Biomass Gasifiers in India’s Micro, Small and Medium Enterprises (MSME) and Rural Electricity Access: Experiences and Opportunities

ECONOMIC SUSTAINABILITY: Increasing energy security and energy access

3rd Bioenergy Week
Indonesia, Medan (Sumatera)
25-29 May 2015

Sunil Dhingra
Senior Fellow
The Energy and Resources Institute TERI
• Overall Context

• Biomass energy in India

• Development of biomass gasifier – TERI’s experience

• Biomass Gasifier for
  – Thermal applications in MSMEs
  – Electricity generation in rural areas

• Key Highlights and Achievements
IPCC 5th report

- Bioenergy to play significant role in carbon mitigation
- Potential to cover a larger share of the world’s energy consumption than today:
  - Growth from 12% today to 20% in 2030
  - Requires more energy effective technologies, especially in the 3rd world.
- By 2100 growth up to 40-60% if BioCCS (BECCS) is included and new technologies are applied
- Important energy source for the 3rd world – an opportunity to skip the oil-era
India’s Industrial sector - mix of large energy intensive industries and Micro, Small and Medium Enterprises (MSMEs) units

MSME sector includes approximately **36.2 million enterprises** spread over 180 clusters

Energy context:
- **Approx 50% of total commercial energy use**
- **Energy costs accounts for 30 – 50% of overall production cost**
- **Widespread use of locally available cheaper fuels**
  - Rural MSMEs - fuel wood/biomass energy
  - Urban MSMEs – coal, coke and other fossil fuels

About 42,000 villages (7%) in the country still remain un-electrified.

Nearly 33% of rural households mainly in rural India are without electricity access (Census 2011)

Providing clean affordable energy through local sources is important for achieving low carbon growth path and meeting energy security
Biomass Energy in India

- **Biomass energy** an important **renewable energy resource** for India

- **150 million tonnes** per annum of **surplus biomass** is generated from different sources

- **Gasification technology** a viable alternative for efficient utilisation of surplus biomass

- **Biomass energy** is fast emerging as a potential for meeting **India’s energy security** and for its **low-carbon development path**
Development of Biomass Gasifiers - TERI’s Experience

1994-1996: Biomass energy journey begins
- Silk Reeling in Karnataka

1997-2000: Technology development & demonstration
- Textile Dyeing, Rubber, Puffed Rice
- Lead recovery, Namkeen & Khoya, Bakeries, Mid-day meal cooking, Candle making
- In 2002 foray into decentralised power generation for rural electrification

2001-2004: Technology Replications
- Replications and awareness through Local Service Providers
- New sectors – Powder Coating, Foundry (Sand drying), Non-ferrous melting furnace (aluminum, lead), Chemical industries
- In 2002 foray into decentralised power generation for rural electrification

2005-2011: Mainstreaming in MSMEs
- Replications and awareness through Local Service Providers
- New sectors – Powder Coating, Foundry (Sand drying), Non-ferrous melting furnace (aluminum, lead), Chemical industries
- Testing of small power gasifier in 7 villages
- Development of advanced 2-stage gasifiers

2013-2015: Accelerated diffusion in MSMES
- Scaling-up diffusion and expanding network of local delivery mechanism in new industrial cluster
- Technology automation of thermal gasifiers
- Implementation of 2-stage gasifier in four villages
Comparative energy cost with different fuel types (50000 kcal/h)

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Cost Rs/unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>6.5</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>55</td>
</tr>
<tr>
<td>LPG</td>
<td>75</td>
</tr>
<tr>
<td>FO</td>
<td>52</td>
</tr>
<tr>
<td>Diesel</td>
<td>62.5</td>
</tr>
<tr>
<td>Lignite</td>
<td>5</td>
</tr>
<tr>
<td>Wood</td>
<td>4</td>
</tr>
<tr>
<td>Briquettes</td>
<td>5</td>
</tr>
<tr>
<td>Hard coal</td>
<td>8</td>
</tr>
</tbody>
</table>

### Comparative useful energy cost in Rs for 50000 kcal/h

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Cost Rs/unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer gas</td>
<td>125.00</td>
</tr>
<tr>
<td>Hard coal</td>
<td>333.33</td>
</tr>
<tr>
<td>Briquettes</td>
<td>416.67</td>
</tr>
<tr>
<td>Wood</td>
<td>370.37</td>
</tr>
<tr>
<td>Lignite</td>
<td>238.10</td>
</tr>
<tr>
<td>Diesel</td>
<td>486.76</td>
</tr>
<tr>
<td>FO</td>
<td>552.90</td>
</tr>
<tr>
<td>LPG</td>
<td>578.70</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>350.77</td>
</tr>
<tr>
<td>Electricity</td>
<td>419.90</td>
</tr>
</tbody>
</table>
650+ thermal gasifiers installed in different MSME sector across country

- **Replications** have established biomass gasifiers as a **cost-effective energy delivery system**
- Generated **positive spin-off effects** within and across clusters
- **Local manufacturing** and services creating clean energy entrepreneurs and employment
Lessons from Dissemination

Economically Attractive

- Pay back period: 6 months (fossil fuel) to 2 years (biomass)
- Reduction in cost per unit of useful energy through gasification: 60-80% reduction (fossil fuels); 50% reduction (biomass fuels)
- Improved productivity and quality of end products due to better process/heat control

Cleaner Production

- Enforcement of environmental and pollution norms in MSME sector acting as driver for shift towards clean technologies/processes
Huge Untapped Potential

- Biomass gasifier systems can meet thermal energy capacity needs
  - 25 kWth - 3 MWth
  - Temperature requirements of 60°C – 1000°C
- Potential in MSME units such as:
  - Silk reeling, Textile dyeing, Hot water/steam generators
  - Food Processing
  - Non-Ferrous metal (Aluminum and Lead recycling), Powder Coating, Chemicals, Foundries (allied operations), Glass melting
  - Charcoal making, Brick making
  - Ceramics
Continuing Challenges

- Needs **customised/tailor-made system design** for each end-use application; impedes scaling-up

- **Supportive services** – local manufacturing and supply, maintenance, finance, skilled human resources – remain weak

- Sustainable biomass fuel **supply linkages** and local delivery mechanisms requires strengthening

- **Information failure** and slow pace of **technology up gradation** (system automation) resulting in limited scale-up
• Rural electricity demand could be broken into 4 broad categories:
  (a) Basic household electricity needs (lights, fans, mobile charging)
  (b) Household electricity use for lifestyle i.e. refrigeration, TV etc, ..
  (c) Electricity needs for pico enterprises i.e. charging station (lighting, phone charging), refrigeration, IT services (internet, photocopying)
  (d) Electricity needs for micro enterprises i.e. water pumping, flour/oil mills, weaving, metal work (welding), carpentry, milling, cold storage, ice making, telecom operation, and other economical activities

• It would be technically and economically viable to use solar PV to provide categories (a) and (c); biomass based energy solutions are most viable for categories (b) and (d).
Biomass Gasifier based Mini Grids for rural areas

- Biomass based power plants that uses rice husks/agricultural residues and forestry residues
- Biomass gasifier based Small capacity power plants system coupled with producer gas engine
- Local mini-grids to supply electricity with distribution network spread over a few kms
- Serves households, community and commercial loads for 6-8 hours daily
- Investment cost per kW is low compared to SPV system
• Development of two-stage biomass gasifier system in collaboration with DTU, Denmark, Effin Art Switzerland and NTPC, Ltd

• A two stage gasifier design developed based on Danish Technical University (DTU) and TERI technologies

• The system is being implemented in villages of State of Odisha and Jharkhand
# Key Performance Indicators

**Key parameters** | **Fixed bed gasifier** | **Two stage gasifier**
--- | --- | ---
**Resource Use Efficiency** | | |
**SFC** | 1.2 kg/kWh | 1 kg/kWh |
**Input fuel moisture** | up to 15% | up to 30% |

**Environmental Benefits**

<table>
<thead>
<tr>
<th><strong>Tar (Raw gas)</strong></th>
<th>500-600 mg/Nm³</th>
<th>Less than 25 mg/Nm³</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas cooling and cleaning system</strong></td>
<td>Water scrubbing - 350 litre of fresh water for 50 hours of operation</td>
<td>Without water scrubbing</td>
</tr>
<tr>
<td><strong>Waste water generation</strong></td>
<td>350 litre after 50 hours of operation</td>
<td>No waste water generation</td>
</tr>
</tbody>
</table>
Potential Clusters

- Deoghar
  - Lift Irrigation

- Sidhi
  - Poultry Feed Making

- Balaghat & Harda
  - Bamboo Furniture

- Chhindwara
  - Agro Processing

- Koraput
  - Cashew Processing

- Rayagada
  - Nutrimix Making

- Puri
  - Nutrimix Making, Jute Products
Village Implementation

**Approach**

TERI identified livelihood clusters in villages to sustain the economics of two-stage gasifier.

Villages around the cluster were selected for household electrification.

**Implementation Model**
Two-stage biomass gasifier would run micro-enterprises during day time and electrify households during evening time.

**Institutional Model**
Partner with local NGOs for overall facilitation and social mobilization. Partner with SHG Federation for administration and management of gasifier.

**Revenue Sustainability**
Revenue generation share:
- Micro-enterprise 90%
- Households 10%
Gasifier operational cost can be met without payment by households.
Rayagada District - *Chhatua* (Nutrimix) Making

- Anganwadi provides this dry nutrition mix (*chhatua*) to pregnant/lactating women and children

- This comes under Integrated Child Development Services of the Women and Child Department
### Key Highlights of Project in Rayagada

<table>
<thead>
<tr>
<th>Villages</th>
<th>Papudambu and Karli, Bissamcuttack Block, Rayagada District</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of Households</strong></td>
<td>116</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>438 (Males: 193, Females: 248)</td>
</tr>
<tr>
<td><strong>Local Partner NGO</strong></td>
<td>AKSSUS - Adivasi Krushi Swasthaya Sikhya Unnayan Sakiti</td>
</tr>
<tr>
<td><strong>SHG Federation</strong></td>
<td>MDMMS – Maa Dharni Mahila Maha Sangha</td>
</tr>
<tr>
<td><strong>Electrification of</strong></td>
<td>116 households, 1 school, 1 Anganwadi Centre and streetlighting</td>
</tr>
<tr>
<td><strong>Livelihood Activity</strong></td>
<td>Nutrition mix Making for Pregnant Women &amp; Children – For Anganwadi</td>
</tr>
<tr>
<td><strong>Current Electrification Status</strong></td>
<td>Electricity supply – less than 5 hours/day and very low voltage</td>
</tr>
<tr>
<td><strong>Proposed Size</strong></td>
<td>30 kW</td>
</tr>
<tr>
<td><strong>Distribution Distance</strong></td>
<td>2 km</td>
</tr>
<tr>
<td><strong>Domestic Load and Tariff</strong></td>
<td>16 kW (120 W per household) at Rs. 1.8/unit</td>
</tr>
<tr>
<td><strong>Livelihood Load</strong></td>
<td>17 kW at Rs. 5.4/unit</td>
</tr>
<tr>
<td><strong>DDG Model</strong></td>
<td>A 30 kW two-stage biomass gasifier designed by TERI and DTU to supply power for 8 hours during the day for livelihood activities (9am-5pm), and 5 hours in the evening to households through the existing grid network at 440V</td>
</tr>
<tr>
<td><strong>Project Cost</strong></td>
<td>Rs. 55.5 lakhs</td>
</tr>
</tbody>
</table>
The livelihood activity will include:

- Cashew Processing
- Dal Processing
- Tumeric Processing
## Key Highlights of Project in Koraput

<table>
<thead>
<tr>
<th>Villages</th>
<th>Bilaput, Nuaput and Patraput, Nandapur Block, Koraput District</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of Households</strong></td>
<td>85</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>338 (Males: 147, Females: 191)</td>
</tr>
<tr>
<td><strong>Local Partner NGO</strong></td>
<td>SPREAD – Society for Promotion of Rural Education &amp; Development</td>
</tr>
<tr>
<td><strong>Electrification of</strong></td>
<td>85 households, 2 schools, 1 hostel, 2 Anganwadi Centres and streetlighting</td>
</tr>
<tr>
<td><strong>Livelihood Activity</strong></td>
<td>Cashew, Dal and Tumeric Processing</td>
</tr>
<tr>
<td><strong>Current Electrification Status</strong></td>
<td>Electricity supply – less than 3 hours/day and very low voltage</td>
</tr>
<tr>
<td><strong>Proposed Size</strong></td>
<td>25 kW</td>
</tr>
<tr>
<td><strong>Distribution Distance</strong></td>
<td>2 km</td>
</tr>
<tr>
<td><strong>Domestic Load and Tariff</strong></td>
<td>13 kW (120 W per household) at Rs. 1.8/unit</td>
</tr>
<tr>
<td><strong>Livelihood Load</strong></td>
<td>17 kW at Rs. 5.4/unit</td>
</tr>
<tr>
<td><strong>DDG Model</strong></td>
<td>A 25 kW two-stage biomass gasifier to supply power for 8 hours during the day for livelihood activities, and 5 hours in the evening to households through the existing grid network at 440V</td>
</tr>
<tr>
<td><strong>Project Cost</strong></td>
<td>Rs. 50.5 lakhs</td>
</tr>
</tbody>
</table>
Thank You for Your Kind Attention

For further information, please contact:
dhingras@teri.res.in