Global Energy Management System Implementation: Case Study

Thailand

PTT Global Chemical PCL Branch 6 Refinery

During 2013 – 2016, PTTGC6 achieved energy saving of more than 470 TJ, equivalent to around 25.4 tonnes of CO_2-e reduction.

To save energy sustainably, PTTGC6 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 Solomon Associates.

Figure 1: PTTGC6 Plant in Rayong, Thailand

Business Case for Energy Management

PTT Global Chemical Public Company Limited – Branch 6 (PTTGC6), was established in 1996 as Rayong Refinery Public Co., Ltd (RRC). In 2007, RRC was acquired by PTT Aromatics & Refining Public Co., Ltd. (PTTAR). In 2011, it merged with PTT Chemical Public Co., Ltd. (PTTCHEM) to form PTTGC, the largest integrated refinery and petrochemical company in Thailand. PTTGC6 produces refined petroleum products, such as liquid petroleum, reformate, gasoline, light naphtha, jet fuel, diesel, and bunker oil by using the crude oil imported mainly 70-80% from Middle east and the rest from West African and Far East. The crude throughput capacity is 280,000 barrels per day of crude oil and condensate with product outputs of around 228,000 barrels per day. Around 85% of these products are consumed domestically whilst the remaining 15% is exported.

"Energy efficiency is the key strength at our refinery, ISO 50001 EnMS provides us with a systematic approach for managing energy resulting in continual improvement of the operation."

Mr. Ratchada Sawasdirak, Vice President Refinery

Case Study Snapshot	
Industry	Oil Refinery
Product/Service	Refined petroleum products
Location	Rayong, Thailand
Energy Management System	ISO 50001
Energy Performance Improvement Period	2013 – 2016 (4 years)
Energy Performance Improvement (%) over improvement period	1.89% for the period. (Normalized using total production with 2013 as base year.)
Total energy cost savings over improvement period	Saving of $USD5,599,714/4 yrs
Cost to implement EnMS	Cost for implementation $USD1,231,934/4 yrs
Payback period on EnMS implementation (years)	2.64 months
Total Energy Savings over improvement period	469,727 GJ
Total CO_2-e emission reduction over improvement period	25.4 Metric tons

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:

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 PTTGC6, average energy cost is around 75% of operating cost. Therefore, both cost and emission reductions are the main drivers behind PTTGC6's effort in improving its energy efficiency.

ENERGY MANAGEMENT PROGRAM

Another important driver for implementing EnMS is Thai legal requirements. Under Thailand's Energy Conservation Act, PTTGC6 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, PTTGC6 (PTTAR at that time) improved its energy performance by focusing mainly on implementing energy no-cost/low-cost, capital energy saving projects and, **most importantly, implementing "efficiency-by-design concept with new facilities or plant expansion**. The approach could not sustain long term effort to save energy since it required significant investment. Once the Thai EnMS was announced, PTTGC6 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 PTTGC6 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 PTTGC6 to systematically focus its mission in reducing its environmental impact and energy consumption. It integrates all energy management elements such as awareness & training, assessment, indicators, metering, controls & analysis, etc., which used to spread among various job functions, into one cohesively connected system. Actions are being taken at the right time due to smooth 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, PTTGC6 has achieved energy saving and CO_2-e reduction of more than 470 TJ and around 25.4 tons, respectively.

EnMS Development and Implementation

ORGANIZATIONAL

Chief Executive Officer (CEO) of PTTGC group acts as the top management for all plants within the PTTGC 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 Upstream Businesses (COU) 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 purchasing officers.

- **Integrated Management Representative (IMR) and Assistance EnMR**
- **EnMS Internal Audit Team**

Figure 2 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 requires having right personnel, clear collaboration among the teams and staff, best practices and energy efficient processes. This is the foundation of a successful EnMS at PTTGC6.

ENERGY REVIEW AND PLANNING

PTTGC developed a procedure for energy review and planning. The process specified in the procedure is shown in Figure 3 and summarized below.

Information from various sources is transferred to and saved on PTTGC6 Central Database. Parameters that considered to be Key Energy Efficiency Parameters (KEEP) is then analyzed and compared against operation guidelines. In order to control KEEP at optimum conditions and within specified controlled window, PTTGC6 employs Real-time Optimization (RTO) and Advance Process Control (APC) technologies. The monitoring, controlling and analyzing tasks are supported by teams from Operation, Asset, and Maintenance Departments.

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 by the facility and major equipment, is generated daily and

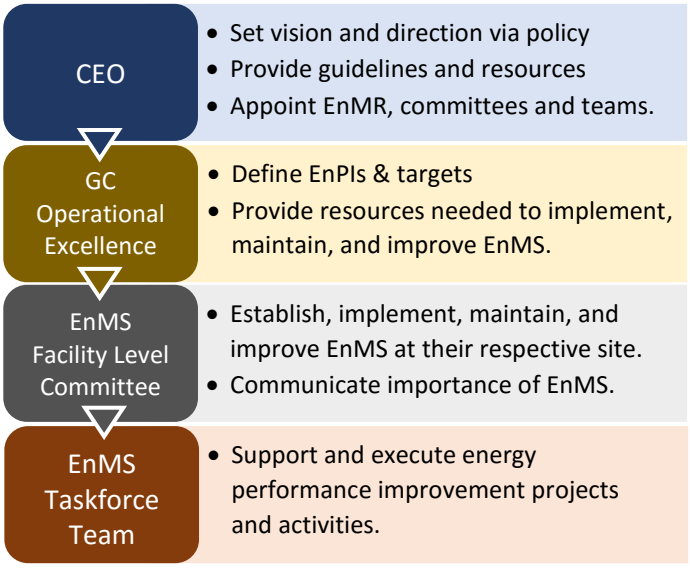

Figure 2: Responsibilities of CEO, committees, and team

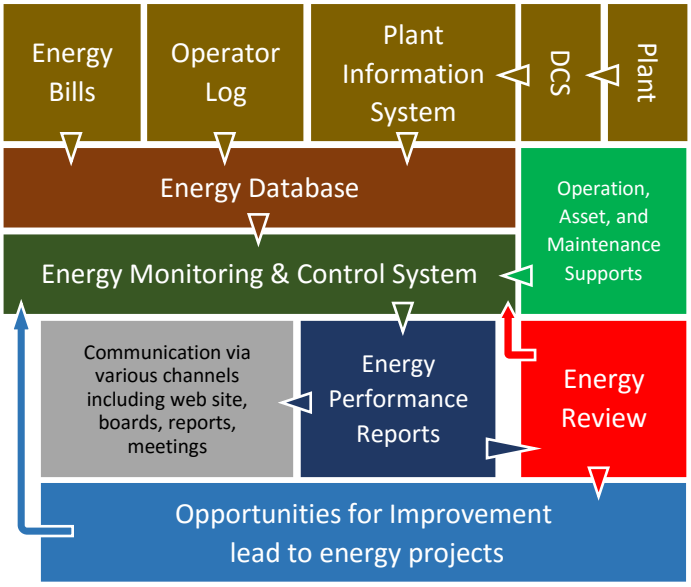

Figure 3: Energy Review and Planning @ PTTGC6

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, for each measure, 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 PTTGC6 covers different levels of operation – organization, facility, and significant energy uses/equipment.

For organization level, PTTGC6 uses "monthly consumption" as EnPI. Users for this EnPI are the CEO, OpEx Committee, and EFC.

For facility level, PTTGC6 also chooses "monthly consumption" as the indicator. Users for these EnPIs are OpEx Committee, EFC, ETT, management of each plant, and operation and technical engineers.

For significant energy uses/equipment, PTTGC6 uses either intensity or efficiency concept in setting the EnPIs, for example, % Efficiency based on API 560 for fired heater and kW/100 scfm for air compressors. Technical and maintenance engineers are the main users of these EnPIs.

To achieve high energy performance, an Energy Excellence (E^2) model was developed for implementation by every plant within the PTTGC group. 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 4 shows the main concepts for each section.

On issuing guidelines based on optimized conditions, at PTTGC6, technical engineers are responsible for developing operation guidelines by using lesson learned and simulation software. The approach used depends on feed compositions and feed conditions. If everything above remains unchanged, past operation records will be used for developing the guideline. However, if it is new feed compositions and/or conditions, then a simulation software is used to obtain optimized conditions.

As mentioned earlier, apart from saving energy by controlling operations, PTTGC6 also uses the stored energy data for identifying opportunities for improvement. Some of the measures in the energy saving action plans included:

- Coating inside fired heaters with ceramic materials to reduce radiation losses and formation of oxidation scales,
- Installing PACKINOX® feed effluent heat exchangers for platformer unit, and
- Modifying pipe networks to introduce hot feeds to next units.

Cost-benefit analysis. PTTGC6 started implementing ISO 50001 early 2013 and was certified in December 2013. The total time for the implementation was about 9 months. Since being certified, PTTGC6 has spent around $USD1,231,934 in staff cost, energy campaigns, technical assistance, certification and surveillance

Figure 4: Energy Excellence (E^2) Model at PTTGC

audits. The savings from the EnMS program and the energy saving action plans was around $USD5,599,714. The payback period was 2.64 months. The action plans for the 2013-1016 period required investments around $USD3,429,429.

Approach used to determine whether energy performance improved. For the organization and facility levels where monthly energy consumption is used as EnPI, the ratio between monthly energy consumption for the reporting period (2014 – 2016) and the Solomon standard, called Energy Intensity Index or EII, were calculated. EII lower than 100 indicates better performance than the Solomon standard. Figure 5 shows an EII plot for 2014 – 2016. The plot is generated monthly and reported to OpEx Committee, EFC, and ETT.

Approach used to validate results. Plan-Do-Check-Act (PDCA) continual improvement cycle is the key to PTTGC's EnMS. At PTTGC, the "check" step is taken very seriously.

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 in the crude preheat train, or leaks in steam traps, etc. The findings not only help fine tuning the guidelines in the future 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 system. 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.

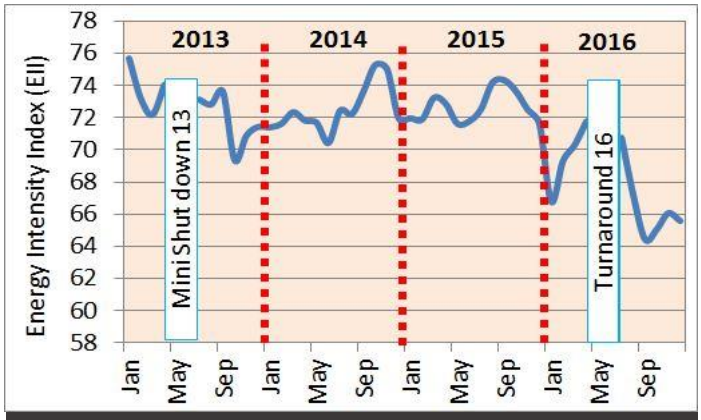

Figure 5: Plot of EII for 2014 – 2016 with 2013 as base year

Steps taken to maintain operational control and sustain energy performance improvement. By identifying KEEPs, providing operation guidelines and deploying of RTO and APC, PTTGC6 operations can effectively control their processes within the controlled windows to achieve maximum gross refinery margin.

Standard Operating Procedures (SOPs) for SEUs were developed. Personnel relating to SEUs were trained to ensure full understanding of the best practices described in the SOPs.

Development and use of professional expertise, training, and communications. PTTGC6 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 are considered to be practical and innovative. Figure 6 shows the team from PTTGC6 with the SEEK Day Award in 2015

Professional expertise. PTTGC6 participated in the global benchmarking by Solomon Associates. PTTGC6 was ranked in the 1st Quartile group.

Figure 6: Team from PTTGC6 with the SEEK Day Award in 2015

Tools and resources. PTTGC developed the OpEx Guideline which covers every aspect of operations. In addition, PTTGC6 also has access to the PTT Knowledge Sharing Web Portal where ideas from employees of companies within PTT group are stored. All PTTGC employees study ideas that are shared by their colleagues. During 2014 – 2016, 9 ideas from the portal were implemented at PTTGC6 resulting in saving of more than $USD752,857.

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.