Energy development in Vietnam's Mekong river delta: a 'green' or 'grey' outlook?

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Received 27 February 2018; accepted 1 June 2018

Abstract:

The Vietnamese Mekong river delta (MD) is recognised as the biggest agriculture and aquaculture region of Vietnam. The MD plays an important role in ensuring food security for the country. The MD also has many sensitive ecosystems reliant on the ecology of the Mekong river basin. However, during the last decade, many electricity generation plants, both renewable and non-renewable power projects, have been built and some will be built in the near future in the MD. These energy plants' construction and operation may prove to be a challenge to the national energy strategy.

This paper is a monograph review of two sides of energy sector industrialisation in the MD with a focus on 'green' and 'grey' socio-economic development (as 'xanh' and 'xám' in Vietnamese respectively). 'Green' energy is understood as the electricity generated from inexhaustible sources and known as renewable energy. It emits fewer greenhouse gases and causes less harm to habitats in comparison to traditional fossil fuels and hydropower. 'Grey' energy is another word for non-renewable energy or polluting energy, which can have negative effects on human health, environment, and climate. This paper finds that the MD's energy development plans at present might not be as 'green' as expected, due to more 'grey' power plans in the planning pipeline. This paper also considers an outlook on energy prices and impacts on long-term sustainable development of the MD.

Keywords: **air pollution, energy sector, green or grey, Mekong river delta, sustainable development.**

Classification number: **6.1**

Background

The MD of Vietnam is located between 8-11° latitude and 104-106° longitude, belonging to a monsoonal humid subtropical climate zone of South East Asia Region (Fig. 1). Since it lies in the most downstream portion of the Mekong river basin before entering the East Sea via seven river mouths, the topography of the MD is very low and flat. The MD's average land elevation is less than 1.5 meter above the mean sea level. The MD climatic regime is dominated by two seasons: the dry season, from December to April and the rainy season, from May to November. Annual rainfall is substantial in all provinces, ranging from 1,600 (the North-West areas) to 2,200 millimetres (the South-East coastal areas), with humidity averaging 85% throughout the year. More than 85% of the precipitation in the MD, within 100 to 110 rainy days, occurs during the monsoon season. Because the MD has strong solar radiation potential, the average daily temperatures in the MD are rather high - varying between 25-29°C with monthly average temperatures invariant throughout the year. In the dry season, the MD receives a lot of solar radiation resulting in a very high surface land temperature (Fig. 1). The absolute minimum/maximum temperatures in the MD rarely exceed 15/39°C. In general, weather and river flows' characteristics support very favourable conditions for agriculture and aquaculture development of the MD when compared with other regions in Vietnam. The MD is drawn on a rich endowment of biomass to achieve the highest levels of agriculture - aquaculture - mangrove forest production in the nation [1].

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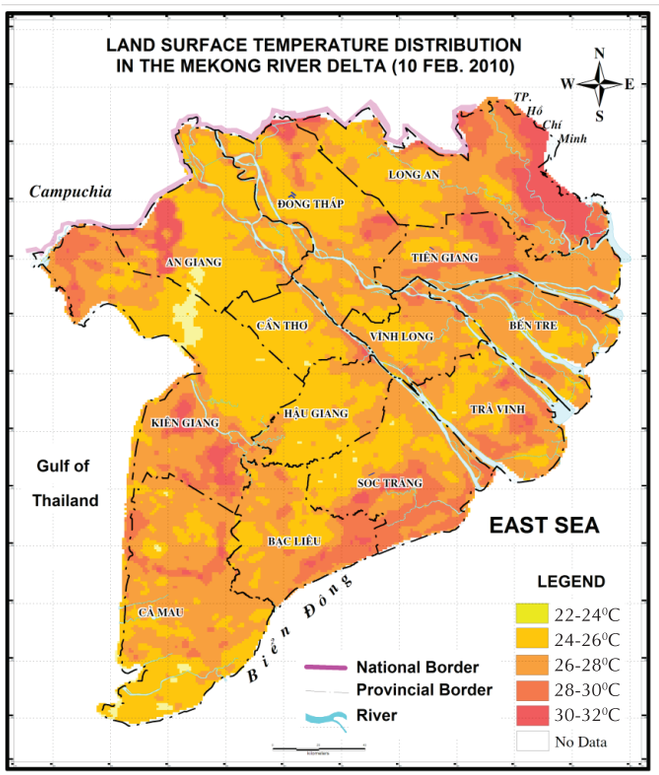

Fig. 1. Map of the MD's land surface temperature distribution treated by using MODIS satellite image on 10 Feb. 2010 [2].

Power development policies in Vietnam

On 17th June, 2010, the Law on Economical and Efficient Use of Energy was promulgated by the National Assembly [3]. The main purpose of this Law is to provide economic and efficient use of energy; policies and measures to promote economic and efficient use of energy; and to outline the rights, obligations and responsibilities of organisations, households and individuals for economic and efficient use of energy. One year later, the National Master Plan for Power Development for the period of 2011-2020 with the vision for 2030 (called shortly PDP VII) was approved by the Vietnamese Government in Decision 1208/QĐ-TTg [4]. In March 2016, the Prime Minister approved the revision of the National Power Development Master Plan for the period of 2011-2020, vision for 2030 with main target to satisfy the country's electricity demand and to meet the objectives of national socio-economic development with an average GDP growth of about 7.0% per year through the period 2016-2030. According to the PDP VII Revised, the electricity generation mix for 2013-2030 is demonstrated in Fig. 2. The development of renewable energy sources for electricity production will increase from 3.7% of total electricity production in 2013 to 10.7% by 2030. However, coal thermal power distribution for the country from 19.8% in 2013 will rise up to 58.2% in 2030, while hydropower as a primary electricity source will fall down from 42% to 12.4% during the period 2013-2030. The plan discusses how Vietnam will apply nuclear power generation for electricity with 5.7%, but the country's current plans for nuclear power generation have been put on hold indefinitely.

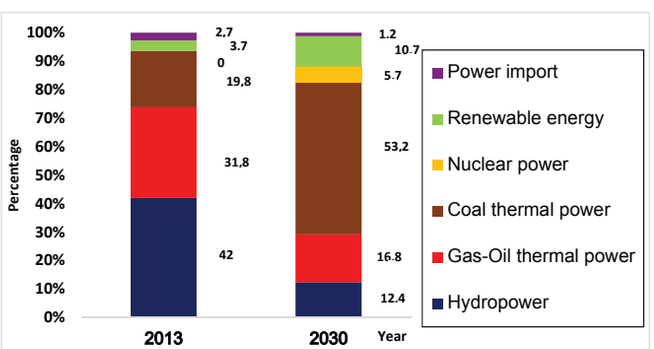

Fig. 2. Energy structure distribution in percentage in 2013 and 2030 (Graphic drawing by Le Anh Tuan from data source in PDP VII Revised).

Environmental concepts on energy sector: 'green' or 'grey'

Green energy (or 'xanh' in Vietnamese) comes from natural sources such as sunlight, wind, rain, tides, plants, algae and geothermal heat. These energy resources are renewable, meaning they can be naturally replenished [5]. Green energy sources have significantly lower carbon footprints when compared to other energy generation sources. Renewable and nuclear sources are near-zero carbon generation sources [6].

Traditionally and predominantly, many countries have burned fossil fuels as coal, oil, gas or combustible fuels as solid-waste or biomass in thermal power plants for electricity production. Fossil fuels are exploited by either mining or drilling deep into the earth and sea, often in ecologically sensitive locations. Almost all thermal power plants produce pollutants such as greenhouse gases (carbon dioxide, water vapor) and acid gas emissions (sulphur dioxide and nitrogen oxide) as a by-product, contributing to global warming phenomenon and to climate change. Gaining access to fossil fuels typically requires either mining or drilling deep into the earth. Coal-thermal plants are favourable to build because coal is inexpensive, plentiful, relatively easy to transport, and easy to purchase in the

global market [7]. In 2012, coal was responsible for 72% of electricity-sector emissions [6]. Coal and other fossil fuel burning power plants are environmental polluters. They are known as 'grey' energy (or 'xám' in Vietnamese) and can have negative effects on human health, environment, and climate. Even the most efficient coal plants generate twice as much carbon pollution as gas-fired power plants and over 20-80 times more than renewable energy systems.

Since the late 19th century up to the present, hydropower has been a popular source for generating electricity in America, Europe and Asian countries. Although hydropower is considered, by many, as a renewable energy, most hydropower plants are built with large reservoirs-dams, which block rivers. This can have significantly negative social and environmental impacts. Additionally, hydropower is associated with deforestation for reservoir building, which may emit more greenhouse gas concentration in the atmosphere. So, a large-scale hydropower plant is possible to rank as a term of grey energy. Officially in Vietnam, large-scale hydropower plants are not labelled as a form of renewable energy.

Energy power development in the MD

Green energy development

As part of the Power Development Master Plan VII released in July 2011, the country will give priority to developing renewable energy sources. The rate of renewable power is planned to account for 4.5% by 2020 and 6% in 2030. However, the revised Power Development Master Plan VII released in March 2016 adjusted those rates upward. In PDP VII, power from renewable energy is estimated at 4.5% by 2020 and 6.0% by 2030, compared with the system's total power output. The estimated capacity by 2020 shall be at 5.6% and 10.7% by 2030.

In 2013, the total installed capacity of renewable energy was approximately 1,800 MW, accounting for 5.6% of total installed capacity and approximately 3.8% of total power production. In the recent years, the share of power produced from renewable energy is increasing primarily through small hydropower development (installed capacity less than 30 MW). Thus, the actual share of renewable energy in the power mix has reached its set target seven years earlier than expected in PDP VII. With the current trends related to renewable energy technologies and cost reductions, promoting additional contributions of renewable energy to meet Vietnam's future power demand is a promising opportunity.

The MD has approximately 700 km long coast lines facing the East Sea and the Gulf of Thailand, the Delta is advantageously positioned to receive wind streams from the sea. The potential of wind energy in Tra Vinh, Soc Trang and Bac Lieu coastal lines at the height of 80 m above the coastal land surface, with the average wind speed reaching the range of 5.57-6.0 m/s is presented in Fig. 3. According to [8], Cong Ly Construction-Trade Tourism Limited Company has invested in an installation of 52 wind turbines each having a 1.6 MW capacity, for a total capacity of 83.2 MW in Bac Lieu province. The Bac Lieu wind farm will have a gross annual electricity output of 335.2 GW hours at full operational capacity. This power plant reduces 143,761 tCO_2 emissions on average per year and 1,006,328 tCO_2 over the first crediting period [9]. The project's third phase will reach a total wind power capacity of up to 300 MW by 2030 as expected.

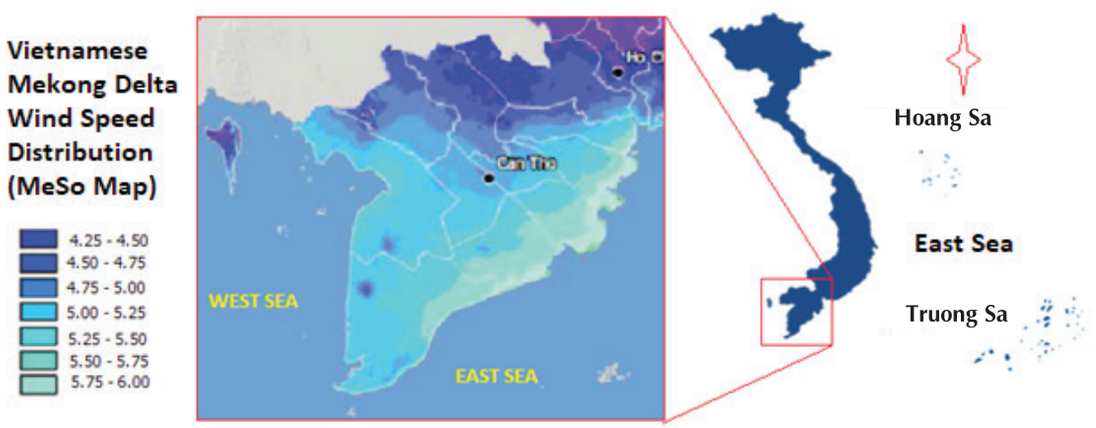

Fig. 3. Wind speed (m/s) distribution map in the MD based on the Meso Map simulation [10].

It is estimated that the entire MD receives about 2,000-2,600 sunshine hours per year. Can Tho, a central city in the MD, receives around 2,300±200 sunshine hours per year (equivalent of 6.300 MJ/m^2 per year), corresponding to more or less 2,000 kWh/m^2 per year [1]. Aisma, et al. [11] have reported that the South of Vietnam (including the East South and the West South Region) has a maximum regional solar photovoltaic (PV) resource potentials up to 535 GW. Based on 2014 statistical data for rice production [12], the MD produced nearly 5 million tons of rice husk taken from 20% of 24.7 million tons of harvested rice grain. Furthermore, about 26 million tons of rice straw is produced annually [13]. Assuming that a half of provincial rice husk amounts from paddy milling stations are used to make rice husk charcoal briquettes, the MD can also produce approximately 1.1 Million Kcal per year for heating value or equivalent of 265,160 KJ per year.

Grey energy from burning fossil fuels

According to the Revised Power Development Plan VII to respond to the increasing power demand in the MD, the government plans to build 13 additional new coal-thermal power plants taking the existing total to 14 by 2030. See Table 1 and Fig. 4 for a list of coal fired power plants. With 14 coal thermal plants equivalent to estimated approximate 110.34 billion kWh power produced annually by 2030, the MD will become Vietnam's top region for coal power production. These 14 coal-fired thermal power plants will increase the total capacity of Vietnam's power generation 15 times by 2030 (Table 2).

The amount of coal used for generating power from those plants will also increase to 15 times higher than the current amount. While pollution control equipment can reduce toxic air emissions, they only eliminate a portion of pollution. Instead, they transfer much of the toxic air pollutants to liquid and solid waste streams. Oftentimes, companies and governments' priorities profit public health concerns and thus a full suite of available pollution control equipment is not installed. In these cases, toxic pollution still goes into the air, leading to premature deaths and increased rates of diseases. Moreover, according to international experiences, coal power has the highest portion of water consumption among energy generation processes. Coal plants consume vast amounts of water for cooling and steam production. A typical 1,000 MW coal plant uses enough water in one

Table 1. List of coal-fired power plants in the MD [14].

No	Names of coal thermal plants	Total capacity (MW)	Coal sources	Locations	Water used (Mil. m^3/day)
1	Duyen Hai I	1,200	Quang Ninh	Tra Vinh	16.5
2	Duyen Hai II	1,200	Import		
3	Duyen Hai III	1,200	Quang Ninh		
4	Duyen Hai IV extended	660	Import		
5	Song Hau I	1,200	Import	Hau Giang	12.4
6	Song Hau II	2,000	Import		
7	Long Phu I	1,200	Import	Soc Trang	16.7
8	Long Phu II	1,320	Import		
9	Long Phu III	1,800	Import		
10	Long An I	1,200	Import	Long An	10.8
11	Long An II	1,600	Import		
12	Tan Phuoc I	1,200	Import	Tien Giang	9.3
13	Tan Phuoc II	1,200	Import		
14	Bac Lieu	1,200	Import	Bac Lieu	4.6

Table 2. Key figures about coal-fired power plants in the MD.

Key figures	2016	2030	Comparison
Number of plants	1	14	14 times higher
Installed capacity	1,245 MW	18,390 MW	15 times higher
Annual power production output	7.47 billion kWh/year	110.34 billion kWh/year	15 times increased
Coal fuel consumption	3.36 million tons/year	49.7 million tons/year	15 times higher
Coal ash	1.1 million tons/year	16.6 million tons/year if using coal from Quang Ninh mines	15 times higher
Water demand	5.38 million m^3/day	79.44 million m^3/day	15 times higher
CO_2 emission	6.7 million tons CO_2	99.3 million tons CO_2	15 times higher

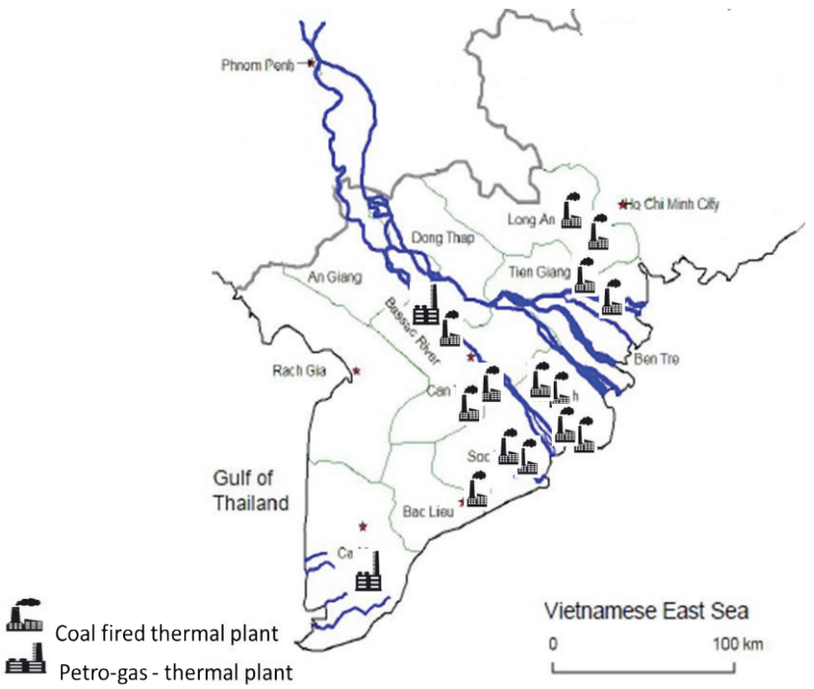

Fig. 4. Location map of proposed thermal power plants in the South-West of the Hau river (Bassac) area.

year to meet the basic water needs of 500,000 people. The operation of coal power plants in the MD in the near future will likely add another layer of threat for water resources in this region, especially during the dry season. Technology to capture and store carbon dioxide is expensive and largely unproven.

Discussion

The application of renewable power generation such as wind, solar and biomass energy in the MD will contribute to a sustainable green revolution. Although initial installation costs for these renewable energy sources are rather high compared to hydro and thermal electricity, these renewables provide virtually no additional environmental pollution impacts and fit well within the Clean Development Mechanism's expectations. However, the cost of renewable energy scoping and operation will decrease rapidly over time. According to the International Renewable Energy Agency (IRENA) [15], costs of most renewable energy generation has fallen below the price range of fossil fuel generation. Solar photovoltaic (PV) is most competitive. Solar PV module prices in 2014 were around 75% in comparison with prices from 2009. Between 2010 and 2014, the total installed costs of utility-scale PV systems have fallen by 29% to 65%, depending on the region. The Levelised Cost of Energy (LCOE)[1] of utility-scale solar PV has fallen by half in four years. The most competitive utility-scale solar PV projects are now regularly delivering electricity for just $0.08/kWh without financial support, compared to a range of $0.045 to $0.14/kWh for fossil fuel power plants. LCOE cost of electricity generated from biogas, geothermal, and hydropower have remained unchanged since 2010. Onshore wind is also an increasingly competitive energy source. In

[1]According to IRENA (2014), the LCOE of a given technology is the ratio of lifetime costs to lifetime electricity generation, both of which are discounted back to a common year using a discount rate that reflects the average cost of capital.

addition to the reduction in installation costs, technology improvement has contributed to the decreasing LCOE. Some wind projects with a preferable location can have the price of $0.05/kWh without financial support.

Under the national electricity generation development program, coal-run thermal power will take up 60% of the country's total electricity output. The policy of building 14 coal fired thermal power plants, if fully or partially implemented, will subject the MD to a number of risks for sustainable development. The burning of coal emits hazardous air pollutants that can spread for hundreds of kilometres throughout the MD. Exposure to these pollutants can damage people's cardiovascular, respiratory and nervous systems, increasing the risk of lung cancer, stroke, heart disease, chronic respiratory diseases and lethal respiratory infections. Children, the elderly, pregnant women, and people with already compromised health will suffer most. The emission of sulfates and nitrates also leads to acid rain, which damages streams, forests, crops and soils. It is noticed that coal as fossil fuel source for Duyen Hai I and Duyen Hai III thermal power plants is mainly exploited from anthracite reserves in Quang Ninh province but these reserves are expected to deplete by 2030. Other coal-fired power plants in the MD will have to import coal from Australia or Indonesia.

In Vietnam, according to Decision 37/2011/QD-TTg [16], the buyer must purchase 100% of wind power production at 7.8 US Cent/kWh. The investor can enjoy preferential loans and tax reductions or fee exemptions. However, according to some experts, with the current level of incentives, investors still suffer heavy losses. With such mechanisms, wind power cannot be developed as expected. With the target of increasing the total wind power capacity from the current 52 MW to around 1,000 MW by 2020 and 6,200 MW by 2030, the share from wind power will account for 0.7% in 2020 to 2.4% in 2030. However, progress is very difficult to achieve without changing current mechanisms.

Regarding biomass, Decision 24/2014/QD-TTg [17] decided that biomass energy will be sold at 5.8 US Cent/kWh. Investors also enjoy advantages in capital and tax exemptions similar to wind power. There are 41 sugar mills in Vietnam using bagasse to produce self-service electricity with a capacity of about 150 MW. It is said that to build a plant of biomass power from bagasse, tariffs need to be at least 8 US Cent/kWh because bagasse power plant requires about $750,000 to $1 million/MW of installed capacity. Thus, expectations regarding the tariff of domestic biomass power at 8-9 US Cent/kWh over the next three to five years seem to be impossible. Therefore, it is necessary to have more support for the feed-in tariff from the Government.

In term of solar power, there has not been any mechanism to encourage the development of solar power so far, specifically in remote and off-grid areas. Currently, the Government is ordering the MOIT to complete the mechanism for grid-connected solar power, including energy market sharing quota mechanism and long term stable electricity price frameworks. Besides, the Government should consider to provide financial support for effective combined renewable energy sources models as well as to exempt renewable energy production and circulation taxes as one of the climate change mitigation solutions of Vietnam.

Conclusions

Based on scientific evidences and discussion, it is important for the government to issue new policies, which will remove barriers of renewable energy development. Using more renewable energy and reducing the share of coal-fired power means reducing greenhouse emissions and ensuring energy security, which is believed to be the best method for current electrical systems in Vietnam.

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