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Analysis of Renewable Energy as Export Commodity (Case Study Indonesia-ASEAN)

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Abstract. The net zero emission commitment under Paris Agreement has fostered the clean energy transition agenda. ASEAN becomes the home of untapped renewable energy resources due to its geographic condition. However, the distribution of renewable energy is far from it has expected. It is not only limited extent due to the country spread, but also the high capital investment costs that caused sluggish progression. It is believed that the interconnection grid and integration energy market across region becomes a prominent key to broaden energy access and bolster the growth of Gross Domestic Product (GDP) as well. Hence, it is essential to study and analyze the scheme to foster the energy security across border through clean electricity that produced from renewable energy, particularly in ASEAN. The qualitative method through desk review approach was adopted for the paper work. There are two study objectives for this paper: (1) Renewable energy as export commodity in ASEAN which in line with ASEAN Power Grid (APG) agenda and (2) Indonesian future potential as renewable energy exporter. It is found that untapped renewable energy across ASEAN possibly meet the regional electricity demand through interconnected grid and electricity market integration. Such condition also supports the on-going APG project. Electricity trades are regulated through bilateral and multilateral agreement between countries with certain tariff. In this case, a comparison between Indonesia and Singapore about renewables export issue has been analyzed and studied. For attaining the status of renewable energy exporter in the future, it is suggested that Indonesia should deal with policy & regulation certainty (including its harmonization) and renewable energy infrastructure readiness.

INTRODUCTION

Globally, energy security becomes the main issue that to be addressed amidst the looming crisis. Every country has its own strategies to fulfill domestic energy demands. Business as usual through coal and gas are pragmatic option to maintain the economic growth. Fossil fuels remain the biggest portion for global electricity supply. At the same time, however, those dirty fuel emits almost 46% of global carbon emission[1], [2]. Under Paris Agreement 2015, global country has committed to preserve 1.5ºC target by reducing carbon pollution. Clean energy transition seems to be the best pathway to achieve energy security through bolstering renewable energy without sacrificing the earth sustainability.

The main skepticism of renewable energy lays on its intermittency. Without durable energy storage technology, the growth of electricity production from renewable energy is projected sluggish. But, according to International Renewable Energy Agency (IRENA) Outlook 2022, it is argued that renewables have attained promising development in the electricity sector. Over the past decade, the capacity of installed renewables increased by 130%, while non-renewables only surmount by 24%[3]. For complying with 1.5ºC scenario, installed capacity of

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renewables need to be tripled by 2030. This target is possibly achieved while the global investment share streamed to the renewable energy sector by USD 380 billion[1]–[3].

Solar Photovoltaic (PV) installations have seen the fasted growth among renewable technologies. The number of installed solar PV rapidly multiplied to 21-fold during the last eleven years (2010-2021). By the end of 2021, the capacity of installed global solar PV peaked at 843 GW, with 57% comes from Asia[1], [3], [4]. The same trends also experienced by Wind power and Hydropower. Wind installation mounted by over four-fold to 769 GW while installed capacity of Hydropower reached 1230 GW at the same period (2010-2021). Similar trend with solar PV, Asia leads the market with more than 45% for both commodities. This progressiveness as an effect of cost reductions that bolstered by technological advancements, policy support, high learning rates, and also ingenious financing models[1], [3], [5].

In terms of cost, power generation from renewable technologies are typically the lowest sources of new electricity production. Between 2010 and 2020, the global weighted-average levelized cost of electricity (LCOE) of newly commissioned utility-scale solar PV projects fell by 85%, onshore wind by 56%, and offshore wind by 48%[2], [3], [6]. The outcomes of competitive renewable energy procurement through auctions or power purchase agreements (PPAs) demonstrate on their cost-competitiveness. According to IRENA renewable auction and PPA database, demonstrate that global solar PV has an average price of USD 0.04/kilowatt hour (kWh) in 2021. It is around 27% cheaper compared to coal-fired plants as the cheapest fossil-fuel competitor with USD 0.084/kWh[3].

Referring to the calculation, many scholars believe that the average price of renewable energy will continue to decrease in collateral with the global clean energy market growth. Although renewable energy development is on the positive trend, electricity access problem remains steady[6]–[8]. Needless to say, power generation from renewable technologies have promising opportunity to lift up the electricity barrier due to its abundance resource in almost everywhere. However, the huge amount of investment on the renewable technologies are still unreachable for developing countries, compared to their domestic electricity demand[3], [9].

Hence, it is essential to analyze the scheme to foster the energy access across border through clean electricity that produced from renewable energy, particularly in ASEAN. One of the promising ways is through renewable energy as export commodity. This will provide reciprocal benefit between countries with renewable energy excess and deficiency. This study has pointed two main objectives: (1) Renewable energy as export commodity in ASEAN which in line with ASEAN Power Grid (APG) agenda and (2) Indonesian future potential as renewable energy exporter. It is expected, this study can provide the insight of renewable energy as export commodity in ASEAN and also the strength of Indonesia as renewable energy exporter.

METHODOLOGY

The methodology that has been used in this study was qualitative method through desk review approach. A desk review has been used to analyse and criticize scientific literatures to obtain the whole picture of current condition and gain the prominent insight to the relevant stakeholders. This study has delved into 17 scientific journals and 5 reports from 2017 to 2022. The topics revolved in the keyword of renewable energy, policy and regulation, energy transition, electricity access, export commodity, ASEAN renewable energy, Indonesia current renewable energy, ASEAN Power Grid (APG), electricity pricing scheme to renewable energy outlook. Then, the result of desk review becomes a theory basis for mapping the current condition of Indonesia and ASEAN renewable energy and analysing the potency of renewable energy as export commodity across region.

RESULTS AND DISCUSSION

Renewable Energy as Export Commodity in ASEAN

Untapped ASEAN Renewable Energy

Renewable resources are abundant across the ASEAN countries due to its geographic condition. The distribution, however, is far from even. Indonesia and the Philippines have a large number of geothermal resources while countries like Myanmar, Lao PDR, and Cambodia are rich in hydropower resources[8], [10]. Because of their geographic spread, renewable energy sources can only be used to a limited extent. Due to huge capital investment costs, an absence of funding, inadequate knowledge transfer, and other factors, the use of these renewable energies in the production of electricity is not particularly high[11][12]. Furthermore, the development progress on renewable

energy-based generating is hampered by unbalanced economic development. As a result, the majority of the electricity in this area is produced using fossil fuels, which raises the carbon pollution across the area.

From the energy demand perspective, ASEAN is still not uniform on the major energy consumption rate. The greatest energy consumer in ASEAN is Indonesia, which accounts for 36% of the region's total energy demand. Indonesia uses 66% more energy than Thailand, which comes in second place, and 50 times more than Brunei Darussalam, which has the lowest energy consumption[3], [8], [9]. With a growth rate of 6.4% annually, electricity demand has the greatest rate of primary energy consumption and is the main cause of carbon emissions. For ASEAN to achieve this electricity demand at its normal business pace will be exceedingly difficult. Additionally, the availability of power in this region diverges widely from government-to-government. For instance, Brunei Darussalam, Malaysia, Thailand, and Singapore can supply their respective countries with enough electricity, yet just 50% of the people in Myanmar and Cambodia can gain electricity[6], [13].

Interestingly, both renewables and fossil fuels are affluent in almost at the same level throughout the geographical region of ASEAN, according to IRENA energy outlook[3]. This condition will give the ASEAN more option to secure their energy security across region. Table 1 shows energy resources landscape in ASEAN countries.

TABLE 1. The landscape of energy resources across ASEAN countries until 2021[3], [4], [6]–[8], [10], [14]

Country	Fossil Fuels			Renewables				
	Oil (BBI)	**Gas (TCF)**	**Coal (MMT)**	**Solar (MW)**	**Geothermal (MW)**	**Hydro (MW)**	**Onshore Wind (MW)**	**Biomass (MW)**
Brunei	6	34.8	-	300	-	-	-	-
Indonesia	10	169.5	38,000	55,512	29,000	75,625	9300	49,810
Cambodia	-	9.89	-	8750	-	15,000	1300	1712
Lao PDR	-	3.60	600	560	-	26,500	24,000	730
Malaysia	3.42	84.4	1024.5	14,120	-	29,500	2,599	29,000
Myanmar	3.1	12.1	-	88,967	-	108,000	1600	6849
Philippines	0.285	4.6	346	3500	2047	13,107	76,000	20
Singapore	-	-	-	-	-	-	-	-
Thailand	0.156	12.2	1240	6000	-	16,655	190,000	22,831
Vietnam	5	19.2	4500	9111	-	68,500	642,000	9688
Total	**27.961**	**350.29**	**45,710.5**	**186,820**	**21,705**	**352,887**	**946,799**	**120,640**

The ASEAN region is estimated to contain 27.96 billion barrels of oil reserves (BBl). As a result of having the greatest oil reservoir in the region, Indonesia produces the most oil. The second-largest oil reserve is in Brunei, which is followed by Vietnam, Malaysia, and Myanmar. However, the only net oil exporters in the region are Brunei and Malaysia. 350.29 trillion cubic feet (TCF) of natural gas reserves are reported for the ASEAN area, with Indonesia, Malaysia, and Brunei holding the top three positions. The most plentiful fossil fuel in the area is coal, which has an 80-year reserve-to-production ratio and a maximum production of 45,710.5 million tons (MMT)[3]. The countries with the largest coal deposits are, in order, Indonesia, Thailand, Malaysia, and Vietnam.

On the renewables, large, mini, micro, and pico hydropower plants, with a combined capacity of around 344 GW, are abundant throughout the ASEAN region. As 134 million people in ASEAN lack access to electricity, mini, micro, and pico hydropower facilities may be essential to the rural electrification of the region. Additionally, Thailand and the Philippines have abundant hydropower resources, and their governments are actively developing this industry. With a combined 31.05 GW of geothermal energy reserves, the Philippines and Indonesia rank second and third in the world for geothermal power generation[3], [4], [7].

In ASEAN, agricultural waste products such rice husks, rice straw, corn cobs, sugarcane waste, cassava stalks, bagasse, as well as coconut and palm oil, provide a sizeable source of biomass energy. Thailand, Indonesia, and Malaysia are the top three countries with the biggest theoretical biomass energy reserves, respectively, due to Thailand's active dependence on agriculture for 40% of its population and Indonesia and Malaysia's high levels of palm oil production[3], [8], [14]. The difficulty of gathering these wastes from its dispersed geographic domain, however, means that the biomass energy in its technical and economic potential aspect are substantially lower.

Due to the fact that ASEAN nations are often tropical, the region has the highest solar irradiation, with an average of 4.5 kWh/m^2 across a sizable area. Solar is one of the most significant and useable clean energy sources in the world. The yearly solar insolation level in ASEAN nations ranges from 1460 to 1892 kWh/m^2. As a result, Cambodia, Malaysia, Myanmar, Thailand, and Vietnam have a major solar energy advantage. Most ASEAN nations,

with the exception of Singapore, have excellent on-shore wind energy potentials, which equate to 947 GW of electric power. The ASEAN region's highest theoretical wind energy potentials are found in Vietnam, Thailand, the Philippines, and Laos, respectively[7], [8], [10].

Based on above analysis data, it can be surmised that the integration of the energy market, particularly for renewables, possibly enhance the utilization of untapped energy resources and maintain energy security across ASEAN.

ASEAN Power Grid (APG)

What happens in the energy resources allocation in ASEAN is crystal clear. Obviously, there are discrepancies between nations with high prospective energy resources and nations with high power demand. Additionally, ASEAN's uneven economic development makes it challenging to use sustainable energy resources to meet the region's high electrical consumption. Moreover, fossil fuel reserves are draining day by day, making it crucial to develop an integrated grid system for this area by harnessing the distributed energy sources and reducing reliance on fossil fuels.

Those integrated power system possibly be realized through ASEAN Power Grid (APG). It is interconnected grid project across ASEAN countries through ASEAN Heads of States/Governments, under the ASEAN Vision 2020. The main goal of APG is to promote the efficient use and sharing of resources for the benefit of the entire region in order to achieve regional energy security. The national power grid will be connected with dependable, efficient, and cost-effective operations in order to improve cross-border electricity trade. Member nations will also share any excess electricity generated in order to increase system security by lowering system costs. APG will assist to create the necessary arrangements for future energy trade, jointly utilize the plentiful energy resources found within ASEAN, and lessen reliance on fuel imports from other areas[7], [8], [10].

According to ASEAN Interconnection Master Plan (AIMS), APG have been divided into three regions, namely Eastern region (including Philippines, Indonesia, and Malaysia), Northern region (consisting Myanmar, Vietnam, Lao PDR, Cambodia, and Thailand) and Southern region (covering Singapore, Malaysia, and Indonesia). This connection is mainly based on bilateral beyond border, followed by terraced expansion to sub-regional basis, and into a completely integrated ASEAN power grid. The investment for realizing APG amounted to USD 5.9 billion with a net benefit projected up to USD 662 million[9], [10]. The existing APG has an installed capacity at 5192 MW, while on going project cover 5589 MW and future project will reach 27,979 MW. The electricity transfer system both adopted High Voltage Alternating Current (HVAC) and High Voltage Direct Current (HVDC)[6], [13], [15].

Theoretically, by integrating the ASEAN energy market, it will be quicker to facilitate cross-border trade and the free flow of green electricity throughout the ASEAN region, which will encourage geographically distributed renewable power development. Cross-border trade in the integrated energy market promotes the trade of electricity from nations with abundant renewable energy sources to nations with fewer renewable energy sources, and developed nations will push developing or least developed nations to invest in renewable sources, which will in turn promote the transfer of knowledge and technology between these nations[11], [16]. Furthermore, the introduction of carbon pricing following the construction of cross-border trade facilities may consequently cause base load power dependence on coal and natural gas to change to renewable sources.

Renewable Energy as Export Commodity

Like other trade commodities, electricity has the market value for securing domestic energy security through electricity market. According to International Energy Agency (IEA), the top exporters of fossil fuel-based electrical energy in 2020 were Germany (USD 3.87 billion) followed by France (USD 2.52 billion). At the same year, the top importers were Italy (USD 2.23 billion) adhered by the United States of America (USD 2.01 billion)[1], [2], [17]–[19]. Normally, the electricity trades are conducted through bilateral and multilateral agreement between countries with certain tariff.

Renewables-based electrical energy trade has no significant differentiation with fossil fuel-based. However, the deficiency of transmission system infrastructures and capacity for transferring renewables generated power becomes the big deal and affect the electricity tariff. Since the majority of renewable generators are situated distant from current load centres, it is required to build a transmission network infrastructure that spans a sizable geographic area in order to convey the generated power from renewable sources.

One of the promising cases on renewable energy as export commodity is Laos, in which the electricity market

belongs to Thailand. Although Laos becomes one of the poorest countries in ASEAN, they are rich in water resources and mountainous terrain in which enable the country to generate and export large amounts of hydroelectricity to its neighbours. Nearly 8,000 MW of the approximately 18,000 MW total potential capacity have been contracted for export to Thailand and Vietnam. Since the first dam in Laos was completed and put into service in 1972, there has been an electricity trade between Laos and Thailand[11], [19]. The governments of Thailand and Laos have signed a number of Memorandum of Understandings (MOUs) to expand Thailand's imports of electricity from Laos.

Even if there are now only bilateral agreements in place for trade between two neighbouring nations, having access to regional electricity markets will help increase grid flexibility. The first multilateral trade effort for ASEAN was recently signed by Laos, Malaysia, and Thailand, with the possibility of future participation from Singapore. This might be a positive step toward developing a regional electricity market that goes beyond just agreements between neighbours. The regional grid interconnection for electricity commerce in Europe and the characteristics of regional electricity trade are comparable. Notable European nations like Portugal and Denmark have more than 30% of renewable energy integrated into their grid systems. Europe gains access to a greater pool of resources through a regionally interconnected grid, which enables smoother generation of both excess and deficit electricity across the area[4], [10], [11], [16].

Although ASEAN has not yet finished installing an ASEAN Power Grid, the initiative and accompanying average daily load profile point to a positive future for individual countries in terms of improving grid flexibility and possibly increase energy access across region.

Indonesian Future Potential as Renewable Energy Exporter

Indonesia Domestic Condition

Following the Paris Agreement, Indonesia made a commitment to combating climate change by proposing a Nationally Determined Contribution (NDC) to the United Nations Framework Convention on Climate Change (UNFCCC) secretariat and enacting Law (UU) No. 16/2016. According to both agreements, Indonesia will reduce its emissions by 29% below Business as Usual (BAU) levels and 41% below BAU, respectively, in 2030. This goal is supported by the Medium-Term National Development Plan (RPJMN) which claims that Indonesia can achieve 27.3% lower emission levels than BAU in 2024. Indonesia plans to use 23% renewable energy in the total major energy share in 2025 and 31% in 2030 to meet this goal[5]. These renewable energy targets, however, are still far from expectations until 2021, as coal continues to account for more than 60% of all electricity shares. As a result of this change, the context in their Long-Term Strategy paper that net zero emissions across sectors can be achieved by 2060 or earlier[20].

Indonesia can meet its electricity needs with 100% renewable energy and achieve net zero emissions before the year 2060 by deploying approximately 1,700 GW of renewable energy. The primary contributors to this amount of renewable energy are 1,492 GW of solar PV (88% of the primary energy mix), 40 GW of hydropower, and 19 GW of geothermal energy. The economic sector will benefit from using a high proportion of renewable energy. The cumulative yearly system cost of renewable energy-based systems in 2050 will be 20% less than those of fossil fuel-based systems. Future capital expenditures (CAPEX) for constructing new renewable energy power plants will also be less expensive (i.e., residential rooftop PV CAPEX will only be 498.3 USD/kW in 2050 compared to 1,100 USD/kW in 2020)[21].

According to the Presidential Regulation No. 22/2017, which determined Indonesia's national energy plan (RUEN), the country has the potential to produce 29.5 GW of geothermal energy, 75 GW of large hydropower, 19.4 GW of mini and micro hydropower, 32.7 GW of bioenergy, 207 GW of solar energy, 60.6 GW of wind energy, and 18 GW of tidal energy. Only 10.5 GW of the 443.2 GW total renewable energy potential was actually used in 2020, according to the Ministry of Energy and Mineral Resources Republic of Indonesia. These anticipated potentials need to be re-examined because, according to a report by the Institute for Essential Services Reform (IESR), solar power has a 37-fold greater potential than that estimated by RUEN. It is clear evidence that Indonesia can meet its entire electrical needs with renewable energy, up to and beyond 100%[5], [20].

Case Study Indonesia-Singapore

Early 2022, Singapore expressed his intention to purchase solar power from Indonesia through clean electricity

market mechanism. A memorandum of agreement was signed between Masdar, the state-owned renewables company of the United Arab Emirates, Singapore's Tuas Power, the French energy company EDF, and the state-owned utility PT Indonesia Power to investigate the progress of renewable energy in Indonesia for export to Singapore. The joint venture would look at the construction of 1.2 GW of solar power and potential storage facilities[16].

Almost the same time, Energy and Mineral Resources Minister Arifin Tasrif and Singapore's Second Minister for Trade and Industry Tan See Leng signed a memorandum of understanding (MoU) to strengthen bilateral energy cooperation. The scope of the MoU includes cross-border electricity interconnections and regional power grids, energy trading and energy project financing between the two countries[4], [20]. For further, Energy and Mineral Resources Ministerial Regulation No. 11/2021 on the electricity exports, which has provisions for cross-border electricity trading, is one of the regulations that govern electricity exports in Indonesia. Under the prevailing rules, there were three schemes for exporting electricity, namely the point-to-point, grid-to-grid-I and grid-to-grid-II schemes[10], [11].

However, in the midst of 2022, concerns were raised about plans for export-oriented renewable energy projects, such as the export of solar power from Batam to Singapore, when the Investment Ministry asked for a restriction on the export of electricity produced from new and renewable energy (EBT) sources. It is maintained that if homegrown EBT electricity were exported, the importing nations would experience the associated industrial boom. The government will conduct the evaluation and create the necessary regulation.

Compared to Indonesia’s untapped renewables sources, solar power in particular, it should be no doubt that Indonesia will experience lack of electricity supply. According to IESR report, Solar electricity production should experience a sharp rise from 0.05% in 2020 to 24% by 2030, and then reach 88% in 2050. By contrast, renewable energy should produce 50% of all electricity by 2030 and 100% by 2050. On the other hand, coal production should decrease from 60% presently to 45% in 2030[21]. The solar power production trends in Indonesia are projected increase year to year. By 2025, 108 GWp of installed solar PV capacity must be reached, and by 2030, 1492 GWp. Approximately 80% of the necessary installed capacity would be provided by utility-scale solar PV, with the remaining 20% coming from distributed (prosumer) solar PV[21].

At least, there are four domestic concerns from government related to case of Indonesia-Singapore renewable energy export. First, the restriction arises due to domestic market obligation (DMO). Indonesia needs to meet their electricity demand through DMO mechanism. Such mechanism is well-known for other commodity such as coal. However, renewables are completely different with coal. Solar power, for instance, is abundance resource and seems impossible to gain scarce status like coal so-called non-renewable source[15]. Second, it is about lack of domestic renewable energy supply (11.7%). Establishing renewables electricity market between both countries will give an external nudge to Indonesia for boosting its renewables infrastructure. This will not only provide clean electricity to Singapore, but also intensify domestic renewable energy supply. Third, foreign direct investment still stumbles on inconsistency. It is mainly caused by energy security index, such as availability, affordability, technology development and efficiency, environmental and social sustainability, and regulation & governance[7], [9], [12]. Fourth, it is alleged that renewable energy export will benefit Singapore through carbon credit for accelerating its Nationally Determined Contribution. Theoretical speaking, the NDC calculation on carbon credit has been arranged on Article 6.2 Paris Agreement.

Indonesia as Renewable Energy Exporter

There are two issues that potentially slowing down Indonesia progress as renewable energy exporter. First, policy and regulation certainty. Such condition has happened in APG Project, although Indonesia fully supports those interconnected grid project. However, due to policy, regulatory and fiscal obstacles, progress remains slow. For coping this problem, Indonesia needs to address the lack of policy attention[4], [20]. Mainly, there are three indicators. Primary measures, including national policy on energy and renewables, rural electrification strategy and master plan, mini-grid policies and regulation (consisting legal and licensing provision, cost recovery and tariff regulation, grid interconnection and arrival of main grid, and public financing instruments) also quality and standards. Secondary measures are environment and health protection, taxation and other measures, land rights and use, banking and also incorporation, company information. Tertiary measures are about technically assistance and capacity building, data and information access and synergies with other sectors[1], [3].

Furthermore, Indonesia domestic regulation about renewables need to be harmonized for the sake of efficiency. Renewable energy exports need to be added into account for future preparation. Adopted from Ministry of Energy and Mineral Resources[21], figure 1 briefly depicts the regulatory framework on energy and electricity planning in

Indonesia.

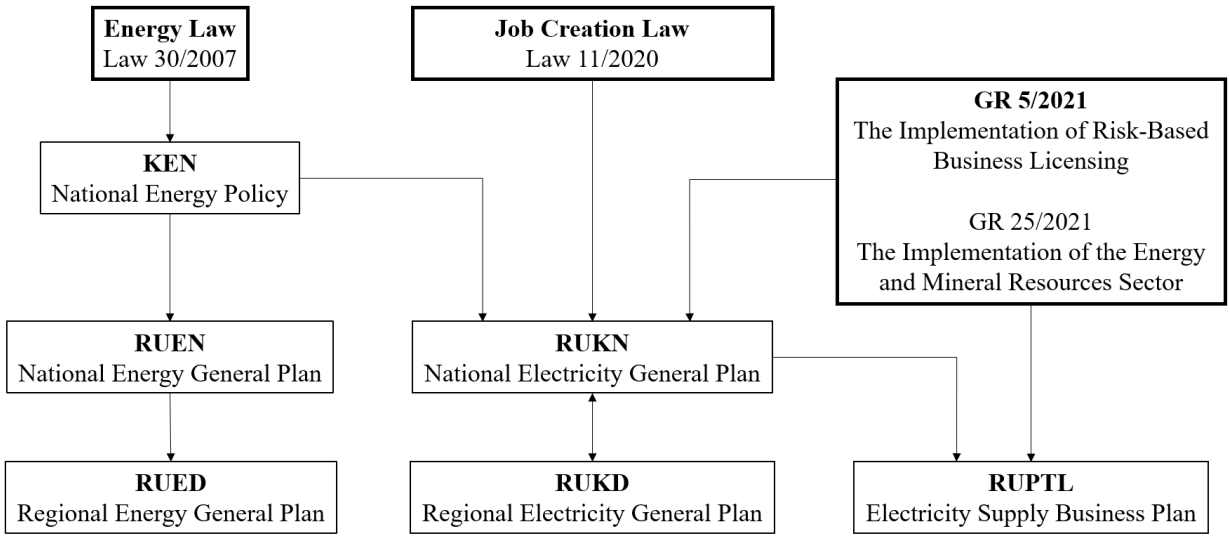

FIGURE 1. Regulatory framework on energy and electricity planning in Indonesia

Law No. 30/2007 on Energy (the Energy Law) and Law No. 30/2009 on Power (the Electricity Law), as revised by Law No. 11/2020 on Job Creation, are the two key laws that govern Indonesia's electricity industry. According to Government Regulation No. 79 of 2014, the National Energy Policy (KEN), as well as other implementation regulations related to national energy and national electricity planning, i.e., the National Energy General Plan (RUEN) and the National Electricity General Plan, are all based on the Energy Law (RUKN). RUKN serves as the policy foundation for PLN's Electricity Supply Business Plan (RUPTL)[20].

On the other side, the Electricity Law provides the legal framework for all commercial operations related to the provision of electricity, including electricity production, transmission, distribution, and sale. The Government Regulation No. 14/2012 further regulates how this law will be put into effect. Government Regulation No. 23/2014 on the Business Activity of Electricity Supply (as amended by the Government Regulation No. 5 and 25 of 2021, as an implementation of the Job Creation Law)[22].

At the presidential, ministerial, and director general levels, further technical laws are also passed, covering things like land acquisition, the sale of power, the selling of energy, and national and international connectivity. Additionally, according to the laws and regulations governing regional autonomy, provincial governments may enact electrical restrictions (i.e., licensing and prices) in accordance with the Electricity Law[12]. The Job Creation Law (Law No. 11/2020), which was passed more recently, made a number of legal changes that transferred some licenses and powers from the municipal government to the central government, including the requirement of an electricity supply business license and the setting of electricity tariffs (primarily for concessions outside of PLN's business concession[22]).

Second factor, renewable energy infrastructure preparedness that affect transmission cost. It is composed of two parts, the transmission line and transmission loss. If the distance between two countries is less than or equal to 1600 km, the operation cost and transmission loss are assumed to be $3/MWh and 1.0%, respectively; if the distance is between 1600 km and 3200 km, they are $5/MWh and 5.0%; and if the distance is over 3200 km, they are $7.5/MWh and 17.4%, respectively[7], [10], [14], [17], [18]. The distance between two nations' capitals is used to gauge distance. The transmission cost is the total of the transmission expenses for each step in the chain connecting two countries even when there is no direct link. For instance, there is a connection between Laos and Myanmar, although it is not a direct one. Their transmission costs are equal to the sum of the transmission costs between Laos and Thailand and between Thailand and Myanmar because they should trade through Thailand. For attaining Indonesia as renewable energy exporter in the future, both policy & regulation certainty and renewable energy infrastructure preparedness need to be addressed[19].

CONCLUSION

Analysis study on renewable energy as export commodity has been conducted with the subject region covering Indonesia, Singapore, and ASEAN countries. It has been observed that ASEAN region has an abundant of untapped renewable energy that possibly meet the electricity demand. However, due to the geographic spread, renewables can only be used to a limited extent. High capital investment costs are another issue on the development of renewables electricity in which still hampered by unbalanced economic development. Hence, the integration of the energy market, particularly for renewables, possibly enhance the utilization of untapped energy resources. At the same time, it also maintains energy security across ASEAN. The existence of ASEAN Power Grid (APG) project will support those interconnected grid to broaden the energy access. Also, the mechanism of renewable energy as export commodity has been studied on this paper. Generally, the electricity trades are conducted through bilateral and multilateral agreement between countries with certain tariff.

Furthermore, as one of the biggest renewables resources in ASEAN, according to this paper analysis, Indonesia has a promising opportunity to be renewable energy exporter in the future. The case between Indonesia and Singapore about renewables export issue has been analyzed and studied from both countries' perspective. The reluctancy from the government was based on four issues, domestic market obligation (DMO), lack of domestic renewable energy supply, the inconsistency of foreign direct investment in clean energy, and carbon credit calculation for nationally determined contribution (NDC). The response analysis about above domestic concern has been explained in the results. For attaining the renewable energy exporter status in the future, Indonesia should deal with, at least, two issues: policy & regulation certainty (including its harmonization) and renewable energy infrastructure readiness. For further study, the role of each stakeholders needs to be analyzed for fostering the progress, both from APG project and also domestic concern related to renewable energy export.

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