The Potential for Sustainable Biomass in the Romanian Energy Sector

Activity 10: Mapping of new technologies for sustainable biomass in the energy sector

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Objectives

Main objective

Provide a contextual analysis for the CO_2 reduction potential of using black pellets for energy production in Romania.

Secondary objectives

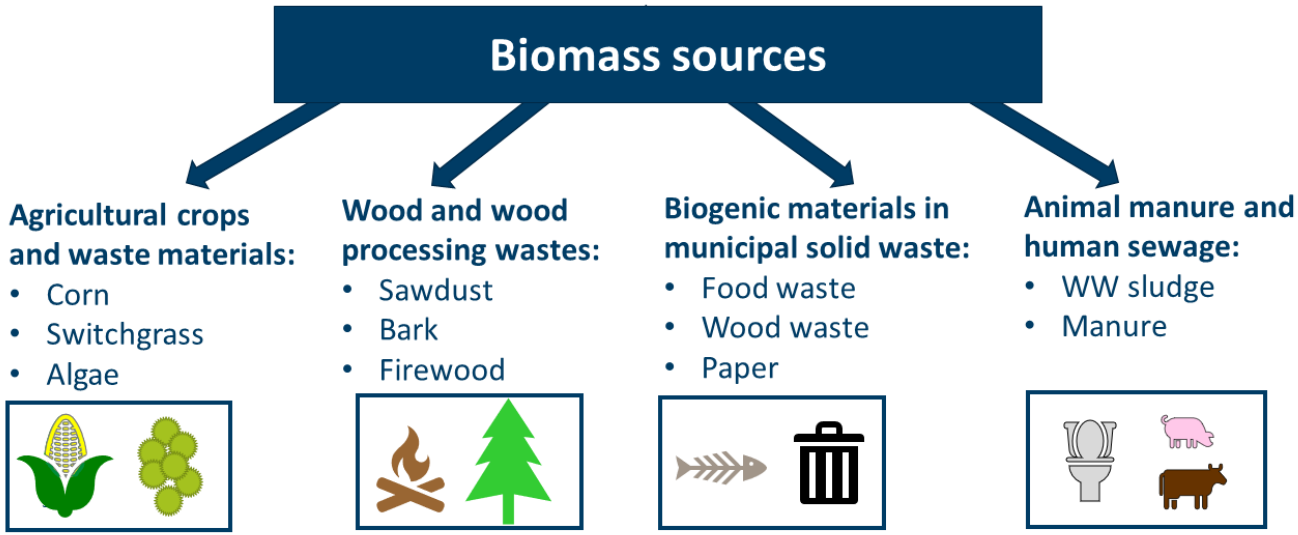
- Mapping of currently available technologies for using biomass in the energy sector.
- Detailed analysis of black pellets technology.
- Comparative analysis of black pellets technologies.
- Estimation of CO_2 emissions reduction potential of the black pellet technology.

Mapping of currently available technologies for using biomass in the energy sector

- Technologies for using biomass in the energy sector
  - Biomass sources
  - Biomass conversion products
  - Biomass conversion technologies

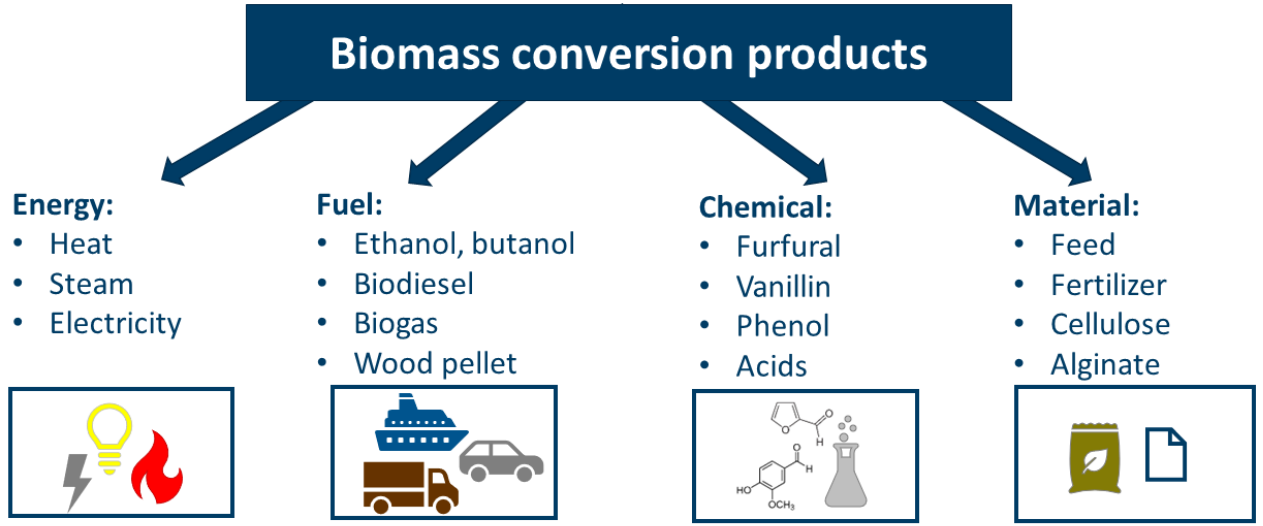
Mapping of currently available technologies for using biomass in the energy sector

- Biomass is considered emission free even though there can be emissions during their utilization since they capture CO_2 throughout their life cycle.
- Wood is traditionally the most used biomass.
- Higher quality biomass fuels (wood pellets, black pellets) can be produced from wood processing wastes (bark, sawdust, mill residues).



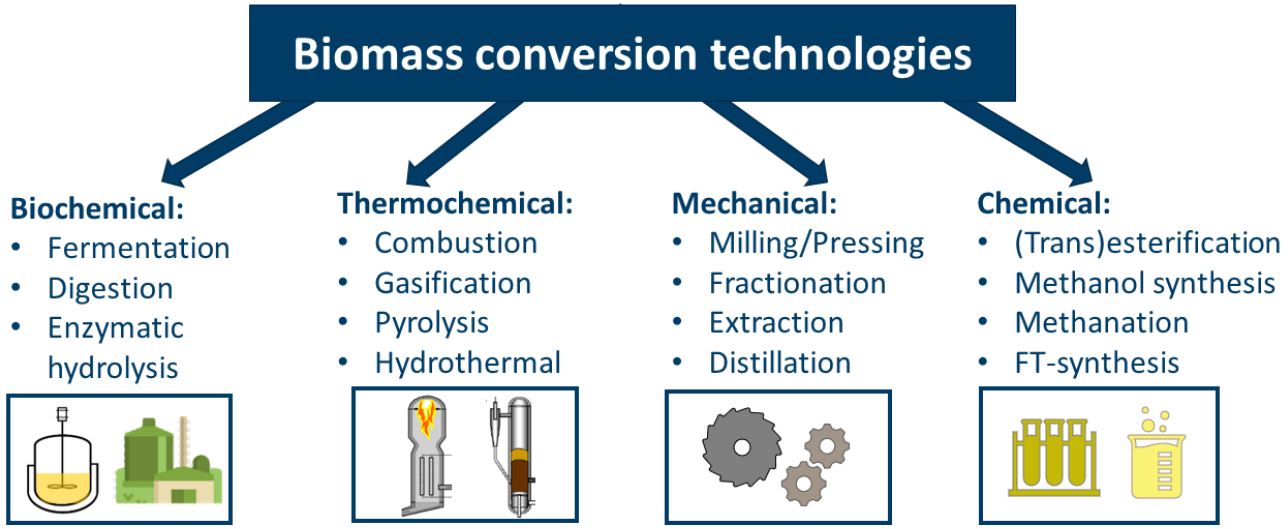
Mapping of currently available technologies for using biomass in the energy sector

- Heat from wood has traditionally been the most common product.
- Economic desirability from highest to lowest value: material → chemical → fuel → energy
- Biomass products have the potential to replace fossil-based products, thus lowering the CO_2 footprint.
- Wood chips, wood pellets, black pellets, torrefied pellets have the **potential to replace coal** for energy production.



Mapping of currently available technologies for using biomass in the energy sector

- There is often a range of gaseous, liquid and solid products obtained from utilization of biomass.
- Thermochemical conversion happens at high temperatures: < 300 °C and pressures of up to 400 bar.
- Combination of thermochemical and mechanical conversion if often used for production of solid biomass fuels for energy use.



Detailed analysis of black pellets technology

- Black pellets technology
  - Steam explosion
  - Steam torrefaction
  - Dry torrefaction
  - Dry torrefaction with air
  - Wet torrefaction

Detailed analysis of black pellets technology

Black pellet term might refer to the torrefaction of pelletized materials, the resulting product of pelletization of torrefied materials using various reaction medium or steam explosion.

	Wood chips	Wood pellets	Black pellets	Torrefied pellets	Hard coal
Heating value (GJ/ton)	10-12	17	19.5-21.3	21-22	25.82
Bulk density (kg/m^3)	300	650	750	750	850
Energy density (GJ/m^3)	3	11	14.5-15.5	17	21
Co-firing rate (%)	3-5	5-8	100		N/A
Dust delivered (%)		3-7	<1	5-10	

Comparative analysis of black pellets technologies

	Steam explosion	Steam torrefaction	Dry torrefaction	Dry torrefaction (with air)	Wet torrefaction
Temperature (°C)	170-250	180-250	250-280	220-300	180-250
Pressure (bar)	12-17	10-39	39	1-6	39
Residence time	10 seconds - 10 minutes	5-10 minutes	5-10 minutes	15-35 minutes	5-10 minutes
Medium	Steam	Steam	Inert (nitrogen)	Air	Water
Commercial application	Yes	Yes	Yes	No	No

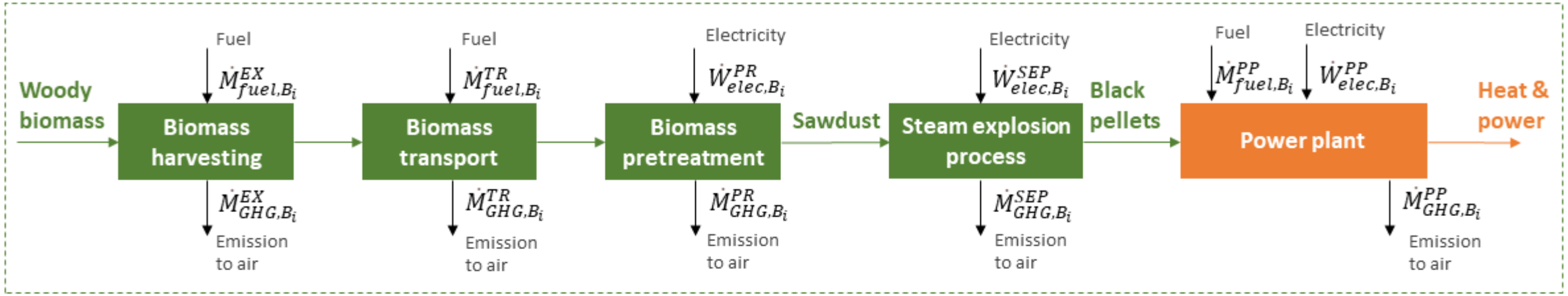
- Torrefaction and steam explosion are most common.
- Steam explosion and steam torrefaction have different reactor configurations. SE has sudden pressure release.
- Wet torrefaction require large amounts of medium resulting in large waste.
- Medium can impose large costs.
- Operating conditions affect the operating and maintenance costs (corrosiveness).

Estimation of CO_2 emissions reduction potential of the black pellet technology

- Black pellets value chain
  - Biomass harvesting
  - Biomass transport
  - Biomass pretreatment
  - Steam explosion process
  - Power plant
- Coal value chain
  - Coal extraction
  - Coal transport
  - Power plant

Estimation of CO_2 emissions reduction potential of the black pellet technology

Value chain of black pellet power plant



Value chain of coal power plant

Estimation of CO_2 emissions reduction potential of the black pellet technology

- Emissions are due to
  - Fuel consumption
  - Electricity use
  - Combustion of coal

for a 50 MW plant capacity

Coal power plant		**Black pellet power plant**	
Coal HHV (MJ/kg)	25.82	Black pellet HHV (MJ/kg)	21.3
Coal amount (t/h)	6.97	Black pellet (t/h)	8.45
Coal amount (kt/y)	55.77	Black pellet amount (kt/y)	67.61
		Sawdust amount (kt/y)	141.55
		Wood log amount (kt/y)	157.58

Estimation of CO_2 emissions reduction potential of the black pellet technology

		Black pellets value chain [kton CO_2/year]	**Coal value chain** [kton CO_2/year]
Harvesting/extraction		1.57	173.85
Transport		2.08	0.12
Pretreatment		1.93	-
Steam explosion		7.54	-
Power production	Fuel	0.23	0.23
	Electricity	2.93	2.93
	Combustion	0	134.97
TOTAL		**16.27**	**272.10**

- The difference is mainly due to the larger emissions occurring during coal extraction and emissions released during the combustion of coal for power production.
- Net emissions from combustion of black pellets are considered to be zero since the biomass captures CO_2 during its lifetime.

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