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# CONCEPTUALIZING RENEWABLE ENERGY HUBS FOR VIET NAM

*International Case Studies Focusing on Offshore-Wind*

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GIZ Energy Support Programme
Room 042A, 4th floor, Coco Building
14 Thuy Khue, Tay Ho District, Hanoi, Viet Nam
T + 84 24 39 41 26 05 | F + 84 24 39 41 26 06
E office.energy@giz.de
I www.giz.de/viet-nam | www.gizenergy.org.vn

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**Authors** Dr. Ralf Leutz (leopil)
Dr. David Jacobs (IET)

**Reviewers** Philipp Munzinger, GIZ ESP
Chi Mai Vu, GIZ ESP
Bui Ngoc Thuy, GIZ ESP
Joscha Albert, GIZ ESP

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| | |
|---|---|
| **BOT** | Build Operate Transfer |
| **Capex** | Capital Expenditure |
| **CBAM** | Carbon Border Adjustment Mechanism |
| **CO2** | Carbon Dioxide |
| **DNO** | Distribution Network Operator |
| **DPPA** | Direct Power Purchase Agreement |
| **DSCR** | Debt Service Cover Ratio |

| | |
|---|---|
| **EAV** | Electricity Authority of Viet Nam |
| **EIB** | European Investment Bank |
| **EU** | European Union |
| **EVN** | Viet Nam Electricity |
| **IDB** | Industrial Development Bureau (Taiwan) |
| **JETP** | Just Energy Transition Partnership |
| **LCR** | Local Content Rules |
| **MOIT** | Ministry of Industry and Trade Viet Nam |
| **O&M** | Operation and Maintenance |
| **OEM** | Original Equipment Manufacturer |
| **OREC** | Offshore Renewable Energy Catapult |
| **PDP8** | National Power Development Plan for the 2021-2030 period, with a vision to 20250 |
| **PVN** | Petro Viet Nam |
| **RE** | Renewable Energy |
| **REDZ** | Renewable Energy Development Zone |
| **REIP** | Renewable Energy Industry Precinct |
| **SWOT** | Strengths, Weaknesses, Opportunities & Threats |
| **TVET** | Technical and Vocational Education and Training |
| **UK** | United Kingdom |

# Acknowledgement & Disclaimer

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**Mr. Florian Wuertz**
*EVP Business Development Offshore Wind, EEW-Group*

**Ms. Sharissa Funk**
*Energy Sector Counsellor, Embassy of Denmark in Viet Nam*

**Mr. James Smith**
*Offshore Wind Specialist, Danish Energy Agency (DEA), Viet Nam*

**Mr. Riccardo Felici**
*Director APAC, OWC - The Renewable Energy Consultants*

**Mr. Nguyen Quoc Hung**
*Deputy Head, Petrovietnam (PVN)*

**Mr. Vinh Bui Thang**
*Viet Nam Country Manager, Global Wind Energy Council (GWEC)*

**Ms. Mette Moglestue**
*Deputy Head of Mission, Norwegian Embassy in Viet Nam*

**Ms. Trinh Quynh Chi**
*Head of Regulatory and Government Affairs, Ørsted Asia Pacific*

**Mr. Stuart Livesey**
*CEO, Copenhagen Offshore Partners (COP) & Copenhagen UInfrastructure Partners (CIP) Representative Viet Nam*

**Mr. Xuan Tran Bach**
*Localisation Manager of Copenhagen Offshore Partners (COP), La Gan Wind, Viet Nam*

**Mr. John Rockhold**
*Chairman, Pacific Rim Investment & Management Inc. (PRIM)*

# Executive Summary

The plan to establish Renewable Energy Centres (hereon "RE Hubs") originates in the National Power Development Plan VIII for the 2021-2030 period, with a vision to 2050 (PDP8), adopted by the Viet Nam Government in May 2023, and revised in April 2025. It is seen as an important pillar in Viet Nam's energy transition towards net zero emissions in 2050. Supported by the European Union (EU), United Kingdom (UK), Japan, Germany, France, Italy, Canada, Denmark, and Norway, the Just Energy Transition Partnership (JETP) supports the implementation of Viet Nam's ambitious energy transition targets. In September 2024, the Ministry of Industry and Trade (MOIT) established a dedicated JETP sub-working group, co-chaired by the Electricity Authority of Viet Nam (EAV) and GIZ on behalf of Germany, to advance the development of RE Hubs in the country.

This study, commissioned by MOIT, provides an overview of global developments in RE Hubs, with a focus on real-world examples and features most relevant to the Vietnamese context. Based on consultations with EAV/MOIT, Petrovietnam (PVN) and Viet Nam Electricity (EVN) the study places particular emphasis on localising the offshore wind value chain as a foundation for systematically developing RE Hubs. The focus on offshore wind energy as the cornerstone technology for RE Hubs in Viet Nam is both logical and strategic, for several key reasons.

**First,** Viet Nam has the largest offshore wind potential in the Association of Southeast Asian Nations (ASEAN) - estimated at approximately 168 GW after taking all technical, biodiversity and social constraints into account (World Bank 2024) - and the recently revised PDP8 sets an ambitious target of 17 GW by 2035, ramping up from 113 GW to 139 GW of installed offshore wind capacity by 2050, leveraging the country's position as having the largest offshore wind potential in the ASEAN region. Additionally, to support the production of new energy carriers such as green hydrogen and ammonia, Viet Nam aims to develop 15 GW of offshore wind capacity for this purpose by 2035 and approximately 240 GW by 2050.

**Second,** given this scale, it is essential for Viet Nam to assess which components — particularly large-scale ones that are best manufactured near specialised ports — and services along the offshore wind value chain can be localised. Doing so could create comparative cost advantages while also delivering socio-economic benefits, such as job creation and regional economic development. Moreover, the development of offshore wind presents an opportunity to strengthen the offshore industry by leveraging the existing expertise and infrastructure from the oil and gas sector, thereby creating synergies across the value chain.

The intention of this report is to further conceptualise RE Hubs for Viet Nam. However, this is just the first step. More detailed analyses will be executed in follow-up studies, including identifying suitable locations for offshore wind hubs around specific ports, assessing the existing and potential future regional value chains of offshore wind, and developing an integrated industrial policy framework to localise RE manufacturing Viet Nam.

Assessing relevant RE Hub components and various RE Hubs in operation resulted in the following key recommendations to Viet Nam's approach moving forward.

## The different components of RE Hubs can be developed independently at different time scales

The concept of RE Hubs in Viet Nam includes several components, essentially manufacturing, renewable electricity generation, and training for the development of technical abilities.[1] These components can be developed at different time scales.

Establishing operations and manufacturing **(O&M) hubs, manufacturing hubs** and localised value chains for offshore wind and other RE technologies will require a **planning horizon of five to ten years**. However, **RE electricity generation hubs can be established quickly**. RE technologies that can be deployed within just a few months or years (e.g., solar PV with battery storage) could be developed in these regional hubs. Renewable Energy Development Zones (REDZs) can be used to streamline and accelerate developments (see Option 2 in Chapter 3). **Training and the development of technical or job specific abilities can start immediately while also requiring a long-term outlook** in line with PDP scenarios for various power generation technologies.

[1] The PDP8 also refers to "auxiliary services".

## The various components of RE Hubs can be established in different locations as they serve different functions

**Considering different locations for the RE Hub components might also be useful,** as they have different functions. RE manufacturing hubs need to be aligned with existing supply chains and logistical parameters (e.g., close to offshore wind harbours), whereas RE electricity generation hubs could be located elsewhere, in line with resource availability and grid contraints.

**Specilised training centres are often located in the vicinity of manufacturing hubs.** In some cases, this is strategically planned and steered by political decision makers (e.g., in China). However, more often university courses and training centres develop organically around RE manufacturing hubs. **Vocational training is often executed "in-house" and/or close to manufacturing sites. Universities and Technical and Vocational Education and Training (TVET) colleges that offer academic training and general technical training are not necessarily co-located with offshore manufacturing hubs.** In some cases, universities are located close to offshore wind hubs (e.g., Esbjerg, Cuxhaven). However, generally, skills such as management, engineering, business or financing can usually be obtained from universities located elsewhere in the country or internationally. Nonetheless, co-locating TVET colleges and universities with manufacturing hubs can create spill over effects and engagement.

## Plan RE manufacturing hubs around offshore wind energy, as manufacturing is bound to specific locations for logistical reasons

**Building RE Hubs around offshore wind energy reflects the importance of this technology in the Vietnamese context.** Offshore wind energy will play a crucial role in Viet Nam's energy transition. In recent years, offshore wind energy received a lot of attention due to the significant wind resources in Vietnamese waters, the potential for national value creation and jobs, and the opportunity to become a regional offshore wind leader.

**Planning RE Hubs around the requirements for offshore wind manufacturing makes sense from a logistical point of view.** Therefore, it is useful to conceptualise RE manufacturing hubs as widening circles around selected ports suitable for offshore wind logistics. Offshore wind manufacturing includes very large-scale components (turbines, nacelles, blades) which can only be produced in specific locations, i.e. **locations right on the coast with the necessary harbour infrastructure for logistics.** Manufacturing of these components cannot be moved to inland locations). Typically, a series of Tier 2 or Tier 3 supply chain industries consolidate themselves around such large-scale (Tier 1) components to provide supportive services and parts (coating, welding, services, secondary steel, etc.).

**INFOBOX:** Required space for offshore manufacturing (port size & investment)

**Port areas dedicated to offshore wind services and manufacturing must be waterfront areas, with heavy-duty floor loads of 15-25 t/m², level quays and storage spaces suitable for docking of large vessels and loading/unloading turbine components weighing up to 2,500 t using cranes and roll-on/roll-off ramps**. Manufacturers of the large components (nacelles, turbines, etc.) often produce on or near the quay provided by a port. Potential ports have already been pre-investigated in Viet Nam. The relevant report recommended that 11 ports pre-identified in the site screening should be further investigated once the location of the first offshore wind projects has become clearer (COWI, 2024: 10).

**The specific area required in a port for the production, trans-shipment, storage and assembly of offshore wind turbines has been estimated to be 30 ha/GW** [Stiftung Offshore Windenergie, 2023].[2]

The specific production and port area is influenced by the size and location of the wind farm, due to installation seasons, which are March to September in the North Sea, the distance between port and wind farm construction site and the number of available installation vessels. The origin of components, along with their shipment schedules, and the potential storage capacity at the manufacturers' sites influences the storage capacity at the port. Construction time contingency is important: the tighter the time frame, the larger the storage and logistics requirements at the port.

**The specific port area investment (for port area only) is estimated to EUR 1 bn/100 ha** [Stiftung Offshore Windenergie 2023; Wind Europe 2021; Zukunft Energie 2024]. This includes quay construction in concrete and gravel as well as the improvement of infrastructure and building ground. Not included in the specific port area investment are production capacity, hinterland connection, and dredging of the access channel.

Both the specific production and logistics area, and the specific port area investment, are rough estimates for Europe and should be adapted to the conditions in Viet Nam, with planned wind farm construction schedules and contingencies, as well as construction costs influencing requirements.

## Conceptualise RE Hubs as regional manufacturing clusters, rather than specific, geographically confined locations

Analysis of offshore wind value chains in other countries indicates (offshore) manufacturing is not clustered in one specific location but rather in the form of **regional clusters, spanning at least a 100 km radius or more.** Therefore, RE hubs should be conceptualised as regional clusters rather than specific, geographically confined locations.

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[2] This figure is based on an analysis for Germany, based on an annual manufacturing capacity of 4 GW. The number is understood as aggregate area of production and port areas. It is a no-regret area, i.e. an estimate of the lower bound space required for offshore wind. Other reports yield similar specific production and logistics areas in ports for Europe [Wind Europe 2021], and for the case study Cuxhaven [Zukunft Energie 2024].

## Prepare for a globally integrated offshore wind value chain

The international offshore wind industry is maturing. Supply chains are becoming increasingly global, with Chinese manufacturers shipping monopiles to Europe, Vietnamese manufacturers shipping jackets and offshore substations within and outside of the APAC region and German companies shipping steel for turbines to Asian countries. Experience shows that prioritising segments of the value chain where there is a clear global competitive advantage yields the most significant strategic benefits. Localisation strategies need to be based on a detailed assessment of international market structures and a national "Strengths, Weaknesses, Opportunities, and Threats" (SWOT) analysis.

## Build offshore hubs around core manufacturing activities (OEM & Tier 1) but allow for regional variation and flexibility for Tier 2 & Tier 3 suppliers

Industrial policies and infrastructure investment can help to **build the core of a regional RE Manufacturing Hub around the activities of an original equipment manufacturer (OEM) and Tier 1 suppliers (producing the turbine, nacelles, towers and foundations).** Case studies depicted in this analysis show that manufacturing of these components typically takes place directly at the ports, e.g., in Shantou (China), Taichung (Taiwan) and Esbjerg (Denmark). Tier 2 and Tier 3 suppliers (supplying components for OEMs, Tier 1 and raw material supply) typically grow organically around regional manufacturing hubs or can be sourced from existing ones in other parts of the country or internationally.
**The establishment of a regional offshore RE manufacturing hub should not be overplanned but provided with sufficient scope and flexibility to grow organically. Tier 2 and Tier 3 suppliers do not necessarily need to be located close to the core RE manufacturing hub.** These components can be transported over larger distances and these suppliers may also produce products for other industries located elsewhere. However, where space and convenience allows, reducing travel time and having close association with Tier 1 manufacturers can be beneficial.

## Consider legacy industry and existing infrastructure as starting point when planning regional RE Manufacturing Hubs

Most successful industrial policy strategies are not designed on the drawing board but evolve incrementally and develop organically from legacy industries (e.g., oil and gas) leveraging existing infrastructure (e.g., roads, ports). When assessing potential locations for RE/Offshore Hubs in Viet Nam, it is beneficial **to identify relevant industries and seek to leverage existing infrastructure where possible.** Most obviously, the PVN gas infrastructure and know-how in Southern Viet Nam is an important starting point.

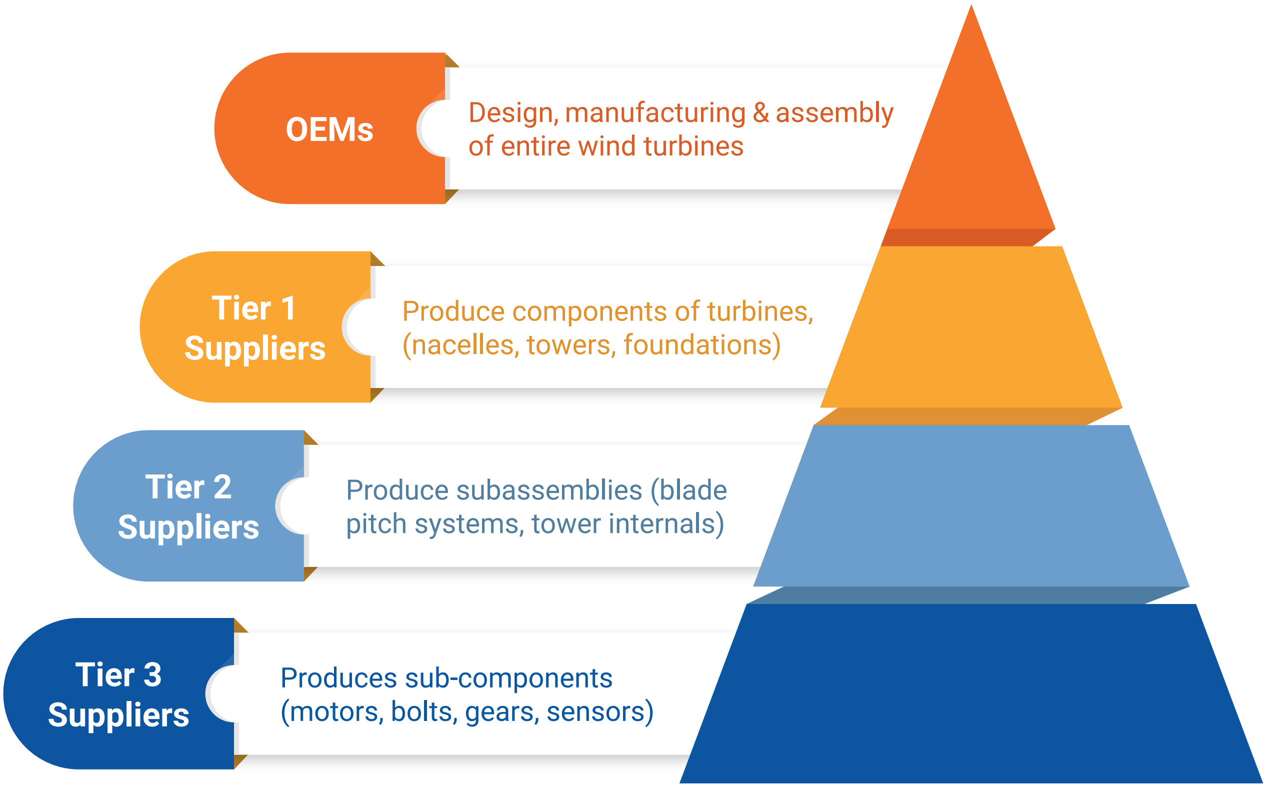



***Figure 1:*** *Actors along the offshore wind value chain (OEMs, tier suppliers). Source: [Author]*

## Allow for alternative locations for manufacturing hubs for solar PV, batteries, hydro power, onshore wind and green hydrogen

There are synergies between manufacturing of certain RE technologies, i.e. onshore and offshore wind, green hydrogen production and offshore wind. However, international case studies suggest that **manufacturing hubs for one technology (e.g., offshore wind) are not necessarily in the same geographic location as manufacturing hubs for other RE technologies** (e.g., solar PV). Just as coal and gas value chains are located in different parts of Viet Nam, so the value chains and manufacturing of wind, solar PV, biomass and hydro power will evolve in various parts of the country.[3]

Therefore, **it might be necessary to plan and conceptualise different manufacturing hubs for different RE technologies.** Alternatively, **policymakers could try to pool the manufacturing of various RE technologies in specific regions or locations by creating favorable investment conditions as part of industrial policies,** e.g., Special Economic Zones in a particular area.

As a next step, it is important to analyse the existing and potential future value chains of solar PV, batteries, green hydrogen, hydro power and onshore wind and their respective location – similar to the analysis already executed for offshore wind. Based on the analysis of various RE technologies, potential synergies and differences will become more apparent.

[3] Some overlap of value chains for various RE technologies exists. Logically, there are overlaps between the onshore and offshore wind value chains. In addition, international case studies suggest an overlap between the offshore wind value chain and the future green hydrogen value chain.

## Providing electricity from renewable energy for manufacturing hubs is critical for export opportunities

Many offshore wind and renewable energy manufacturing hubs have mechanisms in place to **ensure that electricity required for production comes from renewables.** This is especially important in the light of the EU's Carbon Border Adjustment Mechanism (CBAM) and other international initiatives that implement carbon border taxes for all equipment not produced with clean energy sources. Some auctions for offshore wind energy projects in Europe now require or incentivise project developers to source equipment produced using electricity from renewables or clean energy sources. Options to source RE electricity can be pursued in parallel to each other, including REDZs, certificate trading mechanisms and direct power purchase agreements (DPPAs).

## Industrial policy can play an important role in strengthening the national (offshore wind) value chain but needs to be finely calibrated

**Industrial policies consist of a multitude of mutually reinforcing incentives creating both demand for offshore wind products and support for the supply side.** On the supply side, establishment of Special Economic Zones (including tax breaks and exemptions from duties), regional research and development (R&D) programmes and tax incentives can lead to regional clustering of RE technologies.

On the demand side, measures should be taken to support the development of a solid and credible pipeline of projects, ideally with forward visibility many years into the future. These measures could include a strategic approach to site licensing and granting of concessions; removal and mitigation of project risks through, for e.g., Strategic Environmental Assessments (SEAs), proactive allocation of grid connections and strategic upgrades/reinforcements/balancing and mechanisms to support project bankability and commercial offtake.

**A consistent pipeline is key to establishing the economic case for investment** in manufacturing facilities. Peaks and troughs should be avoided where possible through the planning process with a comitment to an annual delivery target and a comitment to maintain a consistent rate for a period in excess of 10 years, ideally in the range of 20-35 years which is consistent with the expected lifetime of a turbine. This would therefore create a perpetual buiness case to underpin the required manufacturing investment.

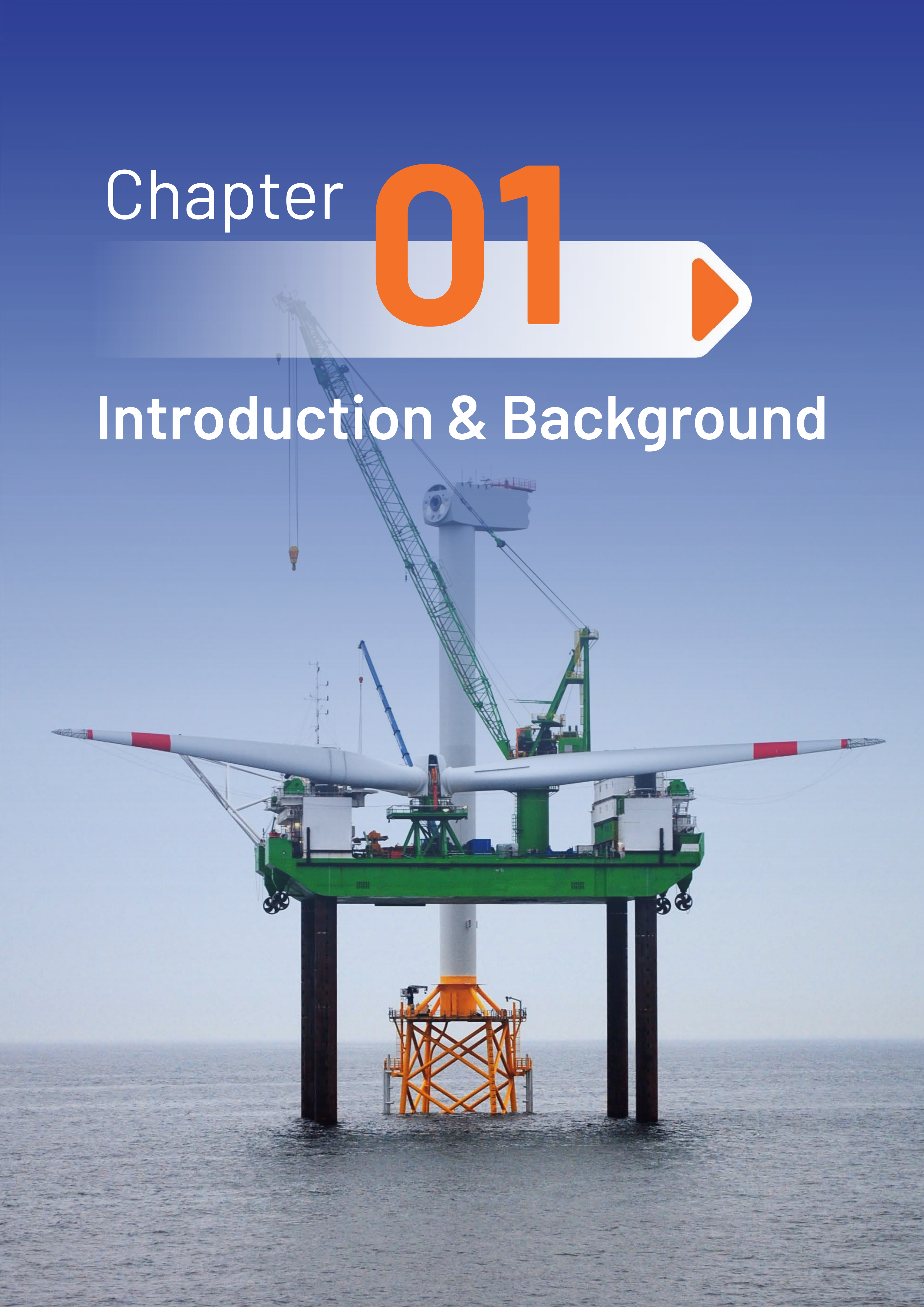
## Next steps & follow-up studies to move from conceptualisation to implementation

To move from conceptualising RE hubs in Viet Nam towards real-world implementation, a number of in-depth follow-up studies are required, including:

- **Pre-selecting potential RE hub locations:** Identifying suitable locations for offshore wind manufacturing hubs around specific ports, including assessment of regional offshore wind value chains.
- **Value chains of other RE technologies:** Assessing the existing and potential future regional value chains of other RE technologies, including solar PV, batteries, onshore wind, hydro power and green hydrogen. Identifying potential synergies and (locational) differences in relation to the offshore wind value chain.
- **Comprehensive industrial policy:** Develop an integrated industrial policy framework to localise RE manufacturing Viet Nam, including local, provincial and national incentives.
- **Training and skills hubs:** Assess skills gaps and develop training concepts for specialised training centres, TVET.

# Chapter 01

# Introduction & Background



# Chapter 1: Introduction & Background

## 1.1 PDP8 (Revised) & RE Hubs for Viet Nam

Viet Nam aims to achieve zero emissions in 2050. The 8th Power Sector Development Plan (PDP8) describes how the country plans to decarbonise the power sector. According to both the original and revised PDP8, so-called Renewable Energy (RE) Hubs or Centres will be a crucial facilitator of a net zero economy. In this report, we will apply the term "RE Hubs" (instead of RE Centres), as this terminology is more appropriate to describe manufacturing and power generation clusters and is in line with terminology used in other countries.

According to the revised PDP8, the Government plans to establish two RE Hubs in high-potential areas of the country.

> *"By 2030, it is expected that two interregional renewable energy industry and service hubs will be established in high-potential areas such as the Northern, South-Central, and Southern regions, when conditions permit.*
>
> *The interregional renewable energy industry and service hubs are expected to include* ***renewable energy power plants*** *with a capacity of 2,000–4,000 MW (mainly offshore wind power);* ***manufacturing facilities for*** *renewable energy equipment, new energy production equipment, and equipment and vehicles for transportation, construction, and installation of renewable energy systems; ancillary services;* ***green industrial zones*** *with low carbon emissions;* ***research centres; and training institutions*** *for renewable energy."*

In sum, **the concept of RE Hubs in Viet Nam describes an eco-system approach,** consisting of various interrelated but also independent elements. This includes RE electricity generation, RE manufacturing (with focus on various aspects), RE industrial policies (including green industrial zones), and RE training and research centres.

## 1.2 Conceptualising elements of RE Hubs

RE Hubs can play a pivotal role in advancing sustainable energy development and local value creation. However, there is no universally accepted model or definition of a RE Hub. Their design must be tailored to specific local circumstances and priorities — in this case, the Vietnamese context. To support the Ministry of Industry and Trade (MOIT) and other stakeholders in understanding the potential components of RE Hubs, a comprehensive report featuring international best practices and case studies is required.

This report aims to detail key elements of RE Hubs, providing real-world examples and insights from relevant jurisdictions to help MOIT and other stakeholders in understanding the potential components of RE Hubs in the Vietnamese context. Key components include:

- **RE hubs with offshore wind manufacturing as a core element,** given the impressive pipeline of offshore wind energy projects and the legacy of the oil & gas offshore industries in Viet Nam.
- **Hubs for renewable electricity generation** to accelerate the deployment of RE power plants to tackle potential power supply shortages and provide clean electricity for green manufacturing.
- **Training hubs,** including specialised and vocational training, as well as research institutions, universities and TVETs.
- **An overarching industrial policy,** including demand-side pull and supply-side push policies

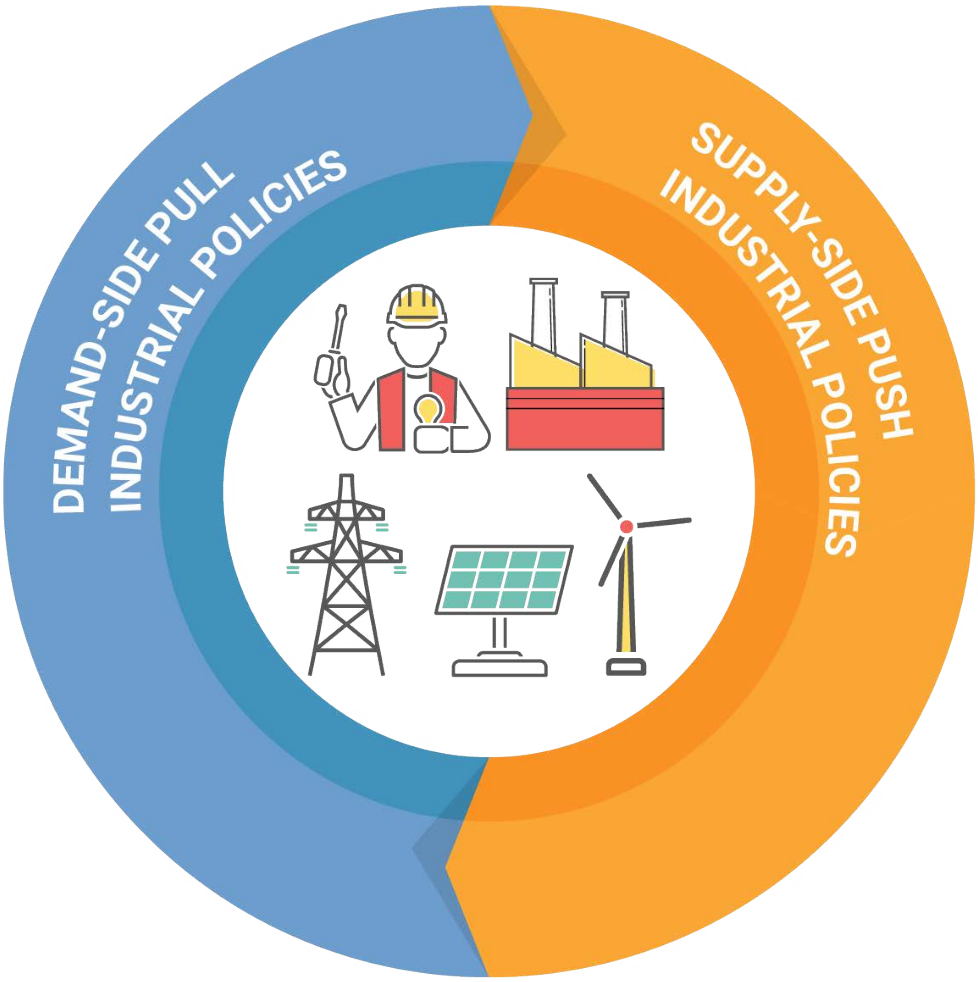



***Figure 2:*** *Elements of RE Hubs*
*(manufacturing, power generation, training and industrial policies. Source: [Author]*

The analysis is intended to create decision parameters for conceptualising RE Hubs in the Vietnamese context, including the various components (manufacturing, green electricity for manufacturing, training & industrial policies). This will inform the selection of sites for the RE Hubs in Viet Nam (see Chapter "Next Steps and Follow-up Projects).

**This report primarily focuses on hubs for offshore wind energy.** Offshore wind has the potential to play a pivotal role in Viet Nam's energy transition. In addition, the development of offshore wind can help revitalise the offshore industry, leveraging existing expertise and infrastructure from the oil and gas sector to create synergies across the value chain.

The manufacturing of offshore wind components needs to take place in locations near shore or directly at the harbour. Many components of offshore wind turbines, such as towers, blades and nacelles, are large (200 m long) and heavy (2,000 t), making production at the quay to support transfer to offshore installation vessels essential.

Manufacturing of other RE technologies and associated services may complement the offshore wind manufacturing hub. The supply chains and technical or job specific abilities are different, but the administrative setting is similar.

This study looks briefly at the market environment for offshore wind in East Asia and details the offshore wind manufacturing value chain in the remainder of this Chapter 1. Case studies on offshore wind manufacturing hubs are the subjects of Chapter 2. Renewable energy electricity generation from offshore wind and any renewable source of power for green manufacturing is the subject of Chapter 3, looking at drivers for green manufacturing and options to produce renewable power for RE manufacturing hubs. Chapter 4 is about training in the offshore wind energy industry. Chapter 5 concludes the study with key findings.

The intention of this report is to further conceptualise RE Hubs for Viet Nam. More detailed analyses will be executed in follow-up studies to elaborate specific aspects further. This will include more detailed assessments of regional value chains, detailed concepts for training and skilling centres, and the assessment and development of a wholistic industrial policy for offshore wind.

## 1.3 Understanding the competitive market environment in East Asia & Australia

**Manufacturing needs markets. Industry localisation and investment decisions depend on an existing or expected project pipeline.** Figure 1 shows the market situation of offshore wind farms in East Asia and Australia. There is 44 GW of operating offshore wind in China, Taiwan, South Korea, Japan, and Viet Nam. In the same countries, there are 31 GW of offshore wind farms under construction. In Viet Nam, existing projects are categorised as near-shore (within six nautical miles of the coast). However, based on international definitions, they count as "offshore" in the global statistics.

Offshore wind farms in pre-construction, defined as projects actively moving forward in seeking government approvals, land rights or financing account for 218 GW, driven by projects in Viet Nam, The Philippines, South Korea and China. Australia has a pipeline of 18 GW. It is noted that China, Taiwan and Japan have the most solid project pipelines, in the sense that the numbers of projects under construction and in pre-construction are balanced [GEM, 2025].

**This regional market should be taken into account** when planning offshore wind hubs in Viet Nam [GWEC 2024]. The offshore wind industry is becoming increasingly global: **Value chains are becoming increasingly global,** with Chinese manufacturers shipping monopiles to Europe and German companies shipping steel to Asian countries. Rather than attempting to develop the entire offshore wind value chain domestically, Viet Nam should strategically focus on segments where it can establish a strong global or regional competitive advantage, building upon existing offshore wind manufacturing skills and evolving industries and skills that can transition more quickly rather than starting from scratch. The recent APAC Supply Chain report published by GWEC highlights exisiting supply chain capability and gaps within the APAC region [GWEC 2024]. This should be used as a starting point to identify areas which could be focused on for RE manufacturing in Viet Nam.

The local market in Viet Nam is vital for initiating and sustaining manufacturing. Vietnam has already started manufacturing various offshore wind components, including offshore wind substations, foundations, towers, onshore electricial and others. However, the broader regional market — driven by demand from neighboring countries with less developed infrastructure, technical capacity and job-specific skills than Viet Nam — could serve as a significant driver of growth. Viet Nam's cost structure enhances its appeal to the global market, positioning the country as a competitive hub for investment and manufacturing in the offshore wind sector.

Figure 3 shows the localations of  the case studies (see Chapter 2), named after the ports at their centres, Shantou, Taichung, Gwangyang and Newcastle, as well as Esbjerg and Cuxhaven in Europe.

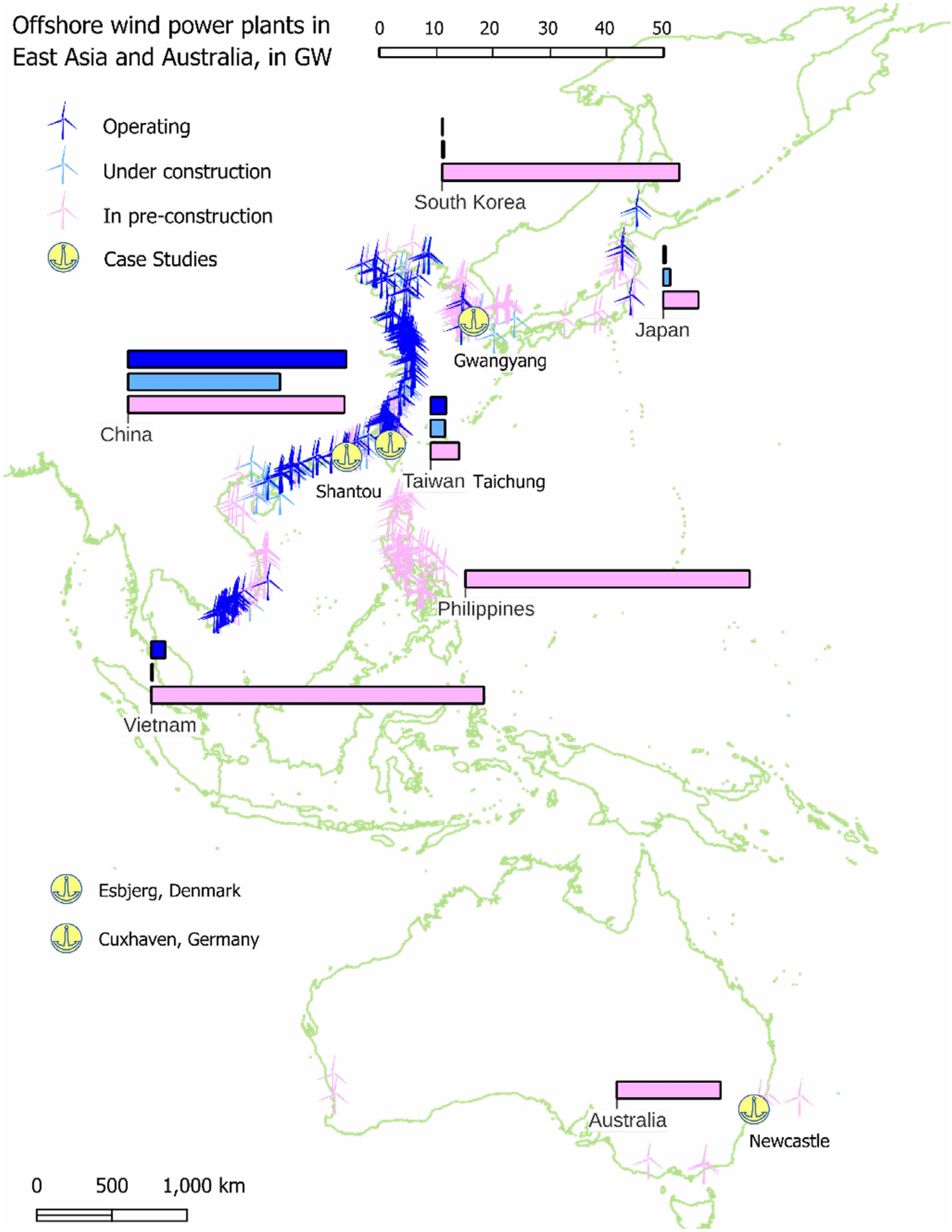



***Figure 3:*** *Offshore wind power plants operating, under construction and in pre-construction stages in East Asia and Australia, in Gigawatt (GW). Locations of the case studies presented in this report. Source: [Open Street Maps (OSM); GEM, 2025]*

## 1.4 Offshore wind power value chains

### Production & processes

The value chain of offshore wind turbines is depicted in Figure 6 [Leutz et al, 2024]. **Offshore wind turbines are complex products.** The value chain can be divided into three main sections: the upstream section, which involves raw materials and core precursors; the production processes that create the final product; and the downstream section, where the product is installed, operated, maintained, decommissioned and recycled.

**Several supply chains play a role in adding value to the offshore wind turbine value chain.** The definitions of contributors, intermediates and even the boundaries of each section are not always clearly defined. The production chain involves numerous individual steps carried out sequentially on the core product, while precursor processes often occur in parallel.

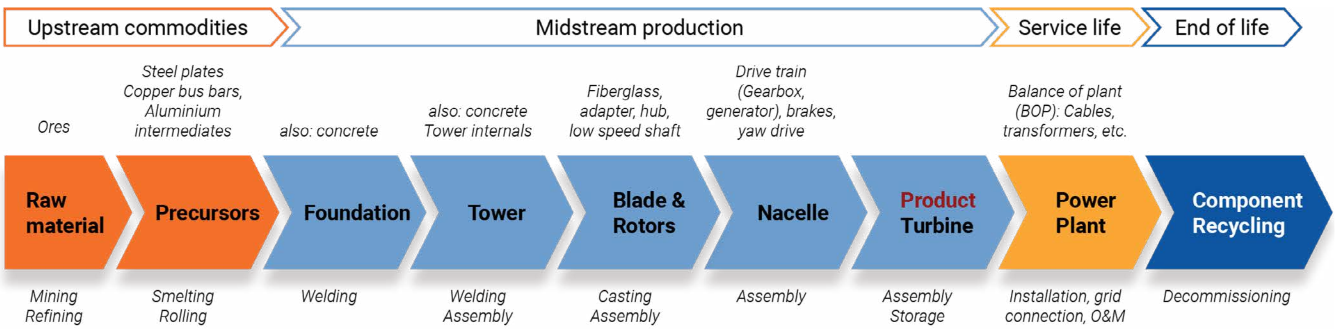



***Figure 4:** Schematic of the offshore wind turbine value chain. Based on [Leutz et al, 2024]*

### OEMs & tier suppliers

To understand the composition of regional manufacturing hubs it is useful to differentiate actors along the offshore wind value chain. Offshore wind **manufacturing hubs are frequently designed around the activities of the original equipment manufacturer (OEM) & Tier 1 suppliers.**

- **OEMs** are companies that design, develop and manufacture the core products used in offshore wind energy projects, namely the wind turbines [NREL 2022]. Offshore wind turbines are heavy, large and complex products. The value chain is dominated by serial processes with associated diverse supply chains. Examples of OEMs are GE, Goldwind, MingYang Siemens Gamesa, and Vestas.
- **Tier 1 suppliers** provide critical components, services or infrastructure directly to the OEMs. They typically do not produce the turbines themselves, but they supply key products. This includes larger-scale components such as nacelles, tow-

ers and foundations. These products are highly specialised and characterised by their massive size. Tier 1 suppliers also provide critical services for offshore wind projects (e.g. installation services, O&M). [NREL 2022]. Examples are Sinoma Wind Power Blade Co. (for blades), PTSC (for jacket foundations), PTSC M&C + Semco Maritime (for offshore substations) and CS Wind (for towers).

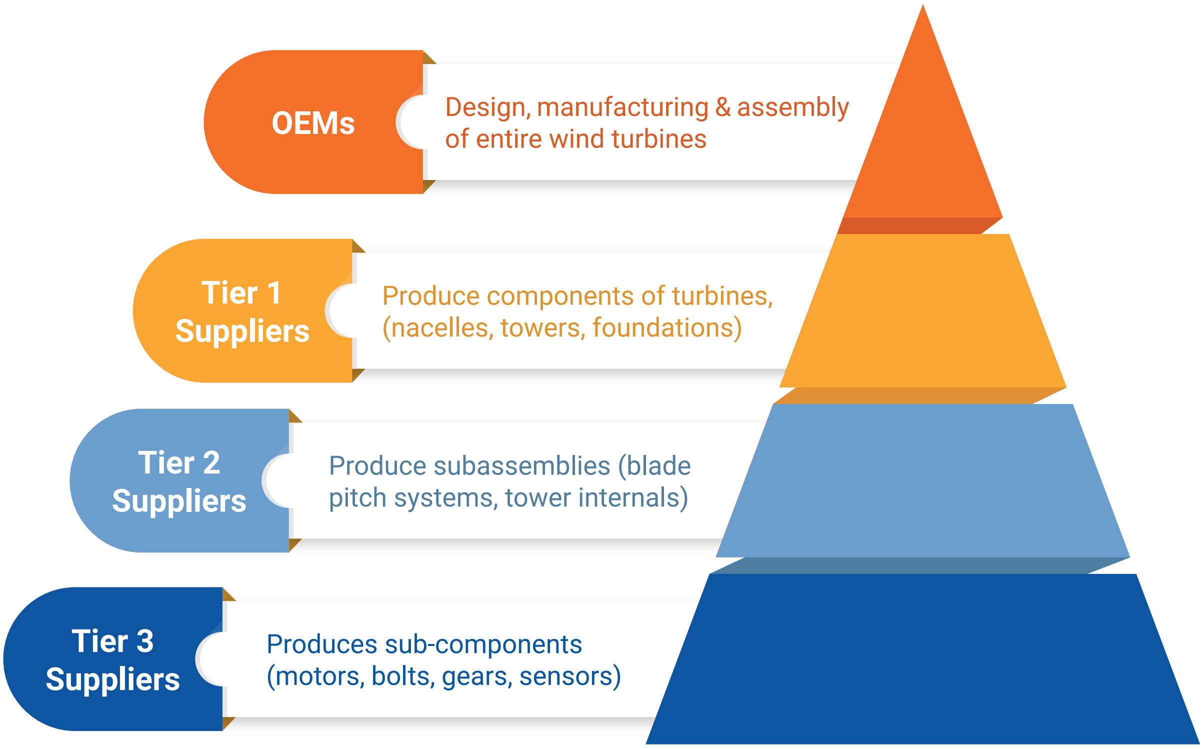



***Figure 5:*** *Actors along the offshore wind value chain (OEMs, tier suppliers). Source: [Author]*

Tier 2 & Tier 3 suppliers (providing the components for OEMs and Tier 1 and raw material supply) grow organically around the regional manufacturing hubs or already exist in other parts of the country. Tier 2 and Tier 3 suppliers do not need to be close to the core RE manufacturing hub, but this can be beneficial where possible, as components can be transported over larger distances and Tier 2 and Tier 3 suppliers also deliver products for other industries in other parts of the country.

- **Tier 2 suppliers** are subassembly manufacturers. They provide components, services or materials to Tier 1 suppliers, which then integrate them into systems or assemblies used in offshore wind farms [NREL 2022]. For instance, they produce components such as blade pitch systems that adjust the angle of turbine blades to optimise performance or nacelle control units.
- **Tier 3 suppliers** provide sub-components and raw materials. Examples include motors, bolts, steel plates and gears.

**A wind turbine is a relatively complex product, though the main material by weight is steel.** A 2022 utility-scale onshore wind turbine contains some 8,000 parts [US-

DOE, 2025]. An offshore wind turbine has a specific material intensity of 290 t/MW,of which 87% is steel, 3% cast iron, 5% other metals, 4% composites and polymers and 1% other materials [NREL, 2023]. There are many products not made from steel in a wind turbine. Viet Nam is the 12th largest producer of crude steel globally, at 20 Mt/year.

## Value composition

**The value composition of offshore wind power plants highlights the importance of the production of the wind turbine and O&M activities** (see Figure 6). The assessment is based on a 1 GW plant, using 10 MW turbines, in 30 m of water, 60 km from the shore and commissioned in 2022 [Sylvest, 2020].[4] The total cost amounts to EUR 4.2 bn.[5] Major shares in cost are the production of the wind turbine (tower, blades, hub and equipped nacelle). The production of the balance of plant (BOP) amounts to nearly one fifth of the offshore wind power plant. Installation and grid connection amount to a tenth, just like decommissioning. O&M over the lifetime of the turbine requires 28% of capital. **Over the lifetime of wind farm, two thirds of the costs go into sectors other than the manufacturing of the turbine itself.**

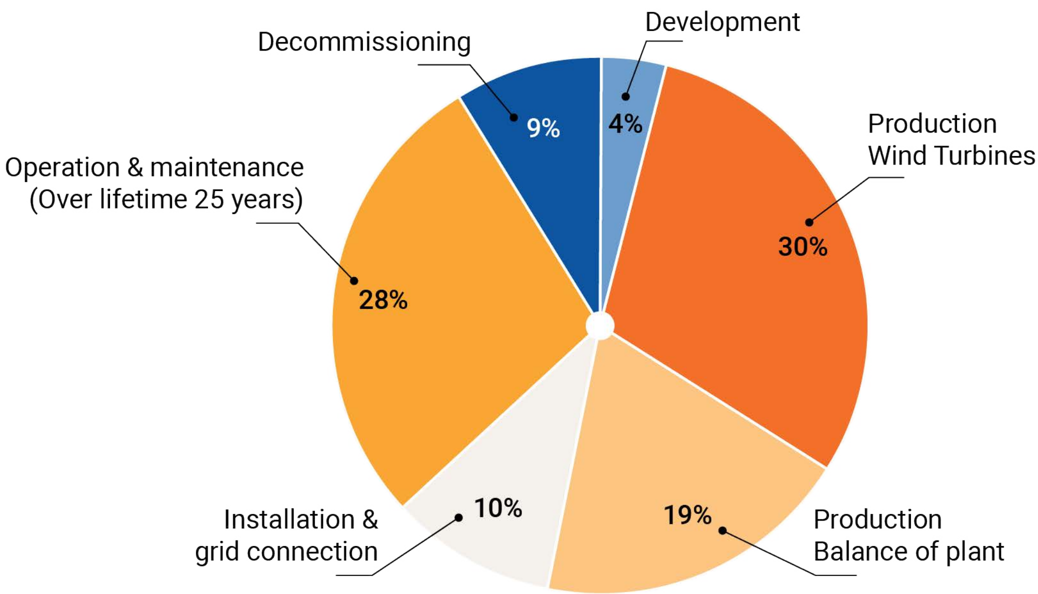



***Figure 6:** Value composition of offshore wind power [Sylvest, 2020]*

**Offshore wind is a global industry, so having a fully local supply chain is not necessarily required.** A company's procurement team does assess local suppliers and qualifies them using standardised procedures but maintains a global supply chain as a fallback. In fact, key semi-finished products — such as high-quality steel sheets and flanges, which serve as precursors for towers and foundations — are often sourced internationally from a limited number of capable suppliers.

[4] Note that the offshore wind turbines that will be deployed in the 2030s in Viet Nam will likely have an installed capacity of 14 MW of higher.
[5] It should be noted that turbine costs have increased considerably since 2020.

**Similarly, Tier 1 and Tier 2 suppliers will seek a supportive supply chain in the local area for services** (such as welding, coating, secondary steel, etc.) and an additional supply chain (nuts and bolts, crane hire, etc.). Securing a locally available, good quality and abundant supply chain is by far preferable when competitively priced and assuming all other procurement requirements are met.

However, globally one can also observe the trend towards regionalisation of offshore wind supply chains, driven by rising geopolitical tensions, tariff risks and the strategic imperative of energy security. The COVID-19 pandemic and recent trade disputes, including between Russia, China, the U.S. and the EU, have revealed the vulnerabilities of globally fragmented supply chains. For Viet Nam, this presents both a challenge and an opportunity. On the one hand, reliance on a narrow set of international suppliers could expose projects to sudden cost escalations or equipment delays. On the other, Viet Nam's geographic location, cost competitiveness and bilateral relationships position it to become a reliable partner in a more regionalised Asian offshore wind value chain. Strategic alignment with key partners such as Japan, South Korea, Taiwan and Australia, and those companies operating within these markets, could support technology transfer, reduce import dependency and insulate Viet Nam from tariff-related risks.

## High Capex & overnight costs

**Manufacturing offshore wind requires high capital expenditure (Capex).** This includes manufacturing turbines and parts, but also the logistics of moving and installing large and heavy components. For instance, the steel monopile for the foundation of a 20 MW class offshore wind turbine may weigh 2,000 t (more than most cranes can lift) and it may be 60 m long with a diameter of 14 m. The steel sheets which are bent and welded into tubes have a thickness of up to 16 cm. Only the most experienced rolling mills can provide the strength and homogeneity of the steel used.

**Manufacturing plants can cost several hundred million Euros,** roughly half a million Euro per position created (as in the case of the recent upgrade of the nacelle factory in Cuxhaven [Siemens Gamesa, 2024]). As depicted in Figured 7, the IEA estimates overnight unit capital costs for offshore wind technology manufacturing facilities in selected countries in 2023 for the turbine to be between EUR 300 and 600 million per GW, for China and Europe/USA, respectively [IEA, 2024].

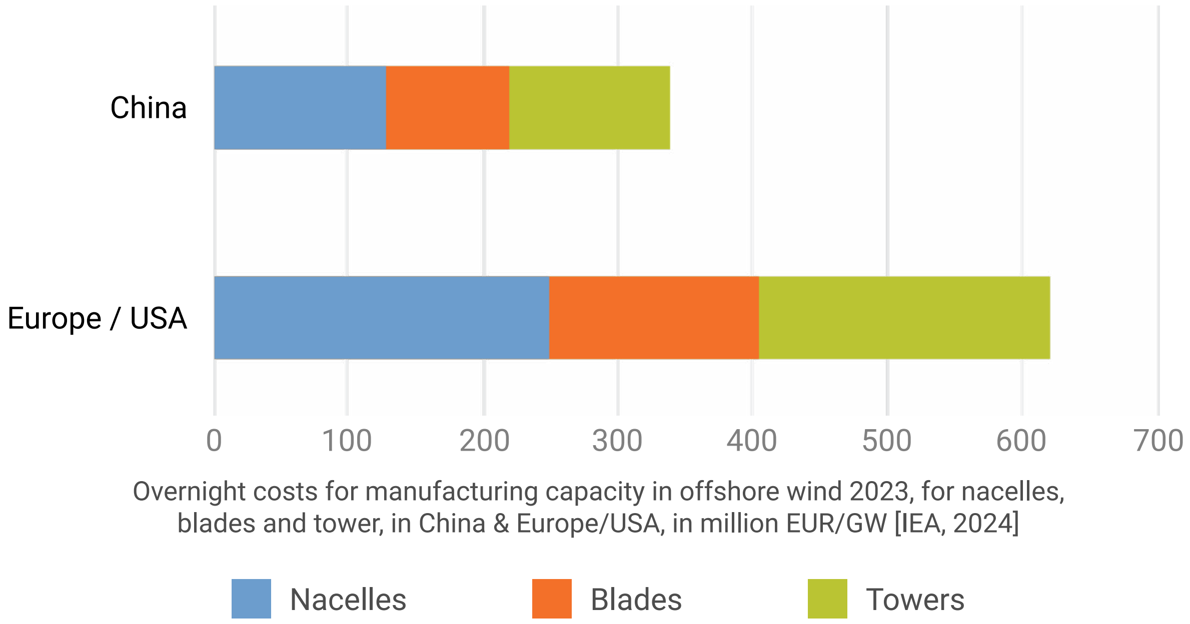


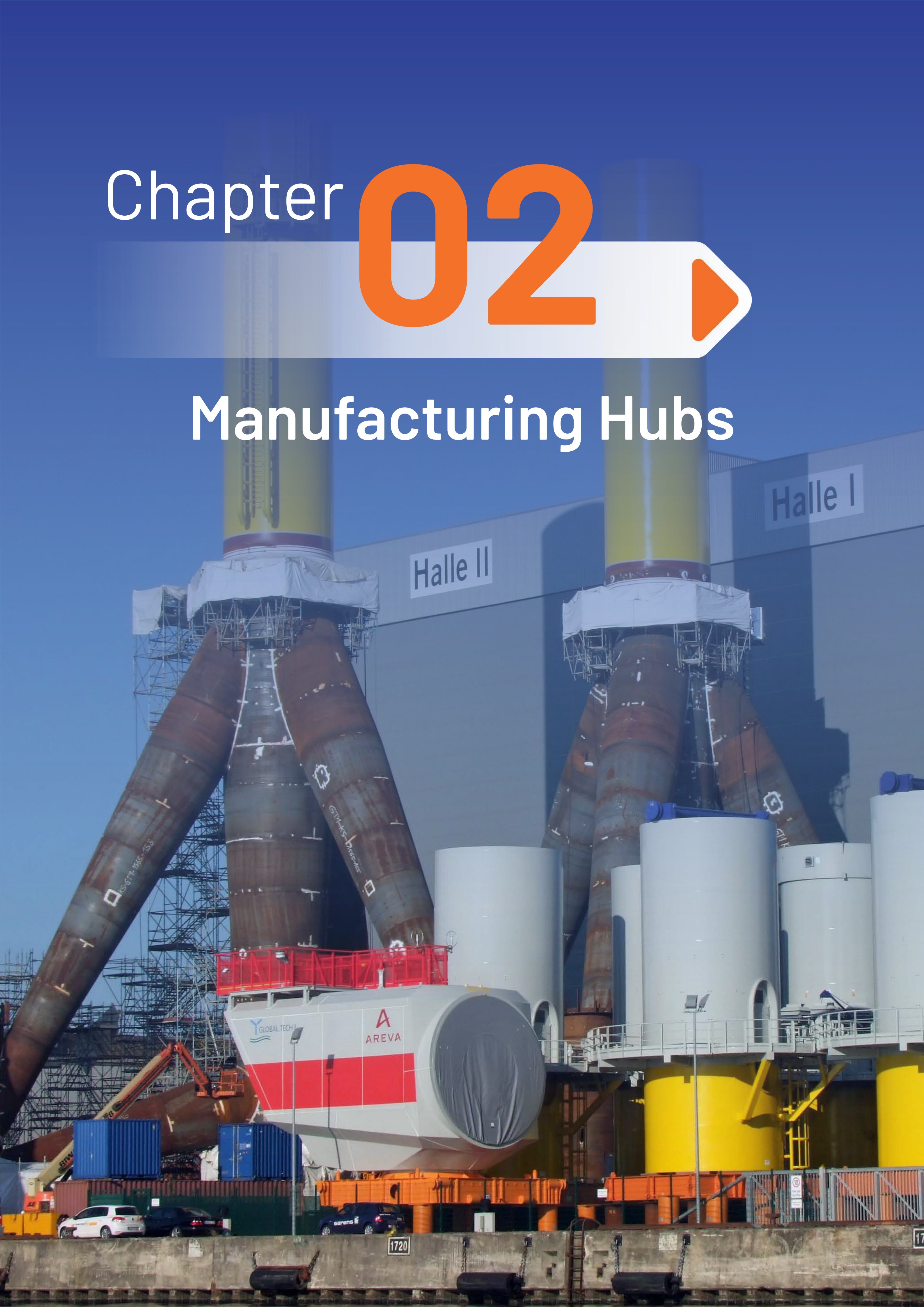

***Figure 7:** Overnight cost for manufacturing capacity in offshore wind 2023, for nacelles, blades and tower, in China and Europe/USA, in million EUR/GW [IEA, 2024]*

**High costs also occur for installation and O&M activities.** The operation of a modern installation vessel costs at least EUR 100,000-300,000 per day [Tradewinds, 2024]. A 500t crane is EUR 6,500 per hour [Esbjerg, 2024].

**Due to the high costs for manufacturing, services and O&M, localisation decisions are risky. Manufacturers require a solid project pipeline before investing in local offshore wind manufacturing.** With the cost advantages in some countries, even substantial transportation costs may not prevent successful tender participation in overseas countries.

# Chapter 02

# Manufacturing Hubs



# Chapter 2: Manufacturing Hub

Manufacturing hubs may be defined as regions characterised by a concentration of manufacturing along value chains, with a trained workforce, supported by infrastructure. Historic examples of industrial hubs include regions where coal mining drove steel making and heavy industries. These were the industrial hubs from the industrial revolution of the mid and late nineteenth century in Europe. **Modern manufacturing hubs are less distinct than historic coal and steel areas, as products have become more diverse and trade opportunities have deepened the division of labour.** Yet, areas with concentrated offshore wind manufacturing have evolved around ports. This chapter looks at some case studies. Every case study is different. There are many lessons learned and several aspects to consider when planning offshore wind manufacturing hubs.

**Case studies form the core of this work,** focusing on manufacturing value chains centred around port locations with OEMs and Tier 1 suppliers. These case descriptions are primarily qualitative and geographic in nature. Quantitative data — such as job numbers, employee qualifications or company turnover within the manufacturing hubs — is often proprietary and therefore not always accessible. The content is based on both literature reviews and insights gathered through interviews.

**The six case studies were selected by the authors to represent diverse regions — East Asia, Northern Europe and Australia** — and to capture different experiences in manufacturing components for offshore wind power plants across the entire value chain. Hubs focus on the upstream segment, building on their expertise in steel production (Gwangyang). Others feature a fully developed midstream value chain, where all major wind turbine components are produced within or near the port area (Taichung). In some cases, production steps are highly integrated, with greenfield factories built side by side to streamline processes (Shantou). Meanwhile, other hubs tend to concentrate on the downstream segment of the value chain (Esbjerg), providing services such as operations and maintenance, which can account for nearly one-third of the total value generated over the offshore wind power plant's lifetime.

The case studies examine the historic development of key offshore wind manufacturing hubs, ranging from established sites such as Esbjerg — the earliest example — to newer centres like Shantou in China. The selection places particular emphasis on East Asian hubs, including Gwangyang, Shantou and Taichung, based on the assumption that their experiences offer the most relevant insights for the Vietnamese context. The selected hubs vary in scale — from smaller sites such as Cuxhaven in Germany to large-scale hubs like Shantou in China — and in strategic focus, ranging from those dedicated exclusively to offshore wind to others, such as Newcastle, where offshore wind is part of a broader industrial restructuring agenda. Offshore wind manufacturing hubs vary in their stage of development. Some, like Esbjerg, are mature and have already delivered several gigawatts of offshore wind capacity. Others are operational and actively engaged in the manufacturing value chain, meeting the expectations of key stakeholders. A third category remains in an exploratory phase — such as Gwangyang — where offshore wind is not yet the primary focus and activities are largely supported by other established industries while opportunities in the sector are being evaluated.

Other international projects are currently under development and have not been included among the case studies. However, these initiatives reflect growing ambitions to establish coordinated RE Hubs. Among them, Italy's Med Wind project involves floating offshore wind generation near Sicily, supported by a government-backed joint venture, and aims to establish a domestic industrial supply chain within the country.

**Many manufacturing hubs derive their competitive advantage from a legacy in the offshore oil and gas industry,** benefiting from equipment and vessels, as well as an experienced workforce, and administrative pressure to transition toward cleaner energy sources. Some hubs leverage partnerships with universities and research institutions (Newcastle, Cuxhaven), while others recognise that attracting trained labour is crucial and therefore promote initiatives aimed at improving work-life balance. Additionally, the Gwangyang hub encourages investment through the establishment of Special Economic Zones (SEZs)

The case studies include a brief description of the manufacturing hub's most prominent characteristics and are as follows:

- **Esbjerg, Denmark –** the oldest offshore wind port with a strong downstream value integration, organically grown and atarget for carbon-neutrality in 2030;
- **Shantou, Guangdong, China –** with a highly integrated midstream manufacturing value chain, holistic planning, and high investments at a key manufacturing site of an OEM;
- **Taichung, Taiwan –** planned production integration, enforced by local content rule which eventually needs to be taken back because of WTO conflicts and other challenges including a shortage of trained labour and geographical challenges;
- **Gwangyang, South Korea –** exploiting its location as the biggest steel works in the world, experience in oil and gas industries and a large SEZ with concepts for attracting workers and investment;
- **Newcastle, New South Wales, Australia –** the only case study without any remarkable offshore wind manufacturing value chain, but the pressure for industrial restructuring away from a coal-based economy towards green steel aluminium and cement;
- **Cuxhaven, Germany –** a smaller port and city with dedicated research and training institutes and a singular commitment to offshore wind power.

According to interviewees,[6] the localisation factors most critical for setting up a new manufacturing plant are:

**(a)** a solid **project pipeline;**

**(b)** existing **infrastructure** such as port approach depth, quayside space, and access for oversized land vehicles; and

**(c)** the availability of a **trained workforce** with technical or job specific abilities and its cost.

[6] These experts were selected by the study's stakeholders and the interviews were conducted via video calls in a qualitative format. The insights provided were instrumental in understanding the industry's localisation strategies. The list of interviewees is shown in Chapter 6.

## **INFOBOX:** The UK's Offshore Renewable Energy Catapult (ORE Catapult)

An interesting approach for offshore wind manufacturing hubs has recently been developed in the UK. Offshore Renewable Energy Catapult (ORE Catapult) is the UK's leading technology innovation and research centre for offshore renewable energy. Part funded by the UK Government, ORE Catapult leads and collaborates in a wide range of industrial research activities focused on the offshore wind and renewable energy sectors in the UK and with partners from around the world.

ORE Catapult has recently been conducting some work on an alternative construction and installation (C&I) strategy for offshore wind that could potentially address some of the constraints around port capacity in emerging offshore wind markets while leading to a more efficient manufacturing and installation methodology with enhanced capacity and reduced costs.

This approach encompasses several related concepts, namely:

- **Serial, just-in-time, manufacturing**
- **Consolidated manufacturing**
- **Feeder vessels and customised wind turbine installation vessels**
- **Factory-to-farm installation strategies**

This alternative C&I strategy could potentially reduce port requirements by up to 80% and increase throughput by as much as 30% while improving quality and reducing costs. The conventional approach to construction and installation of offshore wind turbines is illustrated in Figure 8 below:

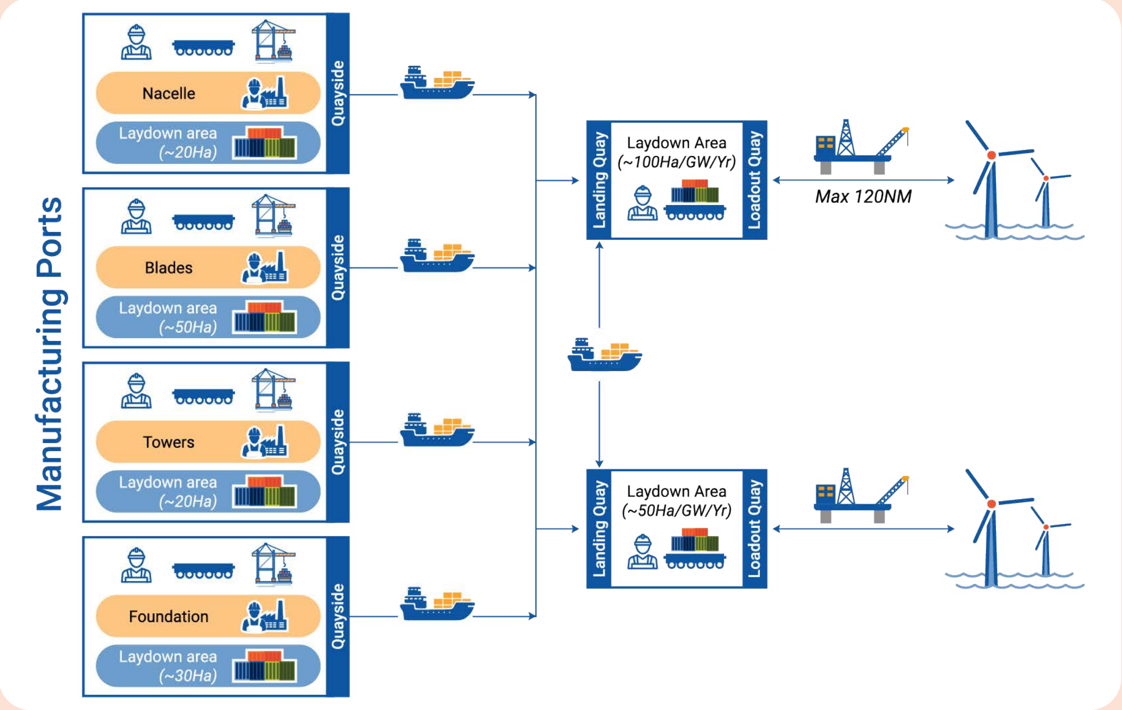



***Figure 8:*** *Offshore wind ports and C&I procedure. Source: [ORE Catapult]*

In the conventional approach, separate ports are used for the manufacture of wind turbine components such as blades, nacelles and towers which are then shipped in batches to a local (adjacent to the wind farm) marshalling port where they are stored temporarily before being installed using a wind turbine installation vessel (WTIV).

This approach requires multiple ports, each with their own investment in quayside, cranage and handling equipment, and inevitably results in a build up of inventory which can lead to supply chain bottlenecks and limitations on the scalability and ultimate capacity or throughput of the system.

In the alternative approach, a single consolidated manufacturing port would produce the main components for a wind turbine, namely nacelle, blades and tower sections. The facility would be geared to produce a given quantity per year, with a likely optimum at around 200 units or 4 GW per year assuming 20 MW turbines).

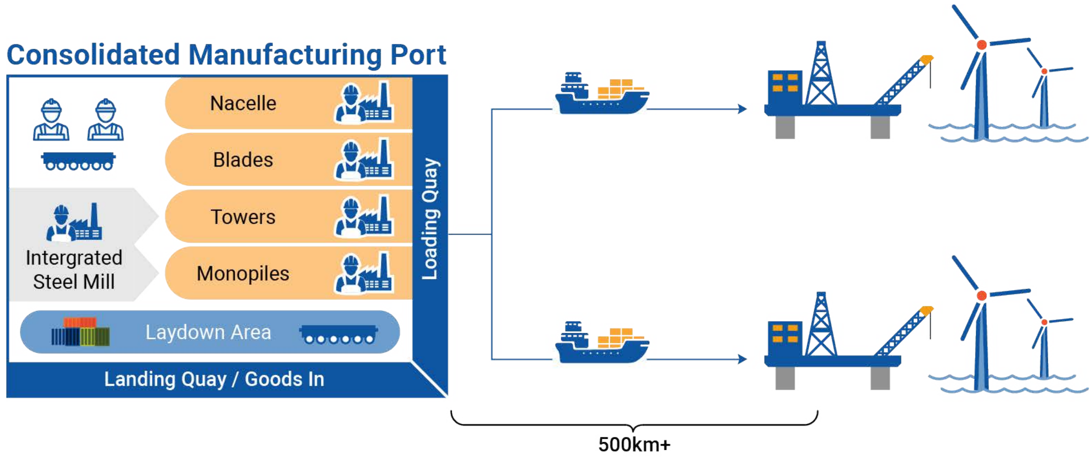



*Figure 9: Consolidated manufacturing and feeder vessel strategy. Source: [ORE Catapult]*

Components are manufactured in sets (as opposed to batches) and loaded straight onto a dedicated feeder vessel optimised to transport the components for a single turbine i.e. one nacelle, three blades and a tower.

The feeder vessel then transports the components directly to the wind farm site where it will rendezvous with a specialised WTIV that completes the turbine installation. Following the turbine installation, the feeder barge returns to the manufacturing port, whilst the WTIV moves to the next turbine location where it will rendezvous with another feeder vessel. This approach has the potential for dramatic efficiency improvements and cost savings across the entire C&I workflow.

This approach would be a reasonably innovative and potential radical and disruptive change from the established methodology. There are many implications that need to be carefully considered prior to adopting this strategy. ORE Catapult has initiated a logistics and techno-economic study that can help to establish the business case and provide insight on the various risks and strategic considerations.

## 2.1 Esbjerg, Denmark

**KEY FINDINGS:**

- Esbjerg (Denmark) is an example of an offshore manufacturing hub that has grown organically over time.
- The port and manufacturing hub benefits from a direct grid line to offshore wind farms, allowing for green manufacturing.
- The case study also shows how manufacturing and other offshore activities have led to the co-location of training institutes & academia in close vicinity.

Esbjerg in south-western Denmark is the world's oldest port dedicated to offshore wind installations. Built in 1868 as fishing port, **manufacturing of offshore wind energy components has organically grown around the harbour.** Since 2000, the Port of Esbjerg has been a public self-governing port owned by the Municipality of Esbjerg. The port is well connected politically. Chairman is Søren Gade, Speaker of the Danish Parliament. Vice Chairman is Jesper Frost Rasmussen, Mayor of the Municipality of Esbjerg [Port Esbjerg, 2025]. The first offshore wind farm off Esbjerg, Horns Rev 1, was built in 2002, consisting of 80 turbines, each 2 MW. In total, 23.6 GW of offshore wind installations, 80% of the European total, had been shipped through Esbjerg port up to 2023 [Port Esbjerg, 2025a]. The region benefited from its first-mover advantage as an offshore hub.

Esbjerg is an example of continuous growth and development. The offshore wind capacity handled at the port is to triple from 1.5 GW to 4.5 GW annually [Memija, 2023]. About EUR 779 million is being invested in offshore wind production capacity, to be ready by 2027. The offshore wind pipeline in the North Sea is 134 GW by 2030 and 300 GW by 2050.

The investment is shouldered by the Danish pension fund, Pension Danmark. The fund invests in age-based pools, aiming to adjust the investment risk accoring to members' age and expected time to retirement. Investments in infrastructure, along with real estate, fall into higher age groups and amount to 12.5% of total investments [Pension Danmark, 2025]. To that end, Pension Danmark initiated a first fund managed by Copenhagen Infrastructure Partners (CIP) in 2012. It invested EUR 4.4 bn in all CIP funds [Pension Danmark, 2025a].

While Pension Danmark invests in the Port of Esbjerg already, there is a need for 'properly designed' financing models such as public-private partnerships (PPPs) and blended finance, in a predictable and clear framework [European Pensions, 2025]. Blended finance defines a combination of public and private means to finance development projects with social and ecological goals. Public entities may reduce the risk of blended finance for private partners by providing free land (for example), something they would not do for a PPP.

Aside from growing Esbjerg's core business, EUR 94 million will be spent towards power-to-X (i.e. hydrogen production) and EUR 67 million invested in sea, road, rail and air infrastructure measures, making Esbjerg a transportation 'multi-model hub' [Memija, 2023].

**The evolution of the Esbjerg offshore hub was supported by the Government through infrastructure investment and industrial policies.** Esbjerg has only 116,000 inhabitants but plans to play a serious role in the energy system of Denmark and Europe. Its development is supported by the local business council, private companies, and deep-pocket long-term financing, with infrastructure support via national and European industrial policies. The Danish Government and the European Union have both supported infrastructure enhancements of the port area to accommodate the growing offshore wind industry. Recent examples include a government grant of EUR 90 million through the North Sea Agreement to accommodate more offshore wind activity and a grant by the European Union totalling EUR 28 million for deepening the fairway accessing the harbour [Port Esbjerg 2024]. Denmark is also investing EUR 2 billion into a hydrogen pipeline linking Esbjerg and the German border [Onyango, 2025].

**Green manufacturing and a carbon neutral port are part of the Esbjerg vision.** A 700 MW subsea cable connects Esbjerg with the Netherlands, via offshore wind farms in the North Sea. Another interconnector to the UK is under construction. This way, green electricity from offshore wind energy can be used directly to power the manufacturing activities in the port area. In the future, the green electricity shall also be used for the planned power-to-X facility (H2 factory) close to the existing airport [Business Esbjerg, 2024] and planned data centres. The objective is to make the port of Esbjerg carbon neutral by 2030.

**The Esbjerg offshore wind energy hub also illustrates how training and academic institutions have located nearby.** Esbjerg has six institutes of higher education [Business Esbjerg, 2024]. Several of these universities and TVETs offer specialised courses related to the (clean) energy sector. For instance, University of Southern Denmark (SDU, Esbjerg Campus) offers a programme titled Energy Systems Engineering (for Bachelor and Master students).[7] Aalborg University offers a Master's programme in Sustainable Energy Engineering.[8] There is also an offshore wind test centre for blades [Interred, 2025]. These courses and programmes have been developed in the past years as a response to job requirements of the offshore and energy industry in the area.

Figure 10 shows the port of Esbjerg and the surrounding infrastructure relevant for the regional offshore wind (manufacturing) hub. The map shows the 700 MW cable connecting it to offshore wind farms, the offshore wind test centre and the planned

[7] https://www.sdu.dk/en/om-sdu/fakulteterne/teknik/forskning/energy
[8] https://www.en.aau.dk/education/master/sustainable-energy-engineering

data centre and hydrogen (H2) factory. It also shows the port expansion area, allowing for the development of a new 57 hectare terminal dedicated to offshore wind energy operations. This expansion is intended to support the logistical requirements associated with the growing production and deployment of wind turbines [EIB 2024].

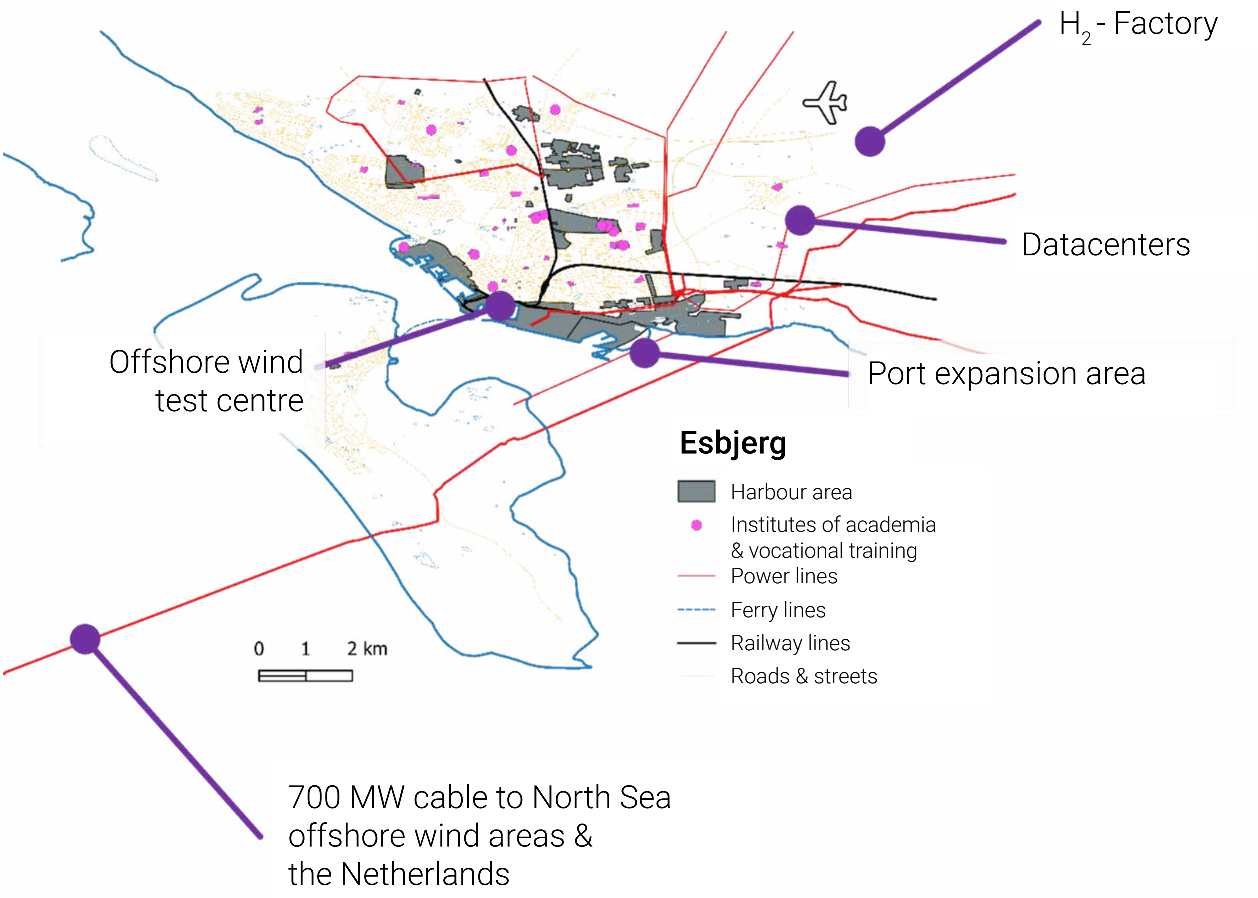



***Figure 10:*** *Port of Esbjerg, Denmark. Source: [Open Street Maps (OSM)]*

**The case of Esbjerg also reveals the synergies between the offshore wind industry and the oil and gas sector.** The modern port of Esbjerg is dedicated to offshore wind, but also serves the offshore oil and gas industries. There are more than 150 companies involved in the offshore industries related oil and gas, employing around 10,000 people directly [StateOfGreen, 2022, Business Esbjerg, 2024]. **There is a large overlap of the offshore wind sector and the oil and gas sector.** More than half of the supply chain companies (56%) work for both sectors [Business Esbjerg, 2024].

The composition of the value chain in Esbjerg is shown in Figure 6. Together, logistics and installation and O&M contribute to more than 50% of the value chain. **O&M accounts for the largest share of the Esbjerg value chain (29%).** Between 2002 and 2013, some 15,000 helicopter services of 45 min flew out of Esbjerg [StateOfGreen, 2013]. It is also noted that the airport near the harbour is vital for the downstream value chain related to offshore wind.

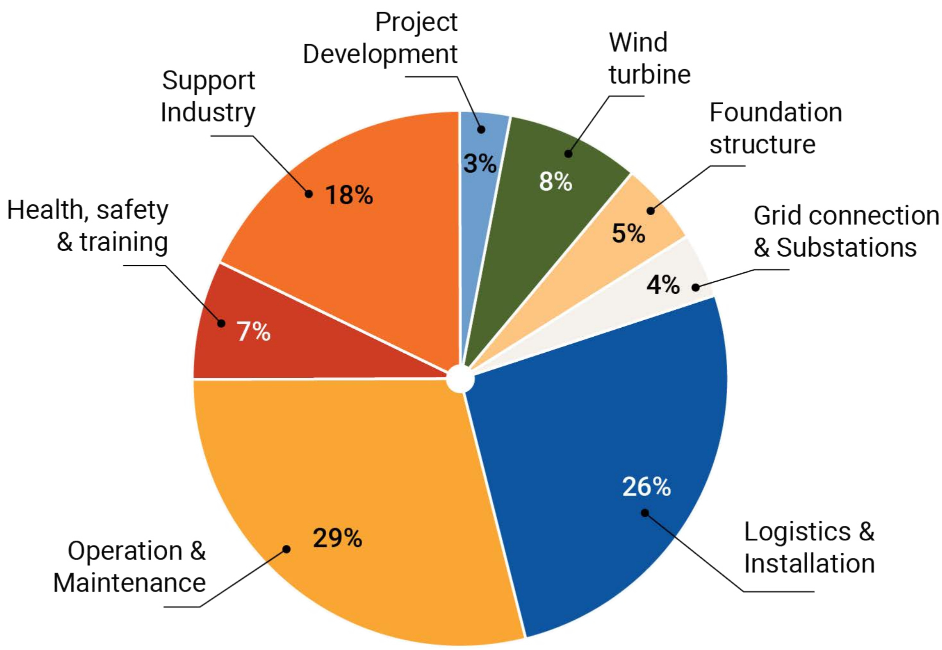



***Figure 11:*** *Industry distribution across the offshore wind value chain in Esbjerg around 2021 [Business Esbjerg, 2024]*

## 2.2 Shantou, Guangdong, China

**KEY FINDINGS:**

- Shantou (Guangdong, China) is an example of an offshore wind manufacturing hub planned by governmental administrations.
- Central to planning the manufacturing hub and its economic viability is the creation of an offshore wind project pipeline locked in step with the manufacturing capacity of the location selected by companies.
- Thus, Shantou is an example for a coordination of energy policy & industrial policy.

**Wind energy component manufacturing in Shantou, in eastern Guangdong Province, China, has become a showcase for the country.** Shantou's population exceeds five million and Guangdong is the most populous province in China at 126 million.

**Shantou has been transformed into one of the largest offshore wind manufacturing hubs worldwide in less than a decade.** The fast uptake was triggered by the political decision to diversify away from Guangzhou, Shenzhen and the Pearl River Delta as important economic centres and to set up green industries in Shantou and seven other regional centres [Li, 2022].

In 2019, Chinese OEM Shanghai Electric began turbine manufacturing, starting with 7 MW turbines and later moving to 11 MW turbines. The production of 16 MW turbines was being planned in 2022 [Lu, 2022; Qiushi 2023]. In 2024, the Shantou Offshore Wind Power Equipment Manufacturing Industrial Park was created close-by [Yu, 2024], with investments for infrastructure and the integrated manufacturing value chain amounting to around EUR 500 million each [Lu, 2022; Seetao, 2022]. The second OEM on site, Goldwind, produced the first 22 MW turbine in 2024 [Goldwind, 2024]. The industrial park aims to cover the entire offshore wind value chain, including R&D, design, manufacturing and testing certification [China Daily 2024].

China has successfully promoted the growth of its offshore wind industry. Four instruments stick out:

- Solid and predictable project pipeline;
- Top-down target allocation (from national to provincial governments);
- Interaction between policy makers and renewable energy developers (to the point of that state founding developers); and
- Tradeable Green Certificates (TGC) incentivising the system.

**The massive investment in manufacturing infrastructure has been triggered by a steady & foreseeable demand for offshore wind products in the Chinese market.** The national market and ambitious targets for offshore wind energy are key drivers for the fast development in Shantou. In other words, there is no manufacturing without a market.

**The regulatory environment in China** incentivised early movers for offshore wind projects in the 2010's by paying, through its National Renewable Energy Fund (NREF), a feed-in-tariff equal to the difference between the local on-grid price for coal-fired power paid by the grid company and the on-grid price of offshore wind power set by the National Development and Reform Commission (NDRC). The on-grid price for offshore electricity was CNY 0.75/kWh and CNY 0.85/kWh for intertidal and near-shore plants respectively until 2018 (Wei, Zou, Lin, 2021).

Replacing national subsidies, different subsidies were paid by provincial governments. In the case of Guangdong, local projects approved by the end of 2018 were given CNY1,500/kW if fully grid-connected by 2022, CNY 1,000/kW if connected by 2023 and CNY 500/kW if connected by 2024, rewarding short installation times (Dutch Ministry of Foreign Affairs, 2022).

Local governments in China are recognising the advantages of offshore wind:

> *"As an emerging industry, the value chain of offshore wind power includes many other economic activities and industries. It not only contributes to energy, environment and green sectors, but also GDP, jobs and new industries."*
> *(Wei, Zou, Lin, 2021)*

China and its provinces set up wind power related companies, presumably hundreds (70 in the province of Jiangsu alone), and charged large state-owned enterprises with offshore wind power development (Wei, Zou, Lin, 2021).

As the burden of subsidies on national coffers increased, the regulations **adopted an auction system of Tradable Green Certificates (TGC),** first separate from the use of the green energy generated as REC, but successful (Huang et al., 2024), and then linked to it as Green Energy Certificates (GEC), intended to be the sole proof of renewable energy use from Apr 2025 (ACT, 2024). While the energy transition is one reason, China aims at making the carbon footprint of its renewable energy products internationally traceable to be prepared for future trade (Liu, 2025).

Figure 12 shows a map of the Shantou offshore wind hub. It includes a SEZ (where manufacturers benefit from tax incentives and other incentives), the manufacturing site of OEM Shanghai Electric and the Integrated Offshore Wind Manufacturing Hub. The new container harbour is located out of the city, where the traditional port area lines the river, across the peninsula to the south. The expansion of the new harbour towards the west is possible.

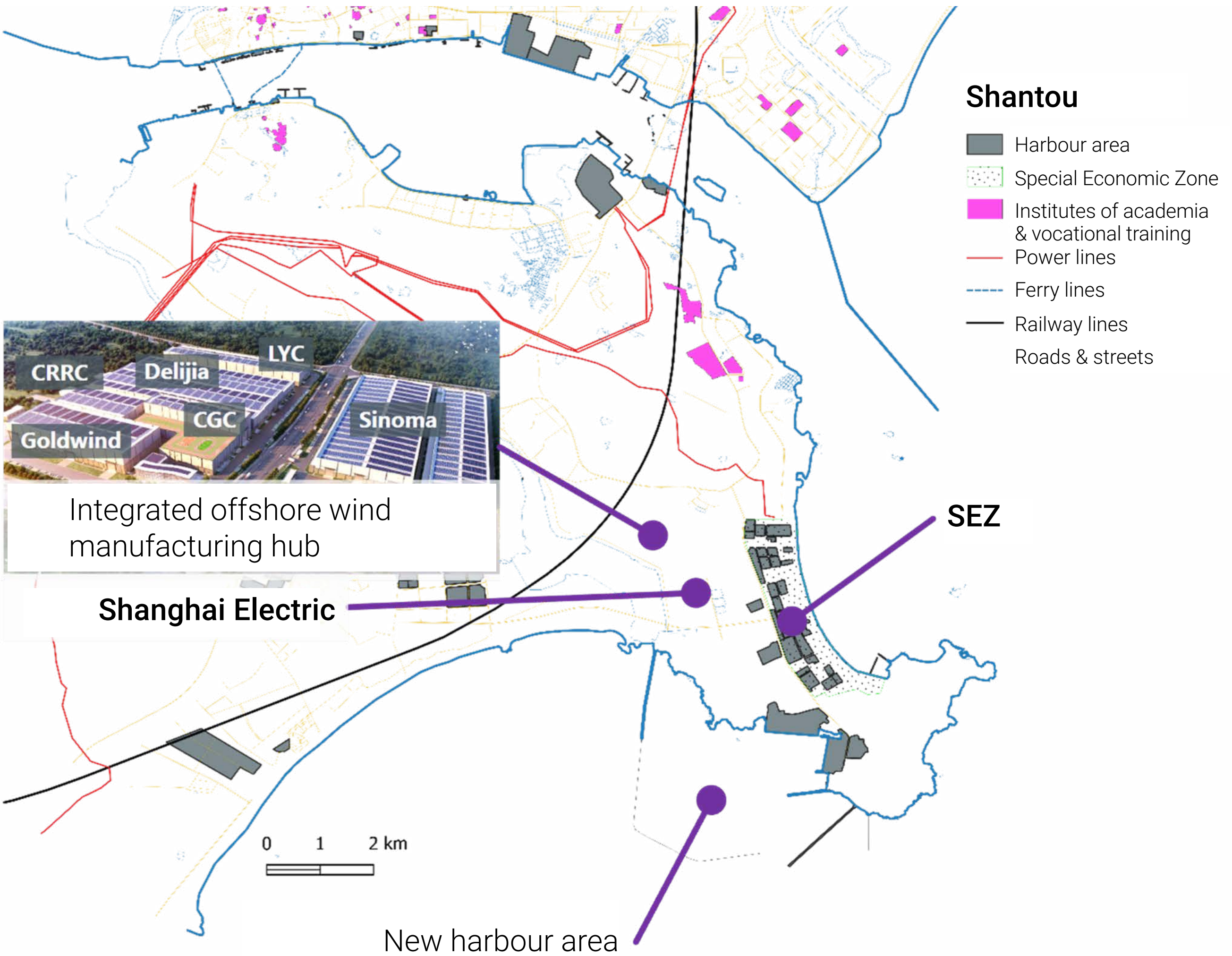



***Figure 12:*** *Port of Shantou, Guangdong, China. Source: [Open Street Maps (OSM); Baidu; Yu, 2024]*

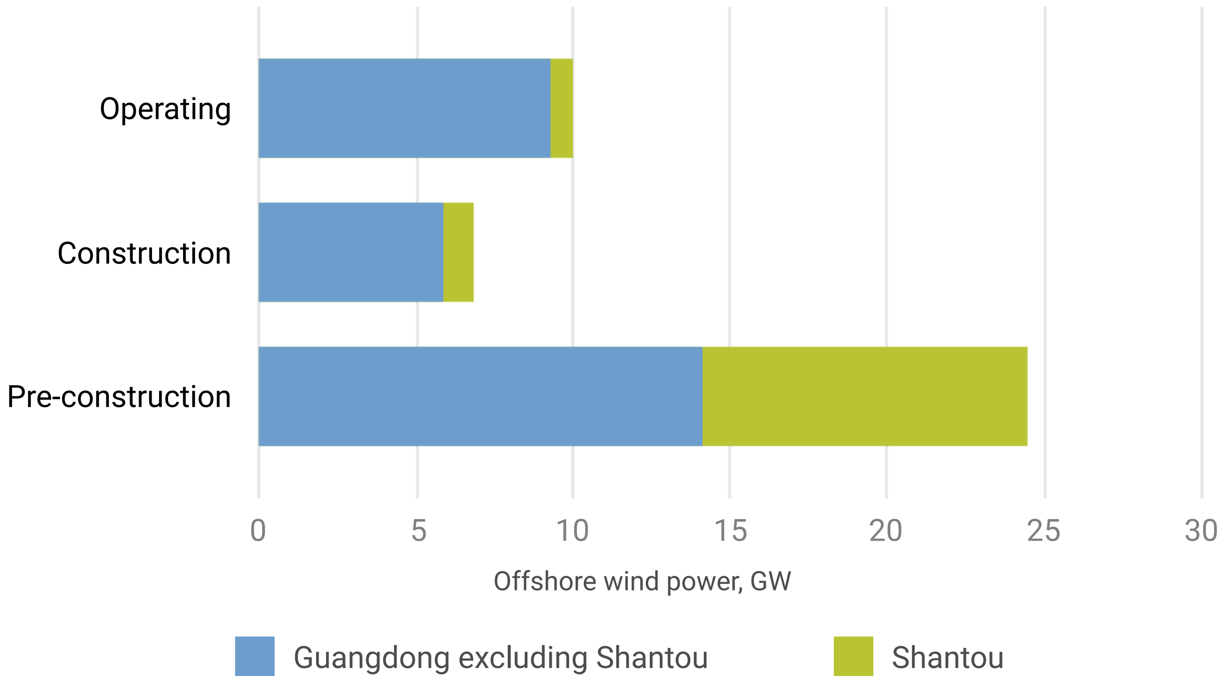



***Figure 13:*** *Offshore wind project pipeline in Guangdong province (excluding Shantou City) & Shantou City, China. Plants operating, under construction, and in pre-construction, in gigawatt (GW). Source: [GEM, 2025]*

Guangdong province currently has a 10 GW project pipeline [GEM, 2025] (Figure 13). The pipeline consists primarily of offshore wind projects for the regional market. **The offshore wind manufacturing sector in China is supported by a comprehensive industrial policy.**[9]

[9] An analysis of the detailed elements of the Chinese industrial policy are beyond the scope of this analysis but should be the focus of a follow-up analysis.

## 2.3 Taichung, Taiwan

**KEY FINDINGS:**

- Taichung (Taiwan) was created via a detailed local content policy by the Government but has suffered from a number of setbacks as an offshore wind manufacturing hub.
- The costs of domestically manufactured offshore wind plants are considerably higher than those produced internationally, primarily due to gaps in the value chain, quality challenges and the complex geomorphology of the seabed.
- Eventually, the local content policies had to be abandoned.

**For Taiwan's Government, the development of offshore wind is not solely a matter of energy security, but also a strategic initiative to stimulate industrial growth and position Taiwan as a regional hub** for supply and expertise in the expanding Asian offshore wind market (Metal Industry Intelligence 2022). The Government of Taiwan announced a 'Thousand Wind Turbines Project' in 2012. After lifting sanctions on foreign ownership of manufacturing companies and the introduction of 20-year guaranteed feed-in tariffs, offshore wind power investments from the EU had, by 2020, grown to become the largest source of foreign investment in Taiwan.

A zonal and phased development plan was released in 2021, with 1.5 GW of offshore wind to be installed in the years 2026 to 2027, 1.5 GW in the years 2028 to 2029 1.5 GW in the years 2030 to 2031, and a possible 6 GW between 2031 and 2036 [Chiang, 2023]. Nonetheless, the development process has faced notable setbacks. Early assessments highlighted challenges such as a complex seabed, inadequate local infrastructure and a shortage of skilled labour [Harris, 2019]. In addition, typhoons have caused damage to wind turbines in Taiwan [Chou, 2019].

**The case of Taiwan reveals the impact of local content requirement on offshore wind manufacturing.** There are two possible approaches to implement local content rules for renewable energy projects in Taiwan:

- A percentage-based system and an item-based system. Under the more common percentage-based system, a given share of the equipment used in the renewable energy project must come from local sources.
- Under an item-based system, as in Taiwan for offshore wind, project developers must adapt components from a list provided by the Government.

**Taiwan had clear but strict local content rules (LCRs)** in 2023. **The item-based system was criticised for being less flexible than a percentage-based system** which "would free the industry to find the most globally competitive players in Taiwan's manufacturing sector" (Ferry 2020). According to Ferry (2020), as few of the suppliers listed by the Tainwan's Industrial Development Bureau (IDB) have the manufacturing capacity or know-how to participate directly in the supply chain, they require substantial investment in equipment, training and technology transfer. Local suppliers are struggling to reach the quality standards required for the industry. Referring to the first two rounds, Gao et al (2021, p.8) state that "developers have complained about Taiwan's industrial capacity for the LCR after securing a beneficial power purchase agreement with Taipower". GWEC has also stressed that "most challenging for the offshore wind industry has been local content provisions in place in Taiwan, which have slowed market growth due to the challenge of offshore wind developers finding sufficient local capability" (GWEC 2022, p.15) and that despite its more flexible rules, "the requirements in the Round 3 rules are still very challenging" (GWEC 2022, p.61).

**Local content requirements in Taiwan emerged in mid-2017 to adjust plans and consider industry development.** In early 2018, detailed rules addressed LCR and non-LCR selection and a tender scheme was adopted by the country's Ministry of Economic Affairs (MOEA). Two rounds of auctions were organised in this "transition" stage[10]. Then a slight modification of the LCR policy was approved in 2021 and a third round is being conducted under the new rules, which increased the flexibility to achieve the local content requirements. Therefore, two stages regarding LCRs in Taiwan can be discerned:

- Transition rounds (2018, first and second auction rounds)
- The Industrial Relevance Programme (third auction round)

## Transition rounds (2018, first & second auction rounds)

The IDB developed a policy framework to promote supply chain localisation, listing critical development items for localisation for different phases: tower, foundations and onshore power facilities for the Preparation Phase (2021-2022) and another 14 items including blades, castings and nacelle assembly for Phase 1 (2023) and Phase 2 (2024-2025). Developers which are awarded contracts during Phase 2 (Zone Application for Planning) are required to submit a detailed Industrial Relevance Plan (IRP), along with relevant formal or conditional commercial contracts, within the specified time limit. If a Taiwanese supplier fails to deliver in time due to poor product quality or a production scheduling issue, the Government will ask the developer to propose a support plan. If the developer fails to fulfill its IRP commitments, the MOEA may, in accordance with the administrative contract entered between both parties, confiscate the performance bond previously paid by the developer, cut the feed-in tariff price or terminate the administrative contract in the event of a substantial breach (Metal Industry Intelligence 2022).

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[10] In April and June 2018, 3.098 GW of the allocated 5.7 GW was subject to LCRs (Gao et al 2021).

Most developers with LCRs were obliged to follow the detailed offshore wind IRP (Table 1) and submit their LCR reports for review by the IDB. The IDB published review guidelines on November 13, 2018 (Gao et al 2021). Table 20 indicates an ambitious supply chain requirement for the short term by 2025.

| Timetable for grid connection | 2021 / 22 | 2023 | 2024 | 2025 |
|---|---|---|---|---|
| **Phases** | **Pre-stage** | **Phase 1** | **Phase 2** | **Phase 3** |
| **Required industrial development items** | **Tower - Foundation - Electrical Components:**<br>1. Transformer<br>2. Switchgear<br>3. Distribution panel<br>*(the above are onshore electric equipment)*<br>**Marine engineering planning, design, construction, supervision & manufacturing:**<br>1. Construction & supervision of investigation, cable laying, exploration, etc. Planning of ship and machine tool design and safety<br>2. Shipbuilding: development of ship industry supply chain for new ships or ship restoration *(including ships for investigation, support, seabed preparation, transportation & cable laying)* as per the IDB. | **Wind turbine components:**<br>Rotor nacelle assembly, transformer, distribution panel, uninterruptible power supply, spinner, cable, rotor hub, bolts<br>**Submarine high voltage cable**<br>**Marine engineering planning, design, construction, supervision & manufacturing:**<br>1. Construction and supervision of tower, foundation, etc. Planning of ship and machine tool design & safety *(BOE)*<br>2. Shipbuilding: provide the construction ship industry supply chain for new ships or ship restoration *(including ships for transportation & construction)* as per the IDB<br>**Pre-stage items for 2021 & 2022** | **Wind turbine components:**<br>Gearbox, generator, power converters, rotor blade and epoxy resin, nacelle cover, nacelle bed frame / plate<br>**Marine engineering planning, design, construction, supervision, and manufacturing:**<br>Construction & supervision of wind turbines and others. Planning of ship and machine tool design and safety *(BOE)*<br>**Pre-stage items for 2021 & 2022**<br>Phase 1: items for 2023 | **Pre-stage items for 2021 & 2022**<br>Phase 1: items for 2023<br>Phase 2: items for 2024 |

***Table 1:*** *Taiwan's Offshore Wind Power Industrial Relevance Implementation Programme Plan. Source: Adapted from Gao et al (2021).*

## The Industrial Relevance Programme (third auction round)

On December 6, 2021, the IDB introduced the Industrial Relevance Programme for Zonal Development, labeling 25 critical development items required for localisation and 56 items for “bonus points”. The required items are mostly the same as in the previous phase, with a few new additions such as onshore cable and engineering design service (Metal Industry Intelligence 2022). Compared to the LCRs in the Transition Round, the IDB now classifies the technologies that are difficult to localise (such as the generator for wind turbines) as optional items of industrial relevance. It also provides a more flexible requirement of implementation (Jones Day 2021). A bidder will have to commit to locally procure all the “key development items” for at least 60% of its proposed capacity. There will also be opportunities to go beyond the 60% and receive additional points in the scoring system (GWEC 2022, p.61), i.e. the remaining 40% are for the optional items. Therefore, the new localisation policy for Phase 1 of Round 3 auctions for wind farms operational from 2026-2027 sets a 60% local content with the remaining 40% on a bonus point mechanism for engineering service segments, which usually has limited local content. Locally made key development items will only need to make up 60% of the capacity applied for, instead of 100% as previously proposed, to give developers greater flexibility (Harris 2021).

**As of November 2024, Taiwan has ceased applying local content requirements for offshore wind energy projects.** This policy change resulted from an agreement with the EU to address concerns about the fairness of Taiwan's previous localisation policies. The EU had initiated a dispute through the World Trade Organisation (WTO), arguing that Taiwan's local content requirements discriminated against imported goods and services. In response, Taiwan committed to removing these requirements from future offshore wind project allocations, both as eligibility conditions and award criteria (The Maritime Executive 2024). The recent tender round 3.2 ended without European companies winning any bids [Maritime Executive, 2023]. Offshore wind companies are producing in Taiwan [Buljan, 2024]. About 2.5 GW of offshore wind is operational, 2.5 GW under construction and 5 GW in pre-construction [GEM, 2025]. Manufacturing seems mostly according to plan.

Figure 14 shows the map of the Taichung offshore wind hub. Nacelle, monopile and blade production sites have been erected on the quay next to the steelworks. Expansion of the manufacturing hub is possible.

**The cost for offshore wind in Taiwan is reported to be USD 190/MWh (2024) due to the issues with local content and an ‘immature’ local supply chain** [Ferry, 2024]. As an example of the latter, there are no production facilities for high USD 107/MWh [Lazard, 2024]. There appears little doubt that various challenges have significantly increased the cost of offshore wind projects. Attributing these complications solely to an ambitious local content policy oversimplifies the issue.


***Figure 14:*** *Port of Taichung, Taiwan. Source: [Open Street Maps (OSM)]*

## 2.4 Gwangyang, South Korea

**KEY FINDINGS:**

- Gwangyang in South Korea is an example of an offshore wind hub specialising in a specific part of the value chain, namely production of essential steel components. It is not a typical offshore wind manufacturing hub but focuses on the upstream section of the value chain.
- The port is home to the world's largest steelworks. Companies can provide competitive high-quality steel plates and flanges that are required for wind turbine foundations and towers.
- South Korea's offshore wind industry is 'nascent', but South Korea has a competitive advantage in the manufacture of these critical steel parts and around the planning of offshore wind power plants.

**Gwangyang in South Korea is an example of an offshore wind hub specialising in a specific part of the value chain, namely production of essential steel components.** Gwangyang is home to the world's largest steel works. As offshore wind turbines and their foundations require high-quality rolled steel, Gwangyang is a natural choice for localising parts of the offshore wind supply chain. Steel plates made in Gwangyang have been certified to the norm S355, relevant for wind turbines [Posco, 2022].[11] Buyers claim this steel grade is not available everywhere, making it a good example for unique selling points (USPs) of certain industrial regions, on the one hand, and an example for the challenges of local supply chains and local content rules on the other hand.

**The Gwangyang Bay Area Free Economic Zone (GFEZ) aims to develop a hub for new industries, logistics, tourism and high-tech materials** [GFEZ, 2021; Korean Free, 2025]. **The SEZ attracted the world's largest wind tower maker in 2014 [Invest Korea, 2014],** though the company appears to have moved on and currently only has manufacturing in other countries, e.g. in Vung Tau, Viet Nam. The company entered a joint venture with a wind turbine maker in 2022 [CS Wind, 2022], dedicated to the Korean market, yet without tangible results to date.

Figure 10 shows the western part of the harbour of Gwangyang in South Korea. The massive port is dominated by a SEZ around the world's largest steelworks. Residences and a national park are designed to attract workers taking interest in a work-life balance. Living quarters and work areas are connected by public rail transport.

[11] Offshore wind relies on heavy plates made to S355 (the number refers to a yield point exceeding 355 MPa), 170 mm thick, 42t in weight, corrosion resistant, cold formable and easily weldable [Dillinger, 2024].

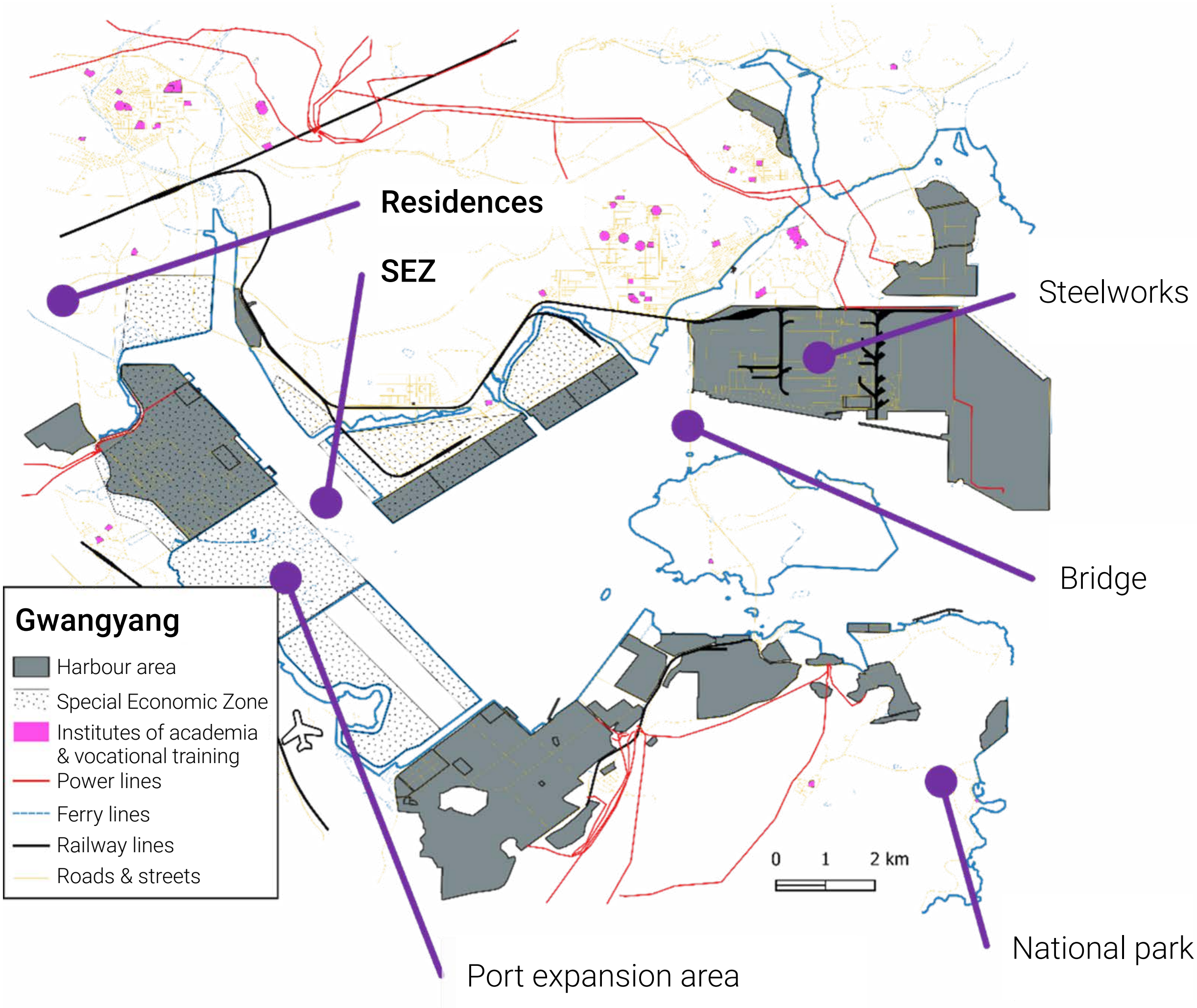



***Figure 15:*** *Port of Gwangyang, South Korea. Source: [Open Street Maps (OSM); GFEZ, 2021]*

**The 2023 supply chain in Korea is described as 'nascent'** [Carbon Trust, 2023]. Of about 200 companies working in offshore wind, more than half of them were involved in the planning stages of the offshore wind power plant. These services are required early in the lifestage of a wind farm and give hope to the evolvement of an industry ecosystem accompanying the life of the wind turbine towards decommissioning. There is no company here which is involved in the end-of-life tasks. Korean companies are world-leading in tower production and in forged parts for wind, such as flanges [Korean-German Chamber of Commerce, 2023].

Gwangyang is a deep-water harbour with water depths of 5-23.5 m and a 25 km quay. The Yi-Sun-Sin-Bridge limits the clearance of ships entering the western parts of the port to 80 m [Wikipedia, 2024]. This will prohibit very large WTIVs entering the port. Also, vertical transport of towers, blades and monopiles can only happen east of the bridge.

## 2.5 Newcastle, New South Wales, Australia

**KEY FINDINGS:**

- Newcastle is trying to restructure its coal-based industry and fulfil the goals of the energy transition at the same time. The restructuring described below is currently conceptual and in a planning stage.
- The economy of Newcastle and the surrounding Hunter region suffer from the volatility of coal export prices. Still, Newcastle is the world's largest coal export port.
- The offshore wind industry does not currently follow the invitation to produce locally, as the project pipeline is small.
- Australia is taking local participation and societal consent seriously, affecting industrial restructuring.

The Hunter region around the port of Newcastle, in New South Wales, Australia, proposes to restructure into a **Renewable Energy Industrial Precinct (REIP), the Australian equivalent of a RE Hub.** Businesses within each hub would be powered by 100% renewable energy. They could produce green steel, green aluminum, critical minerals, ammonia and cement, and manufacture all products using renewable power in a local hydrogen economy. Newcastle's industry encompasses hard-to-abate processes which cannot be easily electrified.

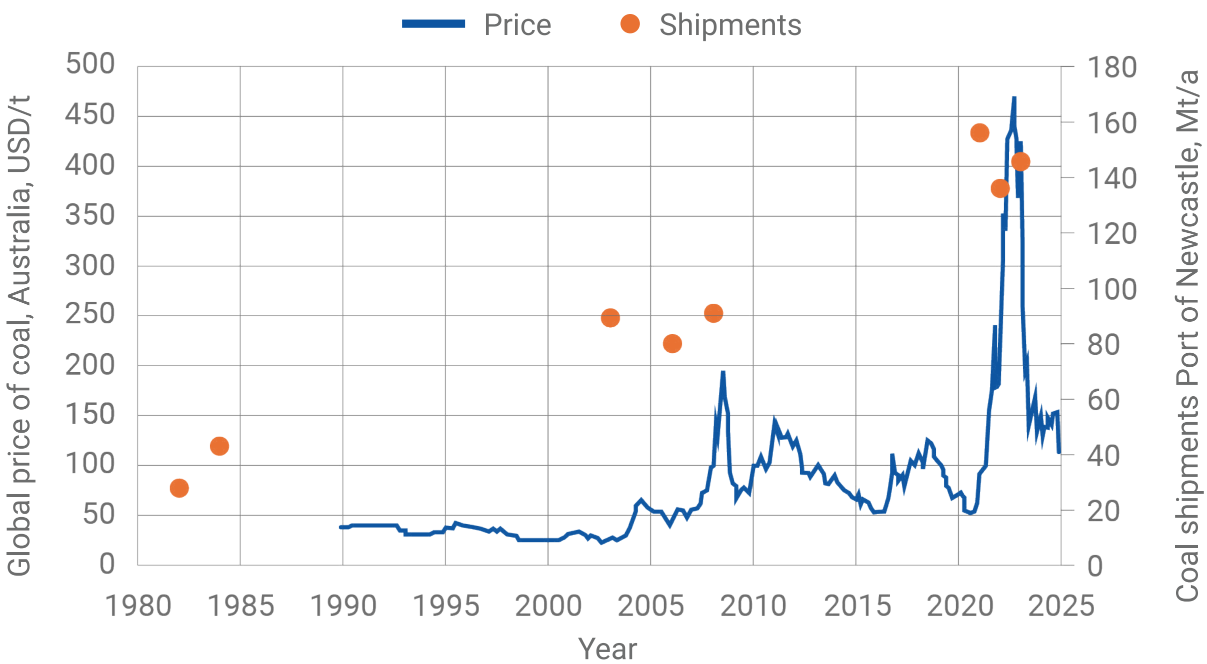



***Figure 16:*** *Global price of coal, Australia, in USD/t. Source: [FRED, 2025]. Coal shipments out of Port of Newcastle, in million tonnes per annum. Source: Zacarias, 2008; Argus, 2024]*

**Newcastle is the world's largest coal export port.** Shipments have steadily increased to 160 million tonnes per annum [Zacarias et al, 2008; Argus, 2024]. Unfortunately, the spot price paid for a tonne of coal has fluctuated widely from lows of USD 50/t in 2016 and 2020 to highs of USD 450/t in 2021 (see Fig. 16) [FRED, 2025]. While coal is still in demand globally, Newcastle planners understand that, both economically and from the standpoint of the energy transition, industrial restructuring is unavoidable and an opportunity: 'Establishing a Renewable Energy Industrial Precinct (REIP) in the region will support the Hunter's ambition to diversify its economy and realise its full potential in the zero-emissions economy' [Beyond Zero, 2022]. The REIP could unlock capital of AUD 28 bn, create 34,000 jobs, generate AUD 11 bn in revenue and protect existing manufacturing activities by repowering with renewables.

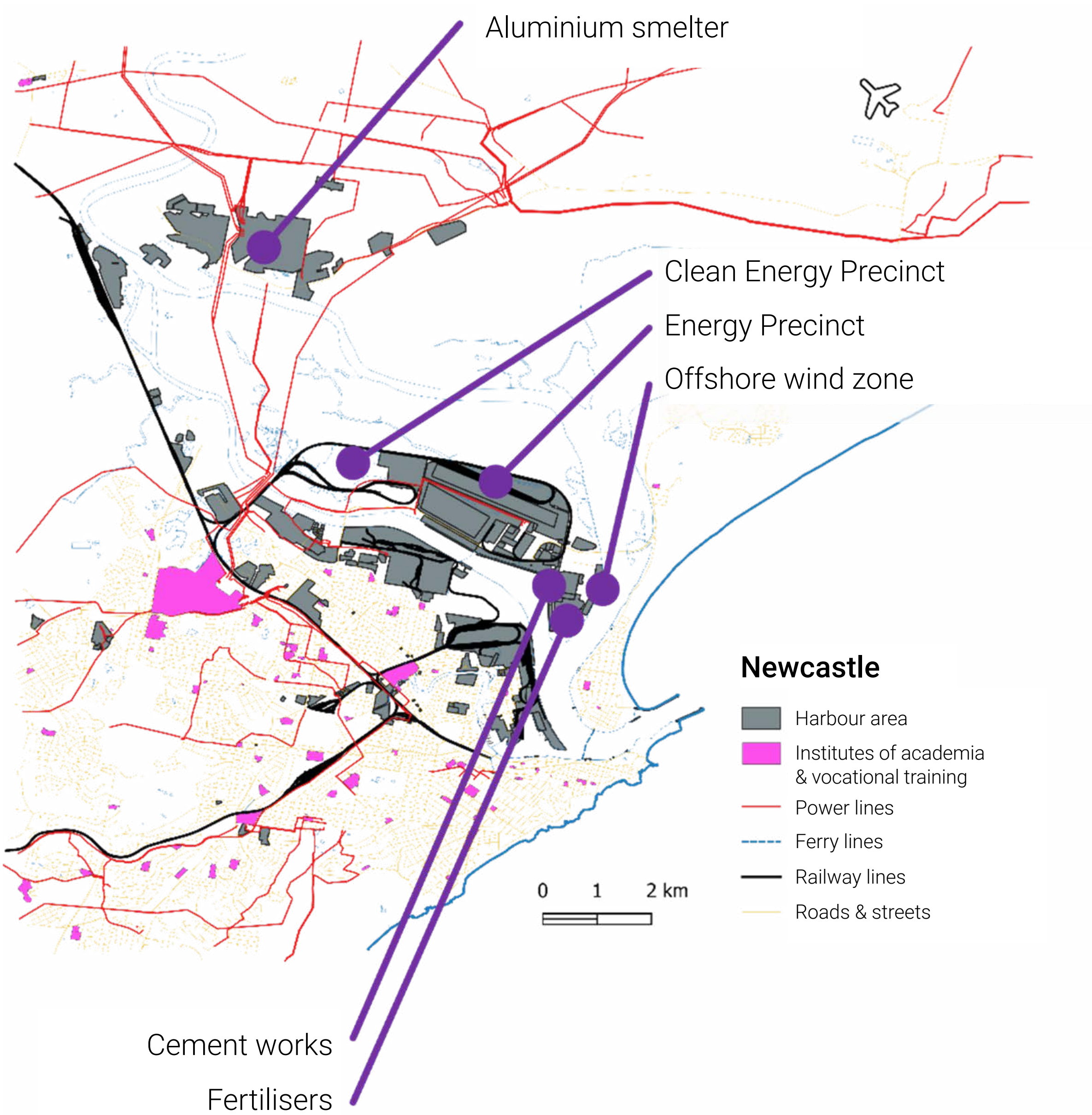



*Figure 17: Port of Newcastle, New South Wales, Australia. Source: [Open Street Maps (OSM); Port of Newcastle, 2025]*

**The Hunter REIP can be seen as an example for industrial restructuring and the energy transition, moving from a coal hub to green manufacturing.** Figure 17 is the map of Newcastle in New South Wales, Australia. The city is dominated by traditional industries based on coal. The Port Authority has published maps describing the introduction of a Clean Energy Precinct upriver from the Energy (coal) Precinct [Port of Newcastle, 2025], and a **harbour zone for manufacturing and loading offshore wind power components** [Port of Newcastle, 2025a].

The energy-intensive production sectors, such as aluminum smelting, cement manufacturing and fertiliser production, are not only heavily reliant on coal, but also represent hard-to-abate processes, where electrification poses significant technical and economic challenges. The planned renewable energy hub could generate hydrogen, which can be used in hard-to-abate processes or become part of it as a chemical compound in ammonia used in fertilisers.

**There is academic support for offshore wind from universities forming the Australian Centre for Offshore Wind Energy** (ACOWE) [Newcastle, 2024]. The shortage of a skilled workforce has been identified as a potential bottleneck that could hinder the development of offshore wind in Australia [ACOWE, 2025].

**Currently, there are no immediate plans by offshore wind OEMs to establish manufacturing operations in Australia, as confirmed by interviewees.** As Larkin et al. (2024) highlight, industrial restructuring — including re-industrialisation — is a complex policy challenge that demands broad societal support, local engagement, a robust pipeline of offshore wind projects and a competitive supply chain. Realising the economic opportunity will require significant effort and investment.

## 2.6 Cuxhaven, Germany

**Cuxhaven has become a key strategic location in Germany's offshore wind energy sector.** Central to this development is the German Offshore Industry Centre (Deutsches Offshore-Industrie-Zentrum, DOIZ), **a 450 hectare integrated facility designed to support the production and logistics needs of the offshore wind industry.** The centre includes specialised port terminals, heavy-lift platforms and expansive storage areas for large-scale wind turbine components, underscoring the region's long-term commitment to advancing renewable energy infrastructure.

Cuxhaven is a small city of 50,000 inhabitants located 100 km west of Hamburg, in Germany. Its location at the mouth of the river Elbe is close to offshore wind plants in the North Sea. Cuxhaven is a deep-water port with 15.8 m depth. Quays have been adjusted to the requirements of heavy wind components, with floor loads reaching 90 t/m², allowing complete wind turbines to be assembled on land [Cuxhaven Development, 2025].

**Cuxhaven is partner in the European Offshore Wind Port Alliance, a partnership of ports involved in offshore wind** [Port Alliance, 2025]: Port Oostende in Belgium, Groningen Seaports/Eemshaven in the Netherlands, Niedersachsen Ports/Cuxhaven in Germany, Nantes-Saint Nazaire Port in France, Humber in the UK and Port Esbjerg in Denmark, as well as Szczecin-Świnoujście in Poland. The alliance covers the Baltic Sea, North Sea and Mediterranean Sea.

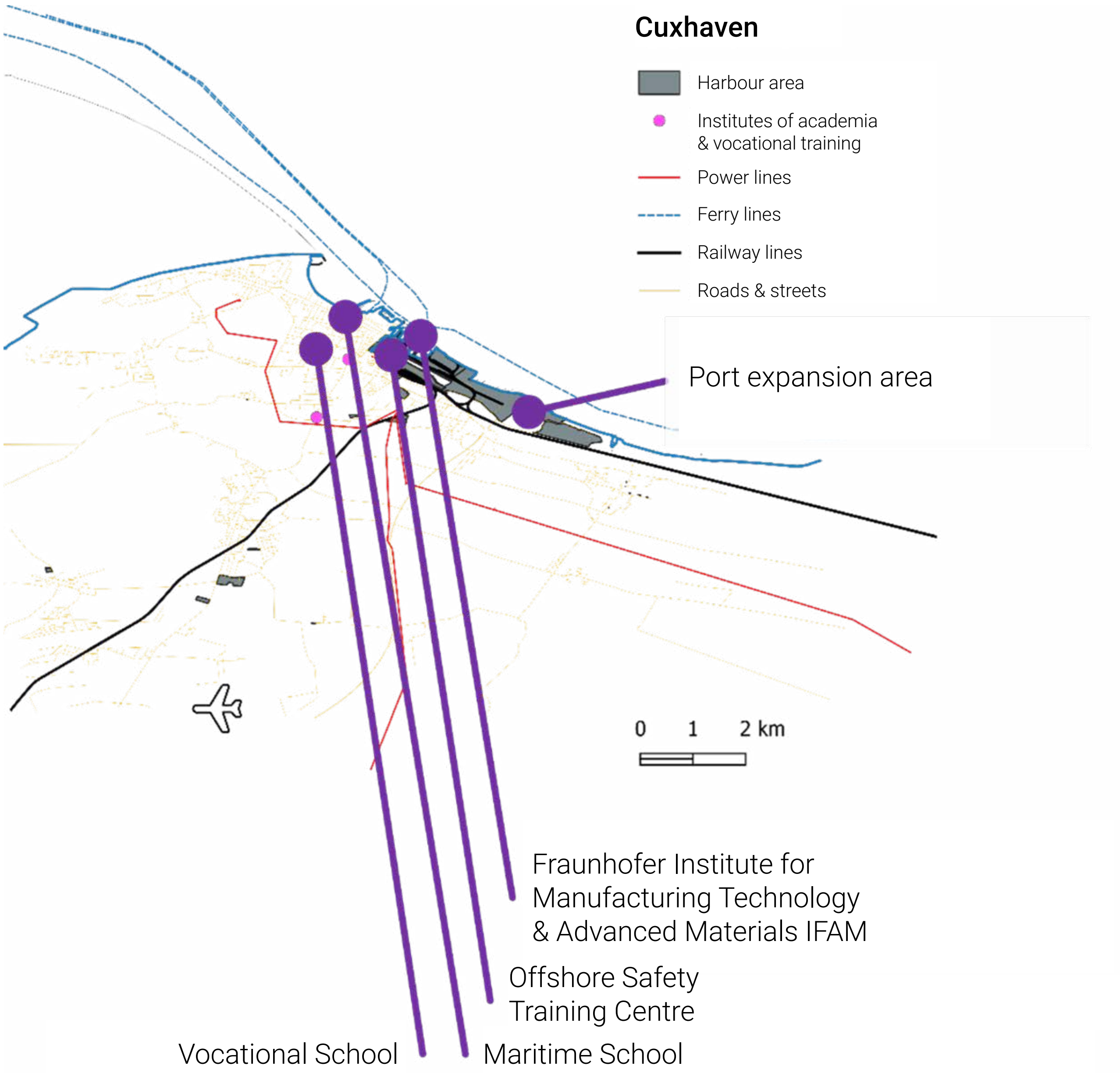



***Figure 18:*** *Port of Cuxhaven, Germany. Source: [Open Street Maps (OSM)]*

Figure 18 shows the map of Cuxhaven, Germany. **The small city has a 24/7 airport and is a deep-water port.** The expansion of the harbour along the river Elbe is possible. There are several vocational schools, one offshore safety training centre and a national research institute.

**Cuxhaven is supported by the EU and the state of Lower Saxony,** which have invested EUR 250 million between 2006 and 2018 in infrastructure in Cuxhaven [Cuxhaven Development, 2025]. National and regional governments support national manufacturing industries at 20% of Capex in the case of an OEM for the upgrade of turbine size [Lower Saxony, 2024]. Foreign companies are indirectly supported by providing the logistics in and around the port. A foundation maker which invests EUR 300 million, benefits from a harbour expansion provided by another EUR 300 million [NDR, 2024]. Importantly, in the European landscape of subsidies, the EU has cleared the process [Erneuerbare Energies, 2024].

Cuxhaven City's Agency for Economic Support has short-term and long-term plans for the hydrogen economy and focuses on the energy transition towards renewables [Cuxhaven Development, 2023].

**Training and skills development is a core element of Cuxhaven's strategy.** As part of its strategic approach, Cuxhaven leverages its maritime heritage to foster a strong training and research ecosystem. This is further reinforced by the establishment of a national research institute presence, positioning the region as a knowledge hub for offshore wind innovation and workforce development. The two largest offshore wind manufacturers employ 1,600 people combined (out of 20,700 total jobs available in all sectors in Cuxhaven) [Cuxhaven Development, 2023; Komsis, 2025].

**Cuxhaven is home to several vocational training institutes and a national research institute** (see Figure 18). BNVHS GmbH Cuxhaven offers modular training programmes specifically designed for the wind energy industry, including qualifications in fibre composites, offshore welding and safety procedures.[12] The Offshore-Kompetenzzentrum Cuxhaven UG[13] provides essential safety and emergency training tailored to offshore conditions. Its programmes cover areas such as helicopter evacuation, underwater escape and height rescue, ensuring personnel are prepared for the challenging offshore environment. DEWI-OCC Offshore and Certification Centre GmbH, an accredited body for wind turbine certification, also contributes to workforce development through specialised training linked to onshore and offshore wind technologies.[14] These institutions form a comprehensive skills development network that supports Cuxhaven's position as a key node in Germany's offshore wind energy supply chain.

[12] https://www.offshore-windindustry.com/20-bildung
[13] https://en.wind-turbine.com/providers/offshore-kompetenzzentrum-cuxhaven-ug
[14] https://en.wind-turbine.com/providers/dewi-occ-offshore-and-certification-centre-gmbh

Chapter 03

# RE Electricity Generation in RE Hubs & for Green Manufacturing

# Chapter 3: RE Electricity Generation in RE Hubs & for Green Manufacturing

The concept of RE Hubs in Viet Nam includes several components, namely manufacturing, RE electricity generation, up-skilling and others. When planning RE Hubs for manufacturing, it is crucial to also plan the necessary RE electricity generation assets in order to allow for "green manufacturing" with green electricity

## Drivers for using RE electricity for green manufacturing

Several offshore wind and renewable energy manufacturing hubs have mechanisms in place to **ensure that electricity required for production process comes from renewables.**

This is especially important in the light of **international initiatives that implement carbon border taxes** for specific products that have not been produced with clean energy sources. The EU Carbon Border Adjustment Mechanism (CBAM), for instance, is a climate policy tool that places a carbon price on imports of certain carbon-intensive goods (EU 2023). Producing goods with low carbon emissions will help avoid potential negative trade-related impacts.

In addition, **many auctions for offshore wind energy projects in Europe now require or give preference to project developers that use equipment that has been produced with renewables or clean electricity.** The UK, for instance, has included "decarbonisation output" as one of the non-price criteria when selecting offshore wind project developers as part of the competitive procurement process. The "decarbonisation output" selection criteria will reward projects with the least carbon intensive supply chains. Similar mechanisms have been put in place in France, Norway and the Netherlands (WWF 2024).

## Options to produce RE electricity for green manufacturing hubs

To accelerate the deployment of RE installations in RE Hubs and provide green electricity for green manufacturing, Viet Nam will have several options which can also be pursued in parallel:

- **Option 1:** Build RE generation units (plus batteries) close to RE manufacturing hubs.
- **Option 2:** Plan the offshore wind grid in a way that electricity from offshore wind can be directly delivered to the manufacturing hub (plan landing substations at RE manufacturing hubs).
- **Option 3:** Establish REDZs, easing the planning and construction of renewables in these areas and providing electricity via direct transmission lines from these REDZs to RE manufacturing hubs.
- **Option 4:** Establish a certificate trading mechanism, allowing manufacturers to certify that their electricity is from renewable energy sources via "virtual" certificates (no direct connection between RE generators and RE manufacturing hubs required).
- **Option 5:** Source RE electricity generation directly via DPPAs.

## Option 1: Build RE generation units (plus batteries) close to RE manufacturing hubs

Renewable energy and storage power plants can be located within or close to RE manufacturing hubs to, at least partially, provide electricity for green manufacturing. In this way, RE electricity can be produced on-site and consumed directly in manufacturing.

Wind and solar PV require relatively large plots of land (approximately 1 hectare of land for 1 MW of solar PV; at least 10 hectares of land for 1 MW of onshore wind), so the amount of electricity produced will likely not be sufficient for all large-scale manufacturing. Therefore, this solution will likely need to be combined with options discussed further below.

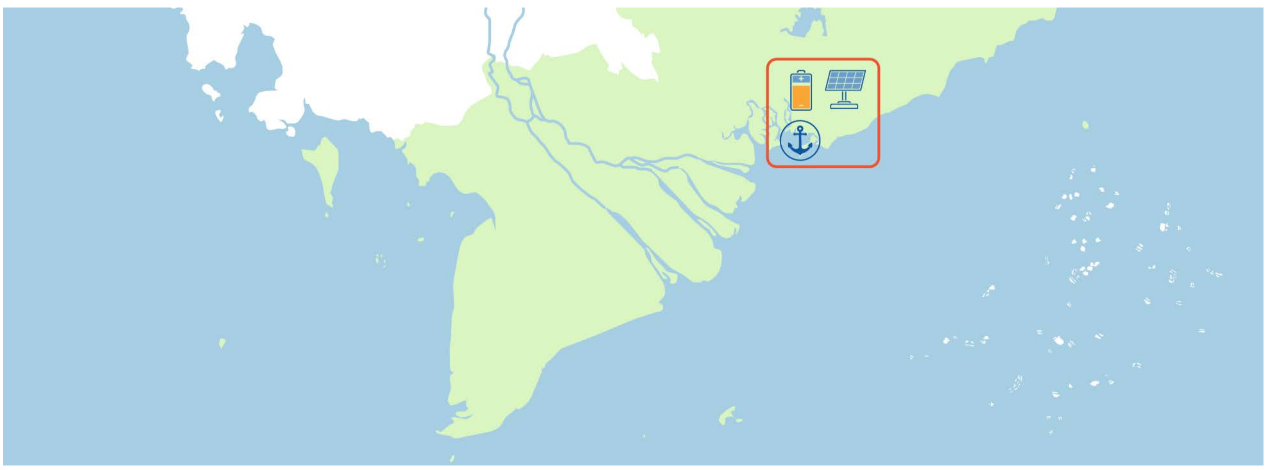


***Figure 19:*** *Illustration of RE electricity produced with the offshore wind manufacturing hub. Source: [Author]*

## Option 2: RE electricity from Renewable Energy Development Zones

Viet Nam could designate (REDZs to produce larger amounts of RE electricity. This electricity can be used to provide electricity for green manufacturing.  For example, these zones could be 100 km away but connect to a RE manufacturing hub via the national transmission network or via a direct (new) transmission line (see Figure 20).

Renewable Energy Development Zones are typically planned around existing grid infrastructure. They are usually located in the area of backbone transmission lines, where grid capacity is still available to host new power generation projects. Sometimes the grid operator even offers a new substation to connect various renewable energy projects that will be installed within a REDZ.

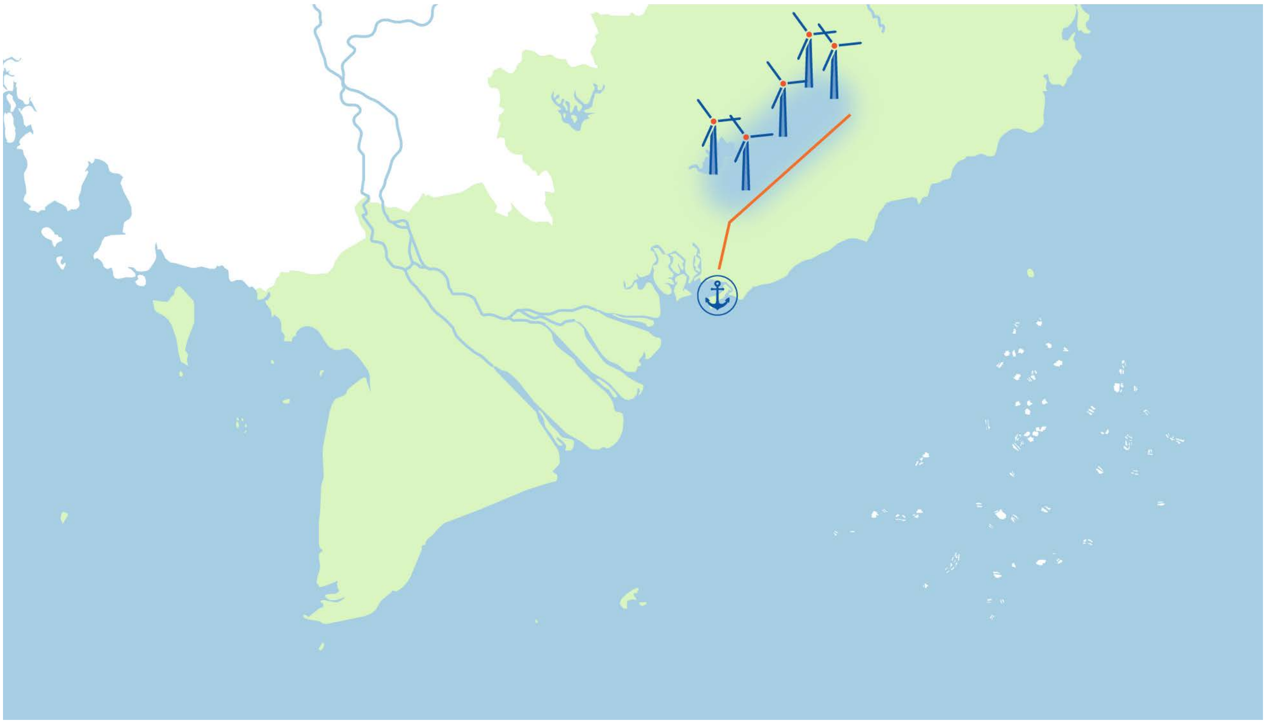


***Figure 20:*** *Illustration of RE electricity produced in a Renewable Energy Development Zone. Source: [Author]*

One example of REDZs for faster and more coordinated uptake of renewable energy projects within defined geographical areas is in South Africa. As it can be seen from Figure 21 below, various REDZs were designated in different parts of the country,alongside the major transmission backbones. In these areas, renewable energy project developers do not need to execute complex environmental impact assessments for each individual project, thus shortening the project development process and reducing costs.  Grid capacity and grid connection points (substations) are readily available. The risks and costs of developing new RE projects are reduced. In these areas, wind measurements and assessment of solar radiation have been carried out, ensuring that REDZs are located in areas with high resource availability. REDZs in South Africa are typically also close to demand centres [CSIR 2019].

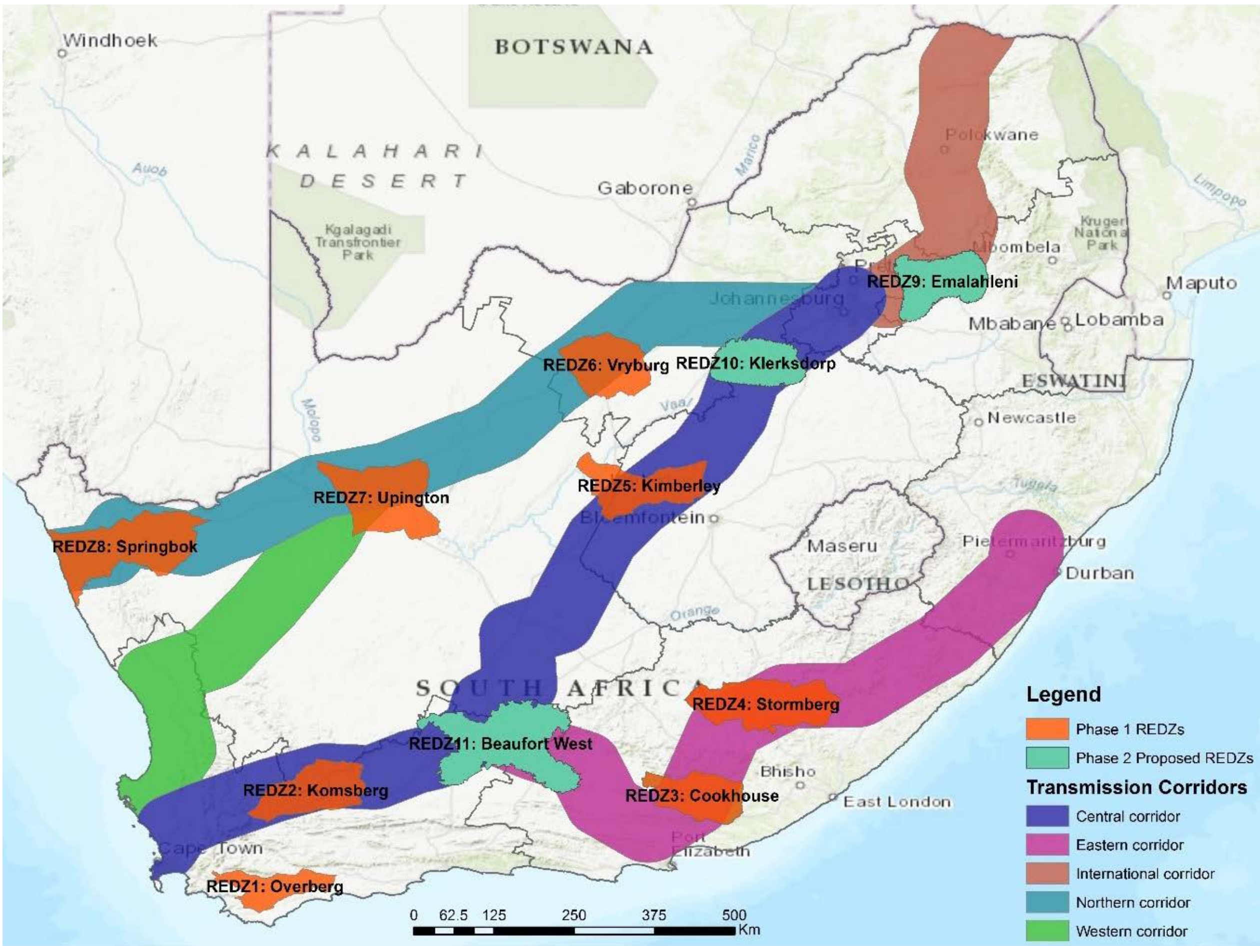



***Figure 21:*** *Example of a Renewable Energy Development Zone in South Africa. Source: [CSIR]*

## Option 3: RE electricity from offshore wind farms

Another – more long-term – option is to source electricity directly from future Vietnamese offshore (or existing near-shore) wind energy projects. This way, the offshore manufacturing hub can be powered directly by offshore wind electricity. To make this happen, offshore grid planning needs to be aligned with the planning of RE hubs. It should be ensured that a substation will be installed close to a RE manufacturing hub so the offshore grid can reach connect to shore in this specific location (see Figure 22).

One example of this is the Esbjerg manufacturing hub in Denmark (see case study above). A 700 MW subsea cable connects Esbjerg with offshore wind farms in the North Sea. In this way, green electricity from offshore wind energy can be used directly to power the manufacturing activities in the port area, including future green hydrogen production [Business Esbjerg, 2024].

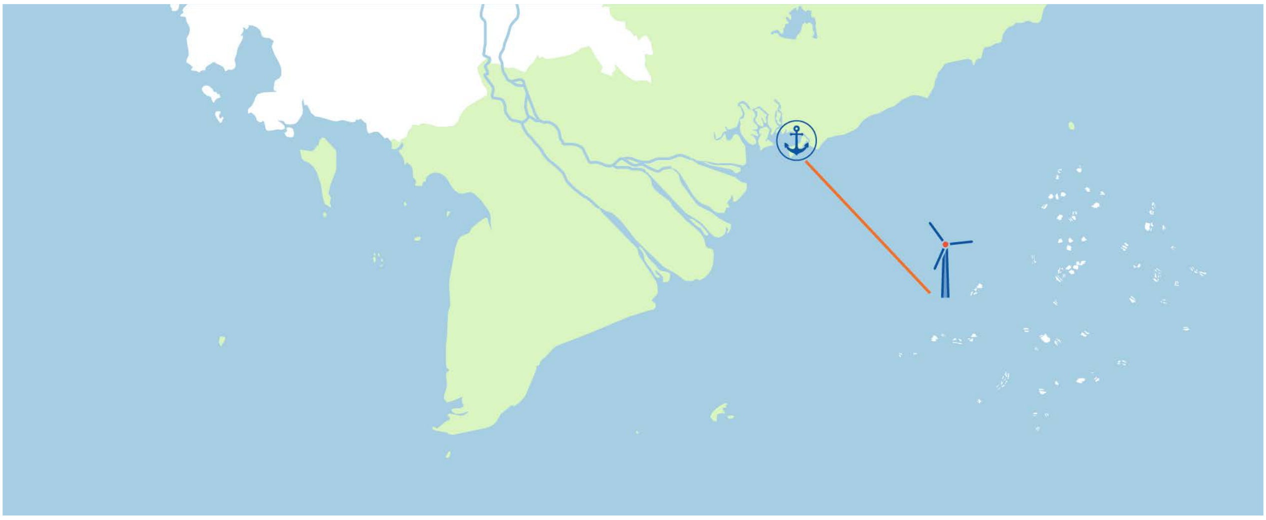


***Figure 22:*** *Illustration of an offshore wind farm providing RE electricity for green manufacturing. Source: [Author]*

## Option 4: Verification via certificate trading regimes

A more decentralised way of sourcing renewable energy is via certificate trading. In this way, renewable power generation from various parts of the country can be "used" to certify that electricity for manufacturing was actually green electricity.

In the EU, many RE projects use so-called Guarantees of Origin (GO) as a mechanism to verify that their electricity is from renewable energy sources. Established under the Renewable Energy Directive (RED), GOs are issued per MWh of renewable electricity generated, providing consumers with verifiable information about the source of their energy. The system is standardised through the European Energy Certificate System (EECS) [AIB 2025].

In Viet Nam, some renewable energy projects are using International Renewable Energy Certificates (I-RECs) to prove their electricity is produced in a clean manner. The I-REC system is a globally recognised framework that enables tracking and verification of renewable energy production and consumption. Each certificate represents 1 MWh of electricity generated from renewable sources, allowing businesses to credibly document their renewable energy usage [IREC 2015].

## Option 5: Direct sourcing via DPPAs

Direct Power Purchase Agreements (DPPAs) are another option to provide electricity for large-scale manufacturing consumers in RE Hubs. Based on the regulation of Decree No. 57/2025/ND-CP, the DPPA model facilitates direct electricity transactions between RE producers and large consumers through a private connection, such as a dedicated transmission line. The DPPA model also allows for using the national grid and paying wheeling charges [EVN PECC3, 2025]. In this case, both physical DPPAs or virtual DPPAs could be an option.

Chapter 04

# Skills Development for Offshore Wind Manufacturing Hubs

# Chapter 4: Skills Development for Offshore Wind Manufacturing Hubs

**KEY FINDINGS:**

- Vocational training is often executed "inhouse" and sometimes close to the location of manufacturing.
- Universities and TVETs that offer academic training & general skills requirements are not necessarily co-located with offshore manufacturing hubs.
- Research institutes can add value to the ecosystem of a manufacturing hub and are also frequently located close to manufacturing hubs.

## 4.1 Training & knowledge creation along the offshore wind value chain

The concept of RE Hubs in Viet Nam includes several components, namely manufacturing, RE electricity generation and training to develop technical or job specific abilities. **Training** and establishing the required university and training courses **can start immediately but also requires a long-term outlook** in line with PDP scenarios for various power generation technologies.

**Interviewees see the availability of a trained workforce as one of the top three localisation factors for manufacturing plants in the offshore wind sector.**[15] Specialised training and the development of job-specific skills are crucial and therefore adequate training centres and academic institutions need to be established to provide the necessary workforce.

One interviewee estimates a need of 1,200 additional qualified offshore wind personnel by 2030 for Viet Nam. Workers would support the economic growth of the industry, whereby quality and innovation lead to cost saving potential. Workers would also be required to build and support the offshore wind industry as an industry of systemic relevance.

[15] The other two factors are a solid project pipeline and infrastructure.

Different types of training courses can be provided and skills can be acquired through different institutions:

- **Vocational training for specialised technicians** is frequently done in-house, within the supply chain and on-site/near-site.
- **Specialised training for O&M** activities is often provided by specialised training centres, often close to national offshore wind hubs.
- **Graduates from universities and academic institutions** form a national and international labour market accessible to global offshore wind companies.
- **Upskilling & re-skilling** of oil & gas workers is often done in-house by oil and gas companies that diversify their business and enter the offshore wind industry.

The types of skills and their transferability between industries (see, for example, [Carbon Trust, 2023]) is beyond the scope of this report.

## Vocational training for specialised technicians

**Many offshore wind technicians are trained in-house.** This is due to the specialised technical and job specific skills required for offshore wind related activities. Technicians in offshore wind perform specialised tasks, such as welding of 160 mm thick steel plates, assembly of structures as tall as 200 m, or O&M services after a helicopter flight in winter weather.

A good example for in-house vocational training is in Germany. The German apprenticeship system is a three-year dual education where private companies and public schools train for a rather general profession. Once having passed, the apprentice often stays with the company which paid for their training, though he or she may decide to move on, just as the company may discontinue the relationship.

An OEM in Cuxhaven, for example, strongly advertises apprenticeships on its website [Siemens Gamesa, 2025]. Though apprenticeships are expensive for the company, they help create a class of trained workers with lateral mobility. Hierarchical progress allows for and fosters engagement and further learning by the worker. The company benefits from a growing personnel base. The better the system functions, the more companies are involved and the higher the acceptance of the apprenticeship system. Once the number of companies increases, jobs, rather than specific positions, may be trained for. This gives rise to a qualified class of workers sustaining the industry with their competitiveness.

In countries where private training is the norm, offshore wind companies see a lack of higher skills and technical or job-related abilities (e.g. in the Anglo-American job market). Asian countries see a higher appreciation of blue-collar work and a climate positive to manufacturing, according to interviewees.

## Specialised training for O&M

In some countries, the emergence of **training companies specialised in offshore security training and O&M activities can be seen.** Specialised training institutions are sometimes located within or near offshore manufacturing hubs.

One example is the German offshore wind training centre OffTEC, close to the North Sea. OffTEC offers comprehensive safety and technical training for onshore and offshore wind personnel at a single training campus. Courses include the GWO Basic Safety Training (BST), covering modules such as First Aid, Working at Heights, Fire Awareness and Sea Survival. Specialised programmes like Helicopter Underwater Escape Training (HUET) and DGUV-certified first aid courses are also available.[16] Figure 23 shows the map of the OffTEC campus, including training wind farms, advanced rescue simulator training tower, marine training centre and others.


***Figure 23:*** *Map of an offshore wind training centre in Germany. Source: [https://www.offtec.de/en/training-centres]*

[16] https://www.offtec.de/en/offshore-training

## General academic training

Universities & other institutes for higher education do not need to be close to an offshore wind manufacturing hub. More general technical or job specific skills (engineering, finance, human resources, etc.) can be obtained from any university in the country. More specific qualifications are typically added later via in-house training courses. In fact, most OEMs are globally active companies which also access job candidates from the international market.

Nonetheless, some case studies (e.g., Esbjerg in Denmark) have shown that in some instances universities do locate close to manufacturing hubs and also offer courses with specialisation in energy. In Australia, there are university courses including offshore wind topics available, with associated research, such as at the Australian Centre for Offshore Wind Energy (ACOWE) [Newcastle, 2024]. Post graduate research tailored to offshore wind is available through national research institutes like the Fraunhofer Institute for Manufacturing Technology and Advanced Materials [IFAM, 2025] in Cuxhaven.

## Upskilling and re-skilling workers from oil & gas companies

Internationally, oil and gas companies have started re-skilling and upskilling programmes to train staff for the offshore sector in terms of technical or job specific abilities. **These training programmes are typically conducted in-house, sometimes in cooperation with national universities** (see Viet Nam example below). Upskilling typically refers to an employee learning new technical or job specific abilities to optimise their performance in an existing job. Advanced skills can be acquired. However, re-skilling will help employees learn entirely different skill sets and move into different business areas or technologies. Existing assessments in other countries have shown that skill transferability of oil and gas workers to other parts of the energy sector is very high and that only limited re-skilling and upskilling might be needed (Robert Gorden University, 2021).

In Viet Nam, PetroVietnam (PVN) has already started upskilling and re-skilling workers from the oil and gas sector for renewable energy and offshore wind energy. Even though PetroVietnam University (PVU) and PV College will play a crucial role in training and upskilling the existing and future PVN workforce, the sheer scale of the required workforce will likely require additional cooperations. PVU and PV College already have cooperations with other national universities which could be further expanded.

**INFOBOX: Innovation Centres & Centres of Excellence (UK ORE Catapult)**

In the UK, the Offshore Renewable Energy Catapult was established in 2012 to support the development of the UK's domestic offshore renewable energy sector. This government-backed centre established several hubs to promote and support the develoment of local ecosystems through a range of initatives including programmes to support transition of oil and gas expertise (Fit4OR) and accelerator programmes for innovative start ups (Launch Academy).

The ORE Catpault established a world leading test centre enabling OEMs and supply chain companies to test and demonstrate new products and services in laboratory and real-world conditions including through the operation of a full scale operational 7 MW wind turbine and collaborations with established offshore wind farms (European Offshore Wind Deployment Centre).

Additonal centres were established at key offshore wind ports and sites across the UK including an Operations and Maintenance Centre of Excellence at the port of Grimsby (one of the world's largest operational offshore wind O&M bases) and a Floating Offshore Wind Centre of Excellence based in Aberdeen. These initatives have supported the development of local supply chains and valued added services at key offshore wind hubs across the UK.

# Chapter 05

# Key findings & next steps

# Chapter 5: Key findings & next steps

This Chapter summarises the key findings of this report, informing the conceptualisation and design of RE Hubs in Viet Nam. The key findings presented here are the basis for the Executive Summary. However, in this chapter more detailed information is provided to support some of the key findings.

## The different components of RE Hubs can be developed independently at different time scales.

The concept of RE Hubs in Viet Nam includes several components, essentially manufacturing, renewable electricity generation, and training for the development of technical abilities.[17] These components can be developed at different time scale.

Establishing **manufacturing hubs** and localised value chains for offshore wind and other RE technologies will require a **planning horizon of five to ten years,** noting that developing and constructing an offshore wind farm can take 7-8 years in total. However, **RE electricity generation hubs can be established quickly.** RE technologies that can be deployed within just a few months or years (e.g., solar PV with battery storage) could be developed in these regional hubs. Renewable Energy Development Zones (REDZs) (see Option 2 in Chapter 3) can be used to streamline and accelerate developments. **Training and the development of technical or job specific abilities can start immediately while also requiring a long-term outlook** in line with PDP scenarios for various power generation technologies.

[17] The PDP8 also refers to "auxiliary services".

## The various components of RE Hubs can be established in different locations as they serve different functions

**Considering different locations for the RE Hub components might also be useful,** as they have different functions. RE manufacturing hubs need to be aligned with existing supply chains and logistical parameters (e.g., close to offshore wind harbours), whereas RE electricity generation hubs could be located elsewhere, in line with resource availability and grid contraints.

**Specialised training centres are often located in the vicinity of manufacturing hubs.** In some cases, this is strategically planned and steered by political decision makers (e.g., in China). However, more often university courses and training centres develop organically around RE manufacturing hubs. **Vocational training is often executed "in-house" and/or close to manufacturing sites. Universities and Technical & Vocational Education & Training colleges (TVETs) that offer academic training and general technical training are not necessarily co-located with offshore manufacturing hubs.** In some cases, universities are located close to offshore wind hubs (e.g., Esbjerg, Cuxhaven). However, generally, skills such as management, engineering, business or financing can usually be obtained from universities located elsewhere in the country or internationally.

## Plan RE manufacturing hubs around offshore wind, as manufacturing is bound to specific locations for logistical reasons

**Building RE Hubs around offshore wind energy reflects the importance of this technology in the Vietnamese context.** Offshore wind energy will play a crucial role in Viet Nam's energy transition, as reflected in Power Development Plan 8 revised, issued in April 2025. In recent years, offshore wind energy received a lot of attention due to the significant wind resources in Vietnamese waters, the potential for national value creation and jobs, and the opportunity to become a regional offshore wind leader.

**Planning RE Hubs around the requirements for offshore wind manufacturing makes sense from a logistical point of view.** Therefore, it is useful to conceptualise RE manufacturing hubs as widening circles around selected ports suitable for offshore wind logistics. The manufacturing of many offshore wind components needs to take place in very specific locations, around specialised harbours. Offshore wind manufacturing includes very large-scale components (turbines, nacelles, blades) which can only be produced in specific locations with appropriate infrastructure and facilities, i.e. **locations right at the shore with the necessary harbour infrastructure for logistics.** The manufacturing of these components cannot be shifted to other parts of the country (e.g., moved towards inland locations). Typically, a series of Tier 2 or Tier 3 supply chain industries consolidate themselves around such large-scale (Tier 1) components to provide supportive services and parts (coating, welding, services, secondary steel etc).

**INFOBOX:** Required space for offshore manufacturing (port size & investment)

**Port areas dedicated to offshore wind services and manufacturing must be waterfront areas, with heavy-duty floor loads of 15-25 t/m², level quays and storage spaces suitable for docking of large vessels, and loading/unloading turbine components weighing up to 2,500 t using cranes and roll-on/roll-off ramps.** Manufacturers of the large components (nacelles, turbines, etc.), often produce on or near the quay provided by a port. Potential ports have already been pre-investigated in Viet Nam. The relevant report recommended to 11 ports pre-identified in the site screening should be further investigated once the location of the first offshore wind projects has become clearer (COWI, 2024: 10).

**The specific area required in a port for the production, trans-shipment, storage, and assembly of offshore wind turbines has been estimated to be 30 ha/GW** [Stiftung Offshore Windenergie, 2023].[18]

The specific production and port area is influenced by the size and location of the wind farm, due to installation seasons, which are March to September on the North Sea, the distance between port and wind farm construction site, and the number of available installation vessels. The origin of components, along with their shipment schedules, and the potential storage capacity at the manufacturers' sites influences the storage capacity at the port. Important is the construction time contingency: the tighter the time frame, the higher the storage and logistics requirements at the port.

**The specific port area investment (for port area only) is estimated to 1.0 EUR bn/100 ha** [Stiftung Offshore Windenergie 2023; Wind Europe 2021; Zukunft Energie 2024]. This includes quay construction in concrete and gravel as well as the improvement of infrastructure and building ground. Not included in the specific port area investment are production capacity, hinterland connection, and dredging of the access channel.

Both the specific production and logistics area, and the specific port area investment are rough estimates for Europe, and should be adapted to the conditions in Viet Nam, with planned wind farm construction schedules and contingencies, as well as construction costs influencing requirements.

## Conceptualise RE Hubs as regional manufacturing clusters rather than specific, geographically confined locations

Analysis of offshore wind value chains in other countries indicates (offshore) manufacturing is not clustered in one specific location but rather in the form of **regional clusters, spanning a 100 km radius or more.** Therefore, RE hubs should be conceptualised as regional clusters rather than specific, geographically confined locations.

[18] This figure is based on an analysis for Germany, based on an annual manufacturing capacity of 4 GW. The number is understood as aggregate area of production and port areas. It is a no-regret area, i.e. an estimate of the lower bound space required for offshore wind. Other reports yield similar specific production and logistics areas in ports for Europe [Wind Europe 2021], and for the case study Cuxhaven [Zukunft Energie 2024].

Figure 24 is a visual concept of regional clusters, drawn as concentric circles around the port as the core of the hub. OEMs and Tier 1 equipment manufacturers are typically located close to the port, as they require direct access to the sea for logistical reasons. However, Tier 2 and Tier 3 suppliers do not have to be geographically close to the centre of the manufacturing hub. First, land availability in the port area is limited and expensive. Second, in many cases Tier 2 and Tier 3 suppliers are already established in various parts of the country, as they also provide equipment for other industries. In addition, the Figure shows that electricity generation for green manufacturing but can also take place further way.

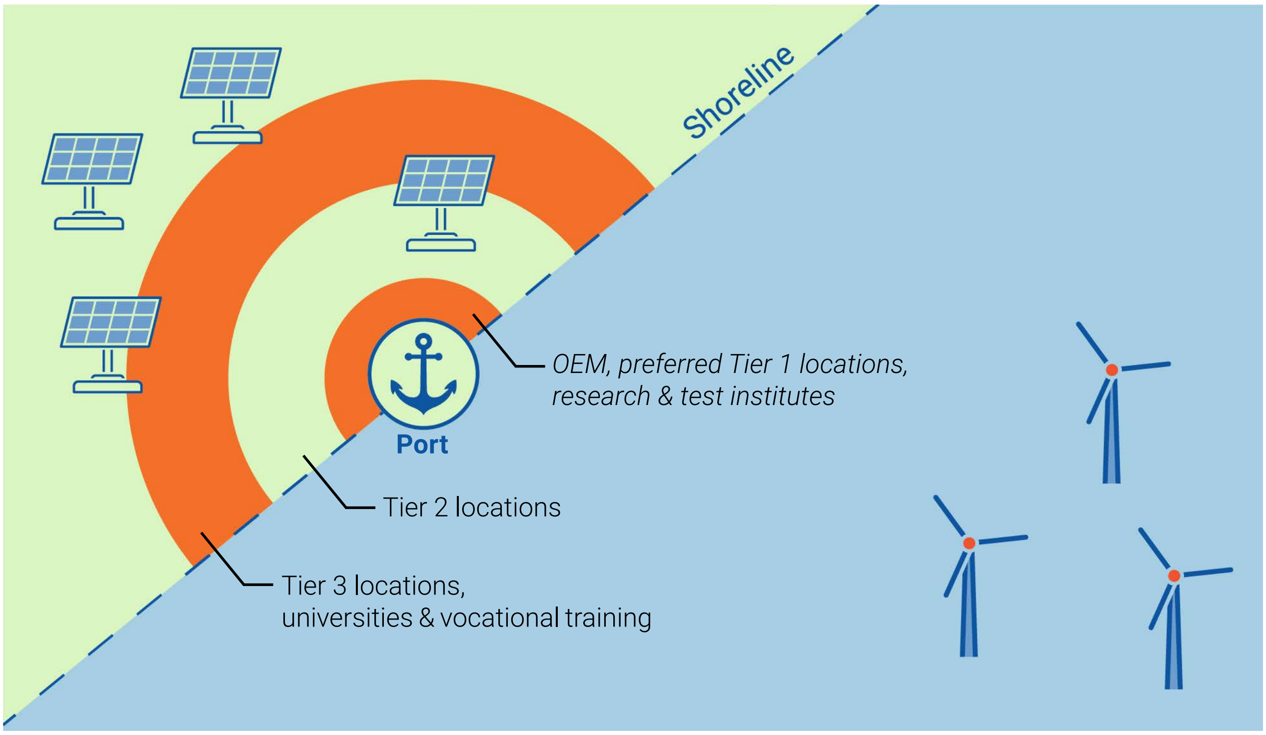



***Figure 24:*** *Conceptual drawing of the Renewable Energy Hub, centred around a port, where OEM and some Tier 1 manufacturers are located. Tier 2, Tier 3, and training locations are less dependent on the quay locations and can be 100 km or more away from the port. Renewable power generation is depicted here as land-based solar & offshore wind power plants. Source: [Author]*

## Prepare for a globally integrated offshore wind value chain

The international offshore wind industry is maturing: Supply chains are becoming increasingly global, with Chinese manufacturers shipping monopiles to Europe, Vietnamese manufacturers shipping jackets and offshore substations within and outside of the APAC region, and German companies shipping steel for turbines to Asian countries. Experience shows that prioritising segments of the value chain where there is a clear global competitive advantage yields the most significant strategic benefits. Localisation strategies need to be based on a detailed assessment of international market structures and a national "Strengths, Weaknesses, Opportunities, and Threats" (SWOT) analysis.

## Build Offshore Hubs around core manufacturing activities (OEM & Tier 1) but allow for regional variation and flexibility for Tier 2 and Tier 3 suppliers

Industrial policies and infrastructure investment can help to **build the core of a regional RE Manufacturing Hub around the activities of an Original Equipment Manufacturer (OEM) and Tier 1 suppliers (producing the turbine, nacelles, towers, and foundations).** Case studies depicted in this analysis show that manufacturing of these components typically takes place directly at the ports, e.g., in Shantou (China), Taichung (Taiwan) and Esbjerg (Denmark). Tier 2 and Tier 3 suppliers (supplying components for OEMs, Tier 1, and raw material supply) typically grow organically around regional manufacturing hubs or can be sourced from existing in other parts of the country, or internationally.

**The establishment of a regional offshore RE manufacturing hub should not be over-planned but should be provided with sufficient scope and flexibility to grow organically.**

**Tier 2 and Tier 3 suppliers do not necessarily need to be located in close proximity of the core RE manufacturing hub.** These Components can be transported over larger distances and these suppliers may also produce products for other industries located elsewhere.

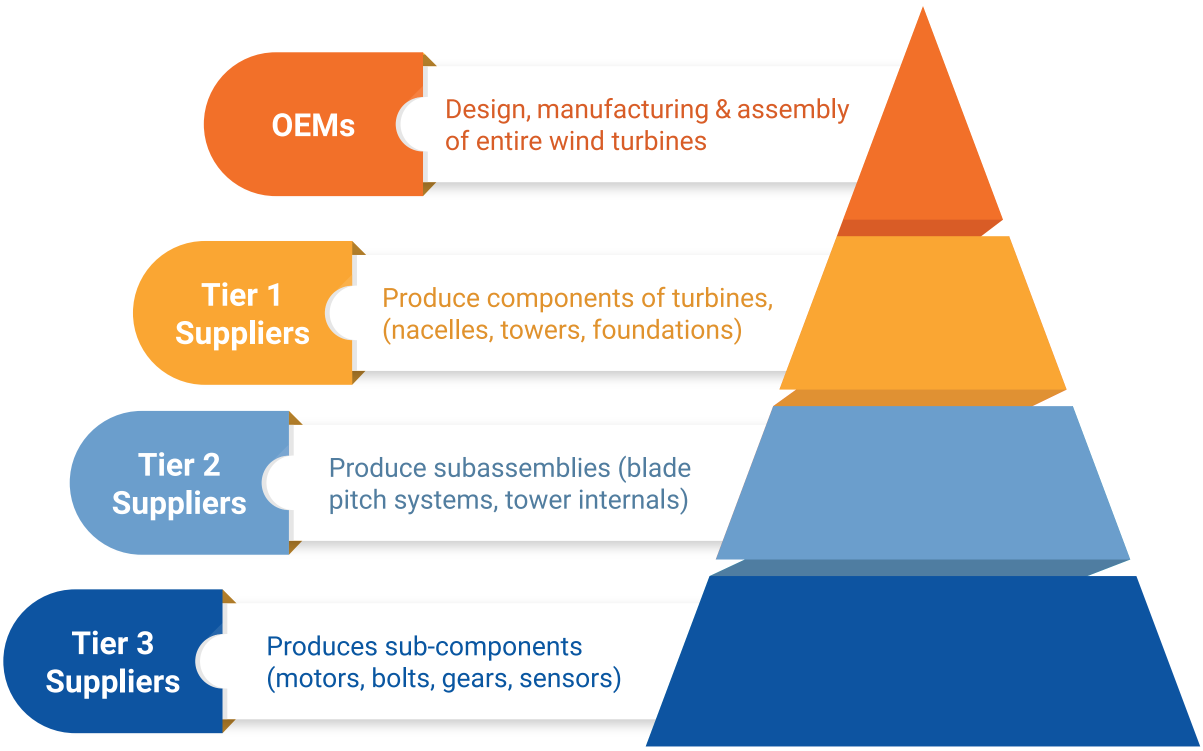



***Figure 25:*** *Actors along the offshore wind value chain (OEMs, tier suppliers). Source: [Author]*

## Consider legacy industry and existing infrastructure as a starting point when planning regional RE Hubs

Most successful industrial policy strategies are not designed on the drawing board but evolve incrementally and develop organically from legacy industries (e.g., oil and gas) leveraging existing infrastructure (e.g., roads, ports). When assessing potential locations for RE/Offshore Hubs in Viet Nam, **identify relevant industries and seek to leverage existing infrastructure where possible.**

**Government support from a national or regional level has been crucial for planning and providing infrastructure** for offshore hubs, namely transportation infrastructure. Next to ports, rail and road links, airports/heli-ports have also proven to be essential for offshore wind O&M.

## Identify competitive advantages & maximise value addition when choosing products to manufacture

Value chains and supply chains are not the same. Supply chains are characterised by the Tier-structure, organising the movement of materials, information, and products—from raw materials to the final customer. **A value chain assessment focuses on adding value in the different parts of the value chain and gaining a competitive advantage in the international market.**

Industrial policy hence looks into value chains to identify parts of the value chain where a competitive advantage can be gained. maximising value addition for local producers. Gaps and quality issues in the supply chain can guide hub planners towards products that can be manufactured competitively. Niche products, and 'unsexy' products like cables, or flanges can be well suited to existing cost and industry structures in the field, and to experiences fitting legacy industries i.e. oil and gas infrastructure.

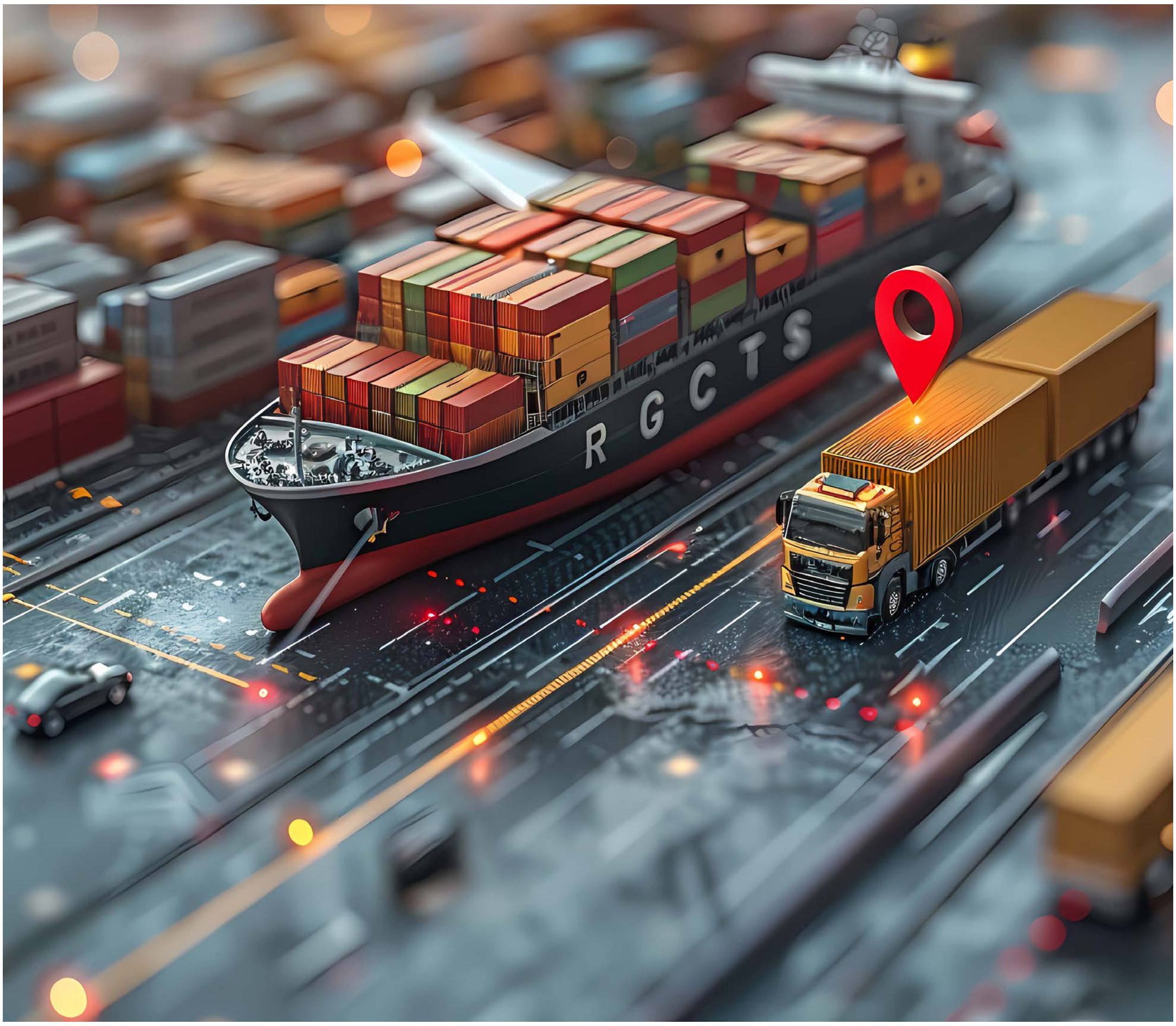
**The value chain extends from raw materials to decommissioning.** The hub may consider underlying geography (its own location), societal factors (acceptance of manufacturing, cost structure) and should consider products other than the offshore wind turbine itself, in installation, service life, and end-of-life.

## Allow for alternative locations for manufacturing hubs for solar PV, batteries, hydro power, onshore wind & green hydrogen.

There are synergies between the manufacturing of certain RE technologies, i.e. onshore wind and offshore wind, green hydrogen production and offshore wind. However, international case studies suggest that **manufacturing hubs for one technology (e.g. offshore wind energy) are not necessarily in the same geographic location as manufacturing hubs for other RE technologies** (e.g., solar PV). Just as the coal and gas value chains are located in different parts of Viet Nam, so the value chains and manufacturing of wind, solar PV, biomass and hydro power will evolve in various parts of the country. Therefore, the concept of RE Hubs as centres for manufacturing of all RE technologies simultaneously might be misleading. Nonetheless, synergies between onshore wind and offshore wind and also offshore wind and green hydrogen need to be analyzed in more detail.

**Some overlap of value chains for various RE technologies exists.** Logically, there are overlaps between the onshore wind and offshore wind value chain. In addition, international case studies suggest an overlap between the offshore wind value chain and the future green hydrogen value chain.

**Therefore, it might be necessary to plan and conceptualise different manufacturing hubs for different RE technologies.** Whereas the offshore wind manufacturing will likely gravitate around specific harbours in northern and southern Viet Nam, the solar PV manufacturing industry might form around existing manufacturing facilities in the northern part of the country. **Alternatively, policymakers could try to pool the manufacturing of various RE technologies in specific regions or locations by creating favorable investment conditions as part of industrial policies,** e.g. Special Economic Zones in one particular area.



## Providing electricity from renewable energies for manufacturing hubs is critical for export opportunities

Many offshore wind and renewable energy manufacturing hubs have mechanisms in place to **ensure that electricity required for the production process comes from renewables.** This is especially important in the light of CBAM (EU) and other international initiatives that implement carbon boarder taxes for all equipment that has not been produced with clean energy sources. In addition, many auctions for offshore wind energy projects in Europe now require or incentivise project developers to source equipment that has been produced with renewable or clean electricity.

In order to provide renewable electricity for RE manufacturing, Viet Nam will have several options which can also be pursued in parallel:

- **Option 1:** Build RE generation units (plus batteries) with the RE manufacturing hubs
- **Option 2:** Plan the offshore wind grid in a way that electricity from offshore wind can be directly delivered to the manufacturing hub (plan landing sub-station at RE manufacturing hub).
- **Option 3:** Establish Renewable Energy Development Zones (REDZ), easing the planning and construction of renewables in the areas, and providing electricity via direct transmission lines from these REDZ to the RE manufacturing hubs.
- **Option 4:** Establish a certificate trading mechanism, allowing manufacturers to proof that their electricity is from renewable energy source via "virtual" certificates (no direct connection between RE generators and RE manufacturing hubs required)
- **Option 5:** Use the newly established DPPA framework.

## Industrial policy can play an important role in strengthening the national (offshore wind) value chain but need to be finely calibrated

**Industrial policies consist of a multitude of mutually reinforcing measures creating both demand for offshore wind product and support for the supply side.** To trigger the supply side, the establishment of Special Economic Zones (including tax breaks and exemptions from duties), regional R&D programmes and tax incentives can lead to a regional clustering of RE technologies.

To ensure sufficient (national) demand and create the (international) competitiveness for offshore wind manufacturing, it is important to understand that **the offshore wind industry is project driven and needs a solid pipeline of power plants under construction and pre-construction.**

A project pipeline perceived as not fully committed, too small, or not sufficiently long-term (10 years) is likely to be answered by industry with **'no market, no manufacturing'.** Investing in volatile, project-dependent markets is a risk for capital intensive industries like offshore wind. Companies usually rely on organic growth and increase capacities only when politics and off-takers alike guarantee a solid project pipeline. **As capex for manufacturing can reach one billion Euros for a manufacturing ecosystem of a capacity of one GW annually, it takes financially strong players, planning, and long-term mutual commitment.**

**Industrial restructuring equals industrial politics.** Regions are frequently under pressure to enhance the competitiveness of their industrial base. The steel sector exemplifies this challenge, requiring the identification of successors, the development of new processes and products, and the exploration of emerging markets. Offshore wind manufacturing offers such a path, as manufacturing requires high-quality steel and steel rolling capabilities. The energy transition is a core element of industrial policy. Green steel requires green hydrogen which in turn requires green electricity produced in RE hubs. Planning must be integrated and favoring a holistic view, carefully adjusted to find its place in a competitive world.

## 5.1 Next Steps

The objective of this study was to further refine the concept of RE Hubs in Viet Nam. Based on international experiences, the location and structure of offshore wind manufacturing hubs was depicted. In addition, the interaction of offshore manufacturing with training centres and options for RE power generation (for green manufacturing was elaborated.

As next steps, the Vietnamese context for RE Hubs needs to be further elaborated based on the lessons learned from the international case studies. In this regard, the following steps are recommended:

1. Identifying regions & locations for offshore wind manufacturing hubs in Viet Nam
2. Analysis of comprehensive industrial policies to support RE Hubs & offshore wind industry in Viet Nam and development of an investment roadmap
3. Analysis of detailed training requirements for offshore wind (and other RE technologies)
4. Assessing the value chains of other RE technologies and localisation potential

### Identifying regions & locations for offshore wind manufacturing hubs in Viet Nam

**RATIONAL FOR ANALYSIS:**

Potential provinces for the establishment of RE Hubs in Viet Nam have been identified, including:

1. Northern Region (EVN's Site): Hải Phòng or Quảng Ninh.

2. Southern Central Region (PVN's Site): Ninh Thuận or Bình Thuận.
3. Southern Region (PVN's Site): Bà Rịa Vũng Tàu, a key area with well-equipped infrastructure for oil and gas exploitation.

**CONTENT OF ANALYSIS:**

Further narrowing down is required to determine the most suitable regions and locations. Based on site visits and research on offshore wind value chains in specific regions of Viet Nam, the following decision parameters need to be considered:

1. **Port Infrastructure & OEMs:** The ports and the surrounding areas will inform the ideal location for OEMs and Tier 1 suppliers. Existing port mapping studies can inform this decision-making process (e.g., Viet Nam Port Study for Offshore Wind). Further analysis of the port locations is required, including assessment of potential upgrades and expansions of the port infrastructure.

2. **Analysis of Tier 2 & Tier 3 suppliers:** Execute a more detailed analysis of industries supplying subassemblies and subcomponents for offshore wind turbines. Even though Tier 2 and Tier 3 suppliers do not need to be in the close proximity of OEMs and Tier 1 suppliers, analyzing the regional value chain and potential supply chains is necessary. Identify potential regional integration with OEMs and Tier 1 suppliers.

3. **Analysis of O&M hubs:**
   - **Overview of specific logistics and O&M activities:** Establish an overview of activities related to "services", "logistics" and "O&M"; Determine which activities can take place in what locations (different ports and hubs).
   - **Port selection for O&M:** The O&M hubs will be located in various ports. Whereas major O&M activities will likely be centralised in a few locations in Viet Nam, day-to-day O&M activities for offshore wind need to be located relatively close to the offshore wind project in order to reduce costs. Therefore, two types of O&M hubs need to be identified: **First, major ports** (likely geographically identical or connected with the manufacturing hubs) which will serve as **hubs for installation activities and principle O&M activities** (i.e., corrective maintenance such as component replacement and electrical infrastructure maintenance such as subsea cable monitoring and report). **Second, smaller ports** that can serve as hubs for **routine maintenance activities**, such as inspections. It is important to also assess this second type of ports to reduce the activities taking place at the major manufacturing and O&M hubs which will likely be characterised by space restrictions (port space is limited and has a premium cost). Large ports in Northern Viet Nam are very busy – conflict between various marine industries, including offshore wind

4. **Identify existing "legacy" infrastructure & planned Industrial Hubs:** Next to the port infrastructure, other existing infrastructure (roads, oil & gas infrastructure, etc.) need to be closely mapped in order to identify ideal locations. "Legacy indus-

tries" (e.g., steel, oil & gas) need to be identified, including geographic location of existing manufacturing sites.

- Detailed analysis of the Oil and Gas industry in the Vung Tau Hub and potential for synergies with offshore wind hub development.
- In terms of industrial hubs, Viet Nam currently has two "Industrial Development Support Centres" under the MOIT. The RE Centre could integrate with these hubs to enhance industrial development (Support Centres for Industrial Development).

5. **Export potential:** Consider export potential of offshore wind components to other countries in the region (e.g. Singapore) when determining the location of RE manufacturing hubs.

6. **Land Use Planning / spatial planning:** The spatial planning documents around the potential harbours for OEMs/Tier 1 suppliers need to be analyzed. In particular, land for potential future expansion of the RE Hubs needs to be identified and ownership restrictions should be analyzed. This is relevant for expanding manufacturing capacities, co-locating training institutions or developing RE projects for electricity generation.

7. **Offshore grid planning:** As "green manufacturing" is increasingly important, aligning the offshore grid planning with the planning of RE hubs will be crucial. Ideally, the location of the core offshore hub (OEM and Tier 1 supplier) will be at a location where the offshore grid meets the shore).

8. **RE resource quality assessment around RE hubs:** As RE manufacturing hubs will likely require RE electricity for green manufacturing, the wind speeds and solar radiation levels around the RE manufacturing hubs need to be assessed. In addition, resource quality in regions suitable for close-by "Renewable Energy Development Zones" can be assessed.

## Analysis of comprehensive industrial policies to support RE Hubs and offshore wind industry in Viet Nam & development of an investment roadmap

### RATIONAL FOR ANALYSIS:

Industrial policies have played an important role in the development of offshore wind manufacturing hubs in other parts of the world. The international case studies depicted in these analyses showcase a variety of industrial policy elements but not yet a comprehensive national industrial policy.

### CONTENT OF ANALYSIS:

Policies at different levels (local, provincial and national) need to be aligned and considered together:

1. **Local, provincial & national elements of industrial policies:** The industrial policy for offshore wind energy (and other RE technologies) will likely require a mix of local, regional and national policy elements.
    - **Local level:** At the local level, e.g. around the selected ports for offshore wind manufacturing and services, industrial policy elements frequently include "special economic zones" (with preferential tax treatment), public sector investment in enabling infrastructure (e.g., port upgrades, road infrastructure, others).
    - **Provincial level:** The RE Hubs will likely span several provinces. Next to the local and national level, specific industrial policies at provincial level need to be analyzed. This requires a more detailed analysis of the existing framework in Viet Nam (the role of provincial governments in providing industrial policy incentives) and detailed examples from other jurisdictions.
    - **National level:** To support offshore wind manufacturing, several supply-side push policies have proven to be crucial, namely Special Economic Zones, tax incentives, access to low-cost capital and others. Due to high CAPEX for offshore wind manufacturing facilities, a steady roadmap for offshore wind energy projects in Viet Nam is a crucial demand-side pull. This can be combined with other demand-side pull policies, e.g. local content requirements and political targets for domestically produced equipment.
2. **Analysis of policies for manufacturing of specific components:** Based on the existing analysis of specific offshore wind components that can be localised relatively easily (see Innovation Norway 2024)[19], an assessment of very specific industrial policy incentives needs to be executed (e.g. for national blade or nacelle production). Linking the industrial policy elements to the manufacturing of specific components can be useful to identify potential gaps in the industrial policy framework.
3. **Detailed analysis for industrial policies to establish O&M hubs:** Describe incentives and investments for O&M hubs (e.g., specialised ships, infrastructure investment in dedicated ports, etc.)
4. **Governance:** Analyze governance aspects for implementing comprehensive industrial policies. Consider OSW interministerial group for Viet Nam.
5. **Investment roadmap:** Develop specific investment roadmaps for the RE Hubs, including technology transfer and building local human capacities along the value chains.

[19] https://www.norway.no/globalassets/2-world/vietnam/documents/034625-vietnam-supply-chain-study_eng.pdf

## Analysis of detailed training requirements for offshore wind (and other RE technologies)

**RATIONAL FOR ANALYSIS:**

As indicated in almost all case studies analyzed, the availability or lack of trained personnel is a decisive factor for the establishment of offshore wind manufacturing hubs.

**CONTENT OF ANALYSIS:**

1. **Detailed description of pros and cons of co-locating universities / TVETs with manufacturing hubs, e.g.:**
   - **Advantage:** Strategic decision to create spill-over effects
   - **Disadvantage:** Higher costs due to building of new training infrastructure (buildings, etc.).

2. **Assessment of Current Trainings & Qualifications:** It is crucial to analyse & map all existing skills in Viet Nam.
   - Specialised trainings already provided: PVU, etc.
   - General training: Hanoi University, others.
   - Analyze potential overlaps with the UK-supported OSW Centre of Excellence.

3. **Assessment of Required Future Technical and Job specific Abilities and Qualifications:** An assessment of required future technical or job specific abilities and qualifications should be executed based on energy sector scenarios and related installed capacities (e.g. PDP8 revised).

4. **Training Gap Analysis:** Training gaps are likely to occur in countries with rapidly evolving energy sectors, like Viet Nam. This requires monitoring how knowledge profiles evolve and working with educational institutions and the renewable energy industry to address any mismatches between skill-building profiles and the inventory of technical or job specific abilities required.

5. **Assessing Skills Transfer from the Oil & Gas Sector to Offshore Wind Energy:** Before starting time-consuming re-skilling programmes, it is useful to assess the possibility of skills transfer between the existing activities and tasks of oil and gas company workers and the new tasks and skills required for offshore wind.

6. **Defining Skilling and Up-skilling Programmes:** Analyze the potential role of training centres, TVETs (and universities) of skilling workers in and around offshore manufacturing hubs.

## Assessing the value chains of other RE technologies & localisation potential

**RATIONAL FOR ANALYSIS:**

This analysis has focused on offshore wind energy. However, RE hubs can also be built around localisation efforts for other renewable energy and energy transition technologies, namely solar PV, onshore wind, batteries, green hydrogen and others.

Therefore, it is important to develop a better understanding about the depth & location of value chains of other RE technologies.

**CONTENT OF ANALYSIS:**

The value chains and supply chains of other RE technologies need to be assessed in Viet Nam.

1. **Value chain analysis of other RE technologies:** Like the already existing assessment on offshore wind energy, the entire value chain of other RE technologies needs to be analyzed, including onshore wind (and synergies), green hydrogen (and synergies), solar PV, batteries and hydro power.

2. **Localisation potential:** Identify parts of the other RE value chains that allow for increased local value creation.

3. **Regional gravitation & focus:** Identify regional distribution of various part of RE value chains and compare with offshore wind manufacturing hub locations (overlaps or differences).

4. **Interaction between RE value chains:** Even though the value chains of different RE technologies evolve largely independently from each other, interactions and synergies can be analyzed and enhanced via specific regional industrial policies and spill-over effects.

5. **Co-location:** Assessment of co-locating offshore wind manufacturing with manufacturing of other energy transition technologies (e.g. co-location with green hydrogen and required space for electrolyzers).

Chapter 06

# List of References & Interviewees

# Chapter 6: List of References & Interviewees

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## 6.2 List of Interviewees

| First Name | Last Name | Organization / Entity Name | Position |
|---|---|---|---|
| **Riccardo** | Felici | OWC | Director APAC |
| **Sharissa** | Funk | Embassy of Denmark | Energy Sector Counsellor |
| **Stuart** | Livesey | Copenhagen Offshore Partners (COP), CIP Representative Viet Nam | CEO cum Vice President |
| **Mette** | Moglestue | Norwegian Embassy in Hanoi | Deputy Head of Mission |
| **Hung** | Nguyen Quoc | PVN | Deputy Director, Electricity & Renewable Energy Department |
| **John** | Rockhold | Pacific Rim Investment & Management Inc. (PRIM) | Chairman |
| **James** | Smith | Danish Energy Agency (DEA) | Offshore Wind Specialist |
| **Chi** | Trinh Quynh | Ørsted Asia Pacific | Senior Country Rep. & Regulatory Affairs Viet Nam Country Management |
| **Thang** | Vinh Bui | Global Wind Energy Council (GWEC) | Viet Nam Country Director |
| **Florian** | Wuertz | EEW-Group | EVP Business Development Offshore Wind |
| **Bach** | Xuan Tra | La Gan Wind | Localisation Manager of Copenhagen Offshore Partners (COP) |