Energy Transition Plan of Viet Nam

ELECTRICITY PRODUCTION ASPECT

Tokyo, 12/09/2023

Outline

1. Energy Master Plan of Viet Nam
2. Energy Transition Plan of Viet Nam (electricity production aspect)

Part 1 Energy Master Plan of Viet Nam

- Overview of Energy Master Plan of Viet Nam
- Specific targets

Current Status Of National Energy Supply and Demand

Total Final Energy Consumption (KTOE)

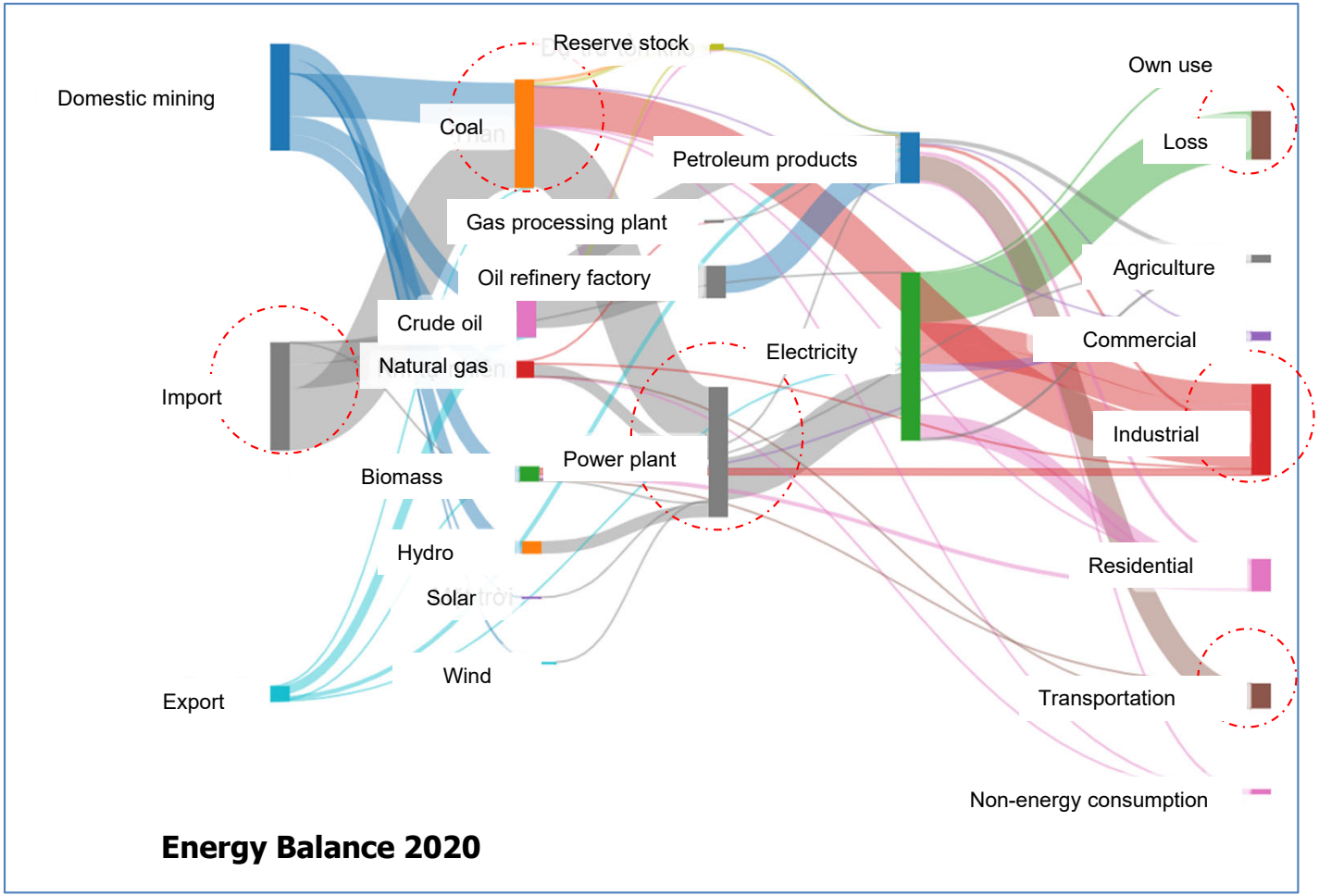
	2010	2015	2020
Coal	7,513	7,960	20,455
Oil Gasoline	14,361	18,030	19,604
Gas	493	1,167	1,495
Renewable Energy	10,185	8,159	5,710
Power	7,278	12,246	18,749
Total	39,831	47,561	66,014

Total Primary Energy Supply (KTOE)

	2010	2015	2020
Coal	13,850	22,590	49,752
Crude oil and Petroleum products	16,099	17,984	23,387
Gas	8,316	8,223	7,821
Renewable Energy	12,959	14,121	14,672
Power import/export	386	84	130
Total	51,610	63,002	95,762

Import/Export (KTOE)

	2010	2015	2020
Import	12,088	17,074	53,605
Export	21,186	11,798	7,666
Net import	-9,098	5,276	45,939
Net import/TPES (%)	-17.6	8.4	48.0



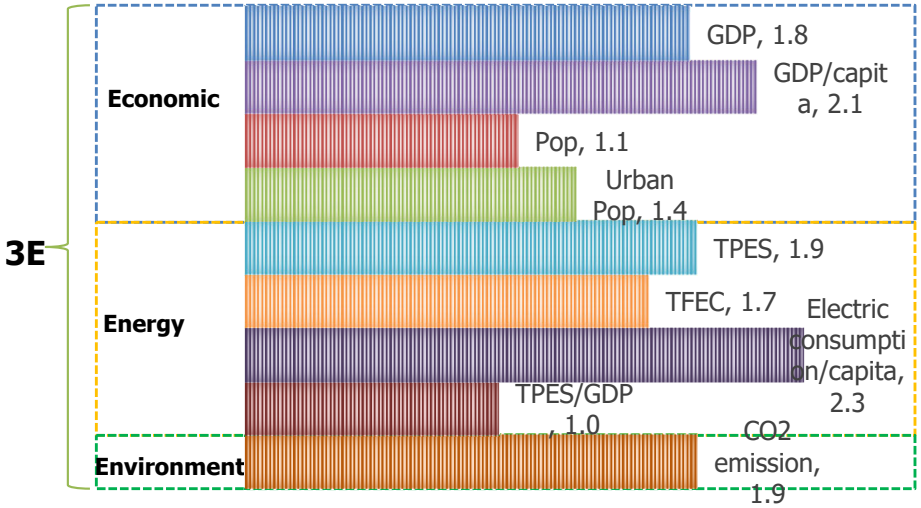
Energy Balance 2020

Environmental Energy Economic Index

Energy economic indicators 2010-2020

TT	Indicator	Unit	2010	2015	2020
1	GDP (comparative price 2010)	Trillion	2,740	3,697	5,006
2	Population	Million people	87.06	92.22	97.58
3	Urban population structure	%	30.4	33.5	36.8
4	GDP per capita (real price)	USD	1,690	2,596	3,552
5	Total primary energy supply (TPES)	Million TOE	51.6	63.0	95.8
6	Total final energy comsumption (TFEC)	Million TOE	39.8	47.6	66.0
7	TPES per capita	kgOE/capita	593	683	981
8	TPES per GDP	kgOE/1000USD	445	408	463
10	Electric consumption per capita	kWh/capita	972	1,548	2,229
11	Electric consumption per TFE	%	18.3	25.7	28.4
12	Total CO2 emissions from energy activities	Million tons CO2	147	158	273

Indicator comparison of period 2010-2020 (2010 = 1)



- Energy demand increased rapidly to meet socio-economic development.
- Electricity consumption per capita raised fast.
- Increased use of fossil fuels leads to significant impact in environmental and increases emissions.

Specific goal

To ensure national energy security

	2030	2050
Total Final Energy Consumption (TOE)	107 Million tons	165 - 184 Million tons
Total Primary Energy Supply (TOE)	155 Million tons	294 - 311 Million tons
Country petroleum reserves net imported	75 - 80 Days	90 Days

Just energy transition

Share of renewable energy in Total Primary Energy Supply	15 - 20%	80 - 85%
Energy saving rate (compare to BAU scenario)	8 - 10%	15 - 20%
Total CO2 emissions	399 - 449 Million tons	101 Million tons
CO2 emission cut – down rate	17 - 26%	90%

To develop energy industry

	2021-2030	2031-2050
Crude oil exploitation volume	6,0 – 9,5 Mill.tons/yr	7,0 – 9,0 Mill.tons/yr
Natural gas exploitation volume	5,5 - 15 Bil.m3/yr	10 - 15 Bil.m3/yr
Coal exploitation volume	41 - 47 Mill.tons/yr	39 Mill.tons 2045 33 Mill.tons 2050
Clean energy produce and development (Green hydrogen manufacturing)	100 - 200 Ktons/yr	10 - 20 Mill.tons/yr

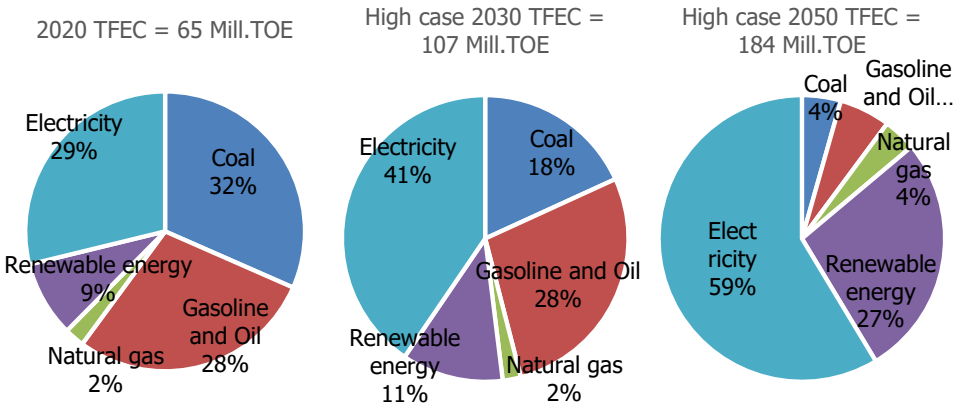
Energy Demand

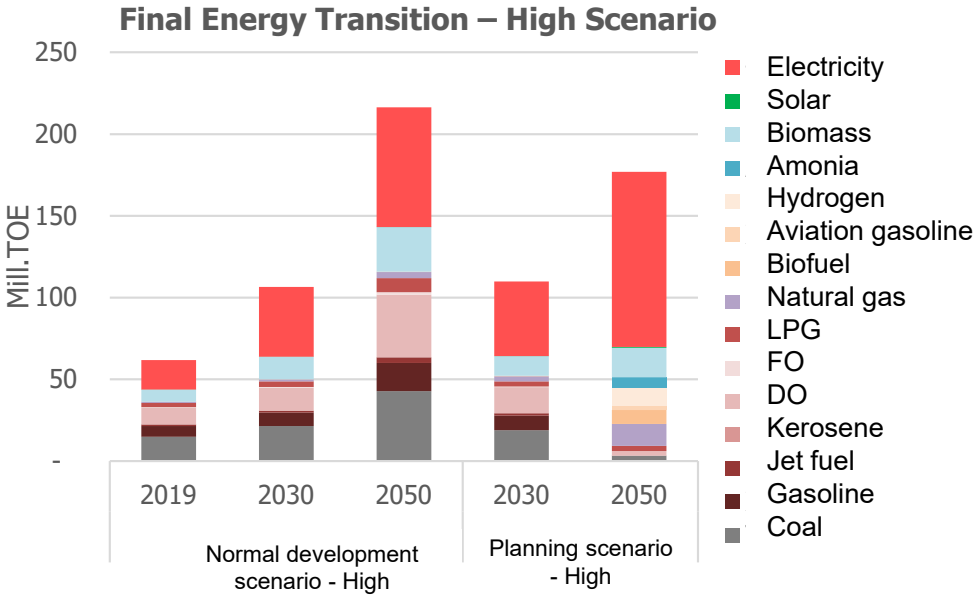
- TFEC will increase to 107 million TOE by 2030 and target about 165-184 million TOE by 2050.
- Energy savings of 10 million TOE by 2030, equivalent to 8.4% compared to the normal development scenario.

Demand of Total final Energy Consumption Unit: Mill.TOE

	2020	Planning scenario - Base			Planning scenario - High		
		2025	2030	2050	2025	2030	2050
Coal	20.5	17.9	19.5	7.7	17.6	19.5	8.1
Gasoline*	5.9	7.7	9.0	0.1	7.7	8.9	0.1
Jet fuel*	0.8	1.2	1.5	0.0	1.2	1.5	0.0
Kerosene	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DO*	8.8	13.0	16.1	2.8	13.0	16.0	3.0
FO	0.4	0.4	0.4	0.0	0.4	0.4	0.0
LPG	2.6	2.8	3.0	3.5	2.8	3.0	4.0
Natural gas	1.5	1.0	2.0	5.6	1.3	2.2	6.9
Biofuel	0.1	0.2	0.3	10.2	0.2	0.3	9.8
Aviation gasoline	0.0	0.0	0.0	3.0	0.0	0.0	3.5
Hydrogen	0.0	0.0	0.0	11.9	0.0	0.0	12.6
Amoniac	0.0	0.0	0.0	6.1	0.0	0.0	8.6
Biomass	5.6	9.6	11.9	18.3	9.7	11.9	19.0
Solar	0.0	0.0	0.0	0.4	0.0	0.1	0.5
Electricity	18.7	28.8	43.4	95.8	28.8	43.4	107.9
Total	**64.8**	**82.7**	**107.2**	**165.4**	**82.7**	**107.2**	**184.0**

Share of TFEC





* Domestic petroleum demand excludes the amount of fuel supplied to international airlines, temporarily imported for re-export at warehouses

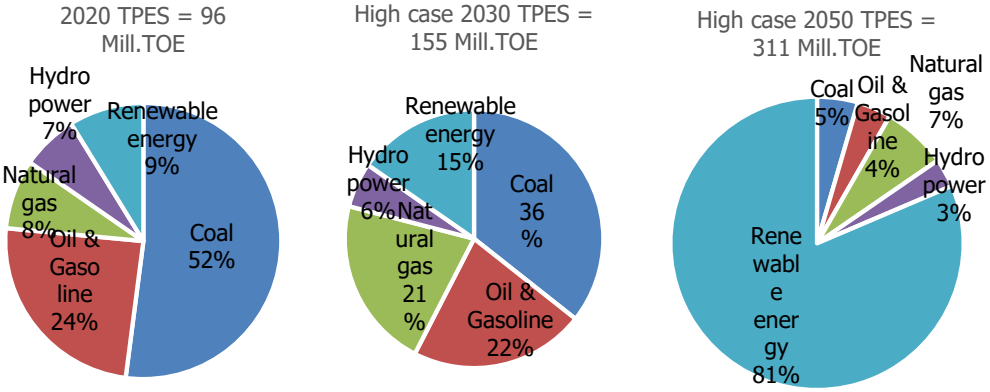
Energy Supply

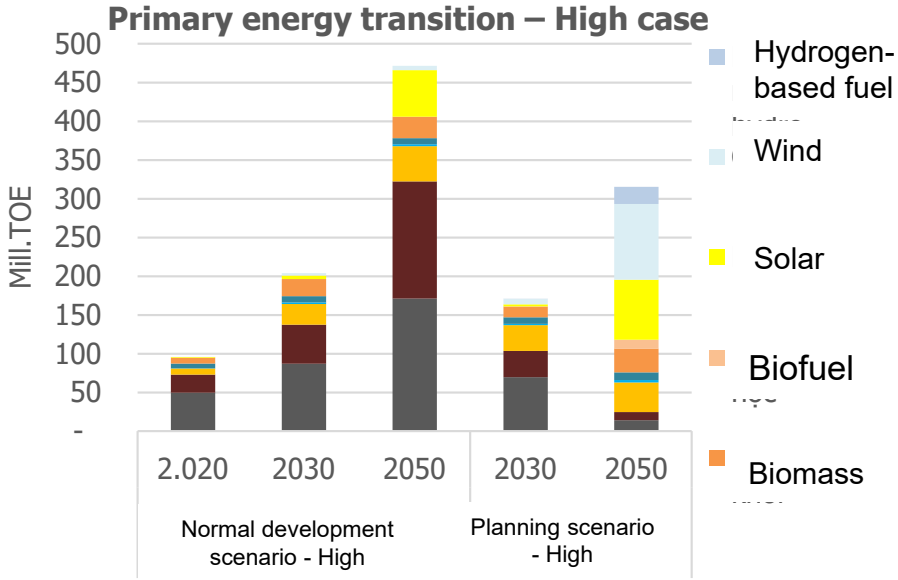
- TPES will reach 155 million TOE by 2030 and orientation of about 294-311 million TOE by 2050;
- The proportion of renewable energy will reach about 19.8% in 2030 and about 80% in 2050
- The proportion of imported fuel will be about 50% by 2030 and the orientation will be less than 15% by 2050

Total Primary Energy Supply Unit: Mill.TOE

		Planning scenario -Base			Planning scenario - High		
	2020	2025	2030	2050	2025	2030	2050
Coal	49.8	52.2	59.1	14	51.9	55.1	14
Oil	23.4	28.1	33.9	10.7	28.2	33.9	11.7
Gas	7.8	9.9	30.7	20.6	10.3	33.2	22.2
Imported Power	0.1	0.1	0.2	0.2	0.1	0.1	0.2
Hydro power	6.3	8.2	8.7	9.9	8.2	8.7	9.9
Biomass	7.4	10.4	14.1	30.9	10.4	13.8	31.5
Biofuel	0.1	0.2	0.3	13.3	0.2	0.3	13.3
Solar	0.8	2.5	2.9	80.9	2.5	2.9	82
Wind	0.1	2.9	4.9	95.4	2.9	6.7	103.5
Hydrogen-based fuel	-	-	0	17.8	-	0	22.8
Total	**95.8**	**114.4**	**154.8**	**293.7**	**114.6**	**154.8**	**311.1**

Share of TPES





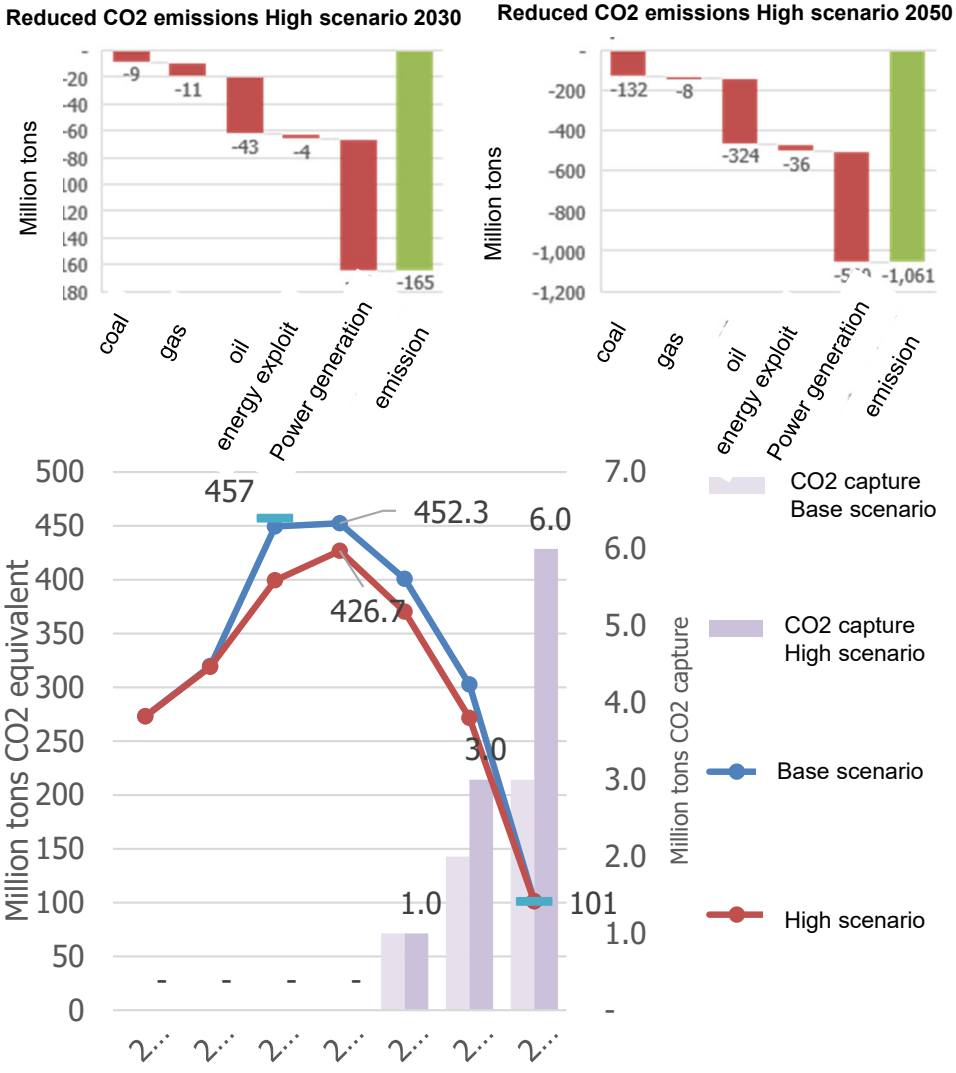
CO2 emission

CO2 Emission Unit: Million tons CO2 equivalent

Scenario	Item	2020	2025	2030	2035	2040	2045	2050
Base	Coal	84	74	80	81	74	64	32
	Gas	4	2	5	7	9	11	13
	Oil	55	75	90	94	87	69	18
	Energy exploitation	16	14	21	17	12	11	10
	Power generation	115	155	254	254	220	149	31
	CO2 capture	0	0	0	0	1	2	3
	CO2 net emission	**273**	**320**	**449**	**452**	**401**	**303**	**101**
High	Coal	84	72	80	81	76	66	33
	Gas	4	3	5	7	10	13	16
	Oil	55	75	89	95	92	77	20
	Energy exploitation	16	14	21	17	12	11	10
	Power generation	115	155	204	226	182	107	27
	CO2 capture	0	0	0	0	1	3	6
	CO2 net emission	**273**	**319**	**399**	**427**	**370**	**272**	**101**

- ✓ Greenhouse gas emissions will reach about 399-449 million tons in 2030 and about 101 million tons in 2050.
- ✓ Emission levels are in line with the emissions target of the Climate Change Strategy to 2050 to achieve PTR0.

Reduced CO2 emissions compared to the normal development Scenario



Solutions and implementation organization

SOLUTIONS ASSURING ENERGY SECURITY AND ENERGY TRANSITION

- Efficient use of energy
- Electrification in economic sectors
- Renewable energy development
- Developing new energy sources (H2, green NH3)
- Carbon capture, use and storage

2025

- Ensure efficient exploitation and use of domestic oil, gas and coal resources
- Construction of LNG import infrastructure
- Encourage self-consumption and co-generation of electricity
- 50%-70% of households have access to high-efficiency technology

2030

- Domestic oil and gas exploitation
- No new coal-fired power development
- Renewable power: 6 GW offshore wind, 22 GW onshore wind, 22.4 GW . LNG Gas Power
- 100% E5 gasoline in transportation
- 70% of households have access to high-performance technology
- Producing, importing and trading in coal-fired boilers is not allowed
- Enforce green building standards
- Guaranteed petroleum reserve over 75-80 days of net import

2040

- Continue to convert fuels for thermal power plants: H2, NH3, biomass
- HVDC Power Transmission
- 90% of households have access to high-performance technology
- Promote production and use of high-grade biofuels in transportation
- Electric vehicles 10-20%
- Implementing a carbon neutral building
- Green H2 production capacity 6 million tons
- Producing non-energy products from coal
- CO2 capture capacity 1 million tons

2050

- Completely convert fuels for existing thermal power: H2, NH3, biomass
- RE: offshore wind 70-91 GW, onshore wind 66-77 GW, Solar power 169-189 GW
- Using 100% green fuel in transportation
- Electric vehicles 40-50%
- 100% of households have access to high-performance technology
- 100% new building construction is carbon neutral
- Green H2 production capacity 10-20 million tons
- CO2 capture capacity 3-6 million tons

Part 2 Energy Transition Plan of Viet Nam (electricity production aspect)

- Energy Transition Plan of Viet Nam (electricity production aspect)
- Challenges to facilitate the enegy transition in power generation

Capacity expansion in the THE NATIONAL ELECTRICITY DEVELOPMENT PLANNING OF 2021 - 2030 AND VISION FOR 2050 (MW)

Category	2025	2030	2035	2040	2045	2050
Peak demand	59,318	90,512	124,857	159,039	187,496	208,555
Total installed capacity	97,234	150,489	242,159	354,089	470,712	573,129
Coal thermal power	28,757	30,127	23,137	15,337	3,635	0
Coal-fired thermal power using biomass/ammonia	0	0	6,990	14,790	18,642	0
Coal-fired power completely converted to biomass/ammonia	0	0	0	0	6,990	25,632
Combined cycle gas turbine and domestic gas thermal power	7,076	14,930	7,900	7,900	7,900	7,900
Domestic gas-fired thermal power with Hydrogen	0	0	7,030	7,030	0	0
Domestic gas-fired thermal power fully hydrogen-converted	0	0	0	0	7,030	7,030
Combined cycle gas turbine using LNG	2,700	22,400	22,700	12,200	0	0
Hydrogen-fired LNG combined cycle gas turbine	0	0	2,700	13,200	21,900	4,500
Fully hydrogen-converted LNG combined cycle gas turbine	0	0	0	0	3,500	20,900
LNG ICE	0	300	9,000	23,100	33,900	46,200
Oil thermal power	1,221	0	0	0	0	0
Hydropower	26,795	29,346	33,654	34,414	35,139	36,016
On the shore wind power	13,416	21,880	30,400	46,100	62,250	77,050
Offshore wind power	0	6,000	18,000	45,500	79,500	91,500
Solar power/Rooftop solar power/self-consumption solar power sources	10,136	12,836	56,866	94,866	135,824	189,294
Biomass and other RE	1,180	2,270	3,290	4,960	5,210	6,015
Pumped hydroelectric energy storage and storage batteries	50	2,700	9,450	19,950	33,750	45,550
Import	4,453	5,000	7,742	10,242	11,042	11,042
Co-generation	1,450	2,700	3,300	4,500	4,500	4,500

(No. 500/QD-TTg)

In the high operating scenario, the total installed capacity of power plants will reach 150,489 MW in 2030 and 490,529-573,129 MW in 2050 (excluding imported electricity, renewable energy serving production of new energy). The share of the capacity of RE sources (excluding hydropower) will increase from 27% in 2030 to 59,5% - 62.4% in 2050. The emissions of CO_2 will reach 253 million t in 2035, 147 million tCO_2-eq in 2045, and an estimated 31 million tCO_2-eq in 2050 which will ensure meeting Viet Nam's commitments at COP26.

THE ROADMAP FOR FUEL TRANSITION FOR COAL-FIRED POWER PLANTS

1. Not building new coal power plants after 2030
2. Converting biomass and ammonia co-firing fuels for existing coal-fired power plants
3. Early retirement for existing coal-fired power plants that are not able to covert to co-firing fuels and fully amortized.

The costs incurred by the fuel conversion

1. Cost of prolonging life
2. Cost of renovation to be able to cofire with other fuels
3. Efficiency reduction rate in the extension life period and when co-firing with co-firing fuels
4. Co-firing fuel prices

- 20% ammonia combusting increases the LCOE by 34%
- Cofiring 10% biomass increases the LCOE by 19%
- Cofiring 15% biomass increases the LCOE by 20%

compared to those of 100% coal firing plants.

Challenges to transform Gas fired thermal power plants fuel

The costs incurred by the fuel conversion

1. Costs incurred in the process of co-firing combustion with hydrogen fuel
2. Reduction rate performance in the extended life period
3. Rate of reduction in efficiency during co-fired combustion and fuel conversion
4. Hydrogen price

Existing turbines can be co-fired to burn with Hydrogen at a rate of 30-50% and plan to use 100% hydrogen after 2030.

With a co-fired combustion rate of 30% hydrogen or less, there is no need to renovate turbines, just renovate the fuel supply and control system of a plant.

Challenges and solutions to facilitate RE deployment

Challenges

Since a **large amount of RE sources, the electricity system is encountering many challenges.**

An imbalance of source - load by regions

In the **noon's off-peak hours** when the **load tends to decrease**, the **solar power** sources generate maximum output, **causing oversupply and overload.**

Solutions

Expand pumped storage hydropower, starting **expansion of existing sites** and prepare **new sites** in mountainous regions

Focus on the sites most conducive to produce **high plant load factors for wind (and solar) power**

Consider **solar PV with battery**

Challenges to facilitate BESS and Hydrogen

Challenges

BESS

The application and development of BESS can be **challenging** that ranges from the **system design** and **battery sourcing** to commissioning and testing to meet grid compliance requirements. Some other challenges include:

- Resources for maintenance and optimisation to maintain BESS for a long lifetime and high performance
- The efficiency of **BESS systems is less than 100**%, so it will be necessary to increase the electricity output from other electricity sources in the system to compensate for the output consumed in the charging / discharging process of BESS.
- The **investment in BESS to limit grid overload** caused by RE sources is only a temporary solution.

Hydrogen production from RE

- Hydrogen production, transportation, and storage **infrastructure** are **not yet developed**.
- Hydrogen production **technology has not been completely developed**, leading to the **high cost** of hydrogen production and not **yet being able to deliver** economic efficiency.
- **Mechanisms, policies, and incentive**s for the development of hydrogen and safety standards and regulations on the production, storage, transportation, and use of hydrogen **have not been available**.

Solutions to facilitate BESS and Hydrogen

Solutions

- Facilitate application and deployment of BESS and production of hydrogen produced from RE sources, including:

o **In-depth studies on roadmaps, technologies, sites and models** for application and policies to facilitate the investment and deployment of BESS and hydrogen technologies in Viet Nam

o **Introduce incentive policies** in testing phase of technologies, with strong foreign funding

Thank you!