ISO 50001 Energy Management System – Case Study

2023 United Arab Emirates

Al Ain Cement Factory

Cement Division- Building Materials

Emirates Steel Arkan

Our journey to a Sustainable Future with Net Zero Carbon Emissions

ISO 50001 Certified ◆ Sheikh Khalifa Excellence Awardee

Case Study Snapshot	
Industry	Building Materials
Product/Service	Manufacturing of Clinker and Hydraulic Cement
Location	Al Ain-Abu Dhabi Truck Road, United Arab Emirates
Energy performance improvement percentage (over the improvement period)	7.8 % Specific Power and 16.62 % Specific Heat improvement over 4 years
Total energy cost savings (over the improvement period)	USD 8,411,486.38
Cost to implement Energy Management System (EnMS)	USD 47,963.00
Total energy savings (over the improvement period)	621,128.68 MWh
Total CO_2-e emission reduction (over the improvement period)	183,720.8 tCO2e

Organization Profile / Business Case

Al Ain Cement Factory is a cement manufacturing plant with daily production capacity of 10,000 Metric ton. One of the Building Material unit of Emirates Steel Arkan. The successor of Emirates Cement Factory that started in 1978, adapted the state-of-the-art technology in cement industry when it started its operation in the new plant location in 2014.

Our leaders believe that the pursuit in greater development should not only be measured by its existing design, the efforts on safety, reliability and efficiency but also its sustainability and social responsibility.

Our vision is to reach the net-zero emissions before 2050 and target the highest energy efficiency by optimizing our operational strategies. Our goal is to improve every year our energy efficiency efforts, reducing our carbon footprint and contribute to the global effort on sustainable future.

Our strong commitment started in 2019 when we identified the Significant Energy Use in our plant through continuous monitoring and measurement of our operations. As of this, we designed a roadmap towards our vision that strategized process optimization and raw mix redesign, with investments in new technologies in the future. This case study describes the first step of our journey.

Given the volatility of the market, ACF's management first priority is to optimize existing processes, prior to any capital investment. So, a committee was formed from various departments, such as Supply Chain, Project, Operation and Quality to explore Alternative Materials and technologies that will save energy cost.

The first applicable idea that has been introduced was to re-design our raw mix design of clinker by substituting Iron Ore, which is between 2-3% of the original raw mix design with bypass products of other industries such as steel and power plants.

With this shift, we successfully obtain our goal of reducing energy consumptions by 7.8% and 16.62% over the span of 4 years. Moreover, the raw material costs has decreased, which was an additional benefit. ACF obtained ISO 50001 Energy Management System in June '20 and recognized by Sheikh Khalifa Excellence Silver Award in February '20.

"Implementing an energy management system that is ISO 50001 certified, aligns with Emirates Steel Arkan's core values and demonstrates our commitment to sustainability and social responsibility. By investing in technologies and initiatives that enable us to reduce energy consumptions and lower emissions, we are creating new opportunities for growth and innovation while contributing to a more sustainable future."

—Engineer Abdelaziz Asad, Arkan General Manager

Business Benefits

Our vision to reach the net-zero emission in 2050, ignited our pursuit to develop as a successful, compliant and responsible company but what drive us more is improving Energy Performance Improvement (EnPI). On our first year of implementation in 2019, we have aimed to reduce our energy consumption by 6.95% from 2018 baseline year. But by the following year, due to external factors such as the pandemic which disturbed our momentum in operations like all other companies. Despite that, due to the systematic approach of ISO 50001, we were able to get back on track in 2022, which supported our goal to achieve year-on-year energy saving. Validating that by maintaining a framework of ISO50001 Energy Management guided us in energy saving to achieve our ultimate goal of net-zero carbon emissions in 2050.

ACF achieved Energy Performance Improvements 7.8 % Specific Power and 16.62 % Specific Heat from 2018 baseline year. Thus, our energy accumulative performance improvements gave us 3.5% Specific Power and 10.2% Specific Heat energy savings for the last 4 years. Most importantly, we were able to reached a cumulative of 18.1% tCO2e Total Carbon Emission reduction since 2019. Figure 1 and 2 shows the specific heat and power energy saving and energy performance improvements respectively.

As a result, the company was able to save energy cost of USD 8.41 M during the improvement years and add value saving to the material we are producing through reducing the specific power, specific heat, raw materials and maximizing the production.

In addition, the collaboration between Supply Chain, Quality and Operations Group were enhanced due to common and clear goals of setting the targets, priorities and line of actions. Our organization is committed to support design and procurement activities that consider Energy Performance Improvements.

Our focus towards Energy Management System certification led us to pinpoint the Significant Energy Use such as electricity and gas consumptions. Our EnPI have decreased the level of GHGs emissions with average of 3.4% tCO2e year on year as can be seen in figure 3.

Though decarbonization is very challenging in our energy intensive operations, we are optimistic and focused to manage and set our priorities and goals to meet them according to our robust energy plan. In 2021,A specific Decarbonization team was appointed on the group level specifically in order to set a plan to reach this goal.

Furthermore, using ISO 50001 in our supply chain engagements, gave us the opportunity to better communicate our organization's priorities and targets as well as establishing a structured approach in dealing with them. Through our data-driven strategy, we have found that there is a strong potential to improve our electricity and gas consumptions and it will give us benefit as cost-savings for the company.

With this step, we are currently co-processing/ recycling other company's byproducts such as Fume Treatment Plant dust and Copper Slag from our Steel Unit. These wastes have been introduced to our systems as alternative to other raw materials we are previously using with the same quality and better energy performance improvements. This saving opportunity has a tangible positive impact on our target to help reduce carbon footprint.

Also, we have identified that investing in Technologies such as Waste Heat Recovery Power Plant that used the waste heat that is disposed could be utilized for power generation that will substitute approximately 20-30% of our electricity consumption. This is elaborated in the last page of the case study report. Moreover, a collaborative study and an MOU was signed with the local waste authority (Tadweer) to study the substitution of upto 30% of our gas consumption by recycling municipal waste to Refuse Derived Fuel (RDF).

For these reasons, the top management supported the committee by launching policy and programs that will encourage and harness our creativity coupled by our skills and experiences. One of the policies stated: "promote creativity across the business, built on ethical and sustainable innovation management principles". Every year, during month of February, we are conducting various activities such as seminars, trainings and workshops which aims to engage us in Innovation and boost our awareness to Energy Efficiency and Sustainability.

One of the programs that have been established is the Nama'a Program. It is designed to comply the required documentations such as Cost-Benefit Analysis, Impact Estimation, and with different level of approving authorities from our leaders in order to obtain financial commitments and resources. All stakeholders involved in any Nama'a initiatives can monitor the progress of the project through online platform. A monthly Technical Meeting is also conducted in order for us to review our energy performance and give us insights on energy saving opportunities and optimizing our processes.

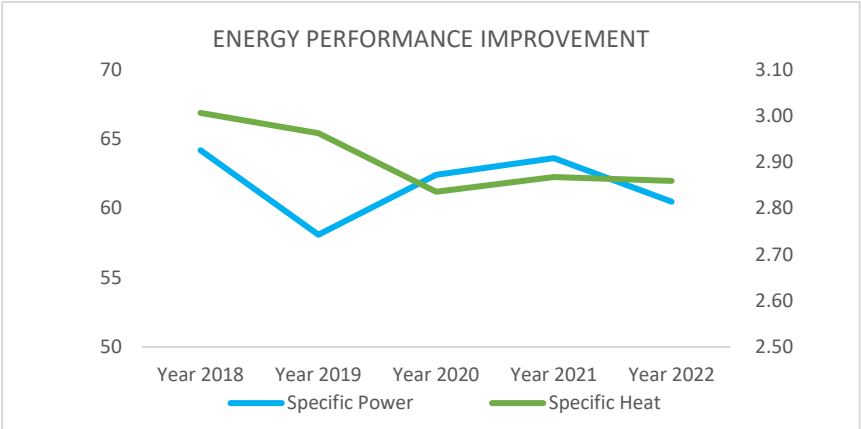


Fig. 1 Energy Performance Improvement shows our Specific Power (Kwh/Mton) and Specific Heat (mmbtu/Mton) Energy for 4 years from

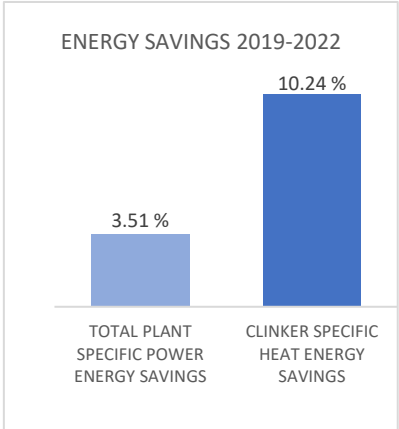


Fig. 2 Total Percentage Energy Savings during improvement period 2019-2022

Plan

In our processes, we are using our historical data and statistics as an energy baseline to move forward. First, we obtain baseline data to determine where we should start improving. Then, we identify the significant energy uses or specific areas for improvement that will greatly impact our improved result such as gas and electricity consumptions.

Then, we set the key energy performance indicator value, achievable energy objectives, monitor and analyze. After that, we take actions for any deviations and non-conformities. Finally, we review and plan for continuous optimization strategies. As of the subject of this case study, after studying all the quality and process parameters, a trial run was planned in order to verify our studies.

In our data-driven strategy, our goal is to get accurate data in regular intervals. Then, identify a baseline to create insights that will help us analyze and decide our priorities while continuously monitoring our performance. In addition, we use Impact Analysis and SWOT methods to determine what needs to be focused on and identify the external factors that could affect our energy performance. In our energy data monitoring KPIs, the following variables are the main KPIs that are being used: Specific Power and Specific Heat (Intensity)

Implementing Energy Management System in our organization is very timely and relevant towards achieving United Nation's mandated global sustainable development goals. It is a structured approach that can easily integrate to existing management systems and further strengthening its effectiveness throughout all levels in our organization. Most importantly, adapting the EnMs as an international standard that is easily comprehensible by our multi-cultural workforce.

Hence, during the course of our study and research, the Greenhouse gas emissions were addressed in implementing our Energy Plans. Our data shows, we have reduced 183,720.8 tCO2e in total since 2019. The carbon footprint calculations started with our ISO certification process in 2019 and unfortunately there is no data for 2018. While in 2022, 2.02% Specific Heat achievement from previous year 2021 target of 1.95% (year on year).

"Implementing an energy management system that is aligned to ISO 50001 is a crucial step towards reducing energy consumption and improving sustainability in Cement Manufacturing. By optimizing energy usage, Emirates Steel Arkan is reducing its environmental impact. In doing so, we are helping to protect the planet and creating a competitive advantage in a rapidly evolving market that is increasingly demanding for lower emission products and solutions."

—Engineer Abdelaziz Asad, Arkan General Manager

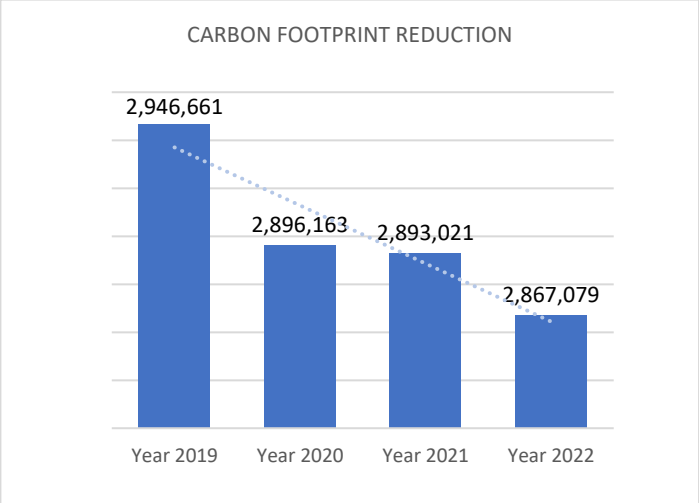


Fig. 3 Carbon Footprint Reduction from 2019 to 2022

Do, Check, and Act

Following the guidelines of ISO50001 Energy Management, we have establish procedures on how we should regularly measure and monitor our energy performance indicators such as gas and power consumption. The first procedure is using Knowledge Manager software and accurate meters. The second procedure is using inter-departmental collaboration to enhance our systems. If in any case it deviates from the objectives, we refer to our established immediate operational and maintenance controls, identify the root cause and create an agreed action plan during Technical Meeting. As can be seen in figure 5, our continuous improvement plan.

Our management team has regular meeting to review and address the issue. Regular meeting are conducted with the concerned departments to perform Root Cause Analysis and develop a clear and concise Action Plan along with the Responsible Department and person. By this approach, we achieve key activities to monitor and implement our EnPI. Figure 8 shows our energy measurement and monitoring plan.

In 2022, using structured approaches and controls that we have identified in our Technical Meetings, we have achieved 4.65% reduction on kWh/ton EnPI which is above the average target 0.356% year-on-year.

This was a result of determining and tracking our performance using our Energy Measurement and Monitoring Plan which details the required measurements, tolerance values and the responsible person and department. Aside from using baseline and monitoring reports, we use Normalization Method and Regression Analysis in determination of our EnPI in our established procedures.

We used data from 2018 as our energy baseload and compare it to the succeeding years. While we used Normalization – Forecasting Method using baseline year and cusum in our calculations of our energy cost savings and Normalization – Forecasting and Chaining Method for EnPI, and Regression Analysis to consider our variables as can be seen in figure 9. Through implementing EnMS, we identify the need for accurate, real-time measurement and monitoring of our EnPIs to further align the concerned departments. In addition, we established an Energy Measurement and Monitoring Plan which details our targets in achieving our EnPI including our identified Significant Energy Use Equipment and Processes to implement operational controls.

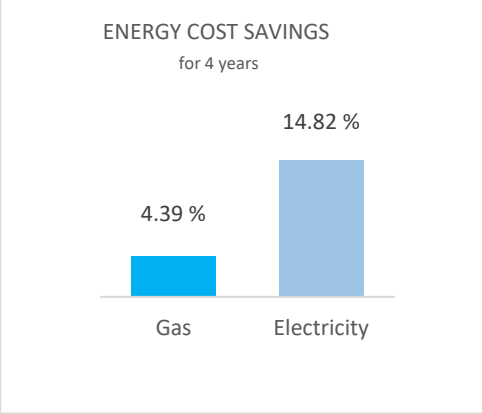


Fig. 4 Percentage Energy Cost Savings during improvement period 2019-2022

Fig. 5 Continuous Improvement of our Energy Management System

Our procurement processes, standard operating procedures were revised and refined to align with the EnMS Energy Performance Improvement targets.

Certainly, we believe that third-party EnMS audit, is a best tool to check the effectiveness of our systems. The third-party survey our plans, procedures, monitoring systems which will enable us to immediately rectify and take action in case of gaps and deviations.

By streamlining our plans and procedures, it reflects our serious actions by engaging employees to be energy-concious in every aspect of our activities. Our leaders believe that every small action leads to greater and more purposely efforts, hence, everyone contributing to reach the company's vision. Our organization, has provided campaigns and training related to Sustainability, Energy Efficiency and Innovations from different contributing departments such as HSE and Excellence and Innovations group. Some of the good demonstration of our collaborative efforts for instance, are the real-time reporting of compressed air leaks and turning off equipment when not in use.

While our Methods Department has a Condition Monitoring Plan and Procedures for SEU which establishes relevant database and collate relevant information for Root Cause Analysis and following the subsequent procedures in maintenance planning and coordinate with procurement. All other departments contribute to enhance the need for review of detected non-conformities based on RCA. In addition, the Research and Development committee studies the potential energy saving solutions that can be adapted to our systems.

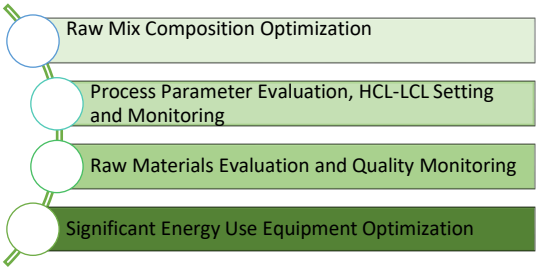


Fig.6 Key Activities to monitor and implement our EnPI

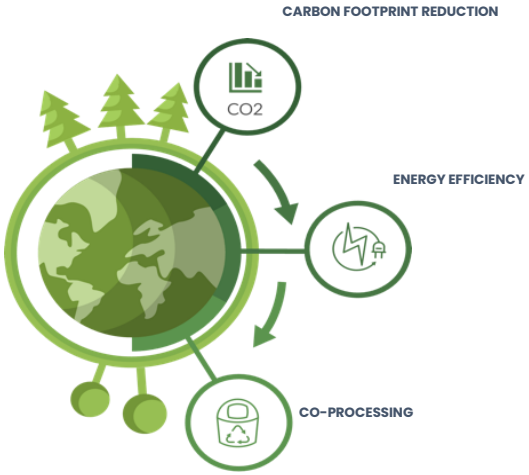


Fig. 7 Emirates Steel Arkan roadmap to decarbonization

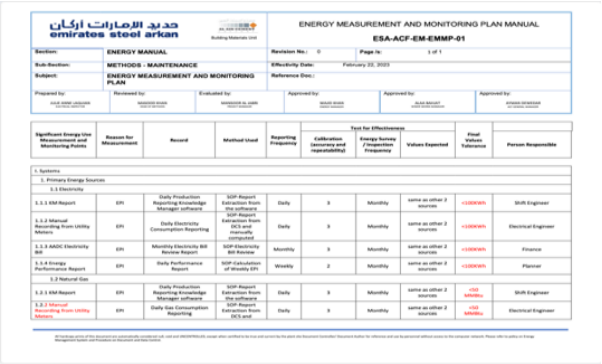


Fig.8 Energy Measurement and Monitoring Plan

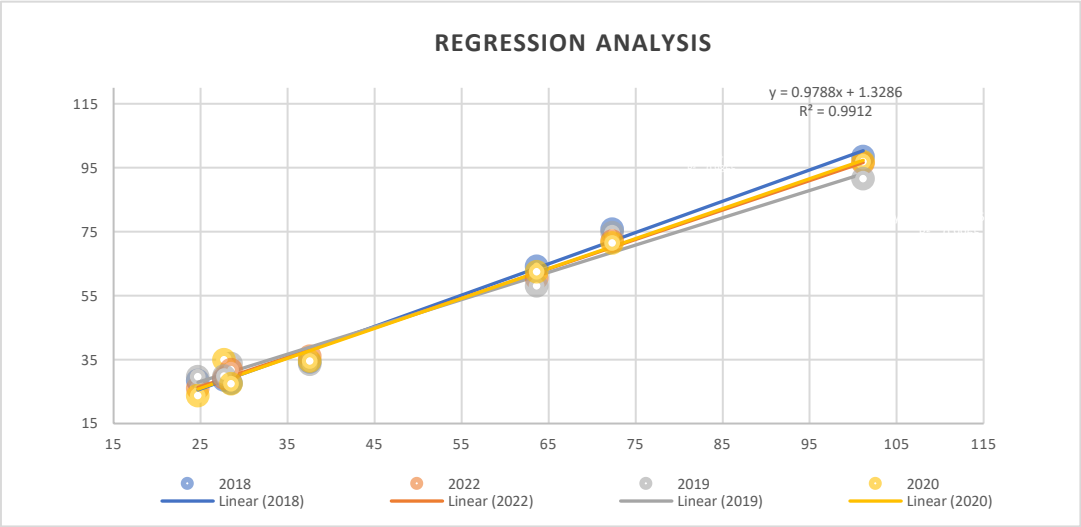


Fig.9 Regression Analysis graph shows the relationships of our variables and how it affects our EnPI through the years. Using 2019 as our model year to reach and guide us in EnPI year-on-year with our roadmap.

Raw Mix Design and Optimization

Cement is manufactured through a closely controlled chemical combination of calcium, silicon, aluminum, iron and other ingredients. Common materials used to manufacture cement include limestone, with shale, silica sand and iron ore.

Limestone as one of the major partaking agent, which ranges up to 76- 77%. However, Red shale, Red Sand & Iron Ore remains comparatively lesser in percentages. Among the minor contributors, Iron Ore remains very expansive during acquisition from its respective mines & subsequent transportation. Although the percentage of Iron ore shares a mere 2.31% of the total Raw Material design.

Alternatively, a Mixture of Copper Slag & FTP was introduced in Al Ain Cement Factory since last three years with a ratio of 70% copper Slag and 30% FTP . FTP dust is a byproduct of Steel Making in an electric arc furnace (EAF). At Steel Industry, EAF feed mix is DRI (Direct Reduced Iron) 90-95% and Scrap 5 – 10%. This produces an FTP dust that has a higher Fe content and as such the recycling of the zinc from FTP dust is not viable due to its low traceability. However, the FTP dust does contain a high value of Fe which can be used as an iron replacement in the cement industry. Similarly, Copper slag, which is the waste material produced in the extraction process of copper metal in refinery plants, has low cost, and its application as a fine aggregate in concrete production reaps many environmental benefits, such as waste recycling, and solves disposal problems.

Raw Mix before & After Copper Slag

KPI'S	Before	
%Limestone Consumption	76.4	77.5
%Red Shale Consumption	17.51	17.56
%Iron Ore Consumption	2.31	-
%Copper Slag	-	**2.07**
%Red Sand Consumption	3.85	2.88

Raw Material	RM Cost %
Iron Ore	100
Copper Slag	33
FTP	15
Weighted Average	32

Table 1. Replacing Iron ore with a mixture of FTP & Copper Slag has brought significant cost saving.

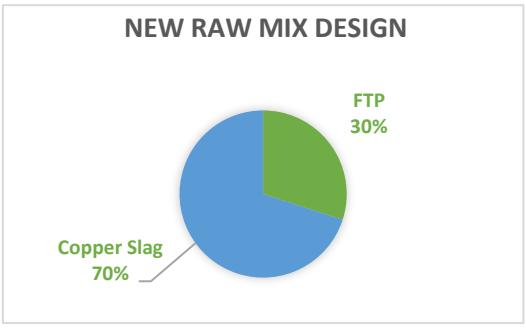


Fig. 10 Alternative Raw Materials through Raw Mix Design and Optimization

An approximated value of 3.68 million USD were saved in a successful evaluation of re-designing the Raw Materials since launch. The current raw mix design has brought not only monetary benefits but eliminated nearly two hundred thousands tons of steel byproducts as a waste recycled material. The co-processing has also supported the waste disposal management of Emirates Steel.

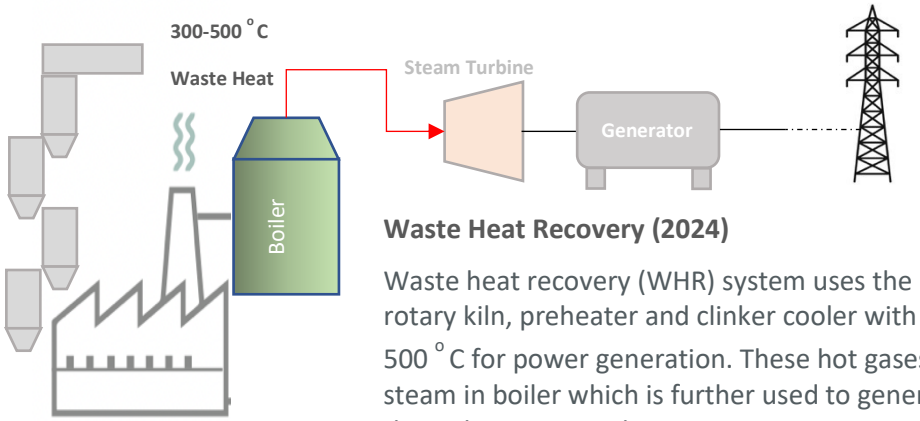
Transparency

One of our core values is Integrity which intrinsic in our activities and processes, as well as in our engagements with our stakeholders. In 2021, we have obtained an Electricity Tariff Incentive due to our transparency with our ISO 50001 Energy Management Systems in place. Moreover, since 2022, we generate a Sustainability Report which also tackles our significant energy uses, savings and emission reductions. These enable us to sustain an added value on our commitment for social and environment responsibility.

What We Can Do Differently

If we were to do it all over again, we will further streamline our plans and procedures. The identification of the EnPI equipment and instruments where we will obtain our accurate measurement and monitoring. Included in our roadmap is to adapt new technologies such as Waste Heat Recovery System and use of Refused-derive Fuel that will enhance our capabilities and strategies in management of SEU such as generation of electricity and reduction of natural gas consumptions so we continue to sustain our annual targets. We aim to improve every year until we achieve our net-zero carbon emissions in 2050.

Our Future Plans – Investing in New Technologies



Waste Heat Recovery (2024)

Waste heat recovery (WHR) system uses the heat generated in rotary kiln, preheater and clinker cooler with temperature of 300-500 °C for power generation. These hot gases are used to generate steam in boiler which is further used to generate electricity through a steam turbo generator.

Municipal Solid Waste Into Refused-Derived Fuel (2025)

In partnership with **Tadweer**, Municipal Waste will be turned into cost-saving, renewable RDF fuel. It will be fed in Kiln as alternative fuel to Natural Gas that is expected to reduce 25% of its costs.

Other Benefits

- Contributes to reduce municipal & commercial waste
- Convert municipal waste as alternative fuel
- Provide low-cost & clean energy source to industries