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"Detailing the Renewable Energy and Energy Efficiency Indicators fo Improving the Energy Security Model of Indonesia? A Preliminary Research"

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BACKGROUND

Energy is the key component to ensure the development of all countries, included Indonesia. Disruption of energy supply, both internally and externally, will directly affect the economic growth and development. To secure the national development, it is required an energy independence that leads to energy security. In general, energy security is defined as conditions that ensure the availability of energy, and public access to energy at affordable prices in the long term and, not affected by regional or international issues. The question now; how is the energy security condition in Indonesia?

Based on the latest data released by British Petroleum [1], since 1998, an increase of energy consumption, either oil, natural gas, coal, and electricity by 3.2%, 2.0%, 13.4%, and 7% year respectively. It should be noted that, in fact Indonesia is not a rich country in fossil energy reserves. The reserves of oil, natural gas, and coal have only 1%, 3%, and 3.6% of world reserves, respectively. Details, oil reserves consist of 3.7 billion barrels with production of about 332 million barrels/year, only enough for 12 years. Natural gas reserves of about 2.9 TCM (trillion cubic meters) and consume 0.07 TCM/year, then this is only sufficient for 41.6 years. In addition, the coal resources of 28 billion tones with a production of about 0.421 per year per year, then this is only enough for about 67 years.

In final energy consumption, industry sector is the biggest consumer, which is 38%, with a share of 40% coal, 23% oil, 28% of gas, and electricity by 9%. Followed by the transportation sector, which accounted for 35% of final energy consumption, which is almost 99, 65% depend to oil, the remaining electricity of 0.015%, and 0.03% of gas. The transportation sector is the highest growth rate consumption, 6.92% per year, driven by the automotive growth of 14.3% per year [2].

Among all the fossil energies, arguably, the most worried about is the oil. Imagine, fuel consumption is about 1.5 million barrels per day (BPD), which can be satisfied only approximately 0.8 million BPD as the average of lifting [1], and even then with the state owned refinery production is only about 0.6 million BPD [3]. That is, Indonesia has to import more than a half its consumption, of course, with world prices, which have a risk of price fluctuations. This condition will get worse if the tendency of personal transportation vehicles continue to increase (growing 14.3% per year [4]), as a result of poor public transportation services. Inevitably, Indonesia must deal with global environmental issues (climate change mitigation, carbon trading, and the commitments to reduce emissions of 26% by 2020 [5]).

Meanwhile, almost 95% of the electrical energy source is currently generated by burning the fossil fuels, mostly coal and gas. Currently, the electrification ratio is about 80% (20% no electricity, especially in remote areas and outer islands). Electric energy demand growth rate is 7% per year, which is not matched by the supply growth, resulting frequent blackouts in several cities in outside Java. The government s target of 100% electrification ratio must be achieved by 2022, or 6 years from now. With an average increase of 1% per year, it seems that the target is difficult to achieve, if not with a mighty change [6].

Admittedly, the number of Indonesian population of about 248.8 million people, with the population growth of 1.49%, and the economic growth of 7% per year [3], have contributed to the increased of energy consumption [7]. However, it should be noted that the high dominance of fossil energy in the primary energy mix which is 97% compared with only 3% of renewable energy. The potential for renewable energy is huge, that is micro-hydro 0.77 GW, geothermal 16,5 GW, biomass 0.18 GW, solar 4.8 kWh/m^2/day, and wind 3-6 m/s [8].

Actually, in the year of 2006, the Government has issued the Presidential Decree No.05/2006, on a target of 17% energy mix from RE, with the details, as follows 33% of coal, 30% of natural gas, 20% of oil, the remaining 17 % of renewable energy, which is; geothermal, hydro, solar, wind, biomass/biofuels, hopely energy investments amounted to USD 13.197 million [9]. As a reference, the status of primary energy consumption in 2006 [1], 24% of coal, 31% of natural gas, 43% of oil, and the remaining 2% of RE. Apparently, the realization of the primary consumption in 2013 is still far from the target, which is 32% of coal, 21% of natural gas, 44% of oil, and the remaining 2% renewable energy [1]. That is, after 7 years, no fundamental changes as a result of energy policies that have been issued previously.

Finally, in 2014, the government made revisions by issuing a new national energy policy, Presidential Decree No.29/2014, which corrects the target energy mix in 2025 and also in preparation for 2050, with details; 25% of coal, 22% for natural of gas, 24% of oil and 31% of new and RE [10]. The lessons learnt from the previous failures, the new current energy policy is an even bigger challenge for Indonesia.

Based on what has been discussed above, the general condition of Indonesia s energy as follows; high energy demand has not been matched due to lack of supply, distribution, and access; fossil energy reserves declined very rapidly due to consumption and export, there are still subsidized energy prices, which affect the poor energy conservation, utilization of RE is not optimal, unsupported by the capacity of R & D and energy industry, Indonesia should maintain the commitment on the issue of climate change.

In conclusion, Indonesia s energy security is quite vulnerable and weak [11] in facing energy trilemma [12]. Even though there have been several actions and programs based on energy policies and regulatory frameworks, include; diversification, substitution, technology development, and sustainability, which generally cooperate with friendly countries, companies and international organizations.

In fact, the discussion of energy security cannot be separated from the topic of energy models. Models are convenient tools in situations where performing tests or experiments in the real world are impractical, too expensive or out-rightly impossible. Energy security models, like other models, are simplified representations of real systems. They vary, rangin from the simple to the complex or from the most important to the less important, depending on the type and number of indicators used.

In other words, the complexity of today s energy security issues, can no longer be anticipated with simple and common indicators, but might include the complex indicators, focus on the priority and objectivity as well. Ideally, designing energy security of a nation must be adapted to the specific context in a country, such as; special condition, level of economic development, risk perception, as well as the strength of the energy system and geopolitical issues [13]. That is, the opportunities for improvement to energy security is still wide open, because there is still a gap and freedom to a specific indicator [14].

OBJECTIVES

The main purpose of this study is to improve the energy security models of Indonesia in order to get the accurate prediction for the spirit of the present and future through renewable energy (RE) and energy efficiency (EE).That is, from the fossil oriented to the development of RE and EE, with a focus on specific sectors (residential, commercial, industrial), and certain regional (rural and urban, Java or non-Java such as Sumatra, Borneo, Celebes, the Moluccas, Papua, etc.). In essence, how Indonesia improve the internal capabilities on energy supply by reducing dependence to the other countries. This is the real challenge and also opportunity. This model is expected to be used easily and widely by the policy makers for both at the central and local governments, or for the other related stakeholders especially in Indonesia.

METHODS AND ANALYSIS

Review: In this preliminary study, we have done some review papers related to the energy security. Energy security is a fairly active area of research in recent years, discussed range from concept of definition, framework methodology to determine the dimensions, the indicators used by certain techniques (surveys, interviews, ec), and the development of the composite index, as well as assessment evaluation for comparision by single or grouped countries. It can be seen from various review papers, such as the discussion of "typology of energy and security" [15], "definition, dimension, and indexes" [14], "perspective to integrate the disciplines root of politics, science and engineering, and economics" [16], and "commontly used methodology and approach" [17][18]. Due to ambiguous and allows for multiple interpretations, the existence of highly multidisciplinary topics within energy security, it is suggested to be categorized into four perspectives geopolitical, economic, policy related, and technological, with diversification strategy is very important for ensuring energy security over the entire supply process [19].

So far, there is no clear and unequivocal agreement on the definition of energy security, but shortly, IEA defined that energy security as "the uninterrupted availability of energy sources at an affordable price" [20]. Previously, the concept of energy security of a country is to secure access to fossil energy sources, such as oil [21]. Then, to answer the challenging complex energy security, the increasing need for energy while depleting reserves of world oil, and increasing pressure on global climate change, the issues extend to such as; price volatility, supply chain, political stability of oil-producing region, environmental sustainability, renewable energy, energy efficiency, and so on, various models have been offered by applying certain methods and techniques involving various indicators, simplified into a composite index. A dynamic model based on Bayesian method for energy security assessment was proposed to forecast the values of indicators, using four different approaches algebraic, ordinary least square, pairwise correlations and the Bayesian method. The method involved the expert judgment as preliminary information (with uncertainties) [22], then tried to assess the Ukrainian s energy security [23].

A study of the applicability of various methods, from more than 90 published papers, summarized that the Multi-Criteria Decision Making (MCDM) techniques are gaining popularity in sustainable energy management which can provide solutions to the problems involving conflicting and multiple objectives [24][25]. Through the quality function deployment (QFD), the experts are guided toward identifying key energy security components, including indicators and policies, and in making these components consistent, focused, and customized for a particular country, to construct a customized set of key factors for new models [26]. To show the level of energy security, a point system assessment scale is used to integrate the characteristics of the indicators [23]. By considering 25 individual indicators representing social, economy and environmental dimensions, AESPI (Aggregated Energy Security Performance Indicator) has been developed which required the detailed time series data for methodology development. With value 0-10, AESPI can evaluate past and future performances trend, improve the overall energy security performance and benchmark for further improvement [27].

Sovacool, researcher from Aarhus University, focused on 5 dimensions such as; availability, affordability, efficiency, sustainability, and governance, produced some comprehensive papers, such as; evaluating energy security in the Asia Pacific with a more comprehensive approach [28] based on previous work by Vivoda [18], an international survey to explore propositions about perceptions of energy security [29], propose the creation of an Energy Security Index to inform policymakers, investors and analysts about the status of energy conditions [30], synthesize the workable framework for analyzing national energy security policies and performance [31], present an energy security index which measures national performance on energy security over time. Based on three years of research involving interviews, surveys, and an international workshop, this study conceptualizes energy security as consisting of the interconnected factors of availability, affordability, efficiency, sustainability, and governance. matches these factors with 20 metrics comprising an energy security index, measuring international performance across 18 countries from 1990 to 2010 [32], and explains why an energy security index is needed, then justifies research interviews as a data collection tool [33] to respond the critiques [34]. Then, his quantitatively methodology was followed to assess the energy security for Malaysia and other ASEAN countries [35].

In 2008, there were already initiated to create an unofficial forum to discuss energy security for countries around Asia Pacific, including Indonesia, called; Asia Pacific Regional Energy Security (pares), initiated by the Nautilus Institute, USA. As described in both papers [36][37], the forum examines such dimensions; energy supply, economic, technological, environmental, social ad cultural, military/security. Unfortunately, so far there has been no official publication of the results that have been achieved, particularly on Indonesia s energy security. Due to lack of coherence as performance in one dimension is not necessarily relevant to the other performances from recent studies, an integrated simulation approach uses system dynamics as a modeling tool, was proposed to identify and establish the relationships between those components. Simulation showed that the individual analysis of the dimensions performances shows the policies designed to improve Indonesia s energy security may conflict with each other [38]. Based on the assessment of energy security from

1990 to 2010 with a focus on five dimensions, such as; availability, affordability, technology development, efficiency, environmental sustainability, regulation and governance [31], shows that the increase in energy sustaibility Indonesia less than 0.1%, lower than the achievement of other ASEAN countries such as Malaysia, Brunei, Vietnam, and Singapore [39].

Analysis: To answer the question in the title of this paper, there are some questions and concerns needed to be discussed here

Why is the energy security of this model focused more to RE and EE? If the paradigm of high dependence on fossil energy has not shifted, both for consumption and export, so do not expect many RE and EE activities will receive serious attentions in Indonesia. As a result, the poor development of RE by the reason of limited investment and research, EE has not been entrenched nationally. To increase both production and proven reserves are a necessity, but to reduce the percentage contribution of fossil energy in the national energy mix is also a top priority for Indonesia. In addition, the contribution of RE in the national energy mix should be encouraged [40]. Hopefully, the model will further accelerate the RE and EE development in Indonesia, ofcourse with the transition from oil [41] to coal, or natural gas [42]. RE and EE are the twin pillars and the foundation of a sustainable energy policy, which can play an important role in mitigating energy security risks and emission issues.

How important is the renewable energy policy for the development of Indonesia? The deployment of RE policy is very important for the development of Indonesia. At least, there are two real contributions from RE projects. First, to increase the diversity of energy sources such as electricity, through local generation, contributes to the security, flexibility and resilience of energy systems. Second, increasing the income per capita as increasing the RE consumption per capita. Across time, RE consumption percapita in emerging economies is expected to grow faster than real percapita income [43]. Both contributions only can be achieved by designing an effective RE policy with a good understanding of energy system and RE income characteristic.

How important is the energy efficiency policy for the development of Indonesia? The deployment of EE policy is also very important for the development of Indonesia. At least, there are two real contributions from EE programs. First, the improving EE policy is relatively preferable to limit the energy consumption policy, which increases the income of the majority of households, without worring "rebound effect", or increasing energy used [44], such as the case of India [45]. Second, the facts, implementation EE energy-saving technologies programs in developing countries, has shown quite favorable investment [46]. Actually, some EE policies have been implemented in Indonesia since 2006, but the results are very small. As one of the highest energy intensity country in the world, also the EE policy has not harmed the economic growth, Indonesia should re-introduce the EE policy [47].

What indicators should be used, especially for the accuracy toward 2015 and 2050? Energy security is difficult to measure using too simple or too complex indicators. Actually, from what we have discussed previously, Indonesia s energy policy has to focus primarily on the simple availability dimension (reflects to Presidential decree No.5/2006 and 30/2007), which the self-sufficiency and the diversification of fossil energy are the main priorities. Indonesia should be more focus to the other dimensions, such as; affordability (energy prices & subsidiy), efficiency, aceptability, socio-effect, environment, governance, and so on. (Note The indicator of RE is normally inclusively in the dimension of availability).

How to interpret the indicators, into a dimension that is easier to understand? To accelerate the understanding of those indicators, they need to be converted into a single index, called the composite index (CI). CI is formed on the basis of an underlying model of the multi-dimensional concept that is being measured. Technically, CI is a mathematical aggregation of a set of sub-indicators for measuring multi-dimension concepts that cannot be captured by a single indicator [48]. When the number of indicators used is small, the energy security index is generally very sensitive to changes in any of the indicators. Changes in the indicators will affect the other indicators, which ultimately affects the stability index. Conversely, when the number of indicators use is dislarge, changes in individual indicators may be muted out by the majority of unchanging indicator. That means, the more widely accepted practice seems to use the presentative set of indicators that can produce a broad overview of the energy security situation.

How to make a more detailed the indicator of RE and EE? According to the title of this proposal, generally for RE and EE, both are made in more detail with the notation based, such as; Sector (residential = R, commercial = C, industrial = I, and Regional (Java = J, out of Java = OJ, splitted to the island of Sumatra (OJS), Borneo (OJB), Celebes (OJC), Moluccas (OJM), Papua (OJP), and so on. Then, specifically for RE, it can be subdivided into non-Solar (NS) and Solar (S), which can splitted to thermal (T), electricity (E), and so on. So, the indicator that describes RE in the residential sector has the notation of RRE, or more details for solar thermal in Sumatera island (out of Java) has the notation OJSTRE. Likewise RE notation is also applied to EE, which can be detailed as; Main (cooling = C, heating = H) and Support (lighting = L, others = O).

Now the question is, can the energy security model provoke the industrialization of RE and EE in Indonesia? Yes, ofcourse, by controlling the right priority and accuracy, the energy security model has the advantage to provoke the industrialization of RE and EE in Indonesia. The effects can be seen from the activities of the intensification and diversification energy supply, technology development, additionally more jobs will be created [49][50]. Those activities will support the economic growth by stimulating the development of national industry based on RE and EE. The results only can be achieved with a greater uptake of more efficient energy technologies to reduce energy demand, and further adding the portion of RE into the national energy portfolio.

RESULTS and CONCLUSIONS

Based on the method and analysis above, the results can be summarized as follows

- The existing models merely the result of calculation, tend to be as predictive analysis without giving an overview and detailed solutions about what to do, especially for specify country.
- From the scientific papers that discuss related to Indonesia, both regional and national, none of which specifically provides more detailed analysis of RE and EE. As a developing and archipelago country, which is divided into several regions and many rural areas in the borders do not have good access to energy, so the development of an energy security like Indonesia needs to be modeled differently [51].
- Since several methodologies are usually used separately, which depart from conflicting assumptions and promote opposing solutions, the option is to combine

thoses methodologies for bridging the gap between of various assumptions and scientific fields for simultaneously improving current valuations [17].

③ The model should be used as accurate long-term planning, as well as tracking, and following up (actual vs. projected), at anytime and anywhere using the advanves of telecommunications technology today. So, for ease and speed of decision-making, it should be considered to visualize the energy security model into the dashboard system, included the composite index.

As conclusion, to increase the security level, the "dynamic and adaptive models with generic methodology" to develop the proper model with the right dimensions and detail indicators for RE and EE [22] and "multi-energy system" to open the implementation opportunity of RE and EE technologies for an archipelagic country multi sectors like Indonesia [52][53], should be considered appropriately.

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