What Future for Electrofuels? – Analysis of Cost-Competitiveness of Electrofuels for Transport in Global Climate Mitigation

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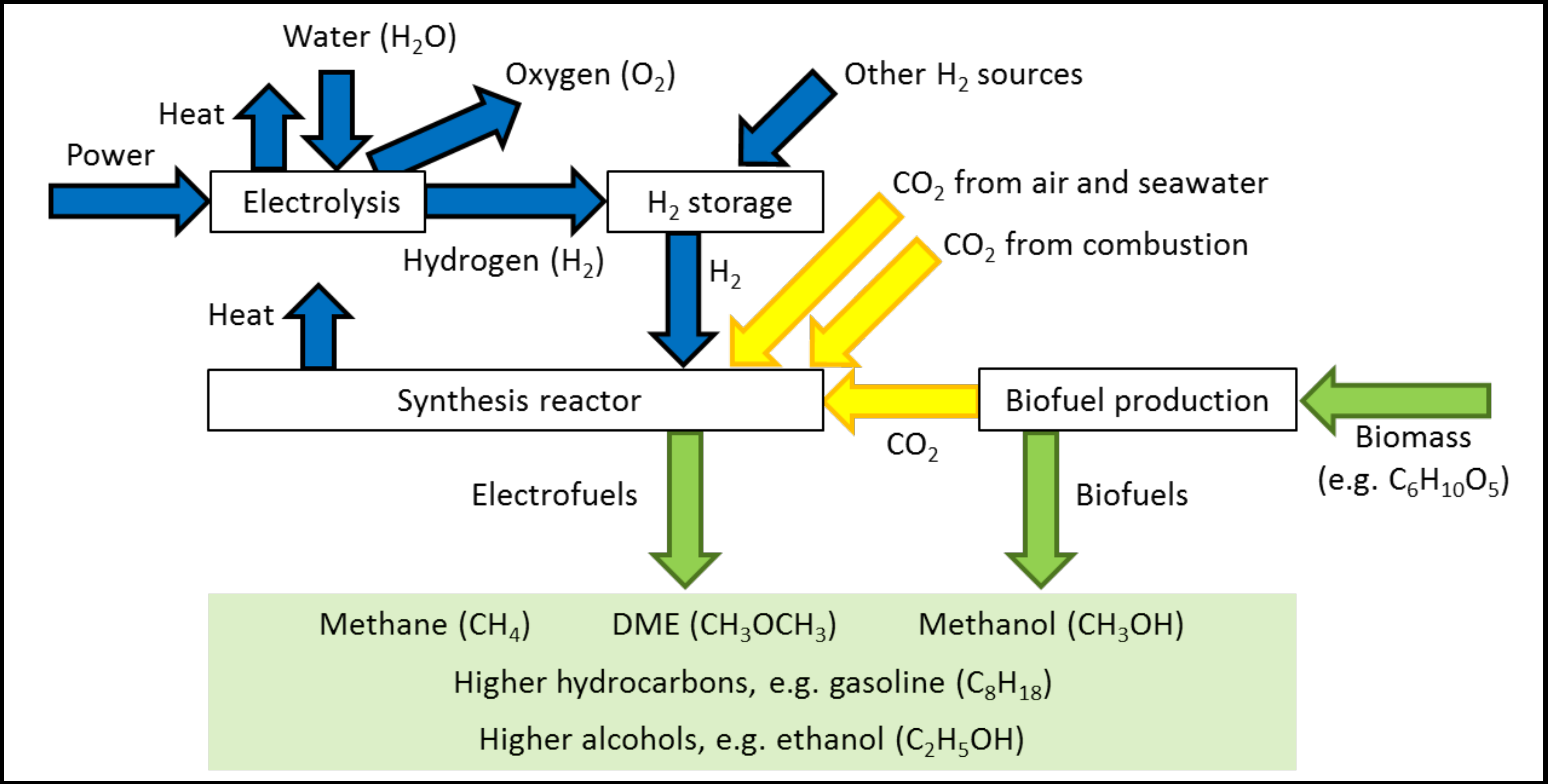
Electrofuels

- Carbon-based fuels produced from carbon dioxide and water (hydrogen), with electricity as the primary source of energy.
- Also known as power-to-gas/liquids/fuels, e-fuels, or synthetic fuels.
- Many different fuels can be produced (methane, methanol, gasoline etc.)
- Using biogenic CO_2 makes electrofuels potentially climate neutral.

Production of electrofuels



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Motivations: variation management for VRE

- Absorbing excess electricity at windy and/or sunny times when the price of electricity is low.
- Making room for dispatchable generation so it can run for more hours and thus at lower cost.

Motivations: limited biomass

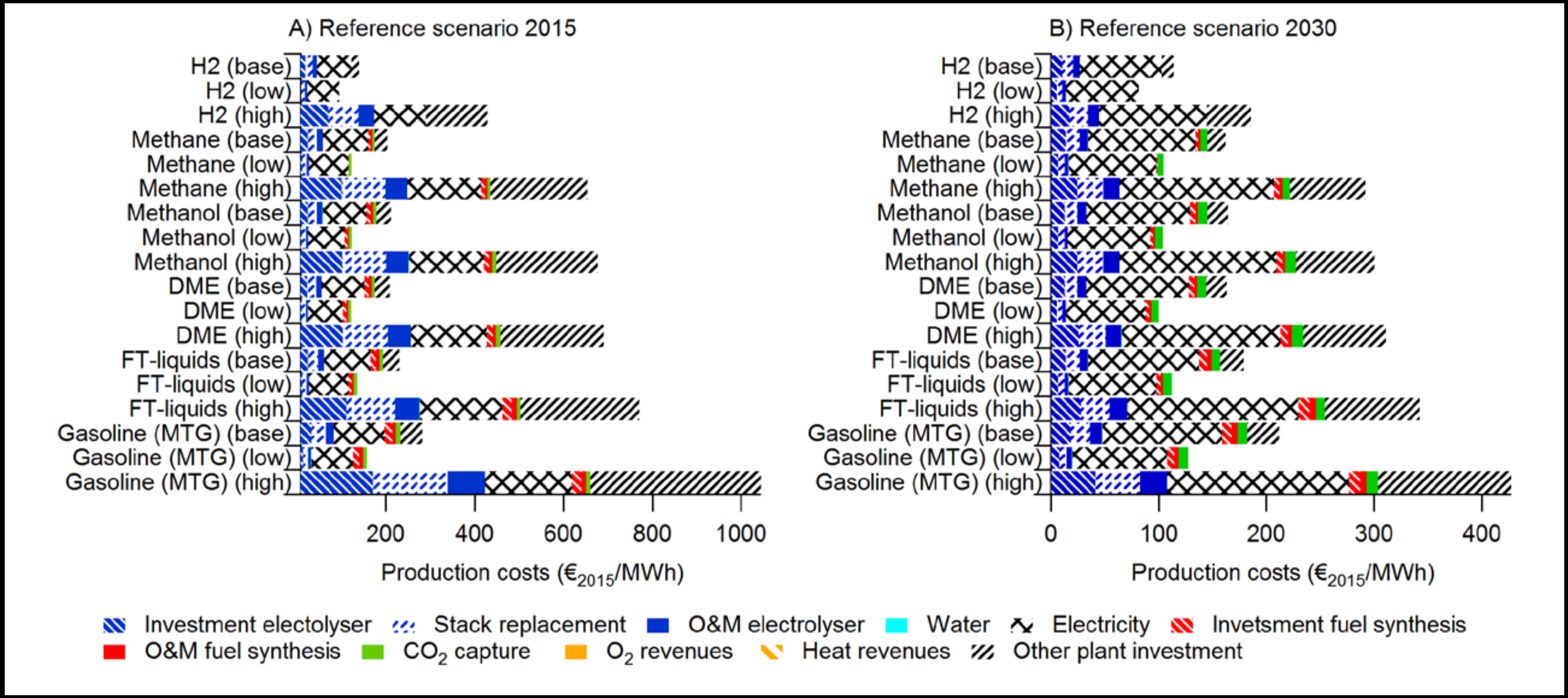
- Biomass may be more needed in other sectors.
- Adding hydrogen to biogas production can increase the yield.
- Reduces transport sectors reliance on biofuels.

Motivations: Hydrogen is difficult to handle

- Hydrogen needs investment in infrastructure to be used in transport.
- It may be difficult to use hydrogen for some modes (aviation, shipping).

Production cost of different electrofuels

Cost of electricity and electrolysers identified as main contributors to the fuel production cost.



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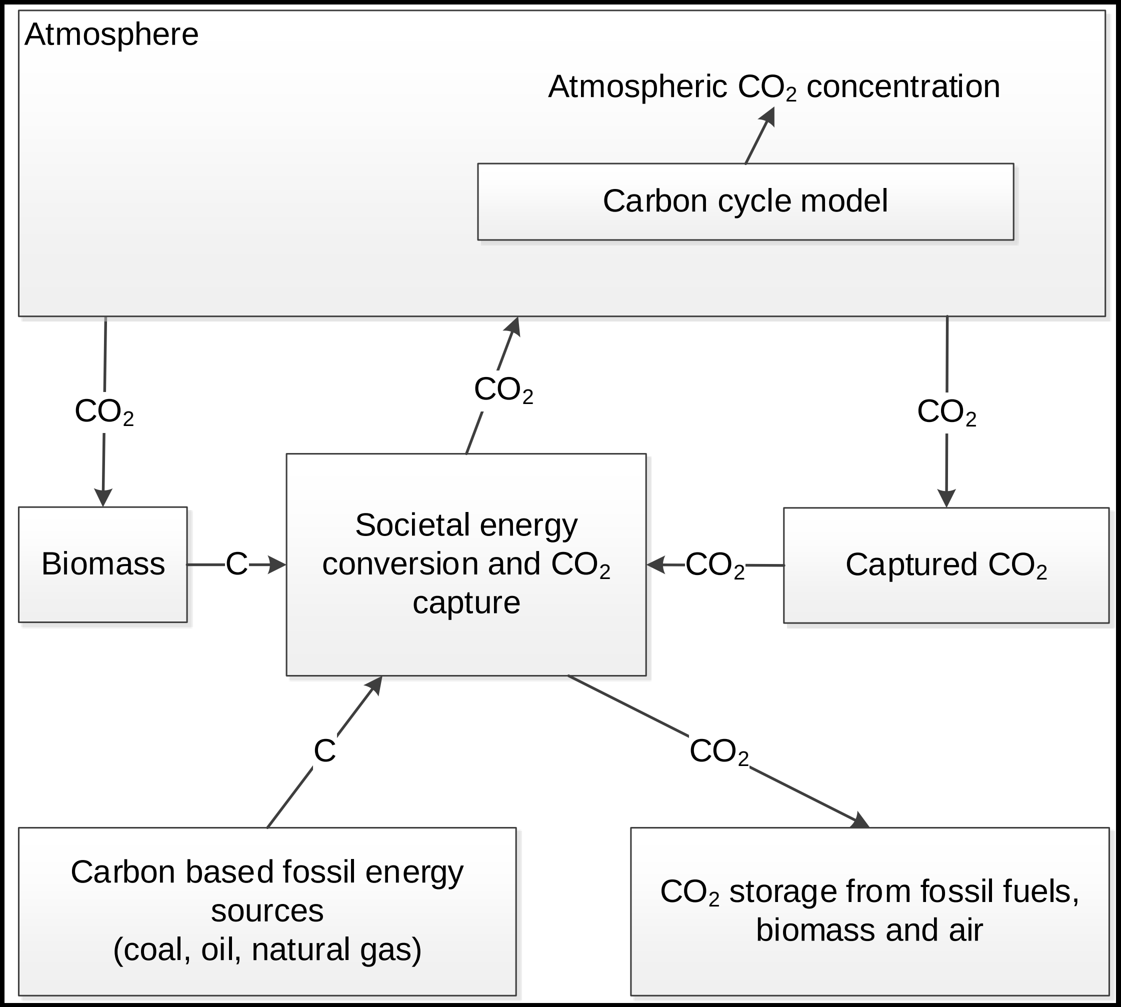
Aim of the study:

To investigate under what conditions can electrofuels be a part of a cost-effective solution for mitigating climate change?

Global Energy Transition (GET) Model

- A cost minimizing systems engineering model of the global energy system
- Set up as a linear programming problem
- Five end use sectors: *electricity, transport, feedstock, residential–commercial heat and industrial process heat*
- Global carbon budget
- Resource based slicing used to capture intermittency of variable renewables
- Used to study mitigation scenarios up till 2100

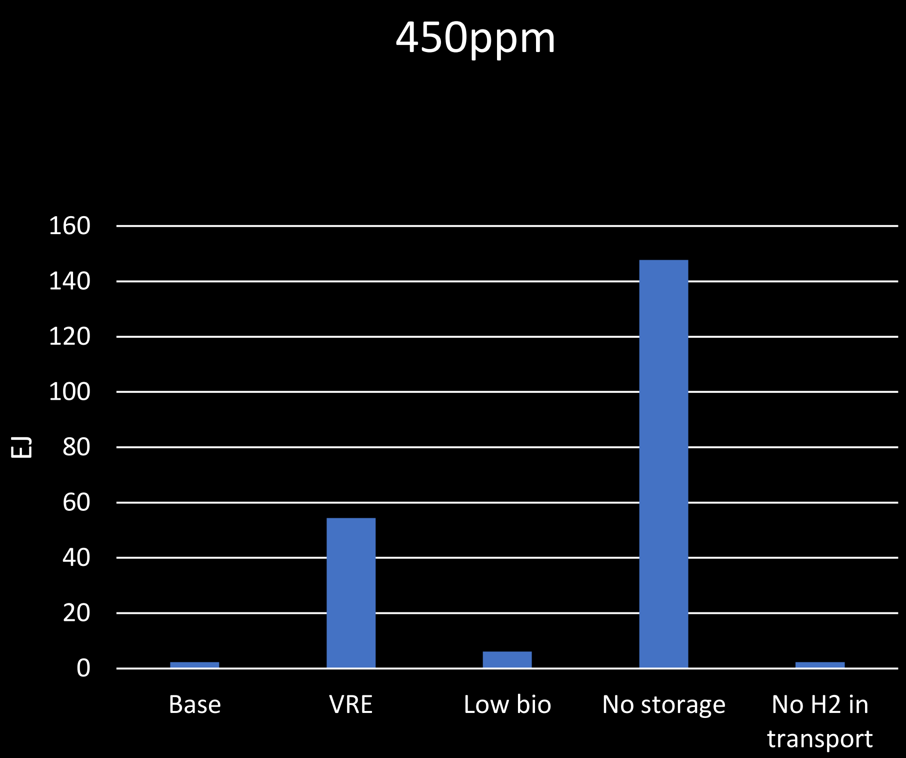
Carbon flows in GET

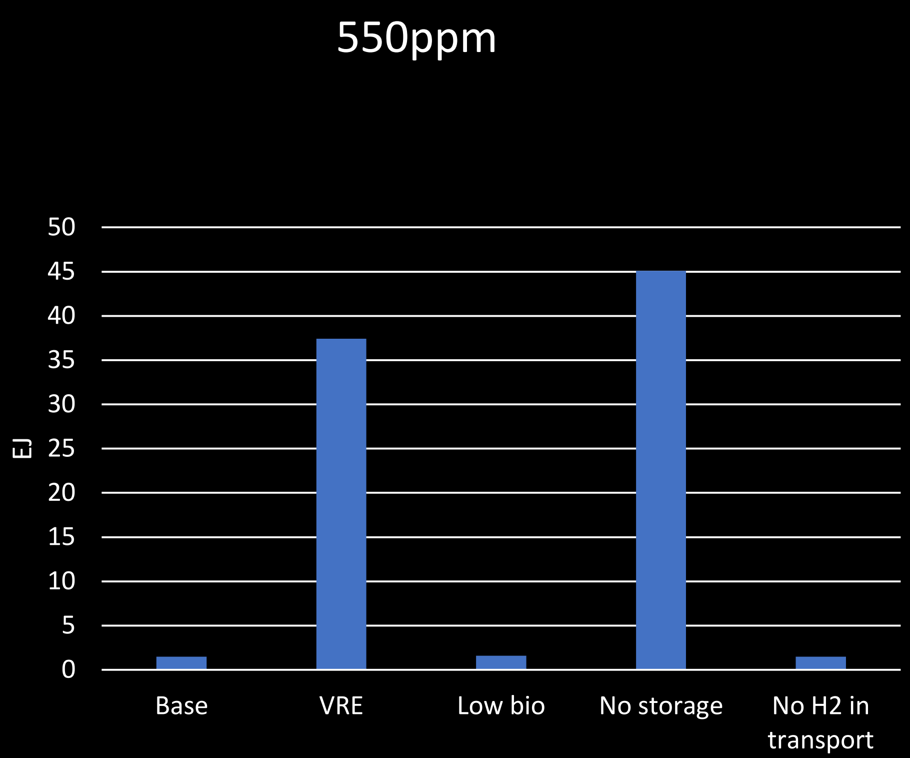


Cases studied:

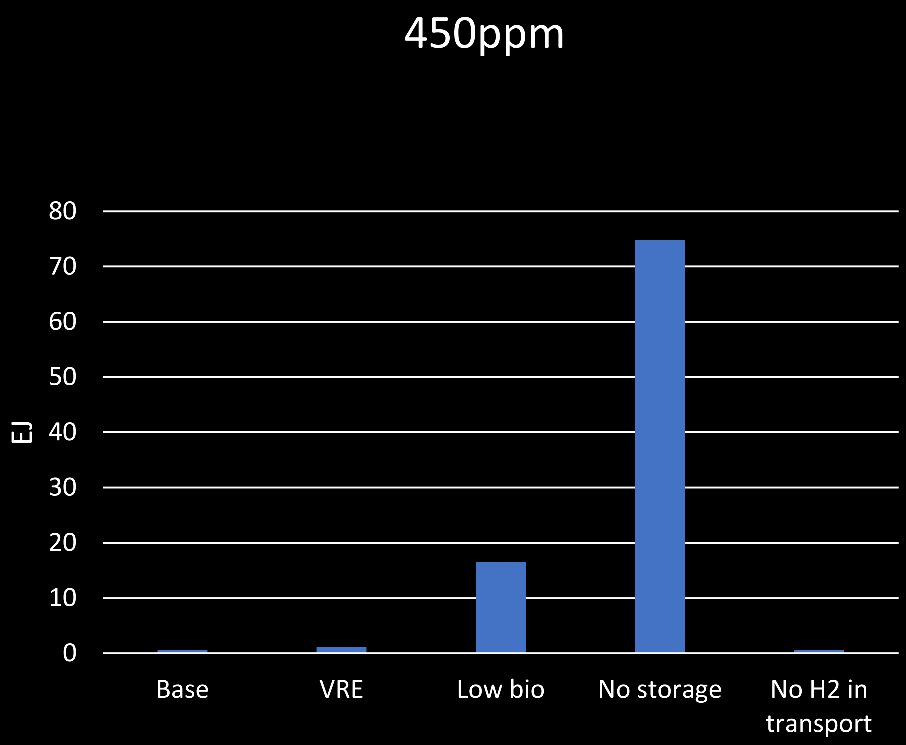
- Base case – 450 ppm and 550 ppm CO2
- VRE case – 50% cheaper wind and solar
- Low bio case – 50% less biomass available
- No storage case – No carbon storage available
- No H_2 in transport case

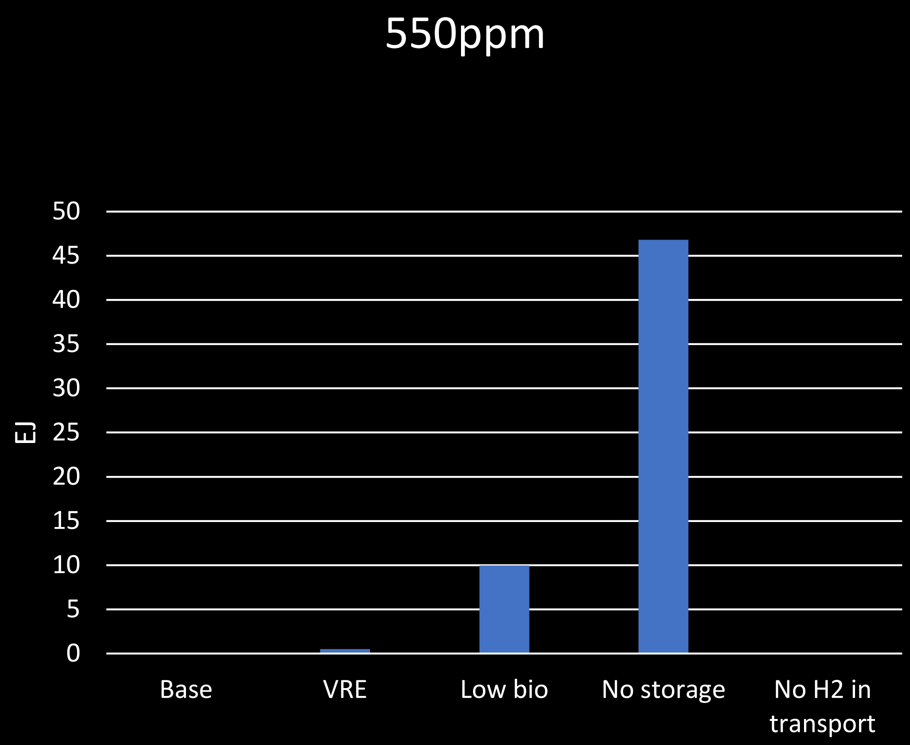
Results: Global H_2 production from electricity 2070



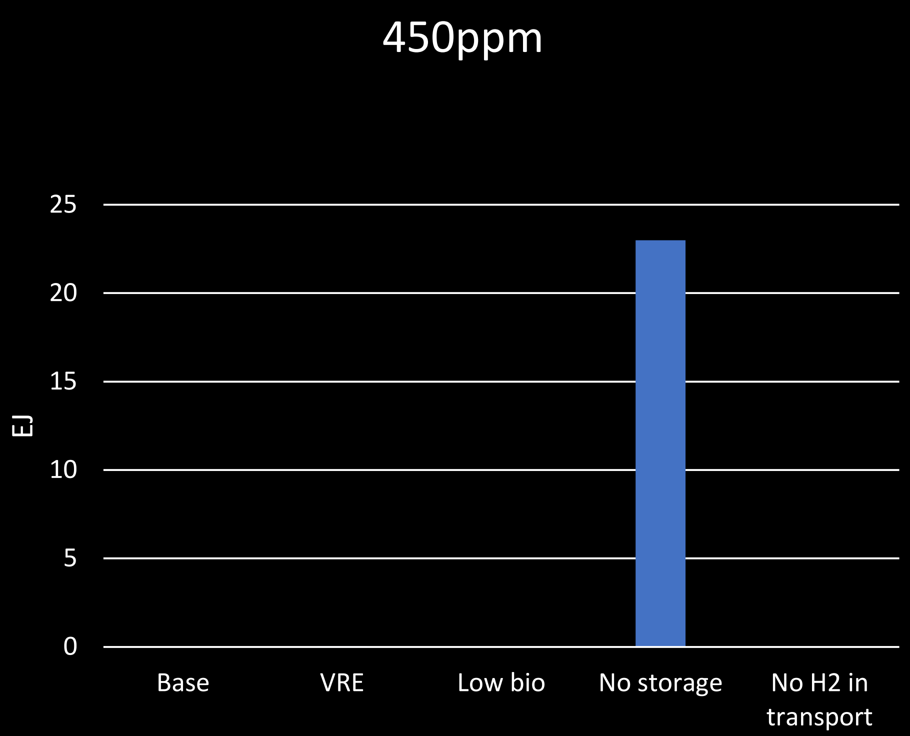


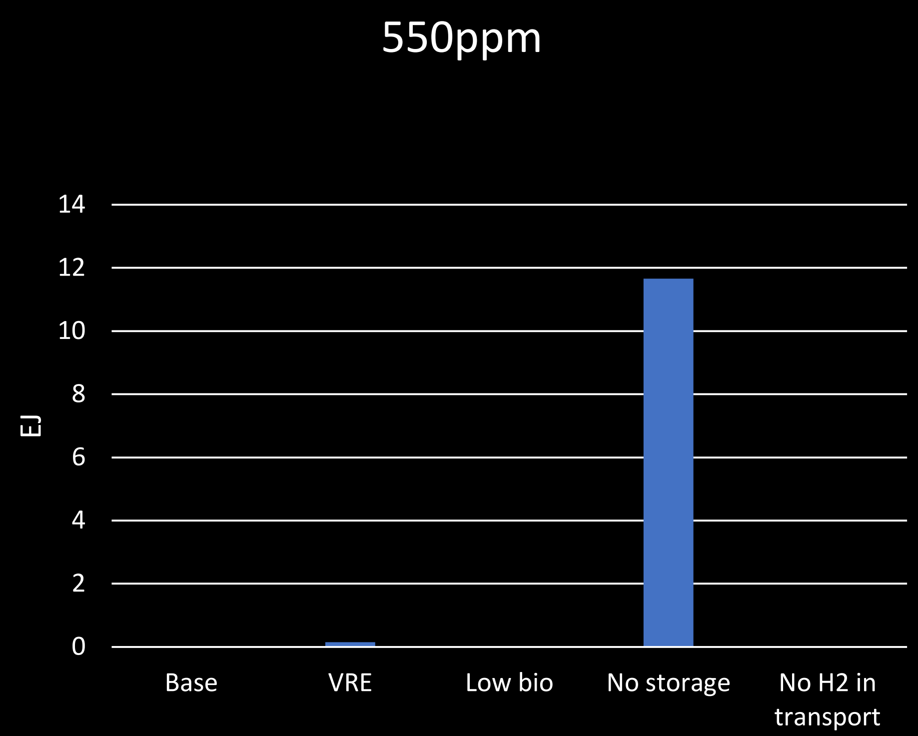
Results: Global methanol production from H_2 2070



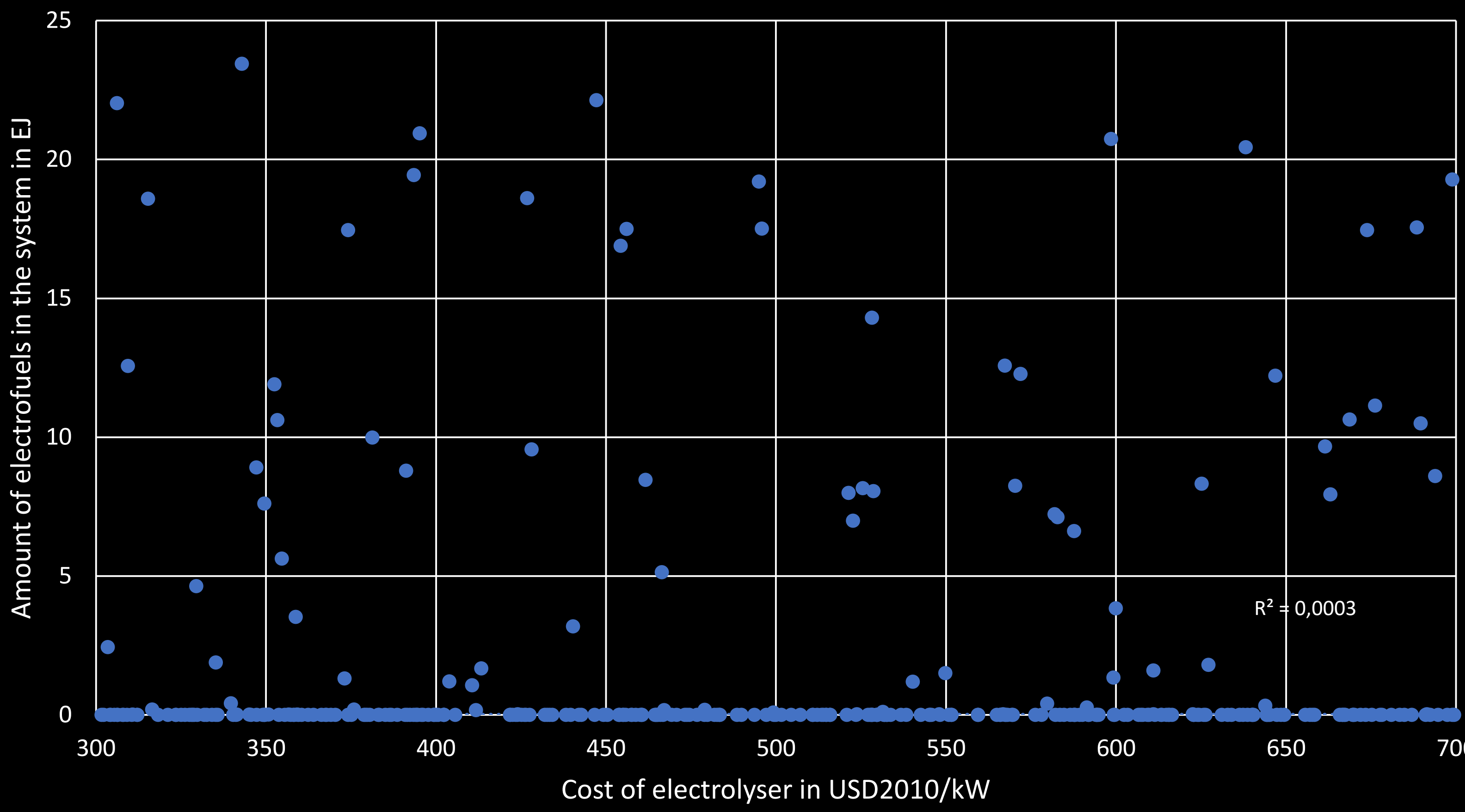


Results: Global potential for electrofuels in transport 2070

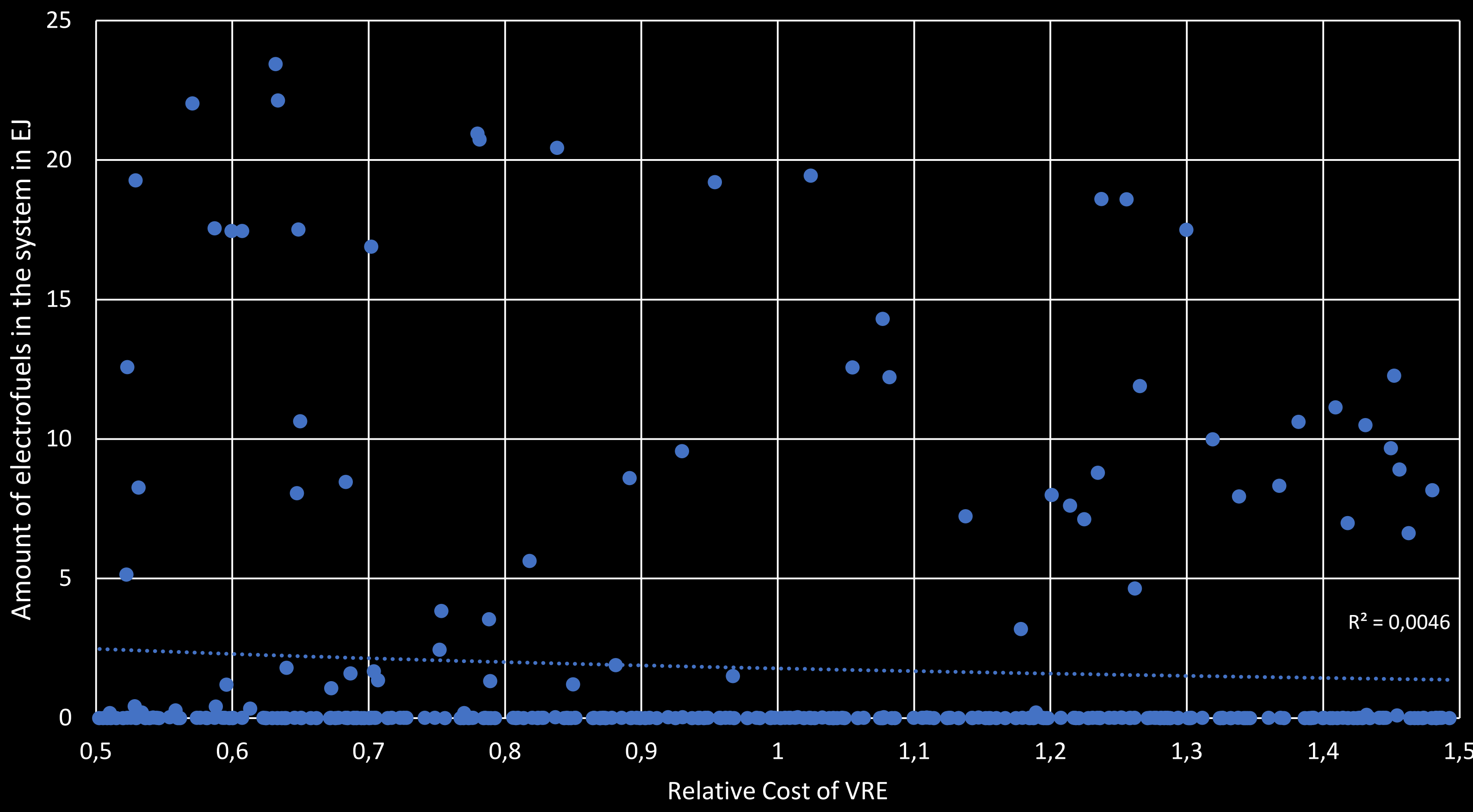




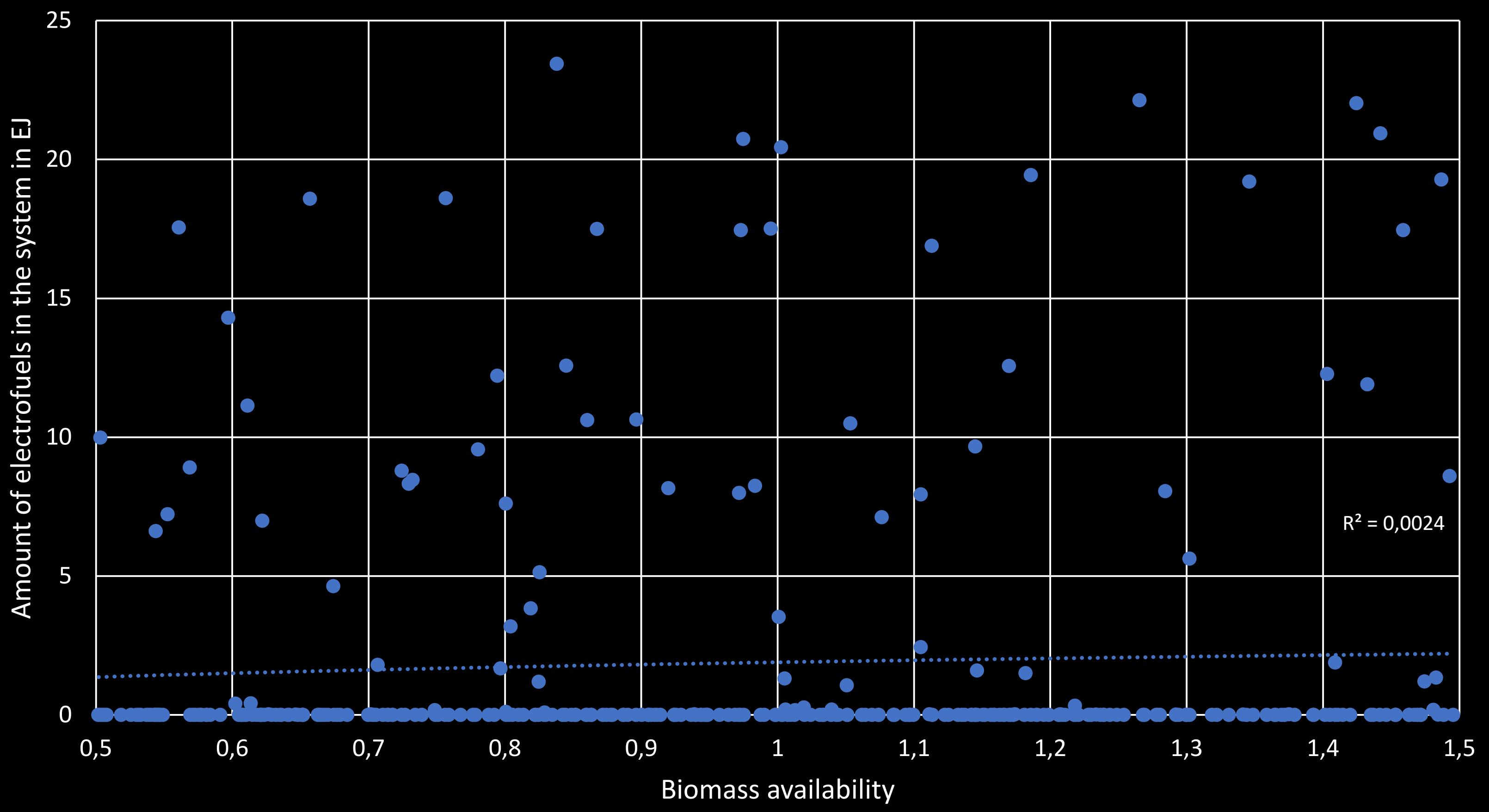
Monte Carlo: electrofuels vs electrolyser cost



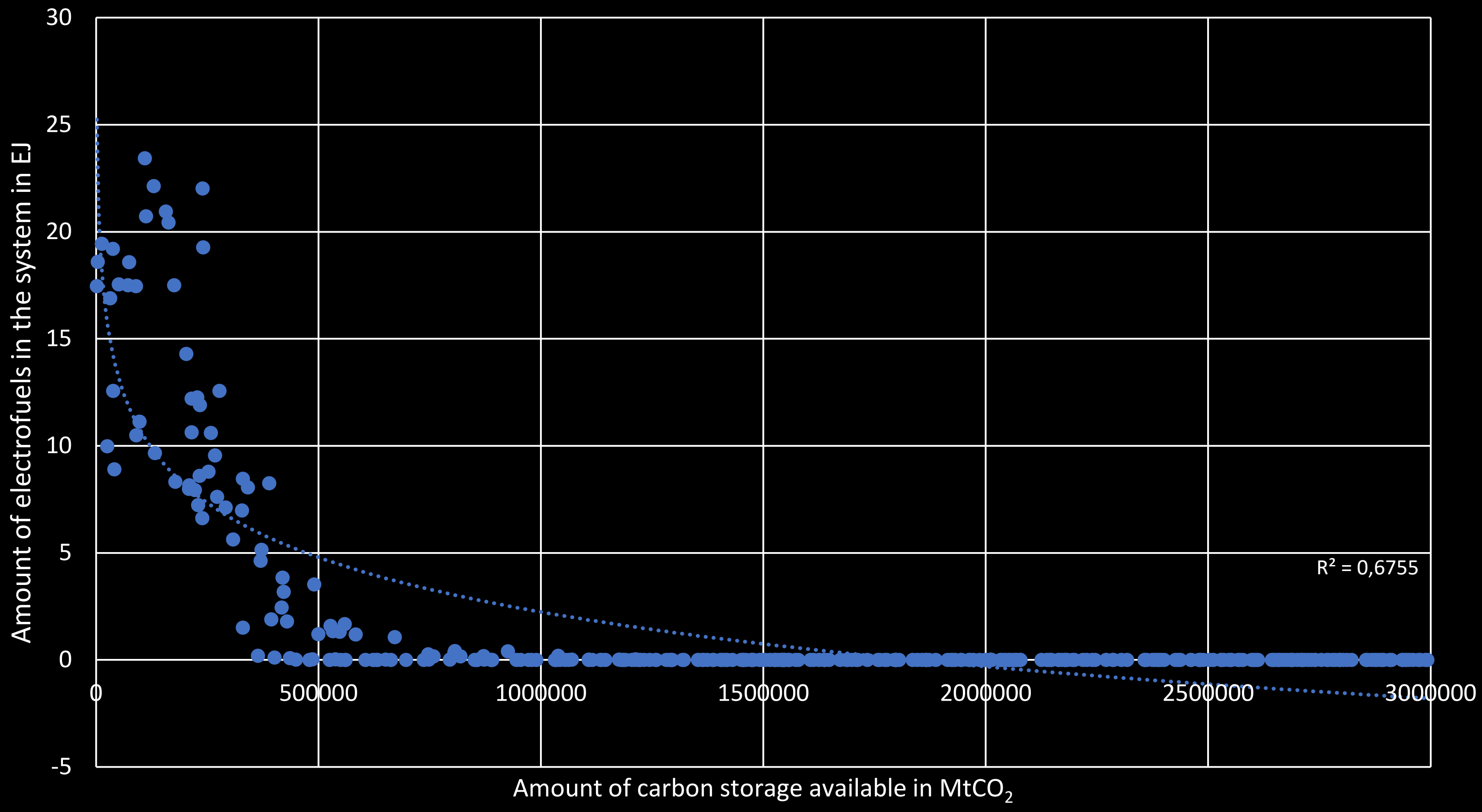
Monte Carlo: electrofuels vs relative cost of VRE



Monte Carlo: electrofuels vs biomass availability



Monte Carlo: electrofuels vs carbon storage



Conclusions:

- The potential for electrofuels in transport is very limited or non-existent in most cases.
- Cost of electrolyser and variable renewables will not be determining factor of whether electrofuels enter the transport system.
- There is a strong correlation between availability of carbon storage and the potential for electrofuels in the system. However, if the global carbon storage potential exceeds 750 $GtCO_2$, electrofuels will not be cost competitive.
- In case of 450 ppm climate target and no carbon storage available, electrofuels have a potential of ca 23 EJ globally at 2070, providing for ca 14% of transport energy demand.