

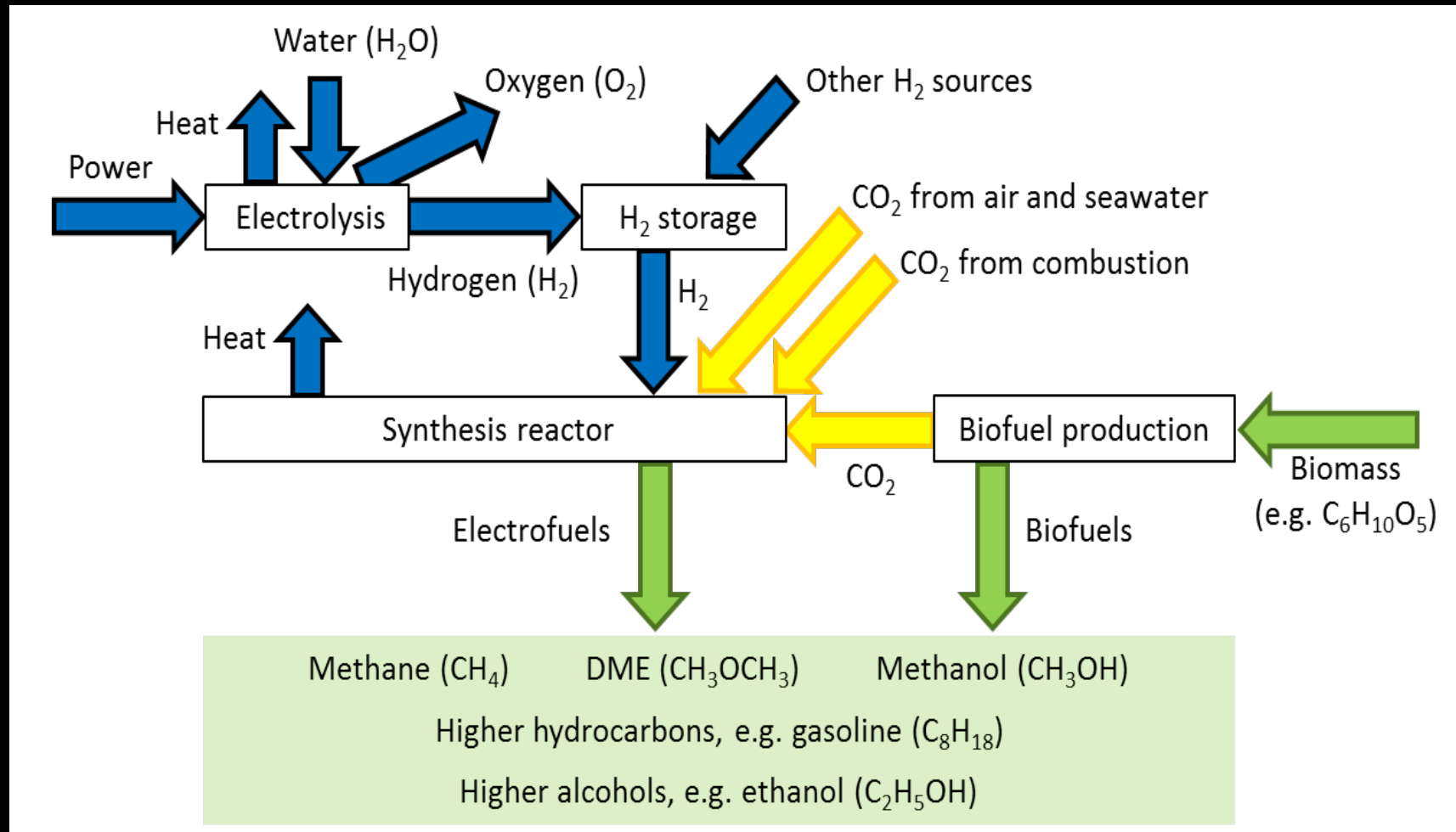
WHAT FUTURE FOR ELECTROFUELS IN TRANSPORT? – ANALYSIS OF COST-COMPETITIVENESS IN GLOBAL CLIMATE MITIGATION

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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 CO₂ or CO₂ captured from atmosphere makes electrofuels potentially climate neutral.

Production of electrofuels



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

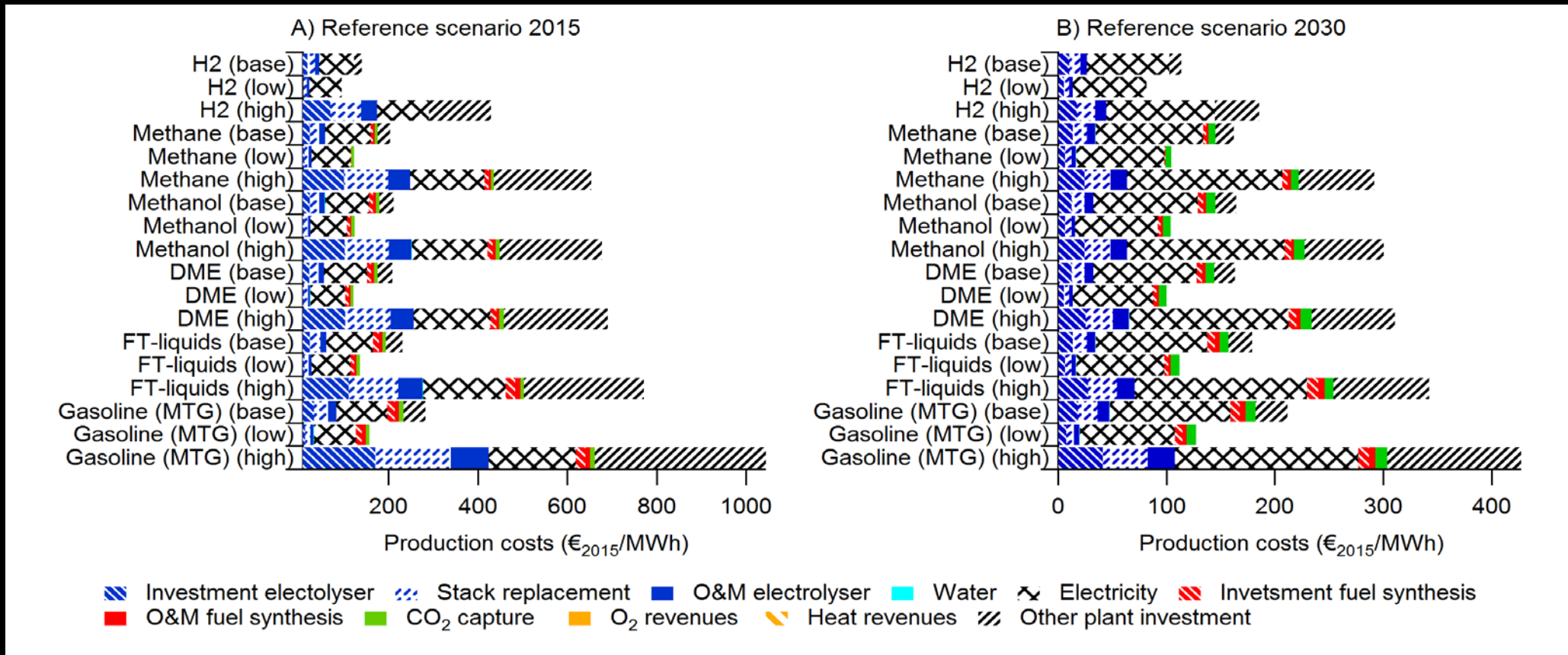
- Biomass may be more needed in other sectors.
- Adding hydrogen to biogas production can increase the yield.
- Reduces transport sectors reliance on biofuels.

Motivations: hydrogen is difficult to handle

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

Production cost of different electrofuels

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



Aim of the study:

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

Global Energy Transition (GET) Model

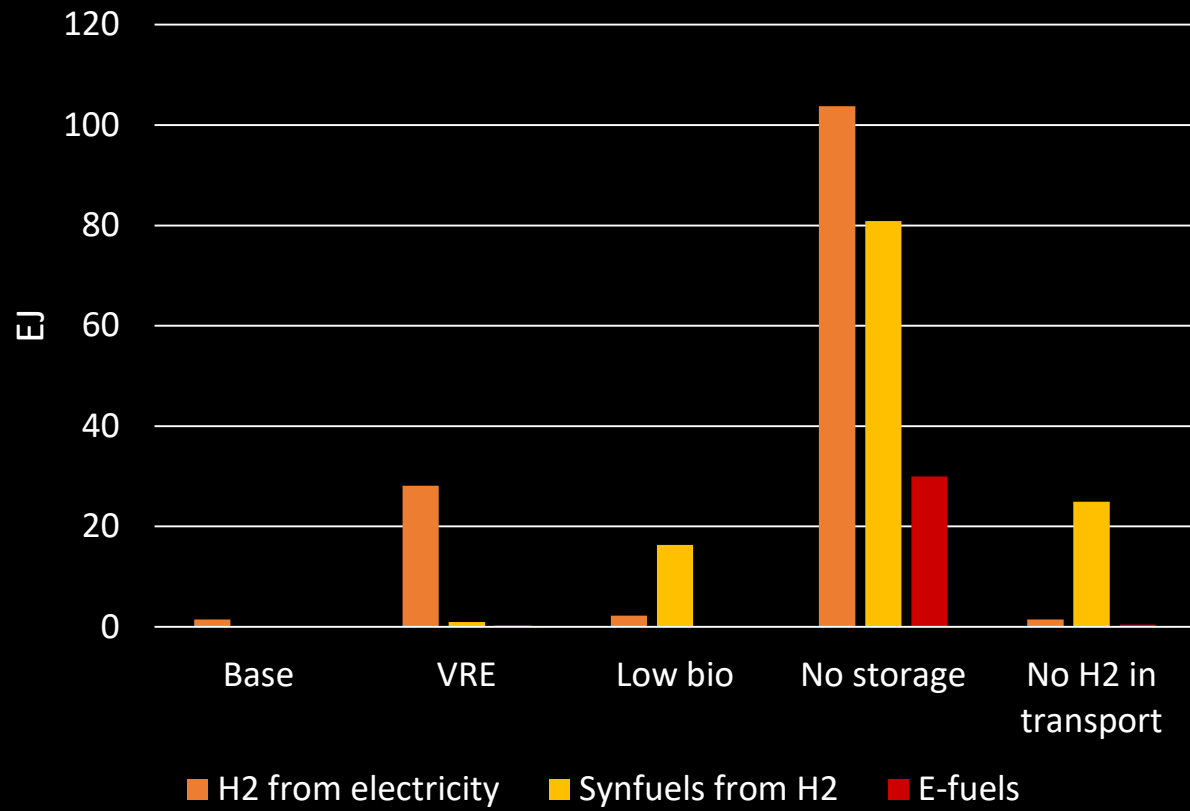
- A cost minimizing systems engineering model of the global energy system
- Set up as a linear programming problem
- Five end use sectors: *electricity, transport, feedstock, residential–commercial heat and industrial process heat*
- Global carbon budget
- Resource based slicing used to capture intermittency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

Cases studied:

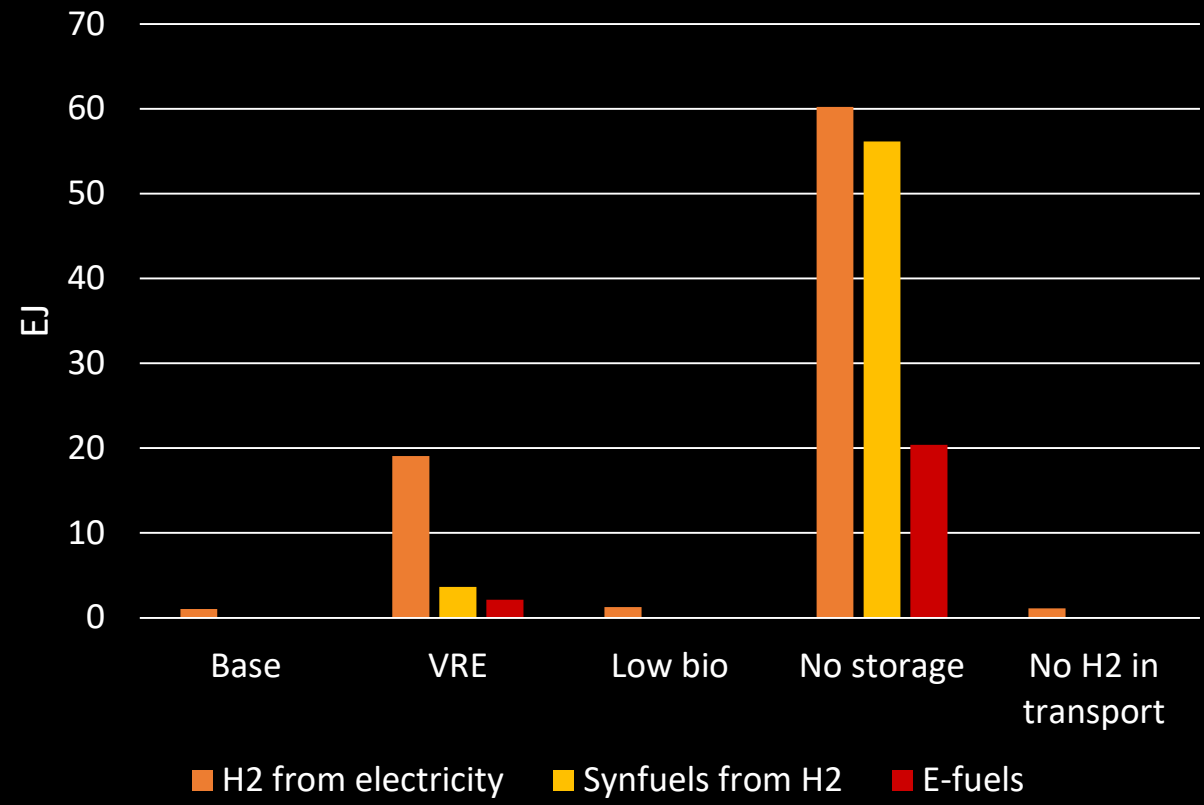
- Base case – 450 ppm and 550 ppm CO₂
- VRE case – 50% cheaper wind and solar
- Low bio case – 50% less biomass available
- No storage case – No carbon storage available
- No H₂ in transport case

Results: Global production 2070

450 ppm CO₂



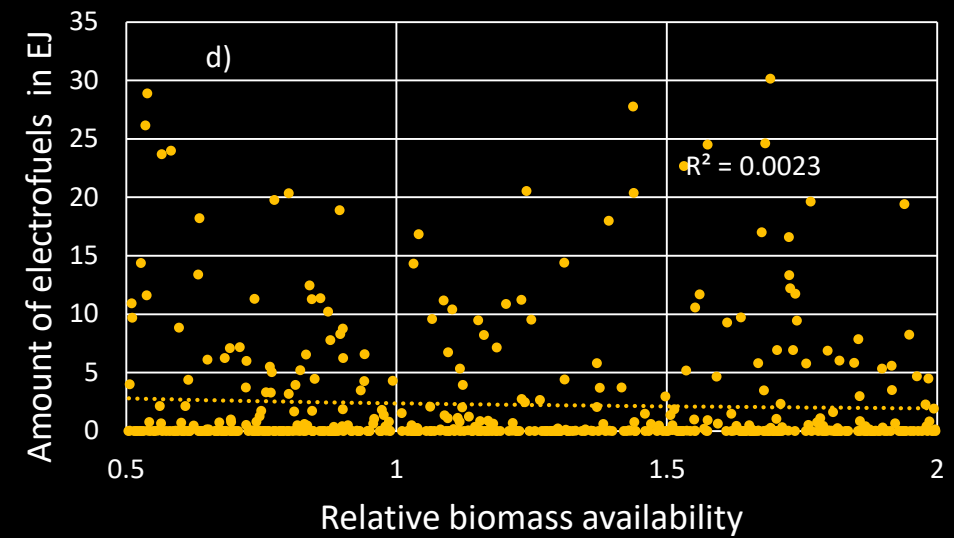
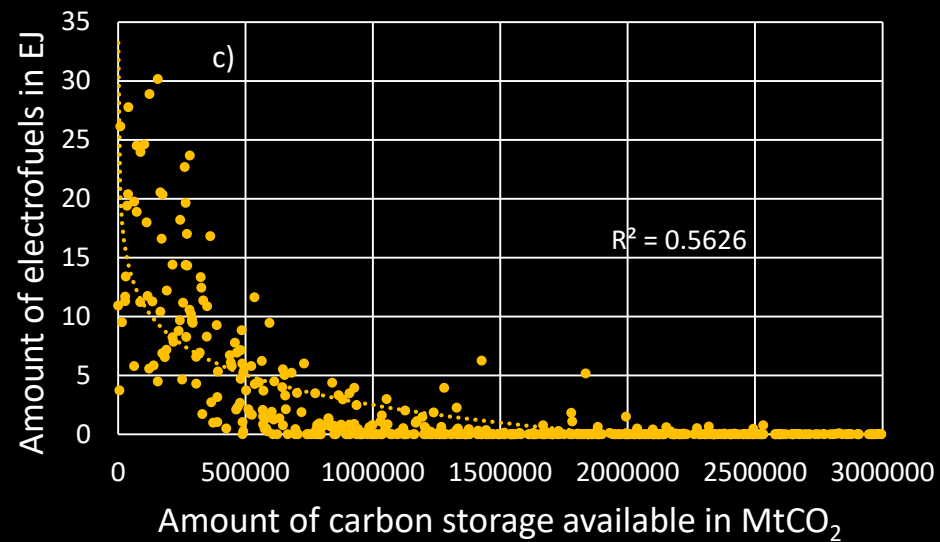
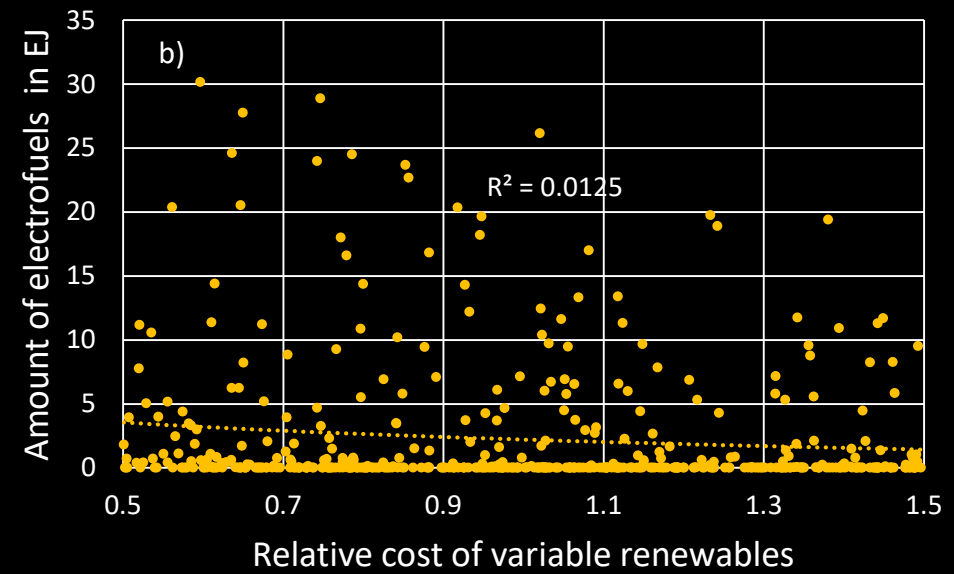
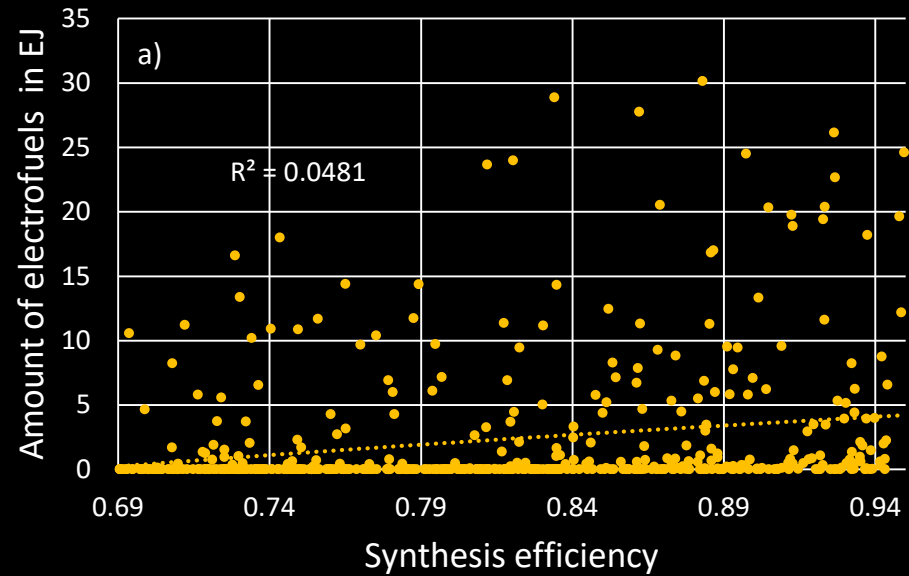
550 ppm CO₂



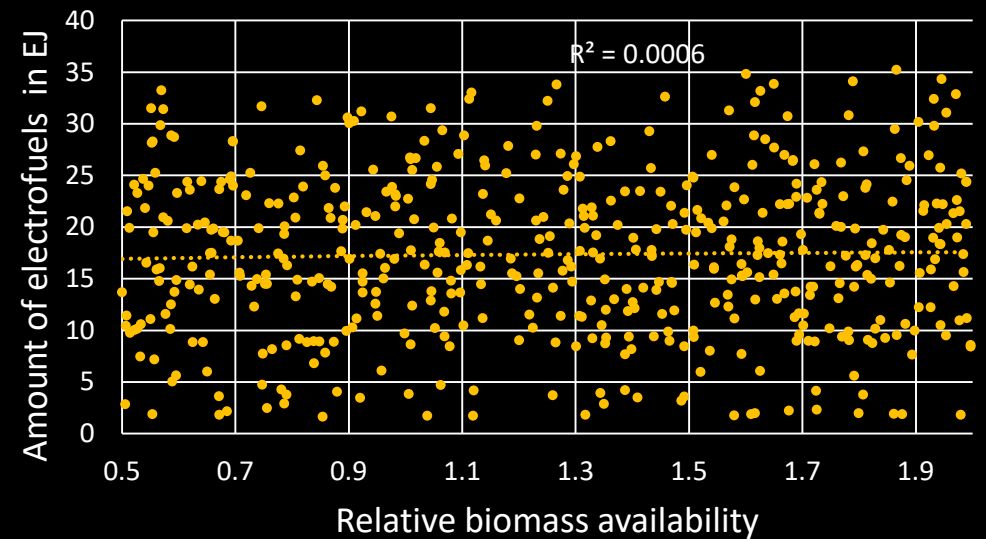
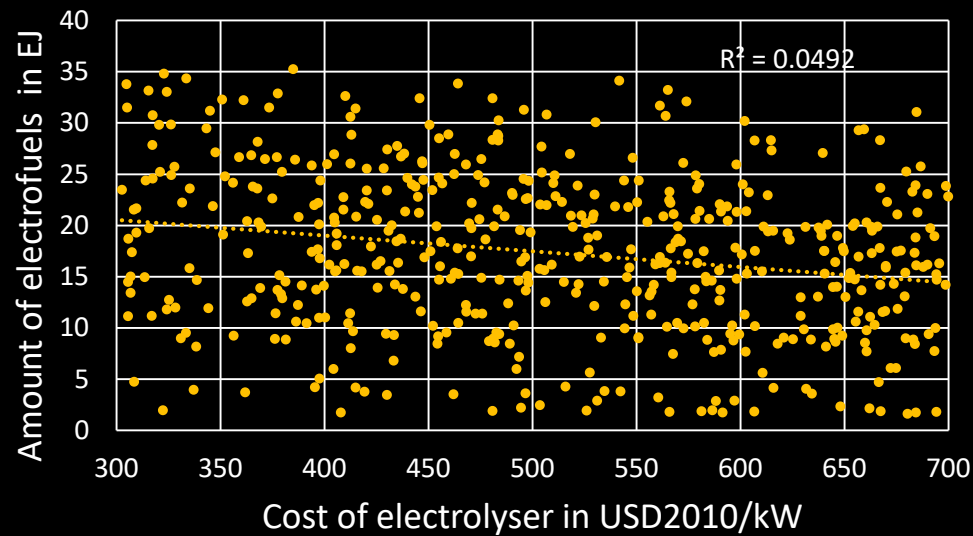
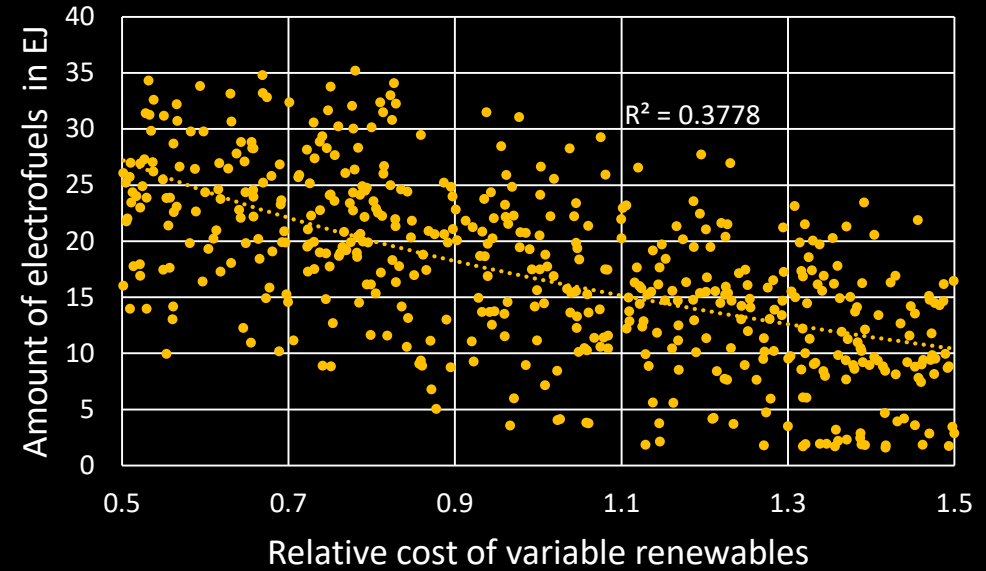
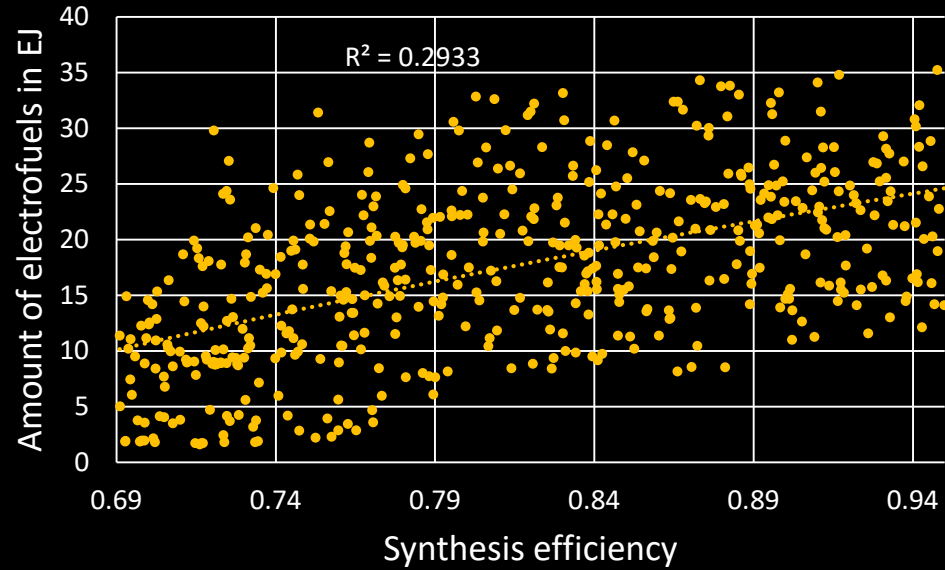
Monte Carlo analysis

- 500 runs with and without storage
- Concentration target 450ppm
- Parameters varied:
 - all previous +
 - cost of synfuel production from hydrogen
 - investment cost of fuel cells
 - infrastructure cost for synfuels and hydrogen
 - direct air capture cost

Monte Carlo



Monte Carlo: no storage



Conclusions:

- The potential for electrofuels is very limited as long as there is an acceptance for large scale carbon storage.
- When the global storage availability is less than 500 GtCO₂, electrofuels enter in all analysed cases.
- Cost of electrolyser and increased availability of variable renewables seem not to be determining factors of whether electrofuels enter the transport system.
- The highest amount of cost-effective electrofuels is observed in the case where carbon storage is not available and climate target is set to 450 ppm, approximately 30 EJ globally at 2070, providing for approximately 15% of transport energy demand.
- Electrolysers can be beneficial for the energy system even at low load factors (~30%).