Hawiyah Gas Plant

of Saudi Aramco

Energy Efficiency is a strategic sustainable driver for Hawiyah Gas Plant department

Hawiyah Gas Plant (HGPD) is one of Aramco's largest gas processing facilities, located at the south of Eastern province of Saudi Arabia, near Ghawar oil field, the largest conventinal oil field in the world.

Case Study Snapshot	
Industry	Gas Processing
Product/Service	Multiple
Location	Saudi Arabia
Energy performance improvement percentage (3 year)	14.7 % improvement
Total energy cost savings (One year)	Note: Financials cannot be shared due to company's policies on confidentiality. However, Energy cost saving in Budget Percentage is averaged 8.7% for each year.
Cost to implement Energy Management System (EnMS)	USD 40,000
Total energy savings (3 year)	1,713,721 MWh
Total CO_2-e emission reduction (3 year)	309,309 Metric Tons of CO_2

Organization Profile / Business Case

Hawiyah Gas Plant (HGPD) is one of Aramco's largest gas processing facilities, located 260km east of Riyadh, as a first Plant in the kingdom to Process Non-Associated Gas & the key supplier through the kingdom's Master gas system. The gas processing capacity of our Hawiyah gas plant was expanded 3.5 billion scfd to raise total production capacity of the plant to 3.3 billion scfd, making it one of the largest gas processing facilities in the world. Hawiyah has become a reliable supplier of Natural gas, Hydrocarbon and Molten Sulfur in a safe, cost effective, efficient and environmentally responsible manner.

Our success in HGPD is based on having a well-structured base and motivated, skilled, and diverse workforce. Our motivation comes from Saudi Aramco's commitment to conserve natural resources, minimize the environmental footprint of our activities. Aramco has set target for net zero by 2050 from its wholly-owned operated facilities. HGPD

supports the aims of the Paris agreement to limit the global average temperature increase as well as to comply with 15% reduction in upstream intensity for Scope 1 and Scope 2 emissions initiatives by 2035.

HGPD EnMS plays key role to achieve HGPD pillars -highlighted below in Fig1- which is the road to achieve HGPD's vision and corporate's strategies. ISO 50001 requirements and Energy Management System are embedded in HGPD Operational Excellence program implementation. The energy management program has been identified as one of the most important success factors of the organization for achieving sustainable energy efficiency performance.

Our sustainability governance model strives to align corporate's sustainability Framework, corporate operational efficiency strategy, and corporate energy transition strategy.

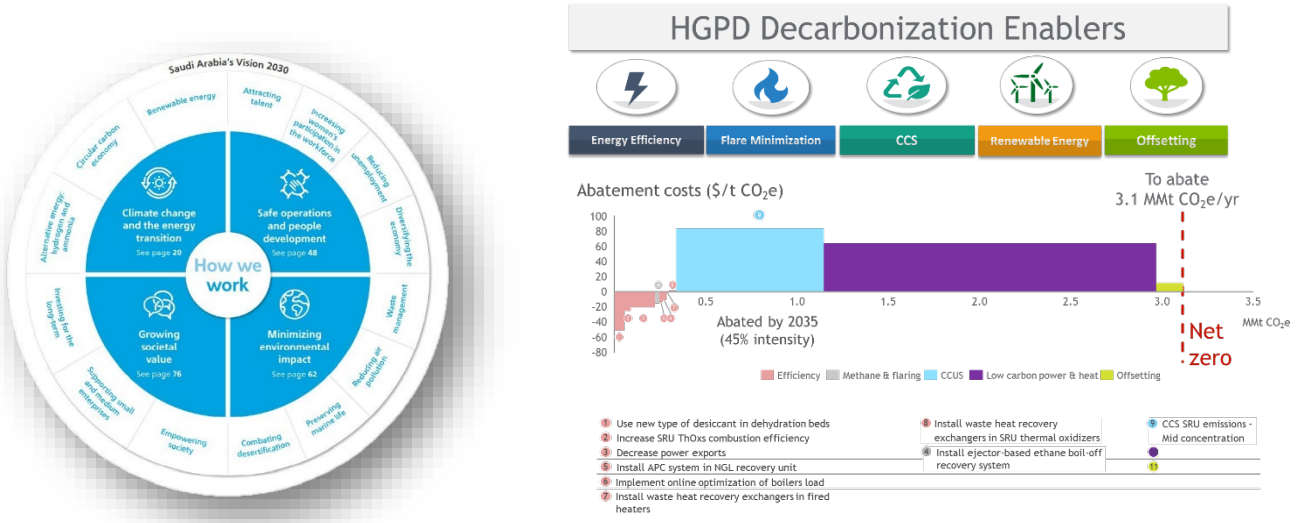

Fig1: Aramco's Sustainability model & HGPD Decarbonization

HGPD proactive steps to reduce its carbon emissions. HGPD is not investing in capital or minor projects only, our workforces have well-structured work-environment, stringent by ISO 50001 full-compliance and detailed Energy Management System (EnMS) to generate environmental sustainability and decarbonization initiatives

By prioritizing sustainability, energy conservation and environmental consciousness, HGPD is making a profound impact in the battle against climate change, where in 2023 & 2024, HGPD has successfully commissioned a new mega-project such as; flare gas recovery system, Liquid Hydrocarbon recovery system. Moreover, capitalizing on EnMS realized benefits, an advanced proven technology and generated innovative ideas/patents by our main assets -HGPD employees - were implemented -such as overhead compressors efficiency optimization and fuzzy logic "patent"- to decarbonize our operation.

"Being an ISO 50001 certified facility is testimony of Hawiyah Gas Plant commitment toward achieving best in-class Energy Management system (EnMS) standard compliance, where the plant energy program is fully integrated to the facility quality and environmental management systems."

—Humaidi Harbi, HGPD Operation Manager

Business Benefits

The primary business drivers for using EnMS to manage these emissions include regulatory compliance, cost savings through improved energy efficiency, and enhancing our market reputation as a sustainable and responsible business. The benefits of employing EnMS are substantial, it provides a clear framework for identifying significant energy uses and setting targeted reduction goals, which directly contribute to lower GHG emissions.

Our organization's Energy Management System (EnMS), certified under ISO 50001, has been instrumental in managing energy efficiency, renewable energy deployment and reducing our energy-related greenhouse gas (GHG) emissions. By tracking fuel gas and power consumptions and adopting new technologies application, we have achieved reduction of energy use across all functions, leading to significant GHG emission reductions, water conservation, waste minimization. Those remarkable results were achieved post the ISO 50001 implementation through effective Plant load management, Flare Gas Recovery system implementation, Liquid Hydrocarbon recovery system deployment and etc. These accomplishments not only underscore the leadership in the gas sector but also highlight the dedication to environmental stewardship.

These accomplishments' results were recorded over the duration of 2022- 1st quarter of 2024, the energy saving percentile is 14.7%, while the total energy saving over the improved period is 1,713,721 MWh and the Energy cost saving in Power Budget percentage is 8.7%. In addition, the total emission avoidance is 309,309 tons of CO2.

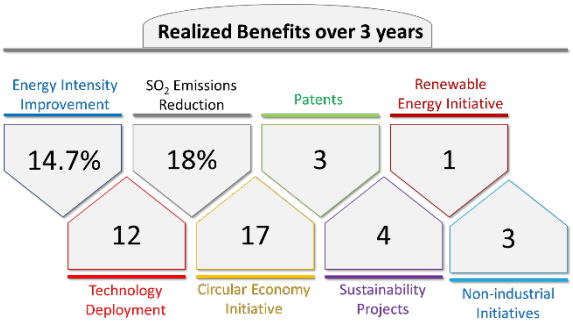

Fig2: Other Realized benefits from ISO 50001 implementation

Rate of return of ISO 50001 certification investment cost is tremendously high. the realized benefits of spending $40,000 -staff and auditing costs- is around 1,713,721 MWh. This is a true reflection of the effectiveness of ISO 50001 implementation. This section represents the benefits of ISO50001 for HGPD as a single site in Saudi Aramco.

Promote the energy conservation culture is one of the added values to all plant workforce, HGPD is conducting several awareness sessions and energy roundtables to raise awareness level to our workforce, external contractors and local community schools as we believe this is part of his professional and social responsibility. HGPD encourages its employees by providing environment and energy related global platforms and motivating them to obtain the most important international certificates such as C.E.M and ISO 50001 lead auditor that help the company's direction. During the few years, HGPD hosted several ISO certification courses to support its employees and local organizations' employees.

Using ISO 50001 in supply chain engagements extends the efficiency and sustainability efforts of an organization to its suppliers, promoting energy management across the entire value chain. This approach enhances consistency and compliance with environmental standards, reduces operational costs through improved energy efficiency. Additionally, it helps manage risks associated with energy price volatility and enhances brand reputation by demonstrating commitment to sustainability. Overall, integrating ISO 50001 into the supply chain supports broader corporate sustainability goals, benefiting both economic and environmental aspects of the business.

Successes like these have shown EnMS and ISO 50001 implementation to be good for business. HGPD has shared its best practices and expertise as a knowledge exchange in many international conferences and scientific journals.

Fig3: Knowledge exchange in many international venues

Hawiyah has become a energy pioneer, achieving excellent energy KPIs, recognized both locally and internationally. These accomplishments are not limited to the organizational level, HGPD employees and initiatives also had an international recognitions and awards, As explained below:

Fig4: HGPD locally and internationally Recognitions

Plan

HGPD energy policy and framework were formalized a in accordance to ISO 50001 to get highest level of commitment from top management. A comprehensive outline is continuously presented quarterly to the top management, which displays benefits of implementing an EnMS, such as significant cost reductions, enhanced operational efficiency, and compliance with environmental standards. By demonstrating potential energy savings and projecting a favorable return on investment.

The management play a critical role by participating in regular review meetings and providing strategic oversight. Their involvement was crucial in reinforcing the importance of the EnMS across all levels of the organization. HGPD formed Energy Management Steering Committee chaired by the department director to set and expedite the action plan based on EnMS responsibilities. Also, allocation of needs financial funding and resources jointly with planning and project groups to successfully implement the EnMS.

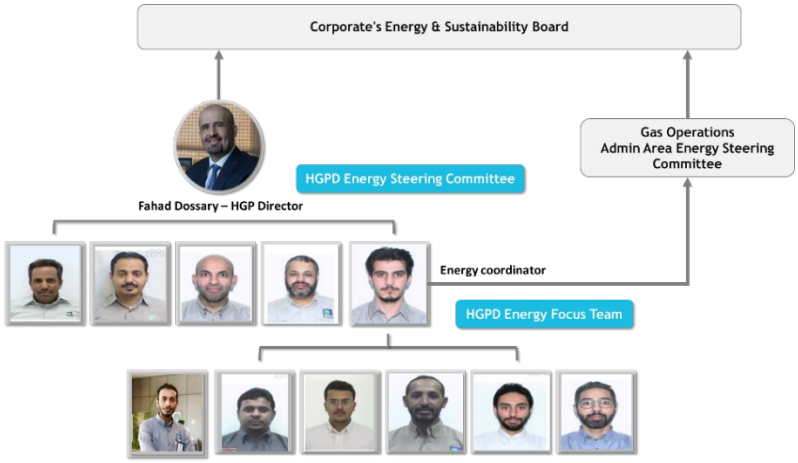

Fig5: HGPD Energy Management Steering Committee & Focus Team

The first step to develop an appropriate approach was to establish a baseline that capitalizing on the corporate best practice "Energy Intensity KPI Guideline". The main Energy and production KPIs were determined to calculate the energy intensity of the organization. The energy intensity data was then analyzed to identify patterns and areas where energy efficiency could be enhanced. Identification of Significant Energy Users (SEUs) is key step to set appropriate monitoring approach to optimize highly rated equipment.

Projects selection is based on several criteria, including potential energy savings, investment required, and impact on our operations and environment. The organization prioritize the projects that offer quick wins or substantial benefits in terms of energy conservation based on detailed Projects selection evaluation Guideline. This strategic selection and prioritization ensured optimal allocation of resources and maximum impact.

The EnMS was designed to support the organization's strategic goals, such as reducing operational costs and minimizing environmental impact. The organization sets specific, measurable targets, a clear road map to achieve Net-Zero-emission and decarbonization goals by reviewing and analyzing plant energy use. A yearly Top management meeting is conducting jointly with stakeholders to review our position from our targeted vision.

Our EnMS planning activities focused on managing energy-related GHG emissions through several key strategies. These included setting energy and emissions reduction targets, incorporating GHG considerations into our energy reviews and baselines, and integrating low-carbon technologies in procurement practices. We also enhanced monitoring systems for better tracking of energy use and GHG emissions using our smart platforms (PI) and advisory tools (Energy Forecasting Solution using machine learning). HGPD has a well-developed training and certification plan that issued every year, to engage the employees with training on the impact of their actions on energy savings and GHG reductions.

HGPD's perspective clearly changed during its journey with ISO50001(since 2018). HGPD became aware of the great impact of the plant's external challenges, and not limited to HGPD boundaries. From other hand, Leadership plays a major part in energy management to foster sustainability. These efforts have reinforced our leadership in sustainable practices within our industry.

"ISO 50001 provides a structure for EnMS, facilitating not only compliance and savings but also fostering a culture of sustainability and efficiency throughout the organization"

—Yousef Mubarak, HGPD Engineering Manager

Do, Check, and Act

Although Energy management steering committee is main driver for successful implementation and facilitating all faced issues. However, HGPD energy focus team is dedicated to identify opportunities to enhance our energy efficiency within our operation. focus team is multidisciplinary team from operations, maintenance and engineering, working as hidden soldiers behind all requirements, compliance, and initiatives, ensuring energy being a key priority in our strategic initiatives.

Top management provided unwavering support throughout the implementation, emphasizing the importance of energy efficiency and aligning the EnMS with our broader sustainability goals. They ensured adequate resources were available and introduced a special quarterly recognition programs and roundtable tournaments to motivate and reward staff for their contributions to energy conservation.

HGPD energy framework is the road map to assist EnMS effectiveness. Main contents of this framework are simplified EnMS steps and sub-steps in reference to ISO 50001:2018.

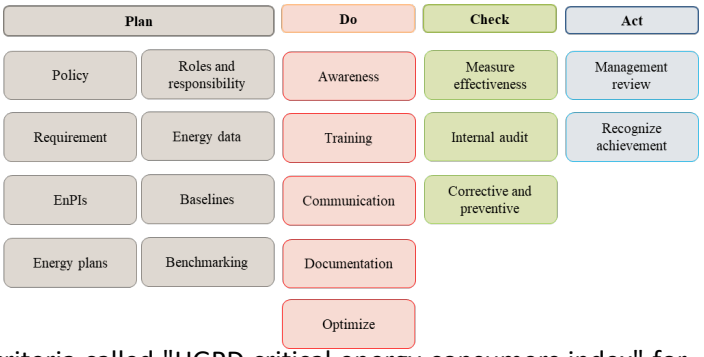

Figure: Simplified EnMS PDCA steps

Execution of Energy Optimization is clearly mentioned in HGPD framework, which classified under three categories;

Stating with operation control, by establishing and setting criteria called "HGPD critical energy consumers index" for the effective operation and maintenance of SEUs energy. For design studies and procurement process, both are governed by "Design Basis Scoping and procurement procedure".

The first task for continual improvement in energy performance is to define EnPIs and establish a baseline that capitalizing on the corporate best practice “Energy Intensity KPI Guideline”. HGPD energy baseline considers a 3-year data period, it is worth to mention that the plant’s is operational 24/7. The right selection of EnPIs will enhance all defined EnMS expectations and other desired performance targets. HGPD applied a lagging and leading EnPIs for tracking of the overall implementation progress. A basic measure of lagging EnPI is energy intensity (EI) and energy utilization index (EUI). EI is a measure of the energy required in generating a unit of products. Meanwhile, EUI is a measured value of the amount of energy annually used in building/facility per area. For leading EnPI , It is a preferred tracking tool to monitor the progress of continuous improvement in overall energy performance, such as; Action plan implantation. Since Significant Energy Users (SEUs) are the most variables affecting energy consumption, HGPD also identified a specific EnPIs for SEUs to optimize these high rated equipment.

$$Energy\ Intensity\ (\frac{MMBTU}{MBOe}) = \frac{Fuel\ Gas\ Consumption\ by\ HGP\ and\ Cogeneration + Power\ Import - Power\ Export}{Sales\ Gas + HC\ Condansate}$$

$$Energy\ utilization\ index\ (kWh/m2/year) = \frac{Enery\ Use}{Area}$$

The method HGPD employed for normalization the energy performance is by analyzing historical consumption data and simulating the facility projected production submitted by corporate's operation center. This is to garner the normalized energy targets and from there strive to achieve it or even go beyond these targets to attain excellence.

Aligned with Aramco's Digital Transformation journey, HGPD teams have been leveraging 4IR solutions like the Energy Conservation Digital Twin such as; Combined Heat and power (CHP) advisory tool and a complete end-to-end CO2 and Flare monitoring platform to monitor the entire plant. This solution will tell us whether performance had improved or actions are required.

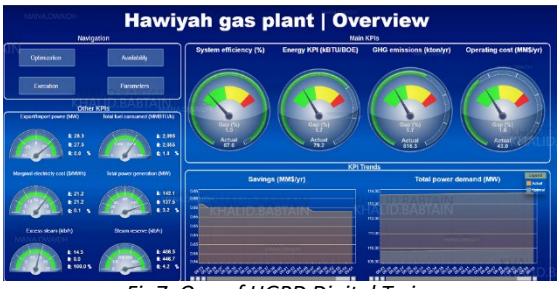

Fig7: One of HGPD Digital Twin

HGPD is following specific communications and escalation protocols to have effective communications of energy related activities inside and out the department, Moreover, HGPD has a detailed documentation protocols are governed by a matrix established by HGPD and updated on annual basis.

HGPD have leveraged its culture on energy awareness, training by conducting questionnaire and EnMS quizzes to identify gaps and areas of improvement, yielding in effective development of the employees toward energy conservation culture. HGPD managed to have good numbers of certified employees. There are four CEM certified engineers, seven certified ISO50001 lead auditors and ten certified maintenance and reliability Professional.

In the check stage, HGPD frequently validate and measure the progress of EnMS implementation and KPIs performance. This is always done by continuously monitor the key characteristics, regularly update the energy action plan utilizing tracking platform, issuing Daily and monthly energy performance report, conduct benchmarking study and EnMS Internal audit by the focus team to ensure its effectiveness and proactively correct any deviations. As result of that, HGPD has achieved zero major findings during the last ISO50001 surveillance audits.

In Act stage, HGPD is conducting quarterly energy management review meeting, the purpose of this meeting is to review relevancy of the energy policy, objectives & targets, energy management plan, discussion on major obstacles in implementing EnMS, status of regulations and other requirement compliance, and corrective plan for year's lessons learned. Moreover, HGPD is recognizing individual or team for each of energy successful initiative. This program is governed by "HGPD Reward and Recognition guideline".

As a true reflection of the effectiveness of ISO 50001 implementation, HGPD has achieved several Success Stories, where EI is trending down over the last years and the realized benefits that highlighted (figure 2) were clearly appeared in the below (Figure 8)

- Effective plant load management, including steam, fuel, and power reduction.
- Eight deployed technologies, as one of them recognized internationally as 2022 best innovative Energy Project of the Year.
- Skylight deployment at central shops as first step toward renewable energy,
- Several non-industrial Initiatives related buildings enhancements.
- 17 circular economy related initiative, where HGPD optimized utilities rejected water and minimizing the intake of treated water sources
- Four mega-projects, Flare Gas recovery system, liquid hydrocarbon recovery system, steam turbine generators, Stabilizers' overhead compressors efficiency optimization.

Finally, As result of the extended effort to promote energy conservation culture according to EnMS program, HGPD employees were able to reduce the need for projects due to their studies, optimization ideas, and patents. Figure 8 shows that 83% of MWh achieved came from our main assets (HGPD employees).

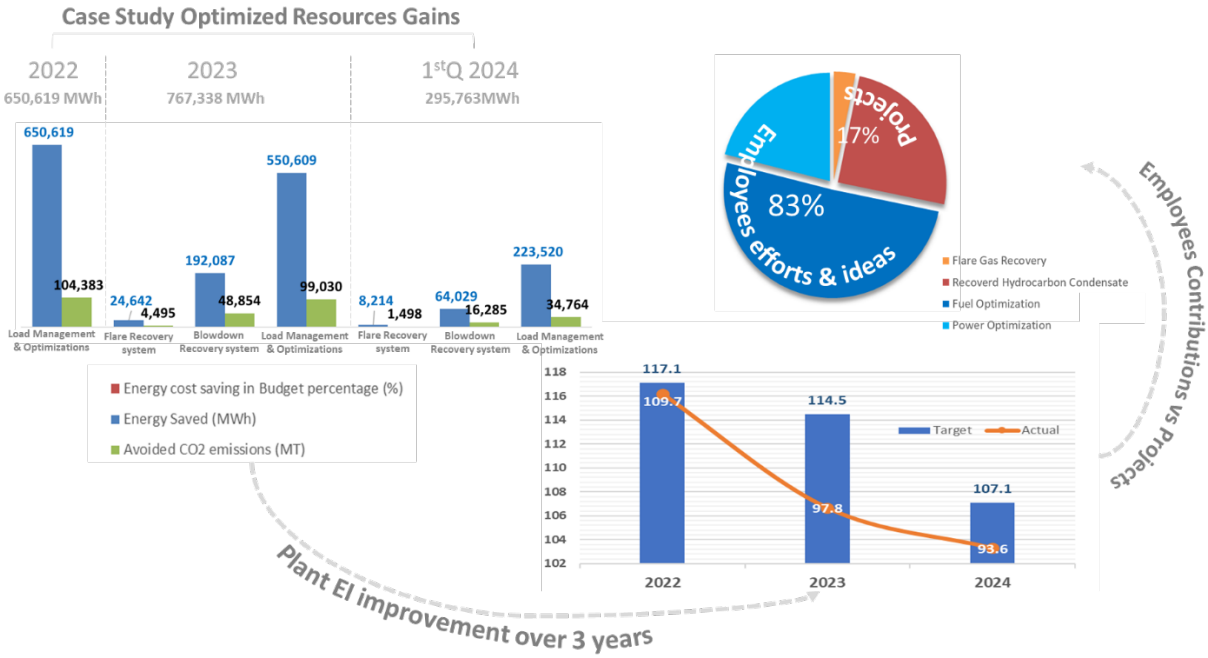

Fig8: Case study benefits as a true reflection of the effectiveness of ISO 50001 implementation (2022 is baseline)

Transparency

As a HGPD commitment to operational transparency, the launch and ongoing communication of our Energy Management System (EnMS) have been publicized to showcase our commitment to sustainability, ensuring broad coverage of our commitment to reducing energy consumption and enhancing efficiency. This was supported by our management with our executives, emphasizing the EnMS's role in our environmental strategy.
Additionally, HGPD regularly update our company website and supervised through real-time visibility in the main corporate's solution center.

We are also publishing our energy performance in the annual energy and sustainability reports (Sustainability | Aramco), providing stakeholders with transparent and detailed insights into our EnMS goals, achievements, and plans. Our yearly policy, ISO50001 certification are visible in every main building at the department.

Posted in HGPD Buildings

The Main Corporate Operation Center

Annual Sustainability Report

Fig9: HGPD Transparency culture

What We Can Do Differently

Reflecting on the beginning of the Energy Management System (EnMS), an area of improvement would be enhancing benchmarking to have broader input and commitment across the organization internally and externally.

The department's future initiatives will focus on adopting more aggressive sustainability targets, including increased use of renewable energy and decarbonizing our operations to achieve net zero emission global initiatives by 2025.

Non-industrial initiatives should have a deserved space, especially in oil and gas organizations. Where HGPD started the focus by implementing LED lighting and Motion sensor technology in all HGPD buildings, units and maintenance shops. These steps aim to solidify our leadership in corporate sustainability and reduce our environmental footprint.

Also, the department is committed to expanding the knowledge exchange networks through participating, sharing, and publishing the gained values from ISO 50001 implementation in oil and gas facilities. Additionally, expanding the employees training programs to boost participation in energy management. It's worth to mention that certificating of the facility energy managers to ISO 50001 lead auditor was planned to elevate the understanding of the EnMS program implementation. Moving forward, HGPD is committed to invest in technologies and refining data monitoring to achieve measurable energy improvement. In addition, HGPD improved the precision of energy tracking by continuously applying updated standards of energy performance indicators and energy baselines, ensuring the achievement of our strategic objectives.

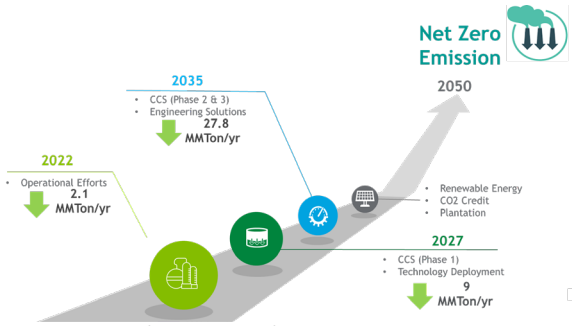

Fig10: Road map toward Net Zero

Fig11: first step toward renewable energy deployment

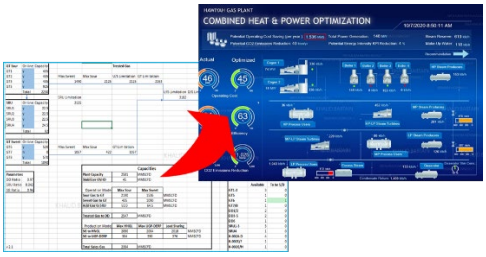

Fig12: Software digitalization for quick monitoring and better validation

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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.