A-2 Data presentation of dimension II: Energy policy framework

A-2.1 Indicator D II-1: Political focus of energy policy

The PDP VII states as its first objective the supply of electricity „in conjunction with the national socio-economic development strategies“. As its fourth objective the PDP VII also includes the „development of power along with protection of natural resources, ecological environment and ensuring sustainable development of the country.“

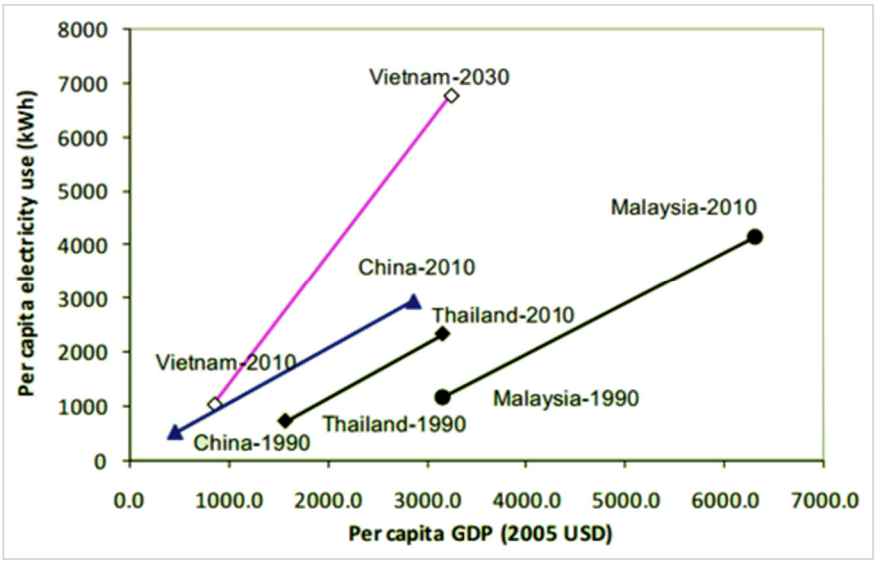
A-2.2 Indicator D II-2: Future electricity demand

Between 2000-2009 for every percentage point increase in growth commercial energy demands increased by more than 1.5 % (SE4all, 2012) with some sectors even recording a two-digit growth in commercial energy consumption (SE4all, 2012).

The PDP VI and PDP VII for 2005-2025 and 2010-2030 respectively envisaged rapidly increasing electrical power demand. Demand was expected to grow at an average annual rate of between 9.9-11.2 % for the 2005-2025 period with annual electricity production increasing from 97.4 TWh in 2009 to 227-305 TWh in 2020, and 695-834 TWh in 2030.

Most analysts seem to agree and expect massive increases in electricity demand of 14 %/a so that demand will have tripled between 2015 and 2025 (Grantham, 2015). Others criticised the PDP VII demand scenario for being unrealistically high which would force too many coal and nuclear capacity expansions into the energy system. Green ID has compared the PDP VII assumption with other countries in the region: The plan expects Viet Nam’s energy intensity to increase from 1,000 kWh / capita to 7,000 kWh/ capita (Figure A-8) which would correspond to the average per capita demand of Germany (Wold Bank, 2015i).

Figure A- 8: Viet Nam’s power consumption per capita according to PDP VII in comparison with other countries in the region



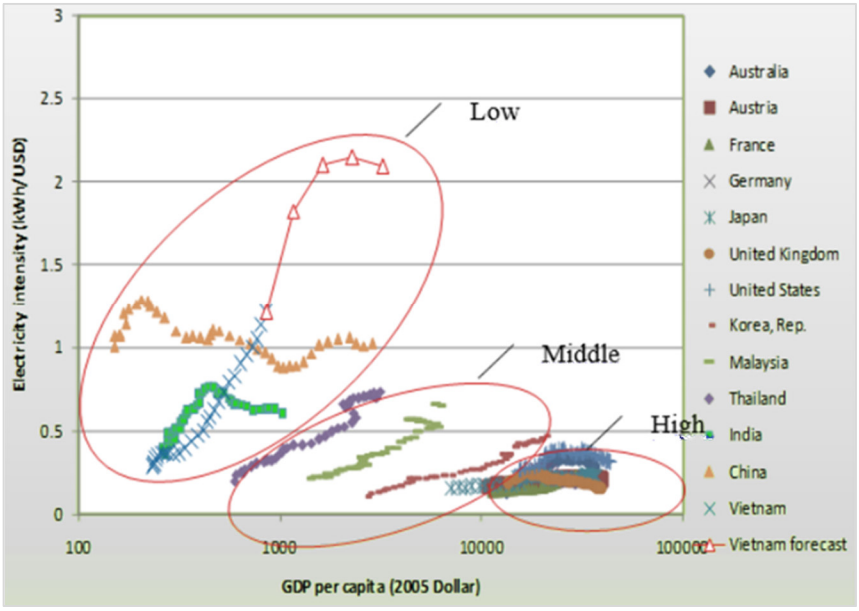
Source: Green ID (2015)

Whilst in 2012 per capita electricity demand in Vietnam was 1,273 kWh/capita (Wold Bank, 2015b), the RE-DS assumes a power demand in 2050 of 1,051 TWh. Per capita electricity consumption in this scenario

would increase to 9,700 kWh[4], comparable to today's electricity consumption levels of New Zealand (9,373 kWh/capita) or Korea (10,346 kWh/capita).

Green ID also presented the PDP VII energy intensity by GDP compared to other countries (Figure A- 9). The electricity intensity per unit of GDP would increase to levels above 2 kWh/USD, higher than even in electricity intensive economies like Thailand (below 1 kWh/USD) or China (around 1 kWh/USD).

Figure A- 9: Energy intensity by GDP per capita of nation groups in the world



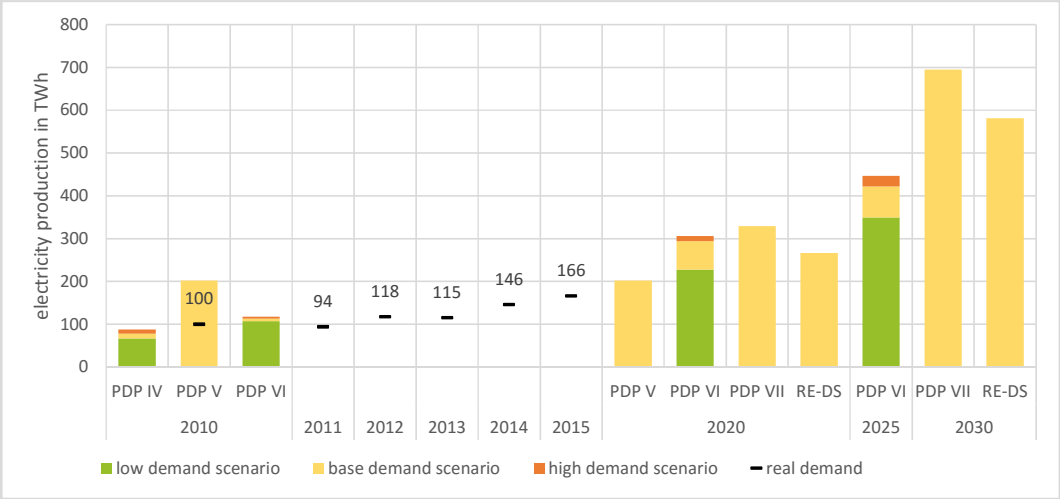
Source: Green ID (2015)

Viet Nam's power demand growth slowed down due to lower economic growth rates than originally expected. The country's demand for electricity is around 166 bn kWh in 2015 (RE-DS), compared with 194 bn-210 bn kWh forecast by the government in 2011 (PDP VII). Annual average growth slowed to 5.63 % from 2011 through 2014, compared with 7.26 % in the 2001-2010 period (WSJ, 2015).

The Renewable Development Strategy has reduced the demand scenarios for the immediate future of 2020 but is assuming an increase of Viet Nam's electricity demand till 2050 to more than 1 PWh. Figure A- 10 compares the power demand scenarios of PDP IV, V, VII and RE-DS with real developments until 2030.

[4] Underlying for the calculation is an population estimation for 2049 of 108,707,000 (General Statistics Office, 2011)

Figure A- 10: Electricity production in Power Development Plans IV-VII and the Renewable Development Strategy 2010-2030 compared to real demand



Base and high demand scenarios are presented as stacked beyond the green low demand scenario.

PDP: Power Development Plan, RE-DS: Renewable Development Strategy

Source: own illustration based on VUSTA (2007)

A-2.3 Indicator D II-5: Energy efficiency targets by sector

Viet Nam's National Climate Change Strategy (NCCS, 2011, p.2) stresses the importance of energy efficiency for reducing greenhouse gas emissions. Energy efficiency could be achieved by reducing the energy subsidies (see p.63) as is planned by the Viet Nam Green Growth Strategy.

Viet Nam's economy wide energy efficiency is rather low. Based on purchasing power parity Viet Nam produces a GDP of 560,000 USD per GWh primary energy use whereas Germany is at 910,000 USD. Based on nominal values it is even worse: 230,000 USD (Viet Nam) vs. 1,015,000 USD (Germany). The energy demand scenarios suggested by the government are very high, and energy demand is claimed to increase far above the economic growth rate. According to these scenarios energy efficiency in Viet Nam would decrease by factor 3 (see Table A- 3) until 2030 LEEN GmbH (2015).

Table A- 3: Development of energy demand and GDP in Viet Nam

	Growth rate	2011	2020	2030
GDP [billion USD]	7,5%	122	234	482
Energy demand [TWh]	13%	535	1,607	5,456
GDP per GWh [USD]		230,000	145,000	88,000

Source: LEEN GmbH (2015)

The Viet Nam Energy Efficiency Program (VNEEP) is a ten-year program, which was approved in April 2006 by the Prime Minister. It includes multiple energy efficiency targets including savings of 3 – 5 % during the period 2006 – 2010 (Phase 1e). By 2010, about 4 % of the total energy consumption was saved compared to a business-as-usual (BAU) scenario (LEEN GmbH 2015). For Phase II (2012-2015) the VNEEP targets for savings of 5-8 % of total national energy consumption compared to BAU levels. In order to reach this goal an energy efficiency law was passed in 2011.

Viet Nam currently has no sectoral efficiency targets (APERC 2013).

Table A- 4: Viet Nam energy efficiency targets

	2006	2010	2011	2015	2020	2030
Electricity elasticity coefficient/ GDP		"current": 2		1.5	1.0	
VNEEP energy savings goal (compared to the BAU case)	3-5 %		5–8 %			

Source: PDP VII

A-2.4 Energy capacity development

Future capacity expansion is laid out in the PDP VII (2011) which is expected to be revised in 2016 and in the RE-DS (2015).

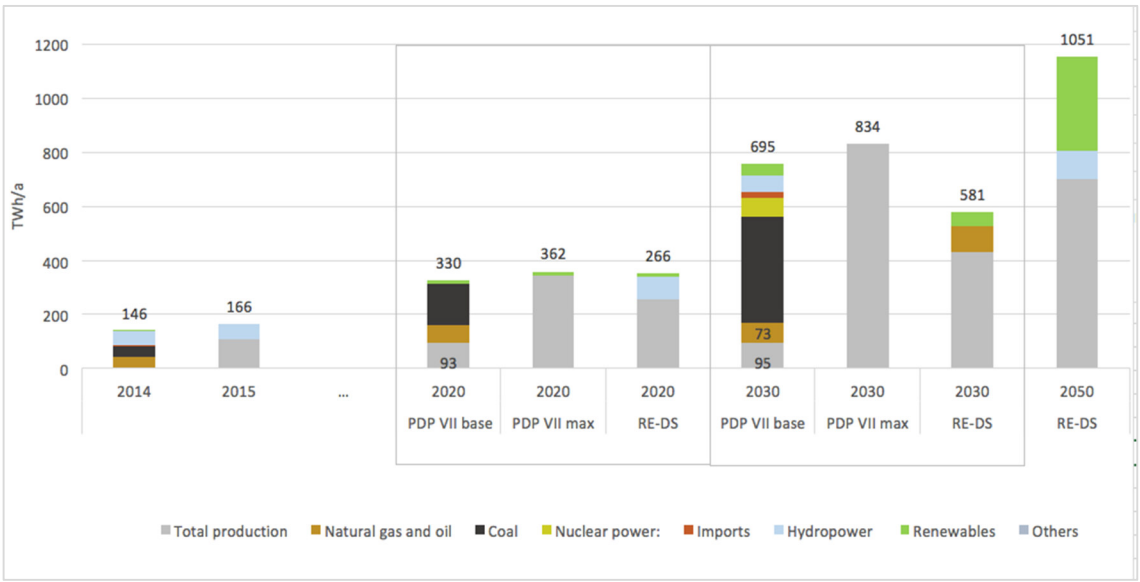
A-2.4.1 Fossil fuel targets

According to the PDP VII, fossil fuel capacity is expanded and most of the capacity additions are planned in the coal sector.

The latest RE-DS reduces energy demand projections by 63 to 96 TWh compared to PDP VII but does not provide new projections for the associated capacity developments. Therefore, in the following we will therefore present the previous PDP VII fossil fuel targets, even though they do not correspond to the RE-DS demand scenario.

Figure A- 11 shows a comparison of PDP VII and RE-DS scenario to the extent that data is available.

Figure A- 11: Comparison of the power production targets of PDP VII and RE-DS by source



Source: Own illustration based on PDP VII and RE-DS

Table A- 5 provides an overview of the most relevant targets. PDP VII proposed a significant expansion of coal power. If the expansion goes ahead as planned in PDP VII, CO_2-emissions are likely to increase tenfold by 2030 (KfW, 2015). Construction work has started on one of the major planned coal plants: Vinh Tan 1 (1,200MW). Five Chinese banks provided a syndicated loan of USD 1.4bn, accounting for 80 % of the total project cost (Bloomberg NEF, 2015).

Table A- 5: Fossil fuel targets according to PDP VII

	2020	2030
Coal production percentage	*46,8 %* [2]	
Gas in MW	10,400 MW	11,300 MW
Production percentage	*24 %* [2]	
In TWh (% of total)	66 TWh (20 %)	73.1 TWh (10.5 %)

Sources: Wold Bank (2015a)

In a statement in January 2016 the government announced that future energy planswill follow "international commitments on cutting emissions"and that all plans of coal-fired power plants will be reviewed (Climate Home, 2016). Since the INDC includes per capita emissions of 7 tCO_2e, the effect of this commitment on energy policy would need further analysis.

A-2.4.2 Nuclear power targets

The development of nuclear power in Viet Nam shall „*ensure stable power supply in the future as the primary sources of domestic energy will be depleted*" (PDPVII 2011) EVN (2015b) states that "*nuclear power development is essential in replacement of thermal power plants using fossil fuels as well as reduction of emissions of greenhouse gases. At the same time, nuclear energy is considered as a solution to meet the power demand of the country in the future."* The Government of Viet Nam considers nuclear energy a green energy technology like solar, wind and tidal energy (VGGS, 2012).

The main drivers behind nuclear energy investment are energy security/import security, growing energy demand and climate change.

The nuclear power development plan (NP-DP) was approved by the government in 2007[5] and set a target of 8 GW of nuclear capacity by 2025. The plan specifies that by 2050, nuclear electricity will account for about 15–20 % of total commercial energy consumption (Grantham, 2015). PDP VII states that the first nuclear power plant in Viet Nam is supposed to enter into operation in 2020 then covering about 10.1 % of electricity production in 2030 (Zimmer et al. 2013). Table A- 6 shows the status of the nuclear plans as of 2015.

Table A- 6: Nuclear Power Capacity Development plans in Viet Nam

	2019	2020	2030
Capacity plan according to Power Master Plan VII		8 GW [1]	
Construction plan as of 2015	Start of construction	2 GW (Ninh Thuan 1)	
Electricity production			70,5 TWh [1]
Share in electricity production		2.1 % [2]	10.1 % [1]

Sources: (1) PDP VII; (2) Wold Bank (2015a)

[5] Decision No. 1855/QD/TTg (2007) Approving the National Energy Development Strategy of Viet Nam for the period up to 2020 with outlook to 2050

There are two nuclear power stations in the construction and concrete planning phase. Calls for a radioactive dumping site have been raised (Tuoitrenews, 2015b), but so far no site has been publicly communicated.

Ninh Thuan 1 nuclear power plant

Russia has agreed to finance and build 2,400 MWe of nuclear capacity in Viet Nam. The first reactor Ninh Thuan 1, with a total capacity of 2,000 megawatts (2x1,000) was bought from Russian nuclear service provider ROSATOM. The plant's location is 340 km east of Ho Chi Minh City in Phuoc Dinh. The reactor is planned to be cooled with sea water and the uranium is imported (IE, 2014). Ninh Thuan 1 has been delayed several times. The original start was planned for 2014, with a scheduled start of operations in 2020. In 2015 the government announced to start construction in 2019 (WSJ, 2015) expecting to complete the plant by 2024 (Tuoitrenews, 2015b).[6]

Ninh Thuan 2 nuclear power plant

Japan has agreed to provide the hardware for the 2000 MWe (2x1,000) Ninh Thuan 2 power station at Vinh Hai.

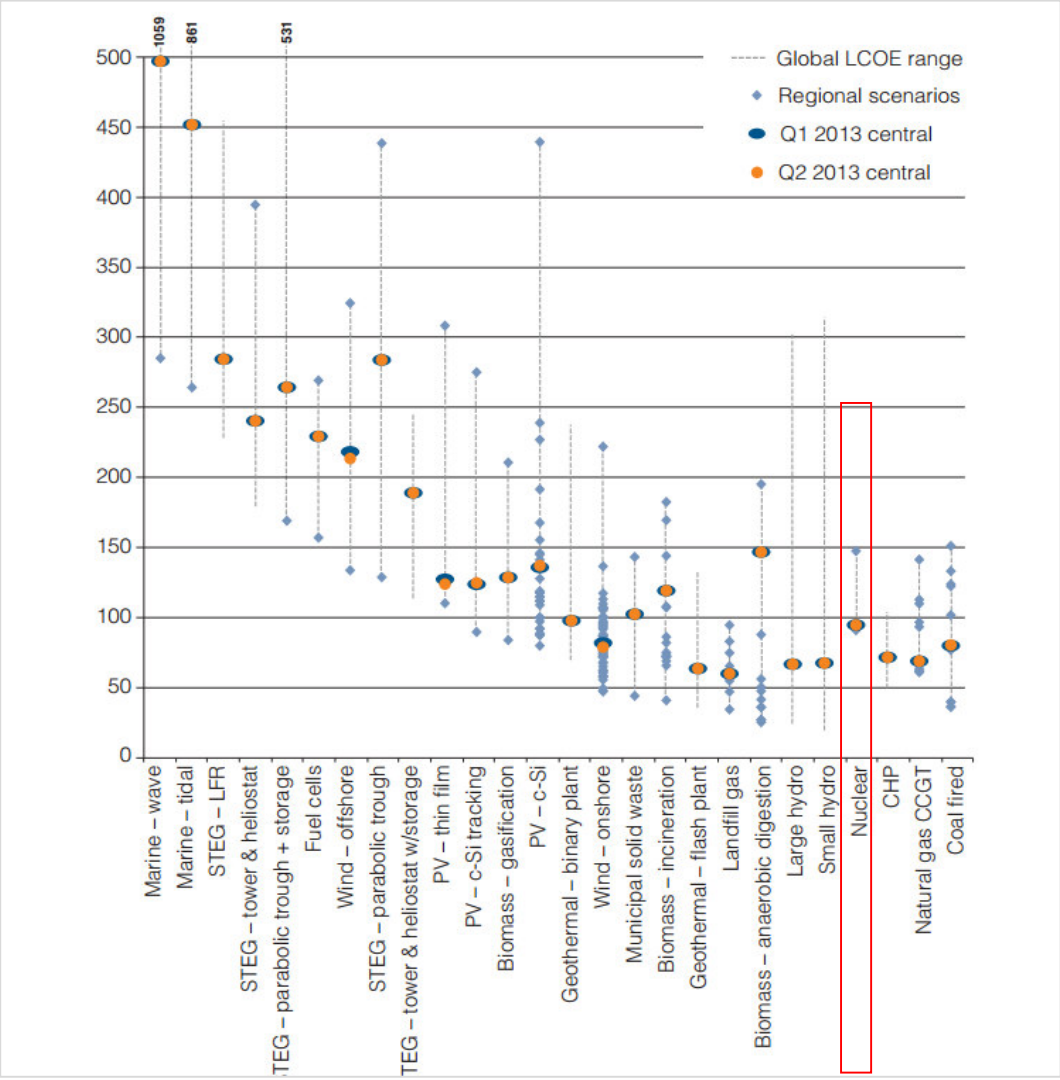
Costs and LCOE of the Ninh Thuan power plants

The construction cost of the two plants, with a total capacity of 4,000 MW a year, was estimated in 2008 at VND200 trillion (USD 9.2 bn) (Tuoitrenews, 2015b). An financing agreement for up to USD 9 bn finance was signed in November 2011 with the Russian government's state export credit bureau, and a second agreement for USD 500 m loan covered the establishment of the Centre for Nuclear Energy Science & Technology jointly by Rosatom and MOST (WNA, 2015).

The Vietnam Atomic Energy Agency (VAEA) project cost assessment assumes that Ninh Thuan 1 is feasible at an electricity price of 7.10 USD ct/kWh in the base scenario and at up to 8.0 USD ct/kWh for sensitivity analysis (VAEA, 2014). This would be considerably below international average LCOE for nuclear which is ranging globally between 9,1 and 147 USD ct/kWh (Bloomberg NEF, 2013n) as shown in Figure A- 12.

[6] EVN in contrast claims that they started construction of Ninh Thuan 1 in 2014 (EVN, 2015b).

Figure A- 12: Global levelized cost of nuclear energy in the second quarter 2013 (USD/MWh)*



*the given range is an average scenario and does not reflect actual maximum and minimum values

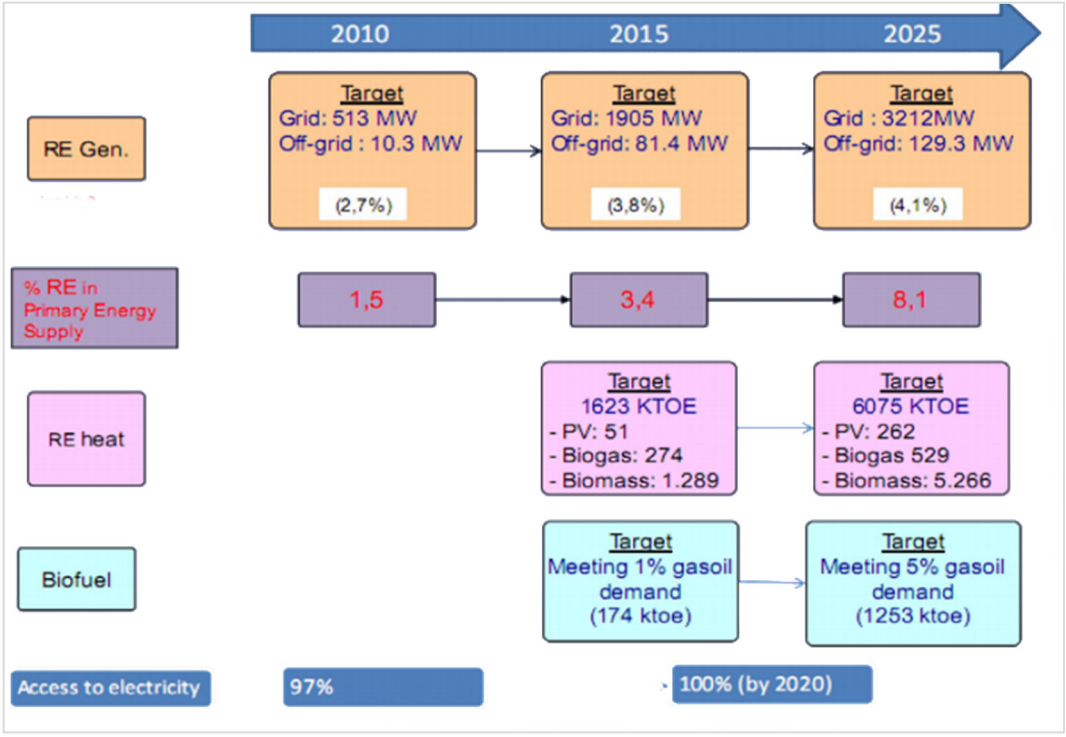
Source: Bloomberg NEF (2013n)

Assuming an employment factor of 16 for construction and 0.33 for operation and maintenance as suggested by Rutovitz et al. (2009), the power plant should offer temporary construction jobs for 38,400 people and offer long-term employment for 372 persons. In the absence of a planned waste disposal site, the employment created at the waste disposal site is not included.

A-2.5 Indicator D II-3 & 6:Renewable energy targets

Viet Nam's RE targets were laid out for the first time in the National Energy Strategy (2007) establishing a 3 % RE target in commercial primary energy by 2010 and of 5 % by 2020. The National Climate Change Strategy 2011 (Decision No: 2139/QD-TTg) sets for the share of renewable energy in total commercial primary energies a target of 5 % for 2020 and of 11 % for 2050 (NCCS, 2011). The first technology specific RE targets were introduced by the Power Plan VII in 2011. According to PDP VII Viet Nam aims to increase the share of electricity generated from renewable resources from 3.5 % of total electricity generation in 2010 to 4.5 % in 2020 and 6 % in 2030. Figure A- 13 lists the key targets.

Figure A- 13: Overview of key renewable energy targets until 2025



Source: MOIT (2013b)

The Vietnamese government has a target for wind power development laid out in PDP VII of 1,000 MW (equivalent to 0.7 % of the total electricity capacity) by 2020 and of about 6,200 MW (2.4 %) by 2030. The target for biomass (co-generation in cane sugar mills) is an aggregate capacity of about 500 MW by 2020,2,000 MW by 2030; corresponding to a production percentage of 0.6 % by 2020 and 1.1 % by 2030. The Governments priority is hydropower, especially projects will multi-purposes: flood control, water supply, power production. The target is an increase of the aggregate capacity of hydropower from 9,200 MW to 17,400 MW by 2020.

The Renewable Energy Development Strategy (RE-DS) 2015 reduced the energy demand scenario of PDP VII by 63-96 TWh. The RE-DS added the first ever targets for solar with a 2050 production target of 210 TWh. The RE-DS increased the previous wind targets of PDP VII slightly and added an additional target for 2050. The wind target of 53 TWh remains far behind the solar targets. In comparison to PDP VII the RE-DS postponed the 2030 pump storage expansion plans from 5.700 MW to 2.400 MW. The RE-DS does not include plans on non-renewable power production or installed capacities.

Table A- 7: Renewable energy targets in the NCCS, PDP VII and the RE-DS

		2010	2011	2014	2015	2020	2030	2050
Power development plan VII, 2011								
Wind	In MW		30[1]			1,000	6,200	
Production percentage	*In %*					*0.7 %*	*2.4 %*	
Electricity production	*In twh*					*2.3*	*16.7*	
Solar	In MW			20				
Biomass	In MW					500	2,000	
Production percentage	*In %*					*0.6 %*	*1.1 %*	
Hydropower	In MW	9,200				17,400	146,800	
Production percentage	*In %*					19,6		
Electricity production according to demand scenario						66-70*		
Pump storage	In MW					1800	5700	
Total new RE capacity	In MW	513				3,212		
RE-production share in electricity produced	*In %*	3.5 %				4.5 %	6.0 %	
Total electricity output (lower range)	In TWh				194	330	695	
National Climate Change Strategy, 201, Decision No. 1885/2007/QD-ttg3								
% RE in total commercial primary energy supply		3 %			3.5 %	4.5 %	11 %	

		2010	2011	2014	2015	2020	2030	2050
Renewable Energy Development Strategy up to 2030 with an outlook to 2050 (2015)								
RE share in total primary energy consumption					31.8 %	31 %	32.3 %	44 %
Total electricity production					166*	266*	581*	*1051**
Total hydropower	In TWh				56	90	96	*104**
Pump storage	MW						2,400	8,000
Wind	In TWh				0.18	2.5	16	53
Production percentage	*In %*					*1 %*	*2,7 %*	*5 %*
Solar	In TWh				0.01	1.4	35.4	210
Production percentage	*In %*					*0.5 %*	*6 %*	*20 %*
Biomass	In TWh				0.6	7.8	37	85
Production percentage	*In %*				*1 %*	*3 %*	*6.3 %*	*8.1 %*
Renewable portfolio standard						3 %	10 %	20 %
Electricity production from RE sources – total	In TWh				58	101	186	452
Production percentage	*In %*				*35 %*	*38 %*	*32 %*	*43 %*

[1] International Copper Association Southeast Asia Ltd (ICASEA) (2014) *** own calculation based on other data provided.***

Source: NCCS 2011, MoIT (2011), RE-DS (2015)

A-2.6 Indicator D II-7: Grid condition and expansion

There are two main lines built as 500 kV circuits from North to South. They have a capacity of 2,300 MW. According to EVN (2015b) further improvements of these transmission capacities are planned for 2015.

A-2.7 Indicator D II-8: Investment in the energy sector

Sectoral representatives assume that PDP VII would require investments of USD 50 bn by 2020 (GIC/AHK, 2015). Media reports state that EVN was expected to mobilize VND 600 trillion (USD 27.51 bn) for the national power grid development alone in 2016-2020 (VietNamNet Bridge, August 2015).

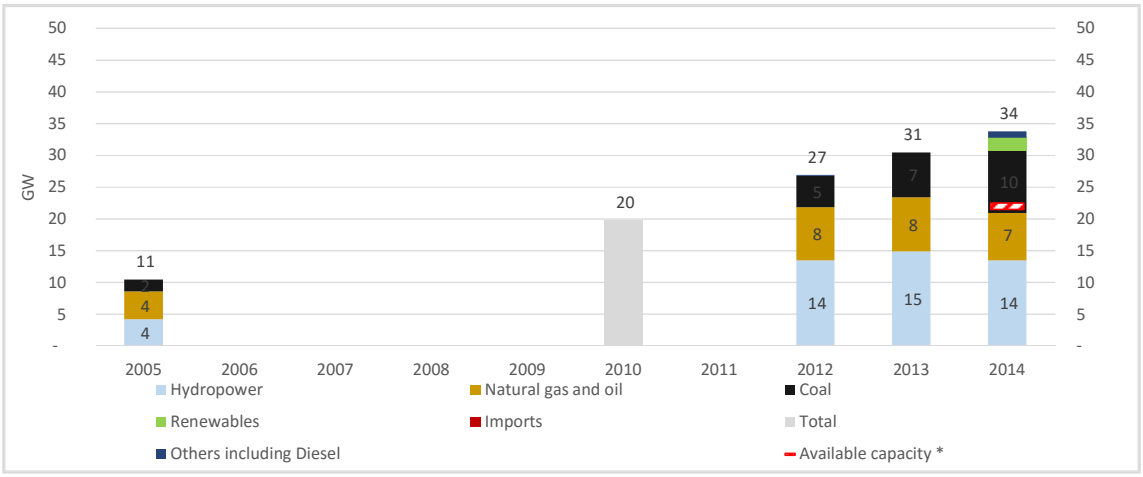
Financing of the energy sector is considered difficult, as donors with Viet Nam having reached lower-middle-income levels will withdraw their support steadily. Energy subsidies make the financial situation of EVN difficult, as EVN is unable to accumulate sufficient investment capital from retained earnings and to pay energy generated by independent power providers (UNDP, 2012).

A-3 Data presentation of dimension III: Electricity sector set-up

A-3.1 Installed capacity

As shown in Figure A- 14 the electricity production capacity installed in Viet Nam in 2012 was 27 GW (EVN, 2013b), by 2014 this had increased to 34 GW (Bloomberg NEF, 2015) (Figure A- 14). Of this capacity 2.3 GW were clean energy technologies such as wind, solar, biomass, small hydro and biofuel technologies. (Bloomberg NEF, 2015).

Figure A- 14: Installed electricity production capacity until 2014 (by source)



** according to the European chamber of commerce*

Source: Nguyen et al. (2008), EVN (2013a), Bloomberg NEF (2015), GIC/AHK 2015

A-3.2 Availability of generation capacity, energy access and security of supply

The European Chamber of Commerce estimates that only about 65 % (21 to 23 GW) of the power production capacity is actually available (GIC/AHK, 2015).

Viet Nam has achieved an electrification rate of 99 % (Wold Bank 2015i). By 1995, roughly half of Viet Nam's population still had no access to electricity. To address this problem, the government set clear nationwide electrification targets the following year. Their implementation brought about rapid

improvements in the power supply, with access to electricity increasing to 93 % of the population by 2004 (ADB, 2015)

Similarly to other countries, e.g. Costa Rica[7], heavily relying on hydropower, Vietnam is facing difficulties meeting electricity demand at the end of the dry season. The availability of hydropower capacities depending on sufficient water especially towards the end of the dry season (October-April). Impacts of prolonged drought such as in 2009/10 were widely felt with widespread power cuts at times of peak demand. Demand shortfalls are expected to continue whilst climate change is causing more exceptionally dry years and additional stresses on hydroelectricity supply (UNDP, 2012). Climate-change induced droughts are already a recognizable impact for Viet Nam (Cruz et al., 2007). The government is well aware of the relationship between climate change and threats to the power supply from hydropower.[8] The EVN annual report regularly states that droughts affect energy production.[9] In the dry season and more so in periods of drought hydropower is causing considerable conflict, since hydropower plants are competing with agriculture for the same water sources (Se4all, 2012; UNDP, 2012). Hydropower is in parts extending the dry season for downstream water users until the reservoirs are filled (GreenID, 2015).

In 2011 EVN asked for VND13 trillion (USD 666.8 m) in additional government funding to operate oil-fuelled thermal plants to overcome a serious power shortage (VietNamNet Bridge 2011). The cut offs cause enterprises to maintain their own generators, raising costs and damaging Viet Nam's competitiveness (UNDP, 2012).

A-3.3 Peak demand and times

Peak time analysis is helpful to identify suitable efficiency measures, e.g. if peak times are occurring in times of particularly high uses of air-conditioning energy efficiency standards for cooling appliances can be effective to cap such peaks. For daytime peaks solar energy can contribute to peak energy supply. Viet Nam Peak demand in 2014 was 22.2 GW (Eurocham, 2015), 19.8 GW in 2013 EVN (2014) and 21 GW in 2012 (Siemens, 2013). Peak demand is expected to increase to 110 GW by 2030 (Siemens, 2013). Peak demand in the past was occurring during daytime hours (e.g. in May 2013 and August 2011), as well as after sunset as in November 2012 (Figure A- 15).

[7] Costa Rica resorts to electricity rationing and the burning of petroleum to compensate for the reduced hydroelectric generation in the late dry season. THE TICO TIMES News (2014)

[8] The BUR 1 states „as a result of climate change …In the last five years, decreases in the dry season surface water led to water shortages and drought in river basin downstream, hydropower reservoirs and irrigation systems" (BUR, 2014).

[9] For late 2012 and early 2013 EVN reports prolonged drought in Central Viet Nam and the West Highland (EVN, 2013b), in 2014 droughts in effecting the central region of Viet Nam (EVN, 2015).