# Waste Age and Renewable Energy

Carlo Perego November 7, 2022 Club Donegani Novara



Stone Age

Iron Age

Waste Age



#### Summary

- Introduction Waste: problem or opportunity
- Waste management and circular economy
- Zero Emission target and biofuel scenario
- Conventional vs advanced biofuel
- Circular economy: waste biomass to advanced biofuel
  - Fermentation vs Thermochemical process
- Circular economy: municipal waste to fuel
  - Wet biomass: Waste to Fuel process
  - Plasmix and (RDF)
- Conclusion



**2.2 billion** tonnes yearly worldwide

2.7 kilos / day
2.12 kilos / day
0.7 kilos / day

1.34 kilos / day

#### Welcome in the Wasteocene: the Waste Era

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- The Antrhopocene definition, the era dominated by the man, was introduced in 2000 (Paul Crutzen).
- According to Marco Armiero it is more correct to call this era Wasteocene, being characterized by resource destruction, waste production and diffusion ("L'era degli scarti", Einaudi Editore, 2021)
- Un camorrista napoletano, mentre era intercettato dalla polizia, ha detto: I rifiuti sono oro.
- Trash is gold! It means that waste is to be consider an opportunity.
- How? By the Circular Economy
- Let's star a trip int the world of waste and how to valorized it as energy vector.



# Municipal Solid Waste in the World



- The World generates 2 billion tonnes of municipal solid waste annually.
- Taking in account the population increase, higher the income level and rate of urbanization it is expected to increase up to 3.4 billion tonnes by



Source: https://www.worldbank.org/en/news/immersive-story/2018/09/20/what-a-waste-an-updated-look-into-the-future-of-solid-waste-management

# Agriculture and Food: the system is overwhelmingly linear

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A very high proportion of food flows into cities where it is processed or consumed, creating organic waste in the form of discarded food, byproducts or sewage. In cities, only a very small proportion (<2%) of the valuable nutrients in these discarded organic resources gets looped back to productive use.

source: © ELLEN MACARTHUR FOUNDATION 2019 - www.ellenmacarthurfoundation.org

# Potential sustainable biomass resources

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Potential sustainable biomass



Primary Energy 2020	EJ
Oil	171.4
Coal	155.8
Natural Gas	139.1
Bio Energy	61.9
Nuclear	29.4
Hydro	15.6
Wind	5.7
Solar	4.7



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# Municipal Solid Waste in Italy



### Waste to energy

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Source: Confederation of European Waste to Energy Plant

# Waste to energy

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Percent of total municipal solid waste that is burned with energy recovery in selected countries



Note: Scandinavia includes Denmark, Norway, and Sweden. Data for the United States, South Korea, and Japan are for 2018; for all other countries the year is 2019.



Transform 730 kTon/y of MSW into:

- 600 GWh electricity (~ 125000 citizen)
- 900 GWh heat (70% of Brescia district heating)

Saving

- 177 kTOE
- 735 kTon CO<sub>2</sub>

### Waste to energy potential



Constantinos S. Psomopoulos. et al., IET Renew. Power Gener. 2022;16:48-64.

# Circular economy and waste hierarchy

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#### Circular economy: waste for renewable fuels





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#### Transport Sector and CO<sub>2</sub> Emissions: Net Zero by 2050

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Overall energy saving higher efficiency, while increasing the number of vehicles (from 1.2 to 2 billion).

Oil drops to less than 75% in 2030 and slightly over 10% by 2050.

 Electricity becomes the dominant fuel in the transport sector worldwide: it accounts for nearly 45% of total final consumption in 2050, followed by hydrogen-based fuels (28%) and bioenergy (16%).

Biofuels almost reach a 15% blending share in oil products by 2030 in road transport. Beyond 2030, biofuels are increasingly used for aviation and shipping, where the scope for using electricity and hydrogen is more limited.



# The biofuels policy in Europe and in Italy

REDII revision under discussion (renewable energy from 32% to 40%)



# The biofuels policy (ITALY)

INTEGRATE NATIONAL PLAN for ENERGY and CLIMATE to 2030 Proposal sent to EU for approval by Ministero dello Sviluppo Economico in 2019

