Escaping the onshore/offshore wind dichotomy: paying extra for better wind nearshore

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Abstract

Technology analysts often dichotomize wind power projects as onshore vs offshore. This neglects nearshore projects, installed in the intertidal flats for example. We explore the characteristics of this third, intermediate, category using an original quasi cross-sectional sample of Vietnam's wind power projects. The median investment for onshore wind power projects in Vietnam is 1 680 USD/kW. It is 2 174 USD/kW for nearshore projects. We computed the relative extra investment cost distribution for intertidal projects compared to onshore projects in our sample. Wind-power generation capacity requires about 50% more investment per MW nearshore than onshore. The interquartile range is 20% – 70%. Escaping the onshore vs offshore dichotomy allows to consider a different policy direction for the industry. Rather than pursuing bluefields megaprojects far offshore, a "small steps" nearshore wind farms extension policy may be cheaper, faster, and more institutionally feasible.

Keywords

Energy policy; Wind power; Nearshore; Investment cost; Vietnam

JEL Classification codes

Q42; D24

Highlights

- We observe a quasi cross-sectional sample of wind power projects in Vietnam.
- 37 projects are neither onshore nor offshore, but nearshore in shallow waters.
- The median investment for onshore wind power projects in Vietnam is 1 680 USD/kW.
- The median investment for nearshore wind power projects in Vietnam is 2 174 USD/kW.
- Nearshore wind power requires 50% (IQR 20%-70%) more investment than onshore.

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1. Introduction

Additions of new wind power generation capacity reached 93 GW in 2020 worldwide (REN21, 2021, p. 23), rising from 61 GW the previous year. That report, like all others, divides wind power projects into two categories: onshore and offshore. This dichotomy is not always sufficient to think about wind industry development. There is an intermediate category: nearshore wind power projects build on the intertidal flats or close to the coastline. This letter shows its importance in the case of Vietnam and characterizes its difference from the other two categories.

(EREA and DEA, 2021, p. 90) calls nearshore stations those in waters below 20 m in-depth and a distance to shore less than 50 km. This includes "intertidal" stations, where the farm is situated in very shallow waters, normally below 2-meter depth or in the so-called intertidal zone.

They have pros and cons compared to onshore or offshore ones. Winds over the sea tend to be stronger and more regular than over the continent. Land use and terrain constrain less the project design. Machines can be accessed on foot from the shore at low tide. Access at high tide remains possible with a causeway to the wind turbines. While access to nearshore stations by sea is more straightforward than reaching remote hilltops by road, the build requires expensive specialized vessels and is more at risk from weat her. Undeveloped tidal areas can have more biodiversity than open sea or anthropized land surfaces. Erecting towers on wet sand is more complicated than on solid rock. And as the electric grid mostly runs over land, nearshore projects will be further away on average, so it may be more expensive to build the connection line.

In this letter, we present a comprehensive historical sample of the wind power industry in Vietnam. Then we compute the nominal investment costs of projects in USD per kW of installed capacity and compare nearshore projects with onshore projects to determine how much more capital intensive they are. The final section compares our results to previously published estimates and showcases the importance of the three-way categorization of wind projects for Vietnam's market.

2. Material and methods

We extracted the sample from our Vietnam wind power dataset described in a companion data paper (Ha-Duong, Minh, 2021). We selected projects with more than 5 MW capacity for which the "location type" and "investment cost" fields were both available. The key features of the source dataset are:

- It aims to provide a comprehensive historical record of the wind power sector in Vietnam.
- It reveals investment costs for all projects currently operational or at implementation stage.
- It includes projects onshore, offshore and nearshore.
- Publicly available sources justify all records.
- The overwhelming majority of projects in our sample aimed at commercial delivery in 2021.

The last trait makes our sample quasi cross-sectional. This is somewhat atypical. In many countries, renewable energy sources have entered the market over a long period, ten years or more. Expansion of wind power in Vietnam fits better a step function than an exponential. After fifteen years of trials with negligible installed capacities, 4 GW were delivered in October 2021.

The Bạch Long Vĩ island hybrid diesel + wind project inaugurated on 30 October 2004 was a false start, not appropriate to the local capacities at the time. Vietnam's first high-capacity wind farm, 30 MW, was inaugurated in the central province of Bình Thuận on 18 April 2012. The next two projects – the Phú Quý island hybrid grid with 6 MW and the nearshore Bạc Liêu phase 1 with 16 MW – both completed in 2013. These three pioneer projects had their lot of technical trouble: one turbine of the Phú Quý system broke down unrepaired; the wind farm in Bình Thuận had acute thermal management issues; the construction of Bac Liêu phase 2 stalled for years. No new capacity was added in 2014 or 2015. The 83 MW Bạc Liêu phase 2 finally completed in 2016. That year also delivered the 24 MW Phú Lạc project in Bình Thuậnh province. The following year, the 30 MW Hướng Linh 2 project in the Quảng Trị province connected. In 2018, the total installed wind power capacity in Vietnam reached 228 MW.

Then Government's Decision 39 (Nguyễn, 2018) raised the Feed-in tariff for wind power projects in Vietnam. From 78 USD / MWh since 2011, it jumped to 85 USD / MWh for onshore wind power projects and 98 USD / MWh for offshore wind power projects (Nguyễn Xuân Phúc 2018). The new electricity tariff applies to a part or whole of the grid-connected wind power projects with commercial operation date before 1 November 2021. The tariff will apply for 20 years from the date of commercial operation. Already operating projects will benefit from the tariffs retroactively from 1 November 2018 for the signed power purchase agreement's remaining period.

On 19 March 2020, Letter 1931 noted: "only nine wind power projects with a capacity of 350 MW have been put into operation so far" and "Total capacity of wind power projects already added to the Planning is approximately 4 800 MW" (Hoàng Quốc Vượng, 2020). Following up, Decision 795 approved the addition of 6 924 MW of wind power projects to the Electricity Masterplan VII (Trịnh Đình Dũng, 2020). Overall there is about 11 000 MW of wind power projects in Vietnam vying to beat the November 2021 deadline.

Letter 10052 issued at the end of 2020 identified the second wave of about 6 500 MW of wind power projects proposed for inclusion into the next electricity masterplan (Đặng Hoàng An, 2020). However, as of January 2021, that wave has not been approved by the Prime Minister. These projects would have no chance to deliver before November 2021.

On 2 November 2021, EVN Letter 6742 (Ngô, 2021) listed the FIT period results. EVN signed a power purchase agreement with 146 wind projects. By the end of October 2021, 84 achieved commercial operational delivery (COD), representing a 3980 MW generation capacity. Of those, 69 (3655 MW) were completed in full, and 15 (325 MW) in part. 62 projects (3479 MW) did not achieve COD. Of those, 4 (178 MW) are connected to the grid, but did not complete the testing on time to obtain their

COD certificate. The financial situation of projects without COD is dire, they cannot sell electricity even if connected to the grid. Early April 2022, they still have no route to market.

3. Results

The dataset comprises 94 projects onshore and 37 projects nearshore. The nearshore class is far from negligible. It weighs even more when looking at investment costs. Figure 1 shows that nearshore projects tend to have higher investment costs per MW of generation capacity than onshore projects. The yellow stars are above the green dots.

We define “technology cost” as a project’s investment cost divided by its installed capacity: a standard energy economics metric that drives electricity production costs for electricity generation technologies that do not use fuels.

Figure 2, top panel, compares the three types of wind power projects regarding technology cost. The median technology cost for an onshore project is 1 680 USD/kWh (interquartile range 1 449 – 1 867). The median technology cost for a nearshore project is 2 174 USD/kWh (interquartile range 2 000 – 2 455). The difference between the distribution of nearshore technology costs and onshore technology costs is statistically very significant (Mann Whitney U test $p = 3.1\ 10^{-12}$, Kolmogorov Smirnov test $p = 4{,}0\ 10^{-12}$). The companion data paper provides source code and statistics tables.

The middle panel in Figure 2 shows that nearshore projects compare to onshore projects in installed capacity (on the lower side). The bottom panel indicates again that nearshore projects compare to onshore projects (on the higher side). Only the joint analysis on the top panel shows clearly that nearshore projects tend to be more investment intensive. How much more intensive? We used three approaches to answer.

The first is to compare median technology costs. Nearshore projects are 29% more expensive.

The second is to compare the slopes when explaining investment (in M$) by capacity (in MW). The intercept is not significant for the nearshore ordinary least squares regression model, so we omit it in both models for simplicity.

Onshore projects: Investment = 1.498 * Capacity

Nearshore projects: Investment = 2.326 * Capacity

The regression approach suggests that the extra technology cost is 55%, about double the first estimate. We used a third approach to reconcile these numbers: Monte Carlo simulations to compute the statistical distribution of the variable of interest. We compared a nearshore MW with an onshore MW in our sample, using weighted random draws with replacement. The average technology cost ratio is 50%, with an interquartile range of 19% – 69%. These numbers vary by about +/-1% between runs of 30 000 draws. We round it to 20% – 70% to avoid presenting a false precision.

4. Discussion and concluding remarks

The 94 onshore wind power projects started in Vietnam around 2018-2019 invested about 1 500 USD per kW of generation capacity on average. The 37 nearshore projects were about 50% more capital intensive, with an interquartile range of 20% – 70%, than the onshore ones.

These cost estimates are in line with previously published results. REN21 (2019, p. 131) reports that onshore wind power technology cost for projects commissioned in 2017 was, on average, 1 173 USD/kW for China (min-max range 1 099 – 1 261). This is lower than our result. We conjecture that projects in Vietnam were more expensive because in spite of four years of technological progress, the market was less mature, projects were smaller, many bought European or American turbines and they went to hilltops instead of flatlands in China. REN21 reports a technology cost of 2 237 USD/kW for Asia, excluding China and India (min-max range 1 783 – 2 565), which is over our results for Vietnam. It is not surprising that costs observed in Vietnam were higher than in China, but lower than in the richer countries like Japan, Thailand, South Korea and Taiwan.

Jakob Lundsager, Nguyễn Ngọc, and Mikael Togeby (2019) published a Vietnam-specific official technology catalogue based on engineering and analogues. They estimate (page 63) the technology cost for wind power onshore in 2020 to be 1 600 USD/kW (uncertainty range 1 400 – 2 000). This number declined to 1 500 USD/kW in the 2021 technology catalogue update (EREA and DEA, 2021). Our econometric estimate for onshore projects is very close to theirs.

A few more years of data will be necessary to observe any profitability differential between onshore and nearshore wind farms. More than better winds justified the higher investment cost for nearshore projects. In Vietnam, the government incentives drove the industry. The feed-in tariff for wind power was 8.5 UScent/kWh for projects on the land and 9.8 UScent/kWh for projects on the sea (Nguyễn, 2018). The government defined the latter as *"Projects with wind turbines constructed and operated offshore - outside the lowest mean high water for many years (18.6) years."* Thus, nearshore wind projects have both a better capacity factor and a better price.

The dataset includes offshore projects. Figure 1, using a log-log axis, shows that offshore projects differ from the rest by their size. They start at 200 MW. They also differ on the economics: the 2021 technology catalogue reports technology costs of 3 500 USD/kW. However, offshore projects costs in our sample are not comparable to the others because they have a different calendar. The announced investment costs for offshore recorded in our dataset are aspirational. Meeting the end of October 2021 deadline to enjoy the FIT was not realistic. In conclusion, the onshore vs offshore wind power dichotomy is insufficient to understand the sector's dynamics in Vietnam. Major international players seek to enter the market with far-offshore megaprojects. Enterprize has a 3.4 GW proposal in Kê Gà, CIP 3.5 GW in La Gàn, Ørsted 3.9 GW in Hải Phòng. These are greenfield –more aptly named "bluefield"– megaprojects. The oil and gas industry history shows that developing offshore megaprojects in Vietnam is politically tricky and subject to a high risk of delays. This may explain why Enterprize pivoted its Kê Gà wind project in 2020, proposing to export green hydrogen.

Escaping the onshore vs offshore dichotomy allows to consider a different policy direction for the industry. A "small steps" nearshore development strategy may execute better than megaprojects far offshore. The Mainstream project in Phu Cuong, for example, starts with a 200 MW phase 4km from the coast. It does not push the envelope compared to existing nearshore wind farms. Progressive extension of nearshore projects is cheaper to invest in and faster to build. Vietnam is not institutionally ready to host the world's largest offshore wind farm. When it comes to renewable electricity procurement auctions, nearshore projects will be competitive.

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Figure 1: Cost and capacity of wind power projects in Vietnam. Source: Author

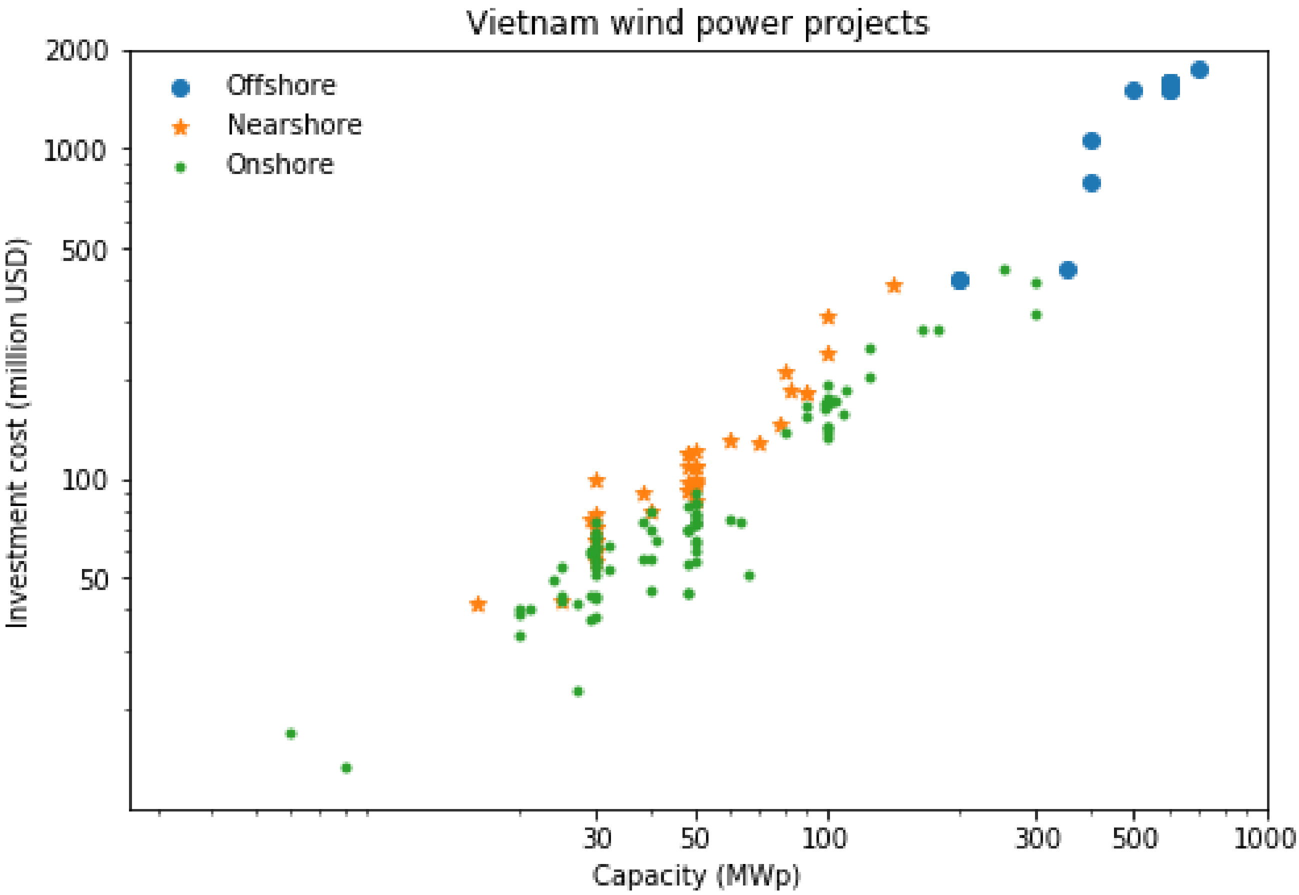

Figure 2: Distribution of wind power project characteristics for different types of projects in Vietnam. Top: Technology cost in M$/MW. Middle: Capacity in MW. Bottom: Investment in M$. Source: Author.