Global Energy Management System Implementation: Case Study

Thailand

PTT Global Chemical PCL
Branch 12 Polyethylene Plant

During 2013 – 2016, PTTGC12 achieved energy saving of more than 64 TJ, equivalent to around 7,500 tonnes of CO_2-e reduction.

To save energy sustainably, PTTGC12 develops its energy management system around the Plan-Do-Check-Act (PDCA) cycle. This resulted in achieving the 1st quartile status in the global benchmarking by Phillip Townsend Associates.

Figure 1: PTTGC12 Plant in Rayong, Thailand

Business Case for Energy Management

PTT Global Chemical Public Company Limited – Branch 12 (PTTGC12), was established in 1989 as Bangkok Polyethylene Co., Ltd. (BPE). In 2013, it merged with PTTGC to form the largest integrated refinery and petrochemical company in Thailand. PTTGC12 produces High Density Polyethylene (HDPE) with raw materials and utilities provided by companies within the PTTGC group. Production process at PTTGC12 consists of 2 plants with 3 identical process trains. Total production capacity at PTTGC12 is 550,000 tons per year of which 40% is consumed domestically whilst the remaining 60% is exported to various countries around the world.

DRIVERS: PTTGC Vision & Legal Requirements

PTTGC issued PTTGC Operational Excellence (OpEx) Management to guide the operation of companies within the group. The OpEx Guide identifies various missions including:

"Consideration for energy efficiency sensibly is the foundation for energy management system"

Mr. Teerasak Nachiangmai, Vice President

Case Study Snapshot	
Industry	Petrochemical
Product/Service	Polyethylene
Location	Rayong, Thailand
Energy Management System	ISO 50001
Energy Performance Improvement Period	2013 – 2016 (4 years)
Energy Performance Improvement (%) over improvement period	1.85% for the period. (Normalized using total production with 2013 as base year.)
Total energy cost savings over improvement period	Saving of $USD1,125,200
Cost to implement EnMS	Cost for implementation $USD190,865
Payback period on EnMS implementation (years)	2.04 months
Total Energy Savings over improvement period	64,105 GJ
Total CO_2-e emission reduction over improvement period	7,468 Metric tons

1. *Give the highest priority to safe operation and caring for environment.*
2. *Continue to improve efficiency, energy intensity to obtain competitive cost operation.*

For PTTGC12, average energy cost for polyethylene production constitutes only a small fraction (around 3%) of average full cost. However, when consider in term of consumption, each year, PTTGC12 consumes electricity (59.6%), steam (40.3%) and fuel gas (0.1%) with the combined total of around 1,100 TJ, resulting in emission equivalent to around 81,500 tonnes of CO_2. Reducing this emission and subsequent environmental impact becomes the main driver behind PTTGC12's effort in improving its energy efficiency. The cost reduction is an added benefit from the improvement.

ENERGY MANAGEMENT PROGRAM

Another important driver for implementing EnMS is Thai legal requirements. Under Thailand's Energy Conservation Act, PTTGC12 is classified as a "designated factory" which is required to implement EnMS that conforms to Thailand Energy Management Standard. This standard has requirements similar to that of ISO 50001 international standard.

ENERGY REDUCTION APPROACH

Prior to the announcement of the Thai EnMS in 2009, PTTGC12 (BPE at that time) improved its energy performance by focusing mainly on implementing energy no-cost/low-cost and capital energy saving projects. The approach could not sustain long term effort to save energy. Once the Thai EnMS was announced, PTTGC12 integrated the EnMS with its certified ISO 9001, ISO 14001, and TIS 18001 to form the Quality, Safety & Health, Environment, and Energy (QSHEE) System. Later in 2013, the system was then upgraded to bring it fully in line with ISO 50001 EnMS. This integrated system allows PTTGC12 to look at all activities from every angle at the same time - a holistic approach instead of a piece meal one.

Business Benefits Achieved

BUSINESS BENEFITS (SUMMARY)

Implementation of ISO 50001 EnMS helps PTTGC12 to systematically focus its mission in reducing its environmental impact and energy consumption. It integrates all energy management elements such as training, assessment, metering, controls & analysis, etc., which used to spread among various job functions, into one system. Actions are being taken at the right time due to efficient information flow - right information, right user, and at the right moment. By effectively control operations, regularly optimize processes, and appropriately implement projects, during 2013 – 2016, PTTGC12 has achieved energy saving and CO_2-e reduction of around 64 TJ and 7,500 tons, respectively. In recognition of the success, PTTGC12 was one of six recipients nationwide who were awarded the Prime Minister's Industry Award in Energy Management Category in 2014.

The success of Energy Management System at PTTGC12 was recognized nationally and was awarded the Prime Minister's Industry Award in Energy Management Category in 2014.

Figure 2: Mr. Pairote Utaisup, PTTGC's Executive Vice President for Polymer Businesses, received the award from Thailand's Prime Minister

EnMS Development and Implementation

ORGANIZATIONAL

Chief Executive Officer (CEO) of PTTGC group acts as the top management for all plants within the group. The CEO manages energy by setting vision and direction via issuing energy policy, providing guidelines and resources, and appointing MR, committees, and teams:

- **GC Operational Excellence Committee.** (GC OpEx Committee) This committee is chaired by the Chief Operating Officer for Center of Excellence (COE) and consists of Executive Vice Presidents (EVP) and Vice Presidents (VP) from every plant, and Energy Management Coordinator (EMC).

- **EnMS Facility Level Committee (EFC).** Each plant has its own EFC which is chaired by the plant VP and consists of Plant Operation Manager, Plant Asset Manager, Plant Maintenance Manager, Plant Technical Manager, Area EnMS Focal Point, and EMC.
- **EnMS Taskforce Team (ETT).** The ETT is appointed by EFC. The team mainly consists of operators, engineers, and personnel from supporting functions such as maintenance division.
- **Integrated Management Representative (IMR) and Assistance EnMR**
- **EnMS Internal Audit Team**

Figure 3 shows the responsibilities of the top management, committees, and team. The CEO, as the top management, provides necessary vision, direction and supports, including resources, necessary for the implementation and improvement of the EnMS. The GC OpEx Committee is responsible for managing the OpEx Management System. This covers overseeing the overall efficiencies of the group's operations including energy. The EFC is responsible for day-to-day issues relating to the EnMS, such as operation and communication, at their respective plants. The ETT's main responsibility is to support EFC in managing energy. The team supports and executes energy performance improvement projects and activities.

The success of managing energy depends on clear collaboration among the teams and staff. This is the foundation of a successful EnMS at PTTGC12.

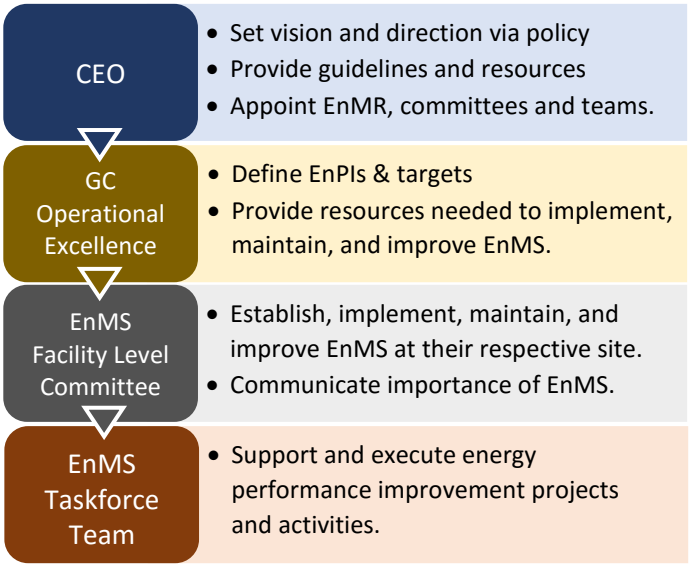

Figure 3: Responsibilities of CEO, committees, and team

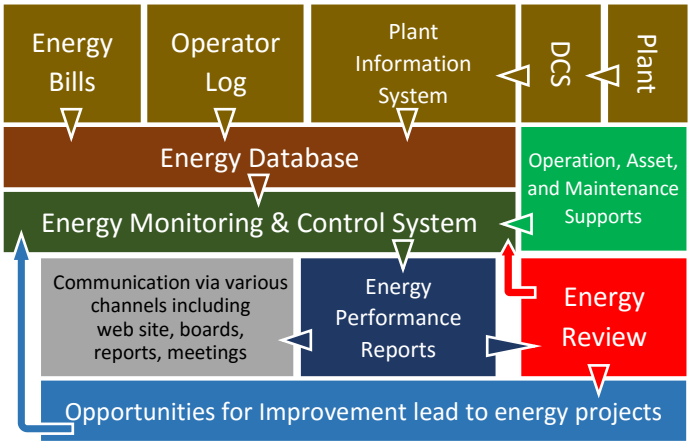

Figure 4: Energy Review and Planning @ PTTGC12

ENERGY REVIEW AND PLANNING

PTTGC developed a procedure for energy review and planning. The process specified in the procedure is shown in Figure 4 and summarized below.

Information from various sources is transferred to and saved on PTTGC12 Central Database. Parameters that considered to be Key Energy Efficiency Parameters (KEEPs) are analyzed and compared against operation guidelines. PTTGC12 employs Advance Process Control (APC) technology to control KEEP within specified controlled window. The monitoring, controlling and analyzing tasks are supported by teams from Operation, Technical, Asset, and Maintenance Divisions.

Energy Performance Reports are generated regularly with frequency that depends on the users' needs. For example, a report with headline numbers for the past 24 hours, such as production level, energy consumed, and kWh/ton, is generated daily and presented to the management team during regular daily operation team meeting. A report showing all EnPIs for shift supervisors is generated at the end of every shift and shown on the computers in the control room. Values of key EnPIs are communicated monthly throughout facility via various channels such as web site, boards, and meetings.

Energy information and results from the analysis are also used for identifying opportunities for improvement. A list of possible energy saving measures is developed during brainstorming sessions. The measures are then prioritized using a gap-idea analysis technique which considers value of saved energy, CAPEX, probability for the project success, and effort required for project implementation. Measures that are both technically and financially feasible will be given highest priority. They will become the major part of the energy saving action plan.

Review, analysis, and planning. Energy performance metrics for measuring energy performances at PTTGC12 covers different levels of operation – organization, facility, and significant energy uses/equipment.

Monthly consumption is used as EnPI for organization level. Users are the CEO, OpEx Committee, and EFC.

Energy Intensity or kWh/ton HDPE is used as the indicator for facility level. Users are OpEx Committee, EFC, ETT, plant management, and engineers.

Either intensity or efficiency, for example, % Efficiency for extruder motors and kW/100 scfm for air compressors, is used for SEUs. Technical and maintenance engineers are the main users.

To provide framework for achieving high energy performance, PTTGC group developed an Energy Excellence (E^2) model. The E^2 Model is used for comparative analysis and gap closing of the potential improvements for process units. Checklists of key activities that could potentially impact energy consumption are developed and regularly updated. There are 4 sections in the E^2 model, they are Design, Maintain, Control, and Operate. Figure 5 shows the main concepts for each section.

On issuing guidelines based on optimized conditions, at PTTGC12, technical engineers are responsible for developing operation guidelines by using lesson learned, simulation software or pilot scale plant. The approach used depends on feed compositions, feed conditions and type of polymerization catalyst. If everything above remains unchanged, past operation records will be used for developing the guideline. If it is new feed compositions and/or conditions, then a simulation software is used to obtain optimized conditions. However, if a new catalyst is developed, then the pilot-scale plant will be used to obtain new operating conditions.

As mentioned earlier, apart from saving energy by controlling operations, PTTGC12 also uses the stored energy data for identifying opportunities for improvement. Some of the measures in the energy saving action plans include:

- Installing heat exchanger to recover waste heat,
- Reducing steam consumption by implementing steam system optimization program.

Cost-benefit analysis. PTTGC12 started implementing ISO 50001 early 2013 and was certified in December 2013. The total time for the implementation was about 9 months. Each year since the certification, PTTGC12 has been spending around $USD190,865 in staff cost, energy campaigns, technical assistance, certification and surveillance audits. The savings from the EnMS program and the energy saving action plans was around$USD1,125,200. The payback period was 2.04 months. The action plans for the 2013-1016 period required investments around $USD738,385.

Figure 5: Energy Excellence (E^2) Model at PTTGC

Approach used to determine whether energy performance improved. For plant level, kWh/ton for the 12 months of 2013 were calculated and formed the baseline. The values for 2014 – 2016 were then compared, at the same production level, against this baseline. Figure 6 shows the comparisons. In addition, the ratio between kWh/ton for the reporting period (2014 – 2016) and the baseline period (2013), called Energy Intensity Index or EII, were also calculated. EII lower than 1.0 indicates better performance than the baseline period. Figure 7 shows an EII plot for 2014 – 2016. These plots are generated monthly and reported to OpEx Committee, EFC, and ETT.

On the organizational level, PTTGC12 uses the CUSUM technique to quantify the saved energy. Two baseline equations, one for monthly electricity consumption and the other for monthly steam consumptions, using 2013 as the base year were developed. Total HDPE production volume was chosen as the driver. Regression analysis of the energy consumptions and production data was performed. Table 1 shows the parameters for the baseline equations. Results from the two equations are then added together to get the "Predicted Total Monthly Consumption." Figure 8 shows the CUSUM plot for the 2013-2014 period. The negative slope indicates actual consumption is lower than the predicted value. The levelling-off in consumption from mid-2014 until mid-2015 was the results of product upgrading and testing of a new catalyst. The overall reduction trend indicates sustainable and continual improvement in energy performance at PTTGC12.

Approach used to validate results. PDCA continual improvement cycle is key to PTTGC's EnMS. At PTTGC, the "check" and "Act" steps are taken very seriously.

Table 1 Parameters for Energy Baseline Equations

Coefficient for tons HDPE/month Plant 1 (kWh/ton HDPE)	Coefficient for tons HDPE/month Plant 2 (kWh/ton HDPE)	Baseload (kWh/month)
Monthly Electricity Consumption (kWh/month)		
276.18	329.83	1,001,425.51
Monthly Steam Consumption (kWh/month)		
234.05	197.13	1,001,346.51

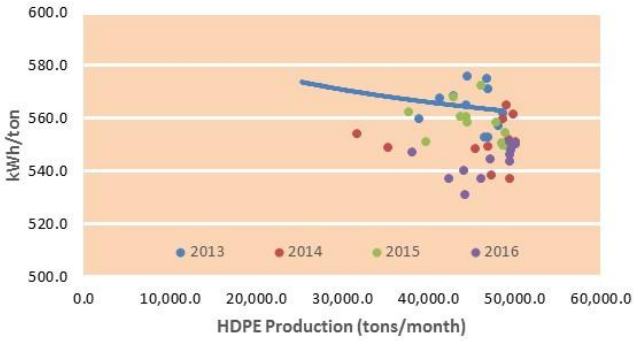

Figure 6: Comparison of kWh/ton for 2013 - 2016

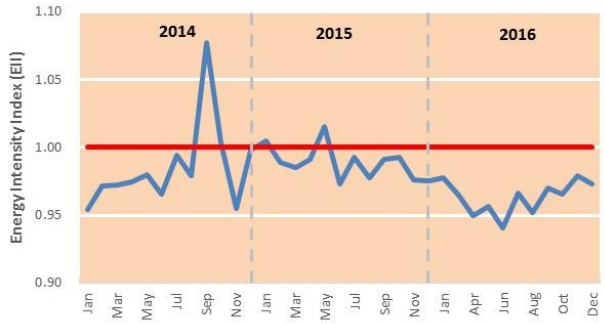

Figure 7: Plot of EII for 2014 – 2016 with 2013 as base year

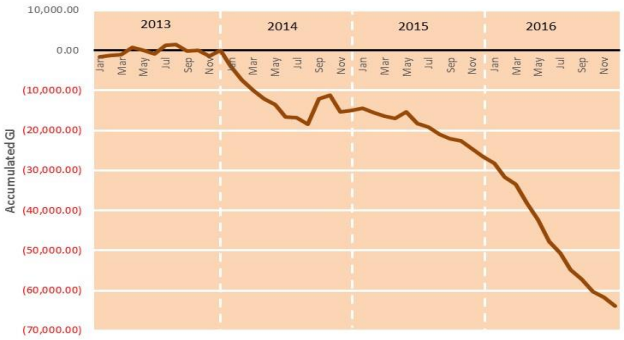

Figure 8: CUSUM Plot from 2013 – 2016 for PTTGC12

Validating Operation Guidelines. Shift supervisors and operators use the values provided in the operation guidelines as the first step in controlling the processes. Product samples are taken regularly to ensure product qualities. If the laboratory results indicate "off-spec" products, then the processes are adjusted accordingly until the products are "on-spec." The technical engineers are informed of the adjustments made. Review and analysis of data is carried out to determine the causes. These might be fouling of heat exchangers,

deactivating of catalyst, etc. The findings not only help fine tuning the guidelines but also provide information for planning turnarounds or mini-plant shutdowns.

Validate energy information and EnMS. Internal audit is also important to the success of EnMS. Independent auditors are scheduled to verify the energy related information and the implementation of EnMS once a year. In addition, since PTTGC issues "Sustainability Report" every year, the energy and carbon emission information published in the report is also audited and validated by third party auditors.

Steps taken to maintain operational control and sustain energy performance improvement. By identifying KEEPs, providing operation guidelines and deploying of APC, PTTGC12 can effectively control their processes within the controlled windows. Standard Operating Procedures (SOPs) were developed. Personnel relating to SEUs were trained to ensure full understanding of the practices described in the SOPs.

Development and use of professional expertise, training, and communications. PTTGC12 participated in the United Nations Industrial Development Organization (UNIDO)'s Industrial Energy Efficiency Program in Thailand. The program provided trainings by international experts on energy management system and system optimization.

Employee engagement. Various activities involving employees were implemented. For example, SEEK (Safety, Energy, and Environment Knowledge) Day is organized regularly every year to encourage staff to submit ideas to improve safety awareness, reduce environmental impacts, and save energy. Awards are given to ideas that considered to be practical and innovative.

Professional expertise. PTTGC12 participated in the global benchmarking by Phillip Townsend Associates. PTTGC12 was ranked among the 1st Quartile group.

Tools and resources. PTTGC developed the OpEx Guideline which covers every aspect of operations. In addition, PTTGC12 also has access to the PTT Knowledge Sharing Web Portal where ideas from employees of companies within PTT group are stored. During 2014 – 2016, 17 ideas from the portal were implemented at PTTGC12 resulting in saving of more than $USD200,000.

Lessons Learned

What set implementation of ISO 50001 EnMS apart from other management systems?

- Energy is about data. Without data, energy cannot be managed. Therefore, the first barrier to the success is availability of energy information.
- Managing energy requires technical knowledge. Therefore, ISO 50001 EnMS working team must include people that are familiar with ISO system and people that possess energy related knowledge.

Keys to Success

- Management plays a pivotal role in the success of EnMS implementation. Without proper supports, implementing EnMS, which is time consuming and requires resources, will be difficult.
- Staff participation is important for the effectiveness of an EnMS. Without their involvement, the EnMS will only be a formality which creates burdens, instead of supports, to operation.
- Though data is importance to managing energy, analysis and review is even more important.