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Options for wind power in Vietnam by 2030

Minh Ha-Duong^a, Sven Teske^b, Dimitri Pescia^c, Mentari Pujantoro^c

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Abstract

Vietnam has an excellent wind resource, and the cost of producing electricity from wind has decreased continuously over the last decade. After the feed in tariff for onshore wind power was raised to 8.5 UScents / kWh in 2018, the sector is finally taking off. The inventory of existing onshore wind power projects in Vietnam shows that the sector is on track to meet the government targets for 2020 and 2025. We explored three scenarios for wind power development in Vietnam up to 2030 and conclude that the wind power installed capacity by that year could be 12-15 GW onshore, 10-12 GW offshore. The policy implications are that first, the next power development plan of Vietnam provides an important opportunity to increase at low costs the level of ambition of wind power development. Second, flexibility should be the guiding principle of that plan. Third, to realize the large potential of offshore wind power, infrastructure planning has to start soon.

Keywords: wind energy; Vietnam; scenarios

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Highlights

1. **Wind power is taking off in Vietnam, with declining costs and excellent resource.** The onshore project pipeline is on track to meet the 2020 and 2025 power development plan 7 revised targets.
2. **Offshore wind has large potential, requiring infrastructure planning to start soon.** It can contribute a non-marginal share of the Vietnamese electricity mix this decade. Offshore wind contribution has been absent from previous energy plans, but the technology has become affordable. In addition, offshore wind energy has very high capacity factor in Vietnam, making it a steadier technology.
3. **The variability of wind energy can be compensated by various flexibility options.** Distribution across the different regions of Vietnam, grid reinforcement and flexible operation of thermal power plants will facilitate the integration of variable power sources, while maintaining a high level of security of supply. We suggest that flexibility should be the guiding principle for Vietnam's 2020-2030 power development plan.
4. **Wind power installed capacity in 2030 could be 12-15 GW onshore, 10-12 GW offshore.** The next power development plan of Vietnam provides an important opportunity to increase at low costs the level of ambition of wind power development.

1. Introduction: Vietnam has excellent wind resource

As an emerging economy, Vietnam is looking at various options to fulfill the growing electricity demand. This paper shows that Vietnam can rely on its excellent wind resource, which potential is often overlooked in recently published modeling studies. The upcoming Power Development Plan 8 (PDP8) presents an opportunity to increase the share of Renewables electricity and could target to have several GW of installed offshore wind capacity by 2030. The analysis is based on bottom-up statistics using a project-level inventory of the wind power sector in Vietnam by mid-2019, complemented by a top-down energy system modeling study recently published by the Institute for Sustainable Future, hereafter 'ISF' (Teske, Morris, and Nagrath 2019).

Vietnam wind resource mostly lies along its coastline of more than 3000 km, and in the hills and highlands of the northern and central regions. The Global Wind Atlas estimates that over 39% of Vietnam's area has annual average wind speed over 6 m/s at a height of 65 m, and over 8% of Vietnam's land area had annual average wind speed over 7 m/s (see Figure 1). This corresponds to a wind resource potential of respectively 512 GW and 110 GW.

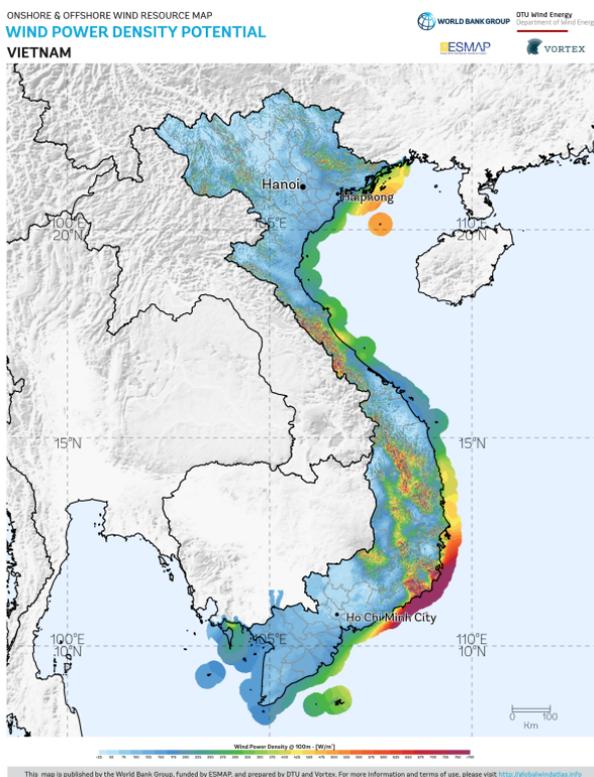


Figure 1: Wind Power Density Potential. Vietnam. Source: World Bank ESMAP (2017) [Global Wind Atlas](http://globalwindatlas.info).

Taking into account land-use restriction, excluding mountain areas with a slope of more than 30%, fractured space with a size of less than 1 km² and areas distant from than 10 km of existing power lines, the ISF analysis found 42 GW of onshore wind energy technical potential for utility scale wind farms.

In Vietnam the offshore wind potential is much larger than the onshore wind potential, because the coastline is long, and more generally winds over sea are higher and more stable, land use constraints are much lower for siting and transmission infrastructure.

Using the Weather Research and Forecasting (WRF) model (10-km resolution for 10 years during 2006 and 2015), (Doan et al. 2019) found that the greatest energy potential was in the offshore area around the Phú Quý island (Bình Thuận province). This area alone can provide the 38.2 GW of offshore wind power generation capacity.

(Sean Whittaker 2019) presented estimates of the wind offshore potential for Vietnam, accounting only for wind speed greater than 7 m/s and less than 200 km from the coast. He found a potential of 261 GW in waters less than 50 m deep, and an additional potential of 214 GW in waters 50 to 1000 m deep.

ISF estimates the offshore wind resource to 609 GW, spreading over a total of 3000 km coastline and over 150 000 km², while taking into account only coastal areas with a maximum water depth of 50 m and maximum distance to the shore of 70 km (based on 2015 meteorological data). The ISF study further estimated the regional breakdown of wind energy potential and capacity factors (for further details see Supplementary Material Table 3 and Table 4). While being a variable energy source, the estimated capacity factor of wind energy in Vietnam is up to 36% for onshore and 54% for offshore wind.

2. A project pipeline on track to meet the 2020 and 2025 plan targets

The history of the sector shows fifteen years of growing pains. The Bạch Long Vĩ island hybrid diesel + wind project inaugurated on October 30th, 2004 was a false start. Vietnam's first high-capacity wind farm, 30 MW, was inaugurated by REVN, in the central province of Bình Thuận on April 18th, 2012. The next two projects – the Phú Quý island hybrid grid with 6 MW and the near-shore Bạc Liêu phase 1 with 16 MW – both completed in 2013.

No new capacity was added in 2014 or 2015. Provincial wind power development plans for eight provinces: Bạc Liêu, Bến Tre, Bình Thuận, Cà Mau, Ninh Thuận, Quảng Trị, Sóc Trăng and Trà Vinh were published in 2016. That year the 24 MW Phú Lạc project in Bình Thuận province and the 83 MW Bạc Liêu phase 2 were completed. The following year, the 30 MW Hường Linh 2 project in the Quảng Trị province was connected. By the end of 2018, the total installed wind power capacity in Vietnam reached about 228 MW.

The wind power industry is taking off in 2019 in Vietnam, although not as spectacularly as the solar power industry. By the end of May 31st, 2019, seven wind power plants (for a total of 331 MW) were in operation. For example the Trung Nam project in Ninh Thuận province inaugurated in April 2019 is an hybrid facility, co-locating a 40 MW wind farm (to be extended by 112 MW in phase 2) with a 204 MW solar PV plant.

The power development master plan PDP 7 revised, published in 2016, sets a target of 0.8 GW of wind power capacity by 2020, two GW by 2025 and six GW by 2030. By our estimates (see Table 2 below and Supplementary Materials Table 5 for the detailed inventory), the number of projects under construction is in line to reach the 2020 target. The number of projects at the “groundbreaking” or “approved” stage is twice what is needed to meet the 2025 target. And if one adds also the capacity of the “announced” projects and “planned” wind development zoned, then there is already today enough for reaching the 2030 objective.

Table 1: Summary of wind projects pipeline in Vietnam, August 2019. Source: author.

Status	Total capacity		Average project size
	(MWp)	Number of projects	(MWp)
Canceled	792	4	198
Operating	346	11	31
Construction	990	17	58
Groundbreaking	160	3	53
Approved	3645	51	71
Announced	4052	24	169
Planned	1251	22	57
Total	11236	132	85

This summary of wind project pipeline is based on publicly available announced project. There is potential discrepancy on how the pipeline develops since the collection date. The table shows at least four projects have been canceled in recent years for making no progress after years of delay. Being “approved” with an investment certificate does not imply that the project will be constructed someday. Projects at the “announced” stage are even more uncertain. However, in

recent year the additions have exceeded the cancelations, so this is another cause for under-estimation. We did not attempt to correct these biases. The table only includes the 600 MW of the first phase of the Thang Long Wind power project, which proposes to develop several GW of offshore wind power near the Kê Gà area, in the Bình Thuận province.

The scenario analysis proposed in the following sections is based on a top-down approach starting from narratives, it does not require pipeline estimates exact to the individual project level.

From a provincial perspective, wind development occurs in 15 provinces mostly located along Vietnam coast lines. By mid 2019, operating wind farms (346 MW) are located only in 4 provinces: Bạc Liêu, Ninh Thuận, Quảng Trị, and Bình Thuận, which also have major share of wind project under construction (752 MW out of 990 MW). Approved projects have expanded to 11 provinces, with minuscule capacity (0.4 MW) in the north. The Northern provinces are lagging behind. According to ISF analysis, up to 6.6-8.8 GW onshore wind can be developed in the Northern region.

3. The cost of wind power went down rapidly

Based on regression analysis of the announced investment cost for wind projects in Vietnam of varying capacity (Figure 7), the investment cost is 1.8 million USD per MW of installed capacity on average (median 2 million, interdecile range 1.2 – 2.6 million).

This number is an historical average including projects onshore and near-shore, started years ago or just announced, and mostly based on forward looking budgets before construction. This is close to (13% greater than) the numbers used in the Vietnam Technology Catalogue for 2020 (Jakob Lundsager, Nguyễn Ngọc, and Mikael Togeby 2019).

We do not have enough data for more detailed analysis, but the outlier point at the top is the Bạc Liêu near shore pilot project, and if it is removed from the sample, then the average investment cost decreases to 1.7 million USD per MW. Others have shown that the wind power technology costs are going down (Prakash and Anuta 2019). The Technology Catalogue (op. cit.) considers that

nominal investment in onshore wind will decrease to 1.31 million USD / MW in 2030, and decrease further to 1.11 million USD / MW in 2050.

While the cost of offshore wind farms is significantly higher than onshore, offshore wind become more and more economic due to its higher yields, larger turbines and clusters. The auctions conducted to lease the rights to build wind farms offshore Massachusetts illustrate the cost decline in the industry. In 2014, they did not get any taker. Running it again in December 2018, the winning developers paid 405 million USD to get the right to build wind farms (Gerdes 2018; Asimov 2019).

Costs will also improve because the average rated capacity size of the unit offshore turbine is increasing. Now it is around 7 MW per turbine, the first 12 MW turbines are being field tested, and the capacity is expected to reach 15 MW per turbine in 2025. The average capacity factor of current projects also ranges from 50-57% (Noonan et al. 2018). From 2020 to 2022, the cost of electricity from newly commissioned offshore wind power projects could range from 60 USD / MWh to 100 USD / MWh based on current trends and the prices awarded in auctions in 2016-2018, a significant decline compared to 140 USD / MWh in 2017.

For example, France targets to have 10 GW of offshore wind power in 2028, and recently conducted an auction for a 600 MW wind farm offshore Dunkerque, to open in 2025-2026. The eight candidates proposed to sell electricity for 20 years between 44 € / MWh to 60,9 € / MWh (equivalent to 48 to 67 USD / MWh), with an average at 51 € / MWh (equivalent to 56 USD / MWh). Germany has held just two offshore wind auctions, one in 2017 and one in 2018. In both tenders, capacity was won by investors who offered to build parks without subsidies.

Since 2011, the Feed in tariff (FiT) was 78 USD / MWh and that was not commercially viable for developers. The tariff was then amended and since November 2018, the FiT for wind power project in Vietnam is 85 USD / MWh for onshore wind power projects and 98 USD / MWh for offshore (Nguyễn Xuân Phúc 2018). The above electricity tariffs are applied to a part or whole of the grid connected wind power projects with commercial operation date before 1 November 2021 for 20 years from the date of commercial operation. Already operating projects will benefit from the tariffs retroactively from 1 November 2018 for the remaining period of the signed PPA.

The future tariff applicable to wind power projects connected after 1/11/2021, is uncertain as of October 2019. The Prime Minister assigned the Ministry of Industry and Trade to propose and submit to the Government for consideration and decision the mechanism for auction of wind power development and tariffs.

The decline in costs and the increase in tariff explain the success in capturing developers' interest. We expect that as more projects come into realization, economy of scale and learning by doing will drive further cost reduction in Vietnam in the next five years at least.

4. Upper, lower and middle scenarios for wind power in Vietnam

The ISF study (Teske, Morris, and Nagrath 2019) examined three visions for the development of the power sector in Vietnam, estimating future demand trajectories and looking at how various energy mix could satisfy it. In these visions, the role of wind power is defined as follows:

Table 2: Visions for Vietnam onshore and offshore wind energy installed capacity in 2030

Scenario	Onshore wind			Offshore wind		
	Capacity in 2030 (GW)	Annual market (MW / yr)		Capacity in 2030 (GW)	Annual market (MW / yr)	
		2020-2025	2026-2030		2020-2025	2026-2030
Old Plan	6.1	300	1000	0.15	7	28
New Normal	16.6	730	3200	9.5	260	2100
Factor Three	21.6	1530	3625	20.9	480	4750

The first scenario corresponds to the PDP7 revised, which planned for 6 GW of installed wind capacity in 2030, accounting for 2,1% of the power production. The other two scenarios respectively achieve that year a total installed wind capacity of 26 GW and 42 GW. In the most ambitious scenario, annual markets are about 2 GW a year for both offshore and onshore wind during the next decade. While the annual market may seem ambitious, the country is expecting a high energy demand growth apparent from the PDP7 revised which planned to install 70 GW of additional generation capacity between 2020 and 2030 – mostly baseload plants. Indeed, important growth rates in the power supply infrastructure are

required to lift a 100 million people from lower to higher middle income country in ten years.

Technological progress is reducing the costs rapidly, leading to considerable shifts in investment patterns. For example the PDP7 solar PV objectives for 2025 were 4 GW, but the installed capacity is expected to achieve already more than 5 GW for the end of 2019. Gauging by the current interest of the business community, a similar trend is expected for wind energy.

The following narratives flesh out the three scenarios, explaining various development rhythms:

In the *Old Plan* scenario, there is a wave of new wind farms connected to the grid in time to get the FIT, before November 2021. After that, the government does not renew the FIT, and legal issues delay the first pilot auction runs to 2022. By then a global economic crisis impacts Vietnam, reducing economic growth and therefore domestic electricity demand. International fossil fuels prices hit historical lows as not only the global demand is depressed, but producing countries try to sell out their remaining reserves before they are made useless. Vietnam policy priority goes to GDP growth rather than climate protection targets, which gives natural gas the first role in the 2020-2030 decade. A rapid catch up in energy efficiency, and a strong development of solar, both utility scale and behind the meter rooftop, leave little room for wind energy to expand above the PDP7 targets revised in 2016.

In the *New Normal* scenario, after the initial wave of wind projects in 2021 there is no second FIT period, the policy makers are afraid of overheating. The market is pulled by direct power purchase agreements –multinational companies in Vietnam procuring green electricity to meet their environmental responsibility targets, directly from wind project developers – and government auctions – the 2020 pilot is a success. As the government credibly commits to an auction program for 1 GW of offshore wind per year, the expected market size lead many industries to choose Vietnam as their Southeast Asia base to manufacture equipment and operate wind projects. The offshore wind industry is organized around two hubs: the port of Vũng Tàu deserves farms in the zone facing Bình Thuận and Cà Mau coasts; and the port of Hải Phòng deserves zones facing Quảng Ninh coasts.

In the *Factor Three* scenario, the national oil and gas company PVN redefines itself as a sustainable energy provider, to play on its offshore work capacities and the complementarity between gas and variable renewables. The Thang Long Wind power project, which proposes to develop large-scale offshore near the Kê Gà area, Bình Thuận province actually meets its goals. It starts operating its first 600 MW phase at the end of 2022. This convinces the government to adopt a regional leadership strategy in the wind energy sector. The Kê Gà offshore project goes on for a total system capacity of about 3,400 MW, at a total investment of nearly 12 billion USD. A national scale offshore transmission infrastructure – under sea power line – starts from this zone. After 2025, the backbone strategy to meet the power demand expansion in Vietnam is to auction every six months two 600 MW wind farms along that line, expanding to the north.

The key early signpost indicating which scenario Vietnam is heading towards will be the government's next decision about for wind power incentives. Feed In Tariff (FIT) is by far the proven policy mechanism, it worked in Germany between 1991 and 2018, and it is working in Vietnam now. Recent experience in Germany is also an example for the *Old Plan* scenario: auction design issues can cool down the wind market. Alternatively, a decision to offer FIT over 90 USD / MWh for offshore wind after 2022 would steer towards the third scenario. Costs would be high, but tendering the rights to use offshore wind development zones could recover part of these costs.

Previously published Vietnam power system development scenarios lie close to *Old Plan* scenario when it comes to wind power. (GreenID 2018, p 39) Renewable Energy scenario sees 8.5 GW of wind installed capacity in 2030. The (Danish Energy Agency 2017, p 45) scenarios grow wind power capacity to 6.2 – 6.4 GW in 2030, which is close to the PDP7. The 2018 update to this Vietnam Energy Outlook (Hưng and Togeby 2019) sees more wind power generation than solar in 2030, and offshore wind entering only after 2030. The Made in Vietnam energy plan (Economic Consulting Associates (ECA) 2016, p 11) assumes that a doubling of the PDP7A target is possible, for a 12 GW of installed wind power by 2030, not mentioning offshore wind. The Pathway to low carbon development for Vietnam report. (Asian Development Bank 2017, p 35) targets 16 GW of wind capacity by 2050, giving a preference to solar, nuclear and biomass energy. Even the most progressive previously published scenario for Vietnam target a maximum of 12 GW in 2030, way below the new trajectories assessed by ISF and still overlook the offshore wind potential.

Yet global trends in offshore wind development are very dynamic. According to IRENA, the offshore wind installation reached its first GW in 2007 and now already has reached 23 GW of installed capacity worldwide, with 5 GW added in 2018. Over 5 500 offshore wind turbines are currently in operation in 17 countries worldwide (World Forum Offshore Wind 2019). Most of the existing offshore wind capacities are located in Europe (18.8 GW), and the rest is in China, Japan, Korea, and USA. Tally with the surging demand in Asia Pacific, industry expansion to new countries and manufacturing capacity will be the ratcheting build-out in Asia.

As Taiwan and Japan both announced the target to install more than 5 GW of offshore wind power, manufacturers are already redesigning their machines and platforms to resist the typhoons and earthquakes prevalent in the Pacific area.

The *Old Plan* scenario neglects the role that offshore wind could play in 2030 in Vietnam, while the *Factor Three* scenario may appear extremely ambitious: the commission of 42 new offshore wind farms in ten years. Both scenarios are unlikely extreme cases. While the most plausible future is something in between, binding the realm of possible with extreme cases is useful for analysis.

We assess that the most plausible of the three scenarios discussed in this paper is the middle one: an installed capacity in 2030 of 15 GW for wind onshore and 10 GW for wind offshore. Given the worldwide trends, the excellent natural resource in Vietnam, the full pipeline of projects, and the urgency to increase electricity supply, we believe that the government will revise upwards the wind targets in the next PDP, and commission more than a few 500 MW offshore wind farm in the next ten years.

5. The power sector 2030 plan should address flexibility needs

Wind power is a variable energy source as it depends on the regional wind speed and seasonal variation. The high wind speed season is during the north-eastern monsoon months (December, January, February) and low wind speed seasons is during the inter-monsoon months (March, April, and May). According to (Doan et al. 2019), the seasonal variability¹ in Vietnam associated with monsoon onsets

¹ Normalized standard deviation of the monthly mean values of wind power density at 105 m height.

and daily variability² associated with the wind diurnal cycles were in the 30–50% range, and that inter-annual variability³ could reach up to 10%.

The wind regimes in the North differs from the wind regime in the South and Center. The central and southern region have high correlation (<80%), while the northern region shows weak correlation with the south (<5%). These fairly low correlations suggest that the wind generation would not peak at the same time within the country, as Figure 2 illustrates. Distributing wind generation deployment across the region and intra-regional exchanges considerably reduces wind output variation and creates balancing effects. The maximum change of wind generation within the central region from one hour to the next is 30%, but the Vietnam-wide maximum change is 2%.

To illustrate how the power system cope with variability, we compare simulations of the power supply under the *Factor Three* scenario in 2030 for the Red River Delta region during for a windy and a windless week.

During a windy week in May 2030 (Figure 3), wind and solar provide major shares of electricity, with minor shares provided by fossil generation. As the high wind speed occurs in other region, wind power from the North East and/or North Central Coast is transferred into the Red River Delta and displaced coal generation in three evenings.

Figure 4 shows the windless week simulation, in August 2030. The majority of power supply during this week came from coal and gas, while solar photovoltaic and wind had minor contributions. The Red River Delta region was self-sufficient in regard to electricity generation almost all week and imported only minor amounts of electricity from other regions during evening hours.

The variability of the two situations described in these figures is already occurring in leader countries that have already today much larger share of wind power in their energy mix. In 2018, wind power represented 41% of the electricity produced in Denmark, 28% in Ireland, 21% in Germany, and 19% in Spain. Because of intra-annual variability, the maximum share of wind at monthly and weekly time scale is higher in some months. For example, wind satisfied 30% of Germany's electricity demand in January 2019 and only 18% in June 2019.

² Normalized standard deviation of hourly data.

³ Normalized standard deviation of yearly mean from 10-year mean.

Experience from Europe shows that anti-correlation of the seasonal weather patterns of monthly onshore wind and PV generation yields a more stable total variable renewable energy output. There is also a seasonal-scale balancing effect between variable renewables in Vietnam. Statistically, from November to February wind speed is high, from February to June solar radiation reaches a peak, and during the wet season from July to November the water inflows are high (Intelligent Energy System and Mekong Economics 2016)

It is observed that offshore wind has more stable output throughout the year than onshore. This alleviates the variability issue and contributes to firm capacity in the mid and long term.

Another lesson from these countries is that variable renewable energy capacity is faster to install than flexibility solutions, in particular grid infrastructure. That can lead to system congestion, high level of curtailment and sub-optimal period of negative electricity prices.

Between 2008 and 2018, China successfully increased renewable power generation from 15 GW to 370 GW (Richard 2019), but failed to keep the same pace in transmission capacities. As a result, wind farms across China had an average curtailment rate of 17% in 2011 and 20% in 2012 (Liu et al. 2015). Increased investment in transmission in recent years succeeded to bring down curtailment rates significantly from 17.1% in 2016 to only 7% in 2018 (Richard 2019).

This challenge also occurs in Vietnam energy system, when installed solar capacity increased to 4.5 GW between April and June 2019 (Kenning 2019). Some solar farms were curtailed 30-60% since the grid was not flexible enough.

The increasing penetration of solar and wind power requires the adoption of technical and economic flexibility solutions. In short, the flexibility solutions are not a distant hypothetical, they are a clear and near-term need. It is time to adapt the system now.

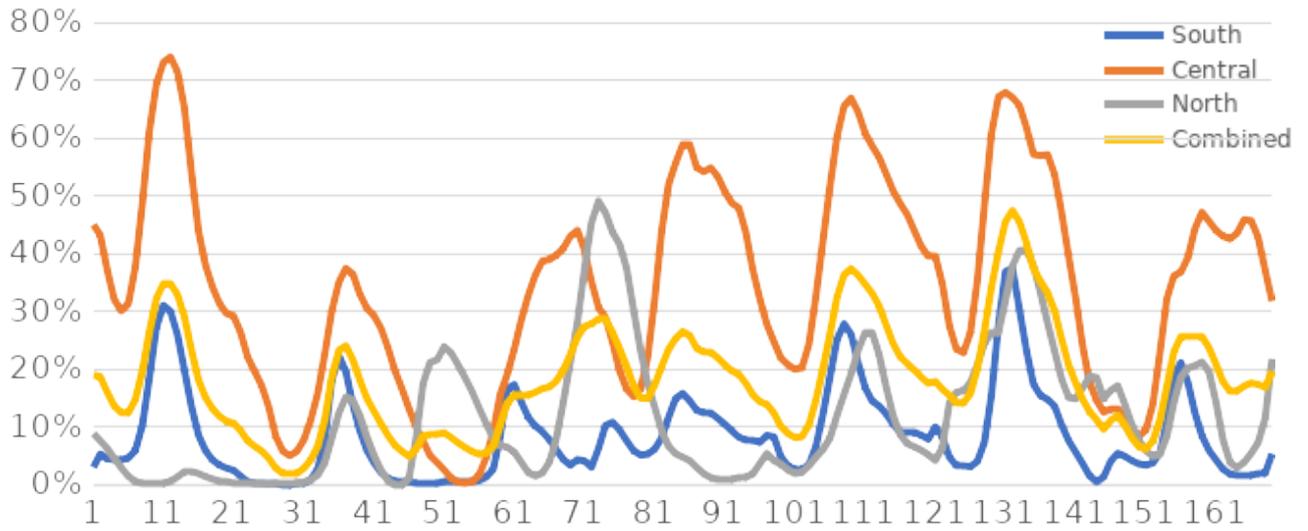


Figure 2: Wind generation profile in 3 regions, first week of January. Generation profile from Renewable Ninja.

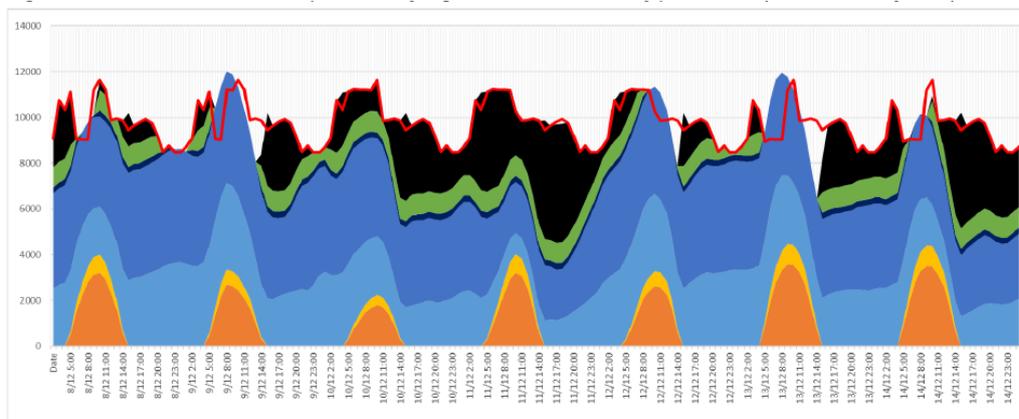


Figure 3: Power mix simulation for the Red river delta in a very windy week (16th to 23th May 2030), Factor Three scenario.

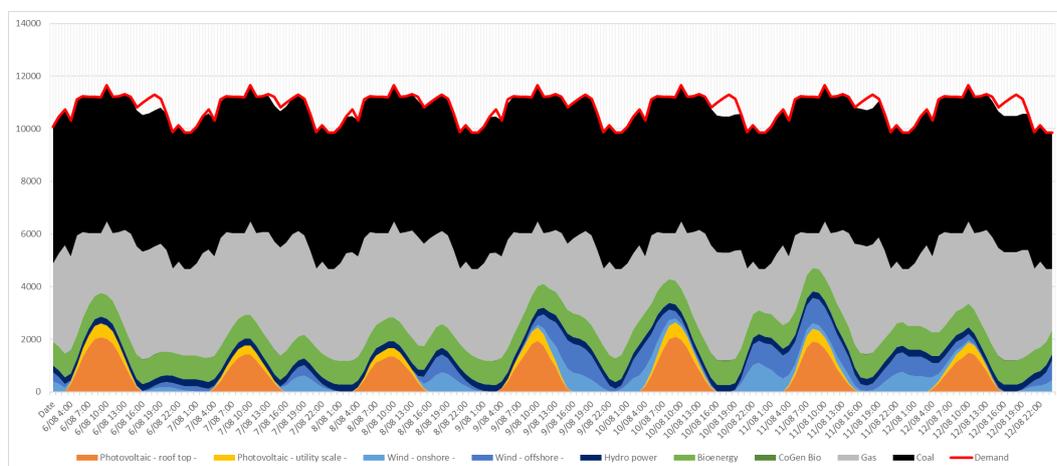


Figure 4: Power mix simulation for the Red river delta in a very low wind week (6th to 13th August 2030). Factor Three scenario. Imported electricity can be seen as white field between the red load

Flexibility should be the guiding principle for Vietnam's 2020-2030 power development plan. There are existing flexibility options in Vietnam like flexible operation of thermal power plants and technical solutions such as smart demand management, robust interconnections with neighboring provinces and countries, hydro or chemical storage, and fuel switching from coal to gas. In the vision to 2050, more innovative technical solutions, such as power to gas, power to hydrogen, or vehicle to grid storage also have to be considered. Floating gas power plants, although legally out of the Masterplan, offer high flexibility at multiple timescales and complement offshore wind well at low investment cost.

Economic flexibility solutions aim to level the playing field for all technologies, replacing must-run and priority dispatch rules with competitive electricity markets. Mature markets include liquid intra-day trading, balancing and ancillary services market, future and derivative markets. Transparency in curtailment decisions is paramount.

6. A national infrastructure to focus an offshore wind program

The rapid development of offshore wind capacity can only happen if the State (the government and the State owned enterprises EVN and PVN) decisively act together towards that common goal. The ISF study (Teske, Morris, and Nagrath 2019) suggests to build that collaboration around a national infrastructure project: an offshore wind busbar. As the power system expands, Vietnam needs to reinforce its electricity transmission network to integrate the North, Center and South electric systems.

It is technically conceivable to use an undersea cable parallel to the coast line. This National Offshore Power Link would transport the power to the two load centers in the north and south and – with lower capacity interconnects – to the other coastal provinces in between. Figure 5 shows a possible position of this offshore wind cable which has interconnections with six currently existing grid knots to each of the six coastal regions. The total length of this cable would be 1775 km – that includes land connections. To date, Ultra High Voltage cables have the largest transmission capacity of around 1 GW with voltage levels of typically 1000 kV per cable.

Similar undersea projects illustrate the magnitude of the cost. The NordLink between Norway and Germany over 620 km long, with a 1400 MW capacity, is

estimated to cost 1.5 to 2 billion euros (Skopljak 2019). The North Sea Link between Norway and UK at 730 km long and 1400 MW capacity is estimated to cost 2 billion euros (North Sea Link 2019). The 1520 km long EuroAsia Interconnector project Stage 1, which is at the final stage of tenders for construction, will have 1000 MW capacity and is expected to cost 3.5 billion euros (EuroAsia interconnector 2018). According to the IEA Wind, the 2017 baseline infrastructure cost for existing offshore project is around 638 € / kW, with total capital expenditure of 3500 € / kW. At the scale of a 500 MW farm, this translates into 320 million euros for infrastructure and 1.75 billion euros capital expenditure.

The proposed infrastructure would lower the costs of connection for offshore and near shore wind projects. The total network length, and therefore cost, may be lower with the common bus topology than independently connecting each offshore wind farm to the inland grid, one after the other.

Having a strategic infrastructure, not only may increase the offshore projects cost efficiency, it would also send signal that Vietnam is committed to generate electricity from offshore and near shore wind farms, and increase investors' confidence to build up a local industry. Diminishing returns due to the scarcity of the good onshore site will be felt in the long term, which increase the attractiveness of offshore wind. An undersea cable does not require sensitive discussions about land-use to reinforce the North-Center-South power system interconnection. The undersea interconnectors may feed the discussions on the regional ASEAN super grid, which in the vision to 2050 could to be an important source of system flexibility and reliability.

More research is needed to assess the benefits and the costs of the idea, for example regarding its contribution to grid frequency stability, supply reliability and geostrategic aspects. More research is also needed on financing the electricity grid expansion. Innovative models involving investment from the private sector could apply to an offshore transmission infrastructure.

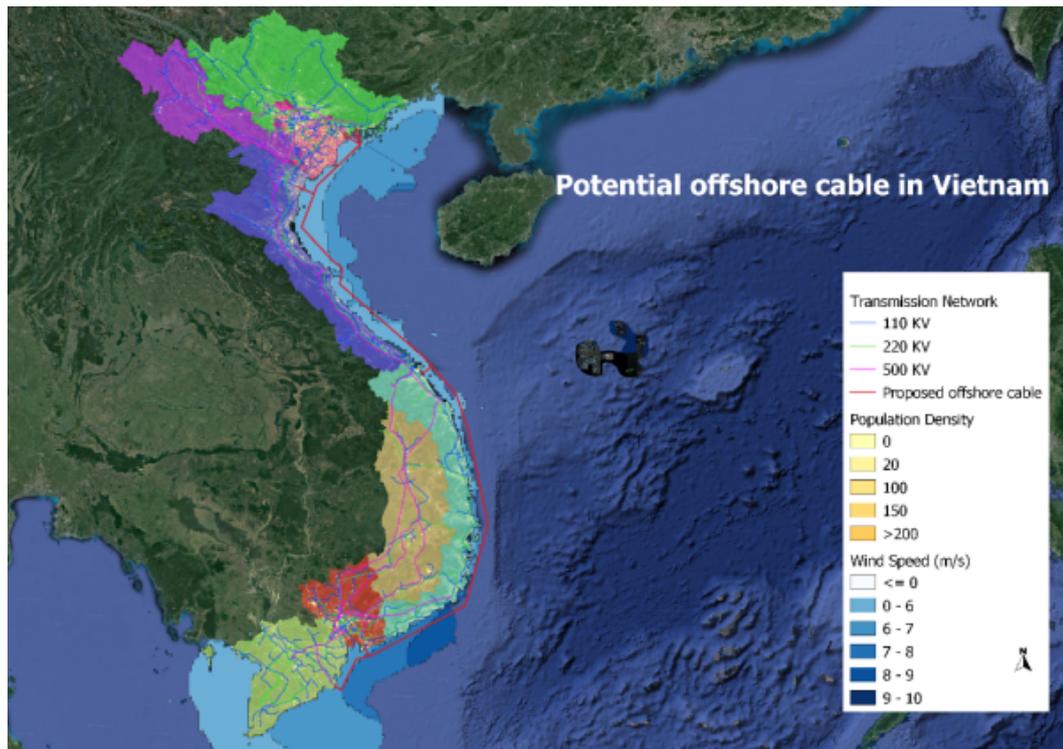


Figure 5: Proposed National offshore power link

7. Conclusions and Policy Implications

Vietnam has an excellent wind resource, with the potential to build dozens of GW capacity, both onshore and offshore. After fifteen years of growing pains, the sector is finally taking off, and we expect to see a cohort of projects connect before November 2021 to benefit from the FIT: more than one GW is under construction and projects at the approved stage with advanced feasibility studies still have time to beat the deadline. Overall, the wind power project pipeline is on track to meet the 2020 and 2025 plan targets.

Previously published studies and the *Old plan* scenario underestimate the role of offshore wind power. Offshore wind energy can contribute significantly to the mid- to long-term Vietnamese energy mix too. We believe that the government will auction more than a few 500 MW offshore wind farms during the period. The most plausible of the three scenarios discussed in this paper is the *New Normal*: an installed capacity in 2030 of 15 GW for wind onshore and 10 GW for wind offshore.

These numbers are orders of magnitude, further studies are needed to reduce the uncertainties. More updated, detailed analysis is needed to better understand how they fit in the fast moving energy supply and demand landscape of Vietnam. It is necessary to clarify the policy mechanisms to make the scenario happen at reasonable cost for the consumer (Đ. V. Nguyễn, Nguyễn, and Nguyễn 2019) The land use constraints for onshore wind require innovative solutions to respect agricultural needs. The offshore wind turbines reliability in East Asian conditions must be demonstrated.

When it comes to policy discussion about 2030, these uncertainties must be considered. The scenario defined from the top-down ISF study is a useful anchor, but giving a range instead of a point estimate is more realistic. These ranges can be roughly defined with conservative extrapolations from the existing registered projects pipeline, and lie between “by 2030, realize all projects registered in 2019” and “by 2030, realize twice as much as registered by 2019”. We propose that further dialogue about the role of wind in the PDP 8 focuses on 2030 installed capacity ranges of: 12-15 GW for onshore, 10-12 GW for offshore.

Our study leads to three robust recommendations for the Power Development Plan 8 (PDP8) which will guide the next ten years of the power sector development in Vietnam. First, considering the amount of variable power generation sources already under construction and the amount foreseeable, increasing flexibility of the electric system should be a guiding principle of the PDP8. Second, the 2030 wind energy targets should be increased considerably compared to the existing plans. Third, infrastructure development planning for deployment of offshore wind energy at several GW per year should start immediately.

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9. Acknowledgements

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10. Supplementary material: data tables

Table 3: Vietnam onshore and offshore wind energy potential. Source: Table 6 page 14 in the ISF study. Onshore potential of areas within 10 km distance of existing power lines, excluding competing land use, and sloped areas. Offshore potential of areas with a maximum water depth of 50m and maximum distance to the shore of 70km. See Figure 6 for the definition of regions.

Region	Onshore	Offshore
	Wind energy potential	Wind energy potential
	GW	GW
Northeast	4.6	64.5
Northwest	2.8	-
Red River Delta	1.5	66.7
North central Coast	0.3	113.0
South central Coast	16.8	78.8
Central highlands	12.5	-
Southeast	3.3	27.1
Mekong Delta	0.2	259.7
Total	42.0	609.8

Table 4: Vietnam onshore and offshore wind energy capacity factors. Source: UTS/ISF Report, chapter 5 table 75ff, data from www.renewables.ninja. See Figure 6 for the definition of regions.

Region	Onshore	Offshore
	Wind capacity factor	Wind capacity factor
Northeast	21%	27%
Northwest	21%	Land-locked
Red River Delta	23%	28%
North central Coast	22%	25%
South central Coast	30%	47%
Central highlands	20%	Land-locked
Southeast	36%	54%
Mekong Delta	34%	45%
Average	26%	38%

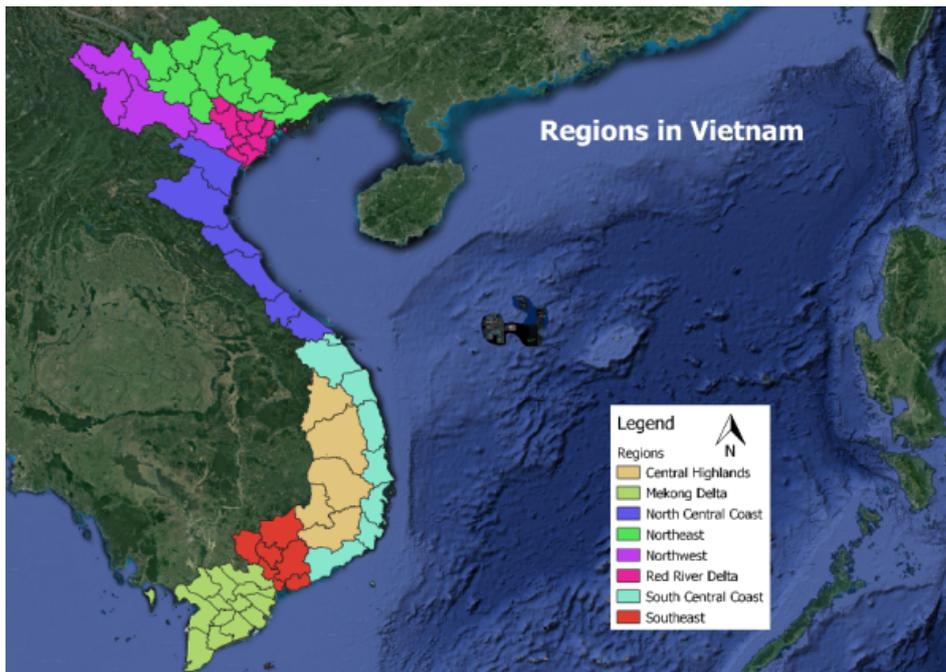


Figure 6: Regional breakdown of Viet Nam for the power sector analysis in the ISF study.

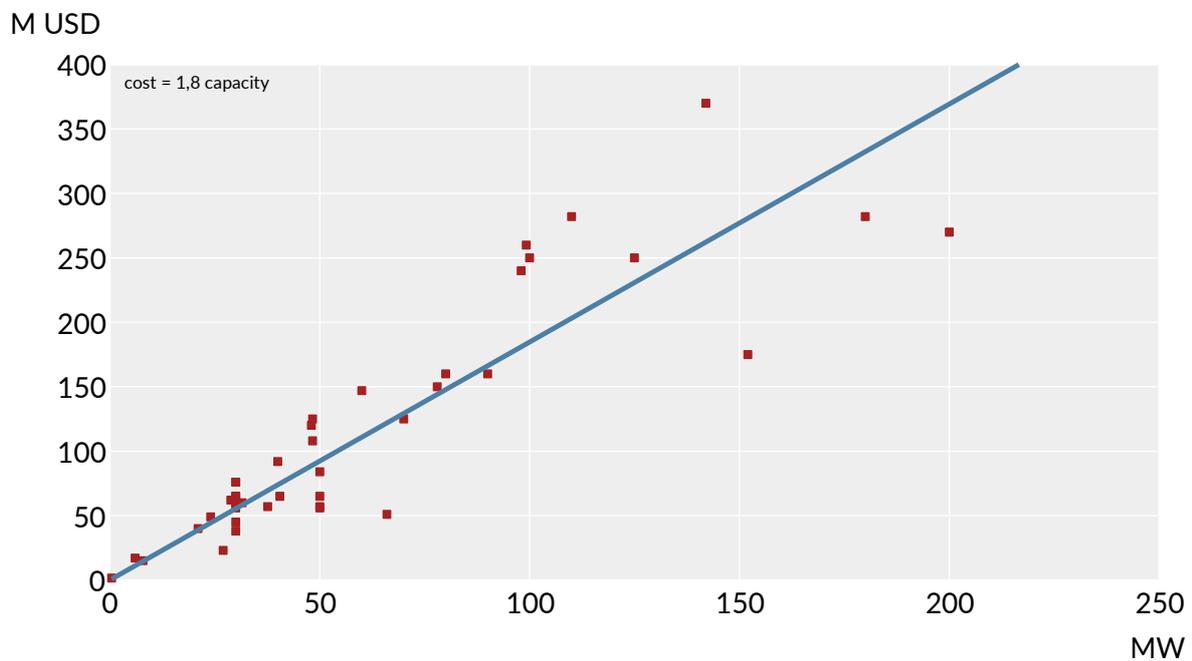


Figure 7: Announced investment costs of onshore and near-shore wind projects in Vietnam.

Table 5 on next page: List of wind power projects in Vietnam. Sources: see electronic version.

Station	Owner	Status	Capacity (MWp)	Investment (million \$)	Location	Province	Wind Plan lot #	Date approved	Investment Licence	Construction start date	Expected COD	Actual COD
Bình Thuận 1 phase 1 (Tuy Phong)	Vietnam Renewable Energy JSC (REVN)	5 operating	30	45	Tuy Phong district, Bình Thuận province	Bình Thuận	Onshore	1				18/04/12
Phú Lạc	EVN - Phong điện Thuận Bình	5 operating	24	49	xã Phú Lạc, huyện Tuy Phong, tỉnh Bình Thuận	Bình Thuận	Onshore	2		27/07/2015		19/09/2016
Mũi Dinh	EAB New Energy Group - Germany	5 operating	37,6	57	xã Phước Dinh, huyện Thuận Nam, tỉnh Ninh Thuận	Ninh Thuận	Onshore	12		8/2016		10/04/2019
Phú Quý	PV Power	5 operating	6	17	Phú Quý island district, Bình Thuận province	Bình Thuận	Onshore			05/2009		12/2012
Bạc Liêu phase 1	Cong Ly Construction-Trade-Tourism Ltd.	5 operating	16		xã Vĩnh Trạch Đông, thành phố Bạc Liêu	Bạc Liêu	Intertidal	*	10/01/11	03/06/11		20/06/13
Bạc Liêu phase 2	Cong Ly Construction-Trade-Tourism Ltd.	5 operating	83,2	260	xã Vĩnh Trạch Đông, thành phố Bạc Liêu	Bạc Liêu	Intertidal	*	10/01/11	03/06/11		29/09/16
Đầm Nai 1	Blue Circle + TSV Vietnam / selling to AboitizPow	5 operating	7875	15	xã Bắc Sơn, huyện Thuận Bắc, Ninh Thuận	Ninh Thuận	Onshore	13		01/04/2017		20/01/2018
Đầm Nai 2	Blue Circle + TSV Vietnam / selling to AboitizPow	5 operating	31,5	60	xã Bắc Sơn, huyện Thuận Bắc, Ninh Thuận	Ninh Thuận	Onshore	13		20/01/2018		12/2018
Hướng Linh 2	Tân Hoàn Cầu JSC	5 operating	30	63	huyện Hướng Hóa, tỉnh Quảng Trị	Quảng Trị	Onshore	4				8/2017
Trung Nam Ninh Thuận phase 1	Công ty CP Điện Gió Trung Nam (Trungnam Win)	5 operating	40		Lợi Hải, Bắc Phong, Thuận Bắc district, Ninh Thuận provin	Ninh Thuận	Onshore	3		26/08/16	9/2018	27/04/19
Trung Nam Ninh Thuận phase 2	Công ty CP Điện Gió Trung Nam (Trungnam Win)	4 construction	64		Lợi Hải, Bắc Phong, Thuận Bắc district, Ninh Thuận provin	Ninh Thuận	Onshore	2			9/2019	
Hướng Linh 1	Tân Hoàn Cầu JSC	4 construction	30	63	huyện Hướng Hóa, tỉnh Quảng Trị	Quảng Trị		3				
Hướng Linh 3	Tân Hoàn Cầu JSC	2 approved	30	65	huyện Hướng Hóa, tỉnh Quảng Trị	Quảng Trị			26/11/2018	09/04/2019	6/2019	12/2020
Thiên Nghiệp - Đại Phong	AC Energy+Blue Circle (Đại Phong dev. inv. co)	4 construction	40	92	xã Thiên Nghiệp và phường Mũi Né, TP. Phan Thiết	Bình Thuận	Onshore	14				
Bạc Liêu phase 3	CP Super Wind Energy Công Lý 1	4 construction	142	370	xã Vĩnh Trạch Đông, thành phố Bạc Liêu	Bạc Liêu				1/2018	6/2021	
Lai Hào wind farm phase 1	CP Super Wind Energy Công Lý 1	4 construction	30	76	Xã Lai Hào, huyện Vĩnh Châu, Sóc Trăng	Sóc Trăng	Intertidal	1			30/01/2018	
Lạc Hòa wind farm	Hoàng Sơn Energy	4 construction	30	76	Xã Lạc Hòa, huyện Vĩnh Châu, Sóc Trăng	Sóc Trăng	Onshore	outside	05/10/2018			
Hòa Đông wind farm	Hoàng Sơn Energy	4 construction	30	76	Xã Hòa Đông, Vĩnh Châu, Sóc Trăng	Sóc Trăng	Onshore	outside	05/10/2018			
Tây Nguyên phase 1	HBRE Wind Power Solution	4 construction	288,8	62	xã Diên Yết, huyện Ea Hlêo, Đắk Lắk	Đắk Lắk	Onshore					6/2018
Phương Mai 3 wind power plant	HALCOM, previously Central wind power JSC (b)	4 construction	21	40	Nhơn Hội economic zone, Quy Nhơn, Bình Định	Bình Định						
Cầu Đất wind power plant	Đài Dương RE JSC	4 construction	50	57	xã Xuân Trường và Trại Hành, TP Đà Lạt	Lâm Đồng						
Korea Wind Power Plant - Trà Vinh V1-1	Climate Investor One and Samtan (South Korea)	4 construction	48	120	xã Trường Long Hòa và Dân Thành, thị xã Duyên Hải, tỉnh Trà Vinh	Trà Vinh	Intertidal	1	2016		21/03/2019	thg 9-2020
Duyên Hải	CP Năng lượng châu Á và Tập đoàn Uniso (South K)	cancelled	48,3	125	xã Đông Hải, huyện Duyên Hải, tỉnh Trà Vinh	Trà Vinh	Intertidal	2		8/2017		never
Khải Long phase 1	CP Super Wind Energy Công Lý 1	3 groundbreaking	100	250	xã Đất Mũi, Ngọc Hiển, Cà Mau	Ca Mau	Intertidal	1	06/06/2018		26/09/2016	
Bình Đại phase 1 and 2	Thanh Thành Cong Group -Mekong Wind JSC	3 groundbreaking	30	65	xã Thửa Đức, huyện Bình Đại, tỉnh Bến Tre	Ben Tre	Intertidal	10		20/07/2017	28/11/2017	
HBRE An Thọ (Phú Yên)	Super Energy Corporation	2 approved	200	270	xã An Thọ, An Hiệp và An Linh huyện Tuy An, Phú Yên	Phu Yen			23/11/2018	01/01/2018		
HBRE Chư Prông (Gia Lai)	Super Energy Corporation	2 approved	50		xã Ia Bàng và Ia Pchin, huyện Chư Prông, Gia Lai	Gia Lai				23/11/2018		
Sóc Trăng 2	Công ty Cổ phần Tập đoàn đầu tư xây dựng Curren	2 approved	60		Sóc Trăng	Sóc Trăng	Intertidal	2		27/08/2018		
Sóc Trăng 3	TNHH BanPhu - Thailand	2 approved	65		Sóc Trăng	Sóc Trăng	Onshore	3			01/11/2019	12/2020
Sóc Trăng 4	Tổng Công ty cổ phần Thương mại Xây dựng	2 approved	130		Sóc Trăng	Sóc Trăng	Intertidal	4		27/08/2018		
Sóc Trăng 5 (Lạc Hòa 1)	Vĩnh Châu - TDC	2 approved	25		Ward 2, Lạc Hòa commune - Vĩnh Châu Town	Sóc Trăng	Onshore	5			01/06/2019	
Sóc Trăng 6	Công ty TNHH Năng lượng tái tạo	2 approved	40		Sóc Trăng	Sóc Trăng	Onshore	6		27/08/2018		
Sóc Trăng 7	Công ty TNHH Xuân Cầu	2 approved	120		Sóc Trăng	Sóc Trăng	Intertidal	7		27/08/2018		
Sóc Trăng 8	Công ty TNHH năng lượng tái sinh Trác Việt	2 approved	100		Sóc Trăng	Sóc Trăng	Intertidal	8		27/08/2018		
Sóc Trăng 11	Công ty TNHH Xuân Thiện Yên Bái	2 approved	100		xã Bắc Sơn, huyện Thuận Bắc, Ninh Thuận	Sóc Trăng	Intertidal	11		27/08/2018		
Sóc Trăng 13	Công ty Cổ phần Tập đoàn Hà Đô	2 approved			Sóc Trăng	Sóc Trăng	Intertidal			27/08/2018		
Sóc Trăng 16	Công ty TNHH Envision Energy	2 approved			Sóc Trăng	Sóc Trăng	Intertidal			27/08/2018		
Sóc Trăng 21	Công ty Nexif Energy Hydro B.V	2 approved	40		Sóc Trăng	Sóc Trăng	Intertidal	12		27/08/2018		6
Hòa Thắng 1.2	Vietracem	2 approved	100		xã Hòa Thắng và thị trấn Chợ Lều (huyện Bắc Bình, tỉnh BI)	Bình Thuận	Onshore	7	16/08/2012			2020-2022
Hiệp Thành	Janakusa Pte LTD (Singapore) + Ecotech (Vietn	2 approved	78	150	thị xã Duyên Hải, tỉnh Trà Vinh	Trà Vinh	Intertidal	5 + 6				
Korea Wind Power Plant - Trà Vinh phase 1	Woojin Construction	8 cancelled	48		thị xã Duyên Hải, tỉnh Trà Vinh	Trà Vinh	Intertidal	1	42424			3/2020
Trà Vinh 3	Ecotech Trà Vinh	2 approved	48		thị xã Duyên Hải, tỉnh Trà Vinh	Trà Vinh	Intertidal	3				
PV Power - IMPSA wind power plant	PV Power - IMPSA	8 cancelled	600	2350	Hòa Thắng commune, Bắc Bình district, Bình Thuận provin	Bình Thuận	Offshore					
Saigon - Bình Thuận wind power plant	Saigon-Bình Thuận power investment JSC	2 approved	200		Bắc Bình district, Bình Thuận province	Bình Thuận	Onshore	outside				
Bình Thuận 1 phase 2 (Tuy Phong)	Vietnam Renewable Energy JSC (REVN)	2 approved	90		Tuy Phong district, Bình Thuận province	Bình Thuận	Onshore	1				
Phước Hữu wind power plant	EAB Viet Wind power	2 approved	50	65	Phước Hữu commune, Ninh Phước district, Ninh Thuận pr	Ninh Thuận	Onshore	near 5		10/2010		
Phước Hữu - Duyên Hải 1	Hưng Tin Ltd. Co.	2 approved	30	1260b VND	xã Phước Hữu, huyện Ninh, Phước, Ninh Thuận	Ninh Thuận	Onshore	outside		13/06/2016		
Phương Mai 1 wind power plant	Phuong Mai wind power JSC	2 approved	30	38	Nhơn Hội economic zone, Quy Nhơn, Bình Định	Bình Định						
Phương Mai 2 wind power plant	GGP Corp. (Germany)	2 approved	200		Nhơn Hội economic zone, Quy Nhơn, Bình Định	Bình Định						
Gia Lai wind power plant	Highland wind power JSC	2 approved	40,5	65	Pleiku, Gia Lai	Gia Lai						
Bach Long Vi island wind power plant	National Youth Union	2 approved	0,414	1,5	Bach Long Vi island, Hải Phòng province	Hải Phòng						
Phước Minh wind farm	Adani Phuoc Minh Wind Power Ltd.(Adani+TSV)	2 approved	27,3		Ninh Thuận	Ninh Thuận	Onshore	near 7			Q1-2019	2019-2020
Phước Dân wind power plant	Thương Tín Power company (Sacoreal)	2 approved	50	56	Phước Hữu, Phước Thái, Phước Hữu communes and Phướ	Ninh Thuận	Onshore	10				
Nhơn Hội wind power plant	SÀI GÒN- BÌNH ĐỊNH ENERGY JSC.	2 approved	27	23	Phú Hậu village, Cát Chánh commune, Phú Cát district	Bình Định						
Công Hải wind power plant	GRETA INC (Canada)	2 approved	66	51	Công Hải commune, Thuận Bắc district, Ninh Thuận provin	Ninh Thuận	Onshore	1	7/2013			
An Phong wind power plant	Thuan Phong Energy Development JSC	2 approved	180	282	An Hải, Phước Hải and Phước Dinh communes, Thuận Nam Ninh Thuận	Ninh Thuận	Onshore	10				
Phước Nam Enfnity Ninh Thuận wind power	Enfnity Ninh Thuận Ltd., Co.	2 approved	125	250	Phước Nam, Phước Minh, Phước Ninh, Thuận Nam provin	Ninh Thuận	Onshore	6		2016		
Phước Thành wind power plant	Global Energy Investment and Consultancy	2 approved	18		Phước Thành commune, Bắc Ái district, Ninh Thuận provin	Ninh Thuận	Onshore					
Thuận Nhiên Phong	ASIA RENEWABLE ENERGY CORPORATION	2 approved	50		Hòa Thắng commune, Bắc Bình district, Bình Thuận provin	Bình Thuận	Onshore	10				
UPC - Quảng Bình 1,2,3,4	UPC Renewables Asia	2 approved	120		Lê Thủy, Quảng Bình	Quảng Bình						
Hướng Phùng 1	EVNGENCO2	4 construction	30	56	thôn Hướng Đức, xã Hướng Phùng, huyện Hướng Hoá, Quảng	Quảng Bình	Onshore	1		01/06/2017	29/06/2019	4/2021
Hướng Phùng 3	Hướng Phùng wind power Ltd. Co.	4 construction	30		xã Hướng Phùng, huyện Hướng Hóa, Quảng Trị	Quảng Trị					29/06/2019	4/2021
Hướng Phùng 2	Việt Ren JSC	4 construction	20		thôn Đa Cù, xã Hướng Phùng, huyện Hướng Hóa, Quảng	Quảng Trị	Onshore	2		11/06/2018	29/06/2019	4/2021
Hướng Hiệp 1	Tân Hoàn Cầu JSC	2 approved	30	60	xã Hướng Hiệp, huyện Đakrông, tỉnh Quảng Trị	Quảng Trị			6/2018			
Gelex 1, 2, 3	Quảng Trị Gelex Energy company	2 approved	90	160	xã Hướng Linh và Hướng Hiệp, huyện Đakrông, Quảng	Quảng Trị			27/12/2018	12/02/2019	01/10/2020	10/2021
Hướng Hòa 1	Licogj 16	2 approved	64		Quảng Trị	Quảng Trị						
Hướng Sơn 2	EVNGENCO2 (BQL Thủy Điện Sảng Bung 2)	2 approved	30		xã Hướng Sơn, huyện Hướng Hóa, Quảng Trị	Quảng Trị						
Kê Gà offshore wind farm	Enterprise Energy + Renewable Energy Global S	1 announced	600		xã Tân Thành, huyện Hàm Thuận Nam, tỉnh Bình Thuận	Bình Thuận	Offshore					2023
Đài Pơ wind farm	Mirat Energy + HLP	2 approved	200		huyện Đăk Pơ, tỉnh Gia Lai	Gia Lai						
Mang Yang wind farm	Mirat Energy + HLP	2 approved	200		huyện Mang Yang, tỉnh Gia Lai	Gia Lai						
Thái Hòa	Công ty cổ phần Năng lượng Pacific - Bình Thuận	2 approved	83		xã Hòa Thắng, huyện Bắc Bình, tỉnh Bình Thuận	Bình Thuận	Onshore	near 10				
Thái Phong	Công ty cổ phần Năng lượng Pacific - Bình Thuận	2 approved	53		xã Chi Công, Hòa Minh và Phong Phú, huyện Tuy Phong, B	Bình Thuận	Onshore	outside				
Win Energy Chiến Thắng	Chinh Thang Wind Power Ltd.	2 approved	50	84	huyện Thuận Nam và Ninh Phước, Ninh Thuận	Ninh Thuận	Onshore					
Đông Hải 1	Bắc Phong Energy JSC / Unison	4 construction	48,3	108	Long Điền Đông, huyện Đông Hải, tỉnh Bạc Liêu ?? or xã Đ	Bạc Liêu	Intertidal	3		11/04/2018	15/04/19	04/2021
Hòa Bình 1	Công ty Phong Anh	4 construction	300		Xã Vĩnh Hậu, huyện Hoà Bình, Tỉnh Bạc Liêu	Bạc Liêu		2				
Trà Vinh phase 2 - Korea Wind Power Plant	Wojin Construction	8 cancelled	96		Trung Long Hoa commune, Duyen Hai town of Trà Vinh	Trà Vinh	Intertidal	2 + 3 ?	5/2016			never
Dam Nai 3	AC Energy+Blue Circle (Đại Phong dev. inv. co)	5 operating	39,375		xã Bắc Sơn, huyện Thuận Bắc, Ninh Thuận	Ninh Thuận	Onshore	13				12/2018
Trung Nam Ninh Thuận phase 3	Công ty CP Điện Gió Trung Nam (Trungnam Win)	4 construction	48	175	Lợi Hải, Bắc Phong, Thuận Bắc district, Ninh Thuận provin	Ninh Thuận	Onshore					
Sóc Trăng 1 phase 1	Cong Ly Construction-Trade-Tourism Ltd.	3 groundbreaking	110		Lai Hoa commune of Vĩnh Châu town	Sóc Trăng					43130	1/2021
Ba Trĩ wind power plant	Ben Tre renewable energy JSC (Ecotech) Woojin	2 approved	30	282	Ben Tre	Ben Tre	Intertidal	7		20/07/2017		
Ben Tre Green Energy	Công ty TNHH đầu tư năng lượng xanh miền Tây	2 approved	70	125	Ben Tre	Ben Tre	Intertidal	8 ?		20/07/2017		
Ham Kiem 2	Construction corporation No.1 - JSC	2 approved	50		Bình Thuận	Bình Thuận	Onshore	21				
Hòa Thắng 1.3	Hao Phong Clean Energy JSC	2 approved	20		Bình Thuận	Bình Thuận	Onshore	8			2016	
Tien Thanh 1	Asia Clean Energy Development and Investment	2 approved	20		Tiến Thành commune, Phan Thiết City	Bình Thuận	Onshore	15				
Tien Thanh 2	Asia Clean Energy Development and Investment	2 approved	15		Bình Thuận	Bình Thuận	Onshore	16				
Tien Thanh 3	Asia Clean Energy Development and Investment	2 approved	20		Bình Thuận	Bình Thuận	Onshore	17				
Văn Lâm		2 approved	50		Văn Lâm village, Phước Nam commune, Ninh Phước distri	Ninh Thuận	Onshore					
Bạc Liêu phase 4	Cong Ly Construction-Trade-Tourism Ltd.	1 announced	158		xã Vĩnh Trạch Đông, thành phố Bạc Liêu	Bạc Liêu						
Bình Đại next phases	Thanh Thành Cong Group -Mekong Wind JSC	1 announced	280		xã Thửa Đức, huyện Bình Đại, tỉnh Bến Tre	Ben Tre	Intertidal	11				
Chu Pơ wind power project	TSV + The Blue Circle	1 announced	200		Kong Yang commune, Kong Chro district, Gia Lai province	Gia Lai					6/2019	5/2020
Chu Se wind project	TSV + The Blue Circle	1 announced	700		Zhuo District, Gia Lai province	Gia Lai					6/2019	5/2020
Cu An wind power project	TSV + The Blue Circle	1 announced	200		Cu An, Dak Lak district, Gia Lai province	Gia Lai					6/2019	5/2020
Dam Nai 4 (Ba Thap) wind power project	TSV + The Blue Circle	1 announced	27,6		Thuan Nam dist, Ninh Thuan province, Vietnam.	Ninh Thuan	Onshore	13				12/2018
Hanbaram	Landville Energy Co Ltd (S Korea)	1 announced	140,3		Ninh Thuận	Ninh Thuận	Onshore	2		2016		
Khải Long phase 2	CP Super Wind Energy Công Lý 1	1 announced	100		xã Đất Mũi, Ngọc Hiển, Cà Mau	Ca Mau	Intertidal	2				
Khải Long phase 3	CP Super Wind Energy Công Lý 1	1 announced	100		xã Đất Mũi, Ngọc Hiển, Cà Mau	Ca Mau	Intertidal	3				
Kong Yang wind power project	TSV + The Blue Circle	1 announced	103		Kong Yang commune, Kong Chro district, Gia Lai province	Gia Lai				6/2019		5/2020
Kosy Bac Lieu wind farm	Kosy Group	1 announced		435	Huyện Hoà Bình, Tỉnh Bạc Liêu	Bạc Liêu						
Lợi Hải - Location 10	Thuan Binh Wind Power JSC (Vietnam) - Danida	1 announced	28,875		58 Lợi Hải commune, Thuận Bắc district	Ninh Thuận	Onshore	4				
No 5 Thanh Hải 1 phase 1	Tan Hoan Cau Ben Tre JSC	1 announced	32		Thanh Hải Commune, Thạnh Phú District	Ben Tre	Intertidal	1 ?				6/2020
No 5 Thanh Hải 1 phase 2	Tan Hoan Cau Ben Tre JSC	1 announced	32		Thanh Hải Commune, Thạnh Phú District	Ben						