Danish Energy Agency

INPUT TO ROADMAP FOR OFFSHORE WIND

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1 Preface

In 2013, Vietnam and Denmark entered into a long-term cooperation agreement for the purpose of strengthening Vietnam's transition to a low-carbon economy. The Danish Energy Agency (DEA) cooperates with the Ministry of Industry and Trade in Vietnam through the joint Energy Partnership Program between Vietnam and Denmark (DEPP). The program is currently in its second phase (DEPP II, 2017-2020) and covers long-term scenario modelling of the energy sector, the integration of renewable energy in the power grid and energy efficiency in the industrial sector.

This deliverable is part of the project "Vietnam Offshore Wind Potential and Roadmap" within the Development Engagement 1: "Capacity Development for long-range energy sector planning with Electricity and Renewable Energy Authority of Viet Nam (EREA)", currently being conducted under the Energy Partnership Programme between Viet Nam and Denmark (DEPP).

The Danish Energy Agency, EREA and the Danish Embassy in Hanoi are the overall responsible for programme activities implementation.

2 Introduction

With a total installed capacity of electrical generation capacity at 55 GW and an ever-increasing electricity consumption on average at 10%/year during the past decade, Vietnam is currently looking ahead and planning its 10-year power development plan (PDP8) and new generation capacity mix.

Vietnam benefits from an abundant offshore wind resource and a multi-GW potential for both bottom fixed and floating projects, and with a view of the offshore wind potential, the Vietnamese Government introduced an offshore wind Feed in Tariff in 2018 at 2,223 VND/kWh (i.e. ~88 EUR/MWh), the second highest FiT offered in Vietnam and only lower than tariffs for Thermal Treatment of Municipal Solid Waste at ~92 EUR/MWh.

Other support mechanisms in the form of tax benefits - such as corporate, land and import tax exemptions - in addition to lifted environment protection fees were also enacted to support the kick-start of the offshore wind sector in Vietnam.

The abundant wind resource and large pipeline potential have certainly attracted strong interest from the offshore wind industry. However, numerous challenges including the lack of regulatory framework, extensive permitting process and un-bankability of power offtake agreements, have to-date prevented the kick-start of the offshore wind sector in the country.

The experience from mature offshore wind markets is that it is possible to manage and balance a system with high renewable and wind power sources. This report aims to provide some local context and build upon key aspects around government activities in order to promote the successful kick-start and the long-term cost-efficient development of offshore wind energy in Vietnam.

This report refers to five supporting documents:

1 Study on offshore wind resource potential and costs in Vietnam, by COWI et al.

2 Cost and transmission upgrading for each offshore wind farm site, by the Institute of Energy. Ref. Confidential.

3 Cost and transmission implication assuming cumulative development scenario, by Institute of Energy. Ref. Confidential.

4 Inputs for Roadmap on Offshore Wind Development in Vietnam, by the Institute of Energy. Ref. Appendix A.

5 Offshore wind project developer requirements for new market projects, by CIP/COP. Ref. Appendix B.

This is a preliminary study based on existing information as a first step to support a much more comprehensive assessment of offshore wind development in Vietnam in the future.

3 Vietnam offshore wind potential and LCOEs

The potential for offshore wind in Vietnam is immense and based on regional screening exercises for bottom fixed and floating offshore wind projects, a (non-exhaustive) technical potential of offshore wind capacity deployment in the order of 160 GWs has been identified – potential sites are listed in Table 3-1 For comparison, this potential represents many times the current European installed capacity during 2019[1] and a significant fraction of total projected EU offshore wind needs by 2050. The technical potential discussed here considered a variety of publicly available desktop-based data and considers areas with a distance to shore from 5 km to 100 km[2]. Furthermore, only areas with a wind speed higher than 7 m/s at 100 meters above sea level were considered. Although these findings remain to be refined based on further data inputs incl. military and oil & gas interests, they provide for the prospects of a robust pipeline and capacity deployment in Vietnam.

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[1] WindEurope, available at https://windeurope.org/wp-content/uploads/files/about-wind/statistics/WindEurope-Annual-Offshore-Statistics-2019.pdf

[2] Technical potential differs from that in Offshore wind roadmap for Vietnam, June 2020, available at http://documents.worldbank.org/curated/en/781371586848751429/pdf/Technical-Potential-for-Offshore-Wind-in-Vietnam-Map.pdf, which considered sites up to 200 km from shore.

Focus Area	Site ID	Main province	Alternative Provinces	Concept	v100 [m/s]	Area [km^2]	Potential capacity	Center point latitude	Center point longitude
FB-1	12	Bình Thuận	Ninh Thuan	Fixed	[8.04, 9.21]	2028	9 GW	10° 19' 10'' N	108° 32' 40'' E
FB-1	13	Bình Thuận	Ninh Thuan	Fixed	[8.04, 9.21]	1531	7 GW	10° 51' 55'' N	108° 35' 12'' E
FB-1	14	Bình Thuận	Ninh Thuan	Fixed	[8.04, 9.21]	1573	7 GW	10° 35' 22'' N	108° 50' 15'' E
FB-1	15	Bình Thuận	Ninh Thuan	Fixed	[8.04, 9.21]	1198	5 GW	11° 1' 1'' N	108° 50' 20'' E
FB-2	3	Trà Vinh	Sóc Trăng, Bến Tre, Ho Chi Minh, Tien Giang, Bà Rịa - Vũng Tàu	Fixed	[7.25, 7.71]	2464	7 GW	9° 5' 21'' N	106° 41' 7'' E
FB-2	4	Trà Vinh	Sóc Trăng, Bến Tre, Ho Chi Minh, Tien Giang, Bà Rịa - Vũng Tàu	Fixed	[7.25, 7.71]	2160	6 GW	9° 1' 53'' N	107° 3' 39'' E
FB-2	5	Trà Vinh	Sóc Trăng, Bến Tre, Ho Chi Minh, Tien Giang, Bà Rịa - Vũng Tàu	Fixed	[7.25, 7.71]	2440	7 GW	9° 25' 2'' N	107° 1' 48'' E
FB-2	6	Trà Vinh	Sóc Trăng, Bến Tre, Ho Chi Minh, Tien Giang, Bà Rịa - Vũng Tàu	Fixed	[7.25, 7.71]	1998	5 GW	9° 42' 28'' N	107° 22' 52'' E
FB-3	8	Bình Thuận	Bà Rịa - Vũng Tàu	Fixed	[7.09, 8.39]	1381	6 GW	9° 51' 26'' N	107° 49' 40'' E
FB-3	9	Bình Thuận	Bà Rịa - Vũng Tàu	Fixed	[7.09, 8.39]	2562	11 GW	10° 23' 39'' N	107° 55' 28'' E
FB-3	10	Bình Thuận	Bà Rịa - Vũng Tàu	Fixed	[7.09, 8.39]	1676	7 GW	10° 5' 36'' N	108° 10' 59'' E
FB-3	11	Bình Thuận	Bà Rịa - Vũng Tàu	Fixed	[7.09, 8.39]	2244	10 GW	10° 38' 57'' N	108° 16' 57'' E
FB-4	20	Hà Tĩnh		Fixed	7.09	469	1 GW	18° 37' 58'' N	106° 59' 15'' E
FB-5	21	Quảng Ninh	Nam Định, Thái Bình, Hải Phòng	Fixed	[7.06, 7.28]	2502	7 GW	19° 49' 8'' N	107° 4' 57'' E
FB-5	23	Quảng Ninh	Nam Định, Thái Bình, Hải Phòng	Fixed	[7.06, 7.28]	1030	3 GW	20° 14' 36'' N	107° 36' 58'' E
FB-5	25	Quảng Ninh	Nam Định, Thái Bình, Hải Phòng	Fixed	[7.06, 7.28]	1141	3 GW	20° 29' 31'' N	107° 59' 23'' E
FF-1	27	Ninh Thuận	Bình Thuận, Khánh Hòa	Floating	[8.20, 9.40]	1418	6 GW	10° 38' 55'' N	109° 8' 30'' E
FF-1	28	Ninh Thuận	Bình Thuận, Khánh Hòa	Floating	[8.20, 9.40]	2186	9 GW	11° 7' 32'' N	109° 11' 21'' E
FF-1	29	Ninh Thuận	Bình Thuận, Khánh Hòa	Floating	[8.20, 9.40]	2291	10 GW	10° 57' 10'' N	109° 28' 31'' E
FF-1	30	Ninh Thuận	Bình Thuận, Khánh Hòa	Floating	[8.20, 9.40]	1242	5 GW	11° 30' 9'' N	109° 23' 58'' E
FF-2	31	Khánh Hòa	Ninh Thuận	Floating	[7.07, 8.84]	1784	8 GW	11° 22' 35'' N	109° 42' 59'' E
FF-2	32	Khánh Hòa	Ninh Thuận	Floating	[7.07, 8.84]	2051	9 GW	11° 45' 30'' N	109° 37' 17'' E
FF-2	33	Khánh Hòa	Ninh Thuận	Floating	[7.07, 8.84]	1315	6 GW	12° 4' 14'' N	109° 37' 31'' E
FF-3	42	Hà Tĩnh	Quảng Bình	Floating	7.17	1961	4 GW	18° 14' 17'' N	107° 14' 10'' E

Table 3-1 Twenty-four bottom fixed and floating sites within shortlisted project development areas. Ref. Deliverable 2 (D2) - Offshore Wind Resource Potential and Costs in Vietnam, COWI et al. Credits: C2Wind[3].

The Institute of Energy has conducted the two phases of the studies. In the first phase (Ref. 2), the study proposes ranking of possible offshore windfarm sites in Vietnam. The selected potential offshore windfarm sites were further investigated for the grid investment cost together with the optimization of power generation development plan until year 2030 (Ref. 3).

In the first transmission grid study, Ref. 2, the grid connection of each 500 MW project was evaluated by the Institute of Energy and an overview of the (confidential) study is presented below:

- The study provides an initial insight into grid connection locations and transmission costs related to each of 24 offshore wind farms. The results of the study targeted to support the process of LCOE ranking possible sites for offshore wind energy development and, in order to compare sites, an initial 500 MW size wind park was assumed for each wind site.

- The study concludes that it is possible to connect and evacuate the power production from all assessed standalone sites but also shows that the connection cost for sites in the North and the South-West region is lower than the sites in the South-Central region. This is because the South-Central region, being the hot spot for renewable energy development in

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[3] V100 wind speeds represent the ranges seen throughout the focus areas, which consider multiple project sites. In addition, a typical wind rose and wind speed distribution for Southern Vietnam was used and was combined with 9 layout concepts. Density was determined by representative WTGs and limiting wake losses to less than 10%.

Vietnam, faces a congestion situation. Further, in the South-Central region, “the power grid cannot be built synchronously and timely to meet the development needs of the regional power generation”. Therefore, grid development bottlenecks are expected in this otherwise attractive region.

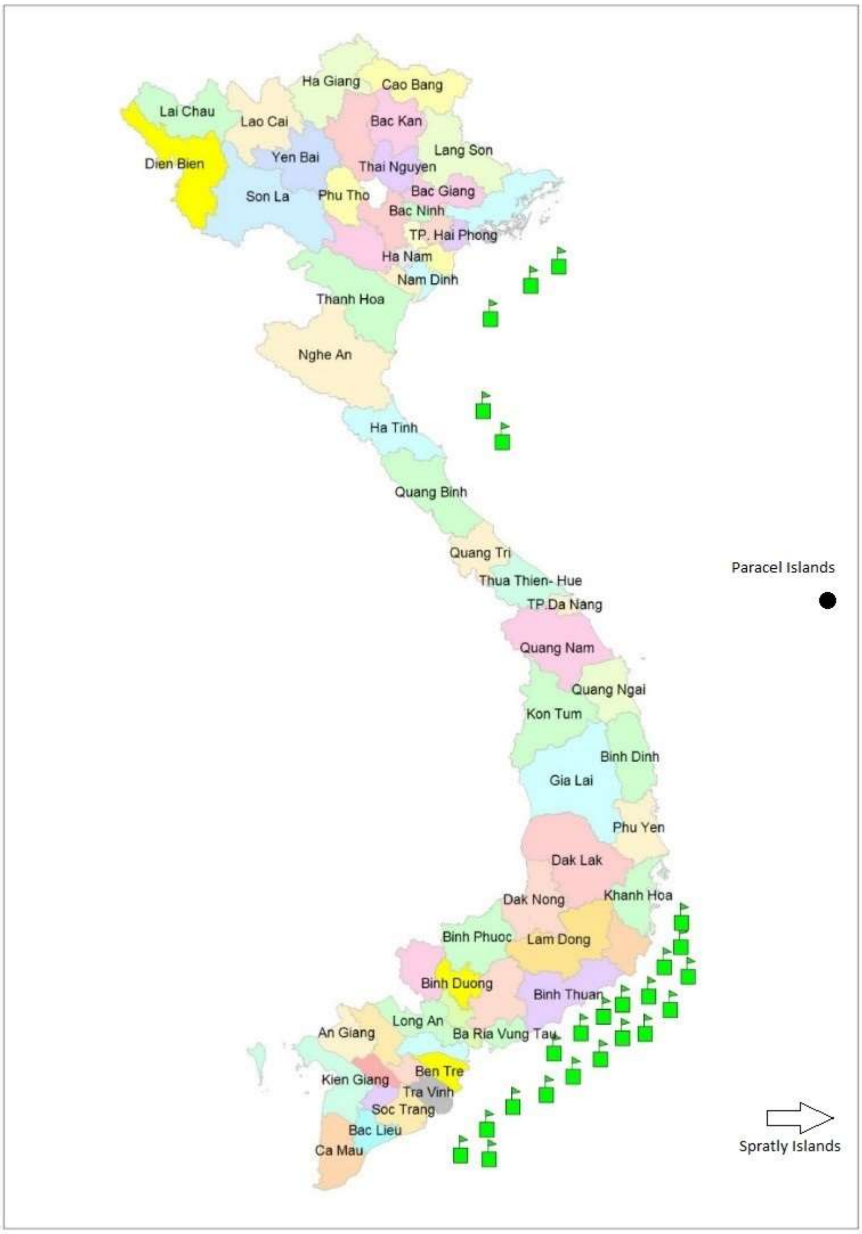


Figure 3-1 Map of offshore wind farm sites evaluated by the Institute of Energy. Credits: Institute of Energy.

Based on both international and Vietnamese input, the LCOE modelling and ranking of the 24 x 500 MW sites distributed throughout shortlisted offshore areas in Vietnam has been carried out, Ref. Table 3-1. Estimates include costs from each 500 MW project to the grid connection and transmission, incl. deep grid extension/upgrade cost estimates by the Institute of Energy, whereas at this stage exclude cumulative grid impacts/costs due to offshore clusters. The resulting LCOE merit order for the 16 bottom fixed projects is illustrated in Figure 3-2 and range from 81 EUR/MWh to 120 EUR/MWh.

Figure 3-2 LCOE ranking of bottom fixed sites incl. grid update/extension costs. Ref. Deliverable 2 (D2) - Offshore Wind Resource Potential and Costs in Vietnam, COWI et al.

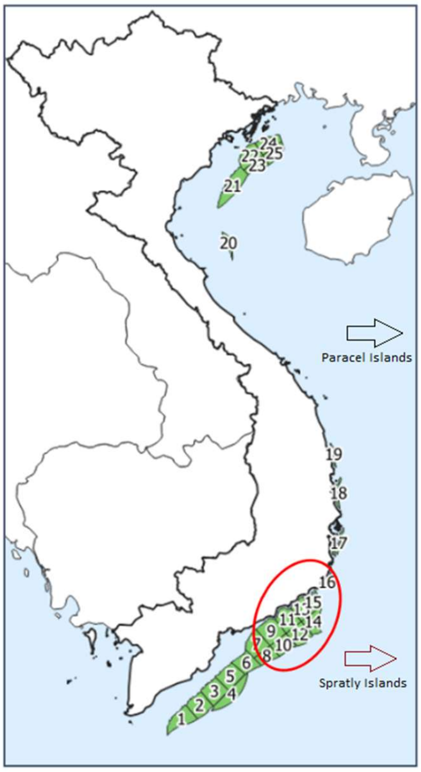


Figure 3-3 Lowest cost area for the first bottom fixed GWs of offshore wind deployment in Vietnam based on country-wide LCOE ranking incl. grid costs for standalone projects. Credits for original background image: C2Wind

The sites with the lowest LCOE, incl. grid/transmission costs, are found along the South-Central coast of Vietnam – highlighted in Figure 3-3. Bottom fixed Sites 14 and 15 present the lowest LCOE incl. grid/transmission, at 83 and 81 EUR/MWh, respectively. Subsequent lowest cost sites are Sites 12 and 13, at 87 and 88 EUR/MWh, respectively.

In terms of capacity deployment magnitude, Sites 14 and 15 present a combined technical potential to accommodate 12 GWs. When added to neighbouring low LCOE Sites 12 and 13, the total combined cumulative technical potential of bottom fixed Sites 12 to 15 rises to 28 GWs, however a significant load such as this penetrating the transmission system in a limited area will create dense load centres. Such figure is however expected to be reduced upon further consideration/data on spatial constraints.

The lowest LCOE along the north-east coast of Vietnam was found to be at least 20% higher than south-eastern projects, at +100 EUR/MWh as seen in Figure 3-2. Hence, from an initial LCOE perspective, offshore project development in Vietnam is expected to start in the southcentral region of Vietnam – an area that benefits from abundant wind resource, large extent of shallow waters and large ports serving the offshore oil industry e.g. Saigon Port, in Ho Chi Minh City, the largest port in Vietnam and serving heavy fabrication for the offshore oil & gas sector. However, for a pipeline of projects in this area, the grid connection bottleneck will have to be further considered and addressed in view of cumulative impacts.

In the second phase of the transmission grid study (Ref. 3) the preliminarily calculation of the investment cost for upgrading and expanding the transmission grid relating to the connection of the large-scale offshore windfarms to power system possibility is presented.

The potential offshore wind farm sites were previously narrowed in first phase of the study (Ref. 2). The LCOE result has shown that Ninh Thuan and Binh Thuan offshore areas have the lowest electricity production cost which should be prioritized for development. Thus, the onshore substation Co Thach (Site 15-FB-1) and Mui Yen (Site 13-FB-1 and Site 14-FB-1) in the South-Central region are considered as the wind farms grid connection points (PoC) in this phase of study (Figure 3-4).

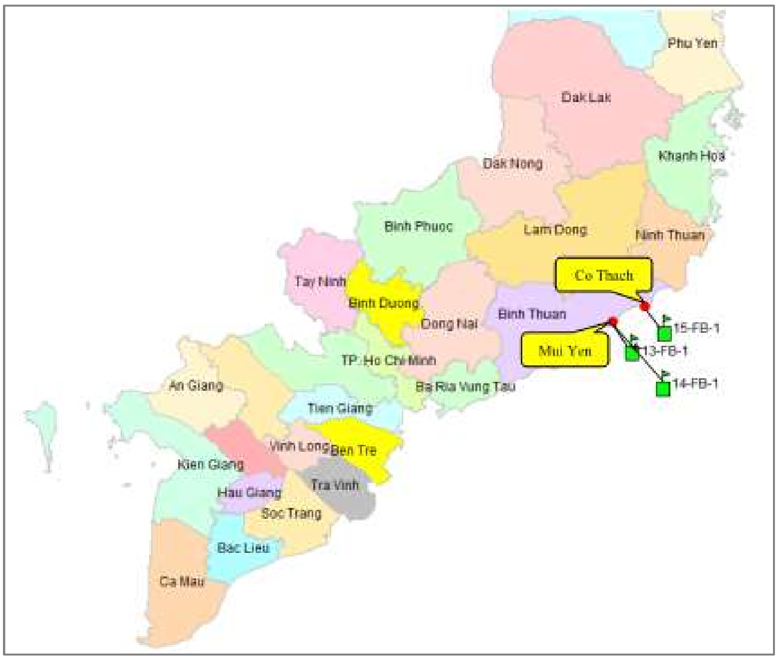


Figure 3-4 Location of studies offshore wind sites *(Ref. 3)*

As agreed, between the Danish Energy Agency (DEA) and the Electricity and Renewable Energy Authority (EREA), three scenarios for offshore wind power development up to 2030 were studied including:

- **Base case**: no offshore wind power development
- **Low case**: developing 1 GW offshore wind power by 2025 and 5 GW offshore wind power by 2030
- **High case**: developing 2 GW offshore wind power by 2025 and 10 GW offshore wind power by 2030

The capacity distribution of the selected offshore windfarms for the low case and high case scenarios can be seen from Table 3-2 according to the year of interconnection.

Table 3-2 Capacity of offshore wind power sites studied according to the scenarios

	Low Scenario		High Scenario	
	2025	2030	2025	2030
Co Thach (Site 15-FB-1)	1 GW	2.5 GW	2 GW	2.5 GW
Mui Yen (Site 13-FB-1 + Site 14-FB-1)	0 GW	2.5 GW	0 GW	7.5 GW

These three scenarios were applied for the optimization of national power development structure in 2025 and 2030 based on a Balmorel energy model. The growth of electricity demand during the period, technical and economic characteristics of all power generation technologies, fuel prices and grid restrictions were considered in the model. Details of power generation development structure for 2025 and 2030 in the three scenarios are presented in Figure 3-5.

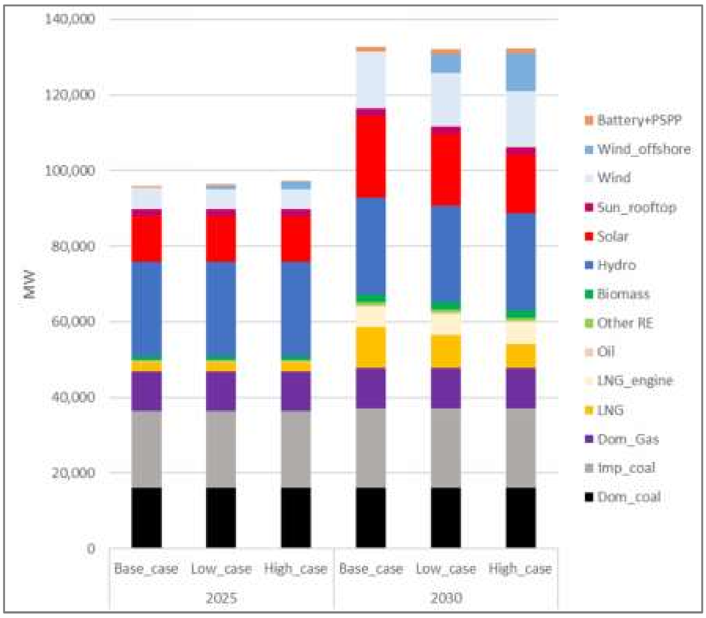


Figure 3-5*: Power generation development structure in 3 scenarios (Ref. 3)*

When 5-10 GW offshore wind power is developed, it will be necessary to reconsider other planned capacity additions (onshore wind, solar, and LNG) in some regions (Highland, South and North) to balancing demand and production capacity. The majority of costs is related to transmission upgrades, such as to construct new 500 kV transmission lines to load centres (Figure 3-6).

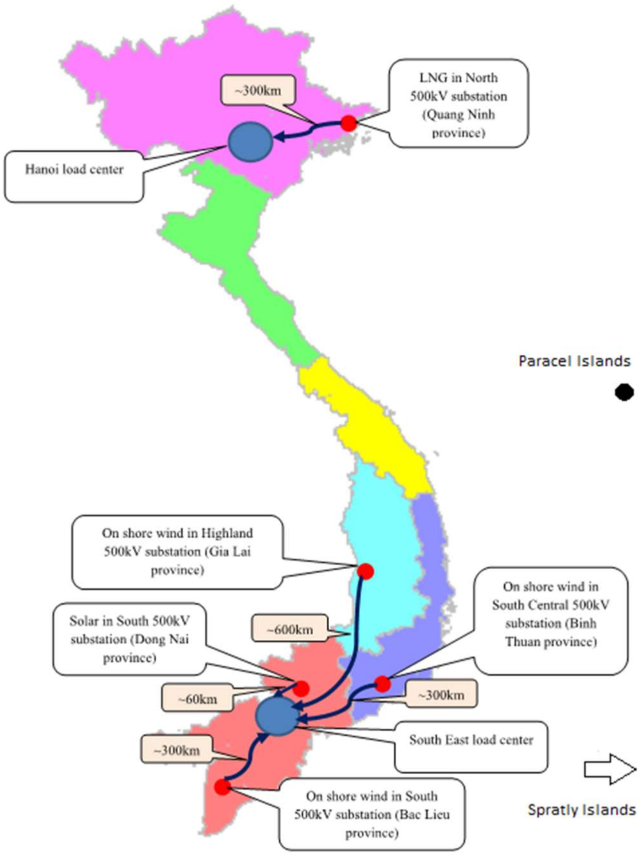


Figure 3-6 Proposed location of 500 kV substation gathering power generation capacity *(Ref. 3)*

Regarding the impact of offshore wind power on transmission grid costs, results of comparison of costs across scenarios are illustrated in Figure 3-7. When looking at the total capacity in 2030, the low case scenario has shown a lower transmission grid investment cost in total than the base case. This means that there are relative savings in transmission upgrade costs to include up to 5 GW of offshore wind, compared to the base case. In the low case, the upgrade costs for offshore wind is 339 million USD/GW. However, to achieve this, the capacity of other generation sources must be reduced. Whereas the highest cost (341 million USD/ GW for offshore wind additions only) is found in the high case scenario with 10 GW (2030) of offshore wind capacity. It should be noted, in the base case scenario, with zero offshore wind, planned grid transmission upgrades amount to 415 million USD/GW.

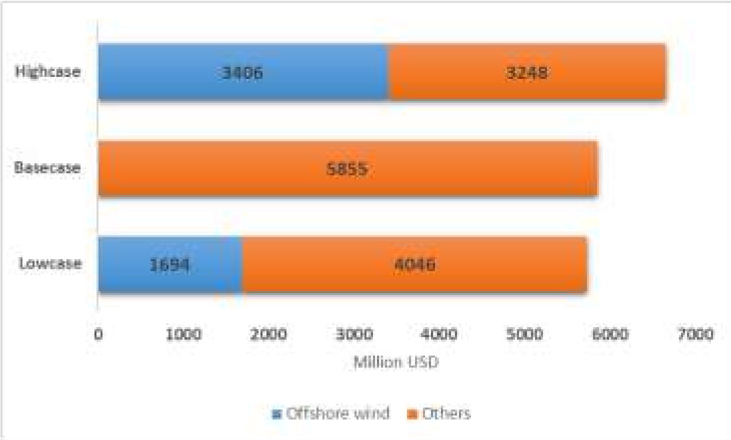


Figure 3-7 Comparison of transmission grid investment cost among 3 scenarios (Ref. 3)

The study has also conducted an techno-economic comparison of DC and AC transmission alternative in high and low offshore wind power development scenarios. The results indicate that HVDC may be the preferred technology for strengthening the transmission grid for offshore wind, but more detailed assessment is needed to consider how the technology can be implemented in Vietnam. HVDC vs. HVAC require intensive techno-economic studies based on factors such as transmission capacity, distances, cables vs. overhead lines etc.

4 Roadmap Inputs

Vietnam clearly presents a very significant offshore potential and, in order to secure a successful kick-start and subsequent cost-effective build-up of the offshore wind industry, careful consideration of developing a supportive enabling environment and long-term vision for the industry must be carried out.

At the national level, this can be captured in a roadmap that sets out clear, forward-looking targets and then suggest a stepwise approach to reach these. As part of the road-mapping process, a key task is thus to identify the most challenging and urgent barriers within the local context and then evaluating options and mitigation strategies to address the identified barriers.

The single act of setting out such a roadmap may reduce the risk perception of country officials, developers, and investors. As each barrier is removed, the stronger the market confidence in the progress towards a sound sector development. Under this context, this chapter touches base on key topics related to offshore wind road mapping, including setting the scene on the value for offshore wind for the national energy mix, considerations for target setting and options to the policy approach.

4.1 The value of offshore wind

Understanding the value of offshore wind is the very first step prior to engaging in setting targets and planning long-term developments. The following highlights key points in relation to the benefits of offshore wind:

- A local clean source of electricity that improves national energy security while contributing to reducing fossil fuel dependence, climate change and air pollution and developing the green economy in Vietnam

- Smoother generation profile, higher wind resource and steadier production and predictability than onshore wind

- Doesn't occupy space on land and as such construction does not impact daily life; avoids onshore land concession and right of way issues, especially in view of large-scale projects needed in Vietnam, but entails maritime planning considerations

- Synergistic development is possible with other marine development projects, e.g., fish farming, to benefit local communities

- Allows for the implementation of large and scalable / modular power plants with potential for long-term cost-competitiveness against other energy generation sources

- Requires capital intensive investments during the project construction phase. But provides significant opportunity for local jobs creation and growth through a localized operations and maintenance service provision, the development of a local supply chain, ports and general infrastructure.

4.2 Setting a vision and targets

Clear, long-term and progressive capacity deployment targets are essential to coordinate policy on a government level and give the industry the confidence that is needed to attract the interest and investments that are needed to support offshore wind development in a new market.

Enough volume is key in order to build up the industry and see best cost benefits, and a pipeline of multiple GW throughout the years provides the grounds to bring competition across multiple project developers and supply chain actors. Volume also brings the confidence that is needed in order to make long-term investments in supporting infrastructure, supply chain and technology.

In Europe, for instance, a pipeline of over 20 GW built over the years allowed the establishment of multiple specialized ports and harbours that contribute to the optimization and cost reduction of offshore wind farm installations and operations. The European pioneering volume in the offshore market has also resulted in the development of offshore wind turbines which are designed to capture the most out of the European offshore conditions, to date broadly benefitting from high wind speeds and the lack of earthquakes and typhoons/cyclones. As new markets emerge, enough long-term local volume allows for the development of targeted designs which provide the lowest cost of energy with respect to local conditions.

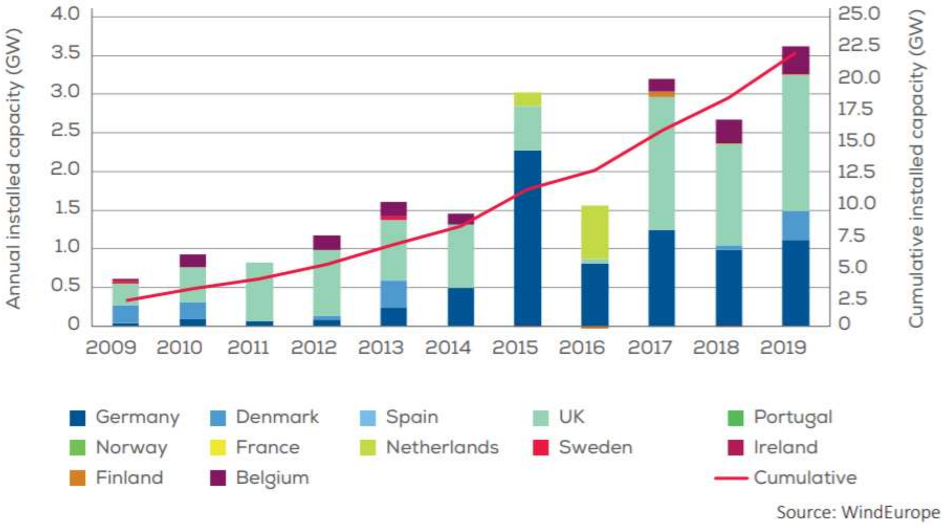


Figure 4-1 Annual offshore wind installations by country (left axis) and cumulative capacity (right axis) in GW. Credits: WindEurope.

Another key aspect when setting targets on a national level is to ensure smoothness and steady growth in the capacity deployment. For an effective and cost sensitive build-out, targets must allow a progressive development of the supply chain and industry. This is because whereas too ambitious short-term targets tend to result in bottlenecks, delays and larger expenditures; a smooth pipeline development allows for up-front planning, coordination and optimizations.

4.3 Barriers and options

4.3.1 First project barriers: Demonstration vs. large-scale

The early stage of a new offshore wind market implies that there are unforeseen barriers and challenges that are not apparent prior to learning-by-doing. These can range from technical to regulatory aspects such as seabed geology risks, unclear permitting timelines and unclarity around supply chain possibilities. At this stage it is too early to foresee all issues and the first offshore wind project in Vietnam is expected to be burdened by variety of possible risks that are intrinsic to the development under untested waters and regulatory framework. This directly contributes to cost/risk premiums which reflect in a relatively high price of energy for the first project(s).

In order to reduce the costs paid by society to the first project and prove the commercial viability of offshore wind technology in new waters, one option is to set up the first offshore wind farm as a small-scale pilot project. Starting in such a way allows the market to test its framework and concentrate inflated offshore wind costs within a relatively small installed capacity. Subsequent larger projects would then in principle benefit from less risks, lessons learned and potential improvements to the framework, ultimately leading to lower costs on subsequent and more substantial capacity additions.

In Europe, the kick-start of offshore wind is largely attributed to the first demonstration projects in Denmark that was an early mover in offshore wind with the 10 MW Vindeby project commissioned in 1991. After Vindeby, Danish authorities recognized that larger offshore projects presented unique challenges and thus the Danish Government obliged its utility company, today named Ørsted, to develop the first large-scale projects. As a result, 160 MW Horns Rev 1 was commissioned in 2002 and 165 MW Nysted was commissioned in 2003. The experience from these two projects provided unmeasurable input to the planning of future offshore wind farms looking ahead.

The typical drawback of small-scale pilot projects, however, in addition to their unrepresentativeness of large-scale project challenges, is that alone they do not typically attract interest from investors and project developers. In addition, they suffer from all characteristic disadvantages of building in small scale as costs – e.g. site characterization, marine operations, management, etc. - cannot be distributed across several MW of installed capacity. Large-scale projects on the other hand, present a sufficient ticket size to allow for needed investments and optimizations along with global industry players.

Figure 4-2 Illustration of Formosa 1 offshore windfarm developed near Miaoli, on the west coast of Taiwan. Credits: Swancor Renewable, Formosa 1 project developer.

A hybrid approach can be the targeting of a phased development of the first large-scale project. Such approach entails the award of a large-scale project which is to be commissioned in phases. The first phase would target a pilot size deployment and subsequent phases would target more sizable deployments. Figure 4-2 illustrates WTGs of Formosa 1 project, the 128 MW windfarm is Taiwan's first commercial-scale offshore wind project and was planned to be developed in two phases: a demonstration phase consisting of two 4 MW wind turbines commissioned in 2017, and a commercial phase with 30 turbines and a combined capacity of 120 MW commissioned in 2019. Subsequent Formosa 2 project consisted of 378 MW in capacity. As offshore wind technology matures in both well established and new waters, late comers to the offshore wind market such as Vietnam can benefit from larger project sizes from the start.

4.3.2 Project revenue level barriers: FiT vs. competitive auctions

As noted in 4.3.1, the first offshore wind projects in new markets typically involve risk premiums and costs that are significantly higher than those associated with mature markets. Options exist that can be deployed to help overcome these economic barriers for the following offshore wind expansion.

One option is to launch competitive auctions as these are known to drive down the costs of energy in many mature markets. Especially when attracting multiple players, auctions are a proven instrument that allow competition, not only in offshore wind energy, but in other energy technologies as well.

When kicking off a market, however, competitive auctions bring uncertainty to investors of needed capital/skill-intensive activities related to offshore wind pre-development activities. Speculations over the expected resulting tariff of an auction in a new market may therefore drive players away and in the direction of markets with more certain returns.

A second, and more applicable option, may then be feed-in-Tariffs (FiTs). These entail a degree of confidence in the level of return on investment a project can yield and, if sufficiently high to cover new market risks and premiums, will encourage experienced market actors to engage. The challenge around the setting of the first feed-in tariff is typically on the definition of the right level to be offered, which should be balanced so as to ensure the economic feasibility of the project and also fair costs to society.

In order to support the definition of the FiT level for the first projects, a LCOE study should be complemented by a careful consideration of the applicable regulatory framework, power offtake conditions and associated risks. For illustrative purposes only Figure 4-3 provides a high-level indication of tariff cost drivers, noting that "investment costs in new markets are normally higher due to immature supply chains, lack of infrastructure, lack of local skills, and higher development costs due to incomplete regulatory frameworks, credit risks and etc." Ref. Appendix B by COP. Furthermore, some specific items that typically contribute to the gap between the LCOE and the FiT include, but are not limited to, currency hedging costs, taxes and PPA contract conditions such as tariff indexation and compensation for curtailment.

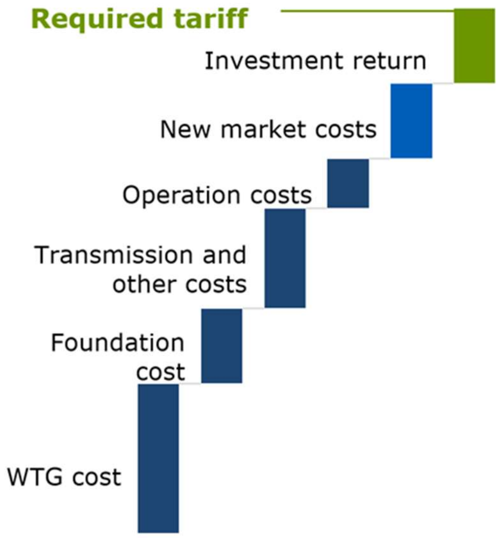
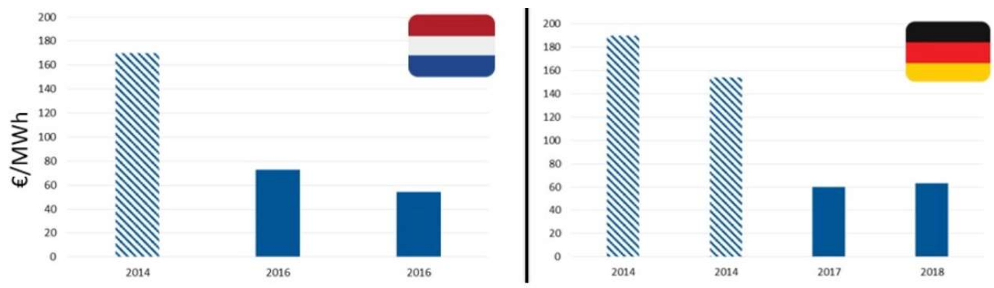


Figure 4-3 – Illustrative cost elements composing required tariff level. Credits: Copenhagen Offshore Partners, Appendix B.

As a new market matures and experience is gained through the first projects and tariffs, the natural next step is then to progress into competitive auctions and consequent cost reduction trajectory ref. Figure 4-4 below and Appendix B slide 6 by COP.



*2014 PRICES IN THE NETHERLANDS AND GERMANY ARE FEED-IN-TARIFFS,
*2017 AND 2018 VALUES FOR GERMANY ARE WEIGHTED AVERAGES OF NON ZERO-SUBSIDY BIDS IN EACH AUCTION ROUND

Figure 4-4 Average strike prices for offshore wind energy in Germany and the Netherlands, illustrating transition from feed-in tariff (dashed columns) to competitive auctions (full columns). Credits: WindEurope.

4.3.3 Consenting barriers: Permitting and one-stop shop

Offshore windfarm developments are typically burdened with a multi-year long development periods which require site identification exercises, offshore surveys and data collection, port assessments, securing grid connection, engaging in permits and consents processes, stakeholder consultations, among others. In worst cases, the process can exceed more than seven years, and this can be related to stakeholder engagement as well as onboarding partners and securing finance. One main cause of long setup times is the permitting process, which even in mature countries can take several years. For those setting up a new offshore wind market, an important initial step is to streamline the permitting process as much as possible, as soon as possible.

Developing offshore wind projects requires complex processes with multiple interdependencies across work packages. Permitting milestones certainly fall within the project implementation critical path, and delays in permits and consents not only affect the project implementation timeline and expenditures but may also result in project development termination and shadow casting (incl. loss of market confidence and delay) in securing the kick-off and future development of the sector. Clear and transparent procedures for the consenting and permitting processes, which are applied in a consistent and timely matter, are thus key for securing project delivery on time and on budget. Securing delivery of projects is also a concern of the Government, as it tries to deliver new capacity on time as well as meet set targets.

In general, the permitting process starts with the party seeking approvals identifying requirements and submitting documentation to the relevant authorities. It is good practice to display the submission for public consultation and to conduct public hearings so that potential conflicting interests are identified and discussed. As part of the process, studies and surveys may apply, especially in relation to environmental impacts, and additional hearings may be conducted in order present related results. As a final step, the responsible party may issue the requested permit.

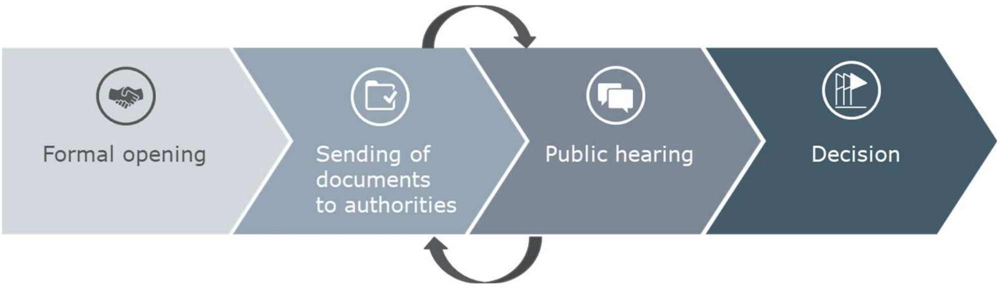


Figure 4-5 Illustration of generic permitting and consent process.

During the past years, several countries have established one-stop shops for the permitting processes, creating a single point of contact between private developers and public authorities. The one-stop shop can take the role of either the central gathering point for all relevant information or be the authority actively supporting or even conducting the permitting.

Given the multiple and sometimes time-intensive permitting processes that are typically required for the scope of an offshore wind project, including both onshore and offshore operations, a one-stop shop comes to support the timely and successful planning and consent process of the project. One of its key roles is to ensure that permits cover the full scope of the project and to actively drive and overcome problems of unclear or overlaying responsibilities between public authorities - thus contributing to reduced project consent uncertainty and risks.

The establishment of a one-stop shop typically emerges with the designation of a government lead nodal agency that interfaces internally with public authorities and externally with project developers and stakeholders. The one-stop shop can also act as single point for the provision of information, response to queries and the definition of consenting timelines – which are key for the planning of offshore wind projects.

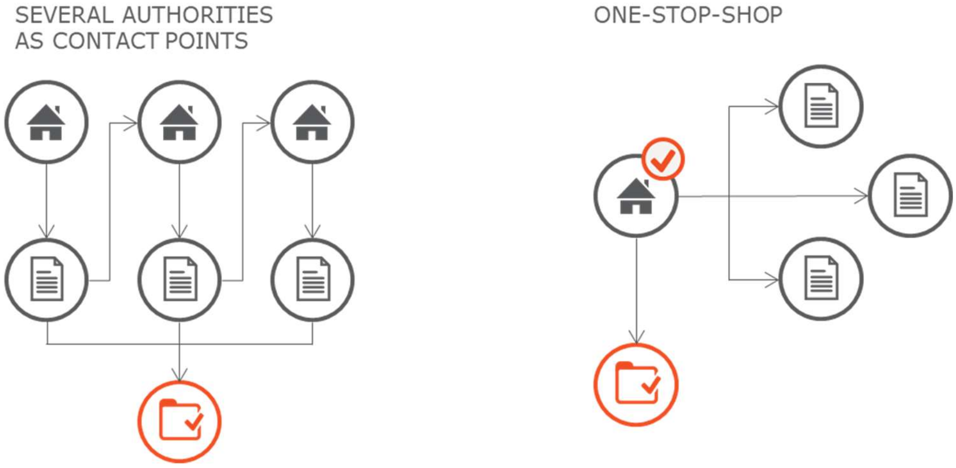


Figure 4-6 A one-stop shop for permitting procedures, as opposed to the project developer interfacing with multiple authorities, supports the fast-tracking of the planning process and cost/risk reduction.

Several countries have recognized the value and adopted the one-stop shop approach for offshore wind. This includes Denmark, through the grant of all permissions through the Danish Energy Agency; the Netherlands, through the Ministry of Infrastructure and Environment; and in the UK and Wales through the Planning Inspectorate, which grants onshore and offshore environmental consents, electricity generation consents and provides compulsory purchase powers.

In the Vietnamese context, as elaborated by the Institute of Energy (IoE) in Appendix 1, there are a variety of certificates/agreements as well as authorities to deal with throughout the project life cycle. The process is divided into Phase A – Preliminary Development and Phase B – Development. When combined, both phases require nearly 20 agreements and licenses from dozens of stakeholders/authorities at different levels (e.g. provincial, ministerial, etc.). As stated by the IoE, "*Experience from developers show that the process to obtain all kinds of agreements/licenses as such requires lots of effort and costs in which risks for developers/investors are very high. Especially, the land clearance and compensation task might take years with high risk of increasing costs. For offshore wind development, additional risk and involvement of other agencies would be much higher, particularly for no-go military zones, marine transportation corridors, protected areas, oil and gas activities*".

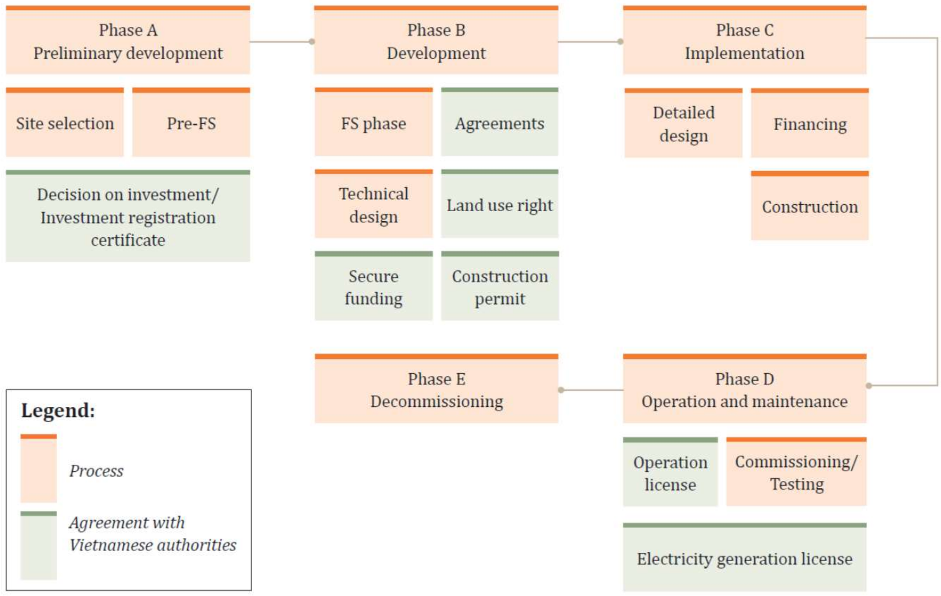


Figure 4-7 Development process for Wind power project in Vietnam. Credits: Appendix A and Wind Power Investment Guidelines. Volume 1: Project Development, GIZ 2016.

Despite the approach towards the consenting process, experience from mature markets shows that a well-coordinated site/zone selection process plays a critical contribution to a timely permitting process. Early and government-led initiatives ensuring inter-departmental coordination - at both central and provincial level - when drawing up zones/sites that will be leased to projects ensure internal government alignment and minimize the risk of show-stoppers at later stages. It is further recommended that the Government defines clear criteria for evaluation of competing uses of the sea and implements mechanisms for a timely dispute resolution - should parties wish to challenge the selection of sites for offshore wind development. A maximum time frame for consenting should ideally not exceed 2 or 3 years. Finally, lessons learned also highlight that the permitting and consenting must be designed to allow for flexibility in the construction and design within a given envelope for the offshore wind project, in order to prevent re-application for permits and delays should design changes be preferable as the project progresses. Such flexibility also tends to allow for ongoing optimisation during the design and construction phases and thus contributes to lowering prices.

4.3.4 Site identification barriers: Centralized vs. decentralized planning

The project planning starts with project site identification and pre-development. This can be a lengthy and costly process that requires a multi-criteria assessment, e.g., of spatial constraints and conflicting maritime interests, technical conditions, grid connection, environmental & human impacts, proximity to ports & harbours, among others. Depending on the market, different approaches to the offshore wind site selection process apply, and in general three main models are well established: open-door, zoning and site-specific approach.

Under an open-door approach, i.e. a decentralized model, it is up to the project developer to identify and spend time and resources to pre-develop the site. Under a zoning approach, i.e. a hybrid model, authorities designate a large area for offshore wind development in which a developer must identify a site within. Under a site-specific approach, i.e. a centralized approach, the authorities designate a specific site for project development and are typically responsible for the first stages of project planning comprising preliminary site investigations including finding solutions for conflicting interests and key stakeholders such as fishing and coastal communities.

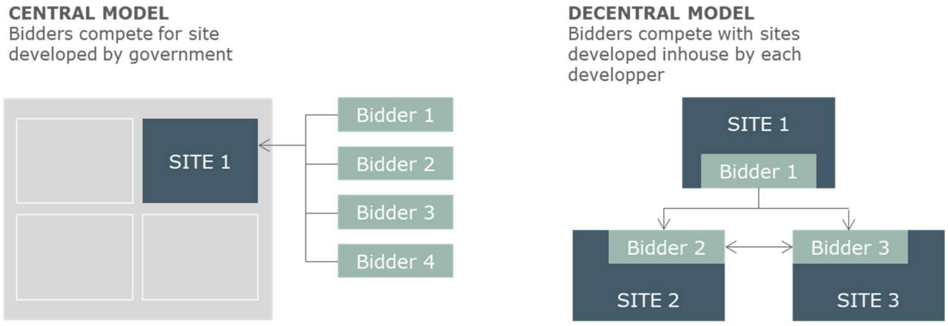


Figure 4-8 Illustration of central and decentral approach towards site selection.

Whereas the open-door approach leaves more flexibility to the project developer, it also entails more time, costs and risks of project failure. This is because the earlier the stage of development of a site, the more unknowns and time/resource requirements in obtaining site data, grid connection, permitting etc. there typically are.

The site-specific approach reduces costs and risks for project developers, as the authorities engage at least to some extent in pre-developing the site. However, it requires a significant amount of planning, resources and capabilities for site selection on the side of the responsible authority. This approach gives Government full control of developments.

The zoning approach hence emerges as a somewhat hybrid model, in which authorities narrow down the spectrum of potential development areas while allowing project developers to use their specialized technical know-how to select specific sites within. The zoning approach ensures no conflicts with major restrictions such as areas of national/military interest, allowing some extent of early data collection within the zone, grid and harbour planning/coordination, etc.

The open-door approach has become less and less common and the zoning approach is still prevalent in the UK. Denmark, the Netherlands and Germany moved to site-specific schemes. While in Denmark the Danish Energy Agency and the Transmission Grid Operator (Energinet) are responsible for the zone identification, site selection, offshore grid connection development and engaging directly in the site investigation and permitting; in the UK it is up to the project developer to identify the site within a zone and conduct all site investigations/permitting prior to construction.

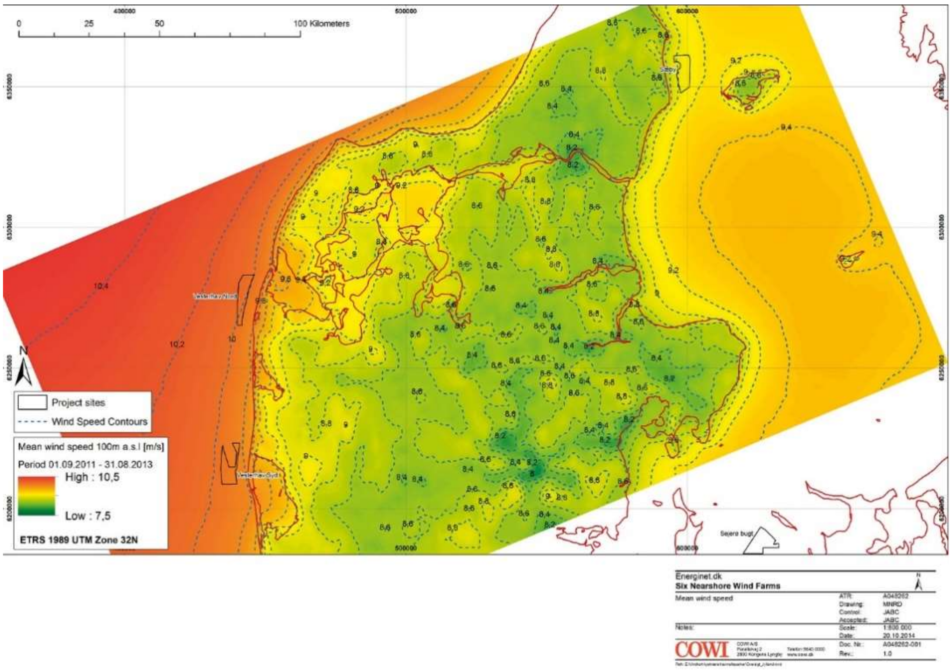


Figure 4-9 Study of nearshore offshore wind sites in Denmark for the Danish TSO Energinet in relation to Denmark's site-specific approach. Credits: COWI.

The optimal balance between central and decentralized planning depends on local market maturity, country-specific maritime and grid constraints within attractive project development areas, scale of project pipeline, experience level from relevant authorities, capacity, among others. Ideally each party – i.e. project developer and government – shall be allocated with the scope/responsibility that best matches its know-how / capability areas, in order to achieve best results. For Vietnam it is expected that a high level of government engagement in the identification of project development zones - in view of capacity deployment targets, military areas, LCOE mapping and in coordination with grid and port/maritime planning - will be key for a successful development of the offshore wind sector in the country. This is because of potential large scale of offshore wind in Vietnam, expected grid integration bottlenecks, extensive oil and gas development areas, unclear areas of military interest, etc.

4.3.5 Capacity barriers: Competence development, supply chain and job creation

As a multi-GW offshore wind pipeline develops in Vietnam, a large pool of labour will be needed to support the development, construction and operation of offshore wind farms. Operation and maintenance alone, which accounts for approximately 35% of the total costs related to an offshore wind farm, are drivers of both localized and long-term steady jobs.

Building a labour pool of welders, riggers, inspectors and mariners, in addition to skilled white-collar experts, will be needed to support the long-term sector development in Vietnam and related activities ranging from port upgrades and environmental assessments to the fabrication and maintenance of engineering of infrastructure.

Establishing domestic research and development activities, in addition to international partnerships across universities, government agencies and private sector, will be of essence to allow local capacity development and know-how. Further, in view of existing competence areas in Vietnam such as offshore oil and gas, a workforce study should be planned to determine skill gaps and support the development of a strategy to enhance local capacity, improve possibilities for local employment and prevent future workforce shortages/bottlenecks.

Figure 4-10 Welding on offshore foundation primary steel. Credits: Riviera.

In terms of local supply chain build-up, it can only be expected that a local supply chain will progressively emerge as result of investments that are made as the market matures and a multi-GW pipeline consolidates, assisted by long-term visibility. The offshore wind sector will benefit from Vietnamese offshore oil and gas industry, for instance, which has for years seen local fabrication - example shown in Figure 4-11. Vietnam also already benefits from wind turbine tower and component production capabilities (e.g. CS Wind, GE and Helukabel) and electrical power component factories (e.g. ABB).

In order to give an order of magnitude to job creation potential, a study[4] carried by COWI et alia for the European Commission in 2019 is hereby referred to. The study evaluated, among others, the job creation potential related to offshore wind development across the Baltic Sea. The low and ambitious deployment cases examined, i.e. 0,5 W to 1 GW of offshore wind capacity added per year, were found to support around 4,000-10,000 man-years of CAPEX-related employment annually, as well as a number of jobs linked to operation and maintenance which increase over time as capacity grows. By 2050, the study estimated support for 15,000-29,000 man-years of OPEX-related employment across the two scenarios.

[4] https://op.europa.eu/en/publication-detail/-/publication/9590cdee-cd30-11e9-992f-01aa75ed71a1/language-en?WT.mc_id=Searchresult&WT.ria_c=37085&WT.ria_f=3608&WT.ria_ev=search

With regard to strict localization requirements, however, experience shows that building local manufacturing capacities takes time and lowest costs of energy are driven by allowing the market to freely meet the pipeline demand based on both local and global supply chains. The benefit of fast-tracked local employment through local content requirements should therefore be carefully weighed against the willingness of the electricity off-taker to pay for cost mark-ups and risks related to non-organic local supply chain development. Hard-line approaches taken toward local content can backfire, e.g., as in France, which has some of the highest offshore wind costs in Europe[5].

Figure 4-11 The Tam Dao 05 120-meter water depth self-elevating jack-up rig, manufactured in Vietnam, being launched in southern Ba Ria-Vung Tau province Credits: VNA.

4.4 Other considerations

In addition to addressing to some of the more urgent and pressing barriers, as noted above, this section includes short descriptions with background in other selected important considerations that will need to be made in roll-out of a national-level offshore wind plan.

4.4.1 Standards and Certification

In order to expand and encourage offshore wind development, it is important to consider what certification requirements, if any, should be imposed on developers and equipment suppliers. If certification is to be required, Vietnam must also decide which governmental agencies will be responsible for setting requirements, issuing approvals, and deciding which standards or schemes shall apply, and set criteria for which entities are allowed to serve as certification bodies capable of overseeing the engineering and development related to

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[5] https://www.rivieramm.com/news-content-hub/news-content-hub/top-down-approach-to-local-content-lsquodrove-costs-uprsquo-in-france-55156

offshore wind. Responsible agencies must be capacitated to deal with this new task.

Certification requirements should be considered from the standpoint of reducing risk to project stakeholders, which includes the government and people of Vietnam, who will be the primary recipient of the local development of offshore wind energy. While the offshore wind industry is a developed and mature industry, having some third-party oversight of design, manufacturing, and construction processes is prudent for developers and suppliers receiving public funds. The offshore wind industry is used to the process of certification based on international standards, guidelines and operational documents, and has largely already incorporated the certification practice into their workflows and project planning. Thus, certification requirements are not likely to pose a hardship to industry, unless the requirements make heavy use of design standards and practices that conflict with international practice.

The topic of standards is closely connected to certification, and the two must be assessed together. Generally, the offshore wind industry utilizes international standards for the design and certification of offshore wind project elements (IEC 61400 series, ISO etc.), with gaps and specific design principles fulfilled by classification societies, such as DNV GL service specifications and guidelines. If too many regional, national, or local standards are required by law or decree, this may have negative effects on market development as this may preclude projects from incorporating new technological developments and cost saving designs that are developing in this rapidly evolving industry.

While certain project elements may need to meet local requirements, e.g., onshore cable termination will always be governed by relevant national electrical codes and seismic design requirements will vary from country to country, requiring excessive standards, especially related to structural design of main components, may exclude some developers and add to project costs. In addition, international certification bodies who are the most experienced will struggle with providing statements of conformity when forced to verify that work conforms to unfamiliar standards.

Current certification practices internationally are largely based on the IECRE system (e.g. IECRE OD-501 and OD-502 documents), or DNV GL service specifications (e.g., DNVGL-SE-0190). These systems are widely recognized and have been applied in many projects worldwide.

Countries have different approaches to certification of offshore wind farms, but industry tries to use international systems to fulfil national requirements, adding any national requirements on top of this. In Europe, Denmark, Germany, and the Netherlands are the only three countries where legal requirements for certification exist. The UK has no national requirements; however, some local permitting bodies may require it. The USA has legal requirements for using a Certified Verification Agent for projects in federal waters, which has many similarities to certification practiced internationally. Even in European countries where no certification is required by law, extensive certification is routinely performed by industry (developers/investors) in order to mitigate risks and satisfy lender and investor requirements.

As Vietnam develops its offshore wind industry, it is recommended to apply international best practice as much as possible, or to develop a local framework where international frameworks for certification can be easily applied. The IECRE system is flexible and can be applied in a way that is inclusive of national practices and requirements – if any. IECRE addresses the high-level process and content of what should be certified – including individual wind turbine components, type certification of the Rotor Nacelle Assembly (RNA) and tower, and full certification of an entire wind project. The IECRE scheme is not a prescriptive one that prescribes design standards to use when designing a project, but describes the system with which certification bodies should use to assess the conformity of the following lifecycle project aspects:

- Design
- Manufacturing
- Installation
- Operation

While minimal requirements could attract lower quality and cheaper developers/OEMs to Vietnam, the use of international best practice in standards and certification sends a positive message to the industry and gives certainty that project/supply-chain investors will not face totally unfamiliar requirements and approval procedures. Adhering to widely used international standards can also arguably place Vietnam in a better position to establish itself as a supply chain hub supplying in accordance to international market requirements/demand.

4.4.2 Cost reduction trajectory

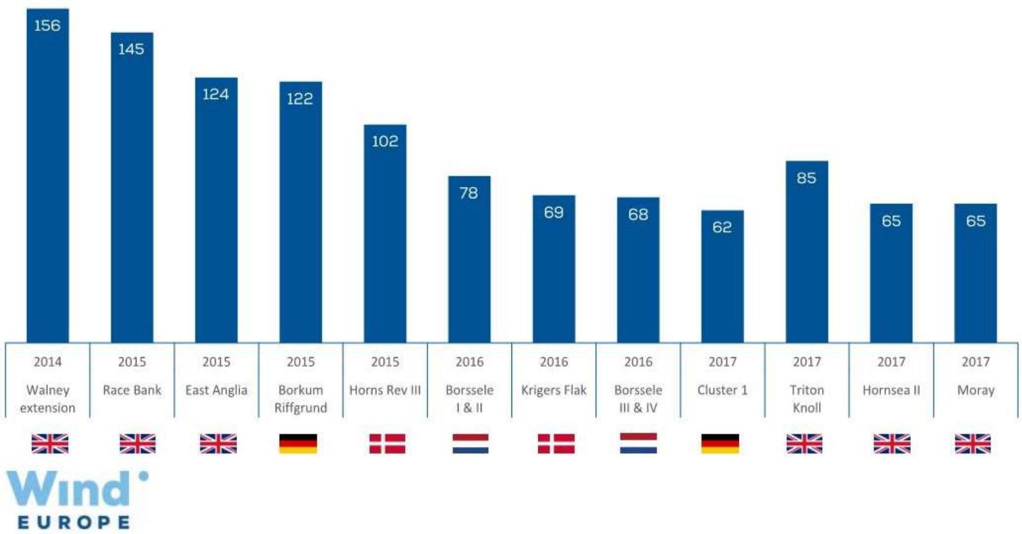


Figure 4-12 Levelized revenue/price of electricity (LROE), incl. transmission until onshore grid connection [EUR/MWh]. Note: LROE consists of the total revenue of a project divided by its energy generation, over the project's lifetime. LROE > LCOE is a precondition for the project to be profitable. Credits: WindEurope.

Illustrated in Figure 4-12, the price of offshore wind in Europe has been following a cost reduction trajectory and has come down from 156 EUR/MWh in 2014 to 62 EUR/MWh in 2017. More recently, these markets have seen auction strike prices around 50 EUR/MWh e.g. Sofia in UK at 43 EUR/MWh incl. transmission, Cr. Beck A Dogger Bank in UK at 47 EUR/MWh incl. transmission and Dunkirk in France at 44 EUR/MWh excl. transmission.
The cost reduction curve as seen in Europe has been driven many factors, including:

- Government planning
- De-risking of investments (lowering risk premiums)
- Multi-GW project pipeline
- Increased project and wind turbine scale
- Innovation, technology maturity and optimized designs
- Long-term infrastructure and supply chain development including ports, harbours and vessels

New markets worldwide certainly benefit from the European market maturity and respective lessons learned. However, cost mark-ups and risk premiums are intrinsic for the first projects in new market waters. Hence, starting costs in new markets are typically expected to be higher than the latest European auction levels.

Despite the exact starting high cost level, offshore wind is an energy source which typically shows best cost-benefits in view of a phased long-term project pipeline development. Take Taiwan as an example, which within a short period of time attracted global players, benefited from substantial cost reductions and emerged as a leading offshore wind market in East Asia. Noting that three key factors contributed to Taiwan success story: clear long-term targets, progressive transition from FiTs to competitive bidding and spatial planning supported by consenting regime. Ref. Appendix B. For Vietnam, it is also expected that a high level of government engagement within these three areas will be key for the successful development of its offshore wind sector.

Based on international experience, an average learning rate of approximately 15% is possible in new emerging markets - Ref. “An Industry Paper to the European Commission”, by WindEurope, 2018. A 15% learning rate implies a 15% cost reduction for every doubling capacity, as illustrated in the indicative Figure 4-13. When drafting long term targets and roadmap for Vietnam, it is very relevant to project such cost reduction trajectory curves in view of both capacity deployment targets and enabling policy scenarios. With regards to the latter, it should be noted that the cost reduction trajectory does not take a strictly declining shape if local content requirements are added. Instead, local content requirements typically inflate costs before contributing to potential cost reductions.

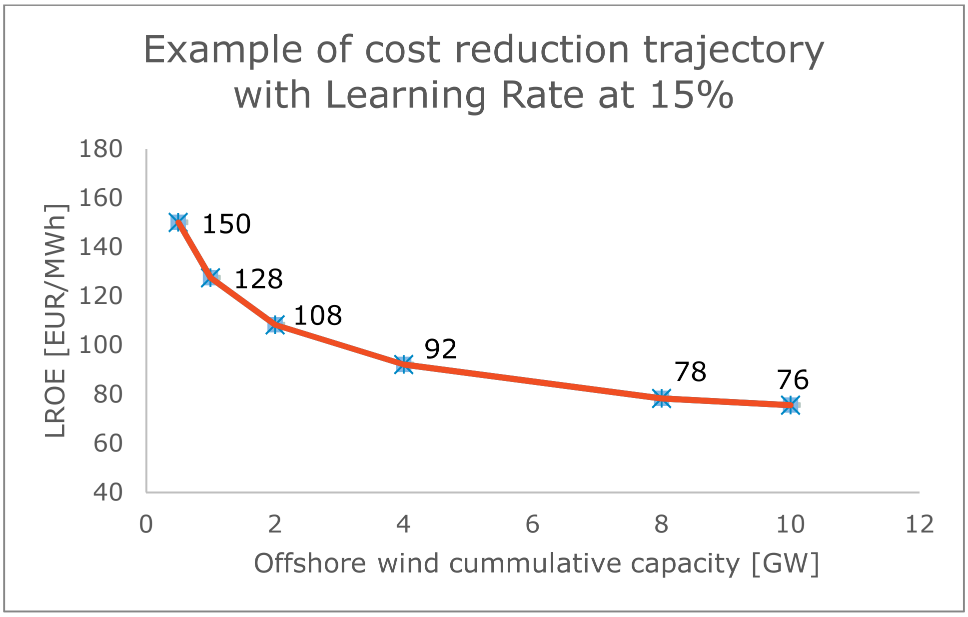


Figure 4-13 Illustrative cost reduction trajectory, from 500 MW at 150 EUR/MWh to 10 GW at 76 EUR/MWs.

In addition to the progressive and long-term cost benefits from capacity deployment, a key aspect for de-costing, de-risking and enabling the bankability of projects are the power offtake agreement contract terms and conditions, as well addressed by previous studies specific to Vietnam and emphasized by the Institute of Energy in Appendix A and Copenhagen Offshore Partners in Appendix B and partially illustrated in Figure 4-14.

Financeable PPA Terms

Lenders and export credit agencies require certain PPA features, including:

1. **Step-in rights**
   - A customary requirement for large-scale projects
   - Provides mechanism for lenders to continue production if borrowers default
2. **Curtailment and grid outage mechanism**
   - A mechanism in place to limit unforeseeable losses due to curtailment and grid outage
3. **Protection from change in law**
   - Ensures key PPA terms and tariff does not change, in the event of a change in law
4. **International dispute forum**
   - Offshore wind projects require significant foreign capital with specific expertise thus an international dispute forum is required
5. **Grid delay mechanism**
   - A mechanism in place to limit unforeseeable losses due to delayed grid availability

Figure 4-14 Financeable PPA terms. Credits: Copenhagen Offshore Partners, Appendix B

5 Overview of recommendations

With a vision of 10 GW of offshore wind in Vietnam by 2030, and building upon the analysis presented, the below summarizes draft high-level recommendations for the sector kick-start and build-out.

- Set out clear, long-term and progressive targets for offshore wind energy deployment in Vietnam
- Designate a government lead nodal agency to front the permitting and consent process of offshore wind projects and to act as a one-stop-shop
  - Streamline permit and consent process at both national and provincial levels
  - Ensure flexibility in the permitting and consents, so to allow a certain degree of project design and construction flexibility as the project evolves from an early stage permit phase to the implementation phase e.g. allowing a range of wind turbine sizes within the applicable permit envelope
  - Support cross-ministerial cooperation, like the Danish model, to smooth the process

- Initiate zoning of areas for offshore wind project development in Vietnam considering e.g. deployment targets, LCOE study, offshore wind spatial requirements, maritime spatial constraints, ports and harbours, grid connection and provincial level consultations

- Kick-start of the sector through the award of a phased large-scale project

- Award the first projects through a stable long-term FiT which should be secured at a sufficient level to attract market interest

- Ensure bankable PPA contract prior to the award of the first project, in consultation with project developers and lenders

- Assess skill gaps and plan national competence building in view of offshore wind capacity deployment targets. Allow for organic supply chain build-out, before considering local content requirements

- Integrate to international best practice with respect to wind farm design and certification

- Draw cost reduction trajectory scenarios, in order to assess pathways for long-term cost competitiveness of offshore wind against other energy generation technologies

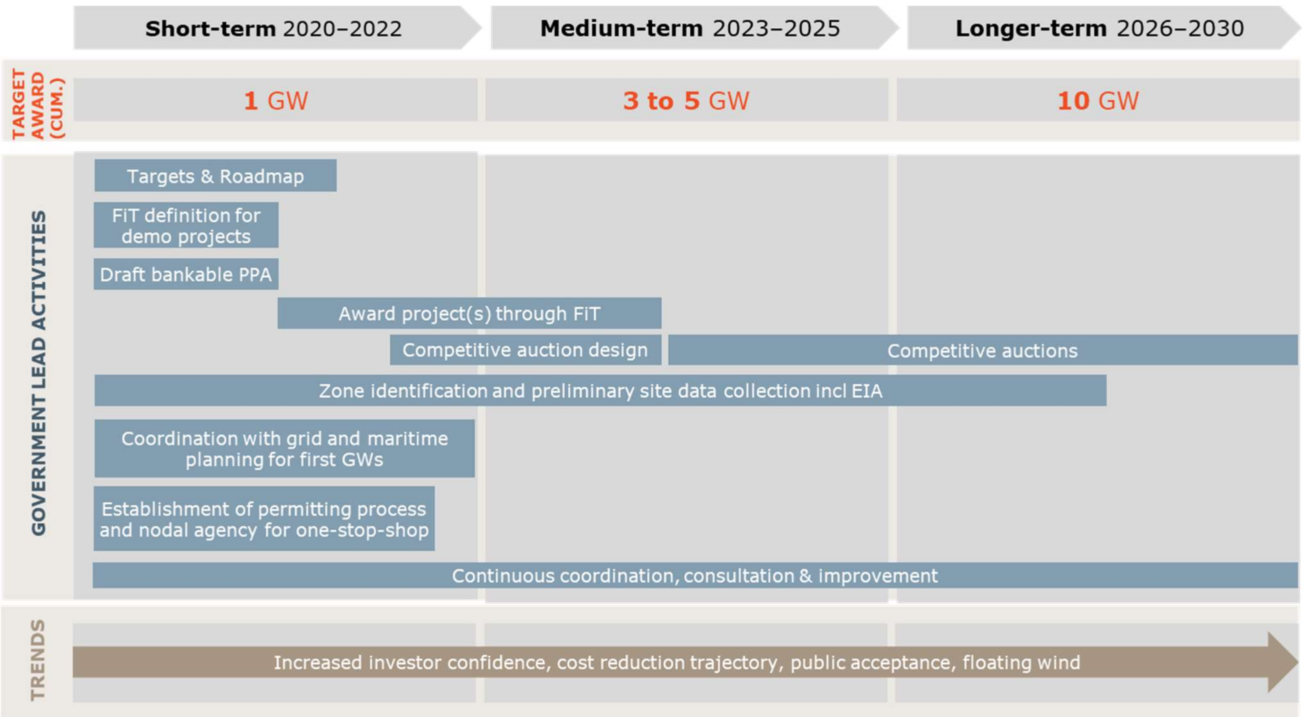


Figure 5-1 Draft high-level activities for offshore wind sector build-out in Vietnam.

Appendix A – Inputs for roadmap on offshore wind development in Vietnam

Introduction

The power sector is critical to all sectors, not only because it is an essential service, but because the subsector is the clearing house for natural gas, coal, and oil and has a determinant impact on their relative prices. The national Power Development Master Plan (PDP) is the governing planning document in the power sector. The current power development master plan (PDP VII) was prepared in 2011 for the period up to 2020, with long-term vision up to 2030,[1] minor revisions were incorporated in 2013.[2] It has been revised by EVN in 2014 and the revised PDP VII was approved in 2016. Currently PDP VIII is under drafting and to be submitted to MOIT by end of 2020 for reviewing and approval

The economic growth set the stage for high demand for electricity and other forms of end-use energies. By the end of 2019, the total installed and operating generation capacity in Viet Nam was 54.9 GW. The average annual electricity demand growth was 12.2% during 2005-2013, 9% during 2014-2019 and electricity consumption increased from 45.6 terawatt-hours (TWh) in 2005 to 210.5 TWh in 2019.

Vietnam has offered very stable economic conditions throughout the last years and a steady economic growth. The country's energy mix is characterized by a strong hydro power capacity (37%) as well as larger shares from coal-fired installations (36%). Variable RE represent small capacity but increasing rapidly (9% by end 2019) despite entering the market late.

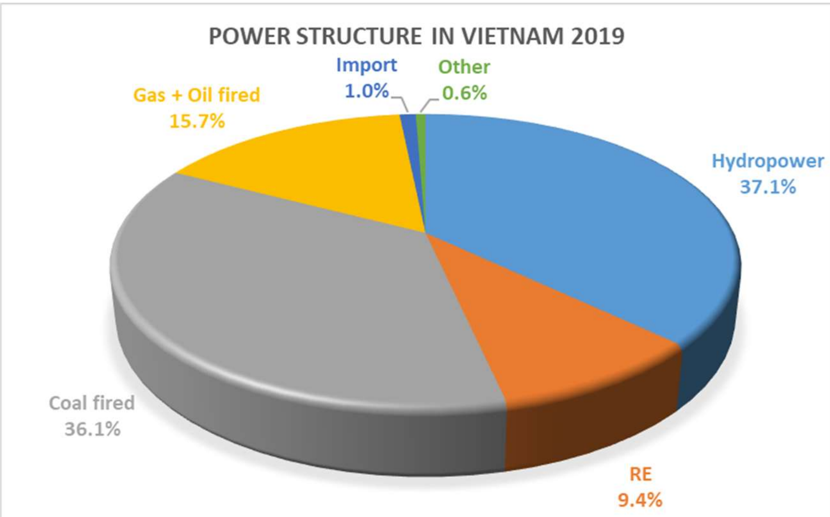


Figure 1: Power structure in Vietnam 2019.

[1] GOV. 2011. Decision 1208/QD-TTg Approval of the national master plan for power development for the 2011 - 2020 period with the vision to 2030. Hanoi

[2] GOV. 2013. Decision 2414/QD-TTg On adjusting list, schedule of a few of power projects and providing for a few of special regulations and policies for investment in urgent power projects during 2013 – 2020. Hanoi

Context: Barriers and Positive driving forces for OWD in Vietnam

The country has set itself very ambitious renewables target for 2020 and 2030. Under the renewable energy development strategy of Vietnam towards 2030 with a vision to 2050 that was approved by the Government in 2015, the country aims to increase the ratio of electricity from renewable sources (including small hydro) from 35 percent of total electricity output in 2015 to 38 percent in 2020 and 43 percent in 2050. This should be seen in a context of rapid power capacity build out combined with a small remaining potential for hydro power plants.

The latest official resolution of the Politburo 55/NQ-TW on "Orientations of the Viet Nam's National Energy Development Strategy to 2030 and outlook to 2045", issued on 11 February 2020, has set new strategic orientation for Energy development with more ambitious target for RE energy:

- The share of renewable energy sources in the total primary energy supply to account for 15 - 20% in 2030 and 25 - 30% in 2045.
- Renewable energy: Formulate breakthrough mechanisms and policies for encouraging and promoting remarkable development of renewable energy sources towards maximal replacement of fossil energy sources. *Give priority to the use of wind and solar power for power generation;* encourage investments in the development of power plants utilizing urban waste, solid and biomass in parallel with environmental protection and circular economy development. Construct and develop several renewable energy centres in regions and localities with favourable conditions. Promptly conduct research and holistic assessment on the potential of geothermal, wave, tidal power and ocean current power, and develop directions for the development of these power sources; realize a number of applicable models, pilot power exploitation with the aim of producing an efficiency evaluation. Conduct technology research and develop several plans for piloting hydropower production and encouraging the use of hydropower in agreement with the global trends.
- Wind and solar power: Give priority to wind and solar power development fitting the capability to assure safety for the national power system and reasonable power price. Encourage rooftop and floating solar PV. Develop supporting policies and a breakthrough mechanism enabling offshore wind power development in association with the implementation of Vietnam's Marine Strategy.

Earlier research by Vietnam Institute of Energy (VIE, 2018) shows that Vietnam can have generation capacity about 8,000MW of small-scale hydropower, 3,000MW of biomass power, and 35,000MW of solar power in 2030. Vietnam can produce about 30GW of onshore wind power, along with 100GW from offshore wind farms.

The potential for offshore wind in Vietnam is immense and based on regional screening exercises for bottom-fixed and floating offshore wind projects carried out by C2Wind, a (non-exhaustive) technical potential of offshore wind capacity deployment in the order of 160 GWs has been identified. For comparison, this potential represents many times the current European installed capacity during 2019 and a significant fraction of total projected EU offshore wind needs by 2050.

As a result, ambitious targets for the development of RES have been committed. With regard to wind power particularly, the revised National Power Development Plan VII (Decision No. 428/QD-TTg, dated 18 March 2016) has required the total wind power capacity to be increased from the at that time negligible levels (160 MW) to around 6 000 MW by 2030 (onshore wind only considered; Vietnam has currently no official target specifically for offshore wind). Understanding the role of promoting policy to the renewable energies deployment, the Vietnamese Government has applied the FIT of 7.8 USct/kWh for wind power since 2011 until 2018. However, the tariff was claimed as too low to boost its deployment, making the market under-developed and fall far behind the Government's expectation. Therefore in 2018, the GOV has issued new FIT, higher and differentiated for onshore and offshore, but it set the deadline for application on 1 November 2021. Currently MOIT has drafted and submitted to PM an extension for wind power up to 31 December 2023 with new to be elaborated FIT.

In parallel with a revision of the FIT level to match with the market conditions, the Government also considers other supporting mechanisms that could contribute to the development of wind power in Vietnam and to help the sector meet its targets. With the aim of efficiently procuring new generation resources while ensuring reliability and security of supply at least possible cost, the Government finds it worthwhile to examine the auctioning as another option of wind power supporting policy.

Policy framework
• **New tariff , is encouraging, as evidences shown. However, it will end by 1/Nov/2021.** • After 1/Nov/2021, it is considered to apply auctioning program, currently under development. Currently the extension of the cut-off date for this FIT is under consideration • The debate: FiT vs Auction • No assessment for offshore wind potential, therefore a lot of uncertainty for policy framework. • **Regulatory framework for offshore wind is under elaboration**
Regulatory issues
• Before 2/2019, there are constraints on wind measurement (above 6m/s, 01 wind mast per 1000 ha), and technology applied (Use of LIDAIR measurement is not allowed yet). Since 2/2019, MOIT has issue updated requirements "The wind power project shall have a wind measurement report which has been made at the project's location before the feasibility study report is made and approved. The wind measurement shall be carried out within a minimum period of 12 consecutive months at the representative locations, and the quantity of the wind measuring poles must be suitable to the topographical change of the project's area. The wind measurement method, equipment and results shall comply with the IEC standards or equivalent international standards". • **Land restrictions hinder wind farm construction.** Most of the wind-rich locations are along black sand areas which, by current regulations, should first be utilized before wind farm construction starts. In Binh Thuan province, viable wind farm areas are also marked for titanium mining. • Regulation on grid connection is complicated and requires different permissions and approvals (approval on PDP, grid connection approval, SCADA & telecommunication, Relay protection, Metering).

Source: Compiled by the consultant

The Government of Vietnam also offers a number of support measures to promote the development of renewable energies, including incentives on the corporate income tax, the import tax, the land use fee and the project escrow.

1) ***Funding:*** *The investor can raise funds in different forms allowed by law from individuals and organizations in and out of the country and have access to State credit for investment as legally regulated.*
2) ***Tariffs:*** *The investor is exempted from tariffs on goods imported to create fixed assets and goods used as raw materials, input or semi-finished products that are not available at home for the project's operation in line with the Law on Export Taxes, Law on Tariffs and other regulations on export and import duties.*
3) ***Corporate income tax:*** *The exemption and reduction of corporate income tax for wind power projects is the same way as other projects enjoying preferential treatment in investment in line with the Law on Investment, Law on Corporate Income Tax and other documents guiding the enforcement of these laws. According to the Circular 78/2014/BTC and 96/2016/BTC, the Corporate income tax will be 0% for the first 4 years, 5% for the next 9 years, 10% for the next 2 years, and 20% for the next 5 years.*
4) *In addition, there is* ***other preferential treatment*** *in infrastructure for wind power projects as follows:*
   1) Projects on installing wind powers, lines and transformer stations connected to the national grid are entitled to exemptions and reductions in land rental in line with the current law applicable to projects of special investment treatment.
   2) *In accordance with the power development plan approved by the competent authority, the provincial People's Committee allocates land to the investor to implement wind power projects. The compensation for and support to site clearance complies with the provisions of land law in force.*

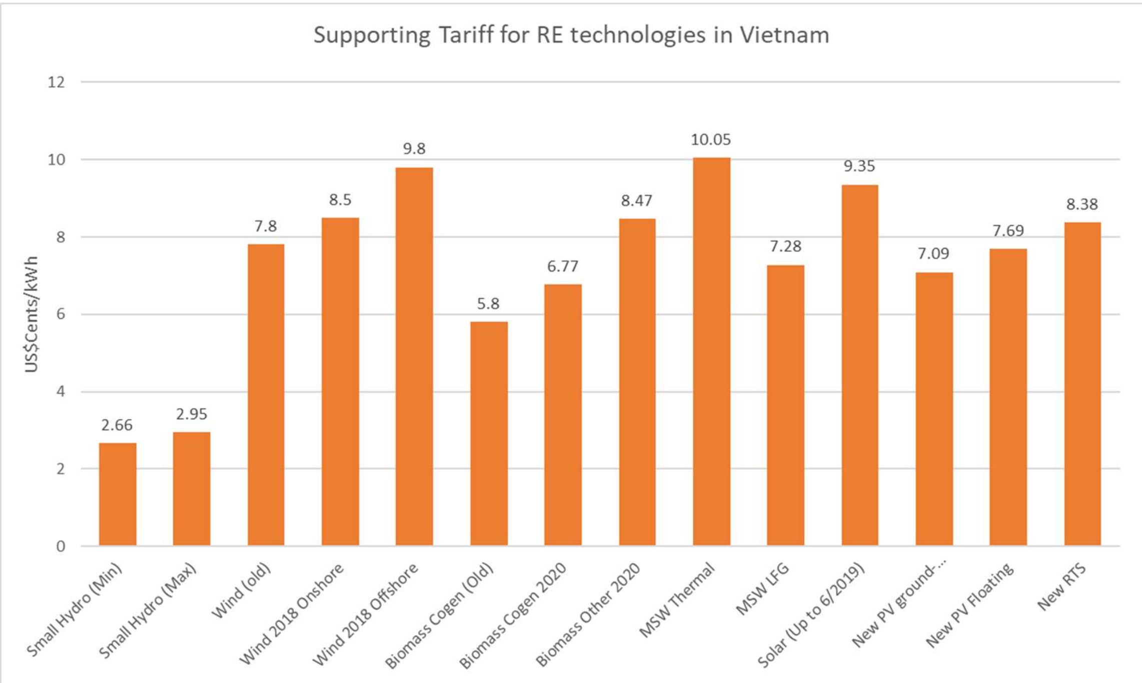


Figure 2: Supporting tariff for RE technologies in Vietnam (Elaborated by Consultant)

Whereas the low level of FIT for wind development is often mentioned as the main factor for the limited wind energy installed capacity so far in Vietnam, the hurdles of wind energy deployment indeed come from many other issues, for example, the lack of reliable data and qualified human resources, and most importantly, the complicated, non-transparent project development and investment procedure. The following figure presents the development process to show difficulties and challenges that investors/developers are struggling within the current regulatory system.

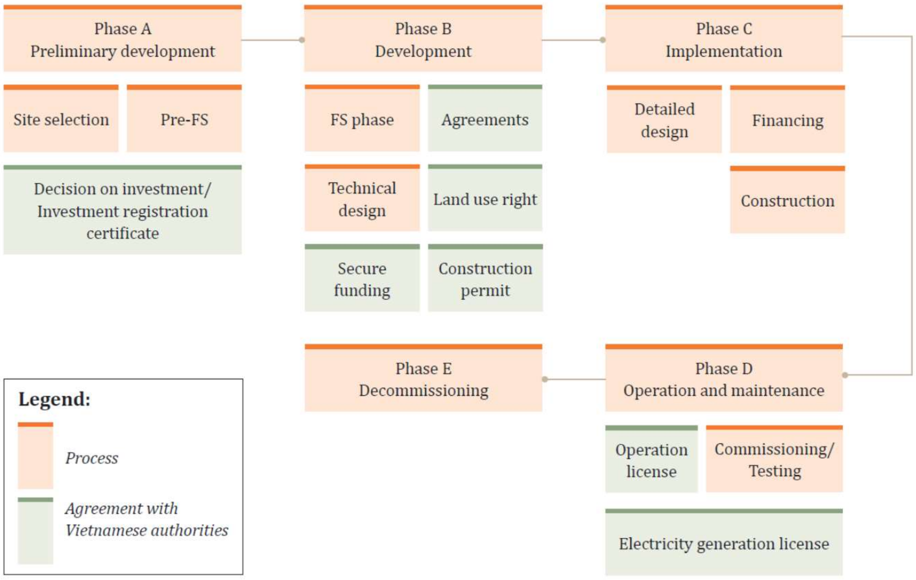


Figure 3: Development process for Wind power project in Vietnam (Source: Wind Power Investment Guidelines. Volume 1: Project Development, GIZ 2016).

Current PPA terms for wind power is another concern for reviewing and revision.

According to the international review and analysis there are several issues with current PPA terms. The following are most discussed issues summarised by Baker McKenzie (Presentation on WS on PPA, 2017):

	Issues	Solution to ensure the feasible in the bank
Structure and clarity	Although the standardized power purchase agreement is expressed concisely, however, it lacks clarity in many areas that extremely important for investors and international donors The standardized power purchase agreement cannot attract international trade financing under reasonable terms.	The standardized power purchase agreement should be structured and drafted tightly, and the obligations and responsibilities of the parties should be clearly defined and limited to the minimum uncertainty about the meaning of the terms and scope of the possibility of a dispute relating to the interpretation of the agreement. Should add the basis of the contract establishment to address the specific context and purpose of an used power purchase agreement. The context in which the standardized power purchase agreement will be used should be clearly stated.

		Needs more conventional definitions of terms in order to improve transparency and avoid disputes. Defined words should be capitalized when used, and the words are not defined should not be capitalized unless it is the proper nouns. Defined words should be used uniformly.
Legislation governing	Apply Vietnamese law Do not apply foreign law	Investors and international donors prefer foreign law. If the Vietnamese law is applied, should allow the application of the foreign law if the Vietnamese law does not fully define contents, issues, situations or circumstances that could occur from or related to the power purchase agreement.
Settlement of Disputes	Mediate at the General Directorate of Energy[3] before settling the dispute in Vietnamese courts (If mediation does not end the dispute) Does not Settle disputes abroad at neutral zone -> major concern for investors and donors Does not designate the expert. Does not specify the Abandoning exemption for sovereignty reason	Settling disputes by a professional and independent organization, e.g. Settling disputes by arbitration by a foreign arbitration institution. Arbitral proceedings abroad under the common rules which are accepted by international community. Put provisions of experts designated for the technical issues. Abandoning exemption for sovereignty reason.
Credit Support	There is no credit support or guarantee for the payment obligations of EVN / buyer	Payment obligations of EVN/buyer should be supported by government guarantee and / or government assistance.
Political force majeure	There is no distinction between political force majeure and other force majeure events. There is no payment protection / power generation implicit/deemed availability in case of Political force majeure	Distinguish between political force majeure and other force majeure events (which means between natural force majeure and "political events in Vietnam" and "foreign political events." The power purchase agreement may include the withdrawal of the additional cost and implicitly deemed energy payments.
Launched implicitly / Deemed to have occurred and the	There is no concept for implicitly operation /deemed commissioning. There is no regulations on implicitly operation/ deemed	The power purchase agreement should prescribe on implicitly operation/deemed commissioning "Launched implicitly "should happen if the power plant or a part of the power plant is

[3] Now it is changed to become Electricity and Renewable Energy Agency (EREA) since 10/2017.

power implicitly /deemed availability	commissioning in the case of the buyer has not completed the grid connection systems or for other reasons that cannot receive power.	ready, but the buyer cannot receive the generated/produced power.
Payments when terminating the Agreement	There is no regulations on the acquisition of control / power plant when terminating early or after the event of force majeure. There is no regulation on the buyer to pay any part of the debt after termination for violating of the Project Company.	The termination terms should be included in a specific method to determine the total amount of money to be paid upon termination of the contract. This ensures that the total value of assets is compensated fairly and accurately. When the buyer has violation and when there is a political force majeure event and the whole owners' equity is preserved and the costs resulting from the termination / cancellation of contracts with subcontractors must be paid. The entire debt is preserved, the termination costs need to be paid – owners' equity can be compensated in part if the force majeure event arising from natural causes Violated Project Company: the debt is entirely preserved.
Change of the tax and law	Inadequate Risk sharing.	The power purchase agreement should specify what happens if the law or the rules changed and specify who will be responsible for any damage to any revenue as a result of the legal change. The power purchase agreement should ensure that the buyer incurs the risk of changes in legislation or tax policy after the date of signing the Escalation contract in ways to alleviate the seller's revenue.

Other matters

Currently there is no binding regulation on localization rate (local content) for power industry.

On Maritime port investment plan, the PM just signed the decision 77/QD-TTg (13 January 2020) to assign MOT to carry out the Master plan for maritime port development period 2021 – 2030, outlook to 2050. This master plan includes the entire existing Vietnamese seaport system, auxiliary infrastructure for seaport development, including storm shelters for ships; maritime signs and areas capable of developing seaports, auxiliary infrastructure for seaports of Vietnam's sovereign regions, including on rivers, coastal areas, islands and water bodies. In addition, consideration is also given to the attractive space of a seaport that is the entire territory of Vietnam and the attractive national regions through inter-regional and inter-national transport axes. This master plan to be completed and approved in 2021. The previous Master plan for maritime port development up to 2020, with outlook to 2030 (1037/QD-TTg) was approved in June 2014 is still in effect (see attachment. List of the Sea port according to this Master plan is presented in the appendix). This current maritime port plan did not take into account any offshore wind development need for port. However, as the list showed in the appendix, there are several large multipurpose sea ports that could be considered for offshore wind logistics.

MONRE and VASI (Vietnam Administration of Seas and Islands) is preparing the Master plan for maritime spatial development plan. However it was not clear yet when this important master plan will be initiated and completed. The main contents of such master plan are follows:

- Analysis and evaluation of factors, natural conditions, resources, contexts directly impacting and the reality of spatial use of activities on coastal land, islands, archipelagos, regions of the sea, airspace, sovereignty, sovereignty and national jurisdiction of Vietnam;
- Identification of areas banned from exploitation, areas subject to conditional exploitation, areas encouraged for development, areas in need of special protection for the purposes of national defence, security, environmental protection and preservation of ecosystems the state in coastal areas, islands, archipelagos, sea areas, airspace under sovereignty, sovereignty rights and national jurisdiction of Vietnam;
- Forecast of natural resources and environment trends, impacts of climate change on natural resources and environment; needs of exploitation and use of natural resources and requirements of environmental protection in coastal areas, islands, archipelagos, sea areas and airspace of sovereignty, sovereignty rights and national jurisdiction of Vietnam in planning period;
- Forecasting contexts and development scenarios; assess opportunities and challenges for marine space use activities;
- Identify development perspectives and goals;
- The spatial arrangement for use of activities in coastal areas, islands, archipelagos, sea areas and airspace under sovereignty, sovereignty rights and national jurisdiction of Vietnam;
- Zoning using coastal lands, islands, archipelago, sea areas and airspace under sovereignty, sovereignty rights and national jurisdiction of Vietnam;
- Solutions and resources for implementation of the planning;
- List of important national projects and priority order for implementation

Offshore project pipelines:

The focus of the offshore project pipelines is now concentrating in Ninh Thuan and Binh Thuan area, where it has relatively good sea facility (depth seaport), wind profiles are excellent, meteorological conditions are favourable, almost no typhoons in the past.

Currently, there are five application in the pipeline:

a. Ke Ga (Thang Long) 3400MW in Binh Thuan province
b. La Gan in Binh Thuan province - 1800MW
c. Co Thach in Binh Thuan province - 2000MW
d. Binh Thuan 1 (MacCap) - 3000MW
e. HBRE in Ba Ria Vung Tau province - 600MW

Some domestic developers also preparing applications to submit to either to Prime Minister Office/MOIT and/or Provincial People Committee (PPC) . This pipeline list is somehow fragmented and speculative, as it is at province level which required more extensive checking and verification:

a. Xuan Thien in Binh Thuan and Ninh Thuan provinces - 5000MW
b. TTVN in Tra Vinh province - 2000MW
c. Asia Petro in Binh Thuan province - 2000MW
d. Xuan Cau in Binh Thuan – No information is available.

Transmission Grid network congestion and integration

Overview of power system in Vietnam in 2019 with its regional transmission capacity and constraints

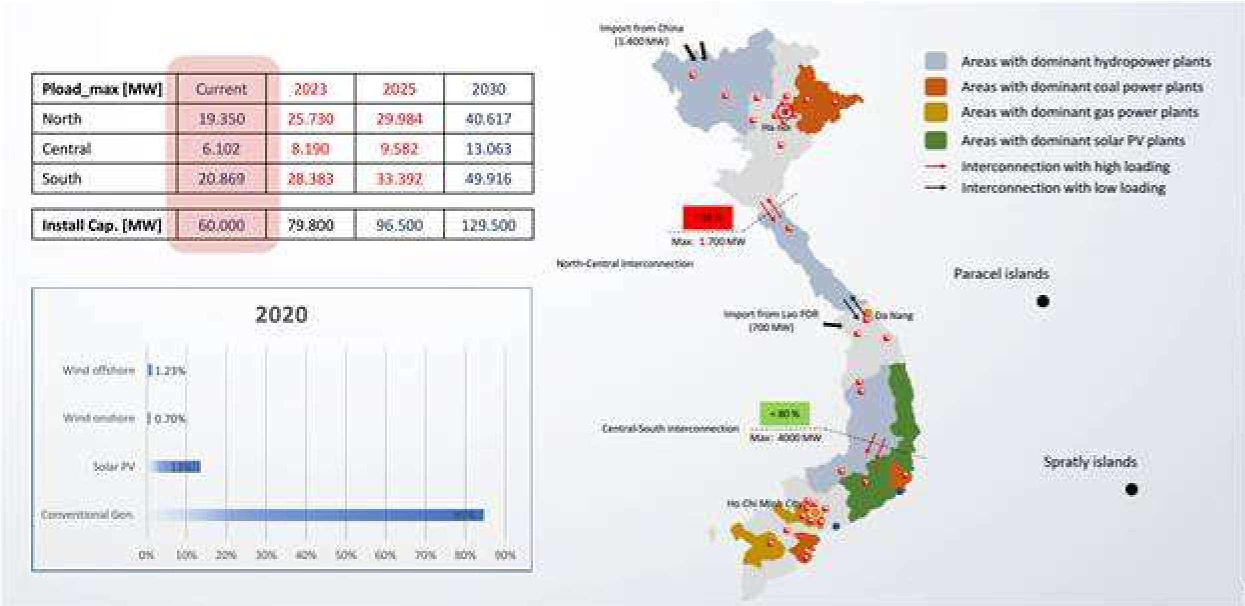


Figure 4: Overview of power system in Vietnam (Source: VIET, 2020).

Table 1: Power production in 2019 (Source: NLDC report 2020)

Production in 2019	10^6 kWh)	%
Total	**240,101**	
HPP	66,117	27.54%
Coal fired	120,158	50.04%
CCGT	42,402	17.66%
Oil fired	1,239	0.52%
Gas turbines using oil	822	0.34%
Thermal using gas	105	0.04%
Wind	722	0.30%
Solar PV	4,818	2.01%
Biomass	350	0.15%
Diesel	53	0.02%
Import from China	2,198	0.92%
Import from Lao	1,118	0.47%

Overview on system congestion time

Table 2: Overall Loadability of the Substation (SS) and Transmission lines (TL) in Power system in 2019. (Source: NLDC report 2020)

Management level	Equipment	Number of TL/Ss	Those at full load	Time that equipment is at full load/overload				
				>80 - 90%	>90 - 100%	>100 - 110%	> 110%	Total
NLDC	Ss 500kV	56	35	5,345	588	20	-	5,953
Regional LDC -A1	SS 220kV	209	60	9,191	3,460	871	1	13,523
	SS 110kV	898	320	84,206	24,225	5,258	-	113,689
	TL 220kV	173	60	3,024	780	62	-	3,866
	TL 110kV	640	220	20,500	6,899	515	-	27,914
Regional LDC -A2	SS 220kV	130	75	21,286	3,457	61	-	24,804
	SS 110kV	634	179	37,077	3,237	52	-	40,366
	TL 220kV	190	56	7,468	1,341	164	-	8,973
	TL 110kV	613	176	28,580	7,616	176	-	36,372
Regional LDC -A3	SS 220kV	103	6	399	22	-	-	421
	SS 110kV	347	42	9,738	1,020	-	-	10,758
	TL 220kV	87	4	1,070	289	27	6	1,392
	TL 110kV	278	9	1,406	571	-	-	1,977

The following analysis on grid congestion and loadability of the 500-220-110 kV in 2019 was extracted from NLDC operation report 2019:

500kV system

Few equipment has been fully loaded for a short duration of time, happen due to

- Demand increase at SS : Nho Quan, Thường Tín, Hà Tĩnh; Quảng Ninh, Sông Mây, Nhà Bè, Tan Định, Cầu Bông.
- Generation increase at SS: Vũng Áng; Hiệp Hòa, Quảng Ninh, Phố Nối, Di Linh, Đăk Nông, Pleiku 2, Duyên Hải, Ô Môn.

Loadability of 500kV TL were set-up to the stability limits of these TL. Majority of transmission flows are from North-Center, Center – South. There are no overloaded TL, but some of them are operated at critical full load: Hà Tĩnh – Đà Nẵng, Vũng Áng – Đà Nẵng; Pleiku 2 – Cầu Bông, Pleiku – Di Linh, Đăk Nông – Cầu Bông and Dốc Sỏi - Pleiku, Thạnh Mỹ - Pleiku 2.

From July to October 2019, load flows were going from South – Center – North due to high temperature in the North and high generation from solar PV. Critical full load flow happened in the TL : Nho quan – Hà Tĩnh, Hà Tĩnh – Đà Nẵng, Vũng Áng – Đà Nẵng và Dốc Sỏi - Pleiku, Thạnh Mỹ - Pleiku 2.

In 2019, power flow on TL North-Center was 6.696 billion kWh, equal 60.2% of 2018. From Center – South it was 9.564 billion kWh, equal 49.6% of 2018. Maximum capacity was 2,224MW on TL North – Center and 3,681MW on TL Center – South.

North system

Some critical full loaded for the North system during June and July 2019 :

- TL 220kV : Hà Đông - Hoà Bình; Thường Tín - Hà Đông, Sơn La - Việt Trì; Nho Quan - Phủ Lý; Sóc Sơn - Vĩnh Yên, Lào Cai - Bảo Thắng ; Hà Tĩnh - Hưng Đông; Sơn La - Việt Trì, Hiệp Hòa - Đông Anh, Nho Quan - Phủ Lý……
- SS 220kV: Bảo Thắng; Phố Nối; Đồng Hoà; Mai Động, Thái Bình; Phủ Lý; Thành Công, Đông Anh; Phú Bình; Than Uyên, Hưng Đông; Quỳnh Lưu, Hà Đông, Sơn La, Việt Trì, Ninh Bình, Tràng Bạch, Nho Quan…..

Following TL and SS are often in full load :

- TL 220kV: Nho Quan - Ninh Bình, Nho Quan - Phủ Lý, Yên Bái - Bảo Thắng, Lào Cai - Bảo Thắng, Chèm - Hòa Bình, Hà Đông - Hòa Bình, Hà Đông - Chèm, Thường Tín - Hà Đông, Thái Nguyên - Phú Bình; Yên Bái - Lào Cai, Hiệp Hòa - Đông Anh, Nghi Sơn - Hưng Đông , Sóc Sơn - Vĩnh Yên, Sơn La - Việt Trì, Hà Tĩnh - Hưng Đông, Thái Nguyên - Phú Bình, Quảng Ninh - Hoành Bồ, Hà Đông - Phủ Lý, Đình Vũ - Hải Phòng ….
- SS 220kV: Thái Bình, Hà Đông, Thành Công, Ninh Bình, Phủ Lý, Tràng Bạch, Hưng Đông, Nho Quan, Bảo Thắng, Phú Bình...
- TL 110kV: Ba Chè - Yên Định, Bắc Giang - XM Đồng Bành, Bảo Thắng - Tằng Loỏng, Bảo Thắng - Tằng Loỏng ....

Center system

SS 220kV : there is no overload SS. There are 06 SS fully loaded (Ngũ Hành Sơn due to high demand; Nha Trang due to maintenance of 01 transformer; Tam Kỳ due to maintenance on TL 110kV Đà Nẵng – Điện Bàn; Kon Tum due to maintenance of one transformer; Sơn Hà due to maintenance and highe generation in area).

SS 110kV, no overloaded SS. 42 SS is fully loaded, mostly due to high demand.

TL 220kV, three TL are overloaded due to high generation from Solar PV (Nha Trang – Tháp Chàm 2, Pleiku – Biomass An Khê, HPP An Khê – Biomass An Khê), and one high load due to high demand (Quy Nhơn – HPP An Khê).

TL 110kV, There are 09 high load TL (Kon Tum – Đăk Hà, Đăk Hà – Tân Mai Kon Tum, AyunPa – HPP ĐăkSrông 3A, AyunPa – EaHleo, EaHleo – Tây Nguyên wind farm, Tây Nguyên wind farm – Krông Buk, Quy Nhơn – Long Mỹ, Long Mỹ - Sông Cầu, Sông Cầu – Sông Cầu 2).

South system

This is most critical situation in this sub-system with many TL, SS overloaded and/or fully loaded due to various reasons: maintenance, high demand delay in upgrading TL:

SS 220kV: there are 06 SS overloaded in dry season due to high demand; 02 SS overloaded due to operational modality switching; 02 SS overloaded due to high generation of solar PV (HPP Đại Ninh:100,6%; HPP : 108,0%);

SS 110kV, there are 09 SS lightly overloaded due to high demand in dry season.

TL 220kV, 04 case overloaded due to contingency case with one transformer at Tan Dinh 500kV SS. 02 cases due to high penetration of solar PV (Di Linh - Đức Trọng 2: 103,5%, Solar PV Hồng Phong 1A - Phan Thiết 2: 104,2%);

TL 110kV, 04 case overloaded lightly in dry season high demand. 47 TL are highly loaded due to solar PV generation.

Study on RE integration in 5 provinces of the Southwestern region

The following are extracted from the IoE study for GIZ phase 1 (5 provinces):

For the whole region of 5 provinces, 500-220-110 kV grids can evacuate the RE in 5 Southwestern provinces with the total capacity of about **3400 MW** (following N-0 criterion for a power transmission grid) and about **2800 MW** (following N-1 criterion for a power transmission grid).

In the scenario that the power transmission grid planned for the period of 2021-2025 (in the revised PDP 7) is put into operation right in the period of 2021-2022, the Southwestern grids in this period will not be able to evacuate all 6300 MW of RE in the region. For the whole region, 500-220-110 kV grids can absorb RE in 5 Southwestern provinces with the total capacity of about **3700 MW** (following N-0 criterion for a power transmission grid) and about **3000 MW** (following N-1 criterion for a power transmission grid).

To ensure the power evacuation of 6300 MW from RE in the Southwestern region, the report proposes solutions for constructing and upgrading some 500-220-110 grids, specifically,

- 500kV grid: Constructing 500 kV Bac Lieu substation (3x900 MVA) and 500 kV Bac Lieu – Thot Not – Duc Hoa line, which will be connected to 500 kV Duc Hoa substation, to evacuate the wind power in Bac Lieu and Ca Mau provinces to the Southeastern region.

- 220 kV grid: Operating 220 kV Vinh Chau, Duyen Hai and Hoa Binh substations in Soc Trang and Bac Lieu provinces to gather their wind power to be transmitted to 220 kV lines.

- 110 kV grid: Apart from splitting phases in 110 kV lines in accordance with the PDP, it is necessary to add some 110 kV lines in Ben Tre province to avoid the overload on grids, split phases in 110 kV Bac Lieu - Vinh Trach Dong - Thanh Trị - Soc Trang line, constructing 110 kV Tran De and Binh Dai switching substations (in Soc Trang and Ben Tre provinces respectively) to be more flexible in power connection.

To evacuate up 6300 MW of wind and solar power in Ben Tre, Tra Vinh, Soc Trang, Bac Lieu provinces and Can Tho city, 500-220-110 kV grids of the Southwestern region need to be constructed and upgraded. The total preliminarily-estimated investment cost is **7723 billion VND** for 500-220-110 kV works to be adjusted and included in the PDP, which will increase total investment cost in the Southwestern grids for the whole period of 2019-2023 by about 50%.

At present, EVNNPT is facing huge pressure in mobilizing the investment for grid development to keep pace with the economic growth needs. If the wind and solar power in 5 Southwestern provinces develop with the registered capacity of 6300 MW, the construction of power evacuation grids will increase the investment burden for the electricity sector. To make the proposed plan more feasible, the construction and upgrade of grids need to be rationally invested by phases in the period of 2021-2025. The implementation progress must be reviewed and updated in comparison to the actual progress of wind and solar power projects in the Southwestern region.

With the presence of wind and solar power projects, the region's power system will have to face emerging issues which require new mechanisms and policies. The report proposes some following issues that need to be brought into sharp focus:

- Researching policies facilitating the investment in grid construction for RE capacity evacuation. It is hard for the construction of lines and substations to absorb the capacity of RE to crack normal economic-financial indicators due to their short time of operation. Therefore, the State's supportive mechanisms for such transmission grid works are very much needed.

- Grid works proposed above are aimed at evacuating RE. However, the progress of power works tends to be slow and difficult to control, which impedes the promulgation of decisions on beginning and investing in grids and affects the distribution of resources such as capital, equipment, manpower, etc. It is thus necessary to have binding mechanisms on the power work progress and synchronized grid works.

- The Government and Ministry of Industry and Trade need to issue mechanisms and policies to harmoniously develop the power among regions and research the rational power structure (especially in case of increasing RE rate) to avoid long-distance transmission which can cause big losses and difficulties to the operation of the power system and risks to power generation security.

- The limit of RE capacity of each region all over the country in general and the South in particular also needs to be studied and calculated in an overarching manner to avoid the increasing pressure on the inter-regional and ensure the safe, confident and stable operation of the power system.

Demand projection

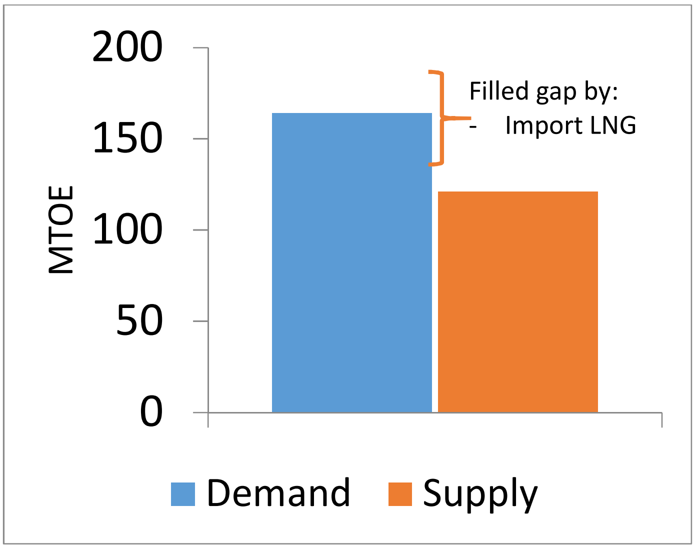
• The demand is projected to be increased on average more than 8%/year for next 10 years, substantially higher compared to other countries in the World.

According to the preliminary demand projection for primary energy consumption up to 2035, Vietnam can have the following supply sources in 2035:

Table 3: Energy balance for Vietnam in 2030 (Source: Compiled by the consultant)

Resources	Projected potential supply (in physical unit)	Converted into MTOE	Converted into PJ
Coal	99.6 -113 mt	50 – 62	2093.4 -2595.8
Crude Oil	20 – 22 mt	20 – 22	837.3 - 921.1
Natural gas	9.6 – 13 billion m3	8.64	361.7
Wind (not including offshore)	10,000 – 20,000 MW (~ 22 billion kWh)	1.88	78.8
Hydropower	18,000 – 20,000 MW (~ 75 – 80 billion kWh)	6.5	272
Biomass		9 – 20	376.8 - 837.4
Solar PV (not including rooftop PV and floating)	40,000 – 50,000 MW (~ 75 billion kWh)	6.5	272.1
Total supply sources		**102.5 – 127.5**	**4291.5 – 5338.2**

With demand projection up to 165 mtoe in 2035, there is a big gap in domestic energy supply. So the offshore wind energy is one of the additional domestic source for power / energy supply for Vietnam to ensure its energy security supply.



Latest MOIT proposal to PM 2491/BCT-DL, dated 09 April 2020 has a preliminary power structure projection from 2021 -2030 as follows:

Table 4: Vietnam Power structure up to 2030 (Source: MOIT report submitted to PM)

VN Power system, Base case						
	2020	**2025**	**2030**	**2020**	**2025**	**2030**
Demand (MW)	42080	63471	90651			
Installed capacity (MW)	59090	104824	145568			
Ins. Cap (no Solar, Wind, BESS)	*51410*	*81944*	*110028*			
Reserve (no Solar, Wind, BESS) in %	*22.20%*	*29.10%*	*21.4%*			
Coal	19637	38842	48932	33.2%	37.1%	33.6%
Dom. Gas + Import pipeline from Malaysia	7133	10514	10774	12.1%	10.0%	7.4%
New LNG	0	1500	12750	0.0%	1.4%	8.8%
Existing plant converting to LNG	0	1883	4213	0.0%	1.8%	2.9%
Oil	1610	575	108	2.7%	0.5%	0.1%
Import	920	3370	5796	1.6%	3.2%	4.0%
Big hydro (>30MW)	17766	19116	19211	30.1%	18.2%	13.2%
SHPP	3800	4900	6000	6.4%	4.7%	4.1%
Wind*	1010	6030	10090	1.7%	5.8%	6.9%
Solar *	6670	14450	20050	11.3%	13.8%	13.8%
Biomass and RE	544	1244	2244	0.9%	1.2%	1.5%
PSPP + BESS	0	2400	5400	0.0%	2.3%	3.7%

Point of View on Stages for OWD: S development curve and roadmap consideration.

At the present, the OWD projection for Vietnam is in very initial stage, acquiring information, knowledge and learning. The initial planning target from DEPP PDP8 Support 2nd Phase and closely related Offshore Wind Support, based on several discussion with stakeholders and DEA colleagues, has 2 scenarios for connection of offshore wind in the Binh Thuan Province (where the most promising sites are located):

	2025	2030
Scenario 1	1 GW	5 GW
Scenario 2	2 GW	10 GW

Whatever scenario and pathway for OWD, it will follow more or less the S learning curve (see below). From international experience (Ireland and Germany), we may have a Inception phase lasting for several years (3-4 years) where the roadmap for OWD is drafted, stakeholder consultation (national and international), established resources function, assessment, mixture of incentive support…At this inception phase, a demo project would be implemented to evaluate financial, technological and logistical issues, stimulate R&D.

At a later stage of market maturity, the introduction of an auction regime for wind power projects seems possible for national and international developers; however, a start under any auction model might be advised only after throughout studies and demo step, to allow for pre-requisites pre-development conditions easing the process for the developers.

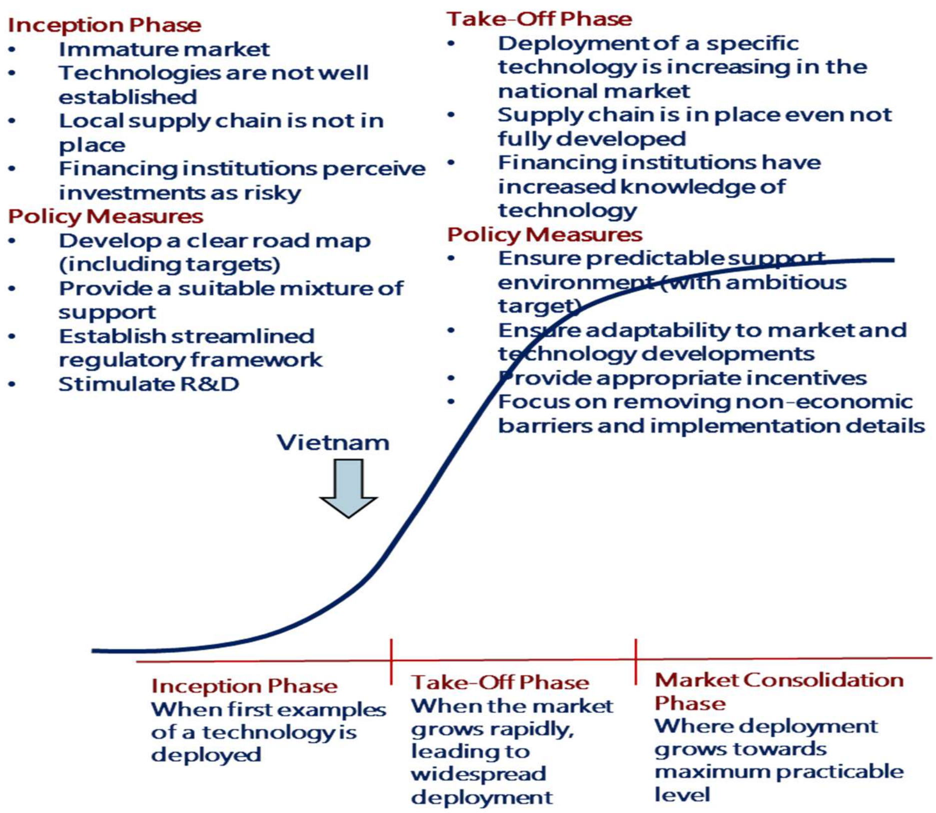


Figure 5: Pathway and Pre-required conditions for OWD in Vietnam

Some inputs for competitive auctioning and its lessons learned[4]:

The question, whether auctions for wind power projects, particularly for OSW can be applied in Vietnam, is complicated one, requiring an in-depth analytical dimension and understanding of political economic and energy contexts. In this note, the consultant just presents a brief understanding of the issue from the previous studies and international experiences based on his own judgements. A consensus on pre-requisites conditions for a successful auctioning are:

- A sufficiently large market,
- A high level of competition,
- A mature market and policy framework with well-designed auction management in place
- A clarity about long-term market developments.

Pre-Requisites for a Successful Shift to Auctions	Implications for Vietnam
1. A sufficiently large national market size	The wind market in Vietnam is still relatively small, and no offshore wind yet. Up to 2020, just slightly over 300 MW of capacity (8 wind farms) were installed under the FIT mechanism. Also, the average project size is relatively small. A larger scale market in Vietnam would lead to more competition and lower prices. At the early stage of OSW development, it not necessary lead to lower price compared to FIT.
2. A high level of competition	Due to several reasons, the wind power market in Vietnam is still dominated by a limited number of actors and there is no clear actor for OSW yet. There is still limited interest from international investors, partially because of the limited creditworthiness of EVN and the difficulty to make projects bankable. A higher level of competition in Vietnam would lead to lower prices in future auction rounds. If the auction for OSW is introduce early (say by 2022), the limited actors (national and international) will surely lead to higher price offer or failure of the auction round). The issue of the creditworthiness of the off-taker (EVN) is also a limiting factor to attract high competition from international actors.
3. A mature market and policy framework	In Vietnam, several wind project developers have stated that there are still no standardised and streamlined processes when it comes to wind power development. It is therefore highly recommended to streamline all administrative process (including clear grid connection procedures) in Vietnam before the introduction of an auction-based mechanism. This is particularly relevant to OSW, where it required a lot more involvement and engagement from new various agencies (Sea management administrations, Maritime military, Fishing, Maritime transport, Oil and gas activities….).
4. Clarity about long-term market development	Vietnam has taken a first important step by defining wind energy deployment targets until the year 2030. However, no longer term targets for OSW yet established. And for OSW, up to 2050 would give an even clearer sign to the international wind energy community and might also enable Vietnam to harness socio-economic benefits.

Source: Adaptation from "Assessing the Applicability of Wind Energy Auction for Vietnam –A Comprehensive Overview"; GIZ 2018.

[4] Upon additional request from RE division of EREA.

List of sea port in operation and in planning, according to the to the decision 1037/QĐ-TTg, date 24/6/2014.

No	Name	Situation	2015 (1000 DWT)	2020 (1000 DWT)	Type
1	**Van Gia**	Operated	5 – 10	5 –10	Multi Purpose
2	**Hai Ha**	Planning	30 - 50	30 - 80	Multi Purpose
3	**Van Hoa - Mui Chua**	Operated	3 – 5	3 – 5	Multi Purpose
4	**Cam Pha**	Operated	20 – 70	20 – 80	Multi Purpose
5	**Hon Gai**	Operated			Multi Purpose
5.1	Cai Lan	Operated	20 – 50	20 – 50	Multi Purpose , Container
5.2	Cement Thang Long, Ha Long	Operated	10 – 20	10 – 20	Coal, cement, clinker
5.3	Oil - B12	Operated	10 – 40	-	Liquid
6	**Hai Phong**	Operated			Multi Purpose
6.1	Lach Huyen	Planning	50 – 80	50 – 80	Container,
6.2	Dinh Vu	Operated	20 – 30	20 – 30	Multi Purpose
6.3	Song Cam	Operated	5 – 10	5 – 10	Multi Purpose
6.4	Yen Hung	Planning	30 – 40	30 – 40	Specific Purpose
6.5	Diem Dien, Hai Thinh	Operated	1 – 10	1 – 10	Multi Purpose
6.6	Nam Do son	Planning	-	-	Military
7	**Nghi Son**	Operated			Multi Purpose
7.1	North Nghi Son	Planning	10 - 30	10 – 30	Oil, Cement
7.2	South Nghi Son	Operated	30 – 50	30 – 50	Multi Purpose
7.3	Dao Me	Planning	over 100	over 100	Oil, Coal for power plant
7.4	Le Mon, Quang Chau, Quang Nham	Operated & Planning	1 – 2	1 – 2	Multi Purpose
8	**Nghe An**	Operated			Multi Purpose
8.1	Cua Lo	Operated	10 – 20	10 – 20	Multi Purpose
8.2	Dong Hoi	Planning	10 – 30	10 – 30	Coal, Construction material
8.3	Cua Hoi, Ben Thuy	Operated	1 – 3	1 – 3	Specific purpose
9	**Son Duong - Vung Ang**	Operated			Multi Purpose
9.1	Vung Ang	Operated	10 – 50	10 – 50	Multi Purpose
9.2	Song Duong	Planning	200 – 300	200 – 300	Multi Purpose
9.3	Xuan Hai - Cua Sot	Operated	1 – 2	1 – 2	Multi Purpose
10	**Quang Binh**	Operated			Multi Purpose
10.1	Hon La	Operated	10 – 20	10 - 20	Multi Purpose
10.2	Song Gianh, Nhat Le	Operated	1 - 2	1 - 2	Multi Purpose
11	**Quang Tri**	Operated			Multi Purpose
11.1	Cua Viet	Operated	1 - 3	1 - 3	Multi Purpose
11.2	My Thuy	Planning		20 - 50	Multi Purpose

12	**Thua Thien Hue**	Operated			Multi Purpose
12.1	Chan May	Operated	10 - 30	30 - 50	Multi Purpose
12.2	Thuan An	Operated	1 - 3	1 - 3	Multi Purpose
13	**Da Nang**	Operated			Multi Purpose
13.1	Tien Sa - Son Tra	Operated	10 - 30	10 - 50	Multi Purpose
13.2	Song Han - Tho Quang	Operated	1 - 20	1 - 20	Multi Purpose
13.3	Lien Chieu	Operated	5 - 20	5 - 80	Multi Purpose
14	**Ky Ha**	Operated	5 - 20	5 - 20	Multi Purpose
15	**Dung Quat**	Operated			Multi Purpose
15.1	Dung Quat I	Operated	10 - 70	10 - 70	Multi Purpose
15.2	Dung Quat II	Planning	100 - 300	100 - 300	Multi Purpose
15.3	Sa Ky	Operated	1	1	Multi Purpose
16	**Quy Nhon**	Operated			Multi Purpose
16.1	Quy Nhon - Thi Nai	Operated	10 - 30	10 - 30	Multi Purpose
16.2	Nhon Hoi	Planning	20 - 50	20 - 50	Multi Purpose
16.3	Dong Da, De Gi, Tam Quan	Planning	2 - 10	2 - 10	Multi Purpose
17	**Vung Ro**	Operated			Multi Purpose
17.1	West Vung Ro	Operated	5 -10	5 - 10	Multi Purpose
17.2	East Vung Ro	Planning	100 - 250	100 - 250	Multi Purpose
18	**Van Phong**	Operated			Multi Purpose
18.1	Dam Mon	Planning	80 – 120	120 - 200	Container
18.2	My Giang	Operated	100 - 400	100 - 400	Oil
18.3	Doc Let - Ninh Thuy	Operated	50 - 100	50 - 100	Multi Purpose
19	**Nha Trang - Ba Ngoi**	Operated			Multi Purpose
19.2	Ba Ngoi	Operated	10 - 50	30 - 50	Multi Purpose
20	**Ca Na**	Operated	100 - 200	100 - 200	Multi Purpose
21	**Vinh Tan**	Planning	50 - 100	50 - 200	For power plant
22	**Ke Ga**	Planning			Multi Purpose
22.1	North Ke Ga	Planning	50 - 80	50 - 80	Multi Purpose
22.2	Sout Ke Ga	Planning	10 - 30	10 - 30	Multi Purpose
22.3	Phu Quy	Operated	1 - 2	1 - 2	Multi Purpose
23	**Vung Tau**	Operated			Multi Purpose
23.1	Cai Mep, Dinh	Operated	80 - 100	80 - 100	Multi Purpose
23.2	Phu My	Operated	50 - 80	50 - 80	Multi Purpose
23.3	Long Son	Planning	200 - 300	200 - 300	Oil
23.4	Song Dinh	Operated	5 - 30	5 - 30	Oil, Oil manufacture service
23.6	Dam - Con Dao	Operated	1 - 5	1 - 5	Multi Purpose
24	**Dong Nai**	Operated			Multi Purpose
24.1	Phuoc An - Go Dau	Operated	30 - 60	30 - 60	Multi Purpose
24.2	Phu Huu - Nhon Trach	Operated	10 - 30	10 - 30	Multi Purpose
24.3	Dong Nai	Operated	3 - 5	3 - 5	Multi Purpose
25	**HCM city**	Operated			Multi Purpose
25.1	Hiep Phuoc	Operated	20 - 50	20 - 80	Multi Purpose

25.2	Cat Lai	Operated	20 - 30	20 - 30	Multi Purpose
25.3	Sai Gon - Nha Be	Operated	10 - 30	10 - 30	Multi Purpose
25.4	Can Giuoc - Go Cong	Planning	20 - 50	20 - 50	Multi Purpose
26	**Can Tho**	Operated			Multi Purpose
26.1	Cai Cui	Operated	10 - 20	10 - 20	Multi Purpose
26.2	Hoang Dieu - Binh Thuy	Operated	10	10	Multi Purpose
26.3	Tra Noc - O Mon	Operated	5 - 10	5 - 10	Multi Purpose
27	**Dong Thap**	Operated	3 - 5	3 - 5	Multi Purpose
28	**Tien Giang**	Operated	3 - 5	3 - 5	Multi Purpose
29	**Vinh Long**	Operated	3 - 5	3 - 5	Multi Purpose
30	**Ben Tre**	Operated	3 - 5	3 - 5	Multi Purpose
31	**An Giang**	Operated	5 - 10	5 - 10	Multi Purpose
32	**Hau Giang**	Planning	10 - 20	10 - 20	Multi Purpose
33	**Tra Vinh**	Planning	10 - 20	10 - 20	Multi Purpose
34	**Soc Trang**	Planning	10 - 20	10 - 20	Multi Purpose
35	**Ca Mau**	Operated	3 - 5	3 - 5	Multi Purpose
36	**Kien Giang**	Operated			Multi Purpose
36.1	Hon Chong	Not Operated	2 -5	2 - 5	Multi Purpose
36.2	Binh Tri	Operated	5 - 7	5 - 7	Multi Purpose
36.3	Bai No - Ha Tien	Planning	2 - 3	2 - 3	Multi Purpose
37	**Phu Quoc**	Planning			Multi Purpose
37.1	An Thoi	Under Construction	30 - 50	30 - 50	Multi Purpose
37.2	Vinh Dam	Planning	1 - 5	1 - 5	Multi Purpose

Appendix B – Developers requirements for new market projects by CIP/COP

CIP
COPENHAGEN INFRASTRUCTURE PARTNERS
COP

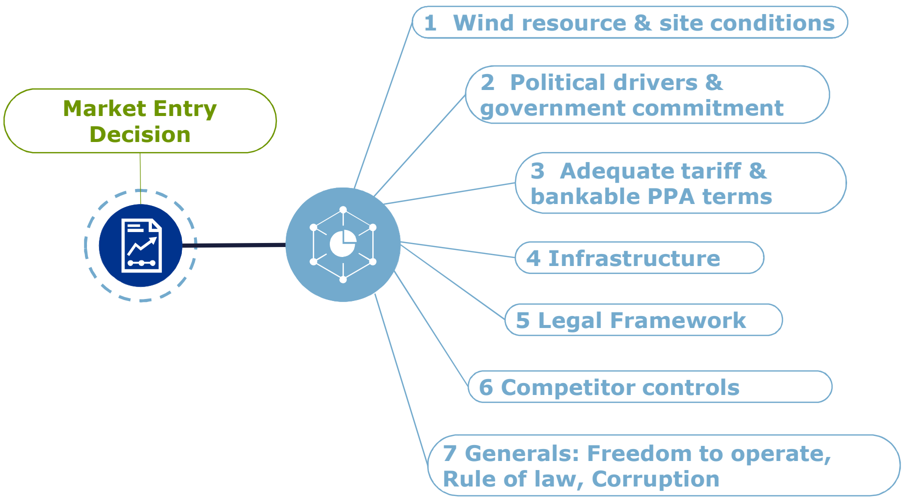
New market considerations for offshore wind developers

For DEA report
17 April 2020

Developers consider multiple factors when evaluating offshore wind projects in new markets

CIP
COPENHAGEN INFRASTRUCTURE PARTNERS
COP

Government commitment to offshore wind and stable tariff are key to balance new market risks



2

Adequate tariff, financeable PPAs and a sound legal framework are key to offset new market risks

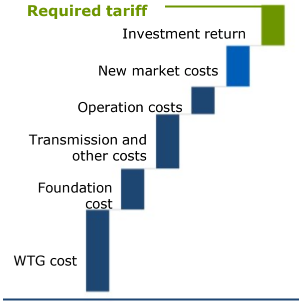
Developers can generally solve supply chain and technical challenges if the financial and legal basics are in place

CIP COPENHAGEN INFRASTRUCTURE PARTNERS

COP

Adequate Tariff

- The tariff level must cover all investment and operational costs, and provide investors a return
- Investment costs in new markets are normally higher due to **immature supply chains, lack of infrastructure, lack of local skills, and higher development costs due to incomplete regulatory frameworks, credit risks** and etc.



Financeable PPA Terms

Lenders and export credit agencies require certain PPA features*, including but not limited to:

1. **Step-in rights**
   - Provides mechanism for lenders to continue production if borrowers default
2. **Curtailment and grid outage mechanism**
   - A mechanism in place to limit unforeseeable losses due to curtailment and grid outage
3. **Protection from change in law**
   - Ensures key PPA terms and tariff does not change in the event of a change in law
4. **Calculation of termination payment**
   - Offshore wind projects are highly capital intensive thus a clear method to determine termination compensation is required
5. **International arbitration forum**
   - Offshore wind projects require significant foreign capital with specific expertise thus requiring an international arbitration forum
6. **Grid delay mechanism**
   - A mechanism in place to limit unforeseeable losses due to delayed grid availability

A robust regulatory framework is required to provide

- **Early knowledge of project exclusivity and tariff levels**
- **Clear rights to develop and use the site**
- **High revenue certainty**
- **Mechanisms to mitigate credit risks for lenders**

*These PPA features already exist in Vietnam, through the Build-Operate-Transfer (BOT) scheme. More details are provided on slide 4

3

Financeable PPAs have been achieved in Vietnam through the BOT scheme[1]

Large scale offshore wind projects require similar PPA terms

CIP COPENHAGEN INFRASTRUCTURE PARTNERS

COP

Category	Proposed PPA amendments	BOT scheme[1]
Deemed commissioning	▪ Seek clarification on applicable reasons ("force majeure" and "legitimate reason") for COD extension due to permitting or grid-related delays ▪ Waive notice period for COD extension	▪ Grid works and unreasonable delay in permitting allow extension of PPA term and payment of deemed capacity charges[3]
Termination payment	▪ Include an express methodology to calculate termination amount similar to BOT projects	▪ Clear termination methodology which in all cases covers and priorities outstanding senior debt
Dispute forum	▪ Refer to international arbitration[3] for amounts beyond USD 3m	▪ International arbitration (SIAC or HKIAC) for dispute resolution
Curtailment risk	▪ Shift burden of proof to EVN in case of alleged technical curtailment ▪ Include an indemnity clause for unjustified (economic) curtailment beyond a certain curtailment threshold	▪ EVN is allowed to curtail production up to a pre-determined annual limit on the number of hours ▪ Beyond such limit, EVN is obliged to pay capacity charges[2] as long as project is declared available
Change in law	▪ Include a mechanism to protect against "discriminatory" change in law against the project, developer or offshore wind	▪ If the impact of a change in law exceeds USD 3m (aggregate over PPA term)[4], the PPA allows a increase/decrease of tariff and/or of PPA term
Step-In rights	▪ Require EVN to enter into direct agreement with the lenders	▪ MOIT and EVN enter into direct agreement with the lenders
Counterparty risk	▪ Comfort letter from Government of Vietnam	▪ Government of Vietnam guarantees EVN's (rated BB by Fitch) obligations towards the project for up to 18 years
Transferability / convertibility	▪ N/A	▪ Government of Vietnam and SBV guarantee up to 30% of net revenues on case-by-case basis

To enable project financing, PPA terms similar to those under the Vietnam BOT scheme will be required

BOT PPA negotiations can take several years in Vietnam - this needs to be fast tracked to enable offshore wind buildout according to government targets

Notes: **1)** BOT schemes have only been applied to conventional power projects; **2)** A conventional power project receives capacity charges (covering debt service and minimum return on equity) so long as it is available for dispatch by EVN; **3)** Arbitration award will need to be recognized for enforceability under Vietnamese law; **4)** "Two-way" change in law under which the beneficiary is required to compensate the other party

4

Taiwan case study

Taiwan offshore wind case study: How Taiwan became the first major offshore wind market in Asia

Government commitment & high tariff drew attention from global developers

1 Good wind resource & site properties

9.5-10.5m/s in wind speed, water depths below 50m, close to shore (5-60km)

2 Government long term commitment

Consistent policy with 36 sites announced in 2015 and commitment to 10GW pipeline by 2030.
Clear drivers to phase out nuclear & gain energy independence

3 High tariff

A very high tariff (~70% higher than Europe) offset the new market risks: regulation uncertainty, immature supply chain, local content requirements, earthquakes & typhoons, political instability

4 Long term price guarantee

Stable 20 year contract with a state owned grid operator

5 Clear delivery plan for grid & harbours

Clear plans for the required upgrades, facilitated by government. Government sought advice and were responsive to developers & suppliers

6 Clear "game rules" and framework

Clear competition process. Dedicated government offices and renewable energy regulation, with specific guidelines for offshore wind

7 Competition Entry hurdle

Requirement to pass EIA limited competition to competent developers

8 First mover in Asia

Taiwan provided developers the first solid base for pursuing more business in Asia. Arrival of developers and suppliers created momentum

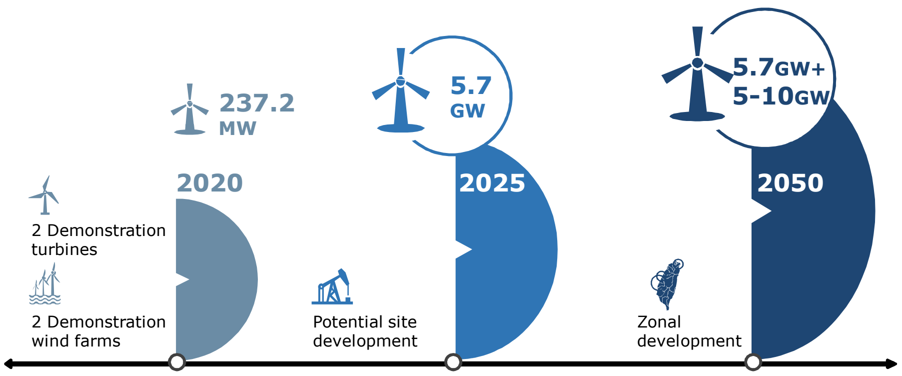
5

Taiwan case study

From zero to 5GW+: A long term plan was set

A consistent policy and offshore-wind-specific regulatory framework created long term opportunities

Policies	Demo- Incentive Program (2012/7/3 announced)	Directions of Zone Application for Planning (2015/7/2 announced)	Zonal Development (To be announced in 2019)



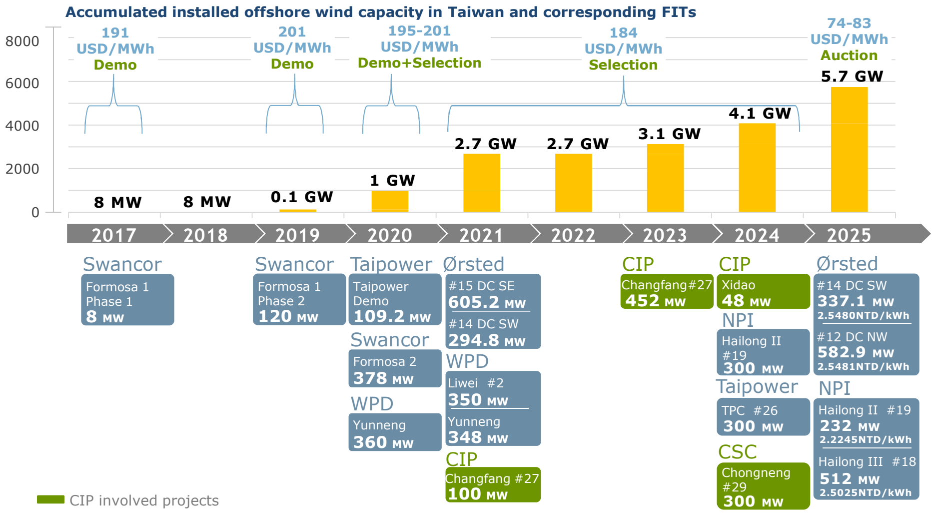
Phase 1 (Demo)	Phase 2 (Potential Zone)	Phase 3 (Zonal Development)
▪ Government subsidies on development and equipment ▪ Project studied by the government to assess required support and infrastructure	▪ Establishment of local supply chain driven by policies ▪ High tariff ensured the stability of first commercial scale wind farms	▪ Market-driven development ▪ Developed supply chain ▪ Low marginal cost for developers already in Taiwan

6

Taiwan case study

Taiwan started with demonstration projects and planned a gradual increase in offshore wind capacity

Initial Feed-In-Tariff (FIT) rates were higher to enable developers to work through regulatory, supply chain and technical issues



7

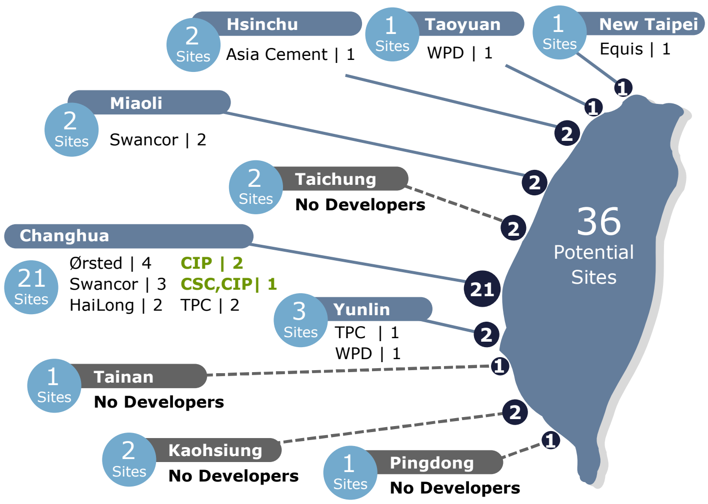
Taiwan case study

Government took initiative to identify, assess and define sites

36 potential sites were identified based on wind resource, water depth, and environmental impact

Site Allocation Approach

- In 2015 the government announced 36 potential sites and guidelines for development
- Research institutes were commissioned to screen sites based on the following criteria:
  - ✓ **Wind resources (9.5-10.5m/s)**
  - ✓ **Water depth (below 50m)**
  - ✓ **Distance from shore (5-60km)**
  - ✓ **Avoidance of sensitive zones (military, environmental, existing cables and pipelines)**



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Taiwan case study

Taiwan offshore wind projects planned in phases

Priority of projects shifted from delivery to localisation, then to cost

	Pre entry	Selection Stage - 3 GW Stage 1 (2020) / Stage 2 (2021- Focus: Delivery / Focus: Localisation	Bidding Stage - 2.5 GW Focus: Price competitiveness
Prerequisite	▪ Preparatory office in Taiwan ▪ Financially capable	▪ Pass pre entry ▪ Opinion letters from authorities ▪ Available grid connections	▪ Pass pre entry ▪ Only projects that participated in Selection are eligible to bid
Process	▪ Apply for site recordation ▪ Apply for EIA from environmental authority	▪ Submit proposal detailing preferred grid connection point & year, technical capabilies, financial strength, and community initiatives ▪ Submit localisation plan (2021-2024) ▪ PPA could be applied for, and final tariff confirmed after award	▪ Submit bid price ▪ Awarded price applied to PPA for 20 years
Selection Standards	▪ Feasibility of proposed capacity and wind farm planning ▪ Environmental impact	▪ Able to deliver projects on time ▪ Localisation plan (2021-2024) ▪ Evaluation standards:	▪ Price

Source: Bureau of Energy Ministry of Economic Affairs, 2017

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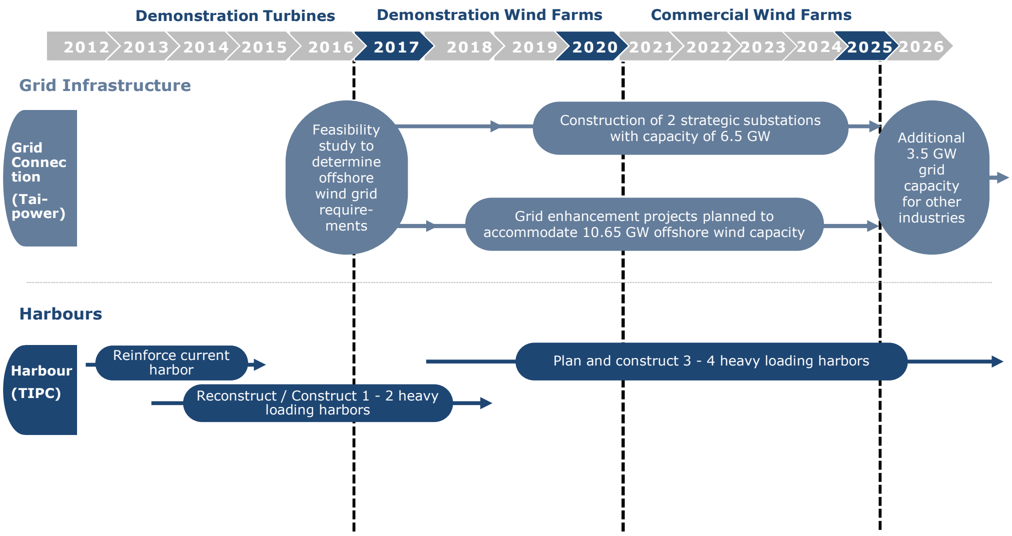
Taiwan case study

Infrastructure gaps were identified and plans put in place

Upgrades of grid and harbour infrastructure led by state-owned companies with government support



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Taiwan case study

Key learnings from Taiwan

Government plays a key role to ensure the success of offshore wind in a new market

- **A stable and sufficient FIT is required to offset new market costs and risks**
- **Industry localization requires supplier investment. In a non-competitive environment, all costs will be passed to developers**. The FIT needs to reflect any prescribed local content requirements
- Development of a new offshore wind industry will require **active and continuous government coordination,** to ensure progress of projects and efficient use of space & infrastructure
- **Technology advancement** and improved **site knowledge** will result in changes. **Regulation needs to be flexible** so developers can optimize their sites within a design envelope
- **High value, subsidized energy projects are political** in nature. Early government support is needed to inform general public and local communities on benefits of offshore wind

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