BIOMASS DERIVED ENERGY POTENTIAL IN PAKISTAN

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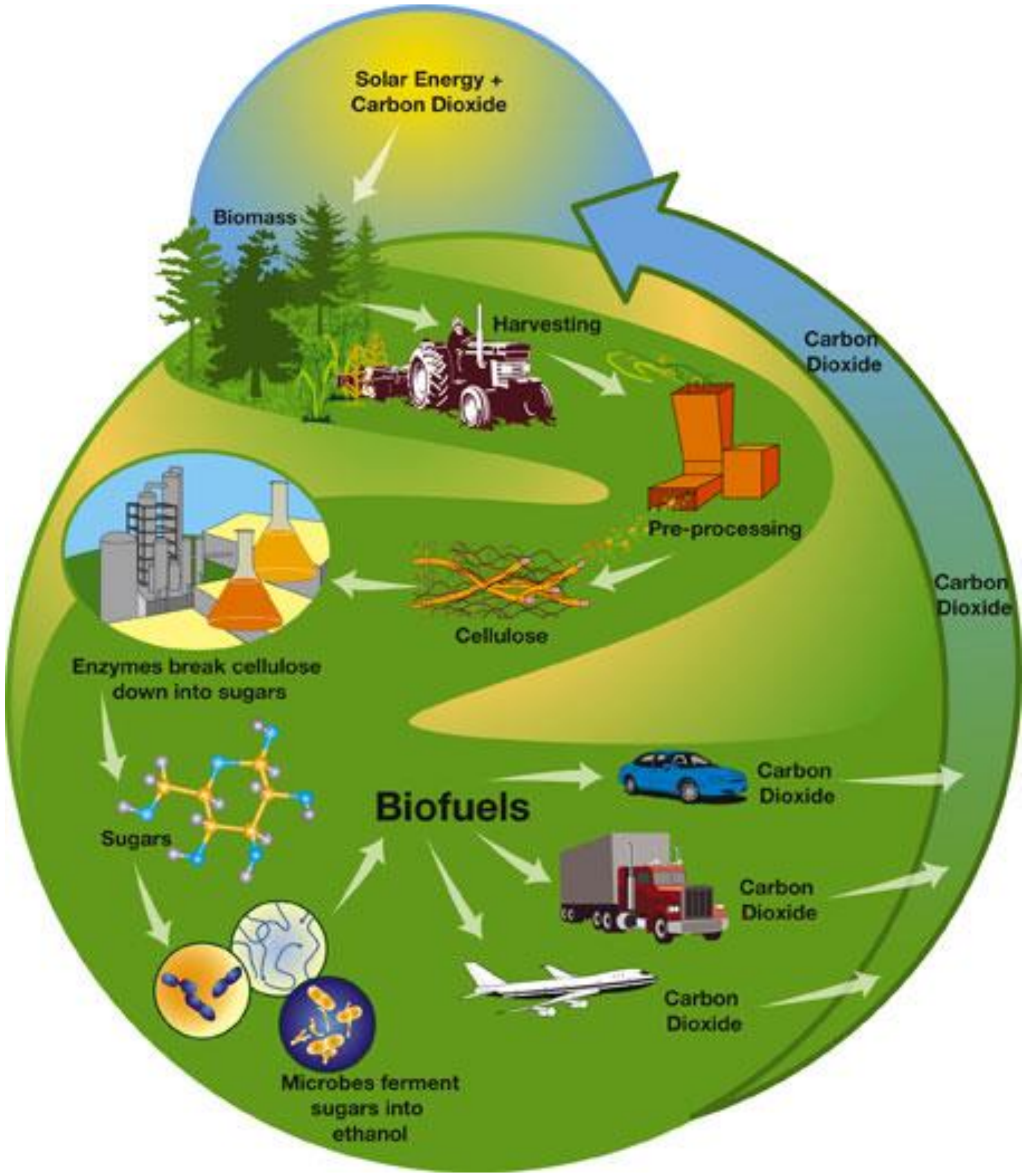
11th March 2020

Introduction

- Biomass types
- Biomass value addition chain
- Challenges with biomass
- Biomass energy potential
- Advantages of bioenergy
- State of the art and polygeneration
- Conclusion

Biomass Power



Types of Biomass

- Current uses for animal feed and fodder,
- Paper mills, paper and cardboard
- Bagasse for co-combustion in boilers in some sugar mills for power
- Low value end uses from selected materials
- Plenty of surplus biomass for energy and other products
- Perfect for rural development and electrifying the rural areas
- Farmers will be energy and food producers
- More jobs in rural than urban areas
- All kinds of wastes such as agro, industrial, MSW, forestry, plastic wastes can be used efficiently

Challenges with biomass

- **Operational**
- Low density
- Low dispersion
- Weak supply chains
- Regional and seasonal availability
- Inefficient conversion technologies (traditionally)
- **Economical**
- Feedstock costs variations
- High risk due to financing, insurance etc
- **Social**
- Competition for uses (food vs fuel)
- Land use
- Environmental – nutrient/soil depletion
- **Regulatory**
- Policies – Subsidies to make it competitive with conventional technologies
- Systems - no specific rules to regulate the work of utilization of biomass resource
- Regulations - no special mechanism to manage the development of biomass resources industry

Wholesale Electricity price: 11-13.5p/kWh
Gas price: 2.9-5.5 p/kWh

Realising value from biomass

CV (MJ/kg):	10	15		17	18	19	21	
Cost (p/kWh):	-5	-3	-1	0	0	1	3	?





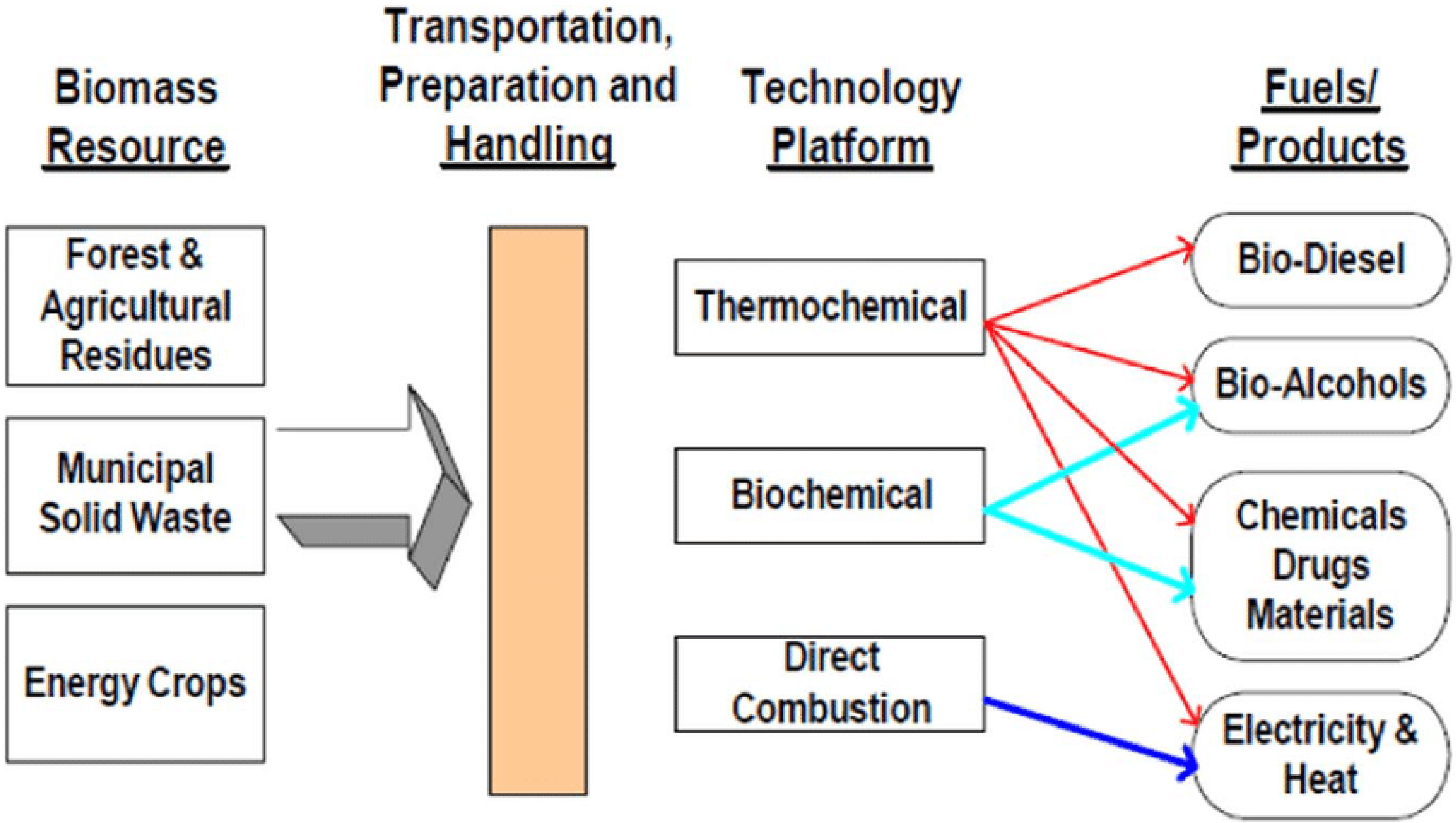



AD-Biogas Pyrolysis Combustion Gasification

Biomass to Energy

Biomass type	Quantities	Energy potential
Crop Processing Residues (Wheat, cotton, rice, sugar, Maize)	25.3 million tonnes/year	62,785 GWh/year of thermal energy
Crop Harvesting residues	114 million tonnes/year	456,440 GWh/year of thermal energy
Animal manures for biogas	368,000 tonnes/year	24,000 GWh/year
Municipal Solid wastes	23,360 tonnes/year	152,000 GWh/year

Bioenergy Pathways



Technology selection

Process type	Working temperature	Feedstock quality	End product(s)
Anaerobic Digestion & Fermentation	Ambient temperature	Uses mostly wet material with high proteins, saccharides and sugars content	Biogas (CO_2 + Methane) Bio-alcohols
Pyrolysis	300-650 Celsius Under no oxygen condition	Can use complex residues, low calorific value, low ash melting point, high ash containing materials	Biochar Bio-Oil Syngas
Gasification	>800 Celsius Partial oxidation	Can use a variety of materials but limited to high ash melting point materials	Syngas for engines to make power, heating and cooling
Combustion	>800 Celsius Full oxidation	Same as above	Heat to steam to electrical power
Trans-esterification	65 Celsius	Uses waste plant oils and fats	Biodiesel as diesel fuel replacement

PRODUCTS

- Densification by pelletisation or briquetting to increase energy density

  Pellets, briquettes for cement kilns, brick kilns, textile industry and paper mills

- ATC – Pyrolysis

  Biocarbons, bio-coal, (charcoal) activated carbons, bio-oil, biochar, syngas

- Gasification –

  Syngas to engines or fuelcell (SOFC) for electricity, heating and cooling

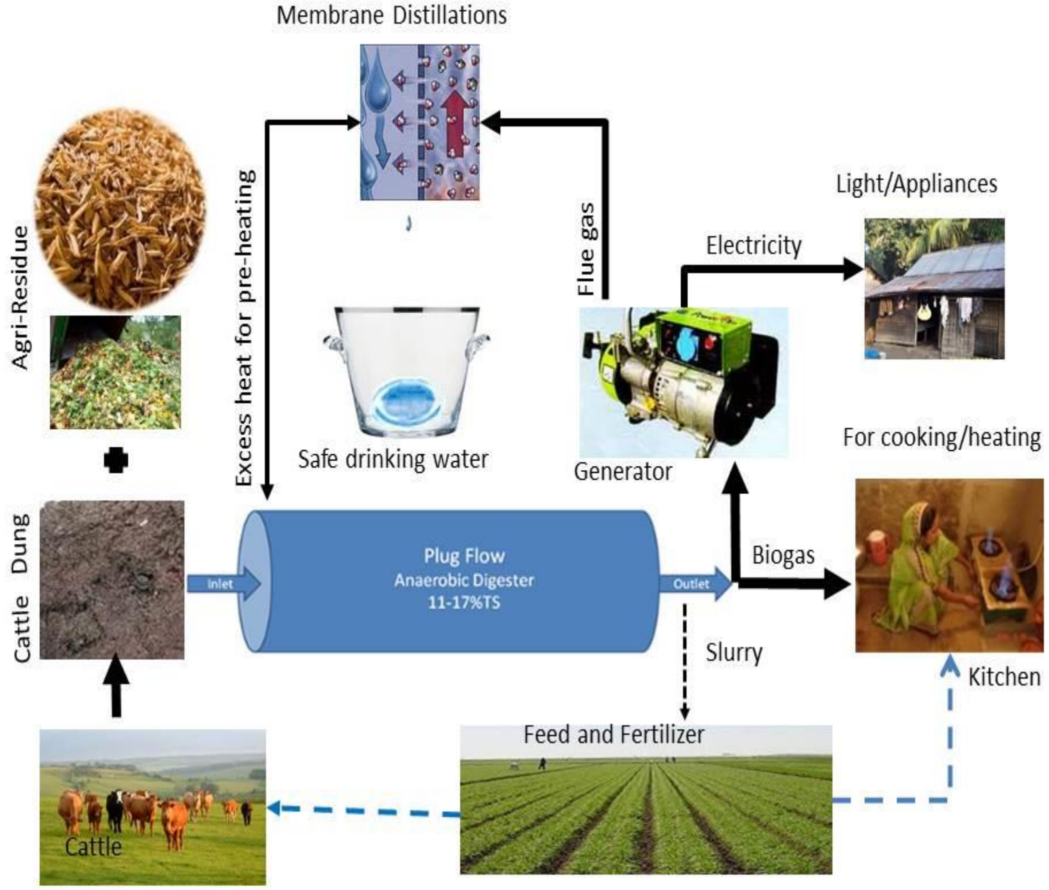
- Anaerobic Digestion

  Biogas, bio-CNG

- Biofuels – Biodiesel, Bio-jetfuel, Bio-gasoline
- Others – Biopolymers, Bioplastics, Bio-composites, 3D printing resins

Polygeneration

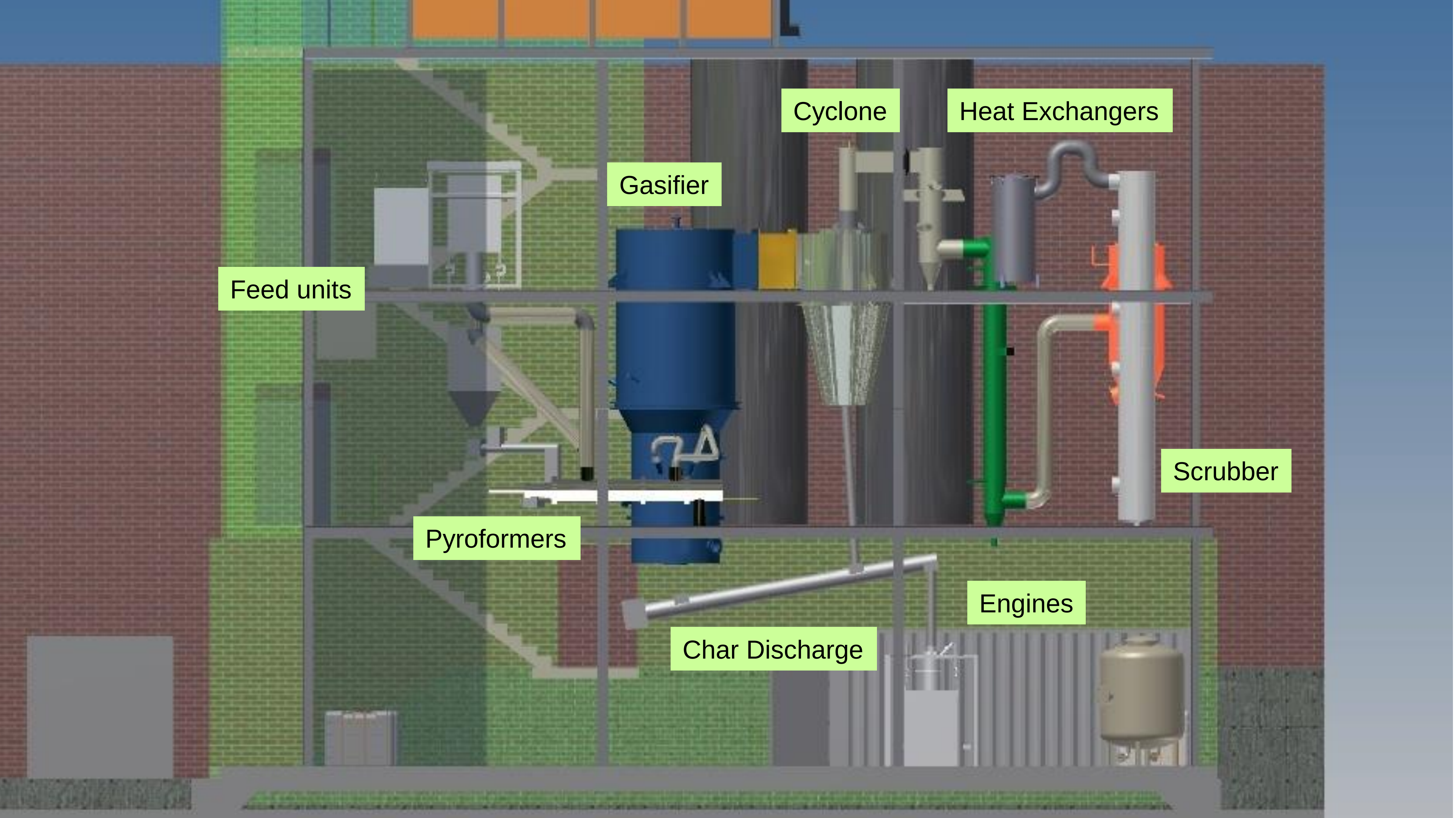
- Waste can be converted into electricity, heat and cooling
- Gasification of municipal solid , commercial and industrial wastes can be a good option for rural areas
- At the same time cooling from heat recovery by adsorption/absorption technologies can be beneficial for greenhouses and livestock farms etc
- Waste resources can be best used in coastal, rural and remote areas for agriculture and horticulture development
- Biochar application in agriculture can increase crop yields more than 30% and in some case can double the yield if used smartly



Integrated systems for electricity, cooking gas and safe drinking water production
Picture: Mainali B.

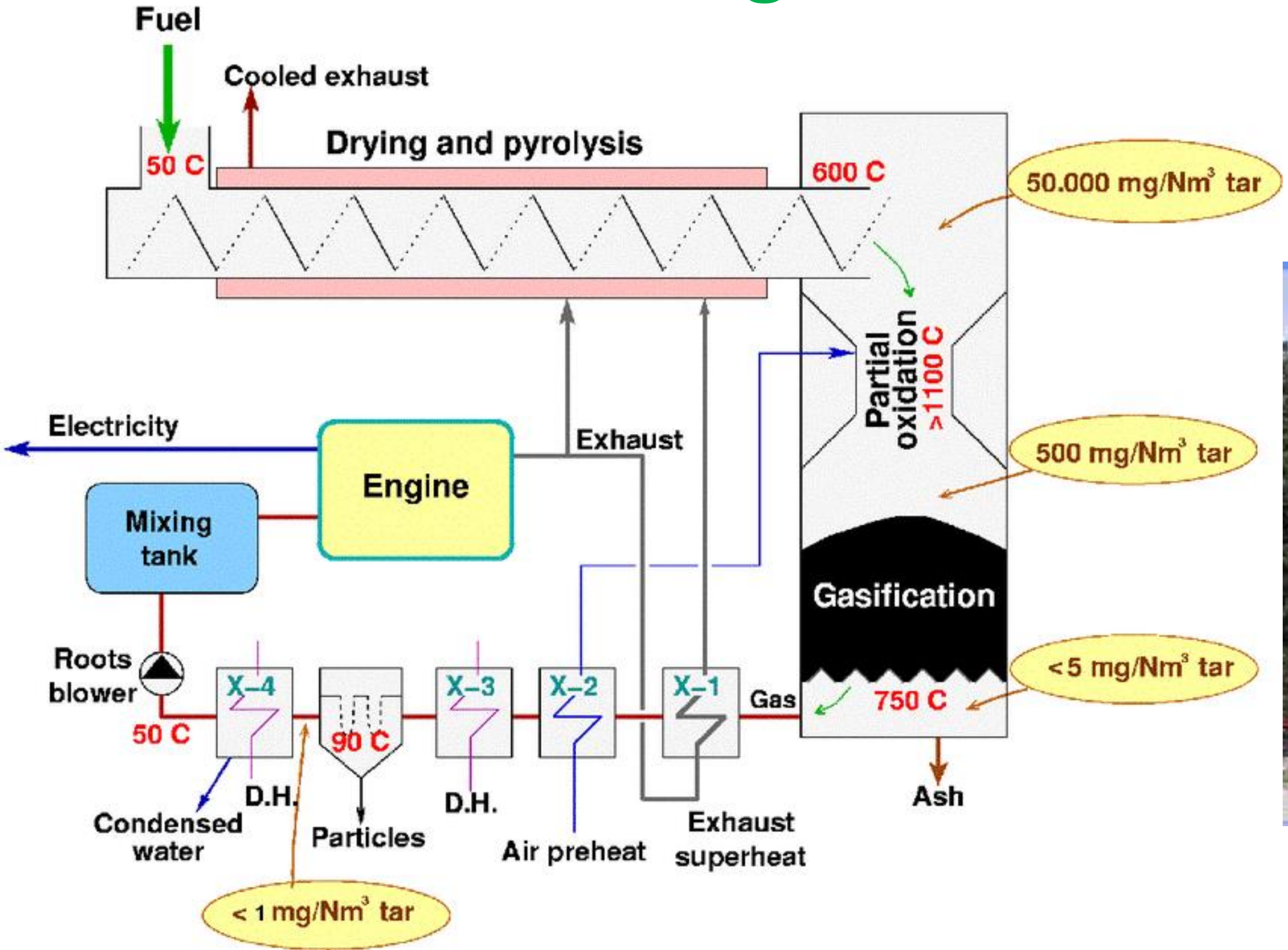
State of the art – Pyrogasification

- State of the art technology in development to use complex and mixed waste residues to produce uniform quality clean syngas and char
- Syngas can then be used in the engines (generators) to produce electricity and at the same time by recovering heat we have heating or cooling also available
- Combined energy efficiency greater than 50% and up to 80% which is nearly double than conventional technologies
- Waste minimisation greater than 95% thus no more waste management issues



1.4 MW Pyrogasification system

Viking Gasifier



High value products from biomass and other wastes

- Bioenergy production at low carbon footprint
- Activated carbon for industrial applications
- Biocomposite materials – wood plastic composites
- Biochar for agriculture and horticulture
- Biochar is solid residue of biomass pyrolysis and is an excellent bio fertiliser
- Waste to energy and then water desalination
- Waste to energy (electricity and cooling) from one process
- Waste based integrated processes best suited for remote locations where there is electricity and heating or cooling demand exists such as farms, warehouses, greenhouses, airports, plants, hospitals etc

Conclusion

- Bioenergy is ideal for an Pakistan as an agrarian country
- Rural development and biomass value addition
- Advanced thermochemical conversion ideal for complex residues
- Feedstock flexibility and end product diversity can be highly beneficial
- Huge bioenergy potential in Pakistan
- Needs supporting policies for wider deployment in Pakistan to address SDGs