

Global Energy Management System Implementation: Case Study

Hashemite Kingdom of Jordan

AES Jordan PSC

Amman East Power Plant is the First power plant in Jordan to implement ISO 50001.



Amman East Power Plant

Business Case for Energy Management

The Amman East Power Plant (AEPP) is a 400 MW combined cycle power plant (CCGT) located east of Amman, Jordan. The project was built and is owned and operated by AES Jordan PSC. With an investment of 300 million US Dollars, the Amman East power plant represents one of the largest foreign investment in power sector of Jordan. The project financing was supported by the US governmental institution Overseas Private Investment Corporation (OPIC) and the Japan Bank for International Cooperation (JBIC) and commercial bank Sumitomo. Mitsui Banking Corporation, Mashreq Bank, Europe Arab Bank with World-Bank partial risk guarantee. AEPP used most modern and state of art equipment and technology which meets all requirements for health, safety and environmental protection and also conforms to World Bank, Japan Bank for International Cooperation (JBIC) and Overseas Private Investment Corporation (OPIC) environmental standards.

Amman East Power Plant is the 1st Power plant in Jordan to implement ISO 50001 which aligned with our mission “To Provide Sustainable energy solution in each market we serve “. Recently Amman East EnMS team has been invited to Energy Management conference hosted by International System Organization (ISO) to share our

experience and knowledge about energy management to other industrial fields.

“By winning the ISO 50001, AEPP becomes the success story for the others in the business filed”

—Marwan Sherri, EnMS Leader

Case Study Snapshot

| | |
|---|---|
| Industry | Electric Power Generation |
| Product/Service | Electricity |
| Location | Amman- Jordan |
| Energy Management System | ISO 50001 |
| Energy Performance Improvement Period | 4 years |
| Energy Performance Improvement (%) over improvement period | 1,7% |
| Total energy cost savings over improvement period | \$ 1,568,700.0 |
| Cost to implement EnMS | \$ 1,264,452.0 |
| Payback period on EnMS implementation (years) | 2013 – 1.49 2014- 1.30 2015- 0.98 2016-0.805 |
| Total Energy Savings over improvement period | 400000 GJ |
| Total CO ₂ -e emission reduction over improvement period | 34330 MT |

The Road to ISO Certificate was starting in 2013 by implementing the main energy performance project as will be explained in following section, the credited energy saving project has put AEPP in the good place where the chance of ISO certificate is applicable.

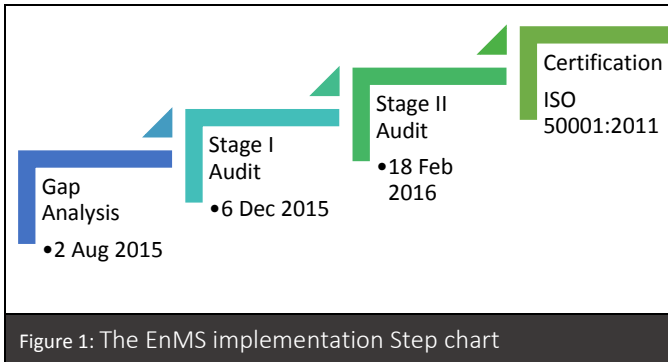


Figure 1: The EnMS implementation Step chart

Driver for Energy Management

National Needs:

Jordan is considered as one of the poorest world countries in the availability of natural resources. Jordan imports 98% of its energy needs from

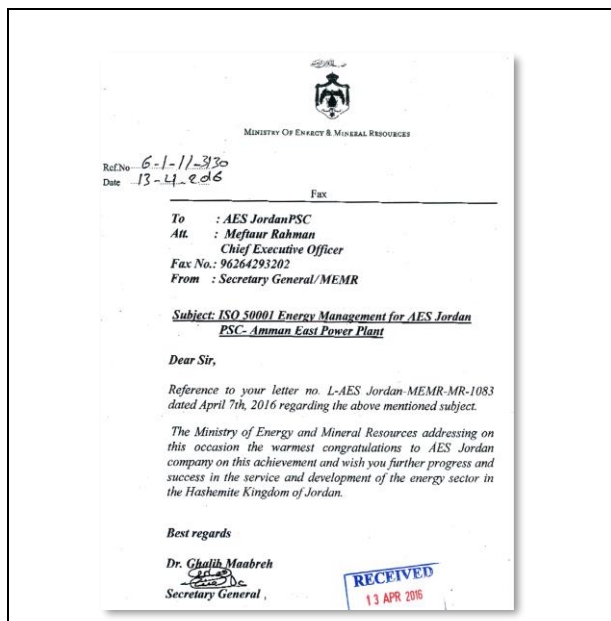


Figure 2: Appreciation letter from Ministry of Energy for Achieving ISO 50001 for Energy management

neighborhood countries. The energy related costs takes the highest share from country total budgets. By implementing EnMS system in one of energy

sector main player like our plant defiantly that helps our country to reduce the main fuel bills

Business Need:

AES Corporation started a program called “AES Energy Star” which is basically to reach cheapest and most efficient power company by managing our assets and optimize our operation through:

- Optimize best performance of current Assets by implementing Asset Management’s System
- Operate the plant on highest level of efficiency by Energy Management Implementation

Why ISO 50001?

The primary reason for ISO 50001 was the focus on building energy management into the systems and culture of the company.

An internationally recognized, externally verified, energy management system carries credibility and ensures diligence in the management of the energy management system.

Business Benefits Achieved

The implantation of ISO 50001 started in 2013 by implanting new system “fogging System” the boost plant output by 30 MW based during first year of operation the plant successfully able to recover 70% of project capital cost.

Then the top management decided to structural approach to apply energy management system, and to have structural process that evolves continual improvement.

EnMS Development and Implementation

The Amman East Power Plant (AEPP) has its own excellence performance program called AES Performance EXcellence (APEX) which leads toward continual improvement management. The plant is a part of Jordan electrical generation facilities where the fuel consumption and the CO₂ product are the most two concerned factors to the business filed.

The most challenges of the Hashemite Kingdom of Jordan (HKJ) are the lack of natural resources like water and fuel. Therefore; the country covers the internal demand of energy by importing the fossil fuel resources from neighbouring country like Gulf Arab region and Iraq State.

Struggling for saving the fuel consumption required for electricity generation and keeping the environment of Jordan as less as of CO₂ products; the AEPP kicked off its internal program for energy saving and efficiency enhancing by utilizing the management program of ISO 50001 to be the first Power Plant in the region who has achieved the ISO 50001:2011 requirements and being certified at 2016. The AEPP presents to the Jordan Power market a good example of energy saving and efficiency enhancing where the country governmental ambitious goals for fuel saving is followed and that clearly reflected by winning the ISO 50001 certificate.

Organizational

The Top management of the AEPP showed a high level leadership commitment to achieve the EnMS program like previous management systems we had (ISO 14001 & OHSAS 18001). The program was put in the highest priority level of all of AEPP business objectives, on the other hand; the Top management declares the full support required to achieve the EnMS program.

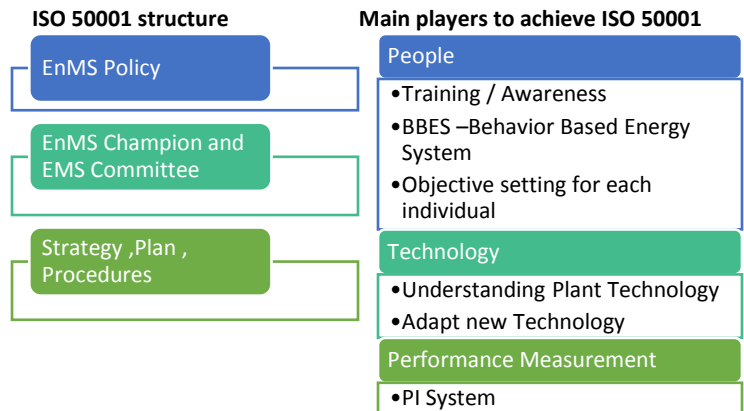
An internal committee was performed including top management engaged with executive engineering level and forced with tools and hands to survey the possibility and the requirements needed to apply the ISO 50001:2011 program where the success story has just begun.



Figure 3: ISO 50001 implementation committee

Awareness trainings for energy management had been conducted by 3rd party to increase a whole team awareness of energy management. In addition, the team has developed in-house training materials for heat rate and efficiency improvement

Tools and Resources:



EnMS Review and Planning

The kind of AEPP business compulsories the Plant EnMS team to achieve the project in a different and non-traditional way, its own process is unique and being a power generation utility based combined cycle technology which integrates simultaneously between two type of generation technology gas turbine and steam turbine unit. Due to uncommon business kind the term of energy efficiency is conversed and the criteria of energy saving is monitored in a different way. The Plant uses the term of Heat Rate (HR) to represent the energy efficiency and to measure energy performance. The Heat Rate is defined as the inverse of the efficiency and simply means: the amount of fuel required for generating one unit of electrical energy where a lower heat rate is better.

$$\text{Heat Rate } \left(\frac{\text{kJ}}{\text{kWh}} \right) = \frac{\text{Thermal Energy (Fuel)}}{\text{Electrical energy}}$$

The team of EnMS committee had put the Heat Rate as the baseline of the energy performance; the heat rate was fixed as the key reference of all of energy sources including capacity of generation, auxiliary consumptions and assets efficiency.

With encouraging from the Top management; the Plant imported a specialized energy monitoring software known as Plant Information (PI-system) provided from OSIsoft. CO. to increase the ability of collect, analyze, monitor, visualize, and share the energy data from multiple sources to people and systems across all operations.

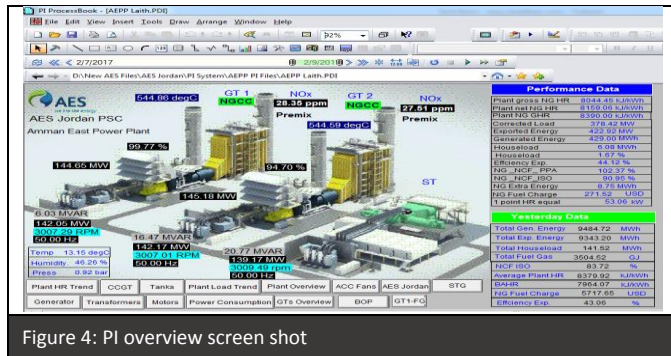


Figure 4: PI overview screen shot

The PI software is the main tool used to monitor the plant energy data and to analyze the Heat Rate performance, the team of EnMS paid great effort to translate the behavior of the power generating machine and its auxiliary from measured metering quantity to readable energy baseline through engineering quality calculations.

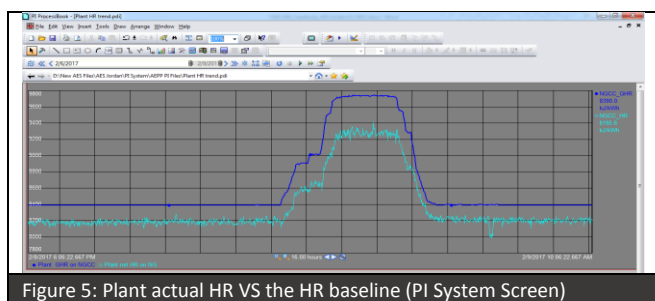


Figure 5: Plant actual HR VS the HR baseline (PI System Screen)

Besides being monitored at 24 hours of the day, the energy baseline became a highly clear readable quantity that allows the EnMS team to manipulate all of its related factors that affected the Heat Rate directly.

The second step that followed to improve the energy efficiency and keeping the heat rate as low as possible which gets the baseline improved was to survey all of the energy consumer and then categorize it into low, medium, and high impact on the Heat rate. All of auxiliary units are programmed into PI system and monitored for certain period then the main energy

consumers are selected and separated from others to be under advanced survey to specify the advanced improvement opportunities. The team built internal program to improve the main energy consumer consumption starting from validation of all of power metering instrumentations to increasing the preventive maintenance programs that keeps the machines behave in high efficient way.

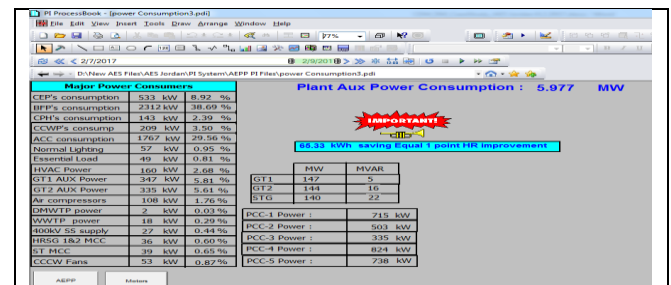


Figure 6: Main Energy consumers (PI System Screen)

The intelligent method used by the EnMS team of the AEPP presents a good opportunity to keep the energy baseline as low as possible where the efficiency and the fuel consumption became in a competitive level comparing with others in the business filed of Jordan.

EnMS Awareness and Training

Employee Training

following the internal policy of energy, the EnMS team conducted intense training and attracted the attentions to focus on the energy management actions and steps, the team started by conducting full awareness session that simplifies the concept of energy baseline and Heat Rate, the session was conducting for all of employee level, the baseline of energy performance was transformed from monitoring to individually action by encouraging the whole team to share their ideas of energy performance improving and efficiency enhancing. Further of and deep knowledge sharing; the EnMS decided to conduct awareness session about ISO 50001:2011 for all employee level which their kind job effect directly on the energy performance and baseline behavior.

Quarter Team Meeting

The team meeting is conducted based quarterly; the top management holds the meeting by updating the employee about the business progress and the KPI targets. The EnMS scores are presented in this meeting to have each employee updated and aware about EnMS related cases.

Posters

EnMS team produced posters that aware the reader about the benefits of energy saving and the important of efficiency enhancing. The posters are well distributed in the active areas to guarantee the max reachability for all of employee levels.



Figure 7: Awareness Poster

Internal Project and energy improvement

The EnMS committee launched new improvement system that allows identifying the improvement opportunity from each level of employee by opening the gate toward each individual sharing that aims to enhance the energy performance. The first project started by dividing the operational level of employee into various committees and each committee targeted to review a certain energy sources and rise up the new points of improvement. The team of AEPP credited the plant with many ideas that support the heading vision of energy management, the main energy performance project which was recorded as the first of its kind in the region is the Gas Turbine Fogging System, the system is an advanced technology that allows to generate extra electricity in summer season by enhancing the quality of the combustion which helps to save high amount of fuel.

The Fogging System was the first and the pilot improvement project of the energy target. In 2013; the Team of EnMS fully completed and commissioned the fogging system.

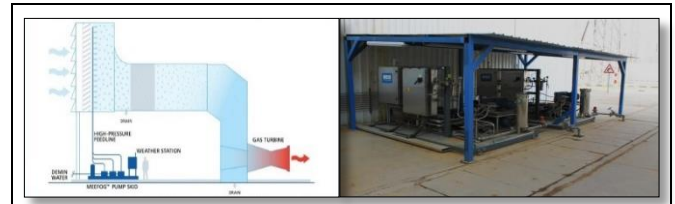


Figure 7: Awareness Poster

In 2014; the Fogging project was recognized for Best Practice Award for Performance Improvement by Combined Cycle Journal. On the next year 2015, the fogging project also won the place of the Best Innovation or Technology Award by Middle East Electricity Award.



Figure 9: Fogging System Awards

Further projects were directed to reduce the house load consumption in different operational sections, the team approved to replace the domestic water electric heater system by solar heater system. In addition to that; the internal lighting system was the second step of reducing the internal house load consumption, all street lights were replaced with LED lighting type instead of halogens lighting, also; the offices are provided with motion sensors that turns the light on or off depending on the occupancy and all of air condition system are set on Auto-timing mode which turn the A/C system off in the period of holidays and day job off time.

In 2016, the team introduced a unique project that is concerned for reducing the power consumption by replacing the machine component, the team found that when replacing the Air condition systems refrigerant fluid from (R-22) to the (R-410a) type, the power consumptions in the air conditioning machines starts to decrease due to the change of the compressibility ratio caused the new refrigerant fluid which affects the power consumption. The project was a part of the success story that completed the internal energy performance improvement till the year of 2016.

Within 2017, the Top management of AEPP continues its internal improving and objective updating by targeting three extra energy enhancement projects by opening the gate for individually employee sharing and vision.

“Amman east power plant is one of the leaders in Energy Management in the Jordan electricity sector and ISO 50001 helps us to continue identifying new opportunities for business improvement”

Cost Benefits Analysis

| | Cost | Saving |
|---------------------------------------|-------------|-------------|
| 2013 projects | \$1,100,000 | \$737,000 |
| 2014 projects | | \$104,000 |
| 2015 projects | \$150,000 | \$427,000 |
| 2015 -Surveillance Audit Gap analysis | \$1,338 | |
| 2015 -Surveillance Audit 1- Stage I | \$1,338 | |
| 2016 -Surveillance Audit 2 - Stage II | \$2,676 | |
| 2016 Training and Awareness costs | \$7,000 | |
| 2016 projects | \$2,000 | \$300,700 |
| Total | \$1,264,352 | \$1,568,700 |

Lessons Learned

The unique business kind of being power generation facility has been overcome and the challenges solved by the privilege AEPP team who worked from starting date to achieve the requirement of ISO 50001:2011, the team has produced intelligent method for monitoring the energy performance of the plant by directing all of the energy factors to be introduced within the main

energy baseline which called Heat Rate, the applied system offers to the other competitors in the business field to adopt the same intelligent techniques for energy monitoring and performance enhancing.

By applying the EnMS program the improvement opportunities have become more visible and the improvement ideas start shining from the employee minds, the continual improvement followed procedure of ISO 50001:2011 encourages all level of employee to share their star ideas with the EnMS team which opens the door for ultimate improvement.

The ISO 50001:2011 has approved its ability to increase the overall revenue by enchainning the efficiency of the plant assets and decreasing the internal house load which led for considered amount of energy saving.

Keys to Success

- Management Commitments and supports toward Energy Management
- Use existing Management system knowledge and experience (ISO 14001, OHSAS 18001) to build ISO 50001 management system
- Utilize available software's (SAP, PI) to support implementation of energy management
- Engage employee at all levels (individual and teams) from top management to driver
- Team motivation to go next step in performance improvement
- Energy saving will help country to reduce fuel bills for generation purpose
- To be aligned with Our Logo “we are the energy”

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.

