

# 20-Biomass Systems

*Off-Grid Electrical Systems in Developing Countries*  
Chapter 5.4

1



## Learning Outcomes

At the end of this lecture, you will be able to:

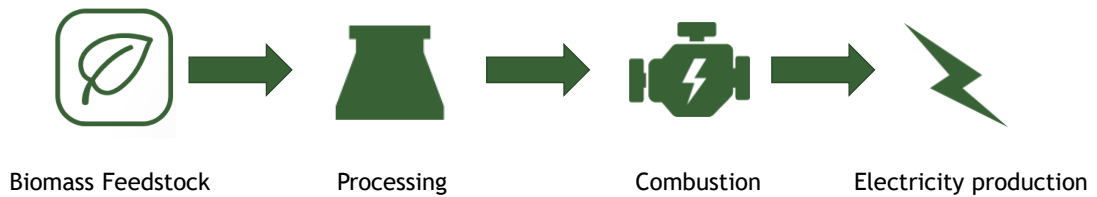
- ✓ understand the role of biomass systems in off-grid electricity access
- ✓ distinguish between syngas and biomass in their chemical composition and how they are produced

Read Chapter 5.4

2

# Biomass

- Organic material from recently alive organisms
- Feedstock biomass is processed into a more convenient form before use in a gen set or steam turbine

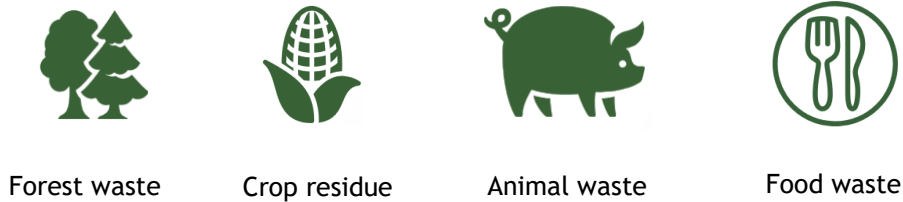


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# Biomass Feedstocks



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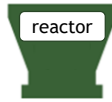
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4

# Biomass Processing

## Feedstock

bagasse, bamboo, nut shells, cotton stalks, forest pruning, rice husk, wood pulp, etc.



thermo-chemical reactions

Syngas  
(hydrogen, carbon monoxide)

pig/cattle manure, chicken litter, food waste, slaughterhouse waste, stalks, straw, etc.



biological processes

Biogas  
(methane, carbon dioxide)

forest waste, manufacturing waste, etc.



cutting, drying

Dried Biomass

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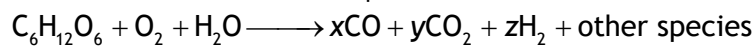
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5

## Syngas

- Thermo-chemical reactions convert dry biomass to syngas (gasification) inside a reactor vessel
- Dried woody biomass or crop residue often used
- High-temperature process, gas must be cooled and filtered before use
- Gas used in modified ICE gen set to produce electricity

Example for Glucose

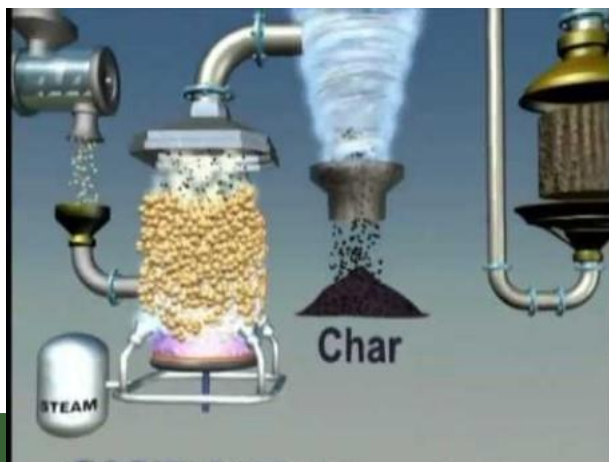


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# Syngas Production

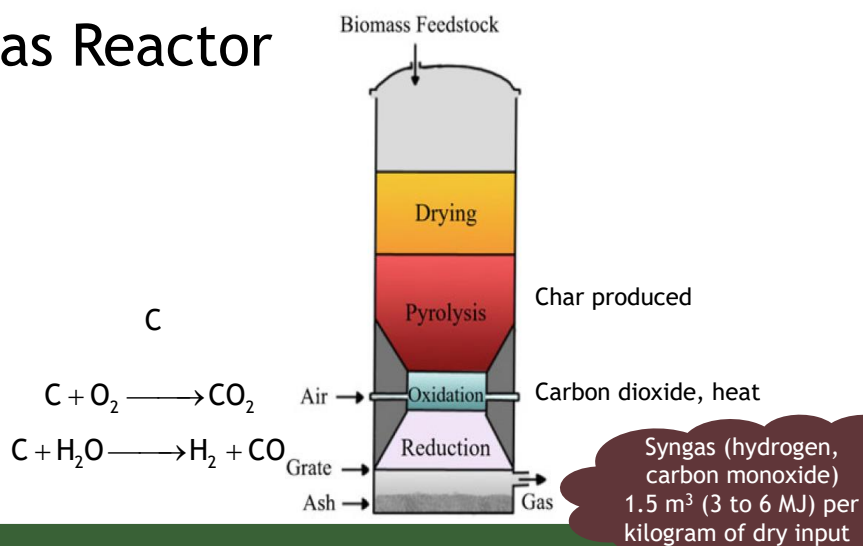


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# Syngas Reactor



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## Syngas Reactor



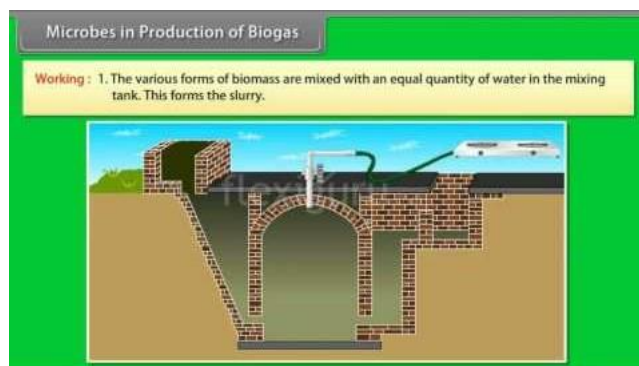
Source: <https://www.fastcompany.com/1714395/husk-power-systems-wants-lead-revolution-electricity>

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## Biogas Production



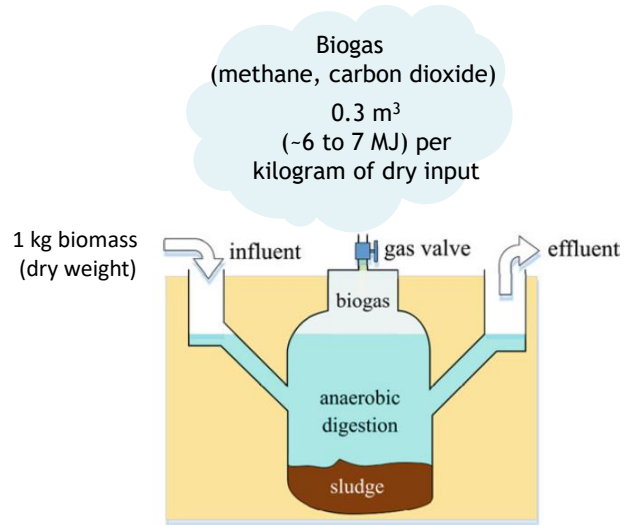
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# Biogas

- Microorganisms convert biomass to biogas
- Requires biomass and water (or wet biomass such as manure)
- Process takes 10-30 days
- High efficiency (up to 85%)
- Digester is simple to construct
- Millions of digesters implemented, very few used for electricity generation
- Gas used in modified ICE gen set to produce electricity



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11

11

# Biogas Digester



Biogas digester under construction in Malawi  
(courtesy P. Dauenhauer)



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12

12

# Biomass Systems



- Can be considered a renewable resource, depending on feedstock and rate of use
- By-product can be used as fertilizer
- Makes use of waste products
- Biomass fuels can be stored and used on-demand
- Potential for Combined Heat and Power (CHP) systems
- Creates employment and cash flow in rural areas (collecting, transporting and processing biomass)



- Requires gen set or turbine to produce electricity
- Feedstock supply chain management
- Seasonal availability of feedstock
- Might compete with crops used for food
- Might require full-time staff to manage systems
- Might require waste to be removed
- Might require reliable water supply

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13

13


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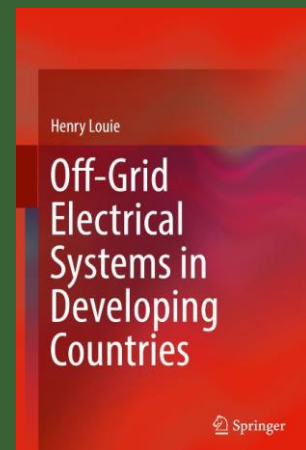
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14

14