INDUSTRIAL ENERGY EFFICIENCY PROJECT IN GHANA

Energy Management Systems (EnMS)

CASE STUDY

Akosombo Paper Mills
Afabeng Area, Akosomobo, Ghana

Company size (personnel)
Large
(100 or more)

Sector
Paper processing industry

Utility intervention
Energy management system implementation

Year joined project
June 2021

Date of implementation	Duration
2021-2022	12 months

Company profile

Akosombo Paper Mill Ltd (APM), formally Worldcool Ltd, was established in 2001 by entrepreneur Paul Adei. It is a tissue paper manufacturing company based in the small town of Akosombo, in the south of the Asuogyaman District, Eastern Region, Ghana. The company aspires to be the largest producer of quality tissue products in Ghana.

In 2014, the mill formed a partnership with Airtel Ghana to collect and recycle all paper waste generated by the company and has since gone on to form similar recycling partnerships with other entities. The mill collects the paper through its logistics partners and recycles it at its plant in Akosombo, turning the waste paper into quality, specialty paper products, with tissue paper its main product. It is now the leading manufacturer of tissue paper from recycled materials in Ghana. This sustainability measure helps to divert paper waste from landfill sites.

APM is in the process of restructuring its operations to leverage the brand identity it has gained in recent years due to its commercial success.

Plant profile

The plant employs approximately 40 people when operating at full capacity. Normally, operations run across five days a week and produce an average of around 10 tons of tissue paper a day. The manufacturing plant is divided into a production area and a packaging area, occupying a total of 8.31 acres of land. The mill has an annual production capacity of about 4,000 megatons. It manufactures quality tissues in jumbo rolls made from recycled pulp in various grades. The company plans to expand its product offering to include virgin pulp jumbos for the production of tissues, such as facial, toilet and kitchen towel, as well as napkins.

The plant currently has no formal management systems in place, such as ISO 9001. It enjoys a reduced electricity tariff because it is located close to a national grid power-generating source.

The company has established a Recyclable Waste Management Division with a staff of more than 25 people. The waste paper used to manufacture tissue/toilet paper now comes from all over Ghana, including public, commercial and government buildings. Waste paper is collected through a partnership network and collated at various depots in Accra before it is transported by truck to the plant at Akosombo.

The waste is sorted into white paper waste and non-white paper waste. Water and other chemicals (like caustic soda) are added to the paper to form a pulp, using separate processes for whites and non-whites. The pulp is then mixed and sieved to form a thick pulp with short fibres. This is then bleached and washed to remove chemicals. Next, the cleaned pulp is pushed through a series of presses to squeeze out the water and produce a thin layer of paper fibres. The fibre layer is allowed to dry then it is rolled onto a large bobbing where it is transferred to the cutting area. Here, the paper is cut and trimmed to produce the final product: rolls of tissue paper.

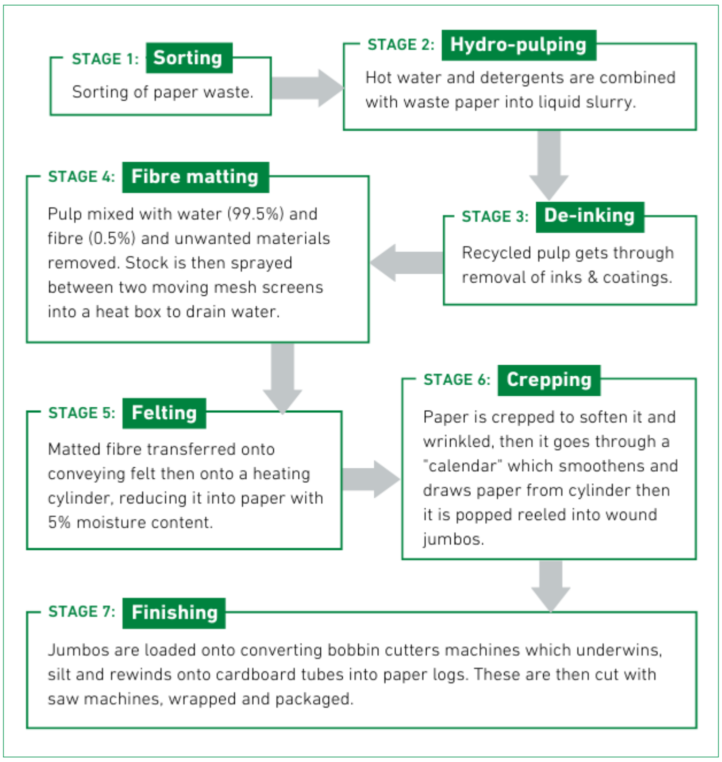

Figure 1: Simplified production process.

Energy breakdown: areas of significant energy consumption

Energy is provided by two main sources: heavy fuel oil (HFO – also called residual fuel oil or RFO) and electricity. HFO is used exclusively to feed the boiler to generate steam. A second boiler has been installed that has been modified to use liquefied petroleum gas (LPG). This boiler was not in operation during this study. Electricity is used for all other machinery and offices throughout the plant.

HFO for the boiler uses 80% of total energy input (based on kWh equivalent), with the remaining 20% derived from the local electricity supply authority.

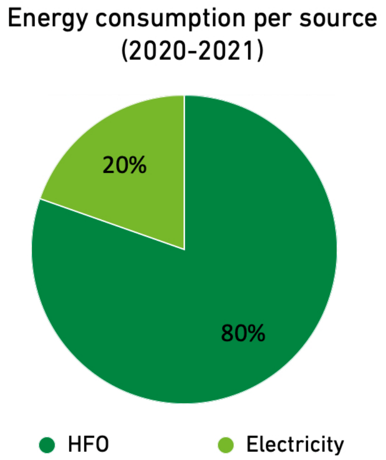

Figure 2: Annual energy consumption per source.

This first phase of implementation was focused on electricity and HFO. Data were available for electrical consumption and local production. For electricity, significant energy users included pulpers, mixers, compressed air and paper machines, plus auxiliaries such as lighting and office equipment.

Nature of challenges

APM's main management offices are located in Accra, quite a distance from the plant. Utility data and other marketing-related data are kept at the main management offices, which means it is not readily available at the plant. Basic operational data were available at the plant. Due to data being distributed across these locations, the company found it difficult to manage and track energy performance. This led to a situation in which no performance indicators relating to energy were in place at the plant.

During the study, the effects of the COVID-19 pandemic were still in evidence at the plant as only a single shift was operating five days a week. Often, the shift would end early due to a lack of resources. In most cases, this was caused by shortages of RFO, which has been in short supply and at elevated prices (another consequence of the COVID-19 pandemic). Worker morale was also low as there was a sense of uncertainty regarding the plant's future.

Based on discussions, capital investment for repairs and upgrades could not be justified due to the low production volumes and low plant utilization. Hence, manufacturing assets were not well maintained and were often pushed beyond their life expectancy. In-house, ad hoc repairs were made where possible.

The ever increasing costs of energy prompted management to look for strategies to improve energy performance and become more operationally effective and energy efficient.

The UNIDO training on ISO 50001-compliant energy management systems (EnMS) provided this impetus and kick-started this journey. The training provided the necessary support and capacity building for the assessment and development of the plant's energy systems.

Since this study, a further downturn in the economy has resulted in the plant temporarily ceasing operations. Further implementation of the EnMS has been suspended until the plant is operational again.

Industrial energy efficiency training programme

In 2021, selected employees, including the plant supervisor, attended the UNIDO-Ghana National Cleaner Production Centre EnMS Training. Using this platform, the plant supervisor identified that there was a lack of available data at the plant to adequately monitor energy performance. Site inspections also revealed opportunities for improvement. However, these could not be easily quantified due to a lack of data.

Training participants gained good background knowledge in energy management in industrial facilities, enabling them to identify areas for improvement in both the management of energy as well as plant operations.

Key achievements

Implementation period	June 2021 to May 2022
Total number of projects	2: (1-raising awareness, 2-refurbishing water supply dams to plant)
Monetary savings in GHS (total projected)	109,800
Energy savings in GJ (total projected)	315.3
Total investment made in GHS	59,750
Overall % of total consumption saved	33% of electrical energy consumption
Payback time period in years	<1
GHG emission reduction (ton CO_2e)[1] (projected for 12 months)	37.7

1. kWh to tCO_2e Conversion Factor set at 0.43 as per the EPC.
2. For the kWh rate use GHS1.25 /kWh.

Implementation of an Energy Management System

The following phases of the energy management system are in the process of being implemented.

Phase 1: Preparation and commitment:

- Liaison with top management to develop a structured system for managing energy.
- Development of management and responsibility matrices to ensure effective management and improvement of energy usage.

Phase 2: Planning – energy review:

- Data collection and development of applicable baselines.
- Estimation of consumption of significant energy uses (SEUs).
- Baseline and energy performance indicators (EnPIs) in progress for all energy sources.
- Objectives, targets and action plans in progress for all energy sources.

The following are in the planning and development phase:

- Operational controls.
- Measurement plan to allow better submetering of SEUs.

Phase 3: Implementation and operation – focus on SEUs:

- Operational training (in development).
- Procedures (in development).
- Energy performance improvement (some EnPIs have been developed and are now being tracked).
- Full integration into an integrated management system (future plan).

Phase 4: Audit and management review:

- Development of review structures for reporting and managing energy trends in the company.

Implementation challenges

Development of energy performance indicators

Performance indicators were developed for electricity consumption, using production as an input variable. The period from January 2020 to December 2022 was used as a baseline for the energy model that was developed (as shown in Figure 3 below). The graph shows a good correlation where the model can be used to forecast future energy consumption.

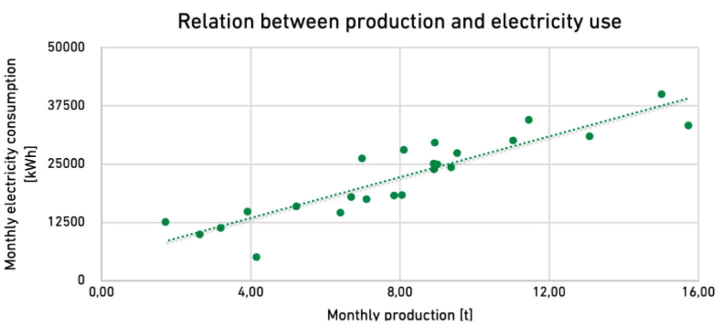

Figure 3: Relation between production and electricity.

Energy performance indicators for the boiler fuel (HFO) could not be calculated. Boiler fuel is purchased on an ad hoc basis and could not be correlated with monthly data. It is recommended that a simple flow meter is installed to measure the actual monthly consumption. This will allow for the development of an indicator for HFO, and thus for steam usage.

Steam challenges

The automatic control for the boiler does not work, and currently the boiler is manually operated. The operator will stop the fuel flow once the maximum boiler pressure is achieved. Similarly, the operator will start the fuel flow when the boiler achieves its minimum pressure. This practice is inefficient.

The boiler is also shut down every evening and restarted every morning. Fossil-fuelled boilers have a long start-up and cool-down period which consumes a lot of energy.

The boiler is operated to maintain a pressure close to 10 bar. At the point of use, pressure is reduced to three bar with a limited steam flow requirement. It appears that the boiler is oversized for the existing operations. This needs to be confirmed through a further study.

The holding tank supplying feedwater to the boiler is ruptured. Consequently, water is being continuously pumped to the boiler room, with the spillage from the cracks in the tanks flowing to the surrounding earth.

Operational / Energy Saving Optimization interventions

Summary of all electrical energy interventions

The effects of the interventions are shown in the graph below. The cumulative energy savings achieved for the first five months of 2022 was approximately 7,300 kWh. This saving resulted from raising staff awareness on energy waste and simple switch-off interventions at the plant.

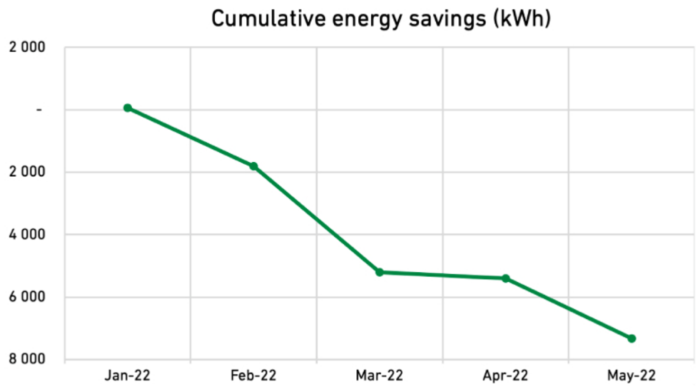

Figure 4: Cumulative energy savings.

General energy awareness

Using learning from the UNIDO EnMS course, the plant manager conducted a high-level inspection to identify no-cost energy saving opportunities. He also conducted awareness raising with operational personnel, explaining the need to save energy. He encouraged staff to switch off production machinery when not required, including lighting.

This resulted in more staff being aware of the switch-off policy and following it. This is reflected in the energy savings achieved for the first five months of 2022 when savings of 7,300 kWh were achieved as previously stated. If this trend continues, annual savings are projected to be around 17,500 kWh per year; equivalent to one month's electricity consumption at full capacity.

Energy uses/users	Intervention	Utility saving period	Investment (GHS)	Projected savings (GHS)	Payback (Yrs.)	Utility saving (GJ)	GHG emission reduction (tCO_2e)
Production	Energy awareness (projected)	2022	0	22,000	N/A	63.3	7.6
Production	Repair of concrete feedwater tank (projected)	2023	59,750	87,800	<1	252	30.1
TOTAL				109,800		315.3	37.7

1. kWh to tCO_2e Conversion Factor set at 0.43 as per the EPC.
2. For the kWh rate use GHS1.25 /kWh

Repair of the feedwater tank and water pump control

The plant contains a concrete feedwater tank. Water is pumped from the river to the feedwater tank. The water is then pumped from this concrete tank to a small hot well in the boiler room. This hot well is leaking, which further contributes to water loss. The sidewalls of the concrete feedwater tank are broken, resulting in water spillages. To maintain the water supply to the boiler, the river water pumps have to operate all day long, even when there is no production.

The concrete wall was repaired in 2022, and the pump has been provided with a remote switch. When operations resume it has been estimated that the river water pumps will only operate for a third of their original operating time, saving approximately 70,000 kWh of electricity per year. Using a rate of GHS 1.25 / kWh, it has been estimated that this will amount to financial savings of GHS 87,500.

General EnMS interventions:

- Collating monthly energy data.
- Installing an HFO flow meter to measure boiler fuel consumption.

Possible identified short-term interventions:

- Repair leakages in the piping (water, steam and compressed air).
- Insulate the piping system and valves (steam piping).
- Implement a maintenance programme for transmission belts on drive motors (six monthly checks and re-tensioning).

Benefits and lessons learned

Benefits

- The EnMS training provided the impetus to improve the energy performance at the plant.
- The training enabled the plant supervisor to identify areas for improvement.
- Awareness was created with top management that improvements could save energy.
- Relating energy data to production/operational data has been useful for developing energy performance indicators.
- The EnMS training provided the opportunity to begin to measure and collect energy consumption and operational data from various parts of the factory.
- Skills transfer assisted in the professional development of local operational staff.

Lessons

- Basic utility and plant operating data are necessary to enable the monitoring of energy performance.
- Formalized training can assist in overcoming people's resistance to change.
- Skills required for implementing energy efficiency projects are frequently lacking – something that training can help to address.
- Opportunities for improvement exist in all companies, even small ones with low production volumes.
- Regular communication between top management and operational staff is essential to drive improvements in energy performance.

Future plans

In the long term, the company has been considering updating many pieces of old machinery and optimizing operations using a systems approach. Short-term objectives are to foster the environment and identify markets that will enable the plant to become operational again.

Identified future projects include:

Steam projects

- Install a simple flow meter to measure steam consumption.
- Participate in energy system optimization training.
- Repair the hot well tank.
- Repair the automatic boiler pressure control.
- Insulate the main steam header, piping and valves (also short-term).

Replacing the boiler will be expensive. It is recommended that a more detailed study of the steam systems is conducted before this happens. The boiler system pressure is 10 bar, but the paper machine only requires 3 bar. By fixing the automatic boiler pressure control, it is possible that a much smaller electric boiler could be used to adequately meet the process steam requirements.

Electrical projects

- Repair the pump that supplies water from the concrete tank to the hot well, and repair the pipe leakages in this pump system.
- Replace or adjust transmission pulley belts on motors and mixers to improve power transfer.
- Adjust water spray nozzles on the paper machine to minimise water losses.
- Replace compressed air tubing used for control valves as many tubes have leakages.
- Adjust compressed air system pressure to a lower acceptable value.
- Move the compressor closer to the main point of use.
- Install a meter to monitor water supply.
- Review the viability of solar energy as the plant only operates during the day.

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