

DECENTRALISED POWER
THROUGH BIOMASS GASIFICATION –
TECHNOLOGY STATUS,
RECENT EXPERIENCES
AND FUTURE PROSPECTS

Presentation by:

Subir Nathak
Team Leader,
Sustainable Energy Program
SEU-UNDP

BIOMASS AS FUEL

- **Age-old and most widely used fuel source**
- **Probably the largest single contributor in terms of primary energy content**
- **Users even today include a large number of industries and institutions. Plantations, Bakeries, Brick and Lime Kilns, Textile Units etc. are just a few examples. Major institutional application is cooking, not only in rural areas but even in a majority of the towns**
- **Annual consumption for these categories is estimated to be of the order of 2 million tonnes or more**
- **And, with traditional technologies, utilization efficiencies are poor, process control is inadequate and health & environmental hazards are numerous**

BIOMASS AS A RENEWABLE RESOURCE – KEY ADVANTAGES

- **Inherent & inexpensive storage in stark contrast to Solar Radiation and Wind**
- **Availability on demand/round-the-clock; hence ideal for captive power generation**
- **High capacity factor; self-contained system (without the need for a back-up)**
- **Wide Range of Conversion Technologies with an ability to produce Electricity, Thermal Energy as well as High Quality Fuels**
- **Low Capital Investments even for Power Generation**
- **Low cost of power generation (TK..2.50 to Rs.3.00 per kWh)**
- **Wide range of power ratings (3 kW to 5000 kW or higher) with high conversion efficiencies**

WHY GASIFICATION ?

- **Converts a traditional, low quality fuel to a modern day energy carrier i.e. combustible gas**
- **Such conversion occurs at relatively high efficiencies and results in total convenience and process control**
- **The process can be applied over a very wide range of output ratings (a few kilowatts to tens of megawatts) with only a small variation in overall efficiency and investment**
- **The process is equally applicable for electricity generation and a variety of thermal applications (be it driers, ovens, furnaces, boilers etc.)**

WHY GASIFICATION ?

(Contd..)

- **Coupled with local availability of biomass, it provides for a truly distributed energy/power system at various output levels**
- **The process is equally applicable for stand-alone utility and grid feeding**
- **Almost all environmental pollution associated with biomass use can be eliminated**
- **Both initial investment as also the cost of energy/power production are just about the lowest amongst all known alternatives**

BIOMASS GASIFICATION – RANGE OF APPLICATIONS

- **Thermal Applications**
- **Simultaneous Charcoal and Power Production**
- **Irrigation Pumping**
- **Pumpset Energisation/Village Electrification**
- **Captive Power for Specific Industries**
- **Grid-fed Power from Energy Plantations on Wastelands**

REQUIRED HARDWARE & SERVICES

- **Gasifiers with individual units being capable of supporting power generation at upto 500-800 kWe level; larger outputs with paralleling of more than one unit**
- **Complete power generation systems including gasifiers, gensets, fuel handling sub-systems and grid paralleling sub-systems, as needed and effluent treatment.**
- **Services to cover**
 - ✚ **Operating Supervision**
 - ✚ **Supervision of Operation and Maintenance**
 - ✚ **Complete turnkey operation and maintenance contracts with biomass supplies and power purchase by the client**

COMMERCIALISING BIO-ENERGY – SOME CONSTRAINTS

- **Diverse Biomass Resources and possible biomass-specificity of technologies and devices**
- **Low energy density and large bulk**
- **Seasonality, particularly in case of agricultural residues**
- **Localized price sensitivity due to relatively high cost of transportation; associated vulnerability of Bio-Energy projects**
- **Perception of “Bio-Resources” as traditional (low-tech) fuels**

WHERE ARE WE NOW?

- **Gasifier Technology is relatively well-established now (though there are areas for further improvement)**
- **Engine interface still poses a few challenges in terms of modifications needed and involvement of engine manufacturers**
- **Heightened customer interest due to attractive potential savings**
- **Hesitation as capital investment is involved and past track record is not very flattering**
- **Attractive near term possibilities for wider promotion and use through**
 - ✚ **Convenient cost sharing**
 - ✚ **Easy, soft financing**
 - ✚ **BOT projects**

BIOMASS GASIFIER INSTALLATION FOR CO₂ PRODUCTION

A Gasifier has been operating at M/s Mahabhadra Industrial Gases, Por, near Vadodara for over seven years. The gas produced by the gasifier is used in the manufacture of Carbon Dioxide.

1. **Prior to Gasifier Installation**
 - Production Capacity : 80-90 kg CO₂ per hour
 - LDO Consumption : 35 litres/hour
 - Fuel cost/hr : Rs.260/hr at low (prevailing) prices seven years ago
2. **With Gasifier**
 - Gasifier Model : AG-150 in thermal mode
 - Production Capacity : 120 kg CO₂ per hour
 - LDO Consumption : NIL
 - Wood Consumption : 90 kg/hour
 - Fuel Cost/Hour : Rs.100/hour
3. **Overall Savings**
 - LDO Savings : 250 KL/annum
 - Monetary Savings : Rs.9 lacs/annum at old prices; Rs.30 lacs/annum at current prices
 - Total Investment : Rs.6 lacs
 - Payback Period : 8 months at old prices
4. **Highlights** :
 - ⬇ Increase in Production Capacity by about 25%
 - ⬇ Use of sulphur dioxide scrubber eliminated, as gas is free from sulphur, hence lower operating costs.
 - ⬇ Improved purity of CO₂, hence better market realisation

BIOMASS GASIFIER INSTALLATION FOR ANNEALING OF STEEL TUBES

A Biomass Gasifier has been installed in January 2002 at M/s Patson Industries, Por, near Vadodara. The gasifier is used to provide thermal energy for a tube annealing furnace, with a view to completely replace the furnace oil with gas.

1. Prior to Installation of Gasifier

- Furnace Oil : 12-15 litres/hour
- Consumption : 1000°C approx.
- Furnace Temp.
- Fuel Costs : Rs.120-150 per hour

2. With Gasifier

- Gasifier Model : WBG-60 in Hot Gas Mode
- Furnace Oil : NIL
- Consumption
- Wood Consumption : 60 kg/hour
- Furnace Temp. : 1000°C approx.
- Fuel Costs : Rs.90/- per hour

3. Overall Savings

- Furnace Oil Saving : 90 KL/annum
- Monetary Savings : Rs.4.0 lacs/annum
- Capital Investment : Rs.3.75 lacs
- Payback Period : One year

4. Highlights

- ✚ Only oil burner replaced by gas burner. No other modification on the furnace
- ✚ Very clean operation as against large amounts of black smoke generated with furnace oil.

BIOMASS GASIFIER INSTALLATION FOR GLUTEN DRYING

AG series gasifier has been installed in July 1996 at M/s Universal Starch-Chem Allied Ltd., Dondaicha (Maharashtra) to provide thermal energy for production of hot air used in their process for drying gluten, thus completely replacing the use of LDO.

1. Prior to Installation of Gasifier

- Production Capacity : 1000 kg/hour
- LDO Consumption : 110 litres/hour
- Fuel cost/hour : Rs.770/hour at old price

2. With Gasifier

- Gasifier Model : AG-500 in thermal mode
- Production Capacity : 1000 kg/hour
- LDO Consumption : NIL
- Wood Consumption : 440 kg/hour
- Fuel cost/hour : Rs.300/hour

3. Overall Savings

- LDO Savings : 660 KL/annum
- Monetary Savings : Rs.31 lacs/annum at old prices; Rs.79 lacs/annum at current prices
- Capital Cost : Rs.20 lacs
- Payback Period : 8 months at old prices; 3 months at current LDO prices

4. Highlights

- ✚ First successful commercial installation of AG-500 gasifier
- ✚ Improvement in product quality in terms of colour etc.
- ✚ Biomass partly from captive plantations

BIOMASS GASIFIER INSTALLATION IN A CERAMIC TILE UNIT

Two WBG Series Gasifiers have been installed in March 2001 at M/s Classic Ceramics, Manufacturers of Glazed Ceramic Tiles. The gasifiers have been installed to provide thermal energy to their kilns. The system details are:

1. Prior to Installation of Gasifier

- Biscuits : Kerosene Fired
1100°C operating temperature
2000 litres Kerosene Consumption/day
- Glazed Tiles : Kerosene Fired
1050°C operating temperature
1800 litres Kerosene Consumption/day

2. With Gasifier

- Biscuits : Gasifier WBG-300
Gas & Kerosene Fired
1100°C operating temperature
Kerosene Saving of 1400 litres/day
Wood Consumption 5200 kg/day
- Glazed Tiles : Gasifier WBG-500
Gas & Kerosene Fired
1050°C operating temperature
Kerosene Saving of 2000 litres/day
(Part gas given to biscuit kiln)
Wood Consumption 7800 kg/day

3. Overall Savings

- Kerosene : 1000 KL/annum
- Monetary Savings : Rs.80 lacs/annum
- Total Investment : Rs.30 lacs
- Payback Period : Four to five months

4. Highlights

- ✚ Such high temperature applications have been successfully implemented for the first time
- ✚ Trouble-free un-interrupted operation in excess of 1000 hours

BIOMASS GASIFIER INSTALLATION FOR STEAM GENERATION

An WBG Series Gasifier has been installed in June 2000 at M/s Carborundum Universal Ltd., (Manufacturers of Industrial Abrasives), at their factory in Chennai. The gasifier has been installed to partially replace (about 50%) furnace oil for their steam generating boiler.

1. Prior to Installation of Gasifier

- Boiler Capacity : 4.0 MT/hour steam
- Furnace Oil Consumption : 6.0 KL/day

2. With Gasifier

- Gasifier Model : WBG-500
- Furnace Oil Consumption : 3.0 KL/day
- Wood Consumption : 12.0 MT/day

3. Overall Savings

- Furnace Oil Savings : 3.0 KL/day
- Monetary Savings : Rs.10,000/ day
- Total Investment : Rs.30 lacs
- Payback Period : One Year

4. Highlights

- ✚ Gasifier designed to operate on totally automatic control mode
- ✚ Fully automatic dual-fuel burner in use
- ✚ Mechanised charging of biomass through skip charger
- ✚ Automatic nozzle closure for shutdown; variable frequency based blower for Hi-Low mode etc.

BIOMASS GASIFIER FOR POWER GENERATION IN TEXTURISING UNIT

Two Biomass Gasifiers have been installed at M/s Dhawal Fab Pvt. Ltd., a yarn texturising unit, located at Pandesara, Surat. The gasifiers have been installed to partially replace (70-75%) the diesel consumed in two DG sets that provide power to the plant.

1. Prior to Installation of Gasifier

- **DG Set Details** : 2 X 100 KVA Ashok Leyland DG Sets
- **Total Diesel Consumption** : 42 litres per hour

2. With Gasifier

- **Gasifier Model** : 2 X WBG-60 in Power Generation mode
- **Diesel Consumption** : 12 litres/hour
- **Wood Consumption** : 100 kg/hour

3. Overall Savings

- **Diesel Savings** : 216 KL/annum
- **Monetary Savings** : Rs.22 lacs/annum
- **Capital Cost** : Rs.10 lacs
- **Payback Period** : Six Months

BIOMASS GASIFIER INSTALLATION AT A RICE MILL IN WEST BENGAL

Gasifier has been installed in June 2001 at Sree Gopal Rice Mills, Kacharipatty Village, PO Bolpur, Birbhum Dist., West Bengal. The gasifier replaces the diesel consumed in DG set used by the rice mill to the extent of about 70-75% using rice husk as feedstocks.

1. Prior to Installation of Gasifier

- DG Set Model : Kirloskar, SL90, 125 KVA– 2 Nos.
- Diesel Consumption : 30 litres/hour
- Operating Hours : 10 to 20 hours/day
- Fuel cost/hour : Rs.600/hour

2. With Gasifier

- Gasifier Model : FBG-120
- Diesel Consumption : 8 litres/hour
- Rice Husk Consumption : 110 kg/hour
- Fuel cost/hour : Rs.225/hour

3. Overall Savings

- Diesel Savings : 22 litres/hour
- Monetary Savings : Rs.375/hour
- Total Investment : Rs.8.0 lacs
- Payback Period : 2150 hours of operation

4. Highlights

- ✚ Trouble-free operation since the system was commissioned in mid 2001.
- ✚ Engine performance has been certified by KOEL, the OEM, on dual-fuel operations.

BIOMASS BASED POWER PLANT FOR ISLAND ELECTRIFICATION

- Location** : Gosaba Island, Sunderbans
(100 Km from Kolkata)
- Installed Capacity** : 500 kW, using 5 X 100 kW
AG series Gasifiers
- Commissioned** : June, 1997
- Highlights** :
- ✚ Catering to about 800 households
 - ✚ No disruption to date
 - ✚ About 6-8 hours operation daily
 - ✚ Operations managed and sustained by Rural Energy Co-operative
 - ✚ Operated & maintained by duly trained local technicians; operating supervision for first three years by Ankur Scientific
 - ✚ Tremendous boost to education, economic opportunities and social/cultural activities

**BASED ON THE UNQUALIFIED SUCCESS OF THE FIRST,
A SECOND PROJECT INSTALLED IN NEARBY ISLAND**

SURPRISES

- **Not all diesel engines are same**
- **National standards for tar and particulates are not necessarily adequate**
- **Turbo-Chargers and After-Coolers need to be treated with respect**
- **However, TC & AC engines can be adapted for dual-fuel operation**

In a nutshell, what you do not know could harm you !

DUAL – FUEL ENGINES

- Major focus of Biomass Gasification based power in India
 - ✚ Historical low HSD cost
 - ✚ Large Genset / Pumpset population
 - ✚ Low initial investment
- Most of the work / projects / installations with power levels of upto 100 kWe using naturally aspirated engines
- Strong expert opinion against gasifiers being coupled to larger turbo-charged and/or after-cooled engines
- Larger rating, naturally aspirated engines are either not manufactured or are generally slow/medium speed and very expensive

DUAL – FUEL ENGINES (Contd..)

- **However, turbo-charged and/or after-cooled engine gensets constitute bulk of captive power and hence could severely limit gasifier technology extension/ expansion**
- **Users of smaller sets have financial constraints and are generally less amenable to another capital investment (in addition to that in gensets)**
- **If compatibility with TC/AC is established, attractive economics and better financial strength of potential customers could result in large savings of HSD with associated environmental/climate control gains**

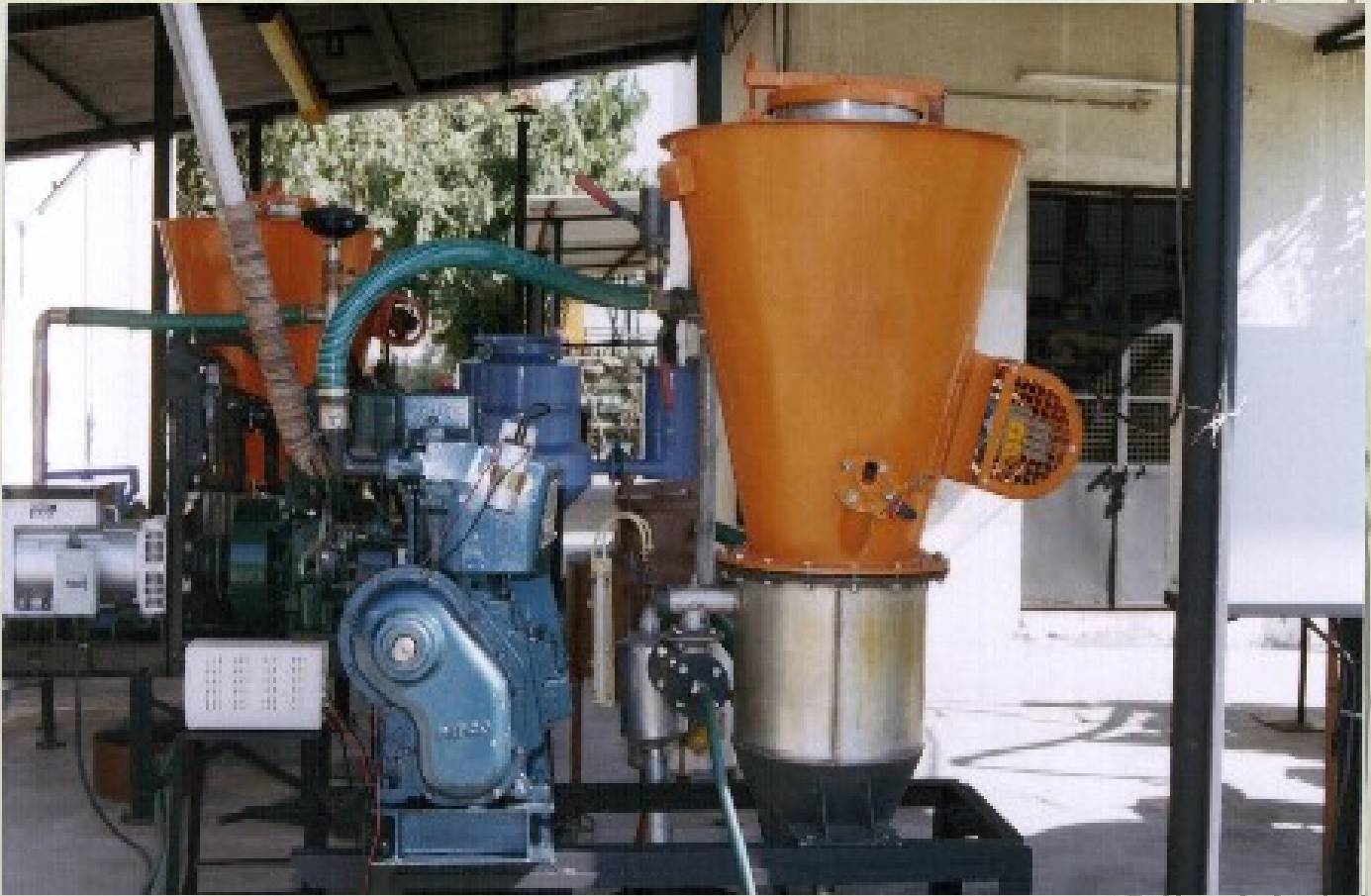


*Generating Power at village
Level – Dual Fuel Mode*

(Output Rating : 15 kW)

100% GAS ENGINES

- **Very Encouraging Recent Developments**
- **100% Producer Gas based systems are now available for commercial installations**
- **Current power ratings go from 30 kWe to 250 kWe**
- **Start-up could be through small genset, petrol or LPG**



***100% Producer Gas Systems –
Ultimate Solution for Self-
Reliance based on Local
Resources***

Output \cong 4 kW

(Next Rating ~ 8 to 10 kW)

WHAT GOES WRONG IN THE FIELD

Customer's Side

- Lack of adherence to fuel specifications
- Frequent change of operating personnel
- Tendency to take liberties – over estimating system capabilities
- Burden to operating / maintenance personnel; Benefit to owner/ management
- Unrealistic expectations – gasifier supplier responsibilities beyond the scope

WHAT GOES WRONG IN THE FIELD (Contd..)

Supplier's/Technology Developer's Side

- **Satisfactory operation requires relatively strict adherence to fuel specifications as well as O&M instructions**
- **Systems are not totally fail safe (damages to throat/nozzles; breakages)**
- **Systems are not “Idiot-proof”**
- **Some features are not user-friendly**
- **Inadequate training of customer personnel**
- **Inability to station own personnel for long duration**
- **Intellectual property protection vs. customer information**
- **Diffidence – few installations putting pressure to ignore customer faults**

VICIOUS CIRCLE

- Customers do not want to be guinea pigs (in spite of subsidies and benefits); yet technology development and perfection requires field inputs
- Equipment Manufacturers (DG sets, thermal equipments etc.) see only miniscule immediate business and are unwilling to put in any substantial effort/resource. Yet, customer confidence requires their being a partner (and an active one at that!)
- For Companies, the task is daunting, resource input (both human & financial) needs are large, future potential could be enormous Yet current business levels and margins are grossly inadequate (Even so, the prices of the systems are seen to be high due to small base for overheads)

THANK YOU