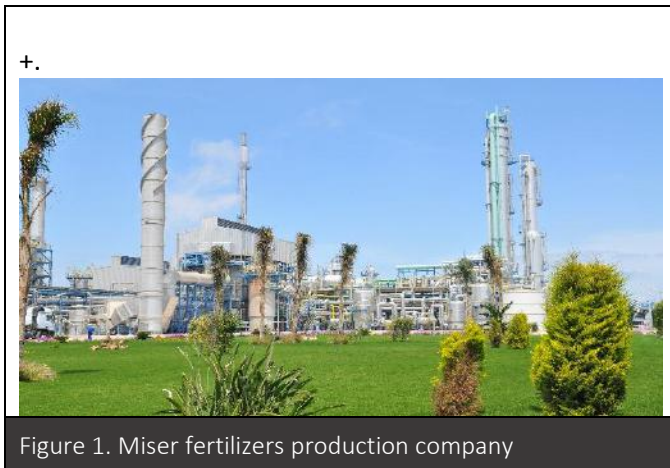


Global Energy Management System Implementation: Case Study

Egypt

Misr Fertilizers Production Company (MOPCO)

MOPCO is the 1st fertilizers plant in Egypt certified with ISO 50001, and 24th all over the industrial firms in Egypt.



Business Case for Energy Management

MOPCO, one of the petroleum sector companies, founded in July 26, 1998 according to rules and provisions of the law of Investment guaranties and incentives number 8 issued in 1997 inside the free zone in Damietta on a space that is 400.000 meters square allocated for MOPCO project and the future expansions. This project produces Urea as a main product and liquid. MOPCO Train one that began operating in 2008 and other two Train that began operating in 2015 and 2016 respectively.

Each plant producing approximately 1200 metric tons per day (mtpd) of Ammonia (UHDE technology), 1925 mtpd urea Granulation (Stamicarbon technology).

MOPCO has established an Energy Management System (EnMS) for all Ammonia and urea production process as part of the continuous management support for sustainable improvement for energy and environmental

Case Study Snapshot	
Industry	Chemicals
Product/Service	Urea and Ammonia
Location	Egypt – Damietta free Zone
Energy Management System	ISO 50001
Energy Performance Improvement Period	2 years
Energy Performance Improvement (%) over improvement period	6.13 %
Total energy cost savings over improvement period	38 million EGP
Cost to implement EnMS	10 million EGP
Payback period (years) on EnMS implementation	0.3
Total Energy Savings over improvement period	252,091 MWh
Total CO ₂ -e emission reduction over improvement period	125,844 tons

performance all over the time. MOPCO has been proceeded in this project in order to better understand the key risks and opportunities associated with the use of energy in our operations.

The benchmarking data will allow us to identify key areas of risk with regards to energy as well as identify opportunities for reducing energy consumption within our operations.

MOPCO has initiated a number of programs aimed at improving quality of its products and processes. The organization is already certified in 2010 against ISO 9001:2008, ISO 18001:2007, and ISO 14001:2004.

Besides, the company is also committed to conserve energy to reinforce its commitment towards energy performance.

In 2015, The Egyptian petrochemical holding company together with UNIDO established an EnMS training session for more than ten companies of petrochemical sector included MOPCO in its pursuit for excellence, MOPCO implemented an Energy Management System and being the first company have got ISO certification in energy management within the participant companies in the UNIDO program, and it is already certified against (ISO 5001:2011) in 2016.

After MOPCO have been certified with ISO-50001, top management create department of energy conservation under supervision of Technical Studies and Development General Manager to continual and sustainable improvement.

“A systematic energy management approach gives Profit increase, Energy cost saving, Reduced greenhouse-gas emissions, Reduced exposure to changing energy prices, Informed decision-making processes and Increased energy awareness among staff and greater participation

Ibrahim Abd Al-Salam—Chairman & CEO

Business Benefits Achieved

The adoption of an EnMS at MOPCO has proven to have several direct and indirect benefits. The direct benefits can be summarized in the achieved energy savings and associated GHG reduction as follows:

- Total Energy performance improvement by 252,091,999 KWh representing 6.1 % from a 2015 baseline (Fuel + Electricity)
- Corresponding GHG reduction 125,844 t CO₂eq.

Other indirect benefits that MOPCO has achieved are:

- Long term reduction in operation and maintenance costs through energy efficient design and procurement.
- Improved operation efficiencies and maintenance practices.
- Better understanding of energy users performance impact resulting in an improved decision making process.

EnMS Development and Implementation

MOPCO top management realized that the best approach for implementing an effective EnMS is by appointing energy management representative , identifying its responsibilities in Dec. 2015 establishing the energy policy in Feb. 2016 and establishing supreme energy committee directed by chairman production officer and involving all departments manager in addition to top management establishing executive energy committee directed by the general manager of technical studies, Development and Energy Conservation which contains 16 members who are representing all energy performance key-influencers namely technical studies, operation, Instrumentation , mechanical maintenance, Electrical maintenance, costing and QHSE departments . Accordingly, roles and responsibilities regarding the EnMS were defined ensuring stronger engagement.

Energy Management representative prepared EnMS manual and 11 procedures to describe the core elements of EnMS, and specified the requirements for an energy management system which take into account legal requirements and information about significant energy uses. This manual and associated documents also act as a basic and authentic documents to provide proper guidelines/directions in regard to manners related to management of energy uses in MOPCO.

The foundation of the Energy Management System is based on the Plan-Do-Check-Act continuous improvement philosophy and contains the following elements:

Planning-Energy Review; MOPCO energy team was identified to conduct an initial review of organization's energy aspects, Energy use and consumption figures are updated every year, The review of energy use and consumption for last 3 years.

The following issues/steps are considered and follows:

- Review Past energy consumption and energy factors for the last 3 years.
- Identify of significant energy area and significance criteria based on Pareto principle besides includes "CONSUMPTION OF ENERGY" and "ENERGY SAVING POTENTIAL".
- Calculate the base line, estimate of the expected energy consumption and saving target during the following 3 years.
- Specify the energy performance indicators through regression analysis of consumption and main drivers (production) in addition to using engineering model (e.g. specific energy consumption for ammonia plant , urea plant boilers and generator & thermal efficiency of boiler , generator & adiabatic and polytropic efficiencies for turbines and compressors)
- Identify more than 45 opportunities and order them according to priority, the identification of opportunities list is through an improved internal communication and discussion, via energy saving opportunity form "EnMS-03", or using suggestion box in plant site or by electronic way through the specified web link. These opportunities are approved then evaluated, after that set in the action plan; the evaluation is done based on the following criteria:

- The Prioritization of the opportunities is dependent upon the factor of Energy saving (S), Implementation difficulty scale (D) and Investment class (I). So that the Prioritization of opportunities is based on the following equation:

$$\text{Score} = (S + D + I)$$

- The opportunity which have more score, have the priority for implementation.
- The action plan designed to ensure that item estimated savings are calculated for each action, implementation duration and responsible personnel are identified.

Energy saving (S) (KWh/h)	Weight
Energy saving less ≤ 100	1
100 < Energy saving ≤ 500	2
500 < Energy saving ≤ 1000	3
1000 < Energy saving ≤ 2000	4
Energy saving > 2000	5
Implementation difficulty scale (D)	Weight
Very Hard	1
Hard	2
Somewhat hard	3
Moderate	4
Easy	5
Very easy	6
Investment class (I)	Weight
High > 100,000 \$	0
10,000 < Medium ≤ 100,000 \$	2
0 < Low ≤ 10,000 \$	4
No	6

MOPCO has focused on implementation of the no/low cost energy saving opportunities in 2016 and 2017 and implementing of medium cost feasible opportunities in 2018, the five medium cost investment of energy saving opportunities are identified, technical-feasibility study for each is finished and implementation is ongoing.

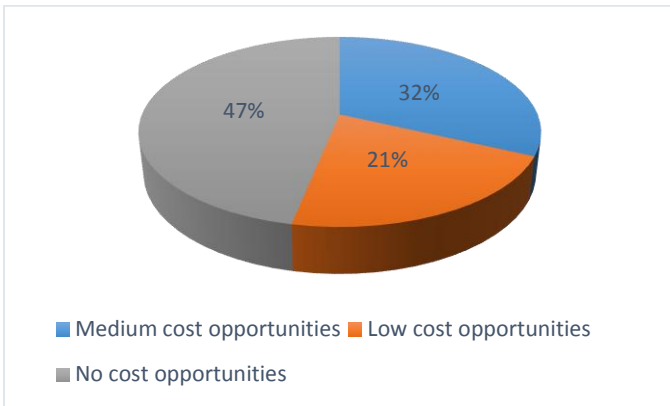


Figure 2. Energy Saving Opportunities

For each SEU the energy performance was continuously monitored based on EnPIs derived from historical baselines. The effect of each intervention was evaluated based on estimated consumption versus actual savings achieved. For example the reformer unit was evaluated based on Fuel natural gas consumption variation in accordance with varying urea production. The graph below shows the energy baseline for NG consumption.

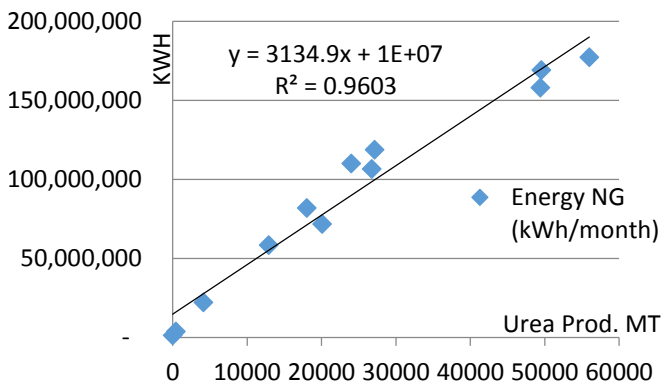


Figure 3. Regression analysis (Urea production & Reformer's fuel gas consumption)

Legal Obligations and Other Requirements:

A procedure has been established to identify, access and understand all the applicable legal obligations. Other energy related requirements are directly attributed to the energy aspects of the activities, procedures and services, the legal (resolution no. 87/2015 & 330/2016), energy supplier contract and other requirements are

taken into account in establishing, implementing, and maintaining EnMS.

Energy Objectives, Targets and action Plans:

Energy objectives are identified and documented at all relevant functional levels. The objectives and targets established are measurable & consistent with the energy policy, including improvements in energy efficiency and comply with applicable legal obligations, it also considers the significant energy aspects identified in the review as well as its technological options, financial, operational & business conditions, legal requirements and the reviews of the interested parties. MOPCO has set a target to increase energy saving by 2% in 2016 from 2015 baseline then increase energy saving by 6% through the next three years.

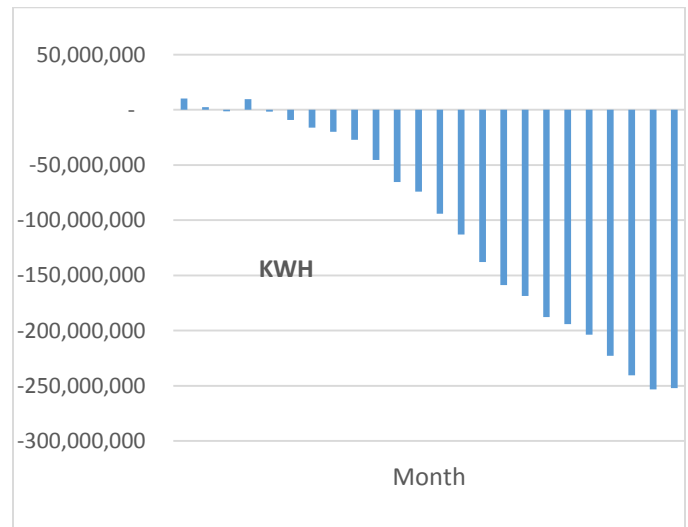


Figure 4. Actual energy saving through year 2016 and 2017.

4.0 implementation & Operation

4.1 Competence, training and awareness

MOPCO has established and maintained a procedure to identify competence requirements and periodically assess the training needs to ensure the capacity of personnel, especially those carrying

out energy management functions which have potential to cause significant energy aspects.

It is planned to conduct the training as per the established procedure of awareness, training and competence.

The awareness, training, and competence procedure has been established to ensure that the whole operation team is aware of:

- (i) The energy policy and energy management plans.
- (ii) The EnMS requirements, including the activities at each process department to control energy use and improve energy performance.
- (iii) The impact of actual or potential, with respect to energy consumption, of their activities and how their activities and behavior contribute to the achievement of energy objectives and targets.
- (iv) Their roles and responsibilities in achieving the requirements of energy management system.
- (v) The operational and financial returns if we improved energy efficiency in our plants.

The Internal audit training was conducted for energy team who hold internal training sessions for 170 of key effective employees undernamed with "Energy Management System - ISO 50001 awareness", and sent more than 30 e-mails for all the company employees regarding energy awareness and to follow-up the energy system activities, in addition to a lot of hanged-posters in the plant control rooms.

MOPCO has participated in the UNIDO technical programs on electric motors system optimization and compressed air system optimization.

We are planning to conduct customized energy training programs in the upcoming year.

In addition to above, shop floor discussions, compaction, exhibition etc. will be carried out to create & promote awareness among employees.

4.2 Communication

MOPCO has established mechanism for internal and external communication.

Internal communication includes providing information to all the persons at various levels for their active participation in the energy management and improvement of energy performance. The various means for communicating energy performance are notice boards, meetings, awareness sessions and e-mail.

External communication includes receiving documenting & responding to interested parties' concerns regarding energy management, communication with Egyptian petrochemicals holding company, ministry of petroleum and UNIDO experts are documented.

4.3 Energy management system documentation

MOPCO has established the following documents related to Energy management system:

- (i) Energy Policy
- (ii) Energy Management System Manual: EnMS manual provides a framework including the interactions among the core elements under the scope of Energy management system (EnMS) which is linked to energy aspects register and legal register. Energy manual acts as a guiding principle from the top management in addressing all the clauses of ISO 50001:2011. The significant energy aspects are assessed to find out energy conservation opportunities. These opportunities are registered in the register of opportunities.

(iii) Energy Consumption / driver and Register of Opportunities (EnMS-05)

(iv) System Procedures (EnMS Procedures) are specific procedures to meet the requirements of core elements of ISO 50001:2011.

4.4 Control of Documents

Documents and data related to Energy management system (EnMS) of all plant units conforming to ISO 50001:2011 shall be controlled with a review to ensure:

- (i) Availability of relevant version of applicable documents at public folder for effective implementation, control, and information.
- (ii) Documents remain legible and readily identifiable.
- (iii) Changes and current revision status of documents are identified.

The documents are controlled as per the procedure for documentation and document control (EnMS-P-08)

4.5 Operation Control

Concerned members of EEC have established critical operational and maintenance parameters for operations and activities that have significant energy aspects and matching with energy policy, objectives and targets.

The procedure for identification and review of energy aspects (Referring to EnMS-P-01) also includes evaluation of energy consumption while considering the design and changing of restoration of all assets which have the potential to affect energy consumption, including buildings.

Energy considerations are also considered in the purchasing of equipment, raw materials and services. While purchasing energy consuming equipment having a significant impact on the total energy consumption, the suppliers are being informed that purchasing is

partly evaluated on the basis of energy efficiency (according to Purchase Procedure EnMS-P-07).

5.0 Checking

5.1 Monitoring Measurement and Analysis

A system, matched with energy policy and energy objectives, has been set for monitoring and measuring the actual performance. This includes recording of information to track the performance and relevant operational control. This procedure is provided for:

- (i) Monitoring, measuring and recording of significant energy consumption and associated energy factors at predefined intervals.
- (ii) Ensuring the accuracy and consistency of monitoring and measuring equipment used. And confirming that it works appropriately to the task, by using asset management software "Maximo".
- (iii) Monitoring records of all significant accidental deviations from expected energy consumption, including causes and remedies.
- (iv) In addition to EnMS monthly progress report, the daily energy report was also issued to increase the close monitoring for the plant conditions The energy daily report contains a lot of KPI's as follow:
 - Specific energy consumption of ammonia, calculated by two methods.
 - Specific energy consumption of urea plant.
 - Energy performance coefficient for total plant, boiler and reformer.
 - Efficiency, ratio and energy specific consumption for boiler.
 - Efficiency, ratio and energy specific consumption for Generator.
- (v) Also a special report is issued internally as a process and energy evaluation for steam turbines, compressors and critical heat exchangers by using energy process modeling software.

- (vi) In addition to the existing online instrumentation device, a portable instruments were procured to be used periodically, such as; portable flow meter, thermo graph camera and motor analysis device.

5.2 Nonconformities, Correction, Corrective Action, and Preventive Action

A non-conformance can be due to:

- (i) Lack of control procedures.
- (ii) Implementation against standard.
- (iii) Parameters not within the limits.
- (iv) Lack of awareness about energy policy and procedures.

It can be identified through audits, inspections, employees' feedback and external audits.

MOPCO has established and maintained a procedure for defining responsibility and authority for these non-conformances. Actions are taken for initiating and completing corrective and preventive actions.

The procedure for nonconformities, correction, corrective and preventive action (EnMS-P-11) shall include the following steps:

- (i) Identifying the cause of nonconformance.
- (ii) Identifying and implementing the necessary corrective action.
- (iii) Evaluating/review of these proposed corrective and preventive actions through energy aspect evaluation prior to implementation to ensure the corrective/ preventive actions taken are effective.
- (iv) Verifying effectiveness concerning corrective/preventive action, identifying opportunities for continual improvement & sharing the results of such timely investigations with the concerned personnel. Records of the corrective &

preventive actions taken are documented & maintained.

- (v) Implementing/modifying the necessary controls to avoid repetition of nonconformance.

5.3 control Records

All the EnMS related records are maintained to demonstrate the performance achieved and the effectiveness of the energy management system.

Procedure for control of records, EnMS-P-08.

5.5 Internal Audit of Energy Management System

MOPCO has established and documented a procedure for energy management system audit (En-P-10). The energy Management system audit is carried out in order to determine whether the Energy Management System:

- (i) Conforms to planned arrangements.
- (ii) Has been properly implemented and maintained.
- (iii) Is effective in meeting the organization's energy policy & objectives.
- (iv) Provide inputs for management review meeting.
- (v) Identifies the improvement issues related to energy management system.

6.0 Management Review

6.1 General

MOPCO has established and documented a procedure to review the EnMS performance by the top management at appropriate intervals to ensure its continuing suitability, adequacy, effectiveness and need for changes including the energy policy/objectives.

The management review shall be carried out at least once a year by the top management according to the procedure of management review (EnMS-P-2)

“Energy Saving approach is an easy way to increase profitability and reduce Global warming and it is considered as a sustainable improvement approach”

Ibrahim Abd Al-Salam — Chairman & CEO

Lessons Learned

- In the first year of EnMS implementation, the energy target has been achievable through implementing no/low cost energy saving opportunities.

The energy awareness for top management and followed by energy performance reporting, in addition to regular cooperation between sites team and management system representative builds a strong foundation for implementation.

- Integration of energy management topics in the daily production meetings.

- The main challenge in implementing the EnMS is the culture of resistance to change and non-cooperation, however; with increasing the energy awareness through informative e-mails, classroom awareness sessions , energy technical trainings, showing the financial benefits and allocation of adequate human resources, the results was very effective which made implementation of the EnMS much easier.

- The top management commitment and establishing a cost benefit analysis model are the main keys to success.

- The standard implementation procedures allowed us to implement the EnMS in another two MOPCO plants in addition to another 10 fertilizers companies in Egypt.

Keys to Success

- Top management commitment.
- Regular cooperation between the concerned divisions' teams and the energy management system representatives.



Figure 4. UNIDO Expert site visit during Motor project assessment.

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.

