Global Energy Management System Implementation: Case Study

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.

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 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

Case Study Snapshot

| Industry | Petrochemical |
| Location | Ammonia, Urea, and Utility |
| 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 |
| Cost to implement EnMS | USD 91,830 |
| Total Energy Savings over improvement period | USD 3,921,855 |
| USD 866,262 GJ |
| Total CO₂-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 |

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

Figure 2. EnMS Implementation Road Map of Pupuk Kaltim

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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](image)

**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](image)

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:** CO2 reduction of 43,565 ton equivalent during 2016-2018, since the main energy source was natural gas, then CO2 reduction calculated based on energy saving (in mmbtu) multiplied by CO2 emission factor 53.06 kg CO2/mmbtu.

Water conservation of 400,769 m³ 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 CO2 reduction potential reaches 475,791 ton 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.

**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 “SiPejasab” 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 (Iv.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.

**Table 1: SEU Analysis**

<table>
<thead>
<tr>
<th>Level</th>
<th>SEU Description</th>
<th>Driver</th>
<th>Baseline</th>
<th>R2</th>
<th>EnPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>PKT-3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>IA (Ammonia Thermal)</td>
<td>Primary Reformer, Ammonia product, Y = 0.23A + 8,552</td>
<td>Ammonia product</td>
<td>0.9895</td>
<td>mmbtu</td>
<td></td>
</tr>
<tr>
<td>IB (Ammonia Power)</td>
<td>Lean Sol. Pump, Flue Gas Blower, Y = 0.38A + 376</td>
<td>Ammonia product</td>
<td>0.9946</td>
<td>mmbtu</td>
<td></td>
</tr>
<tr>
<td>IC (Urea Thermal)</td>
<td>CO2 turbine compressor, Y = 3.73A + 1,732</td>
<td>Urea product</td>
<td>0.9794</td>
<td>mmbtu</td>
<td></td>
</tr>
<tr>
<td>ID (Urea-Power)</td>
<td>HP Ammonia pump, HP Carbamate pump, Y = 0.23A + 60</td>
<td>Urea product</td>
<td>0.9949</td>
<td>mmbtu</td>
<td></td>
</tr>
<tr>
<td>IE (Utility Thermal)</td>
<td>Gas turbine generator, waste heat boiler, Y = 0.01A + 2,798 + 6,658</td>
<td>Electricity &amp; Steam product</td>
<td>0.9923</td>
<td>mmbtu</td>
<td></td>
</tr>
<tr>
<td>IF (Utility Power)</td>
<td>Sea water pump, Sea water flow, Y = 0.16A</td>
<td>Sea water pump</td>
<td>0.9685</td>
<td>mmbtu/m³</td>
<td></td>
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<tr>
<td>IF-A (Utility Thermal A)</td>
<td>Distillation A, Distillation A, Y = 0.46A</td>
<td>Distillation A</td>
<td>0.9685</td>
<td>mmbtu/m³</td>
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<tr>
<td>IF-B (Utility Thermal B)</td>
<td>Distillation B, Distillation B, Y = 0.51A</td>
<td>Distillation B</td>
<td>0.9583</td>
<td>mmbtu/m³</td>
<td></td>
</tr>
</tbody>
</table>

**Figure 5. Budget Allocation 2016-2018**

**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.

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.

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 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

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

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.

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.

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.
**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.

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](http://www.cleanenergyministerial.org/energymanagement).