Wind power development in Vietnam: Current and future aspects

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Abstract

Recently, renewable energies, especially wind energy, are drawn much intention in Vietnam because of their promising potential. Although there are strong supports from government, great interest from developers and constant improvement in wind power technology, it is obvious that there are also much challenges for the success of wind power in Vietnam. This article reviews some key aspects of current conditions and analyses some models to suggest future development for in wind power sector in Vietnam.

I. Introduction

Vietnam has moved towards liberalization and international integration and the Government is prioritizing to modernize the country, the main avenue being the creation of more competitive export-driven industries. In this regard, the Vietnamese economy has been growing steadily over the last decade. 2011 real GDP growth was 5.89%. Inflation was also reduced from 11.8% in 2010 to 6.48% in 2011. From a wind energy perspective Vietnam is very promising. The country has the most abundant wind resources in the Southeast Asian region and at the same time the rapid industrialization has created a soaring need for energy. In 2011 Vietnam set out renewable energy targets of 4.5% by 2020 and 6% by 2030 under its National Power Development Plan 2011 – 2020. Under this framework, the Government created long-term wind power targets of 1000MW by 2015 and 6200MW by 2050. In line with this, on August 20th 2011 the Government implemented its first Wind Policy legislation. The wind policy is a mechanism to support the development of wind power projects in Vietnam. The FIT level has been set at VND 1614/kWh (around US 7.8 cents) with a standardized 20-year PPA. The wind electricity purchase price (i.e. the FIT) is provided by the state utility Electricity of Vietnam (EVN). The legislation also includes other incentives such as 100% tax exemption on technology and equipment and land exemptions. However, until now, only three large scale wind power projects has been in operation in Vietnam: 30 MW in Tuy Phong, Binh Thuan province, 6MW in Phu Quy Island and 16 MW in Bac Lieu province. Other wind power projects are still on the development stage. The reason for the market being in a state of idle is mainly due to the developers' risk/reward not being attractive. The challenges are:

- The FIT level of 7.8 USD cents/kWh is not high enough to generate a business case that lives up to the expectations of the investors (investor IRR of ~15%) and below the production cost of approximately 10.7 USD cents/kWh[1];
- The State utility EVN is in financial distress and thus unable to connect wind power projects to the grid and provide the US7.8 cents/kWh PPA to developers, with the exception of the 3 projects highlighted above;
- Constraints with regard to actual grid capacity and transmission (grid code and integration of wind into grid);

[1] Wind Energy Future Asia, ADB, 2011

- Lack of a national wind energy development plan, being now elaborated by MoIT after the wind legislation issued in 2011;
- Lack of financing options as well as options providing reasonable rates to encourage project developments under the current tariff and EVN/MoIT guarantees;
- Lack of a PPA legislation that allows end users of electricity to purchase wind power directly from independent power producers through bilateral agreements with wheeling fees to EVN;
- Lack of competencies in wind farm design, construction, operation and maintenance;
- Limited project feasibility assessment capabilities and associated low quality of feasibility studies as well as lack of good business case provisions from developers in order to be eligible for the needed portfolio of financing options (private/ multilateral/ public loans);
- Lack of a wind database of the quality needed to evaluate wind resources and direct efforts towards areas and sites with a high wind power potential;
- Poor transport infrastructure and land use conflicts.

However, there are also opportunities:

- There are a vast number of financial players who are increasingly interested in the Vietnamese market and are looking to provide debt to on-grid wind power plant developments for the right business case, including multilateral agencies and international export credit agencies;
- There is a number of project under development, already permitted, in areas with good wind resources, showing a viable business case;
- The business case for off-grid projects is very good and the potential for this type of projects is high in Vietnam. The 6 MW island project (Phu Quy) in Vietnam has shown how to reduce the cost of diesel generation rising in the country and the cost of transporting diesel to the island by using wind power;
- There are good-to-excellent wind resources to harvest, especially in regions such as Binh Thuan, Ninh Thuan, Dac Lac, and the Mekong Delta region (Bac Lieu) etc;
- There is a high appetite from energy intensive industrials, manufacturing and retail companies with operations in Vietnam to source green electricity at a fixed (indexed) price, in order to hedge the exposure to increasing electricity prices and limit their CO_2 emissions;
- There is potential for a good on-grid business case for wind power projects provided that a higher PPA, as well as reasonable financing packages can be found, and grid transmission issues can be avoided.

This study will comprise:

1. An analysis of the conditions for wind energy development in Vietnam;
2. A proposed new project setup model and a comparison of large-scale grid-connected wind energy projects.

II. The local conditions for wind power development

II. 1. Electricity demand trends

Vietnam's fast rise in final commercial energy demand has been driven by three key factors: (a) increasing industrialization; (b) expansion of motorized transport; and (c) increasing household use of modern fuels, especially electricity. These three drivers also are expected to continue to account for most of the energy demand increase over the next decade. About 68 % of final energy demand is fuel – mainly coal and petroleum products. Electricity, including accounting of energy used to produce electricity, accounts for about 32%.[2] During the nine-year period from 1998 to 2007, commercial energy use grew at an average rate of 12.1% per year, while Vietnam's GDP grew at an average of 7.3% per year. Electricity demand in 2010 was three and a half times as great as demand in 2001[3]. Peak energy demand in 2012 amounted to 18,508 MW[4]. With a continuation of past trends, energy demand in Vietnam is poised to triple in the next 10 years (from 2010) and eightfold within the 25 years from 2000 to 2025. Vietnam's primary energy demand is expected to increase rapidly with an expected growth rate of over 12-16% per year through 2015. According to estimates, an additional capacity of 4,000 MW per year on average will be required between 2011 and 2015 to meet the country's rapidly increasing demand for energy.[5] Through its Power Development and Wind Policy Legislation the Vietnamese Government has committed to increase the renewable energy sector's share of the installed energy capacity.

II.2 Electricity supply and pricing trends

For continued economic success, the Government is under pressure to meet a 14-15% annual surge in energy demand[6] . Meanwhile, there are challenges being faced on the supply side as new power capacity is not coming online as planned resulting in power shortages, especially at peak times of demand[7]. A huge expansion of the power market is needed to meet surging demand trends and this cannot be ensured by the public sector alone. Vietnam's energy sector reforms will cost $48 billion through 2020[15]. Vietnam's Seventh Master Power Development Plan of 2011 has laid out aggressive restructuring plans for Vietnam's power generation sector to attract greater inflows of foreign investment. Pricing reform is central to this and in response Vietnam is undergoing a long-term market restructuring initiative to transition to a competitive generation market. In 2011, Vietnam's average retail electricity tariff was 5.97 US cents. This is much lower than the 7 US cents/kWh that was committed to by EVN in 2001 in loan agreements with international financial organizations. The present tariff is lower than cost of production, transmission and distribution.

Item	2005	2006	2007	2008	2009	2010	2011
Average tariff (VND/kWh)	787	815	860	870	948	1,058	1,242
Average exchange rate (VND/USD)	15,800	15,973	16,042	16,400	17,010	18,544	20,803
Average tariff (US cents/kWh)	4.98	5.10	5.36	5.30	5.57	5.70	5.97

Table 1: Average electricity retail tariffs (Source: Institute of Energy, 2012).

[2] Vietnam Energy Statistics 2010, National Energy Efficiency Programme, Hanoi, 2011, Institute of Energy

[3] Doing Business in Vietnam: 2012 Country Commercial Guide for US Companies, US Commercial Service

[4] As of May 2012, taken from EVN presentation "Overview of Vietnamese Power System" at headquarters in Hanoi - 4 December 2012

[5] Doing Business in Vietnam: 2012 Country Commercial Guide for US Companies, US Commercial Service

[6] 2012 Pacific Energy Summit Report, Hanoi, March 20-22, 2012

[7] Eurocham 2013 Trade/Investment Issues & Recommendations

According to Decision No. 24/2011/QD-TTg (2011), adjustment of electricity price can occur every three months. The goal is to move a wholesale competitive market by 2015, finalizing the transition to a competitive retail market by 2022. However, this may not be sufficient progress to meet the energy needs expected in 2015, when Vietnam will shift from a net energy exporter to net importer. The developments in electricity pricing are a key factor affecting the dynamics in the wind energy sector as they may compensate for the low FIT. If prices increase to levels above the 7.8 cents FIT level, wind projects will become far more attractive to end users, thus increasing demand and stimulating supply.

II.3 Challenges and constraints of electricity infrastructure

Some of the continuing challenges that Vietnam's electricity infrastructure faces include:

- Poor grid infrastructure, efficiency & energy storage
- Grid connection is only through Electricity of Vietnam (EVN). As the national energy provider, it controls the market & market share and hence may provide less room for negotiation of utilities' buy-in contracts
- Non-RE industries artificially priced lower & energy waste not penalized
- EVN experiencing weak financial capacity – will hinder grid development
- From 2010-2011 the Government increased electricity prices in the country by 15.28% in order to drive competitiveness in the power market. Furthermore, prices for 2011 increased by 4.6-5%. In addition, EVN is set to increase electricity prices for 2012 by 10% or more in order to offset its losses
- Indirectly, the increased electricity prices provide an additional incentive, as the price increases offset a proportion of production costs

II.4 Wind potential

In 2001 the World Bank and TrueWind Solutions prepared a Wind Resource Atlas for Southeast Asian countries at an altitude of 65 meters[8]. This research identified Vietnam as having the greatest wind energy potential in the region. In 2007 EVN carried out its first study of Vietnam's wind resources, the results of which showed significant deviation from the World Bank study[9]. In 2010 the World Bank and MoIT conducted a joint survey of three sites at 80 meters[10] to update Vietnam's wind resource atlas. Despite such wind studies having been completed, there remains a lack of reliable, standardized and centralized wind data, which presents a significant obstacle to investment in wind energy. To address this gap, MoIT is currently conducting a wind measurement at 10 sites in the Central Highland and Central Coastal areas at altitudes of 80 m, 60 m and 40 m applying the standards of the International Electrotechnical Commission (IEC)[11]. The results are expected around June 2015 and should serve as a useful reference for wind power developers.

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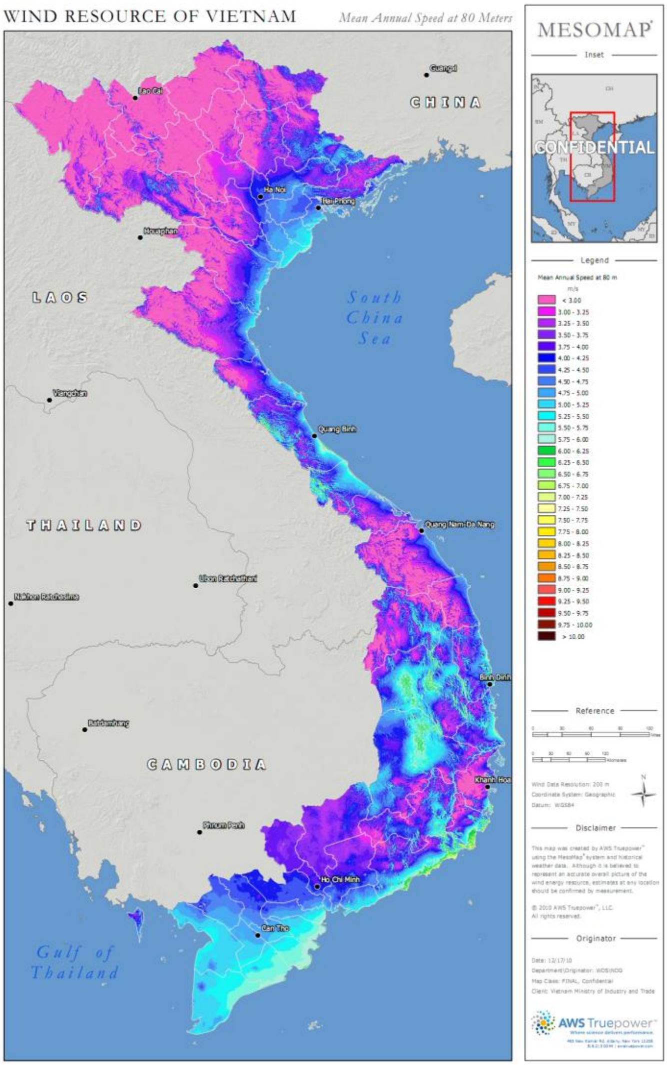
[8] World Bank (2001) Wind Energy Resource Atlas of Southeast Asia, prepared by TrueWind Solutions, LLC, New York

[9] Electricity of Vietnam (2007) Wind Resource Assessment for Power Generation

[10] Vietnam MoIT (2010) Wind resource atlas of Vietnam, sponsored by World Bank, prepared by AWS Truepower. New York.

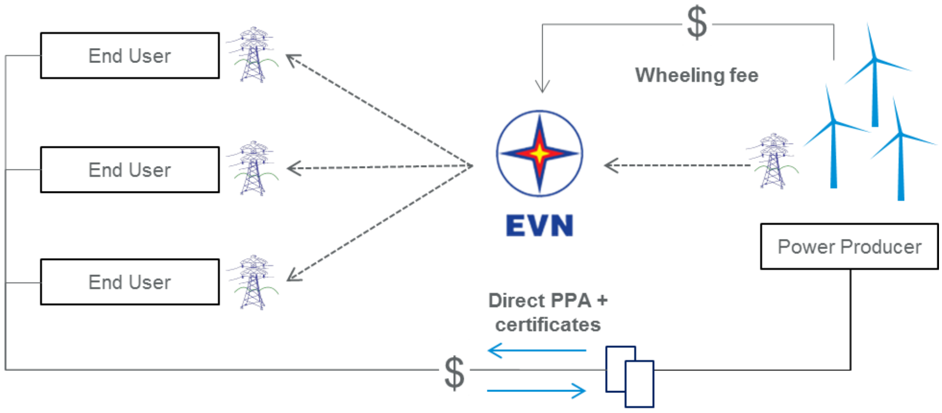
[11] GIZ/MoIT (2011) Information on wind energy in Vietnam, www.windenergy.org.vn



Vietnam wind resource map at 80 m[10]

III. Proposed new project setup model

At present, Vietnam end users of electricity cannot selectively purchase green electricity from the state grid through green procurement programs and direct PPAs with independent producers of green power. Electricity can only be sourced from EVN, the sole entity responsible for transmission, distribution, and management, and therefore EVN is also the only purchaser of green power generated by independent power producers in Vietnam (when this is not utilized for captive use). The structure proposed in this study is a direct PPA option between electricity end users and independent power producers which has been successfully implemented in other developing countries such as India and Mexico. The structure does not involve any physical transmission line between the two parties, meaning that the electricity will flow through the grid currently used to transport electricity from the wind farm to the end user. In this model, the IPP and the energy users will negotiate an electricity price for a long term PPA and subsequently pay a wheeling fee to EVN for transmission, distribution and management of the electricity. The green electricity generated by the IPP will be ‘mixed’ with other power sources once it enters the grid, which relies on various fuel sources. In the absence of energy banking, to ascertain that green power generated equals green power sold to customers and to validate green credentials, end users will require verification by an external third party. The IPP will provide the end users with green certification of the electricity produced.



Direct PPA mechanism

There are several reasons why this structure can be considered beneficial and worth being investigated further in Vietnam:

•The current FIT is considered insufficient for developers to have sustainable returns on their wind power project and this limits developer activity to few sites with the best wind conditions. On the other hand, the same FIT is considered to be too high by EVN, who needs to source wind power at 7.8 USD cents to resell it at a much lower price to the end users. The fact that end users themselves are willing to commit to purchase green electricity at a rate higher than the FIT could solve this issue on both sides.

•EVN would receive a wheeling fee from the independent power produce without having to incur any capital investment (if the project is going to be connected to an existing transmission line).

•Financial institutions are currently reluctant to lend capital at reasonably low interest rates to wind power projects selling electricity under the current procurement structure. This is also due to EVN's credit rating. By having end users directly purchasing electricity from the independent power producer, (provided of course that interested end users with a credit rating higher than EVN's credit rating can be identified) capital at a lower interest rate is more likely.

•End users can achieve their sustainability goals and are also able to hedge against electricity price increases by sourcing wind power at a fixed (indexed) rate over a long term horizon. In fact, electricity price instability is becoming a concern for manufacturers, retailers and energy intensive industrials, which are now actively looking for solutions to their energy needs.

If successful, the example of a similar setup could pave the way for additional MW capacity of renewable energy and therefore contribute to Vietnam's green growth targets.

IV. Project analysis and comparison between different models

The model described above has been studied in detail considering different scenarios and real experiences in the constructed wind power projects in Vietnam. Basically, wind power projects can be divided in to three categories: on shore, near-shore (intertidal in some cases) and offshore. The base for this evaluation is the Bac Lieu project, 16 MW, intertidal project erected in the Mekong delta region, whose cost structure and key parameters have been used as a reference for the cost structure of some of the simulations conducted. For the onshore scenario, references of other existing projects have been utilized. Turbine information is taking from Vestas, a leading company in wind turbine industry.

The following methodology has been followed for the analysis:

1. Determine costs for the total project for two options: On-shore and Intertidal
2. Assess financial feasibility for various revenue options in terms of NPV and IRR
3. Assess Interest Rate Sensitivity
4. Assess wheeling fees that can be paid to EVN (in case of Direct PPA) to make the project viable

Basic assumptions have been made on the cost structure as in the table below.

Component	Details	Onshore (kUSD)		Intertidal (kUSD)		Reference
		TOTAL	Per WTG	TOTAL	Per WTG	
WTG	WTG supply , Transport and Erection	141.750.000	2.835.000	141.750.000	2.835.000	Vestas
BoP	substation HT lines DP switchyard Unit switchyard land foundation hard stands	16.010.000	320.200	40.410.000	808.200	Vestas
Development Cost	Third Party Assessment Land Due diligence Legal Cost during development	750.000	15.000	750.000	15.000	Bac Lieu project
Additional costs for intertidal project				10.000.000	200.000	Bac Lieu project
Total		158.510.000	3.170.200	192.910.000	3.858.200	

Financial assumptions have been made as well according to the following table:

Parameter	Unit	Value
Loan terms		
Interest Rate on Senior Debt	%	9.6%
Amortization	Type	Mortgage
Grace Period Duration	Years	1
Frequency	Frequency	Quarterly
Total Term	Years	12
Tax and depreciation		
Rate of Tax	%	year 1-4: 0%
		year 5-13: 5%
		year 14-15: 10%
		year 16-30: 25%
Depreciation	%	10% SLM
Operating Cost		
Service cost	USD/MWh	15
Escalation on service	%	3%
Insurance	%	0.20% of EPC Cost
Working Capital		
Interest Rate on Cash Balances	%	5.0%
Accounts Payable / Days of Expenses	Days	45
Accounts Receivable / Days of Revenue	Days	45
Cash Sweep	%	0%

Debt Service Reserve	Months	3

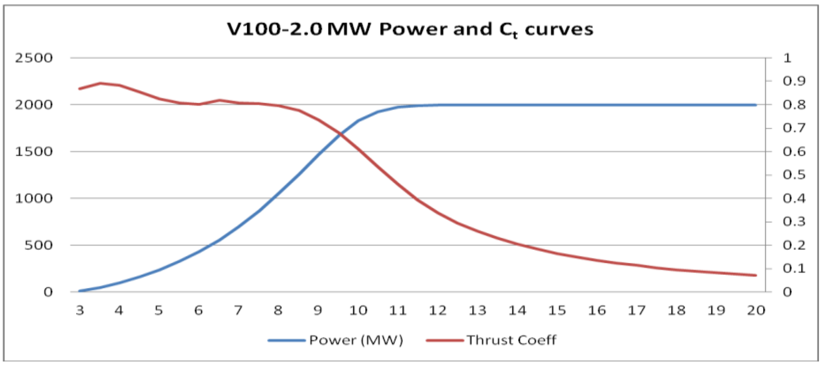
The following site parameters have been used for the evaluation:

Parameter	Symbol	Site Average	Site Maximum	Unit
Normal wind conditions (annual)				
Weibull scale parameter	A	7.9	8.0	[m/s]
Weibull shape parameter	k	2.3	2.3	[-]
Average wind speed	V_{ave}	7.0	7.1	[m/s]
Average turbulence intensity at 15 m/s	I_{ref1}	9.2	9.2	%
Standard deviation of I_{ref}	σ_{Iref}	2.9	2.9	%
Wind shear exponent2	α	0.18	0.12/0.30	[-]
Maximum inflow angle	-	0	0	[º]
Extreme wind conditions (50 years)				
Extreme wind speed (10 min. average)	V50year,10min	26.4		[m/s]
Turbulence at extreme wind speed	T_{Iext}	9.0		%
Survival (gust) wind speed	$V_{50year,3sec\text{-}gust}$	33.5		[m/s]
Topographical and layout conditions				
Height above sea level	m.a.s.l	0 to 0		[m]
Minimum distance between WTGs	L_{min}	269		[m]
Minimum relative distance between WTGs	-	2.7		[rotor diameter]

The calculations are based on energy production from Vestas V100-2.0 MW under the assumption listed in the table below:

Turbine type	No. of WTGs	Installed Capacity [MW]	Operational Conditions Losses/Gain [%]	Energy Result [GWh/Year]	Efficiency [%]
Vestas V100 – 2.0 MW	50	100	4.4	320.888	89.7

Power and C_t curves for V100-2.0 MW are reported in the following graph:



Based on these assumptions, 5 different scenarios have been evaluated:

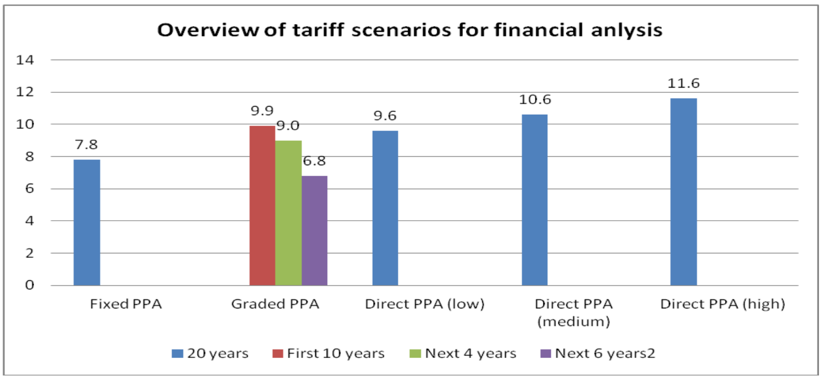
1. **Fixed PPA:** Project receiving a fixed Feed-in-tariff of 7.8 USD cents/kWh

2. **Graded PPA:** Project receiving a Feed-in-tariff equal to 9.9 USD cents/kWh for the first 10 years, then 9.0 USD cents/kWh for the following 4 years and finally 6.8 USD cents/kWh for the following 6 years.

3. **Direct PPA (low):** Project receiving a gross tariff of 10.0 USD cents/kWh from which 4 USD cents/kWh are discounted due to wheeling fees to be paid to EVN, hence leaving a net tariff of 9.6 USD cents/kWh

4. **Direct PPA (medium):** Project receiving a gross tariff of 11.0 USD cents/kWh from which 4 USD cents/kWh are discounted due to wheeling fees to be paid to EVN, hence leaving a net tariff of 10.6 USD cents/kWh

5. **Direct PPA (high):** Project receiving a gross tariff of 12.0 USD cents/kWh from which 4 USD cents/kWh are discounted due to wheeling fees to be paid to EVN, hence leaving a net tariff of 11.6 USD cents/kWh

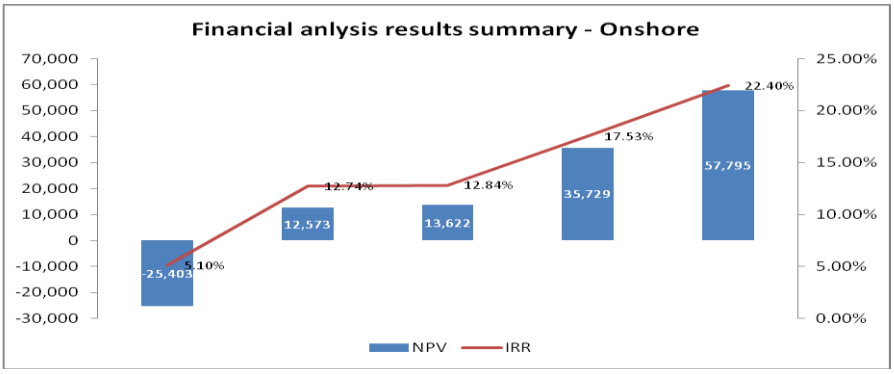


Onshore model

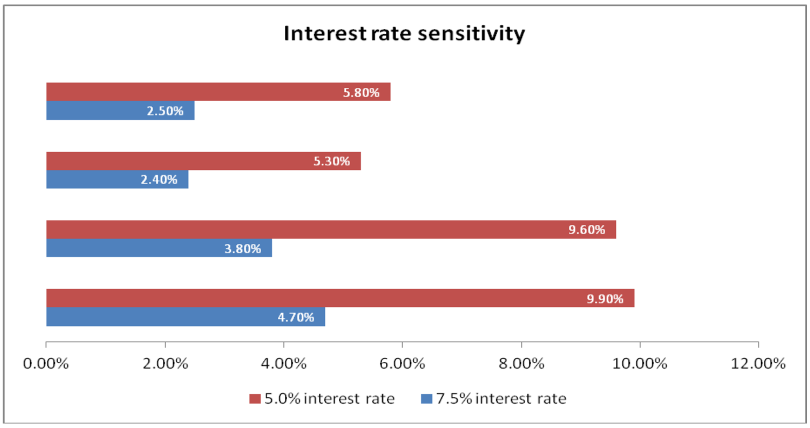
Below the results for the onshore scenario.

	Fixed PPA	Graded PPA	Direct PPA (low)	Direct PPA (medium)			Direct PPA (high)		
Equity IRR	5.10%	12.74%	12.84%	17.53%	17.56%	22.40%	23.56%	5.10%	12.74%
Equity NPV	-25,403	12,573	13,622	35,729	28,330	57,795	57,307	-25,403	12,573
Project IRR	7.69%	11.60%	11.66%	13.72%	11.45%	15.70%	15.70%	7.69%	11.60%
Project NPV	-38,016	-3,456	-3,147	16,310	-5,044	35,768	35,768	-38,016	-3,456

Leverage		65%	65%	70%	75%	70%	75%		65%



The results presented in this chart are calculated using the highest leverage possible for each option. In conclusion, while a graded PPA with EVN would be feasible for this scenario, the current PPA is still not high enough to realize a viable project. The direct PPA option would be instead feasible even with low rates of 10 USD cents/kWh. With a higher tariff, leverage can also be increased to 75%. For this scenario, wheeling fees of 4 USD/MWh have been considered. A sensitivity analysis to interest rates follows showing the change in equity IRR with respect to changes in interest rate for each viable option.



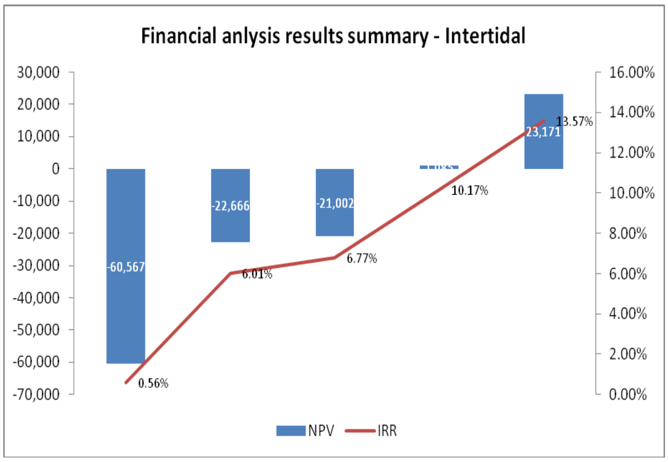
In addition, in the scenario of a direct PPA, there is room for a negotiation of slightly higher wheeling fees, keeping the IRR at a satisfactory level, should that be required due to distance between the wind farm and the energy end users or additional requirement on electricity management and transmission.

Intertidal model

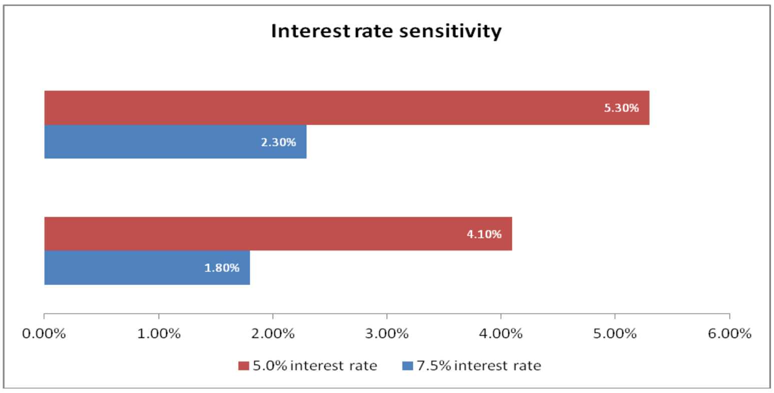
Due to the different cost structure, the results for the intertidal option differ from the onshore scenario. Below the results of our financial analysis.

	Fixed PPA	Graded PPA	Direct PPA (low)	Direct PPA (medium)	Direct PPA (high)	
Equity IRR	0.56%	6.01%	6.77%	10.17%	13.57%	13.75%
Equity NPV	-60,567	-22,666	-21,002	1,085	23,171	22,514
Project IRR	5.01%	8.30%	8.55%	10.36%	12.09%	12.09%
Project NPV	-72,703	-38,143	-37,834	-18,376	1,082	1,082

Leverage	65%	65%	65%	65%	65%	70%



The results presented in this chart are calculated using the highest leverage possible for each option. In conclusion, intertidal projects are feasible only with the highest direct PPA option of USD 12 cents/kWh. For this scenario, wheeling fees of 4 USD/MWh have been considered and there is no room for negotiation of higher fees. A sensitivity analysis to interest rates follows showing the change in equity IRR with respect to changes in interest rate for each viable option.



Conclusions

Wind power development in Vietnam is of potential but also facing many challenges. In order to promote wind industry, there are many improvements are needed from legal framework, advance technology to wind power expertises. This article analyses some current conditions for wind power in Vietnam and also propose a direct PPA mechanism which can make the wind power project more feasible. The financial analysis shows that using the current cost structure for the site being evaluated, the available technology, and the financial assumptions for a typical wind power project, the feed-in-tariff for wind power projects in Vietnam of 7.8 USD cents/kWh results in a negative NPV and a low IRR and it is therefore not a viable option. The financial analysis also supports the new model being introduced and analysed as part of this study, highlighting the advantage of realizing this option compared to the current status quo. In particular this option shows to be the only option for intertidal projects, where even a higher FIT (referred to as Graded PPA in our analysis) is not satisfactory.