

Abu Dhabi Sewerage Services Company (ADSSC)

Having demonstrated an effective Energy Management System, ADSSC gained ISO 50001 certification for one of its flagship assets, Al Mafraq Sewerage Treatment Plant (STP), proving its commitment to energy savings & efficiencies



ADSSC's CEO, Ahmed Al Shamsi with members of the Energy Management Team

Case Study Snapshot

Industry	Wastewater Utility & Infrastructure Asset Owner, part of the Energy Sector
Product/Service	Collection & Treatment of Wastewater & safe disposal/reuse of treatment bi-products
Location	Emirate of Abu Dhabi
Energy performance improvement percentage (over the improvement period)	18.20% over a period of 4 years from 2017 to 2020
Total energy cost savings (over the improvement period)	USD 545,757
Cost to implement Energy Management System (EnMS)	USD 289,409
Total energy savings (over the improvement period)	24,557 GJ
Total CO₂-e emission reduction (over the improvement period)	2660 tCO _{2e}

Organization Profile / Business Case

The Abu Dhabi Sewerage Services Company (ADSSC) is under the ownership of ADQ, one of the region's largest holding companies. ADSSC is a utility company representing the wastewater sector in the Emirate of Abu Dhabi, mandated with the collection and treatment of wastewater and safe disposal/reuse of treatment bi-products. ADSSC's customers fall into the categories of residential, commercial and industrial.

As a wastewater utility, ADSSC is also a key infrastructure asset owner with a portfolio of up to 40 Sewerage Treatment Plants (STP) and more than 260 Pumping Stations (PS) in operation and a wastewater network extending to 12,606 km in length. ADSSC's assets are located throughout the Emirate of Abu Dhabi meeting the needs of 100% of all customers located across city, town and remote areas.

Recognising the impact on carbon emissions and energy demand in the Emirate, ADSSC has demonstrated a historic commitment to addressing and improving the sustainability of its operations through implementation of its energy management and carbon management systems and improvement initiatives. ADSSC is typically well-placed to influence its supply chain in the search for innovative, energy efficient and low-carbon alternatives for purchased material, equipment and services.

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Upon establishing the Energy Management System (EnMS) a representative asset was chosen for ISO 50001 certification to demonstrate commitment to key processes; Al Mafraq STP is ADSSC's oldest and largest overground asset.

ADSSC's vision is to become a recognised leader in sustainability. As part of the corporate strategy, one main goal involves the continual implementation of energy savings measures. Some of the main drivers/aims for implementing the EnMS therefore, were to better monitor energy patterns, identify opportunities to improve energy efficiencies and reduce energy consumption across wastewater treatment assets, prioritise energy criteria in key asset design requirements, reduce energy demand where appropriate and ultimately encourage cost savings. The EnMS provided a well-structured methodology to do this, allowing transparent monitoring and reporting on energy performance data.

A functional Energy Management (EnMS) Team was established with members from key business units. They were equipped to continually measure and monitor the energy performance of assets. This team worked very closely with ADSSC's O&M partners who had also been trained and provided awareness on how to manage energy use and consumption effectively. In 2020, an Energy Reward Programme was introduced to encourage and recognise the efforts made by ADSSC's O&M partners in promoting energy savings.

“ADSSC has demonstrated a strong collective sense of commitment and action towards reducing energy consumption and mitigating carbon emissions. Aligning with the UAE National Energy Strategy 2050, ADSSC recognises the crucial role it plays, leading by example in the sustainable management of key infrastructure assets. The achievement of the ISO 50001 certification verifies and boost our steps on this journey as we seek to optimise our energy management and associated costs”

—His Excellency, Ahmed Al Shamsi, ADSSC CEO

Business Benefits

Quantitative measures were established to identify the benefits of the Energy Management System. Energy Performance Indicators (EnPI's) were developed at the installation level for the entire facilities at Al Mafraq STP, i.e. Level 1 EnPI. Through the EnMS, several measurable benefits have been observed for Al Mafraq STP:

- 18.20% reduction in consumption from 2006.329 kJ/m³ of wastewater treated in 2017 to 1641.17 kJ/m³ in 2020
- Approximately USD \$545,757 in cost savings achieved
- A total of 2660 metric tons of CO_{2e} reduced for the asset from 2017 to 2020

The results quoted above were verified in line with IMVP methods used by ADSSC's EnMS Team. The percentage of operational savings to overall savings was 35%, signifying a good portion of savings achieved through capital investments. Al Mafraq STP represented ADSSC's first ISO 50001 certification. The estimated equivalent staff time to implement the EnMS was more than 1 year.

In addition to improved energy performance, emission reductions and cost savings, the following non-energy benefits were also observed:

- Stronger Top Management commitment towards cost savings through energy & improved energy performance monitoring
- Upskilling of ADSSC's staff and key O&M partners in measuring and reporting energy consumption
- Improved energy management awareness and the importance of seeking energy efficient equipment
- Better identification in calibration of energy meters and other instrumental measuring devices

- Better practice in identifying improvement opportunities
- A more structured process to establishing and reviewing energy management objectives, target-setting and action plans
- Improved documentation control on procedures and recording energy performance and key decisions

Further value added by implementing EnMS, has been in engaging with the supply chain. ADSSC's capital delivery process seeks to optimise the design of new assets and rehabilitate/upgrade existing assets as and when needed. Therefore, ADSSC had been actively reviewing and updating its design guidelines and technical specifications to identify key areas where considerations for energy efficient equipment, materials and processes should be included during the design of an asset. These are not only referenced by ADSSC's design team, but also design consultants, material and equipment suppliers. Communicating and prioritising energy criteria in this way, ADSSC aims to encourage and welcome the supply chain to bring forward better practices, innovations and new ideas. One such example for Al Mafraq STP was the installation of smart metering for all new energy saving devices installed in the facility.

Plan

The UAE's National Energy Strategy 2050 to improve energy efficiencies across all sectors, reduce carbon emissions, improve demand side management, contribute to an optimised clean energy mix and realise cost savings with a target to improve energy efficiency by 40% by 2050. Inspired by this, ADSSC seeks to ensure that its EnMS demonstrates initiatives in alignment with this strategy.

The EnMS was established in line with the ISO 50001:2018 standard and included within ADSSC's existing Integrated Management System. ADSSC established an Energy Management Team in 2019 with members from various functions across the organisation. This included personnel and key stakeholders from the O&M Division, Projects Division, HR, Finance and the Integrated Management System (IMS) team. To ensure appropriate allocation of resources and effective implementation, a Top Management Representative was chosen from the Projects Division to lead the EnMS.

An *Energy Management Policy* was drafted, reviewed by the functional team and approved by ADSSC's Top Management and Chairman to define, endorse and communicate key energy management commitments. The policy was made available to all ADSSC employees and site-based O&M partners and is reviewed subject to any new strategic directives or changes to the EnMS. A manual was also developed to clearly outline all the key processes required within the EnMS.

Some of the main roles and responsibilities of the functional EnMS Team were defined as follows:

- Establish a baseline year from which to monitor data. This was set at 2017 for Al Mafraq STP
- Collect data on energy performance for Al Mafraq STP and monitor trends from the baseline year
- Identification of Significant Energy Uses (SEU)
- Identification and implementation of energy improvement opportunities
- Energy management auditing
- Identification and delivery of programmes to meet energy management training needs
- Reporting to the Management Representative on energy performance and improvement opportunities

Using the Energy Review process to plan for improvements

An *energy review procedure* was established for Al Mafraq STP, setting guidance for assessing the energy performance, consumption and efficiency of the facility, assigning roles and responsibilities for all personnel influencing energy consumption. An *energy improvement procedure* was also developed to describe the process of identifying and reviewing improvement opportunities. The forms associated with these procedures were developed to capture and record data for not just Al Mafraq STP but multiple sites in the future. Top management commitment was ensured through approval and endorsement of these key procedures, thus providing clear direction on appropriate processes.

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To begin with for Al Mafraq STP, the EnMS Team conducted a full review of the energy performance data from the 2017 baseline to identify the Significant Energy Uses (SEU) and the variables affecting these. In considering the potential savings in energy, these SEU’s were defined as follows:

SEU’s	Variables affecting SEU’s
Lights and Plug Loads	Occupancy levels
Pumps	Flowrate
HVAC	Ambient Temperature
Wastewater Treatment Equipment	Volume of Wastewater

Identifying SEU’s and the variables that influence them

 شركة أبوظبي لخدمات الصرف الصحي Abu Dhabi Sewerage Services Company	Form. No.	SOF-3706-A
	Version No.	0
Energy Management System		

SEU Selection (2021)

SR.NO.	UNIT. NO.	TYPE	ENERGY USE	SERVICES	Total Consumption (kWh)	CRITERION A	CRITERION B	COMMENTS	SIGNIFICANT ENERGY USE
						Energy consumption	Energy Saving Potential		
SEUs - Electrical Energy									
1	Mafraq STP	Lights and Plug Loads	Electrical energy consumed by lighting and plug loads	Lighting and plug-loads	2,219,062.74	7%	Medium	-	SEU
2	Mafraq STP	Pumps	Electrical energy consumed by pumps	Pumping of wastewater	7,215,283.44	24%	Medium	-	SEU
3	Mafraq STP	HVAC	Electrical energy consumed by HVAC system	Cooling	2,325,914.25	8%	Medium	-	SEU
4	Mafraq STP	Wastewater Treatment	Electrical energy consumed by wastewater treatment equipment	Treatment of wastewater	18,739,339.56	61%	High	-	SEU
Sub Total					30,499,600				

Al Mafraq STP SEU’s and their relative contribution to overall energy consumption

Following the SEU identification process, Energy Performance Indicators (EnPI’s) were established at 2 levels as follows:

- Level 1 EnPI: Energy consumption at the installation level for the entire facility
- Level 2 EnPI: Energy consumption and the process and equipment level:
 - Wastewater treatment process
 - HVAC
 - Pumps
 - Lighting & Plug Loads

These levels were created to better understand the energy performance of the STP and the relative influence/contribution of process and equipment to the overall consumption of the facility. In order to best capture and monitor ongoing energy performance data, EnPI Toolkits were developed to record this information with data inputs received from ADSSC’s site-based O&M team, reviewed and analysed by the EnMS Team for changes in energy performance versus any observed operational changes. The next step was to identify the Energy Improvement Opportunities for the identified SEU’s. In this way, priority was given to areas where energy consumption could be most influenced. As a key EnMS process, improvement opportunities once identified, were documented and recorded and action plans were developed. These were presented to the Management Representative and Top Management to seek approval to secure financial backing and resources needed for implementation.

ADSSC’s Top Management had traditionally set annual corporate KPI’s to encourage all O&M teams to achieve a %reduction in total energy (electrical) consumption across assets. Various independent initiatives had been

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implemented for assets to help reduce carbon emissions, but it was felt that a clear method to address, manage and reduce specific energy consumption was missing. Hence, through the EnMS, ADSSC found a way to introduce improvement opportunities that could ultimately feed into corporate-level KPI's. As of 2022, ADSSC is now updating its entire corporate business plan and setting new targets on energy consumption across assets, cascading action plans identified through improvement opportunities to all asset managers and site-based O&M teams.

“With an Integrated Management System (IMS) already in place and certified to a number of ISO standards, the ISO 50001 requirements were seamlessly embedded into the IMS, thus aligning with ADSSC’s well-defined PDCA processes and consistent reporting to Top Management”

— Ismaeel Al Khouri, ADSSC Projects Division Director, EnMS Management Representative



Energy Management Training with Al Mafraq STP site-based O&M team

Do, Check, and Act

An Integrated Management System (IMS) is already well-established at ADSSC and is certified to ISO 9001, ISO 14001, ISO 45001 and ISO 55001. The ISO 50001 EnMS was aligned with the key processes defined within the IMS such as document and record control procedures, training and competency, operational processes, internal audit processes, legal requirements etc. With the IMS in place, this eased the integration of the EnMS, avoiding duplicated processes and procedures and ensuring a common use of language and understanding.

Managing Operational Control

ADSSC’s existing O&M procedures and contractual arrangements typically define the necessary processes required to maintain the efficient operation of all equipment and processes across assets and this includes quality checks. The EnMS Team, comprising of the necessary personnel to validate both energy performance and O&M practices, were able to co-ordinate, communicate and implement necessary actions. The Al Mafraq STP EnPI’s were continually monitored by the site-based O&M team as well as all key calibration equipment and reported to the EnMS Team.

Monitoring, Reviewing & Verifying Energy Performance

Energy performance data was monitored by ADSSC’s site-based operators for Al Mafraq STP on a monthly basis. Overall energy consumption data was also cross-checked with ADSSC’s Finance Department to verify expenditure on purchased energy. The data for EnPI’s Level 1 and Level 2 were recorded in the EnPI Toolkits for each asset. Energy forecasting was also conducted to compare the overall energy performance in each year versus the baseline year of 2017 where the specific energy consumption was 2006.329 kJ/m³ of wastewater treated.

The 2017 Calendar Year was chosen as the baseline period with all savings measured against this baseline. As identified in ADSSC’s *EnMS manual*, the factors influencing selection of the baseline year had been identified. These factors included any significant changes in the operational patterns, system or processes for the STP and/or introduction of new technology being adopted. ADSSC doesn’t currently have a baseload.

ADSSC developed a tiered structure for the EnPI's. The Level 1 indicator was normalised against the flow of wastewater, as this is a major variable effecting the STP's overall energy consumption. For the Level 2 EnPI's, the various process units were categorised for HVAC, wastewater treatment process, lighting and plug loads and pumping energy. For each of these, the energy consumption value had to be normalised based on the variables impacting energy consumption. For example, the energy consumption for HVAC systems depended on the area and ambient temperature. Hence the EnPI was calculated by normalising the energy consumption with Cooling Degree Days, FTE and Gross Floor Area (conditioned). Normalising EnPI's in this way and not just focusing on the magnitude of energy consumed provided a better picture of energy efficiencies across the facility.

EnPI's were calculated as follows:

- Level 1 and EnPI Level 2 wastewater treatment processes were normalised to the volume of wastewater treated, being reported as energy consumed (kJ) per (m³) of wastewater
- Level 2 EnPI for HVAC was normalised to energy consumption per square meter per cooling degree day (kWh/m²/CDD)
- Level 2 EnPI for Lighting and Plug Loads was normalised to energy consumption per square meter (kWh/m²)
- For Level 2 EnPI for Pumps, the total electrical power consumed by the pumps was compared to the pump hydraulic efficiencies (%), i.e. (flow rate x pump head)/pump energy consumption)

Once SEU's had been identified, the variables affecting these were also identified. The energy improvement opportunities were then identified and considered prioritised as they were based on the SEU's. Convincing action plans were then prepared by the EnMS Team for review by management, seeking approval and budget allocation to fulfil these improvements. The management representative was able to secure budget and resources from an existing capital rehabilitation project to deliver on the above improvements. Progress was recorded and documented for each action plan against its target date. This enabled clear communication of the intended outcomes with all personnel involved as well as the resources required, observations and corrective actions.

Accordingly, ADSSC identified and implemented the following improvement opportunities at Al Mafraq STP in consultation with O&M partners and Top Management:

- Installation of LED lighting fixtures and motion sensors at Al Mafraq STP
- Installation of Variable Frequency Drivers (VFD) in Al Mafraq STP aerators
- Retrofit of HVAC systems at Al Mafraq STP with energy saving devices

All of the above improvement opportunities were successfully implemented in 2020. 80 energy savings devices were installed across Al Mafraq, 200 new lighting fixtures were installed and 16 VFD's had been installed and were fully functional at the aerators. Further to this, the VFD's were equipped with energy sub-meters to monitor their specific operational parameters and energy consumption.

Energy performance was continually measured to assess the outcome of the implemented energy improvement opportunities, based on the International Performance Measurement and Verification Protocol (IPMVP). ADSSC, in coordination with its O&M partners, used calibration equipment and measuring instrumentation to continually monitor SEU's, EnPI's and the improvement measures. If any non-conformities or any unexpected observations were raised, this was communicated with the EnMS Team for consultation with the relevant personnel and then reported to Top Management to acknowledge root causes and approve implementation of corrective actions.

In addition to this self-check, ADSSC also conducted Internal Audits to verify the appropriate implementation of energy management processes. As a process, Internal Audits are conducted by trained and certified ADSSC Internal Auditors and personnel with some operational experience. This exercise helped to identify areas for improvement as well as to

ensure the EnMS was integrated into ADSSC's business practices. Here are some examples of previous corrective actions implemented from internal audits:

- Verification of calibrated energy meters
- Energy training and awareness for site-based operators
- Clarification of key roles and responsibilities for personnel managing SEU's

Another crucial process that has helped to review the overall effectiveness of the EnMS and improvement opportunities, has been the management review. The management review is a meeting held between key stakeholders (e.g. EnMS Team, management representative etc.) and covers a comprehensive agenda that includes; audit findings and results; review of energy objectives, targets and action plans; appropriate allocation of resources and budgets; results from energy reviews of facilities; training and awareness; any risks and opportunities; updates to any legal requirements that may affect key EnMS processes etc.

Conducting the 3rd Party Audit

Seeking to further validate the EnMS and gain the ISO 50001 certification, the EnMS Team prepared for the external, 3rd party audit with an accredited certification body. A number of consultations and preparation workshops were held with key personnel to co-ordinate and organise key records, anticipate auditor queries and arrange site visits to demonstrate how energy management principles had been implemented. This resulted in ADSSC receiving its first ISO 50001:2018 certification for Al Mafraq STP and the ADSSC Head Office from where the EnMS is centrally located and controlled.

Ensuring Training & Awareness

ADSSC develops annual training programmes, preparing a number of key topics aimed to improve the understanding of energy management for both staff and key O&M partners involved in the management of SEU's. Up to 10 training sessions were provided during 2020 and 2021 on key energy management principles, the use of key energy tools, calculation methods and identifying energy savings for various types of equipment. With an established IMS, ADSSC continually trains internal auditors as well. 8 new ISO 50001:2018 lead auditors were trained and certified in 2021.

Continual Improvement

As the EnMS gains maturity, ADSSC continues to identify energy improvement opportunities where possible, seeking new ways to look at its energy consumption. While this is a long-term process, one major improvement to the EnMS is extension of the current boundary to include all of ADSSC's other STP's and Pumping Stations. With Al Mafraq STP and proving a success as a pilot, a verified level of confidence in the EnMS has meant that other assets/facilities may also benefit from this process and seek to gain both energy and cost savings. Further to this, ADSSC's procurement processes are also being updated to include energy efficiency criteria through a review of the design guidelines and technical specifications as these are mandated for use by all asset design managers.



Installation of VFD's at the aerators at Al Mafraq STP

Transparency

The annual Sustainability Reports published by ADSSC are made publicly available through the company website. In these reports, details of the implemented energy management system, case studies on good practices, lessons learned and the receipt of certification have been included.

What We Can Do Differently

Taking lessons learned from early establishment and testing of the EnMS, ADSSC recorded learnings, areas for improvement and new strategic directions for the EnMS during management reviews with examples as follows:

- The data collection process to measure, monitor and verify EnPI's can be intensive, particularly if there have been changes in the operation of the asset, e.g. specific equipment. ADSSC has established clear, user-friendly and well-documented tools, however, automating some of the data collection processes may help to save time and monitoring. Use of software tools offering Business Intelligence, such as Microsoft Power BI may help to digitise data collection and monitoring
- Continual training and awareness programmes are essential for both ADSSC staff and key O&M partners. This really ensures that knowledge gained is implemented, practiced and passed on to any new personnel joining the process
- A major programme is currently underway at ADSSC since 2021 to extend the boundary of the EnMS to all other assets owned by ADSSC. Re-certification of ISO 50001 is scheduled in 2022, this time for multiple sites
- A major focus of the EnMS has been on improving the energy efficiency of existing wastewater treatment processes and equipment. ADSSC may also explore diversification of its energy mix. For example, using combined heat and power (CHP) systems to produce electricity from biogas energy