

Global Energy Management System Implementation: Case Study

Egypt

Sidi Kerir Petrochemicals Co. (SIDPEC)

The first integral step towards the petrochemicals future in Egypt



SIDPEC Polyethylene Reactors on-spec production since October 2000

Company Profile

SIDPEC is an Egyptian joint stock company established in November 1997 under Egyptian investment law. SIDPEC utilizes the latest technologies to produce Ethylene, Polyethylene, and other intermediate products. SIDPEC area is 180.3 acres located in El-Nahda territory – El Amreya - Alexandria in an industrial area.

SIDPEC, having around 1000 employees, has its continuous operation through two shifts per day in seven days per week to produce about 300,000 MTY of Ethylene (Start-up July 2000), 225,000 MTY of Polyethylene (Start-up October 2000), 50,000 MTY of LPG (Start-up May 2002) and 10,000 MTY of Butene-1 (start-up September 2000) in addition to utilities and offsite facilities complex (Start-up January 2000).

“Our success story started by leveraging organization culture towards Lean Six Sigma that made us ready to implement an effective EnMS in compliance to ISO 50001”
—Mohamed Ibrahim, Energy Management Representative

EGYPTENE® is the brand for SIDPEC products including High Density and Linear Low Density Polyethylene that covers all the plastic applications

Case Study Snapshot

| | |
|------------------------------------|------------------------------|
| Industry | Petrochemicals |
| Location | Alexandria, Egypt |
| Energy Management System | ISO 50001 |
| Product/Service | Polyethylene |
| Energy Performance Improvement (%) | 2.8 |
| Annual energy cost savings | 6.4 Million EGP* |
| Cost to implement | 300,000 EGP |
| GHG Reduction | >100,000 tCO ₂ eq |
| Payback period | 3 months |

* EGP: Egyptian Pound (base 1 US\$ = 8 EGP)

Business Benefits Achieved

- Achieved Energy Savings 27,850 MWh.
- Achieved cost savings about 6.4 Million EGP.
- Reduction in Green House Gases emissions more than 100,000 tCO₂eq.
- It took about 14 months for SIDPEC established an effective EnMS from Oct. 2013 to Nov. 2014
- A step towards renewable energy by Installation of the first 60 KW solar station in Sidpec.

Business Case for Energy Management

SIDPEC staff members were motivated to implement an EnMS at their facility by the clear benefits realized from previous management systems (e.g. ISO 14001 and ISO 9001) and other techniques and tools for process

Global Energy Management System Implementation: Case Study

Egypt

improvement (e.g. Lean Six Sigma). Under a pressuring energy situation in Egypt with rising energy costs and insecurity in supply, it was clear to the company's top management that a serious commitment to improving their energy performance to reduce its overall costs is the way forward. The company was assured that the economic and technically sound approach is to tackle the issue through energy efficiency improvement following a systemized approach. Thus, concrete steps have been taken to adopt an EnMS that is compliant with ISO 50001.

Keys to Success

- Strong Top management begins with buy-in to the business value of a systematic approach to EnMS.
- Reporting is a key element in maintaining management commitment.
- Develop a dynamic cross functional energy team: provide training, and delegate activities.
- Perform complete energy review.
- Strong internal communication: Establish SIDPEC Ideas Bank by which any person can suggest opportunities for improvements to the EnMS.
- Providing recognition for EnMS achievements to motivates staff and employees and brings positive exposure to the energy management program.
- SIDPEC applies Statistical Process Control (SPC) for operational control purpose which is the critical element of the EnMS for energy savings.
- Ensure that the key characteristics of operations that determine energy performance are monitored, measured and analyzed at planned intervals using state-of-the-art control system and historian.

EnMS Development and Implementation

SIDPEC EnMS is based on the assigned energy policy and careful attention to the core elements including energy planning phase, implementation phase and checking phase necessary to improve energy performance and achieve the required effectiveness.

Business Benefits

In addition to the energy saving of 37,500 MWh and corresponding monetary value of 7.4 Million EGP, **The EnMS system had added many other benefits to the Company just to mention some in the following:**

- Management became committed to introduction of the EnMS system in their company and allocated resources for implementation of system in terms of manpower, purchase of energy meters, training etc.
- The energy team that was formulated allowed for orderly planning and application of the EnMS. Definition of the roles and responsibilities of the team encouraged timely and effective collection and analysis of baseline data.
- Definition of the opportunity lists encouraged formulation of teams to identify EnMS action plans based on their specific expertise.
- The training that was provided by UNIDO to selected members of the energy team lead to better appreciation of the EnMS process and deepened their understanding of the process.
- SIDPEC management appreciates that no cost/low cost measures can reduce energy rather than having only medium to high cost investments.
- Raising awareness and training all levels of employees in the factory to energy management and efficiency is planned and appreciated. This will lead to sustainable energy management as caliber is being built inside the factory.
- Elimination of the barriers between the production plants staff as a result of the cross-functional team building.
- Identify the areas that have surplus of utilities, such as plant air and Nitrogen, against the other areas that can use that surplus instead of producing more utilities.

Organizational

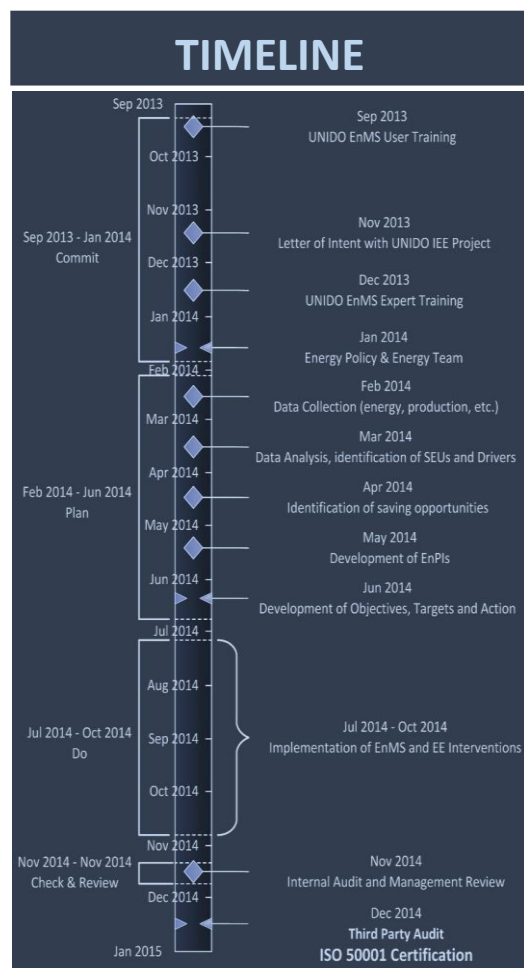
- Top management established and implemented energy policy integrated with quality policy highlighting the concern of sustainability and business excellence.
- Top management appointed management representative and approved energy team formation.

Global Energy Management System Implementation: Case Study

Egypt

SIDPEC decided to establish Energy Team at two-levels; Top Management Committee and Implementation Committee.

- Implementation Committee members chosen to represent a cross-functional team from the operational level and carefully selected according to their knowledge and skills.



legal requirements and information related to significant energy use.

- Data used in energy review are gathered from bills of electricity and imported fuel gas which are supplied by Egyptian Petrochemicals Co. and GASCO respectively. The information about equipment's energy balance like boilers, cooling towers, air compressors and so on, are identified.
- Energy baseline is one of the main deliverables of energy review. Energy baseline represents the amount of energy consumed over a specific period of time before the implementation of energy improvement actions.
- Monthly data was the suitable period choice for representing historical consumption and the trends for baseline period from 2011 to 2013 are the core of the analysis comparing the annualized energy consumption, cost and budget.



Closing Meeting of the ISO 50001 certification audit between Sidpec top management and SGS auditors in Nov. 2014

Energy Review and Planning:

- SIDPEC developed a document titled "SIDPEC EnMS description" that assures the compliance with energy management system (EnMS) requirements of ISO 50001 such as an energy policy, responsibilities, scope and boundaries, objectives, targets, and action plans needed to improve energy performance according to

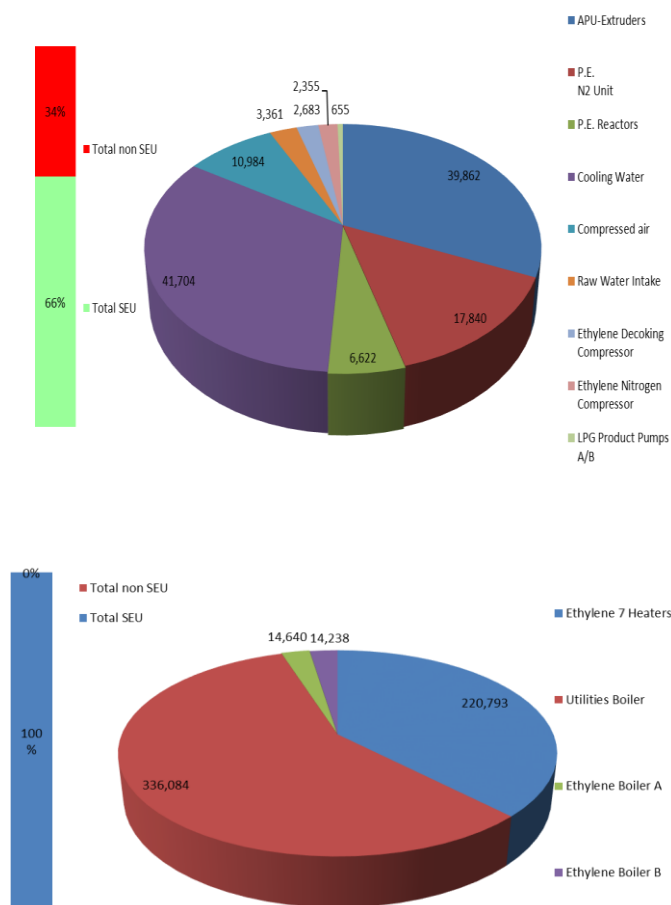
- After identifying the two main energy sources which are electricity and imported fuel gas, SIDPEC identified the significant energy users based on the analysis of energy use and consumption. SEU is defined as energy use accounting for substantial energy consumption and/or offering considerable potential for energy performance improvement.

Global Energy Management System Implementation: Case Study

Egypt

For electricity in the three production plants, equipment uses 66% of the total consumption, while for imported fuel gas, the significant energy users are all the users with 100% of total consumption.

- Determination the areas of significant energy uses (SEUs) was based on estimated annual average of baseline period (2011-2013) as shown below:



- The next step in the analysis of significant energy uses is the identifications of variables or drivers affecting the SEUs energy use and consumption investigated by energy team members.
- Once the drivers were identified, regression analysis was conducted for total energy consumption and/or each plant energy consumption and/or SEU energy consumption as applicable in order to analyze current and future energy consumption.

- The output of the regression analysis is equations for prediction of energy future consumption based on corresponding driver(s). The value of coefficient of determination R^2 indicates how well the data fit the statistical model so that the derived equation could be used or not. In case of having an acceptable value for R^2 based on the analysis, there will be a three additional energy performance indicators (EnPIs) which are energy intensity index (EII), difference between actual and expected (excess), and cumulative summation of that difference (CUSUM).
- In case of fail to accept the statistical model, the only reference for consumption was to compare the actual value to the average consumption of the baseline period 2011 to 2013.
- The next step was to identify the opportunities that improve the energy performance and considered as a base for the energy management planning.
- One of the effective steps taken for creating an energy conservation opportunities (ECO) list was the site survey by cross-functional subgroups of the energy teams which has been done and repeated regularly to exploit the individual experience of the team members and to benefit from the fresh eye effect.

“Applying Gemba within SIDPEC is a key to get more and more energy efficiency improvement opportunities”

—Mohamed Salaheldin, Energy Manager

- Another way to enrich the innovation process is SIDPEC Ideas Bank (SIB) which developed by the SIDPEC IT department to have a recognized channel for ideas from all employees for the purpose of improvement generally and specifically for energy improvement.
- For the purpose of ranking the identified opportunities, SIDPEC assigned prioritization criteria against which each opportunity shall be evaluated and ranked. The prioritization criteria is

Global Energy Management System Implementation: Case Study

Egypt

approved by the top energy committee and communicated to the implementation committee members.

- SIDPEC assigned its EnMS objectives based on the approach of big hairy audacious goal (BHAG). BHAGs are described on a corporate level as nearly impossible to achieve without consistently working outside of a comfort zone and displaying corporate commitment, confidence and even a bit of arrogance. SIDPEC assigned the following long term objectives to be achieved by the end of 2018:
 - Reduce Electrical Consumption by 10 %
 - Reduce Imported Fuel Gas Consumption by 10 %
 - Energy Awareness Training of 80 % of personnel
- It is part of the day to day operation of the EnMS to ensure that the items scheduled for completion in the action plan concerning energy projects for improvement are being addressed, completed and verified to be performing as expected. Based on opportunities list ranking, SIDPEC decided to start with NO COST-LOW COST projects.
- In addition to the long list of opportunities recorded by not only SIDPEC energy team but also by all employees leveraging the level of engagement of people and subjected to evaluation according to prioritization criteria, below are some energy efficiency improvement projects that have been already implemented:
 - **Excessive Air Utilization:** Excessive air from the utility plant was observed. A project was completed which re-directs this excessive air from the utility plant to the Ethylene cracking heaters decreasing the operating hours of decoking compressor.
 - **Stop LPG Recycle Pump:** stop the recycle of LPG pump on the storage tank saving about 90 % of pump electrical consumption.
 - **Waste optimization for high pressure steam (HS) vents:** Operation conditions for main HS network were closely monitored. By adjusting the operation conditions, steam waste was prevented from the ethylene boiler vent.
 - **Optimization of Nitrogen unit:** Excessive Nitrogen from Polyethylene Nitrogen Unit was observed. A project is in-progress which based on using the surplus of Nitrogen of Polyethylene plant in the Ethylene plant instead of that produced by the smaller Nitrogen unit located in the Ethylene plan. The preliminary result indicates that my lead to decrease the operating hours of the smaller Nitrogen unit at least 60% of the current situation.
 - **Rationalization of extruder energy consumption:** Applying Six Sigma methodology for improving the operational parameters of the extruders in Polyethylene plant that was investigated to decrease the electricity consumption of the extruder main motor.
 - **Minimize steam leakages:** Minimizing Steam leakages especially those from steam traps was addressed. A study started to replace the existing type of steam traps in Polyethylene plant by a new one which is more reliable and less exposed for deterioration. Some steam traps were replaced while the new type will be used in other plants.
 - **Reduce electricity consumption of cooling towers:** Reducing the electricity consumption of cooling water circulation pumps was targeted. A plan for installing some smaller pumps from existing inventory was set and required preparation was done while the final tie in will be accomplished in the next turnaround in addition to adjusting some operating parameters.
 - **Solar power station:** For the purpose of focusing on the use of renewable energy source, 60 KW solar station was installed.



During the installation of SIDPEC solar station March 2015

Global Energy Management System Implementation: Case Study

Egypt

Development and use of professional expertise, training, and communications

- To ensure EnMS awareness of all employees who may have an impact on energy performance within the scope and boundaries, SIDPEC conducted 13 awareness training sessions in 2014 and 2015 for 241 employees in relevance to its long-term objectives.
- The output from the annual management review is the starting point for the 2015 year's activities. One of management review output is to establish SIDPEC Ideas Bank (SIB) by the IT department for effective internal communication within the organization and in order to have a recognized channel for ideas from all employees for the purpose of strengthening the commitment of employees to the organization's energy policy and motivating them to contribute in achieving the energy objectives and targets.
- Coordination meetings with energy subgroups team was regularly held to follow up the improvement of EnMS in each discipline and to discuss the status of energy projects, internal audit findings, EnPIs, energy drivers and other opportunities for improvements.
- IEE project provided the necessary technical support for SIDPEC during preparation and implementation of its EnMS until being ISO 50001 certified. This achievement is attained through strong partnership with IEE project in Egypt, implemented by the UNIDO and financed by the GEF in cooperation with Ministry of Environment, the Ministry of Industry, Trade Small and Medium Enterprises and the Federation of Egyptian Industries.
- Following the participation of staff of SIDPEC in the UNIDO EnMS training program delivered within the IEE project and the success demonstrated by the company in implementing Energy Management System (EnMS) and obtaining ISO 50001, UNIDO and Egyptian Petrochemicals Holding Company (ECHM) agreed to cooperate on starting the first peer to peer network within the petrochemicals sector by supporting experts trained at SIDPEC to

transfer their knowledge and expertise to staff of all companies in the petrochemicals sector. Four training programs were conducted according to UNIDO standard EnMS training in addition to two training programs conducted by SIDPEC experts about lean six sigma and statistical process control. Consultation and technical support were provided by SIDPEC to six Egyptian petrochemical companies.



SIDPEC Experts conduct training as a part of the peer-to-peer project

Tools & resources

- Many existing tools and resources supported the successful implementation of SIDPEC EnMS including for example; automated control system and monitoring, historian, CMMS Program, SIDPEC information system (SIS), ISO 9001 and ISO 14001 management system, lean six sigma methodology
- EnMS Spreadsheet Tools provided by UNIDO was the backbone of SIDPEC EnMS that include all the records and documented information required as evidences for effective implementation and continuous improvement.



Steps taken to maintain operational control and sustain energy performance improvement

- SIDPEC ensures that operational and maintenance controls should bring the significant energy uses and the energy uses related to the energy objectives, targets and action plans into efficient

Global Energy Management System Implementation: Case Study

Egypt

and sustainable operation through the following procedures:

- Each SEU has its critical operating parameter list developed during the planning phase. These operating parameters are recorded and reviewed regularly by competent employees.
- Referring to the operational control documents which appeared in the operating and maintenance manuals, monitoring systems and working instructions.
- Planned preventive maintenance is carried out in accordance with the manufactures recommendations.
- Employees carrying out the operation and maintenance activities are to be aware of the impact of their work on the energy performance of the SEUs.

Approach used to determine whether energy performance improved and to validate results

- EnPIs Measurement and Analysis: SIDPEC depended on several ways in order to analyze the measured data by transforming it into useful information upon which action can be taken. There is a regular comparison of actual monthly energy starting from September 2014 versus average baseline (2011-2013) energy to ensure the energy performance measurement.
- There is a saving in total electrical consumption cumulatively at Dec 2015 estimated with 2.5 % compared to baseline.
- SIDPEC is responded to any significant deviation and working to investigate any negative case, to define the process and whether corrective and preventive action or another process shall be used.
- An energy measurement plan has been defined according to measurement needs in order to install new measuring instruments and to ensure that the existing instruments used in monitoring and measurement of EnPIs provides accurate and repeatable readings.
- It is taken into consideration when preparing EnMS internal audits plan for 2015, the prioritization and frequently conduction for areas according to their

influence on energy performance such as objectives, targets, SEUs.

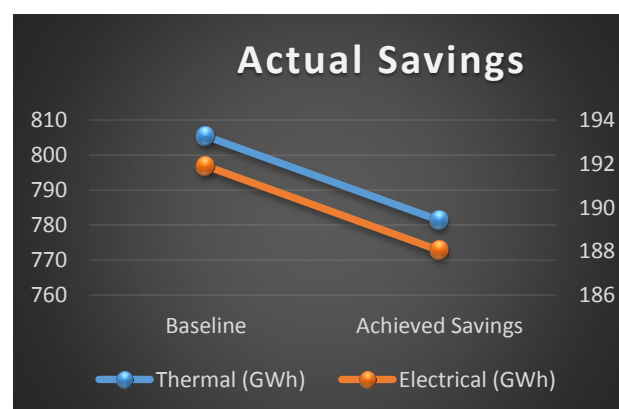
- Internal audits were conducted for the areas of Production plants three times per year, maintenance departments and purchasing twice per year and training department once per year.

“We believe that it’s not difficult to save more than 10% of energy consumption using no cost and low cost opportunities”

—Mohamed Mostafa, Energy team member

Cost-benefit analysis

| Measure | Savings MWh | Savings EGP | Investment EGP | Payback Month |
|---|---------------|------------------|----------------|---------------|
| Excessive air utilization | 1,312 | 710,000 | 0 | immediate |
| LPG Pumps | 114 | 350,000 | 0 | immediate |
| Optimization of Nitrogen Unit | 297 | 160,000 | 0 | immediate |
| Rationalization of Extruder energy consumption | 2,132 | 1,150,000 | 0 | immediate |
| HS vents waste optimization | 24,000 | 4,000,000 | 0 | immediate |
| Minimizing steam leakages* | 9,000 | 1,000,000 | 130,000 | <2 |
| Reduce Electricity Consumption of Cooling Towers* | 600 | 30,000 | 50,000 | 20 |
| Totals | 37,455 | 7,400,000 | 180,000 | - |
| *In progress and should be fully achieved by EOY 2016 | | | | |



Global Energy Management System Implementation: Case Study

Egypt

International Recognition

SIDPEC was honored by UNIDO at the Vienna Energy Forum 2015 that took place in Austria as one of the best practitioners of EnMS that significantly saved energy. High level Egyptian delegation from the Ministry of Environment, Ministry of Trade, Industry, and SMES, Ministry of petroleum and Ministry of Electricity attended this celebration which highlight the significance of energy management and energy efficiency as a key driver for inclusive and sustainable industrial development and a substantial opportunity area to support the achievement of the SE4ALL goal on energy efficiency, and contribute to climate change mitigation.



SIDPEC Energy Management Representative receiving the award of Industrial Leaders of Energy Management System from UNIDO during Vienna Energy forum 2015

Lessons Learned

The implementation of the EnMS in SIDPEC has proven to be both easy and cost effective giving a strong management commitment and the availability of adequate technical resources. No/Low cost measures have proven to be as strong tool in convincing all company staff of the potential benefits that could be achieved if a commitment to continuous improvement becomes an integrated part of the company's culture and day-to-day behavior.

During peer-to-peer project, SIDPEC proved that the highest level of success is achieved by replicating the success to other companies. EnMS consultation and technical assistance is more effective when it comes from companies who work in the same industrial sector speaking the same technical language; that is what SIDPEC provided to other Egyptian petrochemical companies.



UNIDO International Energy Expert with some of SIDPEC Energy team members November 2014

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.

