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A Paradigm Shift of Energy Sources

by Lily Sudhartio

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Research Paper

A paradigm shift of energy sources: Critical review on competitive dynamics of solar PV industry in Indonesia

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ABSTRACT

Background: The development of solar PV industry, both on a global and local level (in Indonesia) has shown a great paradigm shift in the source of energy, from the conventional into the renewables. This condition enhanced the importance of analyzing the competitive dynamics of renewable energy industry, in particular, the solar PV industry.

Purpose: This study examined the competitive dynamics of solar PV industry in Indonesia, through first analyzing the ecosystem and stakeholders in the industry and followed by the analysis of the competitive dynamics and strategy within energy industry in general and within the solar PV industry in specific.

Design/methodology/approach: Literature review was conducted as basis for the analysis. 21st centuries competition theory of Grimm et al. [13] was used as framework for the general energy industry analysis. Whereas Porter [23]'s framework was used as reference to analyze the competitive strategy of solar PV industry in Indonesia.

Findings: Analysis on the structural characteristics of solar PV industry in Indonesia indicates that the industry is on its introductory stage, or also called as emerging industry. Challenges potentially constraining the development of the industry ranges from the absence of infrastructure and technological standardization until the response of threatened entity. Criteria determining the adoption of the product, which in this case is the solar PV system, is also a crucial factor to understand. This ranges from the nature of expected benefit until perception of technological change. At last, the findings also pointed out that despite of its drawbacks (such as uncertainty and risk) of this emerging industry condition, an appropriate implementation of strategic choices will enable solar PV industry in Indonesia to achieve an optimum yield.

Research limitations: This study was conducted using literature review as basis. An empirical study might be valuable to complete this study.

Originality/value: For academicians, this paper can be considered as a valuable starting point to conduct research on solar PV industry, particularly within the strategic management area. For practitioners, this study may serve to enhance understanding on solar PV industry in Indonesia.

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Introduction

Over the past decade, global development of solar PV power has experienced significant growth and has long been signaled as an energy source with enormous potential for the electricity sector [7]. Whereas locally, in Indonesia, the government has set a target to achieve an energy mix with 23% of energy sourced by renewables [27]. Despite of the pricing challenge, several efforts were made by the government to achieve this target. This includes; (1) the roadmap to accelerate renewable energy development 2015–2025; (2) the plan of having a one stop investment portal for renewable energy opportunities; (4) PLN's 4.7GW renewable energy projects in 2019 with focus on solar PV, geothermal, and hydro power plants; and (5) government's plan to replace coal plants that are older than 20 years with renewables, which is accounted for around 11GW [27]. Maulidia et al. [19] stated that without government intervention, it is almost impossible to achieve the target and to expect private companies to invest in electricity in the remote areas. The journal also emphasized that a large-scale investment in a relatively short period of time is

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needed for this industry. Hence, cost and time is the highlight here. This is shown through the fact that the 23% Renewable Energy Target (RET) in 2025 requires an investment of around 1.6 trillion IDR or around 120 billion USD (76% of Government of Indonesia's expenditure in 2016).

To achieve this, PLN's business plan (RUPTL) 2015–2024 estimated the need of private sector investment in electricity generation of 63 billion USD (47% of total investment). This emphasized that not only government should play a role here, but the whole ecosystem including the private sector or entrepreneurs also plays a big deal.

The above elaboration indicates a paradigm shift in the source of energy, from the conventionals/non-renewables (e.g. coal, oil, and gas) into the renewables (e.g. geothermal, solar power, wind, bioenergy, and hydropower). This is also supported by previous researches stating that renewable energy is considered as an innovation in paradigm [29,14,17].

Considering the above, this paper has an objective on analyzing the competitive dynamics of renewable energy (particularly solar PV) within the Indonesian energy industry. Yang and Meyer [28] emphasized the necessity of timely and flexible strategic engagement in the market in order to obtain competitive advantage, particularly in a fast-paced emerging economy. The paper stated that "the more volatile the institutional environment and the faster the rate of growth, the more critical is the speed of action as a competitive parameter" and that "the dynamic interaction between rivals, known as competitive dynamics, is important to explain the success and failure of firms in emerging economies". The success and failures referred herein are not only limited to those of firms within an economy, but in a more macro-level, it can be extended towards those of industries within an emerging economy. Hence, it can also be understood that analysis of competitive dynamics is key in understanding the dynamic interaction between industries, which enables the explanation of the success and failure of industries within an economy. By referring to Cui et al. [8], Yang and Meyer [28] added in their paper that "despite the importance of competitive speed in such contexts, few researchers have investigated competitive dynamics in China or other emerging economies". This is in line with the previously stated objective of this paper, which is to analyze the competitive dynamics of solar PV industry in Indonesia, which is considered as emerging economy[1].

Critical review on ecosystem and stakeholders of the Indonesian solar PV industry

Prior to analyzing the competitive dynamics of renewable energy (particularly solar PV) within the Indonesian energy sector, a holistic comprehension on the industry is deemed as important. This could be done through analyzing the environment of the industry, in other words, both the ecosystem and the stakeholders that are playing its roles in the industry.

Rong et al. [24] stated that "the most common ecosystem type is the business ecosystem, which was first introduced by Moore [20], followed by the innovation ecosystem [2,11], the service ecosystem [26], the entrepreneurial ecosystem [5], the knowledge ecosystem [1] and also recently discussed the platform ecosystem [22]". Since our objective is to analyze the competitive dynamics of solar PV industry, the ecosystem theory that will be referred in this paper is the entrepreneurial ecosystem.

Maroufkhani et al. [18], considers an entrepreneur as a person who continuously seek for an opportunity to take risk to create value, and who is never satisfied with the existing condition. The journal added that entrepreneurs are surrounded by an ecosystem, and in a way, that ecosystem facilitates the process of entrepreneurship. Consequently, the success of entrepreneurship greatly depends on the ecosystem. Furthermore, Isenberg [6] grouped the domains of entrepreneurship ecosystem into policy (leadership and government), finance (financial capital), culture (success stories and societal norms), supports (infrastructure, support professions, and non-government institution), human capital (labors and educational institutions) and markets (early customers and networks). Figure 1 illustrates these domains of entrepreneurship ecosystem.

Maulidia et al. [19] provided a clear example of entrepreneurial ecosystem within the renewable industry in Indonesia, emphasizing on the domains policy (government), finance (investment) and supports (infrastructure). The journal stated that despite of Indonesia's wealth of renewable energy resources as well as the efforts made by the government, multiple constraints and challenges to achieve the RET were identified through numerous studies. These includes geographical, institutional and investment factors. For instance, in well-developed regions, renewable energy-sourced electricity is competing with highly subsidized and cheap coal power plants. Whereas for geographically remote areas, the undeveloped infrastructures are resulting to an expensive electrification. The journal pointed out further that contradictive policies, substantial fossil fuel subsidies, unclear mandates, bureaucratic processes, and lack of accountability and limited institutional capacity, have hampered the development of renewable energy in Indonesia. In order to tackle these challenges, the journal emphasized that Indonesia needs to (1) formulate policies that correctly consider three equally important aspects of energy supply – affordability, security and sustainability – known as the energy trilemma; and (2) create a policy that makes it attractive for private sector investment (that can upgrade its risk and return profile). Another example of the policy domain is also provided by Yudha and Tjahjono [30] who also stated that in the future the government is expected to improve existing policies in the renewable energy sector, such as by giving ease to investors in the renewable energy sector. This is supported by Hasana et al. [15], who stated that "many efforts have been done to promote renewable energy such as to create energy policy and regulations, yet it still did not give any satisfactory result" and Firman et al. [12] who mentioned that "government policies have a significant role in (or is impacting) the success of the project. Arafah et al. [3] also concluded in their journal that "The transition of energy will never happen without a strong desire of the government and the legislature, as it is needed by government and legislative policies and regulations to encourage alternative energy development by both government and private investors". This among others includes providing tax subsidies to renewable energy-based power plants and appropriate energy purchase price of government or PLN for renewable energy in order to increase investor's interest. All of these journals pointed out the crucial role of entrepreneurial ecosystem in the success of renewable energy industry in Indonesia, in particular is the need of an entrepreneurial-oriented policy.

In terms of stakeholders, adapting from Yudha and Tjahjono [30]'s map of stakeholders, the following list of stakeholders was obtained; (1) The government that consisted of (1a) Ministry of Energy and Mineral Resources (MEMR) who is responsible for energy policy and regulation, (1b) Ministry of Finance who conducts control over government budgets and expenditures, including investments and incentives for renewable energy, (1c) Ministry of SoE who supervises state-owned energy enterprises and influences energy policy implementation, (1d-e) Ministry of Environment and Forestry, as well as Ministry of Industry, who have influence on renewable energy policy implementation, and (1f) regional, provincial and regency/municipal governments play role in policy implementation through the development of regula-

[1] https://www.worldbank.org/en/country/indonesia/overview.

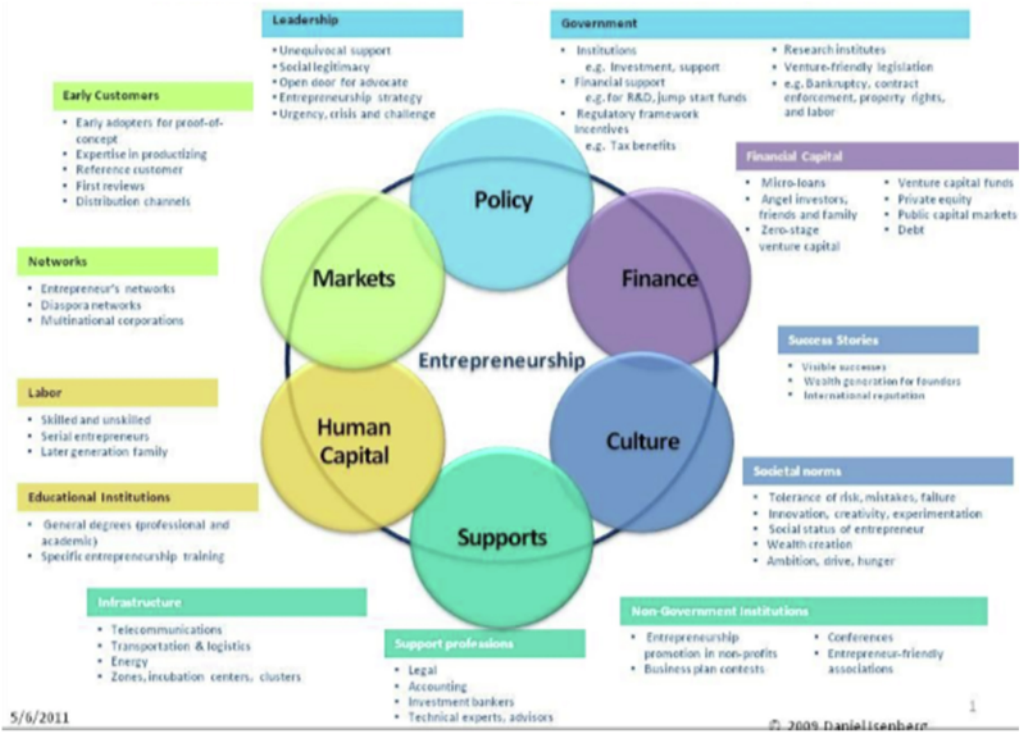

Figure 1. Domains of Entrepreneurship Ecosystem. Source: Isenberg [16].

tions and issuance of permits; (2) The SoEs that consisted of (2a) PLN, who started to shift from initially producing electricity using coal as basis, to using renewable resources and (2b) Pertamina, who started to shift from initially conducting the Exploration and Exploitation of oil and gas to Energy Policy; (4) National Development Planning Agency who is responsible for economic planning that includes the energy sector; (5) Multinational Companies (MNCs) or in particular the Energy Majors, who are started to shift from initially conducting the Exploration and Exploitation of oil and gas to producing energy from renewable resources; (6) Private companies, who act as suppliers, importers, and/or producers; and (7) The customers consisted of (7a) utility scale customers, e.g. PLN, (7b) commercial/industrial customers, e.g. firms in any sector (for instance manufacturers, F& B firms with large producing plants, hotels, restaurants, airports, building owners, or energy companies), (7c) households customers. The role of customers includes solar PV adoption through buying/leasing it from the suppliers/producers and use it to generate electricity to run their day-to-day business operation (as a substitute or complementary to normal electricity obtained from PLN). Figure 2 illustrates this mapping of stakeholders within the solar PV industry in Indonesia.

Apart from the aforementioned roles, some of the stakeholders are also considered as segments being served through entrepreneurship activity in solar PV industry. For instance; (1) the government –who expected to achieve their pre-set energy mix target; (2) the SoEs and energy majors – who expected to achieve sustainable competitive advantages (mainly through green corporate image and profit); (3) private companies – who expected to achieve sustainable competitive advantages (mainly through profit); and (4) the customers – who expected to achieve sustainable competitive advantages (mainly through green corporate image and lower cost of electricity). For example, Danone (one of the customers within the commercial/industrial segment) who already installed solar PV. Also, Unilever Indonesia Tbk (who has already installed 200 kWp worth of solar panels in its facility) and Chandra Asri Petrochemical (who has installed 800 kWp solar-powered rooftop in coordination with Total Solar Distributed Generation)[2]. Through adopting/installing solar PV, the aforementioned companies are expected to achieve sustainable competitive advantage through green corporate image (which at the end is expected to increase its share price) as well as a lower cost of electricity.

Critical review on competitive dynamics of the global and local energy industry

Brito [4] stated that "competitive dynamics are well known for its impacts on sustainability of advantage positions as well as in firm survival" and that "the last decades, macroeconomic fluctuations and the rise of new players from peripheral economies, as well as rapid technology innovation have altered the former competitive configuration among businesses". This is in line with Grimm et al. [13] who stated that several complex reasons (or elements) played a role in increasing the rivalry (or competitiveness) between firms. These elements among others includes globalization, privatization and deregulation, as well as technological change. Figure 3 illustrates the elements and its interaction among each other.

Technological change

The previously elaborated paradigm shift from conventional energy towards renewable energy could best illustrate the result

[2] https://indonesien.ahk.de/infothek/news/news-details/for-indonesias-renewable-energy-solar-pv-leads-the-way.

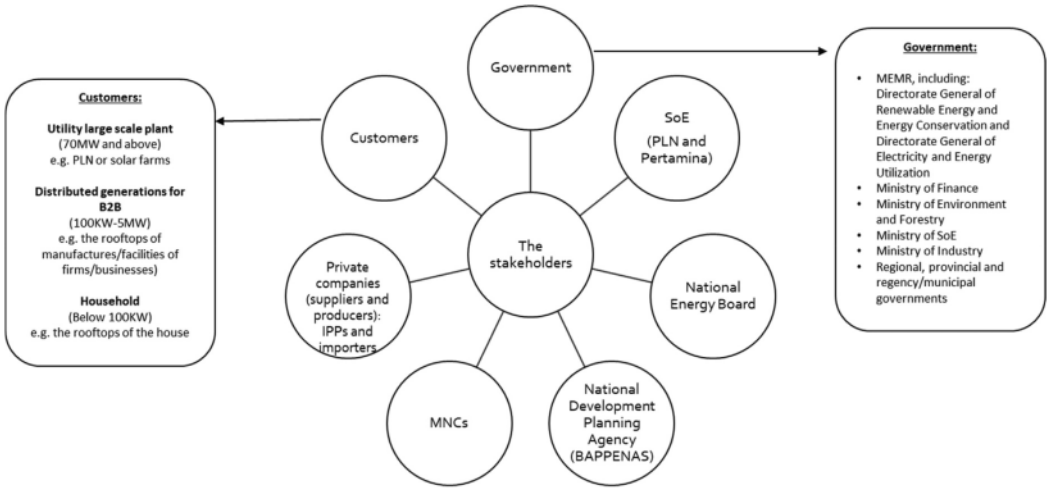

Figure 2. Stakeholders of solar PV industry in Indonesia. Source: Adapted from Yudha and Tjahjono [30].

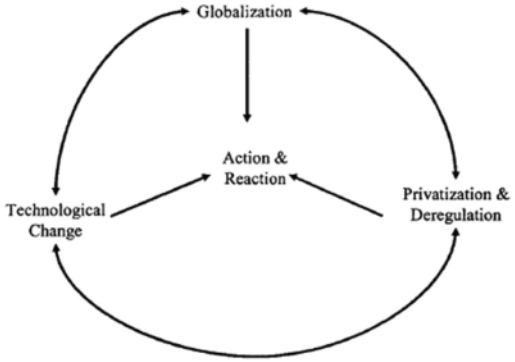

Figure 3. Competition in the 21st century. Source: Grimm et al. [13].

of rapid technology innovation within the energy industry. This has shifted the competition (both globally and in Indonesia), from initially only among the players within the conventional/ non-renewable (e.g. coal, oil, and gas) energy sources, towards the players in both conventional and renewable (e.g. geothermal, solar PV, wind, bioenergy, and hydropower) energy sources. With this, the following industries: coal, oil and gas, geothermal, solar PV, wind, bioenergy, and hydropower, which consisted of both conventional and renewables, are nowadays cumulatively acknowledged and called as energy industry.

Globalization

Grimm et al. [7] stated that "in the last 20 years, national economies have become increasingly integrated into a complex web called the global economy" and that "a significant shift in the organization of business is behind this integration". Technological advances along with the attempt for efficiencies is becoming the highlight here. This is also the case in global renewable industry nowadays, where we can see that along with technological advancement, which leads to innovation, cumulative global solar PV installation has increased from time to time (refer to Figure 4).

As stated by Comello et al. [7], "Solar PV power has long been signaled as an energy source with enormous potential for the electricity sector" and that at a global level, solar power in 2018 is respectively accounted for 6.3% and 1.7% of installed capacity and electricity generation. The journal further added that the rapid growth in solar PV deployments is the result of the falling prices of solar systems. One of the reasons is the lower price of the Balance of System (BOS) components (e.g. inverters, trackers, structural, and electrical components), which can only be achieved through an innovative technological advancement and efficiencies in production. Not to mention that technological advancements such as transportation, information processing and telecommunications, allows a global manufacturing, distribution, as well as marketing of either the components and/or the solar PV itself.

On a country level, in this case is Indonesia, this globalization can be seen both as opportunity as well as threat to the solar PV industry of the country. For instance, should Indonesia be capable to compete with China (as one of the main producing country of solar PV3)[3] in terms of production, Indonesia can become a net exporter of solar PV related products. The market will be widely opened. In the other way round, should Indonesia fail to compete, then Indonesia will only be the market of the imported solar PVs. Another impact from the globalization is that Indonesia has taken important steps in climate change policy, mainly driven by the international negotiati[24] [19]. For instance, in 2016, Indonesia submitted its voluntary greenhouse gas (GHG) emissions reduction plan to the United Nations Framework Convention on Climate Change (UNFCCC) and in the Nationally Domestic Contributions (NDC) document, Indonesia pledged to reduce its GHG emissions of 29% against 2010 baseline to be achieved by 2030 [19].

Privatization and deregulation

Grimm et al. [13] stated that "deregulation efforts have centered on a select group of industries that were protected from competition because of natural monopoly or concerns about excessive competition". They added that such industries may include energy industry. This in fact is not only applied globally, but also in Indonesia. This could be seen from the history of our ene[26] State-Owned-Enterprise (SoE), PT Pertamina (Persero). Born in 10 December 1957, PT Perusahaan Minyak Nasional (PERMINA) was

[3] https://www.investopedia.com/articles/investing/092815/5-countries-produce-most-solar-energy.asp.

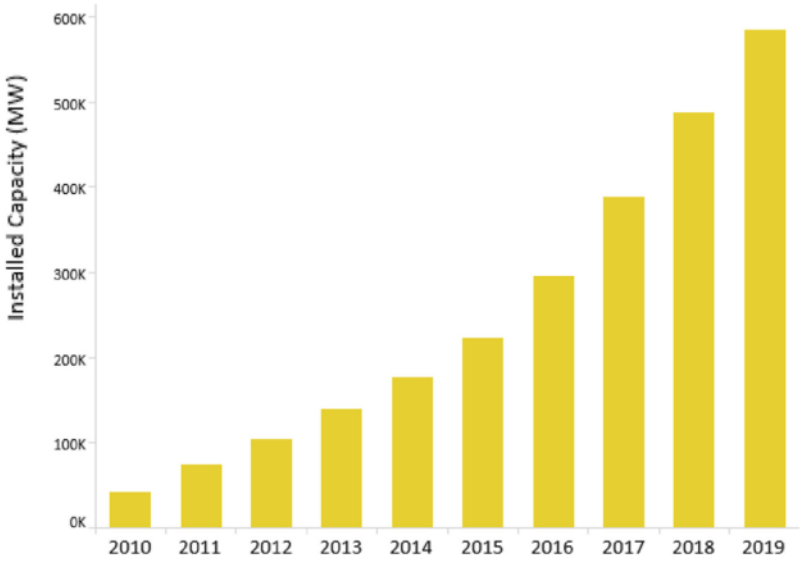

Figure 4. Cumulative global solar PV capacity installations by end of 2019. Source: https://www.irena.org/.

then renamed as Perusahaan Negara (PN) Permin[43] 1960. Then, on 20 August 1968, PN Permina was becoming PN Pertam- bangan Minyak dan Gas Bumi Negara (Pertamina). Until then, Pertamina was still a state company[4]. As a state company, Pertamina had both the regulatory and operational function. Through the Indonesian Law No.22 Year 2001, the regulatory function was moved to BPMIGAS [6] for the upstream activity and to BPH Migas for the downstream activity. Following this, on 18 June 2003, Pertamina is then becoming an SoE and named as PT Per-tamina (Persero). This illustrates the deregulation pattern of energy business in Indonesia, where we can see through this pattern, the level of competition increases.

[11] Critical review on competitive strategy Indonesian solar PV industry (as emerging industry) in Indonesia

Brito [4] stated that "one of the effect[3] of this increasing competitiveness is the shortening of firms' life spans, but for those who manage to survive, the question is how to find the most adequate competitive position". Therefore, in this section we will move to the analysis of the competitiveness of solar PV industry (as an emerging industry) within the energy industry in Indonesia.

In an increasing competition, as D'aveni [9] stated, "Every adva[7]ge eroded". In a more elaborative sense, "once the advantage is copied or overcome, it is no longer an advantage. It is now a cost of doing business. Ultimately the innovator will only be able to exploit its advantage for a limited period, before its competitors launch a counterattack. With the launch of this counterattack, the original advantage begins to erode". Figure 5 illustrates this.

Narrowing down to the Indonesian energy industry (or previously called as the oil and gas industry, before the renewables came in), one of the advantages is the firm's ability to explore, produce and sell hydrocarbons that are available in the country. Yet, as what it is called as "non-renewables", there will be a limit to the discovery of the hydrocarbons one day. Or at least, the discovery will be harder than it used to be, hence requiring more cost to produce, which will then be questioning the economics of the products. At that stage, the advantage of non-renewables will eventually erode.

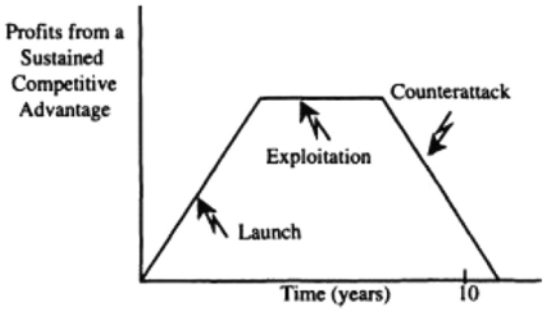

Figure 5. Every advantage erodes eventually. Source: D'aveni [5].

Having this in mind, the renewable business (for instance solar power) came in place. Where there is no limit on the energy sources. Nowadays most of oil and gas company has re-declared themselves from oil and gas company, into energy company. This is following their shift in business from only oil and gas towards all energy sources, which includes both the conventionals and renewables. In Indonesia, this include both local energy companies (including SoEs and private companies), as well as MNCs (the energy majors) that are operating in I[1]onesia. As Grimm et al. [13] stated, "the traditional industry life cycle consists of four stages: introduction, growth, maturity, and decline" and "although the life cycle varies from industry to industry, we can expect an industry to exhibit certain structural characteristics at each stage of development". Figure 6 illustrates this life cycle. Whereas Figure 7 details down the characteristics of each of the life cycle according to Grimm et al. [13].

Applying Grimm et al. (2016)'s framework as depicted in Figure 7, considering the demand, technology, products, manufacturing and distribution, trade, as well as the key success factors, in

[4] https://www.pertamina.com/id/sejarah-pertamina.

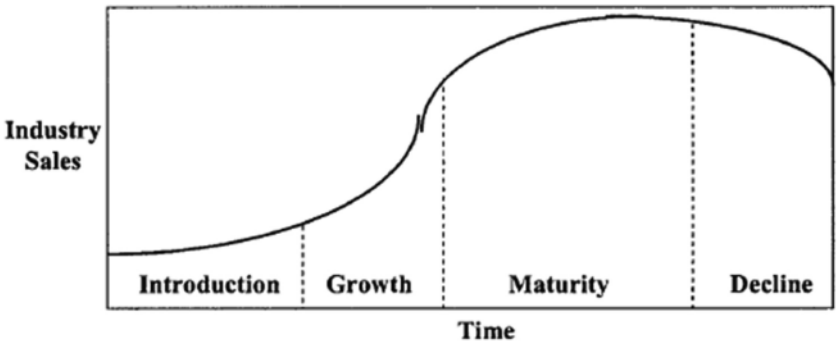

Figure 6. Traditional industry life cycle. Source: Grimm et al. [13].

	Introduction	Growth	Maturity	Decline
Demand	Limited to early adopters: high-income, avant-garde.	Rapidly increasing market penetration.	Mass market, replacement/repeat buying. Customers knowledgeable and price sensitive	Obsolescence.
Technology	Competing technologies. Rapid product innovation.	Standardization around dominant technology. Rapid process innovation.	Well-diffused technical know-how: quest for technological improvements.	Little product or process innovation.
Products	Poor quality. Wide variety of features and technologies. Frequent design changes.	Design and quality improve. Emergence of dominant design.	Trend to commoditization. Attempts to differentiate by branding, quality, bundling.	Commodities the norm: differentiation difficult and unprofitable.
Manufacturing and distribution	Short production runs. High-skilled labor content. Specialized distribution channels.	Capacity shortages. Mass production. Competition for distribution.	Emergence of overcapacity. Deskilling of production. Long production runs. Distributors carry fewer lines.	Chronic overcapacity. Re-emergence of specialty channels.
Trade	Producers and consumers in advanced countries.	Exports from advanced countries to rest of world.	Production shifts to newly industrializing then developing countries.	Exports from countries with lowest labor costs.
Competition	Few companies.	Entry, mergers, and exits.	Shakeout. Price competition increases.	Price wars, exits.
Key success factors	Product innovation. Establishing credible image of firm and product	Design for manufacture. Access to distribution. Building strong brand. Fast product development. Process innovation.	Cost efficiency through capital intensity, scale efficiency, and low input costs. High quality.	Low overheads. Buyer selection. Signaling commitment. Rationalizing capacity.

Figure 7. The evolution of industry structure and competition over the life cycle. Source: Grimm et al. [13].

terms of industry life cycle, we could say that the non-renewable energies are now in the maturity stage. Whereas for renewable energy (particularly solar PV) industry in Indonesia, in terms of demand it is still on its introduction stage as there are still limited to early adopters. As Arafah et al. [3] pointed out, despite of the potential of Indonesia, challenges in renewable energy development are still there, which includes high investment cost and the limited open land for the utilization of solar PV energy. Figures 8 and 9 supported the argument. In terms of technology, it is also in the introductory stage, indicated by competing technologies and rapid product innovation, which is expected to lead to a lower cost of production (to be elaborated later in Figure 10). In terms of product however, it could be said that it is running towards the growth stage, as design and quality are improving nowadays. This is also the case for the trade aspect as the product is started to be imported from other countries. Whereas in terms of manufacturing and distribution it is still on its introductory stage, showed by a specialized distribution channels. Furthermore, in terms of competition and key success factors, as there are still few companies competing in the country and firms are competing to establish credible image of the corporation as well as the products, it could be inferred that it is still in an introduction stage. From this analysis, we can then infer that solar PV industry in Indonesia is still in its introductory stage, or also called as emerging stage. Although for some aspects (e.g. product and trade aspect) it is already moving towards the growth stage.

Porter [23] stated that "emerging industries are newly formed or re-formed industries that have been created by technological innovations, shifts in relative cost relationships, emergence of new consumer needs, or other economic and sociological changes that elevate a new product or service to the level of a potentially viable business opportunity" and that " emerging industries are being created all the time; some of the many creations of the 1970s include solar heating". This confirms further the industrial life cycle position of solar PV in Indonesia, where the industry is (1) newly formed, (2) created by the innovation of technology, and (3) created by the emergence of new consumer needs – in this case is a greener energy. Detailing down further on this, he provided an elaboration on the (1) structural characteristics of emerging industry, (2) problems that may be encountered by this type of industry, (3) what made the market adopt the products within this industry, and (4) several strategic choices. Using these four aspects, analysis on the competitiveness of solar PV Industry, as an emerging industry in Indonesia is conducted.

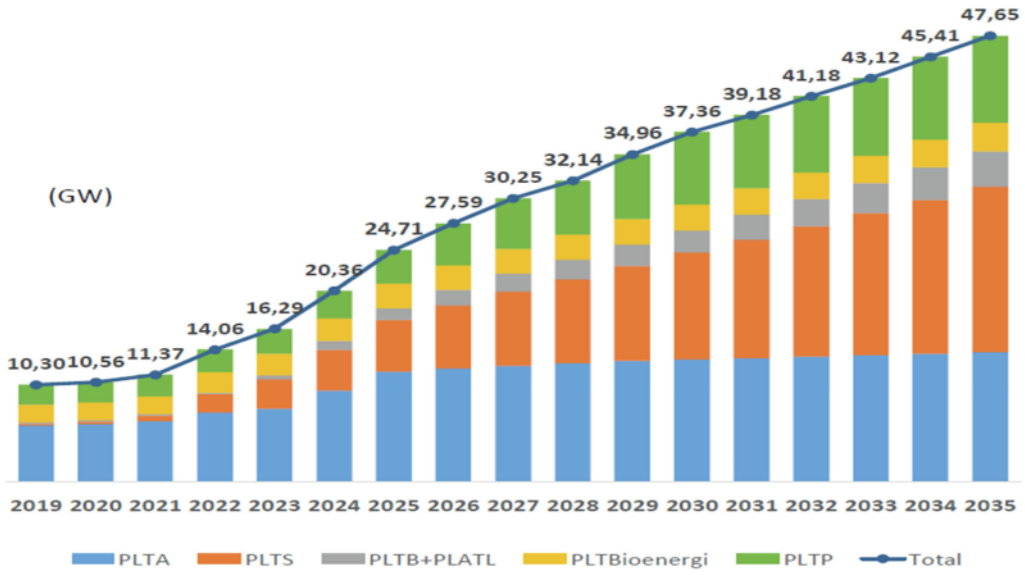

Figure 8. Renewable energy development plan in Indonesia. Source: Grand Energy Strategy of Indonesia: 12 Strategic Priorities – Presentation slide National Energy Council [21].

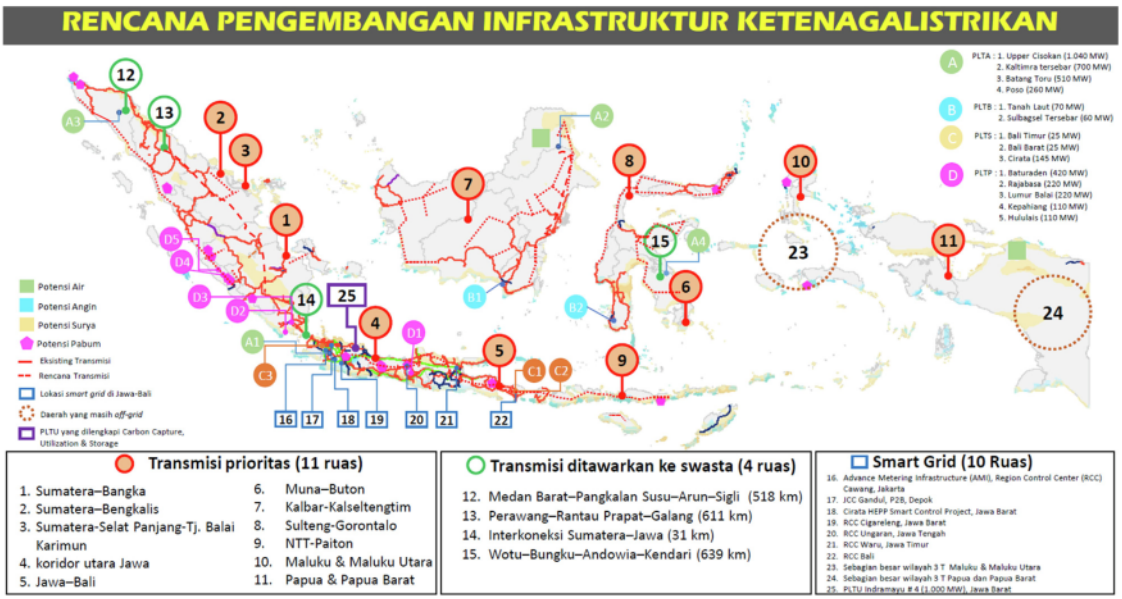

Figure 9. Electricity infrastructure development plan in Indonesia. Source: Grand Energy Strategy of Indonesia: 12 Strategic Priorities – Presentation slide National Energy Council [21].

Structural characteristics

From the list of characteristics listed by Grimm et al. [13] in Figure 7, it could be understood that within an emerging industry technological uncertainty is still high. This is the case for solar PV industry in Indonesia, where government, SoEs (e.g. Pertamina and PLN), private companies, and educational sector are currently working hand-in-hand in finding its way to prove the best and most efficient technology, including its complementary product, the battery storage. Whereas in terms of strategic uncertainty, most private companies are now still exercising different market positioning approaches or strategy, as Wood Mackenzie [27] pointed out "investors are eagerly waiting for the policy to turn favorable". High initial cost with steep cost reduction as progress is also seen nowadays within this industry (refer to Figure 10) and is forecasted to reduce any further. Although, in terms of cost,

Country	2018	2019E	2020E	2021E	2022E	2023E	2024E
Pakistan	$ 0.71	$ 0.61	$ 0.57	$ 0.55	$ 0.53	$ 0.52	$ 0.50
Sri Lanka	$ 0.79	$ 0.68	$ 0.64	$ 0.61	$ 0.59	$ 0.58	$ 0.56
Vietnam	$ 0.90	$ 0.77	$ 0.72	$ 0.70	$ 0.67	$ 0.65	$ 0.63
Thailand	$ 0.90	$ 0.77	$ 0.73	$ 0.70	$ 0.68	$ 0.66	$ 0.64
Philippines	$ 0.91	$ 0.78	$ 0.73	$ 0.71	$ 0.69	$ 0.66	$ 0.65
Taiwan region	$ 0.92	$ 0.79	$ 0.74	$ 0.71	$ 0.69	$ 0.67	$ 0.65
Malaysia	$ 0.94	$ 0.80	$ 0.75	$ 0.73	$ 0.71	$ 0.68	$ 0.66
Indonesia	$ 0.99	$ 0.85	$ 0.80	$ 0.77	$ 0.75	$ 0.72	$ 0.70
South Korea	$ 1.00	$ 0.90	$ 0.85	$ 0.82	$ 0.79	$ 0.77	$ 0.74
Bangladesh	$ 1.30	$ 1.11	$ 1.05	$ 1.01	$ 0.98	$ 0.95	$ 0.92

Figure 10. All-in utility solar system costs (in USD/W), based on 100 MW fixed-tilt project with multi-Si module. Source: Wood Mackenzie [27].

if compared to other Asia-Pacific country, Indonesia is still the third highest after Bangladesh and South Korea.

Embryonic companies and spin-offs as emerging industry characteristics are also seen through the increasing number of Individual Power Producers (IPP) in Indonesia. This includes the establishment of Medco Power Indonesia (claiming as a clean IPP[5]), the establishment of sub holding Power and New Renewable Energy of Indonesian energy SoE (Pertamina) in 2020[6], the establishment of Indonesia Power as a subsidiary of Indonesian SoE power company (PLN)[7], as well as the existence of renewable related entities of energy majors that are operating in Indonesia. In terms of buyers of the products, as previously elaborated, it consisted of utility scale customers (e.g. PLN), commercial/industrial customers (firms in any sectors such as manufacturers, F&B firms with large producing plants, hotels, restaurants, airports, building owners, or energy companies), and household customers. Example of the industrial customer in this sector is Danone, who has recently (in 2020) installed solar panel rooftop in its manufacture in middle Java, which is developed, installed and operated by Total Solar Distributed Generation Southeast Asia[8]. Additionally, Pertamina also has shown its effort (as both supplier and buyer) in this energy transition, through the collaboration of its two sub holdings (Power and New Renewable, as well as Commercial and Trading), in building solar panel rooftops on its 63 fuel stations[9]. Whereas in terms of subsidy, based on an interview result conducted in April 2020 with the government of Indonesia, it could be understood that only non-commercial/ subsidized projects are progressing.

Problems encountered

Analyzing the condition of solar PV industry in Indonesia, it could be said that problems that may be considered as constraining the development of emerging industry includes (1) absence of infrastructure, (2) absence of product or technological standardization, (3) confusion of customers resulting from the existence of a diverse product approaches, technological variations, as well as conflicting claims and counterclaims by competitors, (4) erratic/ unpredictable product quality, where there is still lack of standards and technological uncertainty, (5) image and credibility towards financial community, (6) regulatory problem, (7) high initial costs, and (8) response of threatened entities, which may include industries that are producing substitute products, distribution channels having ties with old products (who prefers certainty of dealing with it), and labor unions. Problem number 1, 5 and 6 obtained a support from Maulidia et al. [19]. Whereas the decrease in cost as depicted in Figure 10 [27] indicates that problems normally encountered by emerging industries (such as difficulties in obtaining raw materials and/or components as well as rapid raw material price increase) are not the case for solar PV industry in Indonesia.

Adoption of products

Identifying early adopters (or early buyers) of the products is important "not only for formulating competitive strategy directly, but also for forecasting industry development since early adopters can have a major impact on the way in which an industry designs, produces, delivers, and markets its product" and "markets, market segments, and even particular buyers within market segments may have greatly different receptivity to a new product" Porter [23]. Criteria considered as crucial in determining this "receptivity" or also called as adoption level of the product, which in this case is solar PV system, includes; (1) nature of expected benefit; (2) state of the art that is needed to yield significant benefits – e.g. "some buyers may be able to achieve valuable benefits even with basic versions of the new product, whereas others will require more sophisticated varieties"; (3) cost of product failure – in the case of solar PV system this occurred due to its' newness in terms of technology, as well as the requirement to have the system plugged in into an existing integrated electricity system illustrated in Figure 11). As Setiawan and Singh [25] stated "non-consideration of post-deployment factors in designing of renewable technology application can lead to less success at the deployment level" and that "the failure in technology adoption often leads to the rejection of such technology in the later stage". Whilst, due to lack of; (4) introduction/ switching cost – this for instance is the cost in

[5] https://www.medcopower.co.id/about_us.
[6] https://investor.id/business/pembentukan-subholding-jadikan-pertamina-lebih-efis
[7] https://indonesien.ahk.de/infothek/news/news-details/for-indonesias-renewable-energy-solar-pv-leads-the-way.
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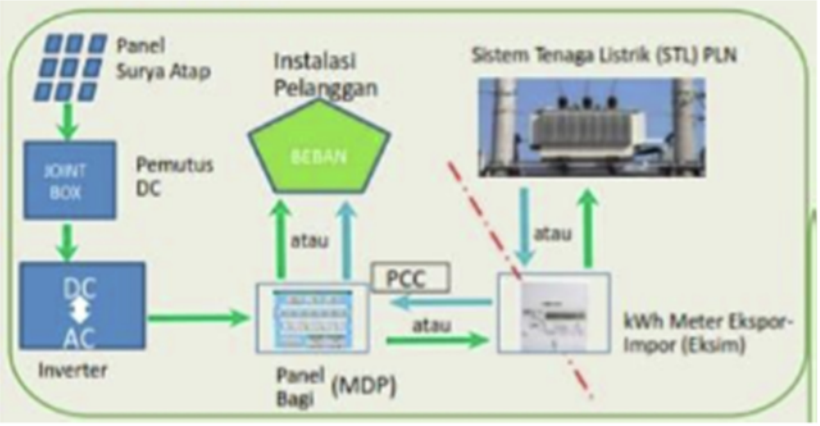

Figure 11. Illustration on on-grid Solar PV system. Source: PT Fairness Indonesia Daya [31].

switching from existing power system into using Solar PV system, which might require installation cost, employee training, support services, engineering and others; (5) personal risk to the decision maker, and (6) perception of technological change – as "buyers may differ in their comfort with and experience in technological change" and that "in businesses characterized by rapid technological progress and possessing a high degree of technological sophistication, a new product can seem a great deal less threatening than in a very stable, low-technology industry" [23]. This infer that technological change can be viewed differently in different industries. It can be seen as an opportunity (e.g. as the case for Danone, Unilever and Chandra Asri as elaborated in point I.III of this paper) or as a threat.

Strategic choices

In an emerging industry, as occurred within the period of industrial development where "the rules of the competitive game are largely undefined, the structure of the industry is unsettled and probably changing, and competitors are hard to diagnose" [23], strategic formulation needs to take extra consideration on uncertainties and risks. This is indeed the case for solar PV industry in Indonesia. From the earlier elaboration Maulidia et al. [19], Yudha and Tjahjono [30], Hasana et al. [15] and Firman et al. [12]'s journals, it could be inferred that the competitive game within the solar PV industry in Indonesia is not yet maturely defined and the industry structure is not yet totally settled. This is seen from the policy, supporting infrastructure, as well as financial intuition's role that are not yet optimal.

Nevertheless, despite of such conditions, this phase of industry's development also has its potential, as there is still room for firms within this phase of industry's development to set the rules of the games (as degrees of freedom within this phase is still high), specifically in the area of pricing strategy, marketing approach and product policy. A good strategic choice in this period will open an opportunity for the firm to obtain a strong position in the market, for a longer term. Another positive side of thi merging industry situation is in terms of externalities, which according to Porter [23], the key strategic issue here is "the balance the firm strikes between industry advocacy and pursuing its own narrow self-interest" and that "the overriding problem for the industry is inducing substitution and attracting first- time ers, and it is usually in the firm's interest during this phase to help promote standardization, police substandard quality and fly-by-night producers, and present a consistent front to suppliers, customers, government, and the financial community". This for instance are the conferences and promotions conducted by stakeholders within the solar PV industry in Indonesia, who are currently hand-in-hand promoting the product and technology, which is not only to achieve their own interest, but also in the interest of the industry and the government (e.g. to achieve the pre-set energy mix target). Furthermore, Porter [23] also pointed o that "the firm in an emerging industry must be prepared for a possible shift in the orientation of its suppliers and distribution channels as the industry grows in size and proves itself" (also rred as the changing role of suppliers and channels) and that "a crucial strategic choice for competing in emerging industries is the appropriate timing of entry". The latter is considering that pioneering (or early entry) is indeed involving a higher risk, but at the same time may also offer a large return. For instance, pioneers of solar PV firms within the industry will be able to have the opportunity to promote and develop its corporate branding and image in the market earlier that its followers, and consequently, if the market are "talking" about solar PV products and technology, it will be the pioneer's brand that appeared in mind.

It can be concluded that, despite of its drawbacks, with an appropriate implementation strategic choice in the factors elaborated above, optimum result from solar PV industry can still be achieved.

Conclusion

Structural characteristic analysis of solar PV industry in Indonesia has indicated that the industry is on its introductory stage, or also ca d as emerging industry. This includes technology uncertainty, strategic uncertainty, high initial costs but steep cost reduction, embryonic companies and spin-offs, first-time buyers, short term horizon, and subsidy.

As an emerging industry, solar PV industry in Indonesia might (and need to be ready to) face several problems, such as the absence of infrastructure; product or te nological standardization; confusion of customers resulting from the existence of a diverse product approaches, technological variations, as well as conflicting claims and counterclaims by competitors; erratic/unpredictable product quality as there is still lack of stand s and technological uncertainty; image and credibility towards financial community; regulatory problem; high initial costs; and response of threatened entities.

Furthermore, criteria determining the technology adoption, which in this case is the solar PV system, is also a crucial factor to understand. This includes the nature of expected benefit, the

required state of the art to yield significant benefits, cost of product failure, introduction/ switching cost, personal risk to the decision maker, and perception of technological change.

Lastly, strategic formulation needs to put extra consideration on uncertainty and risk, as this type of industry is at the period of industrial development, where the competitive game rules are not yet clearly defined, the industry structure not yet settled (with potential changes), and competitors that are hard to identify. Nevertheless, despite of these drawbacks of emerging industry condition, several strategic choices can still be implemented to enable the competitiveness of solar PV industry in Indonesia. This for instance is through leveraging from (1) a high degree of strategic freedom in terms of strategic choices, e.g. in terms of selecting pricing strategy, marketing approach and product policy (2) the balance between governments target, industry advocacy, and the pursue of firm's own interest, (3) changing role of suppliers and channels, as well as (4) the early entry opportunity. With an appropriate strategic choice, it can optimistically concluded that optimum yield/return and competitiveness of solar PV industry in Indonesia can be achieved

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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