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The End of Fossil Fuel Era: Supply-Demand Measures through Energy Efficiency

N. Agya Utama[a]*, Andhy M. Fathoni[a], Mandau A. Kristianto[a], Benjamin C. McLellan[b]

[a]*Department Environmental Engineering, Surya University,Tangerang, Banten, Indonesia*
[b]*G30, Graduate School Energy Science, Kyoto University, Japan*

Abstract

In the last ten years,the world has faced an uncertain oil prices, unlike during 1970 when the oil crisis occurred due to the Middle East political crisis. The problem now facing has more in the increases of oil demand when the developed countries are not the major consumers for oil and other major fossil fuel anymore. China, India, Brazil and South East Asia nations lead the increases of the energy demand inline with their economic growth and population domination. The energy demand in ASEAN is dominated by the countries in Malaya peninsula (cognate) such as Indonesia and Malaysia (225 million and 25 million population respectively), Singapore and Brunei lead the domination in the economics, which are also one of the variables of the increases of energy demand. The paper will estimate the future energy demand (includes fossil fuel) ASEAN by using bottom up approach and various variables such as economic development and population trend from references developed countries, the country's landscape and technological efficiency. It shows that the energy demand increase for the region is inevitable, the increases are followed by some consequences such as local fossil fuel scarcity, technological boundaries and infrastructure adjustment. The efficiency is most likely to be one of the keys for the region to be survived in the next 5 to 6 decades.

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Keywords: energy; supply-demand; ASEAN; efficiency

* Corresponding author. Tel.: +6281393902218.
E-mail address: agya.utama@surya.ac.id

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1. Global and ASEAN energy demand

The future energy demand as predicted by British Petroleum statistic will be increased by two folds, the interesting part of this projection is that the major energy consumption is not dominated by Europe and North America as these two regions had dominated the world energy consumption in the last 100 years [1]. The Asia pacific regions, however, will account almost 50% of the world energy demand in 2030 or it will increase at almost 400% since 1990 (Fig. 1.).

The projection by BP petroleum is mainly based on the population increases with the sloping down growth rate, the projected population growth of 1.4 billion over the next 20 years (or 0.9% p.a.). With regards to global GDP growth, it is likely to accelerate, driven by low and medium income economies. The primary energy consumption growth in 2030 decelerates to 1.6% p.a. (compared to 2.0% p.a. the last 20 years); energy consumption per capita grows at 0.7% p.a., about the same rate as it has since 1970.

Moreover, it is also predicted that in 2030 the world commercial energy use will reach almost 17 billion tons oil equivalent (BTOe). Oil and coal are accounted in more than half of the share, followed by gas in approximate of 3 BTOe.

As part of the Asia Pacific region, the nations located in the south east of Asia or The South East Asian Nations (ASEAN) are also responsible of the increases of energy consumption. From many researchers realize that the worldwide energy per capita shows unequal distribution. Europe, Russia, North America and Australia are responsible for more than 3 TOe per capita and ASEAN member countries are only accounted between 0-2.5 TOe per capita (not including Singapore and Brunei Darussalam) [2, 3], while in Asia the range of energy per capita accounted is not more than 3 TOe per capita (except Japan, South Korea, Taiwan and some countries in middle east) [2]. According to the prediction in 2030, this region will responsible for more than 50% of the global energy consumption, means that quite significant increases are required [4, 5].

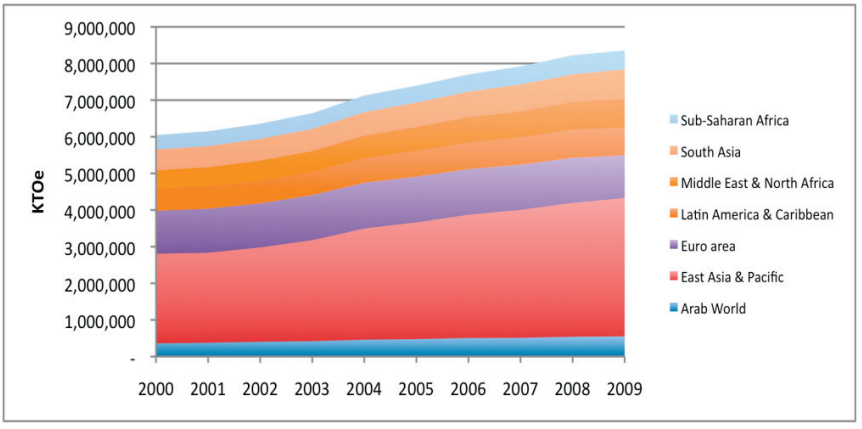

Fig. 1 World energy consumption by region[1]

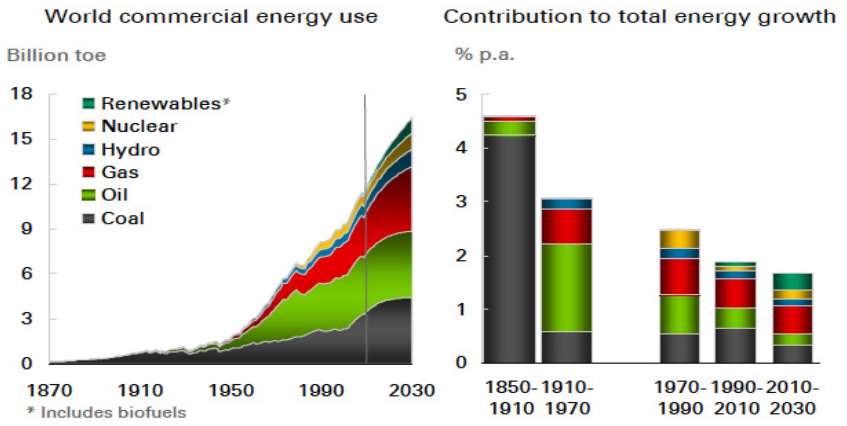

Fig. 2 World energy use (type of energy) and growth [1]

Based on the causality analysis done for ASEAN region the macro economic has strong relation for increasing the power demand. The bi directional relationship from energy causing the increase of economics and vice versa is empirically proven [4]. Moreover apart from the increase of GDP influencing the energy consumption, the increases of population also significantly influencing the increases of energy through transportation sector [5], power demand through urbanization [6] and through residential sector [7]. These economic and population factors are very crucial variables on predicting the future energy consumption in the vast developing region.

2. Methodology

The geographical condition between ASEAN nations and some developed countries can be as refernces for prediction the ASEAN nations future energy percapita. For instance the land scale of the US (9.8 km^2) compare to Indonesia (1.9 km^2), if we includes the sea coverage the size of Indonesia will reached up to 7.9 km^2 almost close to the overall size of the US area. This condition may lead in the future the consumption of energy through sea/water transportation. While in case of Philippines, Malaysia, Thailand, Vietnam and Myanmar which having land size of 300,000 km^2, 330,000 km^2, 513,000 km^2, 331,000 km^2 and 676,000 km^2 respectively these condition relatively similar to the country such as Japan, Sweden and France (between 377,000 up to 676,000 km^2). Moreover the landscape condition for these countries also similar, where the coastal line is dominating the country border rather than land border to its neighboring countries. The condition rather different in case of Lao PDR and Cambodia, where the size of these two countries are less than 250,000 km^2. However Lao and Cambodia can not be compared in term of size these two have significant differences in term of border, Lao PDR is a landlocked country while Cambodia has a coastal lines.

Energy per-capita (Ep) or the energy consumption divided by the whole population in the given year is used as main parameter to predict the future energy consumption in any given countries in ASEAN[8].The methodology was started by using developed countries as references. As mentioned in Fig.3., in the last 20 years with relatively economic stagnancy, in all developing countries show the steady energy per-capita. The references countries are being used mainly because the future economic trend in ASEAN shows a similar trend with those on developing countries. The boundaries, therefore, should be taken into account in order to characterize the differences future Ep will be between the references countries and ASEAN. The boundaries are such as geographic conditions, efficiency measures (each ASEAN countries has different efficiency measures in given years in the future depending upon current act toward energy policy).

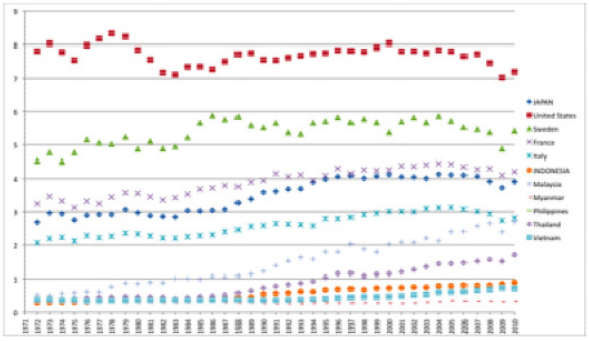

Fig. 3. Time series of energy per-capita for most of the developing countries in the last two decades

2.1. Demographic assumption

Table 1 Assumption for the demand model to the relative similarity of Ep index and demographic between developed countries and ASEAN [8]

Group	Ep (KTOe/ cap)	Country Scale	Population	Landscape	Reference	ASEAN	Note
I	6-8	Large	Large	Long coastal lines	US, Canada	Indonesia	High energy per capita; from transportation and population
II	4.5	Medium	Medium	Inland with long coastal areas	Italy, France, Sweden, Japan, Korea	Malaysia, Thailand, Philippines , Vietnam, Myanmar	Medium energy per capita; from transportation and population
III	4.5	Small-medium	Small to medium	Small coastal line, no coast or landlocked	Switzerland, the Netherlands	Lao PDR, Cambodia, Singapore and Brunei	Low energy per capita; from transportation and population

3. Result

Itshows that Malaysia and Singapore have the highest Ep currently followed by Thailand and Indonesia. However, in 2075 Indonesia will take over in term of Ep to all ASEAN nations, and Malaysia will take over Singapore in 2050 and Myanmar in 2095.

Based on the prediction method done in the methodology and by assuming that in the future, the nations' economic conditions will be similar to their developed countries counterpart, the future energy pictures can be drawn. The prediction assumes merely on the demand side where the supply side, where the future power and/or energy mixture for each nation in ASEAN are open for discussion. One of the direct linier conclusions can be drawn from the demand prediction result to the supply scenarios is the final power generation needed.

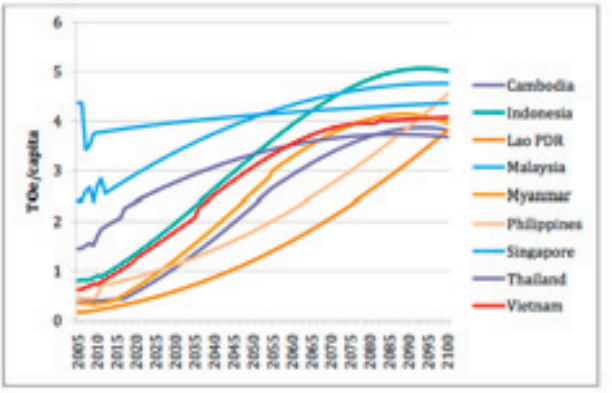

Fig. 4 Predicted Energy percapita up to 2100

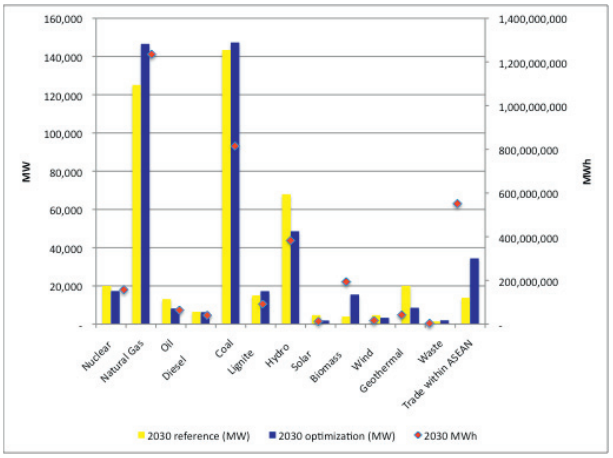

Fig. 5. Predicted type of power plant (after optimization) in ASEAN at 2030

As seen in Fig.5.that shows summary of the power generation supply type in ASEAN as well as the prediction on the generated power at the same year: a comparison between policy and cost optimization. Natural gas and Coal (hard and lignite) still remain valuable and relatively cheap power generation fuel sources in 2030, so it is suggested to increase their share in many countries. Biomass, waste and power trading between member countries will also be a realistic solution to solve power scarcities at 288%, 40% and 149% respectively. Nuclear power is predicted to reduce to approximate 13.5%. A reduction of 28% is predicted for hydropower due to sedimentation, inefficient and old system.

Without optimization the regions need in more than 600,000 MWh of traded power between countries, by means of there is no single country can be relied on their own power generation for their own supply. By optimizing its own natural resources on powering their own countries, these nations require to install 50GW more additional coal power plant (mainly for Indonesia). The figure seems to be rather difficult to be implemented since environmental concern will be the main constraints. Moreover, some countries also plan to increase its renewable energy (RE), however the optimization result shows that generating power from RE is too risky and cannot be relied as baseline. The model shows that the RE plan should be reduced up to 50%.

4. Conclusion

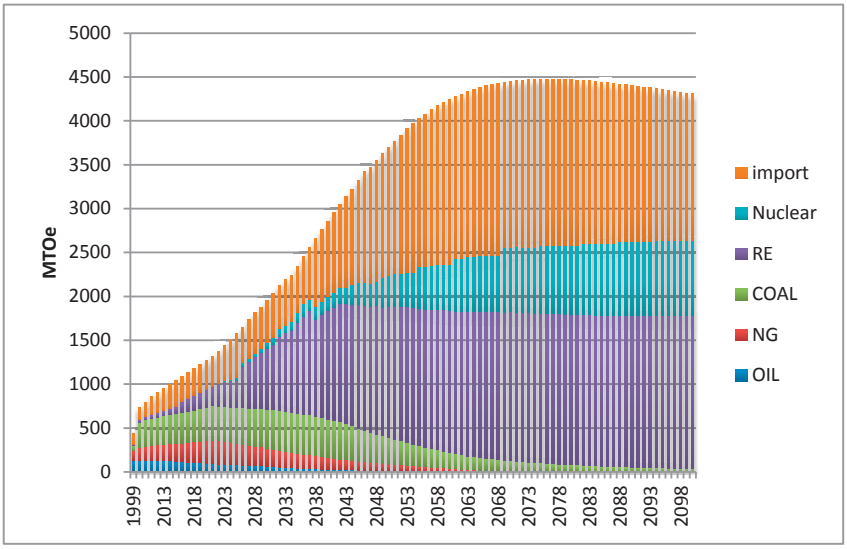

Fig. 6. Predicted primary energy demand in ASEAN nations, required a long termenergy efficiency measures

As seen on the result of energy per-capita as well as indicators of economic, social, emission, resources and energy security, ASEAN could have faced a serious problem in term of high increases of energy demand. The fossil fuel era soon will be vanished, when Middle East could not anymore be the global backbone for fuel supply, while renewable energy is facing different issues, such as its intermittency, power capacity, rare earth and its cost (smaller system tends to have higher cost comparing to the b bigger system). Nuclear is also facing its own issues, from the limited number of uranium available, its safety towards natural disaster as well as global terrorism. Fusing has its own technological challenges when it comes to the energy input-output balance. The suggestion for the ASEAN nations for the future energy management and policy is to go to the supply and demand energy efficiency. The demand energy efficiency in building, for instance, could reduce in more than 30% of its energy through building design efficiency, and up to 70% through passive methods. While energy supply efficiency could reduce the energy being wasted up to 30% (coal to NG).

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