Preliminary Life Cycle Assessment to Support Socio-Energy Innovation for Metal Processing Industry: An Approach from Pindad, Bandung – Indonesia

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Abstract
In order to support and participate in the Sustainable Development Goals (SDGs) contribution, one of the instruments is the life cycle assessment as an approach to the study of clean production in the manufacturing industry. Pindad Bandung, which operates in West Java, Indonesia, is a metal processing manufacturing industry producing multiple Indonesian-made products. As innovation in supporting product quality and more benefits to the surrounding community, a preliminary LCA study was carried out starting from evaluating the energy balance and emissions in the production process. The resulting innovation supports financial savings and provides a competitive advantage in developing environmental-based community empowerment programs and core competencies of business processes. Several discussions are related to special programs in energy, environment, and community empowerment, each of which is related to the basic study of LCA. As for the LCA, the Gate to Gate system has a limitation with ton as the product unit. Meanwhile, in the energy and emission aspects, an electric motor program is internally manufactured to reduce the use of oil-fueled vehicles with an energy efficiency and reduce GHG emissions. In the 3R aspect of B3 Waste, there is a replacement program for coolant, which has a longer lifetime, while in Non-B3 Waste, 100% of the remaining raw materials are reproduced into multi-products. The water efficiency aspect focuses more on assessing water use and potential leakage, integrated with the water performance management roadmap. Meanwhile, in reducing the wastewater load, the unit is rejuvenated to optimize the wastewater treatment, reflected LCA valuation.

Keywords: Life Cycle Assessment, Innovation, Metal Processing Industry, Sustainable Development Goals (SDGs)

Introduction

As commonly declared by various industrial sectors in almost all countries in the world, environmental management is an effort to manage the surrounding ecosystem, both with industrial activities and other domestic activities. To date, various sustainability-based environmental management efforts have been developed, particularly in manufacturing activities such as those carried out by Pindad Bandung. Located in Bandung, West Java, Indonesia, Pindad Bandung is a manufacturing industry that produces and processes multi-metal products.

Figure 1: Pindad Bandung Operational Area

Several integrated programs have been implemented in supporting economic, environmental, and social sustainability, as discussed in this paper. The instrument used to quantify environmental impacts in the next period is the Life Cycle Assessment, an indicator in the Sustainable Development Goals (SDGs). This paper also discusses the journey of Pindad Bandung in superior pioneering programs, increasing the capacity of work team personnel and improving towards continuous improvement over the last three years. The presentation will be further presented as follows.

Overview of Life Cycle Assessment in Pindad Bandung

Life Cycle Assessment (LCA) assesses the life cycle of products in a production process. The aim is to quantify the environmental impact generated per unit of product and identify improvement opportunities in improving resource efficiency. Previously in 2019, a basic LCA inventory was conducted on various products in each Pindad Bandung Production Division. As the continuation of the inventory, a temporary conclusion is obtained; it is decided to continue the preliminary assessment on the rail fastening component product with the limits of the Gate to Gate system, as shown in Figure 2.

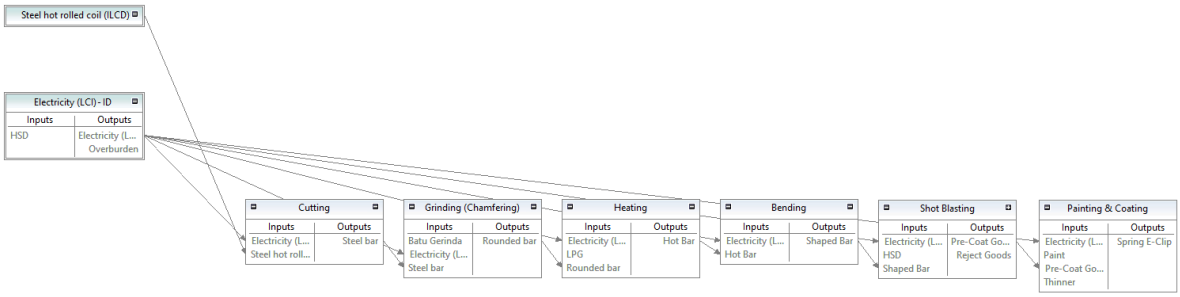

Figure 2: Limitation of Gate to Gate System for Rail Fastening Component Products

The product unit is per ton of metal processing products. The inventory is in more detail based on the production process and energy and emission balances. Later it is continued with the classification of impact categories and calculations. From this calculation, the value of the environmental impact contribution to the electric motor products includes hot spot areas that can be improved in terms of energy, emissions, and other aspects. The electric motor product also contributes to energy efficiency and emission reduction, as described in the section below.

Energy Use Efficiency: Electric Vehicle Innovation

The use of fossil fuels is one of the main issues in the unsustainability of natural resources and their balance on environmental quality. Two-wheeled and four-wheeled vehicles people use for daily activities also use non-renewable fuels, such as fossil fuels. The innovations in energy efficiency for products among the community, such as Electric Vehicles, really help improve energy efficiency by reducing conventional vehicles and switching to electric vehicles. The documentation is shown in Figure 3.

Figure 3: Electric Vehicle Innovation

This program is still in the production stage, and the research and development are still ongoing for more efficient innovations in the future. It has also been utilized for internal activities in the operational area and is calculated to increase energy efficiency by 0.87 GJ from reducing fuel oil[3]. If it is further applied to domestic activities in the community as consumers, the efficiency of using fossil fuels would be reduced gradually. Furthermore, the

supply of environmentally friendly electricity sources through renewable energy will also further improve energy efficiency in the context of LCA.

Lifecycle-Based GHG Emission Reduction in the form of Electric Vehicle Innovation

Emission reduction activities, especially those related to Greenhouse Gases, are generally directly associated with energy efficiency activities. One integrated form of innovation is the electric motor production program. The documentation of electric vehicle use in the operational area is shown in Figure 4.

Figure 4: Use of Electric Motors in Operational Area

In number, the electric motor program in operational areas can reduce GHG emissions by 85 ton CO2 per year. For future improvement programs, it is hoped that the majority of operational vehicles are electric-based or environmentally friendly fuel-based. Many innovations have been made in other production activities in simplifying the production to reduce GHG emissions; some include conventional emissions.

Water Use Efficiency: Reducing Water Leakage by Replacing Pipe in Various Areas

Water efficiency activities are prepared based on the water supply system management plan for production activities and supporting facilities. Over time, it is found that there are several points of water leakage due to the rustic pipes. Leakage could contaminate the quality of the water, as well as causing ineffective water distribution in various areas. This paper discusses water efficiency efforts to reduce leakage in the supporting area, especially in canteen activities. Even during the COVID-19 Pandemic, operational activities in various production continue to operate. Supporting activities, such as canteens, continue to provide food for related employees. In this case, the water efficiency effort replaces Galvanized (iron-based) pipes with stainless steel pipes, as shown in Figure 5.

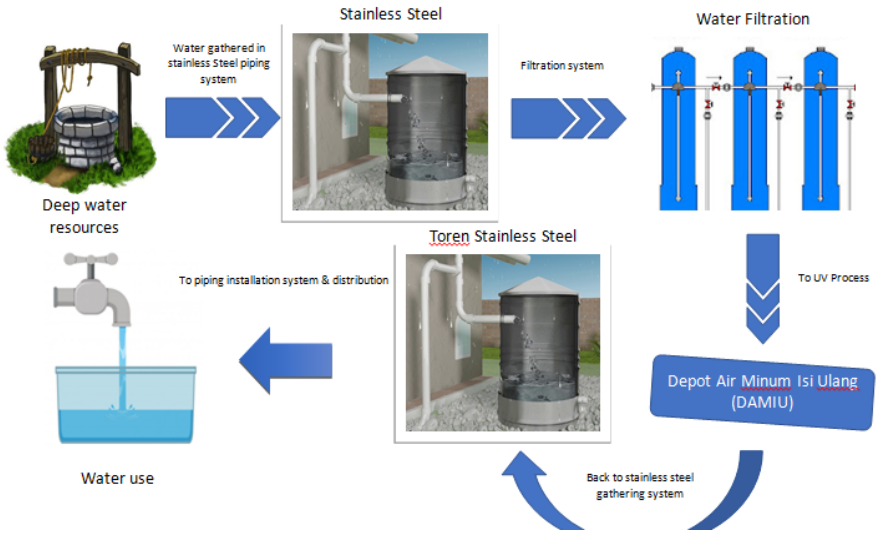

Figure 5: Replacement of Galvanized Pipe with Stainless Steel for Domestic Canteen Activities

This program can reduce the potential for leakage up to 23,556.00 m3 per year and eliminate corrosion potential due to pipe rusting. In addition, there are several other water efficiency innovations in the canteen activities, such as using water from artesian wells, which are directly processed using UV filters, etc. The future optimization is expected to use more efficient resources and also support the LCA-quantified SDGs.

Wastewater Management: Reverse Osmosis Unit Rejuvenation

At the wastewater treatment installation unit in one of the production divisions, efforts were made to rejuvenate the equipment to increase efficiency in reducing the load of wastewater to the environment. Furthermore, at the Surface Heat Treatment (SHT) facility, Reverse Osmosis conversion coating innovation was conducted, as shown in Figure 6.

Figure 6: Reverse Osmosis Conversion Coating Unit SHT

This program consists of several stages, starting from reconstructing the RO engine frame, continued with modifications and engine reinstallation. In calculation, this program can reduce the wastewater load by 1,200.00 tons with treatment unit effectiveness by 90%. This activity also competitively provides financial savings and supports LCA by optimizing activities from the company's scope.

3R of Hazardous Waste: Lifetime-based Coolant Replacement

Coolant or cooling agent is the chemicals used for the cooling process in production machines, often found in machining activities. Coolant has parameters that indicate whether or not it can continue to serve in the production system; commonly, it is shown in the service life, odor level, etc. The effort to reduce the Coolant type of liquid B3 waste by replacing it is shown in Figure 7.

Figure 7: The use of coolant in machining process

This program has been thoroughly implemented in the production division, especially in the special vehicle section, with a total B3 waste reduction of 33 tons per year. It strongly supports the LCA aspect where the reduction of B3 waste and the extension of service life is very integrated with reducing the environmental impact due to chemicals, in the category of LCA toxicity and global warming potential impacts.

Solid Waste Management: Utilization of Leftover Production Materials into Multi-Products

Metal processing manufacturing activities certainly manage various types of metal for production. In the process, various remaining materials with various shapes and sizes can be reproduced as other products. At least three production sectors manage Non-B3 solid waste into multi-products, including the utilization of scrap metal to be used as a railroad track, foundry waste into paving blocks and scrap metal to become counterweights. The documentation for the use of the remaining production materials is shown in Figure 8.

Figure 8: Reusing The Production Remaining Materials

Cumulatively, the remaining materials for metal-based production can be reprocessed into products of up to 1,000.00 tons per year. Each of these reused metal materials reduces the environmental impact due to exposure to scrap metal and provides a competitive advantage in derivative products with added values. More broadly, the program can provide economic benefits and production efficiency.

Biodiversity Conservation: Pigeon Breeding with Semi-Open System in Pindad Urban Forest

Although it might not be directly related to LCA efforts, Biodiversity also plays an essential role in environmental sustainability, especially for flora and fauna around the area. This paper discusses the semi-open system of Fantail Pigeons captivity, where the cage is designed to circulation area and makes it easier for species to breed in the City Forest Park area managed by Pindad Bandung. The documentation of conservation activities is shown in Figure 9.

Figure 9: Pigeon Conservation

This program has been effective since 2020 and has released 13 white dove species. This program also conserves the Fantaii Pigeon biodiversity up to 38 species. Meanwhile, this program is consistently implemented and monitored every six months periodically.

Community Development and Social Sustainability: Land Management of Former Integrated Landfill

As mandated by national regulations, Pindad Bandung also manages former landfills into an integrated facility based on urban farming and its development in social and environmental responsibility. The previous publications described the initial journey of the urban farming program and its benefits. This paper discusses the development and integration of the integrated environmental and energy management concept, shown in Figure 10.

Figure 10: Urban Farming Area Management Activities

The development of urban farming includes the provision of rain-fed water to replace the well water. In addition, alternative energy is developed to replace or substitute the use of

conventional electricity. At this stage, the feasibility and potential of using alternative energy from solar and wind power are under research, which is expected to provide long-term benefits for community empowerment. The basic SROI value calculated for the extended program which is 3.87 and economically, it can increase people's income in the era of social restrictions by 90% of the planned target. Social mapping and stakeholder involvement are also part of the activity; the monitoring and evaluation are conducted every six months.

Conclusions & Recommendations

Based on the activities and initiatives by Pindad Bandung in the initial LCA study, it was obtained that the activities mutually support efforts to reduce resources and reuse waste. From the explanation above, we conclude that there are at least some measurable benefits from the activities.

- The electric motor innovation can reduce the use of fossil fuels with an energy efficiency of 0.87 GJ and a reduction in GHG emissions of 85 tons of CO2-eq.
- Reducing B3 waste from the use of Coolant type with a longer service life of 33 tons
- Utilizing waste metal materials into multi-products of 1,000.00 tons
- Water use efficiency by replacing the Galvanized pipe with Stainless Steel by 23,556.00 m3
- Reducing wastewater load from the rejuvenation of the Reverse Osmosis unit by 1,200.00 tons.
- A total of 13 fan pigeons were released.
- The benefits of the extended program of urban farming development program with an initial SROI value of 3.87.

Acknowledgment

We thank the management and work team of Pindad Bandung for their consistency in innovating and supporting the development of a sound governance system through capacity-building activities in 3 periods. We also thank all stakeholders involved in each program, directly or indirectly. We realize that with all the programs submitted, there are still many that require evaluation and improvement, which the main goal is to realize LCA that can quantify environmental impacts on the production process under research.

References

Anonymous, “Introduction to Pindad Bandung, West Java, Indonesia’’, Internal Report, Unpublished, 2021.

Putri, Y.M.I., Rhamdani, F., and Setiawan, W., “Life Cycle Inventory of Rail Fastening Industrial Manufacturing Product in Pindad”, Internal Report, Unpublished, 2021.

Ruhaman, U., Herliani, R., Kuswana, I., and Hartono, T., “Electric Vehicles Production to Support National Energy Efficiency”, Internal Report, Unpublished, 2021.

Ritaudin, N.A., Kristinina, Y., Kusmirat, H., and Iqbal, M., “Emission Reduction from Green Manufacturing Products”, Internal Report, Unpublished, 2021.

Kuswendy, D., Ruslanna, M., and Yudi, A., “Water Inventories: Internal Audit Report”, Internal Report, Unpublished, 2021.

Ayuningtyas, S.T., Kusdiawan, I., and Bahri, S., “Improvement of Wastewater Treatment Effluent using Reverse Osmosis System”, Internal Report, Unpublished, 2021.

Nurjannah, T.A., Prasetya, Y., Suherman, A., and Mulyana, A.D., “Collaboration Report of Hazardous Waste Management”, Internal Report, Unpublished, 2021.

Permadi, C.A., Mulyani, L.N., Dewantara, P.K., Triyadi, C., and Ramli, N., “Non-Hazardous Waste of Scrap Utilization for Multi-Products”, Internal Report, Unpublished, 2021.

Rusman, P., Hidayat, E., and Andani, R.T., “Biodiversity Conservation Monitoring”, Internal Report, Unpublished, 2021.

Fedyansyah, M., Santoso, M.B., and Humaedi, S., “Laporan Social Return on Investment (SROI) Program Pengelolaan Kompos Raflesia”, Universitas Padjajaran in partnership with Pindad Bandung, 2021.

Somantri, Y., Albarri, R.B.S., and Sumeitri, D., “Monitoring & Evaluation of Urban Farming Development Program”, Internal Report, Unpublished, 2021.