



# Biomass gasification in India (Technology, potential, key challenge and future needs)

**Webinar by IEA Bioenergy Task 33  
Gasification of biomass and waste**



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# Overview of Biomass Gasification in India

## ❖ Biomass Feedstock supply side

- Agriculture Waste (agro-residues, agro-industrial wastes)
- 683 MT from eleven major crops and about 178 MT is surplus quantity
- Large quantity of agro-industrial wastes like rice husk, bagasse and husks are generated
- India generates daily 188,500 tonnes of MSW (Municipal Solid Waste) - 68.8 million tonnes per year



## ❖ Gasification

- India emerging as technology leader worldwide in fixed bed gasification for heat and power applications
- Exports to over 40 countries in all continents.
- Wide range of outputs from a few kilowatts to a few megawatts.



## ❖ Drivers

- To reduce dependence on energy import
- To achieve goal of low -C clean energy pathways
- Policies and incentive system

Advanced biomass gasification process/technology offer big opportunity to convert these waste materials into useful form

# Brief history of biomass gasification in India

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- In India, Biomass Gasification research commenced in 1980's
- Leading R&D/academic institutes (IISc, IITs, TERI .. ) involved in design, development of biomass gasifier technology/system
- Initial years, emphasis was on replace diesel based agriculture pump sets and small scale systems for rural electrification needs
- Expanded the technology for sub-MW scale capacity for grid application and industrial thermal applications
- Gasifier system on biomass fuels such as rice husk, arhar stalks, cotton stalks, wood chips etc. to producer gas successfully developed indigenously.
- More than 15 leading manufacturers in India
- Power range 10 – 2000 kWe and thermal gasifier with 25 kWth-5MWth successfully deployed
- Developed indigenous engines for producer gas operation

# Types of Gasifiers

## ❖ Fixed-bed gasifiers

- downdraft gasifier
- open top gasifier
- Up draft gasifier
- staged gasifier (Two stage gasifier)

Commercial scale

## ❖ Fluid-bed gasifier

- Circulating fluid bed gasifier
- LT-CFB gasifier
- Plasma gasification

Lab scale design

Highly robust, efficient and flexible thermal and power generation from gasification of biomass developed

# Market Segments

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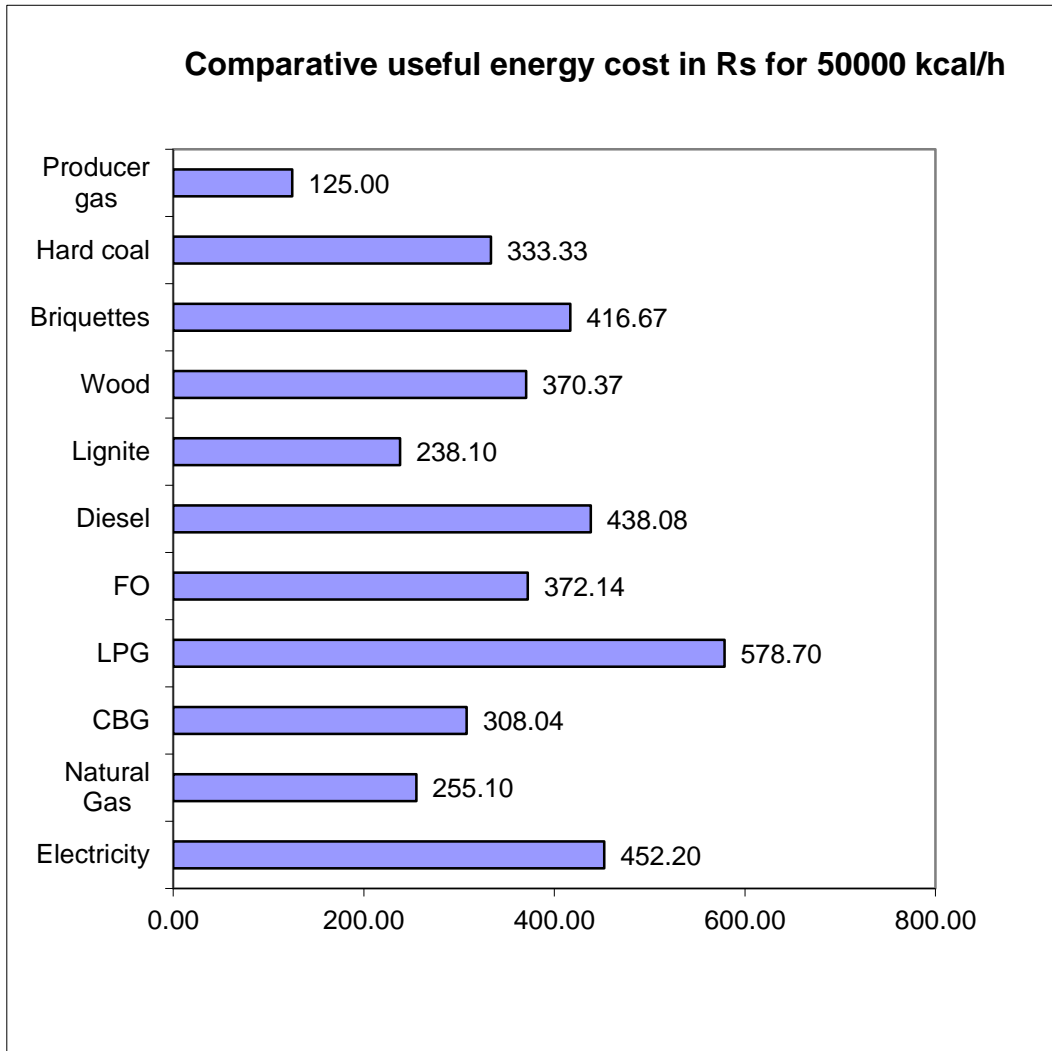
## ❖ Power Gasifier

- Rural Mini Grids (10-40 kWe)
- Captive/Grid applications (50-2000 kWe)
- Economical attractive when diesel is replaced.
- On grid, cost of electricity from biomass gasifier power plants ranged between Rs 6-8/kWh

## ❖ Thermal Gasifier

- biomass gasifier based packages developed
- Capacity range – 25 kWth to 5 MWth
- The replications of thermal gasifier in various MSME have clearly established the gasifier technology as a **cost effective** energy delivery system.

# Comparative energy cost with different fuel types (50000 kcal/h)



Fuel Type	Cost (Rs/unit)
Electricity	7.0
Natural Gas	40
LPG	75
CBG	48
FO	35
Diesel	75
Lignite	5
Wood	4
Briquettes	5
Hard coal	8

**1 USD = IRs 73**

# Thermal Gasifier : Lessons from Dissemination

## ❖ 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:

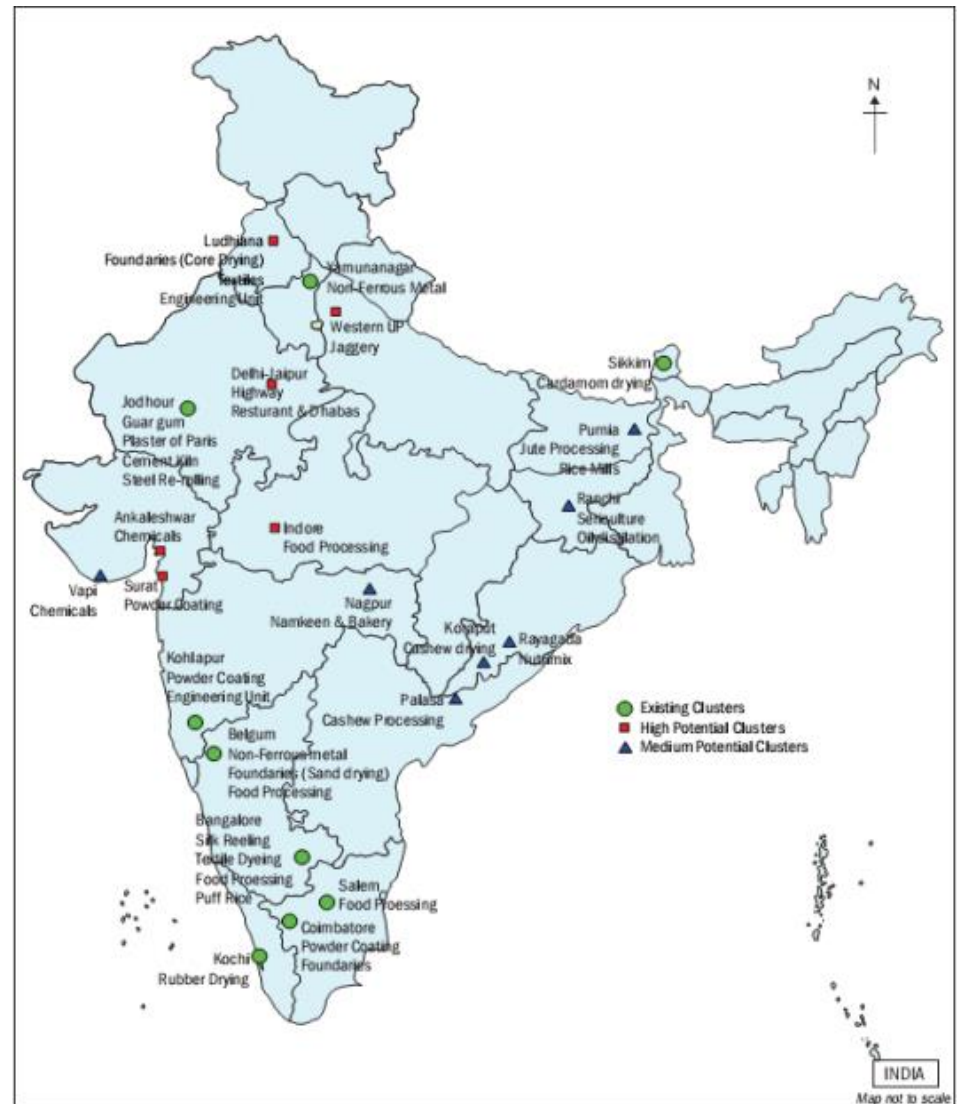
- Silk reeling, Textile dyeing, Hot water/steam generators
- Food Processing
- Non-Ferrous metal (Aluminum and Lead recycling), Powder Coating, Chemicals, Foundries (allied operations), Glass melting
- Charcoal making, Brick making
- Ceramics





# Key Highlights : Thermal gasifiers in MSME sector

- ❖ 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

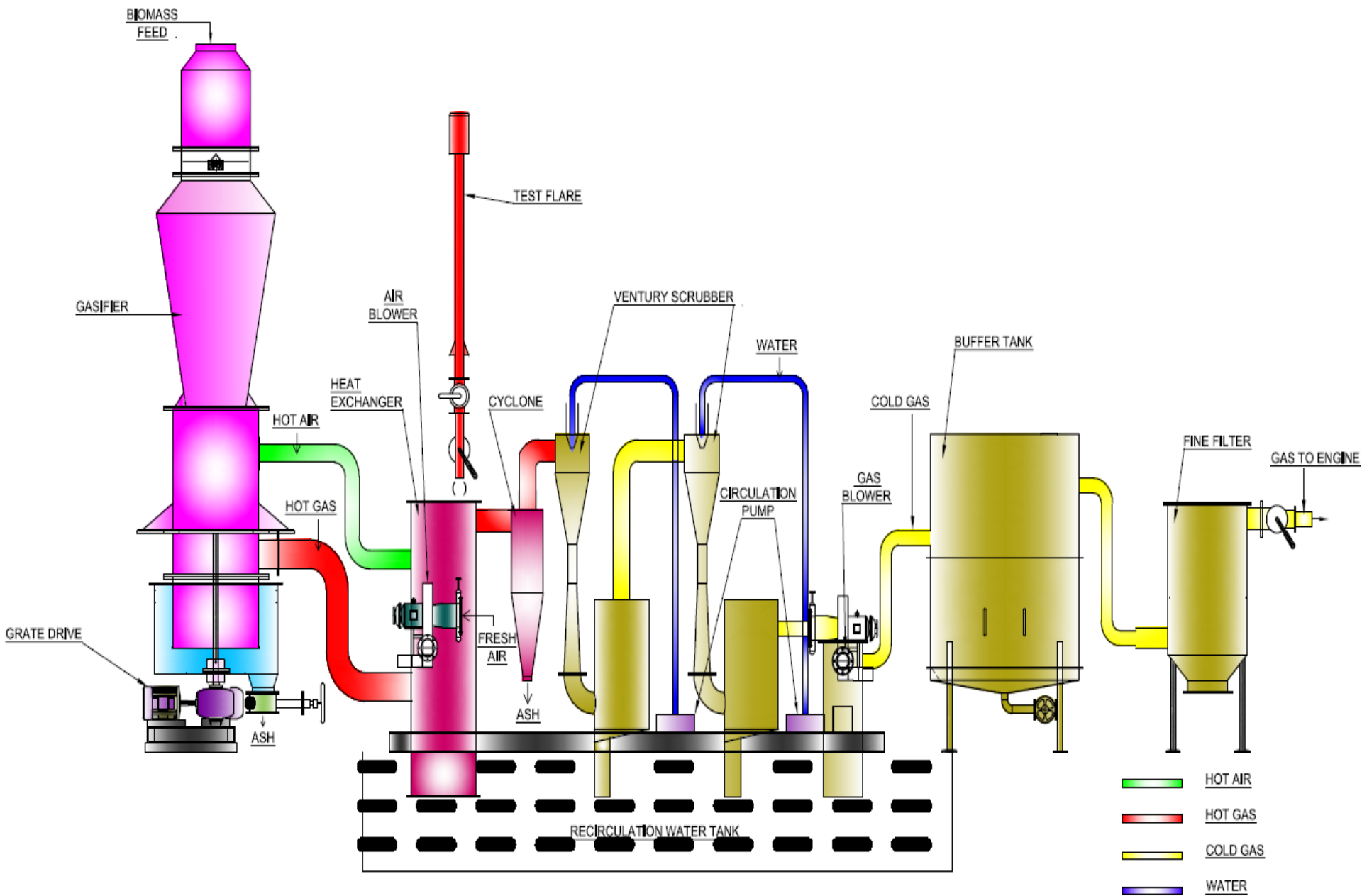


# Biomass Gasifier based cold storage system with focus on agricultural value chain



- ❖ Biomass gasifier coupled with GreenCHILL system
- ❖ 15 to 30 Ton Cold storage, pre-cooler or 1500 liter milk chiller
- ❖ Cool to  $-5^{\circ}\text{C}$
- ❖ Humidity control
- ❖ Automatic operation
- ❖ 10.5 KW (3 RT) Cooling capacity for storage at  $4^{\circ}\text{C}$ , 14 KW (3 RT) for storage

***This type of system helps farmers to store their agriculture produces***



# Key Technology Specifications/Features

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- ❖ Dowlndraft gasifier design
- ❖ Wet ESP has been developed for ultra pure gas (Tar content  $<5$  mg/Nm<sup>3</sup>)
- ❖ Dry ash handling system
- ❖ Fully automatic PLC system
- ❖ Meet the gas quality requirements of all leading engine manufacturer's
- ❖ Got CE marking for our gasifier

# 1 MWe biomass gasifier grid connected system



# Key Highlights

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- Multi-feed gasifier system successful operated on loose biomass, wood chips and RDF extracted from MSW
  - SFC : 1.1 kg/kWh
  - Tar content : < 15 mg/Nm<sup>3</sup>
  - Water consumption : about 0.6 l/kWh
- Successfully operated >7000 h annually in field operation
- Synchronized for feeding the generated electricity with grid
  - SCADA system and PLC control

# 480 KW power based gasifier installed at Guyana, South America



Rice husk based gasifier for power generation;

*Energy Consumption and cost (before gasifier project) :*

Electricity and Diesel bill

Total Energy cost per annum : G\$ 33. 2 million

*After Installation of gasifier (dual fuel fired)*

O & M Gasifier : G\$ 2 million per annum

Diesel:  
annum : G\$ 2.3 million per

Total Energy cost : G\$ 4.3 million per  
annum

**Energy cost saving potential : G \$ 28.9 million per  
annum**

**Investment cost (Budgetary) : G \$ 30 million**

**Pay back period : ~ 1 year**

# Two-Stage Biomass Power Gasifier



**TERI's Power Gasifier**



**Viking Gasifier  
(Danish Technical University)**



**Two-stage biomass power gasifier**



# Design & Development of Biomass –Solar Electricity and Cooling Solutions for Rural India



**This project supported by DST, GoI under Mission Innovation – off-grid challenge**

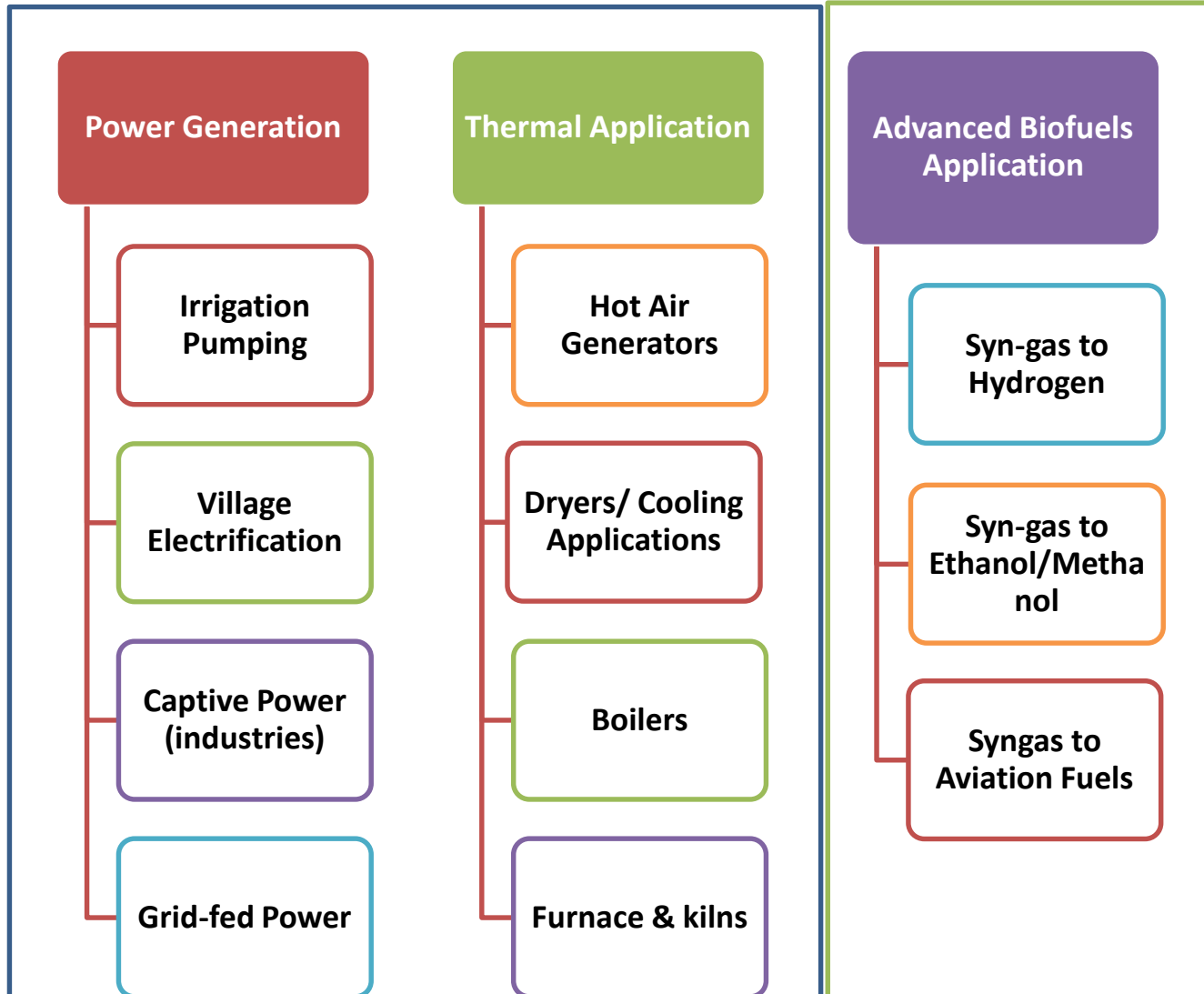
# Demonstration Set Up at TERI Gram



# Recent Development and Focus

- ❖ Supporting R&D aimed at:
  - Reducing costs
  - increasing reliability
  - Dry gas cleaning system
  - Developing new options
    - Solar and biomass hybrids
    - Appliances e.g. cold storage
  - Tri-generation system heat, power and fertilizer/soil enhancer
  
- ❖ biomass gasification for production of hydrogen
  
- ❖ RDF based gasification system for power generation.
  
- ❖ Zero Liquid Discharge and Reduced waster requirement.
  
- ❖ Syngas to Ethanol production through gas fermentation route
  
- ❖ Catalytic Gasification coal/Biomass into Green Hydrogen, Syn-gas to Methanol/Ethanol production

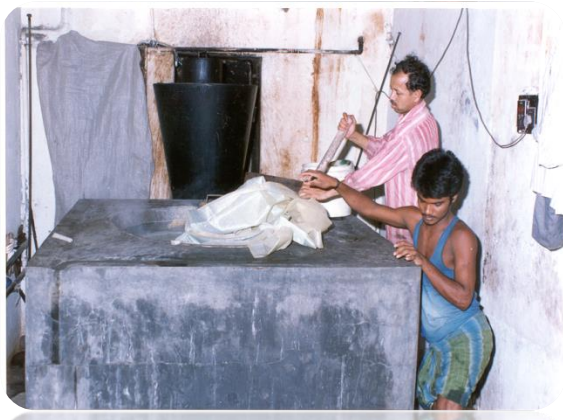
# Biomass Gasification: Experience and Future



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# **Gasification Projects – A Glimpse**

# Gasifier applications in MSMEs





**Biomass Gasifier for electricity production**



**Bamboo Handicrafts**



**Bamboo processing machines**

# Village electrification through biomass gasifier systems



Street lighting





# International Installations





# Thank You