suppliers. This ensured that we could create an accurate narrative and economic impact model.

The estimates were enhanced using new data and insight gained from engagement in the Vietnamese supply chain, as discussed in the next section. Because this study is based on the anticipated costs and supply chain of the project partners, it is more accurate than the study undertaken for the World Bank.

[3] 'World Bank sets out 10GW offshore vision for Vietnam', *Renews*, September 2020, available online at: https://renews.biz/63287/vietnam-could-build-10gw-offshore-wind-by-2030/#:~:text=Vietnam%2520could%2520potentially%2520bring%2520online,develop%2520an%2520offshore%2520wind%2520sector., last accessed January 2021.

1. [4] 'Vietnam approves 7 GW of wind energy projects', *REVE*, June 2020, available online at: https://www.evwind.es/2020/06/29/vietnam-approves-7-gw-of-wind-energy-projects/75395 last accessed January 2021.

[5] Offshore wind roadmap for Vietnam, World Bank Group (2020)

We interviewed 13 suppliers (see Table 5). The companies were selected based on their reputation and industry presence, capabilities and interest in the Vietnamese market. They cover multiple parts of the supply chain and are a combination of Vietnamese and international organisations. They were chosen to provide the most insight and provide knowledge in the most uncertain areas.

Table 3 Suppliers that were interviewed.

Company name	Main area of supply chain	Location	Services provided	Potential services
Northern Center of Planning and Investigation of Marine Resources	Development	Vietnam	Site assessment/surveys	
NIRAS	Development	International (Denmark)	Site assessment/surveys	
GE	Turbine	International (US)	Turbine supplier	
MHI Vestas Offshore Wind	Turbine	International (Denmark)	Turbine supplier	
CS Wind	Tower and Foundation	Vietnam (tower factory), international organisation (South Korea)	Tower supplier, foundation transition piece, jacket pin piles	Foundation supplier
Alpha ECC	Foundation	Vietnam	Turbine foundation supplier, offshore substation topside and foundation	
PetroVietnam Technical Services Corporation Mechanical & Construction (PTSC M&C)	Foundation	Vietnam	Turbine foundation supplier, offshore substation topside and foundation	
Vietsovpetro	Foundation	Vietnam	Turbine foundation supplier, offshore substation foundation supply	Foundation installation, offshore substation topside
LSVINA Cable & System	Cables	International (South Korea)	Cable supplier (array, export and onshore), cable installation	
DEME Group	T&I	International (Belgium)	Wind farm construction	
Jan De Nul Group	T&I	International (Belgium)	Wind farm construction	
Semco Maritime	Transmission	International (Denmark)	Offshore and onshore substation supplier	
Power Engineering Consulting Joint Stock Company 2 (PECC2)	Transmission	Vietnam	Onshore substation supplier, grid integration, onshore cable supply and install	Offshore substation design and construction

We discussed:

1. The products and services the company would offer the Vietnamese market
2. The products and services in the offshore wind supply chain could be sourced from Vietnam
3. The number of local jobs likely to be used to supply these products and services and relative labour costs
4. How the situation could change over time, as the offshore wind market in Vietnam grows.

We took detailed meeting minutes, and some participants sent through additional materials containing useful information. Meeting minutes were sent back to the supplier to check, to ensure the conversation has been accurately captured.

We brought all the available information together and used it to formulate the supply chain narrative and economic impact analysis.

2.3. Supply chain narrative

Using our knowledge of the Vietnamese supply chain and the insight gained through the engagement exercise, we built a picture, or narrative, of the products and services that could be supplied locally or nationally.

This process was informed by:

- The project partners' intentions for the project
- The local and national economic and infrastructure strengths
- Specific known supplier capabilities, and
- The logistical benefits of sourcing locally or nationally.

The narrative is based on the supply chain categories from **Error! Reference source not found.**.

2.4. Economic impact analysis

Using our model and the data gathered, we then calculated the annual employment created by all phases of the project, distinguishing between direct and indirect jobs. We also calculated the GVA over the project lifetime.

Conventional analyses typically use multipliers based on data collected by governments and other organisations, which is structured around industrial sectors.[6] New industries such as offshore wind are not included, which presents methodological challenges. Our approach is to develop multipliers from first principles based on our own, detailed knowledge of the industry.

The outputs of our analysis were the amount of Vietnamese content in each supply chain category, the number of FTE jobs created and the GVA generated over the full project lifecycle. These results are presented in Section **Error! Reference source not found.**.

The metrics included:

- Direct impacts: those associated with the activity of developers and their major contractors
- Indirect impacts: those associated with the suppliers to the developer or its major contractors, and
- Induced: those associated with the personal spending of the direct and indirect workforce.

[6] See, for example data from the Asian Development Bank: https://data.adb.org/dataset/viet-nam-input-output-economic-indicators

3. Results

3.1. Supply chain narrative

This section describes the potential for Vietnamese companies to supply products and services across the full supply chain.

Surveys and studies

Vietnam's first offshore (mainly intertidal) wind farms have had Vietnamese developers and used local supply chains for survey and engineering studies. These will have been active in other maritime sectors such as shipping and oil and gas. Examples are PTSC and Vietsovpetro.

There are benefits of using a local supply chain during development because these companies will have a good understanding of relevant Vietnamese regulations and local companies can minimise logistics and labour costs. The barriers to entry are low, with investments mainly in skills to meet the needs of offshore wind.

As the industry developers, in both market scenarios, global developers are likely to become increasingly involved, in many cases partnering with local developers. The development supply chain is likely to remain mostly Vietnamese, although global developers are likely to use specialist engineering firms active in more established markets. Many of these firms will build a local presence in the high market scenario.

Vietnamese companies can do the majority of offshore surveys, including:

- Geophysical and hydrographic surveys
- Ornithological surveys and marine mammal monitoring, and
- Community impact studies and stakeholder engagement.

Some expertise is sourced from outside Vietnam to take account of specific offshore wind aspects. There are Vietnamese vessels suitable for geotechnical surveys, however international vessels and crews are typically preferred to ensure quality and alignment with international health and safety standards.

There are vessels within Vietnam that can carry out the surveys required for offshore wind, for example NIRAS use the Vietnamese Petroleum Institute (VPI-CPSE) for environmental surveys. Most of the work can be done by Vietnamese companies. CPIM uses Vietnamese oil and gas vessels for most surveys, taking advantage of low rates when the market is quiet. Vietnam does not have geotechnical survey vessels and there is a role for international companies such as Fugro. There are Vietnamese companies that know the environment and metocean conditions well, and Vietnamese content is therefore high.

There are some aspects where international labour is preferred; these include archaeological studies, navigational risk assessment and landscape studies. Here, the Vietnamese market has less experience, and the work tends to involve heavy data analysis rather than taking measurements in the field. It is relatively straightforward to undertake the work remotely.

Foreign companies can do offshore surveys in Vietnam for studies and research, but not for commercial work. Also, removal of unexploded ordinance from the sea bed must therefore be done by the Vietnamese military. It is unclear how these regulations might change into the future; easing of these restrictions could allow international companies to get more directly involved in survey activities without needing to partner with local firms.

While local companies are involved in surveys, the development process can be coordinated from outside Vietnam. For example, NIRAS manages its development activities from Taipei with some staff operating from its Vietnamese office. They are subcontracting about half of the surveys and field work to Vietnamese suppliers.

Business as usual scenario

All surveys are done by Vietnamese companies with exceptions such as geotechnical surveys, archaeological studies, navigational risk assessment and landscape studies.

Baseline scenario

As this work has begun for Vietnam, the baseline scenario is the same as the business as usual scenario.

Turbine

With the involvement of global developers, we anticipate that Vietnamese wind farms will use turbine suppliers that dominate the European and US markets, since these are likely to offer the lowest cost of energy.

Nacelles and hubs

Vietnam has no turbine assembly facilities and the turbines for Vietnam's first offshore wind projects have been onshore products from global suppliers.

As east Asian markets develop, global turbine suppliers will see value in localising their activities. This will reduce transport costs, although decisions are likely to be driven by capacity constraints at existing factories. Local content requirements may also bring forward decisions to localise. At the same time, suppliers are cautious, as their nacelles and hubs have complex supply chains and components that are critical to turbine performance and reliability. The risks of localising the supply chain are therefore high.

Political and market considerations have driven investment in nacelle assembly factories by Siemens Gamesa and MHI Vestas in Taiwan, and GE is committed to a factory in

Guangdong province China. It is likely that this decade, leading wind turbine suppliers will each only establish one set of facilities in east Asia. The opportunity for Vietnam is most likely to come in the supply chain, for example low voltage internal cabling for all turbine suppliers, where it has existing strengths.

There are some examples of components that the major suppliers manufacture in Vietnam. For example, GE manufactures some electrical equipment, notably some generator parts for the Haliade X in Haiphong, which are shipped abroad for assembly. This is a small part of the overall turbine, with more production taking place in China. We do not expect this part of the supply chain to grow in Vietnam as new factories are expensive and unnecessary because parts can be moved relatively easily by road.

Blades

Vietnam has no blade production facilities. The transport costs of blades are high, and manufacture is relatively easy to localize as its supply chain is mostly materials from commodity suppliers. The benefits of local supply of these commodities are much lower than for the finished blade. Given the growing offshore wind market in the region, global turbine suppliers are likely to invest in east Asian manufacturing facilities if they have confidence in their future order pipeline. MHI Vestas and Siemens Gamesa have made commitments to Taiwan and the opportunity for Vietnam is most likely to come from the supply of composite materials. For example, Triac Composites and An Viet Long supply carbon fiber products, although we are not aware of any Vietnamese materials being used currently.

A blade factory would cost approximately €150 million, assuming two blade moulds, and support about 700 jobs. There would need to be a strong pipeline of projects to support such an investment, which we do not foresee for the timescale of the La Gan project.

Towers

CS Wind has a tower production facility in the south of Vietnam, which currently supplies towers to the onshore market. The facility has river access and is close to a port, so CS Wind could look to use this for offshore towers, but some turbine suppliers note that access could be an issue for larger towers.

There are logistical benefits in local supply and in the high growth scenario, there is logic in a coastal Vietnamese facility designed to meet demand from the offshore market. Tower production is largely automated, and Vietnam has a suitably qualified workforce. Tower internals can also be obtained from within Vietnam. Steel plate and flanges are likely to be sourced from Japan or Korea.

Investment risks in tower production facilities are high because it would need at least two customers and turbine suppliers typically do not give long-term contracts to tower suppliers. Profit margins are typically small. Any new facility could support exports and the onshore wind market.

A tower factory with a 1GW annual capacity would create about 150 jobs and cost about €100 million. There would need to be a strong pipeline of projects for a turbine supplier to invest in such a facility. A 1GW offshore wind farm could serve as a suitable anchor project, but there would need to be a continuous market of more than 1GW a year over 10 or more years for a supplier to make the business case.

Business as usual scenario

There are a small number of turbine electrical components supplied from Vietnam, but most turbine components are imported.

Baseline scenario

In addition to the business as usual scenario, a tower factory is built in Vietnam. Blades and finished nacelles and hubs are imported.

Balance of plant

Foundations

There are logistical benefits in the local supply of foundations, particularly for jackets which are costly to transport. The final decision of foundation concept will be made following geological studies.

Vietnam has significant steel fabrication skills, particularly from shipbuilding and oil and gas. There is a significant opportunity for Vietnamese companies in foundation fabrication. Key companies are likely to be Alpha ECC, PetroVietnam Construction, PetroVietnam Marine Shipyard, PTSC and Vietsovpetro.

Even established steel fabrication facilities will require investment to enable the high volume and lean manufacturing needed for offshore wind. Investment risks are high in the low market scenario because of uneven demand but lower in the high market. Risks can be offset if there is clarity over the location of future projects and the foundation technologies likely to be adopted by the industry.

Suppliers that we interviewed indicated that they can supply monopile and jackets to the Vietnamese markets. These suppliers have experience of manufacturing steelwork for oil and gas platforms, and within Vietnam there is a large and capable workforce of engineers. In addition to the interviewed foundation suppliers, CS Wind is also considering investing in a foundation factory, with a decision expected in 2021.

Steel tends to be sourced from outside Vietnam, usually from Korea or Japan. The companies have also indicated

that they would look to export foundations to other Asian countries in the medium term and Europe longer term.

Array and export cable supply

Vietnam has no subsea cable production capability. The logistical benefits are few because in many cases a single cable vessel can transport all the cable for a project from the factory in one or two journeys. Subsea cable factories in China, Japan and Korea are likely to be used for Vietnamese projects. As the Asian market grows, new investment is likely to be necessary, but cable suppliers typically seek to expand existing facilities rather than invest at new sites. This is because long lead times for new factories with low market certainty mean a significant investment risk. Suppliers are also cautious about diluting their technical competency at their centres of excellence.

The growth of the industry from intertidal areas to locations further from shore could drive interest in establishing HV cable and equipment capabilities. The size of the market will dictate any future Vietnamese presence. LS Cable reports that its export cable factory has a full order book for two years. The growth of offshore wind in Vietnam and other Asian markets could lead to suppliers investing in new or existing facilities to grow the supply. Whether Vietnam or another country was chosen for a new factory would depend a lot on the growth of the Vietnamese market compared to other countries, and also the regional strategy of the supplier.

Offshore substation supply

To date intertidal offshore wind farms in Vietnam have been built without an offshore substation and there has been no local experience in other markets.

Offshore wind substation supply has synergies with shipbuilding and oil and gas platform supply as it requires steel fabrication and systems integration skills. Substations are typically one-off designs and therefore new entrants do not need to make investments to enable efficient volume production.

Current suppliers in other markets typically work from existing sites because of the uneven demand and the fact that little specific investment is needed.

Vietnam has several fabricators with the skills and experience to supply substations, potentially through joint ventures with electrical equipment suppliers.

Vietnam also has the capability to supply electrical components. ABB has a transformer factory in Hanoi, and it has high voltage and medium voltage power product factories in Bac Ninh.

The offshore wind industry is typically too small to drive electrical equipment manufacturing investments in new locations. The power transmission and distribution sector is significantly larger and uses similar products.

Vietnamese companies are very interested in supplying substation topsides, and there are similarities with oil and gas platforms. Three of the companies that we interviewed indicated that they could supply these relatively easily: Alpha ECC, PTSC and Vietsovpetro. Companies with onshore experience could also get involved, for example PECC2 indicated that it could design offshore substations and could also build in the future. There is a large amount of expertise and engineering knowledge in Vietnam that could be used.

International companies are also interested in the market, for example Semco Maritime. These organisations could take on an EPCI contract for substation delivery, designing the substation and partnering with Vietnamese shipyards which would fabricate the topside. While some electrical components could be sourced from Vietnam, the majority would be imported from elsewhere in east Asia. Some elements, such as systems used for health and safety, will come from Europe.

Onshore infrastructure

Onshore infrastructure includes the onshore export cable, the onshore substation and the operations base. There are significant synergies with the rest of the civil engineering sector and this work is invariably provided by local companies. No significant investment by Vietnamese companies is likely to be necessary.

Onshore cable can be produced in Vietnam, for example LS Cables produced onshore cabling for the Hornsea project from Vietnam.

Substation construction can be done by local Vietnamese companies; for example, PECC2 has a significant track record in developing the Vietnamese power network and connecting capacity onto the grid. Some components are sourced from Vietnam, for example the transformers and medium voltage cables, however the majority are sourced from outside Vietnam (including switchgear, circuit breakers, shunt reactors and other power electronics).

Business as usual scenario

- Foundation components are sourced from Vietnam.
- Array and export cabling come from outside Vietnam.
- Vietnamese companies supply all onshore low voltage electrical equipment and the offshore substation topside, but the offshore substation electrical equipment and engineering and project management is done mostly with international labour.

Baseline scenario

- Foundations are supplied by Vietnamese companies for both phases.
- A factory is set up in Vietnam, to supply export cables for the second phase.
- Other aspects (array cables and substations) are the same as the business as usual scenario.

Installation and commissioning

Turbine and foundation installation

Pre-assembly at the port and final assembly at the wind farm site are undertaken by the turbine supplier. Conventional fixed offshore wind farms use specialist jack-up vessels built almost exclusively for offshore wind use. Vietnam currently has no suitable vessels.

Foundations may be installed by a jack-up vessel (which may also be used for turbines) or a floating heavy lift vessel. While Vietnam has floating construction vessels with cranes, these do not have the lifting capacity (up to 2,000t) needed for offshore wind foundations.

Vietnam has oil and gas contractors and shipping companies with significant experience working offshore and, in theory, these could enter the market with investment.

Offshore wind vessels can work in any country, notwithstanding any restrictive legislation. The offshore wind industry has seen a significant number of new vessels built, which suggests low barriers to investment. Joint ventures with established European contractors would further reduce investment risk. Several vessels are already under construction in Japan.

A challenge has been balancing the capital cost of the vessel while ensuring that it continues to be capable of installing the ever-increasing size of turbines and foundations.

The larger jack-up vessels needed for installation will come from Europe. Installation contractors like DEME Group and Jan de Nul, with interest in the Vietnamese market, have their own vessels and will have their own crew. Smaller ancillary vessels will be Vietnamese and have Vietnamese crew. These vessels will include guard vessels (typically coastguard or fishing vessels), tugs, crew transfer vessels and barges. Vietnamese labour will also be used in the marshalling yard. There is a lot of skilled labour in Vietnam, but Vietnamese companies are less experienced in offshore wind and so this part of the supply chain will be a combination of Vietnamese and international expertise.

The approach towards health and safety is very different in Vietnam to Western Europe. One supplier indicated to us that the standards do not match those internationally recognised, and so extra European expertise is used to meet the requirements of contractors and lenders. There are increased insurance costs for international contractors when working in Vietnam.

Equipment sourced locally for these marine operations will include health and safety equipment, port facilities and fuel, offshore personnel vessel supplies, catering services and vessel maintenance services.

Vietnamese companies have expressed interest in installing as well as supplying foundations, for example Vietsovpetro and Alpha ECC which have links to vessels used in the oil and gas industry. Offshore wind installation vessels are specialised and are long term investments, costing hundreds of millions of US dollars. This would require a large pipeline of projects to make the business case.

Array and export cable installation

The techniques for laying cables for intertidal projects has similarities with the inshore export cable laying process for conventional offshore wind farms. Otherwise, the expertise and equipment for conventional offshore projects are distinct. Array and export cable installation can in theory use the same vessels and equipment, but optimal solutions differ. Array cable laying vessels need to be manoeuvrable but do not need high carrying capacity. Export cable laying vessels are typically larger, to carry the full length of an export cable. Ideally, they can also operate in shallow water.

Offshore wind cable laying is technically challenging, particularly the process of pulling in and terminating the cable at the base of the turbine, and the risks of entering the market are significant. As well as the investment in vessels, inexperienced cable-laying companies have suffered project delays in established offshore wind markets and the financial consequences can be severe. A partnership with an established contractor would lower this risk.

In our interview with LS Cables, it indicated that it could install offshore wind farm cables using its own vessels. This could include Vietnamese crew and technicians but would depend on the details of the project. It said that there are sufficient vessels and expertise in Vietnam for the work to be done locally, but this may become challenging as farms are built further from shore.

Offshore and onshore substation installation

Offshore substation installation includes the foundation (usually a jacket) installation and the substation platform installation.

The substation foundation is typically installed in the same way as a turbine foundation. It may use similar vessels and may be delivered as part of the turbine foundation installation contract. Our conclusions are therefore the same as for turbine foundation installation. Vietnam has contractors with the skills to undertake the work but not the vessels for current needs.

The substation platform is likely to weigh more than 2,000t. In most cases it is transported to site by a barge then lifted into position by a heavy lift vessel. These vessels are typically 'borrowed' for short-term use from the oil and gas fleet, but none are currently operated by Vietnamese companies.

Onshore substation installation is very similar to the construction of other power transmission infrastructure and Vietnam has suitable expertise to undertake the work.

Business as usual scenario

- Turbine and foundation installation are done by an international vessel, with Vietnamese support vessels using Vietnamese crew
- The cable installation vessel is international, with some Vietnamese crew, and the ancillary vessels are Vietnamese.
- The offshore substation is installed by European vessels and the onshore substation using Vietnamese labour.
- The onshore substation is constructed by Vietnamese companies and labour.

Baseline scenario

- For the second phase, a local vessel is used for foundation and cable installation, with some international crew, and the ancillary vessels are Vietnamese.
- Other aspects (turbine and substation installation) are the same as the business as usual scenario.

Operations, maintenance and service

Wind farm operation

Wind farm operation combines some of the asset management expertise in onshore wind along with offshore logistics. Vietnam has a growing onshore wind industry and therefore has the relevant asset management skills. Offshore logistics expertise is found in Vietnam's oil and gas and shipping industries, although investment in skills and vessels will be necessary. Key companies could be Hai Duong Company, PTSC, Tan Cang Offshore Services and Vietsovpetro,

The barriers to entry are generally low, revenue streams long-term and benefit of local supply high, which suggests potentially high competition in time.

Turbine maintenance and service

Turbine maintenance and service is typically undertaken by the turbine supplier, generally under a service agreement of up to 15 years. A local workforce will be used for much of the work, and there is an opportunity for local companies offering inspection services and technicians during planned maintenance and unplanned service activities in response to turbine faults. These skills can be found in Vietnam's onshore wind industry. The barriers to entry are low and investment will be mainly focused on ensuring a high-level skills base.

Balance of plant maintenance and service

Balance of plant maintenance and service covers foundations and the array and export cables and the substations. Cable maintenance and service is the most significant, with cable failures the biggest source of insurance claims in offshore wind, typically due to mechanical damage caused to the cables. It uses similar equipment to cable installation as array cables are often replaced rather than repaired, and the same companies could undertake the work.

Foundation maintenance and service includes inspections for corrosion or structural defects above and below the water line, and cleaning and repairing areas above the water line. Vietnamese companies such as Tan Cang Offshore Services are well suited to this work.

Substation maintenance and service may be undertaken by the electrical system supplier or subsidiaries of Electricity Vietnam but it is likely that companies offering operational support to oil and gas platforms could undertake this work, such as PTSC, Thien Nam Offshore Services and Vietsovpetro.

Business as usual scenario

- Operations and turbine maintenance and service are undertaken using Vietnamese labour but in many cases employed by global companies.
- Balance of plant maintenance uses local vessels but uses global contractors

Baseline scenario

- Operations and turbine maintenance and service is the same as the business as usual scenario.
- More Vietnamese companies are used for balance of plant maintenance.

Decommissioning

Decommissioning strategies have not yet been developed in established markets. It is most likely that vessels that have been used for installation will also support decommissioning. Companies active in decommissioning could therefore be Huy Hoang Logistic & Transportation, PTSC, Tan Cang Offshore Services, Thien Nam Offshore Services and Vietsovpetro.

Subject to future regulatory changes, the first phase may be decommissioned in around 2046 according to current wind power PPA structure in Vietnam. By this date, if the Vietnamese market continues to grow, then it is possible that Vietnamese vessels will exist that are suitable for decommissioning purposes.

Business as usual scenario

- We assume that a global jack-up is used for decommissioning, with Vietnamese support vessels to assist the operations.

Baseline scenario

- We assume that a Vietnamese jack-up or heavy lift vessel can be used for decommissioning, with Vietnamese ancillary vessels to assist the operations.

Table 4 Supply chain narrative summary. V is predominantly Vietnamese (>60% Vietnamese content); I is predominantly international (<40% Vietnamese content) and V / I is a combination (40-60% Vietnamese content).

Expenditure type	Level 1	Level 2	Baseline		Business as usual	
			Phase 1	Phase 2	Phase 1	Phase 2
DEVEX	Development and project management	Project development (DEVEX)	V / I	V / I	V / I	V / I
		Project management (Construction phase)	I	I	I	I
CAPEX	Turbine	Turbine supply agreement	I	I	I	I
	Foundation supply	Foundation supply	V / I	V / I	I	V / I
	Array cable supply	Array cable supply	I	I	I	I
	Export cable supply	Export cable supply	I	V / I	I	I
	Onshore and offshore substation supply	Onshore and offshore substation supply	V	V	V	V
	Operational infrastructure	Operational infrastructure	V	V	V	V
	Installation and commissioning	Turbine installation	I	I	I	I
		Foundation installation	I	V	I	I
		Array cable installation	I	V / I	I	I
		Export cable installation	I	V / I	I	I
		Substation installation	V	V	V	V
		Construction port	V	V	V	V
OPEX	Operations, maintenance and service	Wind farm operation	V	V	V	V
		Turbine maintenance and service	V / I	V	V / I	V
		Balance of plant maintenance	V / I	V / I	I	V / I
		Transmission maintenance	I	V / I	I	V / I
	Decommissioning	Decommissioning	V	V	V / I	V / I

4. Conclusion

The aim of this study was to examine the economic impacts of the La Gan project. We examined a baseline case, assuming some additional investment in the supply chain, and a business as usual case and quantified the GVA and FTE jobs that the project could supply to the Vietnamese economy.

Our results showed the for the baseline case, the La Gan project could produce over US$9 billion for the Vietnamese economy, with just under half of this being direct impact. The most significant contributors to GVA and FTE jobs are in development of the wind farm, the balance of plant and in operation, maintenance and service. In all three of these areas Vietnam has strong expertise, meaning that local suppliers can be utilised more heavily than in other areas.

As part of this study we also engaged with 13 companies with proven expertise and interest in the Vietnamese supply chain. A common theme was that Vietnam has a skilled engineering workforce, with expertise in shipbuilding and oil and gas which could be utilised and re-skilled for offshore wind. While there are no jack-up vessels operated by Vietnamese companies, typically used to install wind turbines, there are other heavy lift vessels from the oil and gas industry which could be used for foundation and substation installation in the future.

Because the La Gan project is being procured over two phases it is likely that there will be more opportunity to use Vietnamese suppliers for the second phase, as the offshore wind market grows. We expect that some items will always be imported, most notably turbine components, however our interviews with suppliers indicated that further foundation and tower factories are likely. These will increase the expertise in Vietnam and could kick start other areas of the supply chain and the wider offshore wind industry.