Life cycle assessment of the biofuel production from lignocellulosic biomass in a hydrothermal liquefaction – aqueous phase reforming integrated biorefinery

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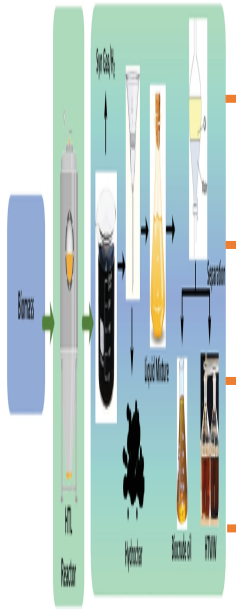
Research framework

Could biofuel be a possible solution for the decarbonization of trucking, shipping and aviation?

WET
biomass



BIOCRUDE

Aqueous phase

Gas phase

Solid phase

Needs upgrade!

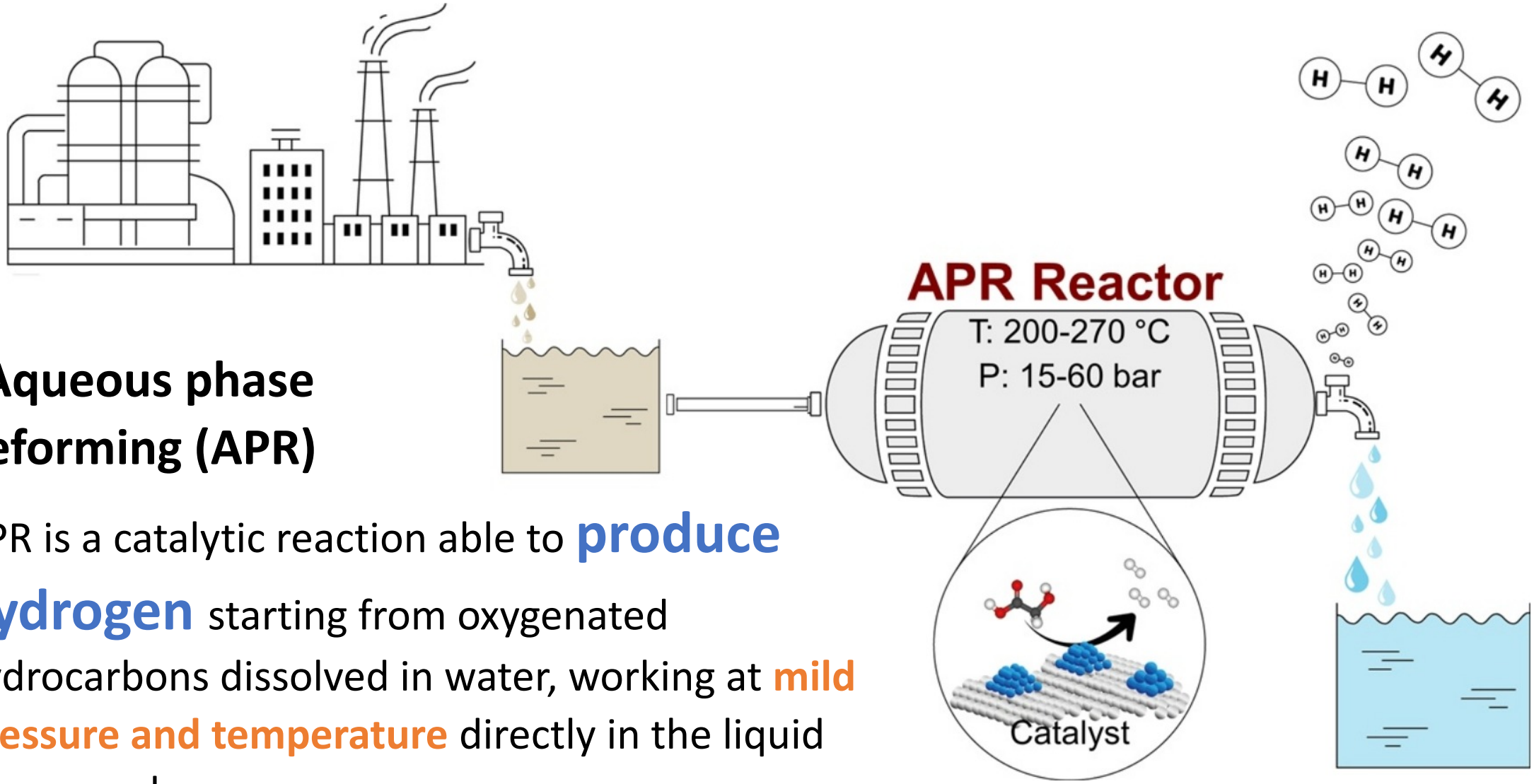
Because of high heteroatoms content

Catalytic hydrogenation: need of **GREEN hydrogen**

Needs valorization!

because of **low concentration of carbon** (0.4-2 wt C%) and expensive wastewater treatment

Research framework



Aqueous phase reforming (APR)

APR is a catalytic reaction able to **produce hydrogen** starting from oxygenated hydrocarbons dissolved in water, working at **mild pressure and temperature** directly in the liquid aqueous phase

Methodology

Our feedstocks

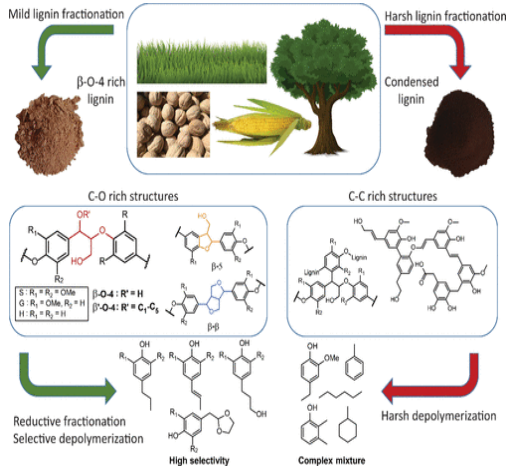
Corn stover (CS)

Generally left on the field after corn harvesting as soil nutrient

↓

RESIDUE

Lignin-rich stream (LRS)



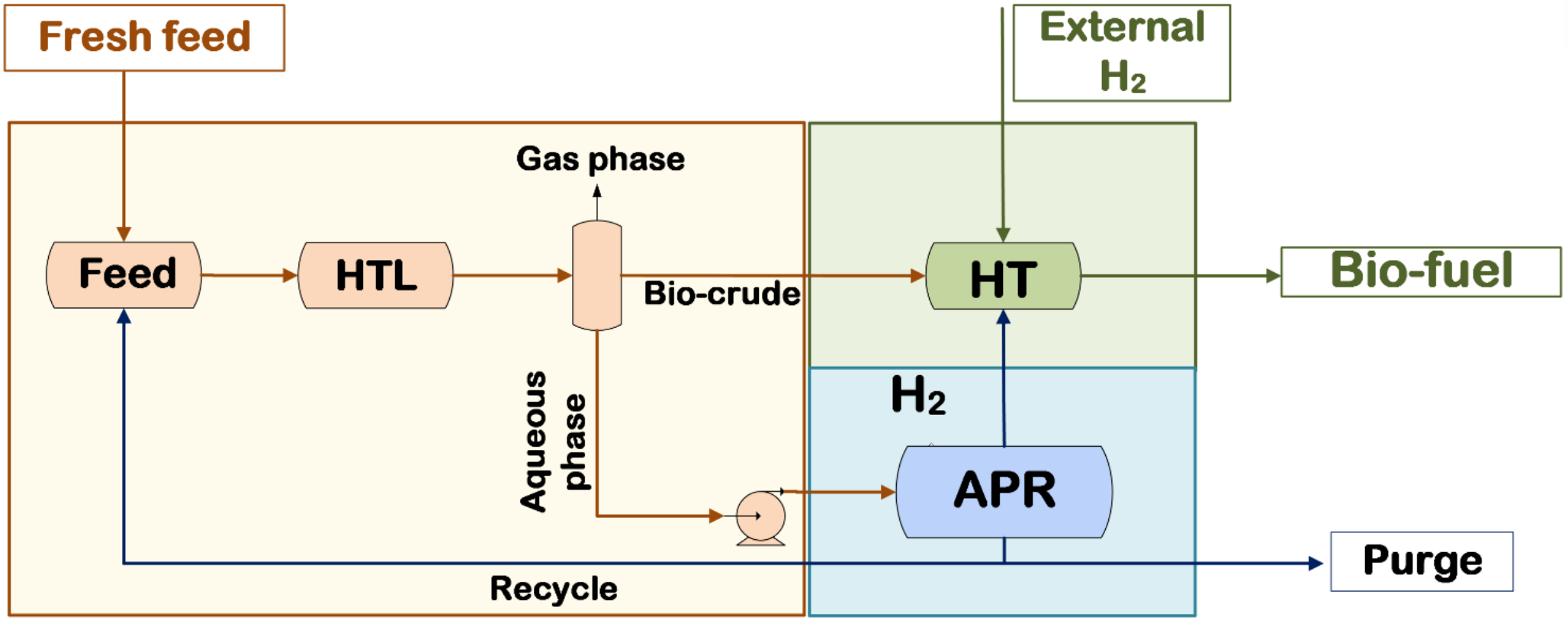
By-product of a 2nd generation bioethanol plant

↓

No value ⍰ WASTE

Methodology

Integration of HTL and APR

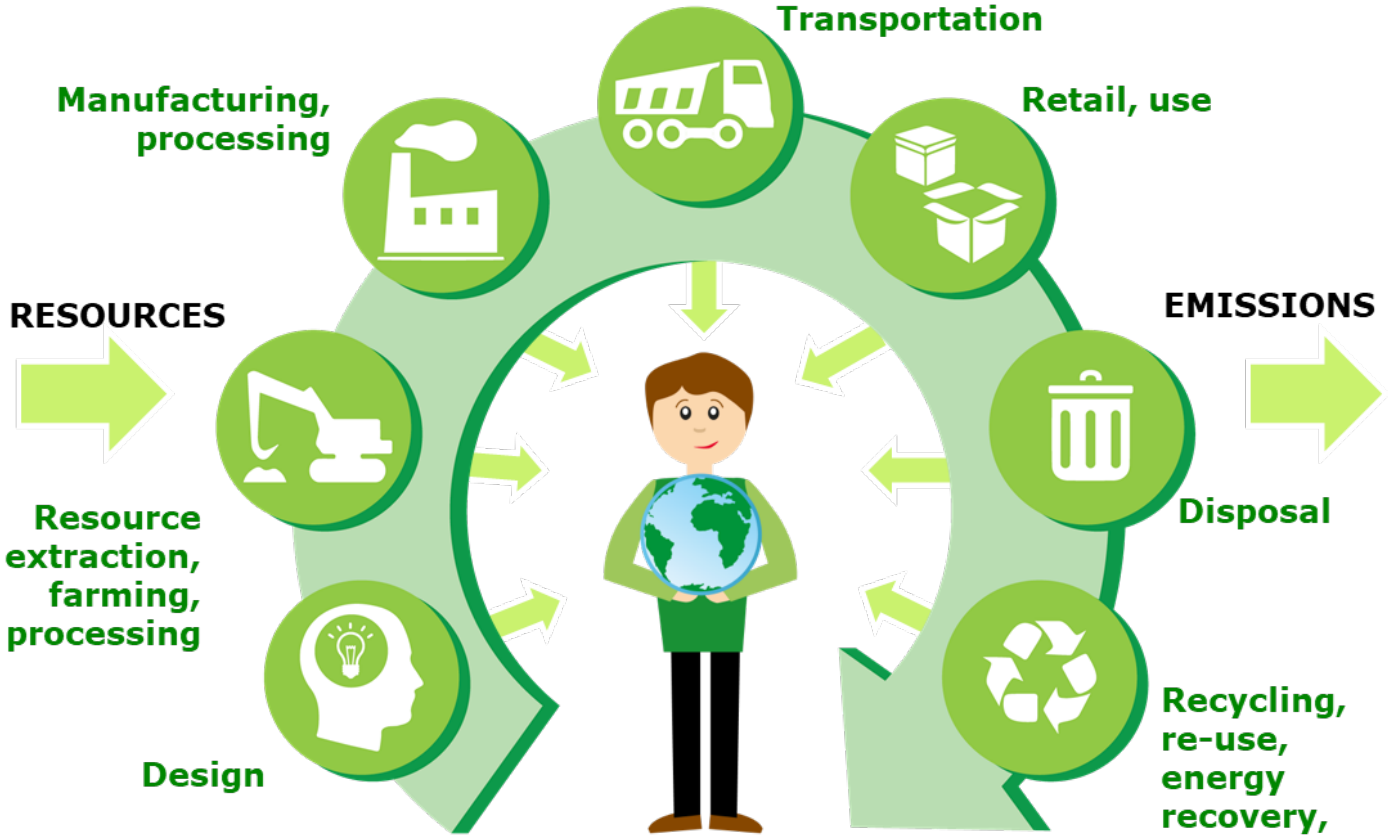


Methodology

Are we sure that it is environmentally sustainable?

Life Cycle Assessment
ISO 14040 and 14044

LCA is an objective tool for **analyzing and quantifying the environmental consequences** of products (services) during all their life-cycle, from the extraction of raw materials, through industrial production, including the use phase and the end-of-life disposal

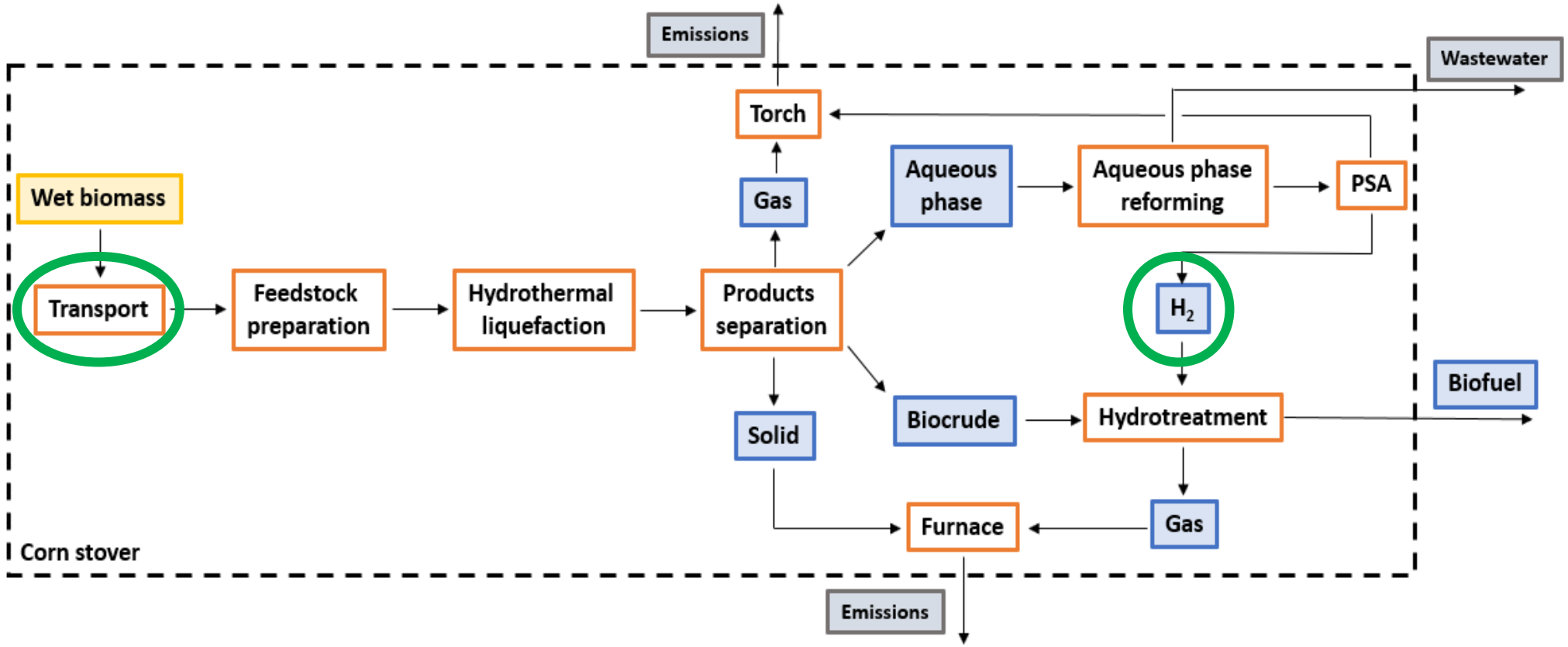


Methodology

LCA of biofuel from CS

Functional unit: 1 MJ of biofuel

System boundaries:

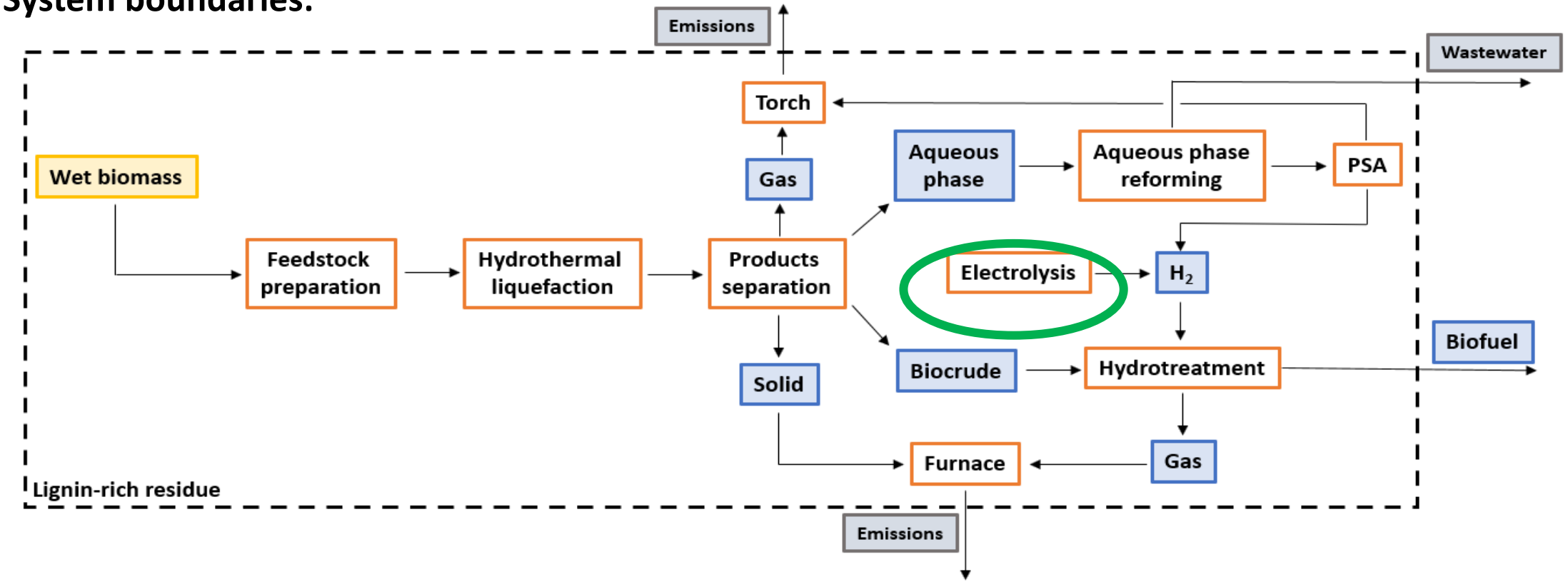


Methodology

LCA of biofuel from LRS

Functional unit: 1 MJ of biofuel

System boundaries:



Methodology

Different ways to assess biogenic carbon

- "**0/0 approach**": neither the uptake nor the release of biogenic carbon is considered in the calculation of impacts for the global warming potential

- "**–1/+1 approach**": the uptake of biogenic CO2 carbon is considered an environmental credit, while the release is considered an environment burden, with the same impact factor of fossil carbon

- **dynamic approaches** based on time-dependent characterization factors

CO2

CH4

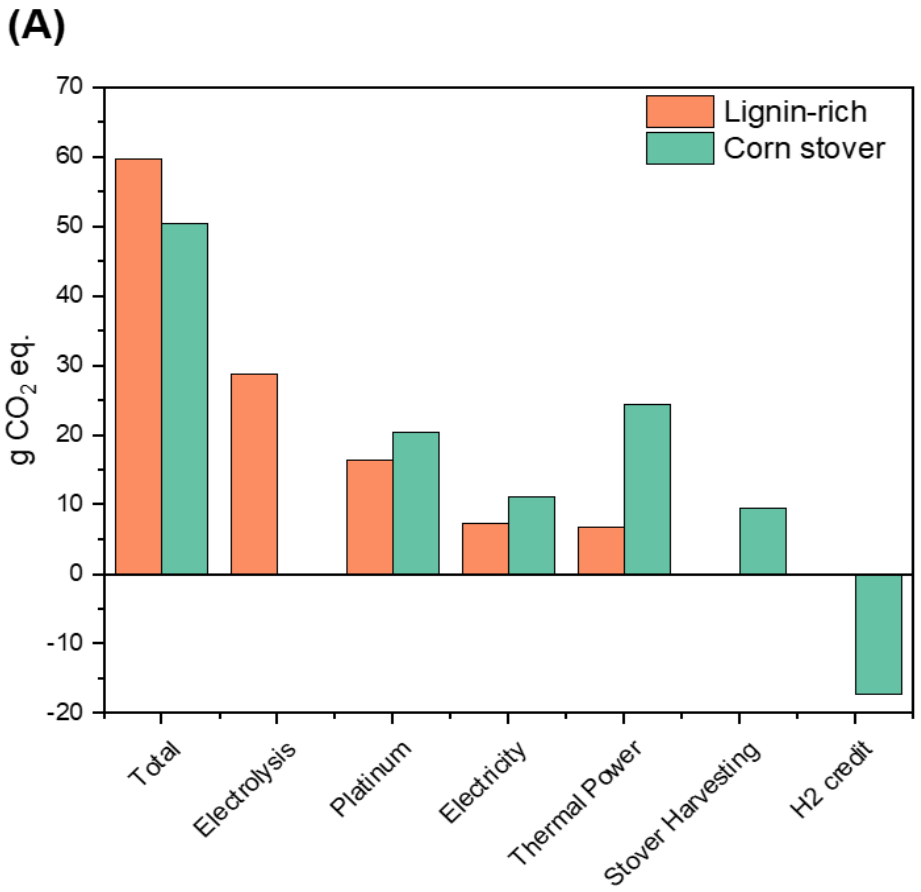
CO

Biomass

Impact results

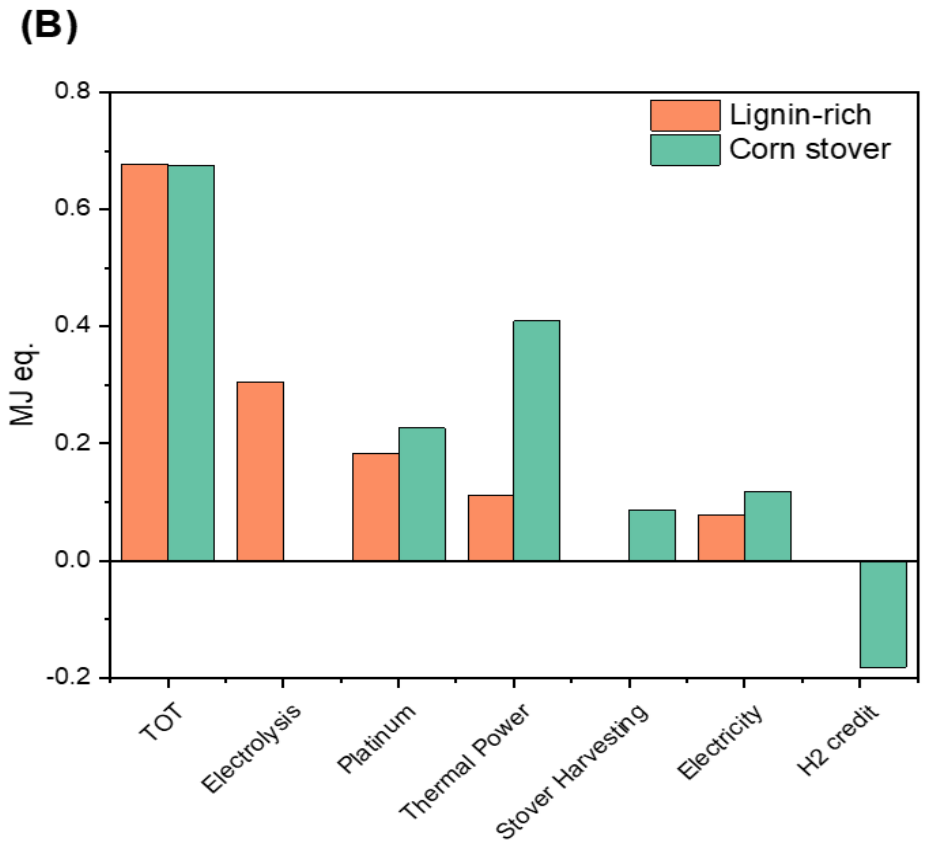
Global warming potential

0.06 kg CO2 eq. for LRS
0.05 kg CO2 eq. for CS



Fossil resource depletion

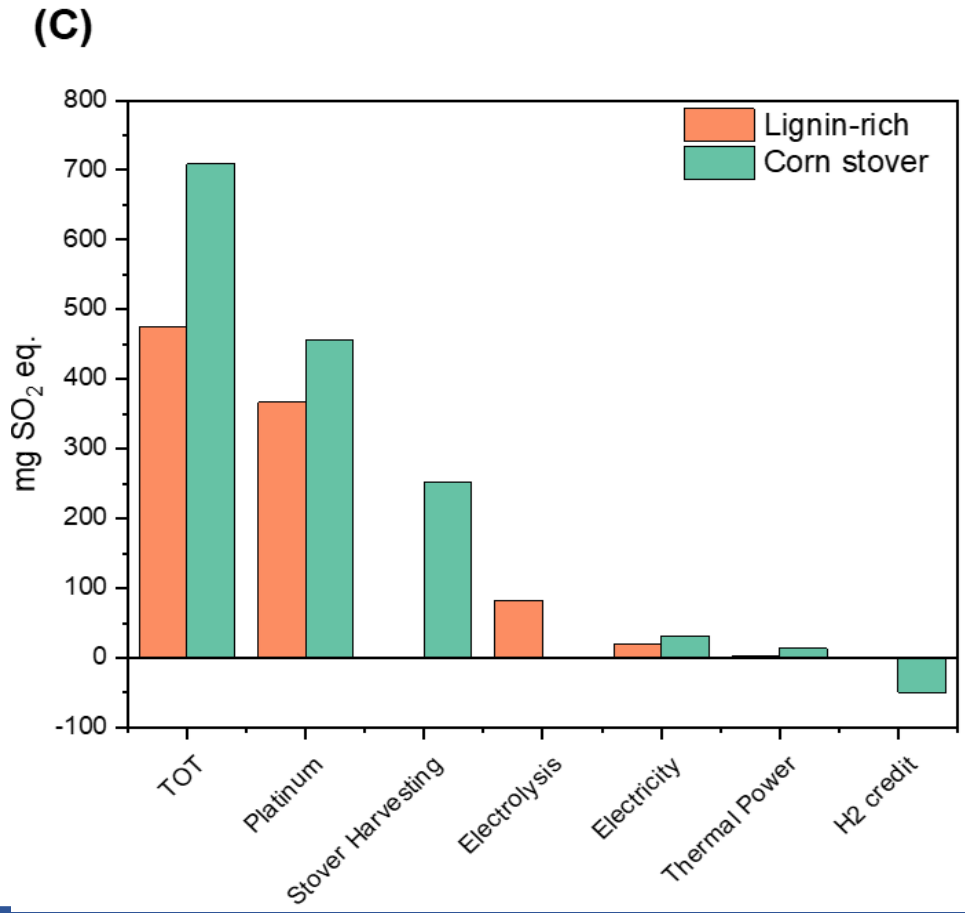
0.68 MJ for LRS
0.68 MJ for CS



Impact results

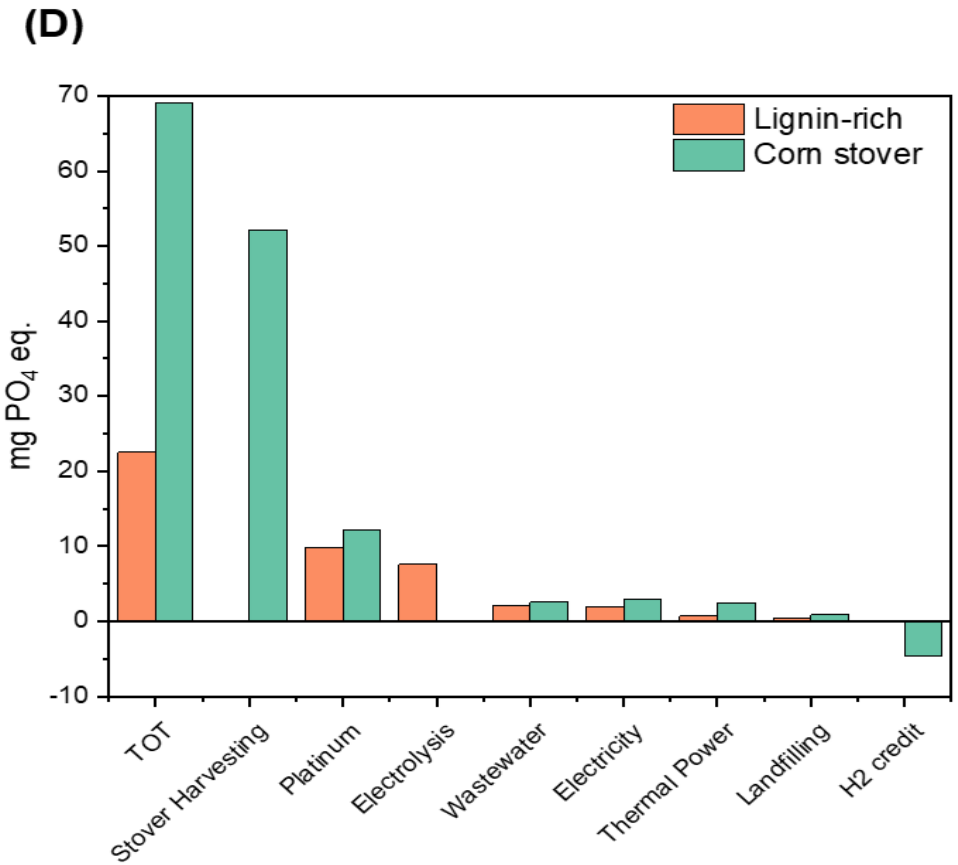
Acidification potential

474 mg SO2 eq. for LRS
709 mg SO2 eq. for CS



Eutrophication potential

23 mg PO4 for LRS
69 mg PO4 for CS

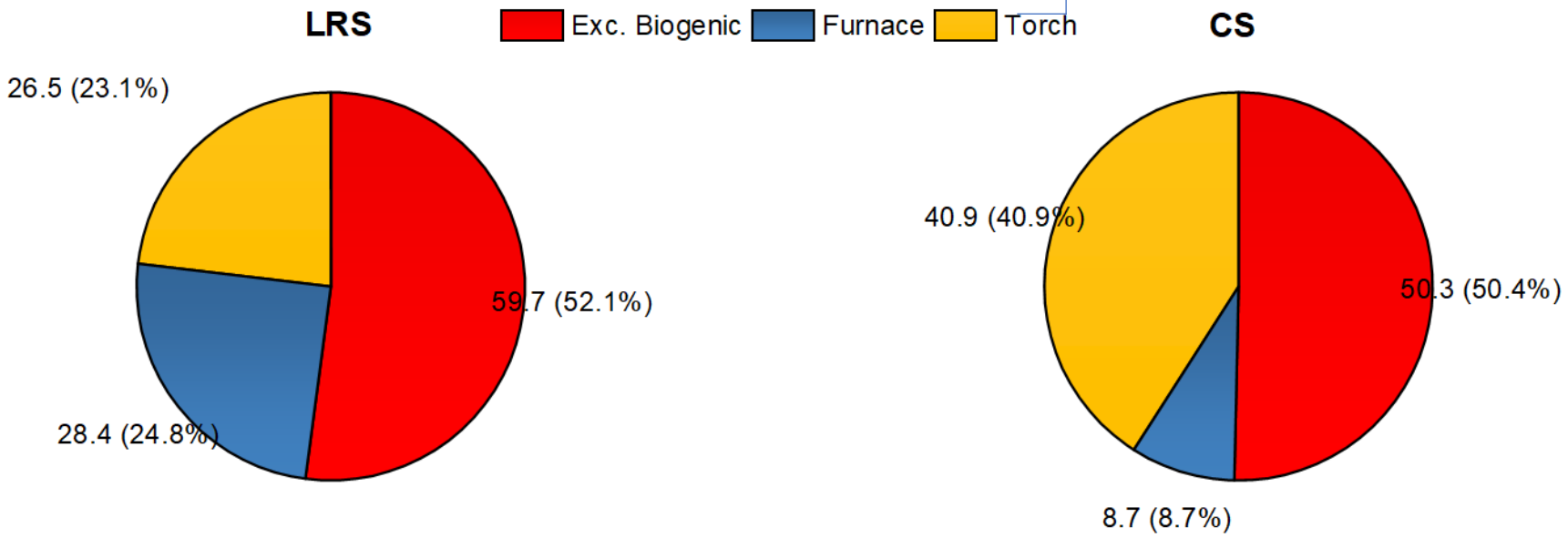


Sensitivity analysis

The non-biogenic nature of biomass

Burning of char during HTL

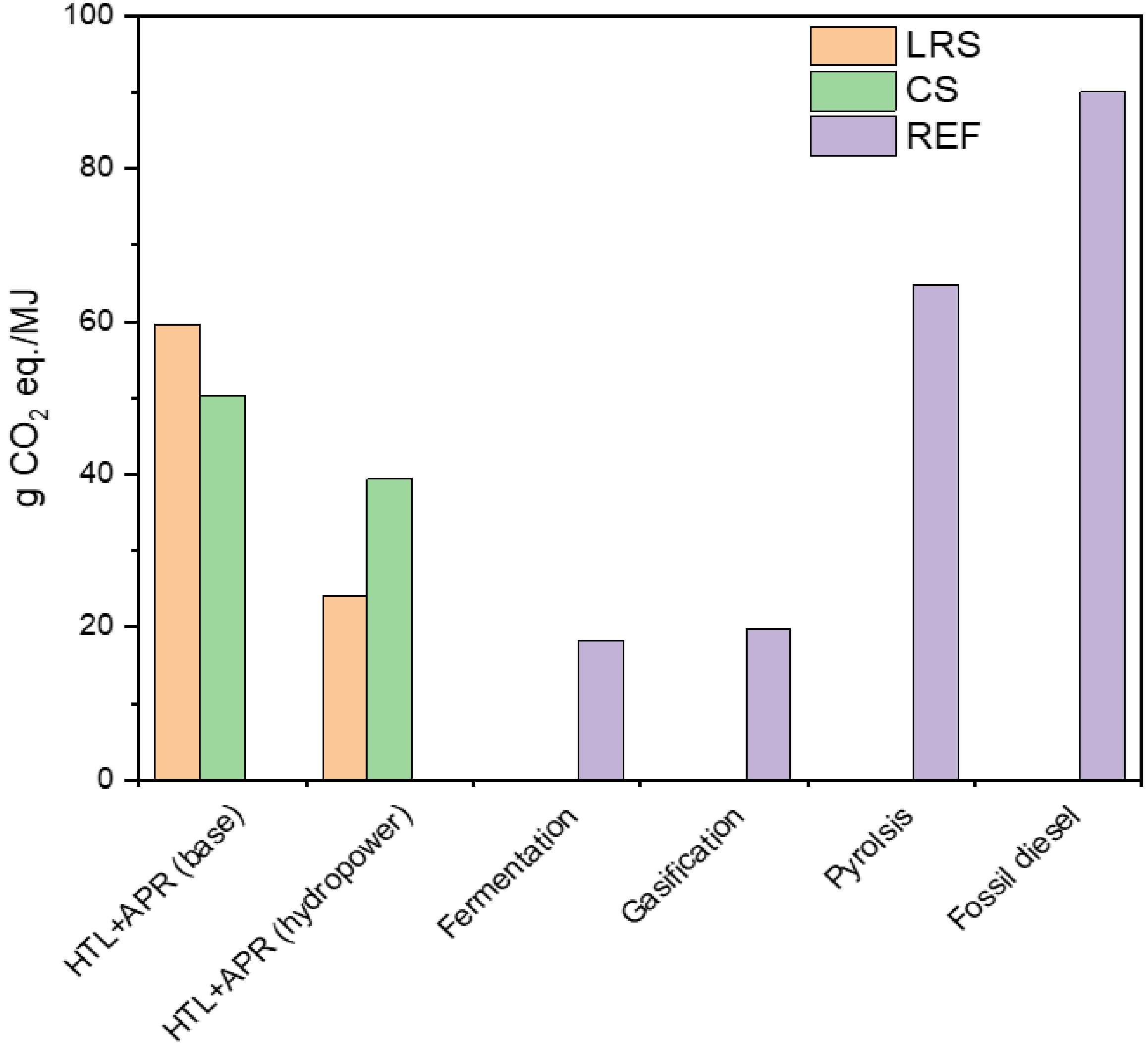
production of gas phase from HTL and APR



The cumulative GWP increased from 59.7 to 114.6 g CO2 eq./MJ biofuel (+92%)

The cumulative GWP increased from 50.3 to 99.9 g CO2 eq./MJ biofuel (+98%)

LCA GWP results



Comparison of global warming potential between HTL-APR and alternative technologies (1 MJ biofuel)

THANK YOU
FOR YOUR ATTENTION

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