Global Energy Management System Implementation: Case Study

Thailand

Map Ta Phut Olefins Company Limited (MOC)

ASEAN Energy Award 2015: *WINNER of ASEAN Best Practices Energy Management for Industries Awards (Large Industry Category)*

Thailand Energy Awards 2015: *The winner, in category of Energy Conservation for controlled factory*

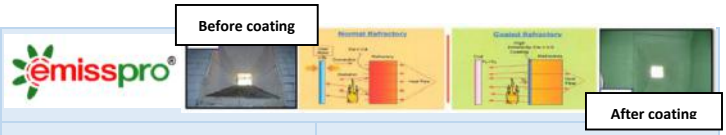
TPM Excellence Award Winner

Business Benefits Achieved

MOC has continuously reduced the specific energy consumption from 18,466 MJ/Ton olefins in 2012 to 17,093 MJ/Ton olefins in 2015.And we can decrease cost more than 10 million USD within four years and can reduce CO_2 release around 64,000 TonsCO_2eq. Moreover, MOC also achieved non-financial benefit from ISO: 50001 implementation as we could encourage all levels of employees to participate in implementing the ISO standard, and develop operating competency. Consequently, for the long-term culture, MOC will be able to continuously improve working efficiency and become a sustainable development.

"Effective execution in energy management system is the foundation of sustainable development"

—Mongkol Hengrojanasophon, Managing Director



Industry	Petrochemical
Location	Rayong Province, Thailand
Energy Management System	ISO 50001 : 2011
Product/Service	Pyrolysis reaction for Naphtha and Light feed to produce Ethylene and Propylene
Energy Performance Improvement (%)	2.27 %
Annual energy cost savings	964,114 USD/year
Cost to implement	800,000 USD/year
Payback period	0.83 year

Company Profile

Map Ta Phut Olefins Company Limited (MOC), a subsidiary of SCG Chemicals was established in 2006 and started up production process in 2010. MOC is one of the two olefins producers of SCG Chemicals. MOC's main products are ethylene and propylene (collectively called olefins). By-products include mixed C-4, benzene, toluene, mixed xylene, depleted pyrolysis gasoline, and cracker bottom. MOC is the first olefins plant that was certified carbon reduction label by Thailand Environment Institute and Thailand Greenhouse Gas Management Organization (Public Organization) in 2012. In addition, company has been certified ISO 9001:2008, ISO 14001:2004, OHSAS 18001:2007, ISO 50001:2011 and has applied TPM principle (Total Productive Maintenance) as a major management system.

Energy Profile

MOC plant is operated with 97.76% usage of thermal energy (natural gas and steam) and 2.24% electrical consumption. Thermal energy is mainly used by cracking furnaces that consume about 87% of total thermal energy usage whereas electricity consumption is mostly used in utilities unit.

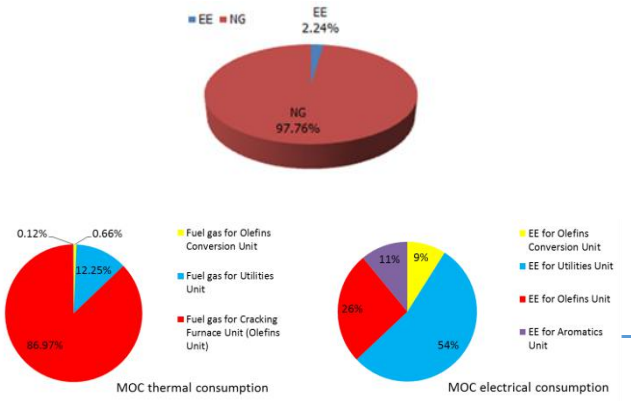


Figure 1. MOC Plant Energy Consumption Characteristic

Business Case for Energy Management

In Olefins production plant, energy is the most significant operating cost. MOC's energy consumption is the biggest portion in SCG Chemicals. So, the executives have set energy efficiency improvement strategy which ISO: 50001 implementation was chosen to be a tool for development and standardization of operating process. The results of energy management system implementation can measure from equipment efficiency and specific energy consumption increasing continuously.

Moreover, MOC's vision is "Sustainability for being the internationality forefront." It includes product quality, safety in work, energy efficiency management, eco factory, corporate social responsibility, and personal development. The energy management roadmap has been targeted to be in the Average First Quartile Performance of Energy Efficiency (SOLOMON index) by the year 2018 and to comply with 10% GHGs reduction by the year 2020 with based year in 2007.

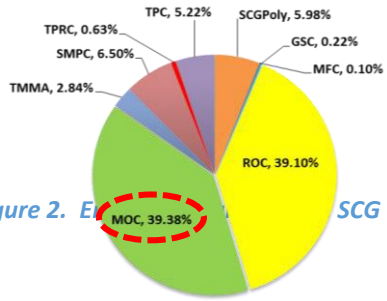


Figure 2. E… SCG Chemicals

Keys to Success

- **Top management level commitment:** MOC's top management has extremely placed importance on energy management. As mentioned in the MOC's management policy that "MOC focuses on maximization energy usage efficiency by improving energy performance" improvement process needs to be appropriate with energy usage characteristics and consumption volume of the plant. Moreover, decreasing of releasing greenhouse gases has been concerned". From this policy, energy target indicator has been set up in order to control energy performance. These indicate that top executives of MOC always have commitment and concern about energy efficiency development.
- **Employee engagement:** Since we started to implement ISO 50001, energy policy and action plans were communicated and delegated to all levels of employees from top management through communication tools and many activities in order to build up understanding and buy in the regulation together.
- **Collaboration:** Good relationship can build up good collaboration in both internal and cross-functional departments through energy conservation activities and campaigns such as Energy Saving Day and Energy Workshop.
- **Capability building:** As mentioned in SCG business philosophy that "belief in the value of individual", MOC has many training programs for building up employee's capability.
- **Show and share:** For continuous improvement, MOC always shows and shares practice with internal and external organization in order to get new ideas or projects for developing existing systems.

EnMS Development and Implementation

MOC has achieved in both financial and non-financial benefits as followings:

Financial benefits

After being certified ISO 50001 : 2011, MOC has continuously developed the effectiveness of energy use in the plant by applying several projects based on energy review and planning, such as, cracking furnace and boiler improvement projects. As a result, we have continuously reduced the specific energy consumption from 18,466 MJ/Ton olefins in 2012 to 17,093 MJ/Ton olefins in 2015. Furthermore, we can decrease cost more than 10 million USD within four years and can reduce CO_2 release around 64,000 TonsCO_2eq.

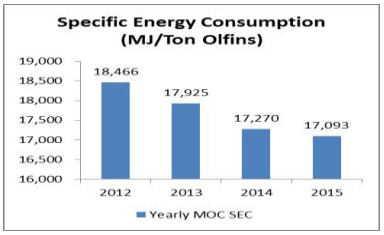


Figure 3. SEC of MOC Plant in 2012-2015

Description	Unit	2012	2013	2014	2015
EE cost saving	USD	15,383	1,381,905	94,070	80,286
Fuel cost saving	USD	4,034,485	285,700	1,960,452	2,867,000
Total energy cost saving	USD	4,049,868	1,667,605	2,054,522	2,947,286
CO2 EE reduction	Ton	140	8,067	848	423
CO2 Fuel reduction	Ton	17,821	13,864	12,698	10,849
Total CO2 reduction	Ton	17,961	21,931	13,547	11,272

Table 1. Cost saving and CO2 reduction

For non-financial benefits, MOC achieved many award such as:

1. TPM Excellence Award 2015

MOC passed criteria of TPM in Excellence Award level from Japan Institute of Plant Maintenance.

Name	Area
B.foods Product International Co.,Ltd.	Kingdom of Thailand
Coca-Cola Beverages Sri Lanka Limited	Democratic Socialist Republic of Sri Lanka
CPF (Thailand) Public Company Limited Bangna Feedmill	Kingdom of Thailand
CPF (Thailand) Public Company Limited Nongkae Feedmill , BPF	Kingdom of Thailand
CPF (Thailand) Public Company Limited Pakthongchai Feedmill	Kingdom of Thailand
CPF (Thailand) Public Company Limited Phitsanulok Feedmill	Kingdom of Thailand
ETI GIDA SAN ve TIC A.S. Grain Plant	Republic of Turkey
Grupo JUMEX Mexicali Plant	United Mexican States
Grupo JUMEX Xalostoc Plant	United Mexican States
HARSHA ENGINEERS LIMITED CHANGODAR AND MORAIYA PLANTS	India
Hindustan Coca Cola Beverages Private Limited - Gobej Plant	India
Hindustan Coca Cola Beverages Private Limited - Ranirajpur Plant	India
IRPC Public Company Limited Petroleum Plant	Kingdom of Thailand
JINDAL STEEL AND POWER LIMITED – BARBIL PELLET PLANT	India
LINDT & SPRÜNGLI SPA INDUNO OLONA	Republic of Italy
Map Ta Phut Olefins Co., Ltd.	Kingdom of Thailand
NAWAPLASTIC INDUSTRIES CO., LTD.	Kingdom of Thailand
OCV Mexico S de RL de CV Owens Corning - TLAXCALA	United Mexican States
Raychem RPG (P) Ltd GMD-CIPF, Halol	India
Shanghai Topoint Precision Technology Company	People's Republic of China
Sigma Alimentos Alimentos Finos de Occidente S.A de C.V	United Mexican States
Suiker Unie Sugar Specialties Roosendaal	Kingdom of the Netherlands

Figure 4. TPM Excellence Award Announcement 2015

2. Thailand Energy Award 2015 in Energy and ASEAN Energy Award 2015

The winner, in category of Energy Conservation for controlled factory type by Thailand's Ministry of Energy, and the winner of ASEAN best practice award for Energy Management in building and industries category.

Figure 5. Thailand Energy Awards and ASEAN Energy Awards

These awards are given to the company having continuous improvement and successful implementation results in EnMS. From these achievements, MOC can increase stakeholder's reliability and business competitiveness ability.

In addition, MOC also achieved non-financial benefit from ISO: 50001 implementation as we could encourage all levels of employees to participate in implementing the ISO standard, and develop operating competency. Consequently, for the long-term culture, MOC will be able to continuously improve working efficiency and become a sustainable development.

Organization: For generating an effective energy conservation management, MOC has appointed two energy conservation committees in addition to a normal organization. Both committees consist of many competent representatives from every department, such as Production Department, Maintenance Department, Environmental Department, Research & Develop Department, etc. The committees comprise engineers, department managers, and top-level management as chairman. More importantly, they have continuously supported many energy conservation projects by developing and putting their objectives and strategies into practice.

1. MOC Energy Conservation Steering Committee: This committee has representatives from top management level. The committee takes responsibility for launching an energy policy and providing practical directions for support energy conservation projects to be implemented.

2. MOC Energy Conservation Task Force Committee: This working group is assembled from engineers. The committee is accountable for operational control and monitoring energy conservation projects of MOC.

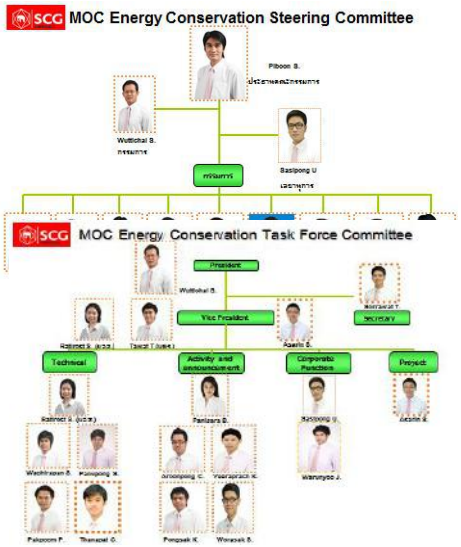


Figure 6. Organization of MOC energy conservation committees

Energy review and planning: Responsible engineers in each area have to evaluate energy consumption annually by using all equipment to define the following elements:

Figure 7. Energy review and planning cycle

1. "Significant Energy Usage" (SEU) by collecting energy consumption annually of their equipment by using "Process Information Program" and verifying which equipment is defined as SEU following the table aside.

Lavel	Electrical Energy (GJ/year)	Thermal Energy (GJ/year)
High Sig	> 10,000	> 1,000,000
Medium Sig	5,000-10,000	100,000-1,000,000
Low/No Sig	< 5,000	<100,000

Table 2: Significant energy usage definition criteria

2. "Significant Energy Parameter" (SEP) by looking at the SEU in all controllable and uncontrollable parameters which affect energy consumption and listing it to find "Opportunity for Improvement" as the saving project.

3. "Opportunity for Improvement" or saving projects are from idea workshop which is created from operator and engineer.

4. Proposing the projects to steering committee to decide what will become the action plan categorized based on existence of investment.

a. No investment cost, if a project does not affect the regulations, it to be proceeded as the action plan.

b. For the criteria of investment for energy saving projects, the company has considered not only the economic benefits, including IRR and payback period, but also environmental impact, health, safety, laws and regulations, and nearby communities. The first priority will be given to the projects that affect environment, safety or contrast to provisions of enforced laws. For the investment project, measures will be considered and marked with the criteria shown in the following table. The first 10 ranked projects will be presented to the company's energy committee meeting. If the project is approved, then it will be managed immediately as action plan project.

5. Monitoring the improvement through "Energy Performance Index", energy performance will be reported to committee in monthly meeting and via Lotus Notes system (internal database) as shown in figure below, which is a program for monitoring the progress of the plan and systemic evaluation of project achievement (Abnormality Report). It will be used to evaluate the project achievement in 4 levels.

- Student A: Good Process + Satisfying Results (Targets Achieved)
- Student B: Doubtful/Incomplete Process + Satisfying Results
- Student C: Good Process + Unsatisfying Results
- Student D: Doubtful/Incomplete Process + Unsatisfying Results

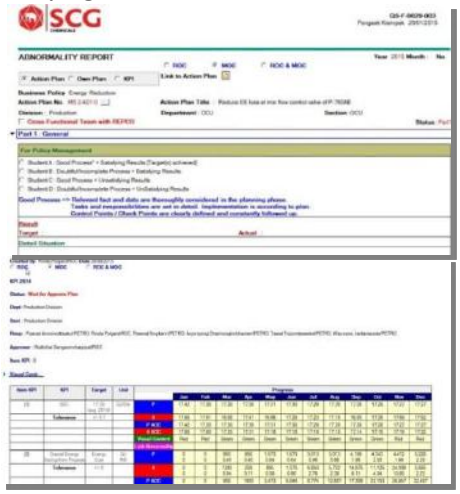


Figure 8. Lotus Notes Database System

Development and use of professional expertise, training, and communications

In addition to energy conservation projects that have been continuously implemented in MOC since its plant started up in 2010, energy conservation activities and campaigns have been organized here as well. MOC has encouraged employees in all levels to participate and engage in those activities so that they will realize the importance of energy management system and become more interested in conserving it. Some examples of events as followings:

- **MOC Energy Saving Day** is arranged every year by energy conservation committee. The objective of this activity is to create energy conservation awareness to all employees .In this event, there are many activities provided in order to educate participants such as, energy talk by EnMR, energy parade, energy knowledge brochure distribution and energy quiz, etc. As a result, all levels of employees including top management have participated and they have realized in energy saving mind set.

- **MOC Energy Workshop** is the annual event that invites representatives of all departments to brainstorm and find energy opportunities for improvement accompany with energy conservation committee. The results will be defined as annual action plans to reduce the energy consumption in the manufacturing process. During 2012-2015, MOC can summarize the annual action plan more than 40 projects from this activity.

Figure 9. MOC energy saving day and energy workshop

Training

MOC gives priority to employee development as can be seen from one of the SCG business philosophy that "belief in the value of individual". The development pathway of all employee level has been defined since first day of work.

To prepare the staffs' physical and mental ability, MOC focuses on increasing knowledge level, skills and attitudes which refer to "Competency". Employees will be developed competence to achieving the goals and strategies of the business. Moreover, employee development method not only focuses on internal and external classroom training, but also practicing, on the job training and other forms of development such as self-learning and other assignments aside from routine work, etc.

For energy conservation personnel, MOC focuses on increasing knowledge and understanding about energy saving and efficiency as well. After finishing courses, the trained employees will convey their knowledge to other employees in the organizations as well.

Training Courses	Date	Attendee (persons)	Amount of training (times)
Internal Courses			
ISO 50001 Awareness	14/06/2013, 18/06/2013, 4/9/2013, 5/9/2013, 6/9/2013, 10/6/2014, 18/6/2014	171	7
ISO 50001 : Requirement	12/2/2013	13	1
ISO 50001 Internal Audit	25-26/04/2013	11	1
External Courses			
Senior Energy Responsible Person	28/07/2014-01/08/2014	1	1
General Energy Responsible Person	06-11/10/2014, 24-29/11/2014 , 12-17/03/2012	3	3
Internal Energy Audit	19/3/2013	1	1
Energy Conservation Potential Evaluation	06-08/05/2014	2	1
Energy Management System Implementation	12-13/07/2012	2	1
EnMs Internal Audit	18-19/08/2014	6	1

Table 3: Energy training course for MOC's employee

Tools & Resources: Energy meter such as natural gas flow rate or ampere meters are applied to all significant energy usage for precisely measure with quality. Each meter has been calibrated by third party to assure the quality of the measurement. In addition, "Process Information Program" is applied for record and evaluation the usage or abnormal status for improvement.

Moreover, MOC has implemented other management systems such as ISO 9001, ISO 14001, OHSAS 18001, TPM, TQM principle, etc. All systems are usefully driven operations to become excellent organization.

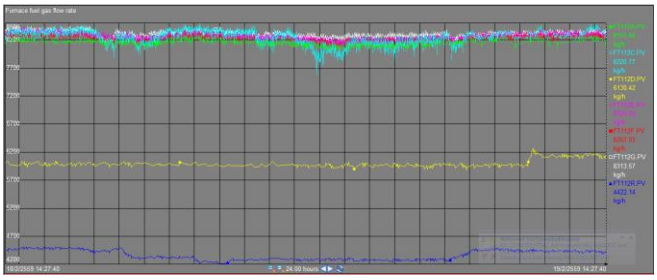
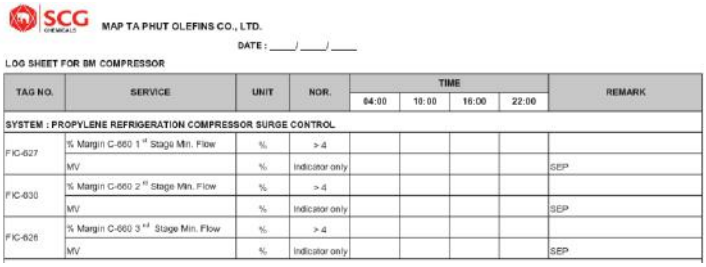


Figure 9. Example of fuel gas flow rate via "Process Information" Program

Steps taken to maintain operational control and sustain energy performance improvement

All "Significant Energy Parameters" are added to the operator work instruction and have been trained through on-the-job training program (OJT). Moreover, to prevent the mis-operation we add "SEP" to their log sheet and set control target.



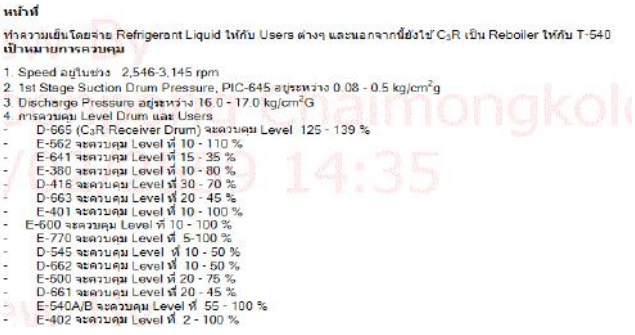
SCG CHEMICALS — MAP TA PHUT OLEFINS CO., LTD.

DATE : ____/____/____

LOG SHEET FOR BM COMPRESSOR

TAG NO.	SERVICE	UNIT	NOR.	TIME 04:00	10:00	16:00	22:00	REMARK
SYSTEM : PROPYLENE REFRIGERATION COMPRESSOR SURGE CONTROL								
FIC-627	% Margin C-660 1st Stage Min. Flow	%	> 4					
	MV	%	Indicator only					SEP
FIC-630	% Margin C-660 2nd Stage Min. Flow	%	> 4					
	MV	%	Indicator only					SEP
FIC-626	% Margin C-660 3rd Stage Min. Flow	%	> 4					
	MV	%	Indicator only					SEP

Figure 10. Example of operator's log sheet with significant energy parameters



หน้าที่

ทำความเย็นโดยจ่าย Refrigerant Liquid ให้กับ Users ต่างๆ และนอกจากนี้ยังใช้ C_3R เป็น Reboiler ให้กับ T-540

เป้าหมายการควบคุม

1. Speed อยู่ในช่วง 2,546-3,145 rpm
2. 1st Stage Suction Drum Pressure, PIC-645 อยู่ระหว่าง 0.08 - 0.5 kg/cm^{2}g
3. Discharge Pressure อยู่ระหว่าง 16.0 - 17.0 kg/cm^{2}G
4. การควบคุม Level Drum และ Users
   - D-665 (C_3R Receiver Drum) จะควบคุม Level 125 - 139 %
   - E-562 จะควบคุม Level ที่ 10 - 110 %
   - E-641 จะควบคุม Level ที่ 15 - 35 %
   - E-380 จะควบคุม Level ที่ 10 - 80 %
   - D-416 จะควบคุม Level ที่ 30 - 70 %
   - D-663 จะควบคุม Level ที่ 20 - 45 %
   - E-401 จะควบคุม Level ที่ 10 - 100 %
   - E-600 จะควบคุม Level ที่ 10 - 100 %
   - E-770 จะควบคุม Level ที่ 5-100 %
   - D-545 จะควบคุม Level ที่ 10 - 50 %
   - D-662 จะควบคุม Level ที่ 10 - 50 %
   - E-500 จะควบคุม Level ที่ 20 - 75 %
   - D-661 จะควบคุม Level ที่ 20 - 45 %
   - E-540A/B จะควบคุม Level ที่ 55 - 100 %
   - E-402 จะควบคุม Level ที่ 2 - 100 %

Figure 11. Work instruction of operator indicates significant energy parameters

Approach

There are two energy indexes for monitoring the energy conservation.

1. SOLOMON's Index *is* applied to benchmark with other global olefins plant. Normally MOC uses specific energy consumption per olefins products (ethylene and propylene products), in additional company also uses the SOLOMON index to international petrochemical industrial benchmarking (GJ/ton HVCs) which is an efficiency energy measure of the company including electricity, natural gas and cracker bottom. Results of energy conservation are continuously reduced over 3 years leading to saving the energy up to 7.9 %. Besides, we also have set the long term target that we aim to be in average of first quartile of SOLOMON INDEX or 12.45 GJ/HVA approximately by 2018.

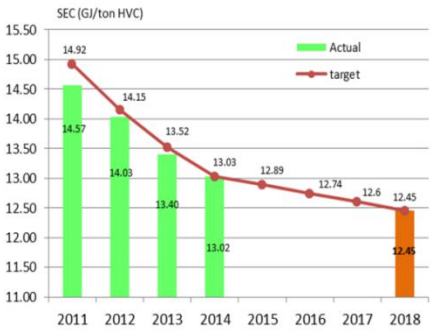


Figure 12. MOC's Solomon Index target in 2018

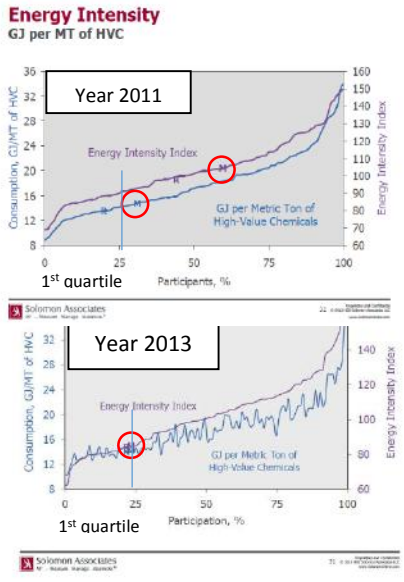


Figure 13. MOC's energy performance verified by Solomon Associates before and after ISO: 50001 implementation. We are in the 1st quartile.

2. EnPI: Company monitoring energy conservation divided into 3 categories:

2.1. Overall plant (Plant SEC)
2.2. Process Section SEC
2.3. Equipment monitoring

Description	Unit	Target
MOC		
SEC MOC	GJ/Net Olefins	17.3
Section OCU		
Reactor Feed Fired Heater	Fuel/Feed Flow	2.72 - 3.08
OCU C4 Feed Pump A	Power (kW)/Flow (T)	3.19 - 3.95
OCU C4 Feed Pump B	Power (kW)/Flow (T)	3.19 - 3.95
SHU-1 Recycle/Effluent pump A	Power (kW)/Flow (T)	0.68 - 0.74
SHU-1 Recycle/Effluent pump B	Power (kW)/Flow (T)	0.68 - 0.74
SEC OCU	GJ/Ton C3	<4.50
Section ARU		
SEC ARU	GJ / BTX Products (ton)	6.63-6.93
GHU-2 recycle gas compressor	kW / GHU-2 Feed flowrate	5.04 - 6.45
GHU-2 recycle gas compressor	kW / GHU-2 Feed flowrate	5.23 - 6.31
Deoctanizer Reboiler	(Steam / Total Feed)x 0.5	0.365 - 0.375
Deoctanizer Reboiler	(Steam / Total Feed)x 0.5	0.365 - 0.376
SRC Bottoms Pumps	kW / Solvent flowrate	0.78-0.90
SRC Bottoms Pumps	kW / Solvent flowrate	0.75-0.88

Table 4: EnPI monitoring

Cost-benefit analysis: As mentioned, we analyze the benefit through our criteria. Table below shows some projects that have and no have investment cost in it.

Energy conservation within the past 4 years	Efficiency Index		Energy Saving Per Year				Investment (USD)	Pay Back (Year)
			Electricity		Natural Gas			
	Before (MJ/year)	After (MJ/Year)	Energy Saving (kWh)	Cost Saving (USD)	Energy Saving (MJ)	Cost Saving (USD)		
Year 1: 2012								
Group 1: Measure Require Non Investment								
1. Reduce electricity consumption at P-760A/B	5,606,400	5,414,293	192,107	15,383				
2. Cracking Furnace Burners Improvement	3,409,150,345	3,260,191,367			148,958,978	1,814,655		
3. Maximize HP/MP Ethylene to reduce energy at Propylene Refrig. Compressor	3,409,150,345	3,357,938,345			51,212,000	672,129		
4. Extend catalyst life for minimize regeneration energy	79,895,776	39,947,888			39,947,888	518,531		
Group 2: Measure Require Investment								
5. Cracking furnaces refractory coating by Emisspro	3,409,150,345	3,331,598,121			77,552,224	1,029,169	855,756	0.8
Total operation in year 1	**10,312,953,211**	**9,995,090,014**	**192,107**	**15,383**	**317,671,090**	**4,034,485**	**855,756**	**0.8**
Year 2: 2013								
Group 1: Measure Require Non Investment								
1. Parallel turbine and pump at Forced draft fans boiler (Electricity increase/NG decrease)	617,107,000	440,239,013	3,096,156	293,282	188,014,148.6	2,132,962		
2. Reduce oxygen excess at Cracking furnaces to reduce natural gas consumption	17,466,073,905	17,463,235,891			2,838,014.0	36,370		
3. Optimize CW consumption for stop excessing pump	808,821,562	770,117,430	10,751,148	1,347,960				
4. Reduce steam comsuption by reduce discharge pressure of Cracked Gas Compressor	2,473,999,200	2,438,266,719			35,732,481.0	461,164		
5. Deoctanizer steam optimization (Phase 1)	597,848,755	577,298,068			20,550,687.0	265,205		
Group 2: Measure Require Investment								
6. Change cooling water blade to super aerodynamic type (Phase 1)	21,422,053	20,153,434	352,394	33,945			61,125	1.8
Total operation in year 2	**21,985,272,475**	**21,709,310,556**	**11,103,542**	**1,381,905**	**247,135,330.6**	**2,895,700.3**	**61,125**	**1.8**
Year 3: 2014								
Group 1: Measure Require Non Investment								
1. Deoctanizer steam optimization (Phase 2)	742,064,000	712,888,360			29,175,640	252,693		
2. Reduce discharge pressure of Propylene Refrigerant Compressor for steam reduction	5,483,553,000	5,371,694,990			111,858,010	968,809		
3. Optimize blow down cycle to minimize energy loss	779,747,744	694,429,196			85,318,549	738,951		
Group 2: Measure Require Investment								
4. Install VSD at treated water pump	9,021,003	7,393,951	451,959	43,668			82,519	1.9
5. Change cooling water blade to super aerodynamic type (Phase 2)	21,422,053	18,845,932	715,589	50,402			79,799	1.1
Total operation in year 3	**7,035,807,800**	**6,805,252,429**	**1,167,548**	**94,070**	**226,352,198.5**	**1,960,452.2**	**162,319**	**3.0**
Year 4: 2015								
Group 1: Measure Require Non Investment								
1. Increase bottom temp T-200 to reduce MS-2 cons. @ E-245	284,123,804	241,483,720			42,640,084	107,714		
2. Maximize opening C-300's Govenor	1,641,086,926	1,271,464,129			369,622,798	933,714		
3. C-560 energy saving by closing min flow CV	178,381,481	104,201,649			74,179,832	168,286		
4. C-460 energy saving by closing min flow CV	124,627,528	93,016,088			31,611,440	71,714		
5. Reduce LS-1 pressure to save C-460/C-560 HS consumption	303,009,009	219,738,735			83,270,274	270,861		
6. Minimum CW temp control to reduce power compressors	766,537,679	739,287,404			27,250,275	63,442		
Group 2: Measure Require Investment								
7. Super aerodynamic Cooling Tower Blade (Postpone to 2016 due to derivery delayed)	21,422,053	-						
Total operation in year 4	**3,035,064,676**	**2,427,708,005**	**-**	**-**	**628,574,703**	**1,615,731**	**-**	**-**
Total operation for 4 years	**42,369,098,162**	**40,937,361,003**	**12,463,197**	**1,491,358**	**1,419,733,322**	**10,506,368**	**1,079,200**	**5.7**

Table 5. Energy conservation measures in 2012-2015

"The best way to save the world is saving energy and the best way to save energy is effective implementation EnMS."

—Wuttichai Sangsomchaipipat,
Energy Management Representative

Lessons Learned

After implementing ISO: 50001, we found that the main problem is to make employees understand and accept the system. To overcome this challenge, effective communication is vital. We communicate the benefits of the system to make employees work more efficiently through the various communication tools, such as training, site media, and operation daily meeting. These methods help all employees to aware of the former problems and participate in continuously proposing suggestions for improvement.