

**MINISTRY OF INDUSTRY AND TRADE
ELECTRICITY AND RENEWABLE ENERGY AUTHORITY**

ASSESSMENT REPORT

**NATIONAL PDPs
(REVISED PDP SVII)**

Hanoi, December 2022

1. ASSESSMENT ON ACTUAL VERSUS FORECASTED ELECTRICITY DEMANDS

PDP7 was prepared in 2010 and approved in 2011 for 2011-2020 period with a vision to 2030. However, after 4 years of the implementation, the PDP7 was revised and then approved under PM's Decision No. 428/QD-TTg dated March 18, 2016. The revised PDP7 report provided updates on the socio-economic situation, provided evidences and assessments of the economic growth rate in line with the actual situation and national orientation, then it provided important inputs to the power source and grid development program for the remaining years. However, the unpredictable Covid-19 pandemic significantly affected economic growth and electricity demand in 2020. In this section, we will focus on the comparison and assessment actual demand in 2015-2020 period as compared with the forecast of the revised PDP7 represented by the main indicators of electricity and capacity. The table below shows actual electricity demand versus forecasts under 2 scenarios under the approved revised PDP7.

Table 1: Comparing actual and forecasted electricity demand under the revised PDP7

Year	Actual		Power Development Plan VII – Aggressive scenario		Power Development Plan VII – Base scenario	
	Atp (GWh)	Pmax (MW)	Atp (GWh)	Pmax (MW)	Atp (GWh)	Pmax (MW)
2014	126.500	22.210	126.500	22.210	126.500	22.210
2015	143.397	25.809	140.000	24.840	140.000	24.840
2016	160.257	28.109	158.021	28.138	156.290	27.830
2017	174.513	30.931	177.278	31.654	173.549	30.988
2018	192.361	35.126	197.879	35.429	191.854	34.350
2019	209.769	38.249	219.961	39.491	211.308	37.937
2020	216.826	38.617	242.578	43.705	230.924	41.605

In electricity demand forecasting, the indicator which has the strongest influence is GDP. The revised PDP7 report used two scenarios of GDP growth in 2016-2020 period, which are 6.9% p.a (Base) and 7.6% p.a (Aggressive). In principle, if the forecast model is suitable enough, other sets of indicators such as population, urbanization rate, electricity price, etc., do not have significant differences between reality and assumption, then the actual electricity demand will be closer to the Base forecast, also known as the Base-case Scenario. However, the impacts from unforeseen Covid-19 pandemic reduced GDP growth rate of 2020 to only 2.91%.

Table 2: Comparison of forecasted and actual commercial electricity by regions

Comparison	Region	2015	2016	2017	2018	2019	2020
Base scenario (GWh)	North	55.239	63.235	70.141	77.644	85.633	93.695
	Central	13.526	15.998	17.862	19.399	21.022	22.632
	South	71.236	77.057	85.545	94.811	104.653	114.598
Actual (GWh)	North	58.917	66.960	73.562	82.184	90.038	94.915
	Central	13.529	14.976	16.081	17.560	19.332	19.119
	South	69.535	76.912	83.220	91.108	99.076	102.788
Differences (%)	North	6,2%	5,6%	4,7%	5,5%	4,9%	1,3%
	Central	0,0%	6,8%	11,1%	10,5%	8,7%	15,5%
	South	2,4%	0,2%	2,8%	4,1%	5,6%	10,3%

The above results show a significant difference between forecast and actual consumption in all three regions.

Specific assessment of electricity consumption for each region and some key provinces by the end of 2020 is as follows:

- Among the three regions, the North has the best transport infrastructure and is rarely affected by the lack of local power sources. Therefore, during the implementation, the North will attract industrial production. According to statistics, the electricity demand growth during 2016-2020 in some northern provinces was very high: 26.2% p.a in Ha Nam (with the particularity of cement production), 22.5% p.a in Thanh Hoa (the existence of the Nghi Son Oil Refinery & Petrochemical) .etc. Some provinces had a low starting point but had a significant increase in electricity demand such as Cao Bang at 20.3% p.a, Tuyen Quang at 17.1% p.a, etc. Meanwhile, major industrial production areas still maintained high electricity consumption growth, such as Thai Nguyen at 17.1% p.a, Vinh Phuc at 16.4% p.a, Quang Ninh at 17.0% p.a, Hai Phong at 13.1% p.a... Although not as high as the previous period, the demand growth in Ha Noi still reached 8.3% p.a.
- The Central region was expected to reach a relatively high growth, via economic zones, industrial parks and commercial centers, hotels, motels and resorts along the central provinces, such as: Chan May EZ (Thua Thien Hue), Chu Lai EZ (Quang Nam), Dung Quat EZ (Quang Ngai), Nhon Hoi EZ (Binh Dinh), Van Phong EZ (Khanh Hoa), and a series of other industrial parks were planned. However, only Chu Lai and Dung Quat EZs required a high demand for electricity in reality. Although the growth was lower than expected, the central region showed a shift in electricity consumption from industrial production to trade and services. The share of industrial consumption in 2015 was 42.1%, down to 40.9% in 2020. Meanwhile, the share of in the commercial and service sector increased from 8.2% in 2015 to 10.2% in 2019 and decreased to 7.2% in 2020, possibly because of Covid impacts. The leading provinces of the Central region still maintained a high growth rate of commercial electricity, such as Quang Nam 17.3%, Quang Ngai 17.1%, Quang Binh 17.0% and Da Nang only reached 7.6% p.a.

Although it was updated, the revised PDP7 was prepared in the context that the key provinces of the South were experiencing high electricity growth rates and this region's RGDP was expected to grow at 7.4% p.a for the period 2016-2020, therefore, the electricity demand was forecasted to grow at 10.8% p.a. But in fact, the actual electricity growth rate was only 9.3% p.a during the period 2016-2020. Meanwhile, many provinces and cities did not achieve the expected growth rate. For example, 6.6% p.a of HCMC vs. expected 7.6%; 8.8% p.a of Dong Nai province vs. expected 9.5%; except only Binh Duong province maintained a high growth rate of 14.2% p.a, higher than the expected 10.1%.

In the next period 2021-2022, the analysis of actual operation data and the structure of power sources by types is the basis for Vietnam to continue to evaluate and prepare the PDP 8 which aims to align to the net zero emissions goals by 2050.

Table 3: Power sources mix – By Investors - in 2021-2022

TT	POWER INVESTORS	2021	2022
	TOTAL CAPACITY (MW)	76.364	77.749
1	EVN + GENCOs	29.901	29.901
1.1	Directly managed by EVN	11.974	11.974
1.2	GENCO1	7.014	7.014
1.3	GENCO2	4.421	4.421
1.4	GENCO3	6.450	6.450
1.5	EVNCPC	42,5	42,5
2	PVN	5.525	6.163
3	TKV	1.815	1.815
4	BOT	7.556	7.556
5	Other investors	30.995	31.743
6	Import	572	572
	SYSTEM-WIDE RATE (%)	100%	100%
1	EVN + GENCOs	39,2%	38,5%
2	PVN	7,2%	7,9%
3	TKV	2,4%	2,3%
4	BOT	9,9%	9,7%
5	Other investors	40,6%	40,8%
6	Import	0,7%	0,7%

Table 4: Power sources mix – By Types - in 2021-2022

TT	TYPES OF POWER SOURCES (MW)	2021	2022
	TOTAL CAPACITY	76.364	77.749
1	Hydropower	21.816	22.504
-	Hydropower	17.839	18.097
-	Small-scale hydropower	3.978	4.407
2	Coal-fired power	24.674	25.312
3	Gas-fired thermal power	7.152	7.152
4	Oil-fired thermal power	1.501	1.501
5	Renewable energy	20.484	20.544
-	Wind power	3,987	3,987
-	Solar farm	8,515	8,515
-	Rooftop solar	7,664	7,664
-	Biomass and Garbage	318	378
6	Diesel and others	165	165
7	Import	572	572
TT	TYPES OF POWER SOURCES (%)	2021	2022
	Power source ratio (%)	100%	100%
1	Hydropower	28.6%	28.9%

-	<i>Hydropower</i>	23.4%	23.3%
-	<i>Small-scale Hydropower</i>	5.2%	5.7%
2	Coal-fired power	32.3%	32.6%
3	Gas-fired thermal power	9.4%	9.2%
4	Oil-fired thermal power	2.0%	1.9%
5	Renewable energy	26.8%	26.4%
-	<i>Wind power</i>	5.2%	5.1%
-	<i>Solar</i>	11.1%	11.0%
-	<i>Biomass and Garbage</i>	0.4%	0.5%
6	Diesel and others	0.2%	0.2%
7	Import	0.7%	0.7%

The above aggregated data shows that Vietnam must balance the development of various types of power sources towards Vietnam's declaration at COP26, but at the same time, must ensure energy security and sustainable development.

2. ASSESSMENT OF THE IMPLEMENTATION OF THE POWER SOURCES DEVELOPMENT PROGRAM

2.1 Power sources development program for 2016-2020 period

In the first 5 years of 2011-2015, the power sector put into operation about 17 GW of different sources (including small hydropower and renewable energy), meeting more than 81% of the volume assigned under PDP7, of which the highest fulfillment was the North at 96%, the South was the lowest at 62.7%. The fact that investors focused on the North in this period was because the Northern region has potential for domestic coal resources, and potential for hydropower, especially small hydropower. The South was expected to develop coal-fired or imported LNG-fired thermal power sources thus it faced more difficulties and slowed down the progress. This led to high North – South transmission volume in recent years.

During 2016-2020, the investment in power sources was implemented according to the revised PDP7, due to the rapid development of solar energy in the years 2019-2020, the total installed capacity of the entire system reached 132% against required total power capacity during this period. However, traditional power sources (coal, gas, and hydropower - mainly coal-fired power) continued their slow-progress trend as in previous periods. During 2016-2020, the volume of traditional power generation sources development only reached nearly 60% of the planned volume, and mostly happened in 2019-2020 in both the North and the South, with the total capacity of traditional power sources behind schedule amounting to more than 7000 MW vs. the capacity volume in the revised PDP7.

There are 10 major power projects expected to be operational in 2016-2020 according to the revised PDP7, but delayed after 2020 including: Song Hau 1 #2 (PVN - 1200 MW), Thai Binh 2 (PVN-1200 MW), Long Phu 1 (PVN-1200 MW), Na Duong 2 (TKV-110 MW), Cam Pha 3 (TKV - 440 MW, not yet invested), Cong Thanh (600 MW), O Mon III... Meanwhile, renewable energy sources (mainly solar) have exceeded the planned volume (mainly due to Government's incentives for RE development). This leads to difficulties in balancing power supply because the equivalent operating hours of RE sources are only about 1/3 of the traditional thermal power sources.

2.2 Reviewing the list of power sources in the revised PDP7

According to the revised PDP7 and other relevant supporting decisions by the end of 2020, the total capacity to be operational in 2016 - 2030 is **109,090 MW/482 projects**, including 35,470 MW for period 2016 - 2020; 45,030 MW for the period 2021-2025; 28,590 MW for the period 2026 – 2030 (*assuming that the win, solar projects added to the PDP which yet operational shall be equally distributed for 2021-25 and 2026-30*).

2.2.1 Coal-fired sources

37 coal-fired power projects with a total capacity of 35,112 MW were approved in the revised PDP7 and were expected to operate during 2016-2030 period. Of which, 12 projects with a total capacity of 8,570 MW have been put into operation in the 2016-2020 period (including the second unit of Hai Duong TPP operating in 2021 according to the revised PDP7) and 25 projects with a total capacity of 26,542 MW expected to be put into operation in the 2021-2030 period. The capacity distribution of these 25 additional projects includes: 16 projects (13,930 MW) in the North, 01 project (1,200 MW) in the Central region and 8 projects (11,412 MW) in the South.

11 projects (11,740 MW) will be stopped or are not feasible in the 2016-2030 period, including: Cam Pha III and Quang Ninh III TPP with no land location planning that Quang Ninh Provincial People's Committee proposed to remove them from the PDP according to its letter 2270 dated April 16, 2021; Rang Dong TPP not yet called investment; Hai Phong III TPP has not prepared a pre-FS report and is proposed to be removed from the PDP according to a letter No. 1424 of Hai Phong People's Committee dated March 8, 2021; Vung Ang III TPP was proposed by Ha Tinh province to convert fuel to LNG according to its report to the Prime Minister No. 400/TTr-UBND dated November 6, 2020; Long An I and Long An II TPP were converted to use LNG fuel according to Decision 1080/TTg-CN dated August 13, 2020; Tan Phuoc I & II TPP were not yet approved the site plan, the Ministry of Industry and Trade is appraising the proposal on converting fuel to LNG, capacity of 2x1500 MW, to be put into operation in 2025-2027; Bac Lieu TPP shall be stopped according to the the meeting conclusion No. 326/TBVPCP of the Office of Government on October 13, 2016.

2.2.2. Gas turbine sources

The total capacity of gas turbine sources approved and put into operation in the period 2016-2030 is 26,640 MW, corresponding to 20 projects. Regarding domestic gas, there are 10 projects with a total capacity of 8,740 MW (the Central region has 6 projects with a total capacity of 4,090 MW, the South has 4 projects with a total capacity of 4,650 MW), of which Kien Giang I & II projects (1,500 MW) in the revised PDP7 are expected to use Block B gas. However, in reality, Block B gas is only enough to supply O Mon Thermal Power Complex, not enough to supply for Kien Giang I & II projects. On the other hand, the natural conditions of the terminal to supply LNG to power plants in this area are also not favorable. Therefore, it is necessary to carefully consider and evaluate the possibility of continuing to develop the Kien Giang I & II factory cluster in this area. Regarding thermal power using LNG, there are 10 LNG projects with a total capacity of 17,900 MW that have been added to the Plan: the North has 1 project/1,500 MW (Quang Ninh LNG), the Central region has 1 project/1,500 MW (Hai Lang LNG) and the South has 8 projects/14,900 MW (LNG Nhon Trach III&IV-1,500 MW, LNG Hiep Phuoc - 1,200 MW, LNG Son My I-2,250 MW, LNG Son My II-2,250 MW, LNG, Bac Lieu - 3,200 MW, Ca Na LNG - 1,500 MW, Long Son

LNG - 1,200 to 1,500 MW, Long An I LNG - 1,500 MW (LNG Long An II - 1500 MW operating before 2035). Long An (Long An I and II), Tan Phuoc 1&2 (2x1,500 MW – proposed to convert fuel from coal to LNG) are located deep in the Soai Rap river, which is difficult and expensive to transport LNG, should also be carefully considered in the concentrated development of LNG power sources in this area.

2.2.3 Hydropower sources

According to the national hydropower statistics of the Department of Electricity and Renewable Energy, the economic and technical potential of medium and large – scale hydropower in Vietnam is about 75-80 billion kWh, equivalent to about approx. 23,000 - 25,000 MW of installed capacity. The total hydropower capacity of Vietnam that has been built and operated by 2020 is nearly 21,000 MW, of which there are about 17,000 MW of medium and large hydropower, *so the potential for medium and large-scale hydropower has been almost exploited in full.*

The total hydropower capacity (including small hydropower) according to the adjusted and supplemented PDP7 put into operation in the period 2016 - 2030 is 7,471 MW, of which 2,540 MW has been operated in the period 2016-2020 and the remaining 4,930 MW is expected to operate in the period 2021-2030

2.2.4. Wind power sources

The revised PDP7 approved the list of sources and grid connections for 190 wind power projects with a total capacity of 11,860 MW. According to Document No. 4219/EVN-TTD dated July 22, 2021 of EVN, a total of 144 projects have signed power purchase agreements (PPAs) with a total capacity of 8,145 MW. Before October 31, 2021 (when the Decision No. 39/2018/QĐ-TTg dated September 10, 2018 of the Prime Minister expired), it was expected that 95 wind power projects with a total capacity of 4,835 MW by the end of the year would be put into operation. Nearly 62% of approved wind power sources are concentrated in the South with 7,339 MW, about 37% are concentrated in the Central with 4,401 MW and only about 1% (120 MW) in the North.

2.2.5. Solar power sources

The revised PDP7 approved the list of sources and grid connection for 175 projects with a total capacity of 19,098 MWp/15,400 MWac of concentrated solar power including 96% in the central and southern regions. In these 175 projects, 8,673 MWac have been operated in the period 2016-2020 and the remaining 6,727 MWac are expected to operate in the period 2021-2030, including 497 MW in the North, 3,556 MW in the Central and 2,674 MW in the South. In addition, in the period 2016-2020, 9,694 MWp/7,755 MWac of rooftop solar power sources have been put into operation, these are sources that do not need additional approval of the revised PDP7, and 93% of rooftop solar power sources are concentrated in the Central and South regions.

2.3 Assessment of the additional source distribution according to the revised and supplemented PDP7 in relation to the power load demand of each region

In the North: In the period of 2021–2030, the North's load capacity is forecasted to increase by 23810 MW (corresponding to an average growth rate of 9.4%/year), but the increase in the North's power capacity is only 21540 MW, 10% lower than the additional load capacity. The growth of power capacity in the North is also only 7.1%/year, much lower than the load growth (9.4%), which causes the difference in installed capacity/Pmax to decrease from 31% in 2020 to only 8%

in 2030. Considering the nature of the rainy vs dry seasons, the peak time without any generation of solar power and the maintenance and repair of coal-fired TPPs, Northern power supply capacity will not guarantee power supply for regional loads. The Northern electricity system will basically not be able to balance itself and must receive a large amount of electricity from the inter-regional transmission system

In the Central and Southern regions: In the period of 2021-2030, the central and southern power systems both have a higher installed capacity of additional power sources than the load growth. In the Central region, the load is forecasted to increase to 4370 MW while the installed capacity increases to 17220 MW, equivalent to 294% higher than the load. The installed capacity of the South's power sources increased by 41097 MW, nearly twice as high as the increase in load. The average annual growth rate of installed source capacity in the Central and South regions reached 12.1% and 9.1% respectively, higher than the growth of load capacity in the regions (10.9% and 9.1% respectively). This will lead to an even higher correlation between installed capacity/ P_{max} in the Central and South regions in 2030 compared to 2020 (272% and 89% respectively). This redundant amount in the Central and Southern regions will increase the transmission volume to the North, putting great pressure on the North-South inter-transmission system.

Assessment: the capacity distribution of the newly added sources according to the revised PDP7 until 2030 is not suitable for load growth by regions. The additional power capacity of the North is 10% lower than the load growth, leading $P_{installed}/P_{max}$ ratio drop to only 8% in the North in 2030. The North cannot balance its own power source and load, especially during the peak times of the dry season, so the North will have to receive a large amount of electricity from the inter-regional grid to balance. On the contrary, the supply-demand balance in the Central and Southern regions, which is already redundant, tends to become more redundant when the amount of additional installed capacity in the Central and South regions in the period 2021-2030 is 294% and 91% higher than the increase in load demand. This phenomenon leads to a sharp increase in the amount of power transmitted back to the North compared to 2020, causing overload on the North-South 500kV transmission power system, especially the sections of Da Nang - Vung Ang and Vung Ang - Ha Tinh - Nho Quan.

3. POWER GRID DEVELOPMENT PROGRAM FOR 2016-2022

3.1 Implementation status

In the period 2016-2020, a number of key grid projects supplying electricity to the South were put into operation to improve transmission capacity, significantly contributing to ensuring power supply for loads and improve power quality. Typically, 500 kV Vinh Tan line – to Song May - Tan Uyen branch, 500 kV Song May - Tan Uyen transmission line, 500 kV Tan Uyen substation and synchronously connecting with Vinh Tan Power Center to enhance reliability for 500 kV power system in the South; 500 kV Vung Ang - Quang Trach - Doc Soi transmission line synchronized with circuit line 3 to enhance North-Central transmission, 500 kV Pleiku 2 substation to support importing hydropower from Southern Laos and relaxing the regional hydropower...

In addition, 2016-2020 is also the period when there is a relatively large change in the source structure of the system, most notably the development of RE sources. Many power grid projects of 500-220 kV have been promptly built to meet the demand for capacity release from large thermal power sources and new RE sources in the region. Due to that actual need, many non-planned transmission grid projects have been additionally researched and built in a timely manner, for example, Quang Trach - Doc Soi - Pleiku 2 500 kV transmission line, RE connection works...

The volume of investment in construction of 500-220 kV power grids was quite high compared with the approved revised PDP7, but there were still some projects behind schedule. The main reasons were the financial difficulties, technical construction solutions, and the delay of other relevant works (power plants, substation). In addition, the compensation for site clearance also faced many difficulties. High-voltage line works pass through many localities while the policy on land compensation and support by each province is different. In recent years, many households have built temporary houses with a large area in foundation locations and corridors to claim compensation thus affecting the progress of projects..

In 2016-2020 period, EVN invested in constructing about 19100 MVA 500kV substation, about 29300 MVA 220kV substation, 2300 km of 500kV transmission line and 5400 km of 220kV transmission line. The implementation rate of 500kV and 220kV substations is 88.8% and 90.6%, respectively. The implementation rate of 500kV and 220kV transmission lines is 77.6% and 73.9%, respectively.

The volume of transmission network implemented in the period 2016-2020 in comparison with the revised PDP7 is presented below:

3.1.1 500 KV power grid

In the period of 2016-2020, 500 kV projects were implemented relatively well, some projects were delayed behind schedule partly due to the need to synchronize with behind schedule power source projects, thus the schedule must be adjusted, and due to some other reasons - the most common of which were problems in the implementation process such as delays in bidding, compensation, site clearance, slow progress of materials and equipment supply...

In the same period, the North invested and built most of the 500 kV substations as planned, except for the 500 kV Vung Ang substation with only 01 new machine built with a capacity of 900 MVA, because there was no location for installation of the second machine. 500 kV substations and

transmission lines will be delayed after 2020 due to difficulties in site clearance and route agreement with the locality. The 500 kV lines connecting large thermal power plants such as Cong Thanh - Nghi Son Thermal Power Plant, Nam Dinh - Pho Noi Thermal Power Plant were behind schedule due to the slow synchronization with the source works..

The Central region is the bright spot in the construction of 500 kV power grid when 100% of the investment plan to build 500 kV substation was implemented and the South, typically 500 kV Pleiku 2 substation, has imported hydropower from Southern Laos and release hydroelectricity in the area, and works to release the capacity of thermal power and renewable energy sources in the region such as raising the capacity of 500 kV substations in Vinh Tan and Di Linh. 500 kV Vung Ang - Quang Trach - Doc Soi transmission line synchronizes the 500 kV circuit 3 to strengthen the North-Central connection. The 500 kV transmission line of Van Phong - Vinh Tan thermal power plant was behind schedule due to the delay in synchronization with Van Phong Thermal Power.

The South implemented about 80%-82% of the 500kV power grid volume of the revised PDP7 . Typically, 500 kV transmission line, 500 kV Vinh Tan – turning to Song May - Tan Uyen transmission line, 500 kV Song May - Tan Uyen transmission line, 500 kV Tan Uyen substation and synchronous connection with Vinh Tan Power Center have brought many economic - political - social importance, enhancing the reliability of the 500 kV power system (adding the third circuit of the 500 kV transmission line from Vinh Tan to Song May), meeting the criteria N-1, N-2..

If low load growth and slow progress of source works are excluded, the volume of 500 kV grid achieved by NPT was relatively high, specifically as follows:

3.1.2. 220 kV power grid

During 2016-2020, from entire industry view, the total volume of new construction and renovation of the 220 kV grid nationwide was quite high compared to the revised PDP7. If estimated for the whole period 2016-2020, the volume of implementation would reach 90.6% for substation and 73.9% for grid/transmission lines. Some projects were behind schedule, the main reason was the problem of compensation, site clearance and alignment with the locality and subjective reasons from the National Power Transmission Corporation (NPT).

Specifically, the volume of construction and renovation of the 220 kV grid, compared with the revised PDP7 for each region is as follows:

- 90.6% of the volume of 220kV substations by NPT has been completed, the remaining 20 projects are being implemented but cannot be energized in time for 2020, concentrated in the North and South. The reason for the delay in putting into operation is still mainly due to difficult site locations or slow implementation.
- Only 73.9% of the national 220kV transmission lines can be operated compared to the revised PDP7, mainly in the Central and Southern regions, reflecting the fact that investment in transmission lines is increasingly difficult. The main reasons are the problems of compensation, site clearance, difficulty in arranging power cut for construction, problems with bidding packages..

3.1.3. 500kV power grid connecting regions

In the period up to 2030, according to the revised PDP7, there are many regional interconnecting grid projects that play an important role in releasing source capacity and ensuring power supply for loads such as: 500 kV transmission line Vung Ang – Quang Trach – Doc Soi – Plieku 2, Vung Ang 3 – Quynh Lap – Thanh Hoa – Nam Dinh 1 – Pho Noi, Central region– Krong Buk – Tay Ninh gas turbine, Binh Dinh – Van Phong – Vinh Tan... . Specifically, the implementation status and expected progress of these grid connection projects are as follows:

Observation: In general, many important grid projects, which were expected to be operational during 2021-2025 period according to the revised PDP7, are still in the PreFS and FS stages such as the Nam Dinh - Thanh Hoa - Quynh Lap- Quang Trach transmission line, Dung Quat - Krong Buk - Tay Ninh gas turbine, Thuan Nam - Chon Thanh gas turbines. Therefore, the construction of the above works is likely to be delayed, affecting the operation of the power system.

Table 5: Volume of the transmission lines during 2021-2022 (Km)

YEAR	TOTAL	NPC	SPC	CPC	HANOI	HCMC	NPT
2021	27,523	0	0	0	8.8	126.6	27,388
500 kV	8,973						8,973
220 kV	18,550				8.8	126.6	18,415
2022	29,728	0	168.0	0	8.8	126.6	29,425
500 kV	10,467						10,467
220 kV	19,262		168.0		8.8	126.6	18,958

Table 6: Volume of power transmission substation during 2021-2022 (MVA)

YEAR	TOTAL	NPC	SPC	CPC	HANOI	HCMC	NPT
2021	112,075	0	0	0	500	2,500	109,075
500 kV substation	43,200						43,200
220 kV substation	68,875				500	2,500	65,875
2022	119,525	0	0	0	500	3,000	116,025
500 kV substation	46,650						46,650
220 kV substation	72,875				500	3,000	69,375

4. ASSESSMENT OF THE PDP7 IMPLEMENTATION

4.1. General assessment

Over the years, the electricity sector has completed the tasks assigned by the Party, Government and people, being one of the pillars of the country's economy; has basically met the increased electricity demand of the country; has well performed its role as a tool for macro regulation and implementation of social security of the Government; gained profits from production and business, ensuring the obligation to pay the state budget, preserving and developing capital.

The main results from 2011 to present are as follows:

- (i). Planning and planning management have been well implemented, serving as an effective tool to manage investment and development of the electricity sector, ensuring sufficient electricity for socio-economic development and ensuring national security. In the period of 2011-2020, the electricity sector has implemented 2 national PDP, i.e. PDP7, revised PDP7, and is currently developing the PDP8. The contents of these PDPs focus on the following items: forecast of electricity consumption demand; calculation and determination of the national electricity source and grid development program; calculation of investment capital needs and economic and financial analysis of electricity development plans; and environmental protection in electricity development. The provinces and centrally-run cities have all made the power plan for the period 2011-2020 and the period 2016-2025 taking into account 2035. The (national) PDPs and their provincial PDPs have really become an effective tool for managing investment in the sector, ensuring sufficient electricity for socio-economic development and ensuring national security and defense.
- In parallel with the PDPs at all levels, their implementation has also received adequate attention and instruction. The national Steering Committee on developing National PDP was established in 2011, and the national Steering Committee on Power sector development was established in 2016 to implement the PDPs. For localities, through the Department of Industry and Trade as focal point, the provincial PDPs have really played an important role in building infrastructure, attracting investment, meeting socio-economic development needs of each locality.
- (ii). The investment in construction of power supply infrastructure has had a strong development, which is an important condition for ensuring the security of power supply.
- (iii). The Government has promulgated many mechanisms and policies to adjust electricity prices according to the market mechanism, creating conditions for the electricity industry to gradually become financially self-sufficient and capable for investment and development..
- (iv). Power business and customer service have been fundamentally improved both in terms of power quality and customer service..
- (v). Power loss and power saving have achieved important results, significantly contributing to the assurance of power supply.
- (vi). The competitive power market has been formed, developed and increasingly perfected, contributing to improvement of the operational efficiency of the power industry.
- (vii). The implementation of the National Program on Power Demand Side Management (DSM) has contributed to reducing the growth of power load demand, thereby contributing to

ensuring the balance of supply and demand, gradually improving the quality of power supply and power supply reliability.

- (viii). The protection of natural resources and environment in power development has been focused.

In the 2011-2020 period, the power system basically ensured the power supply for socio-economic development and national security and defense:

- Load growth was close to the forecast in the revised PDP7. In 2020, the total commercial power output reached 93.9% of the load forecast.
- Development of power sources reached 132% of the total installed capacity compared with the PDP for the period 2016-2020, but the mix was different: thermal power sources only reached 60%, while renewable energy sources exceeded by up to 480%. This caused the risk of short-term power shortage due to the delay in the progress of thermal power sources.
- Construction of the power grid according to the expected data in 2020 was quite high (over 80% for the 220 kV power grid, 72.2% for the 500 kV power grid on the transmission line, and 88% for the 500 kV station). However, the volume of completed transmission grid accumulated to the last year was quite big.

4.2. Shortcomings and limitations and causes

Shortcomings and limitations

4.2.1. Shortcomings in preparation and implementation of the PDPs

In addition to the above-mentioned achievements, in the preparation of the PDPs saw some problems and limitations, specifically:

- Synchronicity of plans: the PDPs are highly systematic. The PDPs are inter-connected to many plans of other industries such as coal, oil - gas, renewable energy, socio-economic development planning, traffic planning, urban spatial planning, industrial development plan.... In fact, synchronizing these plans is quite difficult because the time of formulation of the plans often does not coincide.
- The data serving the planning is not completely comprehensive and is inconsistent, leading to inaccurate forecast and calculation results.
- The appraisal and approval of the PDP take a long time, leading to a shortened time for implementation after approval.
- The revision of the Plan which added many power sources and power grid projects at the end of the 2011-2020 period has strongly affected the overall picture, the synchronization and consistency in the PDP.
- The formulation and revision for renewable energy projects have not been synchronized with the electricity grid development planning, has not kept pace with the speed of technology development and the rate of reduction of project investment costs, leading to the problem that the development of renewable energy projects is not yet methodical, there are difficulties in operating the national power system, and releasing the generating capacity...

- The planning and plan management in the recent period faced difficulties in revising in timely manner. Due to the average growth rate of Vietnam's load growth of over 10% per year, the need to build power sources and power grids to meet the load is very high. In the past period, there were many big changes such as: not building Ninh Thuan nuclear power plant; the construction of coal-fired power plants faced many difficulties due to embargo issues, funding arrangement, site clearance issues, environmental issues; the rapid development of renewable energy sources following the Government's decision to subsidize renewable energy development. Given such realities, the MOIT has directed the implementation of studies, calculations, and proposals for solutions to ensure power supply for the country, such as: adding Nhon Trach 3.4 thermal power plant using liquefied natural gas (LNG); supplementing An Khanh Bac Giang thermal power plant, wind and solar power plants; additional 500kV Vung Ang - Doc Soi - Pleiku 2 transmission line; strengthening inspection and urging contractors to ensure the progress of power plants The above solutions have basically met the electricity demand for socio-economic development of the country. However, there have been times the planning management has not met the desired progress of the project investors, especially the projects of solar power and wind power. This shortcoming also has objective reasons because the above-mentioned energy sources are all unstable renewable energy sources, appearing for the first time in large quantities in Vietnam, thus it is necessary to calculate in detail the absorption capacity of the power system. In addition, the development of the above-mentioned renewable energy sources also needs a suitable roadmap to ensure the overall efficiency of the power system (due to the high cost of renewable energy sources); At the same time, it is necessary to evaluate the environmental issues of the projects: the assessment of the project's land use, the problems of waste collection and treatment such as solar panels, batteries.... The Ministry of Industry and Trade is urgently coordinating with EVN, international organizations and experts, consulting and research units of Vietnam to step by step solve the above problems.
- In order to meet the load demand with a growth rate of over 10%/year, the PDPs need to be regularly updated and adjusted. The PDPs in the recent period has been quite "rigid" in nature, i.e. wherein, both the scale, the time of operation and the investor of each specific power project have been determined. The advantage of this is that the volumes and investment owners of the projects have been accurately determined. But the downside is the lack of flexibility in implementation. If problems arise leading to the need to change the scale and time of operation, the investment owners will have to spend time revising the Plan (*actually they only can propose*). In the document approving the tasks and scope of the PDP8, the Government directed that the PDP8 should be an "open" plan, which only defining the list of key national projects, determining needs and distributing space (*location*) of power projects, thereby increasing flexibility in the plan implementation.

4.2.2. Shortcomings in power source development

Power sources projects, especially those outside EVN, are often behind schedule, seriously affecting the assurance of power supply in the coming time.

According to the revised PDP7, in the 2016-2030 period, there are a total of 116 power source projects that need to be invested and operational (excluding RE projects). After nearly 3 years of implementation, many projects have not been implemented due to proposals and recommendations

of local governments, such as coal TPPs in Bac Lieu, Quang Ninh, Ha Tinh, while many other localities have proposed to supplement new electrification centers such as Bac Lieu, Ba Ria Vung Tau, and Ninh Thuan. Most of the BOT projects implemented by foreign investors are behind schedule specified in the PDP, while many other ongoing projects are also behind schedule such as Long Phu 1, Song Hau 1, and Thai Binh 2. According to the review recently, the total capacity of power projects that were able to be put into operation in the 2016-2020 period was only 15,500 MW/21,650 MW (reaching nearly 72%). The delay in power projects or unimplemented projects according to the PDP are creating major difficulties and challenges in ensuring power supply in the coming time.

The failure to strictly comply with the PDPs have made the power system become unbalanced, greatly affecting the reliability, stability and efficiency of the power industry. Specifically:

- In the national PDP, it is clear that the list of projects to be invested in each year, ensuring the balance of electricity supply and demand in each region, prioritizing projects near the load center to enhance supply security, reducing grid investment costs and reducing transmission loss. But in fact, only the majority of EVN's projects comply with the above criteria, there are many projects belonging to other investors or facing difficulties with registered projects (which are indeed needed to be on schedule) or applying for a mechanism to put ahead power projects which are planned for the following (*later*) years or not yet being prioritized. Such facts lead to problems of increased volume, transmission length, congestion, and unsafety of power supply. The widespread investment and not properly prioritizing key projects lead to unfavorable factors in the management and implementation of projects, including for the investors, PMUs, consulting firms and construction contractors, causing delayed progress. According to the assessment, in the coming period, almost only projects implemented by EVN can meet the schedule, other power source investors, especially BOT power sources, are mostly slow.
- According to the PDPs for the period 2011-2020, the power source projects were approved with the planning attached to the project implementation investor. In which, the project implementation capacity, the ability to mobilize capital of some investors is said to be one of the main reasons for delaying progress or being unable to implement projects, especially coal-fired thermal power projects.

4.2.3. Painpoints in power grid development

Procedures for revising the PDPs are difficult, complicated and time consuming. Especially when the provisions of the Law on Planning are applied, they have been affected the implementation progress of transmission grid projects.

Difficulties and obstacles in compensation and site clearance: This is the biggest obstacle and has a great influence on the implementation of transmission grid projects in recent years, stemming from many causes: (i) Due to many shortcomings in the state's policies and regimes, the compensation unit price is not suitable and inconsistent among many localities, leading to people's disapproval and prolonged processing time; (ii) Due to the low awareness of the people, they do not cooperate and comply with the law; (iii) Due to the fact that local authorities have not been really active in land clearance and compensation work for transmission grid projects in the locality; (iv) Due to the constraint in land management in some localities, especially in remote areas, affecting the identification of land origin, causing lengthy disputes and lawsuits; the compensation unit price is

still inadequate, especially in bordering areas between provinces. There is no regulation on the area of land borrowed for temporary construction, leading to unreasonable demands for compensation by people.

Difficulties in agreeing on location of substations and power transmission lines with local authorities: Currently, EVN has faced many difficulties in agreeing on locations, Substation locations and line route for local governments, especially for localities with limited land bank, led to a lengthy agreement process. There is also a mis-alignment and overlapping in plans (power development, infrastructure development, industrial parks, tourism...) leading to many power projects that have been agreed by the government have to be adjusted, changed of their design and lead to prolonged time and slow progress of project implementation.

There are difficulties and obstacles in the authority to decide investment policies for group A projects: according to the provisions of the 2014 Law on Investment, the investment policy for group A construction investment projects with a total investment below the level of the Prime Minister's approval (under VND 5,000 billion) must be approved by the local government where the project implementing unit's head office or where the transmission grid project is located. This regulation will make it difficult to decide investment policy for power transmission line projects passing through many provinces/cities because it is difficult for a province/city to make an investment decision for a power transmission line project passing through other provinces/cities.]

There are difficulties and obstacles in converting forest land to implement transmission grid projects: according to regulations, transmission grid projects passing through natural forests must be decided by the Government to convert forest land to be used for transmission grid projects. The procedures and order to convert forest land are very complicated, take a long time and go through many levels and ministries (MARD, MONRE, MONRE, MOIT, MOD, Government Office...) which have affected the implementation progress of many key construction projects of EVNNPT in recent years (500 kV line connecting Nghi Son 2 Thermal Power Plant, 220 kV Nha Trang - Thap Cham transmission line, 220 kV Huoi Quang - Nghia Lo - Viet Tri transmission line)....

4.2.4. Shortcomings in renewable energy development

- ***Barriers of the price compensation mechanism:***

The price of electricity from renewable energy sources is currently higher than that of electricity from traditional energy sources (thermal power, large hydropower...). The Vietnam Electricity is being assigned by the State to purchase all electricity from renewable energy projects at the price set by the State. Thus, Vietnam Electricity is performing the function on behalf of the State, the cost of compensating for renewable energy is being merged with the cost of the electricity industry, not clearly separated in the electricity bill. When the proportion of renewable energy increases, the price compensating component will increase and greatly affect the cost of electricity industry.

- ***Technical barriers:***

Due to their dependence on weather conditions, topography, climate, etc., the potential of renewable energy sources is often concentrated in a few provinces and localities (most of the provinces have small on-site consumption loads), the power grid system has not met the requirements for power transmission. In the power system that integrates a large number of unstable power sources such as wind power and solar power, it is necessary to build a large backup power source, which wastes

investment on the grid. The research, construction and operation of energy storage devices; building smart grid systems, building real-time weather and meteorology forecasting systems; problems of power flow control, voltage control; frequency, harmonic suppression in systems with a large proportion of renewable energy, etc. still do not meet actual requirements. In the past time, the progress of construction is still low for a number of power grid projects to ensure the release of capacity of wind power and solar power plants which have been supplemented to the plans of provinces with great potential for wind and solar power like Ninh Thuan, Binh Thuan. It is difficult to supplement the plan of new projects in potentially full/overloaded areas.

- ***Financial barriers:***

Investment in renewable energy projects requires large capital and has high risks because the capacity and output depend on weather and climate, needs long time for payback due to higher investment rates and higher electricity prices than traditional energy sources. Therefore, without the FIT pricing mechanism, it will be difficult for financial institutions and commercial banks to lend to investment projects in the renewable energy sector.

Regarding the synchronization of plannings: the formulation and supplementation of the planning for renewable energy projects have not been synchronized with the electricity grid development planning, and have not kept pace with the speed of technology development and the rate of cost reduction in project investment, leading to the unsystematic development of renewable energy projects, causing difficulties in operating the national power system, and releasing the generating capacity...

4.3. Major causes

- The orientation of the PDPs has not been implemented thoroughly, there are adjustments that have a large impact on the issue of electricity supply and demand (some proposals to change the Plan, change the development plan of Ninh Thuan nuclear power plant, change renewable energy development policy...).
- There is no investor selection mechanism to arrange investment capital for the power industry, causing the lack of investment capital in the power industry.
- There is no sanctions to bind the responsibility of the investment owners for the delayed implementation of important projects (for both state-owned enterprises, private enterprises, foreign enterprises)....
- The coordination of localities in the implementation of power projects is not synchronized and decisive; in some cases, the localities that previously supported the projects changed their opinions later, causing disruption to the power development plan.
- The state management in the process of investment and construction is still inadequate; provisions of the law are overlapping and unclear; lack of a specific mechanism for power sector development; lack of procedures; prolonged project implementation time, reduced efficiency.
- The plan, progress of implementation and determination of resources for a number of power projects are unclear. The capacity of domestic investors as well as contractors is still limited in both financial and technical terms. According to the PDPs for the period 2011-2020, the power source projects are approved in the Plan together with project implementation investment owners. In particular, the weak project implementation capacity and the ability to

mobilize capital of some investment owners is said to be one of the main reasons for delaying the implementation progress or not being able to implement projects, especially projects that are difficult to implement such as coal-fired power projects.

- Many problems in negotiating BOT projects make the project development time longer. The process of negotiating a BOT contract and granting an investment license is still protracted due to the involvement of many ministries/sectors. The problems mainly come from the issues of preferential policies, guarantees, foreign currency conversion, early termination of contracts... The time to consider and give opinions of state management agencies on related issues is often long-lasting.
- Objective reasons are embargos (Long Phu I Thermal Power Plant Project, Contractor is embargoed by the US Government).
- The electricity tariff mechanism lacks breakthroughs, is slow to change, there is no two-part tariff, electricity purchase price by region to give signals for investment orientation and load development.
- Electricity prices of power plants are still not attractive to investors because Vietnam is currently developing a variety of power sources, accompanied by policies on electricity tariff and power purchase contracts for each type of power sources. Especially in the market of variable renewable energy development, it is necessary to adjust and supplement the selling price of electricity for coal-fired and gas-fired power plants when they have to increase costs to integrate variable renewable energy sources.
- Localization of electrical materials and equipment has not met the requirements.
- The work of compensation and site clearance of power projects still faces many difficulties and tends to be complicated, affecting the construction progress of the works, especially at present, there are difficulties and obstacles in land clearance related to conversion of forest land use purposes because the procedure is very complicated and takes a long time. Some important grid projects could not be put into operation or could not be started in 2019 due to problems in compensation and site clearance, especially in big cities; problems related to forest land conversion, investment procedures over a long period of time. In which: some projects have problems with land clearance for a long time (such as: 220 kV transmission line connected 500 kV stations of Pho Noi, Viet Tri, Luu Xa), problems with conversion of forest land use purposes (such as the projects of Nghia Lo 220kV substation and Nghia Lo 220kV - Viet Tri 500kV, Huoi Quang - Nghia Lo 220kV transmission line, Nha Trang - Thap Cham transmission line...). In particular, a number of key projects with BOT power source synchronization were behind schedule (500 kV line connecting Nghi Son 2, Van Phong 1, Hai Duong Thermal Power Plants).
- Land management in some localities is still limited, especially in remote areas, affecting the identification of land origin, causing prolonged disputes and complaints. The compensation unit price is still inadequate, especially in bordering areas between provinces. There is no regulation on the area of land borrowed for temporary construction, leading to unreasonable demands for compensation by people.

Due to the characteristics of power projects, it is always necessary to be adjusted according to the situation of new load development. But due to the influence of the new Law on Planning, when new

factors arise during the implementation process it is not possible to organize the adjustment, thus causing delay to many projects.

4.4. Lessons learnt

- In reality, the socio-economic development, technology development, electricity development have many great changes. Multiple scenarios need to be proposed to assess all impacts.
- It needs to have long-term planning and implementation orientation. There needs to be a specific and detailed roadmap with clear and transparent signals for investors.
- It is necessary to resolutely implement the principle that electricity prices must be calculated correctly, with sufficient costs and reasonable profits to encourage investors.
- The PDPs should be more "open", stating only the list of important power works and accurate projects, creating flexibility for implementation.
- There should be solutions to strictly handle the delay in progress of power sources (rewards and penalties, support policies, cancellation of development licenses of slow project owners, alternative project measures...).
- The delay in grid investment is quite significant, thus the policy of investing in power grid projects from 2 to 3 years should be considered early.

5. PROGRESS OF PDP8

The PDP8 is being finalised by MOIT under latest instructions of D. PM Tran Hong Ha.

It is expected that PDP8 shall be re-submitted to the appraisal committee in the future.

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