

ISO 50001 Energy Management System – Case Study

2022

United Arab Emirates

ADNOC Offshore

ADNOC Offshore saved USD 55.3 million in energy costs through its corporate EnMS since 2014



Supplying sustainable energy to the world through energy efficient operations.

Case Study Snapshot

Industry	Oil & Gas
Product/Service	Oil, gas, refined & petrochemicals, products, Sulphur and marine transportation
Location	Abu Dhabi, United Arab Emirates
Energy performance improvement percentage (over the improvement period)	4.5% improvement over 8 years
Total energy cost savings (over the improvement period)	USD 55 million
Cost to implement Energy Management System (EnMS)	USD 11.3 million
Total energy savings (over the improvement period)	19.6 million GJ
Total CO₂-e emission reduction (over the improvement period)	864,000 Metric Tons of CO ₂ e

Organization Profile / Business Case

Profile: ADNOC Offshore is ADNOC's dedicated offshore arm responsible for the development and delivery of oil and gas resources in Abu Dhabi's waters. In 2018, ADNOC Offshore was formed through the consolidation of two of ADNOC's upstream oil and gas companies: Abu Dhabi Marine Operating Company (**ADMA-OPCO**) and Zakum Development Company (**ZADCO**). The consolidation of the two companies resulted in significant financial and operational benefits. ADNOC Offshore produces crude oil, raw gas, and condensate from several key locations, including well-established fields and newly constructed artificial islands.

Main Drivers: It begins with the UAE's Leadership vision for conserving natural resources and reducing natural gas consumption. It is worth highlighting that His Highness the late Sheikh Zayed Bin Sultan Al Nahyan was not only the founding father of the UAE, but also a great environmentalist and visionary. He deeply respected his bedouin roots and shared his ancestor's close connection to nature. We are staying true to his legacy by continuing to preserve our precious natural resources, strengthen our invaluable biodiversity and lay the foundation for a more sustainable future.

ADNOC focuses on three strategic pillars: People, Profitability and Sustainability. Under the sustainability pillar, a 2030 Sustainability Strategy has been developed to tackle 6 focus areas, one of which targets climate, emission, and energy. Pillars that the company had announced as part of their Sustainability Strategy 2030, pillar one focuses on climate, emission and energy. ADNOC has set a target of reducing GHG emissions by 25% and 50% by 2030 and 2050, respectively. It is evident that emissions can be controlled and minimized by reducing energy consumption and improving energy efficiency. This led to the development of the ADNOC Group Energy Policy to drive energy efficiencies in operations, projects, designs, and procurement processes. Following the development and roll out of the policy, ADNOC Offshore developed a robust energy management system that is driven by a balance scorecard approach in 2014 allowing ADNOC Offshore to be one of the least carbon intensive producer company in the world. All these efforts

ISO 50001 Energy Management System – Case Study

2022

United Arab Emirates

are in line with the UAE's strategic initiatives to achieve net-zero emissions by 2050 and transforming the UAE's economy into the most dynamic one.

The Energy Management Team at ADNOC Offshore does not only drive operation assets to higher energy efficiency, but also green field and brown field projects. EnMS has a well mature energy review tool which monitors energy performance indicators, targets and the baseline on a monthly basis. As part of the energy review, the team is collecting, analyzing data, and generating a detailed monthly site energy performance report that is shared with each site management and the respective Site Energy Committee. The performance report displays achievements as well as deviations and improvement opportunities with respect to every significant energy use. This procedure endeavors to provide an analysis of energy consumption and its evaluation for each site, identification of significant energy uses, identification of new opportunities for energy efficiency improvement, and a review of Energy Performance Indicators (EnPIs) and energy baselines.

Furthermore, ADNOC Offshore has relentlessly implemented energy efficient design philosophy into green field and brown field projects through an in-house developed Energy Efficient Design (EED) Procedure, where it ensures that energy optimization activities are fully considered and implemented at all project stages. In any new project, the Project teams at ADNOC Offshore engage with the Energy Management team to assess the project's eligibility for Energy Efficient Design requirements, ensure that these EED requirements are in the in project's SoW/Tender, and implemented in every stage of the project: Assess, Select, Define, and Execute.

In addition to the Sustainability pillar, there is massive emphasis on PEOPLE. At ADNOC Offshore, people are an asset and a number one priority. Their development and learning journey is a strategic focus area and a key corporate performance indicator at ADNOC Offshore.

The Energy Management Team contributed to the People pillar by:

1. Developing customized training plans to employees, based on their competency matrices, to ensure they gain the proper knowledge on energy management
2. Sponsoring employees to attend world class programs and international certifications to promote a wider set range of demanding and fulfilling expertise. Speaking of international certifications, the energy management team members have successfully completed the 'Lead Auditor Certification' and 'Energy Management Lead Implementer Certification' for ISO 50001:2018, allowing the team to develop the right level of expertise to promote an energy efficient economy in the UAE.
3. Developing an annual training plan which includes awareness sessions on EnMS. In 2021, more than 800 employees attended training sessions relating to Energy Conservation and Carbon Footprint Reduction.

Our team also had the ability to engage in various programs and initiatives to enhance the overall performance. These programs motivate, recognize and reward employees who work towards achieving the company's vision and strategic pillars. **Rise** is an initiative established by the Energy Management Representative, Vice President Central Engineering Division (CED), and it provides an opportunity for employees to be recognized within all CED departments. As Energy Management Team, we have been recognized through Rise for our contribution in achieving a 25% reduction in the GHG emissions intensity as part of ADNOC's De-carbonization 2030 Strategy.

“Through our ISO 50001 certified EnMS, we will continually save energy and improve our profitability to promote energy efficient economy in our country.”

—Dr. Abdulla EKaabi, Manager, Process Engineering.

Business Benefits

ADNOC Offshore has accomplished significant progress in the field of energy management and has made large strides in recent years. The alignment to ISO 50001 and subsequent certification resulted in substantial improvement in the energy performance of its operations. ADNOC's has set an initial target to improve ADNOC's energy performance by

ISO 50001 Energy Management System – Case Study

2022

United Arab Emirates

10% in 2020, compared to 2014 baseline. In 2021, ADNOC redefined Energy baseline to 2018 instead of 2014, to sustain the energy improvement savings achieved in year 2020, continuously monitor energy performance indicators and set a new target of 5% energy savings by end of year 2025. The financial energy savings from all ADNOC Offshore sites in the period of 2014 to Apr 2022 has been 55 million USD reflecting an excellent ADNOC Offshore overall energy performance. Similarly, CO₂ emissions drastically reduced by 864,000 Metric Tons of CO₂e. Energy performance improvement 4.5% over 8 years, total energy savings 19.6 million GJ, and cost to implement Energy Management is 11.3 million USD. Moreover, the company achieved several non-financial benefits such as enhancing accountability, transparency, and recognition when it comes to energy management. Projects at ADNOC Offshore follow a rigorous Energy Efficient Design Procedure where Energy Optimization needs to be considered at the earliest possible during the project cycle. It allows ADNOC Offshore to assess, select, define and execute projects so that they consume the least amount of energy during their subsequent operation stage and over their whole lifetime. Hence, achieving maximum energy savings in a cost-effective manner. A dedicated energy review workshop is conducted and deliverables specific to energy efficient design are generated.

As an example of energy optimization measures during project stage, Offshore site “A” has implemented Waste Heat Recovery Units for process heating instead of conventional gas fired heating. Furthermore, the processing facilities at this specific site are designed for better heat integration which reduces the fuel gas based heating requirements. The expected average annual energy cost savings at this site are worth 4.7 million USD for the period 2019-2030 which is equivalent to the average annual fuel gas savings of 1,192 MMSCF/year. Similarly, Power Generation Gas Turbines in another Offshore site “B” have been equipped with Waste Heat Recovery facility. The available waste heat is recovered by circulating hot oil through Waste Heat Recovery Unit (WHRU), and heated hot oil provides the required duty in other treatment plants. Fuel gas saving at this site are around 1,700 MMSCF/year worth 5.47 million USD

Another example is a multibillion dollar project carried out by ADNOC Offshore called “Project Lightning”. This innovative project reflects the development and operation of a first of its kind high voltage, direct current (HVDC-VSC) subsea transmission system in the Middle East and North Africa region. It will power most of ADNOC Offshore’s production operations with zero carbon clean and more efficient power from the national onshore power grid. Integration with grid power is one of the key enablers to achieve our GHG abatement targets. Power import from Grid leads to various benefits such as saving in the amount of fuel gas, increasing the amount of CO₂ abated, and reducing GHG emissions. Consequently, this would increase the gas that goes directly as a feed in the downstream which results in better energy security and increasing in higher revenues for the UAE. This project will definitely support the 2050 UAE net-zero strategic initiative and enhance ADNOC Offshore pathway to Decarbonization while enabling a sustainable future growth.

Plan

ADNOC EnMS is a corporate Energy Management System that is based on ISO 50001:2018 International Standard, ADNOC Energy Management Standard (HSE-TN-03) and ADNOC Energy Charter & Guidelines. All ADNOC Group Companies are certified as per ISO 50001:2018. ADNOC completed its first Energy Management Strategic Study in 2010 which recommended various strategies including formation of a corporate energy management steering committee and establishment of energy management systems. Prior to processing consolidation at ADNOC Offshore, two separate energy management systems were set in ADMA and ZADCO. After the merge, a unified energy management system was established. ADNOC issued in January 2017 an ambitious Energy Management Policy highlighting its commitment to improve energy performance of its operation through using energy sources such as power, fuel gas, diesel, and petrol in the most efficient, cost effective and environmentally responsible manner. This energy policy was followed by the launch of ADNOC’s Energy Management System and the announcement of a corporate target to improve ADNOC’s energy performance by 10% by 2020, compared to 2014 baseline. To achieve the above target, an energy management structure has been rolled out where it identifies the roles and responsibilities among all stakeholders within the company. ADNOC Offshore's top management appointed VP-CED as Energy

ISO 50001 Energy Management System – Case Study

2022

United Arab Emirates

Management Representative (EnMR), who is assisted by energy management engineers and has full responsibility and authority to ensure that the company's energy management system is implemented, maintained, and continuously improved. In addition, site energy committees have been created at all operational sites where these committees aim to measure, monitor, and improve the energy performance of the sites and ensure that our assets are operated and maintained in the most energy efficient way.

It is essential to ensure that EnMS supports the objectives & targets of the organization. The Energy team is responsible on a monthly basis for collecting data, performing energy review, monitoring EnPIs (Energy performance Indicators) and providing energy performance reports for each site as well as at a company level. The top management commitment in implementation and management of EnMS can be demonstrated through various actions. An annual periodic management review meeting is conducted where the top management reviews ADNOC Offshore EnMS to ensure effectiveness and alignment with the direction of the company's strategy and discuss the requirements as stipulated by ISO 50001:2018 standard.

Furthermore, it takes strategic decisions and provides high level support required to run the EnMS efficiently, and to improve company's energy performance. Additionally, bi-annual site energy committee meetings are conducted. Besides, energy performance for each site is discussed in SIC committee meeting on quarterly basis with the Company's Executive Leadership Team (ELT). Apart from this, energy management team presents energy performance at various committees and forums such as Technical Committee Meeting, Concession Holder Meeting and Board meetings. It is worth mentioning that the energy team is the main focal point and secretary of the De-carbonization Strategy Steering Committee and Taskforce. At ADNOC Group level, ADNOC Sustainability Steering Committee meets on a quarterly basis to review and progress with respect to GHG emissions reduction and energy optimization.

ADNOC Offshore has clearly defined the context of the organization as per ISO 50001-2018 International standard. The ISO 50001 certified system ensures that energy efficiency actions are incorporated into the business plans of the organization. Since we are an offshore oil exploration and production company, power is generated on offshore super complexes and islands. ADNOC Offshore follows and implements ADNOC Group Policy which was established in 2017 and covers all the requirements of ISO50001-2018 standard. ADNOC Offshore has developed a separate risk matrix and opportunity matrix with respect to EnMS. The risk assessment methodology is 5x5 matrix which is based on probability scale and level of impact, allowing us to evaluate the risk based on their potential consequences. A control measure has been established for each of the identified significant risk. On the other side, we have developed a register of opportunities that not only lists energy efficiency improvement actions, but also indicates the amount of GHG emissions reduced for the next 8 years.

ADNOC Offshore systematically conducts energy review for more than 10 sites based on their specific operations. A comprehensive energy review tool is developed for each site that monitors energy performance along with deviations. The energy review for each site provides an energy profile where primary energy uses (fuel gas and diesel), in addition to secondary energy uses (electrical) are identified. In addition, Significant Energy Uses (SEUs) and establish EnPIs for the selected SEU based on the energy use analysis are identified. SEUs indicate areas of operation, equipment which have very high-energy consumption and/or potential for improvement. Power generation, gas injection, gas lift, water injection and gas compression are the 5 major SEUs in our offshore facilities. For example, the EnPI for water injection typically demonstrates the ratio of the energy consumption in kWh to its number of water barrels pumped and compare it to the baseline benchmark of 2018. Later, the personal working with each SEUs and the variables affecting it are identified and trained.

ADNOC Offshore follows one of the best forecasting methodologies for defining energy baselines and predicting future energy consumption based on multivariate regression analysis. It considers the main variables or parameters that have the potential to affect the energy consumption of a given site. These parameters can be for example, oil production rate, gas production rate, gas injection rate, water injection rate, the ambient temperature, etc. Later, statistical tools will be used to define a multivariate regression model which will create a correlation statistical model based on the

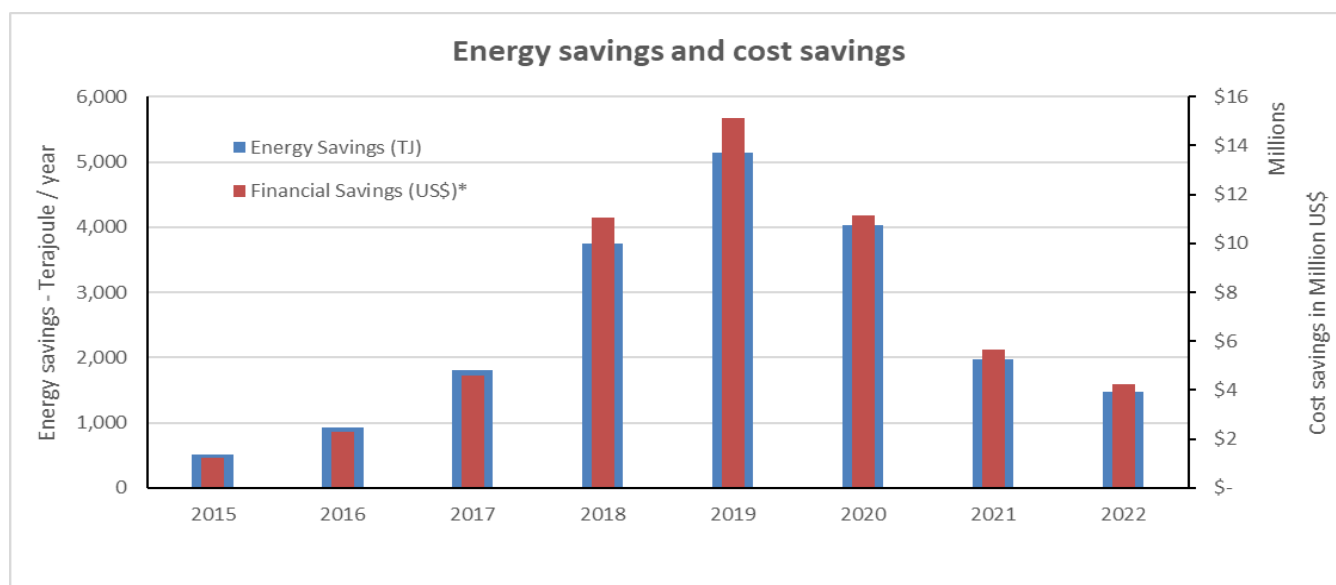
ISO 50001 Energy Management System – Case Study

2022

United Arab Emirates

most pertinent variables. The correlation developed for the baseline year will be used for the subsequent months or years to predict the amount of energy that is expected to be consumed by the site or the plant based on fresh values of the variables. This will allow the site to have a normalized baseline that takes into consideration the change in the main variable. Thus, site teams are able to estimate the energy savings on constant intervals such as months, years, etc. At ADNOC Offshore, we have developed predicative modules for each site which is used in the predicative energy consumption based on the baseline year. ADNOC Offshore review and analyze energy use by collecting historical data and further analyzing to identify significant energy uses which are equipment/area of operation with very high energy consumption and/or potential for improvement. ADNOC Offshore prioritize its actions related to energy saving by focusing on Significant Energy Uses. They are identified based on a methodology where the energy consumed by equipment/area of operation reaches 80% comparing to the total energy consumption. Action will be taken in case of any deviation in the performance such as root cause analysis, to identify the reasons for the reduction in the performance of the SEUs. Corrective actions and mitigative measures will be adopted to restore the performance.

Energy management significantly contributes in the company's effort for Decarbonization and sustainability. In fact, Company CEO is the Chairman of ADNOC Offshore Decarbonization Steering Committee. The Decarbonization Task Leader is VP-CED who is also the Energy Management Representative, and he is supported by the Energy Management Engineers as Secretariats. 32 GHG reduction initiatives, mainly related to Energy optimization have been identified among which 10 have been already completed or under execution. From planning perspective, ADNOC Offshore senior management has signed off energy management system objectives and targets. Apart from that, EnMS specific targets are established on different levels of the company. Energy targets contribute towards not only energy optimization but also towards Decarbonization strategy which requires a reduction of 25% of GHG emissions intensity by 2030, and 50% by 2050. Top management ensures these targets are included in the level 1 (corporate level) performance scorecard.



Energy savings and cost savings 2015-2022

“ISO 50001 certified EnMS streamlined strategic thinking within our organization about longer-term energy savings and aided in identifying new opportunities.”

— Jawed S Ismail, Manager, Engineering Support.

ISO 50001 Energy Management System – Case Study

2022

United Arab Emirates

Do, Check, and Act

Top management have been involved in the implementation of the energy management plan. VP-CED as Energy Management Representative provides high level support required to run the EnMS efficiently and improve company's energy performance. At all operational sites, site energy committee has been established to ensure continuous monitoring of the energy performance. It is worth mentioning that the site energy committees capture any abnormal deviations in the SEU/EnPIs and take corrective measures. ADNOC Offshore has established a systematic procedure for energy review across multiple offshore platforms and super complexes supported by 2 terminal islands as well as 6 artificial islands. The energy team has successfully developed an excel based energy performance monitoring tool which gathers energy and process related data from all sites on a monthly basis through various formats such as word, excel, emails, pdf, etc. Then, the information is checked and manually fed into an excel based energy review tool. Other resources used for data collection are Distributed Control System (DSC) and Electrical Control Management System (ECMS). In 2018, Energy Management Engineers and Digital Oil Field (DOF) team along with electrical and instrument control team discussed the necessity to develop a strategy to connect all energy management metrics to DCS and further to DOF process historians, thus digitizing the entire energy management data to a real-time system. This initially was used for energy performance reporting but will subsequently evolve and migrate to an AI (Artificial Intelligence) based system. Currently, PI Vision is developed for two sites and the other sites are ongoing.

It is important to note that the responsibility of the energy team does not end with manually entering data; it monitors any abnormal deviations and notifies the site focal points accordingly. Each site energy review consists of a dashboard where it shows the overall energy performance in terms of energy savings in terra-joules. In addition, actual energy consumption and the predicted energy consumption based on 2018 baseline. It also calculates energy savings/overconsumption based on the difference between predicted energy consumption and actual energy consumption. Monthly energy performance reports are generated for each operational site after all data has been analyzed and validated. This shows how the energy team establishes, implements, and manages ADNOC Offshore Energy Management System (EnMS) as per ADNOC and ISO 50001 requirements.

ADNOC Offshore Energy team has followed several steps in accordance with the system guidelines and defined the energy boundaries and period. In addition, it has determined appropriate energy performance metrics and established energy baselines. Furthermore, the energy team gathered, normalized the energy data, considering variations in relevant variables and static factors, and analyzed this data to determine energy use, consumption, and performance improvements for more than 10 sites. Breakdown for the overall ADNOC Offshore monthly energy savings % compared to the baseline are periodically analyzed, monitored, and evaluated. This is to ensure our offshore facilities are operated with the maximum efficiency by reducing their energy consumption. ADNOC Offshored has identified key variables affecting energy consumption as quantity of water injection, quantity of gas injection, pressure of water injection and gas injection, gas lift, power generation, gas compression and other geological and topological factors. Apart from the above factors, the location and life of the oil/gas well has a huge impact on the energy consumption because the older oil wells require high quantity of gas and water injection with higher pressure.

ADNOC Offshore follows multivariate regression analysis to estimate the energy savings on constant intervals such as months, years, etc. The multivariate regression equation is $Y = b_0 + b_1X_1 + b_2X_2 + \dots + b_kX_k + \varepsilon_i$. Where Y represents the actual energy consumption for a given site on a baseline year 2018. X_1 and X_2 are variables which have the potential to impact energy consumption in an offshore site such as, quantity of water, quantity of gas injection, pressure of water injection and gas injection, gas lift, power generation, etc. b_0 is coefficient for an intercept term, and b_k represent the coefficient for each variable. Later, Energy performance improvement is measured by comparing the actual energy consumption versus predicted energy consumption. If the actual energy consumption is more than the predicted energy consumption it reflects that we are overconsuming and vice versa. For example: the energy performance of power generation is measured as Giga Joules of energy consumed per MWh of power generated and

ISO 50001 Energy Management System – Case Study

2022

United Arab Emirates

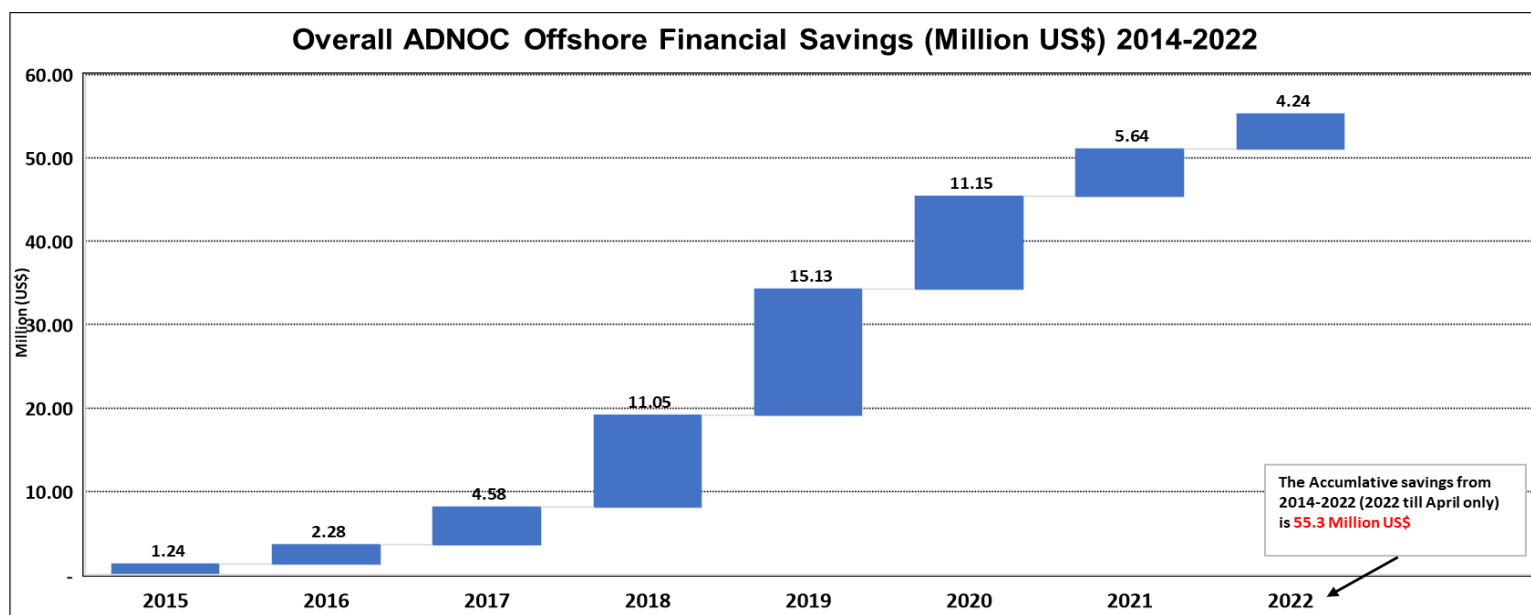
similarly for other SEUs. Energy saving opportunities are identified for improving energy performance of the SEUs at each offshore site.

Despite all the challenges, we have reached in April 2020 the highest energy savings of 14.7% which is far above the 10% target comparing to 2014 baseline. In addition, once ADNOC group has redefined the baseline as 2018 and set a new target of 5% energy performance improvement by 2025, ADNOC Offshore was able to achieve this target successfully in December 2021 with an overall energy savings of 6.9%. Our energy management team is fully aware and working relentlessly to maintain this achievement till 2025.

Internal audit is a systematic process of the EnMS that verifies its function and implementation, and ensures its conformity with the ISO 50001 standard requirements. Audit Findings are expressed as non-conformance or opportunities for improvement. Audit conclusions are based on the findings and focus on the root causes that have led to the non-conformance. Energy management engineers annually perform internal audit for business units/sites. In 2021, Internal Audit was scheduled during the period August to October and has been completed. The audit findings have been already communicated to all sites and action plans have been requested. The audit resulted in 38 findings including 5 minor non-conformances. All non-conformance actions are on track and to be successfully closed.

In addition to that, a third-party external audit (Certification body – TUV Rheinland) was been conducted in May/June 2021, where no non-conformity was raised to the energy team. This external audit aims to continue our certification for ISO 50001 EnMS. Similarly, several audits by ADNOC Upstream, Concession Holders at corporate level, and Business Units/Site levels have been conducted with no non-conformity being raised. Finally, the energy team had successfully conducted training sessions to more than 800 employees on Energy Conservation and Carbon Footprint Reduction. This allowed the team to successfully complete the KPI in the business unit scorecard. The effectiveness of the training sessions was achieved due to adding the training sessions as a KPI in the business unit scorecard.

Top management constantly appreciates the energy management team's effort in ensuring that all the EnMS activities are implemented and that the energy performance and energy performance improvement, based on monitoring and measurement results including the EnPI, are reviewed. For that, management a review meeting is conducted on annual basis to confirm all the objectives and energy targets have been met. This appreciation is done through Rise and star employee of the month.



Overall ADNOC Offshore Financial Savings (Million US\$) 2014 till April 2022

ISO 50001 Energy Management System – Case Study

2022

United Arab Emirates

Transparency

ISO 50001:2011 Certification audit for ADNOC EnMS was completed end of 2014 and certificate received in January 2015. The announcement of ISO 50001:2011 certification was internally within ADNOC Offshore. Top management clearly issued EnMS Structure & Nomination of ADNOC Offshore's EnMR as VP-CED. An email was sent to VP-CED, and it has been shared with external parties. Later, ISO 50001 has been migrated from 2011 to 2018 version in the year of 2020. This was announced by the top management to all stakeholders by providing copy of the certificate. As per UAE and ADNOC, the certification doesn't require to be reported or communicated to any voluntary reporting programs such as Carbon Disclosure Project. To ensure our implementation of ISO 50001 standard, internal and external audits are performed. Furthermore, energy performance reports on monthly basis are reported to stakeholders such as ADNOC Group's Digital monitoring unit (Panorama).

What We Can Do Differently

The formation of Energy Management Structure was successful in driving the energy initiative, resolving interface issues, and streamlining efforts toward corporate targets. The availability, accuracy, and connectivity of sufficient meters to gather energy data from existing assets, especially scattered and remote facilities, is a major challenge that must be addressed early in EnMS planning in order to maintain a reliable monitoring and verification system.

If we had the chance to do it differently, we would have developed PI vision dashboards for real time monitoring of all the sites instead of manually collecting the data, inserting them into the energy review tool, demonstrating the deviations compared to the expected performance, and investigating reasons of these deviations in the monthly energy performance reports for each site. This would have solved the issue for the upcoming month allowing us to achieve ADNOC's energy target. It is worth highlighting the importance of implementing energy efficient procedure at the earliest stage and tracking the project by a systematic approach. Consequently, it will optimize energy for the selected projects.

Future plans for maintaining our ISO 50001-2018 EnMS includes integrating EnMS into ADNOC Offshore's business structure which ensures that the energy efficient design procedure is implemented in all the new eligible projects and a tracking sheet is developed to monitor the compliance of all eligible projects with the EED requirements. Additionally, ensure better implementation of energy performance indicators (EnPI) across ADNOC Offshore assets and facilities to drive continual improvement in energy performance with a focus on identifying missing meters/instruments that prevent the monitoring of the 3rd level of EnPIs (Equipment level). Furthermore, by Q4/2022, a list of measures for each site is to be identified and implanted in order to achieve real-time monitoring of the energy performance and use new digital tools for energy optimization. Besides, contribute to achieving ADNOC target to improve the energy performance by 5% in 2025 compared to 2018 baseline and plan for ADNOC Group's post-2025 target. It will be accomplished by sustaining the energy improvement savings achieved in year 2020 by continuous monitoring of the energy performance indicators and target 5% energy savings by end of year 2025. Also, identify deviations compared to the expected performance and investigate the reasons in the monthly energy performance reports for each site.

Lastly, ADNOC Offshore EnMS contributes to achieving ADNOC 2030 Sustainability Strategy objectives by updating the 2022-2030 GHG emissions profiles twice a year, providing inputs to the company's 5 year business plan and any concession holder request as well as providing energy management inputs to support the high-level third-party feasibility study for the identified GHG abatement initiatives necessary for achieving the UAE Net-zero emissions reduction for the year 2050.