International Society of Waste Management, Air and Water

যাদবপুর বিশ্ববিদ্যালয়
JADAVPUR UNIVERSITY

Potential of economic utilization of biomass waste in India -Implications towards SDGs

United Nations Centre for Regional Development (UNCRD)

Seventh Regional 3R Forum in Asia and the Pacific

2 - 4 November 2016; Adelaide, Australia

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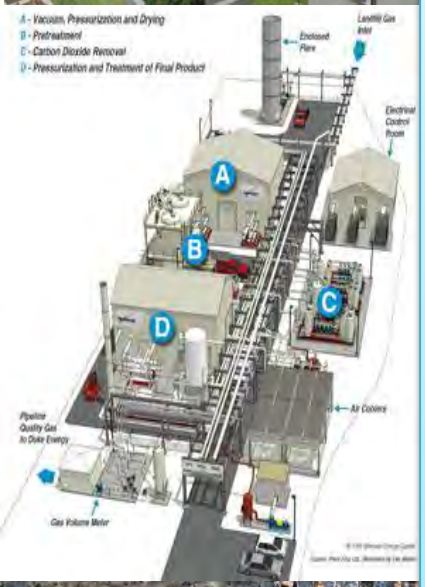

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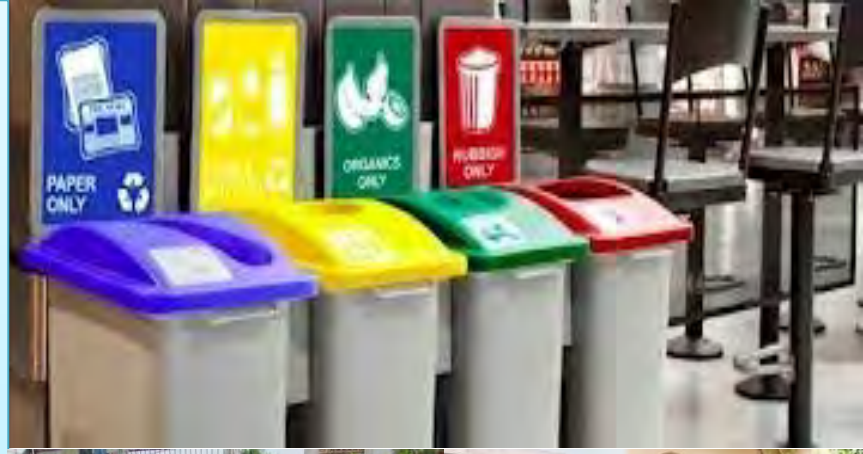
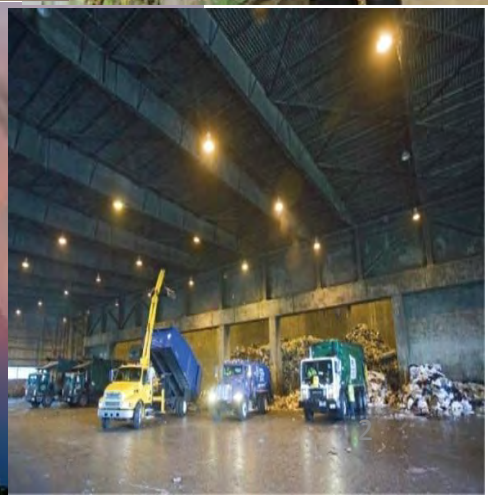
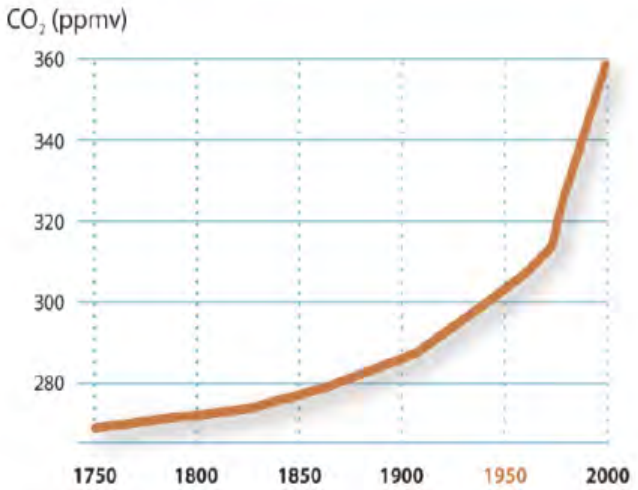


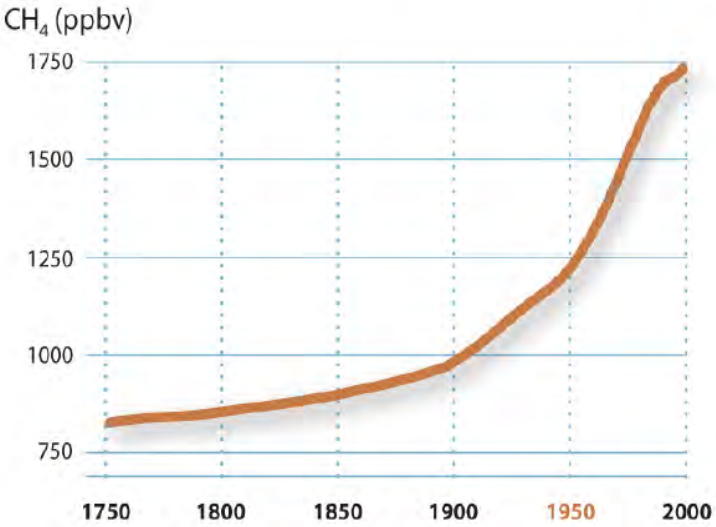


The global environmental challenge- Why SD

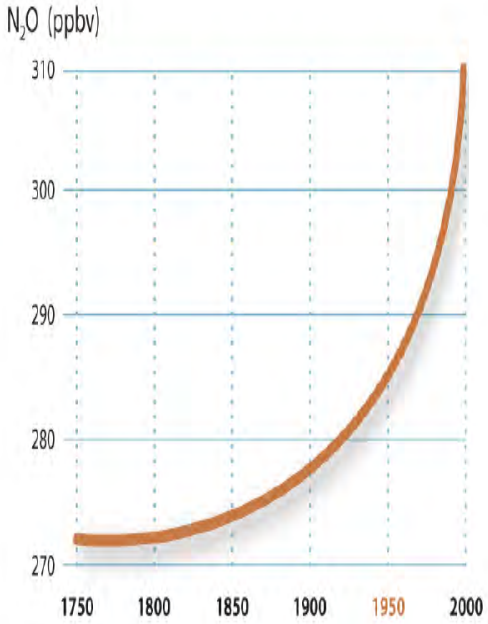
Atmospheric CO_2 concentration



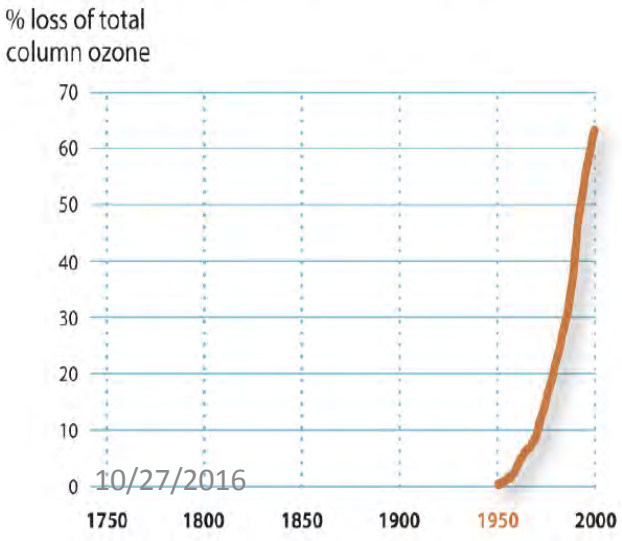
Atmospheric CH_4 concentration



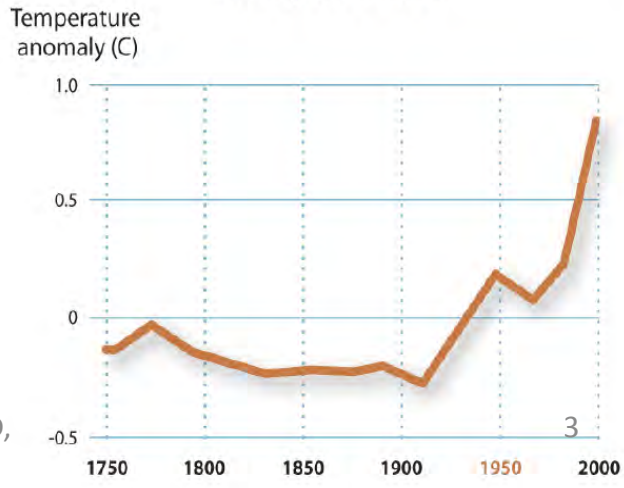
Atmospheric N_2O concentratio



Ozone depletion



Northern hemisphere average surface temperature



India - Language

There are 22 major languages in India, written in 13 different scripts, with over 720 dialects. The official languages are Hindi (with approximately 420 million speakers) and English, which is also widely spoken

As India with great diversity emerges as a major superpower, more and more growth opportunities come up. A large number of foreign firms wish to do business in India**. There are 28 states in India and it is like doing business in 28 different countries.**

India with neighbour countries

Introduction

Biomass : A stored source of solar energy initially collected by plants ,during the photosynthesis, whereby CO_2 is captured & converted to plant materials mainly in the form of cellulose, hemi-cellulose and lignin.

Biomass can be converted into useful bioenergy.

Biomass Waste :

Biomass waste is defined as bio-residue available by vegetation, forest or organic waste, by product of crop production, agro or food industries waste.

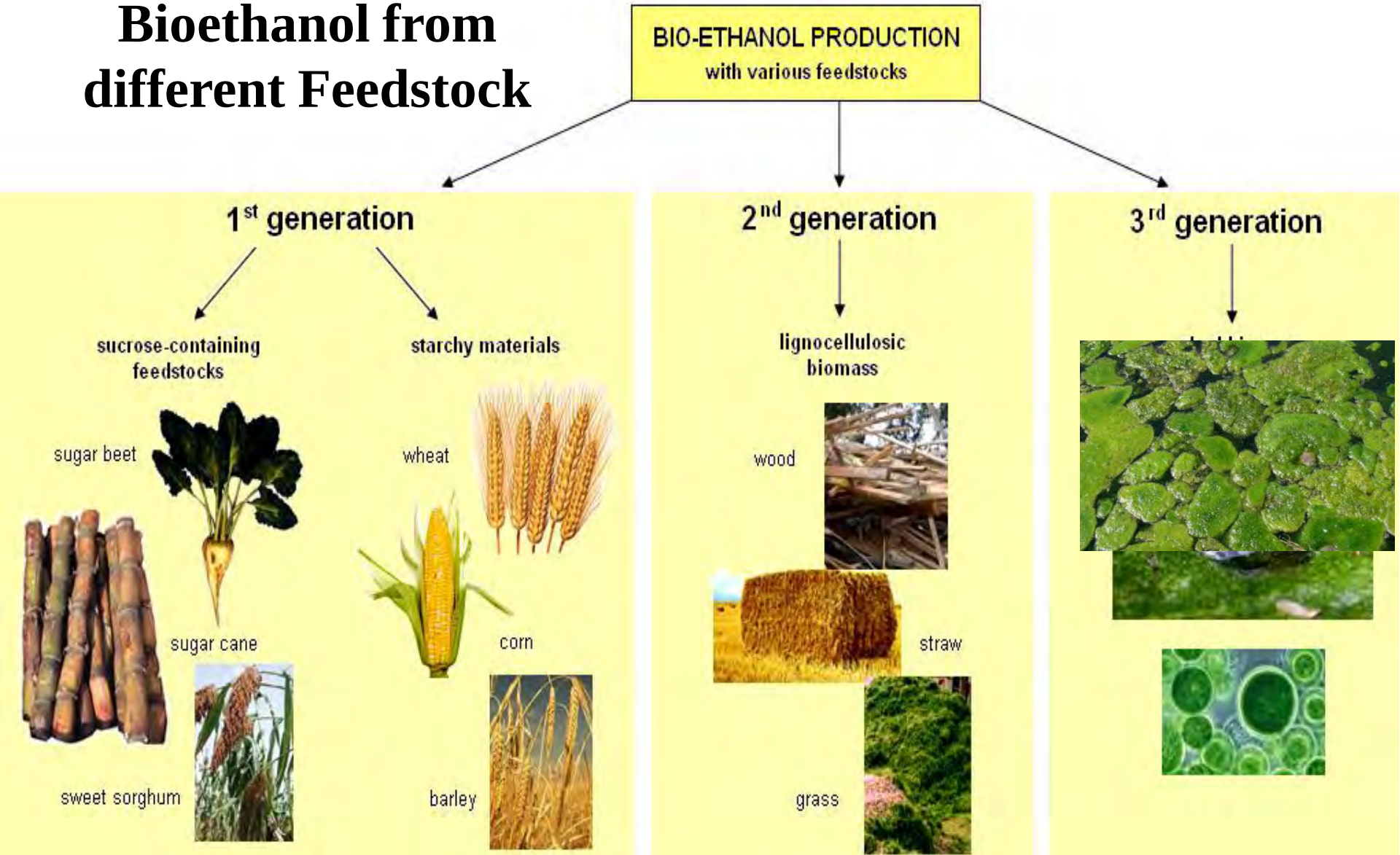
Introduction : Biomass availability, India

Biomass availability in India	Agricultural Biomass	657 (MMT) / year
	forestry & Wasteland' Residues	260 MMT/year
	Total	915 (MMT) / year
	Estimated Power Potential	33,292 Mwe (MW)

Biomass comes from a variety of sources include:

- Wood from natural forests and woodlands
- Forestry plantations
- Forestry residues
- Agricultural residues such as straw, stover, cane trash and green agricultural wastes
- Agro-industrial wastes, such as sugarcane bagasse and rice husk
- Animal wastes
- Industrial wastes, such as black liquor from paper manufacturing
- Sewage
- Municipal solid wastes (MSW)
- Food processing wastes

Production of Bioethanol from different Feedstock



Comparative Study of Biomass (mainly rice straw) Production and Utilization

Biomass Production and Utilization Status	India	Thailand	Philippines
Agricultural residue (mainly rice straw) produced (Million tons)	97.19	21.86	10.68
Percentage (%) of the surplus residue burned in open field	23%	48%	95%
GHG emission contribution (%) through open field burning of rice straw	0.05%	0.18%	0.56%
GHG emission reduction (%) when residue used for electricity production	0.75%	1.18%	4.31%

Available Biomass Resources in India

Energy Crops: Plant exclusively grown for their wood from marginal lands for energy generation. Ex: Prosopis, Bamboo, Leuceana, etc.

Animal by Products: Tallow, Fish Oil, Manure etc

Forest Waste: Logs, chips, barks, leaves, Forest industry based product like sawdust

Feedstock for Biomass Power Production

Agro Industrial waste: Wastes from paper mills, molasses from sugar refineries, pulp wastes from food processing units, textile fibre waste, etc.

Municipal solid waste: Biodegradable such as food and kitchen waste, green waste, paper. Inert waste like fabrics, clothes etc.

Agricultural Wastes: Straws of cereals and pulses, stalks of fibre crops, seed coats of oil seed, crop wastes like sugarcane trash, rice husk, coconut shell, etc.

Introduction : Potential of Biomass to Energy

- About 32% of the total primary energy use in the country is still derived from biomass;
- more than 70% of the country's population depends upon it for its energy needs.
- Biomass power generation in India is an industry that attracts investments of over Rs. 1 billion USD (nearly 600 crores INR) every year, generating more than 5000 million units of electricity.
- Biomass power generation annual employment is more than 10 million man-days in the rural areas.
- For efficient utilization of biomass, bagasse based cogeneration in sugar mills & biomass power generation have been taken up under biomass power and cogeneration programme.

India Target using Biomass

- India government intends to achieve ***40% cumulative electric power capacity from non fossil fuel sources by 2030.***
- The **Renewable Power target** to be achieved by the ***year 2022 so that cumulative achievement is 1,75,000 MW*** in India,
- whereas the ***Biomass Power target is 10,000 MW including the 100,000 Family Biogas Plants, waste to energy plants using MSW , rural & industrial Biomass Gasifiers using Biomass and Biomass Waste***.

Introduction

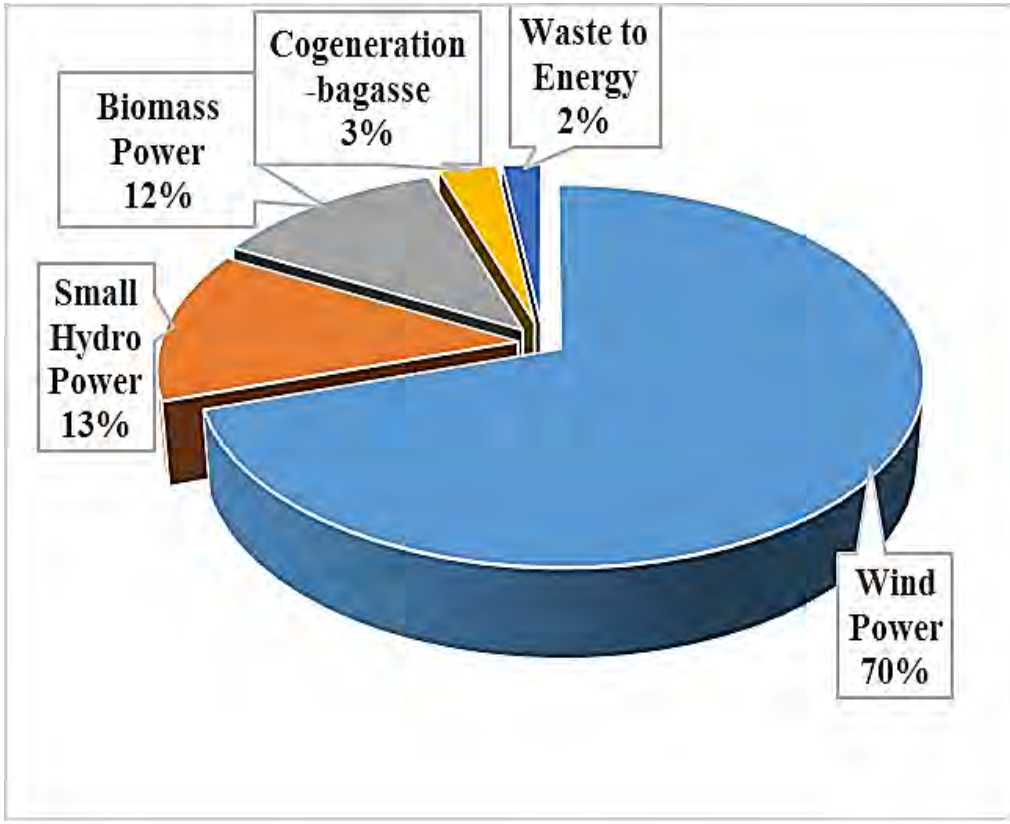
As per Energy statistics 2015 in India,

Estimated Potential for renewable power generation is : 147,615 MW.

(apart from Solar)

This includes,

- 11.88% Biomass power **MW**
- 3.39% bagasse-based mills **5000 MW.**
- 69.6% Wind power potential :
- 13.38% SHP (small-hydro 19749 MW,



Scheme wise Physical Progress in 2016-17 Biomass Power Generation

Biomass Power Source	Installed Capacity, Total MW	FY- 2016-17 Target	FY- 2016-17 Achievement (Aprl -Aug,2016)	Cumulative Achievements (as on 31.08.2016)	2022 target (MW)
I. Grid-interactive power (capacities in MW)					
Biomass Power (Biomass & Gasification, Bagasse Cogeneration) *	4,861	400	51.00	4912.33	*10,000
Waste-to-Power	115	10	7.50	115.08	
Total	4,976	410	58.50	5,027.38	
II. Off-grid/ captive power (capacities in W_{EQ})					
Waste to Energy	**161**	**15**	**1.23**	**161.39**	
Biomass (non-bagasse) Cogeneration	**652**	**60**	**0.00**	**651.91**	
Biomass Gasifiers*					
-Rural	**18**	**2**	**0.00**	**18.15**	
-Industrial	**163**	**8**	**1.80**	**166.04**	
Total	994	85	3.03	997.49	
III. other renewable energy systems					
Family Biogas Plants*		100,000	900,00	4,864,000	

Biogas

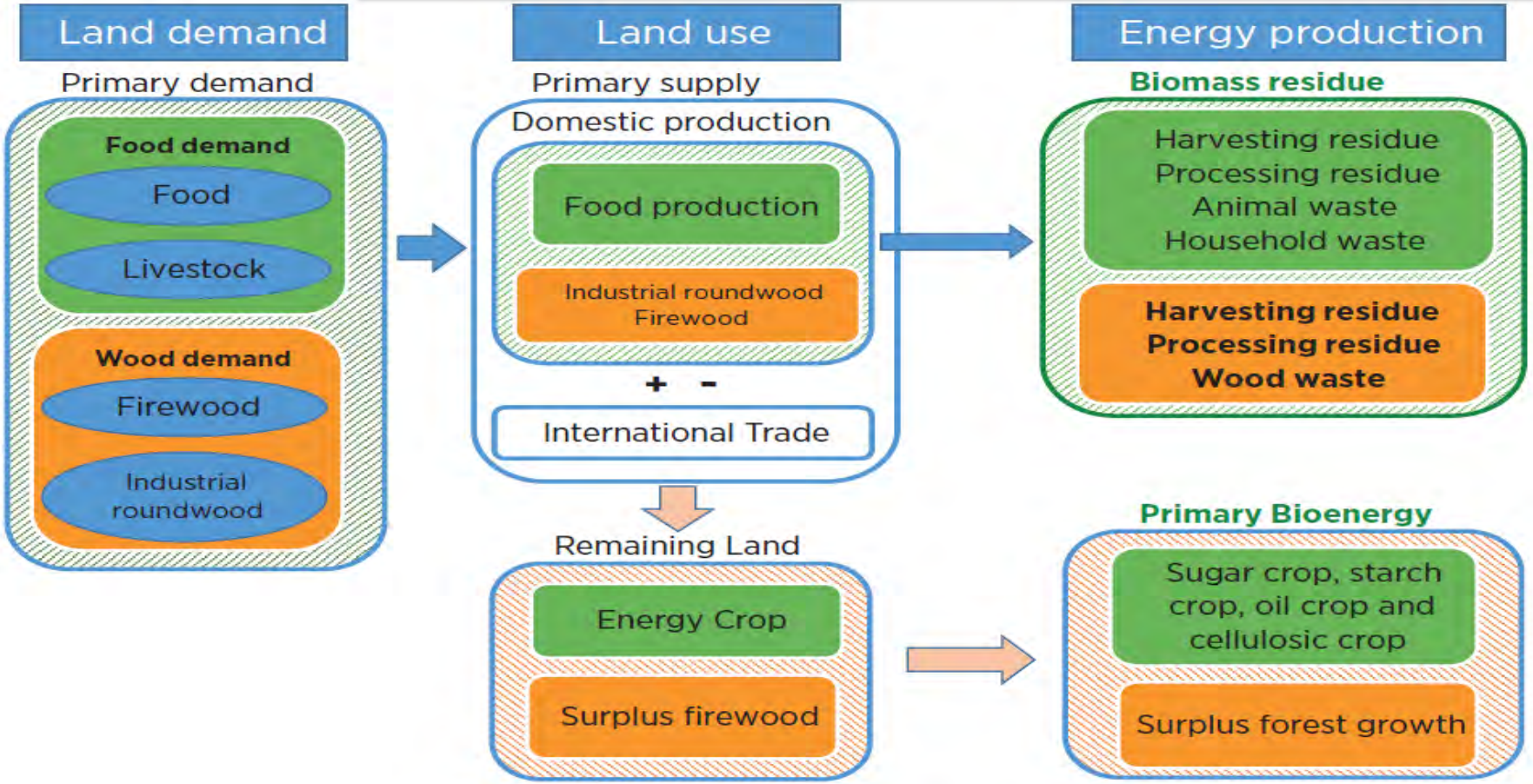
- **In 2014-15, about 20.70 billion cubic meters of Biogas is produced in the country which is equivalent to 5% of the total LPG consumption in the country.** The Government is also extending substantial subsidy for setting up of new Biogas
- Within states, Maharashtra tops the production with 3578 lakh Pradesh comes next with 2165 lakh cubic meters.
- Under the 12th five year plan (2012-2017), the government of 0.65 million biogas plants across the nation with a budget of called, the **National Biogas and Manure Management Program**

Supply and demand framework of bioenergy

Biomass energy comes from two different sources : Primary bioenergy, which uses farmland or forests to produce biomass; Other is biomass residue, which is generated as a by-product of food or wood products throughout their supply-consumption chain.

The potentials of four main types of biomass

Energy crops, including food crops; Forest products (fuelwood, residues and processing, and post-consumer waste); Agricultural residues (harvesting residue, processing residue & food waste); Animal manure.



Supply and demand framework biomass

- Rice is staple food crop in Asia, where 91% of it grown and consumed. Every 4 tonnes of rice grain, 6 tonnes of straw is produced.
- In India, 97.19 million tons of rice straw is produced every year, and around 23% of it is left unutilized. Mostly these are burnt in fields which emit GHG hazardous to human and ecosystem health.
- 61.1 million tons of fuel crop residue & 241.7 million tons of fodder crop residues are being consumed by farmers themselves.
- This can be freed up if alternatives are provided to them. **The survey shows that farmers are willing to sell crop residues provided they get decent remuneration and alternatives.**

Utilization of biomass waste

State Name	Biomass usage
Chhattisgarh	• 64% is consumed as animal fodder; 7.7% consumed for mulching & thatching. • Biomass power plants in the region consume about 18.4%. • Nearly 5% is imported (purchased) from Ambikapur & surrounding
Maharashtra	• 44% is used as animal fodder & 9% is consumed as domestic fuel. • Biomass power plants (Rake Power Ltd, Shalivahana Projects Ltd., Yavatmal) consume 8.6%. • Oil mills and brick kilns consume about 20% and 1.79%, respectively. • About 10% is exported outside the catchment area.
Rajasthan	• About 60% is used as animal fodder.; About 11% is consumed as domestic fuel. • Nearly 4.6% is consumed in Biomass power plants (Suryachambal Power Plant Ltd, Kota, Amrit Env. Technologies Pvt Ltd [AETPL], Kotputli) • Oil mills, brick kilns consume 6.9% & 3.4%, resp., 2% is exported outside catchment area; 4.6% is left in the fields to decompose or burnt in the fields.
Punjab	• 57% consumed as animal fodder;5.6% in regional Biomass power plants • About 17% is exported outside the catchment area. • About 12.5% of total biomass is left on the fields because of low density of fuel and lack of proper mechanical equipment to collect and transport the biomass resulting in low collection efficiency.

Conversion of Biomass to Biofuel Products

Feedstock Harvesting & Supply
- Agro Residues
- Dedicated Crops
- MSW & Industrial waste
- Algae

Logistics
- Collection
- Pre-processing
- Storage
- Transportation

Conversion

Thermochemical
- Combustion
- Gasification
- Pyrolysis
- Other

Biochemical
- Anaerobic (fermentation)
  - Anaerobic Digestion
  - Fermentation
- Aerobic
  - Composting
  - Activated (oxygenated) waste treatment
- Direct Hydrogen

Physicochemical
- Oil extraction
- Hydrocarbon extraction

Utilization

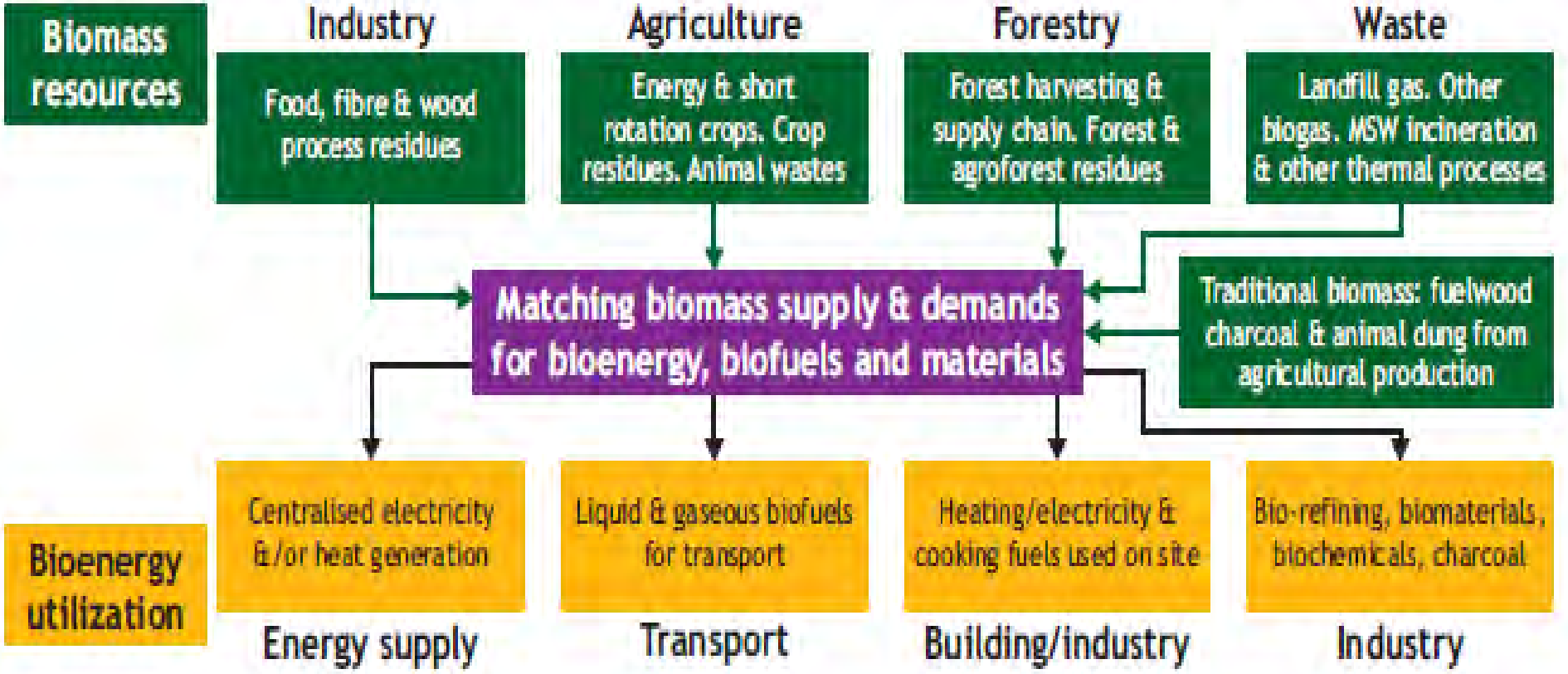
Biopower
- Process and Space Heating
- Power generation

Biofuels
- Ethanol
- Biodiesel
- Methanol
- Pyrolisis liquids
- Biogas (methane + CO_2)

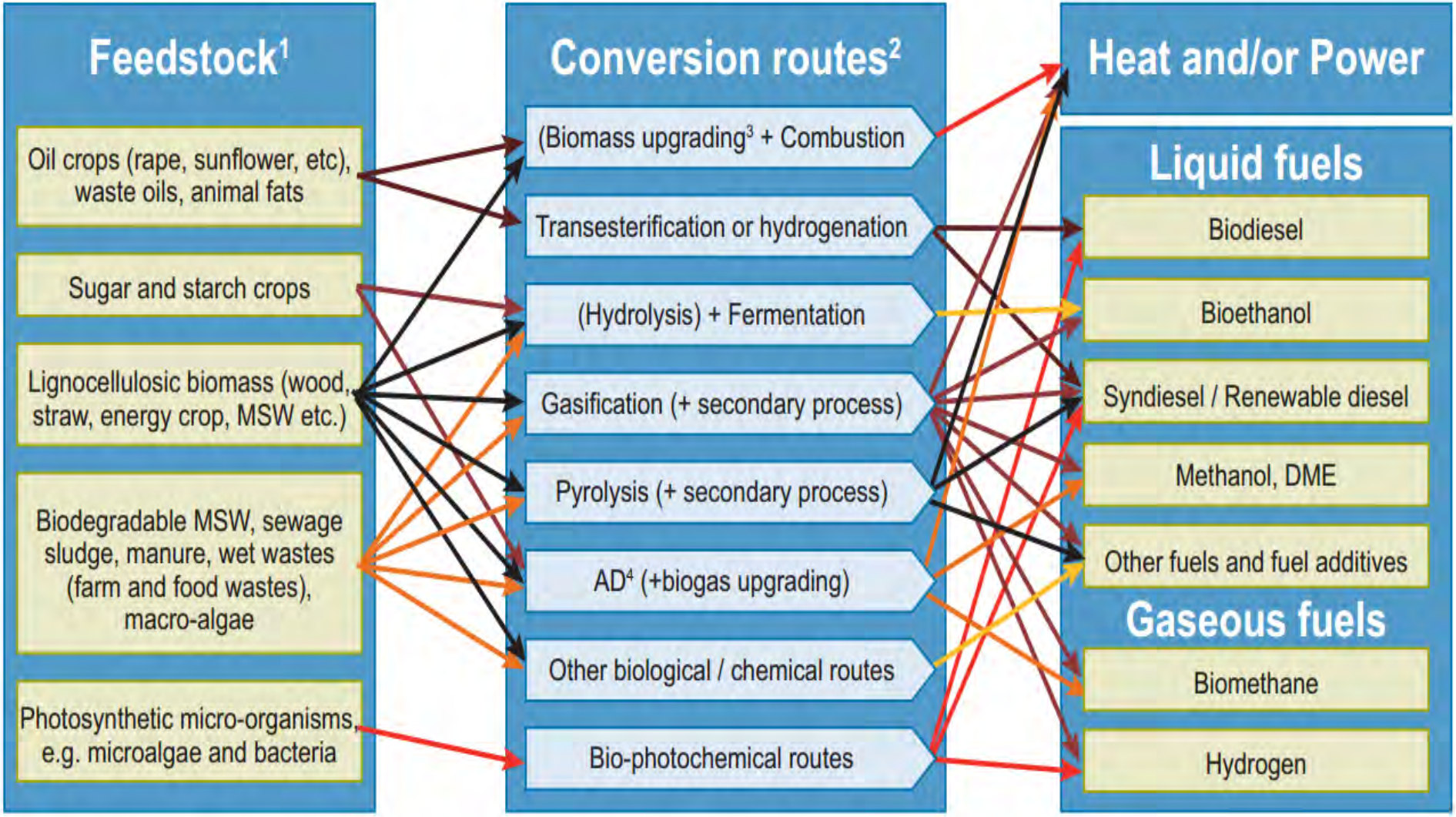
Synthesis gases (CO + H_2)
- Hydrogen
- Charcoal
- Biomass solids

Bio products
- Citric and other acids
- Composite materials
- Fertilizer
- Fibers
- Lubricants
- Pesticides
- Structural materials
- Surfactants

Biomass Resource converted to Bioenergy Carrier



Conversion of Biomass to Biofuel Products



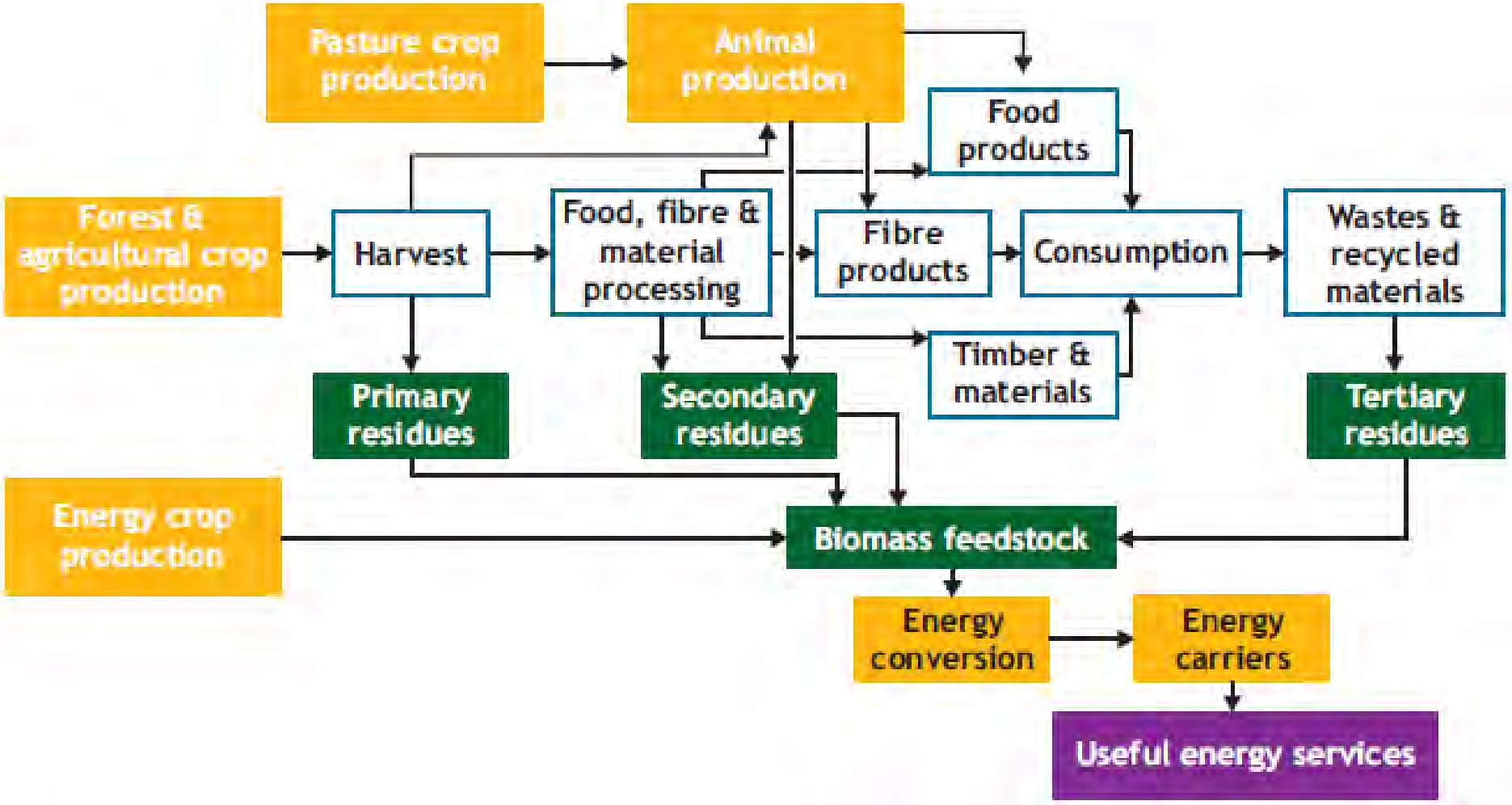
[1] Parts of each feedstock, e.g. crop residues, could also be used in other routes

[2] Each route also gives co-products

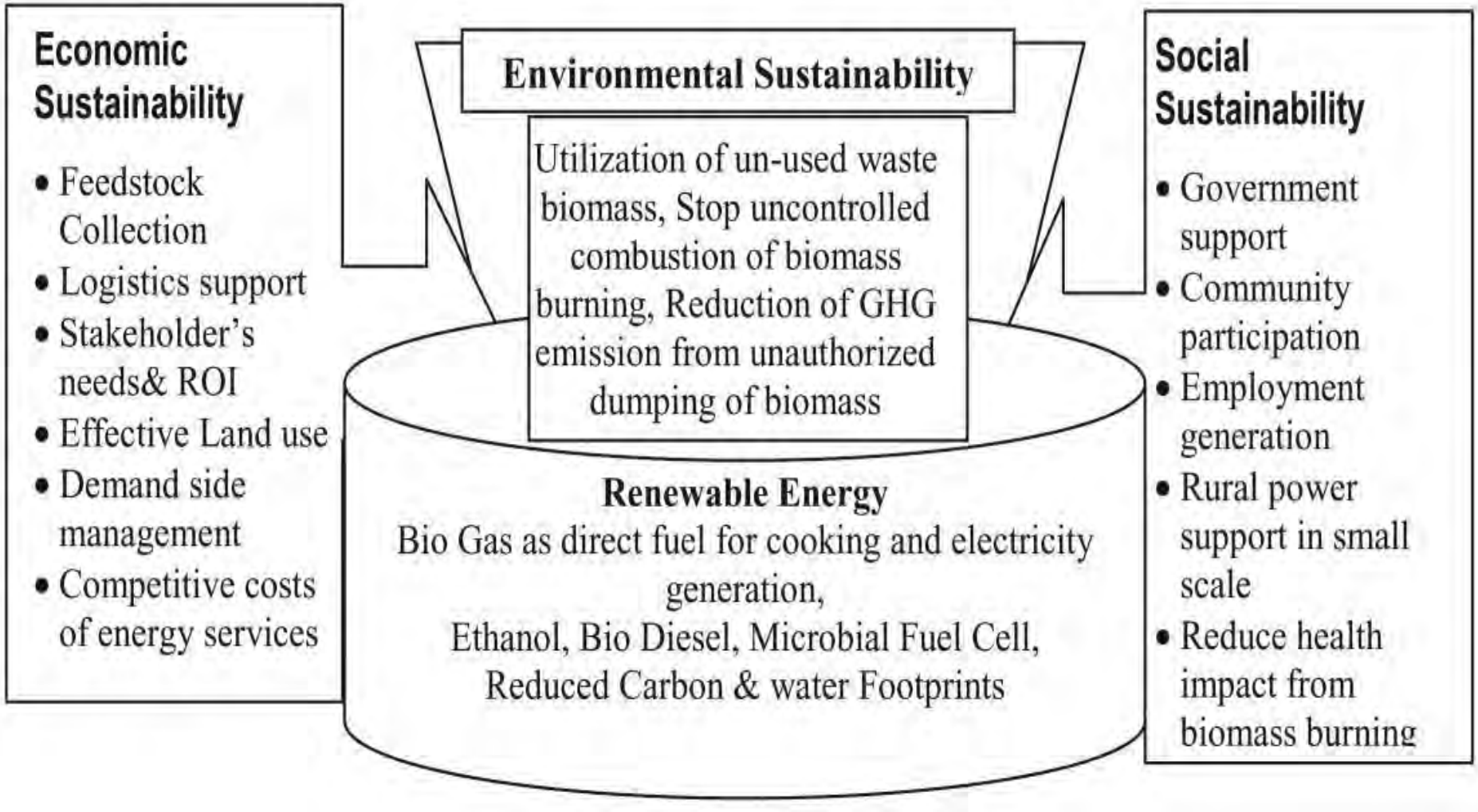
[3] Biomass upgrading includes any one of the densification processes (pelletisation, pyrolysis, torrefaction, etc.)

[4] AD = Anaerobic Digestion

Biomass Feedstock arising from residue and energy crop



Sustainable Model of Biomass production based on Triple Bottom line approach



Challenges

1. **Feedstock production**
2. **collection of biowastes , feedstock logistics,**
3. **Development of energy efficient technologies (pre-treatment, enzyme hydrolysis, and microbial fermentation),**
4. **Co-product development,**
5. **Establishment of biofuel and biochemical standards,**
6. **Biofuel distribution,**
7. **Societal acceptance, and**
8. **Environmental impact minimization.**

All the challenging areas require expertise in,

- agronomy, biomass logistics, biomass conversion, process engineering, chemistry, conversion technology, genetic engg, microbial fermentation, economics, and environmental science.
- In India, there is huge scope of utilisation of waste biomass in economic and environment friendly process.

Uncertainties

Some of the major barriers faced in faster realization of available biomass power potential for a variety of end user applications are,

(i) inadequate information on biomass availability,

(ii) absence of organized formal biomass markets,

(iii) problems associated with management of biomass collection, transportation, processing and storage; problems associated with setting up large size biomass plants,

(iv) Non-availability of cost effective sub megawatt systems for conversion of biomass to energy in a decentralized manner, and

(v) lack of capability to generate bankable projects on account of financial and liquidity problems,

(vi) Policy and regulatory framework, Local, social, & environmental impacts,

(vii) Technical assistance and O&M challenges,

(viii) Sustainable biomass fuel linkage,

(ix) Policy & regulatory support including incentives in different states,

(x) scaling up of different experimental research as implementable project, etc.

Ministry of New and Renewable Energy, GoI, Initiative

- **500 biomass power and cogeneration projects aggregating to over 5,940 MW biomass based power plants comprising 4,946 MW grid connected and 994 MW off-grid power plants.**
- **Major share of grid connected capacity from bagasse cogeneration & 115 MW is from WTE power plants.**
- **Off-grid capacity comprises 652 MW non bagasse cogeneration, mainly as captive power plants,**
- **18 MW biomass gasifier systems being used for meeting electricity needs in rural areas,**
- **164 MW equivalent biomass gasifier systems deployed for thermal applications in industries.**
- **70 Cogeneration projects are under implementation with surplus capacity aggregating to 800 MW.**
- Pioneer sates in implementation of bagasse cogeneration projects : Andhra Pradesh, Tamil Nadu, Karnataka, Maharashtra and Uttar Pradesh.
- The leading States for biomass power projects are Andhra Pradesh, Chattisgarh, Maharashtra, Madhya Pradesh, Gujarat and Tamil Nadu.

Some of the plants in India

Filling gasifier plant with rice husk, Tamkuha.

Dhaincha is the main fuel for SRE's gasifier plant, in Bihar, India

(Source: http://www.ashden.org/winners/husk11 02.10.2016)

30 MW Cogen Power Plant at Sahakarmaharshi Bhausaheb Thorat Sahakari Sakhar Karkhana Ltd., Sangamner, Maharashtra

10 MW Grid Connected Biomass Power Plant at Thimmapur Village, Dist. Haveri

30 MG cogen power plant and 10 MW Biomass Power Plant connected to grid in India

Some Plants in India

Biogas bottling project at Singla Bio-Energy, Vill.–Siaghawali, Teh.-Sadulsehar, Dist.–Sri Ganganagar (Rajasthan)

Equipment for gasification of pine needles

10 MW Biomass Power Project, Wadsa; Gadchiroli District (Maharashtra State

Project Description

Operational from 30/04/2010;
Capital cost about USD **9** Million.
Feedstock: rice husk/other available biomass & purchased from the open market to meet the needs of Raw Material.
oProposed expansion 10 MW to 17.5 MW.

30 MW Bagasse Cog eneration pr oject at a Sugar Mill in Maharashtra

- Commissioned :14.12.2009.
- Mainly operate on mill bagasse during 160 season days of the sugar mill and saved bagasse, cane trash & imported coal for 65 off-season days.
- Use 2.55 MW for self-consumption and remaining 27.45 MW sale to MSEDCL for at a tariff of 4.79/unit.

Project Description:

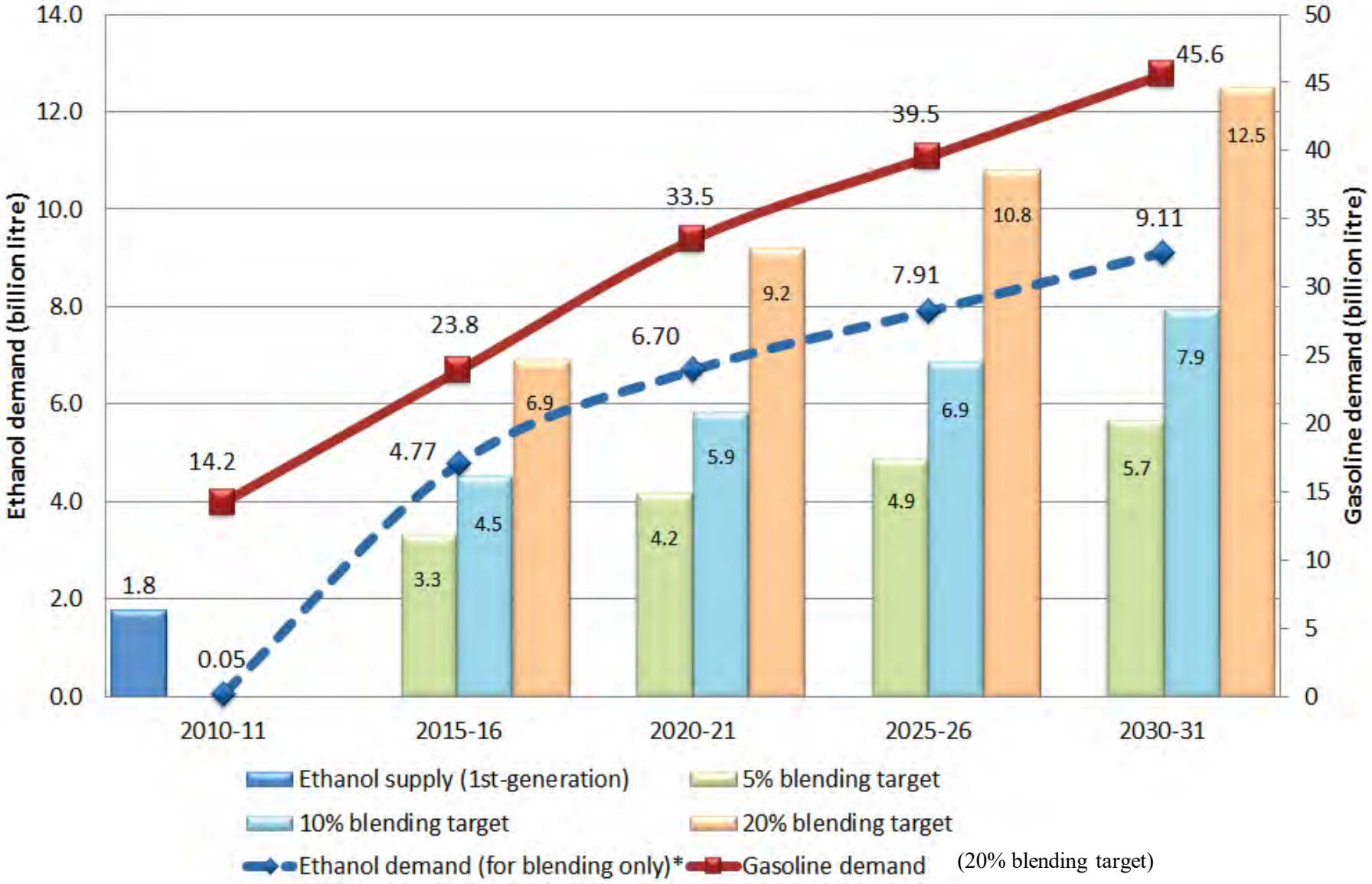
- Commissioned : 22/ 03/2006
- Biomass residues used as fuels are Prosopis Juliflora, Coconut Residues, Sugar Cane trash and Ground nut residues etc.

7.5 MW Biomass based Power Plant at Sipcot Industrial Complex, Pudukottai Dist., Tamilnadu

India state-wise/year-wise list of commissioned biomass power/cogeneration projects (as on 01.04.2016)

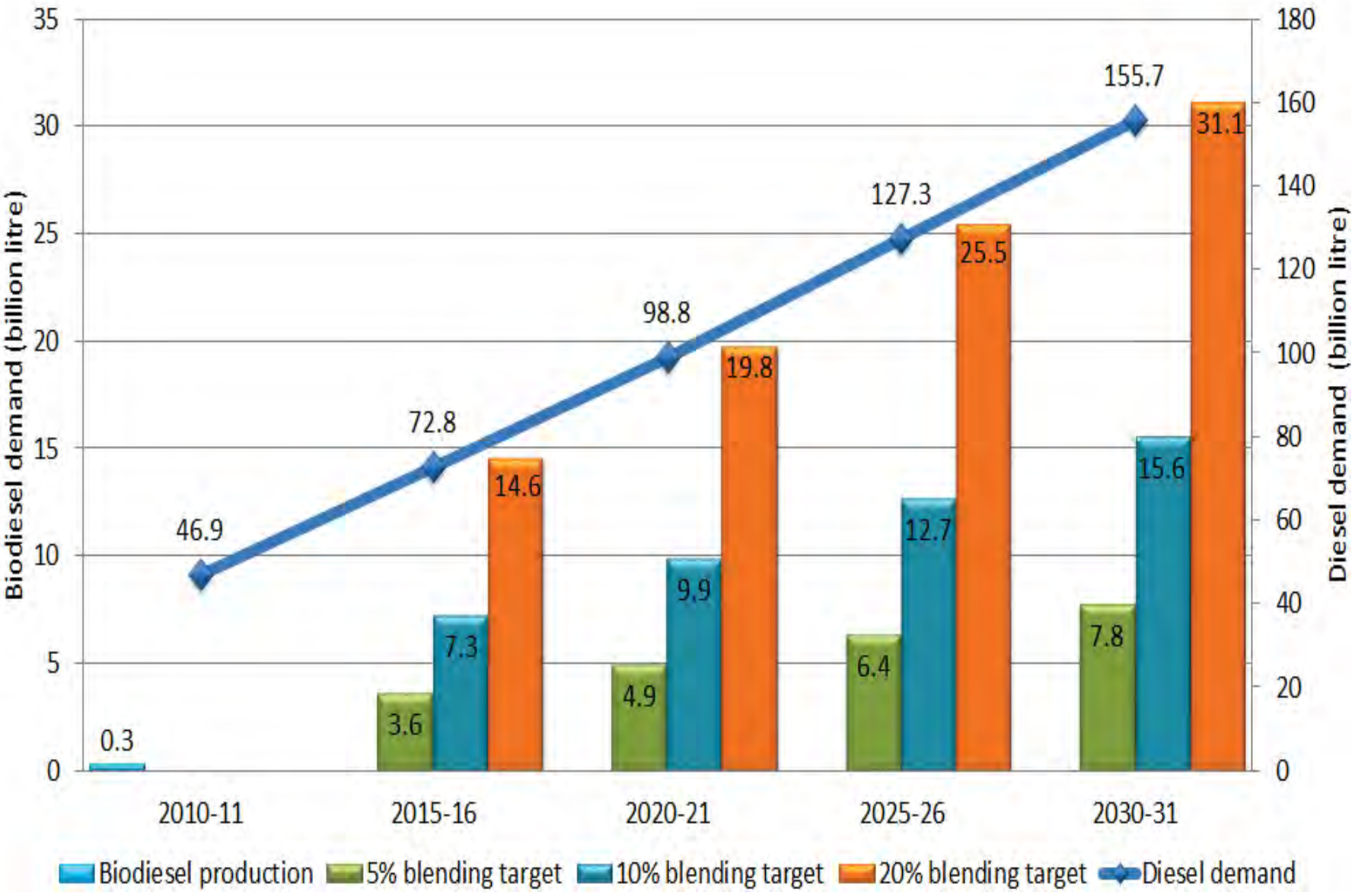
Sl.	State	Upto 31.03.2012	2012-13	2013-14	2014-15	2015-16	Total (in MW)
1	Andhra Pradesh	363.25	17.5				380.75
2	Bihar	15.5	27.92				43.42
3	Chattisgarh	249.9		15	15		279.9
4	Gujarat	20.5	10	13.4	12.4		56.3
5	Haryana	35.8	9.5				45.3
6	Karnataka	441.18	50	112	111	158	872.18
7	Madhya Pradesh	8.5	7.5	10	9		35
8	Maharashtra	603.7	151.2	185.5	184	96.38	1220.78
9	Odisha	20					20
10	Punjab	90.5	34	16	15		155.5
11	Rajasthan	83.3	10	8	7		108.3
12	Tamil Nadu	532.7	6	32.6	31.6	39	626.9
13	Uttarakhand	10		20	20	13	50
14	Uttar Pradesh	644.5	132			93.5	842
15	West Bengal	16	10				26
	Total	3135.33	465.6	412.5	405	400	4831.33

Ethanol demand with blending targets (%) in India



(20% blending target)

Biodiesel demand with blending targets (%) in India



Energy recover from biomass Plants in India

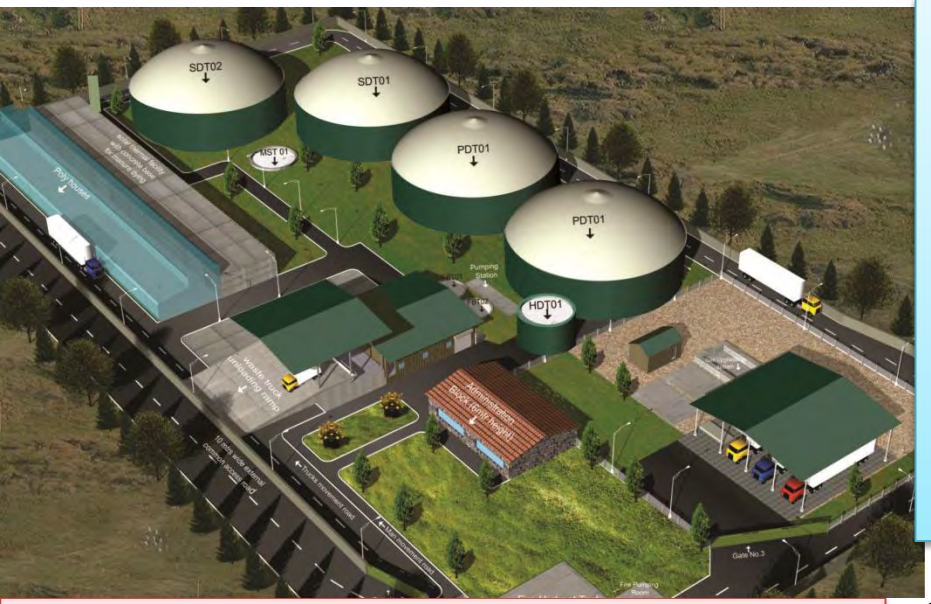
Biomass gasification system, Karnataka

20 tpd Potato waste based biogas plant at ITC Foods Ltd., Ranjangaon, Pune,

Waste to Energy in Okhla, Delhi

Biomass to Energy, Karimnagar

Biogas Plants in India by Mailhem



2 of the world's largest capacity AD Plants, dedicated food waste processing plants, are being designed on 'build, own and operate' basis by NEX - located at **Bangalore (400 TPD)** and **Pune (500 TPD)** partly commissioned in 2015. - When fully commissioned we will process 328,000 tons of food waste every year, converting that into 16,400 TPA of Compressed Bio Gas and 32,000 TPA of Organic Fertilizers

- 5 TPD Segregated Organic Solid Waste – **Pune Municipal Corporation,** Maharashtra,
- 6TPD Segregated Organic Food/Canteen
- Waste – **Tata Motors Ltd., Pune**

3000 kg/day Biogas Plant at **Wipro Technologies Ltd., Bangalore,**

- 200cum Biogas generated from treatment of Cowdung – **University of Agricultural Sciences, GKVK, Mandya, Karnataka, India**

PLANTS

- 1000 kg/day Biogas Plant at **Mangalore Refineries Petrochemicals Ltd, (MRPL) Mangalore**
- **0.4 MLD Leachate** from Compost Plant and 10 TPD organic wastes for **Nashik Municipal Corporation, Maharashtra, India**

Scaling up the DBT-ICT 2G-bioethanol technology

Lab scale process
(1 kg/day)
2009- present

Pilot Plant
(1 ton/day)
2010-2013

Pre-commercial scale
(10 ton/day)
Feb - 2016

30 MTPD Multifeedstock Biodiesel Processing Plant in Kolkata, WB

Project Description:

- Capable of Producing Biodiesel from Karanj oil, Madhucha oil, Neem oil, Jatropha oil, Animal Tallows, Acid Oils (RiceBran, Palm etc).

1.0 MW power project based on cattle dung at Haebowal Dairy Complex Ludhiana, Punjab

- Commissioned on 4/11/04 .
- Power generation from cattle manure .
- About 21000 kWh and 70 TPD organic manure from 235 TPD cattle manure.
- Cost – INR 136 Million .
- PLF of over 90% .

1.2 MW power project based on cattle manure, Dairy Colony in Jabalpur

Biomethanation project for solid waste at Slaughterhouse in Andhra Pradesh

Biomethanation of Tapioca Processing wastewater at Varalaxmi Starch, Salem

- Commissioning: Feb,2003.
- Hybrid Upward flow sludge media anaerobic reactor Technology.
- Energy generation from the plant: 500 kW.

Biomass supply cost

- **The price for primary biomass is determined by three factors :**

1. the supply side factor (technically achievable biomass supply volume with associated cost),
2. the demand side factor (energy demand, land demand associated with food and feed production/energy crop production/and other usages, the price of competing usage (i.e., fossil fuel price, food price), and
3. the policy factor (i.e., tax incentives, blending mandate).

- **In India, no reliable statistics is available for the price of the residue and waste biomass. The supply cost of each biomass type can be estimated for each region and a bottom-up approach can be applied to estimate the total cost.**

Framework for Biomass utilisation for BoP group for local Economy & inclusive Development

Biomass, generation from Agriculture Field , Forest & industry, e.g., rice straw, rice husk, saw dust, wheat husk, jute stick and bagasse

- **Biomass from Industries, Bagasse, jute sticks etc.**
- **Biomass out of MSW**

Collection of Biomass from generation point

- **Transportation by organised Industries**
- **Collection by BoP groups Manuall**
- **Effective supply chain for Collection of Biomass up to utilisation point**

Utilisation for Local Economy Development

- Pre treatment
- Cooking
- Manufacturing products
- Selling products & biogas using technology
- Government Support
- Training BoP group
- Intervention of MNC

Overcoming barrier & encouraging benefits
Government initiatives & support

- India has adopted agenda and actions based on the UN post-2015 development agenda – Transforming our world: the 2030 Agenda for Sustainable Development, with 17 Sustainable Development Goals (SDGs) for the people, planet and prosperity reflecting the commitment of shifting on to a sustainable and resilient path.
- **Integrated Bio Energy Mission** would be to contribute to achieve the GHG emissions reduction targets as agreed in the Nationally Determined Contributions at COP 21
- The indicative outlay for the Mission would be INR 1,000 billion from 2017-18 to 2021-22.

Overcoming barrier & encouraging benefits

Government initiatives & support

- National Policy on Biofuels for Development and utilization of indigenous non-food feed stocks raised on degraded or waste lands,
- thrust on research and development on cultivation, processing and production of biofuels and a blending mandate of 20% Ethanol and Bio-diesel by 2017.
- The ministry supports R & D projects for development of technologies for production of biofuels through Biogas, Pyrolysis and Gasification,
- Promoting deployment of technologies for pilot and full-scale projects on biofuels in general.

Overcoming barrier & encouraging benefits
Government initiatives & support

- **Besides the Central Financial Assistance, fiscal incentives, concessional import duty, excise duty, tax holiday for 10 years, bank loans of up to INR 1.5 billion for biomass-based power generators for Biomass power projects.**
- **The benefit of concessional custom duty and excise duty exemption are available on equipments required for initial setting up of biomass projects based on certification by Ministry.**
- **State Electricity Regulatory Commissions have determined preferential tariffs and Renewable Purchase Standards(RPS).**

Overcoming barrier & encouraging benefits
Government initiatives & support

- **Indian Renewable Energy Development Agency (IREDA) provides loan for setting up biomass power and bagasse cogeneration projects.**
- **MNRE to request all the States, to create a rational and uniform taxation structure to supp**
- **Initiate extending all benefits available to other renewable sectors such as customs and excise exemptions, tax holiday etc., to the biofuels sector for it's growth.**

Implication towards SDGs

- **To end the poverty in all its forms everywhere** : All India Poverty Head Count Ratio (PHCR) has been brought down from 47% in 1990 to 21% in 2011-2012, nearly halved which is still in its continually enhanced performance in 2016.
- **India will ensure availability & sustainable management of water and sanitation** for all and build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation through it Swachh Bharat Mission (SBM) and other new initiatives.
- **India's CO_2 emissions per capita 1.8 tons in 2014,** one of the lowest in the world, the global average being around 4-5 tons.

Implication towards SDG

- India is the 4th largest GHG emitter, responsible for 5.3% of global emissions. ***India has committed to reduce the* GHG *emissions intensity of its GDP by 20% to 25% by 2020.***
- Per capita consumption of electricity has reached 1075 kWh in 2015-16, compared to the global average of 2977 kwH at nearly 1/3rd . Energy from biomass wastes help reducing CO_2 emissions.
- **To make cities and human settlements inclusive, safe, resilient and sustainable,** India has very recently taken the Smart City Programme.
- 68% of India's total population lives in rural areas (2013-14). India is expected to be home to 6 mega-cities with populations above 10 million by 2030. Currently 17% of India's urban population lives in slums.

Conclusion

1. India has a promising Programme for economic utilisation of biomass wastes having positive implication on SDGs.
2. Supply chain of biomass wastes need to be mapped for effective utilisation & economic transportation.
3. 'anchor suppliers' for Biomass waste & biomass treatment facilities from among existing concentrated sources of biomass like sugar mills / rice mills / ULBs appointed vendors.
4. Co-operatives or other local bodies could be encouraged to collect and supply fixed amount of other types of crop residues over a sustained period, the way milk is collected by large cooperatives in many states of India.
5. Standard business cases & effective detailed Project Reports (DPR) for small scale biomass utilisation projects for success.

Conclusion

6. Standard business cases & effective detailed Project Reports (DPR) for small scale biomass utilisation projects for success.
7. Capacity Building for farmers and others stakeholders including government representatives, Politicians.
8. Government support, Research and collaboration, Resource Efficiency, Resource Productivity and standardisation of the energy recovery and possible products from waste biomass need to strengthen in India
9. Rehabilitation programme of BoP group handling Biomass wastes for organised business models. Appropriate Environmentally Sound Technology (EST) for effective utilisation of waste biomass of available character in India in also a need.
10. Standardisation of the energy recovery and possible products from waste biomass by National Standard institutions, e.g., BIS in India.
11. Government policy and Encouraging employment generation.

Questions to address

- How biomass can be made available and recoverable in organised way?
- What is the potential economic utilization of biomass wastes?
- What are the key uncertainties for biomass prospects in India?
- What will be the supply cost and future price of biomass?
- What role government is playing to strengthen biomass deployment ?
- What are the implications towards SDGs?

Questions to address

- What are the gaps between the implementation of different schemes and the reality of economic utilisation of biomass?
- What is the sustainable business model for economic utilization of biomass waste through small business near the biomass generation points?
- What strategies should be adopted to reduce CO_2 emissions per capita and inclusive development by involving the base of the pyramid (BoP) people supported by Multi National Companies and the local governments?

Questions to address

- Is biomass waste a grossly neglected area in Asia and the Pacific?
- What is the cost of inaction?
- What circular economic opportunities can 3R offer in rural areas of Asia Pacific?
- How can Asia Pacific countries strengthen the policies, programmes and institutions to enhance circular economic utilisation of rural and biomass waste towards sustainable regional development?
- What is possible means to stimulate long-term investment on rural resources and waste management? What potential roles can the private and business sectors play in rural resources and waste management?
- What critical lessons can we learn from the Indian case of biomass utilisation? How crucial are they in the context of SDGs?

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