Energy History

- Basic needs : Energy, Food, Clothing, Shelter
- Biomass main fuel upto 1800s
- Fossil fuels (coal, oil, natural gas) gained prominence from 1850 onwards

. Fossil fuels and Nuclear and Large Hydro took over the entire energy industry in the 1900s

- Renewable Energy (solar,wind,biomass) and New fuels (Hydrogen and Biofuels) started contributing in the 1970s in a global movement to replace fossil fuels to mitigate fossil fuel-caused global climate damage
- Biomass and biofuels emerging again for energy security

Energy Transformation

- 20th Century was one of unbridled exploitation of global energy resources by a few western, industrially developed countries for unsustainable life styles leading to present global climate crisis

- 21st century is one with a goal of Energy Transformation to tackle the crisis caused by GHG (mainly CO2 and Methane)

- Consequently, the world is in the initial stages of Energy Transition towards a probable low-carbon scenario by the mid 2050s

Energy Transition

- What is the Energy Transition time ?
- What is the final sustainable Energy-Technology Mix ?
- What is the Energy Transition cost?
- What about Energy Security for individual countries during the transition and in the long term?

Energy Security

Ideal Energy Security

Meeting the total energy needs of a society using only the indigenous energy resources and indigenous technologies developed and funded indigenously

Any dependence on a foreign country for resource, technology,and finance leads to energy insecurity

Practical Energy Security

Making the energy security index as high as possible in a dynamic situation

Energy Sectors

- **Six sectors of energy use**

  Agriculture, Transport, Industry, Residential (Domestic), Commercial , Power

- **Commercial energy**

  Coal, Oil, Gas, Nuclear, Electricity

- **Non-commercial energy**

  Fuel Wood, Crop Residues, Industrial and Agricultural By-Products, Animal Waste, Animal Power

- **Renewable energy sources**

  Solar, Wind, Hydro, Biomass, Geothermal , (Ocean??)

2. Indian Energy Scenario

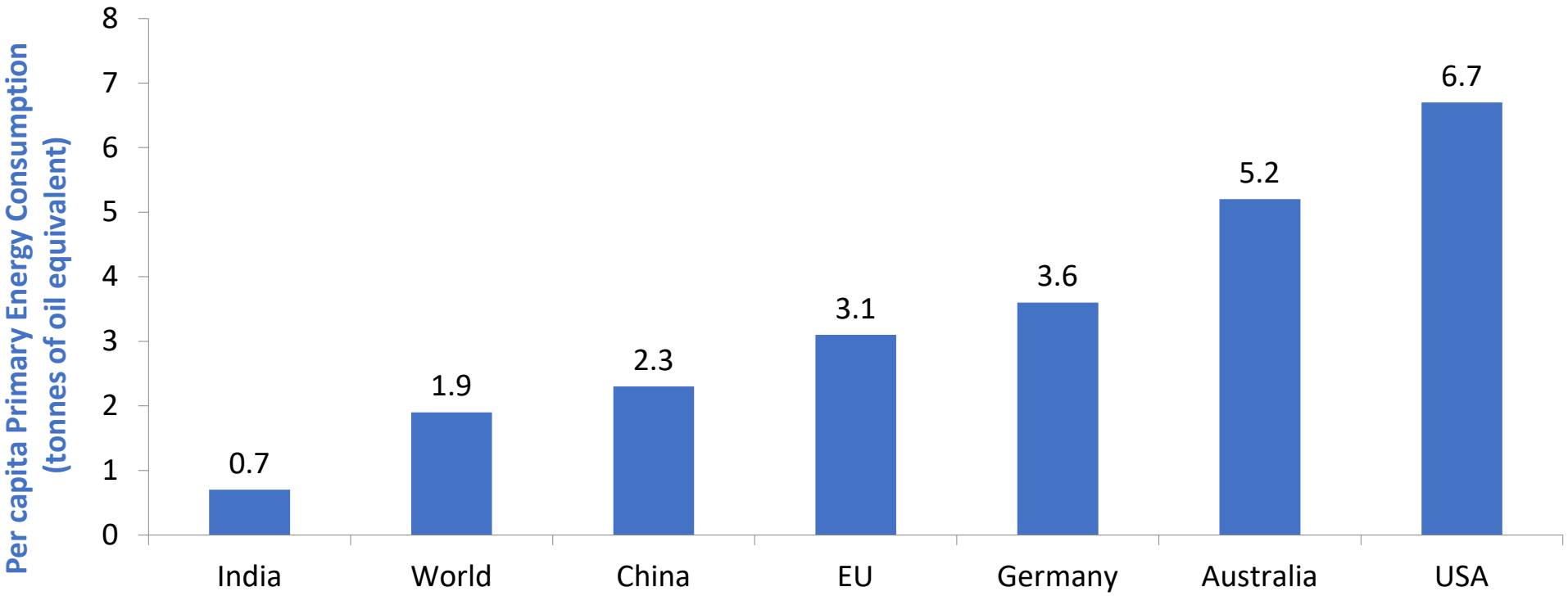
Fuels (2018-19)

- **Estimated HC resources (oil and oil eq gas) ; 42 billion tons**
- **Estimated coal reserves: more than 200 billion tons**

- **Crude oil production** : 34 million tons
- **Crude oil Import** : 226 million tons (forex?)
- **Natural Gas production** : 33 BCM
- **LNG import** : 23 million tons (forex?)
- **Petroleum Products** (Diesel,petrol,LPG,Petcoke,Naphtha,Aviation fuel,kerosine,lubes) : 262 million tonnes
- **Coal production:** 620 million tons
- **Coal import**: 150 million tons (forex?)
- **Biomass** 750 million tons
- **Surplus Biomass** **178 million tons**

Per Capita Primary Energy Consumption (2018-19)

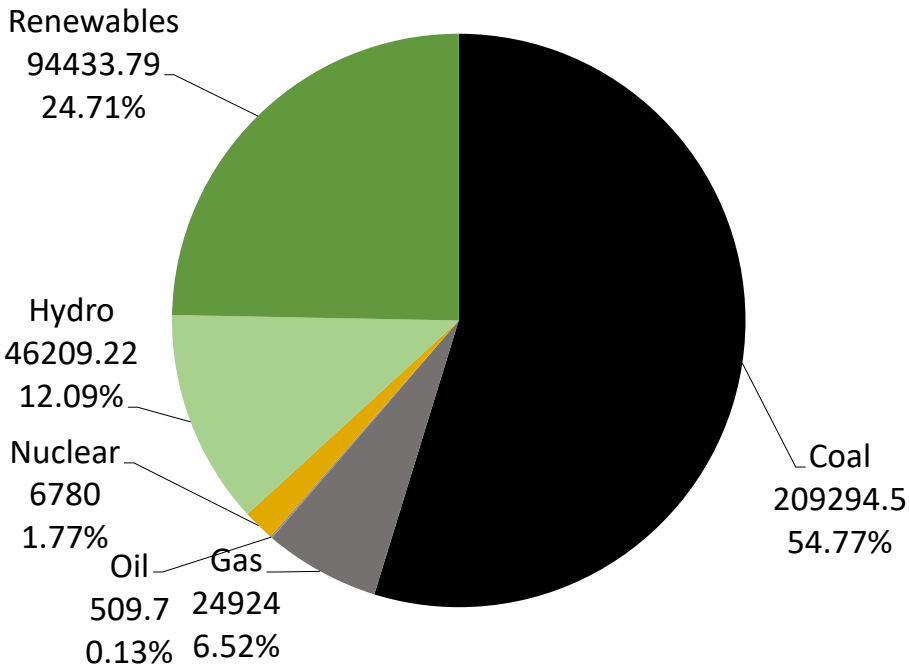
(Total Primary Energy Consumption In India: about 810 million toe).
(To grow by CAGR of 4.2 % till 2040)



Source: Data and Statistics, IEA **(Total Primary Energy Consumption In India: about 810 million toe)**

Installed Power Capacity

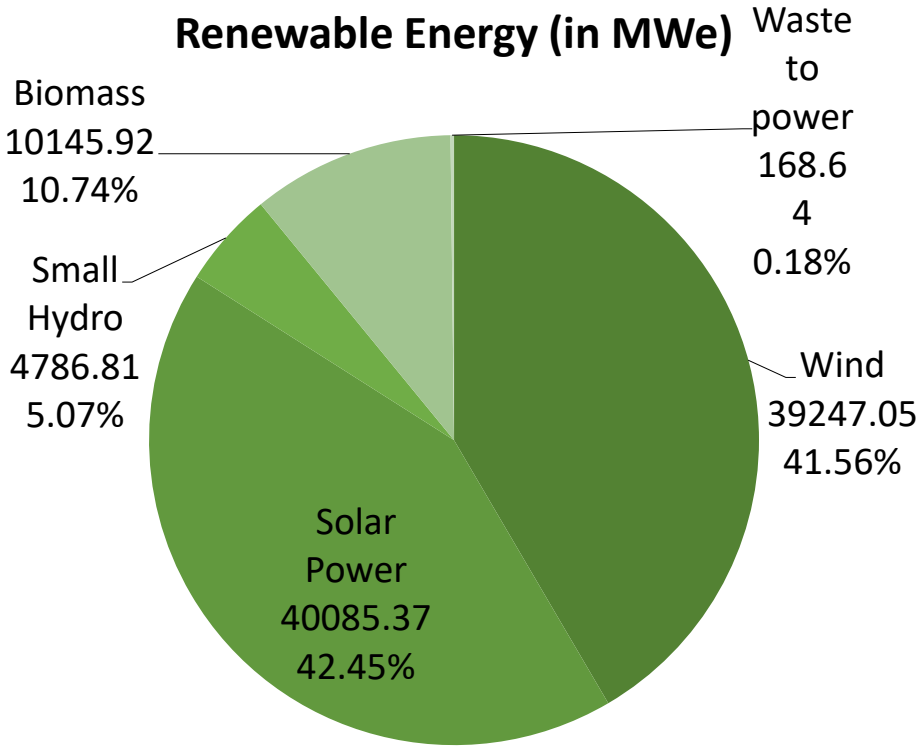
Total Installed Capacity (MWe)



Total Installed Capacity:
3,82,151 MWe as on 31.03.2021

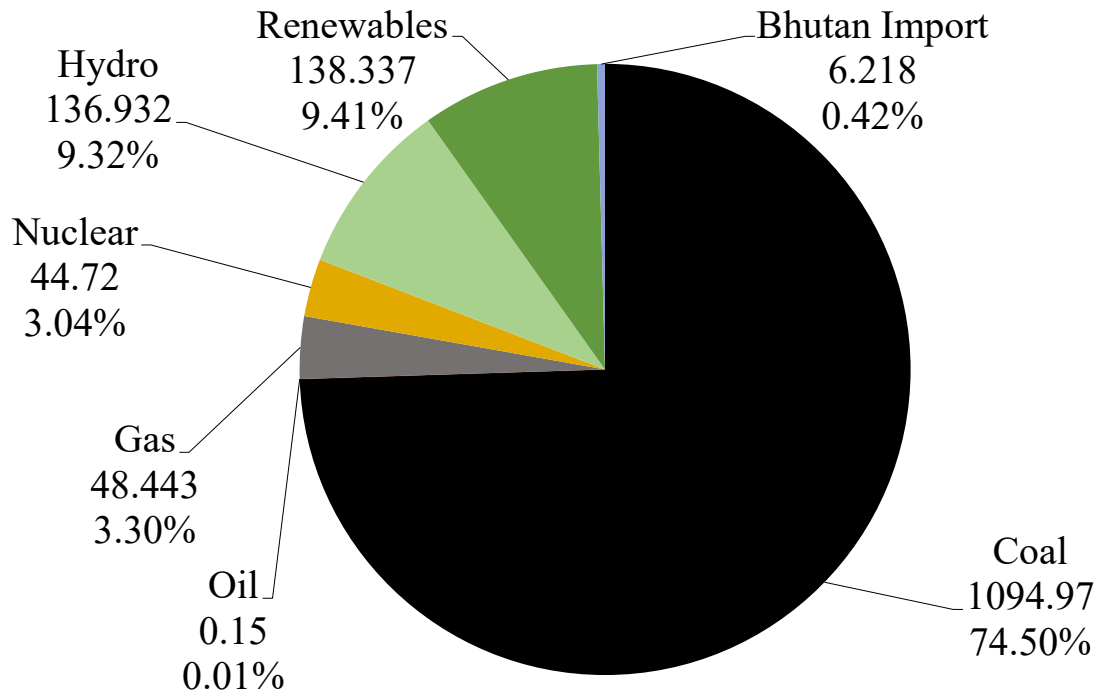
Source: CEA

Renewable Energy (in MWe)



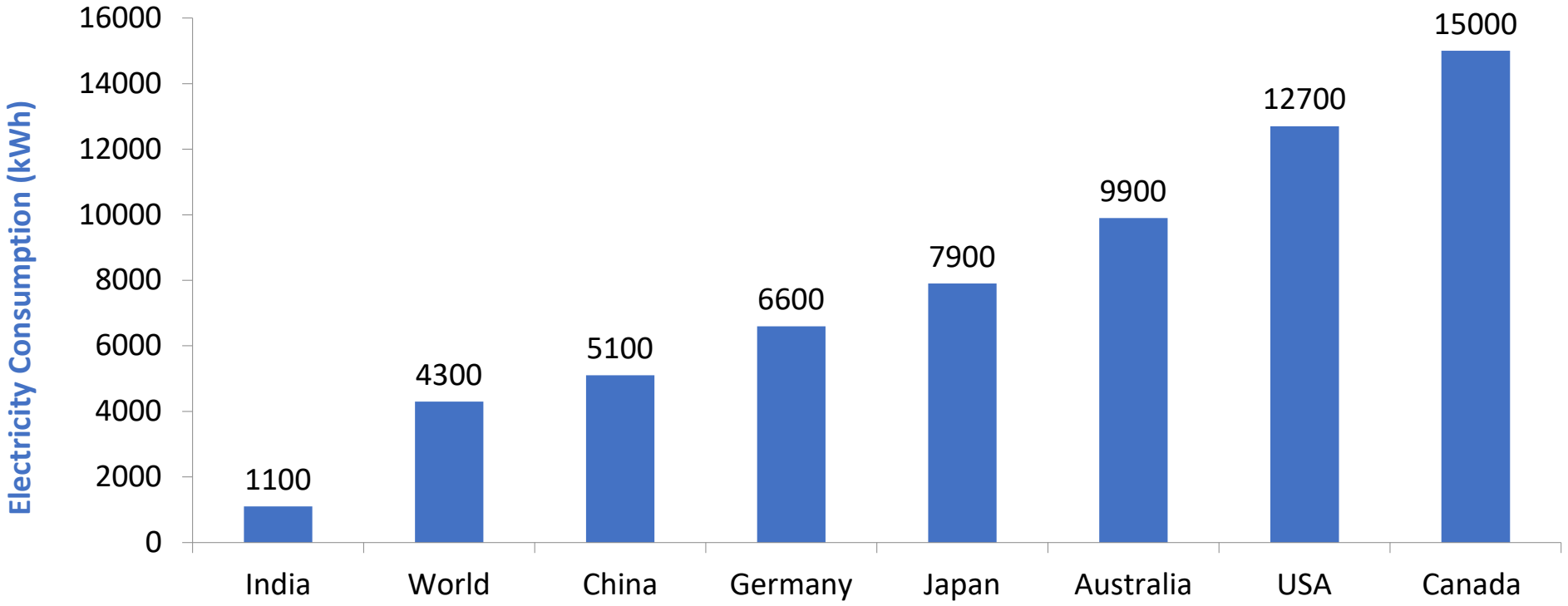
Renewable Energy Installed Capacity:
94,433 MWe as on 31.03.2021

Electricity Generation (in billion kWh)



Power Generation during 2019-20: 1,470 billion kWh

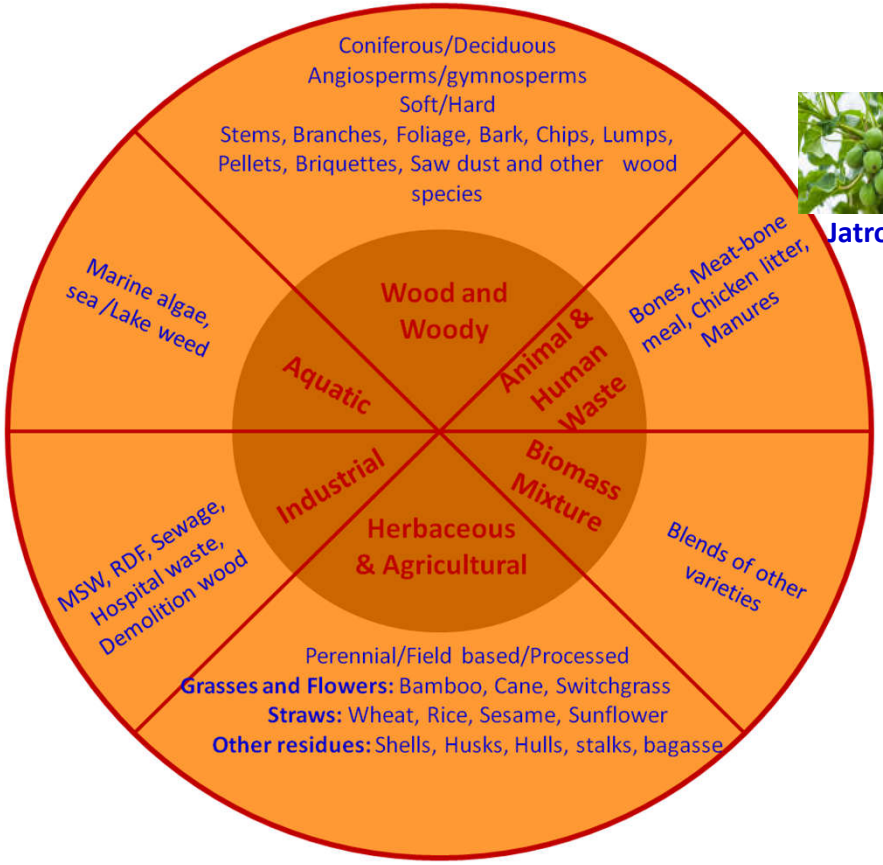
Per Capita Electricity Consumption (2019)



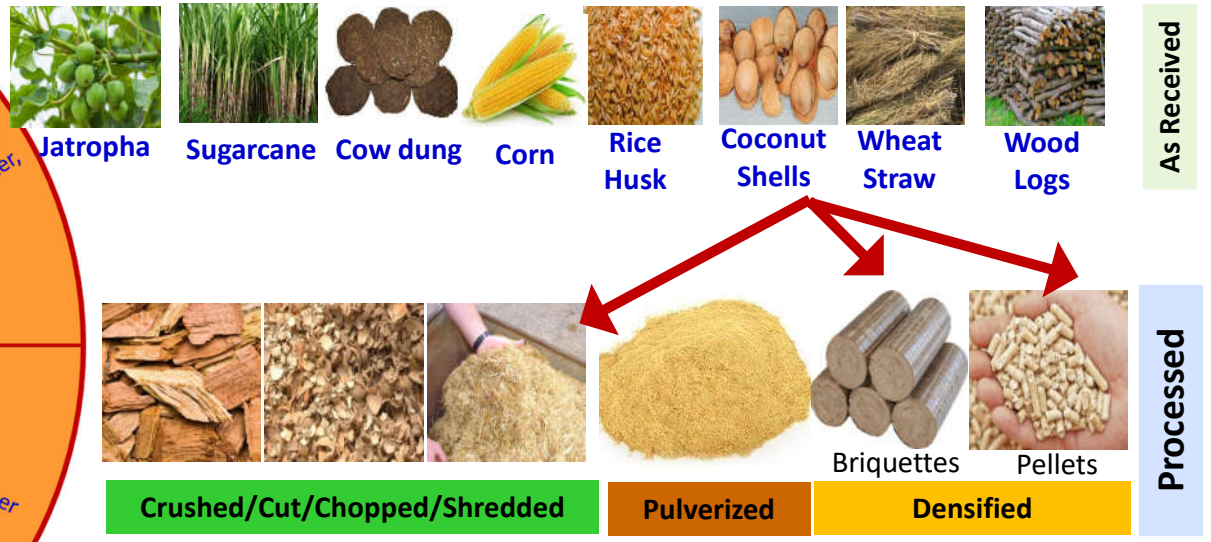
Source: Data and Statistics, IEA

3. Biomass

Biomass



Classification



Physical Forms

Bulk Density : 50 - 600 kg/m^3

Moisture Content: 5-70%

Calorific Value : 11 -21 MJ/kg @ 10% moisture

Mineral Matter: 0.5 - 20% Ash (dry basis)

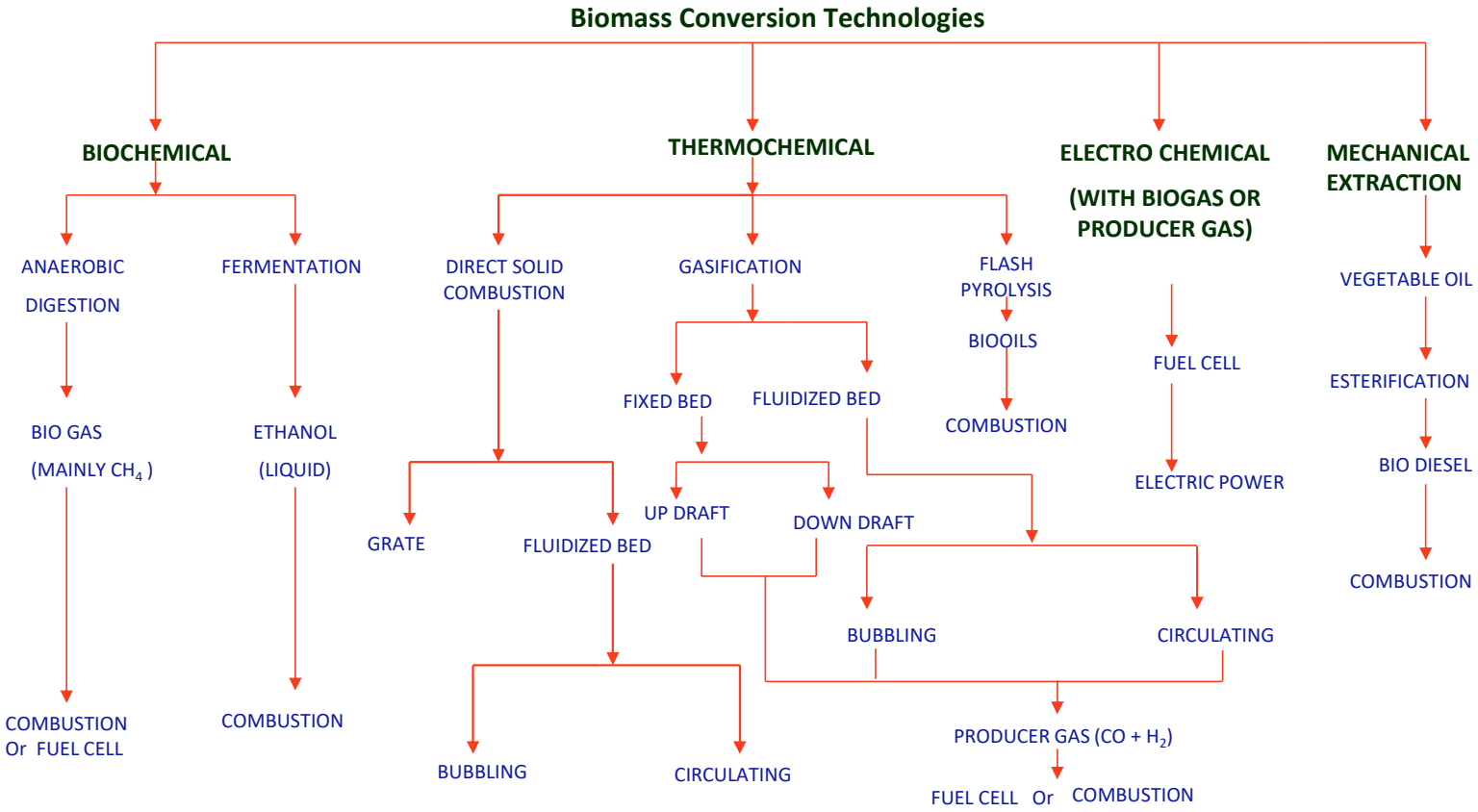
Ash Melting Point: 950 -1400 K

Biomass Applications

- 1. Power Generation
- 2. Industrial Heat and Power
- 3. Transportation Fuels
- 4. Manure (as a byproduct)

- Biomass can be used in the original solid form or in converted forms of liquid and gas

Biomass Conversion Pathways



Biofuels

- Production of bio-gas, bio-ethanol , bio-diesel. bio-methanol , bio-hydrogen

Gen 1: based on food crops like corn,soya, sugar

Gen 2: based on non-food crops (wood, agri residues, forest waste, industrial waste, MSW..) to avoid food-fuel conflict

Gen 3: based on algae and other aquatic biomass

Gen 4 : based on genetically engineered feedstock with genomically synthesised micro-organisms