Global Energy Management System Implementation: Case Study

Indonesia

Pupuk Kalimantan Timur

was the first and the only fertilizer plant certified ISO 50001 in Southeast Asia since 2016. Pupuk Kaltim, the largest fertilizer company in Southeast Asia, achieved cost saving USD 3,921,855 through EnMS.

Figure 1. PKT-1A (left) and PKT-3 (right) of Pupuk Kaltim

Case Study Snapshot

Industry	Petrochemical
Product/Service	Ammonia, Urea, and Utility
Location	PKT-3 Plant and PKT-1A Plant
Energy management system	ISO 50001
Energy performance improvement period	2.5 years (PKT-3) 1 year (PKT-1A)
Energy Performance Improvement (%) over improvement period	5.45% for PKT-3 0.65% for PKT-1A or 3.76% (aggregate)
Total energy cost savings over improvement period	USD 3,696,325 for PKT-3 USD 225,529 for PKT-1A Total: USD 3,921,855
Cost to implement EnMS	USD 91,830
Total Energy Savings over improvement period	813,180 GJ for PKT-3 53,082 GJ for PKT-1A Total: 866,262 GJ
Total CO_2-e emission reduction over improvement period	40,896 metric tons for PKT-3 2,670 metric tons for PKT-1A Total: 43,565 metric tons

Organization Profile & Business Case

Company Profile: PT Pupuk Kalimantan Timur (Pupuk Kaltim) as state-owned company under Pupuk Indonesia Holding Company (PIHC group) was established on December 7, 1977, located in Bontang, Indonesia. Pupuk Kaltim has 5 (five) ammonia-urea plants i.e. PKT-2/3/4/5/1A and 2 (two) NPK Plants. Since 2015 Pupuk Kaltim has become the largest integrated ammonia-urea plant in the Southeast Asia, producing 3.43 million tons of urea, 2.74 million tons of ammonia and 350 thousand tons of NPK per year. Annually, Pupuk Kaltim delivers its products in domestic and exports to the countries in four continents.

EnMS Drivers and Goals:

Core Business Driver

Energy cost, mostly from natural gas, represents the largest (up to 40%) of production cost factors in the fertilizer industry. In 2015, Pupuk Kaltim signed new

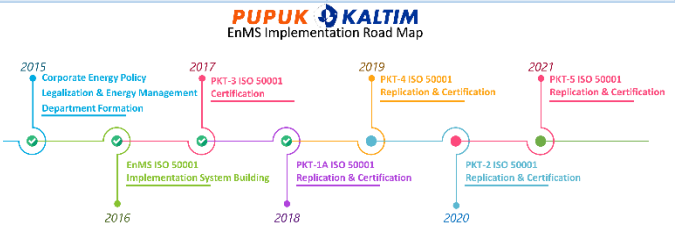


Figure 2. EnMS Implementation Road Map of Pupuk Kaltim

contract of natural gas which has increased 66.7% USD/mmbtu. Moreover, global ammonia and urea prices continued to weaken throughout 2015-2018 and are predicted continue its trend. This condition is aggravated with the sharp increase of rupiah dollar ratio that resulted loss USD 13,980,202 in 2016. The loss occurred due to the fact that Pupuk Kaltim buys natural gas in dollars and sells some of the products domestically to meet the requirement of Public Service Obligation (PSO). Pupuk Kaltim experienced a critical condition at the end

of 2016. It can be seen in Figure 3 where in October-December 2016 production cost of Pupuk Kaltim was higher than global market price. To survive, production cost reduction is absolutely a necessary and notably focused on natural gas efficiency as the most significant subject.

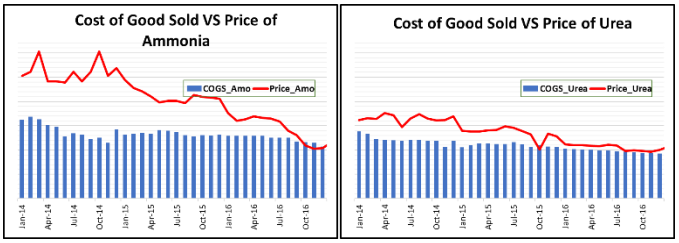


Figure 3. Cost of Goods Sold vs Price of Ammonia and Urea

Survival Driver

- Establishing a system to ensure sustainability of energy efficiency programs which was still sectoral and unstructured in Pupuk Kaltim.
- To achieve Gold-the highest award in PROPER (National Program for Assessment of Company's Performance Rating in Environmental Management).
- Beyond comply to government regulation (PP No. 70/2009) about energy conservation.
- Pupuk Kaltim as state-owned company participate in the government's commitment program to reduce 834 million tons of CO2e in the unconditional target (CM1) and by 1,081 million tons of CO2e on the conditional target (CM2) in 2030.

"Energy efficiency and innovation are two success keys to survive in disruption era, I do not want to hear that there was once a huge factory ever stood up here."

—Bakir Pasaman, President Director

Business Benefits

Pupuk Kaltim initially implemented ISO 50001 at PKT-3 since April 2016 and continued by replication at PKT-1A in January 2018 with total implementation cost of USD 91,830 resulting:

Tangible Benefits:

Financial Benefit: Cost saving USD 3,921,855 calculated based on energy performance gap between actual energy consumption compared to baseline, then can be described in the cumulative of sum (CUSUM) (see Figure 4). Baseline is set refers to ISO:50006/SNI 8669:2018 level 3, EnPI type 3 (regression method), for PKT-3 based on best year April 2015-March 2016 and for PKT-1A January-December 2017. Baseline is set for unit ammonia, urea and utility with sub unit thermal and electricity.

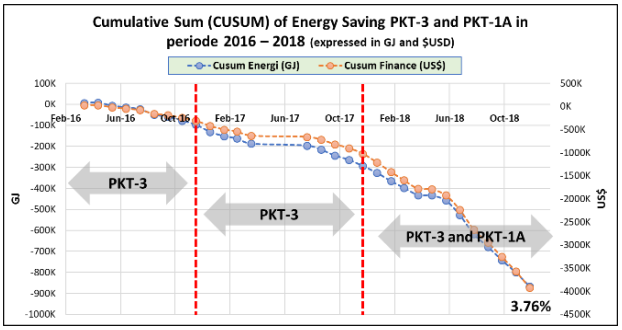


Figure 4. CUSUM of Energy Saving PKT-3 and PKT-1A

Additional benefit of USD 2,822,066 was earned by LCC implementation in the procurement of more efficient LTS catalyst and Primary Reformer Catalyst in 2017-2018.

Environmental Benefit: CO_2 reduction of 43,565 ton equivalent during 2016-2018, since the main energy source was natural gas, then CO_2 reduction calculated based on energy saving (in mmbtu) multiplied by CO_2 emission factor 53.06 kg CO_2/mmbtu.

Water conservation of 400,769 m^3 during 2016-2018 calculated based on reduction of turbine steam consumption which was one of the action plan programs.

Productivity Benefit: Increasing yield 1.3% in ammonia converter lead to product increase 22 ton/day resulted from upgrading ammonia reactor type and more efficient catalyst replacement at PKT-3.

Pupuk Kaltim has the lowest energy cost/unit product among fertilizer company in Indonesia.

Intangible Benefits: With the implementation of ISO 50001, the following are intangible benefits:

- Success story of Pupuk Kaltim on 3.76% energy saving inspired headquarter to implement EnMS at all of subsidiaries consisting 4 (four) other companies which consume total energy of 6,012,638 TOE. If it is assumed that % energy saving equal to Pupuk Kaltim, the CO_2 reduction potential reaches 475,791ton equivalent/year.

- Improving energy-saving culture seen by innovation for energy efficiency has increased from 85 small group activity (SGA) in 2015 to 168 SGA in 2018.
- Increasing competitiveness of Pupuk Kaltim in global market by obtaining 5 (five) new destination countries and 10 (ten) new customers during 2016-2018.
- Pupuk Kaltim has been publishing sustainability report based on GRI since 2011 and implementation of EnMS gives an additional point.
- 1st winner in innovation competition at National Energy Efficiency Award (PEEN) for large industry category in 2018.
- In 2017 and 2018, Pupuk Kaltim has received Gold-the highest award in PROPER assessment out of 1906 industry participate in national level.
- Achievement as world class industry by Global Performance Excellence Award (GPEA) in 2018.

Benefits of Multiple Sites Approach:

- Larger impact in cost saving (see Figure 4). Initial implementation at PKT-3 earned a total cost saving of USD 1,022,860, and with the addition of PKT-1A resulted sharper slope in cost saving aggregate graph.
- Implementation cost saving of USD 47,267. Initial Implementation cost at PKT-3 was USD 69,548 while replication at PKT-1A spent cost of USD 22,281.
- Cutting implementation period. Initial PKT-3 implementation project needed 18 months to set up EnMS system and shall be assisted by consultant, while replication at PKT-1A needed only 5 months and can be conducted by internal Energy Team.

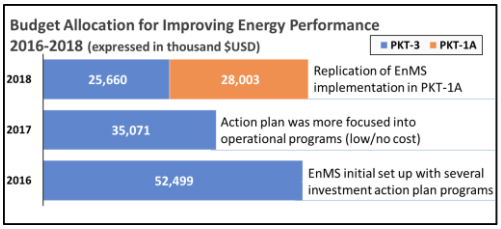


Figure 5. Budget Allocation 2016-2018

Plan

Top Management Commitment: Throughout the implementation of ISO 50001 in 2016-2018, top management has committed to provide necessary resources in term of budget totaling of USD 141,233,904 (as shown in Figure 5).

Top management appoints dedicated implementation team named "Tim Champion" and facilitates with adequate training programs (decanted in "SiPejabat" training syllabus) to ensure personnel competency. Furthermore, Top Management provide additional budget to triple reward for energy efficiency innovation programs in the event of "Pupuk Kaltim Innovation award (PIA)".

Top Management willing to take a risk to issue a Decree for the implementation of the procurement based on LCC even though it was very risky in auditing term as a state-owned company.

Energy Review, Baseline, and EnPI: Pupuk Kaltim has a real-time online monitoring data in all plants for a basis to analyze and identify SEUs i.e. thermal and electricity. The Baseline is set on daily basis for each level. For ease energy planning, each level is divided into several sub-units based on the energy used on that unit. For example, Ammonia (lv.2) is divided into Ammonia Thermal and Ammonia Power (lv.3) as shown detail in Figure 6.

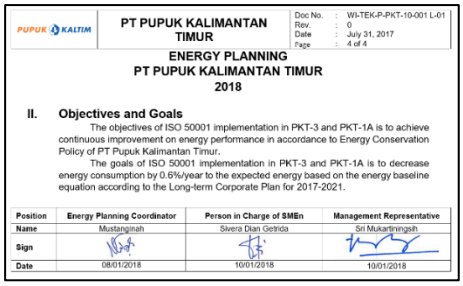
Baseline period was set for 1-year operation after Turn Around (annual maintenance), considered as the best plant performance, with normalization by eliminating start-up and shutdown data.

Level	SEU	Driver	Baseline	R2	EnPI
PKT-3					
3A (Ammonia Thermal)	Primary Reformer	Ammonia product	Y = 9.23A + 8,552	0.9895	mmbtu
3B (Ammonia Power)	Lean Sol. Pump, ID Fan Primary Reformer	Ammonia product	Y = 0.38A + 376	0.9946	mmbtu
3C (Urea Thermal)	CO2 turbine compressor	Urea product	Y = 3.79A + 3,737	0.9974	mmbtu
3D (Urea Power)	HP Ammonia pump, HP Carbamate pump	Urea product	Y = 0.23A + 60	0.9949	mmbtu
3E (Utility Thermal)	Gas turbine generator, waste heat boiler	Electricity & Steam product	Y = 0.01A + 2.79B + 6,658	0.9923	mmbtu
3F (Utility Power)	Sea water pump	Sea water flow	Y = 0.16A	-	kwh/m3
3F-A (Utility Thermal A)	Desalinasi A	Distilate Desal A	Y = 0.46A	-	mmbtu/m3
3F-B (Utility Thermal B)	Desalinasi B	Distilate Desal B	Y = 0.51A	-	mmbtu/m3
PKT-1A					
3A (Ammonia Thermal)	Primary Reformer, Syngas turbine compressor	Ammonia product	Y = 8.02A + 21,745	0.9923	mmbtu
3B (Ammonia Power)	Semi lean Sol. Pump, Flue Gas Blower	Ammonia product	Y = 0.27A + 1,282	0.9796	mmbtu
3C (Urea Thermal)	CO2 turbine compressor, HP Stripper	Urea product	Y = 3.56A + 2,474	0.9863	mmbtu
3D (Urea Power)	Granulator scrubber exhaust fan, atomization air blower	Urea product	Y = 1.26A + 2,281	0.9111	mmbtu
3E (Utility Power)	Sea water pump	Sea water flow	Y = 0.15A + 52,098	0.9704	kwh/m3
3F-A (Utility Thermal A)	Desalinasi A	Distilate Desal A	Y = 0.56A + 431	0.9450	mmbtu/m3
3F-B (Utility Thermal B)	Desalinasi B	Distilate Desal B	Y = 0.54A + 115	0.9948	mmbtu/m3
3F-C (Utility Thermal C)	Desalinasi B	Distilate Desal C	Y = 0.67A + 27	0.9686	mmbtu/m3

Figure 6. Baseline Levelling and EnPI

Objective & target: 3% energy saving target equivalent to USD 7,400,768 by 2021 was top-down base according to long term corporate plan 2017-2021 that passed into "Corporate Energy Planning Document" with target in

2021 all the plants are implemented EnMS based on ISO 50001.



PUPUK KALTIM — PT PUPUK KALIMANTAN TIMUR

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ENERGY PLANNING
PT PUPUK KALIMANTAN TIMUR
2018

II. Objectives and Goals

The objectives of ISO 50001 implementation in PKT-3 and PKT-1A is to achieve continuous improvement on energy performance in accordance to Energy Conservation Policy of PT Pupuk Kalimantan Timur.

The goals of ISO 50001 implementation in PKT-3 and PKT-1A is to decrease energy consumption by 0.6%/year to the expected energy based on the energy baseline equation according to the Long-term Corporate Plan for 2017-2021.

Position	Energy Planning Coordinator	Person in Charge of SMEn	Management Representative
Name	Mustanginah	Sivera Dian Getrida	Sri Mukartiningsih
Sign			
Date	08/01/2018	10/01/2018	10/01/2018

Figure 7. Energy Planning of Pupuk Kaltim 2018

Eco List and Action Plan: Based on efficiency target, the energy conservation opportunity (ECO) list is identified from: detail audit by UNIDO, inhouse energy audit by internal nationally certified energy auditor, forum group discussion, as well as energy patrol. Moreover, ECO list will be classified into operational (no cost), investment, or turn around. Operational ECO list directly turned into action plan program. Investment and turn around ECO list will be an action plan programs through "Risk Matrix Scoring". Energy efficiency converted to value of money by Plant Performance Engineer (PPE) subject to score in financial regime. Higher score in risk matrix represent the priority of action plan.

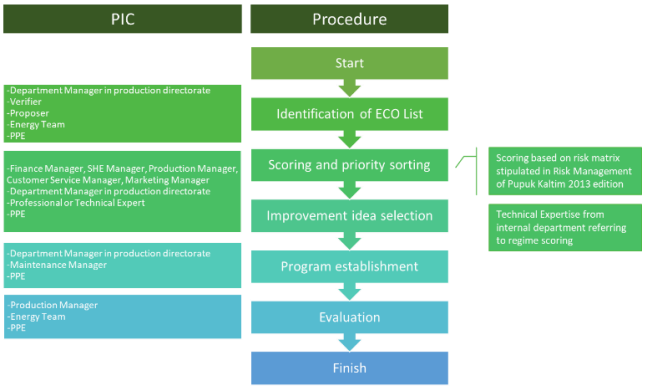

Figure 9. Procedure of Risk Matrix Scoring

Investment program is proposed in the annual corporate budget planning and will be approved when IRR > 12%.

Development for Multiple Sites: The replication in other plant was carried out by separate operational control and action plan team under one coordination structure line. The evaluation of energy Performance was

							Probability				
							Almost impossible (1)	Not likely to occur (2)	Could Occur (3)	Known to occur (4)	Common occurrence (5)
Regimes		Financial and Asset Loss	Health and Safety	Environmental Impacts	Production	Customer Complaint	Reputational Damage	1-5 Occurrence/year	6-10 Occurrence/year	11-20 Occurrence/year	21-50 Occurrence/year	>50 Occurrence/year
Potential Consequences	Catastrophic (5)	> Rp 100 Milyar	One or more fatalities for employees	Environmental pollution that causes legal claim	Plant shutdown for more than 5 days	Written complaints more than 15 a year	Publicity loss of reputation in more than 5 national media	5	10	15	20	25
	Major (4)	> Rp 50 Milyar - Rp 100 Milyar	Work accident that causes disabilities and shall treatment outside BONTANG	Off-site release that effects on community health and led to protests	Plant shutdown for up to 5 days	Written complaints 10-15 a year	Publicity loss of reputation in 1-2 national media	4	8	12	16	20
	Moderate (3)	> Rp 25 Milyar - Rp 50 Milyar	Work accident that causes minor injuries and shall be hospitalization	Off-site release that effects on community inconvenience	Short term production rate cutback	Written complaints 5-10 a year	Province loss of reputation	3	6	9	12	15
	Minor (2)	> Rp 5 Milyar - Rp 25 Milyar	Work accident that causes veryshort-term health concerns	Off-site release that effects on corporate area	Plant interuption led to localized repair	Written complaints 1-4 a year	Local community loss of reputation	2	4	6	8	10
	Insignificant (1)	up to 5 Milyar Rupias	Work accident that causes first aid injuries	Minor localised off-site release with insignificant effects	Insignificant plant interuption	Verbal complaints	internal loss of reputation	1	2	3	4	5

Figure 8. Risk Matrix Scoring

conducted to each plant individually and reported to Top Management. The development of personnel and system set-up for PKT-1A has improved from lesson learnt in PKT-3 implementation.

"I'm glad to be a part of energy team, EnMS makes you know that it's playing golf, not just playing games"

—Bagya Sugihartana, Production Director

Do, Check, Act

Implementation Action Plan: The following are the top programs that have been implemented:

Energy Performance Improvement Program		2016		2017		2018	
		Cost ($USD)	Saving ($USD)	Cost ($USD)	Saving ($USD)	Cost ($USD)	Saving ($USD)
Operasional program (no-low cost)							
PKT-3 & PKT-1A	1 Reducing Steam/Carbon ratio in Primary Reformer (PKT-3: 3.4 to 3.2; PKT-1A: 3.05 to 2.95)	-	26,638	-	57,918	-	307,404
	2 Off gas utilization to reduce natural gas consumption in Primary Reformer (PKT-3: 5%; PKT-1A: 3%)	-	27,970	-	46,334	-	140,837
	3 Reducing O2 excess in flue gas Reformer from 1,2% to 0,9%	-	9,323	-	11,584	-	33,628
PKT-3	4 Trimming operation condition to increase LS admission to CO2 Turbine				63,203		365,362
Investment program							
PKT-3	1 Upgrade Ammonia Converter (S200 --> S300)	3,812,666	332,979	-	378,691	-	568,787
PKT-3	2 Modification of fuel spray nozzle GTG (from 8 to 16 holes)	320,283	55,497	-	81,085	-	168,676
PKT-3 & PKT-1A	3 Catalyst replacement with more energy efficient (PKT-3: Primary Reformer; PKT-1A: Primary Reformer & LTS)			379,572	28,959	1,411,351	498,382
PKT-1A	4 Upgrade 4 chlorination continous dosing pump IEC3 based					72,036	30,137
	5 Innovation: SEUs online monitoring	6,667					
Turn around program							
PKT-3 & PKT-1A	1 Overhaull CO2 Compressor			79,333	18,589	39,667	131,923
	2 Catalyst loading uses a catalyst primary tube reactor pressure difference meter (patent no: IDS0001180)			-	5,792	-	18,090
	3 Speed up the ignition of the burner with a fire igniter (patent no: IDS000001352)			-	5,056		1,332
Additional Saving:							
	Catalyst procurement based on LCC methode (LTS & Primary Reformer)				1,359,150		1,462,916
TOTAL		4,139,616	452,408	458,906	2,056,361	1,523,053	3,727,473

Figure 10. Energy Performance Improvement Program 2016-2018

Pupuk Kaltim has an annual event named "Pupuk Kaltim Innovation Award" which is to reward employee

innovation in term of energy improvement. Several innovations were patented (see Figure 10 item turn around). Throughout 2016-2018, twenty-one SGAs awarded nationally (6 golds, 13 platinum and 2 diamonds) and seven SGAs were appreciated the highest award in global level (6 ICQCC dan 1 APQC).

Design and Procurement: One of the biggest investment decisions to improve energy performance was the replacement of the PKT-3 ammonia reactor in early 2016 with the latest version of the reactor (type S300) which costs around 63% of the total cost from 2016 to 2018 (Figure 10) resulted greatest impact on energy saving of 0.35 GJ/ton product. Furthermore PKT-1A has upgraded its 4 (four) chlorination continuous dosing pump to IEC3 grade to achieve electricity consumption efficiency up to 3.5%. In case of catalyst procurement, Energy team proposed the tender evaluation based on LCC to response the energy policy. This proposal has been approved by Top Management and LCC has been set as SOP in procurement. Implementation of this procedure resulted in saving of USD 2,822,066 by LTS catalyst and Primary Reformer catalyst purchasing in 2017-2018.

Capacity Building: To fulfill the competency requirement of the team based on "SiPejabat" training syllabus, 709 personnel were trained from 2015-2018. In 2018 Pupuk Kaltim has 8 (eight) and 7 (seven) nationally certified energy manager and energy auditor respectively.

Monitoring Measurement Plan: Energy team has prepared monitoring measurement plan to ensure operational control quality and energy performance improvement.

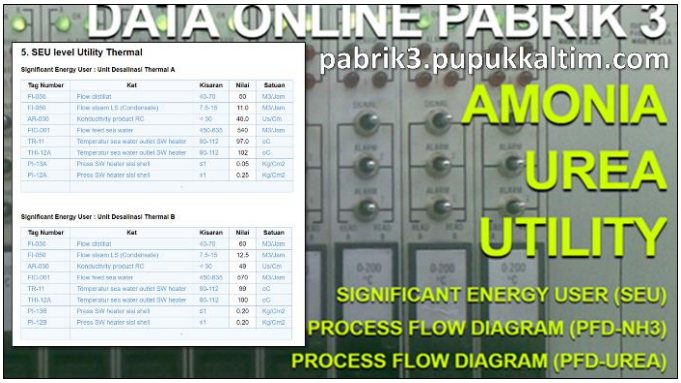

Figure 11. SEU's Online Monitoring

For operational control, Pupuk Kaltim has been implementing industry 4.0 concept where the critical parameter was integrated to DCS (distributed control system). Key operating parameter (KOP) was constrained in threshold limit and it is connected to alarm to warn SEU operator to response based on action guidance (operating window). All of the KOP data and SEU operator action were monitored in SEUs Online Monitoring for investigation purpose in daily energy meeting. The un-solved problem/situation to be reviewed in Monthly Comprehensive Energy Meeting.

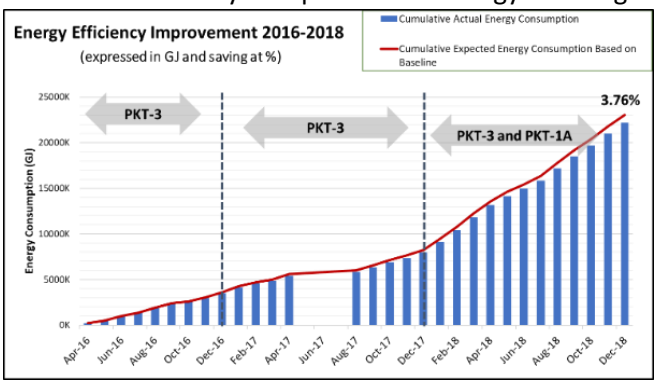

Figure 12. Aggregate of energy efficiency improvement 2016-2018

For objective target accomplishment, operational data from DCS is compared to daily baseline equations to get energy efficiency improvement as shown in Figure 12. From 2016-2018, Pupuk Kaltim has reached 3.76% on energy efficiency and satisfy the top management's target. For energy performance improvement shown in CUSUM (see Figure 13) will be reported to top management monthly.

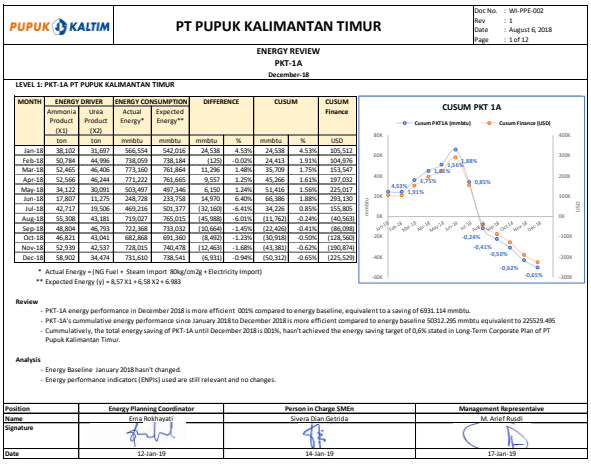

Figure 13. Energy Review Document of Pupuk Kaltim

Verification and Validation: Pupuk Kaltim has no issue related to equipment calibration since Pupuk Kaltim is certified ISO 17025. The monitoring measurement plan is verified by internal nationally certified energy manager and energy auditor refers to protocol ISO 50015/SNI 8670 and to be validated directly by top management. Energy performance was daily reported to Pupuk Indonesia Holding Company as 2nd party and yearly reported to government as 3rd party via POME (Online Energy Management Reporting System). Pupuk Kaltim is waiting for the government confirmation on the assignment of certified verifier in March 2019.

Internal Audit and Management Review: Internal audit was performed annually by internal certified auditor while annually Management Review is lead by Board of Director.

Transparency

Pupuk Kaltim publishes achievements related to energy efficiency and the success story of ISO 50001 implementation through corporate public relation mechanism on media as follows:

Internal Organization: internal Web Portal (portal.pupukkaltim.com).

External Organization: Social media and official website on www.pupukkaltim.com, Videotrons located at Pupuk Kaltim neighborhood and Vendor Gathering (routine meeting with all vendors and share energy policy related to procurement process in Pupuk Kaltim area).

For energy efficiency performance verification, Pupuk Kaltim as state-owned company reported the confidential data to:

1. Daily report of energy performance to Pupuk Indonesia Holding Company.
2. To Indonesian Ministry of Energy and Mineral Resources via Online Energy Management Reporting System (POME). The reported data include energy consumption (type of energy and intensity), energy efficiency in energy user equipment.
3. To Indonesian Ministry of Industrial via National Industrial Information System (SIINas) to update industrial performance as a basis data for national industrial development.
4. To Indonesian Ministry of environment and forestry via PROPER.
5. To announce globally via publishing sustainability report.
6. To announce nationally via innovation competition at National Energy Efficiency Award (PEEN)

Lessons Learned

- Pupuk Kaltim has 8 (eight) and 7 (seven) nationally certified energy manager and energy auditor respectively that successfully self-replicated EnMS at PKT-1A. However, additional energy manager and energy auditor is required to implement ISO 50001 in whole PKT's plants.
- Energy was additional point in innovation scoring. Furthermore, Pupuk Kaltim has to formulate a better version of awarding system. Energy team propose some value of innovation saving is given to the innovator after validating by accountant department at certain period.
- Replication APC (Advanced Process Control) of PKT-1A to other plants.