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

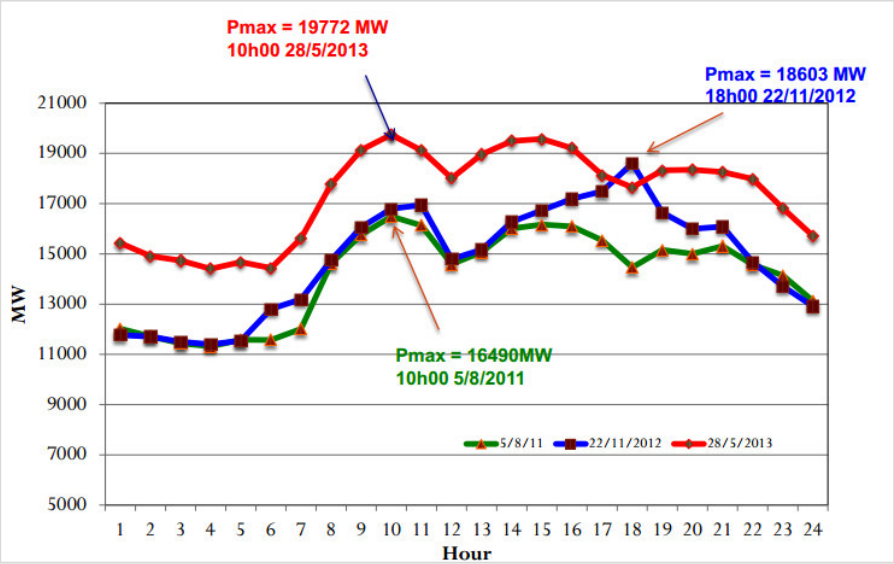
Peak time analysis is helpful to identify suitable efficiency measures, e.g. if peak times are occurring in times of particularly high uses of air-conditioning energy efficiency standards for cooling appliances can be effective to cap such peaks. For daytime peaks solar energy can contribute to peak 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).

Figure A- 15: Hourly load curve of the peak day

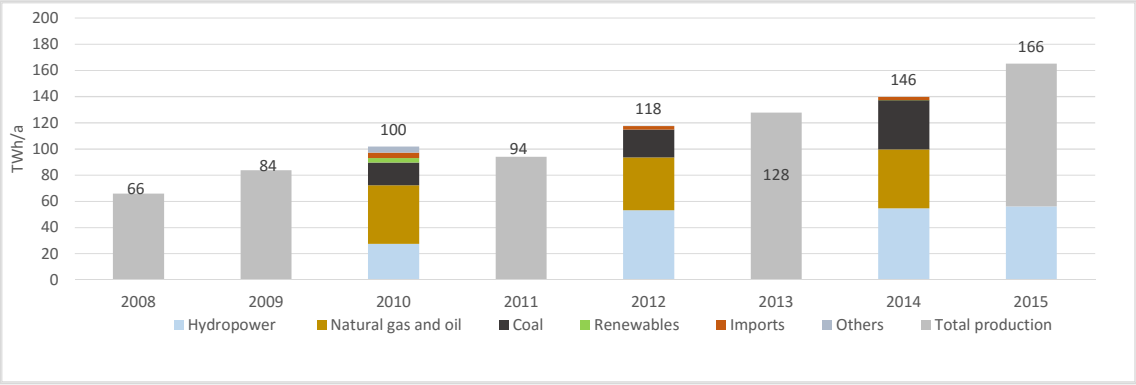


Source: EVN (2013b)

A-3.4 Electricity production

As shown in Figure A- 16 electricity production is dominated by large hydro (2014: 55 TWh/ 38 %), followed by natural gas (2014: 45 TWh/ 31 %) and coal (2014: 38 TWh/ 26 %) (Figure A- 16). Total clean energy production was 5.3 TWh (Bloomberg NEF, 2015)[10].

Figure A- 16: Historic electricity production by source



Source: Hai & Lien (2015), EVN (2012), EVN (2015)

The 2008 grid emissions factor of 0.5764 tCO2/MWh had increased to 0.6244 tCO_2/MWh by 2011 (GEF 2014). For 2011/2012 the average grid electricity emission factor for operating power plants was 0.636 tCO_2/MWh (IGES, 2015) (see Figure A- 17).

[10] Bloomberg NEF (2015) defines new low-carbon emitting clean energy technologies as wind, solar, geothermal, biomass, small hydro and biofuel technologies, but not large hydro and nuclear power.

Figure A- 17: Grid Emission Factor in Viet Nam in t-CO_2/MWh

Combined Margin EF (Average)	Combined Margin EF (Max)	Combined Margin EF (Min)	Operating Margin EF (Average)	Operating Margin EF (Max)	Operating Margin EF (Min)	Build Margin EF (Average)	Build Margin EF (Max)	Build Margin EF (Min)
0,564	0,645	0,496	**0,636**	0,788	0,488	0,491	0,624	0,342

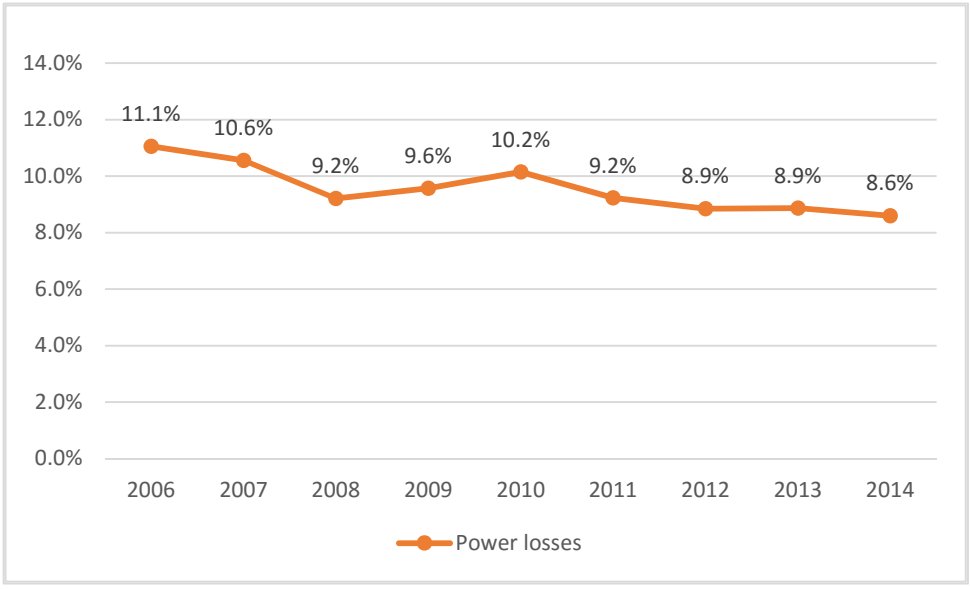
EF-Emission factor, Max-Maximum, Min- Minimum

Source: IGES, 2015

A-3.5 Indicator D III-2: Transmission losses

Transmission losses in Viet Nam have slowly decreased since 2000 but by 2014 still almost 9 % of electricity produced is lost (Figure A- 18). Losses accumulate to almost 13 TWh with an associated carbon - footprint of 8 $MtCO_2$[11]- 2.4 % in the distribution grids and 6.2 % in the transmission grids (Siemens, 2013).

Figure A- 18: Power losses (in %) between 2006 and 2014

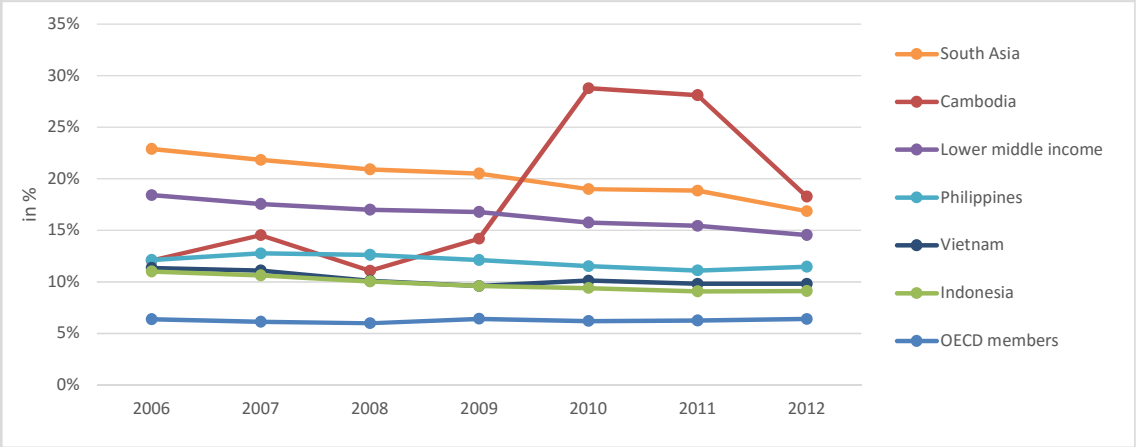


Source: own illustration based on EVN (2013b), EVN (2015b)

Transmission losses are lower than in other lower-middle income countries but significantly higher than in OECD countries (Figure A- 19).

[11] Utilizing the grid electricity emission factor of 2011/2012 of 0.636 tCO_2 /MWh (IGES, 2015).

Figure A- 19: Electric power transmission and distribution losses (in % of output) of Viet Nam and other countries

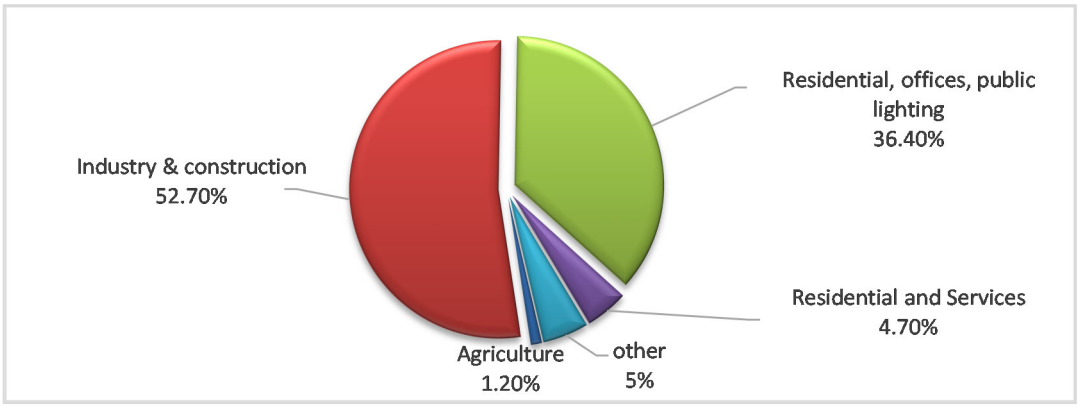


Source: World Bank (2015b)

A-3.6 Electricity demand by sector

Figure A- 20 shows the electricity consumption by sector for the year 2012. Electricity consumption is dominated by the industrial sector (53 %) followed by residential consumption (36 %). Service industry and agriculture play a minor role.

Figure A- 20: Electricity consumption in Viet Nam by sector in 2012



Source: EVN (2012)

In 2010 the largest industrial electricity consumer were the paper industry (5.4 %) followed by cement (4.6 %) and steel industry (4.2 %) (Table A- 8).

Table A- 8: Share of electricity use by industry (in % of total energy)

Electricity use	2007	2008	2009	2010
Steel	1.9	2.08	2.66	4.22
Fertilizers	0.39	0.43	0.55	0.88
Cement	2.08	2.28	2.92	4.63
Paper	2.43	2.66	3.4	5.39

Source: SE4all (2012)

A-3.7 Frequency and time of outages

The system average interruption duration index (SAIDI) of Viet Nam for 2014 was 3,134 Min (EVN 2015b), a decrease from 4,461 Min in 2014 (ENV 2013b). Large differences remain between different regions (CIF, n.d.). Momentary average interruption frequency index (MAIFI) was 2.63 per customer, decreased by 26 %.

The Bloomberg NEF Climatescope Ranking (2015) rates the power outage frequency of Viet Nam as "regular" while the power outages duration is rated as "very long".

A-3.8 Electricity retail price

Viet Nam household customers pay according to a six-level tariff schedule for rural and urban areas.[12] Low-income households receive an electricity credit of 30 kWh.[13] In 2015 average residential electricity price was set at VND 1,622/ kWh (Thanhien News 2015). Electricity prices were increased between 2014 and 2015 by 7.5 %.

According to LEEN GmbH (2015) the electricity prices for the industry and the commercial sector are not subsidised on a relevant scale. On medium voltage level the electricity prices for non-residential consumers ranges between 6 and 11 Euro ct per kWh (off peak and peak). On high voltage level the range is between 3 and 6 Euro ct (LEEN GmbH, 2015). This would correspond with the ADB (2015) claims that electricity tariffs range between USD 0.03/kWh to USD 0.16/kWh.

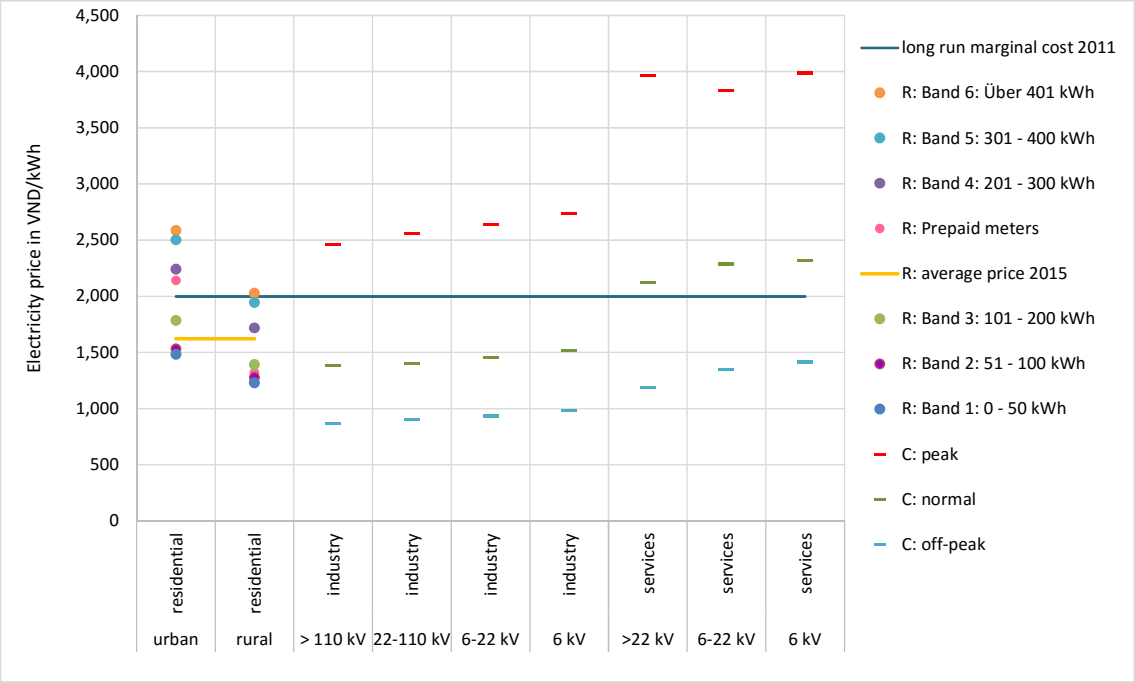
Figure A- 21 shows the tariff structure for residential, industrial and service industry customers in relation to the long run marginal costs according to Khanh (2012)[14] and the average residential price according to EVN reports (Tuoitrenews 2015a).

[12] The price is calculated as followed, e.g. for a 240 kWh urban consumer: Base tariff = (50 kWh*1.484 VND) + (50 kWh *1.533 VND) + (40 kWh *1.786 VND) = 244,519 + 10 % VAT = 268.97 VND

[13]Viet Nam introduced the lifeline tariff, and households officially classified as poor receive a cash transfer of 30 kWh consumption per month at the price of the first block. (MECON Project, n.d.)

[14] Khanh states long run marginal costs of 9.5 USD ct/kWh for 2011, these were converted into VND using a 2011 currency conversion rate of 21,033.

Figure A- 21: Electricity price tariffs of different customers in 2015



R: Residential, C: Commercial

Normal: Mo-Sat 4:00-9:30, 11:30-17:00, 20:00-22:00, Sun: 4-22:00; off-peak: Mon-Son: 22:00-4:00, Peak: Mo-Sat: 9:30-11:30, 17:00-20:00

Source: Electricity Pricing in the Residential Sector: Mecon Project (n.d.), marginal price: Khanh (2012), average residential price: Tuoitrenews (2015a).

A-3.9 Indicator D III-3: Service and quality of electricity provider

The "getting electricity" category of the Wold Bank Doing Business Index can be used as a proxy to assess EVNs service provided to its customers. In the category "getting electricity" Viet Nam ranks in the lower half at 108 of 189 countries.

Table A- 9: List of indicators comprising "getting electricity" of the World Bank Doing Business Index.

Indicator	Viet Nam	East Asia & Pacific	OECD high income	Explanatory notes
Procedures (number)	6	4.7	4.8	The number of procedures to obtain a permanent electricity connection. A procedure is defined as any interaction of the company employees or the company's main electrician with external parties
Time (days)	59.0	74.1	77.7	The number of days to obtain a permanent electricity connection. The measure captures the median duration that the electricity utility and experts indicate is necessary in practice, rather than required by law, to complete a procedure.
Cost (% of income per capita)	1,322.6	818.8	65.1	The cost is recorded as a percentage of the economy's income per capita. Costs are recorded exclusive of value added tax.

Indicator	Viet Nam	East Asia & Pacific	OECD high income	Explanatory notes
Reliability of supply and transparency of tariff index (0-8)	3.0	3.6	7.2	The reliability of supply and transparency of tariffs index is calculated on the basis of the following six components: duration and frequency of power outages, tools to monitor power outages, tools to restore power supply, regulatory monitoring of utilities' performance, financial deterrents aimed at limiting outages, and transparency and accessibility of tariffs.

Source: World Bank (n.d.-a)

The procedure is that is necessary to get electricity is outlined in Table A- 10.

Table A- 10: Procedure to get access to electricity in Viet Nam

	No.	Procedure	Time to Complete
	1	Submit application to EVN HCMC and await clearance	7 calendar days
*	2	Obtain external inspection by EVN HCMC	1 calendar day
	3	Obtain design approval and excavation permit from Traffic and Transport Department	15 calendar days
	4	Hire private firm to design and carry out external works	20 calendar days
*	5	Get design of substation certified by Fire Fighters Prevention Department	30 calendar days
	6	Obtain meter installation and final connection from EVN HCMC	7 calendar days

** Takes place simultaneously with another procedure.*

Source: World Bank (n.d.-a)

A-3.10 Indicator D III-4: Electricity Market

Viet Nam's energy sector is in transition from a single-buyer market model to a competitive retail market system.

The government began the partial restructuring of EVN in 2003, identifying several generation and distribution assets for partial privatization in a process that it referred to as equitization.

The first step in this process is the introduction of a *competitive generation power market* from 2009 onwards *followed by a competitive wholesale power market from 2017 onwards and finalized by competitive retail power market* from 2024 (Vietnam Energy, 2014). The Viet Nam competitive wholesale market (the second phase of the power market) will be introduced as a pilot in the period 2015 – 2017 (EVN 2015b).

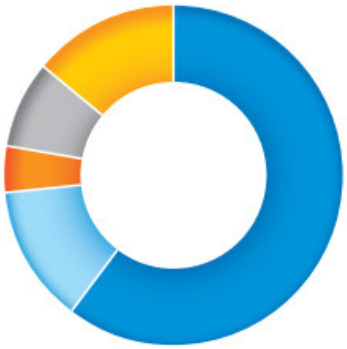
The generation segment has been opened up to build–operate–transfer (BOT) and independent power producer (IPPs) projects. The distribution sector has also been opened up to private distributors, particularly those in rural areas not covered by EVN's distribution network (ADB, 2015).

In 2014 60 % of power generation was owned by EVN, 13 % by PVN and 4 % by Vinacomin (Figure A-22). The remaining capacity was owned by local and foreign investors. The market dominance of EVN is slightly lower in terms of production numbers: EVN produced 43 % of the electricity and purchased 57 % (EVN, 2015b).

Plans exist to restructure key energy corporations such as EVN (Decision 782/QĐ-TTg of 23/11/2012), PVN (Decision 46/QĐ-TTg of 5/1/2013), and VINACOMIN (Decision 314/QĐ-

TTg of 7/3/2013) (UNDP, 2014). The generation side of EVN was reorganized into three power generation companies in 2012 based on the reorganization of EVN's existing plants. They are to be fully separated from EVN when the competitive wholesale market commences (ADB, 2015).

Figure A- 22: Power generation capacity by ownership



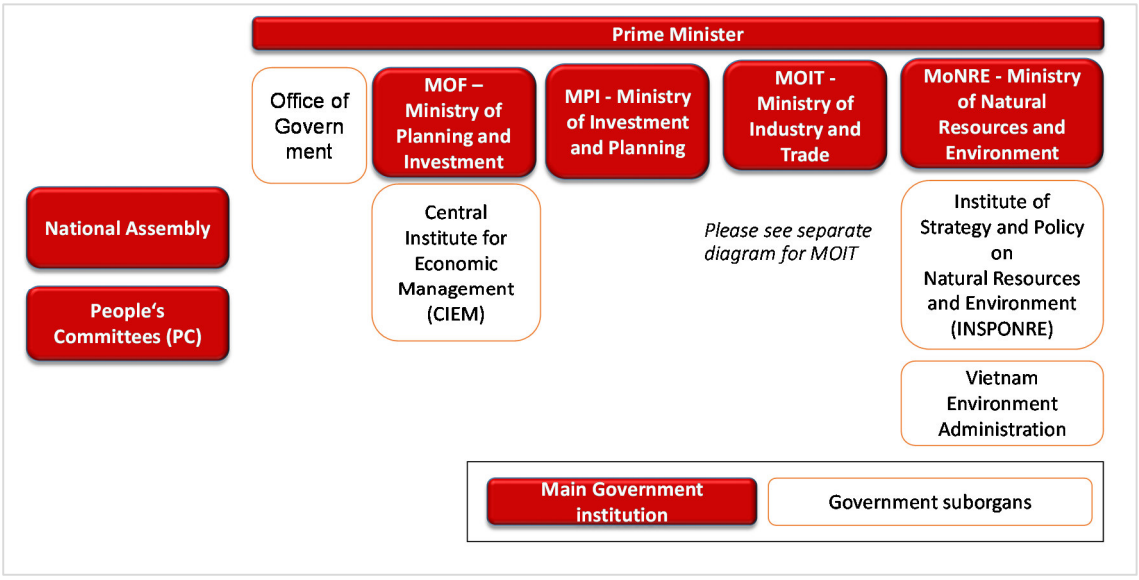
Owner	Capacity (MW)	Rate (%)
EVN	20,539.65	60.27
PVN	4,429	12.99
Vinacomin	1,485	4.37
Local investors	4,765.6	13.98
Foreign investors	2,859.5	8.39
Total	***34,080***	***100***

Source: EVN (2015b)

A-3.10.1 Institutional and market actors in the electricity sector

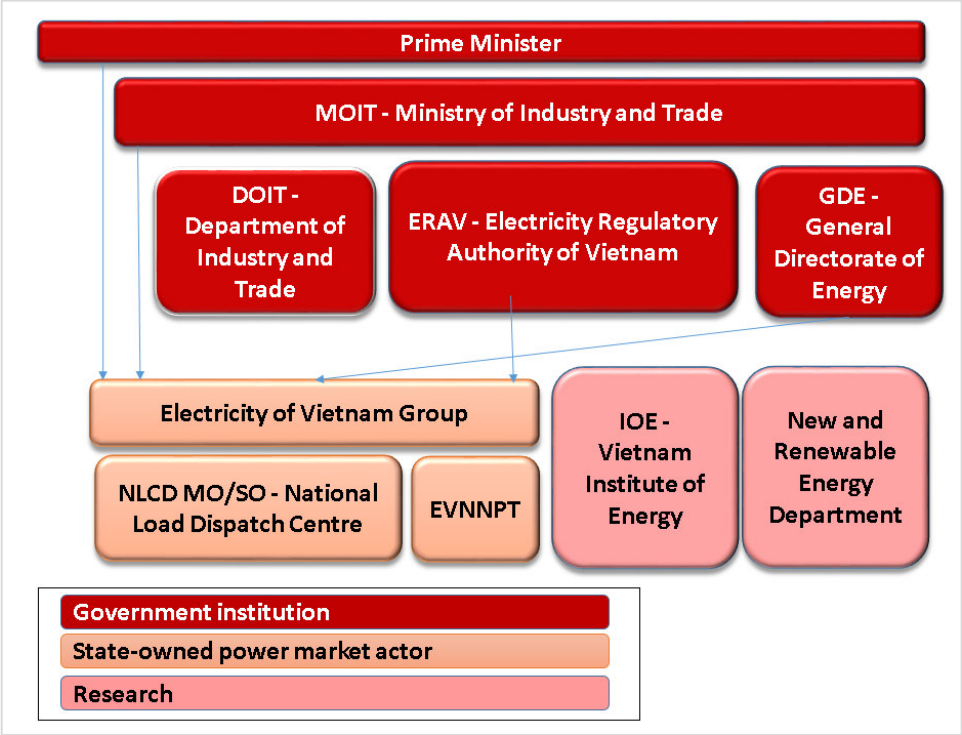
The following figures present the institutional and market set-up of Vietnam in the field of energy and climate change. Table A- 11 describes the roles and responsibilities of these actors.

Figure A- 23: Institutional framework of the energy sector in Viet Nam



Source: GIC/AHK (2015) based on EVN 2015a

Figure A- 24: Institutional framework of the energy market in Viet Nam



Source: GIC/AHK (2015) based on EVN 2015a

Table A- 11: Institutional actors around the energy market

Short	Name	Description of function
DOIT	Department of Industry and Trade	On local level DOIT supports the People's Committees with the administration of the energy sector. DOIT is supervised by MOIT and receives instructions from there. DOIT is responsible for carrying out the power master plans and the use of renewables (GIC/AHK, 2015). At the provincial level, the provincial DOITs are responsible for implementing state management directives for the energy sector, including renewable energy projects (tkn & iisd, 2012; ADB, 2015).
ERAV	Electricity Regulatory Authority of Viet Nam	ERAV is responsible for the power market establishment and supervision, power planning, tariff regulation, and licensing. (ADB,2015). ERAV a department under MOiT. This department manages and regulates electricity market-related activities (also including electricity from renewable sources (tkn & iisd, 2012).
EVN	Viet Nam Electricity Group	EVN is a state-owned enterprise, founded in 1995 responsible for developing and managing electricity production, transmission, and distribution. The EVN Group is the successor of the vertically integrated, state-owned power utility.
EVNCPC	EVN Central power Cooperation	EVNCPC is financially supported by the World Bank to install approximately 10,000 electronic meters with a total investment of approximately 100 bn Vietnamese Dong.
GDE	General Directorate of Energy	Under control of MoIT the GDE is responsible for overall energy sector policy and planning. (ADB, 2015)
IOE	Institute of Energy	State Energy research institute, originally connected to EVN, currently under the direct supervision of MOIT (GIC/AHK, 2015). IOE undertakes and prepares energy sector plans, strategies, and policies (ADB, 2015).
MOF	Ministry of Finance	MoF is responsible for taxation and energy tariff policies applied to the energy sector (tkn & iisd, 2012).
MOIT	Ministry of Industry and Trade	MoIT manages all energy sectors, such as coal, oil, gas, electricity, nuclear energy and renewable energies. The ministry is responsible for policy design and national plans subject to Prime Minister's approval. (tkn & iisd, 2012) MOIT is in charge of energy.
MoNRE	Ministry of Natural Resources and Environment	MONRE is involved in the fields of natural resources, water, minerals and issues like climate change and environmental protection (GIC/AHK, 2015).
MPI	Ministry of Investment and Planning	MPI takes the lead role in coordinating and allocating funds for energy projects submitted by line ministries and agencies, for consideration and approval by the Prime Minister (tkn & iisd, 2012). MPI is leading the Green Growth and the focal point of the Green Climate Fund.

Short	Name	Description of function
PC	People's Committee	The 58 provinces and 5 city administrations are each controlled by one PC. On provincial level, and PC is responsible for approval of provincial power planning and the approval of small-hydropower and wind energy projects (GIC/AHK, 2015).
RED	Renewable Energy Department	RED is in charge of designing plans for renewable energy development (tkn & iisd, 2012).

Source: Own illustration