ISO 50001 Energy Management System
Case Study

2020 Indonesia

PLTU Indramayu

Coal Fired Power Plant with 3 x 330 MW in capacity, has been implemented ISO 50001 since 2015 and achieved USD 46,110,418.91 in cost saving through EnMS.

Figure 1. Indramayu CFPP alongside the productive paddy field, Indramayu area also known as main rice producer in Indonesia.

Organization Profile & Business Case

Company Profile: Indramayu Coal Fired Power Plant (Indramayu CFPP) owned by PT PLN (Persero) as national electric company, managed and operated by PT Pembangkitan Jawa Bali (PT PJB, as subsidiary of PT PLN (Persero)) located in West-Java, Indonesia. Commercially operation since 2011, has 3 identical units with 330 MW installed capacity with lignite coal as the main fuel, Indramayu CFPP consume 61,746,398.83 GJ/year and produce (transferred) 5,509.18 GWh/year, which support 3.2% power supply of Java-Bali System. Our top management has committed in supporting and integrating ISO 50001 into Environmental Management Policies.

"I care, I enlight, with golden heart I succeed."

— Indramayu CFPP tagline that spirited all levels of employee

Case Study Snapshot	
Industry	Power Generation
Product/Service	Electricity
Location	Indramayu, West-Java, Indonesia
Energy management system	ISO 50001
Energy performance improvement period, in years	5 years
Energy Performance Improvement (%) over improvement period	6 %
Total energy cost savings over improvement period	USD 46,110,418.91
Cost to implement EnMS	USD 9,318,090.31
Total Energy Savings over improvement period	17,174,515.31 (GJ)
Total CO_2-e emission reduction over improvement period	474,016.62 (Metric tons)

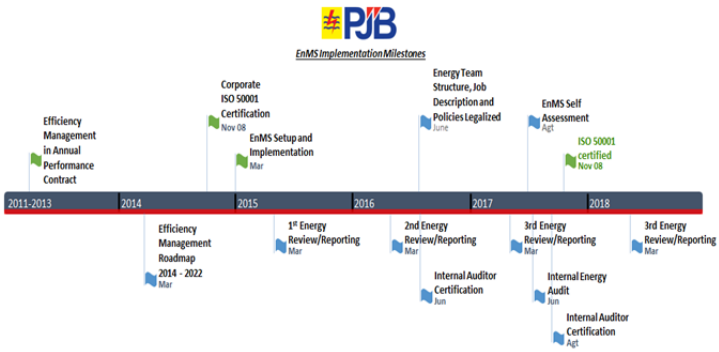

Figure 2. EnMS Implementation Milestones

EnMS Drivers and Goals:

Core Business Driver

- 70% of production cost comes from energy/fuel cost, coal price trend tend to increasing in 2015 (as shown in Figure 3).

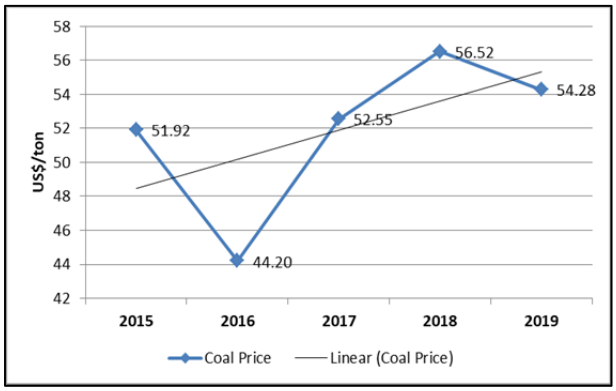

Figure 3. Coal Price Trend

- Increasing competitiveness among power plants, either state-owned and independent power producers, where the more efficient power plant will be prioritized to be bought its electricity.
- To meet PT PLN Persero's (as the holding company) policy in decreasing production cost of electricity.

Survival Driver

- Ensuring integration of efficiency improvement in performance assessment become more systematic and structured.
- Beyond comply to government regulation (PP No.70/2009) concerning in energy conservation.
- Increasing PROPER (National Program for Assessment of Company's Rating in Environmental Management) assessment point especially in Energy Efficiency Stream and Emission Controlling Stream.
- As state-owned company, we are committed to participate in the government's commitment to reduce 834 million tons of CO_2e in the unconditional target (CM1) and 1,081 million tons of CO_2e on the conditional target (CM2) in 2030.

"We are living in sustainable enough of energy, by EnMS we'll made one of the most valued legacy for the children."

— Ubaedi Susanto, General Manager

Business Benefits

Tangible Benefits:

Financial benefits:

Energy cost saving calculated based on gap between actual energy intensity compared to the baseline then multiplied by electricity generated and energy cost in each year. Indramayu CFPP has reduced cumulative 6% energy intensity equal to US$ 46,110,418.91 energy cost saving in 2015-2019 (4.95 times of implementation cost), which is 1.46% better than energy efficiency road map (5 years plan) target for 2019.

"To keep going business in competitive merit order system, EnMS is the only way out"

—Syarief, Engineering Manager

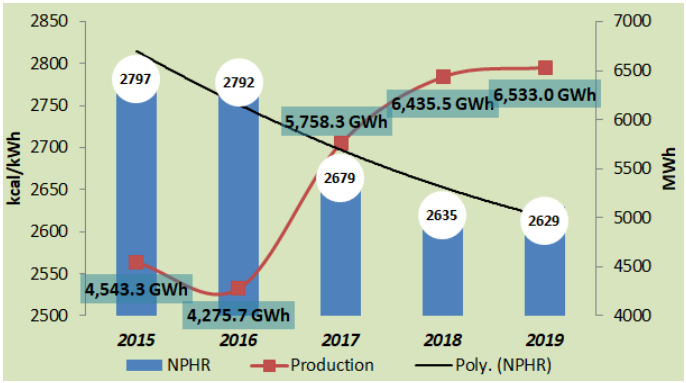

Figure 4. Energy Intensity reduction

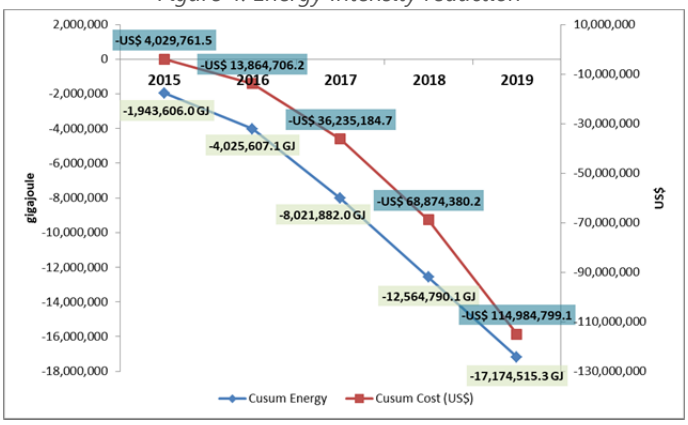

Figure 4. Cusum of Energy and Cost Saving CFPP Indramayu

Environmental benefits:

The energy conservation efforts impacted CO_2 emission reduction of 474,016.62 ton equivalent in 2015-2019, since coal as the main energy, CO_2 reduction calculated based on energy saving (in gigajoule) multiplied by CO_2 emission factor 27.6 kg/GJ for Lignite (2006 IPCC Guidelines for National Greenhouse Inventories) as shown in Figure 5.

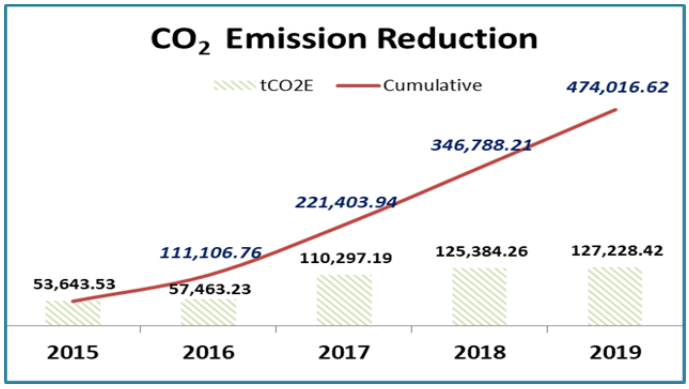

Figure 5. CO_2 Emission Reduction by EnMS implementation

Figure 6. Fly Ash and Bottom Ash used to produce paving block for CSR program and cement industry

We have achieved 2,392,518.8 m^3 of water conservation in 2015-2019 calculated based on reducing freshwater usage from the implemented programs.

Productivity Benefit: Decreasing in energy intensity (6% in 2015-2019) lead to higher load capacity trusted and asked by the grid dispatcher, the production has increased ±43.79% in 2015 to 2019 (as shown in Figure 3).

Intangible Benefits:

During EnMS implementation we have received several achievements, such as:

- The Best Power Plant on Heat Rate Reduction 2017 from PT PLN (Persero) Java-Bali Region as the main customer.
- The Best Power Plant 2018 and 2019 from PT PLN (Persero) Java-Bali Region.
- As the benchmark unit on 5S implementation for Power Plant Category 2018 within PT PLN (Persero) group.
- The Most Improved Effort Electricity Safety Power Plant 2018 in Subroto Award (National Energy Efficiency Award)
- The success story on implementing EnMS and considered as the best plant performance, many others power plant made Indramayu CFPP as benchmark unit.
- Indramayu CFPP has received Green classification in PROPER assessment in 2019.
- PT PJB headquarter has formed and facilitated team from another sites in order to improving their energy performance based on our methods and achievements in the late years.
- Increasing awareness of energy conservation can be seen by number of energy efficiency innovation team (consist of 3 up to 5 employee each team) has increased from 3 teams in 2015 to 8 teams in 2019.
- Before EnMS implementation any energy improvement took estimated 12 up to 16 months to complete since identification of ECO list till executed and evaluated, moreover got to be assissted by expert from PT PJB headquarter and research-development department of PT PLN, afterward took only 3 months for no/low cost program and 12 months as the quickest for investment program, all conducted by internal energy team and supported by the other departments.

Plan

Top Management Commitment: Top management has committed to implement EnMS through allocating USD 9,318,090.31 in energy efficiency programs (as shown in Figure 7).

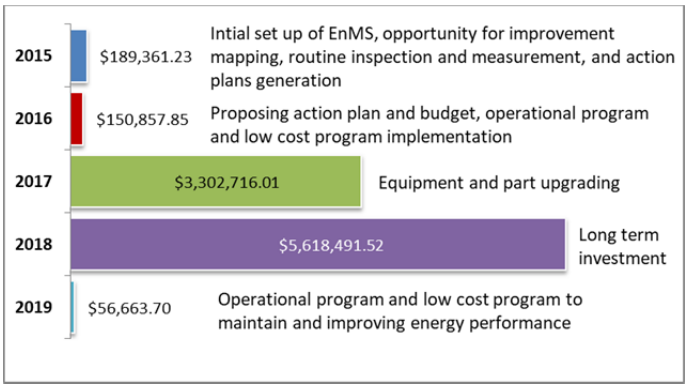

Figure 7.Budget Allocation 2015-2019

The budget allocation was aligned to energy efficiency road map, can also be changed (raised or delayed) when energy audit finding has more priority to be executed. Another top level management commitment was set ISO 50001 implementation to the headquarter office and all plants managed by PT PJB.

Energy Review, Baseline and EnPI: Indramayu CFPP has set EnPI, boundaries, and energy baseline based on ISO 50006. As power plant EnPI used is NPHR (Nett Plant Heat Rate, lower value means more efficient), energy baseline was set from one year historical data of operation, normalized by start-up and shutdown data which using high speed diesel oil.

Plant No.	SEU	Driver	Baseline	R^2	EnPI
#1	Heat Rate	Nett Capacity Factor	-0.0479x2 + 1.7206x + 2828.4	0.87	kcal/kWh
#2	Heat Rate	Nett Capacity Factor			kcal/kWh
#3	Heat Rate	Nett Capacity Factor			kcal/kWh

Figure 8. Baseline and EnPI

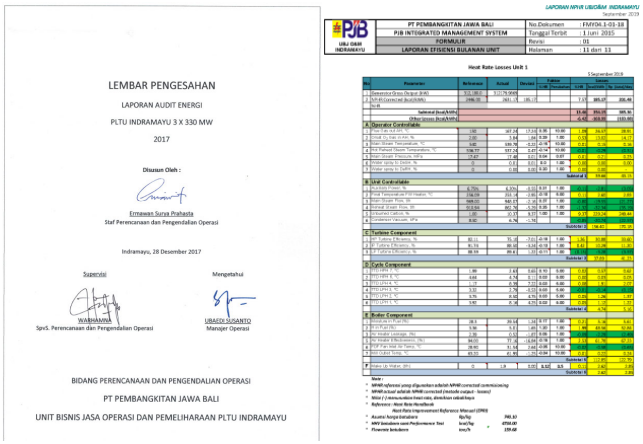

Figure 9. Energy Audit Report and Heat Rate Gap Analysis

Significant Energy Used was heat losses value (using heat rate gap analysis between each component to its reference value), classified (adopted from EPRI Heat Rate Improvement Reference Manual TR-109546) into operator controllable, unit controllable, turbine component, boiler component, cycle component, and make up water. Heat losses obtained from internal energy audit, monthly efficiency report or monthly performance test report.

Objective and Target: Top management has stated Indramayu CFPP targeted to reduce energy efficiency 0.35% equal to USD 514,241.69 by 2022 was top-down base according to long term plan shown in Figure 10.

Corporate has targeted ISO 50001 certification for all plants (Indramayu CFPP is one of them) under its management in 2018 and achieved it in 2018.

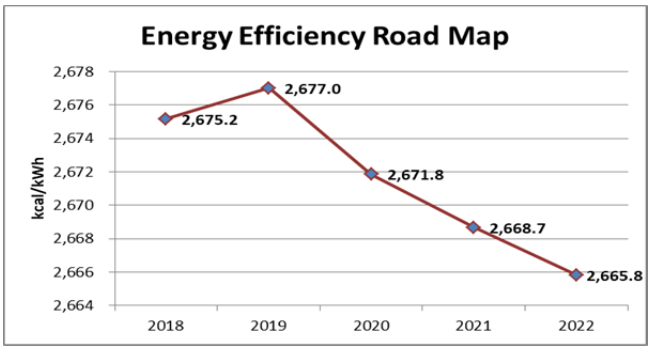

Figure 10. Energy Efficiency Road Map 2018-2022

ECO List and Action Plan: The heat rate gap will be ranked into top ten losses, so it can be focused into program or action plan of energy efficiency improvement. The top ten losses will be analyzed to generate recommendation of possible improvements (the energy conservation opportunity) and classified into three approach: operational (no cost or low cost), investment, and maintenance. Those cost demanding recommendations will be followed up by Engineering Department and Maintenance Department through generating detailed action plan, feasibility study, budgeting, risk analysis, and time of execution. Execution of program that has been approved for its budget then controlled by Engineering or Maintenance Department, Operation Department as supporting and ensuring the operation safety. Evaluation of the program conducted by performance engineer and energy team members, then the results will be reported to the top management.

Do, Check, Act

Action Plan Implementation: We have manifested top rated programs that have been implemented and resulted in significant energy saving as follows:

NO	ENERGY PERFORMANCE IMPROVEMENT PROGRAM	2015		2016		2017		2018		2019	
		Cost (USD)	Saving (USD)	Cost (USD)	Saving (USD)	Cost (USD)	Saving (USD)	Cost (USD)	Saving (USD)	Cost (USD)	Saving (USD)
	OPERATIONAL										
1	Boiler Combustion Optimization					364.81	1,372,255.25	22,665.09	1,102,860.75	6,502.75	712,412.18
	INVESTMENT										
1	Modification of cooling and sealing system for Circulating Water Pump	11,128.85	17,506.41	1,387.74	200,134.58	1,387.74	296,263.89	1,387.74	242,027.57	1,387.74	156,341.94
2	Modification of booster pump and backwash line to improve vacuum pump performance	33,767.46	418,445.81	5,005.20	530,086.19	5,005.20	797,633.54	5,005.20	641,045.99	5,005.20	414,094.86
3	Reverse Osmosis Plant Installation					3,283,293.51	2,197,561.78	27,220.21	1,766,147.11	27,220.21	1,140,873.60
4	Fail safe Protection for Electrostatic Precipitator							4,430.60	1,941,197.82	3,305.18	1,581,668.77
	MAINTENANCE PROGRAM										
1	Valve upgrading for turbine and boiler ar	144,464.91	3,480,785.92	144,464.91	4,409,451.66	12,664.76	2,122,237.02	12,664.76	5,332,456.01	12,664.76	3,444,593.19
2	Dredging intake canal							5,545,117.92	1,308,257.12	577.86	845,091.56
	TOTAL	**189,361.23**	**3,916,738.14**	**150,857.85**	**5,139,672.43**	**3,302,716.01**	**6,785,951.47**	**5,618,491.52**	**12,333,992.36**	**56,663.70**	**8,295,076.12**

Figure 11. Energy efficiency improvement programs 2015-2019

Design and procurement: The biggest impact in improving energy performance came from valve upgrading (material, operation pressure and temperature) in boiler and turbine area since 2015 to 2019, resulted on 10,128,219 GJ equal to USD 18,789,523.80.

Capacity Building: Indramayu CFPP has **participated in** activities related to energy conservation as follows:

- Capacity building and certification of Energy Manager 29-30 Mei 2016; capacity building and certification of Energy Auditor 19-20 Mei 2016,18 Mei 2017, 16-19 July 2019. Indramayu CFPP has 1 energy manager and 3 energy auditor.
- Reviewing operation system and power plant equipments to maintain efficient operation.
- Community of practice plant performance calculation and how to optimizing boiler combustion by operational approach.
- Participated in heat rate workshop for thermal power plants.
- Knowledge sharing focusing on plant performance improvement to another power plants within PT PLN (Persero) group.
- Participated in workshop themed Water-Steam Cycle assessment.

Monitoring Measurement Plan: Each implemented program monitored on daily basis (daily report, shift report, Navitas as CMS used to manage PT PJB's energy management for all power plants under its management), on weekly basis (measuring: flue gas exit temperature, as fired coal analysis, unburned carbon in ash, heat loss), and monthly basis (efficiency report, concession report). Whilst efficiency improvement program during overhaul period monitored by maintenance team, and evaluated by performance engineer after the plant has been synchronized. If a gap still found, then energy team will bring up recommendation to be discussed in the next energy meeting. Low level management up to Board of Director are able to check the energy status through Navitas and immediately giving feedback when inefficiency indication shown. Every level of employee are able to monitoring the current operational performance through intranet web-based dashboard as shown in Figure 12. It shows several operational performance indexes such as: Nett Plant Heat Rate, Equivalent Availability Factor, Equivalent Force Outage Rate, Sudden Outage Factor, Scheduled Outage Factor, Nett Capacity Factor, current gross and nett loads.

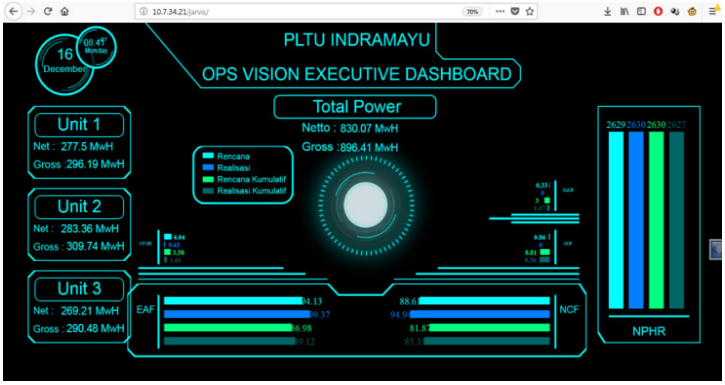

Figure 12. Real-time monitoring, Plant Performance Dashboard

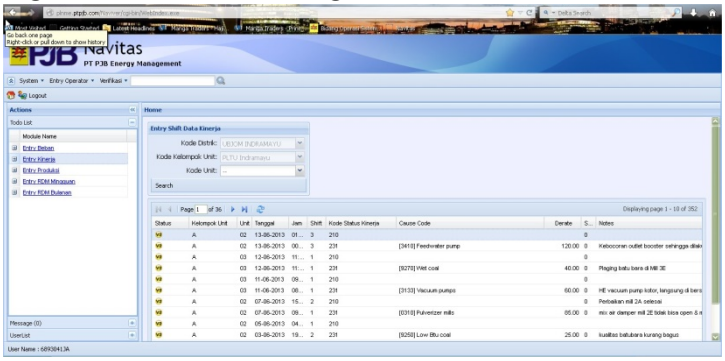

Figure 13. Navitas, CMS for Energy Management in PT PJB

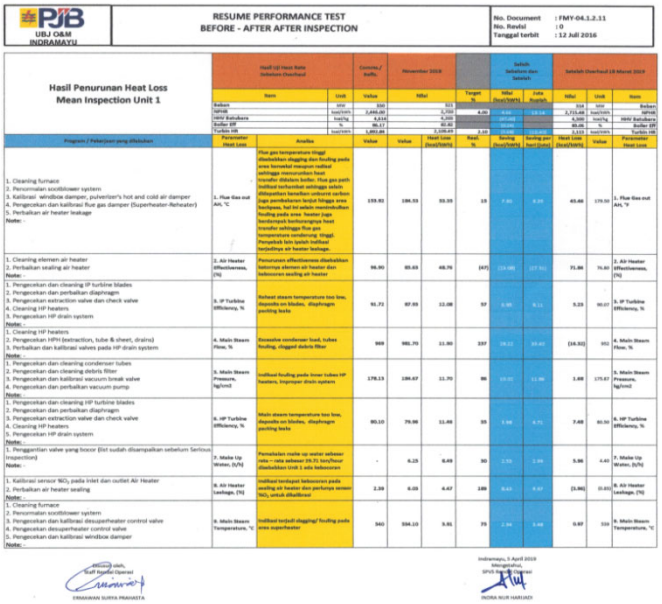

Figure 14. Monitoring form of action plan

Internal Audit and Management Review: Internal audit was performed every two years by internal certified auditor, monthly performance test by energy team and operation department, while monthly management review attended (directly or via video conference) by Board of Director and General Manager of each plant. Energy performance was daily reported to PT PJB and annually reported to government (Ministry of Energy and Mineral Resources) via Online Energy Management Reporting System (POME).

"I think every World Class Company implement EnMS as an obligation as human has to breath"

—Sunarsa, Operation Manager

Transparency

Indramayu CFPP achievements related to energy efficiency and EnMS success story has been published through company's public relation, whether by Indramayu CFPP or PT PJB or PT PLN (Persero).

Internal web portal http://portal.ptpjb.com, whilst external publication can be accessed via http://ptpjb.com and other common social media.

Energy policy related to any work within Indramayu CFPP area was shared to all vendors in routine meeting called Supplier Gathering.

Energy performance verified by confidentially reported the data to several parties as follows:

1. Daily report and annual Energy Review report to PT PJB
2. Annually report to Ministry of Energy and Mineral Resources via Online Energy Management Reporting System includes energy consumption (detailed by energy type and entity energy user), energy efficiency program, CO_2 emission, Energy Review report.
3. Annually report to Ministry of Environment and Forestry
4. Monthly report to PT PLN (Persero)

Lessons Learned

- Unlike before, Top management should be invited to lead quarterly energy meeting to accelerate decision making for budgeting and targeted time particularly the top priority ECOs.
- Build new real-time monitoring system of energy performance status to reach equipment level which can be monitored by all energy team member, performance engineer, all level of management. So they can immediately provide analysis and feedback to the operator and maintenance team.
- Energy team supposed to be given special authority to deliver performance degradation condition out of planned to the top level management meeting so it can be fix immediately.

"Our Earth is already too old to be further explored, carry out energy conservation is a must for a better future"

- —Ubaedi Susanto, General Manager