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AN OVERVIEW OF THE RENEWABLE ENERGY POTENTIALS IN THE MEKONG RIVER DELTA, VIETNAM

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ABSTRACT

The mekong river delta is the most southern region of viet nam, having a whole year strong solar radiation and a long coastal line towards both the east sea and the west sea. The delta also is recognised as a biggest agriculture - aquaculture - mangrove forest production of the nation, promising on her rich-biomass provision. So, this region is quite favourable for the potential development of renewable energy resources in different types and levels. Currently, all provinces of the mekong river delta depend mainly on thermal energy by burning non-renewable sources as coal, oil and gas fuels to produce electricity. These power energy plants are connecting throughout the country over nationwide grid-electricity system. Last three decades, vietnamese government has paid attention on hydropower development in the north and the central of vietnam, while the renewable energies from solar, wind, tide and biogas sources seem to be disregarded in the national and provincial socio-economic development strategy plans. However, during the past 5 years, vietnam has started to promote renewable energy development programs as part of the climate change mitigation and adaptation solutions of the national action plans, special in the southern region. This report will inventory some data figures on the regional renewable energy resources, focusing to solar, wind and rice husk energies. Additional discussion, renewable energy policies are noticed as possible solutions for the development and exploitation of cleaner powers that may be concerned.

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1 BACKGROUND

The Mekong River Delta (MD) of Vietnam is located in a monsoonal - sub-equatorial climate zone of South East Asia Region (Figure 1), extending between latitude: 8° - 11° and longitude 104° - 106°. The Delta is recognised as a strong solar potential region in the whole year of the country that can be exploited to meet the two main demands: thermal and electrical power. The average daily temperatures in the Delta are rather high; varying in the ranks of 25 - 29°C, the monthly average temperatures is invariant throughout the year. The absolute minimum/maximum temperatures in the MD rarely exceed 15/39°C. Most of the Delta receives about 1,600 - 2,000 mm of average precipitation per year, but the south-east coastal areas are considerably more humid and wet, with an annual rainfall of up to 2,200 mm. In general, weather and river flows characteristics support much favourable conditions for agriculture and aquaculture development of the MD if compared with other regions in Vietnam.

For a Green Economic Growth promotion policy, Vietnam has started to support renewable and cleaner energy development programs in the past 5 years. According to the National Master Plan for Power Development for the period of 2011 - 2020 with the vision to 2030 (Prime Minister, 2011), the country will prioritize the development of renewable energy sources for electricity production: from 3.5% of total electricity production in 2010 up to 4.5% in 2020 and 6.0% in 2030. The MD has potentials for power generations from renewable energies (RE) in forms of wind, solar, biomass and sea tidal powers. Although the renewable energy projects are in small scale, they help reduce the pressure of power production needs in Vietnam. They also partly play a noticeable role in supplying national off-grid-based power (Tuan, 2015). Beside them, biomass is an important energy source in the MD (Tu *et al*., 2009). Biogas energy potential (EP) is can be collected from landfills, animal excrements, agricultural residues, industrial wastewater etc. For agricultural by-product biomass, rice husk charcoal briquettes are aimed at producing rural energy. For proximate analysis, rice husk can provide about 4,401 - 5,771 Cal/gr heating value (Jindaporn and Songchai, 2007). Integrated farming systems in the MD are operating small scale biogas plants in rural areas (Julia and Tien, 2009). About 900 biogas plants were built in 2010 in the MD area in households who breed more than five pigs (Thao, 2011). Potentials of sea energy of wave and tidal movements in the MD is promised to be very large, but there is a lack of information on detailed energy potential assessment report.

In this study, the central question is how much available RE potentials, focusing in solar, wind and rice husk sources, in the MD may be established in a sustainable manner. The report aims to share information how to promote renewable energy and raise awareness about alternative energy solutions. The current energy policy is reviewed and recommended to applied and overcome barriers to implementation on RE development.

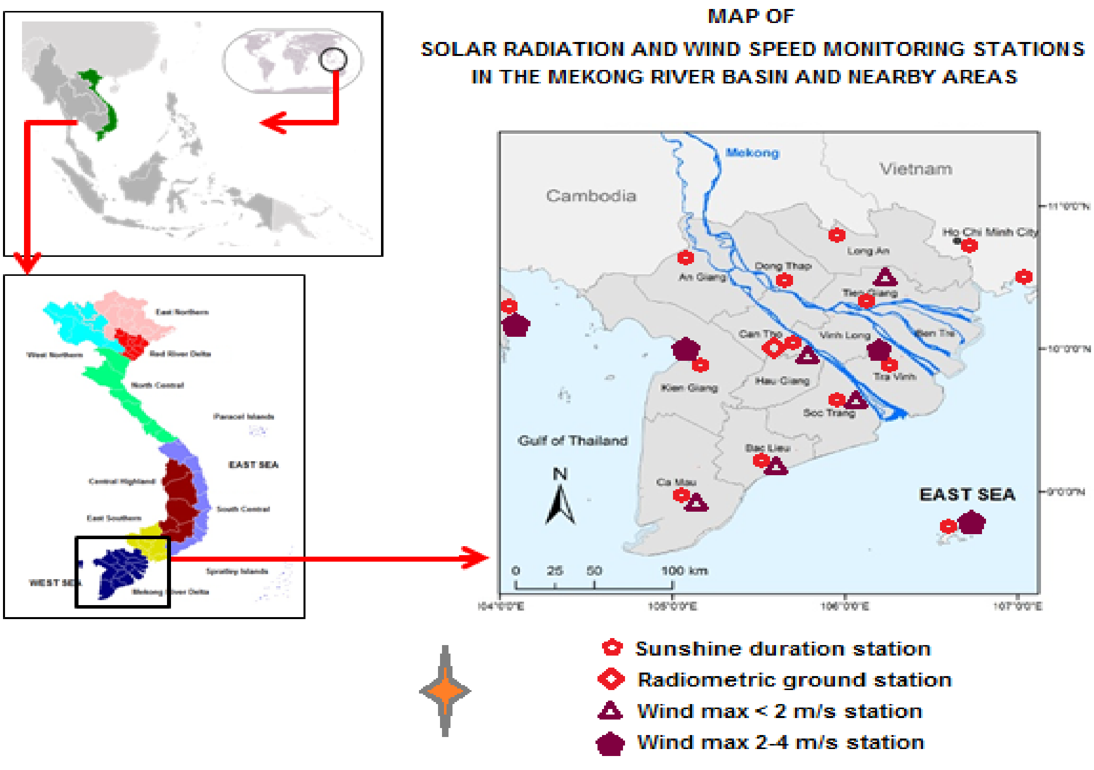

Fig. 1: Location map of the MD and its wind and solar monitoring network

(Source: Author's establishment based on the current weather stations installed)

2 STUDY APPROACHES

The approach of this study bases on specific facts and scientific reports to review, analyse and evaluate. The temperature and wind data collected from the MD provincial hydro-meteorological stations. Some data cited from the Ministry of Industry and Trade or some reports of International/ Governmental Organisations, are used to detect temporal trends. Trend lines were fit using Microsoft Excel®. There are gaps in the weather data set in the MD due to limits of wind and solar monitoring equipment for temporally and spatially energy comparable. Special in the coastal and off-shore areas, the sea wind at the high points (over 80 m), solar and sea waves data are rather rarely. The current wind speed distribution in the MD is presented by the MesoMap simulation (MOIT, True Wind Solutions (USA) and World Bank, 2010). The MesoMap system is MASS (Mesoscale Atmospheric Simulation System), a numerical weather model that has been developed over the past 20 years, both as a research tool and to provide commercial weather forecasting services (AWS Truewind, 2012). This study also used the regional climate model, PRECIS, for downscaling coarse scale Global Circulation Models to derive climate change scenarios for the Mekong River Delta (Jones *et al*., 2004). PRECIS is a regional climate model developed by the Hadley Centre for Climate Prediction and Research and applied to any area of the globe to generate detailed climate change projections. PRECIS can be used as a downscaling tool that adds fine scale information to large-scale projections of a Global Circulation Model as described by Tuan and Supparkorn (2011).

In the MD, there is a station in Can Tho city recording hourly and daily data of solar global radiation. Regarding the sunshine duration stations, there are 11 inland points, including in Saigon and Vung Tau and 2 points in sea inlands (Phu Quoc and Con Dao). The daily global horizontal irradiation (HGI) data in the MD has been computed by fitting a model based on a linear relationship between, and sunshine duration derived data, H_{Sun}. In the MD, below equation can be applied (CIEMAT and MoIT, 2015).

$$H = 0.0755\ H_{Sat} + 0.9376\ H_{Sun} - 0.2105\ (kWh/m^2.day)$$

The daily direct normal irradiation (DNI) is estimated from the GHI satellite derived data by using DirInt model (Perez *et al*., 1992) for overcast conditions and REST2 model for cloudless days (CIEMAT and MoIT, 2015). As a huge part of biomass energy potentials, rice husk source is chosen for heating value estimation, based on the experimental exchange 1 kg of rice husk charcoal can provide approximately 5,000 cal/gr (Nuta *et al*., 2015).

3 RENEWABLE ENERGY POTENTIALS IN THE MEKONG DELTA

3.1 Wind energy

Due to the long coast facing to the East Sea and the Gulf of Thailand approximately 700 km, the MD has a potential of wind energy. In the east side of the Delta, the high monthly wind speeds at the height of 10 m are mainly in February and March, meanwhile in the west side the wind speeds are stronger in July, August (Figure 2). The potential of wind energy in Tra Vinh, Soc Trang and Bac Lieu coastal lines in the height of 80 m above the coastal land surface, with the average wind speed can be reached at the rank of 5.57 - 6.0 m/s (Figure 3). Under climate change scenario A2, it is projected the wind speeds in the coastal areas in the South of Vietnam, including the MD, will be stronger in the future (2020s and 2050s) if compared with the baseline data in 1980s (Figure 4), promising a higher potential wind energy exploitation as a positive effect of climate change. Based on the simulated wind speeds and local conditions, some wind power plants have been planned in MD coastal provinces with the possible total installed capacity up to 1,222 MW (Figure 5). In Bac Lieu province, there is a wind power project has installed 10 wind turbines in shallow waters with the total installed capacity of 16 MW in the first phase. The investor, Cong Ly Construction-Trade-Tourism Limited Company, will consist of the installation of 52 wind turbines each having a 1.6 MW capacity, for a total design capacity of 83.2 MW as the second phase (Black and Veatch, 2014). A feasibility study has been received a grant financial award by the US Trade and Development Agency. It will have a gross annual electricity output of 335.2 GW/h and expected that in full operation; the power plant will result in the reduction of 143,761 tCO_2 emissions on average per year and 1,006,328 tCO_2 over the first crediting period (UNFCCC/CCNUCC, 2012). A total wind power capacity up to 300 MW for Bac Lieu will be expected in the third phase.

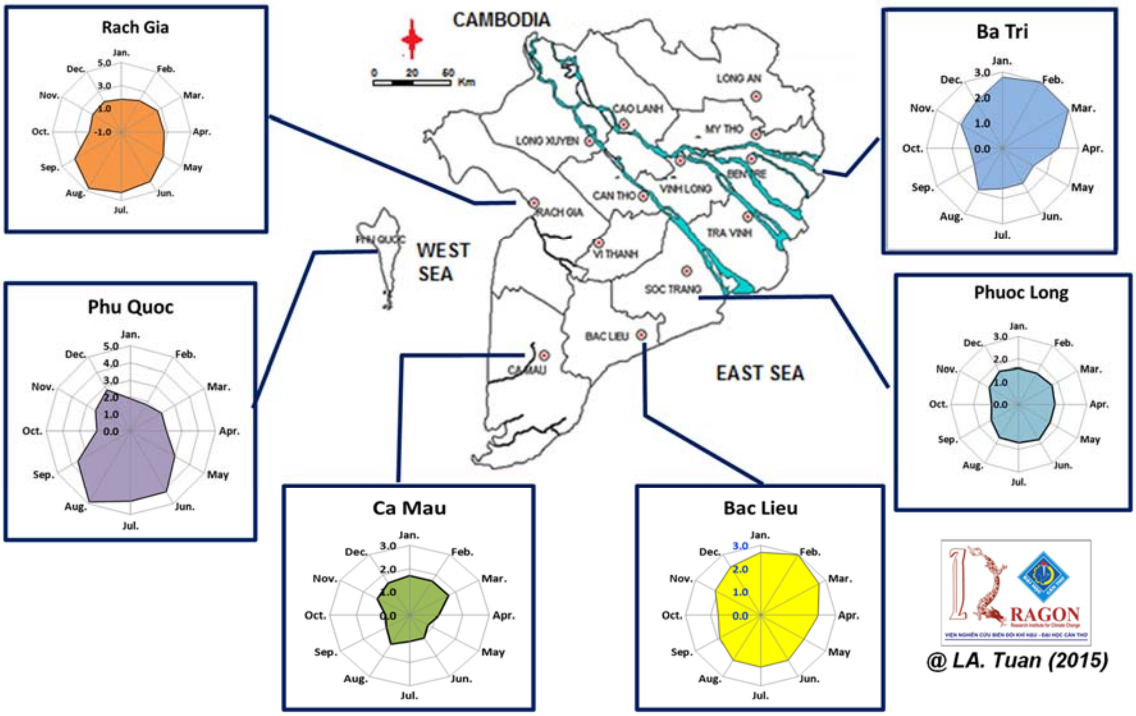

Fig. 2: Monthly distribution of wind speeds (m/s) at 10-m height in coastal areas of the MD

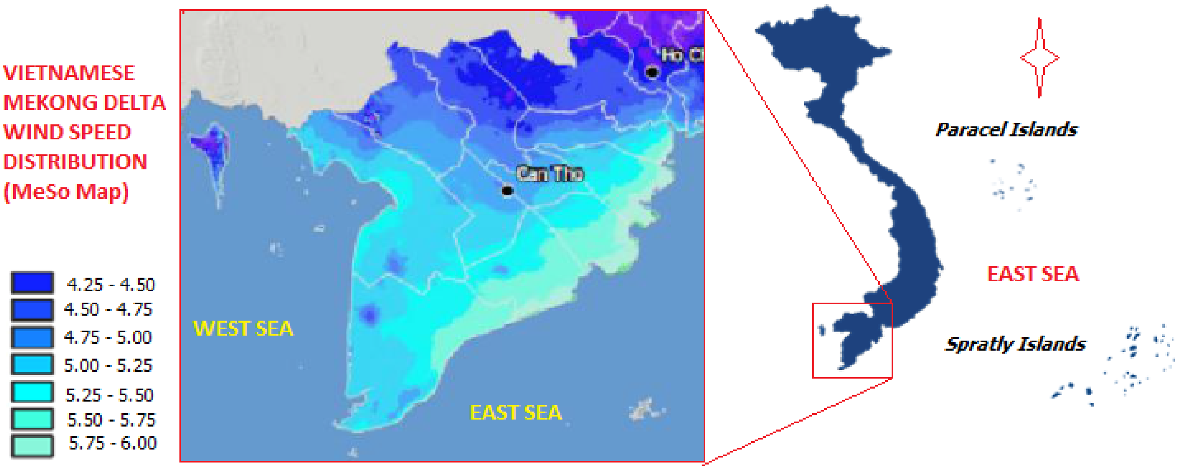

Fig. 3: Wind speed (m/s) distribution map in the Mekong Delta based on the MesoMap simulation

(Source: MOIT, True Wind Solutions (USA) and World Bank, 2010)

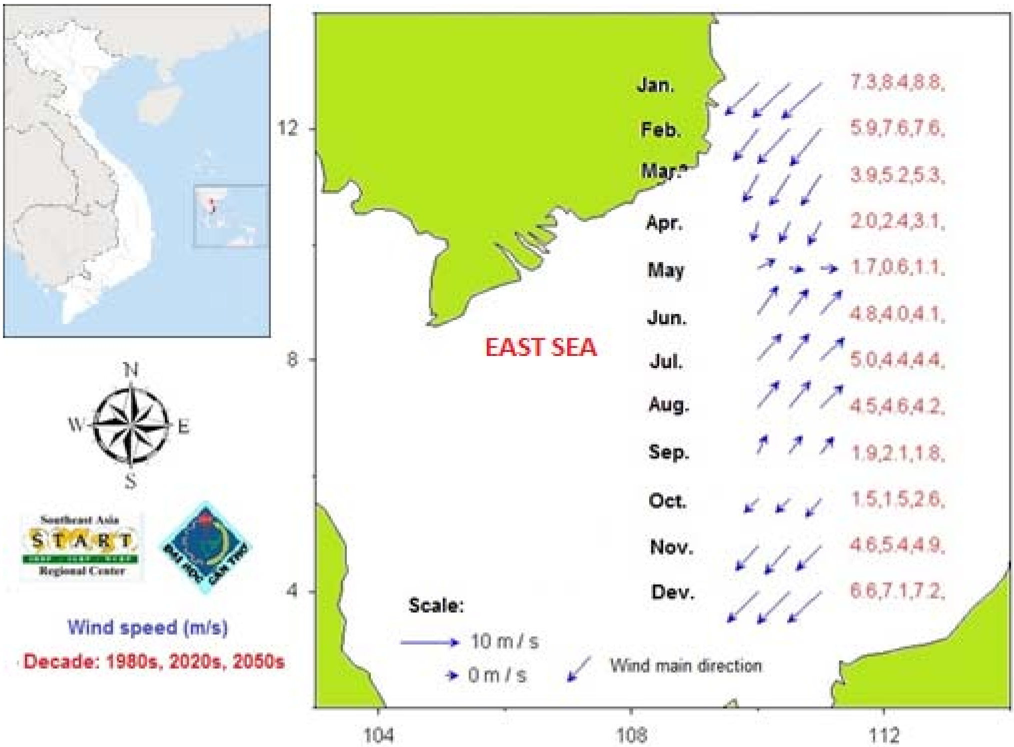

Fig. 4: Wind speeds and direction projection in the South of Vietnam in 2020s and 2050s

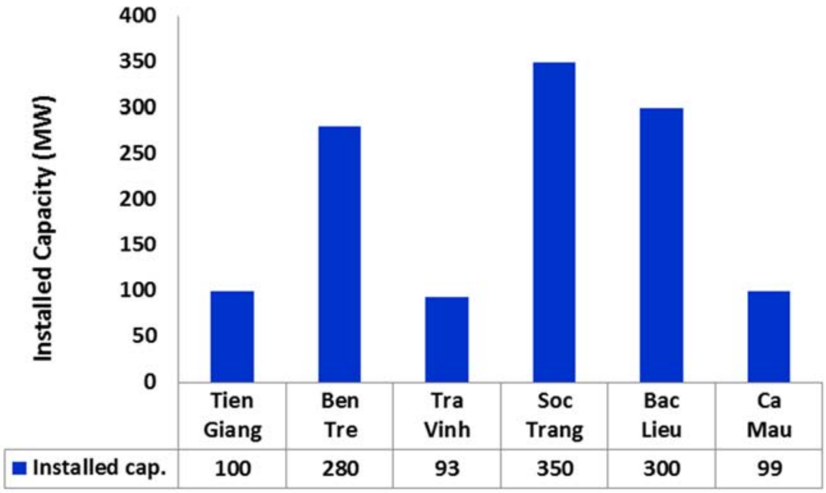

Fig. 5: Proposed wind power plants development in the coastal areas in the MD

(Data source: Power Engineering Consulting Company No. 3, unpublished)

3.2 Solar energy

Vietnam is considered a nation having great potential for producing solar energy, especially in the central and southern area of the country. Solar energy intensity on the average could reach 5 kWh/m^2 per day (CIEMAT and MoIT, 2015). However, due to rather high capital investment, the application of solar panels, or more technically termed photovoltaic (PV) panels, in Vietnam is still small, only around 4.5 MW installed capacity in the end of year 2014.

Can Tho, a central city in the MD, has received 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 (as monthly distribution in Figure 6). It is estimated that about 2,000 - 2,600 sunshine hours per year coming to the whole MD. According the report of CIEMAT and MoIT (2015), with an annual average of daily global horizontal irradiation (DHI) and daily direct normal irradiation (DNI) are as mappings in Figure 7. These energy amounts are possible to provide enough PV rooftop units for a typical household (around 1-50 kWp) or a small scale industry (more than 40 kWp) (EWB 2012). Energy Institute (2011) has planned that up to year 2020 and 2030, the solar power development in the MD can be reached as 18.62 MW and 23.19 MW, respectively (Figure 8).

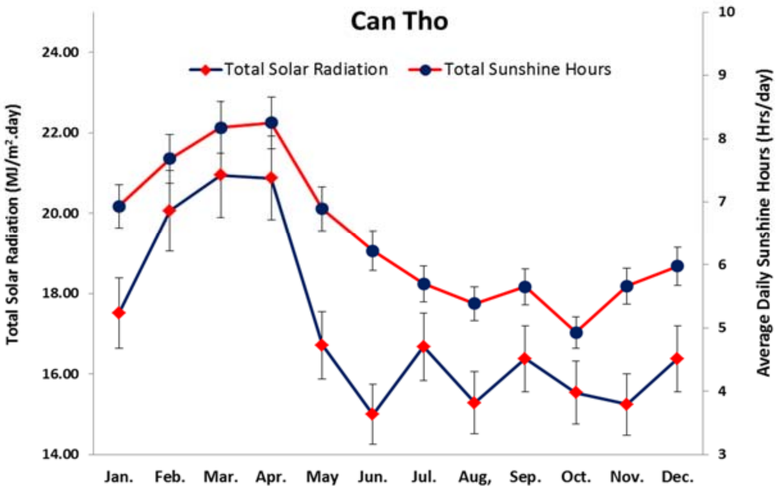

Fig. 6: Monthly average of daily solar radiation and daily sunshine hours in Can Tho

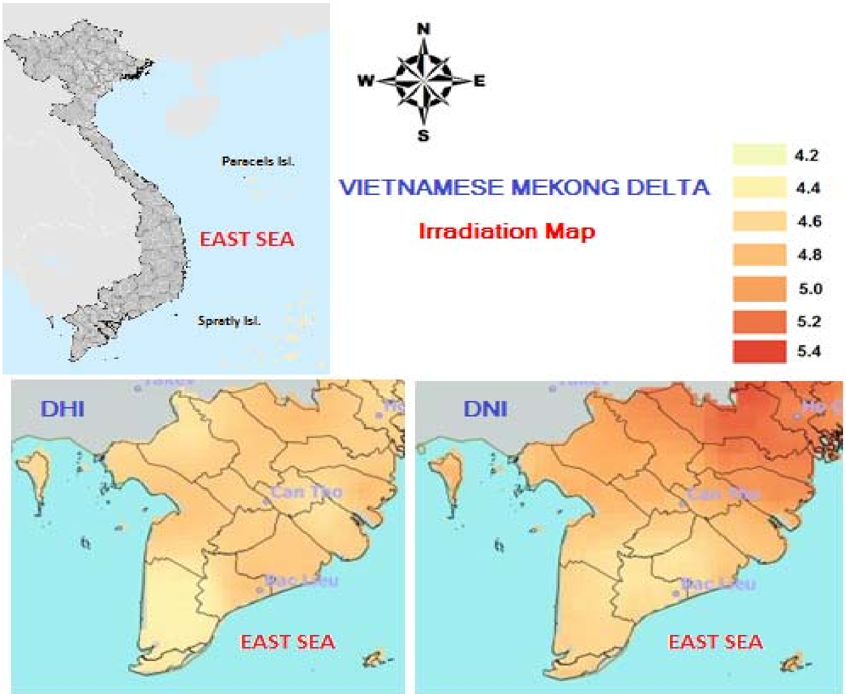

Fig. 7: The MD Map of annual average of DHI (left) and DNI (right) in kWh/m^2.day

(Source: CIEMAT and MoIT, 2015)

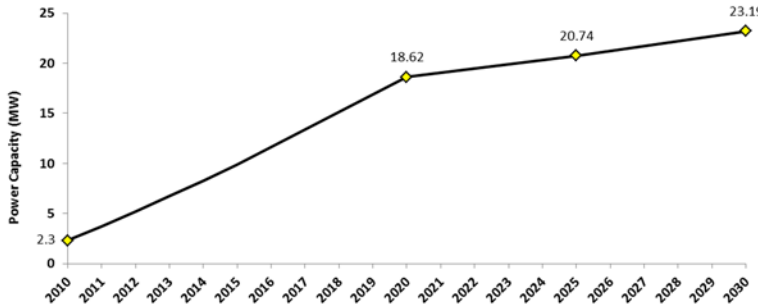

Fig. 8: Solar power development planning in the MD (Energy Institute, 2011)

In the context of climate change, with high greenhouse gas emission scenario A2 as described by IPCC (2000), based on baseline data in 1980s, it is projected in the future (decade 2030s), the average maximum and minimum air temperature will increase in the rank of 1.0 - 2.0°C in two-third areas of the Delta (Figure 9), the numbers of hot days (maximum daily temperature is more than 35°C) in a year will rise also (Figure 10). It may be a favourable for the thermal energy collection.

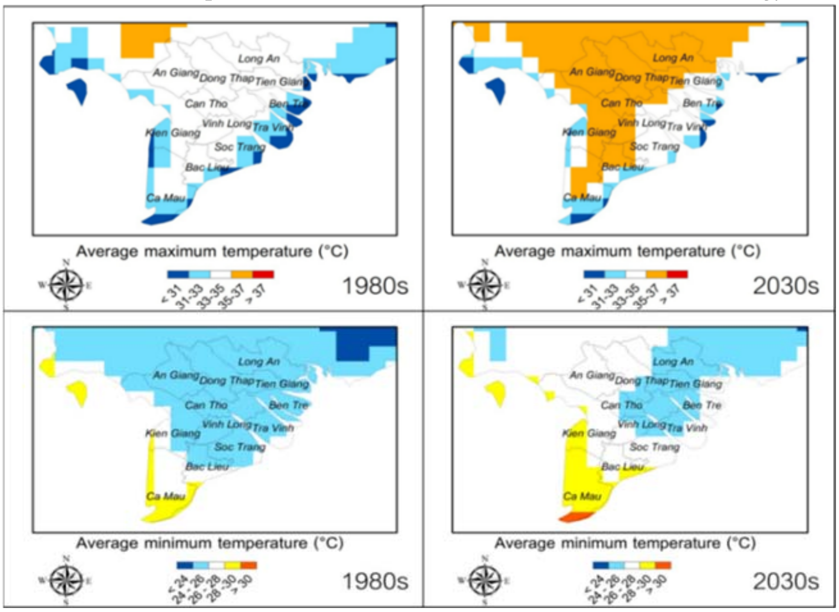

Fig. 9: Average max. and min. temperature in the MD in present and future projection

(Source: Tuan and Supparkorn, 2011)

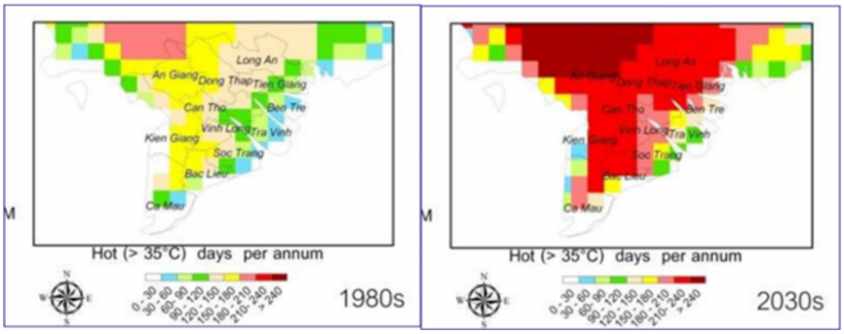

Fig. 10: Numbers of hot days per annum in the MD in present and future projection

(Source: Tuan and Supparkorn, 2011)

3.3 Biomass energy

More than 2.4 million ha of land in the MD (about 60% of total natural area) are used for agriculture and aquaculture production. The MD also has 280,000 ha of land existing in two typical distinctive eco-forestry, i.e. the predominantly freshwater inland Melaleuca forest and the predominantly saltwater coastal mangrove forest (Tuan and Wyseure, 2007). In the view of biomass sources, the MD contributes more than 50% of the amount of agricultural waste in the whole Vietnam. In rural areas, coconut oil and *Pangasius* catfish oil (through pressing and separation) are used as biomass fuels for small-scale industries and locality transportation. In theoretical biomass EP in the MD, agricultural residues have been dominated, providing 91.4% of total EP, while the share of human and husbandry manures and woody biomass are 0.8 and 7.8%, respectively (Tu *et al*., 2009). It is estimated that total biogas yield in the MD is more than 2.7 million m^3/day already used by households for cooking, lighting and running small generators.

Rice is the major agricultural product in the MD. Based on the rice production statistical data in 2014 (GSO, 2015), it is estimated that in the MD there were nearly 5 million ton for rice husk taken from 20% of 24.7 million of rice gain harvested (Figure 11). Furthermore, about 26 million of rice straw has been yearly produced (Diep *et al*., 2015). Assuming that a haft of provincial rice husk amounts from paddy milling stations are used to make rice husk charcoal briquette, the MD can receive approximately 1.1 Million KCal per year for heating value or equivalent of 265,160 KJ per year (Figure 12). This heating charcoal potential source may be higher if rice husks are well mixed with other biomass sources as rice straw, bagasse and water hyacinth that are not be estimated fully their bio-energy volumes yet.

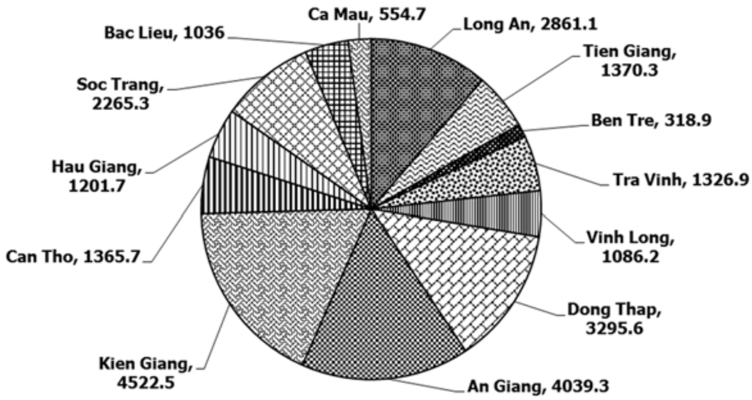

Fig. 11: MD's provincial distribution of rice husk volumes (in 1,000 ton per year)

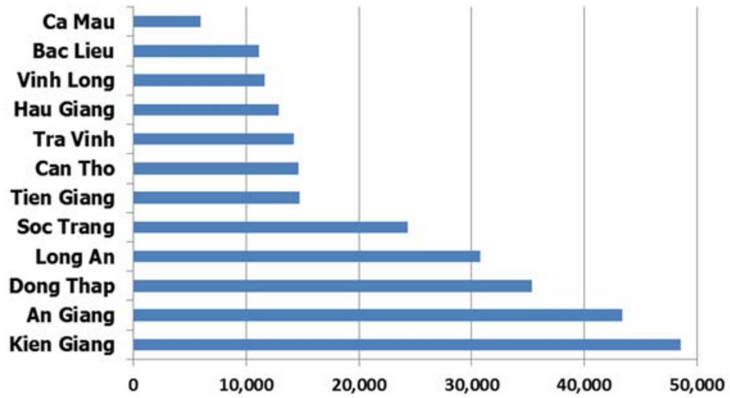

Fig. 12: MD's provincial estimation of rice husk heating value potentials (in KJ per year)

3.4 Renewable energy policies

To promote renewable energy development programs have become a notice policy in the National Plan for Power Development 2011 - 2020 as part of the climate change mitigation and adaptation solutions of Vietnam (Prime Minister, 2011). The National Plan targets an increase in the share of renewable power generation, from 3.5% in 2010 to 4.5% by 2020, and possibly to 6% by 2030. Besides it, energy saving and efficiency use are also priority mentions to encourage people to use compass lights, LED lights, solar water heaters and solar cookers etc. On Nov. 25th, 2015, Vietnam Prime Ministry has approved "*The development strategy of renewable energy of Vietnam by 2030 with a vision to 2050*" with the following notice to increase the total electricity production from RE sources from approx. 58 billion kWh in 2015 to 101 billion kWh in 2020, approx. 186 billion kWh in 2030 and 452 billion kWh in 2050. The share of RE-based electricity in the total national production shall rise from 35% in 2015 to 38% in 2020; 32% in 2030 and 43% in 2050.

Indeed, the renewable energy projects in the MD are still in small scale and the initial costs for installing the solar panels and wind plants are rather high. The subsidy policy in biomass energy promotion is not so clearly. The renewable energy projects meet some difficulties and barriers (Hai and Lien, 2012), such as a lacking of accurate weather recording data, insufficient cost-benefit analysis and social environmental consideration. These information gaps lead to unfair competition in electricity price between wind, solar PV and biomass energy and existing coal-thermal and hydropower energy. Overall, for a sustainable development strategy of renewable energy, it is needed to review and perfect energy policy and mechanisms in national and regional long-term viewpoints.

4 CONCLUSION

Due to the rapidly increasing of population and economic development requirements in the MD, the energy consumption needs will be highly rise. In the MD, abnormal variability of weather and climate are more and more reality. The increasing heat waves and stronger wind intensity in the future seem beneficial for the thermal and wind energy collection. However, the climate change will extend the surface dry area leading decreasing significantly biomass volumes and shortages of water quality and quantity. Overall, renewable energy development is an environmental-friendly directional solution. It may support households in harvesting cheap renewable energy, such as solar heating, wind drying, and biogas cooking… in the meanings of supplying rural off-grid-based power. It is also considered as an adaptation measure of climate change. In wider scale, like wind power plants, they also partly play a noticeable role in reducing the pressure on regional grid-electricity power demands. For a long operation economical consideration, solar, wind and tidal energy sources are possible a cheaper alternative for power supply to the MD people.

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