# ISO 50001 Energy Management System – Case Study

2024 Saudi Arabia

## Saudi European Petrochemical Company (IBN ZAHR) – SABIC Affiliate

*Implementing ISO 50001 is helping to achieve consistent and systematic reduction in Energy consumption. Last year we achieved ~1.8 % improvement in the energy consumption*

IBN ZAHR

| Case Study Snapshot | |
|---|---|
| **Industry** | Petrochemical |
| **Product/Service** | Manufacturing of Methyl Tertiary Butyl Ether (MTBE), Polypropylene (PP), Methanol (MeOH) and Poly Oxy Methylene (POM) |
| **Location** | Jubail, Eastern Province, Saudi Arabia |
| **Energy performance improvement percentage** (2022-2023) | 1.8 % improvement over 1 year |
| **Total energy cost savings** (2022-2023) | USD 1,071,529 |
| **Cost to implement Energy Management System (EnMS)** | USD 49,000 |
| **Total energy savings** (2022-2023) | 251,214 MWh |
| **Total $CO_2$-e emission reduction** (2022-2023) | 51,109 Metric Tons CO2 |

### Organization Profile / Business Case

The Saudi European Petrochemical Company (IBN ZAHR) is the first joint venture between SABIC and European partners. IBN ZAHR consists of two sites as per the synergy project to creating value and leveraging on areas of common interest for all two sites by centralizing work processes and capitalizing on available opportunities:

- IBN ZAHR main site (IZ), which has two main productions units Methyl Tertiary Butyl Ether (MTBE) and Polypropylene (PP).
- IBN SINA site (IS) has three main production units; Methyl Tertiary Butyl Ether (MTBE), Methanol (MeOH) and Poly Oxy Methylene (POM).

IBN ZAHR pays due attention to environment preservation. It strives to harmonize its products to a healthy environment and applies the principles of protecting the environment from industrial pollution.

IBN ZAHR Established an Energy Management System (EnMS) that complies with the requirements of the International Standard ISO-50001:2018. EnMS supports the systematic approach to continual improvement of Energy performance and energy cost index to meet IBN ZAHR long term Energy and Sustainability Strategy as well as meeting regional regulatory requirement of energy efficiency improvement.

Energy Management Goals: EnMS will enable IBN ZAHR to achieve SABIC 2025 strategic objective of a 25% Energy Intensity reduction from the 2010 base line year (12.45 GJ/MT), and to achieve their best possible energy quartile performance as per Saudi Energy Efficiency Program (SEEP) Strategy.

IBN ZAHR EnMS is one of the pillars towards our ambitious target to become carbon neutral by 2050 with an interim target to reduce our GHG emissions 20% form 2018 absolute emissions baseline by 2030 year aligned with SABIC vision.

**"A robust Energy Management System is a key pillar in energy conservation ensuring efficient utilization of our next generation resources"**
—Abdullah Al-Ghamdi, Senior Manager, Process Engineering Department & Energy Leader

## Business Benefits

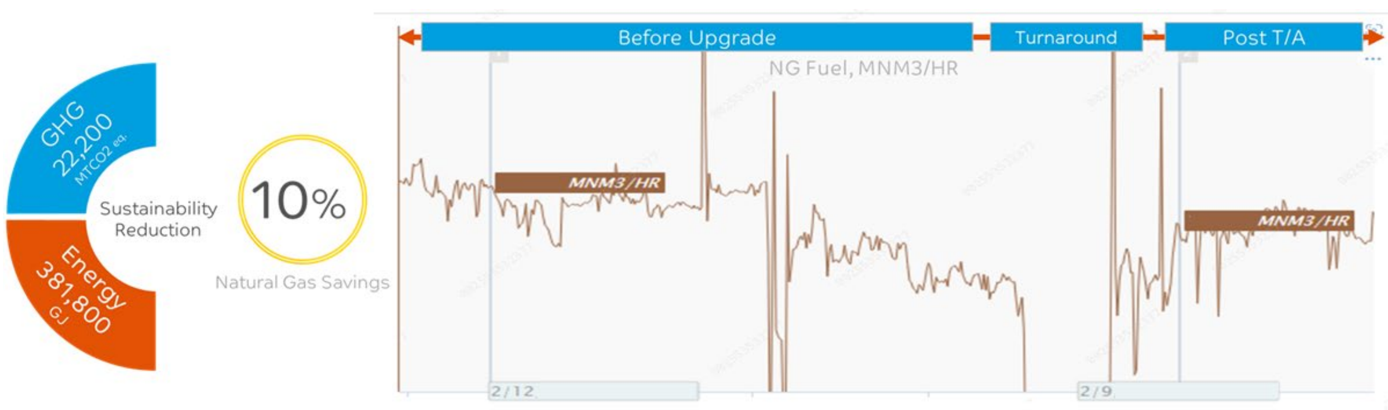
**Case-1: Flare Upgrade Project:**

The flare was experiencing an issue in keeping the flame lit during high wind where a considerable amount of the internally generated purge gas (PG) was utilized as "sweep gas" and directed to the flare header in order to keep the flame light on. The system was designed to utilize minimal amount of purge gas once needed, however, the historical data shows a considerable amount was being continuously consumed.

Leveraging the robust ISO 50001 Energy Management system which was established at IBN ZAHR, the sustainability impact and consequences was highlighted where a technical report and business case was developed with a resilient support from management driving the project implementation.

It was decided to leverage the next turnaround window and during the plant Turnaround, project was implemented successfully from the existing setup to be fitted with wind-shielded pilots.

Once upgraded the amount of Purge Gas (PG) which was directed to the flare was diverted back to the SMR reducing the Natural Gas (NG) fuel consumption. More than 10 % Natural Gas savings equivalent to 0.38 Million MMBTU with more than 22Kt$CO2_{eq}$ of scope 1 emissions reduction from reducing natural gas burning.




**Case-2: Steam Turbine Performance Improvement:**

The steam turbine is the main High Pressure Steam consumer. It is considered as one of the Significant Energy Users (SEUs) among IBN ZAHR energy assets as per ISO 50001 Energy Management.

One of the major steam turbines in the plant was due for replacement and experienced energy performance deterioration with isentropic efficiency below the design figure. Throughout the new turbine selection, Energy team collaborated with OEM to select high-energy efficient turbine with proper extraction flow in order to reduce and optimize the energy consumption across the entire steam system in accordance to the energy management system EnMS.



The project was implemented during the turnaround window and the Steam Turbine Energy Efficiency improved from 66 % to 75 % while the HP steam consumption decreased by more than 15 tons per hour which represents 10% reduction from the boilers energy consumption and scope 1 GHG emissions from reducing natural gas burning in the boilers.

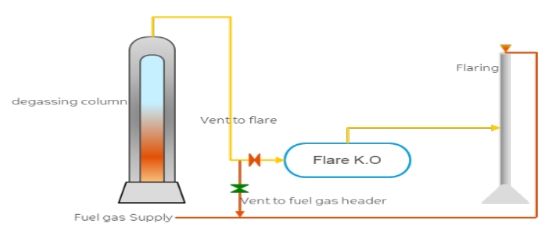
**Case-3: Deaerator pressurization**

LP steam venting is one of the potential area to improve energy and save water. After detail evaluation of steam and condensate system following the energy management system EnMS, it was decided to increasing Deaerator pressure from 0.55 up to allowable limit considering the equipment integrity by re-routing the LP steam vent to the Deaerator. This is resulting in improving the energy performance, reducing low-pressure steam dump and reducing in energy consumption by boilers

The pressure of the Deaerator increased around 28% by increasing the low-pressure steam flow to the deaerator by 5.1 ton per hour. This is consider as a water saving because of used the steam venting to increase Deaerator pressure.

The Energy consumption in the boilers reduced around 54,402 MMBTU and CO2 reduce by 2,684 tCO2e. This saving is a result of boiler feed water temperature increased due to increasing in the Deaerator pressure and temperature by use low-pressure steam. This saving achieved Zero capital investment

**Case-4: Re-routing of degassing column vent to fuel gas header**




De-Gassing column top total amount is around 140 kg/hr and it was sent to flare for all Polymers plant, which can be sent to the fuel gas network to be utilize as pilot gas.

The layout condition before is that fuel gas supply to the polymer plant flaring was taken directly form the natural gas header. After implementing the project, the De-Gassing column flow directed to flaring to supply the pilot gas instead of natural gas. This help to reduce the fuel gas consumption form the natural resource (NG) and use the wasted stream to meet the process requirement.

After implementation of the project natural gas is currently sent to flare and losses are reduced by 13% which equivalent to 437.6 T/year NG saving equivalent to 17,319 MMBTU/year and 1,010 $tCO_2e$ scope 1 emission reduction.

**Cost of EnMS Implementation:** The energy team includes two assigned full-time energy & sustainability engineers whom are either certified energy manager (CEM by AEE) or certified industrial energy professional (CIEP by AEE) and certified in auditing ISO 50001 by third party entity. The sustainability and energy engineers at IBN ZAHR are dedicated, full-time, to monitor, assess and manage IBN ZAHR energy performance. Energy team, on the other hand, are assigned part-time with different disciplines providing the required support as seen fit by the energy leader. Therefore, the cost of implementing the ISO 50001 is well managed in terms of man-hours and training to maintain optimum results. The total cost of implementation of EnMS is around $49,000 (which includes man-hours, audit and training excluding improvement projects implementation cost).

## Plan

SABIC announced a strategic vision to achieve 25% reduction of Energy, GHG and water intensities, and 50% of material effectiveness by 2025 compared to 2010 baseline year. Moreover, Saudi Energy Efficiency Center, SEEC which is a regulatory compliance entity, mandated all large-scale industrial sector companies to achieve 2nd quartile energy intensity target considering global benchmarking approach to ensure efficient utilization of kingdom resources.

IBN ZAHR Executive management demonstrated their commitment by establishing a cross-functional energy & sustainability team, based on the following team model, is created to accomplish energy management goals and objectives.

The site sustainability team structure and the resources needed to implement the EnMS are:

| *Team* | Role | Link with IZOMS-122 | Training Required |
|---|---|---|---|
| *Sustainability & Energy Leader* | Part Time | Process Engineering Leader (PED Sr. Manager) | High Level Training |
| *Sustainability & Energy Engineer* | Full Time | Assigned Engineer from Process Engineering | • Sustainability Footprint<br>• KPI Tool<br>Opportunities Assessment |
| *Operations Engineer Each Plant* | Part Time | Assigned Engineer from each plant | • Sustainability Footprint<br>Opportunities Assessment |
| *Process Engineer Each Plant* | Part Time | Assigned Engineer for each plant from Process/Asset Engineering | • Sustainability Footprint<br>Opportunities Assessment |
| *EHSS Specialist* | Part Time | Assigned Engineer from EHSS Department | • Sustainability Footprint<br>Opportunities Assessment |

The Energy SMT Sponsor ensures that the inevitable cross-functional issues and priorities that any energy program raises are resolved at the right level.

IBN ZAHR Energy Leader ensures that energy management policy and a strategy to improve energy performance is created.

The EnMS defines energy goals and intensity target calculation for the site/ plants, energy indicators for each equipment, energy streams, and key energy variables based on best year performance and the design data. IBN ZAHR EnMS team defined the baseline based on following criteria:

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1- IBN ZAHR overall Energy intensity ($EI = \frac{Energy\ Consumption, GJ}{Production, Metric\ ton\ MT}$) 2010 to be reduced 25% by 2025 to achieve SABIC sustainability target.
2- IBN ZAHR Production Plant Energy intensity ($Plant\ EI = \frac{Plant\ Energy\ Consumption, GJ}{Plant\ Production, Metric\ ton\ MT}$)
3- Reduction percentage is calculated as follow:

$$\%\ Energy\ Intensity\ EI\ Reduction = \frac{Actual\ Energy\ Intensity\ EI - Baseline\ Energy\ Intensity\ EI}{Baseline\ Energy\ Intensity\ EI}$$

Energy Management standard provides the overall structure and processes to implement the standard within Ibn Zahr & Ibn Sina Sites and to deliver continuous improvement.

Regular tracking of Energy Performance Indicators (EnPIs) allows IBN ZAHR to identify improvement opportunities, compared to base year conditions, and reduce the energy intensity.

Annual energy and sustainability meeting conducted with site management team to develop the objective of the year and the following prioritizing index are used by Energy Leader and Energy Management Engineer to prioritize improvement ideas before they are presented to the SMT.

Prioritizing Index = Energy Saving Index x EI Improvement Index x Difficulty of Implementation Index x Capex Index x IRR Index (max index 1,024 for quick win).

Prioritizing Index:

| INDEX | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| **Net energy saving** | <$100k | $100k – $1m | >$1m – $2m | >$2m |
| **EI improvement** | 0%-1% | >1%-2% | 3%-4% | >4% |
| **Difficulty of implementation** | Very difficult technology change | Requires shutdown | Requires project work | Easy/quick win |
| **CAPEX** | >$2m | >$1m – $2m | $500k – $1m | <$500k |
| **IRR*** | <5% | 6-7% | 8-10% | >10% |

GHG emissions is also part of the sustainability KPIs where 25% reduction from 2010 baseline is being set as a strategic goal to be met by 2025 year. Annual performance evaluation is being performed to calculate the percent reduction compared to baseline year

> ***"ISO 50001 is an important enabler to achieve systematic improvement in energy performance while creating a value to our customers."***
> —Fouad Al-Garni, Lead Engineer, Sustainability & Energy

## Do, Check, and Act

IBN ZAHR was certified for ISO 50001 since 2022 where a robust Energy Management system was demonstrated.

TÜVRheinland CERTIFIED
ISO 50001:2018 Management System
Valid until: 2026-01-15
www.tuv.com
ID 9000025820

Our target is to achieve 25% reduction of Energy intensity by 2025 compared to 2010 baseline year (12.45 GJ/MT). Moreover, Saudi Energy Efficiency Center, SEEC provided an energy intensity target considering global benchmarking approach compared to industry peers where we have achieved SEEC 1st cycle target in net credit position utilizing the efficient energy management system.

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The energy management system (EnMS) enable us to easily track and optimize the source of emissions associated with energy consumption which help to certify our value chain product (Methanol) as Low-Carbon under International Sustainability and Carbon Certification ISCC Carbon Footprint Certificate CFC demonstrating our contribution towards circular economy and decarburization.

In compliance to ISO 50001 and our internal energy management system while leveraging the real-time plant information data historian system (PI), we have developed an Online Energy Management Dashboard to monitor and optimize the major energy consumers mainly; Fired heaters, boilers, Reaction Furnace, steam turbines and compressors. The real-time performance and energy efficiency-monitoring dashboard supported the team to observe the performance of the major energy consumer assets, generate daily performance reports and identify the gap for energy optimization. The system retrieves the live data from PI data historian and is available 24/7 for performance evaluation; in addition, historical cases are embedded for non-PI users. The In-House development of the Energy Management Dashboard worth more than 1 MMSAR development cost.


Each plant developed specific energy management procedure for continuous improvement of Energy Performance Indicator (EnPI), Energy Efficiency (EE) and Key Energy Variables (KEV) at equipment level, plant Energy Intensity (EI) and energy gap performance.

Significant energy users are identified based on equipment net energy consumption and anticipated potential for energy improvements. Their performance are monitored to identify potential improvement opportunities.

For each significant energy user, 'key energy variables', which influence the energy consumption and performance of the equipment was identified as follow:

| | Equipment | No of Asset | Energy consume GJ/day | Energy Source | Key Energy driver |
|---|---|---|---|---|---|
| 1 | **Boilers** | 12 | 45,190 GJ/Day | Natural gas and Mix fuel gas | Steam production, Fuel flow, stack temperature , excess air , boiler efficiency |
| 2 | **Reformer** | 1 | 30,070 GJ/Day | Natural gas and Purge gas | Fuel flow, excess air, stack temperature, Reformer efficiency |
| 3 | **Furnace/Heater** | 8 | 27,862 GJ/Day | Mix Fuel Gas | Out let Temperature, stack temperature excess air, heater efficiency |
| 4 | **Extruder** | 8 | 4,928 GJ/Day | Electricity | Electricity consumption, Efficiency |
| 5 | **Gas turbine** | 2 | 24,952 GJ/Day | Natural gas | Fuel flow , Turbine efficacy |

To identify potential energy improvement opportunities, the SEU energy use and the plant energy use is compared to a baseline target.

The energy cost index is calculated to provide the operators with an indicative cost to operate that item of equipment.

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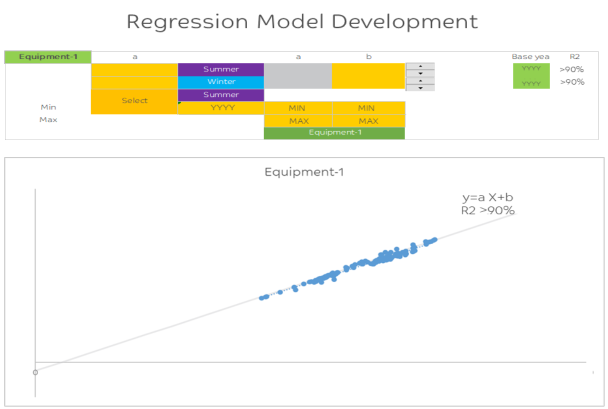
Linear regression was performed for each significant energy users in order to normalize and calculate the energy consumption considering load variation and taking into account the seasonal impact (summer / winter) as shown in below figure.




- EnB target for SEU as per OMS-423
- Seasonal Impact on the energy consumption
- Min, Max values for the KEV


A number of equipment and plant level measures are summed up to produce several measures.

The KPI calculation basis is defined in more detail in the KPI summary

| | # | Level | KPI | Measuring Unit | Source of Data | KPIs Definition | KPIs Formula |
|---|---|---|---|---|---|---|---|
| Site Management KPIS | 1a | SITE | Site Units Energy Performance Gap | GJ | PIMS | Sum of energy performance gaps of all units at a site compared to respective units energy targets at planned production. | $SUEG = \sum_{i=1}^{n} UPEG$ i |
| | 1b | SITE | Site EnPI Potential / Improvement | GJ | Energy Mgt Tool | Site Significant Equipment Energy performance compared to best ever. | $Site\ EnPI\ Improvement\ Potential = \sum_{i=1}^{n} Eqpt\ EnPI\ Potential$ |
| | 1C | SITE | Site Enegy Cost Index | $ | | | |
| Management KPIS | 2a | Unit | Unit Performance Energy Gap | GJ | Unit Energy Intensity (EI), Benchmark Data, Historical Data | Difference of current year Unit EI and Targeted EI at a fixed production.<br><br>Energy Intensity is net energy use (actual energy import over site battery limit plus own make fuel which is burnt rather than primary energy) / unit throughput | UPEG=$(UEI\ Reported\ Period - Targeted\ EI) * YTDProdcution$ |
| | 2b | Unit | Unit EnPI Improvement Potential | Energy Performance, GJ & Million USD | Energy Data Base PIMS | Equipment Energy performance compared to base time period | Unit EnPI Improvement Potential ($)<br>=$\sum_{i=1}^{n} Eqpt\ EnPI\ Imp.\ Potential(\$)$<br><br>Unit EnPI Improvement Potential (GJ)<br>=$\sum_{i=1}^{n} Eqpt\ EnPI\ Imp.\ Potential(GJ)$ |
| | 2C | Unit | Unit Enegy Cost Index | $ | | | |
| Field Operator KPIS | 3a | Equipment | Equipment EnPI Improvement Potential | Energy Performance, GJ & Million USD | Energy Data Base PIMS | Equipment Energy performance compared to base time period | ***EnPI*=(GJ Rpd Prd)/(GJ *Base*\| Rpd Prd)**<br><br>Where GJ Base \| Rpd Prd indicates base line period model applied at the reported period condition and GJ Rpd Prd actual Reported Period consumption.<br>Eqpt EnPI Improvement Potential(GJ)=(1-EnPI)* GJ Base \| Rpd Prd<br>Eqpt EnPI Improvement Potential($)=(1-EnPI)* GJ Base \| Rpd Prd* Cost of Energy |
| | 3b | Equipment | Equipment Energy Efficiency | Energy Efficiency % | Energy Data Base PIMS | Ratio of Net Energy (based on primary energy) consumed at equipment boundary by Significant Equipment to the useful Energy transferred to process | $Equipment\ Eff$=(Energy Transfer by significant Equipment to Process GJ)/(Net Energy Input to Significant Equipment GJ) |

Energy experts in energy team are professional process and multi-disciplined engineers with specific work experience in the process and utilities field. They have skills in both energy technology and energy management and are able to plan a rational use of energy to optimize energy use and reduce energy costs.

Energy Leader is accountable for ensuring that energy team skill level and competency are adequate to improve the energy performance, to maintain the reporting of energy work process KPIs, and to audit energy assessment studies.

Energy Leader will identify competency gaps for new and existing members of energy team, and develop a plan to close these gaps. This may be in consultation with process and energy management team energy experts, if appropriate. The main competencies required within energy team are:

- Thorough understanding of how process operation and operating conditions affect energy consumption
- Basic equipment operational and energy optimization knowledge
- Basic knowledge of capital budgeting techniques
- The ability to set utility usage targets at equipment, plant and Site level
- The capability to plan and implement energy audit activities
- Identifying energy efficient technical solutions to minimize the waste of plant energy
- Auditing conceptual studies (evaluation of investment life cycle costing, alternative options, and risks)
- The ability to apply the relevant government energy regulations and technical standards/specifications

Annual internal audit is being conducted to ensure compliance with ISO 50001 requirements prior to the annual surveillance audit by the external auditor.

Motivation and rewards are essential part of the process to incentivize individuals in the site. At a site level, plant management recognize and reward energy and sustainability related accomplishments through quarterly sustainability employee of the quarter program. On the other hand, at SABIC corporate level, the site and individuals are being recognized through the annual Sustainability Team Meeting.

## Transparency

IBN ZAHR displays all ISO certificates in the admin buildings and accessible to all employees through the enterprise content management ECM.

SABIC Energy Policy was integrated in IBN ZAHR energy management system OMS 423 and available on IBN ZAHR website on the intranet.

## What We Can Do Differently

IBN ZAHR acknowledges that there are missed opportunities that could have been captured to enhance EnMS performance including:

- Overlooking non-significant energy users
- Energy loss not included as a risk in the company risk matrix

We consider those were missed opportunities that could have generated more energy saving.
Moving forward with ISO 50001 EnMS, IBN ZAHR plan to capture those missed opportunities as follows:

- Include non-significant energy user program to EnMS

- Include energy impact for the identified company risk