



## DISCUSSION PAPER

# POTENTIAL FOR ELECTRIFYING INDIAN MSMEs

Prosanto Pal and Will Hall

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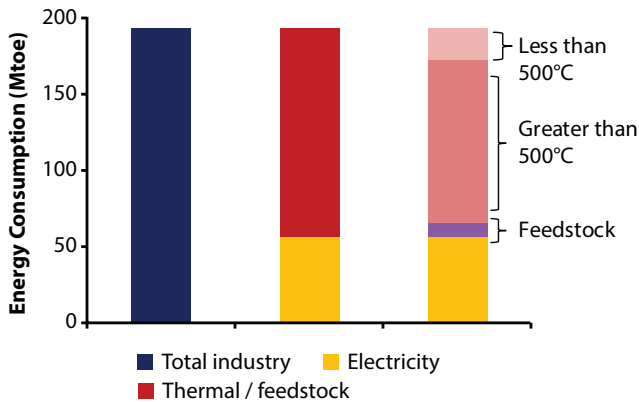


## Introduction

Today in India, we can see rapid changes in the way in which we generate electricity, moving away from coal-fired power stations, towards cleaner sources, such as wind and solar. Equally, in the transport sector, we can see a clear pathway towards decarbonisation, with the advent of e-mobility, whereby battery electric vehicles (BEVs) in many cases are already cost-effective versus diesel and petrol equivalents (Aventus, 2020). However, for Indian industry which consumes around 50% of total energy demand (MoSPI, 2020), a clear path towards emissions reduction across all industrial sub-sectors does not yet exist.

Industry is challenging to decarbonise for three main reasons: need for high temperature heat processes, use of fossil-fuel-based chemical feedstocks, and the presence of process emissions (for example calcination during cement production) (ETC, 2018). Based on the analysis carried out by TERI, nearly two-third of the total energy consumption in Indian industry today is primarily for meeting the direct heat requirements in various processes (see Figure 1). Nonetheless, there are many 'low-hanging fruits' in Indian industry, where processes can be electrified and where technologies are generally available and switchover to electricity-based systems can save both energy and emissions in the immediate term. This is particularly the case in many Micro Small and Medium Enterprises (MSMEs) which form the backbone of the Indian industry sector.

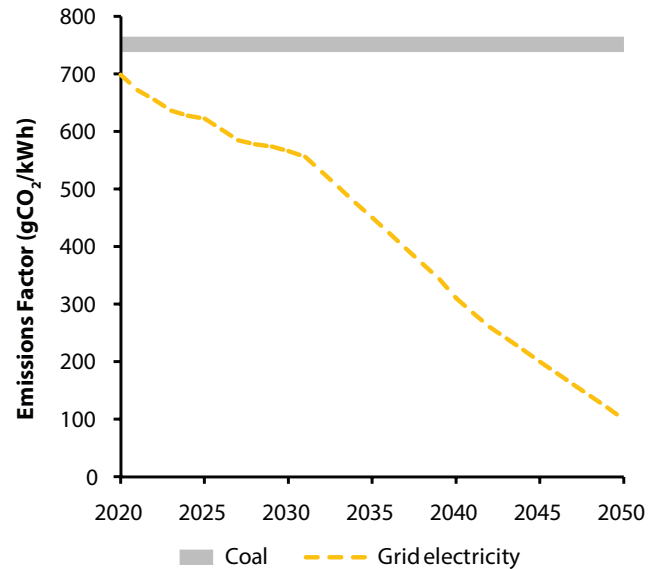
Figure 1: Industrial energy demand by electrical, thermal and feedstock



Source: TERI preliminary analysis based on IEA, 2018

Whilst the Indian electricity grid is still relatively emissions intensive, being fuelled predominantly by coal-fired power generation, this electricity supply is rapidly decarbonising. The electricity grid is at approximately 700 gCO<sub>2</sub>/kWh, which is on track to fall to around 550 gCO<sub>2</sub>/kWh by 2030, supported by the Government of India's renewable power targets (TERI, 2020a; TERI, 2020b). Over the lifetime of industrial equipment installed today, emissions will be far lower from electric sources versus fossil fuel sources. Moreover, electrical equipment tends to be more energy efficient than fossil fuel equivalents. This means that whilst electricity might be more emissions-intensive on a per kWh basis in the near-term, due to less energy being required, the overall emissions impact is lower versus the fossil fuel equipment.

Figure 2: Electricity grid emissions factor, 2020–2050



Source: TERI preliminary analysis

It is also worth mentioning that the financial health of most of the Indian distribution companies (DISCOMs) is very poor with a majority of them running into losses on a continuous basis. The demand for electricity is also not expected to increase significantly in the coming years under the Business As Usual (BAU) scenario. One way to ensure that DISCOMs can make adequate returns on their investment in electricity infrastructure is to stimulate increased electricity demand. An important way to do this is for industry to take active steps to electrify existing processes, reducing emissions and energy consumption, whilst broadening the consumer base for

Indian DISCOMs. In the case studies below, we estimate that electricity consumption can increase by 25% to 130% across different end-uses, representing a real opportunity to expand electricity demand.

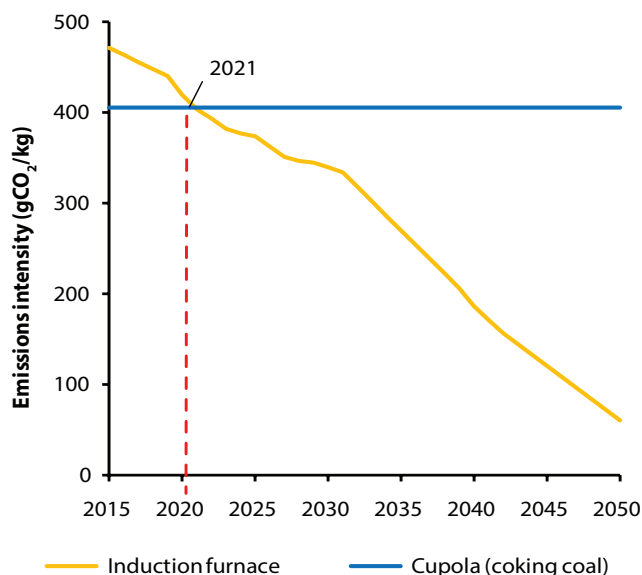
## Case study 1: Foundry

The foundry industry supplies a vast quantity of components for a range of applications in the automobile, machinery, and utility sectors. The sector is largely made up of smaller players, with around 90% of the industry classified as MSMEs (Foundry Informatics Centre, 2020).

The most common type of melting furnace used in small-scale foundries in India is the coke-fired cupola furnace. This technology currently consumes large quantities of coke, approximately 50% of which is imported, resulting in significant carbon dioxide emissions. The average cupola furnace consumes 125 kg of coke to melt 1 tonne of iron, resulting in emissions of 405 kg CO<sub>2</sub>.

This coke fired melting process can be replaced with electric induction furnace. An electric induction furnace is more energy efficient and has the potential to produce far lower carbon dioxide emissions, depending on the source of the electricity. As the electricity sector steadily decarbonises, we estimate that an induction furnace is already starting to produce fewer emissions than the average cupola furnace (see Figure 3).

Figure 3: Emissions intensity of foundry technologies, 2015–2050

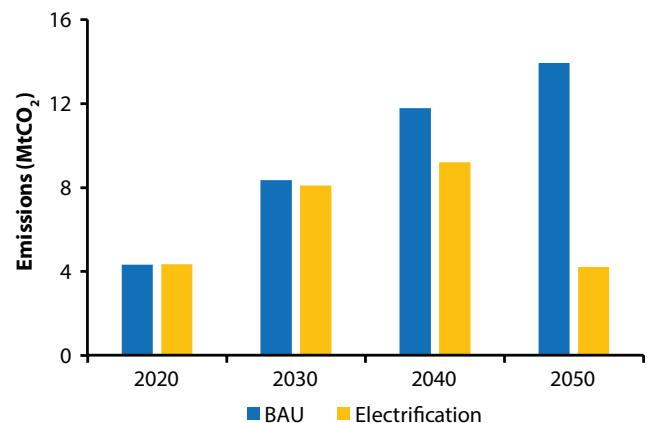


Source: TERI preliminary analysis

It is assumed at present that 43% of the total casting produced in India (~ 10.5 Mt/annum) is through induction furnace route, and the balance through cupola route. Applying the emission intensity numbers to the entire industry results in total emissions of around 4.3 MtCO<sub>2</sub> being produced from the foundry industry in 2020. Under a 'business as usual' (BAU) scenario, it is assumed that the production of castings would rise to 70.4 Mt by 2050, with the share of induction furnace steadily increasing to 60%. This will result in the emissions in 2050 to be nearly 14 MtCO<sub>2</sub> (see Figure 4).

Under an electrification scenario, we assume that the cupola starts to be replaced with the induction furnace more aggressively, reaching 100% penetration by 2050. Under such a scenario, emissions from the sector will peak at 9.7 MtCO<sub>2</sub> around 2040, before falling to 4.2 MtCO<sub>2</sub> by 2050. This represents a 70% reduction in emissions versus the BAU, and a 22% reduction in energy consumption.

Figure 4: Total emissions from the foundry industry, 2020–2050



Source: TERI preliminary analysis

## Case study 2: Forging

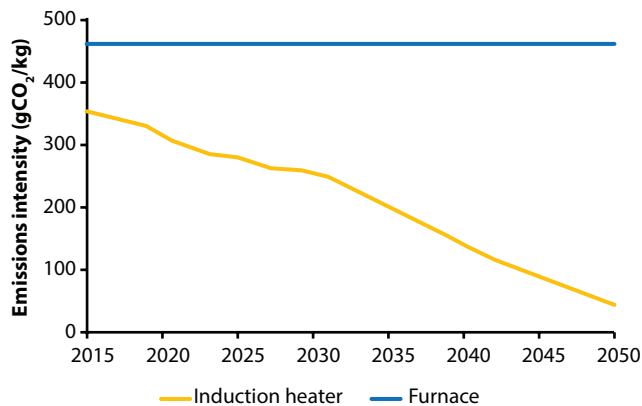
The Indian forging industry is a major contributor to the manufacturing sector of the Indian economy. The industry forges a variety of metals including iron, titanium, and aluminium in order to manufacture products used across a range of sectors, particularly the automotive industry. A large share of the forging industry is made up of MSMEs.

Heating accounts for a major share of energy consumption in the forging process (approximately 80% to 90%). The technology used for heating in most units is the box-

type forging heating furnace, which is relatively energy inefficient. Light Diesel Oil (LDO) and Furnace Oil (FO) have been traditionally used by the forging units (TERI, 2012). However, many units have shifted to energy-efficient electrical induction furnaces over the past few years. The specific fuel consumption of an average forging furnace is 135 litre per tonne of FO which is equivalent to 462 kg of CO<sub>2</sub> per tonne.

The FO-fired forging furnace can be replaced with an electric induction billet heater. The induction heater reduces the energy operating costs, requires less maintenance, and has the potential to produce far fewer carbon dioxide emissions, depending on the source of the electricity. Due to the high emissions intensity of FO and the high efficiency of the electric induction heater, we estimate that electrification in this instance would save emissions from today (see Figure 5).

Figure 5: Emissions intensity of forging technologies, 2015–2050

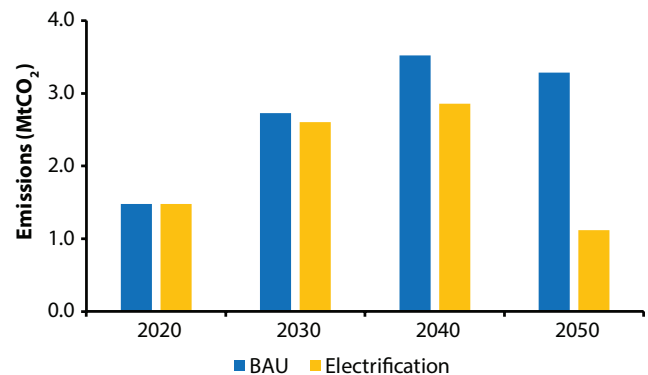


Source: TERI preliminary analysis

It is assumed at present that 50% of the forgings produced in India (~ 3.7 Mt/annum) is through FO furnace route, and the balance through electric route. Applying the emission intensity numbers for the entire industry results in total emissions of 1.5 MtCO<sub>2</sub> from the forging industry in 2020. Under a BAU scenario, it is assumed that the production of forgings would rise to 24.9 Mt by 2050 and the share of induction heater will steadily increase to 80%. This will result in emissions rising to 3.3 MtCO<sub>2</sub> by 2050, with peak emissions of 3.7 MtCO<sub>2</sub> around 2045.

Under an electrification scenario, we assume that FO furnaces start to be replaced with the induction heater more aggressively, reaching 100% penetration by 2050. Under such a scenario, emissions from the sector peaks to 3 MtCO<sub>2</sub> around 2035 and falls to just 1.1 MtCO<sub>2</sub> by 2050. This represents a 65% reduction in emissions versus the BAU, and a 32% reduction in energy consumption.

Figure 6: Total emissions from the forging industry, 2020–2050



Source: TERI preliminary analysis

### Case study 3: Tea

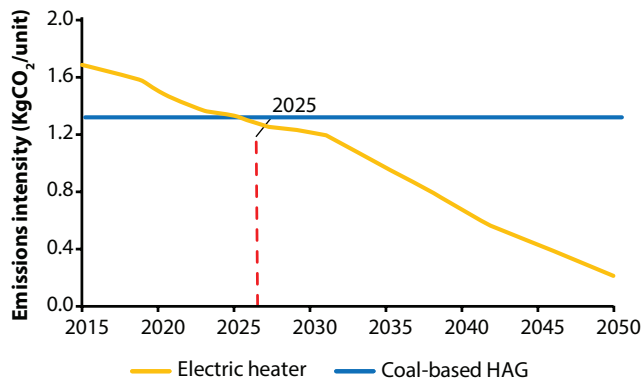
India is the second largest producer of tea globally. About 1.3 million tonnes of tea is produced annually in the country (Tea Board India, 2018). Presently, the withering and drying processes in the production of tea consume large amounts of fossil fuels, namely coal and natural gas.

Coal-fired conventional hot air generators (HAGs) are widely used in tea industry to cater to the hot air requirement of the withering and drying processes. The combined specific coal consumption for both the processes is about 0.73 kg coal/kg of tea produced, resulting in emissions of 1.326 kg CO<sub>2</sub>.

It is techno-economically feasible to replace the coal-fired HAGs in the withering and drying sections with electric heaters and biomass gasifiers, respectively (Scenario 1). The replacement of the coal-fired HAGs in both these sections with electric hot air generators has been considered under Scenario 2. However, the high infrastructure cost of enhancing the connected load of electrical supply, if drying operations are also electrified, is a barrier to implementation of Scenario 2. Based on a continuous process of decarbonisation in the power

sector, we estimate that an electric heater in withering section would start to produce fewer emissions than the fossil-based HAG by around 2025 (see Figure 7).

Figure 7: Emissions intensity of tea processing technologies, 2015–2050

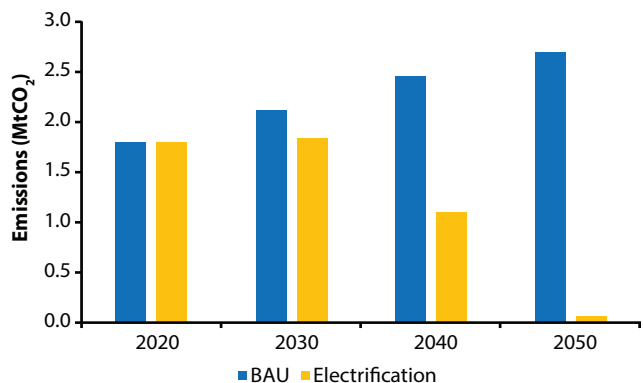


Source: TERI preliminary analysis

Assuming 70% of the total tea produced in India in 2020 (~1.36 million kg) was produced through coal-based thermal processes, the emissions from this industry was around 1.8 MtCO<sub>2</sub> in 2020. Assuming the tea production will increase to about 2 million kg by 2050, the emissions would rise to 2.7 MtCO<sub>2</sub> under a BAU scenario.

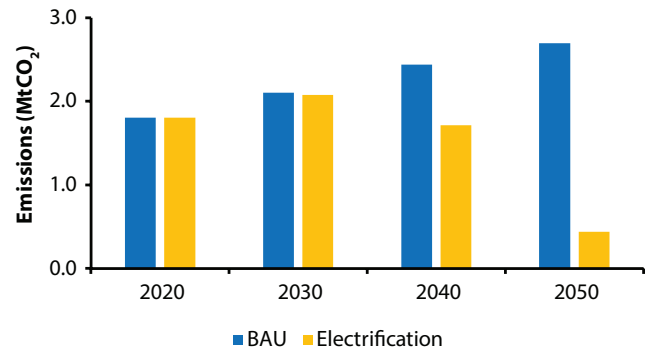
Under Scenario 1, we assume that coal-fired HAGs in withering and drying sections start to be replaced with electric heaters and biomass gasifiers respectively, with 100% penetration of these technologies by 2050. Under such a scenario, emissions from the sector would peak to 1.8 MtCO<sub>2</sub> around by 2030 before falling to just 0.07 MtCO<sub>2</sub> by 2050 (see Figure 8). This represents a 97% reduction in emissions versus the BAU.

Figure 8: Total emissions from the tea processing industry, 2020–2050 (Scenario 1)



Under Scenario 2, we assume that coal-fired HAGs in both withering and drying sections start to be replaced with electric heaters, with 100% penetration of these technologies by 2050. Under such a scenario, emissions from the sector would peak to 2.1 MtCO<sub>2</sub> around by 2030 before falling to just 0.4 MtCO<sub>2</sub> by 2050 (see Figure 9). This represents a 85% reduction in emissions versus the BAU.

Figure 9: Total emissions from the tea processing industry, 2020–2050 (Scenario 2)



Source: TERI preliminary analysis

## Case study 4: Forklifts

Forklift trucks are used throughout India for material handling by industries and warehouses. Forklift trucks are broadly classified into three categories: Light Duty, LD (1–3 tonnes), Medium Duty, MD (4–8 tonnes) and Heavy Duty, HD (>10 tonnes). Although most of the existing forklift trucks run on diesel, the use of LPG and electric forklifts is increasing particularly in the LD category. Based on discussions with manufacturers, it was estimated that about 14,000 forklifts were sold in India during 2020. LD has the highest market share (80%), followed by MD (14%) and HD (6%). Presently about 35% of LD sold in the market are electric and 10% of MD are electric.

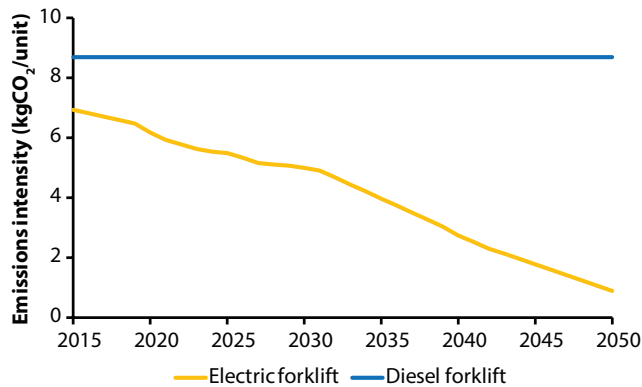
The average specific fuel consumption of MD forklifts is about 1.8 litre of diesel/h, resulting in emissions of 2.68 kg CO<sub>2</sub>. Based on an average of 2,000 hours of operation per year, a MD diesel forklift truck would consume around 3,600 litres, resulting in approximately 9 kg CO<sub>2</sub>.

It is both technically feasible and economically beneficial to replace diesel forklifts with electric alternatives. This will increasingly become the case as the costs of battery technology and electric drivetrains continue to fall. Due



to the higher efficiency of an electric motor versus a diesel engine, electricity supplied from the grid already results in emission savings from switching to an electric forklift. These savings will only increase as the grid further decarbonises (see Figure 10).

Figure 10: Emissions intensity of forklift trucks, 2015–2050

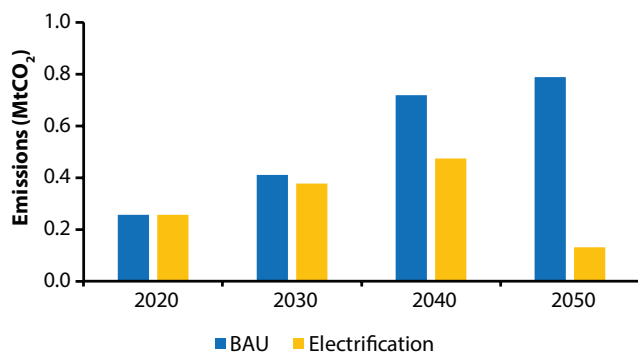


Source: TERI preliminary analysis

Applying these emission intensity numbers to the entire forklift market in India results in around 0.3 MtCO<sub>2</sub> being emitted. Under a BAU scenario, we assume that with the share of diesel forklifts following historical adoption rates, 50% of LD forklifts, 30% of MD forklifts, and 0% of HD forklifts will be on electric by 2050. Thus, the emissions would steadily rise to nearly 0.8 MtCO<sub>2</sub> by 2050.

Under an electrification scenario, we assume that diesel forklifts starts to be replaced with electric forklifts far more rapidly, reaching 100% penetration across all weight classes by 2050. Under such a scenario, emissions from the sector peaks before 2040, falling to just 0.1 MtCO<sub>2</sub> by 2050. This represents a 85% reduction in emissions versus the BAU, and a 60% reduction in energy consumption (see Figure 11).

Figure 11: Total emissions from the forklift sector, 2020–2050



Source: TERI preliminary analysis

## Barriers to electrification of MSMEs

Alongside assessing the potential of electrification, this study has identified several barriers which are limiting the rate of electrification in India, especially among MSMEs. The barriers are related to the energy system economics (high capital and power supply infrastructure investment), business finances (high price of electricity), information availability (low awareness of technical and financial aspects of the technology and its demonstrated track record), technological options (non-availability of customised technological solution), and institutional set-up (under-developed power distribution infrastructure). This is discussed below.

### High capital and cost of power supply augmentation

For the user industry, electricity-based technologies invariably require higher initial investment in comparison to fossil fuel-based technologies. For example, initial costs of electric melting/heating furnaces and forklifts are high. In addition, the user may need to pay for augmenting the power connection infrastructure and also make space available for additional equipment like the transformers, panels, and so on. This barrier is especially relevant for the large number of small-scale industries who lack investment capital and access to commercial means of finance. This barrier can be overcome by making soft loans available, lowering the cost for power delivery, simplifying the approval process, and standardising the required equipment and their specifications.

### Higher price of electricity for industrial consumers

Often the electrification of fossil fuel-based processes is financially unviable due to the high price of electricity for industrial consumers in India. This study found that several traditional small-scale industries, like those involved with melting and casting of metals such as brass, aluminium, and iron continue to use fossil fuels because of their lower operating (energy) cost. Competitively pricing electricity against commercial fossil fuels will automatically facilitate the switchover to electric options.

### Low awareness of cleaner technologies

This study found that there is low awareness of technical and financial feasibility of electric technologies, as well

as their demonstrated track record among industrial consumers. This was found to be a barrier for the scaling-up of electric heaters for withering tea, electric forklifts, and so on. Initiatives aimed at demonstrating and disseminating electricity-based technologies in such industries will help in their faster adoption.

### **Limited connectivity for dispersed SMEs in rural/peri-urban areas**

Underdeveloped distribution infrastructure and lack of connectivity and adequate power distribution capacity especially in peri-urban and rural areas is a barrier to electrification of some small-scale industrial activities, such as clay brick kilns. This barrier can be overcome by strengthening the power distribution infrastructure in areas where it is currently weak. On the flip side, this is also closely linked to the limited financial capacity as well as the willingness of the entrepreneurs in the unorganised small-scale segment to shift from traditional energy sources to electricity.

### **Non-availability of customised technological solutions/technology in the pre-commercial stage**

For some industrial processes, this study found that electricity-based technologies are either not available commercially (are at pre-commercial stage) or require customisation. This was found to be a barrier to implementation of electric technologies in bricks, brass melting, glass, and tea industry. This barrier can be overcome by undertaking research, development and demonstration (RD&D) initiatives with support from government and in collaboration with key industry stakeholders.

## **Recommendations**

To overcome the above mentioned barriers, a few overarching recommendations are enumerated below:

### **1. Rationalizing of electricity tariffs for industry**

The industrial electricity tariffs in India are quite complex. There is considerable variation in energy charges (Rs/kWh) and demand charges (Rs/kVA/month) across states, and even within the same state, depending upon the utility, category of industry, consumption per

month, supply voltage (LT and HT), and so on. Also, the industrial electricity tariffs are high even when compared to developed economies, like the USA and economies in transition, like China. Rationalisation of the industrial power tariffs will not only accelerate electrification but also improve the ease of doing business in the country.

### **2. Technologies and policies on the use of biomass**

Biomass is carbon neutral as it absorbs CO<sub>2</sub> during growth. Replacing fossil fuel sources with biomass (wood) gasifier for thermal applications was found to be a feasible option for the decarbonisation of the tea processing sector. Apart from tea, there may be several other food processing sectors where the use of biomass gasifiers may be feasible. In general, industry has concerns about gasifier technology, as well as ensuring a sustainable supply of biomass. The switch-over from fossil fuels to biomass technologies can be accelerated in the food processing industry through technology demonstration and ensuring availability/supply of biomass in a sustainable adequate manner.

### **3. Knowledge sharing and technological innovation**

Low awareness of technical and financial aspects of electric technologies and/or its demonstrated track record were identified as key barriers to their dissemination. To accelerate the update of electric technologies among industries, holistic interventions encompassing unit-specific feasibility studies, implementation assistance to SMEs, policy dialogue, knowledge sharing and awareness raising should be undertaken. Barriers related to non-availability of 'off-the-shelf' electric solutions can be addressed by initiatives aimed to promote RD&D of improved electricity-based technologies. Government departments at the central and state levels should provide support for developing and promoting electrification options in SMEs. Multilateral and bilateral development agencies can help in facilitating inter-governmental partnerships, bringing international technical experts and technology providers together under such programmes.

### **4. Availability of finance**

The Government can play a proactive role in electrification efforts through their influence over financial institutions and power utilities. Financial support is especially needed when the initial investment requirements are high and

the payback period unattractive. Intermediaries, such as R&D institutes and technology suppliers, should develop business models which bring together financial institutions, utilities, and industry on a common platform to make access to finance easier.

## 5. Supporting measures for improved electricity connectivity and reliability of supply

If SMEs need to shift towards electricity-based technologies, state governments and DISCOMs will need to work towards ensuring easier electricity connectivity, as well as reliability and quality of power supply (e.g. 24x7 supply, voltage fluctuations) for small industrial users. Electrification of thermal energy processes requires industrial users to greatly enhance their electricity load, which can result in costly and time-consuming infrastructure augmentation. This is particularly true where the electrification option requires change of supply (e.g. LT to HT). Providing access to capital and formulating /schemes that would address these issues from the

perspective of user industries would help accelerate switch to electrification technologies in MSMEs.

Another related issue to be addressed is 'Open Access' (OA). Under the Electricity Act, 2003, one of the key measures introduced to facilitate competition and provide a choice to consumers for purchase of power is the introduction of OA in transmission and distribution. OA enables consumers to bring economy in the procurement of power from suppliers other than the DISCOM in whose license area they are situated. Any industry using more than 1 MW of power can avail of this facility. It was found that DISCOMs are generally not keen to enable this provision as they are worried about losing their high tariff paying consumers to OA, which could have an adverse impact on their financial performance (TERI, 2020c). Enabling the implementation of OA in the spirit of the Electricity Act will help industry users draw electricity at competitive prices and thereby consider shifting from their existing thermal systems to electricity-based solutions.

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## About Shakti Sustainable Energy Foundation (SSEF)

Shakti Sustainable Energy Foundation seeks to facilitate India's transition to a sustainable energy future by aiding the design and implementation of policies in the following areas: clean power, energy efficiency, sustainable urban transport, climate change mitigation, and clean energy finance.

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