



IIT ROORKEE



NPTEL ONLINE
CERTIFICATION COURSE

WASTE TO ENERGY CONVERSION

INTRODUCTION -2

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CHEMICAL ENGINEERING



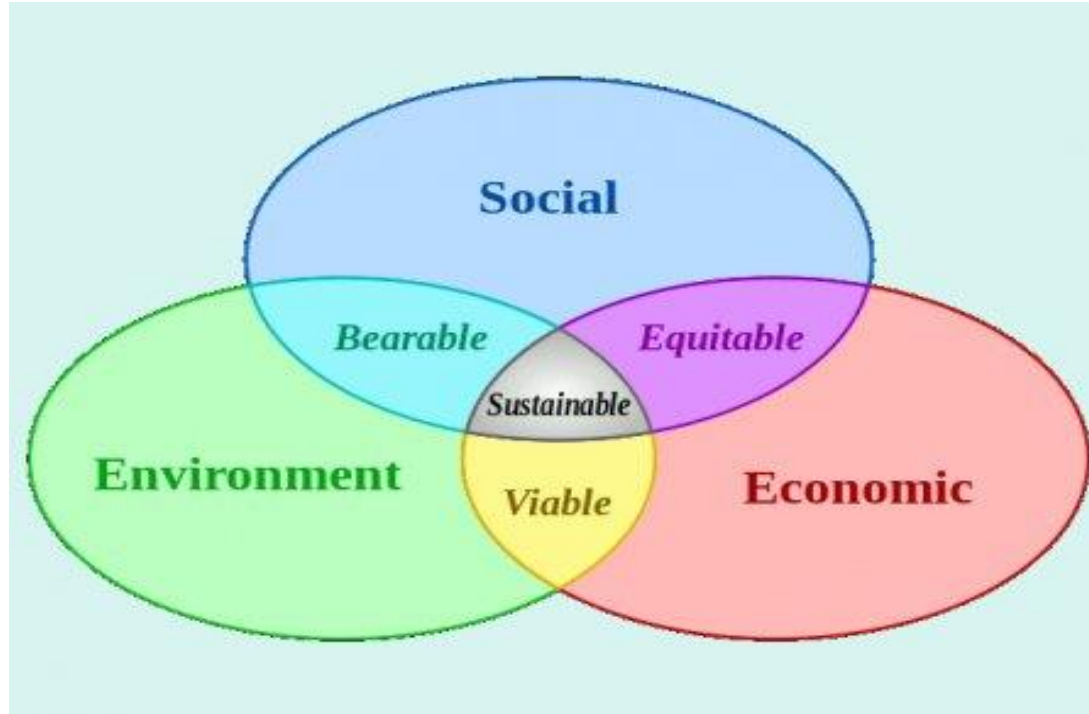
- Definition of wastes and their classification,
- Important quality parameters of different types of wastes
- Wastes suitable for energy production
- Solid wastes and their classification
- Waste water and their classification
- Availability of agro based, forest, industrial and municipal solid wastes in India, vis-a-vis world
- Availability of Wastewater in India, vis-a-vis world
- Routes for solid wastes management
- Need of energy production from wastes
- Energy from wastes, some scenario
- Routes for energy production from wastes

Need of energy production from wastes

- Need of sustainable development
- Increasing generation of wastes and power demand
- Energy potential of some solid waste components and waste waters
- Reduction of inert in MSW



For sustainable development



Source: https://en.wikipedia.org/wiki/Social_sustainability

Venn diagram of sustainable development at the confluence of three constituent parts

Impacts of improper solid waste management

1. It causes: Air pollution, Water pollution and soil pollution
2. MSW clogs drainage system, i.e creating
 - a) Stagnant water for insect breeding
 - b) Floods during rainy season
3. Green house gases are generated from landfills because of decomposition of organic wastes
4. Health problems such as
 - a. Nose & throat infection
 - b. Breathing infection
 - c. Bacterial infection etc.

Comparison between the per capita MSW generation rates in Low, Middle and High Income Countries

Country	Per Capita Urban MSW generation (Kg/day)	
	1999	2025
Low income countries	0.45-0.9	0.6-1.0
Middle income countries	0.52-1.1	0.8-1.5
High income countries	1.1-5.07	1.1-4.5

Source :Ranjith Annepu Thesis 2012, Earth and Environmental Engineering, Columbia University. NJT

City	MSW generated (TPD)	Calorific value (MJ/Kg)	Power production potential (MW)
Greater Kolkata	11,520	5.0	129.9
Greater Mumbai	11,124	7.5	186.6
Delhi	11,024	7.5	186.6
Chennai	6,118	10.9	149.0
Greater Hyderabad	4,923	8.2	91.0
Greater Bangaluru	3,344	10.0	74.9
Pune	2,602	10.6	61.8

Source: Ranjith Annepu Thesis 2012, Earth and Environmental Engineering, Columbia University. NJT

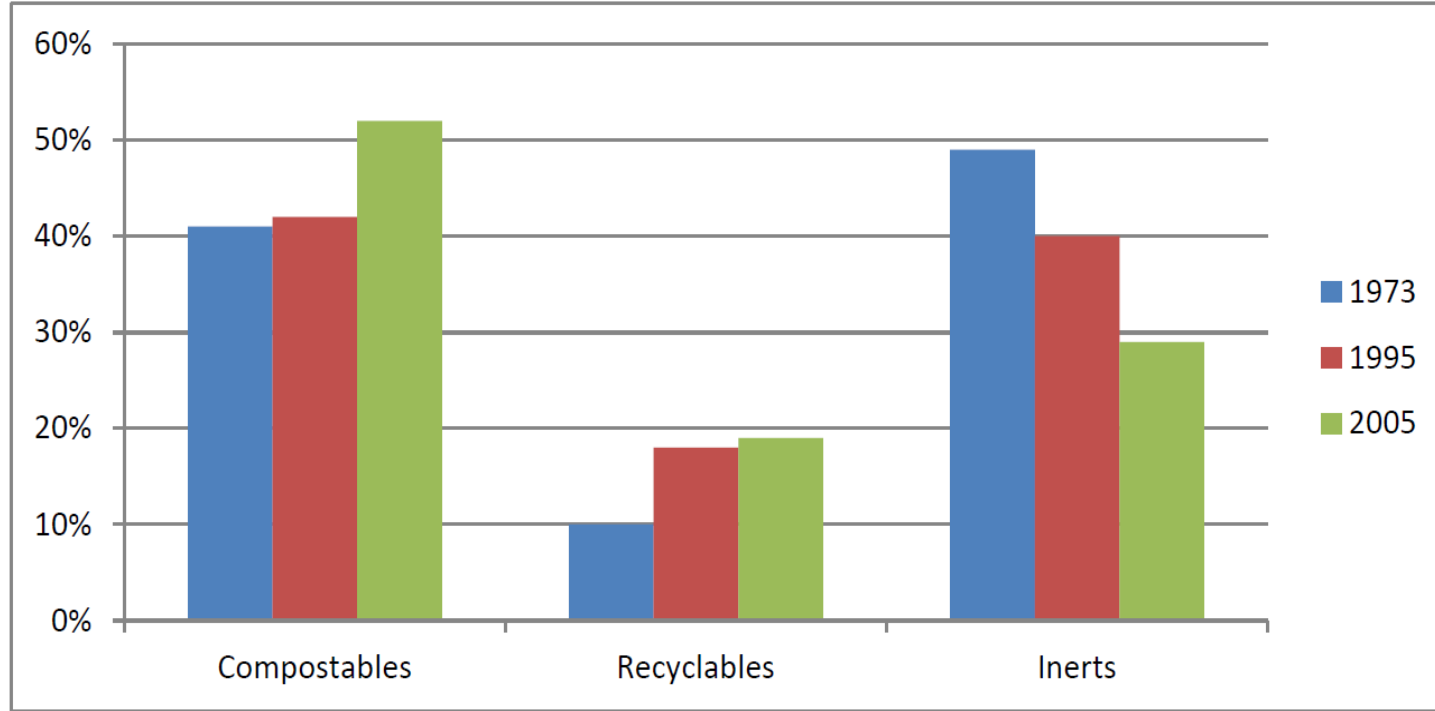
City	MSW generated (TPD)	Calorific value (MJ/Kg)	Power production potential (MW)
Ahmadabad	2,518	4.9	27.9
Kanpur	1,756	6.6.	25.9
Surat	1,734	4.1	16.1
Kochi	1,366	2.5	7.6
Jaipur	1,362	3.5	10.7

Similar kinds of data is available for 59 cities of India, the total of these cities are :

Total	81,407		1292
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Source: Ranjith Annepu Thesis 2012, Earth and Environmental Engineering, Columbia University. NJT

Change in Composition of Indian MSW since 1973, through 1995 and 2005



Source : Ranjith Annepu Thesis 2012, Earth and Environmental Engineering, Columbia University. NJT

	Population without access (million)			Share of population without access		
	Rural	Urban	Total	Rural	Urban	Total
Uttar Pradesh	80	5	84	54%	10%	44
Bihar	62	2	64	69%	19%	64
West Bengal	17	2	19	30%	7%	22
Assam	11	0	12	45%	9%	40
Rajasthan	10	0	11	22%	2%	187
Orissa	10	0	11	32%	4%	27
Jharkhand	8	0	9	35%	4%	27
Madhya Pradesh	7	1	8	16%	3%	12
Maharashtra	6	1	6	11%	2%	7
Gujarat	2	2	3	7%	6%	6
Chattisgarh	2	0	3	14%	6%	12
Karnataka	1	0	1	5%	1%	3
Other states	3	2	6	2%	2%	2
Total	221	16	237	26%	4%	19%

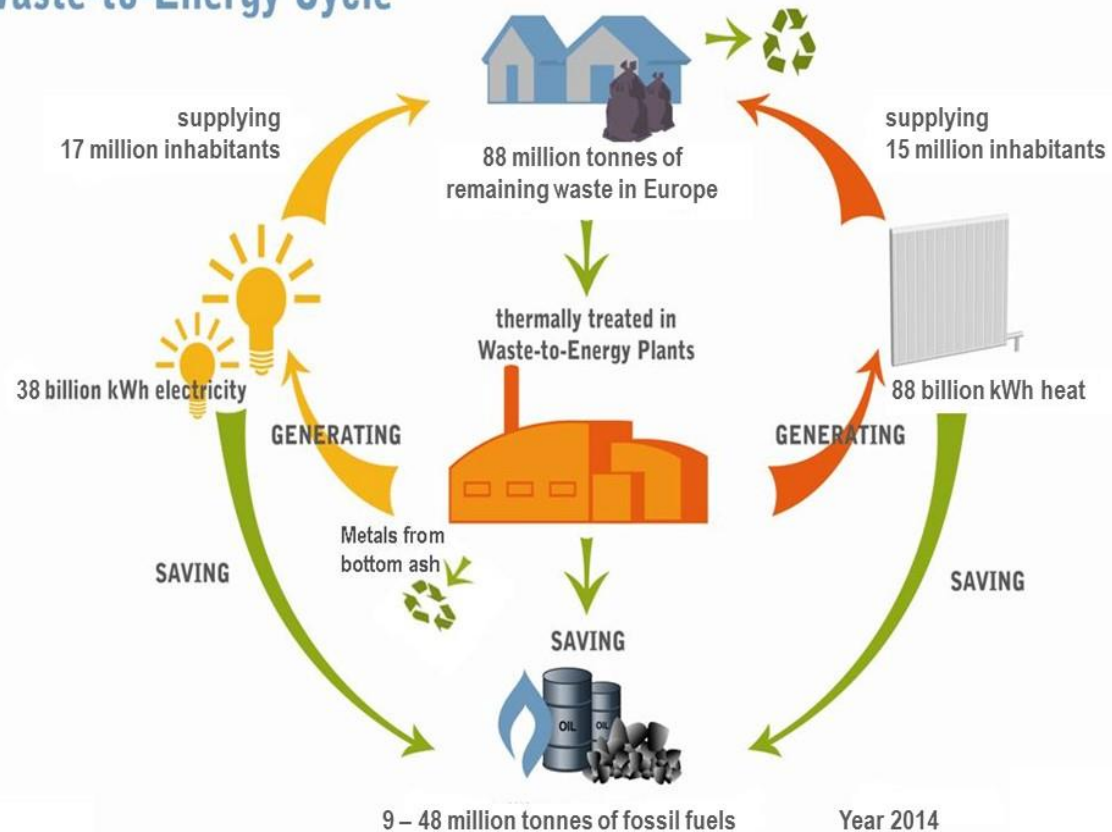
- Waste-to-energy or WTE technologies use municipal solid waste or any waste material containing huge amounts of renewable and biological materials to generate heat, electricity, and fuel through several complex conversion methods.
- The considerable amount of municipal solid waste around the world has given the waste-to-energy technologies a new lease of life and the much-needed impetus. Several environmentalists and other players such as Foster Wheeler, ABB, and China Everbright are working towards for commercializing these waste materials into a viable fuel source.

Energy from wastes, scenario

Across the EU27, over 400 such waste-to-energy plants are currently operating (implying a market share for CNIM of 30-35%) – these plants incinerate approximately 22% of total municipal waste and the volume of waste incineration is rising:

Source: www.cewep.eu

Waste-to-Energy Cycle



National markets, United kingdom, Data appendix(Plants)

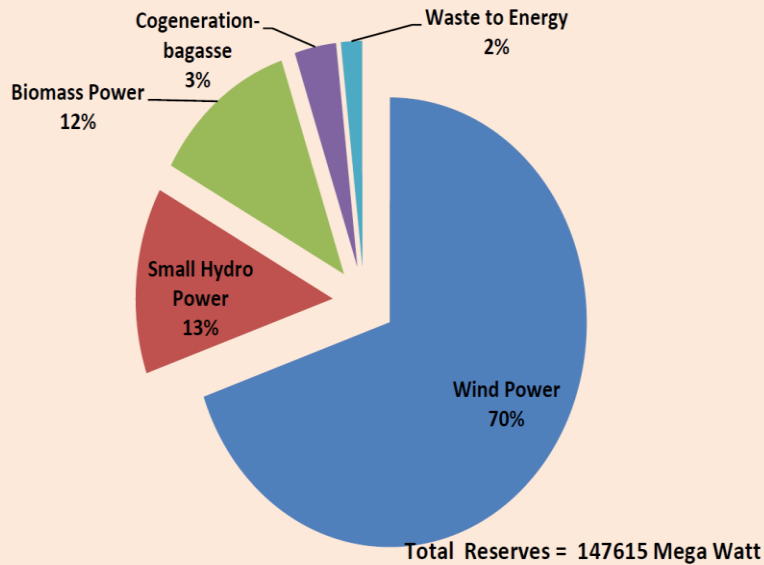
Plants	Status	Capacity (t/a)	Power production Capacity(MW)	Heat production capacity(MW)
United Kingdom				
Billingham	Active	360960	29.2	-
Billingham 2	Active	291840	21.0	-
Belfast east RDF	Planned	120000	-	-
Bilstthrope	Discussed	95000	13.6	-
Belfast RDF	Discussed	211000	14.0	10.0

National markets, China, Data appendix (Plants)

Plants	Status	Capacity (t/a)	Power production Capacity(MW)	Heat production capacity(MW)
China				
Fen yang	Active	576000	12.0	-
Foshan1	Active	479232	30.0	121.5
Fuqing	Active	300000	14.8	-
Fuyang	Under construction	224000	12.0	-

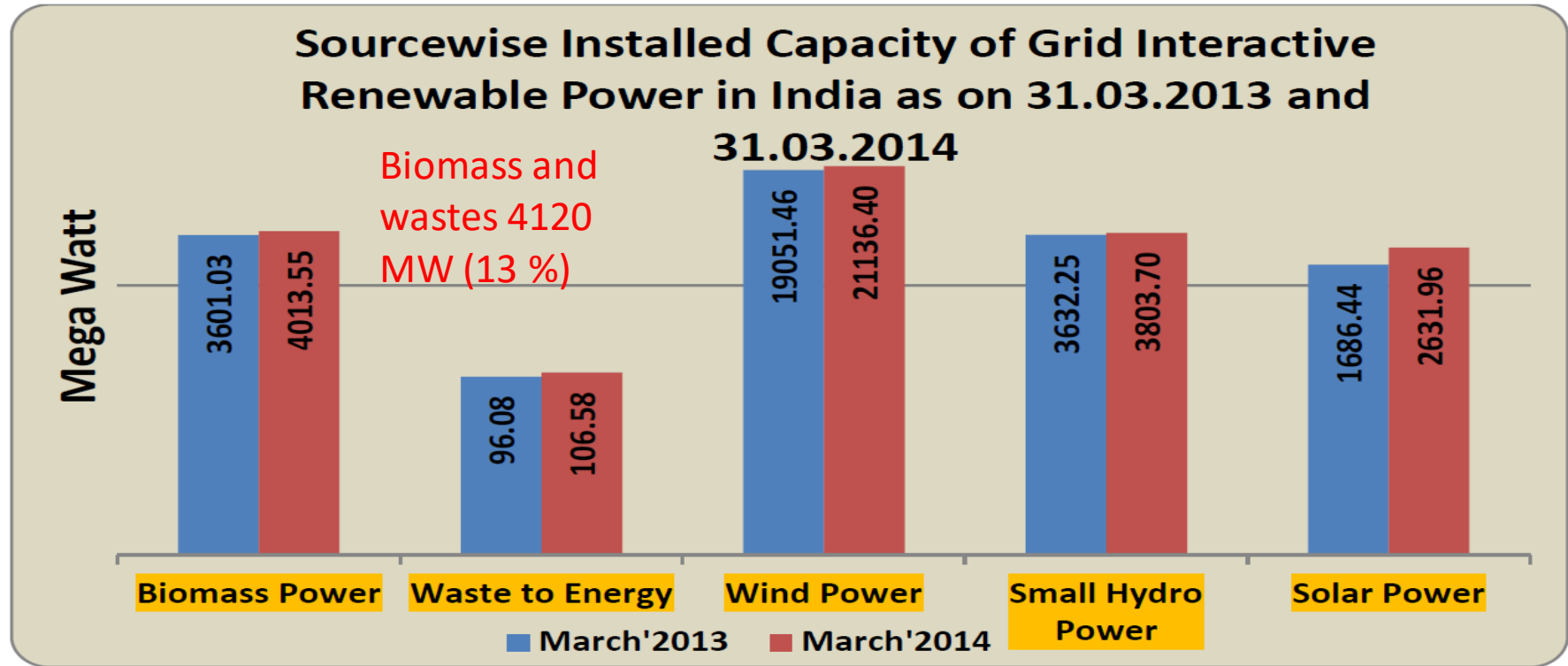
Energy from wastes contd..

Sourcewise Estimated Potential of Renewable Power in India as on 31.03.14

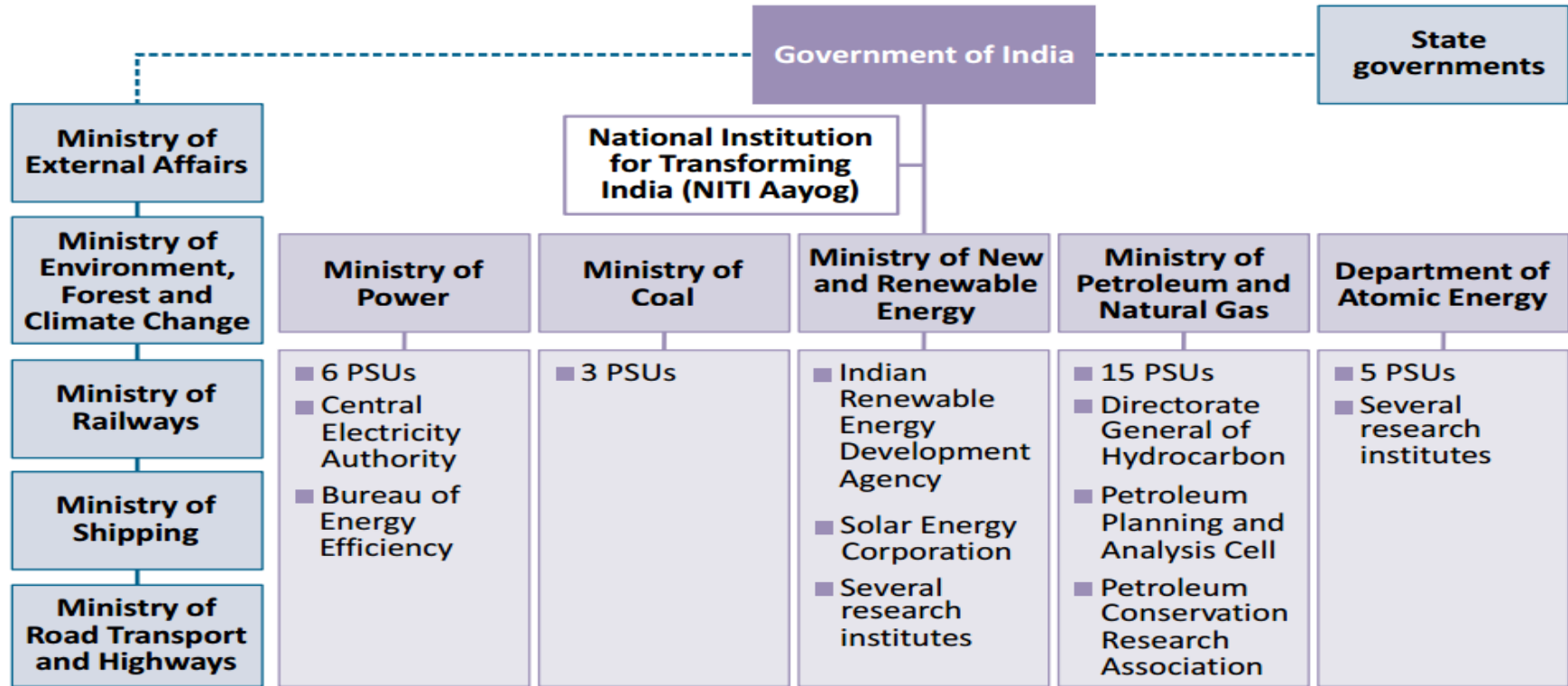


Source: Energy Statistics 2015,
www.mospi.gov.in

- Total installed capacity for electricity generation in India as on 31.03.2014 is ~245,259 MW (Annual growth 7.84 %)
- Renewable 31692 MW (13%).
- The total potential for renewable power generation in India as on 31.03.14 is estimated at 147615 MW (21 % is utilized in 2014)
 - Wind power potential of 102772 MW (69.6%),
 - SHP (small-hydro power) potential of 19749 MW (13.38%), Biomass power potential of 17,538 MW (11.88%)
 - and 5000 MW (3.39%) from bagasse-based cogeneration in sugar mills.

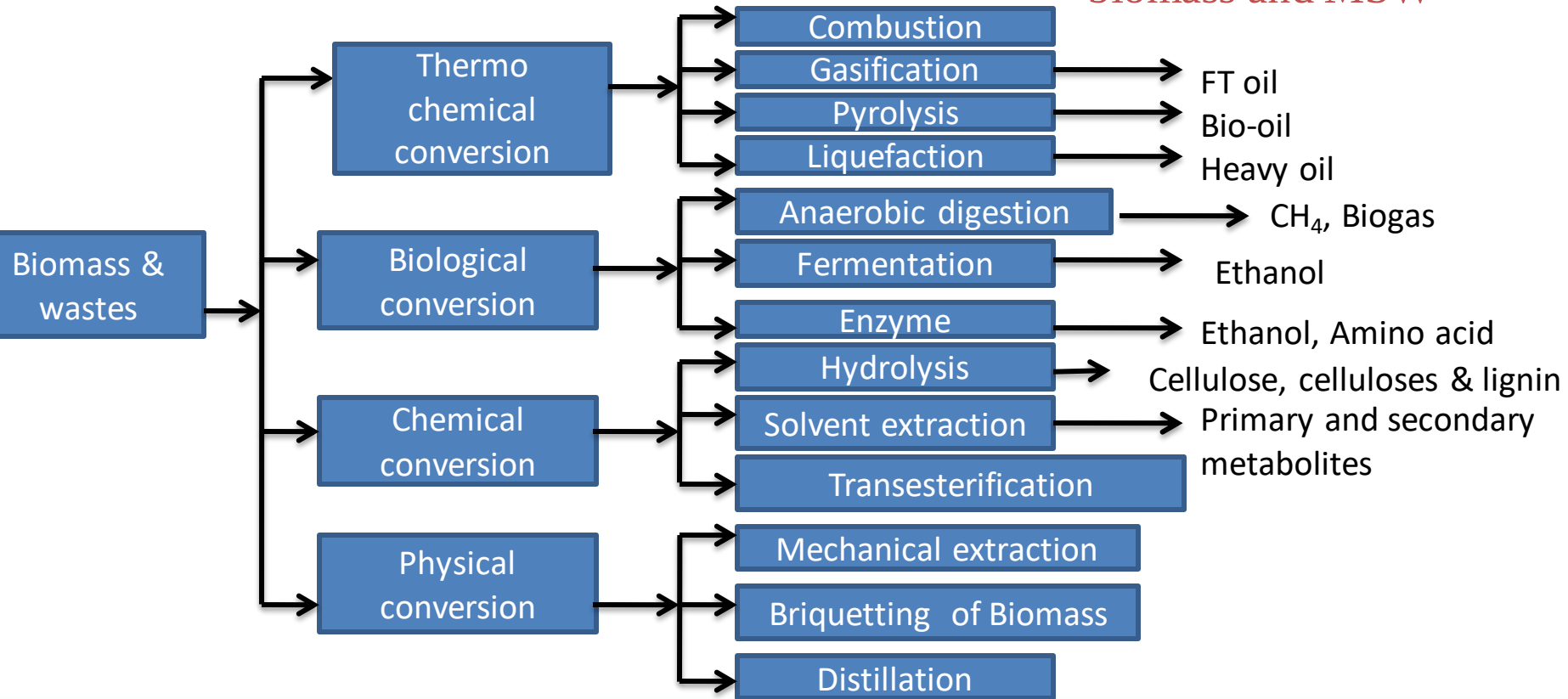


Source: Energy Statistics 2015, www.mospi.gov.in



Source : India Energy outlook, World Energy Outlook Special Report, IEA2015

Routes for energy production from wastes



Routes for energy production from wastes

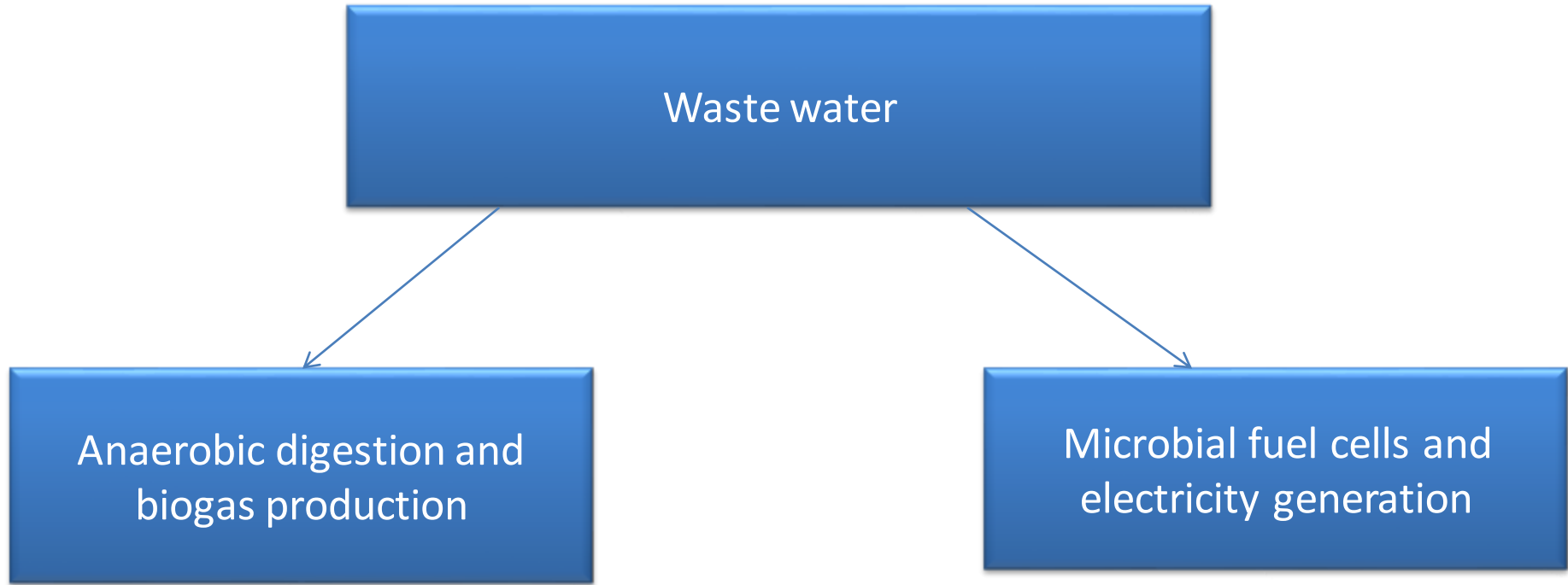
Thermochemical vs. biological conversion

Thermo chemical	Biological
Effectively applied to almost any biomass feedstock	Involves the use of microbes, enzymes or chemicals to utilize limited range of biomass
Relatively higher rate of productivity	Rate of productivity is limited due to biological conversion.
Multiple high-value products are possible using fractional separation	Limited to one or few products
No effect of ambient temperature	Mostly susceptible to ambient temperature i.e., anaerobic digester, sunlight for algal ponds
Mostly complete utilization of the biomass	Production of secondary wastes such as biomass sludge



Routes for energy production from wastes contd.

Waste water as source of energy



- All technology options are not mature enough –
 - Most of the technologies have only been proven in pilot or laboratory operations, or with raw materials other than municipal solid waste.
- Residual disposal–
 - Waste residue to landfill
 - Downtime
- Environmental regulation–
 - The technology must meet all permitted environmental requirements established by regulatory agencies;
- Economic feasibility–

It has to be highly competitive to the other options of solid waste management.

Thanks...

