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Article

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Policy Challenges of Indonesia's Local Content Requirements on Power Generation and Turbine Production Capability

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ABSTRACT

The demand for electricity in Indonesia will continue to increase. Thus, the market opportunity for the power generation industry needs to be optimally utilized by domestic business actors through the Local Content Requirements (LCR) policy. Through exploratory techniques, the primary goal of this research is to assess the capability of Indonesia's national turbine industries and research institutions, as well as to develop policy recommendations for maximizing the use of local content in order to comply with the Ministry of Industry's Domestic Component Level Regulation, also known as Local Content Requirements (LCR). There are at least three challenges that need attention, namely technology capability and efforts, infrastructure, and institution. Although Indonesia has good prospects and opportunities to develop large-scale turbines, the challenges ahead in developing coal-fired turbines will be more complex due to the strengthening of the clean development paradigm. Thus, it is important to rethink the direction of developing LCR policies for coal-fired turbines. The study recommended budget allocation for ensuring continuity of turbine prototyping, simplify the process to obtain technology licensing, and developing industries that can support materials for turbine industries.

Keywords: Electricity Development, Local Content Requirements, Policy Challenges, Power Generation, Technological Capabilities, Turbine Industry

JEL Classifications: O21, O38, Q48

1. INTRODUCTION

The role of national industries in providing turbine components has become highly strategic in the context of building the strength of the power generation industry. The Indonesian government has regulated the minimum level of local component use in power plants, known as the Domestic Component Level (TKDN), in which this article termed as Local Content Requirements (LCR). LCR is the level of use of domestic components/services compared to imported components. The LCR level in the electricity sector still requires more serious efforts, especially in turbine component in various electricity projects is still relatively lower than the minimum required level. The facts that the level of imported components in the electricity generating system is relatively high indicate the weak mastery of domestic electricity technology in Indonesia, one of which is turbine technology. The government encourage optimizing of the level of LCR in the electricity sector as an effort to substitute imported products.

In order to support the economic development on the side of electricity supply, a related LCR policy was stipulated. The strategy to boost LCR is also in line with the vision of the National Long-Term Development Plan (RPJP) 2005-2025, as summarized in the National Medium-Term Development Plan (RPJMN)

2015-2019. LCR regulations are mainly applied to the process of procuring goods, services, or combination of goods and services for the government. LCR is used as a means or instrument of government to: (1) reducing foreign exchange expenditure by import substitution; (2) building a national industry by encouraging priority sectors to create a strong and competitive industrial structure; (3) directing R&D for mastery of science and technology following national development targets; and also (4) increasing in labor absorption, as a result of the increase in product quality, will lead to an increase in production, and thus an increase in the need for labor (Hartono and Santoso, 2013).

Indonesia still has a large market potential to develop the power generation industry. Indonesia had one of the lowest levels of electricity consumption per capita in ASEAN, at about 843 kWh per capita. Other problems are the frequently blackout hamper various parts of Indonesia the low access to electricity in remote areas. To overcome the problems, the Indonesian government established has been establishing various electricity development program, among others the 35,000 MW which was targeted to take place during the 2015-2019. It was expected that with this acceleration program by constructing more power plants, the level of consumption per capita estimated to increase to 1200 kWh per capita in 2019. Further, the program was expected to increase electrification ratio from 81.5% to about 96.6% between 2014 and 2019. Although, the 35,000 MW program stages are later being modified due to changes in some assumptions such as demand on electricity, potential of oversupply, lack of financing capacity, and community pressure to reduce coal generation, Indonesia still needs a lot of power plant to drive economic growth.

The regulation mentioned that turbine is one of components that required local content. Basically, the MOI regulation mentioned two main components such as main component and services. The main components cover steam turbine, boiler, generator, electrical, instrument and control, balance of plant, civil and steel structure, while on service part, it covers feasibility study, engineering, procurement, and construction, checking and testing, certification, and supporting services. The turbine is one of the most important components in an electric power generation system, since it converts potential energy into mechanical energy, which is then transformed into electrical energy by generators. The provision of turbine technology in power plants is one of the factors that influence the smooth and economic feasibility of the power generation system.

This article is part of a study on the technological capabilities of power generation system in Indonesia conducted by the Ministry of Research, Technology and Higher Education (Sitompul, 2019) and we developed it with the dynamics of policies during the administration of President Joko Widodo. The objective is to observe the problems of technological capabilities development, especially turbine technology and explore policy supports and readiness of national industries to develop turbine technology. Industrial surveys and focus group discussions also being undertaken to observe the challenges and potentials at various stakeholders. Based on the findings, the study will elaborate the challenges and potentials to develop LCR in the context of formulating a set of constructive policy recommendations.

The findings of this study will be used to establish policy recommendations for increasing turbine technology mastery in order to achieve the necessary level of LCR in the power generation system to promote national electricity production independence, especially the 35,000 MW power plant program. Findings from this study can be used as a guide in designing government policies in developing the turbine industry so that it can be produced nationally in Indonesia, and in turn increasing the nation's competitiveness in the field of science and technology mastery for sustainable electricity development.

2. LOCAL CONTENT REQUIREMENT (LCR)

Local content programs have been applied as part of industrial policy. The policy usually goes hand in hand with import substitution policy. Although the policy aims to enhance industrialization, in many cases the policy had caused high-cost economy and contrary to the liberalized trade principles. Pursell (2001) pointed out that domestic lobbies and populist arguments have made local content schemes politically difficult to oppose, and once established, even more difficult to remove. The Increasing the capacity and quality of electricity infrastructure plays an important role in enhancing the competitiveness of the real sector. Therefore, the fulfillment of the components of the electric power generation system is a crucial point for the operation of the electricity program. The procurement of the power plant component technology is one of the factors that influence the economic feasibility of the power generation system. As the development of the electricity sector and economic growth as strongly correlated, it is very important to increase the ability to achieve economic independence based on domestic resources. Burke et al. (2018) discovered some evidence that electricity supply reliability is essential for economic growth and recommended that the causal effects of electricity reliability, infrastructure, and access on economic growth be identified (Burke et al., 2018; Yoo and Kim, 2006). Hansen et al. (2020) suggested that LCR should be used as part of renewable energy auction schemes in order to promote local industrial development, while Allan et al. (2020) investigated LCR policy scenarios that would not only stimulate economic activity but also contribute significantly to the government's net zero emission goal, especially in the future development of offshore wind (Negara, 2016).

Product competitiveness is also an important factor in increasing LCR. Negara (2016) examined the impact of LCR in manufacturing sector in Indonesia and observed that the LCR policy has been ineffective in reducing firm's dependency on imported inputs as those inputs is crucial for product competitiveness, therefore suggested that LCR policy should consider substitution possibilities in production. Kuntze and Moerenhout (2012) suggested that the potential of LCR to reduce costs are associated with the knowledge of the current technologies and their infancy level Technology capability or technology mastery refers to ability to use technology effectively (Stephenson, 2013). This implies that new technology can reduce average cost of production. Then technology effort refers to ability in selecting, mixed, and adjusted technology with local condition, or even able to create new technology.

Local content requirements are set of policy measures that require a certain percentage of domestic manufacturers within the goods' production process (Stephenson, 2013). LCR was described by Ezell et al. in a number of ways, including the percentage of locally developed intellectual property expressed in the development of a product or service, or the percentage of locally developed components used in the assembly of a final product (Ezell et al., 2013). LCR are requirements (usually found in a particular law or regulation) that bind foreign investors and companies to a minimum level of products and services that must be purchased or procured locally, according to UNCTAD (Emmanuel, 2016). Macatangay (2016) investigated four implications in applying LCR one of which is providing high-powered incentives for investor compliance. Lin and Weng (2020) studied the effects of LCR both on industrial production and industrial productivity. They observed that initial level of LCR will determine the impact of the policy, when the initial level is lower the LCR policy tend to increase production but decrease productivity, and vice versa (Saluy et al., 2021).

Governments (both existing and developing) use a variety of measures to attract investment, using a "carrot and stick" strategy. LCR are often combined with investment incentives, which has gotten a lot of attention both within and outside the World Trade Organization (WTO). The Indonesian electricity sector's institutional environments, which are marked by natural monopoly characteristics, often distort investment decisions and lead to higher costs, such that requiring different management with more straightforward market characteristics (Setyawan, 2013). In this study, LCR represents the rupiah value of domestic components in a product (goods only, services, or a combination of goods and services) compared to the overall economic value. The substantial rupiah value reflects the product price structure, which forms the cost of goods manufactured. Thus, based on the LCR formula, the weight of each component's economic value in a technology product can be taken from the product price structure determined through industrial surveys to obtain the entire product price structure factually and accurately. Based on this, the government then determines the percentage of LCR. Domestic components are all types of goods and services that are made or produced domestically, among others (Pahala et al., 2021):

1. Goods consisting of finished goods, semi-finished goods, etc
2. Services consisting, direct and indirect services, such as construction services, consultancy services, or analysis and evaluation of projects construction
3. Design and engineering services (design and engineering)
4. Research services
5. Transportation services, insurance services, and other services.

Specifically, for electricity infrastructure, the government has defined rules for LCR covering aspects of generation, transmission, and distribution in the Regulation of MOI No. 54-IND/PER/3/2012. Several policies in the sector of electricity infrastructure development that are supportive and relevant to increase LCR:

1. Holders of electricity supply business licenses are required to prioritize domestic products and potential
2. Any development of electricity infrastructure for the public interest is required to use domestically produced goods and or services
3. Obligation to use domestic production for the development of electricity infrastructure.

The LCR Minimum Value Target for Electricity Generation System Infrastructure based on the type of power plant regulated under Regulation of MOI Number 54/M-IND/PER/3/2012 is compiled from B2TE, MEMR and in MOI as listed in Table 1.

The 35,000 MW project developments was initially planned to pursue the electrification ratio and electricity consumption. Based on the National Energy General Planning (RUEN) in 2020, the ratio of electrification ratio electrification ratio needs to reach 100% and electricity consumption per capita will reach 7000 kWh in 2050. The program is dominated by the construction of CFPP. Based on RUEN, the primary energy supply of coal will increase from about 67.6 MTOE to about 255.9 MTOE between 2015 and 2050. It is estimated that the potential for absorption of domestic components is IDR 440 trillion. A study performed by Hartono et al. (2020) suggests that coal power plant usually need less investment and have better employment and economic impacts. However, over time, problems in the licensing process and others hampered the 35,000 MW constructions. The realization of 35,000 MW by 2019 has only reached around 10% of the target. Added by the impact the Covid-19 pandemic have been slowing down the progress of the development throughout 2020. Electricity development projects have become obstructed, which is also affected by the downfall of electricity consumption in the industrial and commercial sectors (Hirsh and Koomey, 2015; Kasperowicz, 2014; Lu, 2017). As per June 15, 2019, the status of the 35,000 MW program development is mostly in the construction process around 20,120 MW.

3. METHODOLOGY

The methodology in this study uses an exploration approach based on in-depth observations of primary data and secondary data. Primary data sources obtained are varied based on policy, documents, and media analysis as well as input from stakeholders taken during focus group discussions (FGD), several field surveys, and interviews. This study adopted the use of exploratory research tools to examine variety of stakeholder perspectives collected from the FGD, industrial surveys and interviews that are used to broaden the context and viewpoints nuances and become the basis to formulate the policy recommendation. Questionnaires in a semi-structured research interview format was prepared and used during discussion in the surveys and FGD.

The data collection methods in this study are divided into:

1. Institutional surveys: by collecting data from surveys to selected agencies and through national level discussions in a number of FGD sessions with the Ministry of Industry (Kemenperin), Ministry of Finance (Kemenkeu), state electricity company (PT PLN), and the Directorate General of

Table 1: The minimum LCR of electricity generation system infrastructure by type of power plant

Type of power plants	Capacity per unit power plant	LCR of goods (%)	LCR of services (%)	LCR of combination of goods and services (%)
Coal-fired Power Plant (CFPP)	<15 MW	67,95	96,31	70,79
	>15-25 MW	45,36	91,99	49,09
	>25-100 MW	40,85	88,07	44,14
	>100-600 MW	38	71,33	40
	>600 MW	36,1	71,33	38,21
Hydro PP	<15 MW	64,2	86,06	70,76
	>15-50 MW	49,84	55,54	51,6
	>50-150 MW	48,11	51,1	49
Geothermal PP	<5 MW	31,3	89,18	42
	>5-10 MW	21	82,3	40,45
	>10-60 MW	15,7	74,1	33,24
	>60-110 MW	16,3	60,1	29,21
	>110 MW	16	58,4	28,95
Gas PP	<100 MW	43,69	96,31	48,96
	>150 MW	47,82	46,98	47,6
Combined Cycle Gas PP	<50 MW	40	71,53	47,88
	50-100 MW	35,71	71,53	40
	100-300 MW	30,67	71,53	34,76
Solar PP	PLTS SHS (Solar Home Systems) all capacities	30,14	100	53,07
	PLTS Centralized (all capacities)	25,63	100	43,85
	>300 MW	25,63	71,53	30,22

Source: Regulation of MOI No. 54-IND/PER/3/2012

Electricity, Ministry of Energy and Mineral Resources (DJK-KESDM), the Agency for the Assessment and Application of Technology (BPPT), and the Ministry of Research, Technology and Higher Education (Kemenristekdikti)

2. Industrial purposive surveys: by surveying turbine industrial data covering producers/manufacturers of main and small components and exporters/importers also integrators and power plant contractors. The field survey was conducted to PT. Siemens Cilegon Factory, PT Siemens Industrial Power, PT Nusantara Turbin dan Propulsi (NTP), PT. Cihanjuang Inti Teknik, and PT Sucofindo
3. FGDs and in-depth interviews: conducted with various stakeholders of turbine industries to gain knowledge and input for the implementation of targeted and systematic activities
4. Literature study: through research and activity reports and websites of related agencies such as of PT PLN, Directorate General of Electricity and Energy Utilization, Regional Government, Regional Statistics Office, Central Bureau of Statistics (BPS), related organizations/associations, and others.

The data were collected predominately in the framework of the launching of the 35,000 MW program during 2014-2015, which then became the basis of the government's strong efforts to promote the use of domestic products. Several developments in the current situation were taken to observe the progress of the domestic electricity system especially on the of LCR after 5 years of the 35,000 MW program running.

4. RESULTS AND DISCUSSION

4.1. Turbine Industries Capabilities in Indonesia

The turbine is one component of a power generation. Furthermore, the turbine can be broken down in several sub-components. Figure 1 depicts the power generation industrial tree indicates that steam turbine needs three supporting components such as rotor axle, stator, and rotating blade. Then for each component is supported by various industries. The industrial tree shows value creation, resource, and capability for each stage. Form the industrial policy perspective, policy makers interested in looking at how each industry can support each other from up-stream to down-stream.

In general, Indonesia's turbine manufacturing industry includes the basic material industry, namely the iron and steel industry, the machinery industry, and electrical equipment industry. However, the raw material needs in the form of steel required for certain types of turbines cannot be produced domestically, which hamper to completely produced turbines of the Gas Power Plant and CFPP fully domestically. Various factors are the cause, one of which is the inadequate manufacturing ability to produce quality turbines to compete with foreign manufacturers, both in material quality and in quality of workmanship. By far, several national companies have carried out small various turbine manufacturing. Some information regarding the small various capacity turbine manufacturing in Indonesia are:

1. The cooperation between PT Nusantara Turbin dan Propulsi (PT NTP) and the Agency for the Assessment and Application of Technology (BPPT) has supported by the Ministry of Industry since 2005. They have been successful in the manufacturing and developing of steam turbines with capacities from 0,335 MW to 4MW. Nowadays NTP has been constantly manufacturing turbines with 7 MW capacities [30]
2. PT Siemens Industrial Power (SIP) and PT NTP in 2011 worked together to build a steam turbine factory with 20 MW capacity, employing a German experts and 20 Indonesian engineers, and 180 employees with various educational backgrounds. Such a workforce provides opportunities for

the transfer of knowledge between foreign and local parties and provides added value to Indonesian workers. However, the absence of market certainty has prevented the company from surviving, and as a result, PT Siemens Industrial Power experienced asset liquidation
3. PT Barata Indonesia has also been able to manufacture mini turbines of 1.5 MW size and has collaborated with Russia to develop turbines with capacities below 100 MW [32]. PT Barata and PT Pindad with Hang Zhou China licensing can produce steam turbines with 7-10 MW and 15 MW capacities, respectively.

The experiences from the three cases resulted in three major findings. First, the turbine development has involved the role of stated owned research institute and private sector. Second, the level of capacity is relatively small capacity less than 100 MW. By referring to LCR, it needs about 40% of LCR. Third, the limited ability to build large generating capacity, while the need leads to large-scale generation, making the market of the existing industry limited. Thus, there is a mismatch between capacity and demand. Further, the PLN's RUPTL 2015-2024 (State Own Electricity Company – Electricity Business Plan), indicated that in case of Java-Bali system, PLN plans to developed steam coal power plant with 1000 MW super critical technology. This strategy aims to reach economies of scale, and measure land scarcity issue. This implies that local content policy may not effective due to economic feasibility consideration.

4.2. Research and Development Capability in Indonesia

Instead of developing large scale turbine, existing resource and capability focus to develop small turbine. As seen from Table 1, geothermal power plant develops with lower capacity than coal power plant. However, it is surprising that with higher capacity LCR tends to decline. For example, in the case of steam coal power plant, with capacity about 100 MW, the LCR is about 40%, then for geothermal with the similar capacity, the LCR is about 16%. Then it seems that for small-scale renewable energy generating capacity, where Indonesia has the advantage, the local content level is smaller, compared to coal. The following case shows Indonesia's ability to develop geothermal power plants.

BPPT, acts as government's representative in the field of innovation and technology application, seeks to increase the capacity and participation of the domestic manufacturing industry in its effort to increase LCR of products and industrial competitiveness through technological engineering. BPPT has conducted several developments-research on turbines, for instance, the design of Geothermal PP Binary Cycle with a capacity of 2 kW with hydrocarbon working fluid and the development of a small-scale Geothermal PP and the development of a 2-5 MW condensing turbine Geothermal PP during 2011-2013. Currently, BPPT has succeeded in building a 3 MW Condensing Turbine type of Geothermal PP pilot plant in the Kamojang geothermal field, Garut, and the 50 Kilo Watt (KW) Geothermal PP of the Binary Cycle type and in the Lahendong field, North Sulawesi, which functions as an experiment and pilot for Small Scale Geothermal PP. This innovation is carried out by maximizing the use of domestic components [33]. Besides, BPPT is also developing a turbine for a 5 MW CFPP in collaboration with NTP, which is currently in the concept of refinement phase.

The Technology Center for Machining Industry of BPPT, together with its industrial partner's PT NTP, has developed design standards and several prototypes of steam turbines using reverse engineering methods, ranging from steam turbines prototypes of 0,335 MW backpressure and 2 MW backpressure steam turbines. The 3 MW condensing steam turbine has been implemented at Geothermal PP Kamojang. This steam turbine development program is not only a collaboration between BPPT and PT NTP, it leads to forming a national steam turbine industrial cluster involving several educational institutions, and industries such as PT Barata Indonesia, PT PINDAD, and several other supporting industries.

4.3. Achievement of LCR in the Electricity System

LCR is measured in 3 (three) different components, i.e., the LCR component in goods, services or a combination of goods and services. Electricity development projects generally involve goods and services, so that the LCR measured is the combination of goods and services.

4.3.1. LCR in goods

An essential requirement for turbine manufacturing to compete with imported products is the stable quality of both the material and the workmanship. However, other obstacles surfacing is the unavailability of local content raw materials and the limited mastery of turbine technology. Although several national companies have carried out small-scale turbine manufacturing, however, large scale turbines as part of the CFPP (and the Gas PP system) still cannot be made domestically. The level of LCR in goods that can be produced by several domestic manufacturers can be seen in Table 2. The table indicates two main points. First, due to joint venture PT. PAL has a high degree of LCR for high-capacity turbine. One of the industrial business field PT. PAL is turbine industry and other generating equipment. The steam turbine assembly is up to 600 MW, balance of plant and boiler components up to 600 MW, 40 MW compressor module, and 30 MW barge mounted power plant. PT.PAL develops this capacity under its subsidiary namely PT. General Electric Power Solution Indonesia (GEPSI) and ownership status is joint venture. GEPSI has capacity in the area of EPCI, project management, repair and maintenance for boiler, turbines, power stations, power plant facilities, and environmental pollution control. The shareholders of GEPSI are Alstom N.V. Netherlands (78.8% shares); PT. PAL Indonesia (20.1% shares); and PT. Barata (1.1% shares). Similary, one of PT. PAL subsidiary is PT. Power System Service Indonesia (POSSI). The company does gas turbine maintenance and repair. This is a joint venture among PT. PAL (45% shares), Mitsubishi Hitachi Power System (45% shares), and Mitsubishi Corporation (10% shares). Second, for water turbine, some Indonesian companies such as PT. Barata Indonesia, and PT. Heksa Prakarsa Teknik, have relatively high degree of LCR. This implies that for water turbine, many Indonesian companies have relatively better capability than fossil-based turbine.

4.3.2. LCR in Services

According to Regulation of MOI No. 54/M-IND/PER/3/2012, LCR services in electricity development include consulting services, contractor services, Engineering, Procurement, and Construction (EPC), testing and certification services, training suits and or supporting services. An EPC company's work weight consists of engineering 5-10%, 70% procurement, while 20-30% construction which indicates that the key to the success of an EPC company depends on procurement. There is no specific data regarding the achievement of LCR in services specifically in the electricity sector yet. However, based on Table 3, for CFPP alone, the range of LCR target is 86.06-96.31% accordingly with the scale of the power plants. In terms of capability in electricity projects, several EPCs in Indonesia have demonstrated their ability to carry out service work on a scale of power generation capacity up to 600 MW. The following table is a more detailed description of the LCR achievements of the Combined Goods and Services of several power plants up to 2015 (detailed data available until 2015). The available LCR realization data out of 36 power plants until 2015 shows LCR achievement of CFPP (at all scales), and Geothermal PP at a scale of less than 5 MW and 10-60 MW. Based on Table 3, in general, the higher the capacity scale, the lower the LCR achieved. However, this is not the case for CFPPs on a scale below 100 MW, which shows the achievement is getting closer to the set target.

Table 2: LCR capability in the supply of various electricity goods in Indonesia

Company	Category	Capability	LCR
PT PAL Indonesia*	Balance of Plant (BOP)	Condenser, Vessel, Penstock, Turbine Casing up to 600 MW	>60%
PT Barata Indonesia*	Balance of Plant (BOP)	Heat Exchanger, Pressure Vessel, Water Turbine up to 5 MW	60%
Alstom Power**	Boiler	100 MW Cfb Boiler (c erection)	42,86%
Alstom Power**	Boiler	101 MW Cfb Boiler (includes erection)	32,60%
Alstom Power**	Generator	PLTGU 100-300 MW	37,15%
Pindad**	Generator	< 9 MW	NA
PT Nusantara Turbin dan Propulsi (NTP)*	Turbine and Power Plant Components	Gas Turbine, Steam Turbine, C. Pump, C. Comp	45%
PT Heksa Prakarsa Teknik*	Power Plant Components	Water Turbine, Electronic Load Controller	90%
PT Boma Bisma Indra (PT BBI)*	Power Plant Components	Condenser, LP Heater, HP Heater, De-aerator	>60%
PT PLN (Persero) Service and Production Unit*	Power Plant Components, Repairing Service	Generations components	NA
LEN Industri**	Solar Power Plants	SHS (Solar Home System) 50 Wp	24,63%
Siemens Industrial Power (SIP)	Turbine	3-20 MW	28,56%
PT Nusantara Turbin dan Propulsi (NTP) [30]	Turbine	<7 MW	20,57%
Taka Masineri**	Turbine Parts (coupling)	Interstage sleeve	60,47%
Taka Masineri**	Turbine Parts (coupling)	Coupling	62,18%

Source: *Industries-survey results. **S. E. Enterprise. (2015)

Table 3: LCR target of electricity infrastructure and its achievements

Type of power plants	Unit capacity	Number inspected	LCR combination target (%)	Realization of LCR combination (%)
CFPP	s.d. 15 MW	8	70,79	61,8
	>15 s.d 25 MW	6	49,09	49
	>25 s.d 100 MW	8	44,14	38,74
	>100 s.d 600 MW	9	40	25,91
	>600 MW	3	38,21	10.69
Hydro power plant	s.d. 15 MW	-	70,76	NA
	>15 s.d 50 MW	-	51,6	NA
	>50 s.d 150 MW	-	49	NA
Geothermal power plant	s.d 5 MW	1	42	9,52
	>5 s.d 10 MW	-	40,45	NA
	>10 s.d 60 MW	1	33,24	29,42
	>60 s.d 110 MW	-	29,21	NA
	>110 MW	-	28,95	NA
Gas power plant	s.d 100 MW	-	48,96	NA
	>150 MW	-	47,6	NA
Combined gas steam power plant	s.d. 50 MW	-	47,88	NA
	50 s.d. 100 MW	-	40	NA
	100 MW s.d. 300 MW	-	34,76	NA
	>300 MW	-	30,22	29,91
Solar power generation	PLTS SHS all capacity	-	53,07	NA
	PLTS Centralized – all capacities	-	43,85	NA

Data collected from B2TE (2015), and PLN (Persero), (2015) Along with meeting the electricity acceleration program's target, it is necessary to develop the EPC's ability to handle power generation projects for the medium and upper scale. This requires not only regulations that favor the national EPC and the national industry, but also changing business strategy. Zhao et al. (2018) pointed out that there are three reasons for dependency on foreign supplier. First is mastery of technology by foreign companies with patent right. Second, the foreign supplier with technology mastery can provide certainty of spare part supply. Finally, long terms contract that provide exclusive rights to foreign company for delivering maintenance. For strategic projects, the government must support EPC and national industry involvement, especially considering the high target of LCR in services. The clear and strong policy direction is needed to create a healthy and competitive investment climate. All forms of facilities and policies should aim at strengthening industrial structures, increasing the use of technology and the capacity of domestic market.

4.3. LCR in Combination of Goods and Services

Considering that development projects' composition of an electricity system includes goods and services, therefore LCR measurement in a project development is a combination of goods and services. For instance, the components of the cost of goods and services in the CFPP system represents the LCR of CFPP development, as depicted in Figure 2. The component cost structure depicts that Boilers, Turbines and Generators (BTG) are the most significant and main cost components [38], most of which are still imported. The picture below interprets that if all components are locally sourced, the LCR value of CFPP reaches 100%.

Based on another source the fulfillment LCR of PLTMG and CFPP systems in the structure of the utilization of goods and services components' combination in the 35,000 MW program until 2018 is shown in Table 4. There is no domestic use of steam turbines for the CFPP system both yet both on a scale of 100-600 MW and >600 MW. The table also shows the cost component structure that reflects the domestic economic value of each component of the boiler, turbine and generator, civil works, electrical, instrumentation and control, balance of plant and costs for EPC. Despite the government efforts to increase the local content, especially for 35,000 MW program, however, it has not yet reached the target set. A number of different factors influence the capability to reach the required level of LCR, which is dominated by the ability to develop domestic turbines.

Generally speaking, the challenge is not only in terms of fulfilling the LCR for generator turbines, but also other supporting components. Ministry of Industry (2020) indicated that 213 companies in electricity sector submitted certification for LCR. Table 5 indicates that there is a large capacity gap between companies providing goods and services in the electricity sector. This of course can be an obstacle in efforts to fulfill the availability of electricity both in terms of quantity and quality of domestic industries.

4.4. Turbine Industry Challenges to Meet LCR

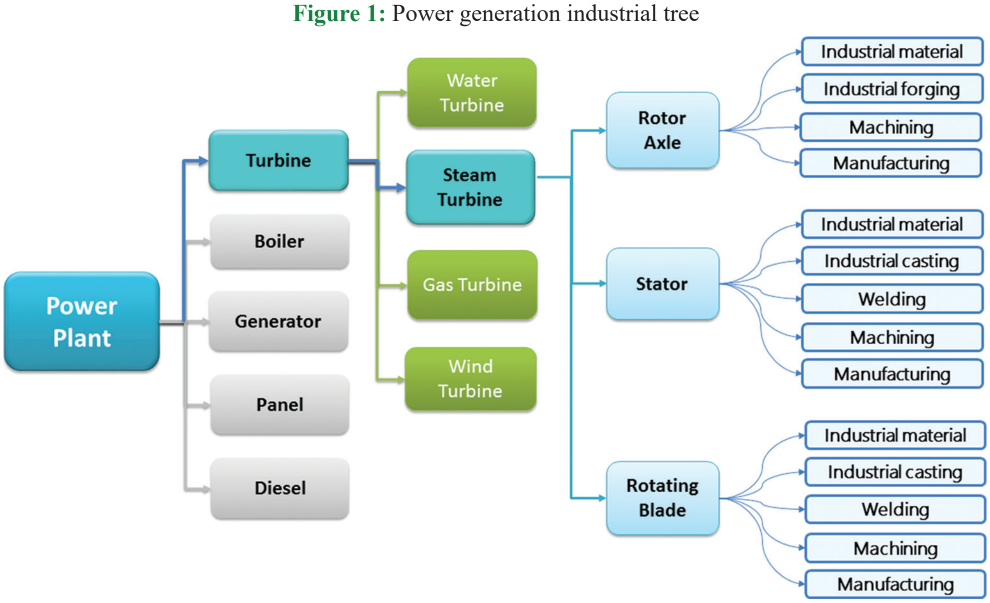
Series of surveys and focus group discussions were conducted with several participants from domestic industrial players and government research and development (R&D) agencies in order

Table 4: LCR value capability with a 35,000 MW scenario

Parameter	LCR value achievement in 35,000 MW programs		
	CFPP		
	Weight	100–600 MW	>600 MW
Boiler	26%	12%	10%
Gas engine/turbine, generators	21%	0%	0%
Electrical	12%	4%	4%
BOP and auxiliary	16%	5%	5%
Instrumentation and control	5%	1%	1%
Engineering services	6%	2%	2%
Civil Works	14%	14%	14%
Total	100%	40%	38%

Source: PLN (Persero), (2015) [40]

Figure 1: Power generation industrial tree



Source: Authors

to obtain information about the obstacles that occurred in the field. The FGDs were conducted with turbine industries and an R&D institution, namely: (1) PT Siemens Industrial Power, (2) PT Siemens Cilegon Factory; (3) PT Cihanjuang Inti Teknik; and (4) PT NTP and (5) BPPT. Generally speaking, turbine production line covers both upstream to downstream business chain which is depicted on the following figure regarding the turbine industry's problem (Figure 3). These problems also apply to other type of turbines.

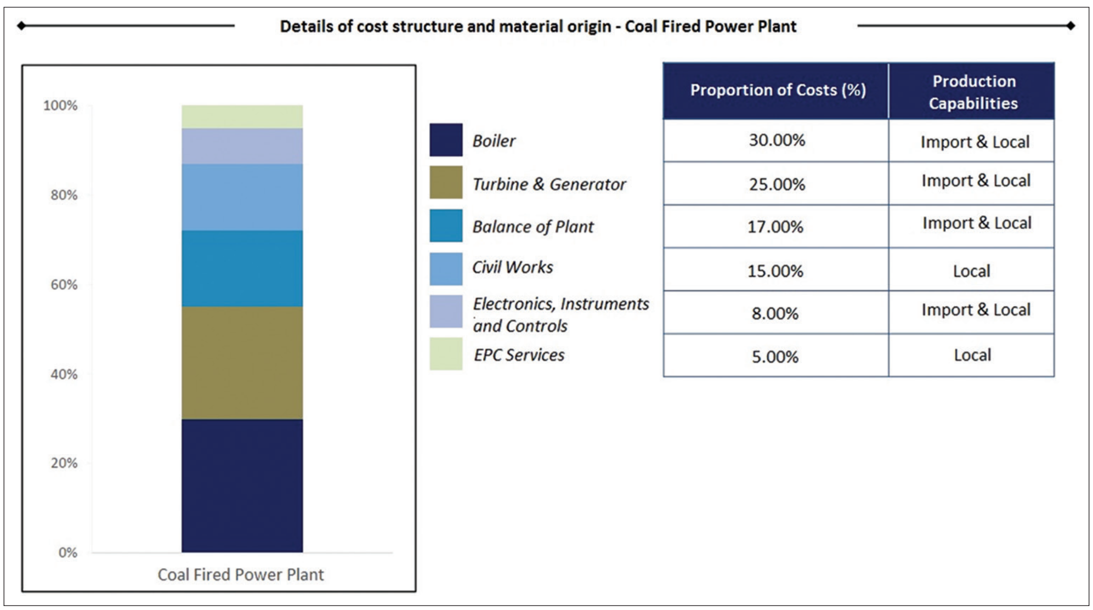
After conducting discussion with experts, we found three major obstacles of LCR for turbine, namely technology capability and efforts, infrastructures, and institution (norms/standard). Technology capability and efforts can be developed if it is supported by domestic science and technology, finance and access to foreign technology. The annual activity-based budgeting mechanism also hampers the continuity of cooperation for

Table 5: Performance of LCR for supporting electricity industry

Component	LCR (%)
Boiler and components	32-52
Circuit breaker	14-45
Isolator	4-75
Tower transmission	49-58
Transformer	15-73
Pipe	20-73
Pressure vessel	17-37
Tank	20-80
Deaerator	15-20
Fan and blower	19-45
Condenser	25-35
Minimum requirements based on government regulation (for good and services)	<15 MW (70,79%); 15-25 MW (49,09%); 25-100 MW (44,14%); 100-600 MW (40%); >600 MW (38,21%)

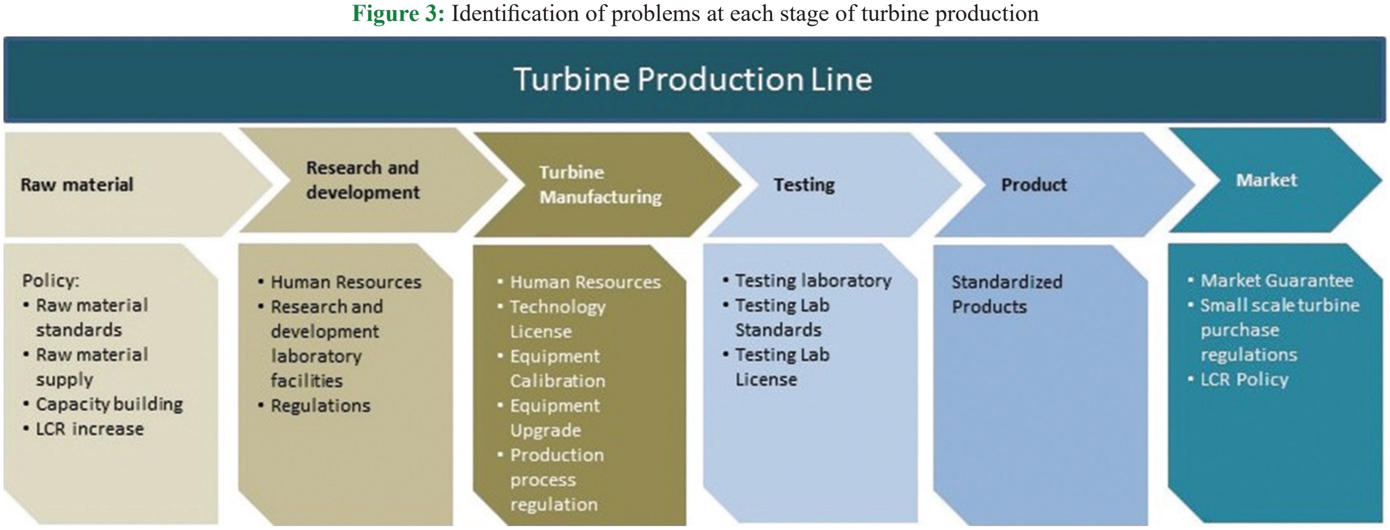
Source: Ministry of Industry, (2020)

Figure 2: Detailed cost structure and material origin - Steam power plant



Source: Electricity State Enterprise (PLN (Perseo), 2015) [38]

Figure 3: Identification of problems at each stage of turbine production



Source: Authors

long-term development. For instance, since 2005-2013, there have been 5 prototypes of turbines (plant and sugar industry) produced by the co-operation of BPPT (Agency for the Assessment and Application of Technology) and PT NTP. However, there has been no continuation due to budget mechanism constraint. The problems endured by the local turbine manufacturing industries converge on the challenges to cut the chain of dependence on imported turbine products. With appropriate policy recommendations and the supports of relevant stakeholders, it is expected that the challenges will become a motivation for the development of the local turbine. Likewise, efforts to improve reverse engineering capabilities are still open as an effort to improve LCR. However, policy support is still needed such as in preparing the road map and the speed to do this is determined by the ability of each party, both the government, the private sector, and research and development institutions to be more actively involved in a turbine generator consortium.

Rapid development on CFPP technology has led high level of capacity. Currently, ultra-super-critical CFPP technology reach larger capacity up to 1000 MW. This will affect the operating conditions such as temperature and pressure. This implies demand on special materials to produce the turbine will increase. In designing a turbine, efficiency is the main goal. Many considerations require a good understanding in turbine technology, especially from mechanical aspect and material aspect. However, only few Indonesian companies have not ability to produce the high technology of turbine.

Then, infrastructure refer to support of laboratories testing in the country. Basically, Indonesia has three Indonesia national Standard (Standar Nasional Indonesia/SNI) – International Electrical Commission (IEC) for steam turbine thermal and it is still applied (SNI IEC 60953-1:2009; SNI IEC 60953-2: 2009; and SNI IEC 7389-3: 2009). There are three experts handling SNI for electricity turbine. However, business actors do not seem to be satisfied with the existing infrastructure, especially in terms of the long time for testing, and the limited space for conducting tests. In addition, efforts to encourage the achievement of SNI need to be encouraged to existing industries. Surveyor Indonesia and Sucofindo are the two agencies that verify LCR achievements. The evaluation results show that the average LCR for coal-fired power plants in 2020 is 22.77%, while the expected target is 42.07%.

Finally, institution covers issues related to processes, rules, and norms. Several highlighted problems have been hampering turbine industries, among others are national standardization, market guarantee and product development through license purchase, also the annual activity-based budgeting mechanism. For instance, if a manufacturer buys a turbine license with proven technology at 1 million Euros, which is valid for 1 year (1-time fee for 1 turbine type) and the industry can only produce 1 unit a year, the license fee will be fully charged into 1 unit of the turbine produced, hence turbine price will be very high. On the other hands, if the turbine industry can produce more than 1 turbine per year, for instance, 10 units, the license price can be divided evenly, and the product price would be more affordable. As a result, the industry would need commercial guarantees from the government to ensure that the goods are consumed, and this policy relating to obtaining licenses for manufacturing turbines in Indonesia should be enforced by appointing state-owned companies to assist in the process (Sitompul, 2019).

Indonesia also needs to be prepared with a clean development paradigm that requires restrictions on the construction of coal plants. In fact, many parties see the coal generation industry as a sunset industry. Responding to the development of this new norm, of course, efforts to encourage LCR will become less relevant in the future, unless the government shifts to the paradigm of strengthening the renewable energy generation industry. Thus, pursuing targets of LCR in coal plants needs to be more focused where Indonesia already has a competitive advantage. The existing companies are expected to be able to replace the components that have been imported so far. Thus, in the threat of an increasingly unpopular coal plant condition, Indonesia is still able to take advantage of the remaining opportunities (Endri et al., 2021).

5. CONCLUSIONS AND POLICY IMPLICATIONS

LCR is an integral part of industrial policy. The Indonesian government has adopted this policy as the basis for strengthening the national industry, particularly in the electricity sector. The development of a 35,000 MW electricity mega project provides a great opportunity for local entrepreneurs to get the maximum benefit from this policy. Coal is still the backbone of electricity supply in Indonesia and will continue to increase in the future. Thus, the LCR-CFPP policy has a strategic dimension in terms of economy, technology, and policy. However, LCR policy actually needs to be implemented carefully because this policy can be exploited by rent-seekers, and also has the potential to interfere with fair trade principles. The LCR policy will work well if it is balanced by efforts to strengthen capabilities and technological efforts. This of course requires a long time and a consistent policy of science and technology.

The Indonesian government implements a different LCR policy for each generation source. However, the pattern that can be observed is that the greater the generating capacity, the more LCR that must be met. In the generation sector, of course, the higher the capacity, the easier it is to achieve economies of scale. However, building large-scale generating capacity is much more difficult. Thus, if domestic actors are more involved in small-scale generators, of course, the potential economic benefits created will also be limited. This study is able to map the value chain of the coal generation industry, especially for turbine components.

LCR policy can be seen from two sides, namely goods and services. If we look at the coal turbine generating capacity, Indonesia can build a capacity of 600 MW. This production is carried out by joint venture companies which are still dominated by foreign ownership. Meanwhile, for power plants on a smaller scale and for hydropower and geothermal bases, Indonesia's competitive position is quite good. The ability of many power companies in Indonesia to achieve LCR varies widely. This of course will have an impact on the conditions of industrial competition, especially for large scale which is relatively more concentrated in a few companies. This will also be related to the efficiency aspect if the achievement of LCR ignores healthy competition both at the local level or by opening up import opportunities. There are at least three main obstacles to the development of LCR for coal turbines, namely technological capabilities and efforts, infrastructure and institutions. These three barriers are of course interrelated with each other. Thus, efforts to solve it need to be carried out simultaneously.

The success of the LCR policy will be largely determined by industrial, scientific and technological policies. Advances in science and technology are the basic prerequisites for the success of the LCR policy. With regards to research and development, the need for a technology license as a "short cut" for the initial steps in developing turbine technology without having to start from scratch. Then, it is recommended to make improvement on the budget mechanism to ensure continuity of turbine prototyping and to obtain easier technology licensing. Lastly, the material used to manufacture turbines cannot yet be fulfilled from the domestic market, due to the absence of supporting materials for turbine industries. Relevant policies aimed to encourage the development of the turbine industries should be imposed so that they can also trigger the growth of the material industries that supports the development of turbine industries.

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