INDUSTRIAL ENERGY EFFICIENCY PROJECT IN GHANA

Energy Management Systems (EnMS)

CASE STUDY

Cargill Ghana Limited
Tema Export Processing Zone, Ghana

Company size (personnel)
Large
(100 or more)

Sector
Cocoa beans processing into finished and semi-finished products

Utility intervention
Electricity, diesel

Year joined project	Date of implementation
June 2021	2022

Company profile

Cargill Ghana (CG) is part of Cargill International, a global business with a team of about 155,000 professionals in 70 countries that draws together the worlds of food, agriculture, nutrition and risk management. As a global corporate strategy, Cargill works alongside farmers, producers, manufacturers, retailers, governments and other organizations to fulfil their purpose to nourish the world in a safe, responsible and sustainable way. Together, they create efficiencies, develop innovations and help communities thrive.

Cargill's core activities include:

- Offering input, expertise and risk management tools to both smallholder and large-scale farmers, helping them boost their productivity and incomes. CG buys farmers' crops and animals and brings them to markets around the globe.
- Processing a wide range of agricultural commodities, turning them into the food, feed and fuel the world needs, and transporting them to the places they will be consumed.
- Partnering with the world's leading consumer goods, restaurant and retail brands to create innovative products that serve the changing values of consumers everywhere.
- Nourishing animals with pioneering feed products, and working with farmers and scientists to ensure animals' well-being in order to sustainably meet the growing demand for animal protein worldwide.
- Joining with community leaders, non-profits and others to enrich the places where we live and work, building a strong, sustainable future for agriculture.

Cargill is committed to implementing new sustainable practices to reduce impact on the planet, produce safe products and protect people.

Plant profile

CG was incorporated in Ghana on 21 February 2005 and obtained its license as a Free Zones Company on 29 June 2006. CG's plant was constructed in the Tema Export Processing Zone on the outskirts of Accra. The plant started production on 4 November 2008 after satisfying the requirements of the government's environmental impact assessment process.

The plant primarily processes cocoa beans into cocoa powder and cocoa butter for export. Initially, the installed plant capacity was 65,000 tons per year of cocoa beans. After 12 years, the installed capacity was expanded to 85,000 ton per year.

By strategy and design, CG has already implemented several significant energy projects. Energy sources include electricity supplied from the grid and diesel stand-by generators. A portion of electrical energy is also supplied by an in-house solar PV plant. This is part of Cargill's commitment to addressing the global challenges of energy price rises and reducing its greenhouse gas (GHG) emissions.

Other energy sources include residual fuel oil (RFO), diesel, liquefied petroleum gas (LPG) and biomass. Energy projects implemented by CG before the Energy Management System (EnMS) training include:

- Replacing T8 fluorescent lights with LED lights to improve lighting, reduce maintenance costs and boost lighting: 60 per cent energy saving.
- Installing a biomass boiler with 10 ton steam/hr capacity, improving efficiency in steam generation and reducing production costs.
- Installing solar panels to reduce electricity costs and GHG emissions.

Energy breakdown: areas of significant energy consumption

At present, more than 80% of steam is generated by the plant's biomass boiler, with the remainder generated by the RFO boiler. Biomass is sourced within the plant, utilising the waste shells from the processed cocoa beans. Diesel is used for transportation as well as for forklifts within the site boundary. The energy split per source is shown in Figure 1 below.

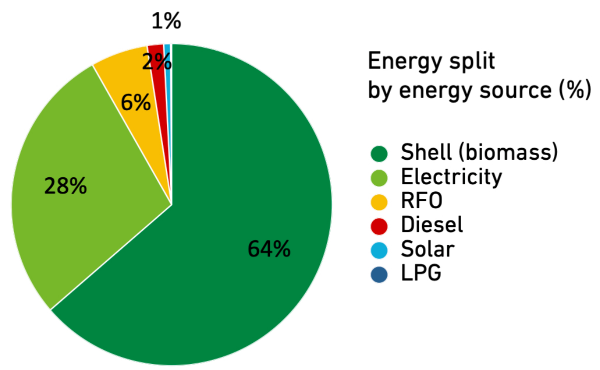

Figure 1: Energy split by energy source.

Industrial energy efficiency capacity building programme

Between June 2021 and February 2022, the United Nations Industrial Development Organization (UNIDO), in partnership with the Ghana National Cleaner Production Centre, conducted an EnMS training for selected CG staff under the Ghana Industrial Energy Efficiency Readiness programme. Through the training, CPC staff have been supported to implement sustainable solutions to identified energy challenges. Through classroom and field exercises, they have learnt how to conduct an energy performance assessment, identify significant energy users (SEUs) and saving opportunities, and propose and develop options to improve energy performance.

Key findings table

Implementation period	June 2021 to December 2022
Total number of projects	2
Monetary savings in GHS per year	304,000
Energy savings in GJ (kWh)	35,590 GJ
Total investment made in GHS	None
Overall % of total consumption saved	1.02% (total 348,770 GJ per year)
Total savings from no cost interventions	35,590 GJ
Payback time period in years	immediate
GHG emission reduction (ton CO_2e)	10,306 tonnes CO_2e per year

Note 1: CO2 conversion factor is set at 1 GJ = 0.2896 tCO_2e.
Note 2: Electrical energy tariff of GHS 1.31/kWh.

Scope and boundaries

The scope and boundary of CG's EnMS have been developed. CG will apply the EnMS to all energy consumption activities associated with cocoa beans processing (production, utilities, maintenance, storage and warehousing) within the geographical perimeter of the site.

It also includes external and internal issues relevant to the EnMS, actions to address identified risks and opportunities for continuous improvement. It does not include transporting raw materials to site or final products from site. The company will review all projects from a financial and technical perspective before going ahead with implementation.

Nature of the challenges

A major challenge to the company is the rising cost of energy, both electricity and other fuels such as RFO, diesel and LPG. There was also an initial misconception that energy efficiency would compromise on quality, safety or productivity and could lead to a loss of customers.

There was also a lack of technical knowledge related to improving energy efficiency and how to track energy performance. Despite this, there was good support from competent staff to assist with implementation.

Increased operating energy costs impacted on the company's ability to purchase energy efficient equipment. Data collection of energy resource consumption has presented a challenge, as submetering equipment was not always installed at measurement points. Purchasing measurement equipment was also seen as an expense that would not improve production.

Energy baseline and energy performance indicators

CG has existing energy performance metrics. These are mainly energy ratios of input energy sources related to the production output. As part of the EnMS, the team has identified an extra set of metrics that are more indicative of actual energy performance. These were identified with support from UNIDO experts (trainers). Metrics were initially developed for biomass, RFO and electrical energy usage at the plant. CG decided to track its energy performance for these energy sources from the inception of the programme. For each study that was done, data for June 2020 to May 2021 were used to determine the baseline. This baseline was then used to track performance throughout the EnMS implementation process.

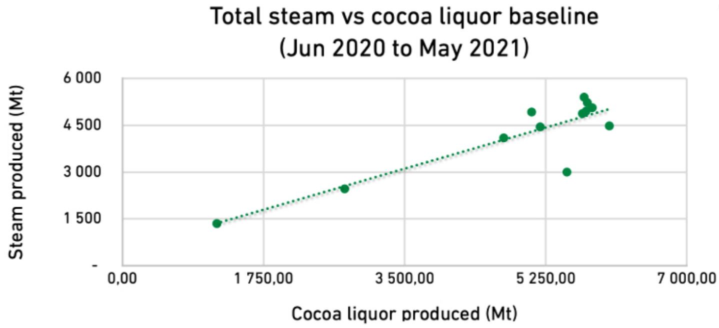

Figure 2: Steam energy baseline.

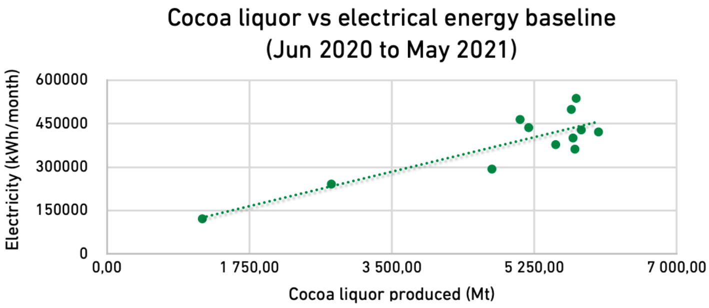

Figure 3: Electrical energy baseline.

Implementation of an Energy Management System

Project implementation was done by closely following the recommended steps in the ISO 50001 standard. This relates to the application of the EnMS tools. The following activities under each phase have been carried out or are still in the implementation stage:

Phase 1: Management responsibility and policy:

- The scope of the EnMS applies to all energy consumption activities associated with cocoa beans processing (production, utilities, maintenance, storage and warehousing) within the geographical perimeter of the CG plant.
- The project's scope was determined by analysing energy inflows and usage trends; that is, by applying an energy balance. In Figure 1 above, the pie chart shows that biomass and electrical energy from the grid accounted for more than 80 per cent (of energy used in 2021.
- A CG energy policy has been drafted.

Phase 2: EnMS planning:

- A quick review of the available data was conducted.
- An energy balance, giving all sources and major usage, was calculated
- Information: From the data, assembled baselines were determined.
- People: Information has been gathered on working with other stakeholders (in production, technical and maintenance). Involving all stakeholders is intended as a continuing activity and is expected to result in joint efforts at operational reviews.
- Technology: The summary of 2021 energy sources shows that steam generation and usage constitute almost 70 per cent of energy. Next in significance is electricity from the grid. The baselines developed therefore centred on the conversion of energy inputs (biomass and RFO) into steam and using steam as an energy source for production processes. The SEUs of electrical energy for production-related activities are compressed air generation and compressed air use. These two areas will be CG's main energy optimization focuses.

- Targets for improvements are yet to be set. As part of an ongoing activity, the team, working jointly with other stakeholders in production, technical and maintenance, will monitor the current trends and recommend interventions..

Phase 3: EnMS implementation and operations:

- Cargill's leadership team has provided adequate resources to ensure competent employees aid in the implementation of the EnMS on site.
- Awareness has been created and clear communication has been conducted with all stakeholders with an integral role to play in the EnMS.
- Operational control to ensure equipment optimization, and therefore energy efficiency, has been established.
- An essential part of the implementation is getting all stakeholders involved. This has been done informally so far. In the process of gathering data, other staff have been involved.
- After determining the baselines, various teams have been involved in establishing what may be happening during production to cause deviations from expected data points. These explanations are key to determining the activities during production that need to be managed differently to attain better energy performance.

Phase 4: EnMS audit and management review:

- No management reviews or internal audits specifically related to the EnMS have been conducted yet.
- Technical energy assessments related to SEUs have been identified and are being planned and scheduled to further identify and quantify energy saving opportunities.

Implementation challenges

- Cargill's corporate head office uses energy ratios extensively, and convincing management to use an alternative set of energy performance metrics presented a challenge. However, top management at the CG site were interested, as the new metrics proposed showed actual improvement in energy performance.
- Obtaining submeter data on specific SEUs was a challenge. Where possible, energy performance was aggregated to the energy source and building.
- A number of other interventions were also in execution. This made it challenging to identify direct savings from energy interventions.

Highlights of operational / electricity system operations interventions

Summary of all interventions

An energy team has been established. It has started implementing the EnMS. Initial energy awareness training has been conducted. Energy performance baselines have been established for the major input energy sources (electricity, biomass and RFO).

General awareness

Following the start of the EnMS programme in Ghana, the company conducted awareness training among operational and technical personnel. The key message conveyed was to switch off lights and machinery when not required.

Process optimization

A key learning from the EnMS training was that conducting an energy balance for each production process often presents no-cost opportunities, not only for energy saving but also for process optimization.

Opportunities include:

- Improvements in the grinding process to produce liquor from nibs.
- Increasing the use of biomass fuels rather than using RFO and boiler fuel.
- Limiting the length of time machinery is idle by optimizing production schedules.

For the interventions above, the total thermal energy savings for 2022 was 34,700 GJ. This represents a 28 per cent saving on fuel input costs for the cocoa liquor production plant. This included fuel input savings from both the biomass and the RFO boilers.[1] These savings are based on the baseline energy performance model that was developed (see Figure 2). The total energy savings achieved since the inception of the EnMS (from June 2021 to December 2022) was 52,280 GJ.

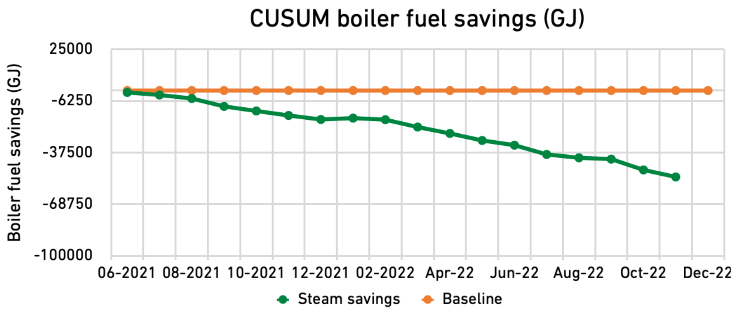

Figure 4: Cumulative boiler input fuel savings (GJ).

For the interventions above, the electrical energy savings was calculated using the energy performance indicator that was developed (see Figure 3 above). The actual electrical energy savings achieved in 2022 was 230,000 kWh. This represents approximately 4.7 per cent of total annual electrical energy consumption for the cocoa liquor production plant, and 0.84 per cent of total plant electricity consumption.

It should be noted that, during the second half of 2021, Cargill was investigating process optimization opportunities so did not always have smooth production. This contributed to increased electrical energy costs for that period. By the end of the year, the company had succeeded in optimization.

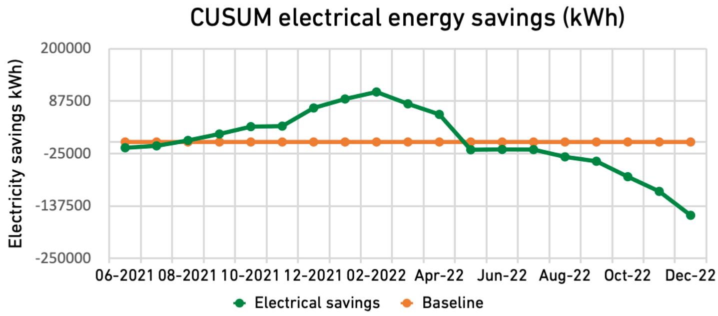

Figure 5: Cumulative electrical energy savings.

Total annual energy savings for 2022 was calculated to be 35,590 GJ, which represents 1.02 per cent of total annual energy consumption. The process optimization also yielded an increase in throughput of 7.3 per cent.

Other ESO Interventions

Cargill has also recently optimized compressed air in one of its buildings on site. This included the rationalization of compressor usage from three compressors to two compressors, following the repair of compressed air leaks in the system.

1. Calculated using 39.5 MJ/kg for RFO and 11GJ/t for biomass

Benefits, lessons learned and value added

Benefits

- The implementation of EnMS has made management and technical staff more aware of the economic costs associated with energy consumption at the plant.
- Real savings have been achieved through minimal investment. There has been a 7.3 per cent increase in process throughput.
- Technical staff have realised that energy savings opportunities can be unlocked through a structured approach to the collection and analysis of energy-related data.

Lessons

- This EnMS project has highlighted some strengths and weaknesses in energy management at CG. These can be a focal point for working to accomplish good energy performance improvements at the company on a continuing basis.
- Good energy performance metrics are an essential part of driving the implementation of the EnMS.
- Data collection is crucial to the quantification of energy consumption and energy performance analysis.
- Providing adequate time resources and support for the energy team is vital for the continuity of the EnMS.

Future plans

- The energy policy needs to be formalized as soon as possible to confirm the management's keen interest in energy issues.
- An update of the definition of the EnMS roles and responsibilities is required.
- The next step in the ENMS cycle is 'improve'. This will be done through:
    - A technical evaluation of systems that have been identified as potentially containing energy saving opportunities.
    - Identifying staff members who require training and awareness, and then determining the kind and depth of training that is needed and the best options for delivering it.
    - Reporting achieved savings to management to unlock a new cycle of improvement.
- The studies show that an intervention in December 2021 to seal leaks on the compressed air distribution system resulted in an immediate reduction in compressor energy consumption in January 2022. This trend continued in February 2022, but then usage fell back to previous consumption. The EnMS project team will work closely with maintenance to determine the optimum approach to maintaining the system so that leaks account for no more than 10 per cent of compressed air demand.

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INDUSTRIAL DECARBONIZATION ACCELERATOR

UNIDO