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This issue has, as its theme, the ‘MSME Energy Map of India’. As the theme story outlines, the Map is an interactive, easy-to-use tool that enables the visitor to access and explore energy-related knowledge and data on a growing number of MSME clusters representing different industrial sub-sectors across the country. Each cluster featured on the Map can be explored individually, through the layers of information hosted on the website itself and with links provided to other sources/repositories of information that are relevant to the cluster and its stakeholders. The clusters can also be sorted, grouped and depicted on the Map based on broader criteria such as geographical area (state-wise), industrial sub-sector, and so on. Options such as these can provide the visitor with different perspectives on an individual cluster, an industrial sub-sector, and indeed the overall MSME sector. It is hoped that these diverse perspectives will help in conducting studies as well as in formulating and implementing projects and schemes aimed at cluster development. In order to show how clusters belonging to the same industrial sub-sector, but located in diverse geographic areas, can have common as well as unique characteristics, this issue carries the profiles of two rice mill clusters that are hosted on the Map: one in Balasore, Odisha and the other in Red Hills, Tamil Nadu.

As of end-March 2017, the Map incorporates energy related information on 79 MSME clusters, which together consume an estimated 26.5 million tonnes of oil equivalent (Mtoe) annually. This includes the state level energy consumption figures for a few clay-fired brick manufacturing clusters. Given the size and geographical spread of India’s MSME sector, there is enormous scope to further enrich the content and coverage of the Map through the addition of credible, updated information and knowledge products such as cluster analyses, case studies, and so on.

SAMEEEKSHA Secretariat
The ‘MSME Energy Map of India’ takes pride of place among the many knowledge products related to the Indian MSME sector. The Map is an integral component of the SAMEEEKSHA website. It is a dynamic tool that provides data and insights into a host of energy intensive MSME clusters across the country. The Map was conceptualized and developed under the ongoing EESE partnership between SDC and TERI. At present, the Map features 79 MSME clusters on which detailed energy related information and data are available. The MSMEs in these clusters consume a variety of fuels in their production processes. These clusters together consume an estimated 26.5 million tonnes of oil equivalent (Mtoe) annually.

**Salient features**

The Map allows access to useful information on the hosted MSME clusters at a number of levels. Each MSME cluster is assigned a colour code, depending on the industrial sub-sector it represents: e.g., green for food processing, red for foundry & forging, and so on. Suitably colour-coded icons are placed on the map of India, and on the individual state maps concerned, to depict the location of the MSME clusters.

Each icon provides a very brief outline of the cluster concerned (cluster name; products manufactured; number of MSMEs). For visitors desiring to know more about the cluster, the icon...
also offers access to a one-page overview of the cluster, summarizing information such as cluster-level energy consumption, the types of fuels used, technology/process used, leading industry associations at cluster level, and so on. Hyperlinks are provided to enable the visitors to access the main cluster profile report, and wherever possible, to navigate directly to other information/entities relevant to the cluster.

The Map can also be explored with an easy-to-use search engine, based on search criteria such as industrial sub-sector; state; energy consumption (low/medium/high), and organization(s) involved in cluster interventions. A very useful aspect of the Map is that the search tool can be used to depict, for a specific industrial sub-sector, the nation-wide distribution and locations of MSME clusters under that sub-sector, as well as provide access to information on each of the clusters. This gives a holistic view of the sub-sector concerned, highlighting the contrasts as well as common aspects among its various clusters and offering potential for comparative studies, cross-learning among the various clusters, and so on. By way of illustration, this issue carries clusters profiles of two rice mill clusters that were studied under the EESE project: the Red Hills cluster in Tamil Nadu, and the Balasore cluster in Odisha.

Overall, the MSME Energy Map of India is a unique, dynamic knowledge bank that provides, in the public domain, comprehensive and updated data and information pertaining to Indian MSME clusters. The population of clusters on the Map is growing steadily, as TERI continues to collect and collate energy-related data on more MSME clusters. A swift analysis of MSME clusters by TERI, based on information provided by the Ministry of MSME, indicates that there are about 200 energy intensive MSME clusters across the country for which very limited or no information is available on energy front.

It is envisaged that the macro-level information on MSME clusters, made accessible via the Map, will provide vital inputs to the various state and non-state stakeholders that are engaged in overall development of the MSME sector. Technical details such as technologies in use and energy efficiency options can effectively be used by industry and other stakeholders such as local service providers (LSPs) for identifying, developing and implementing appropriate solutions. They will also help policy makers in formulating cluster-specific programs aimed at promoting the adoption of energy efficient technologies and practices.
Background

Odisha is among the important rice-producing states in India. In 2014–15, Odisha contributed over 8.3 million tonnes of rice to the country’s total rice production of 104.8 million tonnes\(^1\). There are over 50 traditional aromatic paddy varieties being grown in different regions of Odisha. The paddy is processed into rice by rice mills, which are located in different parts of the state. The industrial district of Balasore (also known as Baleshwar) hosts a prominent cluster of about 35 small and medium-sized rice mills, of which 25 were operational during the year 2016. Most of the rice mills are located within 50 km of Balasore town. The Balasore rice mills process about 0.18 million tonnes of paddy each year to produce parboiled rice. The Odisha government procures the paddy and supplies it to the rice mills under the ‘Public Distribution Scheme’ (PDS). The government pays the rice mills around 300 rupees per tonne of paddy towards processing charges, and also reimburses transportation costs. The processing charges are based on a yield ratio: that is, the rice mill is paid based on the output of milled rice per 1000 kg of paddy.

The capacity utilization is generally low among the rice mills, at about 50%. The total rice production from the Balasore cluster is estimated at 122,400 tonnes per year (tpy). The important by-products from the rice milling process include husk and bran. The husk is used in-house as fuel for boilers; the bran, which contains about 60% of the nutrients in the rice kernel, is sold for processing into products such as rice bran oil and poultry feed.

<table>
<thead>
<tr>
<th>Paddy processing capacity (tpd*)</th>
<th>Total units</th>
<th>Paddy processed (tpy)</th>
<th>Rice production (tpy)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>21</td>
<td>130345</td>
<td>88634</td>
</tr>
<tr>
<td>100</td>
<td>4</td>
<td>49655</td>
<td>33766</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>180000</td>
<td>122400</td>
</tr>
</tbody>
</table>

\(^*\)tpd—tonnes per day

The following industry associations represent the interests of the Balasore rice millers: (1) All Orissa Rice Millers Association (AORMA); (2) Balasore Rice Millers Association; (3) Balasore Chamber of Industries & Commerce (BCIC); and (4) North Orissa Chamber of Commerce & Industry (NOCCI).

Other important cluster-level stakeholders include District Industries Centre (DIC), Balasore; Central Rice Research Institute (CRRI), Cuttack; MSME Development Institute (MSME-DI), Cuttack; and Odisha University of Agriculture and Technology (OUAT), Bhubaneswar.

The cluster has formed a special purpose vehicle (SPV), registered as ‘Balasore Rice & Rice Bran Cluster’, for the purpose of setting up a Common Facility Centre (CFC) for the production of rice bran oil. Through the SPV, efforts are being made to obtain financial support from the MSME-DI, Cuttack for establishing the required facilities at the CFC.

Technology status and energy use

The processing of paddy into parboiled rice in the Balasore cluster involves four broad stages, with different kinds of equipment used in each stage, as summarized below.

- **Paddy preparation:** Vibrators and blowers are used to remove contaminants such as dust, rice straw, sand, stones, and seedless paddy from the raw paddy.
- **Steaming:** The cleaned paddy is loaded into ‘steaming bowls’. Hot water at about 60–70° C is prepared by mixing steam and water, circulated in the bowls for 20–30 minutes in closed loop, and drained after 10 minutes. Thereafter, steam is directly injected into the bowls: in two stages for full-parboiled rice, or in a single stage for semi-parboiled rice.
- **Drying:** The steamed paddy is dried, either on open floors in sunlight or by indirect heat transfer in a hot air dryer system. In larger units, the hot air for dryer systems is generated by passing steam through a heat exchanger. In smaller units, the hot air is directly generated in wood-fired dryers.
- **Milling:** The milling process involves de-husking
and polishing of rice grain, using blowers and elevators; and separation of the rice grain from husk and bran using separators and conveyors.

In addition to the equipment used in the above processes, the rice mills use utilities such as pumps for hot/cold water pumping, material conveying systems, and air compressors.

**Energy consumption**

The rice mills mainly use thermal energy, which accounts for 82% of total energy consumption in the cluster. Husk is used as fuel in boilers for generating steam and hot water, which are used in the steaming and subsequent drying of paddy. Electricity is drawn from the grid, and from diesel generation sets (in case of power outages), for meeting different motive loads in the processing sections, water pumping and blowers. The total annual cluster-level energy consumption is about 11,327 toe.

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Annual energy consumption</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Units</td>
<td>toe</td>
</tr>
<tr>
<td>Husk/wood</td>
<td>31050 tonnes</td>
<td>9315</td>
</tr>
<tr>
<td>Electricity (grid)</td>
<td>13 million kWh</td>
<td>1115</td>
</tr>
<tr>
<td>Diesel (for DG sets)</td>
<td>1044 kiloliters</td>
<td>897</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>11327</td>
</tr>
</tbody>
</table>

**Potential options for energy saving**

The following energy saving measures can bring benefits to the rice mills in Balasore.

**Economiser and condensate recovery system for boilers**

None of the boilers used by the rice mills have waste heat recovery (WHR) systems. All the units can benefit by fitting their boilers with WHR systems (economisers) so as to recover and reuse heat from flue gases to preheat boiler feedwater to 90°C. Adoption of this measure by all the rice mills would save 3105 tpy of rice husk (equivalent to 932 toe), with a monetary value of 3.7 million rupees.

**Solar water heater**

The rice mills require hot water, at about 60–70°C, for steaming the paddy. Solar water heaters can be installed to generate hot water, which can be used for steaming paddy, and also as boiler feedwater—thereby reducing husk consumption. Boiler efficiency is expected to improve by 6%. The estimated energy saving potential through adoption of solar water heater is 2450 tpy of rice husk (equivalent to 735 toe), with a monetary value of 2.94 million rupees.

**Other options**

In addition to the above, short term energy saving measures include insulation of steam pipes, hot water pipes, and other hot surfaces; and steam traps for removal of condensate from steam distribution lines. In the medium term, significant energy savings can be achieved through the following measures: combustion control in boiler; enhanced recycling of hot water drained from steaming bowl; improvement of condensate and waste heat recovery from dryer; replacement of mild steel buckets with plastic buckets in elevator system; use of energy-efficient motors in different drives; and switch to energy-efficient lighting. Long term energy saving options include replacement of existing boiler with energy-efficient boiler; and using surplus husk from boiler as fuel in biomass gasifier-based system for captive power generation (thereby saving diesel).
Background

Tamil Nadu is an important rice-producing state in India. In 2014–15, Tamil Nadu contributed 5.8 million tonnes of rice to India’s overall rice production of 104.8 million tonnes (about 5.5%). There are a number of rice mill clusters that process the paddy into rice. One of the prominent clusters of rice milling units in Tamil Nadu is Red Hills, a town to the north-west of Chennai in Thiruvallur district. The cluster has about 200 small and medium-sized rice mills, of which only about 100 were operational during the year 2016.

The rice mill units in Red Hills cluster process about 429,000 tonnes per year (tpy) of paddy, producing about 279,000 tpy of rice. This includes 191,000 tonnes of parboiled rice (69%) and 88,000 tonnes of raw rice (31%). Around 70 of the operating mills in the cluster produce only parboiled rice. The remaining 30 mills are ‘hulling’ units that produce only raw rice, which is procured by the state government of Tamil Nadu for the ‘public distribution system’ (PDS). The paddy processing capacity of parboiled rice mills varies between 10–20 tonnes per day (tpd); the average processing capacity of hulling units is about 50 tpd. Husk and bran are important by-products of the rice milling process. The husk is used in-house as fuel for boilers, while the bran, which is rich in protein, is sold for further processing into rice bran oil and other products.

There are two active industry associations in the cluster: (1) Red Hills Rice Millers, and (2) Paddy and Rice Merchants’ Association. The industry associations are keenly interested in technology upgradation of rice mills, including the use of renewable energy-based options such as solar water heaters and biomass gasifier systems. Other important cluster-level stakeholders are MSME-Development Institute (DI), Thiruvallur and the District Industries Centre (DIC), Thiruvallur.

Technology status and energy use

The processing of paddy into parboiled rice involves a number of stages: paddy cleaning, soaking/draining/wetting, steaming, drying, and milling (see flow chart). Boilers are used to generate steam

<table>
<thead>
<tr>
<th>Profile of rice mill units in Red Hills cluster (2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Category</strong></td>
</tr>
<tr>
<td>Parboiled rice - medium</td>
</tr>
<tr>
<td>Parboiled rice - small</td>
</tr>
<tr>
<td>Hulling (raw rice)</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

required for the parboiling process. The steam is used for two main purposes: (1) direct injection into ‘steaming bowls’ filled with soaked paddy; and (2) drying the wet paddy after steaming, by generating hot air in heat exchangers. In raw rice production, there is no need for soaking or steaming: the paddy is cleaned and sent directly for milling.

**Energy consumption**

The Red Hills cluster meets its energy needs from two main sources: husk and electricity. Husk is primarily used as fuel for boilers in parboiled rice units. The burning of husk generates significant levels of particulate emissions, which are controlled with the use of pollution control systems such as cyclone separators. A few units have also switched over to wood as fuel in order to address environmental concerns in the cluster regarding particulate emissions. Electricity from grid is used for different motive loads in the processing sections, water pumping, and operating blowers.

Typically, in-house generated husk provides about 85–90% of the total energy needs in a parboiled rice unit; only about 10–15% is met through electricity. Since the hulling units do not require steam, these units use only electricity for husk removal and polishing activities. Based on present levels of capacity utilization and energy use, the overall annual energy consumption of Red Hills rice mill cluster is estimated at about 19,118 tonnes of oil equivalent (toe).

However, condensate from the drying process is usually recovered and sent as feedwater for boilers, thereby achieving a sub-optimal degree of heat recovery.

**Potential options for energy saving**

There are a number of energy saving options specific to the rice mill cluster of Red Hills. For most of these options, the simple payback period on investment is estimated at one year or less, making them attractive for adoption by the rice mills.

**Economiser and condensate recovery system for boilers**

In the absence of WHR systems in boilers, the useful heat in flue gases is being wasted. Most of the units recover condensate from process steam (mainly from the drying section) for use as feedwater for the boilers; but because of inefficient design and layout of pipes, drains, etc., most of the sensible heat in the condensate is lost during recovery. By equipping the boilers with economisers, the waste heat can be recovered from flue gases and utilized for preheating feedwater up to 90° C. The use of an economiser, along with improved condensate recovery, can yield about 10% saving in fuel. About 75 units in the cluster can benefit by adopting this energy saving measure. The overall fuel saving at cluster level is estimated at 5500 tonnes per year (tpy) of husk (= 1650 toe), with a monetary value of 11 million rupees.

**Hot air generator for paddy drying**

Currently, the hot air used by dryers to dry steamed paddy is generated by passing steam through heat exchangers—an inefficient process. Instead, hot air can be generated directly in husk-fired hot air generators (HAG) with heat exchangers. Husk consumption can be reduced by about 30% with HAG systems, equivalent to about 250 tpy per unit. With steam no longer required for paddy drying, the steam load of the plant will be greatly reduced. A boiler of about 1 tph capacity can provide the steam needed for parboiling. The investment required is 0.55 million rupees per HAG system with a simple payback period of about one year.

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**Cluster-level energy consumption**

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Annual energy consumption</th>
<th>Share</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Units</td>
<td>toe</td>
</tr>
<tr>
<td>Husk/wood</td>
<td>54,990 tonnes</td>
<td>16,497</td>
</tr>
<tr>
<td>Electricity</td>
<td>30.5 million kWh</td>
<td>2,621</td>
</tr>
<tr>
<td>Total</td>
<td>19,118</td>
<td>100</td>
</tr>
</tbody>
</table>
Optimization of air supply and reduction of unburnts in boilers

Most of the boilers do not have control systems to monitor and regulate combustion air supply with respect to husk feed rates. As a result, the level of ‘unburnts’ (unburned husk) in bottom ash is quite high, and the flue gases contain black smoke. The rice mills in the cluster may install automatic/semi-automatic control systems in boilers for optimizing air supply with respect to husk feed rates, and also undertake regular monitoring of flue gases to check and optimize the level of excess air supplied to boiler. The estimated husk saving is about 5%, equivalent to 60 tpy per unit. The investment requirement is about 0.07 million rupees with a simple payback period of about 7 months.

Solar water heater

In both small and medium-sized rice mills in the cluster, there is significant scope for the adoption of solar water heaters that can be used for generation of hot water at about 60–70°C. The hot water can be used for soaking of paddy in steam bowls, and also as boiler feedwater—thereby helping save fuel. The overall energy saving potential is estimated at 700 tpy of husk (equivalent to 220 toe) equivalent to a monetary saving of 1.5 million rupees.

Other options for energy saving

In addition to the above energy saving measures, there is potential for units to achieve significant reductions in energy losses in areas such as steam distribution including insulation and steam traps, steaming bowl, and paddy dryer. Also, there is scope for recycling/reuse of water from different processes, and for using surplus husk as fuel in biomass gasifier-based systems for captive power generation. On the electrical side, there is scope for improving the energy efficiency of utilities such as compressed air systems and water pumps. The use of instrumentation to monitor and control operating parameters in different process areas will further enhance the overall efficiency of units.