VIET

Vietnam Initiative for Energy Transition

Contributions to Preliminary Results of Power Development Plan (PDP) VIII

Copyright and authors

This document presents the comments to "**Preliminary Results on Vietnam's 8th Power Development Plan (PDP8) for the period 2021-2030, with a vision to 2045** of Vietnam Initiative for Energy Transition (VIET) and other energy consultants: Dr. Nguyen Quoc Khanh, MSc. Cao Thi Thu Yen, Dr. Nguyen Hong Phuong, Dr. Dinh Van Nguyen, and MSc. Nguyen Hai Long.

The comments and suggestions in this report based on the contents presented by the Representative of Ministry of Industry and Trade – Department of Electricity & Renewable Energy and Institute of Energy at the consultation workshops: (i) July 8, 2020 – Workshop of the Power Generation Development Program; (ii) August 12, 2020 – Initial workshop on strategic environmental assessment report of PDP8; and (iii) September 28, 2020 – Workshop on Power transmission grid development program.

Report number: PN/07 – VIET09.2020/EN

We welcome all comments from readers about the contents included in this document. The authors hope that the discussions in this policy note can contribute to the energy policy-making process to promote the development of the Vietnamese electricity system sustainably.

Any questions or requests regarding copyrights and licenses, please contact us at:

Vietnam Initiative on Energy Transition
7th Floor –18 Lý Thường Kiệt Building
Hoàn Kiếm, Hà Nội, Việt Nam
Tel: +84 (0) 243 204 5554
Website: www.vietse.vn
Email: info@vietse.vn

Contents

List of Figures

List of Tables

Introduction

Power Development Plan 8 (PDP8) is one of the important infrastructure development plans of the country. This Plan is based on multidimensional studies to ensure the short and long-term power system development for each region and the whole country with high reliability and reasonable costs, that conform to the national socio-economic development speed as well as minimizes negative impacts on the environment.

Pursuant to Article 12 of the Planning Law, effective 01 January 2019, regarding the public participation in the planning activities, the authors would like to provide comments and recommendations to the PDP8 as following:

- The criteria for selecting / ranking source development scenarios should be made clearer and quantified in the Plan:
  - Add criteria for evaluating power source scenarios on (1) system flexibility (operating capacity range, must-run requirements, ramping rates, especially for coal and gas power plants) in the presence of variable renewable energy sources, and (2) diversity of primary energy sources for the generation system.
  - Add criteria on financial accessibility for developing power projects.
  - Clarify the ratio of Pmax (maximum power) / Installed capacity to evaluate the efficiency of investment costs (the current draft proposes this ratio at 60% - 65%) and add criteria or requirements for reserve capacity for the system.
- Analyze the sensitivity of scenarios to prices uncertainty, particularly about fossil fuels and energy storage:
  - Covering the fluctuation of fuel prices in the past to reduce the uncertainty of the modeling results. Regarding the assessment method, identify which type of power planning (medium or long-term planning) is appropriate if the price of imported fuel varies and there are high uncertainties for accurately forecast in the future.
  - Take into account the trend of decreasing investment costs for renewable energy and energy storage technologies such as pumped-storage hydropower and storage batteries (the Draft mentions only the reducing investment costs for offshore wind power technology).

- The balance between the power supply-demand within the regions and reducing long-distance inter-region transmission:
    - Set the target for power generation by sources in each period while solving the regional supply-demand balance to reduce investment costs for the inter-regional transmission system.
    - Develop a generation development program based on the demand for each type of primary energy sources (hydroelectricity, thermal power, renewable energy, etc.) by region for different period instead of giving a list of power generation projects with the specific location and capacity.
    - Set limits on power capacity and generation for each region according to the electricity system zones.
- Power transmission development issues:
    - Specific technical criteria should be included to ensure the requirements for the safe and efficient operation of the power transmission system;
    - It is necessary to consider and evaluate the ability to mobilize capital and the investment efficiency of transmission grid projects and diversify financial sources for power grid development...
    - Given a scope of nationwide implementation, the transmission grid development plan should consider feasibility and harmonization with other national development plans.
- Need to fully internalize the environmental costs and other external costs for power generation sources.
- A seaport planning roadmap for developing liquefied natural gas (LNG) and renewable energy (especially offshore wind power) should be integrated.
- Add the competitive power generation market factor for plants or plant clusters, based on different types of primary energy sources in the power development plan.
- It is necessary to synchronize the Power Development Plan with the Socio-economic Development Plan, Land Use Plan, and Marine Spatial Planning.

The above comments will be elaborated in the next sections of this document.

Proposing to add criteria for evaluating power generation scenarios

The result of the power generation scenario calculation[1] is evaluated based on five (05) criteria to select power generation development scenarios in PDP8: (i) Ability to meet policy targets, (ii) System costs, (iii) CO_2 emissions, (iv) Volume of transmission grid construction, and (v) Diversification of primary energy sources. Although these criteria include basic aspects to evaluate power generation development scenarios, however, with the shift in electricity generation structure as well as the rapid development of generation technologies, it is necessary to have three (03) additional evaluation criteria as follows: (i) System flexibility; (ii) Access to financial resources, and (iii) Reserves for installed capacity.

1.1. The flexibility of the power generation system

With the current trend of energy transition, the power system is gradually shifting from traditional, centralized, large-scale based generation using fossil fuels to decentralized systems with a flexible operation for high integration of renewable energy (RE). In that context, flexible operation is one of the most important criteria to ensure a complete, stable, and secure power supply system.

The requirement for flexible system operation is proportional to the variable RE share - VRE (wind and solar) in the power system. When electricity from wind and solar accounts for about 10-20% of total electricity generation, flexibility is crucial to the stable and secure operation of the system. Low flexibility system can lead to decisions to cut off generating capacity from renewable sources or cause sudden power outages, both of which result in economic losses. Therefore, a criterion for evaluating the system's flexibility should be included in the development and comparison of power generation development scenarios.

System flexibility is the speed at which the power system responds immediately to operation decisions for ensuring supply-demand balance.

The higher share of VRE in the power system, the more flexible it is required. A low VRE curtailment rate is a reliable indicator to evaluate the success of VRE integration and the power market. In other words, a high curtailment rate of generated VRE generation indicates low flexibility of the power system. Maximizing the integration of electricity produced from VRE into the power system while ensuring power supply stability and reliability is a difficult challenge when the regulations on the responsibility of forecasting electricity RE generation output have not been legalized in Vietnam yet.

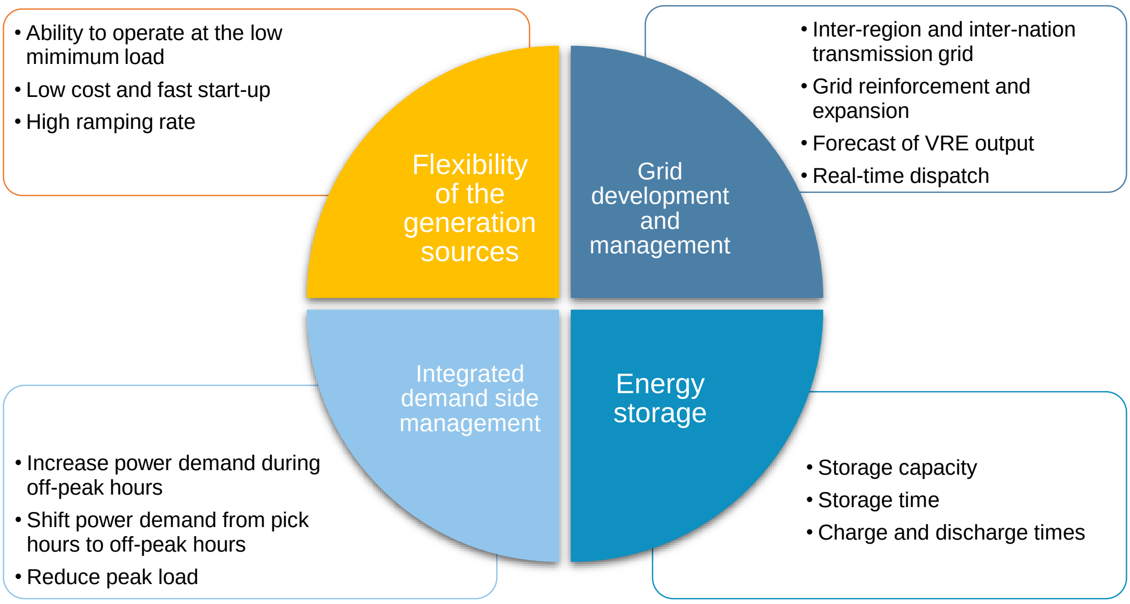
[1] Workshop 1 - Slide 35, Presentation 4: "Primary energy source inputs and results on electricity generation development".

Therefore, it is necessary to build a set of operational criteria for power plants to ensure the flexible operation of the power system, including:

- Ensuring the flexible and affordable operation mode, even under minimum load. This means that the power system is capable of adapting to operate at low minimum load for dispatchable power plants. More specifically, the power plants must be able to "be on-grid" with a wide range of operating capacity. The system should require low must-run capacity, especially for coal-fired, gas, and LNG thermal power plants.
- The speed of increasing and decreasing capacity must be fast enough to meet fluctuating demands (fast and steep ramping).
- Short start-up time and integration of alternate generators.

Besides, the system flexibility can also be assessed through storage capacity, grid infrastructure management and development, and demand-side management. These factors are shown in Figure 1.

Figure 1: Criteria for evaluating the flexibility of the power system



1.2. P_{max}/installed capacity ratio and reserve capacity for the system

In 2017, 2018, and 2019, ratio P_{max} over the installed capacity of power plants at 67.3%, 71.1%, and 69.7% respectively. However, according to the PDP8's preliminary results, by 2025, 2030, 2035, and 2045, this ratio will be 59.8%, 64.7%, 60.9%, 59.5%, and 56,2% respectively. This low ratio may lead to high investment demand for power generation development.

To determine reasonable ratios, the following factors should be considered:

- Define criteria and requirements for the rate of the capacity reserve for the system, especially the proportion of VRE in the future generation structure.

- Long-term forecast: assessment of VRE's maximum operating time (Tmax) in different areas, including consideration of offshore wind power potential, which has substantial high Tmax.
- Hydrological forecast and evaluation of the water inflows to hydropower reservoirs with consideration of climate change factors.
- Consider increasing T_{max} of the recently built coal and gas power plants and to set specific requirements for T_{max} of new coal and LNG power plants.

1.3. Financial accessibility

In recent years, Vietnam's electricity industry has made breakthroughs in improving the stability and reliability of the power supply and the nation-wide access to electricity. Vietnam has also developed a competitive power generation market and is making efforts to establish a fully competitive wholesale market by 2021.

In recent decades, Vietnam's power generation structure has mainly relied on hydroelectricity, followed by gas and coal power. However, the hydrological conditions in recent years are not favorable, unusual droughts occur in many river basins. Also, gas and coal resources are being exhausted, which increase Vietnam’s dependency on imported resources to meet its fast-growing electricity demand. Power generation capacity from imported coal plays a key role in the Power Development Plan 7 (approved in 2011) with 61 coal-fired plants planned to be built by 2030 in total. However, after 10 years of implementing this plan, Vietnam can only deploy 22 coal power plants with a total capacity of 16.4 GW, accounting for 22% of the planned total coal power capacity in 2030 (75 GW).

A key reason for the delay in investment and development of planned coal power projects is access to finance. Before 2010, the financial capital model for Vietnam's electricity sector was mainly based on public investment and was chaired by three state-owned corporations: EVN, PVN, and Vinacomin. These groups have access to preferential loans and are guaranteed by the Government to develop coal power plants. After 2010, this source of capital is under increasing pressure from both macroeconomic and fiscal barriers. Moreover, since Vietnam has become a middle-income country, preferential finance is increasingly scarce. Besides, due to the pressure of delivering the global emission reduction goals at the United Nations Conference on Climate Change 2015 (COP21), international financial institutions and many development partners have refused to support new coal power projects(2). Development partners such as the World Bank (WB)(3) and the Asian Development Bank (ADB) have announced that they will not finance new coal-fired power plants.

In April 2020, Sumimoto Mitsui and Mizuho from Japan (two of the world's leading coal-fired thermal lender financial institutions) updated their new lending policy stating that they will not provide loans to build new coal-fired power plants. In the coming time, international insurance companies won’t provide insurance contracts for newly built coal power plants either.

2 https://tuoitre.vn/dong-nam-a-dan-tu-bo-nhiet-dien-than-20191024093345129.htm

3 In 16th March 2013, The World Bank has announced its funding restrictions for new coal plants in developing countries.

In 2019, 17 of the world's largest international insurance companies announced the liquidation of insurance contracts for coal power plants. This group of companies controls 46% of the reinsurance market and 9.5% of the original insurance market(4). The sequence of actions from financial institutions and multinational insurance groups has been significantly affecting the feasibility of constructing coal power plants. Therefore, the criteria for finance accessibility need to be included in the electricity generation scenario selection in PDP8, including LNG power projects.

Access to finance to build new power plants can be more feasible if barriers are overcome such as Risk sharing in investment (PPAs for RE); Government support for gas power projects and its fiscal impacts (contingent liabilities); the ability to convert foreign currency; Co-ordination between electricity and gas.

With the addition of the above criteria, together with the selected scenario (KB1B), it is advisable to compare and analyze the financial feasibility of the “no_new_coal” scenario and the RE scenario “KB3” to evaluate the feasibility level of PDP8.

Note: Mui Ne Solar Power Plant, Binh Thuan. Copyright @VIET

4 https://insureourfuture.co/2019scorecardnews/

2 Extend fuel price ranges in the sensitivity analysis

For the least cost optimization method, the input parameters of fuel price and investment costs for each type of power generation technology play an extremely important role in deciding the generation mix. The volatility of fuel prices in the future is difficult to predict, therefore to reduce the uncertainty in the modeling outputs, the draft PDP8 applied the model's sensitivity analysis method to these parameters.

In the LNG and coal price sensitivity analysis scenario, LNG price from now to 2045 ranges from 10 to 12 USD/GJ and that of coal from 3 to 5 USD/GJ. According to the statistics of the World Bank (WB)[5], during the past 25 years, coal prices fluctuated with a range from 0.89 to 4.3 USD/GJ. For LNG[4], price volatility in the period 1995 – 2019 is in the range of 2.8 – 15.2 USD/GJ. These price fluctuations are larger than the range currently used for the sensitivity analysis in the draft PDP8 (Figures 2 and 3). *This suggests that the sensitivity analysis should use more realistic fluctuation ranges of fuel prices as input parameters.*

The sensitivity analysis should consider cases with a broader range of fuel price fluctuations.

Sensitivity analysis scenarios for power source investment cost in the draft PDP8 consider the potential of offshore wind power's investment costs declining. The expected reduction is 7% (2025 - 2029), 15% (2030 - 2039), and 25% (2040 - 2045) compared to the investment cost in the 2019 Vietnam Technology Catalogue[6], that is in line with the development trend of this technology. However, other technologies, such as battery storage, should also be included in investment costs sensitivity analysis. In the future, large-scale batteries will play an important role in promoting energy transition and increasing the flexibility of the power system operation[7]. A recent report of NREL[8] has shown that the cost of a large-scale lithium-ion battery storage system could be reduced from 30% to 80% by 2050 compared to the 2018's level.

The sensitivity analysis should consider the decrease of investment costs of the storage battery system in future.

---

5 World Bank Commodity Price Data (the Pink Sheet). Annual prices, 1906 to present in nominal US dollars. Updated on July 02, 2020. https://www.worldbank.org/en/research/commodity-markets

6 Vietnam Technology Catalogue 2019,investment cost for offshore wind power is 2.36 M$/MWe in 2020; 2.25 M$/MWe in 2030 and 1.93 M$ in 2050

7 IRENA (2019), Innovation landscape brief: Utility-scale batteries, International Renewable Energy Agency https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_Utility-scale-batteries_2019.pdf

8 Cole, Wesley, and A. Will Frazier. 2019. Cost Projections for Utility-Scale Battery Storage. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-73222.

Therefore, storage batteries should be included in the generation technology cost sensitivity analysis scenarios to be able to assess and support decision making to choose the most suitable generation mix.

Figure 2: Historical coal price fluctuation and the price volatility range used for sensitivity analysis in the draft PDP8

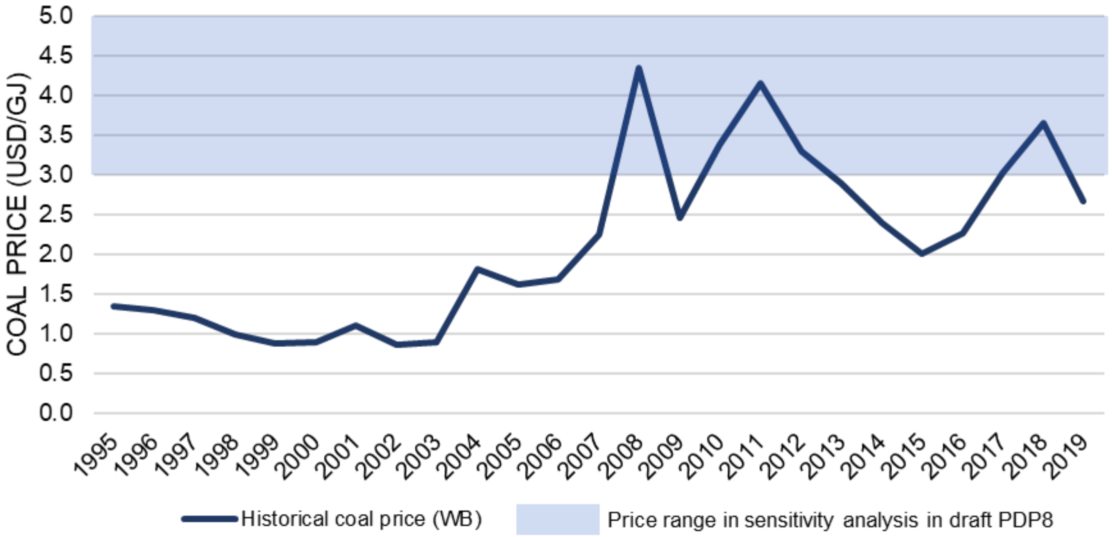
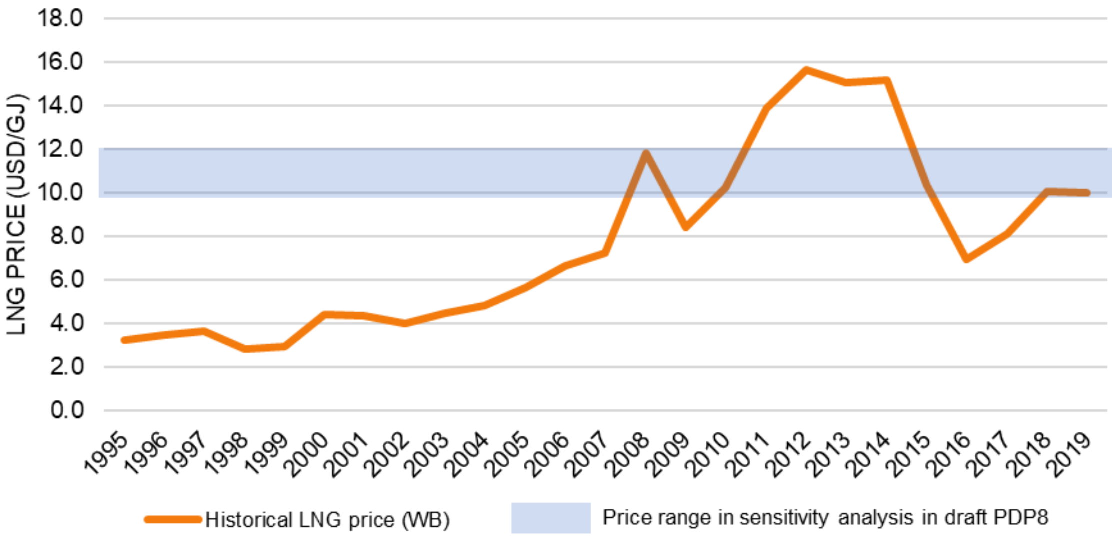


Figure 3: Historical LNG price fluctuation and the price volatility range used for sensitivity analysis in the draft PDP8



3 Optimize regional supply-demand Reduce inter-regional transmission

3.1. Optimization of the regional supply-demand balance

An example to show how the regional supply-demand balance approach can help to reduce the need for electricity transmission over long distances is the case of offshore wind power development in the North Sea of Vietnam. According to research done recently by VIET[9], the North Sea region (Hai Phong and Quang Ninh) has the potential to develop about 3 GW of offshore wind power in the period 2025 - 2030. During this period, the North region will have supply shortage, especially during peak load hours in the dry season when the hydropower plants have lower generation output. The generation system will face the two following challenges:

- If coal-fired power continues to be developed despite an exhausting hydropower potential and limited availability of domestic coal for power generation, the dependence on international fuel supplies will increase. This dependency has potential risks for national energy security.
- If new super-high voltage power transmission lines are built to transmit a large amount of electricity generation from the Central or the South to the North, land-use need and environmental challenges will increase as mentioned earlier and huge investment costs (about 0.75 million USD/1km of 500kV AC dual circuit line) are required for the power transmission line from the South to the North.

To address these two challenges, developing offshore wind power in the North could be considered. This option can significantly improve the power supply for the North and reduce transmission pressure for the North-South transmission line. Besides, the development of offshore wind power will also bring opportunities to establish domestic supply chains and operations and maintenance (O&M) services. This also creates more jobs and improves the energy independence of the region in particular and of the whole country in general.

According to the draft PDP8, potential LNG and combined cycle gas turbine projects are currently being modeled with predetermined regional locations (PDP7 revised), the model will only select the scope of the projects to satisfy the conditions of ensuring supply and cost optimization. However, using these input parameters in the least-cost computation model may cause the model to ignore regional power balance optimization since projects are already located in each region. The results might not be optimal for the transmission costs. Besides, several planned coal-fired

9 Vietnam Initiative for Energy Transition. 2020. Offshore Wind Power Integration in Vietnam – Techno-economic Assessment

Note: 500kV transmission line, in the 500 kV Quảng Ninh substation area. Copyright @VIET

power projects, such as Bac Lieu, Long An, Tan Phuoc, and Van Phong 2, were switched to LNG as primary fuel using combined cycle gas turbine technology but still keep the same or have a higher installed capacity. These projects should be included in the least-cost optimization, not only in terms of capacity but also in terms of the construction location. This approach can help to reduce inter-regional transmission costs and exploit more efficiently the potential advantages of each region.

According to the PDP7 revised, coal-fired thermal power projects were planned to be built in the Southeast region to ensure the supply to the region. This plan was made in the context of renewable energy not yet developed. Over the past two years, renewable energy has grown rapidly, especially in the South Central and Southeast coastal areas with more than 5 GW of solar power and more than 300 MW of wind power in operation. Besides, tens of GW of wind and solar power have been added to the power development plan. Thus, it is necessary to have an assessment of economic efficiency between the option of building thermal power plant development and the option of renewable energy in the Southeast region.

3.2. Decentralized power source planning to reduce inter-regional transmission

Regarding the electricity demand, major load centers are located in Hanoi, the Northeastern provinces, the Red River Delta, North Central, Ho Chi Minh City, and the Southeastern provinces.

Regarding the electricity supply,each region in Vietnam has its advantages for developing different types of power sources. Hydropower is concentrated in the Northwest, the North Central, and the Central Highlands; Coal thermal power has been built mostly in the Northeast, the North Central, the South Central, and the Southwest. Gas and oil thermal power are mainly located in the Southeast, the Southwest and being developed in the South Central region. Solar power has been developed in the South Central Coast and planned to be built in the Central Highlands and several Southern provinces adjacent to Cambodia. Onshore wind power is being developed in the North Central (in the ravines of the Truong Son range), the Central Highlands, the South Central Coast and the South West. Offshore wind power has great potential in the sea areas from Thai Binh to Quang Ninh, from Ninh Thuan to Ba Ria - Vung Tau, and along the coast of southwestern provinces; LNG facilities are planned to be built in many provinces across the country. *Annex 1. Map of potentials of different types of electricity generation sources in economic regions of Vietnam on the mainland* - describes the potential for power source development by regions and 500 kV transmission lines that are currently under construction and planned in the PDP7 revised.

The decreasing construction/investment costs for renewable energy power plants is a favorable condition for the development of decentralized power sources. Therefore, the power source development should be shifted toward decentralized planning. This means that the regions should optimize their internal supply-demand balance while transmission lines are to improve the efficiency of the system's operation and provide backup.

There are some issues to be considered in the power supply-demand balance:

- Power generation targets should be defined by primary energy sources in each period, and at the same time solving the problem of regional supply-demand balance to reduce investment costs for the inter-regional transmission system. It is not advisable to develop a power generation development program based on a project portfolio with specific locations and capacities.
- Issue limits of power capacity and power generation for each zone of the power system.
- Include the criterion on the need and associated costs for long-distance transmission between non-adjacent regions (i.e. from the Central Highlands to the North, from the South Central to the North) into the system optimization model.

3.3 The electricity generation development should be associated with the load demand management

The energy crisis of the 1970s ended a period of relatively stable energy prices and supply-demand relationships for a long time after World War II. After this period, demand-side management, least-cost development planning, and integrated power supply planning have emerged. Power development plans are often constructed using an integrated system analysis approach that optimizes energy supplies and energy efficiency to reduce future power demand. Forecasts in electricity or energy development planning, in general, must always accurately reflect population growth and economic development projections. A typical example of the implementation of the energy source development plan associated with energy efficiency is Germany with the motto "Using energy efficiently is the prerequisite factor" (Efficiency First) in their national energy development strategy to 2050. Intending to reduce energy demand by 50% by 2050, Germany expects to build a sustainable energy system based mainly on renewable sources. Therefore, power development targets should be coupled with energy efficiency and conservation programs to reduce investment costs for power generation and transmission systems.

4 Comments on power transmission grid development

The following issues should be addressed with concrete solutions in the power transmission development plan:

Methodology for transmission grid development planning. It is necessary to consider supply and demand balance within each of the 6 regions, according to natural conditions (dry season, rainy season → high/low capacity of VRE) to assess the excess or lack of power capacity and generation in each region. These results can be used as inputs for inter-regional transmission plans. Data on the feasibility of transmission lines and substations construction should be included as mandatory input for the verification of the outcomes or used as a boundary condition in the grid development planning process.

Increase the flexibility of the transmission grid must be a necessary condition in the planning. The flexibility of the transmission grid depends on its ability to respond to changes in operation modes (e.g., automatic isolation, troubleshooting, or self-switching to reduce overload) and to the uncertainty of power supply – demand, while still meeting technical requirements at a reasonable cost, in different time frames.

It needs to have solutions **to reduce the trend of increasing short-circuit current.** In Hanoi and some surrounding area, Ho Chi Minh City and the Southeastern provinces short-circuit currents already occurred, exceeding the 63 kA threshold for 500 kV grids (exceeding the tolerance of common manufacturing equipment). In most regions, except the Central Highlands and the South Central Coast 1, there are short-circuit currents exceeding the 50 kA threshold on the 220 kV grid. Short circuit current restriction is needed through transmission grid design methods with appropriate grid configuration including changing the existing grid integration model and refer to transmission grid design solutions of countries such as America, Japan, China, Europe, Thailand, Malaysia...

The Plan **should propose a solution for the synchronous implementation of the power sources and the grid** to ensure benefits to society, the power sector, and investors (developing roadmaps for the grid development and the RE integration into national electricity development planning). A remaining question is that when the location and capacity of power plants, especially wind and solar power are not yet determined, what are solutions for selecting the optimal scale and technical solutions for inter-regional transmission lines?

The draft PDP8 proposes six 500 kV AC North-South power lines, thirteen, and four 500 kV AC lines connecting power plants in the South Central and the South West to Ho Chi Minh City, respectively. Because the proposed number of 500 kV AC lines is too large, it is necessary to assess the grid development plan before building 500 kV AC lines to match the timeline of power source development. In the period afterward, when the demand for transmission capacity increases**, shifting some existing or planned 500 kV AC lines to DC transmission lines with DC / AC** converter stations.

The issue of **investment capital for transmission grid development**. In the 2016 – 2020 period, the value of net investment each year for the transmission grid is about 12.7 - 14.3 trillion VND. However, the draft PDP8 estimates that the capital demand for the transmission grids investment in the 2021 - 2030 period will be 865 trillion VND. The required capital is enormous while domestic banking institutions are about to reach their credit limit for the power sector. Mobilizing and securing sufficient financial resources for the transmission grid is a key challenge for the implementation of power grid development projects proposed by the Plan.

Transmission grid investment efficiency. The current transmission fee for the whole system is not economically feasible to invest in the transmission grid if it is only for the integration of renewable energy sources with the maximum operating time (Tmax) in the range of 1500 - 2500 hours a year. We should consider the plan to charge the transmission fee at different rates according to Tmax (the lower the Tmax, the higher the transmission fee).

Criteria to evaluate the investment in the national electricity transmission system and the transmission grid system connecting only one plant or one group of plants should be considered. The transmission grid is the backbone of the national power system, playing a crucial role in ensuring national energy security. Therefore, the investing and managing procedure of the power transmission grid need to comply with strict technical standards and regulations to ensure quality, safety, and reliability in operation management. To reduce the fiancial burden for the power sector's development, it is necessary to have mechanisms to incentivize investments such as transmission price bidding and a roadmap to socialize the investment in a part of the transmission grid that does not belong to the backbone. Constructing transmission grids according to the plan:

- The volume of transmission grid implemented in the 2016 - 2020 period is only about 82% on average compared to the volume foreseen in the PDP7 and the PD7 revised. The amount of transmission grids investment mentioned in the draft PDP8 is enormous, 3 times higher than the actual amount deployed in the past period. Therefore, it is advisable to combine the assessment between the demand, the actual capacity, and the difficulties in implementation to make investment plans for the transmission grid more realistic.
- Power development planning is not linked to land use planning, including forest land, other infrastructures planning and comes with inadequate compensation and site clearance mechanisms, which are the key issues leading to delays in transmission grid development projects.
- Procedures for submitting and approving transmission grid projects are still complicated with many administration levels, especially with projects using ODA loans and Group A projects, leading to prolonged project preparation time.
- Evaluate the possibility of expanding the existing transmission grid projects to offer feasible solutions to the proposals to renovate and upgrade these grids.

The unfavorable factors in the implementation of the national power transmission system planning in the previous period should be considered and evaluated to obtain solutions ensuring the feasibility of new power development plan to avoid the planning suspension.

5 Comprehensive calculation of external costs

Traditional power generation development planning plays an important role in building regulations and guiding the development of the energy sector to ensure the security of the national energy supply. In recent decades, many countries have deregulated the electricity market, leading to an increasingly enhanced role of the market's "self-determination". This is becoming a driving force for competition in the field of energy generation development. In the context that global warming and environmental pollution are of strong concern, many countries have put in place stricter conditions for GHG emissions reduction targets in their long-term power and energy development planning. Besides, many countries have taken into account the costs of the environment, health, etc. to propose power generation development scenarios with the lowest total cost for the whole society.

By definition, external costs related to the power sector include 2 main sources: taxes on the use of natural resources (space, land resources, water, minerals, organisms, types of energy sources...) and environmental protection tax/fee (treatment of waste gas, wastewater, and solid waste)[10].

In order to efficiently use resources for power generation in the future, especially in the context that the core national plans have not yet been approved, it is necessary to have land use rate for each MW of installed capacity by type of power sources and for each 100 km of power transmission lines by voltage level (500kV, 220kV ...).

The draft Strategic Environmental Assessment (SEA) study in PDP8 has mentioned the important resources: land and water. However, because the draft PDP8 was developed prior to the approval of the national land use plan, the national spatial marine plan and during the period of preferential natural resources taxes (for land and water use) while taxes for some resources (space, biological resources, renewable energy ...) are not yet imposed. Hence, the economic value of resources in power sources and power transmission investment has not been fully reflected and is likely to change substantially during the planning period.

[10] The definition of external costs in this report is different from the one presented in the draft PDP8 SEA that divided these costs into mandatory taxes and fees (including water resource tax, land use tax, waste-water fee, forest environmental services fee, solid/hazardous waste collection and treatment fees and transmission charges) and external costs (including costs of damange cased by air pollution, biodiversity loss/reduction costs, solar panel recycling costs).

Note: Trung Nam Renewable Energy Complex – Thuận Bắc, Ninh Thuận. Copyright @ VIET

The draft PDP8 has stated some external cost components for environmental protection and referenced the cost of CO_2, NO_x, SO_x, and $PM_{2.5}$ emissions treatment, the cost of processing solar panels at the end of the project lifetime, the cost of handling chemicals in the batteries. This is an advancement of the PDP8, however, the external composition of environmental protection is not fully covered yet and the inputs for external costs calculation in Vietnam is very different from other countries.

Specifically, in the draft PDP8, the external cost of CO_2 used as input for the calculation is 0.4 $/ton for 2019[(11)] or 5 $/ton (2021-2025), 8 $/ton (2026-2030), and 10 $/ton (2031-2045)[(12)]. These values are much lower than some of the estimated values for Vietnam which are in the range of 11-13 $/ton[(13)] or the ones used in EU, about 25-30 $/ton[(14)] .

In order to properly and fully calculate external costs and gradually incorporate into electricity costs, it is necessary to conduct statistics on all external cost components on (i) resources use and (ii) protection environment related to power generation and transmission, and the sensitivity analysis of changes (increase, decrease, incentives) in tax rates and natural resources charges in each stage of the planning period.

11 PDP8 Slides by MOIT 7/2020

12 SEA PDP8 Slides by MOIT 8/2020

13 Draft Decision of the Prime Minister on piloting payment for forest environmental services for absorption and storage of forest carbon
https://www.mard.gov.vn/Pages/hoi-thao-ve-thi-diem-chi-tra-dich-vu-moi-truong-rung-doi-voi-dich-vu-hap-thu-va-luu--.aspx

14 https://www.eex.com/en/market-data/environmental-markets/spot-market

6 Integrating energy seaport planning

Currently, Vietnam has 320 specialized ports located along the coast, including 44 major seaports in Hai Phong, Da Nang, and Ho Chi Minh City. Development of the seaport system Vietnam is an important driver of marine economic growth through shipping and import-export services. Regarding the scale, the length of the whole seaport system has increased by 4.4 times compared with the first-year implementation of the Seaport development plan (in 2000). Investment has been made in upgrading ports's capacity to receive bigger ships. Most multipurposes and key regional ports, including Quang Ninh, Hai Phong, Nghi Son, Ha Tinh, Thua Thien - Hue, Da Nang, Quang Ngai, Quy Nhon, Khanh Hoa, Ba Ria - Vung Tau, TP. Ho Chi Minh City, Dong Nai, Long An has been renovated and upgraded recently to allow receiving ships with a tonnage of over 30,000 DWT, compatible with the development trend of the world shipping fleets. However, in terms of structure, Vietnam's port system still has many shortcomings such as redundancy of small ports, lack of large ports, and inadequate investment. On average, each coastal province has about 10 ports, but there are only about 10 ports nationwide that are eligible to receive medium-sized ships. The quality of Vietnam's port infrastructure ranks lower than that of regional countries such as China, Thailand, and India[(15)].

6.1. Port for developing liquefied gas thermal power (LNG)

According to the calculation results in the draft PDP8 up to 2045, the proportion of generation capacity in the Vietnamese power system depends on fuel imported from international markets is substantial. Vietnam started to import coal for power generation a few years ago and the amount of imported coal will increase in the coming years. At the same time, the liquefied natural gas (LNG)power plants projects has also been commenced. It is forecasted that, as a new trend in the coming decades, the demand for LNG imports for the power sector will also increase to billions of cubic meters per year. Therefore, it is necessary to determine a development roadmap and technical requirements of the seaport infrastructures to serve the needs of LNG import in each planning period to ensure financial feasibility and construction progress. This is also a condition to ensure national energy security while minimizing negative impacts on other economic, environmental, and social activities in the coastal areas.

15 Global Competitiveness Report 2017 - 2018, World Economic Forum 2017, published at https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018,

To meet Vietnam's demand for LNG in the future, infrastructures such as transportation systems and specialized vehicles for the transportation, storage, and recycling of this fuel need to be developed and improved.

In Vietnam, the development of LNG ports for power generation depends heavily on the structural design of the industry. According to international experiences, the gas market for thermal power is operated through the separate role of the Gas Supply Unit (SuppyCo) → Gas Transport Unit (InfraCo - PV Gas) → Gas thermal power plant. This market model helps to clearly define the roles, responsibilities, and cost transparency of all stakeholders in the gas industry. It is also recommended that the construction and operation of the LNG ports to be carried out by a subsidiary of the GasTransport Unit (Infraco), which will help to clearly define roles and costs and create conditions for a third party to invest in these ports if desired. Sharing the LNG gas port's infrastructure can reduce costs, use marine resources efficiently and avoid conflict of economic interest with other industries (the area of the coast can be used for tourism or logistic purposes), and facilitate the development of a competitive gas market in the future. The separation of LNG infrastructures from other infrastructures can be a driving force for competition by avoiding cross-subsidies between LNG ports and other actors in the gas value chain.

Note: Eimhaven Energy Port– Netherlands, photo from https://www.groningen-seaports.com

6.2. Seaports for offshore wind power development

The energy port for offshore wind power development is divided into two categories, one is the port used for the pre-installation period of the wind farm while the second one provides the operation and maintenance services. These ports are different from the ports serving the near-shore wind farms as the technical criteria applicable to the later ports are less strict because the turbine and foundation size is significantly smaller.

The port serving the installation phase should withstand the load equivalent of 100 Wind turbine generators (WTGs) with a capacity of 10 MW every year. The port will provide services for the assembly of the towers, the storage of the Nacelles-Hub complex and the blades. The storehouse needs to provide appropriate services to accommodate 2 installation vessels at the same time, capable of holding up to 6 complete WTGs on board. This means the area and load of the berth area of the port shall be able to accommodate components of 12 turbines. The minimum requirements for ports serving offshore wind power development are shown in Table 1.

Table 1: Minimum requirements for ports serving offshore wind power projects

Requirements	Ports for Installation	Ports for O&M
Area	> 10 ha	> 0,5 ha
Depth	> 11m	> 4m
Length of the pier	> 350m	> 100m
Ability to bear rotational force	> 20 ton/m^2	> 5 ton/m^2
The load-bearing capacity	5 - 10 ton/m^2	5 ton/m^2
Others	high gravity area along the rotating bridge	The shortest distance to the offshore wind farm

A preliminary assessment of the current state of Vietnam's seaport system shows that the following seven ports are suitable to include in the port planning for offshore wind power development but need to be upgraded to meet technical requirements. They are Hyundai Shipyard, Vinashin (Van Phong Bay), Vietsovpetro Port (Vung Tau), Tan Cang - Cat Lai Port (Ho Chi Minh City), Tien Sa Port (Da Nang City), Ha Port save PTSC (Vung Tau), Tan Cang - Cai Mep (Ba Ria). These ports are mainly required to improve the bearing capacity of the port and warehouse area or the depth and width of the port area.

7 Other issues

7.1. Power market-related issues for plants/plant clusters

For power plants participating in the competitive power generation market, the output and generating capacity of these power plants at different locations will be decided by the market through the electricity purchase price and depending on the actual demand. The cost of power generation of coal, natural gas, and LNG power plants is highly dependent on the fuel cost. If the cost of primary fuels increases, the cost of electricity production increases, and the output of electricity sold in the market from these plants will decrease due to competition with other types of power source, leading to a decrease in the investment efficiency of the project. If the power project has low investment efficiency, which leads to no investment in power plants and clusters, this will change the binding conditions in the power source planning problem.

Therefore, in addition to the Levelized cost, it is necessary to add indicators related to the market (electricity market, primary energy market, technology market ...) in the power generation planning to help PDP8 close to actual implementation in the future.

7.2. Synchronize Power Development Plan with Socio-Economic Development, Land Use, Urban Planning and Transport Infrastructure Plans

As a national sector plan, the PDP8 must synchronize with the National Master Plans for the period 2021-2030 including the National Development Plan, the National Marine Space Plan, and the National Land Use Plan.

However, the draft PDP8 requires precise orientation and high practicality, while some of the above-mentioned basic plans are still under development or have not been approved. Therefore, the analysis and selection of the core plans to integrate into the forecasting of national electricity demand and the ability to realize power source and grid development scenarios during the planning period needs more careful consideration.

Urban areas and industrial parks, including power generation plants, are linked together by essential technical infrastructure networks (road systems, power grids) and occupied the land. The integration of land use requirements of the Power Development Plan with other plans including the master plan, urban plan, industrial zone plan, and transport plan will optimize the use of land resources, avoid land-use overlap, reduce compensation costs, and minimize the disturbance to people's lives.

Land use orientation should be integrated synchronously in the PDP8 for each planning period due to the need for the power sector's infrastructure to meet the increasing power generation and transmission capacity. Integrating the National Electricity Development Plan into the National Land Use Plan will create a legal corridor for a synchronous development of power generation plants and grids at local level.

The use of renewable energy sources such as wind or solar becomes increasingly important in ensuring long-term energy security and reduce emissions. Compared to traditional power generation sources, due to some specific characteristics of renewable energy, the demand for land or space use, either onshore or offshore, for renewable power plants is considerable. Therefore, with the share of renewable resources expected to increase significantly in the coming decades, it is necessary to consider the detailed spatial-temporal plans related to the power development plan to ensure harmonious and sustainable development between the electricity/energy sector and the economic, social and military sectors of the country.

Annex

Potential Map of power sources in Vietnam's economic regions on the mainland

BẢN ĐỒ TIỀM NĂNG CÁC DẠNG NGUỒN ĐIỆN THUỘC CÁC VÙNG KINH TẾ CỦA VIỆT NAM TRÊN ĐẤT LIỀN

Miêu tả:

Việt Nam có đặc điểm địa hình đa dạng với, bờ biển trải dài. Mỗi vùng miền đều có những tiềm năng, lợi thế riêng về phát triển các nguồn điện.

Vùng Miền núi phía Bắc với địa hình hiểm trở, nhiều đồi núi là điều kiện thuận lợi phát triển các nguồn thuỷ điện.

Vùng Đồng bằng và Trung du Bắc Bộ có trữ lượng than lớn tập trung tại khu Đông Bắc là điều kiện thuận lợi phát triển các nguồn nhiệt điện, bên cạnh đó vùng này cũng rất giàu tiềm năng về điện gió ngoài khơi (theo nghiên cứu Tích hợp điện gió ngoài khơi được thực hiện bởi VIET).

Các Vùng Bắc Trung Bộ và Nam Trung Bộ với đặc điểm địa hình có bờ biển dài, nhiều khu vực nước sâu gần bờ, số giờ nắng và gió trong năm cao là những điều kiện thuận lợi cho phát triển nhiệt điện khí, điện mặt trời, điện gió trên bờ và điện gió ngoài khơi.

Vùng Tây Nguyên cũng có địa hình nhiều đồi núi dốc, bên cạnh đó lại có số giờ nắng và gió cao trong năm, do đó có điều kiện thuận lợi phát triển các nguồn thuỷ điện, điện mặt trời và điện gió.

Các vùng Đông Nam Bộ và Đồng bằng Sông Cửu Long đều có các đặc điểm có trữ lượng khí lớn, dễ dàng bố trí cảng biển, có số giờ nắng và gió trong năm cao là các điều kiện thuận lợi phát triển nhiệt điện, điện mặt trời và điện gió

Ghi chú:

Nhà máy nhiệt điện

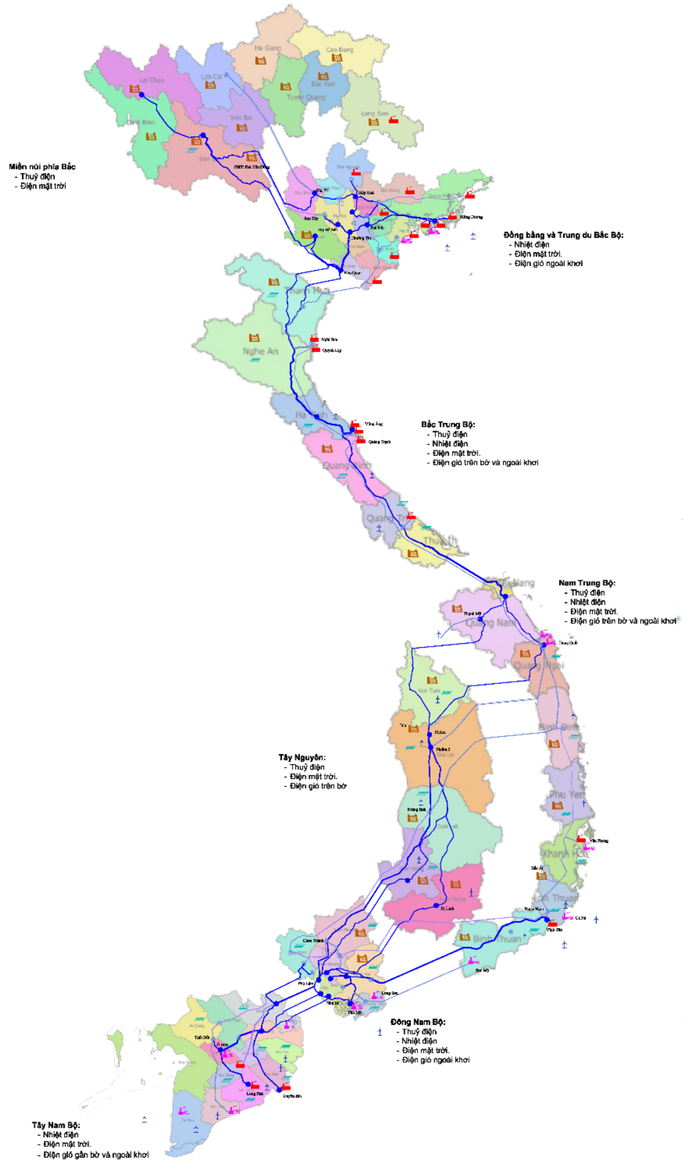
Nhà máy điện khí

Nhà máy thuỷ điện

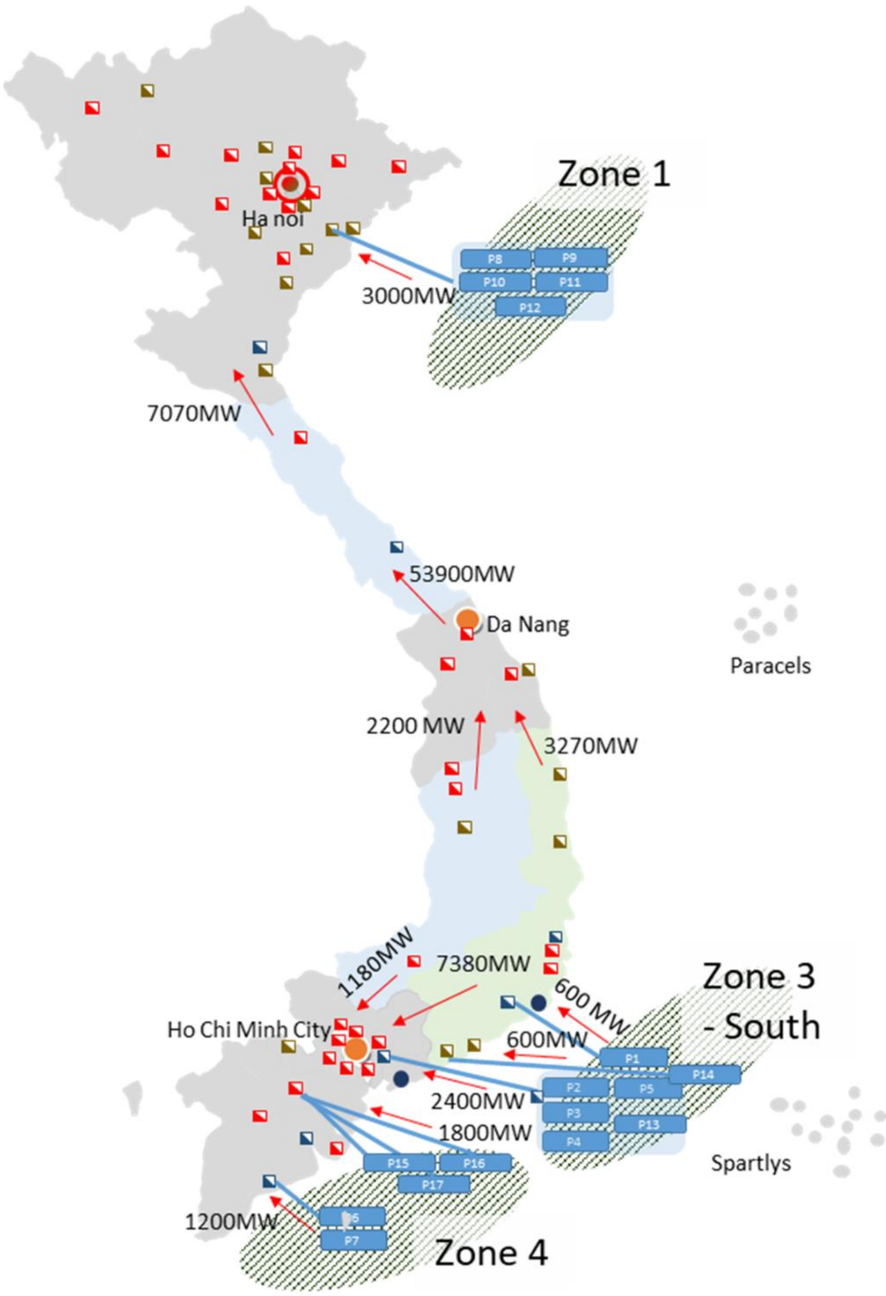
Trang trại điện mặt trời

Trang trại điện gió

	Existing	2021-2025	2026-2030
Trạm biến áp 500kV			
Đường dây truyền tải 500kV			



Scenario for developing 10 GW offshore wind to 2030



Source: Vietnam Initiative for Energy Transition. 2020. Integrating Offshore Wind in Vietnam Power System – A technical-economic assessment

Vietnam Initiative for Energy Transition

Address: 7th floor – 18 Ly Thuong Kiet
Phan Chu Trinh, Hoan Kiem, Hanoi, Vietnam

Telephone: +84 (0) 243 204 5554

Website: www.vietse.vn

Email: info@vietse.vn