

Constrains in Developing Waste - to - Energy Installations in Indonesia

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Abstract: *The problem of waste management in Indonesia is still a big issue that has not been fully resolved, especially in urban areas. Although the Waste Management Law has been enacted since 2008 and many derivative regulations have been issued, it still does not solve the problems. Recently, the government's strategy has changed and focused on converting waste into electrical energy to accelerate the resolution of waste management problems. In the experience of developed countries, converting waste into energy is a very effective way of reducing the volume of waste. Regulations were made to support this policy including Presidential Regulation. However, only one location was successfully constructed and commercially operated, and even then because development preparations had been carried out long before the issuance of the Presidential Regulation. Why these regulations are ineffective in encouraging related parties to develop waste management installations into electricity. Maybe there are still many risks to face by developers. The answer to these questions will be obtained through this research. The risk data will be collected through the parties related to the construction of the waste - to - energy installation. Based on the risk data, the mitigation is compiled by more comprehensive articles in New President Regulations.*

Keywords: Regulations; Acceleration; Waste; Electricity; Risk

1. Introduction

Indonesian Law No 18/2008 ^[1] has regulated waste management which explains in an integrated and comprehensive manner how to manage waste to achieve optimal benefits in public health, cleanliness and beauty environment, economy, and resources as well as educating the public to behave in concern for waste and environmental problems.

It is further regulated in Government Regulation of the Republic of Indonesia No 81/2012 ^[2] on how to implement the 3R concept in waste management, namely reduce, reuse, and recycle. Therefore, various innovations have been made to implement the 3R concept, but only 10% of the waste is managed, the remaining 60% is disposed of in the final landfill and the other 30% is not managed and pollutes the environment. ^[3] The production of waste continues to increase along with the increase in population. The Indonesian Ministry of Environment and Forestry stated that the volume of waste in 2020 reached 67.8 million tons and is projected to increase to 71.3 million tons in 2025 ^[4] That is why many cities in Indonesia are experiencing a waste emergency.

Many studies have been conducted in many countries to find effective waste management methods, including how to improve waste management with 3R principles ^[5], but in the last 10 years, research has focused more on converting waste into energy which is considered the most effective way to manage it. ^{[6] [7] [8]}

Indonesian Law No.18 of 2008 states that an alternative in waste management is processing waste as a resource. Then it was further regulated in the derivative regulations that these

resources can be converted into electricity. This alternative is believed to be the most effective way of managing waste, especially since it is supported by Law no.30 of 2009, Government Regulation no.14 of 2012; 81 of 2012, Minister of Energy and Mineral Resources Regulations No.4 of 2012 [9], no.19 of 201, No 44 of 2015, Minister of Home Affairs Regulation No.22 of 2009 and many other regulations. In addition to the laws and regulations issued, to encourage the development of waste power plants, in December 2015, the Ministry of Energy and Mineral Resources in collaboration with the EU Trade Cooperation Facility under the management of GOPA Consultants issued a Converting Waste to Energy manual. ^[10]

However, the development of waste - to - energy installations (waste power plants) in Indonesia has not shown significant progress. Therefore, presidential regulations were issued to accelerate the development of waste power plants, such as Presidential Regulation No.3 of 2016 ^[11]; No.4 of 2016 ^[12]; No.18 of 2016 ^[13]; No.97/2017 ^[14], and No.35/2018. ^[15]

Particularly in Presidential Regulation No.35 of 2018, the direction of government policy is very clear in accelerating the resolution of waste management problems, focusing on 12 major cities in Java, Bali, Sumatra, and Sulawesi, using zero waste and environmentally friendly technology. Articles in President Regulation No.35 of 2018 are made to support accelerated policies such as feed - in tariffs, direct appointments, compensation, and budget allocations.

With the policies stipulated in Presidential Regulation No.35 of 2018, investors should be interested in developing waste

power plants for these 12 locations. However, until now only the 9MW waste power plant Benowo in Surabaya has been successfully constructed and commercially operated since May 2021. In other locations, there are 2 locations under construction, meanwhile, the rest are still in the procurement or planning process.

Many studies have been carried out related to the development of waste power plants in Indonesia. However, the focus of the study is the potential for waste energy and the type of technology. There is something related to regulations but the studies conducted are more about informing regulations that must be referred to in carrying out waste power plant development. Even if there is research on progress and obstacles, it is sectoral and not comprehensive so the results of the study have not had an impact on increasing development progress. It seems that no one is interested in examining the business risks in existing regulations which may be the cause of bottlenecks in the development of waste power plants. Therefore, this research was conducted to find out the obstacles in the development of waste power plants through risk analysis in the business scheme regulated in Presidential Regulation No.35 of 2018.

2. Literature Survey

The waste referred to in Presidential Decree No.35 of 2018 is municipal waste based on data from the Indonesian Waste Management System in November 2021, the composition of municipal waste in Indonesia is 65.95% organic and 34.1% non - organic. [16]

If we look in more detail at the composition of organic waste, it turns out that more than 60% comes from food. That is why municipal waste often brings big problems in urban areas, destroying the scenery and the environment and becoming a hotbed of disease. The food waste also will be fermented quickly by decomposing bacteria to produce foul - smelling gas and leachate (a toxic liquid) that can contaminate the soil and its groundwater sources.

Organic waste is included in the category of biomass which is a low - calorie energy source. There are two processing methods to convert biomass into energy, namely biochemical and thermochemical methods. [17] However, both of these methods require quite a long time to convert waste into energy and there will be a residual waste. Both of these method of conversion does not meet the technical criteria referred to in Presidential Regulation No.35 of 2018.

Recently, the process of converting waste into energy is not only for organic waste but also for inorganic waste, using an incinerator with a very high combustion temperature of > 8500 C emission.

Regarding waste power generation technology, several technologies are commonly used. The choice of waste power generation technology is highly dependent on the conversion technology chosen to convert waste into energy. The selected technology must meet the requirements listed in Presidential Regulation No.35 of 2018, can significantly reduce waste, and is environmentally friendly.

The business concept for the development of a waste power plant mentioned in Presidential Regulation No.35 of 2018 was adopted from the Independent Power Producer business scheme in PLN, State Owned Electricity Utility Company (see fig.1).

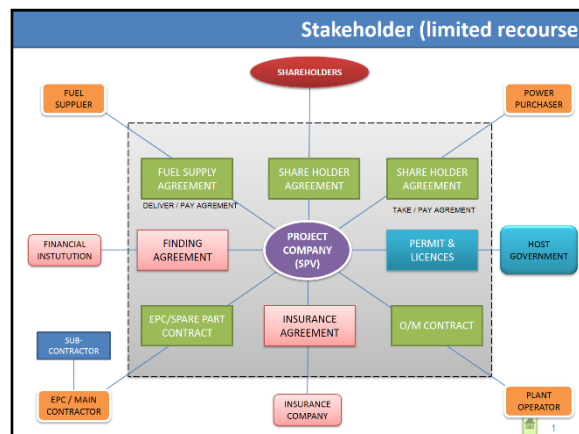


Figure 1: Scheme of Business for Independent Power Producers in PLN

There is one fundamental difference between the waste power plant business scheme developed by the Regional Government and the PLN scheme in that there is no fee for the waste supply agreement between the Regional Government and the developer. However, if the Regional Government is unable to supply the agreed amount of waste, liquidated damage will be imposed on the Regional Government.

There are Some potential business risks may arise in the business scheme for building a waste power plant as mentioned in Presidential Regulation No.35 of 2018, that the local government, developers, and PLN must handle, as happened in the private electricity business scheme in PLN as shown in Fig.2.

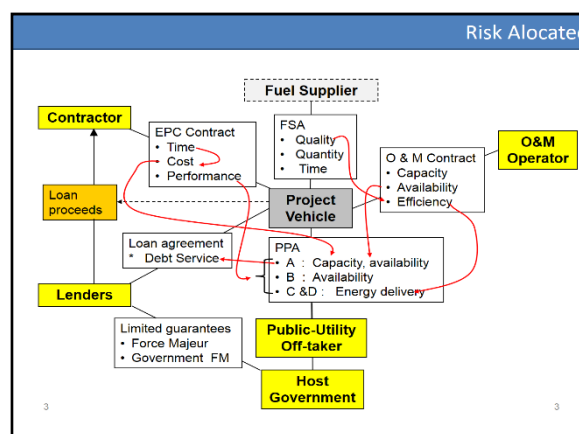


Figure 2: Risk Allocated in Scheme of Business for Independent Power Producer in PLN

From the developer's position, the potential risks that may arise are as follows:

- a) The potential business risks in the Power Purchase Agreement with PLN as an off - taker are related to the capacity, availability, and distribution of electricity from power plants.

- b) The potential business risks in the Loan Agreement with Financial Institutions or Banks, are related to debt repayment and the possibility of force majeure.
- c) The potential business risks in an EPC Contract with EPC Contractor are related to the cost, time, and performance of the power plant.
- d) The potential business risks in the Fuel Supply Agreement with the Fuel Supplier are related to Quality, Quantity, and Time.
- e) The potential business risks in the Operation & Maintenance Agreement (O&M Contract) with the O&M Contractor are related to capacity, availability, and efficiency.

Most of the potential risks mentioned above can be mitigated by regulating the articles of the cooperation agreement by taking into account the relationship between one potential risk and another potential risk. As an example:

- a) In the EPC Contract, the risk of delays in the execution of work by the EPC contractor will increase investment costs, and subsequently because it is related to component A in the electricity tariff, it will have an impact on the repayment of loan debts. To mitigate the possible risk of delay, the EPC cooperation agreement makes a delay clause with a late penalty whose value can be calculated as equivalent to the loss caused by the delay.
- b) In the Cooperation Agreement for Fuel Supply, the risk that the fuel quality received by SPV is lower than the agreement will have an impact on the efficiency of the generator and subsequently affect components C and D in the electricity tariff sold to PLN. To mitigate the possible risk of fuel quality below the required, a rejection article is made if the quality of the fuel received is lower than the required one.

The potential risks studied are limited to the potential risks associated with the 24 articles in Presidential Regulation No.35 of 2018. A risk analysis for each article is made and then the results are outlined in the table of matrix

3. Methodology

The type of research chosen is phenomenology where the research conducted is qualitative and the focus of the phenomenon to be studied is the response from respondents who represent the key participants involved in waste power plant development in this case the Regional Government, Developers, and PLN. ^{[18] [19]} Then the responses from the respondents were further explored to determine their influence on the activities of the development of waste power plants.

Two types of data will be used, namely primary data from the results of filling out questionnaires and interviews, and secondary data from references such as waste management regulations, development of waste power plants, journals from previous research, and relevant investment management guidelines. The frame work of data collection can be seen in fig.3.

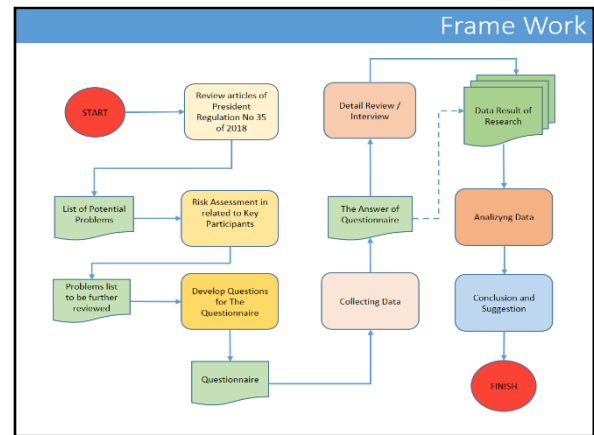


Figure 3: The Frame Work of Data Collection

The framework for data collection methods can be seen in fig.3 with the following explanation:

- a) Review in detail the articles of Presidential Regulation No.35 of 2018, then compile potential problems that may be faced by key participants for each article and then enter them into the list of potential problems.
- b) Make a risk assessment of any potential problems faced by key participants.
- c) Develop questions for the questionnaire based on the above risk assessment results. Prepare two choices of answers, agree or disagree, however, the answer chosen by respondents should be with the explanation.
- d) Data collection was carried out at 4 selected locations (samples) from 12 waste power plant locations (population), by filling out a questionnaire which was followed up with interviews to deepen the answers.
- e) Analyzing research data, starting with checking the validity of the data using the Triangulation and Audit Trail methods.
- f) Conclusions and suggestions.

4. Result and Discussion

As explained above, data collection begins with conducting a risk assessment of each article in Presidential Regulation No.35 of 2018 which may have impacts on key participants in the development of waste power plants. Then a potential risk matrix map is made as a basis for compiling questions in the questionnaire.

This is qualitative phenomenological research where the focus of the phenomenon to be studied is the response of respondents representing the Key Participants in developing waste power plants to the articles of Presidential Regulation No.35 of /2018 through questions in the questionnaire.

There are two types of questions asked in the questionnaire to all respondents. Type 1 is general questions (10 questions) given to all respondents to ensure that all respondents had the same understanding of the spirit and content of Presidential Regulation No.35 of 2018. Type 2 is specific questions (5 questions) given to respondents according to their background to understand their opinions on the potential risks that may arise, and should be handled and mitigated.

Data from the results of filling out the questionnaire by the respondents must be clarified back to the respondents

through interview techniques. Clarification is needed to ensure that the respondent has provided an answer to the intent of the question. Sometimes the answers do not match the questions in the questionnaire because they have a different understanding of the questions.

According to Presidential Decree No 35 of 2018, the population of this study is 12 waste power plant locations, and according to the theory of Gay and Diehl, the sampling of this study is more than 20% of the population. In this study, it determined four samples: Jakarta, Bandung, Semarang, and Denpasar, and for each sampling there is three (3) respondent representing local government, developers, and PLN. However, PLN is represented by only one respondent from PLN Head Office. Finally, there are only nine (9) respondents in this study instead of twelve (12).

After receiving the answering response of questionnaire from the respondents, to determine the validity of the answers from each respondent, verification was carried out using the triangulation method by looking for correlations between the results of the risk assessment, the questionnaire, and further explanation during the interview. When the verification is done, its mean the data has validated.

The next stage is compiling the validated data into tables, then making the resume of respondents' answers for each question, then displaying it in the resume table of questions and answers of the questionnaire.

The next stage is compiling the validated data into tables, then making the resume of respondents' answers for each question, then displaying it in the resume table of questions and answers of the questionnaire. Furthermore, according to the qualitative data analysis concept, the reduction of validation data is made by making new groupings based on the institutional, financial, technical, educational, and regulatory aspects.

Before concluding data reduction validity, there is another step by doing another type of analysis which will become a tool for decision - making of conclusion. The analysis referred to is a SWOT analysis related to the implementation of Presidential Regulation No.35/2018 in accelerating the construction of PLTSA, using the combined concept of S - T (Strength - Threat) and W - O (Weak - Opportunity). Analysis of SWOT is made for Local Governments, Developers, and PLN to add insight and consideration when concluding.

Based on the explanation above, herewith are the results of the analysis:

Institutional Aspect

Law of the Republic of Indonesia No.18 of 2008 concerning Waste Management, especially chapter III.5, explains that the duties and responsibilities of the Government and Regional Governments are to ensure the implementation of environmentally sound waste management following the objectives referred to in this Indonesian Law.

Meanwhile, chapter I.1 of Indonesia Law No 18 of 2008 explains that the Government is the President of the Republic of Indonesia, and holds the governing power of the Re-

public of Indonesia as referred to in the 1945 Constitution of the Republic of Indonesia; and Regional Governments are Governors, Regents, Mayors, and Regional Officials as elements of regional government administration; Minister is the minister who carries out government affairs in the field of environmental management and other related government fields.

Based on the analysis, it is better if the institutions involved in the program of Presidential Regulation No.35 of 2018 should reduce and only the Government, in this case, the Ministry of Environment and Forestry, and Regional Governments. Other agencies outside the two institutions, such as PLN may be involved, but their involvement must not increase the potential risk for PLN itself and other institutions.

The Ministry of Environment and Forestry and the Regional Government have to coordinate early with other agencies to develop waste - to - electrical energy installation so that it will not become an obstacle during its procurement, execution, or operation.

Matters that need to be coordinated early with PLN include but are not limited to:

The development of a waste power plant project as an installation for processing waste into electricity is already in the PLN RUPTL (Electricity Supply Business Plan) because it is the main requirement for PLN to carry out the procurement process.

Electricity tariffs to PLN must be below or equal to PLN's local production costs so that PLN does not have to deal with other institutions such as the Ministry of Energy and Mineral Resources, Ministry of Finance, Ministry of State Own Company, Parliament, and others to get compensation.

PLN procurement team must be involved in the procurement process by Regional Government, and PLN IPP procurement standards must be adopted so that the appointed developer does not need to be verified again by PLN and can directly sign the Power Purchase Agreement

From the developer's perspective, with only the Ministry of Environment and Forestry and the Regional Government coordinating the development of the waste power plant, the procurement process is simpler and faster. Thus the program of development waste power plants becomes more attractive to investors. Especially if the Regional owned enterprises is part of the developer, the project can become more bankable:

Procedures for participation in the procurement process will be clearer, more professional, and meet the requirements of a good corporate governance concept because the procurement team is a combination of related agencies.

The quality of the tender document is better and more complete, and if necessary additional data needed by the developer can be obtained through one door (the joint procurement team) so that it is more effective for the preparation of bid proposals.

The appointed Developer candidate can sign a Power Purchase Agreement with PLN immediately after finishing the Procurement process. Developers do not need to wait for the Regional Government to make a proposal letter to the Minister of Energy and Mineral Resources and do not need to wait for an assignment letter from the Minister of Energy and Mineral Resources to PLN

The project becomes more bankable because it is directly supported by the government in the form of a guarantee fund or government guarantee.

For the Regional Government, which by Indonesian Law No.18 of 2008 is the agency most responsible for waste management in the region, the success of developing a waste processing installation into electrical energy becomes more measurable because all processes are under the control of the Regional Government;

The waste management process that has been running so far, such as collecting waste from the source and bringing it to the final landfill location, can be continued and increased in quantity and quality because it is related to the obligation of the Regional Government to provide waste.

The articles of the Waste Procurement Agreement between the Regional Government and the Developer are prepared using a back to back concept with the Waste Management Agreement between the Regional Government and the Contractor so that the Regional Government avoids the risk of penalties

The certainty funds needed to finance the waste management process into electrical energy are more secure and bankable since the source of funds for payments to developers comes from the Government through the Ministry of Environment and Forestry.

The joint team will make the procurement process faster and more effective so that the results can be immediately received by all relevant agencies because their interests have been represented in the Joint Team.

The Public Private Partnership (PPP) scheme used in President Regulations No 35 of 2018 needs to make it simple for the procurement process for an integrated waste management installation so that it is more bankable. In many developed countries, the use of the PPP concept is very effective in helping accelerate the construction of waste management installations. ^{[20] [21] [22]}

Financial Aspect

Law of the Republic of Indonesia Number 18 of 2008 concerning Waste Management, in particular, chapter VII.245 explains that (1) The government and regional governments are obliged to finance the implementation of waste management, (2) The sourced from the state revenue and expenditure budget as well as the regional revenue and expenditure budget.

The investment cost to build an environmentally sound power plant is relatively expensive. In fact, according to research results, tariffs to PLN should be lower or equal to the local

PLN's production costs. Therefore, the Government must allocate a budget using the Special Allocation Fund of the Ministry of Environment and Forestry to reduce investment costs for developers. The Use of the Special Allocation Fund of the Ministry of Environment and Forestry is allowed by law because the Presidential Decree No.35 of 2018 is included in the national strategic policy program and targeted for completion in 2025.

Regarding tariffs, component A depends on the initial capital for its development and the planned rate of return on capital. Component A consists of depreciation expense and loan interest expense. The value of component A is fixed and does not depend on electricity production. Therefore reducing component A can be achieved by minimaxing land acquisition and site development costs and reducing EPC contract costs, licensing fees, and working capital costs.

Some parts of the cost component could be taken over by the Government or Regional Government with the PPP concept, including the cost of land acquisition by placing the installation at an existing TPA location, License Fees, and Part of the cost of the EPC contract.

Technical Aspect

The technical requirements for the installation of converting waste into electricity as stated in Presidential Regulation Number 35 of 2018 Chapter I.5, are installations that can convert waste into electricity that are environmentally friendly and can reduce the volume of waste and the processing time in real terms. provision. and proven way.

Another requirement in choosing the technology of installations must be able to process waste production per day. Based on data from the Indonesian Waste Management System for the 12 major cities mentioned in Presidential Regulation No 35 of 2018, the waste products are more than 1000 MT/day.

Based on the above criteria, the waste power plant technology that meets the requirements is an incinerator equipped with equipment to filter emissions. The incinerator can convert both organic and inorganic waste with a volume of more than 1000 MT/day, the duration of construction is relatively fast, the required land area is not large, zero waste, easy operation and maintenance can support government programs to increase the energy mix from renewable energy in 2025.

Education Aspect

Law of the Republic of Indonesia No.18 of 2008 concerning Waste Management, in particular chapter III.6, explains that the duties and authorities of the Government and Regional Governments include fostering and increasing public awareness of waste management.

Most Indonesians perceive waste as useless residue, not as a resource to be utilized. They rely on an end - of - pipe approach, where waste is collected, transported, and disposed of at a final waste processing site. Piles of large volumes of waste in landfills have the potential to release methane gas (CH₄) which can increase greenhouse gas emissions and contribute to global warming. The process of the decomposing landfill through nature takes a long time and requires

expensive maintenance. This waste management paradigm must be changed with a new paradigm that makes waste a resource.

The new paradigm views waste as a resource that has economic value and can be used, for example, for energy, compost, fertilizer, or industrial raw materials. Waste management is carried out with a comprehensive approach from upstream, before a product that has the potential to become waste is produced, to downstream, where the product has been used so that it becomes waste, which is then returned to the environmental media safely. Waste management with the new paradigm is carried out by reducing and handling waste. The waste reduction includes limiting, reusing, and recycling activities, while waste handling activities include sorting, collecting, transporting, processing, and final processing.

Based on questionnaire data, 100% of respondents understand that Presidential Regulation 35 of 2018 aims to reduce waste significantly, not to generate electricity. In addition, 100% of respondents also agree that the most effective and efficient way of managing waste to reduce the volume of waste is to convert waste into electrical energy. But why are there still indications of rejection of the construction of waste power plants?

People who live around the Gede Bage area of Bandung refuse the construction of PLTSa in their residences because they are worried that it will reduce the groundwater level around the settlements so that it will be difficult for the community.

WALHI, the largest and oldest environmental advocacy NGO in Indonesia, stated that the processing of waste into electrical mentioned in Presidential Decree No.35 of 2018 is considered unrealistic, expensive, and has the potential to fail because it is considered contrary to the principle of solid waste. as a sustainable resource, both in terms of financing, technical, and emissions that are not environmentally friendly.

The Corruption Eradication Commission of Indonesia indicated the policy mentioned in President Regulation would cause additional costs that would burden the state budget of 3.6 Trillion Rupiah per year over 25 years of waste power plant operation.

The above conditions affect the Regional government, developers, and PLN hesitant to develop a waste power plant. Waste at the landfill site piles up becomes a source of disease, destroys the beauty of the environment, and causes the effect of greenhouse gases. As a result, the budget for public health increased while revenue opportunities from tourism decreased. Based on the explanation, if the development of the installation program is running well, the regional government can reduce public health costs and has opportunities to get additional local revenue from tourism. Even though government has to spend more additional costs for the construction and operation of installations, it can be covered by reducing health costs and incomes from tourism. In this regard, regulations must provide for the public to obtain comprehensive information related to waste management and to

actively participate in realizing the construction of these Waste Power Plants.

Regulation Aspect

The government has issued many regulations related to waste management in Indonesia, including Law No.18 of 2008 and its derivative regulations, as well as a waste management manual for processing waste into electrical energy. However, related to President Regulation No 35 of 2018, only one waste power plant installation has been developed and operated. From results of the questionnaire, 100% of respondents stated that the local government, developers, and PLN still face potential risks in the existing regulations. Based on this explanation, it is recommended to make adjustments to several articles of Presidential Regulation No.35 of 2018 to eliminate or minimize the potential risks

5. Conclusion

Based on this research, its seen that the effectiveness of Presidential Regulations to accelerate the construction of waste power plants in Indonesia is constrained because there are still many potential risks in the articles of Presidential Decree No.35 of 2018 must be handled by the Regional Government, Developers and PLN without any mitigation given to them, that is why they do not dare to take the initiative to start development of waste power plant

Based on this research, it is suggested to make adjustments to several articles in Presidential Regulation No.35 of 2018 so that all parties related to the development of waste power plants, as waste - to - energy conversion installation, can be implemented before end of 2025. In general, the recommendations are as follow:

- 1) The agency is responsible for the procurement developer process only to the Ministry of Environment and Forestry and local governments. Any other agencies involved must serve as a catalyst and not add to the potential risk.
- 2) The Regional Government should lead the process of the procurement but shall be fully assisted by the government, in this case, the Ministry of Environment and Forestry, and related institutions
- 3) The tariff to PLN is not more than or equal to the local PLN production costs by reducing investment costs of waste power plants with government participation through the Special Allocation Fund of the Ministry of Environment and Forestry (new PPP concept).
- 4) Establish a joint procurement team under the coordination of the Regional Government supported by the PLN procurement team and other members from relevant agencies from stakeholders in the construction of a waste power plant.

6. Future Scope

The Indonesian government should issue a New Presidential Decree or Amendment to Presidential Decree No.35 of 2018 to make adjustments to several articles in Presidential Decree No.35 of 2018 to eliminate or minimize the risk of developing waste - to - energy installations in Indonesia.

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