Global Energy Management System Implementation: Case Study

United Arab Emirates

Dubai Municipality(DM)

DM was succeeded in saving US $ 423,652 as a result of the implementation of EnMS since 2012.

Dubai Municipality – Al Twar Building

Business Case for Energy Management

Organization Profile/Business Case– Dubai Municipality (DM) is the municipal body with jurisdiction over city service and the upkeep of facilities in the Emirate of Dubai, United Arab Emirates. It was established in 1954 by the then crown prince of Dubai, Sheikh Rashid bin Saeed Al Maktoum for purposes of city planning, citizen services and upkeep of local facilities.

DM chose to reduce energy use and also gaining recognition for supporting a green initiative via Etisalat Energy Efficiency Services (E3S) which had scope for the energy management. It has large number of office buildings that are intermittently occupied, creating an opportunity to reduce energy use. By controlling the HVAC, which is nowadays the most dominant factor in energy consumption, the program helps to reduce the consumption with limited investment. Controlling these components without being physically present to ensure the comfort and also continuous usage of equipment decreases the life of the equipment and building value, thereby consuming a lot of energy.

"Plan, develop and manage an excellent city that provides the essence of success and sustainable prosperity."

—Dubai Municipality – Mission

Case Study Snapshot	
Industry	Government
Product/Service	Public services
Location	Dubai, United Arab Emirates
Energy Management System	ISO 50001
Energy Performance Improvement Period	6 years (July 2012 till present)
Energy Performance Improvement (%) over improvement period	29%
Total energy cost savings over improvement period	US $423,652
Cost to implement EnMS	US $48,188
Payback period (years) on EnMS implementation	5 months (0.43 years)
Total Energy Savings over improvement period	9094.08 GJ
Total CO_2-e emission reduction over improvement period	2,087.2 tones

Drivers: The building is supplied by air cooled chiller system that consists of 2 chillers with a total capacity of 320 TR. There is an existing Building Management System (BMS) that controls and monitors the other electromechanical equipment such as FAHUs, AHUs and FCUs. HVAC components are the vital assets of any organization. It provides thermal comfort and acceptable indoor air quality and costs for installation, operation, and maintenance. Controlling these components without being physically present at the site to ensure the comfort of the customer and continuous usage of these equipment decrease the life of the equipment and building value, thereby consuming a lot of energy. To prevent these, remotely monitoring the building in real time 24x7, comparing actual energy use with the forecast base load and identifying the cause of variations from the expected consumption, energy use can be optimized. Target energy use levels can be set and HVAC systems remotely controlled to keep within the target. By turning down or off low-priority areas when consumption exceeds the target level, energy use can be kept within budget.

Energy management program: Etisalat Energy Efficiency Services (E3S) offers a managed energy solution for existing buildings to reduce energy consumption and carbon footprint via IoT platform.

Energy reduction approach: DM has its HVAC system integrated remotely reporting the consumption trends via IoT controllers and IoT platform. This helps optimization of existing HVAC systems. It's been a part to reduce the carbon footprint of the UAE by optimizing energy usage in facility, without compromising on occupant comfort level. However, the implementation of ISO 50001 ensured continuous monitoring and measurement daily, weekly, monthly, quarterly and yearly basis to study and analyze a continuous and improved implementation on power consumption.

Business Benefits Achieved

Dubai Municipality has received many benefits from implementing the energy conservation measures. So far, it has reduced 29% overall from the 2011 – 2012 baseline. In terms of energy, it has saved an overall energy of 3,537 MWh, and emission of 2,087.2 tons of CO_2 reduced equivalent to planting 448 trees. The result is a US $423,652 cumulative savings.
In addition, further energy savings are anticipated by implementing procedures for air handling design concentrating 24x7 areas and increasing the efficiency of the HVAC unit for productivity and optimization. Below benefits were achieved since implemented:

1. Reduce energy cost & carbon footprint.
2. Convert existing buildings to SMART buildings.
3. Increase equipment life by optimizing run hour.
4. Alarm notification by real time monitoring 24x7.
5. Identify energy wastage.
6. Effective response to HVAC with control 24x7.

EnMS Development and Implementation

Energy management reduces the carbon footprint by optimizing energy usage in the building, without compromising on occupant comfort conditions. This will enable not only reduce but also monitor and report on its carbon footprint in real time. The degree of cost cutting can improve the bottom line, increase profit, and put facility in more price competitive position.

Organizational: This initiative offers a managed energy solution for existing buildings to reduce energy consumption and carbon footprint through continuous online monitoring, controlling and reporting of consumption trends and optimization of existing HVAC systems. Good use of energy is good for everyone. It has drastically reduced the electricity bills, greenhouse gas (GHG) emissions and the reliance on fossil fuels. Smarter energy use, rather than using less energy, ensures our everyday lives can still move uninterrupted. Buildings are responsible for 60 percent of the world's electricity consumption and one third of GHG emissions from energy use, which makes them the largest source of GHGs produced by human activity. Given the current concerns about climate change, the Ministry of Environment in UAE is devoted to reduce energy use wherever possible. To support the reduction of carbon

footprint in the region, Dubai Municipality has implemented the EnMS.

Energy review and planning: L1, L2 and L3 engineers were involved to gather the necessary data, analyze energy performance, review energy exceptions, and develop energy conservative measures. Firstly energy baseline is made with the normalized electricity bills collected from the distribution company. The objects, target and method statement is made from an initial survey of the facility. After an extensive study and action plants, energy conservative measures are taken depending on the operational hours, weather, occupancy, equipment deterioration, and critical areas like the server rooms.

L1 engineers monitor the facility remotely 24x7 to make sure the energy measures are in place and is in accordance to the algorithms. L2 engineers are experts in measurement and verification to verify the energy savings, delivering dashboards (Graphic User Interface) and compute monthly energy report against the baseline. L3 engineers are accountable for logics and automating the control on HVAC to reduce the energy consumption and study the energy pattern daily basis. From the above points, following services are delivered:

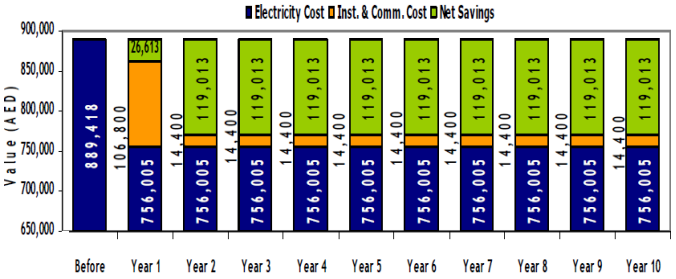
1. 24x7 monitoring in command control center.
2. Monthly energy savings report.
3. Graphic user interface.
4. Energy analytics.
5. Secured IoT platform application layer.
6. Facility management.
7. Measurement and verification.
8. Alarm management.
9. Fault detection and diagnosis.

Smart energy meters for the MDBs were installed for measurement and verification of energy consumption, power quality and phase imbalances. Data is logged within the RMS Panel and transferred to the Command Control Center through Etisalat network technology. Real time and logged data are analyzed by engineers and applied to optimize the HVAC plant sequencing and it is used to provide online support.

"Dubai Municipality supports the leadership's sustainability commitment in every aspect of operations, from sustainable urban planning to waste management and green buildings – and everything in between. The strategic plan is in line with the Government's goals, and with the long-term vision of building "an excellent city that provides the essence of success and comfort of sustainable living."

— H.E. Eng. Hussain Nasser Lootah, Director General of DM

Cost-benefit analysis: The cost required to enroll into this service is contract based. The first contract involves the cost for the device like the direct digital controllers (DDC) and IoT controllers, 3G router with M2M sim card for remote connection apart from the cabling and the platform. This cost is added with the monthly monitoring fee. After the first contract, all the commissioned devices belongs to the facility (Dubai Municipality) and the only charge would be monthly monitoring fee and the warranty charges which is paid in EMI. The savings in terms of cash is a lot compared to the cost of implementation (especially after the first contract), increasing the net savings relatively.



Optimizing the operation of HVAC system through run time equalization adds additional cost savings (maintenance, wear and tear) and reporting super critical alarms immediately and taking necessary actions, is not considered in this analysis. Other expenses include such as improved control systems, changes in flow of air handling unit and operational modifications.

Approach used to determine whether energy performance improved: Following are the before and after implementing EnMS:

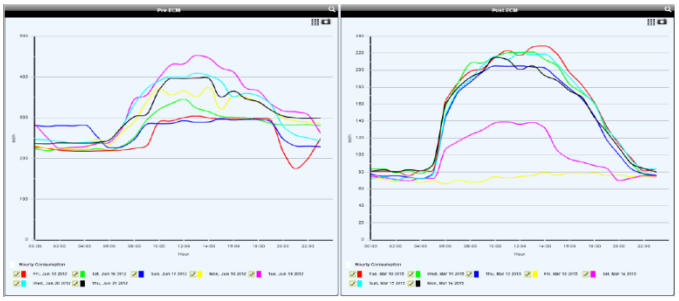
Before:

1. Operational round the clock.
2. No scheduling.
3. No optimization.
4. No performance monitoring system.

After:

1. Temperature set point reset based on load.
2. Run time equalization.
3. Chiller set point based on CHWR temperature.
4. Speed control (VFD) for pumps.
5. Fail over logic.
6. Scheduling based on occupancy for AHUs.
7. Valves for AHU controlled though PID feedback.

Below graphs represent 7 days energy consumption data before (left) and after (right) EnMS -



Before the program was implemented at DM, the average consumption was 280 kWh – 400 kWh and the peak almost to 450 kWh. For the same period after EnMS, average consumption comes down to 140 kWh – 210 kWh and the peak almost to 230 kWh only.

Methodology used for energy savings calculation:

The energy savings calculation is based on the normalized electricity bill taking into consideration the factors which affects the behavior of the equipment such as weather and deterioration.

Step 1: Baseline kWh was dated correctly to fit the monthly profile so that cooling degree days (CDD) will correspond to the month (CDD is the difference between the average daily temperature and the base-load temperature (18.5°C) of the building. Defined baseline kWh will serve as base year kWh, a reference on calculation of savings after EnMS.

Step 2: Weather adjustment was done between base year kWh and CDD. Adjustment is calculated considering the MDBs which consist of HVAC equipment that are weather dependent.

(Weather Adjustment = ((Base Year kWh/Base Year CDD)* Actual CDD) - Base Year kWh)

Step 3: Some amount of wear and tear may occur on the equipment during normal operations, thus adjustment is determined through the following:

1% - With regular maintenance, 2% - Irregular maintenance, 3% - No maintenance at all

In this facility, 1% equipment deterioration considered.

(Equipment Deterioration = Base kWh*0.01)

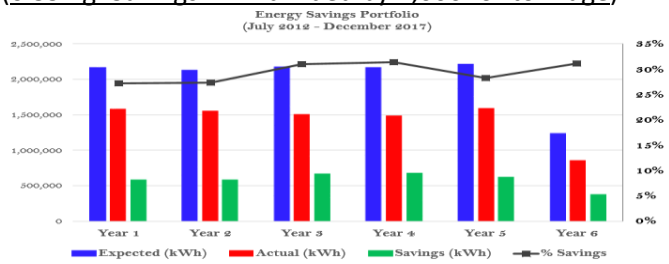
Step 4: (Expected kWh = Base year + Total adjustments)

Step 5: (Savings kWh = Expected kWh – Actual kWh)

Thus expected consumption depicts the system behavior against the weather and deterioration providing a point of reference for the savings achieved.

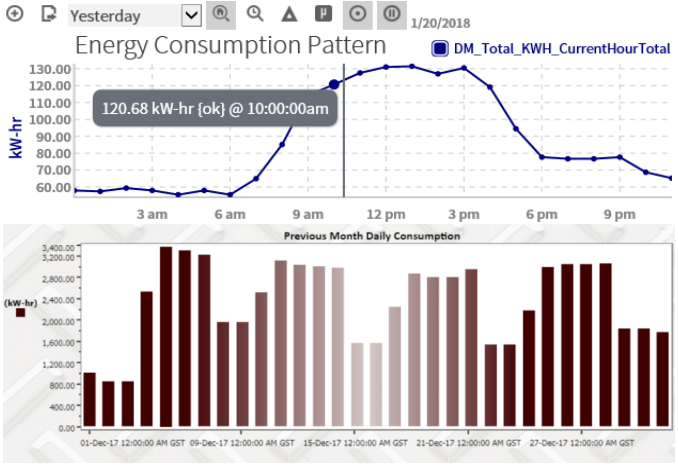
The conversion factors used for the CO_2:

(0.59 kg*Savings kWh divided by 1,000 for tonnage)



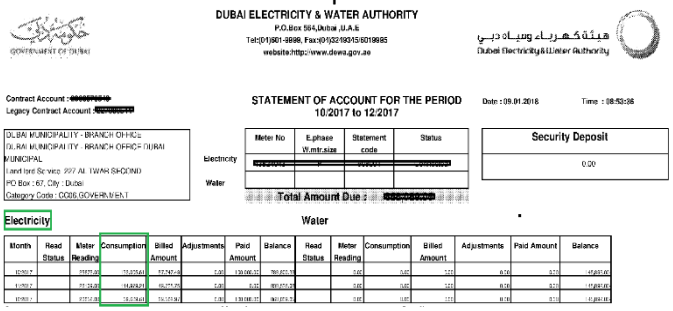
IoT system is integrated to the the existing chiller management through CCN protocol to control and monitor the chillers and pumps. Controls of the FAHU, AHU and FCU are through LON protocol from BMS.

Approach used to validate results: Below graphs help analyzing the performance, evaluate, track and measure the strategies and activities to reduce the energy use.



Any deviations or abnormalities in the energy pattern from the desired outcome can be deeply analyzed

(weekly, daily, hourly & even by minute) and corrective actions can be taken. For ex, if the consumption in a weekend is almost equal to a weekday or if the after work hours pattern is equal to the unoccupied hours, we can study through the history log to find the root cause of the deviation. Every month, L2 engineers collect the energy bill (shown below) to compare the current actual kWh consumption with the baseline.



DUBAI ELECTRICITY & WATER AUTHORITY

STATEMENT OF ACCOUNT FOR THE PERIOD 10/2017 to 12/2017

Security Deposit

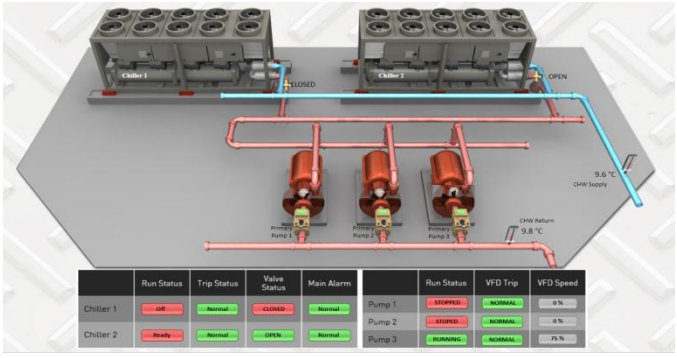
Total Amount Due :

Electricity

Water

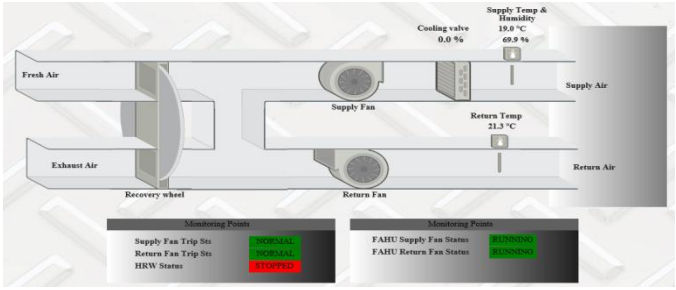
The main focus is to identify the gaps with the relevant structure to increase the measure of energy savings.

Steps taken to maintain operational control and sustain energy performance improvement: Certain procedures were developed to maintain operational controls and sustain the energy performance. The standard operating procedures for the significant energy users for efficient operations and proactive maintenance. Moreover, each algorithm is divided depending on the load demand.



Load based set point reset of the chilled water plant will be varied based on the outside air temperature and load hours such that the water temperature is increased as the cooling requirement for the building decreases. Chiller start / stop will be switched on based on the pull down load (time required to bring the temperature of the conditioned space to optimum). During shut down, chillers will be switched off such that the load of the building is sustained. Night set back of chillers switching off will vary depending on analysis of load profile. Temperature reset based on occupancy for occupied mode, space temperature will be maintained to set point temperature. Unoccupied mode temperature will be reset to higher than the set point temperature.

Free Cooling Mode to optimize outside air conditions to cool inside condition space when the ambient temp is equal to or less than the conditioned space. If the ambient temperature is low, the chiller plant will be stopped and the FAHU (shown below) will feed in directly the cool outside air.



Development and use of professional expertise, training, and communications: The engineers are aware of the services and the strategies involved in achieving the results. The team lead is certified energy audit and the engineers are certified with the platform to perform the automation and logics for optimizing the system. Weekly meetings are held to discuss on the energy performance of the facility. The engineers are communicating with the facility management almost every day to provide extensive support in energy management and proactive maintenance.
DM is getting the support, guidance and cooperation for identifying innovative products to improve the energy performance from E3S.

Tools & resources: There are numerous best practices, the most up to date tools and IoT resources which is globally recognized to support the operation and increase the savings. Etisalat IoT platform is used for implementation, analysis measurement, monitoring of the facility system, reporting energy usage and share the performance data monthly for DM.

Above analytics and trend is open and can be accessed anytime by the concerned through E3S online portal.

Lessons Learned

Of all operating costs, energy is the most controllable, through the use of energy efficient equipment and practices. Energy costs are volatile, but the underlying trend is upwards. Improved energy management will reduce vulnerability to fluctuations in price and savings go straight to the bottom line.

At time of proposal, the desired savings promised was 15%. However, with the most modern technology, the achieved target was 29%, almost double. Thereby maximizing the value and information.

When implementing ISO 50001, it helps in both to reduce energy use and also gaining recognition for supporting a green initiative.

With limited investment, it was possible to:

1. Reduce maintenance costs and system failures.
2. Increase equipment life and building value.
3. Provide comfort and satisfaction levels.
4. Reduce energy consumption and electricity bill.

The availability and connectivity of sufficient smart meters to gather the data, remotely monitor and control the facility is a major challenge.

This award helps to promote energy awareness and increase the involvement of green initiatives.

Keys to Success

- GHG emissions and the reliance on fossil fuels.
- Smarter energy use, rather than using less energy, ensures our everyday lives can still move uninterrupted.
- Increased assets life, lower utility bill and rapid ROI.
- Can be implemented in any building environment.
- Reduced CO_2 emissions and electricity bills.
- Given the current concerns about climate change, Dubai Municipality is devoted to reduce energy use wherever possible to support the reduction of carbon footprint in the region.
- No hassle, “One-Stop Shop” solution.
- Reliable metering and monitoring system.
- Energy & field engineers for managed operations.