INDUSTRIAL ENERGY EFFICIENCY PROJECT IN GHANA

Energy Management Systems (EnMS)

CASE STUDY

Accra Brewery Limited

South Industrial Area, Accra, Ghana

Company size (personnel)
Large
(100 or more)

Sector
Beverage manufacturer

Year joined project	Date of implementation	Duration
June 2021-2022	2022	12 months

Company profile

Established in Accra in 1931, Accra Brewery Limited (ABL) is West Africa's first brewery. It was first registered in Switzerland as Overseas Breweries Limited. The company's creation marked the start of non-traditional manufacturing in Ghana. In 1975, the assets of Overseas Breweries Limited were taken over by the locally registered ABL to facilitate Ghanaian participation in the business. It later became a subsidiary of Anheuser-Busch InBev (ABInBev) after the latter acquired controlling shares of ABL's former parent company, SABMiller Plc. The product range has grown over the years, and a plant expansion project has been carried out to meet increasing consumer demands. The expansion consists of the construction and installation of three new packaging lines, a warehouse with a hard stand and loading area, an electricity substation, two additional power generators, ten new beer tanks, two additional water storage tanks, a water treatment plant, sidewalks for the location road and a new entrance with a gate house and offices. ABL's product range now includes Club Beer, Club Shandy, Budweiser, Eagle Extra Stout, Eagle Lager, Beta Malt and Corona Extra.

Plant profile

The brewery is 90 years old. It has several production floors, known in the factory as houses. Although all the houses work toward the production of packaged assorted beverages, each house is structured to realize a specific stage in the production process or provide a specialized service to aid the process. Some of the houses include the Boiler House, the Brew House, the Packaging House, the Power and Compressed Air House, the Chiller House and the PET House[1]. Worldwide, ABInbev uses an approach called world class operations management, which it has adapted to what it calls Voyager Plants Optimization. This is a pillared approach which includes an environmental pillar. As part of this, the company is using specific energy consumption as an energy performance indicator (EnPI).

The beer making process:

- Raw material collection (maize, cassava and malt).
- Quality checking for yield and moisture content.
- Brew-house for grinding to obtain fine texture.
- Boiling (using a mash kettle).
- Sieving to separate the chuff from the water.
- Water (first wort) is then filtered.
- Storage period for fermentation.
- Filtration.
- Bottling and packaging.

Energy breakdown: areas of significant energy consumption

By way of scope and boundaries, the factory uses utility grid electrical energy and residual fuel oil (RFO) as its main energy sources, with diesel and petrol as minor sources for technical, economic and procedural reasons. The company has plans to begin using liquefied petroleum gas on a trial basis in the future.

The bulk of energy used comes from RFO, followed by grid power then almost negligible amounts of diesel. RFO forms about **73 per cent of energy use**, and utility grid electrical energy forms about **27 per cent**. The majority of the small amount of diesel that is used fuels a few boilers, plus standby generators that are used to safeguard against grid outages.

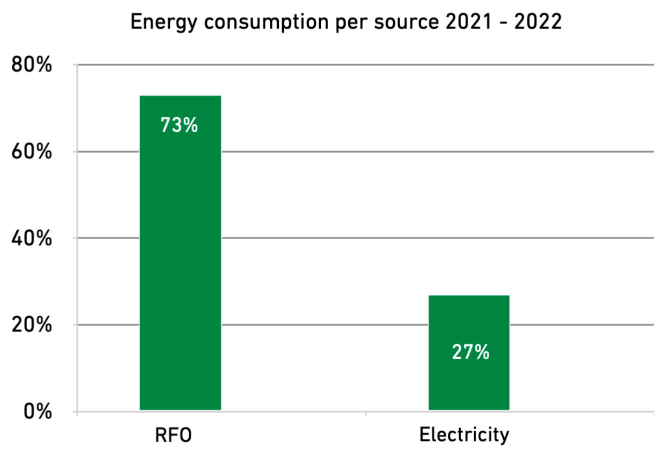


Figure 1: Energy consumption per source 2021 - 2022.

This phase of implementation focused on RFO and diesel. Available data for RFO consumption and local production were obtained. The significant energy users (SEUs) were steam boilers, ammonia compressors (cooling), air compressors, mash kettle and washer/pasteurizers (packaging).

1. PET stands for polyethylene terephthalate; the plastic that the bottles are made out of.

Nature of the challenges

The increasing costs of energy and water were a growing concern to the company and this spurred ABL to collaborate with the Ghana National Cleaner Production Centre under the UNIDO Ghana Industrial Energy Efficiency Readiness Project in late 2021. The UNIDO team undertook a resource efficiency, cleaner production assessment and follow-up visits at the site. The assessment revealed several high-level opportunities to reduce energy use. The company anticipates implementing some of the energy system optimization recommendations that stemmed from the audits.

During the energy visit, the UNIDO team recognized ABL for its environmental sustainability efforts but found some gaps in the energy management aspects of the site. The company pledged to implement an energy management system (EnMS) to improve energy performance, reduce energy costs and carbon emissions and, most importantly, implement a systematic and sustainable methodology for managing energy efficiency, usage and consumption.

EnMS capacity building programme

The firm's engineers attended a four-module EnMS training workshop. Senior management attended an awareness raising session on industrial energy efficiency. The benefits of this training were as follows:

- Participants developed a clear understanding of the critical energy performance indicators within each department and the driving factors that influence energy consumption in these areas.
- The energy awareness-raising sessions contributed toward improved operational control and led to behavioural change among staff who influence energy consumption.
- Participants developed a greater understanding of the 'business case' for energy efficiency, especially the management team.

Although ABL's top management is now well informed on the importance of the EnMS programme. Staff (workforce and supervisors) are yet to be trained on energy awareness due to challenges, such as a lack of time caused by heavy work schedules and maintenance problems.

Proposed interventions

Two interventions were proposed for implementation during the programme:

1. Installing cascade boilers.
2. Repairing leakages in the packaging area.

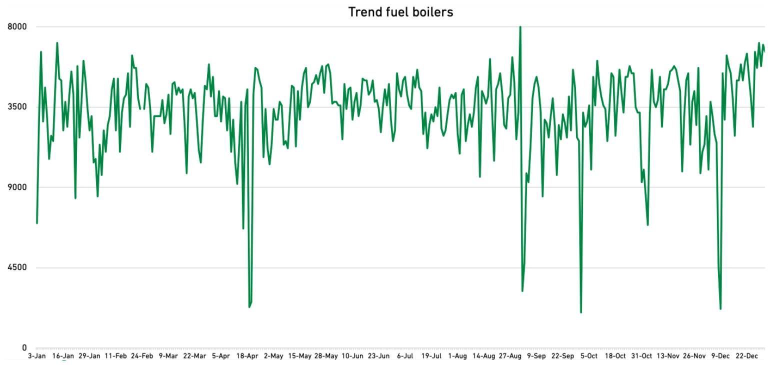
Steam boilers, ammonia compressors (cooling), air compressors, mash kettle and washer/pasteurizers (at the packaging section) were identified as the SEUs.

Electricity consumption is measured by metering installed at the packaging site and the utility site. Production data are extracted from shifts on a daily basis. Alignment of the dates of the electricity meter readings, fuel consumption and production dates is crucial to obtain acceptable regression models instead of using a specific energy ratio.

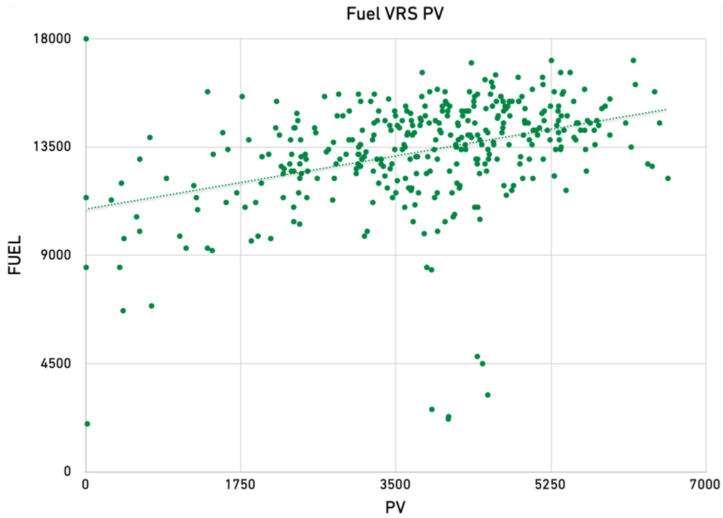
A baseline period from January 2021 to January 2022 was chosen, and the expected consumption was calculated for February 2022 to January 2023. Three EnPIs were developed for some departments. These were the energy performance coefficient, actual consumption minus expected consumption (kWh saving), and the CUSUM (this stands for cumulative sum control chart, and is used to compare energy consumption over a certain period). Overall, the biggest opportunities lay in improving operational control, energy awareness created during operational training, and implementing low-cost opportunities. Critical operating parameters were listed by each department manager.

Project 1: Installing cascade steam boilers

ABL installed eight new boilers running on diesel. Before, the company had three boilers running. The biggest boiler was running independent of the production. The main reason for installing the new smaller boilers was to produce steam in relation to demand (figure 2).



We established a poor correlation between the fuel consumption for steam and the packaging volume, which is shown below.



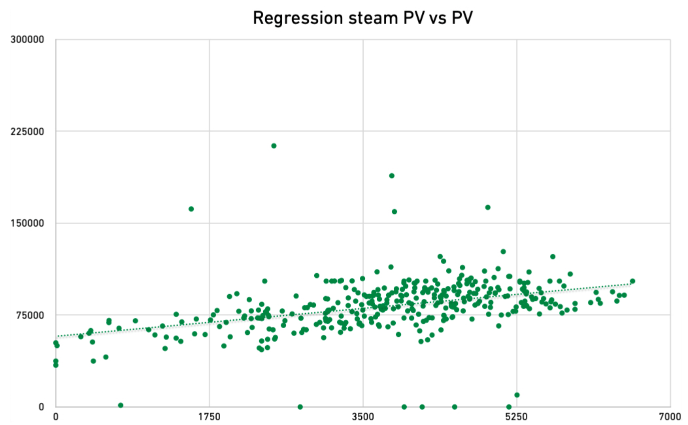
Production is a variable, as is the caloric value of RFO and diesel. ABL doesn't measure the caloric value. ABL is not fully in control of the fuel consumption. In a period when only the cascade boilers were running, performance improvements were visible.

The cost of diesel (cd 15/litre) is almost twice the cost of RFO (cd 9/litre). The running hours of the new boilers is reduced due to the cost. ABL is now focusing on operation control. In the case of the boiler, the operational opportunities are:

- control the pressure,
- clean the economizer,
- clean the pipes of the boiler.

The indicators that suggest the need for cleaning are the temperature of the exhaust air and the consumption of RFO. These are corrective actions instead of predictive actions. Based on average consumption, cleaning the boiler pipes will lead to a saving of approximately 2,000 litres of RFO per day, which equates to a cost saving of GHA 18,000,00 per day. The next step is cleaning the boiler pipes before increasing consumption.

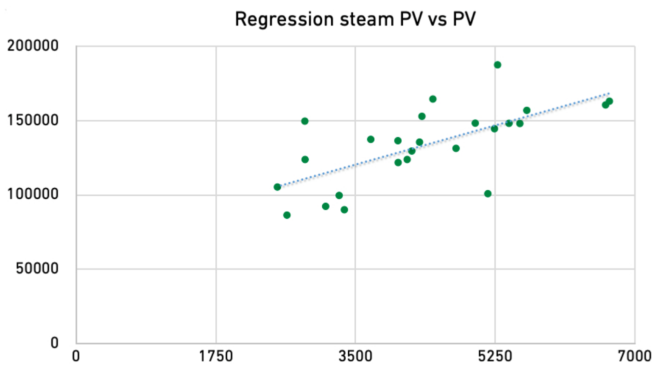
We established a poor correlation between the steam consumption and the packaging volume, which is shown below (figure 4).



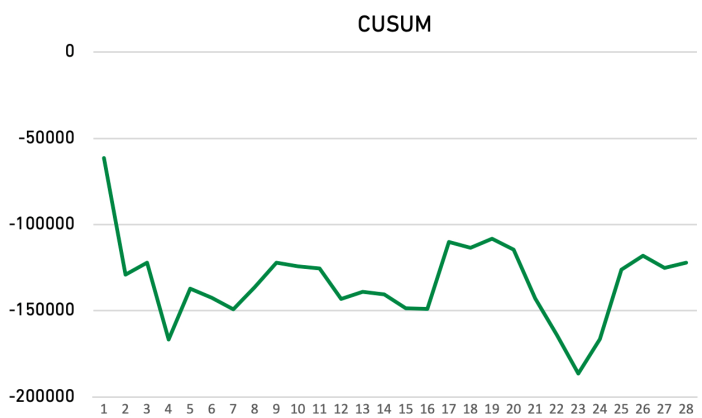
The poor correlation was caused by the following:

- Huge steam leakage at the heat exchange system in the PET line to produce hot water for the pasteuriser. There were three of these leakages.
- A lot of hot pipes were not insulated.
- The front of the plate small heat exchanger was not insulated.
- Different pumps had the same diameter.
- The machines were poorly maintained.

The steam leakages were repaired at the end of 2022. This led to a better correlation, as shown below (figure 5).



The baseload is around the same level and better controlled. Based on the regression improvement, ABL identified the saving using a CUSUM (figure 6).



In one month, 120,000kg of steam was saved, which lead to a reduction of 24,300kg CO_2 and a financial saving of GHA 81,900,00. The investment for repairing leaks was around GHA 80,000,00. The simple payback time is less than one year.

Implementation of an Energy Management System

The EnMS implementation project has five distinct phases and will take place over a period of 12 months.

Phase 1: Management responsibility and policy:

- Top management has expressed a lot of interest in the implementation of an EnMS.
- Appoint a management representative and an energy team with assigned roles and responsibilities.

Phase 2: EnMS planning:

- A Energy data were obtained for analysis and for developing a baseline.
- SEUs were identified based on their energy consumption.
- Baseline and EnPIs are in progress for all energy sources.
- Objectives, targets and action plans are in progress for all energy sources.

In addition, maintenance and operational controls are in the planning and development phase.

Phase 3: EnMS implementation and operations:

- Reinforce the energy awareness campaign and follow up with ABL personnel.
- Identify and implement operational controls on equipment.
- Develop and use energy efficiency design technology.

Phase 4: Checking:

- Monitor, measure and analyse key characteristics of the EnMS.
- Conduct performance monitoring and technical checks.
- Hold an internal system audit.

Phase 5: Management review:

- Conduct a management review (top management and energy team).

Implementation challenges

- Management is only partially committed to implementing EnMS strategies.
- There are insufficient data from the new boiler systems that were installed.
- There are constraints on staff time due to heavy workloads and maintenance issues.
- There is a need to use daily data to establish more EnPIs.
- An energy consumption baseline for diesel could not be established due to insufficient data generated during the stipulated time period.
- An energy consumption baseline for sub-operational processes couldn't be directly recorded due to insufficient sub-metering installed at the site.
- Regression models and baselines were developed for total consumption. An accurate regression for the overall facility could not be obtained for the reasons mentioned above.
- An accurate regression for each SEU could not be established due to lack of adequate sub-metering on sub-production lines.

Highlights and other energy saving optimization interventions

1. During the visit we identified some energy saving strategies were already being used. For example, no lights were on, and the company employed the use of day lighting.
2. Operating procedures were checked and recommendations made regarding the setup of operational controls and appropriate critical operating parameters (relating to the newly installed boilers) to improve energy performance.

Steam

3. A complete insulation of pipes and valves in the steam system is needed.
4. Leaking pipelines need to be fixed.
5. There is a need for operators to be trained to use the new steam boilers.
6. Switching from RFO and diesel to natural gas would provide an alternative fuel to use.
7. The steam traps need to be checked because the pipes are trilling (this is when steam flashes in the pipe).
8. Operation controls and critical operating parameters for the steam generators need to be set up.

Compressors

9. Manual air compressors should be changed to variable speed drive compressors.

General

10. There is a need to raise awareness levels across all departments on the importance of improving energy performance and the impact of switching off equipment while not in use as well as reporting and repairing all compressed air leaks.

Benefits, lessons learned and value added

Benefits

- Awareness has been created among top management about the need for an EnMS.
- The opportunity has been created to begin to measure and collect energy consumption and operational data from various parts of the factory.
- The training provided participants with knowledge on EnMS implementation.
- The training provided participants with the know-how to use production and energy data to develop EnPIs.

Lessons

- Change is necessary to adapt and modify.
- Resources and time are required for successful implementation of an EnMS.
- It is critical to determine the key factors affecting energy performance for each SEU.
- Availability of accurate and timely data is vital for efficient operation of an EnMS.
- Improving energy performance makes good business sense. It saves money and reduces costs while increasing the reliability of the plant and equipment. It also has a positive effect on productivity and enhances the reputation of ABL.
- Energy management is a continuous improvement process, and prioritizing the basics provides the foundation for long-term success.

Future plans

- ABL plans to effectively train and communicate with its workforce about the EnMS.
- ABL will continuously investigate the opportunity of no/low-cost interventions.
- The company will explore the implementation of basic maintenance interventions.
- ABL plans to add more projects to existing ones to help achieve energy efficiency.
- ABL will consider becoming ISO 50001-certified.
- Regular energy audits will be conducted.

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