WIRE

Waste biorefinery technologies for accelerating sustainable energy processes

Contribution of biomass wastes in a 100% circular economy model

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cost
EUROPEAN COOPERATION IN SCIENCE & TECHNOLOGY

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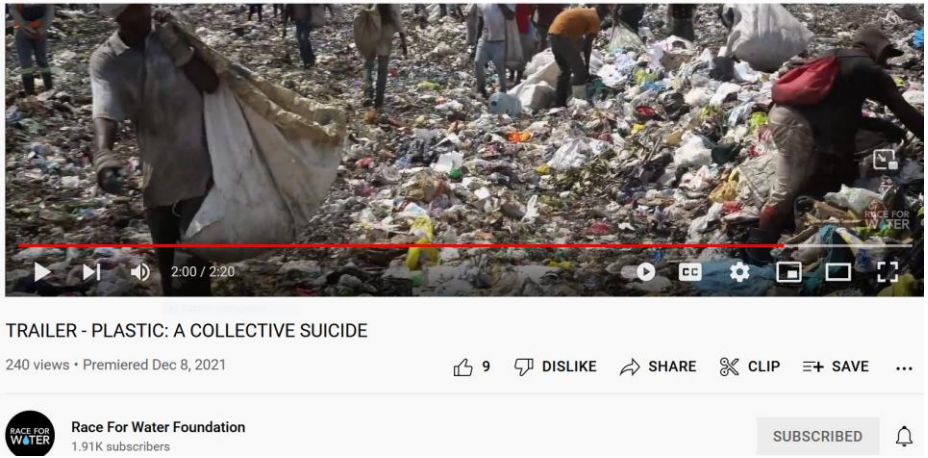
My affiliations



Humana training & consulting

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- Reports & Biofuels & waste statistics (IEA, Eurestat)
- The case of plastics
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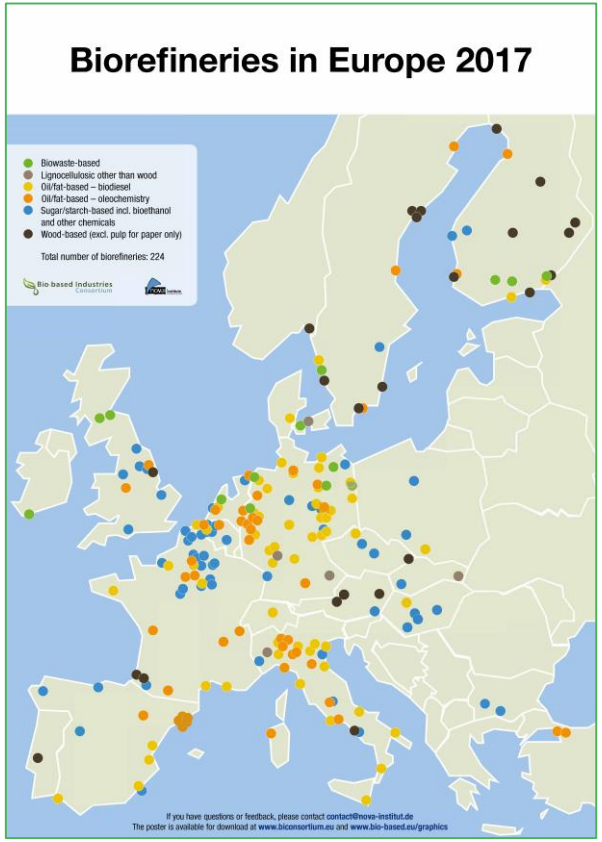
Biorefinery surveys



NC PARTNERING

BIOREFINERIES IN EUROPE

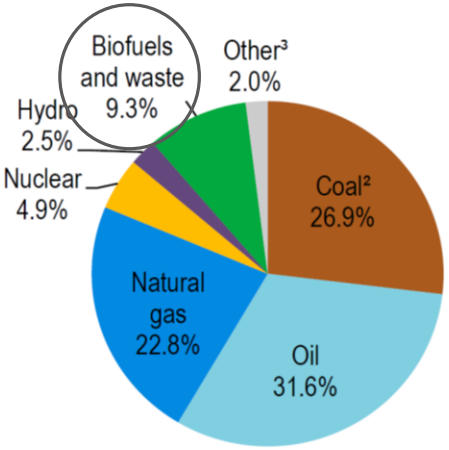
Is there enough biomass for a 100% circular economy

- We can replace all fossil fuels by renewable energy but
- what about the use of fossil fuels for materials & products (plastics, rubber, fertilisers, chemicals, ...) ?

→ is non energy use of fossil fuels < sustainable bioenergy resources ?

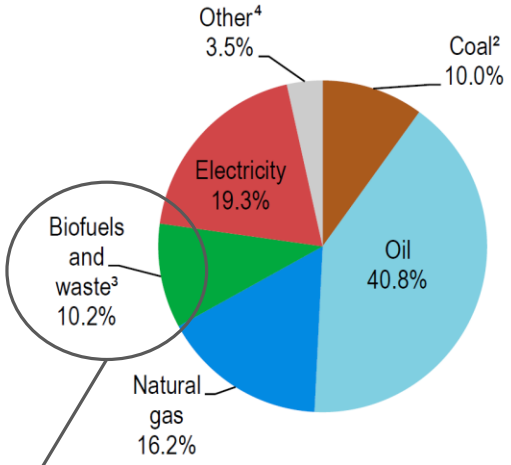
World & Europe energy situation

Supply side
2018



14 282 Mtoe

Consumption side
2018



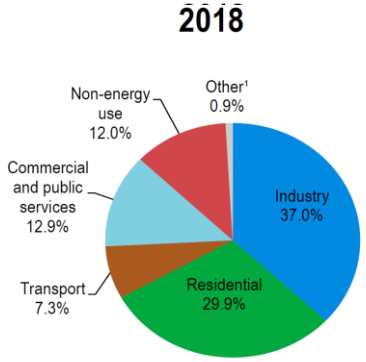
9 938 Mtoe

1034 Mtoe

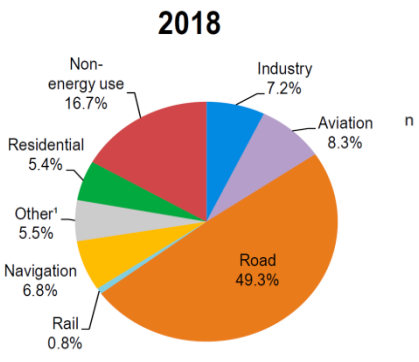
EU28: 120 Mtoe

EU28 1260 Mtoe

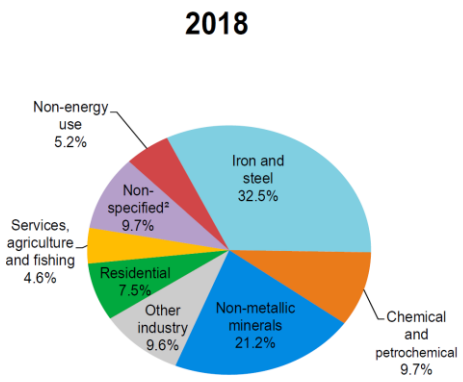
Non-energy use of fossil fuels



1 611 Mtoe



4 051 Mtoe



994 Mtoe

NATURAL GAS : 193 Mtoe

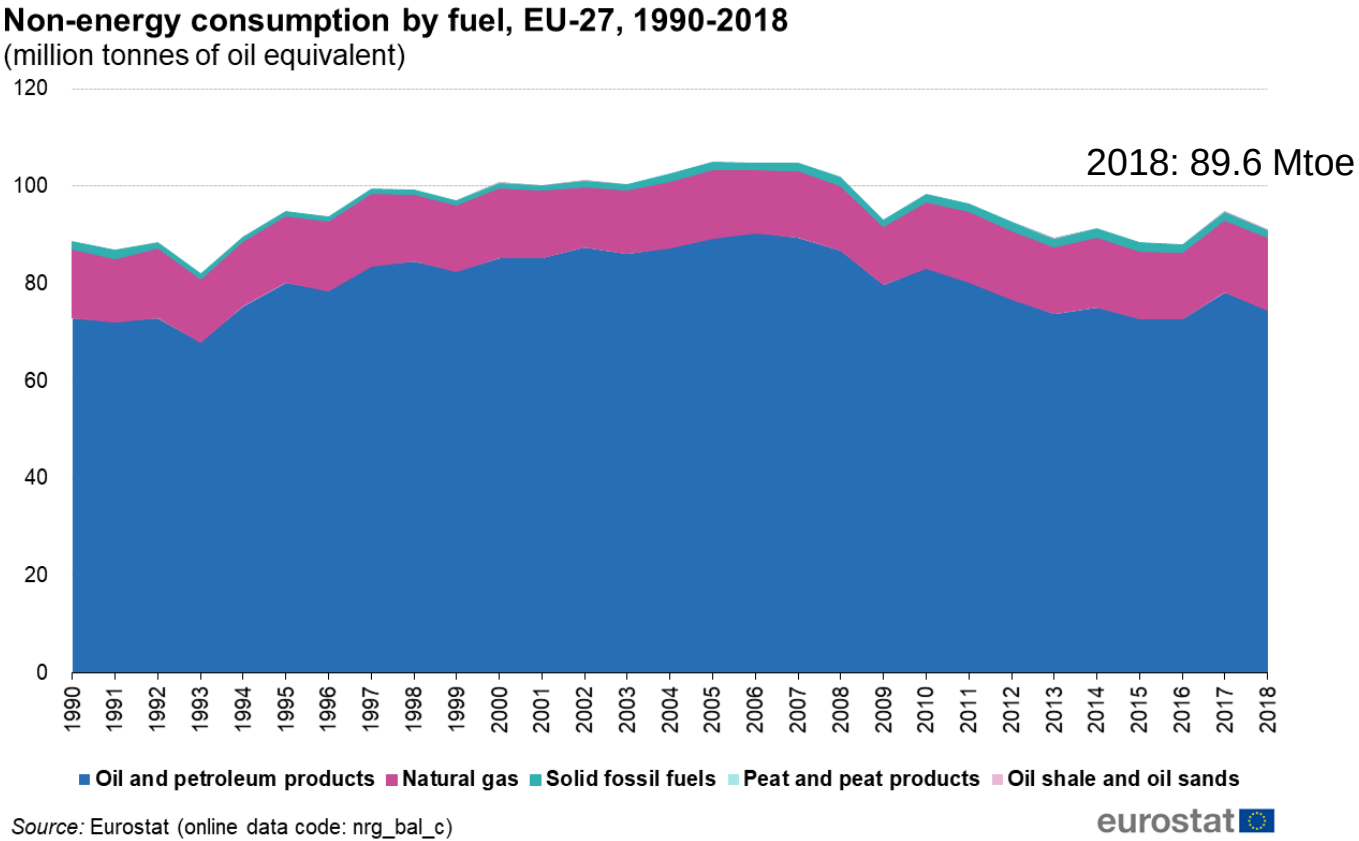
OIL : 677 Mtoe

COAL: 52 Mtoe

Non energy use: 922 Mtoe i.e. 9,3% of the world energy consumption

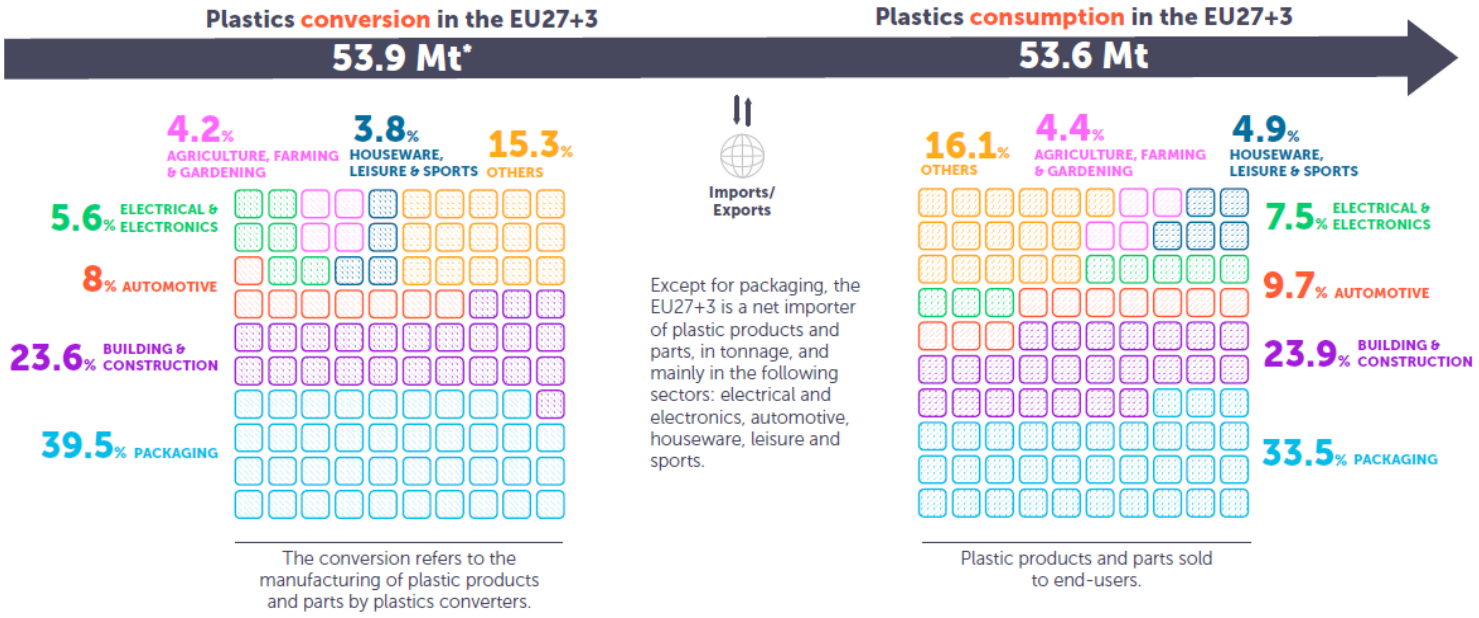
→ In theory biomass & renewable waste should be sufficient to replace fossil-fuel based materials worldwide

The case of Europe



The case of plastics in Europe

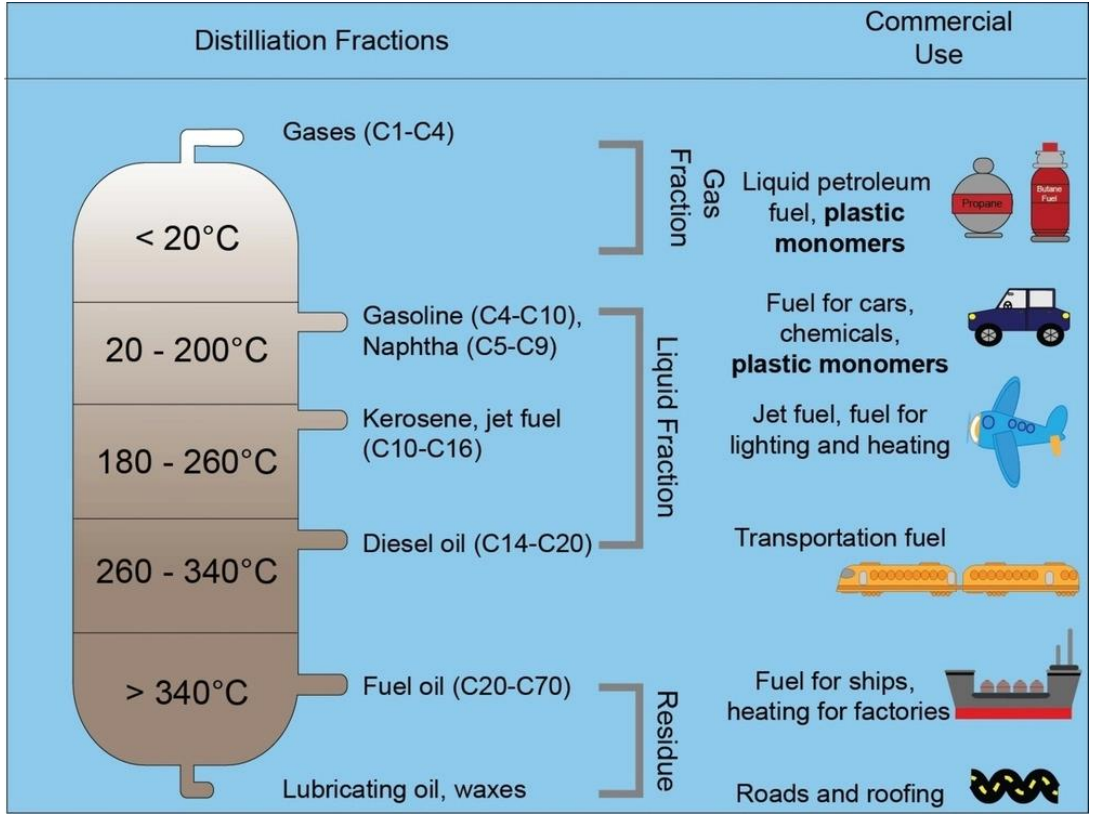
PLASTICS CONVERSION AND CONSUMPTION



The plastics packaging consumption data used for the above graph were extrapolated based on 2019 available figures. The above data were rounded.
*Comprising 45.7 million tonnes from plastics production (polymerisation), 4.6 million tonnes of post-consumer recycled plastics and 3.6 million tonnes of pre-consumer recycled plastics.

https://plasticseurope.org/knowledge-hub/plastics-the-facts-2019/

From an oil refinery to a biorefinery

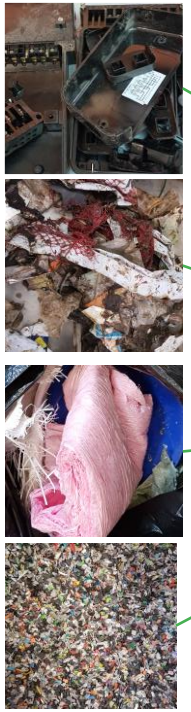


Syngas

Biocrude oil

Biochar

Inventory of plastic wastes locally sourced (CH-F) near Lausanne

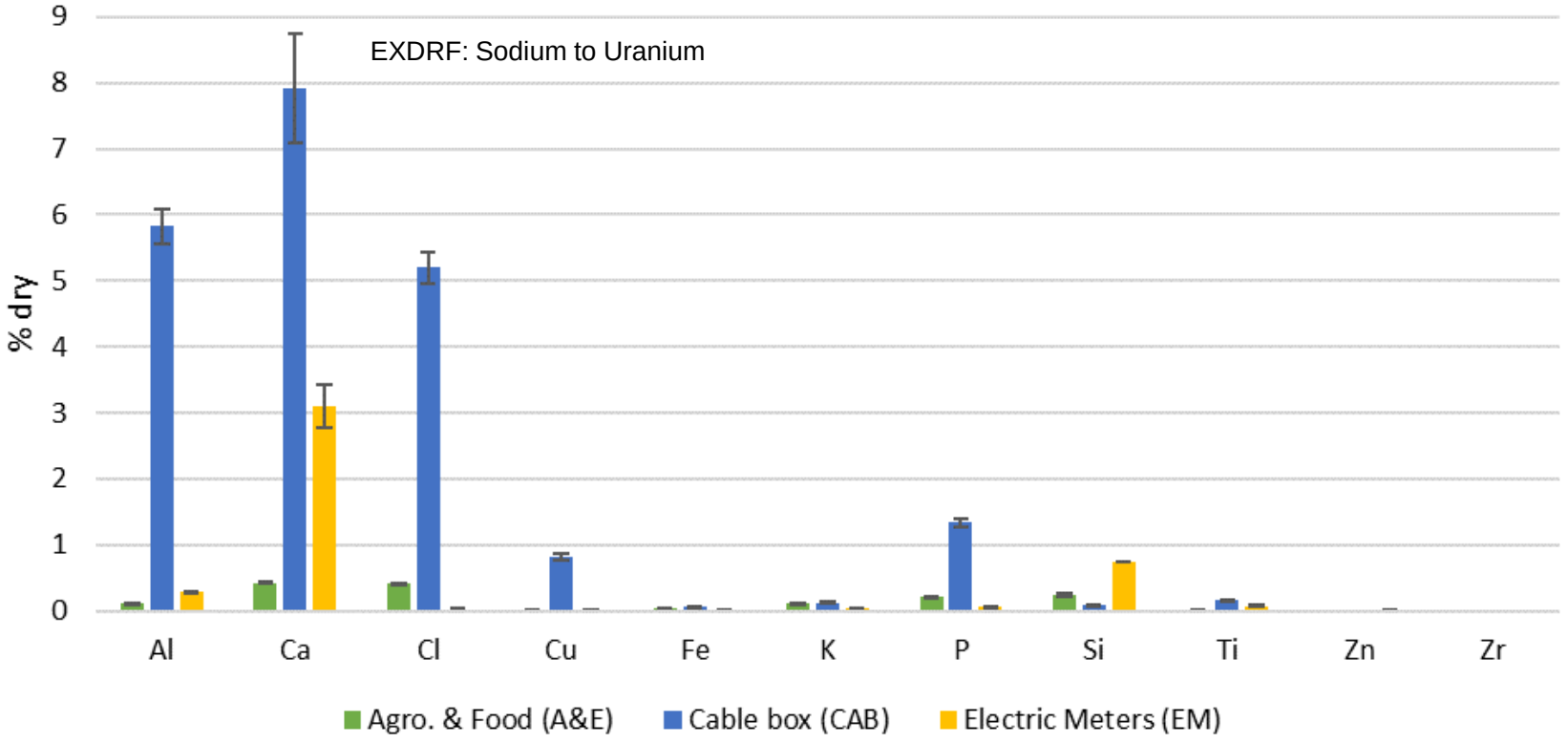


Plastic origin	Quantities (t/year)	Moisture (%)
Electric meters (EM)	33	0
Food packaging (F)	1’200 – 2’400	67±20
Agricultural (A)	~ 150	–
Electric cable (CAB)	2’500	0

Chemical characterization of the wastes

Characteristics	Agricultural and food packages	Cable coating	Electric meters
Ash material A [% dry]	5.6 ± 0.7	41.1 ± 5.0	11.6 ± 0.3
Higher calorific value $q_{v,gr,d}$ [kJ·kg^{-1}]	38'154 ± 863	16'000 ± 606	23'977 ± 774
Lower calorific value $q_{p,net,d}$ [kJ·kg^{-1}]	35'697 ± 863	15'284 ± 606	22'921 ± 774
C [% dry]	72.3 ± 2.0	24.1 ± 1.2	60.0 ± 1.5
H [% dry]	11.5 ± 0.3	3.3 ± 0.1	4.9 ± 0.2
N [% dry]	1.2 ± 0.1	0.1 ± 0.1	2.2 ± 0.2
O [% dry]	12.9 ± 1.4	19.6 ± 0.5	22.6 ± 0.6

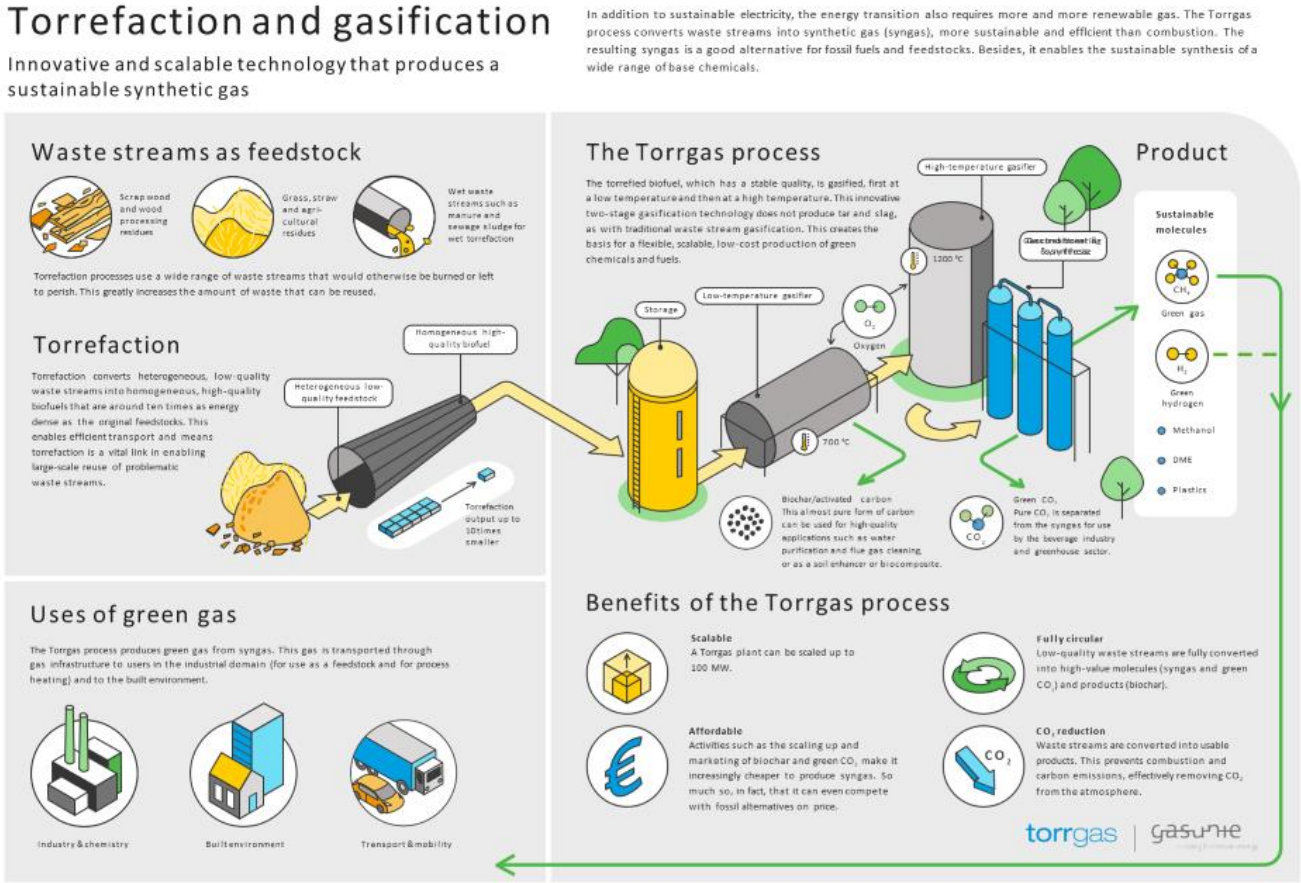
Secondary elements contained in the raw materials before pyrolysis



Main Technologies identified

Temperature ranges	Batch process	Continuous process
Average reactor temperature 400°C – 450°C Plastic to Fuel	1 to 5 t/day • Greenlina (Switzerland) • R-ONE (Taiwan) Cycle of 4 to 6 hours Normally 2 batch/day Plans for semi-batch or continuous	1-30 t/d • Biofabrik (Germany) • TCC-Energy (Switzerland) • APchemi (India) 30 – 50 t/d • Valoren (BR) • Recycling Technology (UK) • Nexus Fuel (USA) 15t/d at > 50 t/d : • Plastic Energy (Cynar process) • Quantafuel
High temperature 750°C – 1000°C Plastic to gas	Not commercially applicable	> 25 t/d: Powerhouse (UK) 12 t/d: Metal Expert (Poland) Up to 5 t/d: ETIA/VOW (France)

Molecules from biomass



http://torrgas.nl/

Concluding remarks

- Lots of studies, data, and information available
- Conflicting priorities and point of views of stakeholders
- Short term (economy, security) vs long term (sustainability) needs differ
- Need prioritize and agree on criteria of choice
- → focus of processes and applications with greatest bioeconomy impact
- Integrated, transdisciplinary, approach absolutely vital