Reducing Energy Consumption in Tea Production:

A case study of Mulindi Tea Factory

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Over 90% of tea factory energy requirements are for heat used in withering and drying. Ensuring maximum boiler efficiency can significantly reduce energy requirements and production costs.

Tea production industries are some of the biggest consumers of woody biomass in Rwanda. In addition, Rwanda is embarking on a tea expansion program, and therefore it is important that the new and the existing factories include best practices in energy efficiency to reduce forest degradation, carbon emissions, and wood fuel demand. In this regard, the Government of Rwanda (GOR), through Fund for Environment (FONERWA) is implementing the project Strengthening Climate Resilience of Rural Communities in Northern Rwanda (SCRNRP) funded by the Green Climate Fund (GCF). The project aims to increase the resilience of vulnerable communities to climate change among other objectives. The project has commissioned a study, to assess energy efficiency needs in 5 tea factories in Rwanda in order to deliver on the outcome of improved management of land or forest areas contributing to emissions reductions. This study has been conducted on 5 tea factories namely: Mulindi, Nyabihu, Gisovu, Kitabi, and Pfunda in order to assess their energy efficiency need and identify alternative energy sources, especially for tea heating and reducing wood fuel consumption.

In Gicumbi, there was a high demand for wood to fire the boilers of the Mulindi Tea Factory to dry tea. Tea factories are heavy users of energy, using wood fuel to power the boilers for factory processes, and are the largest industrial source of greenhouse gas emissions in the country. Wood for the boilers was typically grown in large managed forests nearby (though often supplemented by additional suppliers) and 1 hectare of forest is needed to produce sufficient wood fuel for every 3 to 4 hectares of planted tea.

By 2018, the supply of eucalyptus from the factory’s 280 Ha eucalyptus plantation to dry tea was inadequate and there was an urgent need to improve the efficiency of the drying process as well as improve the productivity of existing stands and expand and diversify forest resources over hilly terrain to cope with current and future demand for biomass and construction materials. A detailed technical audit and study concluded that the factory performed well against best practices in the tea industry internationally, but that significant improvement can still be made.
Under this study, the analysis conducted on the energy usage in these factories covered the last 3 years. The study findings indicate that the five factories consume a total of 33,466m³ of firewood per year, Mulindi being the highest consumer of firewood at 11,437m³ per year and Nyabihu the least with 3,291m³ per year with an average of 6,693m³ per factory per year.

The total firewood consumption by 5 factories cost Rwf 325,503,266 per year. Regarding electricity consumption, the same trend follows with Mulindi consuming 2,530,374 kWh annually and Nyabihu consuming 993,678 Wh per year with an average of 1,741,065 kWh per year per factory. The total electricity consumption by all five factories is 8,705,323 kWh per year at a cost of Rwf 954,914,720.

Potential alternative energy sources

The analyzed Energy Use Index (EUI) for these factories was benchmarked against average Kenyan factories with EUI of 482kgMT/m³ and 1.96kgMT/kWh for firewood and electrical EUIs respectively. Thus, the Project can set a target of 450kgMT/m³ and 1.9kg/kWh for firewood and electrical EUI respectively as a standard KPI of energy efficiency in tea factories in Rwanda based on benchmarking of the EUIs. The higher the value of EUI the better, hence this target can be reviewed periodically.

After analyzing energy usage in Rwandan tea factories and benchmarking with similar Kenyan factories, there was a need to highlight the energy efficiency opportunities and alternative energy sources that can enable the tea factories to improve on energy efficiency, energy conservation and environmental protection.

A number of alternative energy sources were looked at, and the following two were identified and recommended for implementation:

1. **Compressed natural gas for heating and drying in the tea factories**;
2. **Captive grid-tied solar photovoltaic to supplement the grid electricity**

From the figure above, approximately 92% of the energy consumed in the factory is thermal (heat energy) from firewood for use in the steam boilers. This energy is in the tea drying process and other times in the withering process during wet seasons. When focusing to reduce energy consumption, a significant reduction in firewood consumption can result in a huge saving in the overall energy use.

Electrical energy constitutes 7.64% of the total energy and is used to run all the machinery/equipment in the factory. A backup diesel generator provides electrical energy to the facility in case of grid power outage which accounts for 0.57% of the total energy in the facility.

**Supporting Mulindi Tea Factory towards Energy Efficiency**

With this energy source becoming more difficult and expensive to obtain in some areas, some factories have started exploring energy efficiency opportunities and alternative energy sources that can enable the tea factories to improve energy efficiency, energy conservation, and environmental protection.

Furthermore, Rwanda is embarking on a tea expansion program, therefore, it is important that the new and the existing factories include best practices in energy efficiency to reduce forest degradation, carbon...
emissions and wood fuel demand. In this regard, the Government of Rwanda (GoR), through National Fund for Environment (FONERWA) is implementing the project Strengthening Climate Resilience of Rural Communities in Northern Rwanda (SCRNRP) known also as the Green Gicumbi Project funded by the Green Climate Fund (GCF).

Owing to the results of a detailed technical audit which was conducted in 2018 which indicated that the factory was performing below international standards and best practices, the Green Gicumbi Project stepped in to help Mulindi Tea Factory towards energy efficiency. Felix Rurangwa, Forestry Specialist and Component lead under the project said that in order to reduce the amount and demand of wood from forests, the Green Gicumbi Project has supported Mulindi Tea Factory with systems that reduce wood fuel consumption and carbon emissions. This factory is one of the biggest in Rwanda and is located in one of the 9 Sectors covered by the project.

“We have built wood drying infrastructure (Hangar) in Mulindi Tea Factory because when the factory uses well-dried wood, they use less quantity and reduce emissions in the air,” he said.

He said that the project has also distributed over 40 energy speed drivers that ensure energy efficiency or use less energy in Mulindi Tea Factory. This is also coupled with rehabilitating forests owned by this factory as a way to tip them on forest rehabilitation good practices, for them to follow suit in the future.

“We over the last two years, people have changed behaviors toward protecting the environment. When we restore a degraded forest, the neighbors and partner institutions learn from the achievement and restore their forests using their own means,” he said.

Results

Green Gicumbi Project contributed significantly to the reduction of the use of biomass with improved energy efficiency.

Emissions per kg tea produced has significantly reduced from 2.74 to 1.98 kg CO2e/ kg tea respectively in 2017 and 2021 due to the factory co-funding. This was mainly a result of the construction of a wood drying hangar & VSDs.

Further still, the project is assisting forest owners and users to improve forest productivity and timber quality to support diversified sustainable livelihoods while at the same time introducing measures that reduce the harvesting of wood for household cooking and Mulindi tea factory to reduce pressure on forest and wood resources, reducing vulnerabilities associated with deforestation and degraded forest cover.

This case study was compiled by:

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