Jurnal Aplikasi Manajemen dan Bisnis, Vol. 8 No. 1, Januari 2022
Permalink/DOI: http://dx.doi.org/10.17358/jabm.8.1.66
Available online
http://journal.ipb.ac.id/index.php/jabm

ELECTRICITY SUPPLY STRATEGY FOR PT FREEPORT INDONESIA'S PRODUCTION EXPANSION

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Abstract: PT Freeport Indonesia (PTFI) plans to build a new power generation facility in the face of production expansion, especially underground mine and mill optimization, which has an impact on increasing the demand for electricity up to 374.8 MW. The selection of the right type of power plant, will greatly determine the continuity of the electricity supply operation. There are many things to consider, making it difficult for companies to determine the type of new power plant. Therefore, this study aims to (1) determine the most important factors to consider in the construction of PTFI's new power plant; (2) provide recommendations for the choice of the best type of new power plant for PTFI. This study uses the method of literature review, expert interviews and questionnaires, which are processed using the Analytical Hierarchy Process (AHP) method. The results of the study indicate that conformity with the existing power generation facilities and support from government policies are the most important factors and sub-factors that must be considered by PTFI in the construction of new power plants in the Special Mining Business License (IUPK) area. The recommended type of new power plant is the Dual Fuel Power Plant (DFPP).

Keywords: analytical hierarchy process, consideration factors, electricity supply strategy, power generation, production expansion

Abstrak: *PT Freeport Indonesia (PTFI) berencana akan membangun fasilitas pembangkit listrik baru, dalam menghadapi ekspansi produksi, khususnya tambang bawah tanah dan pabrik pengolahan, yang berimbas pada meningkatnya kebutuhan daya listrik hingga 374,8 MW. Pemilihan jenis pembangkit listrik yang tepat, akan sangat menentukan keberlangsungan operasi penyediaan listrik. Banyaknya hal yang harus dipertimbangkan, menyulitkan perusahaan untuk menentukan jenis pembangkit listrik baru. Oleh karena itu, penelitian ini bertujuan untuk (1) menentukan faktor-faktor pertimbangan terpenting dalam pembangunan pembangkit listrik baru PTFI; (2) memberikan rekomendasi pilihan jenis pembangkit listrik baru terbaik di PTFI. Penelitian ini menggunakan metode ulasan literatur, wawancara pakar dan kuesioner, yang diolah menggunakan metode Analytical Hierarchy Process (AHP). Hasil penelitian menunjukkan bahwa kesesuaian dengan fasilitas pembangkit listrik yang dimiliki saat ini dan dukungan kebijakan pemerintah, merupakan faktor dan sub faktor terpenting yang harus dipertimbangkan oleh PTFI dalam pembangunan pembangkit listrik baru di area Izin Usaha Pertambangan Khusus (IUPK). Adapun saran jenis pembangkit listrik baru yang direkomendasikan adalah Pembangkit Listrik Tenaga Mesin Gas (PLTMG).*

Kata kunci: *analytical hierarchy process, faktor pertimbangan, pembangkit listrik, peningkatan produksi, strategi penyediaan listrik*

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INTRODUCTION

PT Freeport Indonesia (PTFI) is an affiliated mining company of Freeport-McMoRan (FCX) and Mining Industry Indonesia (MIND ID), which has now entered the transition period from open-pit mining Grasberg, to underground mining. Currently PTFI manages 4 underground mines, both in production and in the development stages, namely the Deep Ore Zone (DOZ), Big Gossan (BG), Deep Mill Level Zone (DMLZ) and Grasberg Block Cave (GBC). Efforts to optimize and develop production to meet the production deficit due to the closure of the Grasberg open pit mining operation in 2019 have continued. One of current concern is the underground mine and Mill optimization. In the development plan, it is projected that there will be an increase in electricity demand from year to year, until the peak load reaches 374.8 MW in 2033. In the expansion plan, it is projected that there will be an increase in electricity load from year to year, until the peak load reaches 374.8MW in 2033 and decreases gradually until mine closure in 2041, as shown in Figure 1. Long-term load forecasting is estimating the electricity load over an annual period, long-term loads have a very important role in the control and actual function of an energy management system (Massarang et al. 2015). To prepare for the increasing electricity demand, the strategy that has emerged is the construction of new power generation facilities, that will be managed independently. The selection of the right type of power plant, will greatly determine the continuity of the operation of providing electricity with the new power generation facility.

PTFI currently relies on Diesel Engine Power Plant (DEPP) and Coal Fired Steam Power Plant (CFSPP) as the main power plants, with a total managed electricity capacity of 299.6 MW on the 60 Hz system and 25 MW on the 50 Hz system. Since the limitation and enforcement of concentrate export tax, PTFI has implemented a comprehensive cost efficiency program in all divisions and departments. Even though the situation is different, to date PTFI continues to carry out various efficiency programs, one of which is fuel. As Ramadhani (2010), in the industrial world, energy costs are often the largest cost component that must be paid each month, energy costs can be in the form of electricity and fuel bills (oil, gas, etc.). DEPP is one of the largest fuel consumers at PTFI's job sites. On the one hand, PTFI is required to implement an efficiency program, but on the other hand, the reliability and practicality of this type of power plant, in the unique PTFI area, is difficult to replace. The average value of DEPP generation from the last 10 years data is US$ 187/MW. With the increase in the price of fuel oil, the industry began to think about switching to alternative fuels (Rianto et al. 2017). High oil consumption is not accompanied by the amount of domestic production, to meet oil demand, Indonesia imports oil. This threat can threaten national energy security (Persia, 2018; Silitonga et al. 2020), there is a need for energy savings (energy conservation) (Prasetyo et al. 2020). CFSPP with abundant coal in Indonesia, as Silitonga et al. (2020) Indonesia's natural resources are very abundant, such as coal and renewable energy, the average generation cost in PTFI is US$ 48/MW, now receiving special attention related to environmental issues (Nasir and Edy, 2015; Sahlan and Abdul, 2019) and permits in fly ash and bottom ash waste management (Damayanti, 2018; Zacoeb et al. 2012) in a very limited area in Amamapare, as well as tightening air emission regulations (MENLHK, 2019). Therefore, further research is needed to find a way out of this problem, especially in the procurement of new power generation facility in the face of PTFI production expansion.

However, studies that discuss strategies to meet the company's increasing electricity demand, especially underground mining, are still very limited. Mostly related to PLN (state-owned enterprise), to the community. strategy carried out by PLTD Subrayon Giligenting is, in the field of electricity supply and service sector (Fiki et al. 2013), implementation of new energy and renewable energy policies (Azhar and Dendy, 2018), the government needs to make policies that are firm, clear, and consistent in efforts to improve national energy security (Pradnyana, 2016), alternative solutions for the provision of Electrical Energy Sources in Kabupaten Kupang found that the first choice is a photovoltaic solar system (PLTS), the second option is wind power system (PLTB), the third option is microgrid (MG system), and the fourth is the hybrid power system (PLTH) (Sinaga, 2017), prioritizing studies on renewable energy based on potential energy sources in the region and monitoring the use of the budget for the use of renewable energy (Marini, 2018), 3 criteria which are the best priorities, namely generating new revenue, market share, and increasing opportunities in the future. While the determination of the main alternative for the construction of the Power Plant Project is the Java 7 PLTU the Java 8 PLTU, and the Java 3 PLTGU (Pratomo and Bambang, 2019).

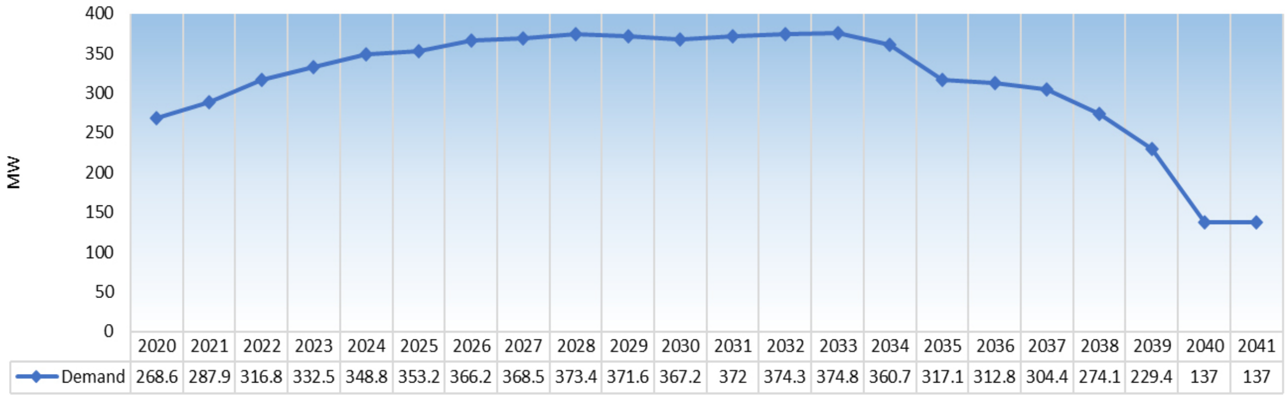

Figure 1. Projection of PTFI Electricity Load 2020-2041 (PTFI, 2017)

PTFI, which has often been the focus of public and government attention, must be very careful in making decisions, especially on issues that have many criteria, often conflicting, many alternatives, such as power plants. The Multi Criteria Decision Making (MCDM) is believed to be able to help in this problem, as Asabadi, (2019) and Mulliner et al. (2016) stated, the MCDM methods was developed to facilitate the selection of alternatives for multiple criteria. There are six types of investment in power plants; new projects, expansion projects, renewal projects, up-rating projects, refurbishment projects (life-time extension), and technology upgrade projects (Warsono, 2020). Meanwhile, utilities are expected to switch to other energy sources, that is, cheaper fuel for generating electricity and for maintaining supply and electricity costs remain low (Liun and Sunardi, 2014).

Based on the research background explained, especially since there are many factors, criteria, and alternatives, which one is the most important? Likewise, what type of power plant is most suitable for PTFI? Therefore, the objectives of this research are (1) to determine the most important factors PTFI should consider in the construction of a new power generation unit, and (2) to provide recommendations for the best type of power plant that can be chosen by the Management to be built, to meet PTFI's increasing operational power requirements.

METHODS

This research was conducted in the operational area of PT Freeport Indonesia both in the Highlands and Lowlands, which is located in Mimika Regency, Papua, especially at Power Service Department (PT Puncak Jaya Power), Technical Services Division, in the 60Hz and 50Hz systems. This research has been held from December 2020 to April 2021.

The preparation of this research includes collecting information on previous research, supporting research data, interviewing experts, processing data, writing and consulting research. This study uses a qualitative approach, which is carried out through in-depth interviews with respondents to collect information about the variables researched. This study uses primary data and secondary data as research material. Primary data for this study was collected through in-depth interviews with PTFI internal and external power generation experts who have 10 years of experience or hold important positions. While secondary data was obtained from a previous research literature review.

The research begins by conducting a literature study to find out information about the factors that are considered in the selection of the power plant type of. By conducting a literature review, the author has insight into these factors so that interviews with experts become more focused and on target. These factors were then discussed with experts to find out other factors that PTFI should consider. The in-depth interview with 7 power plant experts both internal and external (PLN) who occupy management positions, with an average time of 1.5 hours with 6 developing questions. The results are then ranked through a questionnaire to 16 respondents who have more than 10 years of experience in the field of power generation. The final AHP ranking was carried out through a questionnaire to 7 experts.

When the relevant consideration factors have been gathered, the data will be processed using qualitative data analysis methods, where the process is in the form of a cycle, not linear, with four stages, namely data, data reduction, data presentation, withdrawal and leverage

(Rijali, 2013). The best four will be further processed in the AHP method.

In AHP, the first step is to define the problem and determine the focus or goal. In this study, the focus or goal that the author wants to achieve is to choose the best type of new PTFI power plant, the box belonging to the improvement strategy is placed at the top of the hierarchy. The second step is to create a hierarchical structure starting from the top level, namely the focus or goal to be achieved. The second tier is the most important factors to consider in determining PTFI's new type of power plant. After these factors, the hierarchy is relegated to sub-factors. The sub-factor will contain the most important parts of the factors that are considered to greatly affect the focus and factors. The third level is alternative, namely the choice of the type of power plant that is most recommended for PTFI. The third step is to make pairwise comparisons. Descriptive analysis was conducted to explain the factors, sub-factors, targets and strategies that greatly influence the electricity supply strategy for PTFI's production expansion. The AHP method provides easy and complex solutions simultaneously in the sense that it can handle complex real problems (Saaty, 1986; Saaty, 1987). In general, the research framework can be seen in Figure 2.

RESULTS

After conducting a review and discussion with the experts, it was found that the actual condition of PTFI's electricity in 2020 is 268.8 MW of maximum load used for operational and supporting activities. The peak load is projected in the next few years, along with the expansion of PTFI's production to be 374.8 MW or will increase by 39.6%. PTFI is currently managing the power plant in details; The total installed capacity on a 60Hz system is 299.6 MW and 25MW in a 50Hz system, whereas if the estimated electricity demand reaches a peak of 374.8 MW in 2033, PTFI must prepare to build a new power generation unit that can meet the deficit of 75, 2 MW.

Underground Mine Development Plan and Processing Plant

Based on PTFI internal data, PTFI production expansion both in underground mines and concentrate processing plants will gradually change the capacity of electricity needs from year to year, the detail of planning shown in Table 1.

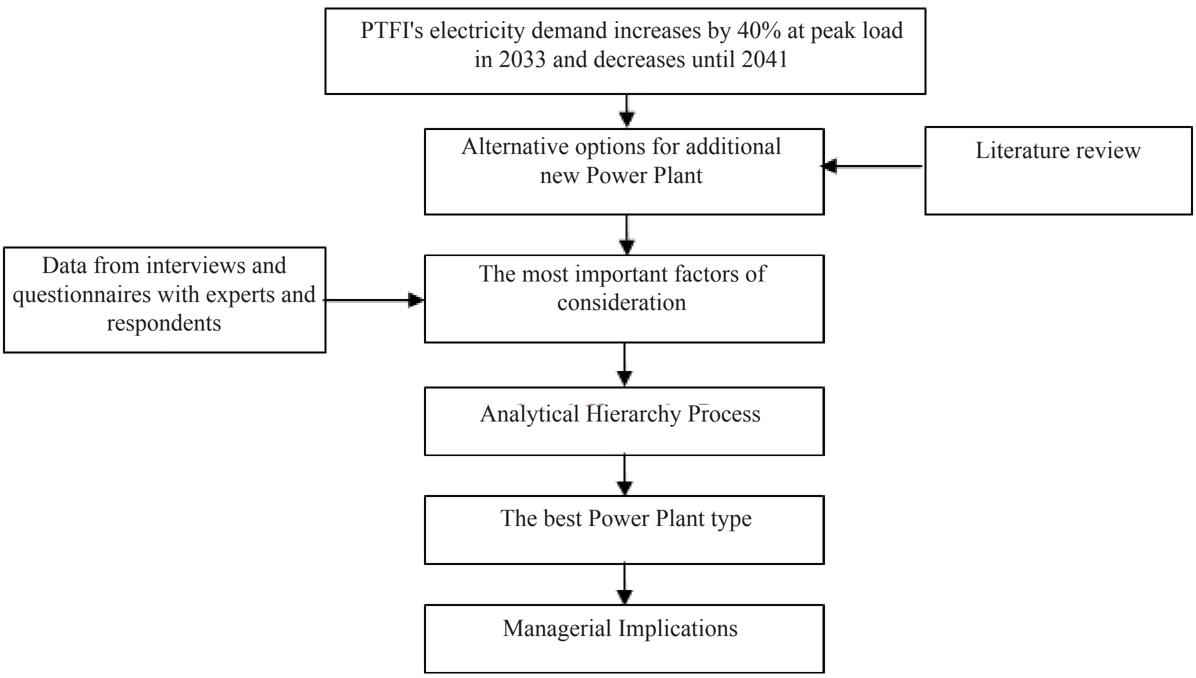

Figure 2. Research framework

Table 1. Capacity change of electric power requirements from 2021 to 2041

Year	Increase	Decrease
2021	SAG Pre-Crusher 240K Mill 4.5 MW	
	Grasberg Block Cave (GBC) 1.8 MW	
	Deep MLZ 3.4 MW	
	Existing Mill 8.6 MW	
	Town site 1.1 MW	
2022	Pre-Crusher 240K Mill 2.9 MW	Existing Mill -0.8 MW
	Ball Mill C3 7.4 MW	
	GBC Cu Cleaners 15.3 MW	
	GBC 2.4 MW	
	DMLZ 0.4 MW	
	Common Infrastructure Projects 0.2 MW	
2023	Pre-Crusher 240K Mill 1.5 MW	PH 2800 -0.6 MW
	GBC 0.3 MW	DMLZ -0.2 MW
	Common Infrastructure Projects 0.5 MW	
	Mill 13.8 MW	
	Town site 0.2 MW	
2024	GBC 1.2 MW	DMLZ -0.3 MW
	GBC Py Cleaners 6.5 MW	Common Infrastructure Projects -0.6 MW
	GBC Utilities 0.7 MW	
	GBC Py Concentrate Handling 4.1 MW	
	Existing Mill 3.7 MW	
	Town site 0.4 MW	
2025	N/S Ball Mill 5.1 MW	GBC -0.9 MW
	Existing Mill 0.1 MW	DMLZ -0.2 MW
	Common Infrastructure Projects 0.5 MW	Town site -0.3 MW
2026	GBC 2.3 MW	Town site -0.2 MW
	DMLZ 0.3 MW	
	Lime Plant 1.6 MW	
	Mill 1.8 MW	
	GBC Cu Cleaners 6.7 MW	
2027	GBC 2.6 MW	DMLZ -1.4 MW
	Mill 1 MW	
	Town site 0.1 MW	
2028	GBC Py Cleaners 6.5 MW	GBC -0.9 MW
		Common Infrastructure Project -0.6 MW
		Town site -0.3 MW
2029		GBC -1.5 MW
		Common Infrastructure Projects -0.3 MW
		Town site -0.1 MW
2030		GBC -3.8 MW
		Town site -0.4 MW
2031	GBC Cu Cleaners 5.3 MW	GBC -0.5 MW
		Town site -0.2 MW
2032	GBC 2.5 MW	Town site -0.2 MW
2033	GBC Py Concentrate Handling 2.7 MW	GBC -1.6 MW
		Big Gossan -0.8 MW
2034		GBC -4.5 MW
		Mill -4.7 MW
		DMLZ -4.5 MW
2035		GBC -0.5 MW
		Big Gossan -2.6 MW
		DMLZ -20.1 MW
		Mill -18.3 MW
		Town site -0.3 MW
2036		GBC -1.6 MW
		Mill -0.2 MW
		Big Gossan -2.3 MW
2037	Mill 0.2 MW	GBC -8.1 MW
		Town site -0.1 MW.
2038	Town site 0.2 MW	Mill -29.4 MW
2039	Town site 0.2 MW	Mill -43.3 MW.
2040		GBC -28.3 MW
		Mill -58.7 MW
2041	Mine closure plan. 137 MW	

Identification of Factors to Determine the Type of Power Plant

Based on the interviews and literature study, 28 factors were identified that need to be considered in the construction of PTFI's power plant (PP), in alphabetical order as follows; (1) Investment costs (Wahid, 2015), (2) Operational & maintenance costs (fixed & variable) (Wahid, 2015), (3) Community support around the PP location, (4) Stakeholder and/or shareholder support (Pratomo et al. 2019), (5) Support natural resources around the PP site, (6) New and renewable energy (Jonan, 2018), (7) Suitability of PP type with the direction of the Government's energy policy, (8) The suitability of PP types with the company's strategic direction (Pratomo et al. 2019), (9) Compatibility of PP types with existing facilities, (10) Match the type of PP with the required capacity, (11) Readiness of infrastructure (Pratomo et al. 2019), (12) Readiness of company competence (employees), (13) Availability of fuel/energy sources in a sustainable manner, (14) Availability of government guarantees or incentives from the government (Pratomo et al. 2019), (15) Availability of spare parts, (16) Availability of experts, (17) Load responds, (18) Project location (Pratomo et al. 2019; Wang et al. 2019), (19) Future development opportunities (Pratomo et al. 2019), (20) Introduction of new technology to companies (Pratomo et al. 2019), (21) Increasing company competence, (22) Increase in market share (Pratomo et al. 2019), (23) Potential to generate new revenue for the company, (24) Risk of project failure (Pratomo et al. 2019), (25) Occupational health and safety risks, (26) Environmental risk (waste management), (27) Lifetime, and (28) Construction time. From those factors data collected, a ranking questionnaire was carried out to 16 respondents with the following results (Figure 3).

Decision Modeling Based on the Analytical Hierarchy Process Structure

From all the data collected, the priority weights for each element have been obtained, and it is recognized that DFPP is the best type of power plant that can be built, as summarized and presented in the AHP structure as shown in Figure 4. From the data, it is known that the change of PTFI's Contract of Work into a Special Mining Business License, especially after the majority of the shares were taken over by the government, the government's policy support is considered to be the most decisive for the operational sustainability of the power plant that supports mining operations. Suitability with existing facilities is still the main choice, because of its practicality and availability in the shortest time.

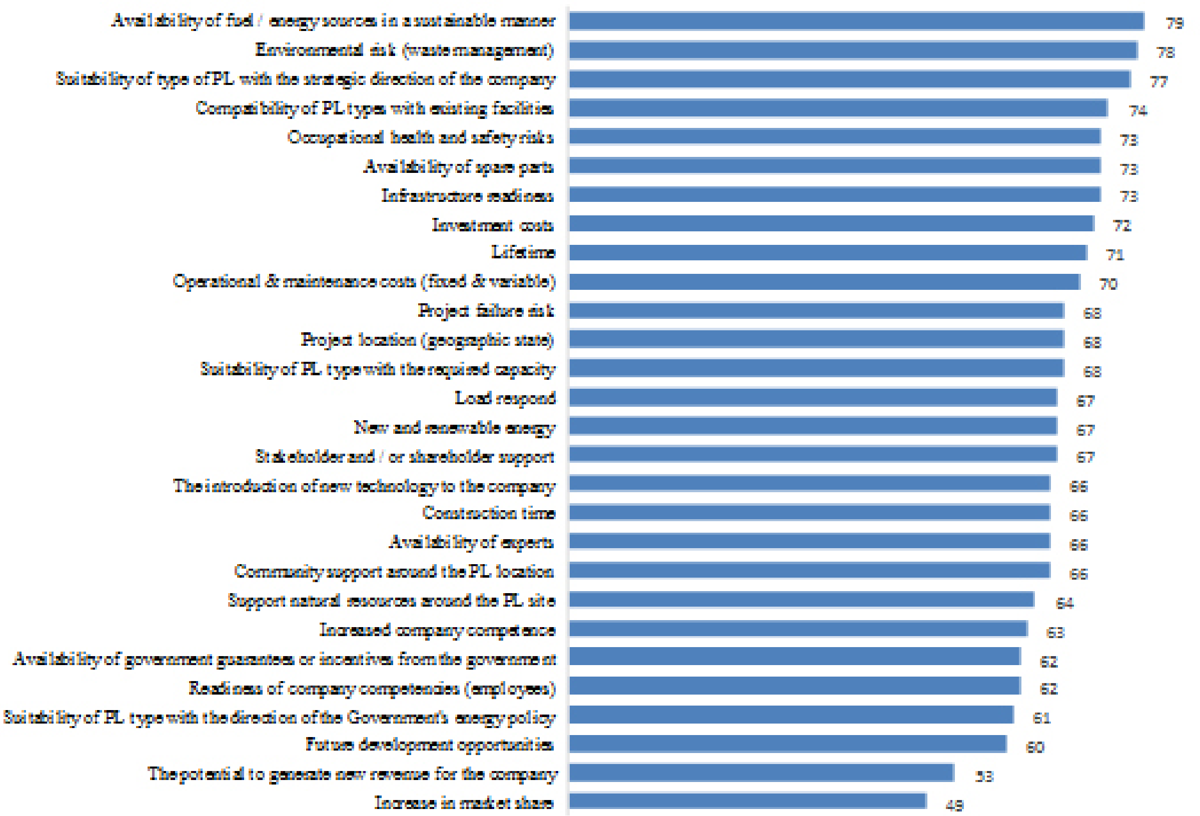

Figure 3. The ranking of the factors considered in selecting PTFI's power plant type

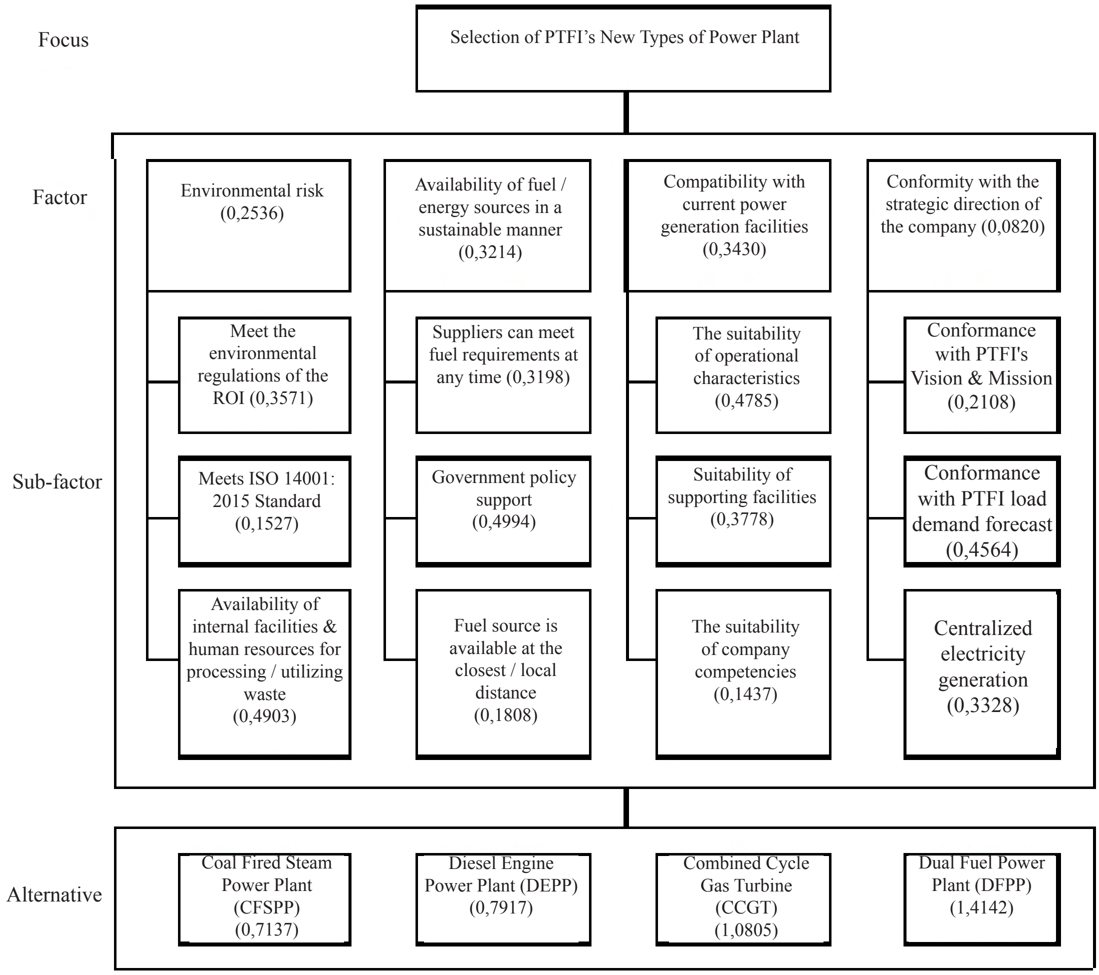

Figure 4. Results of the calculation priority in the AHP structure

Managerial Implications

PTFI is advised to immediately carry out this stage in 2021 or continue it if this stage has already started. As shown in Figure 5, it is necessary at the planning stage; inter-departmental studies coordinated by the EVP Technical Service, funding planning coordinated by the Finance & Accounting Department, the formation of a DFPP development team / authority coordinated by the EVP Technical Services, the activities of the DFPP development team / authority coordinated by the DFPP Project Manager such as location determination, feasibility surveys, preparation of specifications, assessment of bids, negotiation of contracts, and preparatory work, while the process of this stage is licensing which is coordinated by the Legal & Government Relations Department. Furthermore, at the implementation stage it can be carried out by dividing tasks and responsibilities based on the contract structure and implementing work schedules, construction implementation, evaluation, and handover which is coordinated by the DFPP Project Manager, and all HR activities coordinated by the Support Service Manager.

The final study or finalization needs to be carried out, namely; analysis of actual electric power requirements, evaluation of current generation and distribution capabilities, analysis of annual electricity demand fulfillment until 2041, suitability analysis of electricity generation and distribution facilities, coordinated by EVP Technical Services. As for the implementation stage of DFPP Project Manager and Power Service General Manager, it can apply the electricity demand fulfillment plan as shown in Figure 6, and also apply the electricity generation technology needed on an ongoing basis to ensure its availability and reliability.

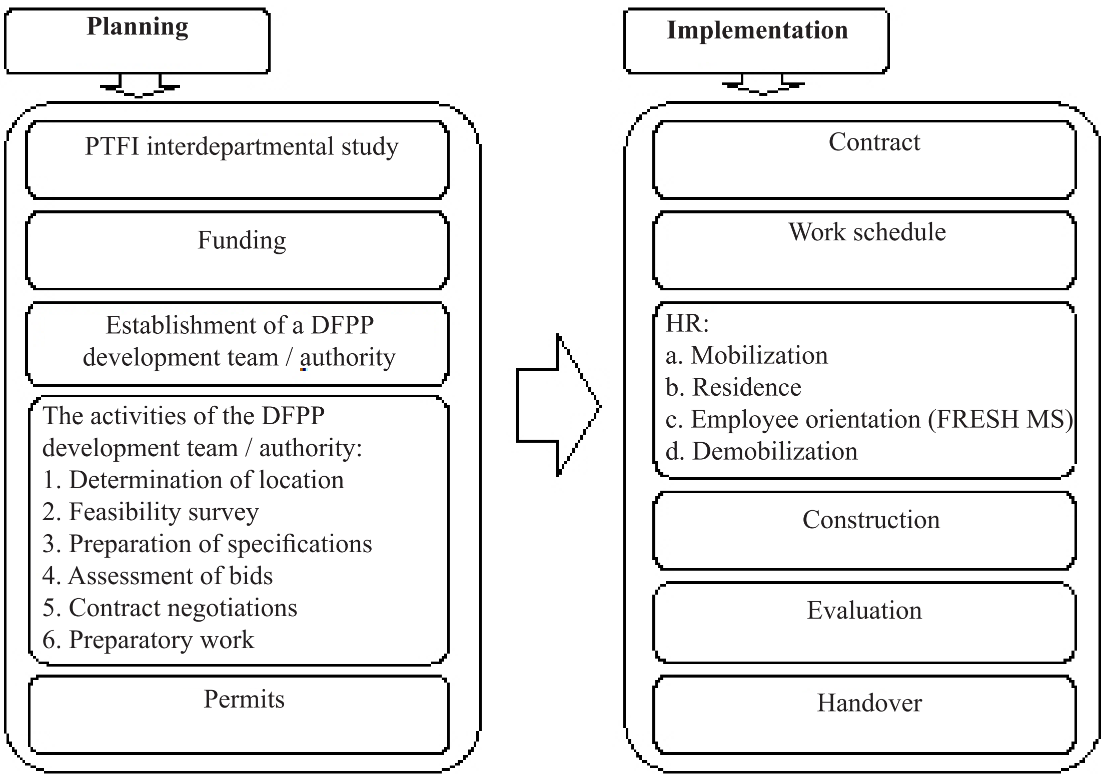

Figure 5. Stages of planning and implementation of the PTFI's DFPP construction

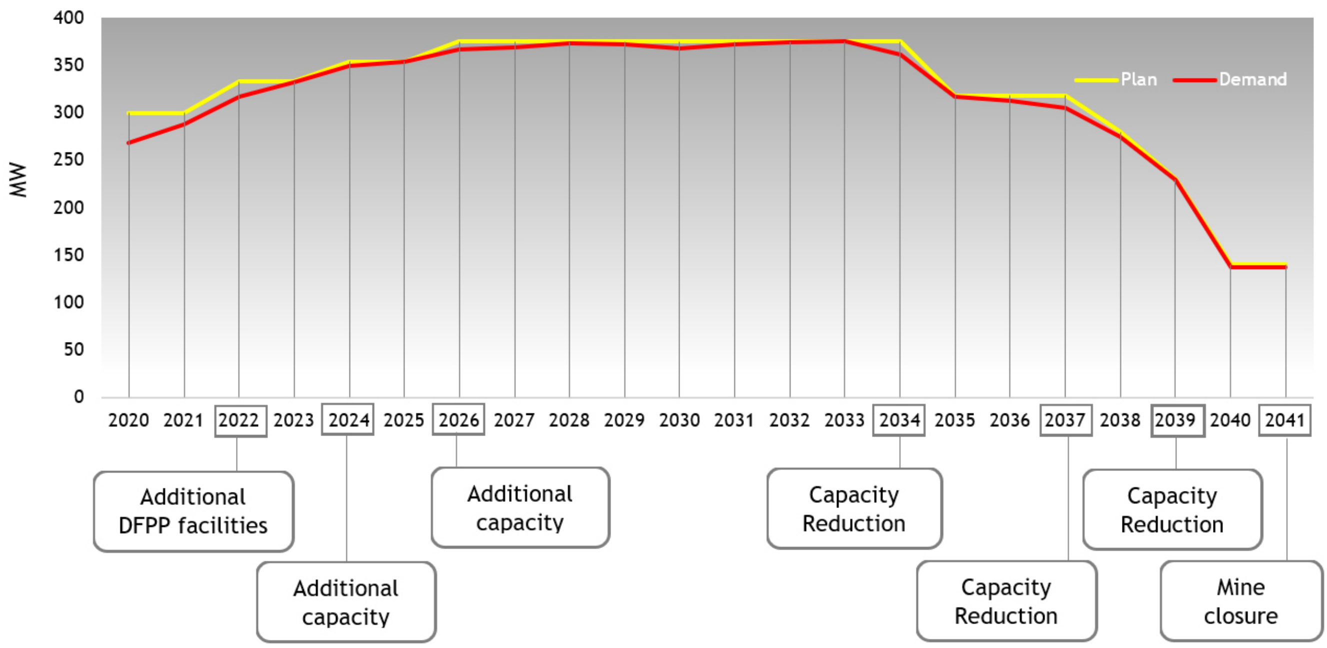

Figure 6. The plan to meet PTFI's electricity needs in proportion to PTFI's electricity needs until 2041

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

Based on data from the results of this study, the most important factors that need to be considered by PTFI in the construction of a new power generation unit have been identified in the following order of priority; (1) suitability with current power generation facilities, (2) sustainable availability of fuel / energy sources, (3) environmental risks, and (4) conformity with the company's strategic direction. The four sub-factors of the highest consideration are; (1) government policy support, (2) availability of facilities and human resources for internal waste management / disposal, (3) suitability of operational characteristics, and (4) conformity with PTFI load demand.

The best strategy in meeting the needs of electrical energy in facing underground mining expansion and optimization of PTFI's processing plant until 2041 is to build or build a new centralized power plant facility with a capacity of 75.2 MW (rated capacity). The best type of power plant to choose from is DFPP, whose procurement can be adjusted to the increase or decrease in PTFI's operational power requirements until 2041.

Recommendations

Research limitation, This research is different from most studies in the strategy of supplying electricity needs, because generally it is the provision of electricity by PLN for public services, while this study is a private plant that supports underground mining operations with unique operational characteristics. This research is also still limited to considering the technical factors of the type of power plant, which only corresponds to the current generating units and facilities. In addition, the data used is limited to PTFI's electricity demand fulfillment strategy plan made in 2017, without any underground mining areas that were not yet predicted to operate when the plan was made, including Kucing Liar.

Further research can be adjusted, capacity for electricity needs for other mining areas that are planned to operate in the future, including optimization of other supports that have not been included in the plan. Alternative types of power plants, especially those that are more efficient and environmentally friendly, can be an alternative that can be chosen, along with technological advances that continue to develop in the future. In addition, other considerations such as socio-political, financial, and other non-technical can be discussed in more depth.

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