# ISO 50001 Energy Management System
## Case Study

**2021** United Arab Emirates

# Dubai Municipality

*In line with Dubai's global leadership in the smart city sector, and Paperless Strategy 2021, in February 2018, in order to digitize all internal and external government transactions and make them paperless, the municipality has succeeded in qualifying its team and the support mechanisms to issue their contracts digitally, which is a major achievement in the digital transformation of contractual procedures."*

Dubai Municipality – Twar (left) & Manara (right) Buildings

## 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 for purposes of city planning, citizen services and upkeep of local facilities. DM chose to reduce energy use and 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. The implementation of the energy management will follow DM strategic objective is to "Implement Pioneering Sustainability Practices)" in its 5 years strategic plan (2016-2021).

***"ISO 50001 played a role for the Municipality to achieve its strategic target and objectives."****—Mansoor Al Rais, Head of Section, General Maintenance Department*

| Case Study Snapshot – Al Twar & Manara Centers | |
|---|---|
| **Industry** | Government |
| **Product/Service** | Public services |
| **Location** | Dubai, United Arab Emirates |
| **Energy management system** | ISO 50001 |
| **Energy performance improvement period, in years** | 9+ years (July 2012 till present) – **Al Twar**<br><1 year (March 2021 till present) - **Al Manara** |
| **Energy Performance Improvement (%)** over improvement period | 30% - **Al Twar**<br>20% - **Al Manara** |
| **Total energy cost savings** over improvement period | $USD 679,847.26 – **Twar**<br>$USD 9,056.41 - **Manara** |
| **Cost to implement EnMS** | 100,729.61 $USD |
| **Total Energy Savings** over improvement period | 20431.764 GJ – **Twar**<br>272.178 GJ - **Manara** |
| **Total $CO_2$-e emission reduction** over improvement period | 3,348.5 tones – **Twar**<br>44.6 tones - **Manara** |

## Business Benefits

**Drivers**: Both the buildings are supplied by air cooled chiller system that consists of 2 chillers with a total capacity of 320 TR. Earlier conventional lights were in use inside and outside the facility, these lights consume a lot of energy and when used for longer hours, additional heat is produced which mildly affects the cooling. 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. 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 converting the lights to LED with motion sensor enabled wherever possible, while also turning down or off low-priority areas when consumption exceeds the target level, energy use can be kept within budget.

**Energy management program**:

- Down lights & outdoor street lights were converted to LED for enormously energy-efficient and increase in durability and lifespan.
- Managed energy solution on HVAC to reduce energy consumption via IoT and AI.

**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. DM has received many benefits from implementing the energy conservation measures. So far for Al Twar Centre, it has reduced **30%** overall from the 2011 – 2012 baseline. In terms of energy, it has saved an overall energy of **5,675 MWh**, and emission of **3,348.5 tons of $CO_2$** reduced equivalent to planting **719 trees**. The result is a **US $679,887**cumulative savings. Al Manara Centre which has recently been commissioned to utilize smart energy consumption has resulted with reduction of **20%** overall from 2018 baseline. In terms of energy, it has saved an overall energy of **75,605 kWh** and emission of **44.6 tons of CO2** reduced equivalent to planting **10 trees**. The result is a **US $9,056** cumulative savings.From the above figures, LED lights & motion controlled lights have contributed in saving an overall energy of **16,561 kWh** which resulted in **US $2,000** annually.

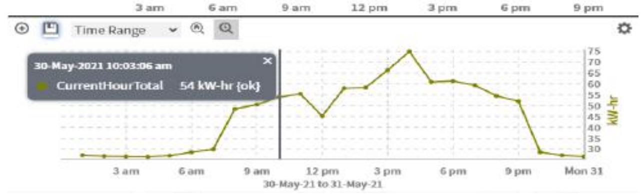
In addition, further energy savings are anticipated by implementing procedures for sticking posters to remind everyone to shut down their computers before leaving and encouraging leased clients to use LED lights with motion sensor wherever possible.

Below benefits were achieved since implemented:

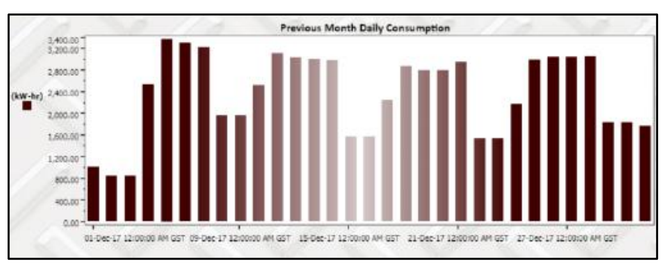
1. Reduce energy cost & carbon footprint.
2. Increase equipment life by optimizing run hour.
3. Alarm notification by real time monitoring 24x7.
4. Identify energy wastage.
5. Effective response to HVAC with control 24x7.

By ensuring the high quality services HVAC provides thermal comfort and acceptable indoor air quality. It provide comfort to the place and have less noise from old type of AC. The best practices increases the happiness index.

**Energy Performance Improvement:** Below graphs (Twar – top, Manara – bottom) 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 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 to compare the current actual kWh consumption with the baseline. The main focus is to identify the gaps with the relevant structure to increase the measure of energy savings.

**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 ECM.

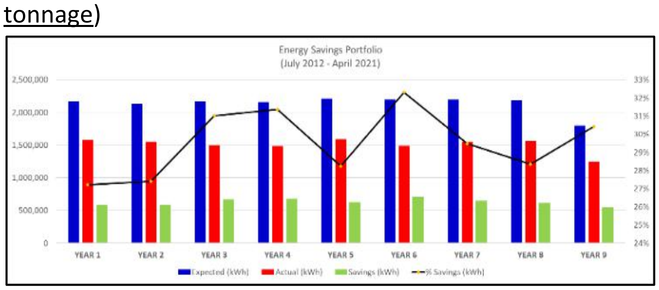
Step 2: Weather adjustment was done between base year kWh and CDD. Adjustment is calculated considering the MDBs, which consist of HVAC equipment that are weather dependent. (Weather Adjustment = ((Base Year kWh/Base Year CDD)* Actual CDD) - Base Year kWh)

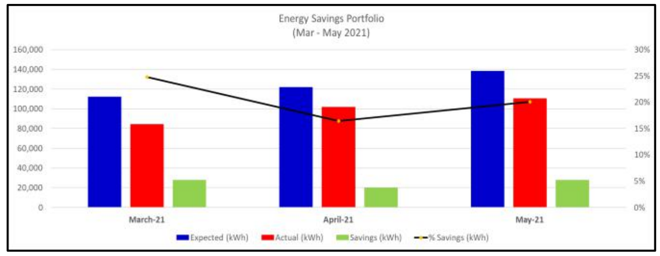
Step 3: Some amount of wear and tear may occur on the equipment during normal operations, thus adjustment is determined through the following: 1% - With regular maintenance, 2% - Irregular maintenance, 3% - No maintenance at all. In this facility, 1% equipment deterioration considered.(Equipment Deterioration = 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 existing chiller management through CCN & BACNET protocol to control and monitor the chillers and pumps. Controls of the FAHU, AHU and FCU are through LON protocol from BMS & existing controllers.

**Below is the estimated savings achieved by upgrading to smart energy efficient lights:**

| Description | | Down light | 60 X 60 | Outdoor Street lights |
|---|---|---|---|---|
| Type of savings | | Lighting Control Sensor | | Lighting Replacement |
| Quantity | | 60 | 150 | 33 |
| Total kW | | 0.9 | 6 | 1.05 |
| Working hours | *Before* | 12 | 12 | 12 |
| Existing Wattage | *Before* | 15 | 40 | 70 |
| Annual Energy kWh | *Before* | 3,370 | 22,464 | 10,118 |
| Average operation hours | *After* | 8 | 8 | NA |
| New LED Wattage | *After* | NA | NA | 15 |
| Annual Energy kWh | *After* | 2,246 | 14,976 | 2,168 |
| Annually Savings kWh | | 1,123 | 7,488 | 7,950 |
| Annually Savings AED | | 505 | 1,086 | 3,577 |

## Plan

Role of top management plays an essential role in the decision-making. Therefore, DM assigned a structural manner to determine project priority in term of serving the strategic objectives. Project governance in DM refers to roles and processes that guide project management activities to create a unique result, supporting DM to meet its corporate strategy. In application, the Project Management Office (PMO) oversee the coordination between 34 municipal departments and project steering committee exercised by DM board of directors. The role of project steering committee provides leadership in enforcing or communicating decisions while the PMO govern the decision making process. Making effective decision in evaluating a project involves strategic alignment and priorities, resources allocation and structural approval hierarchy acting as advisory body and decision maker. Documents such as feasibility study and project portfolio are reviewed and approved by the committee. 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.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. 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. Given the current concerns about climate change. To support the reduction of carbon footprint in the region, DM has implemented the ECM. 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 and Energy analytics.
2. Secured IoT platform application layer.
3. Facility management.
4. Measurement and verification.
5. 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. Moreover, power measurement units are being installed at individual electrical DBs to further drill down to optimize the energy use by breaking down every electrical equipment contributing to the power consumption.

**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 / motion-controlled 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 belong to the facility (DM) 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.

***"The focus is to shift the UAE towards a knowledge Economy with a happy, Healthy population"***

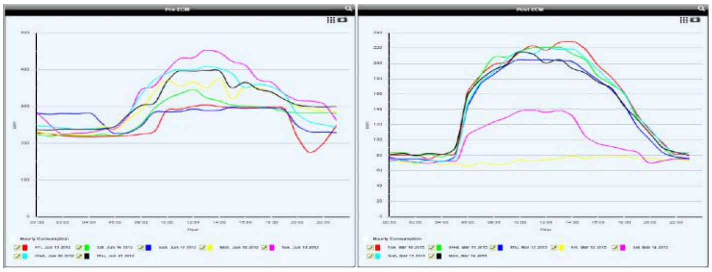
—Dubai Municipality

## Do, Check, Act

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

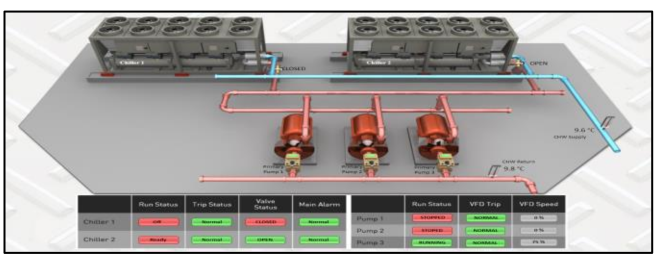
| Before implementing ECM | After implementing ECM |
|---|---|
| Operational round the clock | Temperature set point reset based on load |
| No scheduling | Run time equalization |
| No optimization | Scheduling based on occupancy for AHUs. |
| No performance monitoring system | Lights changed to LED |
| High power consumption lights | Motion detectors for lights installed inside offices, meeting rooms & common areas |
| Lights ON irrespective of the occupancy level | Chiller set point based on CHWR temperature. |

Below graphs represent 7 days energy consumption data before (left) and after (right) ECM –



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 ECM, average consumption comes down to 140 kWh – 210 kWh and the peak almost to 230 kWh only.

**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.

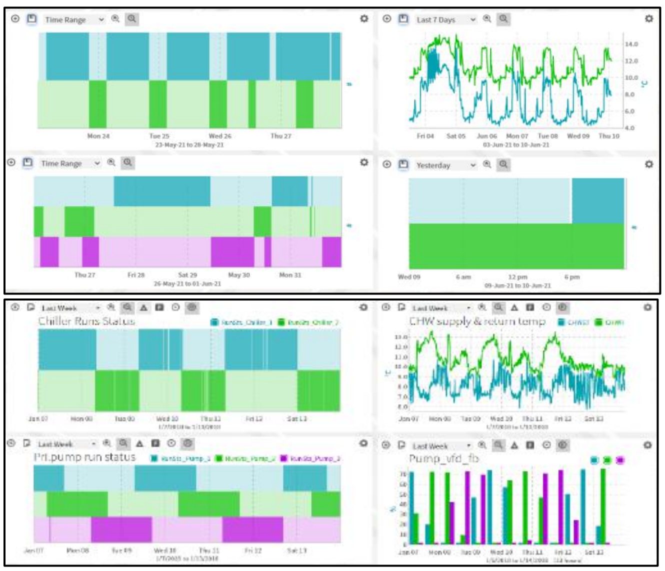


Load based set point reset of the chilled water plant will be varied based on the outside air temperature and load hours such that the water temperature is increased as the cooling requirement for the building decreases. Chiller start / stop will be switched on based on the pull down load (time required 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. 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 30%, 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.

**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.

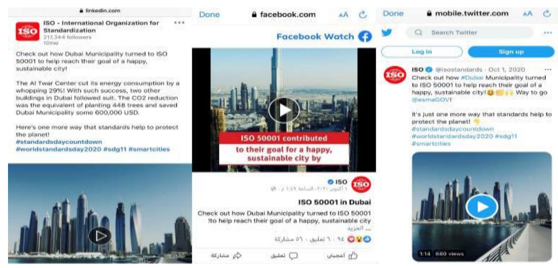


Above analytics (Twar – top, Manara – bottom) and trend is open and can be accessed anytime by the concerned through E3S online portal.
With limited investment, it was possible to:

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.

## Transparency

DM had an international recognition from ISO organization (ISO sustainability campaign) by filming a short video about the implementations. There was a public reporting of the project in the social media accounts of the organization as shown in the pictures bellow.



## What We Would Have Done Differently

In the future there are plans for enhancement and controlling the usage of the water. By implementing vacuum system in toilets. The system will decrease more than 80% of the consumption of the water. As well as adding variable frequency drives. Further sustainable practice was implemented in other building and was not included in this project scope which is recycling the excess water from the AC and use it the flushing system. DM a had plan for implementing parking shades with solar panels for different centers in DM including Al Twar Center and Al Manara Center. Aiming to support of the use of clean energy in Dubai, the reduction of $CO_2$ emission. Al Twar Center parking area will install around 2,203 solar panels and the estimated production capacity of the solar panel will reach to 80%. Al Manara Center parking area will install around 1,142 solar panels and the estimated production capacity of the solar panel will reach to 50%.

The Energy Management Leadership Awards is an international competition that recognizes leading organizations for sharing high-quality, replicable descriptions of their ISO 50001 implementation and certification experiences. The Clean Energy Ministerial (CEM) began offering these Awards in 2016. For more information, please visit www.cleanenergyministerial.org/EMAwards.

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