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SAMEEEKSHA

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NEWSLETTER

Inside...

- Exploring electrification options for MSMEs
- Feasibility studies on electrification of fossil fuel-based technologies



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



The Energy and Resources Institute



A PLATFORM FOR PROMOTING ENERGY EFFICIENCY IN SMEs

IN THIS ISSUE...

This issue focuses on the huge potential for MSMEs in energy intensive sub-sectors to reduce their energy consumption and save energy costs by switching over from their existing fossil fuel-based technologies to electricity-based options. Efforts in this direction assume increasing salience in the light of India's commitment to reduce the emission intensity of its GDP by 33–35% below 2005 levels by the year 2030 under the Paris Agreement of 2015 (COP-21). A major barrier that MSMEs have faced till recently is the lack of reliable (i.e., dependable and steady voltage) electricity supply. In recent years, however, reliable grid electricity supply is being extended across increasing areas of the country. Also, the share of renewable energy (RE) in grid electricity is increasing, leading to a corresponding decrease in the grid emission factor (an indicator of the carbon emissions from electricity generation). These aspects make the switching over from fossil fuels to electricity-based solutions a sound strategy for industries and other consumers to reduce their own carbon footprints and contribute to the national-level reduction in carbon emissions.

The theme article outlines the SSEF–TERI project under which feasibility studies were undertaken in select energy intensive MSME sub-sectors/clusters across the country to explore the replacement of existing fossil fuel-based technologies with electricity-based solutions. Besides highlighting insights and lessons from the project, the article also summarizes the salient points from a Consultation Workshop held in July 2019 to share the project experiences with other MSME sector stakeholders, and to chart a future course of action. A separate article presents two of the feasibility studies undertaken in more detail, highlighting the opportunities for electrification as well as the barriers that have to be overcome in order to enable MSMEs to adopt the identified electricity-based options on a wide scale.

SAMEEEKSHA Secretariat



EXPLORING ELECTRIFICATION OPTIONS FOR MSMEs

Context

Under the Paris Agreement of 2015 (COP-21), India has committed to reduce the emission intensity of its GDP by 33–35% below 2005 levels by the year 2030. With the major portion of its electricity generation coming from fossil fuel-based power plants, India has also pledged that 40% of its cumulative installed electricity generation capacity will be based on sources other than fossil fuels by 2030, and set itself a target of installing renewable energy (RE) capacity of 175 GW by 2022, including 100 GW of solar energy. Significant progress has already been made in ‘greening’ grid electricity: TERI estimates that by 2030, about 45% of electricity in the grid can come from RE sources. As the share of RE in grid electricity is increasing, the ‘grid emission factor’ (an indicator of the carbon emissions from electricity generation, measured in tonnes CO₂/MWh) is coming down. This trend makes the switching over from fossil fuels to electricity-based solutions an increasingly sound strategy for industries and other consumers to reduce their own carbon footprints and contribute to the overall reduction in emissions.

Industry and emissions

International Energy Agency (IEA) statistics indicate that globally, the three biggest energy consuming sectors are industry, transport and buildings, and that two-thirds of industry’s energy consumption is derived from burning fossil fuels (with only about 23% coming from electricity). In India, the industry sector accounts for nearly 50% of total commercial energy consumption in the country, and is one of the major consumers of fossil fuels.

Also, for India to achieve its ambitious emissions reduction target, it is imperative to find ways by which the major energy consuming sectors like industry, transport, and buildings can reduce their fossil fuel consumption—through parallel strategies focused on energy efficiency (EE) measures and switchover from fossil fuels to electricity and RE-based solutions. In the industrial sector, BEE is already engaged in bringing about emission reductions among large-scale industries under the PAT Scheme. However, in the MSME sector—which accounts for a large portion of industrial output—the majority of MSMEs continue to rely on obsolete,

low efficiency technologies and processes based on fossil fuels. While electrification of fossil fuel-based processes makes economic sense in many cases, a major barrier that MSMEs have faced till recently is the lack of reliable electricity supply (e.g., interruptions in electricity supply, voltage fluctuation, etc.)

It is in this context that TERI, supported by Shakti Sustainable Energy Foundation (SSEF), has conducted a project to explore the replacement of existing fossil fuel-based technologies and processes with electricity-based solutions in select energy intensive MSME clusters across the country.

The project

Under the project, TERI consulted a range of stakeholders in the MSME sector, including government bodies like BEE and their state development agencies (SDAs), various industry associations, technology suppliers/vendors and cluster-level support agencies, in order to identify applications and processes in various industrial sub-sectors that consume significant amounts of fossil fuels. A few ‘cross-cutting’ applications/processes (i.e., that are used in different sub-sectors) such as boilers, material handling systems etc. were also identified for study. Based on the consultations, TERI shortlisted a number of MSME sub-sectors and fossil fuel-based applications/processes for detailed investigations (table 1).

Table 1: MSME sub-sectors and fossil fuel-based applications/processes studied by project

Sub-sector(s)	Applications/ Processes
Foundry	<ul style="list-style-type: none"> • Melting furnace • Drive for fans • Core drying
Forging	<ul style="list-style-type: none"> • Billet heating
Wire drawing & Galvanizing	<ul style="list-style-type: none"> • Lead bath
Magnesium carbide refractory	<ul style="list-style-type: none"> • Oven
Clay brick	<ul style="list-style-type: none"> • Drive for fans
Chemical & Food Processing	<ul style="list-style-type: none"> • Boiler
Cross-cutting	<ul style="list-style-type: none"> • Chiller • Forklift truck (material handling)



In each of the shortlisted sub-sectors, one or more MSME clusters were selected and unit-level studies were conducted on the relevant applications/processes with focus on the following:

- » Understanding the reasons why MSMEs continue to use 'dirty' (high-carbon) fuels such as coal, pet-coke and diesel in the various applications and processes
- » Identifying electricity-based technological solutions that are available in India and abroad, and assessing their economic viability in the long term
- » Determining the policy and regulatory changes that might be required in order to enable the MSMEs to switch over to these clean, electricity-based technological options.

In each sub-sector, the studies enabled the project to identify a number of electrification options for the identified processes/applications and examine their feasibility, as well as to understand the barriers and challenges that have to be overcome in order to enable MSMEs to adopt these electrification options on a wide scale. A separate article in this issue presents feasibility studies on a few electrification options in more detail.



Coke-fired cupola melting furnace



Diesel-fired boiler

Consultation workshop

On 24th July 2019, the project organized a Consultation Workshop titled 'Accelerating switch to cleaner fuels (Electrification) in industrial processes' to share the experiences and insights from the project studies with other MSME sector stakeholders; to discuss other potential electrification options that could be studied in future; and to deliberate on the major issues and barriers that inhibit the implementation



Consultation workshop in session

of electrification options by MSMEs—particularly in heat processes—and identify possible ways in which to address these barriers. The participants in the workshop included representatives from Alliance for an Energy Efficient Economy (AEEE), Bureau of Energy Efficiency (BEE), Energy Efficiency Services Ltd (EESL), Federation of Indian Chambers of Commerce and Industry (FICCI), Petroleum Conservation Research Association (PCRA), Small Industries Development Bank of India (SIDBI), Tata Power, MSME entrepreneurs, industry associations, and technology suppliers. Some of the important points and insights from the project studies and workshop discussions are summarized below.

Benefits of electrification

- » The project studies have clearly highlighted the following benefits of electrification at the unit level:
 - Higher energy efficiency compared to fossil fuel-based systems, with attractive payback periods on investment in many cases
 - Greatly reduced air pollution, and consequent improvement in working environment
 - Ease in control and operation of electrical systems compared to fossil-fuel based systems
 - Space saving (less paraphernalia required compared to fossil fuel-based systems)
 - Reduced maintenance requirements
- » In many of the existing fossil fuel-based processes/applications, a major reason for low energy efficiency is the absence of instrumentation & control systems for monitoring and regulating process parameters like temperature, air pressure, fuel consumption, air-to-fuel ratio, and so on. Electricity-based technology options have a great advantage in this regard, because they come with built-in instrumentation & control systems and offer instant start-stop operation.



Barriers to electrification

The major barriers to electrification are:

- » High capital cost—electricity-based options typically require a high upfront capital investment, which MSME entrepreneurs are often reluctant or unable to make
- » Low awareness—often, the entrepreneurs lack awareness and knowledge on the feasibility and benefits of the electrification options that are available (e.g. the quick payback offered on investments, other advantages of electrical systems like better working environment, improved productivity and product quality, etc.).
- » High cost of grid electricity—this directly impacts the payback on electricity-based options and acts as a disincentive for entrepreneurs
- » Initial infrastructure costs for electrification—in sub-sectors where the electrification options require high tension (HT) power connection (e.g., induction furnace in foundry, induction billet heater in forging), it is expensive to set up the infrastructure for providing the necessary HT supply (such as new transformer, panel, cables, and so on). Applying for and obtaining an HT connection is itself a cumbersome and time-consuming process. In comparison to these initial infrastructure costs for electrification, the cost of electricity actually used in the process/application is much less.
- » Need for customization— typically, each individual MSME has unique requirements, particularly in its primary processes (e.g. melting furnace, forging furnace), and any new electricity-based technology may have to be customized to meet these individual needs while remaining economically feasible. The new technology may also require new infrastructure and/or support systems such as material handling systems (requiring track laying, etc.), which not only entail additional costs but may be difficult to implement without disturbing the existing layout in old units having limited space.

Other insights, lessons and suggestions

Electricity pricing, reliability, emission factor

- » Electricity price is a critical factor in determining the feasibility of electrification options, if energy costs alone are compared for the existing and proposed technologies. For example, in the

foundry sub-sector, the switchover from cupola to induction furnace is not viable if electricity is priced at over Rs 7.5 /kWh.

- » The high cost of electricity in India has been recognized among policy circles as an important issue to be addressed. Recently, the Union Minister for Power and Renewable Energy was quoted in media as remarking that Indian industry cannot be expected to compete with China if electricity is being provided at Rs 9/kWh.¹
- » Assured reliability of power supply in the long term is essential for MSME entrepreneurs to be confident enough to switch over to electrification options—particularly because in many clusters where power supply has hitherto been erratic, they have made large investments on DG sets to provide backup power for various processes/applications in case of outages.
- » When calculating the reduction in CO₂ emissions for electrification options, in some cases (e.g. electric boilers, forklift trucks) the results are negative—implying that the CO₂ emissions may actually go up with electrification. This is because a significant portion of grid electricity still comes from thermal power plants based on fossil fuels, resulting in a high grid emission factor value at present². However, the emission reduction values for these electrification options are expected to become positive as the grid emission factor becomes lower with increasing share of RE in the grid.

Feasibility assessment, implementation, capacity building

- » While examining the economic feasibility of electrification options, it is very important to take into consideration the many benefits that electrification offers in addition to matching or bettering the energy performance of the existing fossil fuel-based technologies (i.e., in terms of reduced pollution, improved productivity and product quality, ease in operation, reduced labour costs and so on).
- » Electrification options that do not require customization can be promoted as EE measures on a large scale through the 'demand aggregation' model, which has been applied successfully in a number of projects (e.g., replacing low efficiency ceiling fans with energy efficient BLDC fans in Thangadh ceramic cluster; replacing standard

1 See <https://economictimes.indiatimes.com/industry/energy/power/grants-only-if-states-adopt-procedures-says-r-k-singh/articleshow/70285955.cms>

2 Central Electricity Authority (CEA) quotes grid emission factor of 0.82 tCO₂/MWh for 2016–17 [http://www.cea.nic.in/reports/others/thermal/tpece/cdm_co2/user_guide_ver13.pdf]



motors with IE3 motors in Ankleshwar chemicals cluster).

- » Awareness generation initiatives have a vital role in promoting electrification. For instance, the project studies revealed a common misconception among a MSME personnel that power from DG sets is cheaper than grid electricity. They were convinced otherwise only after the project team presented them with detailed analyses.
- » The potential for setting up 'common utilities' at the cluster level should be explored: for instance, a common boiler facility that generates power, and also supplies steam to various units in the cluster. Such common utilities would greatly benefit the individual MSMEs in each cluster, and also help in reducing local (shop-floor) emissions. The potential for setting up such common utilities could be assessed by conducting studies in various clusters across the country. A national-level program could then be developed to facilitate the establishment of such common utilities.

Way forward

The project has highlighted a number of areas in which further initiatives need to be undertaken at cluster, regional or national level for promoting electrification options in place of fossil fuel-based applications/processes. They include the following:

Widening industry coverage through feasibility studies

Apart from the areas identified under the SSEF-TERI project, there are a large number of other industrial processes/applications across different MSME sub-sectors which use fossil fuels and have the potential to switch over to electricity. More such options should be identified and investigated through feasibility studies. The studies will help in quantifying the potential for energy savings and GHG reductions, as well as highlight the social benefits of switchover from fossil fuels to electricity (cleaner working environment, safer and less arduous working conditions, and so on). The studies will also help in devising strategies to overcome the present barriers to electrification, and enable the preparing of a road-map to promote electrification across the entire MSME sector.

Explore business models for implementation

In the sub-sectors where feasibility studies indicate that electrification makes economic sense today,

different business models should be explored to promote electricity-based solutions, to determine which business models work. Based on these proven business models, the required policy and regulatory changes can be brought about for large-scale replications.

Increase awareness

Awareness is very low among MSMEs and other stakeholders regarding the huge potential that exists for replacing traditional fossil fuel-based technologies with clean electrification options in different industrial applications. A series of workshops, consultations and other outreach activities should be launched to enhance awareness on the benefits of electrification among MSMEs as well as key stakeholders such as policy makers, donor agencies, industries, equipment manufacturers/suppliers, and financial institutions.

Launch deep-dive initiatives through cluster-specific programs

The project has highlighted a number of commercially available electricity-based technologies having attractive economic viability in different MSME sub-sectors. The large-scale switchover by MSMEs to these electrification options can be greatly expedited through cluster-specific 'deep-dive' initiatives, under which unit-specific studies are undertaken, coupled with handholding support to the units during implementation.

Facilitate technology development and innovations

The studies have identified a few fossil fuel-based processes/applications that offer significant scope for GHG reductions, but where commercially viable electricity-based solutions are not available (e.g., boilers of small/medium capacity). The need is to develop technology-specific RDD&D programs to facilitate the development and dissemination of clean electricity-based options.

Develop innovative financing models

The studies have shown that attractive energy savings are possible by replacement of fossil fuel-based technologies with electrical systems. There is need to develop and roll out innovative financing models and policies to support the implementation of these electricity-based solutions.



FEASIBILITY STUDIES ON ELECTRIFICATION OF FOSSIL FUEL-BASED TECHNOLOGIES

Under the SSEF-supported project, TERI conducted feasibility studies for replacing fossil fuel-based technologies with electricity-based options in a number of MSME sub-sectors (table 1).

Table 1. Summary of feasibility studies

Sub-sector	Electrification option	Energy saving (toe/year)	Investment (Rs lakh)	Monetary saving per year (Rs lakh)	Simple payback (years)
Foundry	Replacing coke-fired cupola with induction furnace	317.0	102	(-) 39.3	Not viable at current electricity price
	Replacing coal-fired core drying ovens with electric ovens	14.4	9.5	(-) 2.1	Not viable at current electricity price
	Replacing diesel engine-coupled FD/ID fans with motor-driven fans	8.4 (FD)	2.0 (FD)	4.0	0.5
		3.7 (ID)	1.6 (ID)	1.3	1.3
Forging (small & large capacity units)	Replacing FO-fired forging furnace with induction billet heater	13.5 (S)	9.0 (S)	0.9	10
		67.0 (L)	52.0 (L)	7.7	6.7
Wire drawing	Replacing FO-fired lead bath with electrical heating	271.0	23.0	15	1.5
Galvanizing	Replacing FO-fired lead bath with electrical heating	153	35.0	(-) 79	Not viable at current electricity price
Magnesium carbide refractory bricks	Replacing HSD-fired oven/room with electric heating	5.0	6.75	2.7	2.5
Clay brick (zigzag kilns)	Replacing diesel engine coupled ID fan with motor-driven fans	3.3	0.9	1.9	0.4
Food processing	Replacing LDO-fired boiler with electric boiler	16.0	6.1	3.2	1.9
Pharmaceutical	Replacing LDO-fired boiler with electric boiler	28.0	16.5	6.7	2.5
General (cross-cutting)	Replacing diesel forklift with electrical forklift	4.8	13.6	3.3	4.0
	Replacing steam-based VAM chiller with electrical vapour compression system	407.0	35.0	62	0.6



Two of the feasibility studies—on the wire drawing industry and on forklift trucks—are outlined below, to provide insights into the relevant issues and highlight the barriers that have to be overcome in promoting the identified electrification options among MSMEs.

Wire drawing industry

Electrification option: Replacement of FO-fired lead bath with electrical heating

Clusters studied: Howrah and Ranchi

The wire drawing industry is very energy intensive. About 40–50% of total wire production in India is through the ‘stress relieving process’, a low-efficiency technology in which the metal is drawn through a bath of molten lead maintained at a temperature of 200–220 °C by means of a burner at the bottom of the bath. A primary reason for low energy efficiency is that there is no monitoring of essential parameters like fuel consumption, bath temperature and air–fuel ratio. At night, when there is no production, the lead solidifies in the bath; when production begins the next morning, it takes 2–3 hours of heating to melt the lead again, resulting in further energy wastage.



Lead bath used in wire drawing

The project study focused on replacing the FO-fired lead bath with an induction heating system. The induction heater has a coil through which the metal is drawn to make a wire—a continuous process that offers the convenience of on–off operation and start time of just a few minutes.

Insights

- » So far, no significant interventions have been undertaken to improve energy efficiency in the wire drawing industry.

- » Despite the relatively high investment of about Rs 23 lakhs required on the induction heater, the simple payback on investment is attractive—at about 1½ years when the electricity price is Rs 6.50/kWh. Technical and financial support program will be essential to promote this electrification option. There are a number of wire drawing units in and around Ranchi, where the electricity price is below Rs 6/kWh; yet the project team found only one unit that has adopted an induction heater—and no other units in the area seemed to be aware of this electrical technology or its benefits.

Material handling systems (all industries)

Electrification option: Replacement of diesel-operated forklift with electrical forklift

SMEs studied: Various

Forklifts are used for material handling in all kinds of applications. In India, about 10,000 forklifts are introduced into the market every year, of which about 6000 are used in industry, and the rest in railways, airports, construction and other material handling applications/areas. Forklifts of 3–5 tonnes account for about 80% of total market.

Diesel-operated forklifts of 3-tonne capacity are most commonly used by MSMEs. Diesel cost accounts for about 64% of the running costs, while maintenance/consumables like oil, filters, etc. account for the remaining costs. A major drawback with diesel forklifts is that they cause huge pollution, particularly when used inside factory sheds as is often the case. The project study focused on replacing the existing diesel forklifts with electric (battery-operated) forklifts.



Diesel forklift





Electric fork lift

Insights

Electrical forklifts offer the following significant advantages over diesel forklifts:

- » They require much less maintenance (diesel forklift trucks require servicing every 3 months, with frequent replacement of spares and periodical overhaul—all adding to expenses).
- » The life of the electric forklift is virtually limitless, as only the battery requires replacement. In the course of its work, the project team came across an electric forklift of 1981 vintage that is still being used! In comparison, the life of a diesel forklift is typically not more than 10 years.
- » The payback on switching from diesel to electric forklift is about 4 years maximum (assuming 2500 hours operation annually).
- » Battery banks can provide speedy 'drive through' replacement of spent batteries with fully charged batteries.
- » Electric forklifts of up to 24-tonnes capacity are available in the market.
- » As with all the electrification options studied, low awareness among MSMEs is a barrier.
- » If the batteries are charged with a DC-DC charging system based on (say) solar energy, the electric forklift can be a zero-carbon technology.
- » A number of MSMEs use diesel-operated JCB machines and even tractors for material handling. These systems too can be converted to battery operation.

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.

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