Global Energy Management System Implementation: Case Study

Indonesia

PT. PJB Gresik Power Plant

PT PJB Gresik power plant has been saving US $ 9.69 million in energy cost through EnMS since 2014

Gresik Power Station

Business Case for Energy Management

Leading Power Generation Company in Indonesia

Established in 1995 PT Pembangkit Jawa-Bali (PT PJB) comprises 6 power plants, one of which leading power plant locates in Gresik, East Java. Being the largest electricity supplier in East Java, PT PJB Gresik Power Plant contributes to 35.8% of the East Java electrical system and 5.1% of the Java island system by operating 18 units of power plant having 2,140 MW installed capacity. We also have a gas power plant to support for the normalization of Java island system, if black-out accident occurs.

Having the average annual energy consumption of 2,390 KTOE, we determine to implement energy management system (EnMS) ISO 50001. After the implementation of a structured approach of energy management system in the last 3 years, the Net Plan Heat Rate (NPHR) is improved by ± 1.5%.

"We will be cleaner and greener Power Plant throught EnMS implementation"

- Ompang Reski Hasibuan, General Manager -

Table 1. Case Study Snapshot

Case Study Snapshot	
Industry	Electric Power Generation
Product/Service	Electric Power Generation
Location	Gresik, East Java, Indonesia
Energy Management System	ISO 50001
Energy Performance Improvement Period	3 Years
Energy Performance Improvement (%) over improvement period	4.05 %
Total energy cost savings over improvement period	US $ 9.69 million
Cost to implement EnMS	US $ 3.33 million
Payback period (years) on EnMS implementation	0.75 Years
Total Energy Savings over improvement period	13.01 million gigajoules
Total CO_2-e emission reduction over improvement period	2.72 million metric tons

"We can do energy conservation in many ways no matter who we are"

- Sunarto Els Mardja, Operational Manager -

The driving force

In line with the Government Regulation of Republic of Indonesia No. 70/2009 on energy conservation, as a company consuming energy more than 6,000 TOE and hence having the obligation to report its energy consumption and to undertake energy conservation, PT PJB Gresik Power Plant is determined to strive towards its annual energy efficiency target.

Apart from the determination to achieve its annual energy efficiency target, PT PJB headquarter has set the target in the annual performance contract: establishment of NPHR and PROPER (Indonesian award of company environment performance assessment). In view of the target set, the power plant units are designed to implement energy efficiency in proper and sustain manner. To best achieve its goals PT PJB Gresik power plant decided to implement ISO 50001.

Through the implementation of EnMS ISO 50001, we commit to apply energy efficiency in all division. Creating stakeholders energy efficiency awareness, procuring materials based on the consideration of energy saving, and reducing the production cost are the real actions.

Figure 1. *PT PJB Gresik's Energy Team*

Business Benefits Achieved

By implementing EnMS PT PJB Gresik Power Plant has successfully saved 4.05 % of its energy consumption based on the 2015 baseline. Meaning in 2017 there were 13.01 million Gjoule energy saved, US $9.69 million cost saving and reduction of emission up to 2.72 million metric tons of CO_2.

While all measured goals are achieved,,the implementation of EnMS supports us in conducting energy efficiency awareness and innovation training for our employees in all levels. Since then the employee's behavior of energy management has been changed. We were able to reduce energy consumption up to 4,195 MWh in 2017, equal to US $285,415,by applying the bottom up approach.

The implementation of ISO 50001 also leads to non-financial benefits, such as:

- GREEN PROPER from the Ministry of Environment
- ENERGI PRATAMA Award from Ministry of Energy and Mineral Resources
- Emerging Industry Leader Criteria in Indonesia Quality Award
- 1st Winner of Regional Innovation Work of PT PLN
- Best Achievement annual Performance Contract Achievement for Thermal Unit of PJB 3 Years in a row

"As a leading power plant company, EnMS implementation in PT PJB Gresik power plant is crucial for long-term corporate program."

\- Abdul Kholiq, Energy Manager -

EnMS Development and Implementation

In 2011 our General Manager as representative of the top management, was committed to implement EnMS ISO 50001. In March 2014 the requirement with guidance for EnMS implementation was released by our corporate. Consequently, we initiated to comply with certification requirements. After all preparation and audit for certification, in October 2014 our company was successfully certified to ISO 50001. The certification journey depicts as follows:

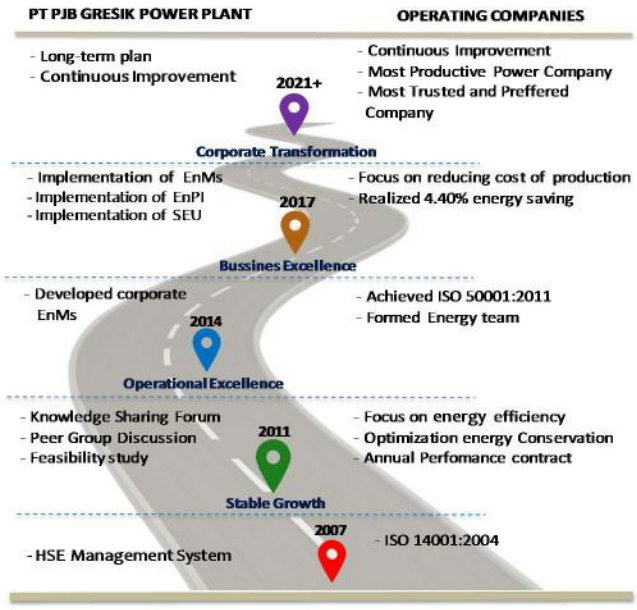

Figure 2. *PT PJB Gresik Power Plant EnMs Timeline*

Organizational:

To comply with ISO 50001 PT PJB Gresik Power Plant developed a policy stated in the Decision of Gresik Power Plant General Manager **No. 022.K / 020 / UPGRK / 2017**, defining the energy management team Structure, and assignment of Energy Managers certified by the National Agency of Profession Certification (BNSP) supported by the Energy Profession Certification Body (LSP Energy). The energy team (*see figure 1*) was designed with the involvement of all fields and its task was included in the individual key performance indicator (*see figure 3*), to implement energy conservation in all activities. In order to monitor the EnMS implementation, the energy team conducted monthly meetings inviting top management within the frame work of monthly RTM forum which also evaluated any constraints of the EnMS implementation.

Figure 3. *KPI, Sosialitation & Supplier Gathering*

For awareness raising of the importance of energy efficiency, the energy team conducted EnMS socialization to all employee and contractors working together with PT PJB Gresik Power Plant.

Energy Review and planning:

The energy team conducted energy review as a process of gathering, calculating, analyzing processed data of energy consumption. It was obtained through an analysis of energy consumption, significant energy use (SEU) related to the area, and possible energy performance improvement.

The result of the energy review was the energy consumption baseline, energy performance indicator (EnPi), objective of target and action plan.

To materialize the review, the proposed method was a combination of the regular performance test based on ASME PTC and the competent third parties audits. The value shown is as follows:

- The energy measurement for tapping the performance of all units.
- The map of SEU and energy losses.
- The baseline energy arrangement and energy performance indicator (EnPI) as a benchmark for performance unit.

Through the measurement test, the indicator of heat rate was identified as kCal/kWh. The identified indicator number represented SEU and energy losses as well. Meanwhile, baseline as the ground to define future performance, was set referred to the data from the last three years (2011-2014). Following the defined baseline, EnPI was determined in accordance to PT. PJB corporate's key performance indicators.

Furthermore the energy use of PT PJB Gresik Power Plant were HSD oil (High Speed Diesel), MFO (Marine Fuel Oil) and natural gas. Meanwhile, the demand of electricity was supplied either from the output of the generators or from the electricity grid.

The composition of the energy use in PT PJB Gresik power plant consisted of 98.73% fuel and 1.27% electrical energy as shown in the pie chart (*see figure 4*).

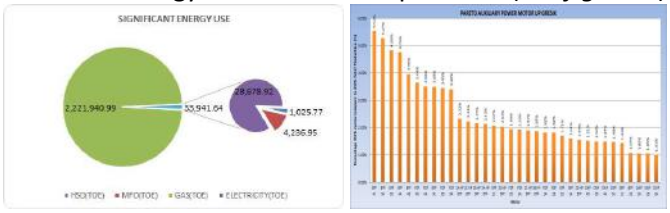

Figure 4. *Significant Energy Use PT PJB Gresik*

Since the application of EnMS in 2014, through the energy audit data we identified the improvement of energy performance. In 2014 the EnPI initially showed 2,368 kCal/kWh and in 2016 it changed to 2,294 kCal/kWh. To have advance guidance we had been applied ISO 50006 type 4. We did modelling the system using software 'GateCycle' (*see figure 5*) resulting to the Pareto heat loss (*see figure 6*) and the 'Reliability Block Diagram'. The final outcome was the reliability index (*see figure 7*). From the index we understood that if the loss occurred on the condenser vacuum (for example) then the consequences was to renew the condenser retubing

and flexible joint. The software guided us to monitor and determine whether energy performance had been improved or not.

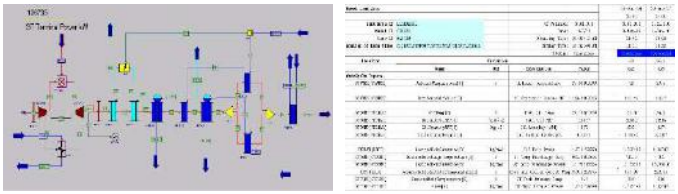

Figure 5. Modelling by Gate Cycle

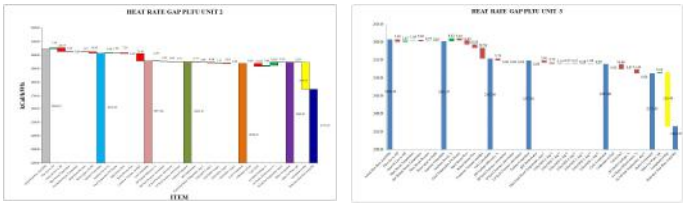

Figure 6. *Pareto Heat Loss*

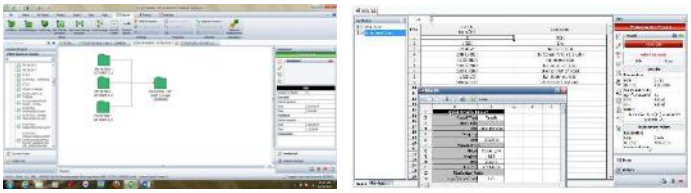

Figure 7. *Reliability Block Diagram*

Financing:

PT PJB Gresik power plant has long term planning so called 'RJPU' comprises programs for the improvement of equipment efficiency and reliability. 'RJPU' is for 5 years planning which derived annually can be called 'RKAU'. The investment cost for improving both efficiency and reliability are budgeted in 'RKAU' approved by the top management.

Duration:

In 2014 PT PJB Gresik Power Plant was certified with ISO 50001. Meaning before 2014 we already concerned on the energy conservation, proven by the good performance of our annual contract target (NKU).

Cost Benefit Analysis:

The investment to implement the EnMS in PT PJB Gresik Power Plant was as follows:

- Development and implementation costs: total cost spent for gap and awareness analysis, training and hiring consultants and experts, third party payment, certification and internal communications.
- Project Implementation Costs: expenses related to implementation of low and medium-cost opportunities such as lighting modifications, and operational modifications. In addition, it also includes project which significantly impactful for energy performance.

Table 2. *Cost Benefit Analysis*

Year	Activity	Cost	Saving
2014	Gap and Awareness Analysis, Training	$ 11,033.47	
2014	Audit and consultancy	$ 2,942.26	
2014	Internal communications	$ 588.45	
2014	Project (lighting, operational modification, feed water heater restoration, online washing installation)	$ 697,315.19	
2014	Saving		$ 1,428,626.89
2014	Certification Audit	$ 12,872.38	
2015	Project (Air Heater replacement, flexible joint restoration)	$ 2,022,802.50	
	Saving		$ 4,501,769.75
2016	Project (partial retubing Condenser, partial retubing Boiler, drain trap replacement)	$ 298,639.21	
	Saving		$ 3,186,561.49
2017	Project (partial retubing Condenser, partial retubing Boiler, seal Air Heater replacement)	$ 286,870.17	
	Saving		$ 579,405.35
	Total	$ 3,333,063.63	$ 9,696,363.48

	2014	2015	2016	2017
Investment (A)	$ 786,171.39	$ 2,079,808.75	$ 298,639.21	$ 275,836.70
Saving after tax (B)		$ 4,447,797.48	$ 2,389,921.11	$ 786,349.36
B-A	$ (786,171.39)	$ 2,367,988.73	$ 2,091,281.91	$ 510,512.65
	PV	$ 2,152,717.02	$ 1,728,332.16	$ 383,555.71
Sum PV	$ 4,264,604.89			
Cost	$ 3,440,456.05			
NPV	$ 824,148.84			
IRR	276.45%			
MIRR	86.59%			

*Tax 25%
*Weighted Average Cost Of Capital (WACC): 10%
*Risk Free Rate: 2%

Approach used to determine whether energy performance improved:

PT PJB Gresik power plant adopted ISO 50006 type 4 as a guidance. We applied the approach of modelling use software Gate Cycle and Reliability Block Diagram (*see figure 4,5,6*). To facilitate the performance monitoring activities, we had an **online 'Gate Cycle'** (*see figure 8*). Through the tools we were able to monitor and determine some potential energy improvement concerning on design changes or operation process terms.

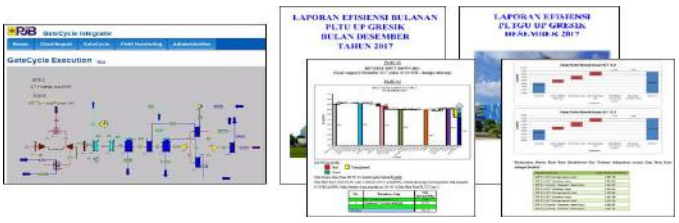

Figure 8. *Online Gate Cycle Integrator*

Based on the online 'Gate Cycle' and RBD we could get Pareto heat loss and hence we would be able to determine and analyze the energy performance, for further report to headquarters, management and employees.

Approach used to validate results:

The first verification and validation conducted was the instrument checking by third parties. We had appointed Sepuluh Nopember Institute of Technology (from academics) and PT PLN Puslitbang (from practitioner) to ensure standard calculation method in line with ASME PTC. As for our monthly efficiency performance, it had been reported and validated by the Cost Management Division of PT PJB Headquarters. Therefore if we could not achieve the NPHR target, then we would have financial penalty.

Step taken to maintain operational control and sustain energy performance improvement:

Supported by the EnMS expert our energy team conducted monthly management review meeting called 'RTM' to evaluate SEU and **determine critical operating parameters based on SEU**, then **determine adding operating parameters**. From these operating parameters, SOP (Standard Operating Procedure) or Work Instructions would be made and validated by the top management. The updated SOP were further disseminated to all employees in **COP (Community of Practice) forum** on monthly basis before being applied to operate power plant efficiently. Operators were given **training of G-EXPO (Gresik Excellence Operation)**, for better understanding on the function of the parameters to improve the energy performance.

One example of SOP is the **Backwash Condenser** (*see figure 9*) for maintaining the condenser performance.

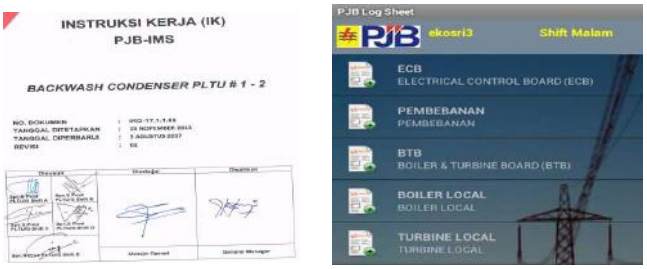

Figure 9. *Work Instruction and E-Logsheet*

We always monitor our operating parameters by **E-Log sheet** (*see figure 9*) to ensure the operational control based on the SOP. Furthermore, every employees have **4DX score board** (*see figure 10*) as the tool for the top management to evaluate operational control on weekly basis.

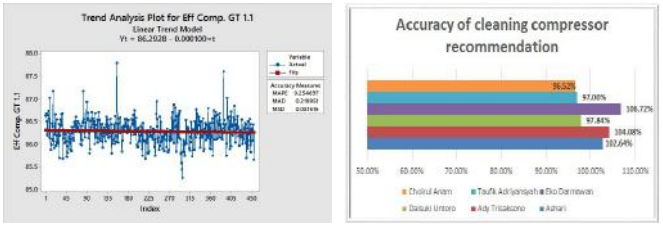

Figure 10. *4DX Scoreboard - Compressor Efficiency*

Development and use of professional expertise, training, and communications:

Management of PT PJB Gresik power plant is committed to develop the capability of employees especially in energy management system by providing training and certification as follows: Certification and training of Energy Auditor and Manager by HAKE Certification Professional Body, Life Cycle Cost Management by Sepuluh Nopember Institute of Technology (ITS), Operation and Maintenance Collaboration with MHPS (Mitsubishi Hitachi Power Systems). As for the communication aspect, we developed awareness in COP (Community of practice) ISO 50001.

The management held **a program of creative ideas** and **innovation competition** to increase awareness and understanding of the importance of energy management

and given reward money and tour abroad. All energy management system activities were communicated to all employees through **OA (Office Automation) and announcement by banner** and in **coffee morning discussion forum** (*see figure 11*), in addition to the cooperation with external parties of PT. PLN (Persero), educational institution and expert of ISO 50001.

Figure 11. *Banner and Coffee Morning*

Tools & resources:

Prior to the compliance to ISO 50001, we are certified with the Malcolm Baldrige Criteria for Performance Excellence (MBCfPE), ISO 9001: 2008 in 2007, ISO 14000 : 2004 in 2007, OHSAS 18001: 2007 in 2007, ISO 50001 in 2014, PAS 99: 2012 in 2014, ISO 55001: 2015 in 2015 and ISO SNI 17025: 2008 in 2017.

Through EnMS ISO 50001 implementation, all the implementet management system in our power plant could run properly and in an integrated way. Along with that, we also applied Lean Six Sigma method in order to find efficiency problem and determine suitable improvement plans.

Lesson Learned

Since the 3-year implementation of ISO 50001 PT. PJB Gresik Power Plant has been able to achieve various target (*see table 1*) and hence following lesson to be learned:

a. The active role of management is absolutely necessary to harmonize and encourage energy conservation activities throughout the field
b. Establishing a culture of energy saving in all activities to all employees requires time and intense socialization
c. Setting company targets down to staff level should be delivered by providing clear direction from management
d. A method or concept is required so that energy-saving culture can always be developed

By certified as ISO 50001 company, we are optimist to become the green and clean power plant as well.

Keys to Success

- EnMS are aligned with Company Objectives
- Management commitment to ISO 50001
- Involvemend all employees at any levels
- Metering and monitor energy performance properly
- Reward to energy conservation innovation
- Good communication is a mandatory

Figure 12. *a. Opexcon Award, b. Green PROPER, c. Innovation Award, d. Top 5 power plant company*

Through the Energy Management Working Group (EMWG), government officials worldwide share best practices and leverage their collective knowledge and experience to create high-impact national programs that accelerate the use of energy management systems in industry and commercial buildings. The EMWG was launched in 2010 by the Clean Energy Ministerial (CEM) and International Partnership for Energy Efficiency Cooperation (IPEEC).

For more information, please visit www.cleanenergyministerial.org/energymanagement.

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