The Journey on Sustainable Energy and Environmental Preservation for Improving Community's Welfare: the Ideas from Pesanggaran Power Generation, Bali - Indonesia

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Abstract
Energy efficiency and environmental sustainability are now the highest priority for Pesanggaran Power Generation, Bali – Indonesia. Considering the energy demand has increased exponentially along with environmental degradation, both local and global impact, Pesanggaran Power Generation commit certain efforts to minimize waste disposal from electricity main process, supporting process, and domestic activity. This paper mainly discuss about the journey on implementing the efforts, consist of several aspects: (a) Environmental Management System ; (b) Energy Efficiency ; (c) Hazardous Waste Management ; (d) Solid Waste Management; (e) Emission Reduction; (f) Water Efficiency; (g) Reduction on Wastewater Load; (h) Endemic-Biodiversity Protection; and (i) Community Empowerment. Several ideas intended to improve the local community's welfare by conducting environmental issues and economic as a value added to it. Bali itself has its own uniqueness, due to the usage on resources mostly taking into account the cultural, the heritage, and the complexity of endemic-biodiversity. As the very-fast-growing activity on tourism required energy demand, Pesanggaran Power Generation as one of the biggest companies on electricity generation has to support the demand. The journey on this paper starts from people of Pesanggaran Power Generation together with all local community so it will have mutual-integrated-sustainability for the future.

Keywords: Environmental Sustainability, Energy Demand, Pesanggaran Power Generation, Community's Welfare

Introduction

Electricity and its mutual to environmental sustainability are the priority of business for Indonesia Power Corporation. PT Indonesia Power Generation Unit (Unit Pembangkitan - UP) of Bali, though it is one of generation unit that using non-renewable primary energy source to generate electricity in Bali Island through Java-Madura-Bali (JaMaLi) interconnection grid system. PT Indonesia Power UP Bali, generates three units of power plant, consist of Pesanggaran Diesel-Gas Power Plant in Denpasar City, Gilimanuk Gas-Turbine Power Plant in Jembrana District, and Pemaron Gas-Turbine Power Plant in Singaraja District [Dewi P., *et al*., 2015].

Pesanggaran Power Generation situated in Denpasar, Bali Province, Indonesia, as depicted in Figure 1. It operates 4 Unit of Gas-Turbine (installed capacity of 125.45 MW) and 12 Unit of Diesel-Gas Turbine (installed capacity of 200 MW). Currently, several primary energies are used in Pesanggaran Power Generation, such as Natural Gas, High Speed Diesel (HSD), and/or Marine Fuel Oil (MFO).

Figure 1: Overview of Pesanggaran Power Generation, Bali Province, Indonesia. It operates by PT Indonesia Power UP Bali, a subsidiary of State Electricity Company (PT Perusahaan Listrik Negara – PLN Persero), with main core business in operation and maintenance of power plant [Subawa P., 2016].

This paper presents the journey of Pesanggaran Power Generation on environmental preservation along with sustainable electricity generation, which emphasizes to their social responsibility on surrounding Bali community. The journey begins with innovation idea from People of Pesanggaran that has been reflected on achievements of appreciation in Environmental Compliance (EC) and Corporate Social Responsibility (CSR) as discussed below. It is also brings Balinese cultural and the heritage, and the importance on generating electricity for supporting tourism activity in Bali Island.

Achievement on Environmental Preservation and Community Development

For the last decade, Pesanggaran Power Generation has been contributed to support governmental goals on conserving the nature, mainly in topics of environmental sustainability and community development. There are some appreciations achieved by Pesanggaran Power Generation [Sumanta, I.M., *et al*. 2017], which are:

- Green PROPER (Period of 2016) – Awarded by Indonesian Minister of Environment and Forestry
- Platinum Indonesian CSR Awards (Period of 2014) – Coastal Community Development in Seahorse Conservation
- Indonesian Green Awards (Period of 2014) – Developing Community's Welfare Throughout Coral Reefs Conservation
- Green PROPER (Period of 2013) – Awarded by Indonesian Minister of Environment, latest becoming Indonesian Minister of Environment and Forestry
- Platinum CSR Best Practice for MDG's (Period of 2012) – Women Empowerment in Koperasi Bangkung Sari
- Platinum Indonesian CSR Awards (Period of 2011) – Coastal Development "Blue is New Green" in Jembrana and Buleleng District, Bali Province

This paper discussed about comprehensive environmental compliance assessment, taking into account energy management and community development [Edgar S., & Adisa A., 2014], which in Indonesia known as PROPER (Program Penilaian Peringkat Kinerja Perusahaan dalam Pengelolaan Lingkungan Hidup). PROPER is a mandatory instrument to measure compliance and beyond compliance effort for industries in many sectors in terms of implementation of 3P Conception (People, Planet, and Profit). It is assessed and awarded by Indonesian Ministry of Environment and Forestry every one year period. PROPER has effectively drive industries to improve their concern on sustainability of business and the environment, as Pesanggaran Power Generation successfully transformed the society not only as regulatory comply but also innovate beyond the regulation.

Overview of Environmental Compliance Assessment and Beyond (PROPER) in Indonesia

Regulatory Framework

As mentioned previously, that Indonesian Government has endorsed national environmental conservation in many sectors (industrial and non-industrial). The government drive industries to contribute in environmental compliance and beyond which commonly known as PROPER (Program Penilaian Peringkat Kinerja Perusahaan dalam Pengelolaan Lingkungan Hidup). It is currently regulated under Indonesian Minister of Environment Regulation No. 03/ 2014 within more than ten years period implementation of transforming industries to green paradigm [Ministry of Environment and Forestry, 2014]. PROPER, it has also many improvements in regulatory enforcement, field assessment and evaluation, *etc*.

PROPER will be awarded to industries, whose invited or voluntarily participated, after sequential assessment criteria have been fulfilled. Pesanggaran Power Generation believe that PROPER is an effective instrument to measure the whole

system of industrial activity, as main and supporting process, and also the way industries manage social impact, through Corporate Social Responsibility (CSR).

Assessment Sequence

According to PROPER current system of rules, there are some steps for assessing criteria as described in this part.

- Preparation; the very first step, consists of periodical data collection, lesson learned of the best practice from previous PROPER result, and program inventory in on going year activity.
- Compliance Assessment; step where each participant should report their data and supporting evidence. There are some of environmental aspects in this sequence, for energy sector (as Pesanggaran Power Generation is one of it) such as water and air pollution control including ambience monitoring, hazardous waste management, environmental permitting (EIA, sub-EIA, etc.), and also company profile with total numbers of employee and production capacity. This step delivers the results of percentage which divided into Comply (**Blue Ranking**), Barely Comply (**Red Ranking**), and Totally No Comply (**Black Ranking**).
- Beyond Compliance Assessment; the candidates of this step were chosen by considering the results of compliance percentage. Only participants that bringing "100% Compliance" have a chance to propose their beyond compliance document. There are several aspects assessed: the Summary of Environmental Performances with absolute-proven calculation and innovative action, Environmental Management System, Energy Efficiency, Hazardous Waste Management, Solid Waste Management, Emission Reduction, Water Efficiency and Effort on Reducing Wastewater Load, Biodiversity Protection, and also Community Development (a CSR non-charity implementation). Results on this sequence categorized as 25% bottom percentile (back in **Blue Ranking**), between 25% to 75% percentile (**Green Ranking**), and 25% highest percentile (promoted to the **Gold Assessment** – latest known as **Gold Candidate**).
- Gold Assessment; the last but the hardest step to follow. Only the top 25% per sector can be promoted. There is also consideration of environmental consistency as in PROPER required at least twice Green Ranking in-a-row of periodical assessment. The chosen candidates will present their Not-Business-as-Usual (NBaU) and innovative way of thinking, and if necessary, there will be field verification to make sure the adequacy of the NBaU program. This step delivers **Gold Ranking** and **Green Ranking** (if does not meet **Gold Standard** of the ongoing year).

Environmental Goals

The society of Pesanggaran Power Generation believes that **Gold Ranking** is the furthest goals for every industry, with many deserving efforts to imply. Pesanggaran Power Generation has just started their journey in beyond compliance area, the certain goals is to optimize resource conservation and utilization as much as possible for better environment and sustainable electricity in Bali Island.

Best Practice Results and Discussions

PROPER drives many industries to promote environmental conservation, for instance introduce new technology or approach to reduce fossil fuel usage. Therefore, the combination between waste utilization and community involvement are perfect match to promote green paradigm. There are some aspects that assessed under PROPER regulation, every single of them is an optional but mandatory to fulfill progressively. The best practices of Pesanggaran Power Generation for each aspect are discussed below.

Environmental Management System

PT Indonesia Power UP Bali has been certified with International Organization for Standardization - ISO 14001: 2015 (Environmental Management System). UP Bali conducted EMS as fundamental reference on environmental planning to implementation (as for PDCA cycle; Planning-Doing-Checking-Action), and continuous improvement [Rakayana, I.M., & Dewi, A., 2017]. Certified EMS fundamentally is a basic management system as a function of guidance to manage environmental aspects. It is reflected in overall environmental aspects, which aim to manage the impact to the environment as a cause of power generation activities.

EMS is the key role to maintain the activities in Pesanggaran Power Generation, also as guidance awareness on environmental potential harm. Situation and activities is well documented under EMS implementation and monitoring, as depicted in Figure 2.

Figure 2. Effect on EMS Implementation: (left) symbol of potential harm to environment provided in certain location; (right) operational activity in Control Room – all evidences are well documented and controlled by person in charge. It is also communicated both top-down and bottom-up system.

In order to measure the effectiveness of EMS implementation, periodical audit (internal and external) also conducted. Each environmental aspect represents the importance of EMS as guidance to manage environmental impact, not only in physical environment, but also in every point of environment that covered under Environmental Impact Assessment (EIA) document.

Energy Efficiency: Mini-Scale LNG Facility

Pesanggaran Mini-Scale LNG Facility is the first Mini-Scale LNG Terminal in Indonesia, that initiated by PT Indonesia Power UP Bali since year of 2016. The objectives of this program are to reduce fuel oil consumption and to increase energy efficiency from main process. There is also indirect positive impact by implementing this program, such as to reduce emission released to the atmosphere and liquid hazardous waste generation. Mini-Scale LNG Facility illustrated in Figure 3.

Figure 3. Illustration on Mini-Scale LNG Facility that has been built and initiated by PT Indonesia Power UP Bali, introduced as energy efficiency innovative effort for Pesanggaran Power Generation.

The first three months implementation of Mini-Scale LNG, this program has effectively increased energy efficiency about 1,142.83 MWh [Wiadnyana, K.N., *et al*, 2017].

Hazardous Waste Management: Re-Design Waste Gate Coupling

Pesanggaran Diesel-Gas Turbine Power Plant of 200 MW (Wartsila 18V50DF) is motor-combustion power plant that consists of 12 units within each installed capacity of 17 MW. As per June of 2016, Pesanggaran Diesel-Gas Turbine Power Plant has operated with natural gas fuel consumption of 32,000 MMBTU per day [Sofwat, S.,

2017]. This situation enforced Pesanggaran Power Generation to compel and maintain the reliability of power generation using natural gas as primary energy.

Waste-Gate Valve is one of main equipment in Diesel-Gas Turbine Power Plant that controlled the rotation of Turbocharger in order to maintain stability of Air-Fuel Ratio of combustion. Any interference on Waste-Gate Valve could decrease absorption on natural gas fuel realization. That situation significantly reduce the potential power generation due to time consuming on amelioration of Waste-Gate Valve within at least required 6 hours/unit of down time. When this condition happen to power operation, disadvantage could occur neither in financial aspects nor in increasing liquid hazardous waste generation due to engine operational mode will automatically switch from Gas Mode to Diesel Mode.

According to that condition, the engineer collaborates to conduct Re-Design of Waste-Gate Valve to minimize or even to eliminate the operational failure. Rigid coupling modification design is illustrated in Figure 4, while the situations on program activities are depicted in Figure 5.

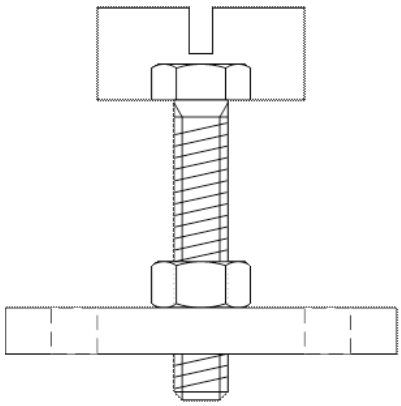

Figure 4. Rigid-Coupling Modification Design

Figure 5. Activity of Re-Design Waste-Gate Valve: (left) Dismantling the Waste-Gate Valve in PLTDG 10 Pesanggaran; (right) Assesmbly the Re-Designed Waste-Gate Valve in PLTDG 10 Pesanggaran.

As in integrated environmental perspective, this program aims to minimize operational failure within gas mode. That is also preventing the liquid hazardous waste disposal 2,630 liter/disruption/engine.

Solid Waste Management: The Bank of Solid Waste

As mentioned previously that Pesanggaran Power Generation generates electricity within environmental concern and surrounding community involvement. Domestic activity in Pesanggaran Office however has consequence on solid waste generation. In order to be able to prevent the solid waste disposal to the environment, we initiate integrated solid waste management program that adopted banking system conception. It is known as Pesanggaran Bank of Waste that has a main purpose to assist local community, in the same time, improving their earnings and knowledge about practical municipal solid waste management. Program activity is shown in Figure 6.

Figure 6. Bank of Waste Activity: (left) Waste Collection; (right) Waste Weight Measurement.

As per May of 2017, at least 431 kg inorganic solid waste has been managed in Pesanggaran Bank of Waste [Sukarma, I.M., et al, 2017]. It is monitored and evaluated periodically (weekly, monthly, and also quarterly per year).

Emission Reduction: Methane Gas Utilization

As part of integrated emission reduction to improve community's welfare, Society of Pesanggaran contribute to reduce anthropogenic global warming potential from landfill waste activity [Thomas G., & Edgar H., 2014]. We utilize Methane Gas from Landfill Waste "TPA Suwung" Pesanggaran to eliminate the use of Liquefied

Petroleum Gas (LPG-Household Gas Consumed). Schematic process is shown in Figure 7.

Figure 7. Schematic process of Methane Gas Utilization from TPA Suwung for Household Application [Mahendrayana, I.G.N., *et al*, 2017]

The aim of this program is to optimize renewable energy utilization from Bali Waste Landfill where organic waste is dominant compared to inorganic waste. The potential is much higher than other regions in Indonesia since Bali has high organic waste from cultural and religious activity of Balinese. Program has been initiated in year of 2017 within stage one development of 10-burner methane-gas stove. It is calculated that the program potentially reduce 453,600 ton CO_2 per year.

Water Efficiency: Reverse Osmosis Reject Water Utilization for Demineralized Water

Power generation operation does require certain amount of water, for main and supporting process, and domestic activity. As water resource plays important role on business operation, it is highly recommended to manage the use of water wisely. Water efficiency program that conducted in this paper came from reverse osmosis reject water, which utilized for demineralized water. The utilization taking into account pipeline modification, as depicted in Figure 8.

Figure 8. Pipeline Modification for Reverse Osmosis Reject Water Utilization

This program has been started since year of 2016, which effectively reduce groundwater consumption [Ponidi, *et al*, 2017] as shown in Figure 9.

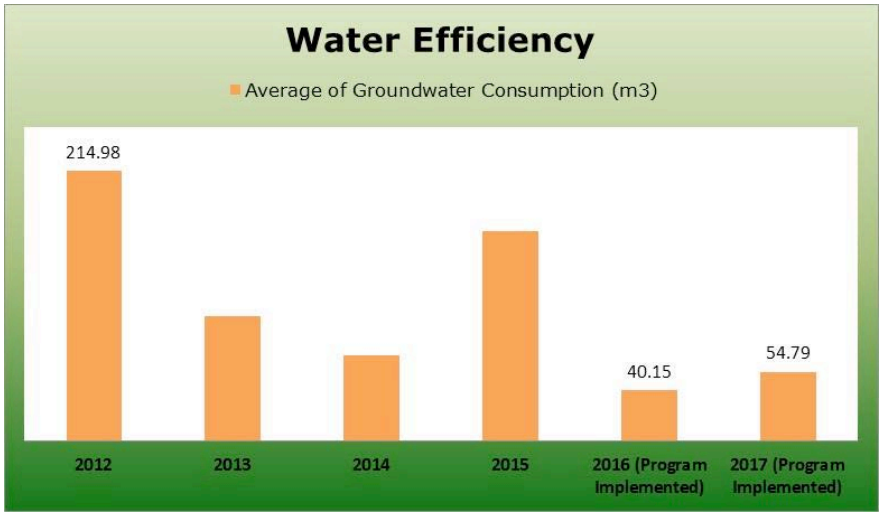

Figure 9. Profile of Groundwater Consumption: before (2012-2015) and after Program Implementation (2016 – present).

Figure 9 shows the effectiveness of water efficiency program that reflected on amount of groundwater consumption. It can be seen that after program has been implemented, groundwater consumption reduced significantly compared to previous year of operation. However, the amount of water consumption for power generation activities also depending upon actual number of power plant unit operates.

Reduction on Wastewater Load: the Integration of Water Efficiency

The water efficiency program discussed above also has indirect impact to the amount of wastewater load to the stream environment. Calculated wastewater load disposed to the stream is depicted in Figure 10.

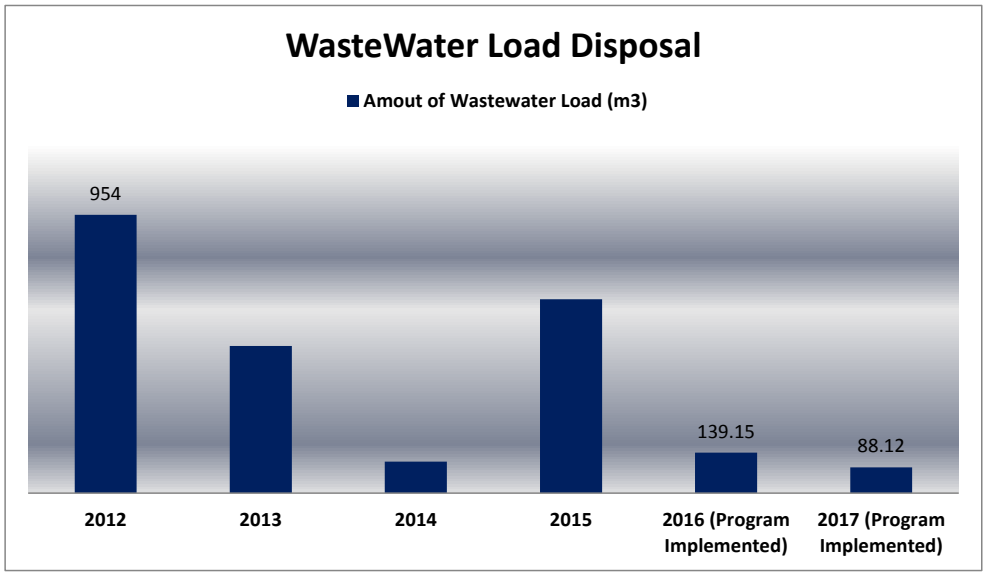

Figure 10. Calculated Wastewater Load Disposal to the Environment

The first year of implementation in 2016 has been effectively reduced wastewater load approximately 79% in comparison with previous year before implementation. Monitoring and evaluation has also played important role to measure the periodical effectiveness of the program [Ponidi, *et al*, 2017].

Endemic-Biodiversity Protection (I): Sea-Turtle Conservation

In addition to focusing on waste utilization as consequences of power generation activity, Pesanggaran Power Generation also taking action to preserve number of natural biodiversity in Bali. It is also contribute to support government and surrounding community as part of tourism development. There are two programs discussed in this paper, which consists of marine biodiversity (I) and land biodiversity (II).

For marine biodiversity preservation, Society of Pesanggaran collaborated with Bali Sea-Turtle Conservation Troop (Kelompok Konservasi Penyu Bali). It is located in Saba Village, Blahbatuh, Gianyar District, Bali Province. The program also supported under Center of Natural Resource Conservation of Bali (Balai Besar Konservasi Sumber Daya Alam) - Indonesian Ministry of Environment and Forestry. Monitoring activity also conducted by local university [Mirela, S., 2014] in order to contribute knowledge development of endemic biodiversity in Bali. Several activities are depicted in Figure 11 – Figure 12.

Figure 11. (Left) Cultivation of Sea-Turtle Eggs; (Right) Hatchling Sea-Turtle that Ready to Release to the Sea

Figure 12. (Left) Overseas student visit to Bali-Sea Turtle Saba Village; (Right) Representation of Pesanggaran Society in Preparation of Sea-Turtle Release

As a result of collaborative action in 2017, at least 200 Hatchling-Sea Turtles (*Lepidochelys olivaceae*) has been released to the sea [Sukerena, I.W., *et al*, 2017]. We believe that the program will continue and even improved the number of biodiversity index of Sea-Turtle.

Endemic-Biodiversity Protection (II): Balinese White-Ox Conservation

For land biodiversity conservation, we conducted biodiversity based on Balinese cultural and religious point of view. It is White-Ox Conservation (Lembu Putih) that initiated in year of 2017, in collaboration with White-Ox Taro Foundation (Yayasan

Lembu Putih Taro) – see Figure 13. This program is stil under planning and field visitation of Pesanggaran Team.

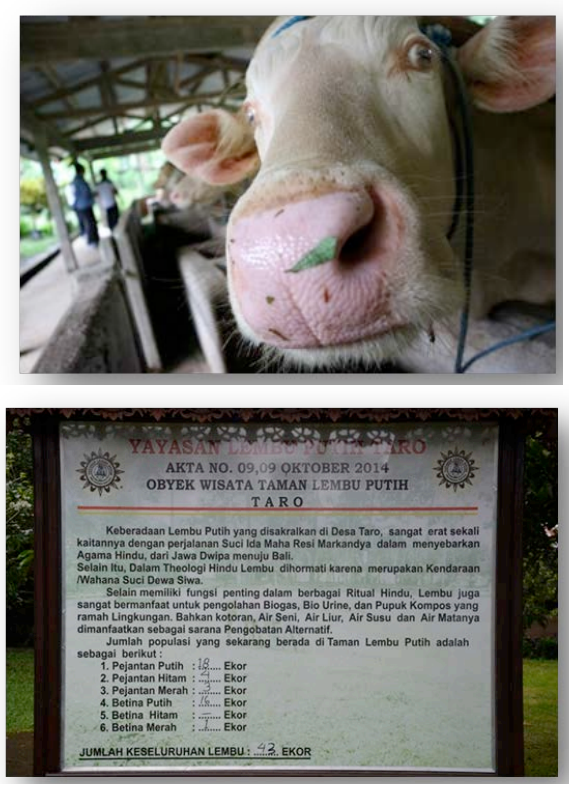

Figure 13. (Left) Appearance of White-Ox in Taro Village; (Right) Monitoring Board of White-Ox Population

There is uniqueness of Balinese White-Ox, where it used for rituals and ceremonies activity [Sukerena, I.W., *et al*, 2017]. This animal is much respected and sacred mainly for Balinese due to it is the ride of Lord Siwa, the symbol of mother of the earth, and the complimentary animal as the witness of certain ceremony. After ceremony is over, Balinese White-Ox is given many offerings and foods, and then this holy White-Ox is taken back to the Forest in Taro Village.

Community Empowerment: Organic Farming Development in Subak Kedua Rice Clusters

Pesanggaran Power Generation has been awarded in many criteria of integrated Corporate Social Responsibility (CSR). They have value added to CSR implementation, which is not only focus on charity, but also even more focus in community empowerment [Gusti, K.S., 2012]. This paper discussed the new-launched community development program based on recommendation of social mapping study.

Pesanggaran Power Generation empowered women [Rita, V., et.al., 2014] as an icon to drive food security in organic farming. It is situated in Subak Kedua Rice Clusters – see Figure 14, with main purposes to introduce new-paradigm of farmer-based-entrepreneurship development [Sumanta, I.M., et al, 2016]. The program also aims to support governmental goals to improve community's welfare.

Figure 14. Subak Kedua Rice Clusters: Organic Farming Women Empowerment Program

Subak Kedua Rice Clusters development initiated since year of 2016, and under ongoing implementation in year of 2017. Monitoring and evaluation will be reported in other publication by considering particular parameter, such as time scheduling, benefit recipients, feedback from the community, etc.

Conclusions and Recommendations

We conclude that program conducted by Society of Pesanggaran, cannot applied effectively without collaboration and teamwork among certain actors. Program that under planning or even has been implemented require monitoring and evaluation procedures as covered by Environmental Management System manuals.

We also recommend to the industry to collaborate with government, higher education, and local community to campaign for environmental preservation. These all are the key to establish surrounding environment.

Acknowledgement

We would like to thanks to overall persons in charge of each aspects, for their remarkable effort from planning to implementation of each program. We also deliver our gratitude for surrounding community in Pesanggaran Power Generation implementation program. Overall program will not be able to complete without support from government, expert from universities, etc. We hope that those programs

could inspire any other industries to develop environmental conservation campaign to reduce negative impact from industrial activities.

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