

Borouge

A strategic partnership between
ADNOC & Borealis



Case Study Snapshot

Industry	Petrochemicals
Product/Service	Polymers / Polyolefins
Location	Al Ruways Industrial City, Abu Dhabi
Energy performance improvement percentage (over the improvement period)	20 % improvement over 4 years
Total energy cost savings (over the improvement period)	USD 30,656,339
Cost to implement Energy Management System (EnMS)	USD 1,602,000
Total energy savings (over the improvement period)	3,317,473 MWh
Total CO₂-e emission reduction (over the improvement period)	709,998 Metric Tons over 4 years

Organisation Profile

Our Company:

Founded in 1998 through a strategic partnership between ADNOC and Borealis, Borouge was formed to build and operate a petrochemical complex in Al Ruways, United Arab Emirates, with a sales and marketing business in Singapore.

Borouge, listed on the Abu Dhabi Securities Exchange (ADX symbol “BOROUGE” / ISIN “AEE01072B225”), is a leading petrochemical company that provides innovative and differentiated polyolefin solutions for the energy, infrastructure, mobility, advanced packaging, healthcare and agriculture industries. ADNOC owns a majority 54% stake and Borealis holds a 36% stake in Borouge.

We employ more than 3,100 people with 49 nationalities, serving customers in over 50 countries across the Middle East, Asia and Africa. Borouge is made up of two entities:

- Abu Dhabi Polymers Company (Borouge) is a production company based in Abu Dhabi and primarily responsible for petrochemicals production, commonly referred to as “Borouge ADP”
- Borouge Pte is headquartered in Singapore and primarily responsible for the marketing, sales and delivery of products to the customers of Borouge around the globe

From hereafter, the entire company and all its entities are referred to as “Borouge”, thereby representing them all as one company sharing the same vision, mission, brand, values and strategy.

Our Vision:

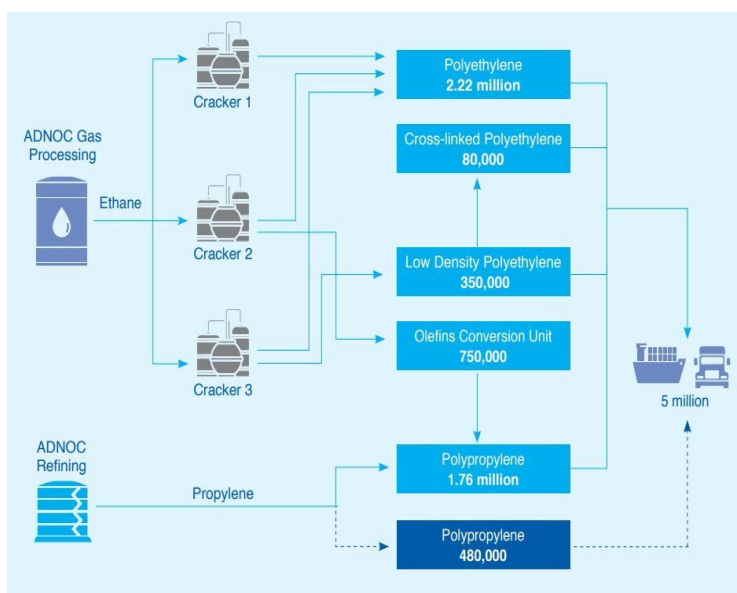
The recognized leader in creative polyolefin solutions that have a positive impact on society today and tomorrow

Our Mission:

Value creation through people and innovation.

Our Operation:

Our petrochemicals and polyolefins manufacturing plant is located in Al Ruways Industrial City at a distance of about 250 km west of Abu Dhabi City. The facility is now one of the largest fully integrated single-site polyolefins complexes in the world, with an annual capacity to produce 5 million tonnes of polyethylene (PE) and polypropylene (PP). The complex is also the largest Borstar® process technology-based plant in the world, providing enhanced innovative bimodal polymers for a broad range of polymer applications. We remained on track to increase our production through Borouge 4, the next mega-project expansion that will significantly increase our production capacity by 2025. Moreover, we have already started-up our fifth polypropylene plant (PP5) in Al Ruways Industrial City.



Achievements

- OPEX reduction from Energy optimisation initiatives: 30.7 Million USD in 4 years
- Lowest ever annual energy intensity achievement consecutively for the past 4 years, each year breaking the record of previous year.
- Digitalisation of reporting and monitoring systems due to readiness of availability of information in a structured and systematic format due to the adherence to ISO 50001 standard.
- Ruwais Environmental Sustainability Programme (RESP) was awarded the ADNOC Excellence award in 2021 in the 100% HSE category.

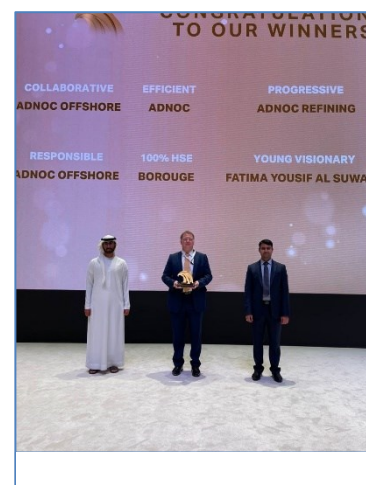
Ruwais Environmental Sustainability Programme (RESP):

Signaling our commitment to mitigate our environmental impact, we launched our 2025 Al Ruways Environmental Sustainability Programme (RESP) in 2020 that yielded positive results during the years. Through the implementation of RESP, we are able to achieve significant optimization, particularly through our zero flaring and energy efficiency projects, improving the livelihood of the people living in the Al Dhafra region. Compared to the 2018 baseline we managed to:

- Reduce continuous flaring by 66 %
- Increase water efficiency by approximately 25 %
- Reduce energy intensity by about 20 %
- Reduce Scope 1 and Scope 2 GHG emissions by about 23 % and 22 % respectively

A key enabler of the RESP project was the Borouge Energy roadmap 2030, which was developed as part of the Borouge Energy management system.

“We inspire creativity by working closely together as one diverse family, and good neighbors that build a brighter future focused on values creation to create an impact.”



Case Study: Upgradation of ISO 50001 Energy management system to the new 2018 standard & delivery of 2030 strategic targets

Introduction

Borouge had established, documented and maintained an Energy Management System (EnMS) in accordance to the requirements of the standard ISO-50001:2011 since 2015. With increasing focus on de-carbonization, sustainability and climate change, Borouge wanted to have clear targets towards improving these aspects of our operations. Energy optimization was identified as the first step towards Borouge decarbonization goals, since the primary fuel of plant operations at Al Ruways Industrial City in Abu Dhabi was natural gas. An ambitious goal of reducing energy intensity of our Al Ruways operations by 30% from a 2018 baseline was set as part of the company decarbonization strategy.

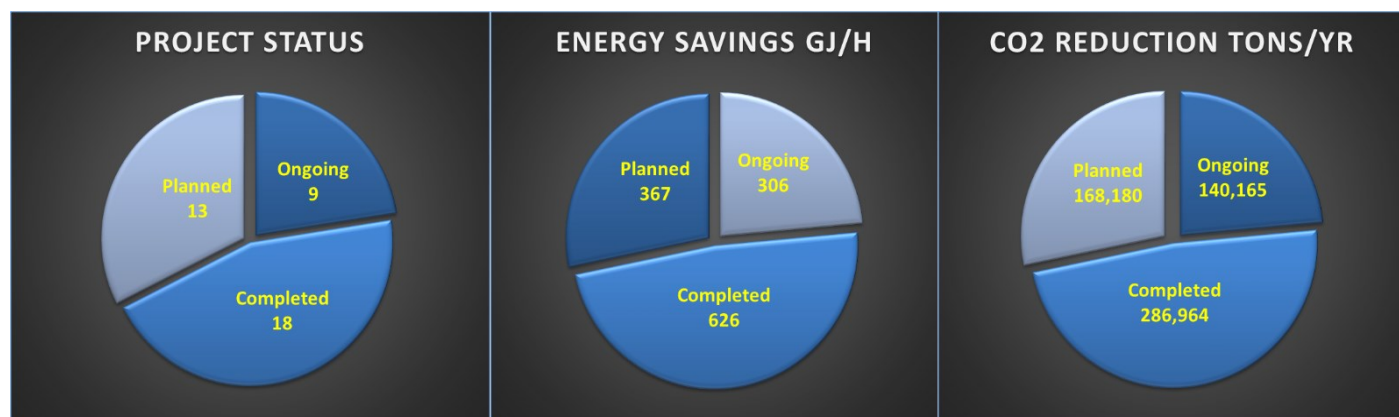
This required a comprehensive, holistic and systematic approach for energy management, which was possible through ISO 50001 standard. Borouge was already certified for the ISO 50001:2011 version of the standard and it was decided that the upgradation of this standard to the new 2018 version would be utilized as an opportunity to align the strategy towards delivery of decarbonization goals, in addition to the previous objectives, which were mainly focused on profitability and efficiency improvement.

In 2020, the ISO 50001 certified energy management system has been upgraded to the new ISO 50001:2018 version that allows us to manage our energy performance even more effectively and achieve a higher level of continual improvement.

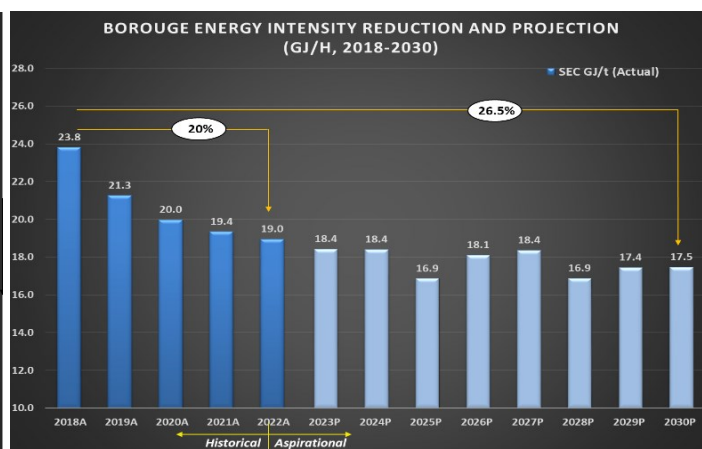
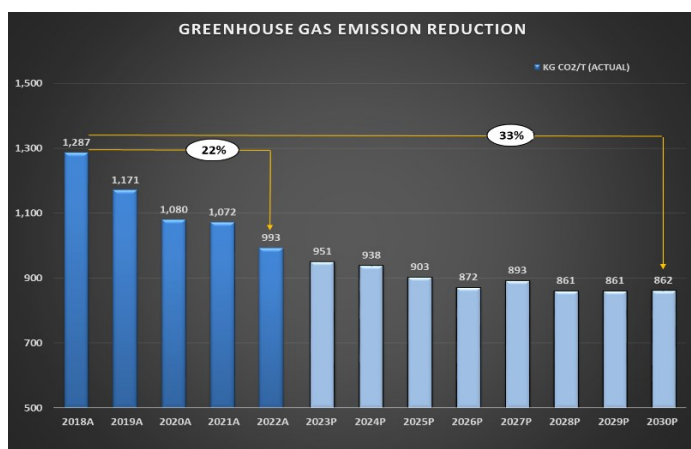
Also in 2020, we finalized a comprehensive energy study for our assets to develop a long-time energy roadmap to ensure continuous utilization of best practices, tools and technology, now and in future. As an outcome of the study, a detailed energy and GHG reduction roadmap until 2030 was created with a strategic ambition to reduce our energy consumption by 30 % from the 2018 baseline.

The comprehensive energy study was performed with an external consultant at a cost of 300,000 USD and included various engagement sessions with in-house plant Subject Matter Experts. The upgradation of the ISO 50001 standard was done in house by the energy management team at no additional cost to the company. However, certification of the same through certified ISO auditors and development & implementation of energy roadmap has come with significant investment- totaling to about 1.6 million USD till date. Further investments are captured in the business plan 2023-27 to the tune of about 40 million USD for major CAPEX projects, which will further deliver the 2030 strategic targets.

A summary of progress achieved till date with the Energy roadmap implementation post the upgradation of ISO 50001 to the new 2018 standard is given below. Due to confidentiality reasons, the actual list of energy initiatives or process modifications are being withheld.



Other non-monetary benefits of this initiative are increased awareness and focus towards carbon emissions reduction amongst all employees and the impact on climate change our operations can have. In addition, we have started working with our business partners and licensors encouraging them to get ISO 50001 certification by incorporating this as a requirement in new contracts.



- In 2024-25 commissioning of our new cracker and polyolefins plants are planned.

Plan

Planning is done in the beginning of the year each year and it now includes development of the energy management action plan with two objectives in mind.

- To identify actions that will be implemented during the year and will enable Borouge to meet the current year energy target.
- To capture in the energy management action plan a list of ideas that will enable Borouge to meet the 2030 target. These were long-term/mid-term process modifications that need to complete various stages of project management including Assessing, Selecting, Defining and Executing. However, the energy management action plan would capture the steps to be taken in the current year to further move along the implementation of the project through the various stages of the project management.

Snapshot of compiled energy saving ideas as part of Energy Management action plan is given as under:

Sr. No.	Plant	Activity	Task	Schedule	Energy Saving, GJ/hr.	OPEX Saving, kUSD/year	Responsible	Accountable
1	EU2	Commissioning of steam system APC	Commissioning	Q2 2023	101.2	2,478.1	Himansu/Praveen	Marjo
2	EU2	Steam trap & PSV/Flare control valves leak check and maintenance	Walkthrough surveys	Full year	10.8	264	Hasan Al Hammadi	Marjo
3	EU2	Boiler stack temperature reduction by optimizing BFW temperature to Economizer	Regular operation	Full year	15.2	371	Nilesh/Reddy	Marjo
4	EU2	PSG blowdown minimization	Operational	Full year	2.5	61.7	Himansu	Marjo
5	EU2	Periodic cleaning of heat exchangers (HE-305/327)	Regular operation	Full year	16	384	Nilesh/Reddy	Marjo
6	EU2	Increase of boiler steam temperature up to design level	Implementation	Jan 2023	24.7	775	Hamad	Harish

This was a new change to the planning stage and forms basic intent of the energy management action plan. The plan was no longer limited to focusing on delivering the present year targets. It also included actionable items that will not necessarily complete a project in the current year, but work towards implementation of the project in the next few years to enable Borouge meet the 30 % energy intensity reduction target. Plan, therefore, now included items such as completion of the feasibility study for particular process modification, completion of tendering and awarding the engineering contract to the licensor for a process modification, etc.

The planning stage involved break-out sessions with the energy champions of each plant by the energy manager.

Separate meetings were required for each plant. The process flow diagram of the plant was then reviewed from design perspective and intent was challenged by the team to identify **“Is there a better way?”**

Borouge is conducting energy review as the process of identification and evaluation of energy use to define areas of significant energy use and identify opportunities for further improving energy performance.

Various steps involved as follows:

- A. Analyze energy use and consumption of its assets based on measurements.
- B. The areas of significant energy users (SEU) are identified based on this analysis, i.e.
 - the facilities, equipment, systems, processes and personnel working for, or on behalf of, the organization that significantly affect energy use and consumption;
 - other relevant variables affecting significant energy uses;
 - determine the current energy performance of facilities, equipment, systems and processes related to identified significant energy uses; and
 - Estimate future energy use and consumption.
- C. Identify relevant variables, gaps between the actual energy efficiency performance and design and/or the benchmark figures, where available and identify the person(s) controlling, influencing or affecting the SEUs
- D. Prioritize and record opportunities to improve energy performance.
- E. Estimate future energy use(s) and energy consumption.
- F. Review relevant external and internal issues
- G. Review of stakeholders and the requirement
- H. Review of risk and opportunities and action plans



The energy review is done by the energy team that is led by the Energy Manager on an annual basis. It is also conducted, when there are major changes implemented for facilities, equipment, systems or processes.

The energy review lists energy savings opportunities and prioritize them using the cost–benefit analysis. Annual energy review provides investment proposals for corporate business plan.

The strategic planning inputs are given to the management representative in the Executive leadership communication (EXCOM) meeting, chaired by CEO with entire company leadership team in attendance. Decisions pertaining to approval of investments for next year energy initiatives based on business case, NPV, IRR calculations, impact on energy efficiency, water consumption reduction, flare loss reduction and carbon emissions are taken in the meeting.



In addition, updates regarding adequacy and quality of implementation of ISO 50001 standard and required improvements are also discussed.

Do, Check, and Act

Energy Baseline

Borouge has established an Energy Baseline for all the plants including Significant Energy Users. The Energy Baseline for all production plants is the Specific Energy Consumption (SEC) figure (expressed in GJ/tonne of high value chemicals). For the production plants, it is calculated as a weighted

Functions	Baseline GJ/ton or GJ/h	Outstanding SEC	Target SEC	Threshold SEC
Olefins (Excl. OCU and 1-butenes)	18.80	18.4	18.8	19.2
Site Integration (Incl. non-process build.)	1261	1236	1261	1286
Polyolefins PE	4.34	4.3	4.3	4.4
Polyolefins PP	4.12	4.0	4.1	4.2
Polyolefins (Incl. PO common)	4.64	4.5	4.6	4.7
Specialty polymers	9.07	8.9	9.1	9.2
Borouge (internal approach)	29.4	28.8	29.4	30.0
Borouge (ADNOC approach)	21.1	20.7	21.1	21.6

average of the monthly SEC's against the high value chemicals production. For the utility plants, the absolute energy consumption GJ/h is used as a baseline.

All plant upsets and disturbances are included in the calculations.

The period selected is a broad period that reflects normal frequency of plant upsets. The baseline period is normally selected as a full calendar year to avoid effects due to ambient conditions. The baselines are reviewed and adjusted, in case the existing baseline no longer reflects the organisational energy use and consumption or, there have been major changes to the process, operational patterns or energy systems. Baselines will be also adjusted, if the current baselines are no more relevant in view of the current energy performance. If the baselines no longer reflect the actual performance, they are discussed in quarterly energy performance meeting and will be adjusted, if necessary. Energy Baselines are normalized, when relevant variables significantly affect energy performance.

Once baseline is established, targets set in the management review meeting will be cascaded to all plants and facilities and, Energy Management Action Plan is developed to meet the individual plant level energy targets. The individual initiatives are also quantified for energy impact and OPEX savings impact for the year along with agreed month of implementation of the initiative. Monthly follow-ups are done through emails followed by quarterly meetings to discuss the progress. The initiatives from Energy Management Action Plan are also included in 2030 Energy roadmap.

Post implementation of any initiative, the energy benefit is calculated from PI tags in DCS and reported to Energy manager and site cost controller for approval. The initiatives should clearly demonstrate reduction in primary KPIs like Energy intensity (GJ/t) and GHG intensity (kg CO₂/ton) OR Tons per year CO₂ reduced. Majority of the savings of energy roadmap impact company's steam demand.

Utilizing above, Borouge was able to stop one boiler from operation by optimizing steam demand, to the extent that the boiler need not be in continuous operation anymore.

The initiatives are also coming from electricity consumption optimization, which reflect in reducing import electricity bills.

The values are audited subsequently by ADNOC sustainability team through a separate portal and accruals are certified.

With the completion of the current year energy review, the cycle starts again to set targets for subsequent year based on actuals achieved from previous year adding 2% further reduction in specific energy consumption. The planning stage

follows the target setting and the cycle continues every year.

The screenshot shows the 'INITIATIVES' management system interface. At the top, there is a search bar with 'INI_03049' and a filter button. Below the search bar, there are navigation tabs: 'New Initiative', 'Restore Initiative', 'Delete Initiative', and 'Suspend Initiative'. A dropdown menu shows 'Portfolio: All initiatives'. The main content area has several tabs: 'Active Initiatives', 'My Initiatives', 'Suspended Initiatives', 'Deleted Initiatives', 'Legacy', 'Best Practices', and 'Technologies'. The 'Active Initiatives' tab is selected, displaying a table with the following data:

Status	Initiative Type	Open	ID	Title	Maturity	Pending Action	Action Timer (Days)	Owner Description	Initiative Sponsor	Stream Champ
<input type="checkbox"/>	Standard	<input type="checkbox"/>	INI_03111	EU-2 Steam system APC implementation	3. Impact Recognized	4a,4b,4c. Owner to submit Milestones & Final C...	128	Himansu Pal	Shamsa AL Junaibi	Harish SVS
<input type="checkbox"/>	Standard	<input type="checkbox"/>	INI_03112	EU-3 Steam system APC implementation	3. Impact Recognized	4a,4b,4c. Owner to submit Milestones & Final C...	128	Krishnan Mani	Shamsa AL Junaibi	Harish SVS
<input type="checkbox"/>	Standard	<input type="checkbox"/>	INI_03113	OCU APC implementation	3. Impact Recognized	4a. Owner to Submit Implemented Milestones ...	128	Perttu Hihnala	Shamsa AL Junaibi,Omar ...	Harish SVS
<input type="checkbox"/>	Standard	<input type="checkbox"/>	INI_04044	High Temperature Heat Pump (HTHP) for...	2. Impact Identified	3a. Owner to Submit Roadmap & Milestones	85	Satheeshkumar Ramalin...	Shamsa AL Junaibi	Harish SVS

Energy Objective

Borouge's objective is to reduce specific energy consumptions by at least 2% per year.

Monitoring, Measurement and Analysis

Borouge energy management system monitors the energy performance of its operations by monitoring, measuring and analysing its key characteristics.

- The significant energy-using equipment like Furnaces, Boilers, Turbines, Extruders etc;
- The relevant variables related to significant energy uses like Excess O₂, Turbine heat rate, SEI of extruders etc,
- Energy Performance Indicators like GJ/t of furnace energy consumption,
- The effectiveness of the action plans in achieving the objectives and targets, which is demonstrated through monthly KPIs like energy intensity.
- Evaluation of actual vs expected energy consumption. It is demonstrated through deviations from set targets on monthly basis.

Deviations Analysis

Any unexpected deviations in energy performance are investigated and outliers are identified.

Analysis is performed by constituted investigating teams and/or energy management team using the i5 approach. Significant deviation is event with medium or higher risk rating categorised using the Borouge risk matrix, and is beyond the outlier criteria. Also, it cannot be explained or normalized with variables effecting the energy performance.

Management Review

The Energy Management Representative (EnMR) and the energy management team will review the EnMS once a year to ensure its effectiveness, adequacy and continuous improving.

The management review includes the consideration of:

- the status of actions from previous management reviews;
- changes in the external and internal issues and associated risks and opportunities that are relevant to the EnMS;
- information on the EnMS performance, including trends in:
 - nonconformities and corrective actions;
 - monitoring and measurement results;
 - audit results;
 - results of the evaluation of compliance with legal requirements and other requirements;

- opportunities for continual improvement, including those for competence;
- energy policy
- energy management team set-up.

The energy performance inputs to management review include:

- the extent to which objectives and energy targets have been met;
- energy performance and energy performance improvement based on monitoring and measurement results including the Energy Performance Indicators EnPI(s);
- status of the action plans.

Transparency

Internal audits are conducted as per the Internal & External Integrated Management System (IMS) and Compliance Audit Procedure to provide a reasonable assurance on the Borouge EnMS adequacy and effectiveness.

A contract with an accredited certification body for the performance of external (third party) audits and the initial and continued certification of the ISO 50001:2018 certification is established through the Corporate Audit & Assurance function. Same is published in Borouge Sustainability Report released annually.

As part of the mandatory disclosures for our listing on Abu Dhabi stock exchange, we have shared the mandatory disclosures that include certification of ISO 50001:2018.

What We Can Do Differently

Borouge plans to modify the energy management system data management practices to automate the data collection and reporting efforts. We plan to do this through digitalization. The tool that we are currently developing is called the Energy Management Information System (EMIS). The intention behind this is to free up the time taken by people in data collection and reporting, and instead, use this time for identification and implementation of the energy efficiency measures. Automation of the repetitive tasks such as reporting and reconciliation is happening all over the world in every industry, and Borouge will be pioneering this in the petrochemicals industry.

In addition, the automation of data and calculations evidences greater transparency for auditing purposes. This tool will be used for the energy planning stage where monthly reports are currently being used. The monthly reports are too infrequent to capture the individual bad actors or incidents that prevented energy efficient operation. The new EMIS tools will be running the monthly balance calculations every 15 minutes. Therefore, we will be having many more data points to analyze the Borouge energy consumption patterns even up to the equipment level, and this will be leveraged for identifying opportunities for improvement. EMIS is currently operational. However, it was not integrated into the Borouge Energy Management System. Borouge plans to verify the EMIS results with monthly reporting results for one year to establish confidence in accuracy of the real time EMIS calculations before transitioning to the EMIS as the data source for our EnMS.

With the availability of higher numbers of data points in the EMIS, Borouge is also planning to leverage the Artificial Intelligence and machine learning technologies to set dynamic targets for each Significant Energy User (SEU). The value addition here is that the targets are presently set based on the annual business plan production rates. Hence, the targets are fixed for the entire year. If the production rates are lower for a particular month compared to target, there will be an opportunity for hiding inefficiency under the context of the low capacity operation. Borouge plans to eliminate this reasoning such that those targets will be dynamic based on the actual current production rates, and the only explanation for the higher-than-target performance will be inefficiencies. These inefficiencies will then be targeted for improvement. This is our plan in the next 5 years.



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.