KEY FACTORS TO BE ADDRESSED TO DEVELOP BIOMASS POWER IN INDIA

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AREVA RENEWABLE ENERGIES INDIA PRIVATE LIMITED

22 August 2015

6TH World Renewable Energy Technology Congress ,
New Delhi

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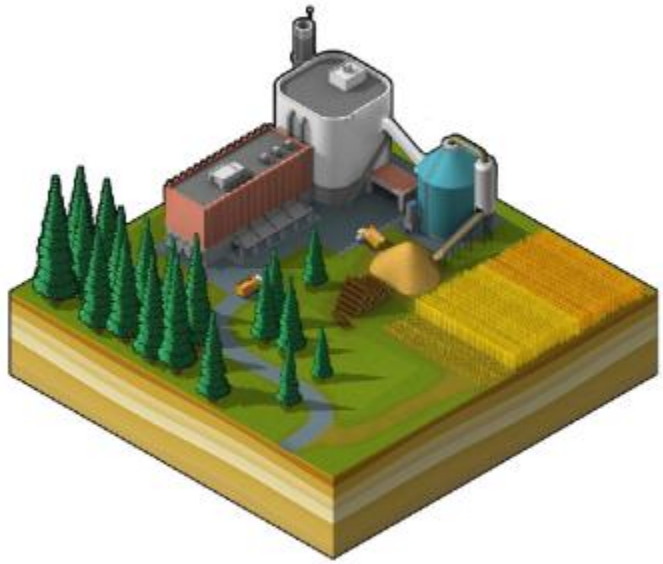

AREVA BIOENERGY

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AREVA supply solutions for power generation with less carbon

Number 1 worldwide in nuclear power

- Products and services to ensure nuclear reactor safety and performance throughout the lifecycle
- An integrated model covering every stage of the fuel cycle, reactor design and construction, and operating services

A major player in renewable energies

- Advanced technology solutions: offshore wind, bioenergy, concentrated solar power and energy storage

Core business: integrated solutions for bioenergy power plants

Scope of projects

- Cogeneration or full electricity
- Output 3 to 150 MWe
- All types of biomass feedstock
- Complete EPC services

Key Assets

- Leader in Bioenergy
- 39 years of experience
- 2.5GW of bioenergy power projects worldwide
- Strong engineering expertise
- Wide offering from EPC to technologies
- Focus on safety and execution excellence

Performance & delivery guarantees

Pre-EPC support — AREVA — **EPC scope**

Development	Investment	Design & Engineering	Procurement	Erection and Commissioning	O&M / Servicing
-Technical support to define best possible solution for customer -Thermal cycle optimization - Fuel assessment - Combustion technology selection	-Support for project financing	- Solution design in collaboration with customer - Engineering and design of the plant	- Equipment procurement	- Installation, testing, commissioning and training	- Training - EPC Warranty period

Project Management

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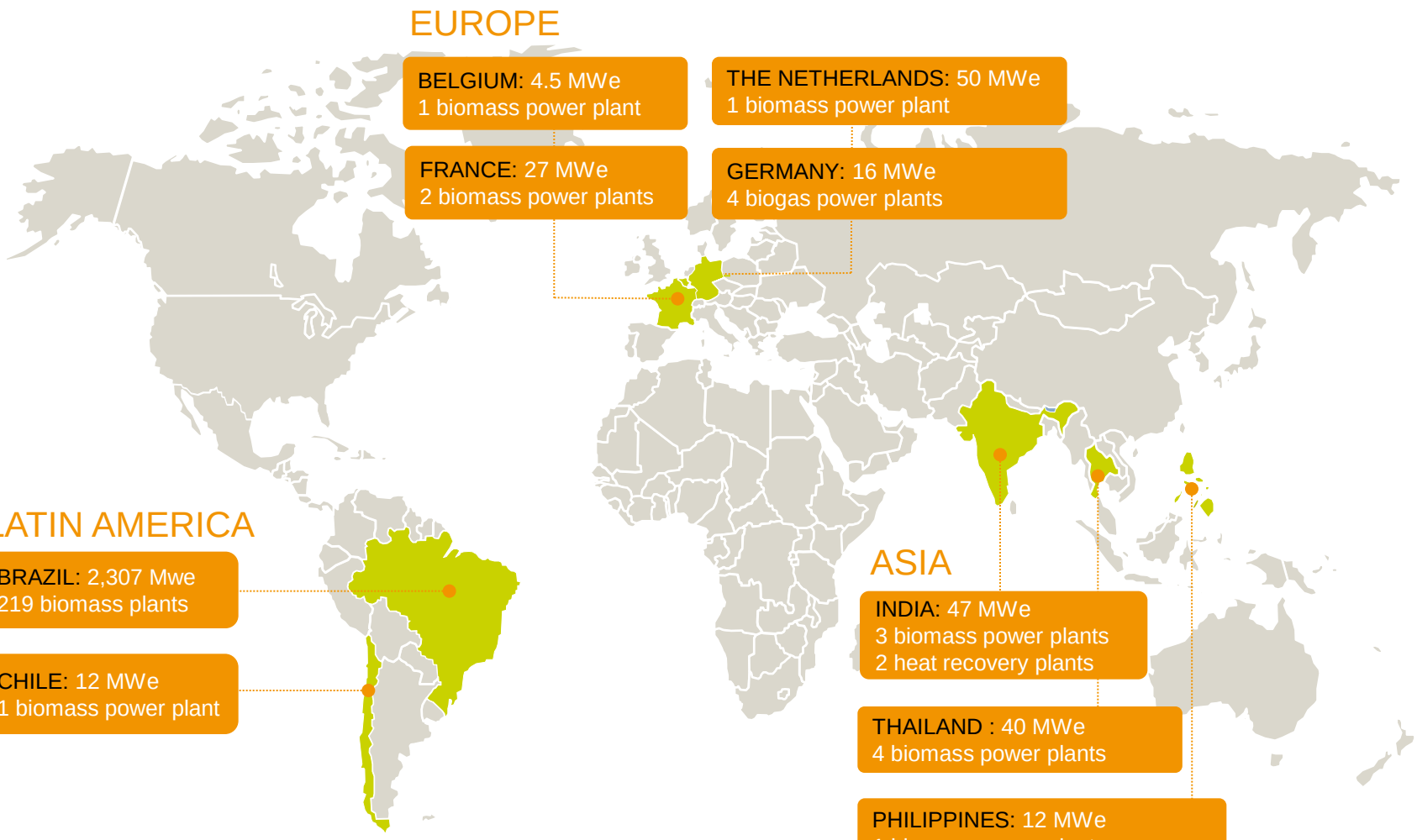
More than 2.5 GW worldwide, the largest biomass installed base



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AREVA Bioenergy projects in SEA

Bua sommai – 1 & 2 , Thailand
10MWe , COD 2007
10MWe , COD 2009
Rice Husk

U-THONG, Thailand
Signed: Mar. 2012
COD: Jan 2014
Rice husk & Bagasse

NAKON PATHOM, Thailand
Signed : April 2013
COD : Nov 2014
Rice husk, Bagasse , bamboo

GIFT, Philippines
Signed: Nov. 2013
COD: Sept. 2015
Rice Husk

OUR COMMITMENTS

1. Quality and Safety
2. On time delivery
3. Technical performances
4. Responsiveness and transparency
5. Best suitable solution
6. Customer satisfaction

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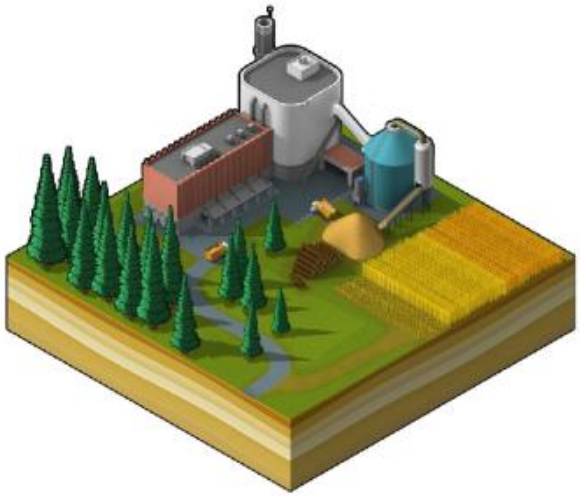
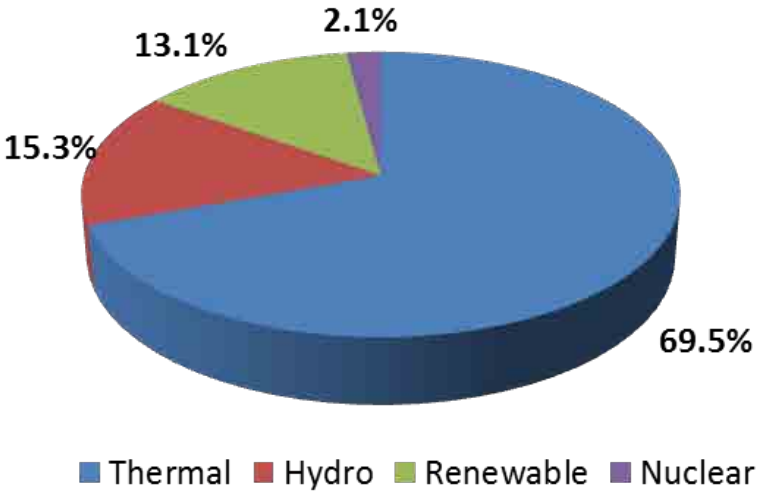
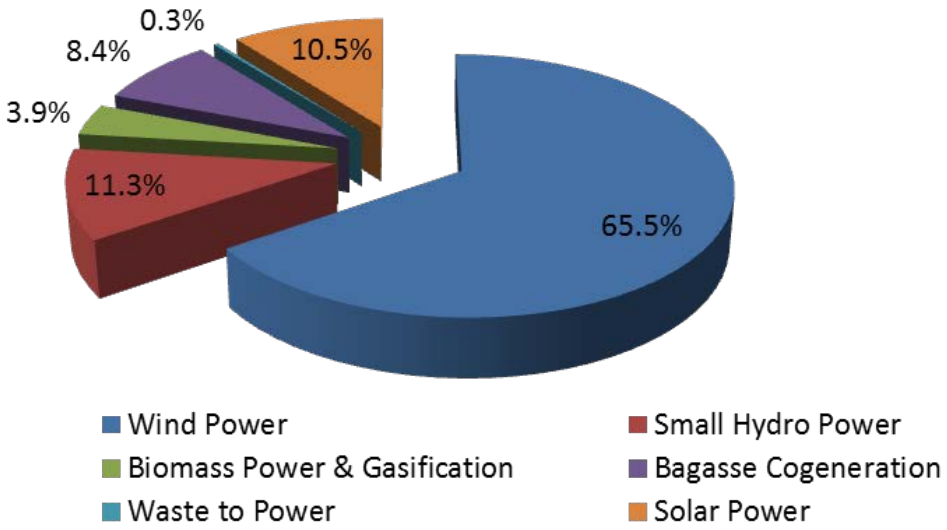


(i) A LARGE UNTAPPED BIOMASS POTENTIAL

Overall installed base and RE share in India



India 2015 Overall Installed Power Capacity = 272.687 GW



Renewable Energy Scenario

- Today 13.1% of the power generated from India is through renewable energy resource, out of which power generated through biomass based plants is 3.9% & through bagasse based cogeneration plant is about 8.4%.
- Ministry of India has been implementing biomass power / co-generation programme since mid nineties.

Sources: Power Ministry of India & MNRE India

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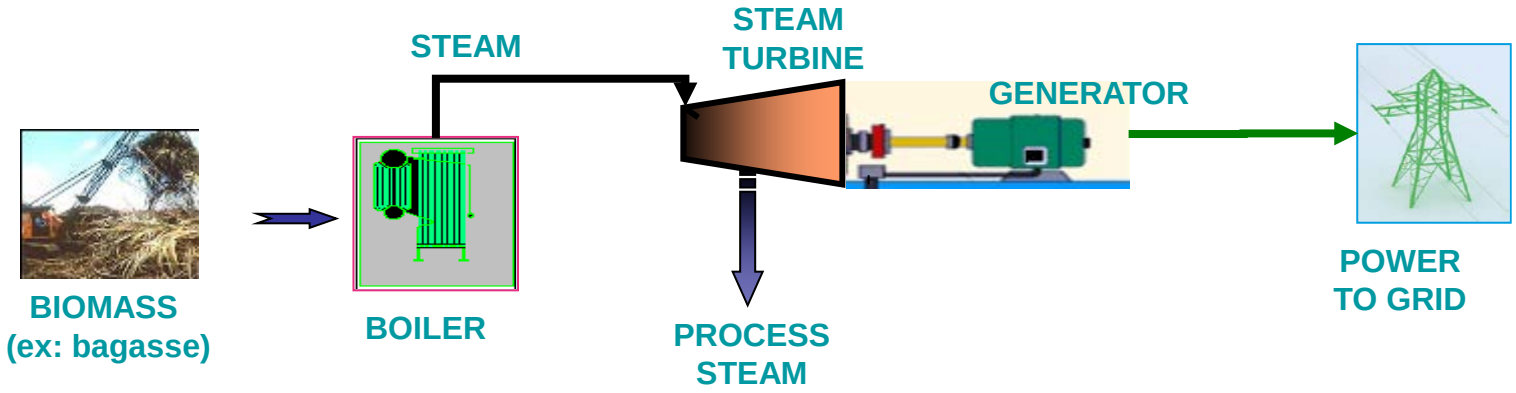
WHY BIOMASS POWER ?

Compared with other renewable energy sources, biomass power offers the following advantages:

- Higher availability
- Stable generation (to the contrary of solar or wind that are intermittent)
- Higher PLF
- O & M is simpler
- Hybridisation is possible
  - Biomass based power plant can be combined with Solar / Wind / Biogas based power plant.

BIOMASS BASE POWER PLANT IN INDIA

- **138 biomass plants & 58 bagasse based cogeneration plants** are running in India and exporting Power to Grid
- Around 30 biomass power projects totaling 350 MW & 70 Cogeneration projects totaling 800 MW are under execution.
- The States like Andhra Pradesh, Karnataka, Tamil Nadu, Chhattisgarh, Maharashtra, Punjab and Rajasthan have taken a serious initiatives to implement biomass power projects.
- About two dozens of plants in India are using 100bar cycle and very sugar mills operating at 130bar cycle.



Cogeneration Plant (or) Combined Heat & Power (usually referred as CHP) are the most efficient plant. Modern cogen plants can generate up to 5000MWe. Most of the bagasse cogen plants are using 60 bar cycle.

Sources: MNRE India

FEED IN TARIFF FOR BIOMASS & COGENERATION PLANTS

State	Tariff fixed by Commissions - Biomass based power plant	Tariff fixed by Commissions - Cogeneration Plants
Andhra Pradesh	Rs.4.28/kWh (2010-11)	Rs.3.48/kWh
Gujarat	Rs.4.40/unit (with accelerated depreciation)	Rs.4.55/unit (with accelerated depre.) for 1st 10 yrs
Haryana	Rs.4.00/unit	Rs.3.74/unit with 3%escalation (base year 2007-08)
Karnataka	Rs.3.66 per unit (PPA signing date) & Rs.4.13 (10th year)	Rs.3.59/unit, (PPA signing date) & Rs.4.14/unit (10th Year)
Maharashtra	Rs. 4.98 (2010-11)	Rs.4.79/unit (Comm yr.)
Madhya Pradesh	Rs.3.33 to 5.14 /unit paise for 20 yrs. With escl of 3- 8paise	-
Punjab	Rs.5.05 /unit, (2010-11)escalated at 3%.	Rs.4.57/unit (2010-11) escalated at 5%
Rajasthan	Rs.4.72 / unit-water cooled (2010-11) & Rs.5.17-air cooled(2010-11)	-
Tamil Nadu	Rs.4.50-4.74 / unit(2010-11)	Rs.4.37-4.49/unit (2010-11)with escalation 2%
Uttaranchal	Rs.3.06/unit. (2010-11)	Rs.3.12/unit (2010-11)for new projects
U.P.	Rs.4.29 / unit, for existing and 4.38 for new with escalated at 4 paise/year, base year (2006)	-
Bihar	Rs. 4.17/unit (2010-11)	Rs.4.25/unit (2010-11) for existing Plant Rs.4.46/unit (2010-11) for new plant

Sources: MNRE India

AVAILABILITY OF BIOMASS

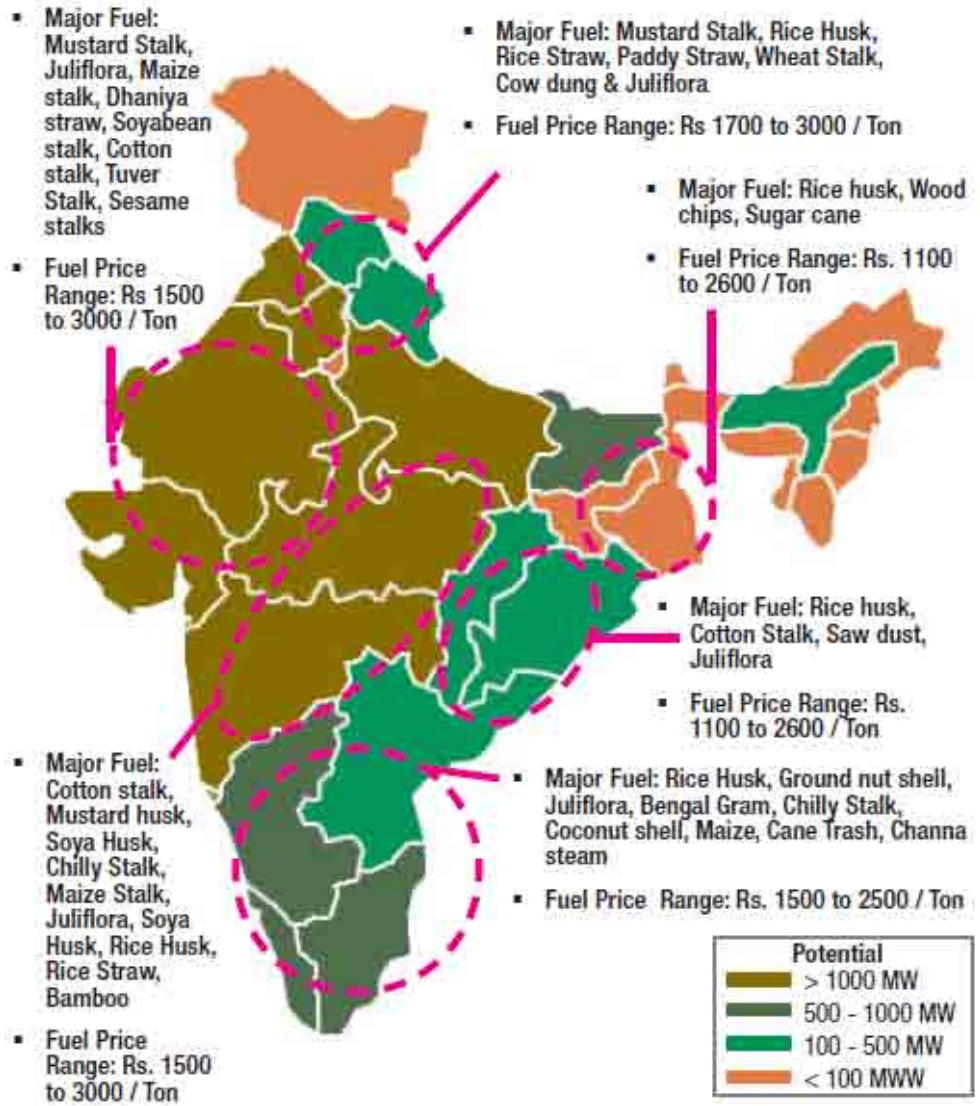
- The current availability of biomass in India is estimated at about 500 millions metric tones per year.

- However studies sponsored by the Ministry have estimated surplus biomass availability at about 120 – 150 million metric tones per annum covering agricultural and forestry residues corresponding to a potential of **about 18,000 MW.**

- But, biomass in India is predominantly from agriculture and is available only after harvesting period which can stretch only for 2-3 months in a year. Hence the need for storage becomes mandate depending on sourcing plans of the plant.

Sources: MNRE India

BIOMASS MAP OF INDIA



Sources: Market research report 2014 by Idata Insights

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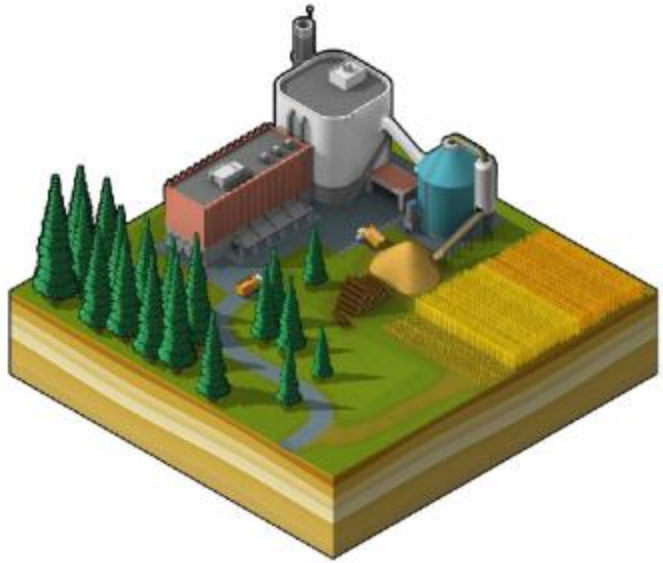


(ii) BARRIERS TO BIOMASS POWER DEVELOPMENT

BARRIERS TO BIOMASS POWER DEVELOPMENT IN INDIA

The following factors / barriers have to be considered for the development of biomass power in India :

1. Technology specific barriers
2. Availability of Biomass
3. Logistics
4. Cost of Biomass
5. Institutional / State Policies
6. Informational barriers
7. Financial

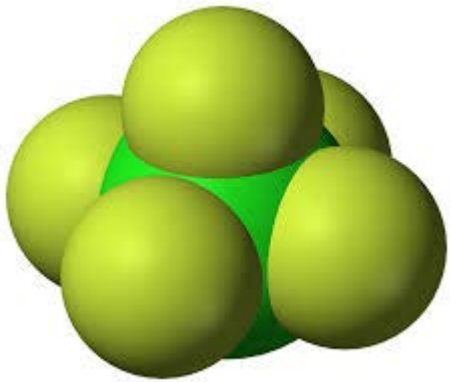
1. TECHNOLOGY SPECIFIC BARRIERS

- Biomass fuels are complex in nature
- Their characteristics are as follows:
  - Non – Homogenous fuels
  - Lower bulk density, High moisture
  - Fibrous in nature
  - High alkali & Chlorine content
  - Varying physical & Chemical properties
- They therefore **need special attention for preparation & feeding system**.
- A suitable technology has to be selected for firing.
- Other barriers as listed below shall also be taken into account
  - Availability of land (approximately 10MW requires 4 acres land)
  - Grid vicinity
  - Water availability
  - Environment clearance
  - Plantations (1MW requires 200 acres of plantations)

1.1 CRITICAL FACTORS IN DESIGN OF THE BOILER

The following factors shall be given importance while designing the boiler:

1. Chlorine content
2. Alkali content
3. Fuel size and volumetric flow
4. High volatiles / Moisture in fuel



1.1.1 EFFECTS OF CHLORINE

- Accelerated corrosion especially in super-heater area
- Chlorine corrosion will further be increased with presence of SO_2
- Extent of Chlorine corrosion depends on Temperature, Concentration of Chlorine, presence of Sulphur and Alkali metals

Photo caption - © Copyright

1.1.2. EFFECTS OF ALKALIES

High Alkali & alkaline earth constituents results in deposit formation, which is a complex process depending on

- Mineral characteristics of Fuel
- Fuel Chemistry
- Combustion Chemistry
- Particle Transport
- Fluid Dynamics
- Condensation

Photo caption - © Copyright

Deposit formation results in:

- Reduction in heat transfer rates
- Fouling
- Accelerated rate of fire side corrosion

1.1.3 FUEL SIZE AND VOLUMETRIC FLOW

- The bulk density of all biomass fuel is very low.
- This necessitates handling of large quantity of fuel for firing in the boiler.
- Also its nature and high moisture levels, make it unwieldy for processing the fuel.

Rice Husk

Cotton Stalk

Bagasse

1.1.4 HIGH VOLATILES AND MOISTURE IN THE FUEL

- High Volatiles result in lower ignition temperature and more combustion in upper furnace

- High moisture reduces available heating value & inhibits proper combustion. Combustion air staging more pronounced to maintain Furnace temp where moisture is being vaporized.

Napier Grass typically with 45% moisture

2. SEASONAL AVAILABILITY OF BIOMASS

Residual Availability	Jan	Feb	March	April	May	June	July	August	September	October	November	December
Maize Stalk												
Maize cobs												
Cotton stalk												
Mustard Husk												
Jute sticks												
Mesta sticks												
Rice Husk												
Ground nut sheels												
Arhar stalks												
Bagasse												

Sources : Energy from cotton stalks & other residue by Anil kumar Duby, Pitam Chandra, Debasish Padhee & S. Gangil

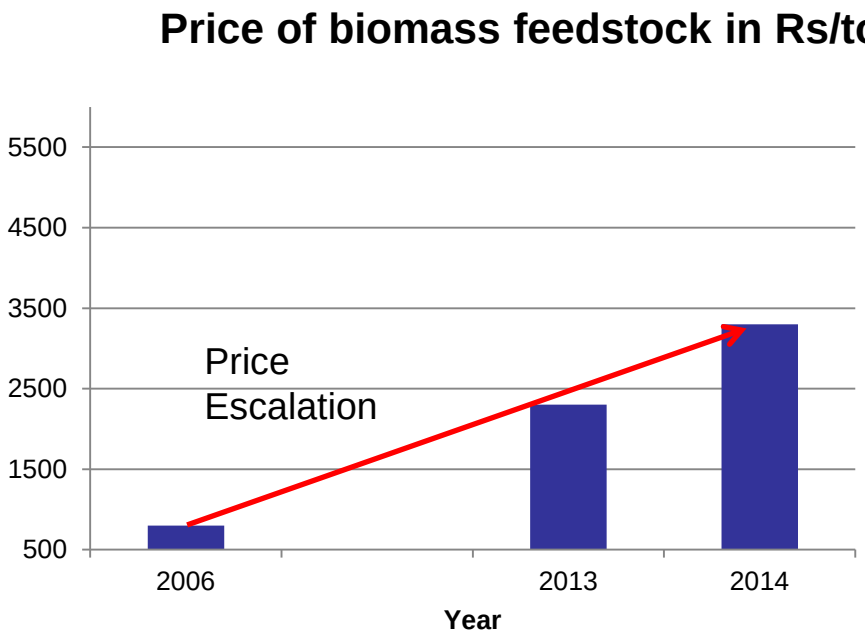
Main Source : Junginger 2000

3. LOGISTICS OF BIOMASS

- Plays Key Role in cost of feedstock
- Transportation more than 50 Km becomes unviable for a power plant of size 10-15MW.
- Oil price is fluctuating and hence the transportation cost of fuel becomes a variable cost.
- The biomass is transported either in loose form (or) balled condition. This becomes unyieldy. However the biomass are transported either in pellets (or) in briquettes for the larger power plant capacity.

Transportation of Rice Husk

4. COST OF BIOMASS



- The cost of biomass feedstock in India has increased **from Rs 800/ Ton in 2006-2007 to Rs 3300 in 2014**
- As the feedstock prices have increased rapidly and the availability of the fuel have decreased, the necessity for using **new biomass** fuels have increased.

Sources: CERC & IREDA

5. INSTITUTIONAL INCENTIVES / POLICIES

- Institutions often end up chasing **unachievable targets**, instead of developing sustainable dissemination at local level.
- The institutional framework in India currently **lacks a viable strategy to empower local communities**. Community organisations and institutions are rarely involved in the planning, implementation and management of the rural electrification.
- While subsidies have been introduced as an incentive to induce early adoption, **implementation** has not been well thought out (marginal impact)

AREA / PROGRAM	INCENTIVES / BENEFITS
Accelerated Depreciation	Claim of 80% depreciation in the first year for certain specific equipment required for co-generation systems such as turbine and vapor absorption systems.
Income tax Holidays	Income tax holidays for biomass projects for 10 years.
Customs & Excide duties	Concessional customs & excise duty exemption for machinery and components during setting up of biomass projects.
Sales tax exemptions	Sales tax exemption in certain states
Loans	Financial aid from the Indian Renewable Energy Development Agency (IREDA) setting up biomass power and bagasse cogeneration projects

Sources: MNRE India

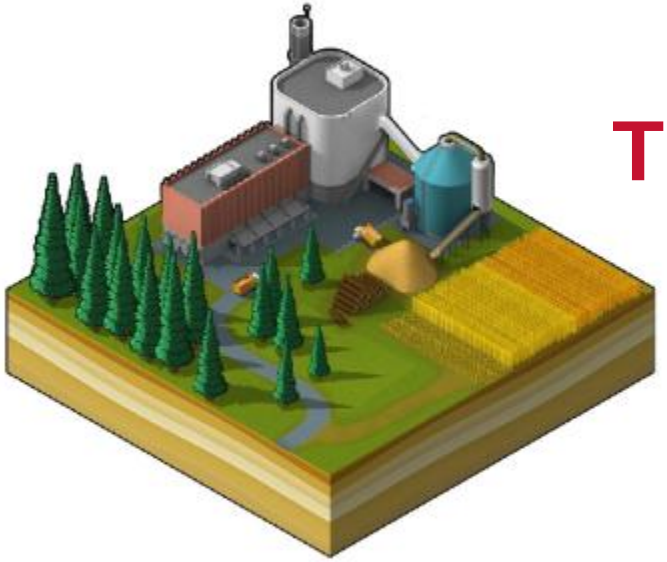
6. INFORMATIONAL BARRIERS

Stakeholders such as NGOs, industry groups and finance institutions, as well as policy-makers, are often unaware of the benefits of bioenergy:

- Lack of knowledge
- Uncertainty and distrust in the source of information
- Climate change is not being as a immediate threat
- Social behavior and expectations
- Absence of an enabling environment, i.e. government, local organizations, village panchayat
- Inadequate training, capacity-building and user-education programme

7. FINANCIAL ASPECTS

- High initial capital costs
- A 10MW plant requires 50 – 60 Crores
- O & M cost of the plant is approximately 5.6%.
- IRR rate – 15%
- Gestation Period – 2 to 3 Years
- Financial Risk comprises of
  - Cost over run
  - Increased cost of O & M over the years
  - Fuel Pricing
  - Government Policies
  - Fiscal incentives for biomass plant



(iii) SOLUTIONS TO OVERCOME THOSE BARRIERS

EXPLORATION OF NEW BIOMASSES
NICHE FUELS

- The **standard biomass** fuels are often referred to Rice Husk, Bagasse, Wood Chips
- The **term "new biomass"** refers to unusual biomass fuels such as palm oil residues, cotton stalk or napier grass.
- Prices of new biomasses are comparatively lower than the regular biomass.
- However the choice of new biomass depends on the availability near by the proposed area.

NAPIER GRASS AFTER DRYING

COTTON STALK

EXAMPLE OF NICHE FUELS

POULTRY LITTER

MUNICIPAL SOLID WASTE (MSW)

NAPIER GRASS

COTTON STALK

DRIVERS FOR GROWTH

It is India interest to pursue biomass power development because:

- Power demand is increasing
  - The gap between demand and supply is increasing as the population grows. This is calls for the additional generating units and the need to strengthen India's energy security
- Need solutions for rural electrification with help of decentralized power generation
- Can grow along side other renewable portfolio like Wind, Solar etc, as an large untapped potential is available.
- India is growing country. Considering future strict emission norms & Concerns for the environment will force to develop Renewable / Biomass base plants on large scale.

Key drivers to increase biomass generation in India are the followings:

- Competitiveness – For establishing & running the plant.
- More incentives / state policies will spur higher growth
- Increase well trained resource. As mature technology are used of suitable equipment within India (Indigenisation).

DRIVERS FOR GROWTH

- Task force committees to explore the newer, cheaper & quickly replenishable biomass fuel.
- Innovative methods for sourcing biomass for power @ competitive prices.
- Implementation of programs to encourage high efficient biomass plant even usage of complex biomass (as in china).
- Instant database for the biomass availability through various regions in the country.

State-wise Biomass Data Based on Survey Data of year [2002-04] Considering All Biomass Class : All

State	Area (kHa)	Crop Production (kT/Yr)	Biomass Generation (kT/Yr)	Biomass Surplus (kT/Yr)	Power Potential (MWe)	Biomass Class
Andhra pradesh	3623.9	NA	5151.6	3484.4	487.8	Forest & wasteland
Andhra pradesh	9983.2	21167.1	43893.2	6956.4	863.3	Agro
Arunachal pradesh	208.5	251.1	400.4	74.5	9.2	Agro
Arunachal pradesh	5467.4	NA	8313.1	6045.3	846.3	Forest & wasteland
Assam	2676.8	NA	3674.0	2424.2	339.4	Forest & wasteland
Assam	3460.3	8250.6	11443.6	2346.9	283.9	Agro
Bihar	906.0	NA	1248.3	831.9	116.5	Forest & wasteland
Bihar	7348.7	18817.6	25756.9	5147.2	641.1	Agro
Chhattisgarh	4758.2	6636.6	11272.8	2127.9	248.5	Agro
Chhattisgarh	8762.1	NA	13592.3	9065.8	1269.2	Forest & wasteland
Goa	153.4	NA	180.7	119.3	16.7	Forest & wasteland
Goa	154.2	489.5	668.5	161.4	20.9	Agro
Gujarat	8007.6	23895.7	29001.0	9085.5	1224.8	Agro

DATABASE DEVELOPED BY IREDA UNTIL 2004

Sources: IREDA

DRIVERS FOR GROWTH

- Industrial conglomerates are keen to have a share in RE portfolio & schemes / benificial policies boost the implementation. One such policy is

A MAJOR NEW NATIONAL PROGRAM. DESIGNED TO FACILITATE INVESTMENT. FOSTER INNOVATION. ENHANCE SKILL DEVELOPMENT. PROTECT INTELLECTUAL PROPERTY. AND BUILD BEST-IN-CLASS MANUFACTURING INFRASTRUCTURE. THERE'S NEVER BEEN A BETTER TIME TO MAKE IN INDIA.

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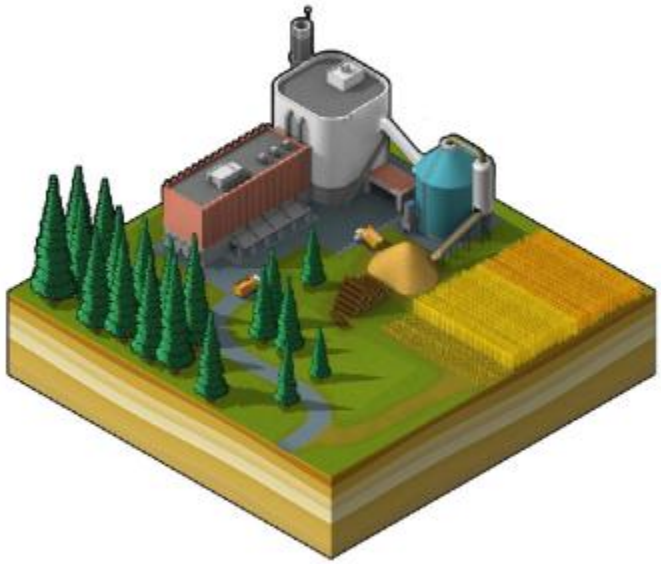
BENEFITS OF MAKE IN INDIA POLICY

- 100% Foreign Direct Investment - Attracts to setup new plants
- Transfer of new Technologies to India (Indigenization)
  - Will be competitive solution to as mature suppliers / fabricators already available.
  - Readily available manpower / resources creating a employment opportunities for budding professionals
  - Industrial conglomerates are keen to have a share in RE portfolio & with these scheme
- Motivates Leadership thrust

Similar policies to be initiated, to put Indian Renewable energy in proper track.



ANY QUESTION?