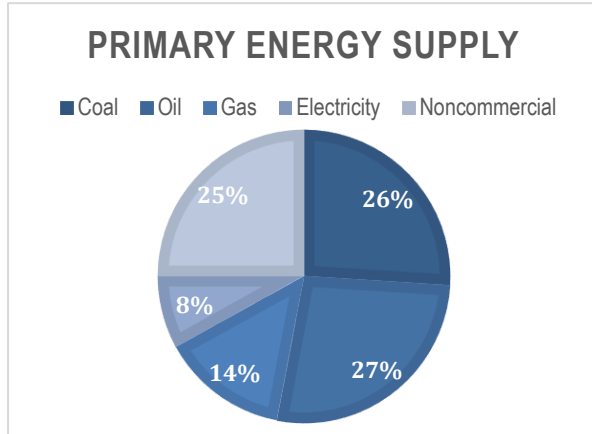


Vietnam’s Energy Sector Outlook and Engineering Opportunities

\$123.8 billion is needed for the energy sector’s development over the next 20 years, averaging \$6.8 billion per year (66% power plants and 33.4% network development), according to EVN (2017).

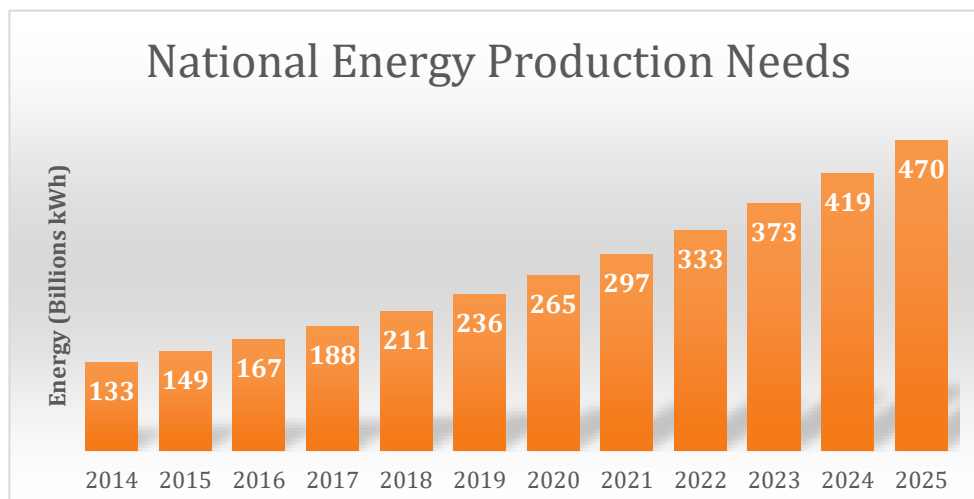


- Industry is the highest energy consumer sector, representing 39% of the total (MoIT 2012). As industry accounts for 36% of GDP (World Bank 2016), a reliable energy supply is a crucial government priority. The 2nd highest sector for energy consumption is residential at 33%, and 3rd is transport at 24% (MoIT 2012).

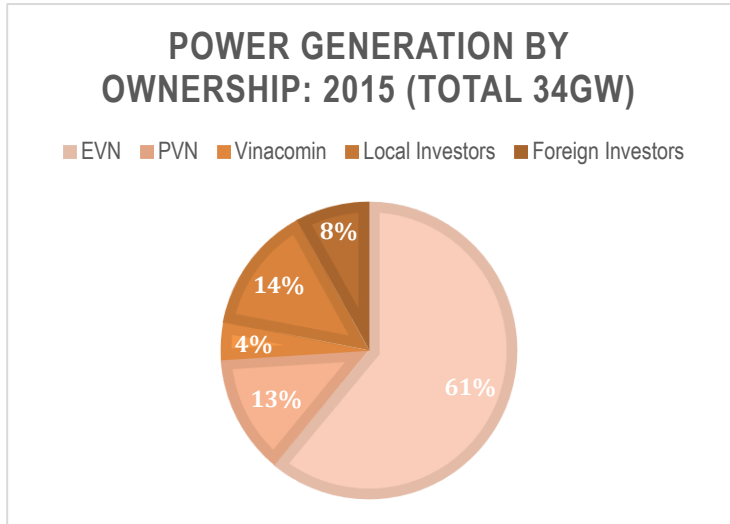
Source: Ministry of Industry and Trade (MoIT) 2012

Power Subsector

- Energy production must double its 2014 value by 2020 to reach demand of 265 billion kWh, then double capacity again by 2025 to reach demand of over 400 billion kWh. This is based on the population growth rate of 1.03% (World Bank 2016) and consumption/capita growth rate of 11% (GVN 2016). Power demand must be met by both domestic and imported energy resources.
- Additional power of 4,000MW per year will be required on average through to 2020 to meet demand from increasing consumption per capita (effects of industrialization, urbanization and increasing socio-economic status) and increasing population.



- Vietnam power sector currently is composed of state owned groups Vietnam Electricity (EVN), Vietnam National Oil and Gas Group (PVN) and Vietnam National Coal-Mineral Industries Group (Vinacomin), plus local investors (14%) and foreign investors (8%).

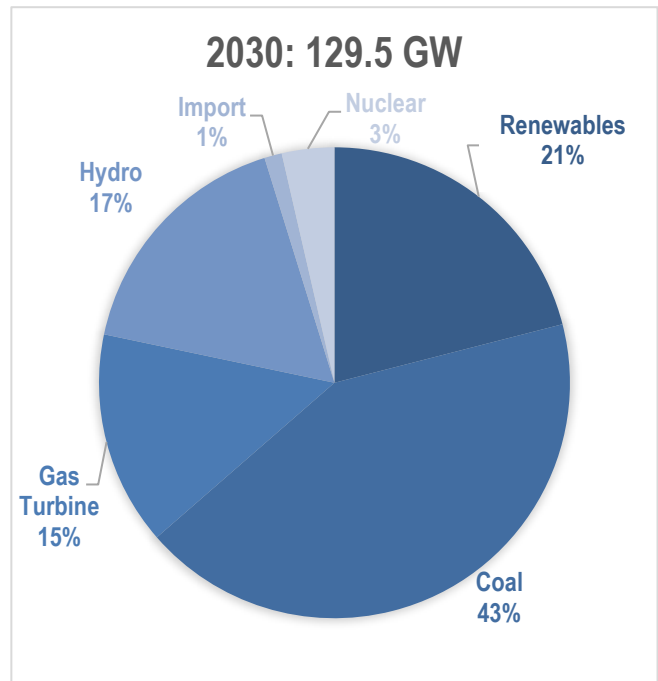
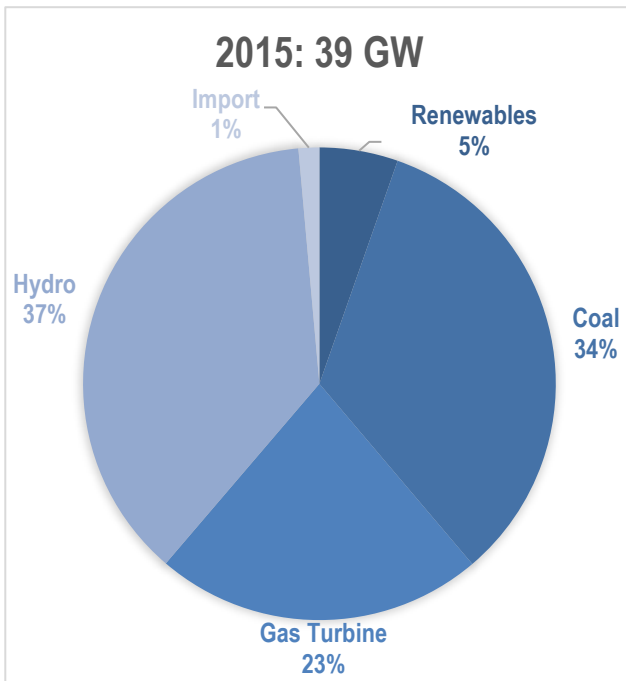


Source: EVN National Report 2015

- Independent Power Producers (IPPs) are anticipated to play a major future role in Vietnam’s power sector

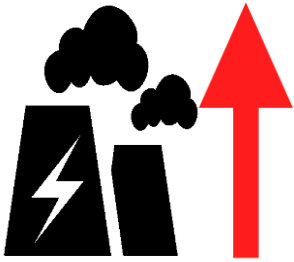
as EVN’s self-financing will only meet about 66 % of the total investment requirement. Policy reforms and stable tariffs are required to support this shift to foreign private ownership. Currently there is only one US IPP, AES Corporation, whom invested in Mong Duong 2 Coal-fired Power Plant (US\$2.1 billion with 1,240 MW capacity).

- Unstable electricity supply concerns businesses, yet electricity price increases have yet occurred. This is potentially due to consequences of economy instability, dissatisfied businesses and consumers and the severe financial pressures on energy-dependent industries of steel, fertilizers and cement where electricity costs represent about 60% of total costs.



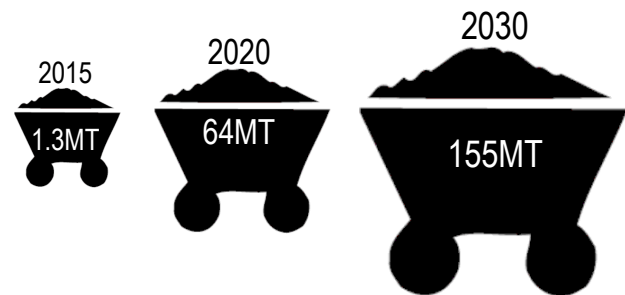
Power sources by installed capacity. Source: Vietnam National Power Development Plan 7 (revised)

Energy Sources

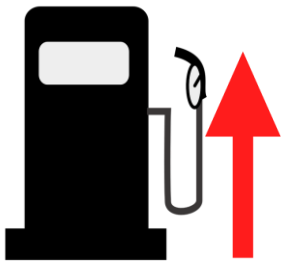


Coal investments are to increase despite environmental hazard and consequent decreased investor or ODA interest. Coal is expected to fuel 53.2% of total energy production by 2030, from 34.4 % in 2016 and 11.6 % in 2000 (revised Power Development Plan (PDP) 7). Coal imports must significantly increase to meet anticipated production capacity. By 2030 Vietnam may be burning 15 times as much coal as it did in 2012, becoming the 8th largest user of coal for energy globally.

Increasing coal import demand:



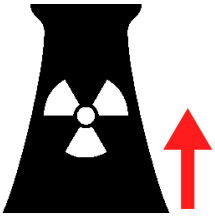
Coal's demand means Vietnam's CO₂ emissions will continue to increase, accumulating to the large emissions increase of 150% per capita observed between 2000 and 2010.



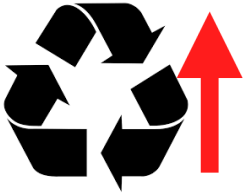
Natural gas based power is expected to increase to 6.75 GW of installed capacity by 2026 (revised PDP 7). This planned production utilises Vietnam's own resource potential as proven gas reserves have been reported at 600 billion m³, almost exclusively offshore. An extensive pipeline system must be improved to bring gas onshore and achieve the targeted gas exploit output of 21 billion m³ per year (in 2026-2035 period). Natural gas will serve as a secure fossil fuel with 60% less CO₂ emissions than coal. A further 5 GW capacity increase from imported **liquefied natural gas** (LNG) is anticipated by 2028 (revised PDP 7). This calls for an increase of LNG imports from zero (at present) to 6Mtpa. Related infrastructure, including ports, must be invested in to ensure domestic gas supply-demand balance. According to the Master Plan for Vietnam Gas Industry Development to 2025, gas-fired power plants need to be developed to use 70-80% of total production, including import LNG.



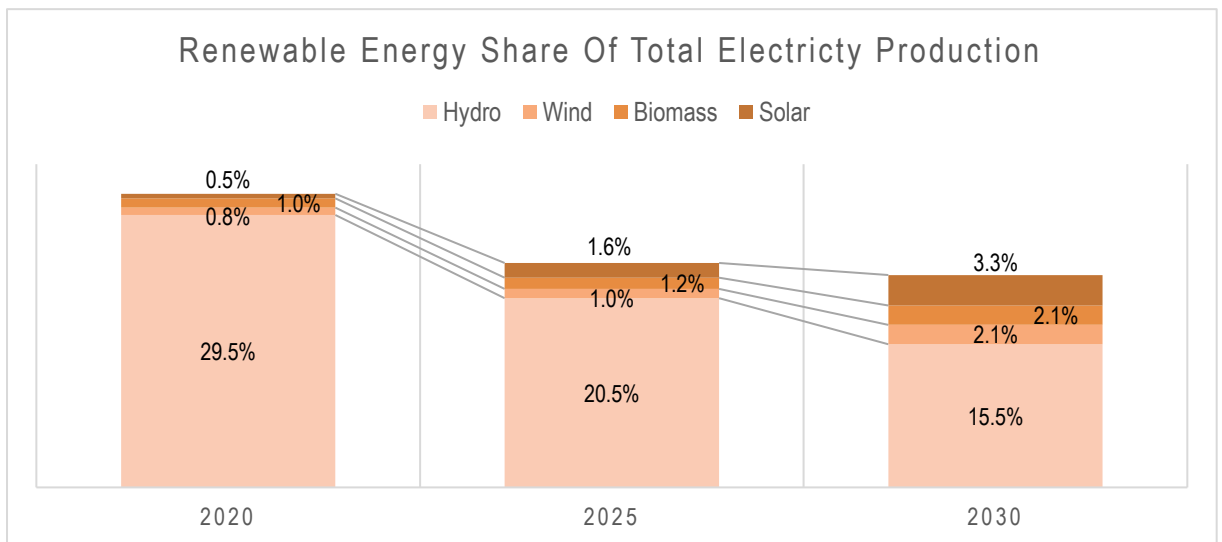
Oil production peaked at 20 MT in 2004, reduced to 17 MT in 2013, and is expected to increase modestly to 18 MT by 2025 (ADB 2015). Oil was solely exported until the first refinery, in Dung Quat of central Viet Nam, opened with annual capacity of 6.5 MT. According to ADB, a total refinery capacity of 25.0–30.0 MT is planned for 2020 through construction of a \$7.5b refinery at Nghi Son with annual capacity of 8.4 MT (using crude oil imported from Kuwait) and a third refinery with an annual capacity of 10.0 MT (using crude oil from Venezuela). Major consumers are the transport (approximately 70%) and service (approximately 10%) sectors.



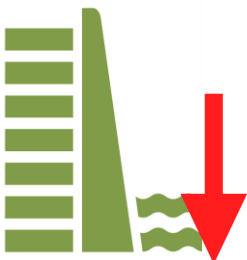
Nuclear power will be initiated in Vietnam with the first nuclear power plant in 2028, to supply 5.7% of Vietnam’s energy mix (revised PDP 7).



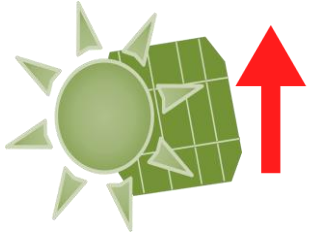
Renewable energy sources are increasingly focused on as a priority for foreign investors and ODA. Excluding hydropower, renewables will grow from 0.4% of total energy production in 2015 to 7% in 2020 and 10% in 2030 (revised PDP 7). CSR of major manufacturing companies is increasing demand for renewable energy use. Samsung, Vietnam’s largest electronics manufacturing company, states in its mission to ‘increase the use of renewable energy and invest in the development of renewable energy technologies such as fuel and solar cells.’ Clean energy investments are a booming market which Vietnam is yet to take advantage of, only totalling \$67 million in 2014. For comparison, Indonesia attracted \$1.9 billion in clean energy in 2014 (Made in Vietnam Energy Plan 2016). Competitiveness of renewable alternatives is quite low due to high production costs at 10-12 US cents per kWh and low Feed-In-Tariffs (FiTs).



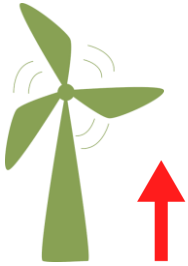
Source: National Power Development Plan 7 (revised)



Hydropower is to decline as the utilisation of Vietnam’s river system for hydropower has been saturated. The major disadvantage of hydropower is its weather dependency, leading to diminished power supply during dry season which will be further exacerbated by climate change. The Mekong Delta’s flow to lower course has also severely been disrupted by hydro projects, affecting natural resources, biodiversity and agricultural productivity. **Small hydropower** (including pumped-storage) is to increase capacity from 17,000 MW (2015) to 27,800 MW (2030), according to the government’s revised PDP 7. Projects with combined benefits for flood prevention, water supply and electricity production will be prioritised.



Solar power has been incentivised by the government's Decision No.11/2017/QĐ-TTg of April 2017 which requires Electricity of Vietnam (EVN) to purchase all electricity produced by grid-connected projects at a minimum of US\$9.35 cents/kWh. Multiple mounting options are available: roof-mounted, ground-mounted and floating panels, however the major technology issue is battery power storage. Solar power is planned to increase to 0.5% of energy production by 2020 and 3.3% by 2030 (revised PDP 7).



Wind farms offer great potential with wind reserves estimated to be 513,360 MW, six times higher than the total electricity output, by 2020 (World Bank). World Bank also estimates that 8.6% of Vietnam's mainland has favourable conditions for installing large turbines, plus the potential for off-shore wind power. Yet the unattractive price mechanisms mean wind energy market is yet to become competitive. Of the 50 registered wind projects, only 10% have been implemented and 4 are operational (MOIT). Three of these are in Binh Thuan: Tuy Phong-30MW; Phu Quy-6MW and Phu Lac-20MW. The largest is in Bac Lieu with a capacity of 99MW. General Electric (GE) owns wind turbine manufacturing plants in Haiphong where it has recently invested \$2b in R&D.



Bio-energy sources will be increased to 1% energy production in 2020 and 2.1% by 2030 (revised PDP 7). Focus will be in cogeneration at sugar mills and food processing factories, as well as the use of biomass and coal simultaneously in coal-fired power plants. **Waste-to-energy** is yet to be proven feasible predominantly due to high transportation fees of waste which aren't subsidised by waste collection and disposal fees commonly charged by governments. Whilst Australian firm Trisun reportedly plans a \$520m waste-to-power plant based on plasma gasification in Cu Chi District (as the first of between 12 and 20 electricity generating waste treatment plants they plan to build), the fruition of their plans has yet been proven tangible. The first waste-to-energy plant in Vietnam was inaugurated at the Nam Sơn Waste Treatment Complex in Hanoi in April 2017, representing a US\$29m investment with waste treatment capacity of 75 tonnes per day. Technology trials are also being tested at the Go Cat Solid Waste Treatment Complex in Binh Chanh district.



Opportunity for Investment: Solar

- FIT Incentive

Solar offers the greatest return on investment with an FIT of 9.35c/kWh, much greater than wind at 7.8c/kWh, biomass at 7.34-7.55c/kWh or waste-to-energy at 7.28-10.05c/kWh (Dragon Capital 2017).

- Auction Implementation Scheme

The World Bank and MoIT plan to pilot a solar power auction where the Vietnamese government will issue capacities for companies to bid on, submitting complete project plans and budget based on set FIT price. A Power Purchase Agreement will be awarded to the winning bidder, designed to accelerate the development of registered projects and lure in new investment capital.

- Provincial Government Support

Tay Ninh Province (South-Western Vietnam) have proposed MoIT add 15 solar powered projects to the provincial planning scheme on electricity development worth total capital of US\$678.4 million and combined capacity of 554MW (Aug 2017). The province supports the enterprises whom have asked permission to construct solar projects with combined designed capacity of 554MW, to be implemented from 2017 to 2019 and worth total capital of US\$678.4m.

Binh Thuan province (South-Western Vietnam) approved investment of five solar power projects worth over US\$651.2m (May 2017) plus studies for investment in 30 other solar electricity projects. The province plans to attract solar electricity projects with a combined capacity of over 4,000 MW by 2030.

- Foreign interests: US, South Korea, India, Germany

July 2017, Dragon Capital (US) plans to invest US\$44m in a solar power project in Can Tho, with first phase capacity of 29 MW and second phase capacity of 100 MW.

June 2017, Hanwha (8th largest Korean corporation) and BCG Bang Duong (Vietnamese infrastructure contractor) formalised plans to develop a \$100-million solar power project in the southern province of Long An with designed capacity of 100MW.

Sep 2017, SY Panel Group (Korea) plans to develop a US\$450m solar power plant in Dong Hai district of the Mekong Delta province of Bac Lieu with designed capacity of 300MW.

Aug 2017, Hero Future Energies Asia Pte.Ltd (India) proposed developing a solar power project in the southern province of Binh Phuoc.

Sep 2017, 50 project developers and engineering service companies from the Vietnamese solar sector participated in the first German Solar Training Week in Ho Chi Minh City.

- Large Energy Potential

Solar resources are abundant with a daily average solar irradiation of 4-5 kWh per square meter in most of southern and central Vietnam. Solar PV power generation capacities in Vietnam are expected to increase from around 7 MW (mid-2016) to 850 MW by 2020, 4,000 MW by 2025 and 12,000 GW by 2030 (PDP 7).

Solar Innovations

- Floating solar farms to alleviate demand for land
- Panels lined above water sources (e.g. canals) for simultaneous benefits of electricity production, prevention of water evaporation and cooling of panels.
- Battery Technology: Vanadium, Tesla, Molten Salt (receive and store energy for up to 15 hours)
- Rooftop solar panels on a decentralised energy system means electricity could be traded on a digital marketplace, providing consumer incentives
- Solar roads, bike lanes and car lanes, lined with customised strong and stiff solar panels (the world's 1st solar cycle path was open in the Netherlands in 2014)
- Solar planes (the world's 1st round-the-world flight of 40,000km powered only by solar was completed in 2016 by Swiss company Solar Impulse)