

***Socio-Energy-Environmental Management in West Bali: a Case Study of
Gilimanuk Gas-Turbine Power Plant, Indonesia***

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Abstract

This paper mainly presents about Environmental Management, taking into account energy and societal aspects, of Gilimanuk Gas-Turbine Power Plant (GTPP), West Bali – Indonesia. Currently Gilimanuk GTPP is a stand-by unit for electricity back-up in Java – Madura – Bali (JaMaLi) interconnection grid system. Over the last couple years, Gilimanuk GTPP is not in full operation condition, which has been challenged to maintain environmental aspects of Gilimanuk GTPP as a beyond compliance initiatives without focusing on profit. Furthermore, Gilimanuk GTPP still needs some natural resources, such as produced water, primary energy (high speed diesel), and for domestic activity. As for the consequences of resource utilization, the impact on the environment is a must to be reduced. This paper proposes several programs to maintain environmental preservation particularly in West Bali. The objectives of this paper are to share 3 (three) fundamental efforts on resource conservation: (1) technical innovation for energy efficiency and emission reduction; (2) waste minimization for water resource and wastewater management, including hazardous and non-hazardous waste responsibility; and (3) sustainable biodiversity conservation surrounding community development area. Some items have been implemented, monitored and evaluated periodically, while other programs are still in the design and planning which will be implemented in mid to late 2017.

Keywords: Environmental Management, Gilimanuk Gas-Turbine Power Plant,
Resource Conservation.

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Introduction

Electricity, as part of energy security, is now the most vital demand for both domestic and industrial activity. Prolific energy sources in Indonesia also drive many power generation companies to accomplish electricity demand by considering the most viable primary energy to be used. According to that situation, Gilimanuk Gas-Turbine Power Plant (GTPP), one of power plant unit operated by PT Indonesia Power UP Bali, is currently stand-by unit for power generation back-up. It is due to the electricity demand already fulfilled by other power plants in Jawa-Madura-Bali (JaMaLi) interconnection grid system.

However, stand-by unit doesn't mean there is no activity in Gilimanuk GTPP. In fact, it is still require natural resource for temporary start operation (produced water, primary energy – represents as high speed diesel, etc.) and also for domestic activity in office building. This situation has challenged People of Gilimanuk GTPP, to manage environmental impact without focus in creating any profit since its current operational condition. We believe that even a very small amount of natural resource utilization, the effect to surrounding environment is unavoidable. In this paper we present the effort from People of Gilimanuk GTPP in order to conduct environmental management, by taking into account energy and societal aspect [Edgar, S., & Adisa, A., 2014].

Gilimanuk GTPP located in West Bali, Jembrana District, Bali Province, Indonesia (see Figure 1). It has been operated since 1997 within total installed capacity of 133.8 MW [Dewi P., *et al.*, 2015]. Primary energy used in Gilimanuk GTPP is High Speed Diesel (HSD).



Figure 1. Appearance of Gilimanuk Gas-Turbine Power Plant in West Bali [Purwakanta, I.N., 2017]

Effort on environmental management in Gilimanuk GTPP has achieved appreciation from Indonesian Minister of Environment and Forestry as Green PROPER 2016. This achievement was the first environmental accomplishment for People of GTPP. It is

also becoming a motivation to maintain the way they manage environmental impact and the surrounding community.

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

Regulatory Framework

As mentioned previously, that Indonesian Government has supported global environmental conservation in many industrial sectors. The government drives 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 green industries [Ministry of Environment and Forestry, 2014]. PROPER has also many improvements in regulatory enforcement, field assessment and evaluation, *etc.*

PROPER will be awarded to industries, whose invited or voluntarily participated, after some systematically assessment criteria have been fulfilled. People of Gilimanuk GTPP believe that PROPER is an effective instrument to measure the whole system of industrial activity, and also the way industries manage social impact, through Corporate Social Responsibility (CSR).

Assessment Sequence

According to PROPER's current system of regulation, there are some steps for assessing criteria as described below.

- Preparation; the very first step, consists of periodical data collection, lesson learned of the best practice from other company based on previous PROPER result, and program inventory in ongoing year activity.
- Compliance Assessment; each participant should report their data and supporting evidence. There are some of environmental aspects in this sequence, for energy sector (as Gilimanuk GTPP 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 with "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 implementation, 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

People of Gilimanuk GTPP, as part of PT Indonesia Power UP Bali, presume that **Gold Ranking** is the very furthest goals for every industry, with many deserving efforts to imply. Gilimanuk GTPP has just started their journey in beyond compliance area, the certain goals is to minimize environmental impact to the environment. We also focus on exploring potential innovation about energy-environment-social management mainly in Gilimanuk area, West Bali, Indonesia.

Best Practice and Discussion

PROPER drives many industries to actively encourage environmental conservation, to drive innovation in waste utilization and resource optimization. Collaboration between stakeholders (higher education, local community, local to regional government, etc.) and company is other key role towards excellent environmental management. There are some aspects that assessed under PROPER regulation, every single of them is suggested to fulfill progressively. The best practices of each environmental compliance aspect are discussed below.

Environmental Competencies

People of Gilimanuk GTPP commonly have background of study in mechanical and electrical engineering. Only a few of them have background and basic knowledge in managing environment. As the complement of their competencies, the human resource division provides every person in charge an informal education, either in training or certification of specific environmental aspects.

There is also discussion forum about current progress of environmental management program, including energy efficiency and community development [Dewi, P., *et al.*, 2017]. Discussion forum are depicted in Figure 2.



Figure 2. Environmental Discussion Forum for People of Gilimanuk GTPP

Providing certain environmental competencies is also a part of strategic planning on environmental compliance and beyond. There are several training and certification, such as:

- Training and Certification on ISO 14001: 2015 (Environmental Management System)
- Training and Certification of Manager of Energy
- Training and Certification of Auditor of Energy
- Training and Certification of Air Pollution Control Management
- Training and Certification of Water and Wastewater Management
- Training of Hazardous Waste Management
- Training of Municipal and Industrial Solid Waste Management
- Training of Biodiversity Protection
- Training of Basic on Implementing Community Development

In order to maintain adequacy and effectiveness, overall aspects were mapped by human resources department by considering passion of each person in charge. Training and/ or certification also updated at least every 2 years period.

Energy Efficiency: Motion Detection System (Passive Infra-Red and Oto-Switch Lamp

As Gilimanuk GTPP is under stand-by condition, the use of energy consumption for main and supporting process is very modest. This situation left no chance on implementing previous energy efficiency program, such as VIGV (Variable Inlet Guide Vane) and TAT (Temperature after Turbine). Those two programs have been successfully implemented before Gilimanuk GTPP becoming stand-by. So that energy efficiency program maintained until nowadays is from domestic activity.

In this paper, we presents energy efficiency program, which is motion detection system using Passive Infra-Red and Oto-Switch Lamp (see Figure 3).



Figure 3. One of Motion Detection System in Gilimanuk GTPP

This program is located in several points such as Office Building, Demineralization Plant, *etc.* with an objective to use electricity wisely. Motion Detection System has been started since year of 2012 with approximate total energy saving until May 2017 is about 2.43 MWh [Jun, F.S., 2017]. Other program in energy efficiency will be evaluated later examine power generation status in Gilimanuk GTPP.

Integrated Effort on Hazardous Waste Management

There are currently three main programs in hazardous waste management, such as:

- Reduction on Hazardous Liquid Waste (See Figure 4)

This program is focusing on the reduction of hazardous waste in liquid form and also to avoid its disposal to the environment. The fuel waste generates from combustion drainage, leaching fuel filters, and residual product from combusting process. Meanwhile lubricant waste generates from First Line Maintenance (FLM) activity. As per May of 2017, there is only one activity on maintenance, with amount of liquid waste reduction about 2,000 liter [Francisco, S., & Darmawan, I.N., 2017].



Figure 4. Recycle on Hazardous Liquid Waste for Internal Reuse

Other advantage shows in financial perspective, where lubricant and fuel can be used as a recycled product. It has been calculated that the program effectively reduce fuel and lubricant consumption about 11,478,000 IDR.

- Substitution of Mercury Lamp to Light Emitting Diode (LED) Lamp

This program can be considered as the longest common practice on industries in Indonesia, mainly in power generation sector. It is aim to substitute the use of Mercury Lamp into Light Emitting Diode (LED) Lamp. Environmental advantage based on this program is the reduction on hazardous waste generation (Mercury Lamp). At least, it shows an effort as part of integrated hazardous waste management as depicted in Figure 5.



Figure 5. Substitution of Mercury Lamp to LED in Office Building

This program mainly implemented in office building of Gilimanuk GTPP, and monitored the effectiveness periodically by specific person in charge.

- Reduction on Dust Cloth Waste (See Figure 6)

Dust cloths are used to protect workers from hazardous material contamination, which is part of safety procedure. As a consequence, there will always dust cloths waste generates from each maintenance activity. People of Gilimanuk GTPP, as mentioned previously works in operation and maintenance area, reduce dust cloths waste disposal within behavior based safety and environment. They accentuate carefulness and awareness around working area, so that contaminated dust cloths can be reduced. The used-dust cloths that still properly usable, is then re-using in the next maintenance activity.



Figure 6. Activity on Reduction of Dust Cloth Waste

The three program at least capable to reduce hazardous waste disposal for the last five year, as depicted in Figure 7.



Figure 7. Ratio of 3R Hazardous Waste Implementation

Figure 7 shows that the effort on implementing hazardous waste management with 3R basic conception (Reduce, Reuse, Recycle). At least it is capable to increase the 3R ratio to 86.05% as per 2016.

Solid Waste Management: Plastic Waste to Handicrafts

This program was firstly implemented in the beginning of 2017, with an objective to improve community skills in processing plastic waste. Located near area of Gilimanuk GTPP, we also empower local community that in the same time promoting environmental campaign in reducing plastic waste. The community icon of this program is empowering local women in manage the processing to marketing of the handicrafts product (handicrafts product see Figure 8).



Figure 8. Handicrafts Product Made from Plastic Waste

Program has successfully implemented for the first semester of 2017 [Ryan, T.P., & Wijaya, I.W., 2017], as depicted in Figure 9.



Figure 9. Amount of Plastic Waste Processed into Handicrafts

As shown in Figure 9., amount of plastic waste mostly increases depending upon number of waste that viable to be used as handicraft raw material. The most concern about waste management is not amount of waste that can be processed, as long as the waste generation reducible from the source.

Emission Reduction: Re-Design of Ignition Torch to Minimize Start Failure

One of original innovation from People of Gilimanuk GTPP in action of emission reduction is Re-Designing Ignition Torch in order to minimize failure on start operation. Apparently operational problem starting since start-stop pattern on power operation has been effectively applied. The root-cause of start failure is due to disruption on ignition torch, which is in Gilimanuk GTPP the old-type of ignition torch has obsoleted spare part. Moreover, whorl-shaped of ignition connector require time-consuming overhaul. So it is considered as chronic operational problem that require re-design.

This program aims to improve reliability of power operation by replacing isolator ceramic within thicker and bigger diameter. Specification of isolator is porcelain with approximate dielectric strength 6 kV/mm. The changing on ignitor isolator ceramic is from 2.5 mm to 5 mm within dielectric strength from 15 kV to 30 kV [Wahyu, D.N., *et al.*, 2016]. The objective is to increase life time of it as depicted in Figure 10.

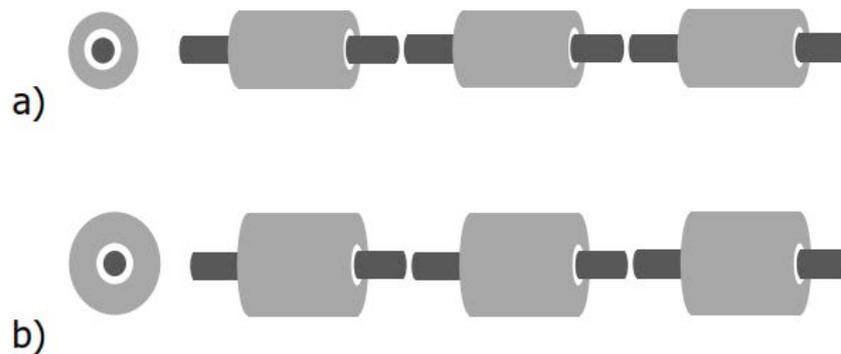


Figure 10. Ignitor Isolator Ceramic: (a) before ; (b) after innovation

Based on calculated emission reduction potential, this program possible to reduce 5.4 ton CO₂-eq per year per start operation, as shown in Table 1.

Table 1. Emission Reduction Potential from Re-Designing Ignition Torch in Gilimanuk GTPP

Year	Amount of Start (Unit/ year)	CO ₂ Reduction per Start (ton CO ₂ -eq/year)	Total Emission Reduction	Remark
2013	216	5.4	1166.4	Fully Operated
2014	182	5.4	982.8	Peak Load
2015	9	5.4	48.6	Standby
2016	0	5.4	0	Standby
2017	3	5.4	16.2	Standby
Total			2,214.00	ton CO ₂ -eq/year

Based on Table 1., total emission reduction on various operational condition in Gilimanuk GTPP as per year of 2017 is about 2,214.00 ton CO₂-eq per year [Wahyu, D.N., 2017]. it is very additional where power generation is not in operation condition, but has effort to reduce emission released to the atmosphere. This program also monitored periodically, mainly every start-up.

Water Efficiency: Reverse Osmosis Reject Water Utilization for Demineralized Water

This program aims to utilized reject water as substitution for raw water, which is clean water treatment processed from local water company – Perusahaan Daerah Air Minum (PDAM) Gilimanuk. The utilization is using Reverse Osmosis unit as the process briefly shown in Figure 11.

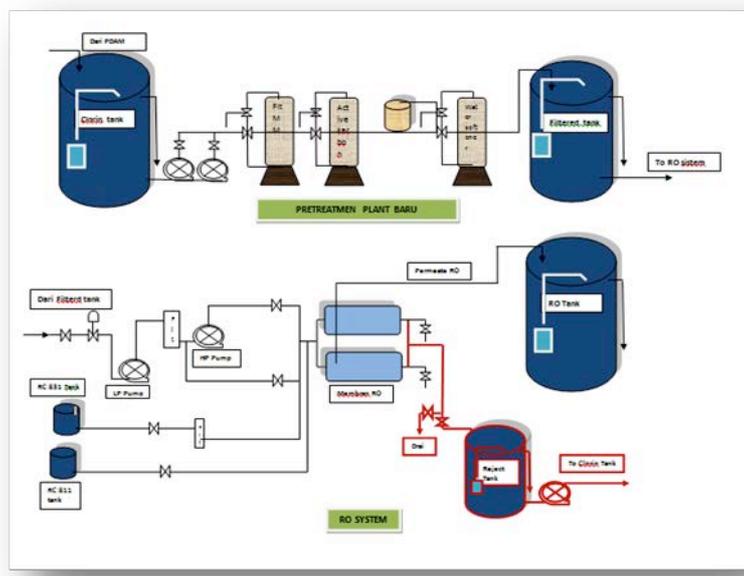


Figure 11. Process Flow Diagram of Reverse Osmosis Reject Water Utilization

Reject water utilization for demineralized water is a program towards water conservacy due to start-stop operation condition. Water efficiency measured and calculated as an positive impact in Gilimanuk GTPP is then depicted in Figure 12.

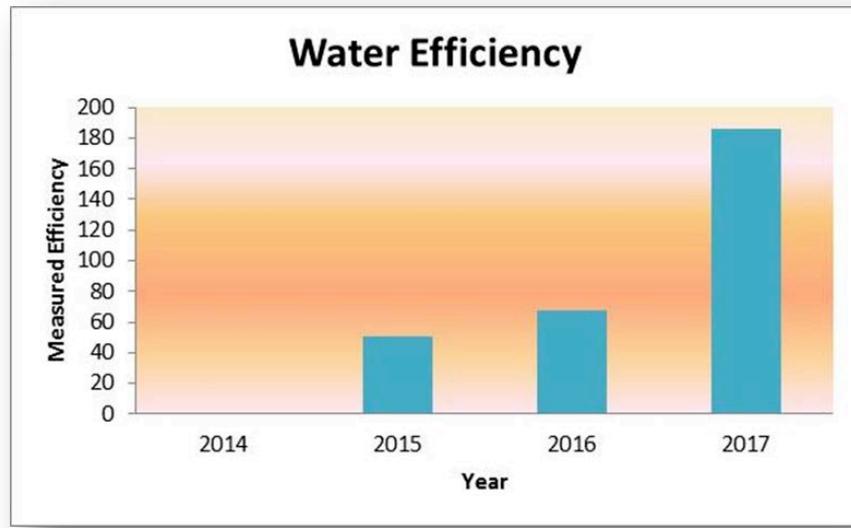


Figure 12. Water Efficiency (in cubic meter-m³)

Figure 12 shows the effectiveness on this program based on water measurement. As per March of 2017, the water efficiency of this program has increased more than 275 percent in comparison with previous year of implementation [Pasek., I.W.M., & Swartana, I.N., 2017].

Reduction on Wastewater Load: Wastewater Garden Land Application

People of Gilimanuk GTPP show their concern in reducing wastewater load disposal to the environment by utilizing treated wastewater into land application. Wastewater garden land application also aims to reduce the use of groundwater or processed clean water. Other advantage on applying this program is shown in Figure 13. The essential-organic content in treated wastewater is better than processed clean water for improving fecundity of the plants.



Figure 13. Appearance on Wastewater Garden Application

Treated wastewater content on several parameters since implementation of this program is depicted in Figure 14.

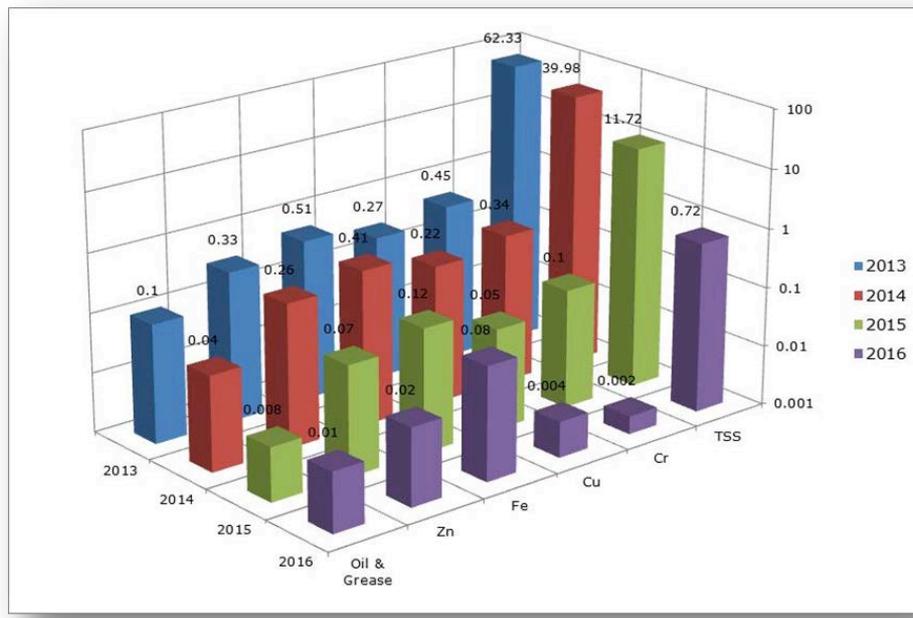


Figure 14. Treated Wastewater Content in Gilimanuk GTPP for Land Application [Dewi, P., *et al.*, 2017]

Figure 14 shows the fluctuation on treated wastewater content that used in land application during four year of implementation. It is clearly shown that content of each parameter decreased year by year. The impact on plant fertility are not discussed in this paper and planned to be monitored furtherly.

Endemic-Biodiversity Protection: Lovebird Conservation

Lovebird or *Agapornis* birds has number of species variety, with also vary conservation status (from Stable, Least Concern, Vulnerable, to Near Threatened). This situation is becoming one of concern in Gilimanuk area due to the power plant location adjoined with National Parks of West Bali (Taman Nasional Bali Barat-TNBB). So that, the person in charges taking action on various lovebird conservation to increase the status of lovebird population. For at least two and half year of implementation, this program has progressively increases the proliferation of lovebird as depicted in Figure 15.

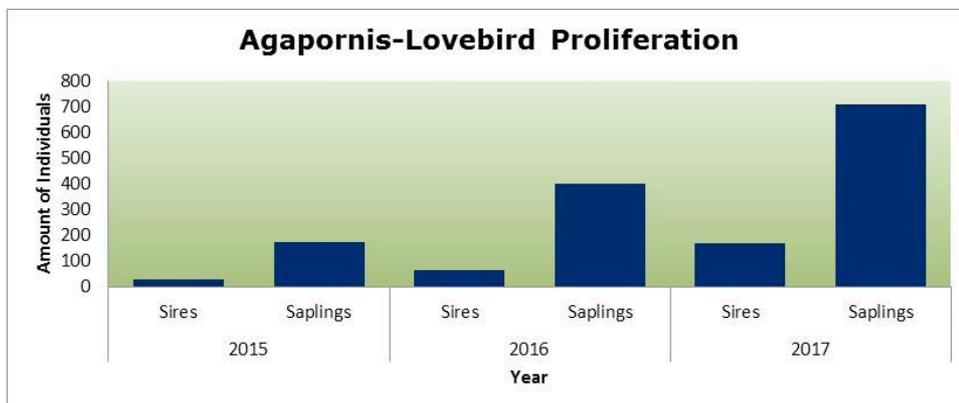


Figure 15. Lovebird Proliferation in Gilimanuk Conservatory Area

Figure 15 shows population trend on Lovebird conservation during the last three years of initiatives. It is known that the population has been increased both Sires and Saplings [Rizal, I.K.M., *et al.*, 2017], and also increasing the color and uniqueness variety of Lovebird as depicted in Figure 16.



Figure 16. Variety of Lovebird Population

This program has been successfully increased number of population and variation of *Agapornis* birds in West Bali. The other advantage also shows in social perspective, due to this program is integrated with local community empowerment.

Community Empowerment: Integration to the Environmental Endeavor

As an integrated effort in environmental management within surrounding local community, Gilimanuk GTPP has been implemented some program taking into account CSR perspective. This paper discussed two environmental based community empowerment program that initiated by People of Gilimanuk.

- Plastic Waste to Handicrafts

The objective of this program is to utilized used-plastic waste by enhancing women as agent of change. The empowerment of local women as an icon believes to effectively transform waste into something valuable. As per year of 2017, craftswomen empowered in this program have been increased up to 9 persons from only 2 persons in the beginning. Gilimanuk GTPP facilitates the craftswomen informal education, such as workshop and training on related activity. It is then depicted in Figure 17.



Figure 17. Activity on Waste Crafting using Sewing Machine and Manual

As the community development officers monitored and evaluated the program, it has been increasing average income up to 47% in comparison with regional standard [Airlangga., *et al.*, 2017]. We believe this program is effective way to connect people with environment by realizing the important of waste, not to be wasted but to be processed.

- Lovebird Conservation

As already stated this program has begun with initiatives to preserve biodiversity surrounding West Bali Area. Not only implemented in biodiversity concept, Lovebird conservation also broadening community involvement. This program started with one breeder, and for the recent three years period it has been expanded to ten breeders. It is very significant as reflected in growing population number depicted in Figure 15 above. The uniqueness of Lovebird also became a magnet to attracting tourism in West Bali, as depicted in Figure 18.



Figure 18. Tourism Visitation in Lovebird Conservatory Area

As number of breeders growing significantly along with tourist visitation [Abdul, R.A.R., *et al.*, 2013], the interest of nourishing the birds also positively drives the tourist to purchase. This program has successfully increased current average income amount 2,600,000 IDR per month per breeder.

Conclusions and Recommendations

This paper concludes that environmental management in power plant industry also taking into account energy and societal aspect. People of Gilimanuk wish overall environmental management program can be improved within or without considering operational condition. We believe that the effectiveness of environmental sustainability represents in the way we conserve natural resources and manage its impact in many aspects. We wish that our effort inspired other industries to conserve the environment because sustainable environment start here.

Acknowledgement

We wish to express our gratitude to surrounding community in Gilimanuk, Jembrana District - West of Bali. We comprehend that overall environmental management effort initiated in Gilimanuk GTPP are nothing without their genuine involvement. We also thank to local government in Jembrana District for their support on our initiatives. This paper will also not going to be published without support from top management of PT Indonesia Power Generation Unit of Bali. Their vision to develop sustainable electricity generation towards becoming World Class Service Company has endorsed every single part of corporation to transform into environmental paradigm.

References

Abdul, R.A.R., Nor, H.M., Syed, S.S.A.K., Mohamad, Z.M., Mohd, Y.A.H., Amran, H., & Zainab, K. (2013). Developing Human Capital for Rural Community Tourism: Using Experiential Learning Approach. *Journal of Procedia – Social and Behavioral Sciences*, 93, 1835 – 1839.

Airlangga, Rongsin, I.W., & Ryan, T.P. (2017). *Waste to Handicrafts: Community Progress on Implementation*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

Dewi, P., Subawa, P., & Ibnu, A.S. (2015). Capacity building towards improvement of energy, environment, and community development compliance in Indonesia: a case study of Pesanggaran Power Generation. *The Asian Conference on Sustainability, Energy and the Environment 2015*, Kobe, Japan (pp. 761 – 779). Official Conference Proceedings, ISSN: 2186 – 2311.

Dewi, P., Iyan, J., & Sedana, I.K.P. (2017). *Environmental Competencies and Management System*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

Dewi, P., Pasek, I.W.M., & Swartana, I.N. (2017). *Wastewater Garden Land Application: Calculated Wastewater Load*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

Edgar, S., & Adisa, A. (2014). Sustainability assessment of energy systems: integrating environmental, economic and social aspects. *Journal of Cleaner Production*, 80, 119-138.

Francisco, S., & Darmawan, I.N. (2017). *Hazardous Waste Management Implementation Report*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

Jun, F.S. (2017). *Energy Efficiency Monthly Monitoring Report*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

Ministry of Environment and Forestry of Indonesia. (2014). *Peraturan Menteri Lingkungan Hidup No. 03 Tahun 2014 tentang Program Penilaian Peringkat Kinerja Perusahaan dalam Pengelolaan Lingkungan Hidup (PROPER)*. Regulatory Framework. Indonesia.

Pasek., I.W.M., & Swartana, I.N. (2017). *Reverse Osmosis Reject Water Utilization for Demineralized Water: Monthly Report*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

Purwakanta, I.N. (2017). *Overview of Gilimanuk Gas-Turbine Power Plant (PLTG Gilimanuk)*. PT Indonesia Power UP Bali. Internal Report. Unpublished.

Rizal, I.K.M., Sedana, I.K.P., & Airlangga. (2017). *Lovebird Conservation near West Bali National Park: Community Based Monitoring Report*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

Ryan, T.P., & Wijaya, I.W. (2017). *Plastic Waste Management – Integrated Community Development Program: Report on Implementation*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

Wahyu, D.N., Iyan, J., & Airlangga. (2016). *Re-Design Ignition Torch Unit PLTG Gilimanuk: Innovative Idea*. PT Indonesia Power UP Bali. Internal Report. Unpublished.

Wahyu, D.N. (2017). *Emission Reduction Monthly Report: Re-Design Ignition Torch*. PT Indonesia Power Unit PLTG Gilimanuk. Internal Report. Unpublished.

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