SMALL AND MEDIUM ENTERPRISES: ENERGY EFFICIENCY KNOWLEDGE SHARING

VOLUME 11 | ISSUE 3 | SEPTEMBER 2020

SAMEEEKSHA NEWSLETTER

www.sameeeksha.org

Inside...

- Electrification of industrial processes for achieving low carbon growth
- Workshop on scaling-up electrification in industrial processes
- Clean energy technologies for tea processing plants

Promoting Energy Efficiency in SMEs

SAMEEEKSHA

VISION

SAMEEEKSHA envisages a robust and competitive SME sector built on strong foundations of knowledge and capabilities in the development, application, and promotion of energy-efficient and environment-friendly technologies.

Bureau of Energy Efficiency

SHAKTI SUSTAINABLE ENERGY FOUNDATION

teri
The Energy and Resources Institute

MSME
MICRO, SMALL & MEDIUM ENTERPRISES

A PLATFORM FOR PROMOTING ENERGY EFFICIENCY IN SMEs

IN THIS ISSUE...

This issue focuses on the urgent need for 'decarbonizing' the industry sector, which drives economic growth but is also responsible for generating about a third of total global CO_2 emissions. For India to sustain economic growth and yet make significant strides towards achieving a 'near-zero' carbon economy by 2050, it is vital to find ways by which industries, including MSMEs, can replace their existing fossil fuel-based technologies and processes with options based on 'clean' electricity and renewable energy (RE) sources.

The theme article elaborates on the significant progress being made in 'greening' grid electricity in India: RE sources accounted for over 23% of total installed generation capacity in August 2020, and TERI estimates that by 2030, RE will contribute about 45% of electricity in the grid. As a consequence the grid emission factor is steadily decreasing, making it an increasingly sound strategy for Indian industries to switch over from fossil fuels to electricity-based and/or RE-based solutions wherever these are feasible. The article summarizes the recent studies conducted by TERI in five energy intensive MSME clusters, under a project supported by Shakti Sustainable Energy Foundation (SSEF), to assess the feasibility of replacing fossil-fuel-based technologies currently in use with commercially available electrical and RE-based options. In coming days TERI plans to support MSMEs in adopting the identified electrical/RE options, starting with the foundry and tea industries in West Bengal.

The second article in the issue summarizes the points made during an awareness workshop on electrification of industrial processes, organized by SSEF–TERI and attended by representatives from the Government of West Bengal, Bureau of Energy Efficiency (BEE), MSME entrepreneurs, industry associations, consultants, and technology suppliers. The final article outlines the feasibility studies conducted by TERI for the adoption of electricity and RE-based options by tea processing plants in place of the coal-based technologies that they now use in the tea withering and drying processes.

SAMEEEKSHA Secretariat

ELECTRIFICATION OF INDUSTRIAL PROCESSES FOR ACHIEVING LOW CARBON GROWTH

Global scenario

Across the world, industry relies heavily on fossil fuels for energy. The industry sector accounts for almost one-third of total global CO_2 emissions.[1] Industry is also the engine that drives economic growth. Hence, it is imperative to control and mitigate CO_2 emissions from industry, i.e. to 'decarbonize' industry, if the world is to sustain economic growth and yet move towards a 'near-zero' carbon economy in the future by adopting clean electricity.

Clean electricity generated from non-fossil fuel-based energy sources has a low emissions factor (BOX). For industry, transition to electrical technologies offers a range of other benefits such as energy efficiency, improved product quality, precision in monitoring and control of equipment and processes, improved working conditions on factory floor, and so on. Hence, electrification presents an effective strategy to increase energy efficiency, improve competitiveness and reduce emissions. This is particularly the case when the electricity drawn from the mains has a low grid emissions factor, or when the electricity comes entirely from renewable energy (RE) sources such as solar and wind which are not associated with any CO_2 emissions.

It is encouraging that the use of electricity by industry has seen steady increase in recent years; electricity now meets around a quarter of total demand in the industry sector (IEA, ETP 2020). It is also encouraging that energy supply is being progressively decarbonized—primarily in Europe, United States, China and India— by increasing power generation from RE sources such as wind and solar photovoltaic (SPV). In 2019, wind power accounted for over 5% of global power supply, and SPV about 2.5%. Furthermore, recent times in India have seen spectacular drops even in RE Round The Clock (RTC) power costs, with a tariff of Rs 2.90/kWh. These trends underline the importance as well as effectiveness of electrification as a strategy to decarbonize industry. The Energy Transitions Commission, an international think-tank focusing on economic growth and climate change mitigation, too emphasizes that clean electrification will be the primary route to decarbonization of the global economy, and that the dramatic fall in RE costs will make electrification an affordable option in all sectors[2].

Grid emissions factor

In many countries including India, a significant proportion of grid electricity comes from thermal power plants that burn coal and other fossil fuels. As a consequence, every unit of power in the grid is associated with a certain quantum of CO_2 emissions, known as 'grid emissions factor' which is typically measured in terms of tonnes of CO_2 per megawatt-hour (t CO_2/MWh). The grid emissions factor comes down as the share of electricity from RE sources (hydro, solar PV, wind, biomass, geothermal, etc.) and waste heat power generation increases in the grid electricity 'mix'.

Challenges and opportunities

Industry is the most challenging sector to decarbonize, for two broad reasons.

- **Heterogeneity:** The industry sector is made up of highly diverse sub-sectors, each consuming energy for diverse end-uses in a variety of industrial processes and applications. In India, for example, an unorganized sub-sector like clay-fired brick manufacturing is the third largest consumer of coal. Hence, it is difficult to find one electricity-based solution that will suit all industrial units across sub-sectors or even within a particular sub-sector.
- **Need for high-temperature process heat, and process emissions:** Many energy intensive industrial sub-sectors require high-temperature process heat for extended periods of time. While in theory such heating requirements can be met by electricity, there are no proven and affordable electric technologies for many processes. In addition, in sectors like cement, there are process emissions due to calcination reaction. Hence, most industrial

[1] International Renewable Energy Association (IRENA). 'Renewables at Heart of Reaching Zero Emissions in Industry and Transport'. 09 September 2020. https://www.irena.org/newsroom/articles/2020/Sep/Renewables-at-Heart-of-Reaching-Zero-Emissions-in-Industry-and-Transport. Accessed 15 September 2020.

[2] Energy Transition Commission. 2020. 'Making Mission Possible: Delivering a Net-Zero Economy'. https://www.energy-transitions.org/publications/making-mission-possible/

units in these energy intensive sub-sectors meet their high-temperature, long-duration process heat requirements by burning coal and other fossil fuels which are usually available at relatively lower prices than electricity. As a reflection of this reality, just four energy intensive industrial sub-sectors—aluminium, cement, chemicals, and iron & steel—currently account for over 21% of global energy and process-related emissions.[3]

However, not all industrial processes and applications require high-temperature heat. International studies indicate that 30% of industrial heating needs require heat below 100 °C; 27% require heat between 100–400 °C; and 43% require heat above 400 °C. Even energy intensive sub-sectors require heat at low to medium temperature for diverse applications (figures 1 and 2).[4,5]

Heat at low to medium temperatures is typically needed for applications such as cleaning, washing, cooking, sterilizing, distillation, drying, etc. There are many commercially available electrical heating technologies, as well as solar thermal options, which can provide heat in this temperature range. For decarbonizing a large sector like steel, which is the single largest industrial consumer of fossil fuels, green hydrogen based Direct Reduction route is a promising option being explored in the developed countries like Sweden.

[3] IRENA: ibid.

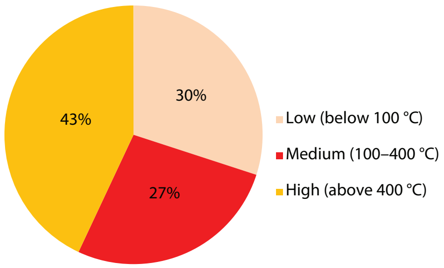

Figure 1. Temperature-wise profile of Industrial process heating needs [Based on data from US EPA: www.epa.gov/rhc/rhc-industrial-processes]

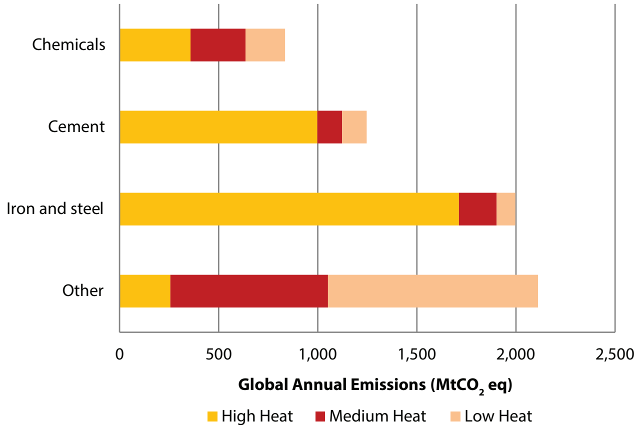

Figure 2. Process heat temperatures needed in a few energy intensive sub-sectors, with global annual CO_2 emissions (Mt CO_2 eq = million tonnes of carbon dioxide equivalent)

[4] US Environmental Protection Agency (EPA): www.epa.gov/rhc/rhc-industrial-processes

[5] Stephane de la Rue du Can. 2020. 'Electricity Pathways: Exploring a new technology paradigm'. Presentation at webinar organized by Energy Management Centre, Kerala, 20 August 2020.

Indian scenario

In India, the industrial sector accounts for about 50% of total commercial energy consumption and contributes over 45% of the nation's total energy-related carbon emissions[6], with fossil fuels like coal, gas and oil continuing to be the preferred source of thermal energy in boilers, kilns, furnaces, dryers and other applications. Niti Aayog estimates that the energy demand from Indian industry will triple over the next 25 years.[7] If India is to sustain its economic growth yet become a net-zero carbon economy by 2050, it is essential to find ways by which Indian industry, including the MSME sector, can be decarbonized through electrification of technologies and processes.

On the energy supply side, significant progress is being made in 'greening' grid electricity: the Ministry of Power, Government of India reports that of the total installed generation capacity of 372,693 MW as of August 2020, RE sources accounted for over 23% (88,730 MW).[8] TERI estimates that by 2030, about 45% of electricity in the grid will come from RE sources[9]; and that the grid emissions factor, currently at about 0.7 t CO_2/MWh, is expected to fall to 0.1 t CO_2/MWh by 2050. These trends make it an increasingly sound strategy for Indian industries to switch over from fossil fuels to electricity-based and/or RE-based solutions wherever these are feasible in their plants.

Solutions for MSMEs

TERI, with the support of Shakti Sustainable Energy Foundation (SSEF), has been studying and assessing the potential for replacement of existing fossil fuel-based technologies with commercially available electricity-based and RE-based options in a number of energy intensive MSME clusters across the country. The findings and insights from the initial phase of the project, which focused on eight MSME sub-sectors and two cross-cutting applications, have been carried in an earlier issue [see SAMEEEKSHA 10(3), September 2019]. In its second phase, the project studied five more

[6] Stephane de la Rue du Can. 2019. 'Industry electrification for a low-carbon future'. Energy Manager 12(04), October–December 2019.

[7] Figure 5(a), p.15 in https://niti.gov.in/sites/default/files/2019-07/India%E2%80%99s-Energy-and-Emissions-Outlook.pdf. Also, SN Sahay Secretary, Ministry of Power; quoted in SAMEEEKSHA December 2019.

[8] https://powermin.nic.in/en/content/power-sector-glance-all-india

[9] Dr Ajay Mathur; at the Consultation Workshop on 'Accelerating switch to cleaner fuels (RE & Electrification) in industrial processes' held on 24th July 2019

energy intensive sub-sectors—aluminium utensils, aluminium extrusion, brass lamps, glass bangles, and tea—and has identified and conducted feasibility studies on electricity-based and RE-based solutions for a number of applications/processes (table 1).

Table 1. Electric and RE-based solutions for small-scale industrial processes

Sub-sector	Process/ Application	Temperature required	Electrical/RE-based option
Aluminium utensils	Melting	740 –780 °C	Replace FO-fired furnace with electric furnace
	Annealing	415–430 °C	Replace LPG-fired furnace with electric annealing furnace
Aluminium extrusion	Melting	710-765 °C	Replace FO-fired furnace with electric furnace
	Reheating	425–485 °C	Replace LDO-fired roller type furnace with electric induction billet heater
Brass lamps	Melting	1000 °C	Replace used automotive oil-fired furnace with electric furnace
	Core baking	230–250 °C	Replace charcoal/ cow dung-fired furnace with electric oven
Glass bangles	Annealing	500 °C	Replace NG-fired furnace with electric furnace
Tea	Withering	45–65 °C	Replace coal-fired hot air generator with electrical heater
	Drying	120–125 °C	Replace coal-fired hot air generator with biomass gasifier-based hot air generator system

The project has also underlined a number of issues that must be addressed in order to facilitate the scaling up of electrification among MSMEs across different sub-sectors and in different regions. These include:

- **Reducing and stabilizing the cost of power.** High power cost acts as a deterrent to the adoption of electrification options, especially when fossil fuels are available at lower costs. Competitively pricing of electricity against commercial fossil fuels will encourage industries to switchover to electrification options. The importance of rationalizing and stabilizing power price has been recognized at policy level; for instance, in a recent interview the Union Minister for Power and Renewable Energy Mr R K Singh remarked: *"The cost of power in India… has to be much less if we want to attract industrial activity. We also need to do away with additional surcharges to stay competitive."*
- **Assuring reliability of power supply.** MSME entrepreneurs will consider electrification options only if they have the confidence that good quality power will be available for them at affordable price in the long term. This is particularly important in the numerous clusters and industrial areas which are regularly facing erratic power supply due to local issues.
- **Creating awareness.** The project has clearly revealed the need to create awareness among MSMEs on the benefits that electrification can bring, in tangible terms like increased productivity and earnings through energy efficiency, better working environment through reduced pollution, and so on.

Looking ahead

In coming days, TERI plans to focus on promoting and providing support for adoption of the identified electrical/RE options among MSMEs, starting with the foundry and tea industries in West Bengal. It may be mentioned that TERI's engagement with MSME stakeholders in West Bengal goes back nearly 25 years, to the time when TERI worked in the Howrah foundry cluster and successfully demonstrated the clean and energy efficient divided blast cupola melting technology in 1998. Over the decades TERI has sustained and further strengthened its ties with entrepreneurs, industry associations, technology providers, government agencies and other stakeholders in the state at cluster, institutional and policy levels. This provides a solid foundation on which to undertake an intervention aimed at promoting electrification among MSMEs in the state. On its part, the West Bengal government has expressed its keenness and enthusiasm in supporting and participating in such an intervention.

Acknowledgment

In addition to the references cited in footnotes, this story has drawn on the following articles/presentations by Ms Stephane de la Rue du Can, Program Manager and Assistant Group Leader of the International Energy Studies Group at Lawrence Berkeley National Laboratory, University of California, USA:

- *'Industry electrification for a low-carbon future'. Article published in Energy Manager 12(04), October–December 2019.*
- *'Electricity Pathways: Exploring a new technology paradigm'. Presentation at webinar organized by Energy Management Centre, Kerala, on 20 August 2020.*

WORKSHOP ON SCALING-UP ELECTRIFICATION IN INDUSTRIAL PROCESSES

Shakti Sustainable Energy Foundation (SSEF) and TERI jointly organized a regional awareness workshop [webinar] titled 'Scaling-up the switch to cleaner fuels (Electrification) in industrial processes' on 26th August 2020. The participants included representatives from the Government of West Bengal, BEE, MSME entrepreneurs, industry associations, consultants, and technology suppliers.

In his introductory remarks Mr Girish Sethi, Senior Director, TERI placed the workshop in the context of the need for industries to switch from fossil fuels to clean energy options. Mr Shubashish Dey, Associate Director–Energy Efficiency Program, SSEF outlined the aim of the SSEF–TERI project, to identify and promote technologies based on electricity and renewable energy (RE) among industries including MSMEs.

Mr Milind Deore, Director, BEE, summarized the various interventions undertaken to promote energy efficiency in over 100 MSME clusters representing over 30 industrial sub-sectors. Also, BEE has compiled the 'Energy Conservation Guidelines for MSME Sector'; prepared video tutorials on energy efficient technologies successfully adopted by MSMEs in different sub-sectors; and supported the demonstrations of 10 electricity-based technologies in the Ludhiana forging cluster, which have since been replicated by over 200 MSME units.

Mr S Suresh Kumar, Additional Chief Secretary, Department of Power, Govt. of West Bengal welcomed the initiative to promote electricity-based EE technologies among industries; particularly because West Bengal and other regions of eastern region have in recent years faced a sluggish demand for electricity from industry, which in turn has adversely affected the profitability of DISCOMs. Mr Rajesh Pandey, Principal Secretary, Department of MSME and Textiles, Govt. of West Bengal suggested that TERI should broaden the scope of its initiatives to encompass technologies based on 'cleaner' fuels rather than focus only on electrical technologies. He added that the West Bengal government has launched a number of initiatives to support the adoption of EE technology by industries: for instance, reimbursement of energy audit fees. Mr Anurag Srivastava, Director, Department of MSME, Govt. of West Bengal and Mr K D Bhattacharya, Director (I/C), MSME-DI, Kolkata added that the Department of MSME will help in providing the necessary 'last mile connectivity' to the concerned MSME clusters.

A background presentation was made by Mr Prosanto Pal, Senior Fellow, TERI in which he summarized insights and lessons from the studies conducted by TERI to identify clean energy options including electricity and RE-based solutions for various industrial sub-sectors/applications, and to assess their technical feasibility and financial viability. The initiative focused on India's eastern regions including West Bengal, covering sub-sectors such as tea, forging, wire drawing, etc. Some of the key insights from the presentation, and from the discussions that followed, are summarized below.

Key points

- MSMEs confront many challenges in adopting electricity-based options, at the technological level as well as in the domains of policy and finance. For example, the price of power varies sharply across states and is particularly high among eastern states; hence, tariff rationalization is required in order to make electricity-based options financially viable.
- The relatively high costs of electricity, along with the significant capital cost of installing the electricity connection, act as barriers to electrification.
- Low awareness levels among entrepreneurs, and the lack of technology demonstrations, also act as barriers to the adoption of electrification and other clean energy options.
- TERI has identified 19 electricity-based technologies for 11 industrial sub-sectors, which should be promoted vigorously among MSMEs as well as among large-scale units.
- The refractory industry offers huge scope for promoting clean energy options, including electricity-based solutions.
- There is significant scope to introduce electricity-based options in tea factories—such as electric heaters along with dehumidifier systems.
- Aluminium industries at one time used electrical technologies in various processes, but switched to fossil-fuel-based technologies when electricity became costly. Hence, aluminium units will now consider adopting electricity-based options only if they are assured that good quality electricity will be readily available at affordable cost in the long term.
- The possibility of providing affordable electricity to small-scale aluminium units via captive solar power plants could be explored.

CLEAN ENERGY TECHNOLOGIES FOR TEA PROCESSING PLANTS

The tea industry is one of the energy intensive sub-sectors studied by TERI under the SSEF-supported project, to explore the feasibility of replacing the existing fossil fuel-based technologies with clean energy options based on electricity and/or renewable energy (RE). India is the second largest producer of tea in the world after China, with an annual production of about 1.3 million tonnes. The primary tea producing areas are Assam, northern regions of West Bengal, the Niligiris in Tamil Nadu, and Munnar in Kerala.

The common steps in processing fresh tea leaves into black tea are withering, bruising, oxidizing, fixing, and drying. About 80% of total energy consumption is in the form of thermal energy, mainly in the withering (12%) and drying (60%) processes as shown in figure 1. Most of the tea processing plants, particularly in West Bengal and Assam, meet their thermal energy requirements by burning coal and natural gas. The specific coal consumption for both drying and withering is about 0.73 kg coal/kg of tea produced, which is equivalent to emissions of 1.326 kg CO_2/kg of tea produced. Based on these figures, the Indian tea industry produces an estimated 1.8 million tonnes of CO_2 emissions annually from the withering and drying operations. Clearly, there is a huge need as well as an opportunity to reduce fossil fuel consumption and CO_2 emissions through electrification of the withering and drying processes in the tea industry.

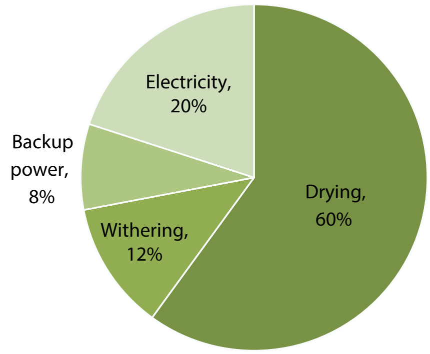

Figure 1. Energy usage profile in tea processing

TERI conducted its study at the tea processing plant of a tea garden located near Siliguri, West Bengal, and analysed the feasibility of replacing the coal-based technologies being used in the withering and drying processes with electricity/RE-based options. The findings and recommendations of the study are summarized in the following sections.

Withering

Withering is the first major step in the processing of fresh tea leaves. Freshly plucked leaves are laid out in a series of open troughs (withering beds) fitted with perforated trays. Hot air is forced from below the trays by means of axial flow fans (figure 2). There are a large number of withering troughs (45–60) in the withering section, and each bed is equipped with an individual fan. This process reduces the moisture content in the leaf by about 30%, making the leaves soft enough for rolling. Withering also helps intensify the volatile compounds in the leaf, including the levels of caffeine and the flavours. Temperature, time and relative humidity are critical parameters in the withering process.

Figure 2. Axial fan attached to withering bed

The plant was using two coal-fired hot air generators (HAGs) to provide hot air for the withering process. The two HAGs were operating at very low efficiencies (38% and 49%), and did not have temperature controls. Furthermore, significant heat losses took place during the transfer and distribution of the hot air to the large number of withering beds. Overall, only about 3.8% of the heat input to the HAGs was being effectively utilized in the withering process.

Clean energy option and benefits

TERI recommended replacement of the existing HAG system for withering with an electricity-based system, in which an electric heater and blower assembly is fitted on to each withering bed (figure 3). The proposed system requires an investment of Rs 55,000, and offers an annual saving of about Rs 18,000 in energy costs (figure 4). The simple payback period is 3.1 years. The electricity-based system brings about annual emission reductions of about 23 tonnes CO_2 for each withering bed (table 1).

Figure 3. Withering fan with electric heating assembly

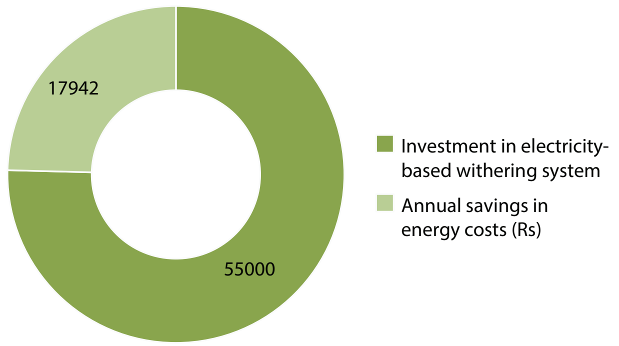

Figure 4. Energy savings with electricity-based withering system

Table 1. Clean energy option for withering process: cost–benefit analysis [1]

Particulars	Proposed electricity-based system
Investment (Rs)	55000
Annual savings in energy bill (Rs)	18000
Simple payback period (years)	3.1
Annual emissions reduction (t CO_2)	23.2

Note: the calculations are for 250 batches processed per year

Drying

Drying is the final operation in tea processing before the tea is packed. Drying involves passing hot air at 120–125 °C through the tea leaves to bring down the moisture content to less than 3% and ensure long shelf-life.

The plant was using two HAGs, fired by coal, to provide the required hot air for drying (figure 5). The two HAGs were found to have very low efficiencies (44% and 69%), primarily due to poor combustion, heat lost via flue gases (with flue gas temperature at about 165 °C), and high surface/structural heat losses.

Clean energy option and benefits

TERI recommended replacing each of the two existing coal-based HAGs with a biomass gasifier-based HAG based on wood chips. The biomass gasifier-based systems offer significant reductions in energy costs and CO_2 emissions as well as attractive payback periods on investments (figure 6, table 2).

Figure 5. Coal-based hot air generator (HAG) for drying

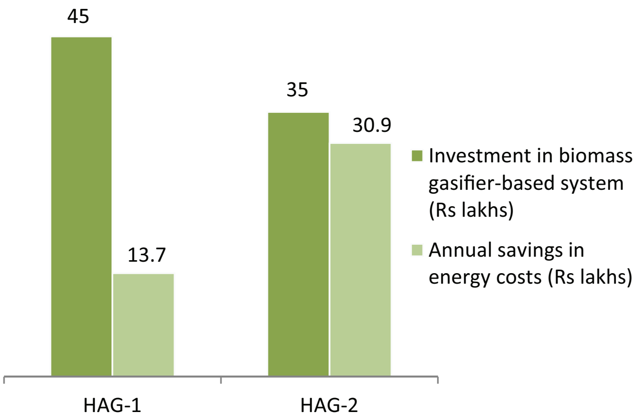

Figure 6. Energy savings with biomass gasifier-based drying systems

[1] Based on table 4.0: 'Feasibility report on electrification of hot air generator used in withering of tea leaves – Siliguri, West Bengal.' TERI, December 2019.

Table 2. Clean energy option for drying process: cost–benefit analysis[2]

Particulars	Proposed biomass gasifier-based systems	
	HAG-1	HAG-2
Investment (Rs)	45 lakhs	35 lakhs
Annual savings in energy bill (Rs)	13.7 lakhs	30.9 lakhs
Simple payback period (years)	3.3	1.1
Annual emissions reduction (t CO_2)	1397	1137

[2] Based on 'Feasibility report on biomass gasifier based hot air generation system for drying of tea leaves – Siliguri, West Bengal'. TERI, December 2019

Other benefits

Besides lower operating costs and reduced CO_2 emissions from the withering and drying operations, the electricity-based withering system and biomass gasifier–based drying systems offer a number of additional benefits such as:

- Better temperature control, and hence improved product quality.
- Reduced particulate and SO_2 emissions, and minimal ash disposal problems
- Improved workplace environment for plant personnel.
- Easier inventory management, as the issues associated with procuring and stocking coal are eliminated.

ABOUT **SAMEEEKSHA**

SAMEEEKSHA is a collaborative platform aimed at pooling the knowledge and synergizing the efforts of various organizations and institutions—Indian and international, public and private—that are working towards the common goal of facilitating the development of the Small and Medium Enterprise (SME) sector in India, through the promotion and adoption of clean, energy-efficient technologies and practices.

SAMEEEKSHA provides a unique forum where industry may interface with funding agencies, research and development (R&D) institutions, technology development specialists, government bodies, training institutes, and academia to facilitate this process.

For more details, please contact

Mr Sachin Kumar
Secretary–SAMEEEKSHA
Industrial Energy Efficiency Division
TERI, Darbari Seth Block
IHC Complex, Lodhi Road
New Delhi – 110 003, India
Tel: +91 11 2468 2100, 2468 2111,
Fax: +91 11 2468 2144, 2468 2145
Email: sachink@teri.res.in
Website: http://sameeeksha.org