Electrofuels potential in the EU in 2030

Stephanie Searle, Adam Christensen

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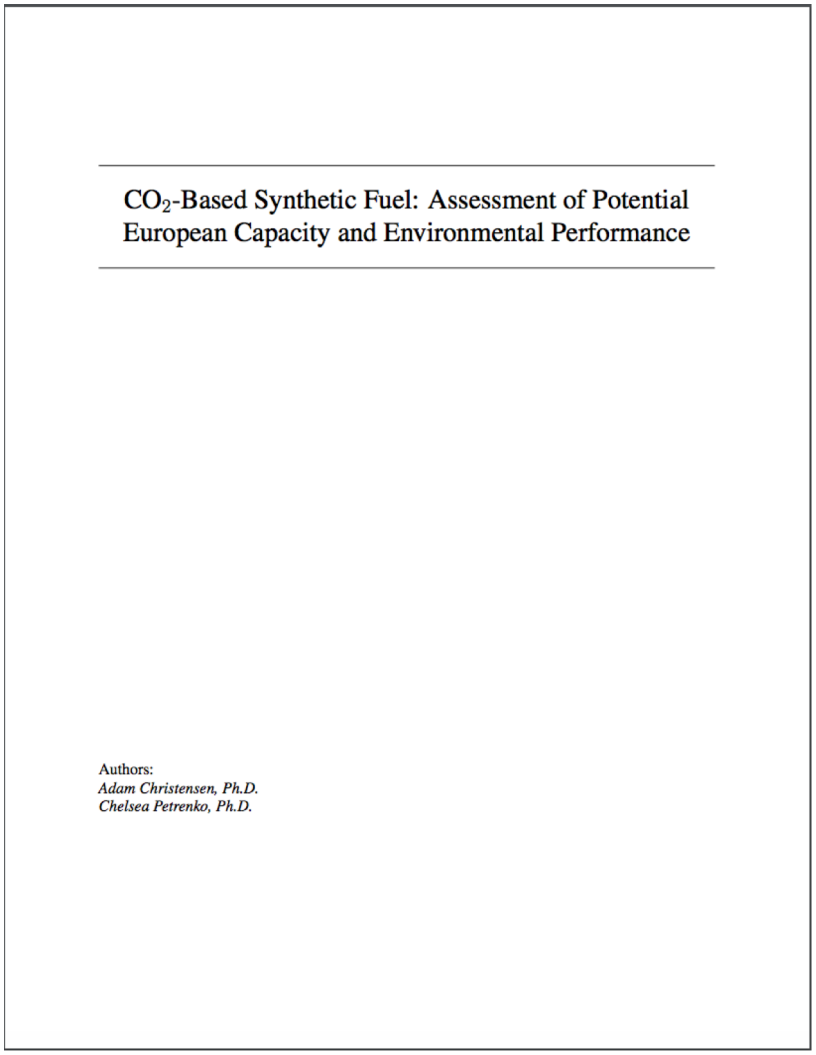
Key questions

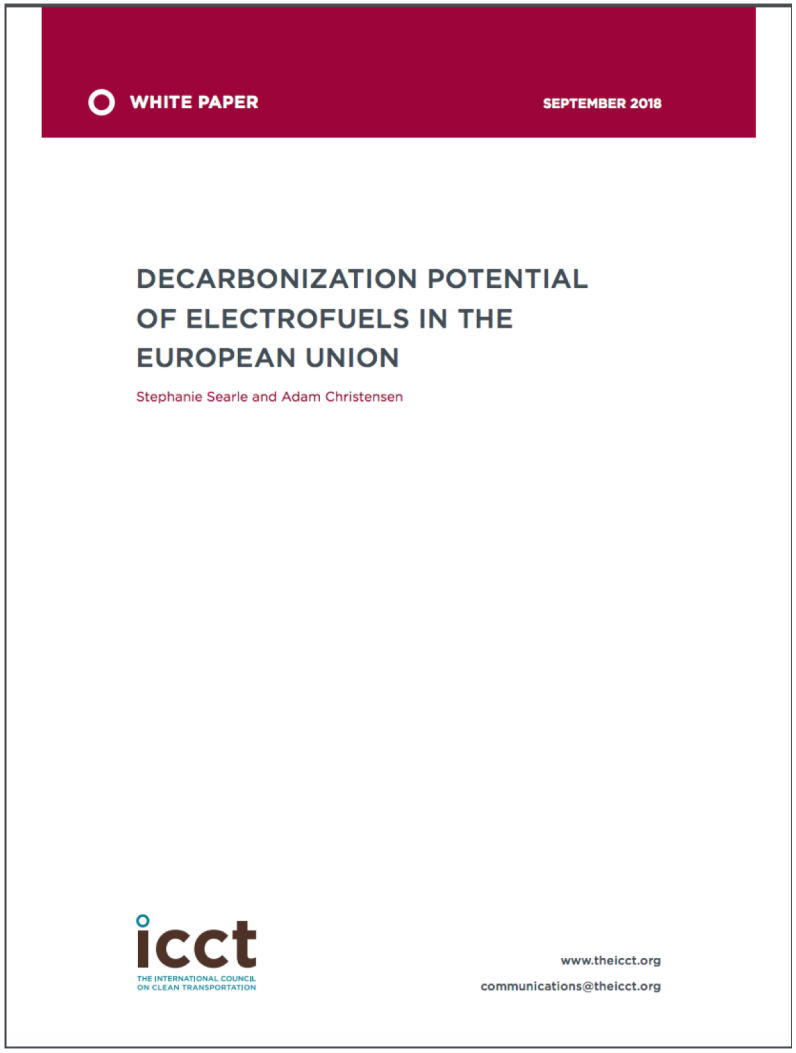
- What is the future potential for electrofuels?
- How much will it cost?
- Do electrofuels offer GHG benefits?
- How should we incentive electrofuels to maximize climate mitigation?

Updated study



CO_2-Based Synthetic Fuel: Assessment of Potential European Capacity and Environmental Performance

Authors:
Adam Christensen, Ph.D.
Chelsea Petrenko, Ph.D.



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DECARBONIZATION POTENTIAL OF ELECTROFUELS IN THE EUROPEAN UNION

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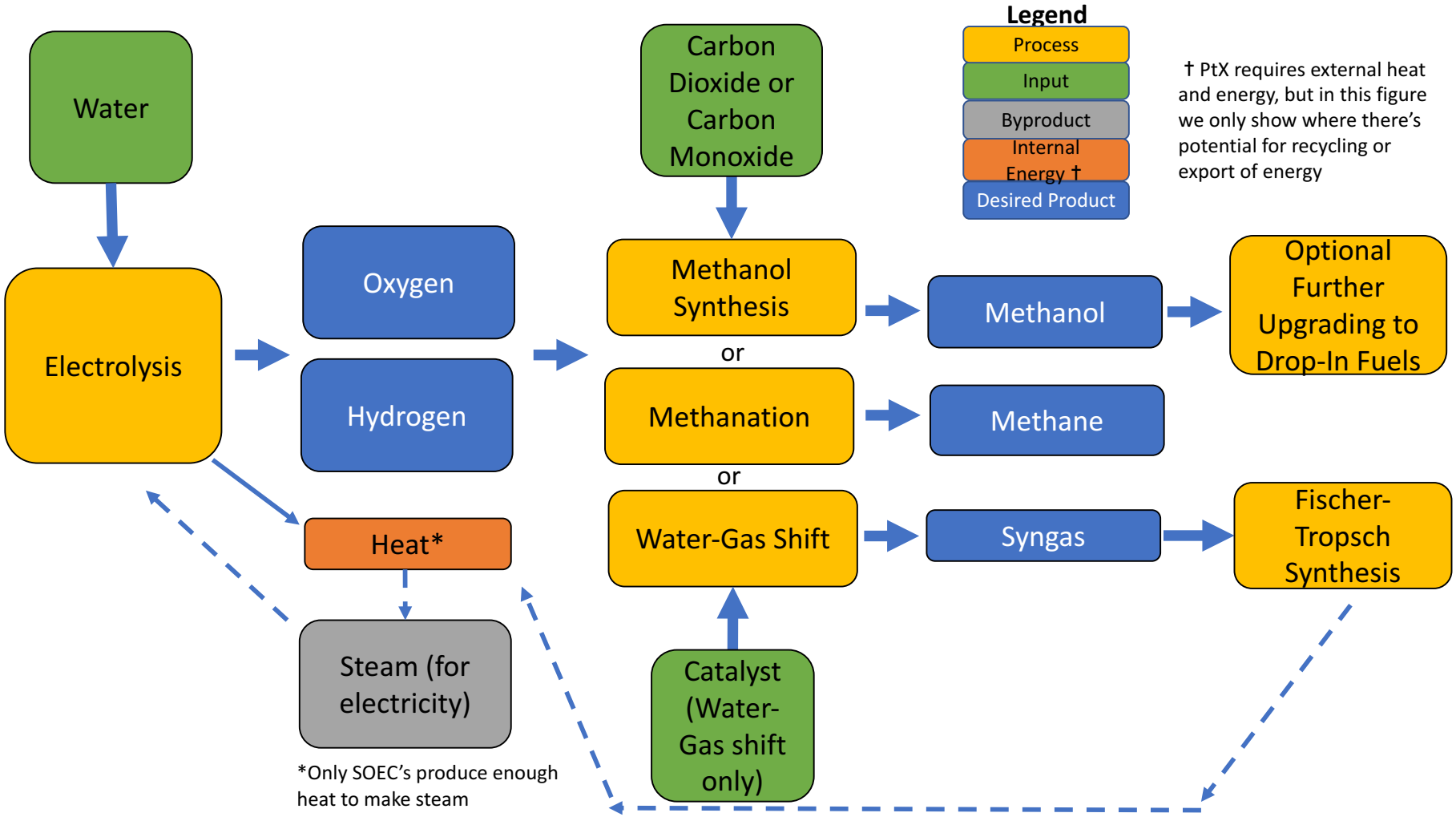
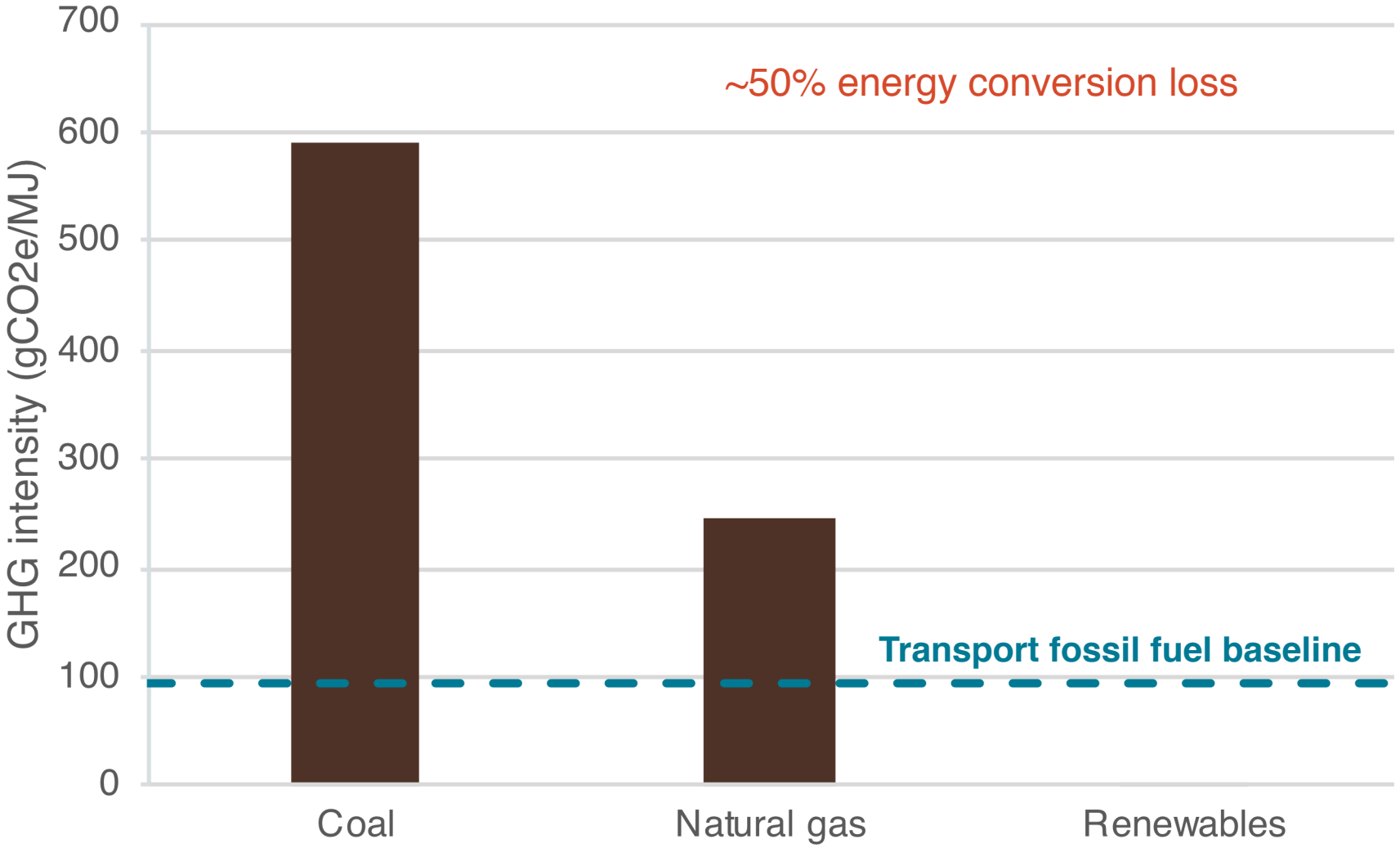
Electrofuels process

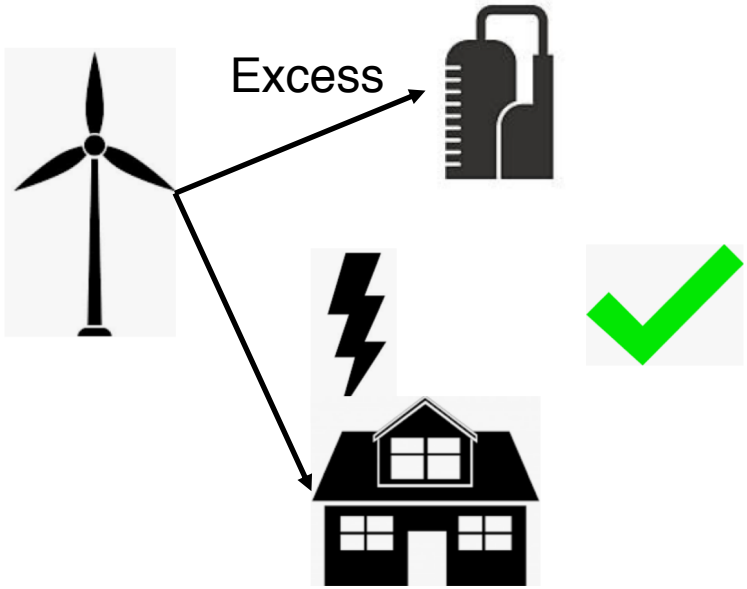


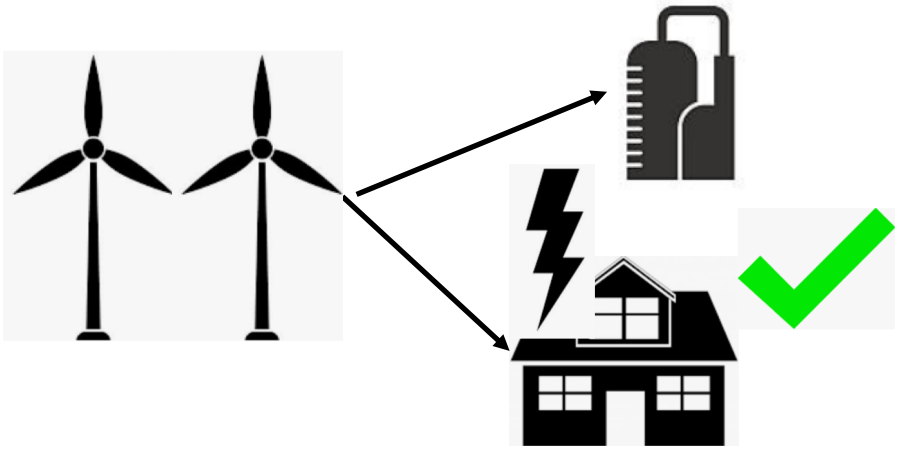
~50% energy conversion loss

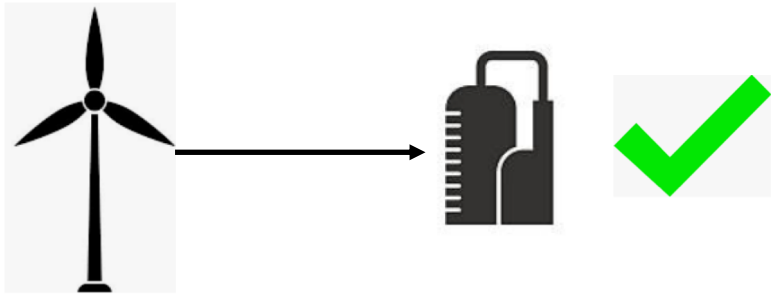
GHG impacts of electricity source

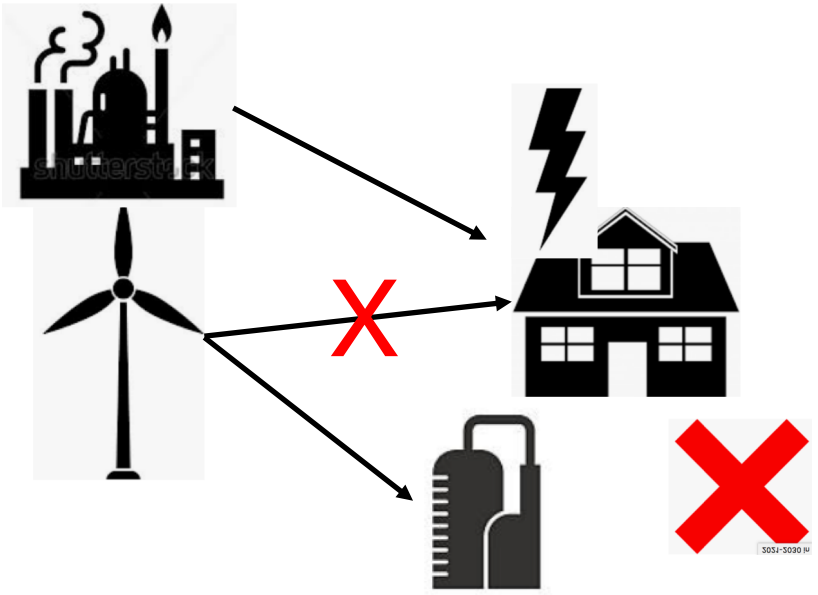


Even for renewables, it depends…

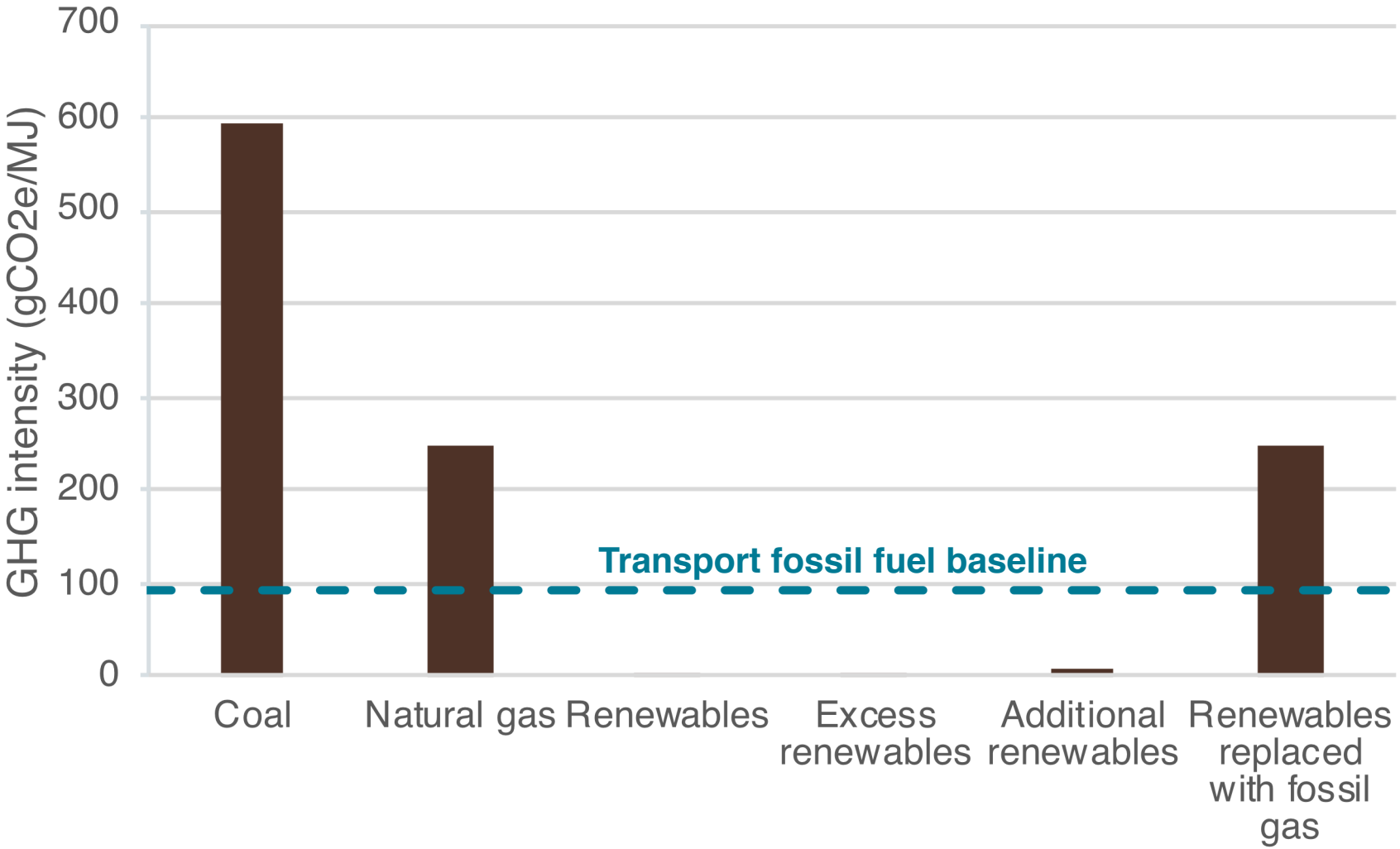








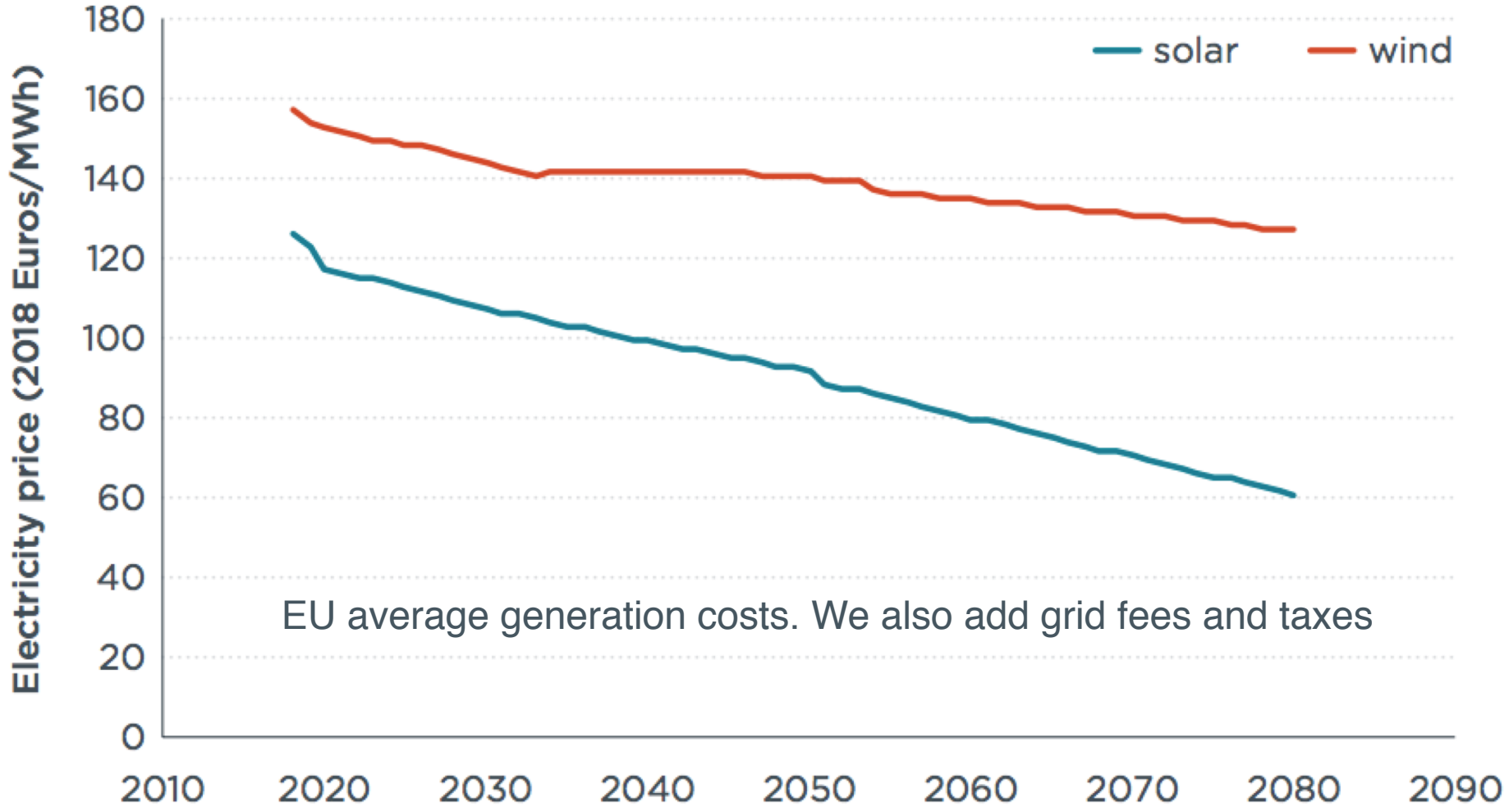
GHG impacts of electricity source



Elements of analysis

Electrolyzer	Fuel synthesis	Renewable electricity	Grid connection	CO_2
Alkaline water	Fischer Tropsch (drop-in diesel, petrol)	Wind	Direct connection (off-grid)	Industrial point source (e.g. coal plant)
Proton exchange membrane	Dimethyl ether (DME) synthesis	Solar	Grid connected, purchase GoOs	Direct air capture
Solid-oxide electrolyzer cells (steam)	Methanol synthesis			
Solid-oxide electrolyzer cells (co-electrolysis)	Methanation			

Renewable electricity prices



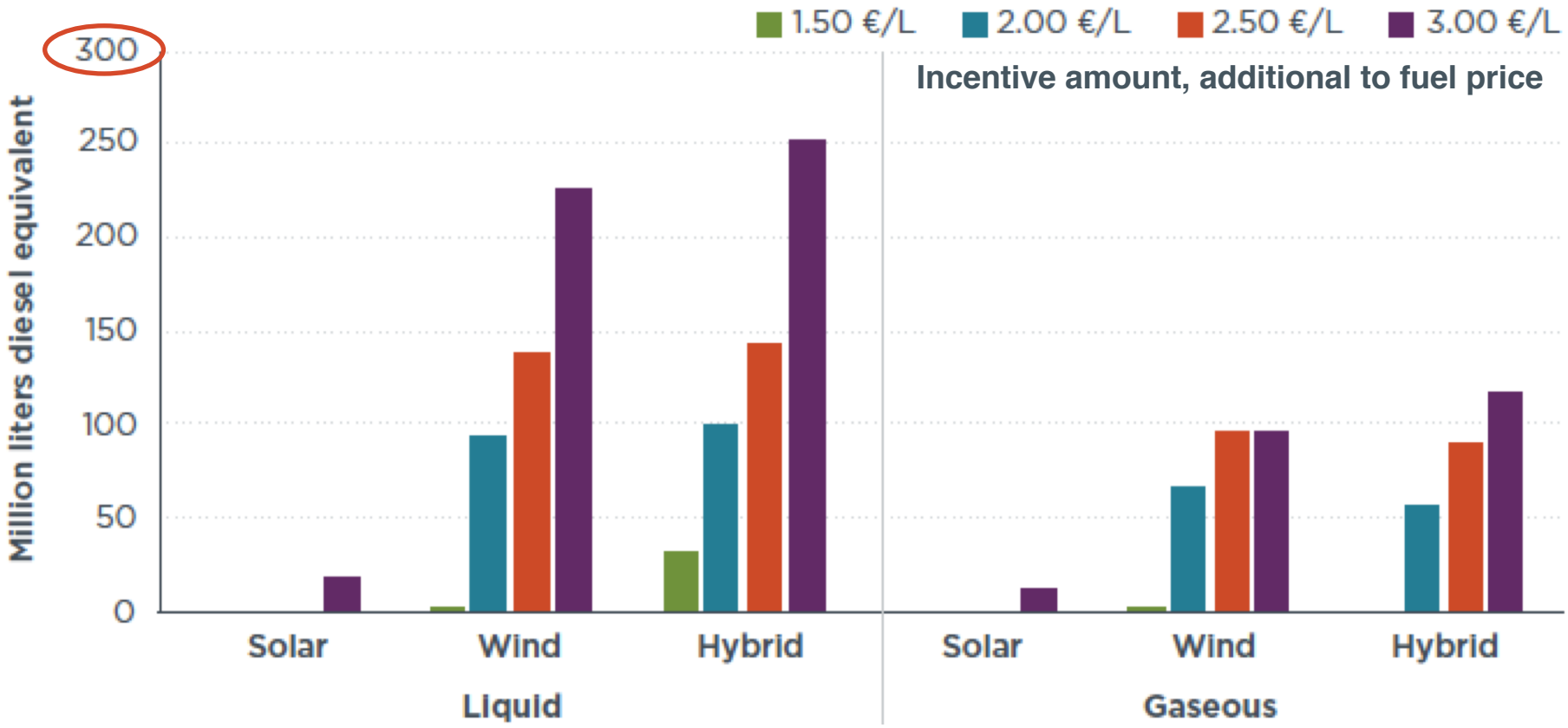
Deployment model

- Facilities built when cost-viable (given renewable electricity prices, capacity factors in each Member State)
- One facility of each technology combination under construction at a time in each MS
- 4 year construction/ramp-up time
- Max 16 facilities constructed every 4 years
- Meant to simulate investment constraints

Excess electricity (otherwise curtailed)

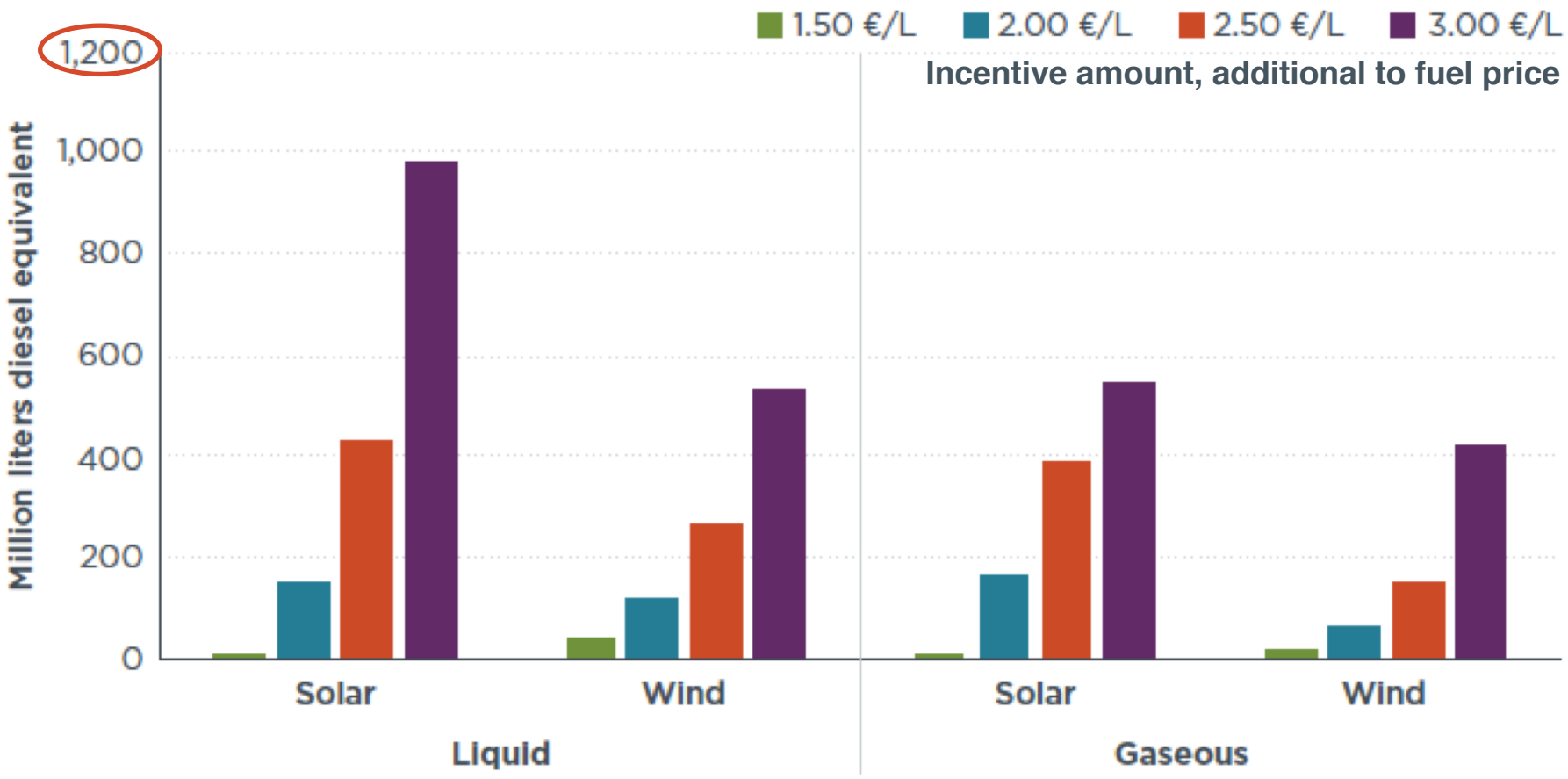
- No cost
- Zero upstream emissions
- Low capacity factor (4 hours per day)
- No cost-viable fuel production

2030 max volumes: direct connection (off-grid)



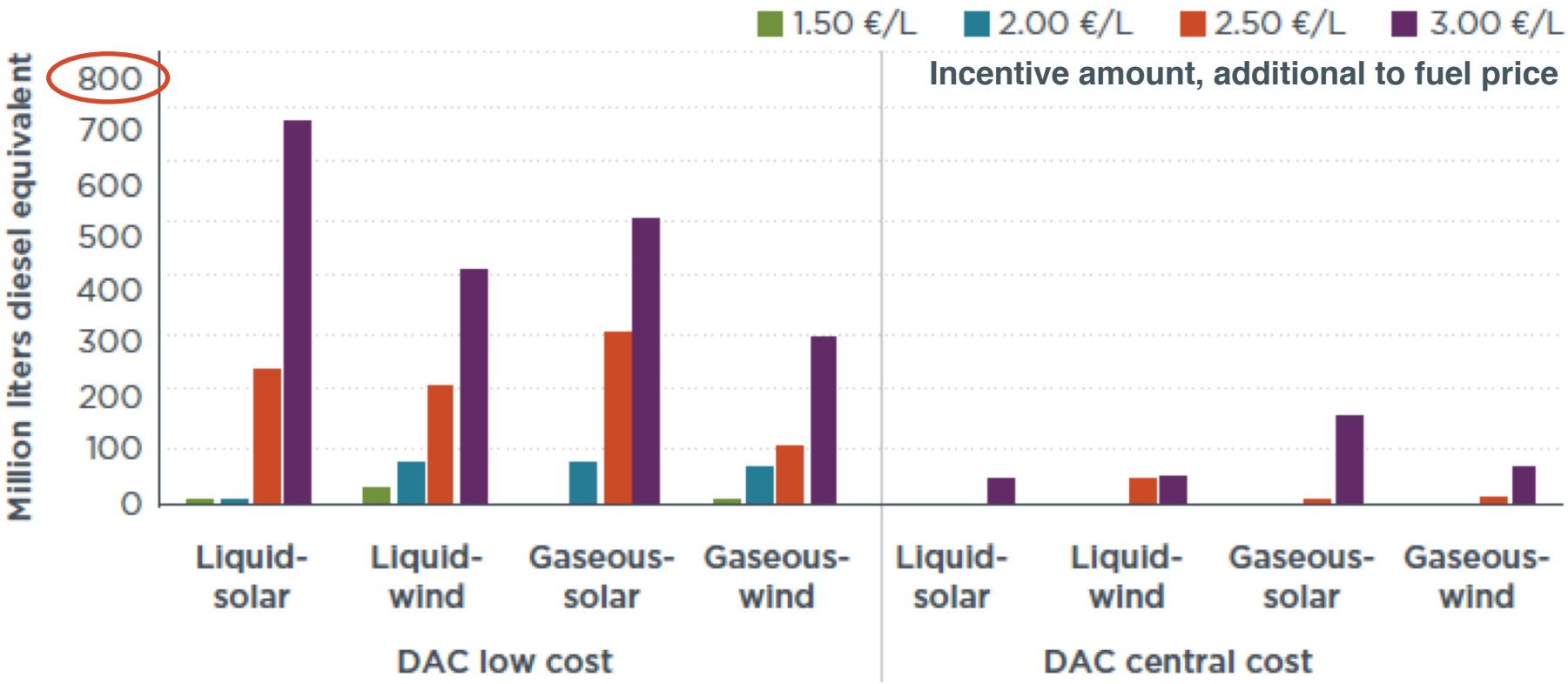
Max 2030 road fuel displacement: 0.03%

2030 volumes: grid connected, purchase GoOs

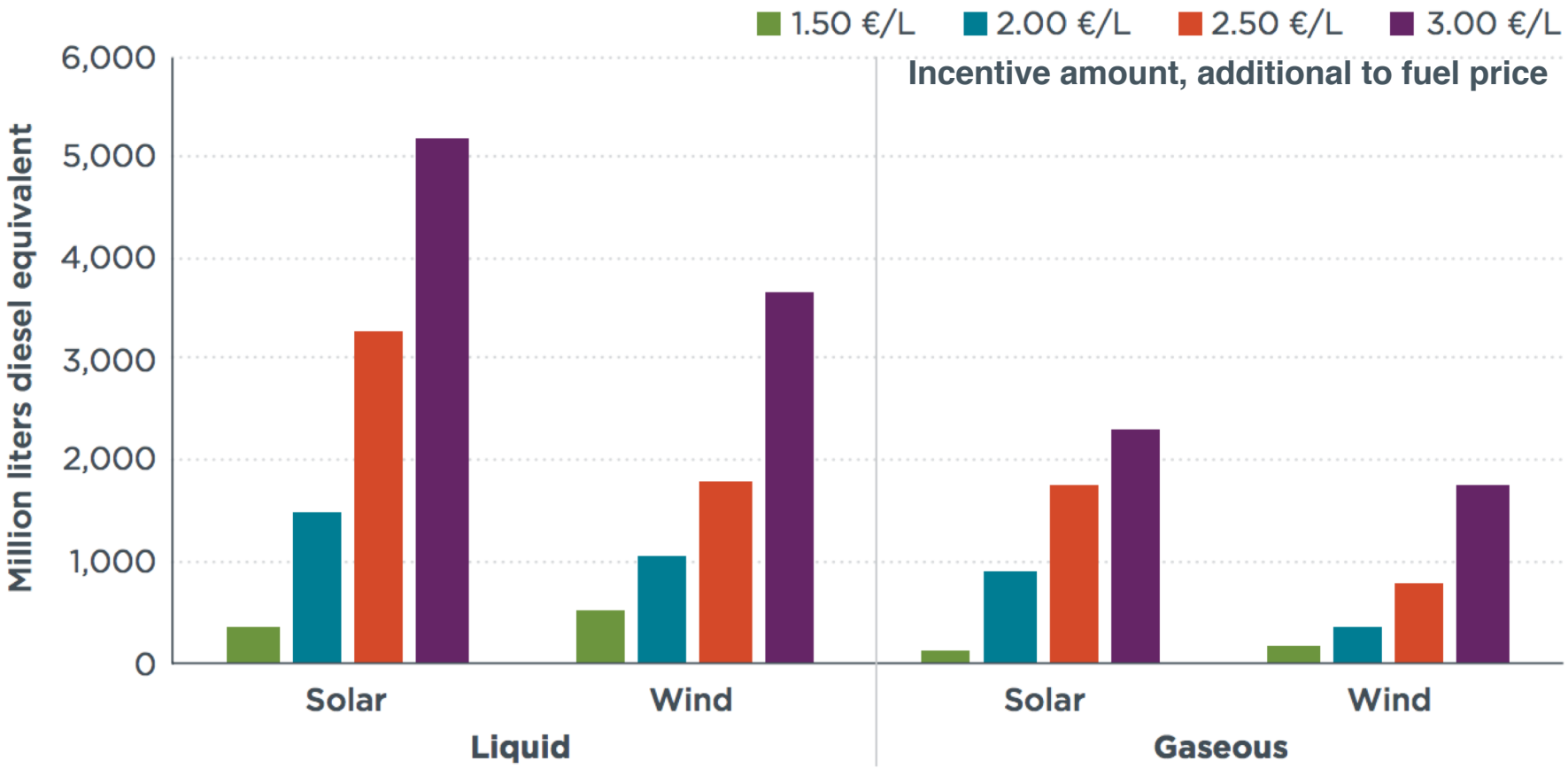


Max 2030 road fuel displacement: 0.36%

2030 volumes: grid connected, CO_2 from direct air capture

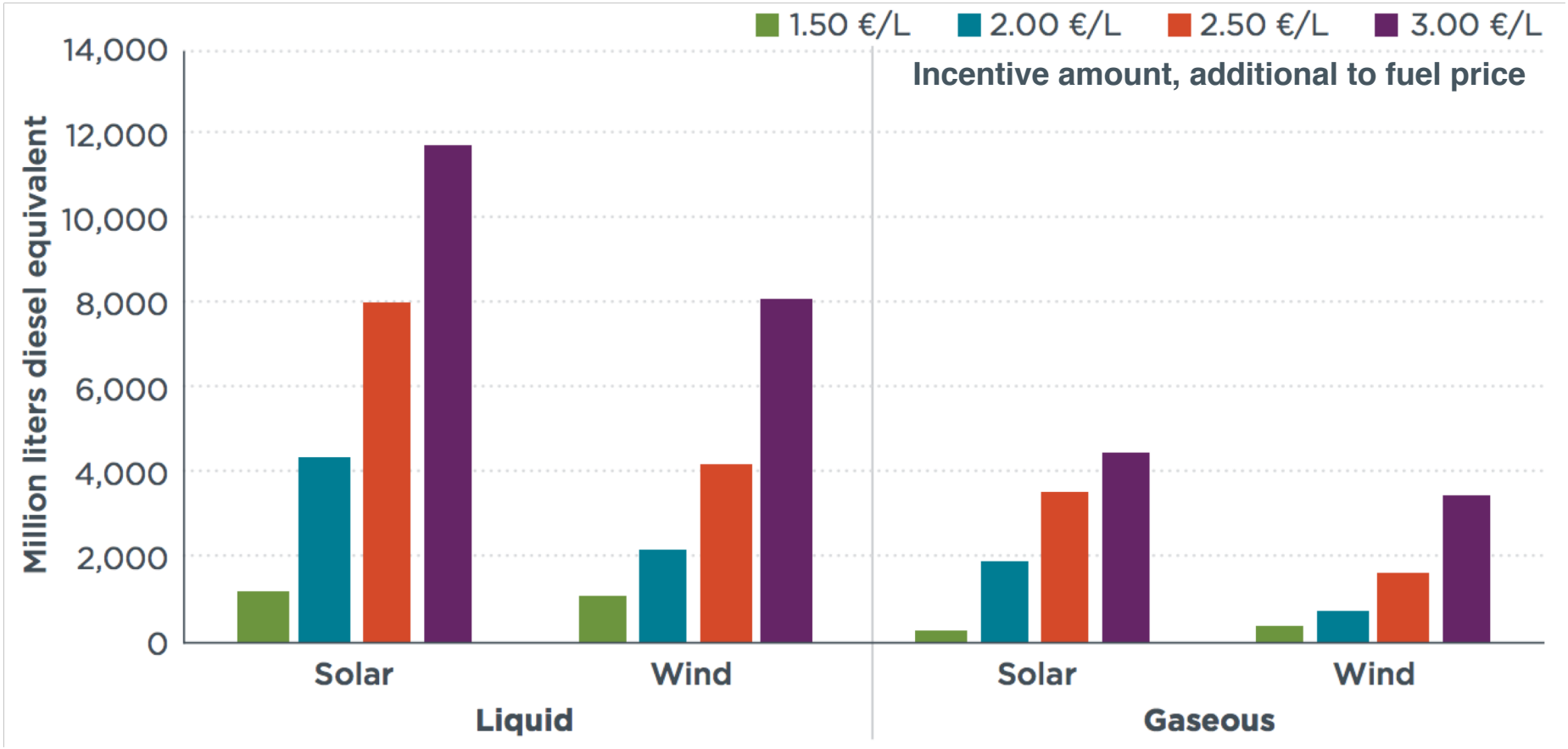


2040 volumes: grid connected, industrial CO_2



Max 2040 road fuel displacement: 2%

2050 volumes: grid connected, industrial CO_2



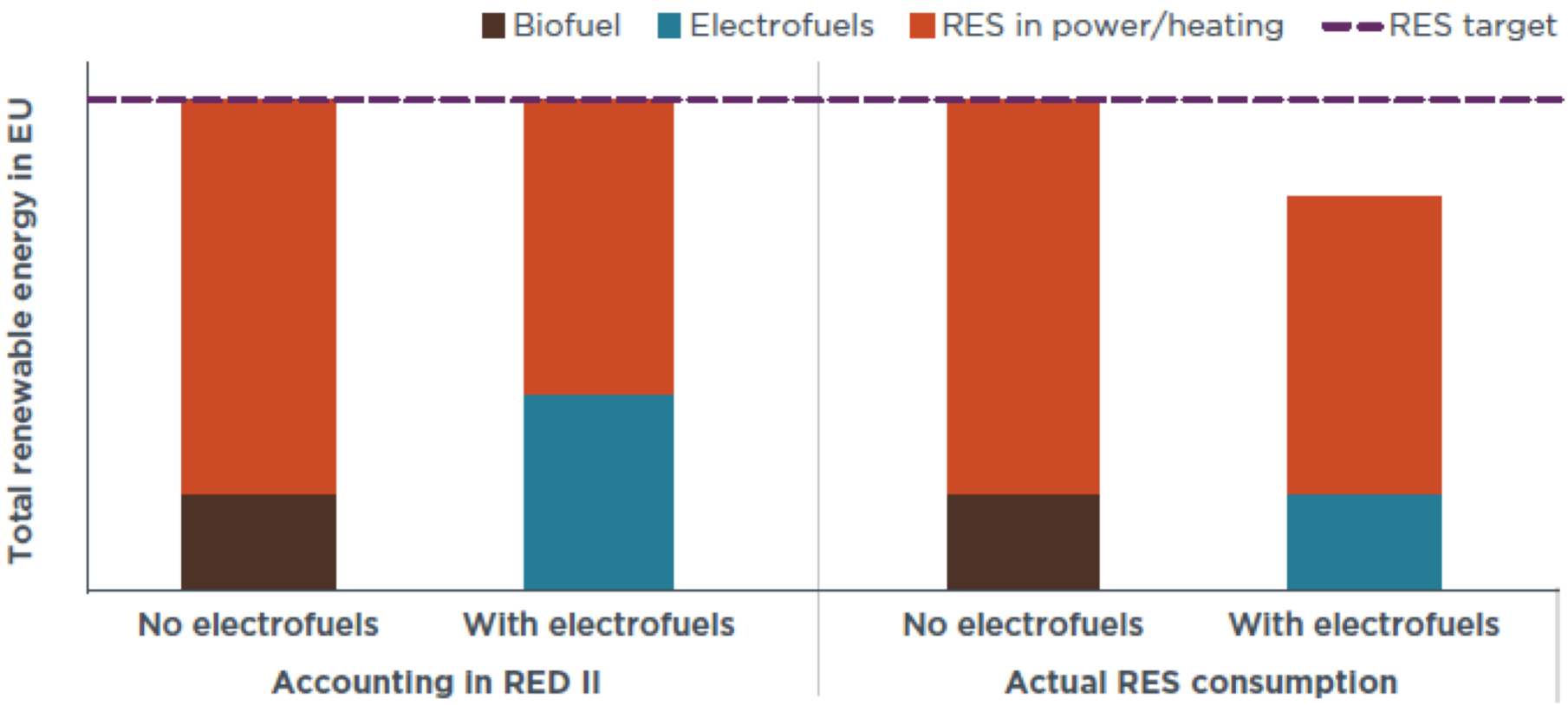
Max 2050 road fuel displacement: 5%

Electrofuels accounting problem in RED II

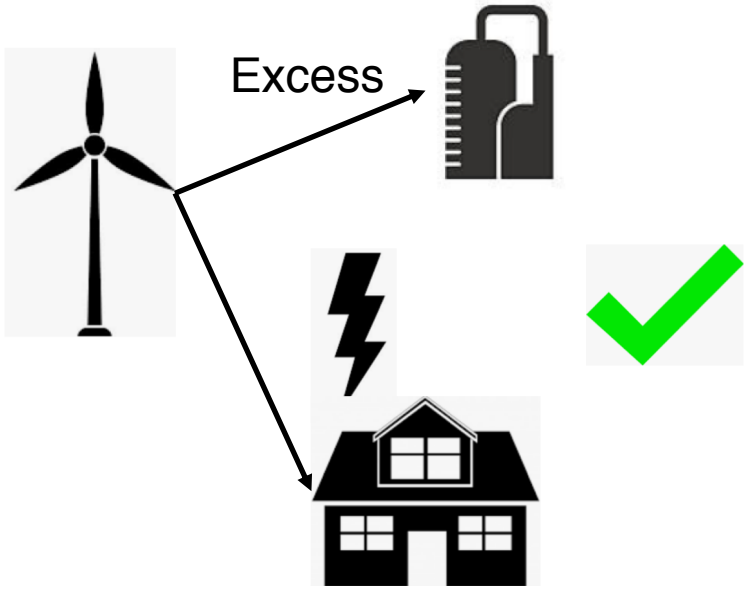
"*Renewable liquid and gaseous transport fuels of non-biological origin that are produced from renewable electricity shall only be considered to be part of the calculation pursuant to paragraph 1(a) when calculating the quantity of electricity produced in a Member State from renewable energy sources*" (RED II, Article 7, paragraph 4a).

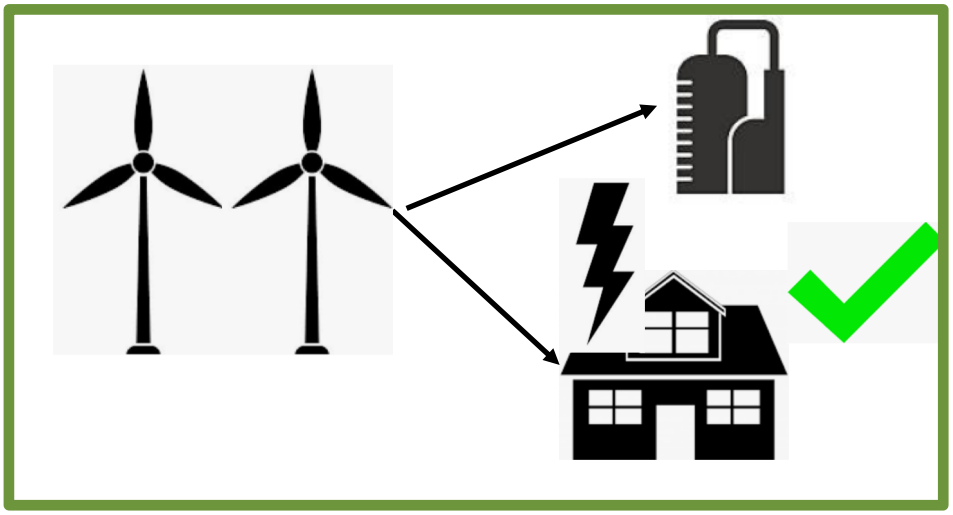
- Paragraph 1(a) is the "*gross final consumption of electricity from renewable energy sources*."

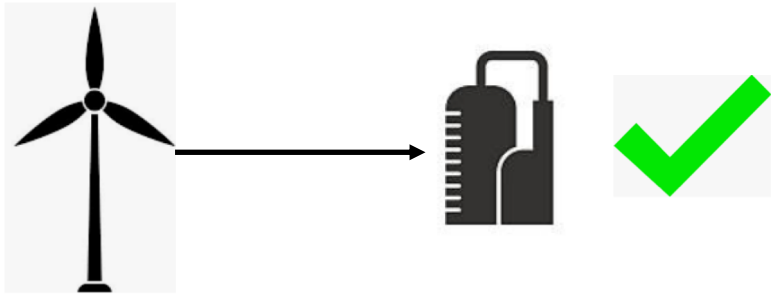
Electrofuels accounting problem in RED II

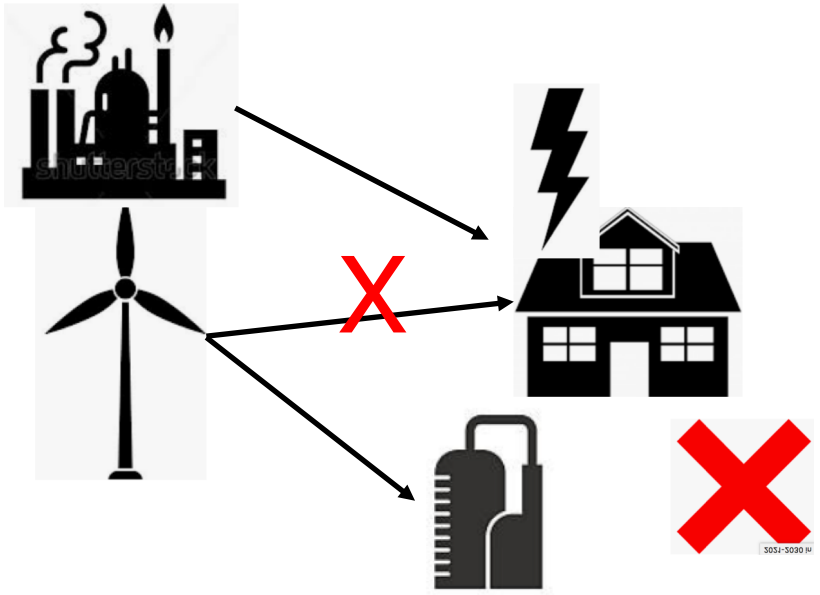


Electricity sources: if fuel energy is counted

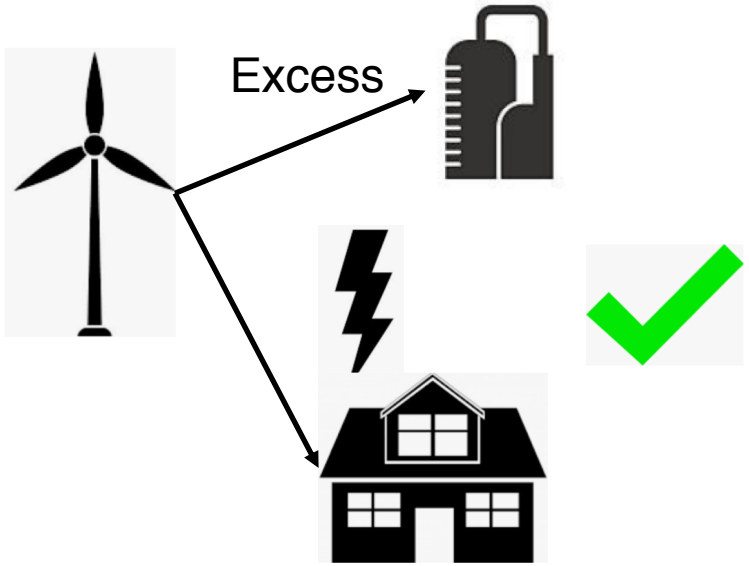


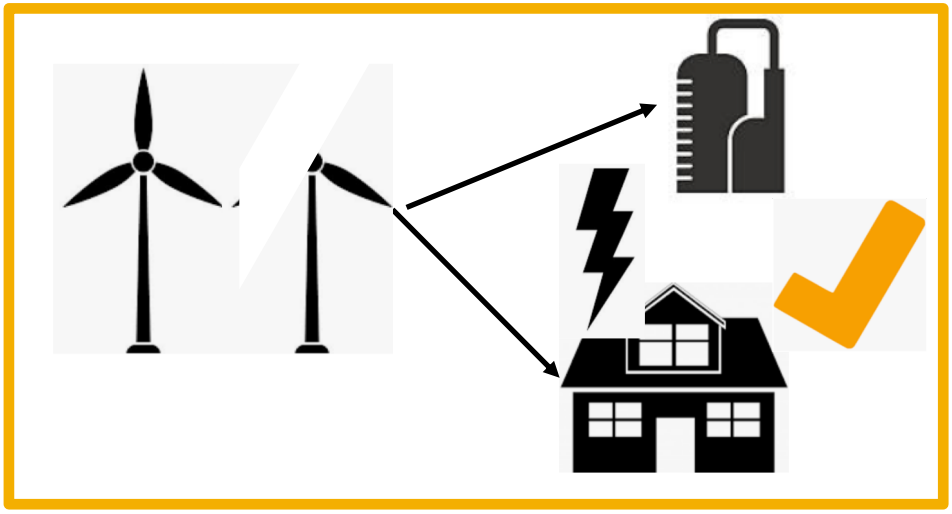


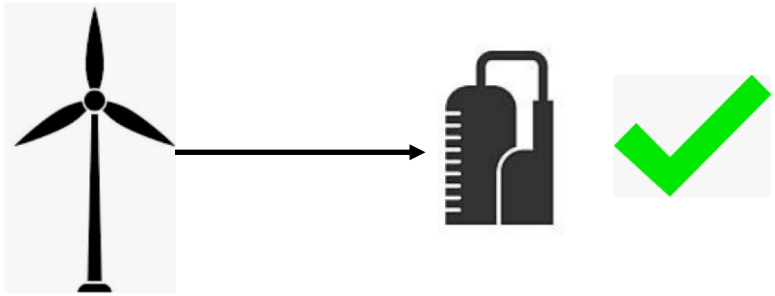


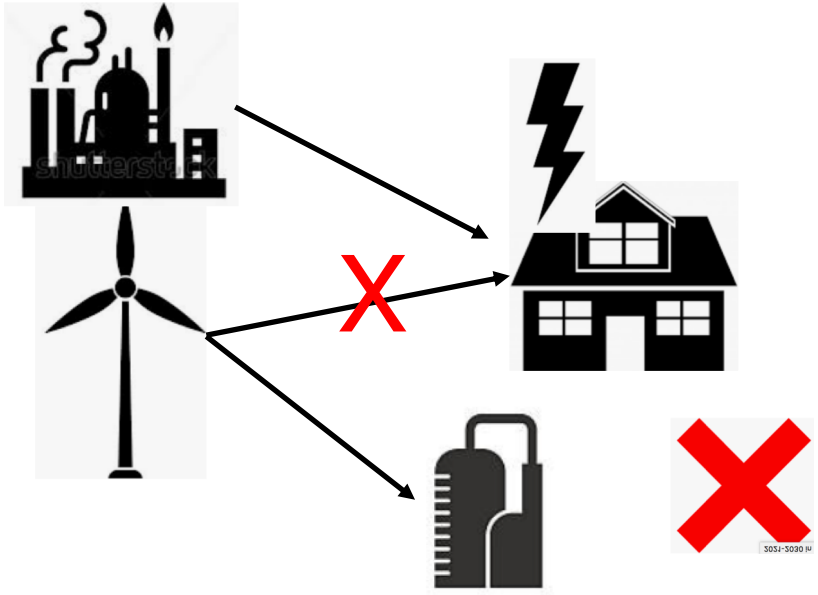


Electricity sources: RED II accounting

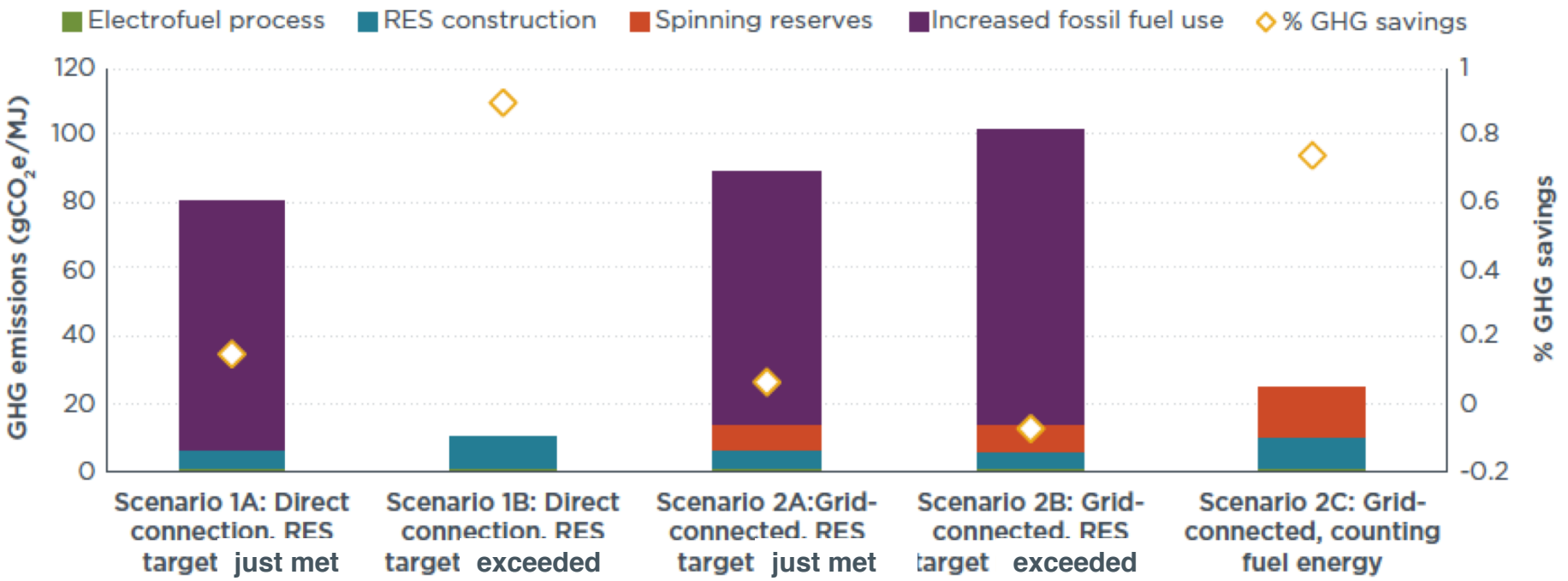






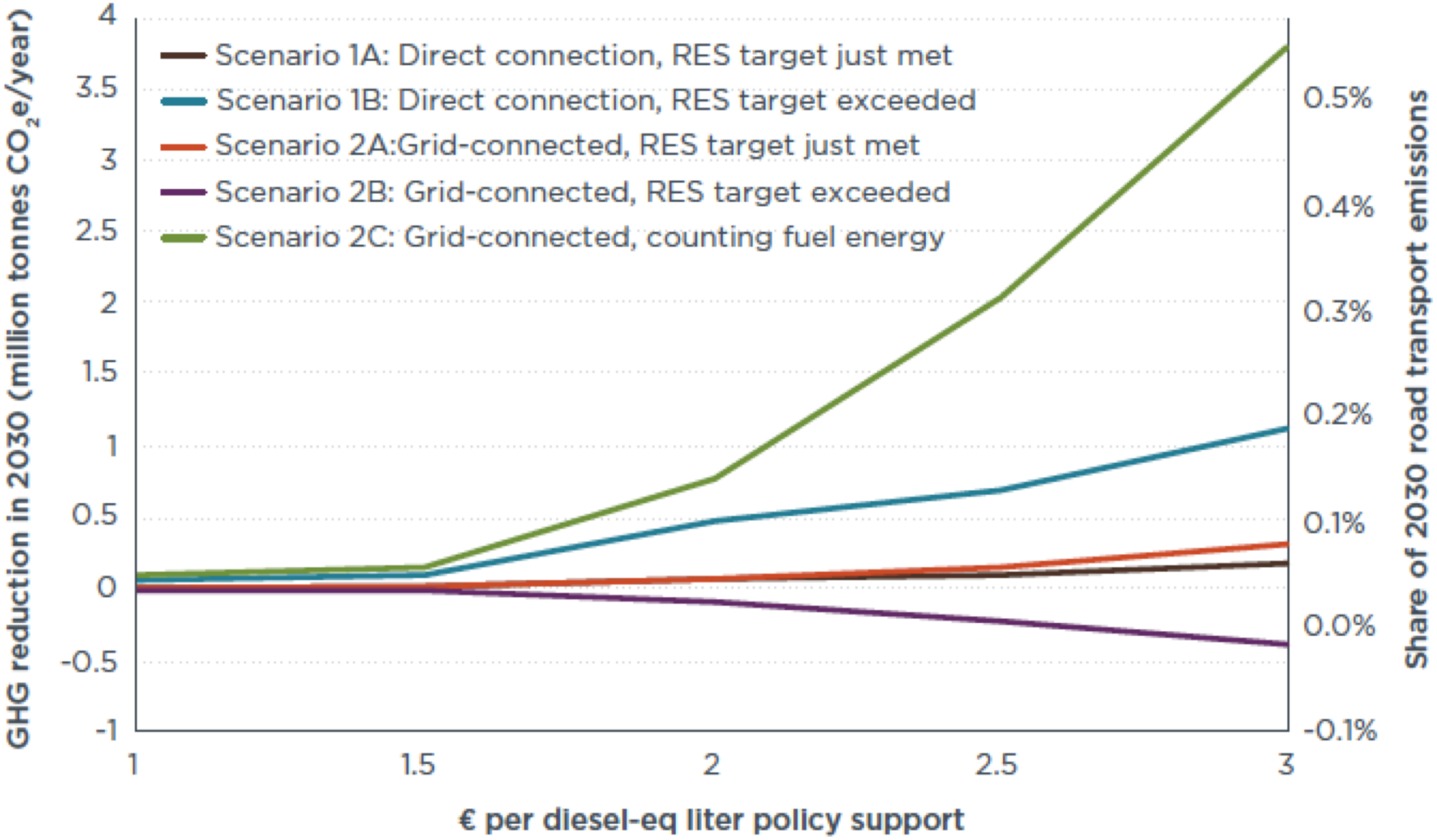


Electrofuels GHG performance depends on RED II implementation, whether RES target is exceeded



RED II accounting is the real problem – much higher emissions than grid impacts or direct emissions

Electrofuels can only deliver significant GHG savings if RED II accounting problem fixed



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Scenario 2C carbon abatement cost: **€1,200 per tonne CO_2**

Policy options to address RED II accounting

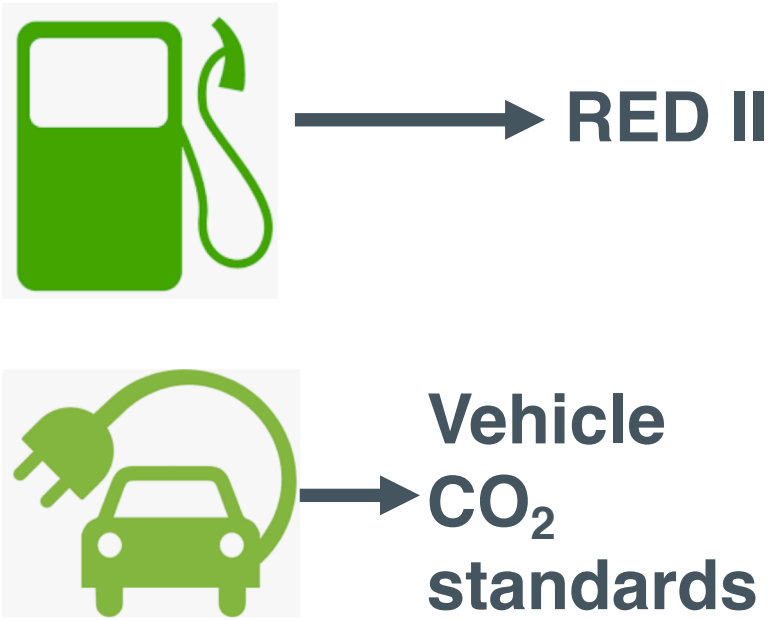
- Member State options
  - RED II language is slightly vague – just interpret as meaning energy content in fuel count to RES target
  - Take measures to increase total RES above 32% target by same amount of energy in electrofuels
  - Require GOplus certificates for electrofuels
- European Commission options
  - Include indirect emissions from accounting problem in LCA for electrofuels: only GOplus would qualify
  - Determine that electrofuels do not meet 70% GHG reduction criteria – do not qualify for RED II

Vehicle CO_2 standards

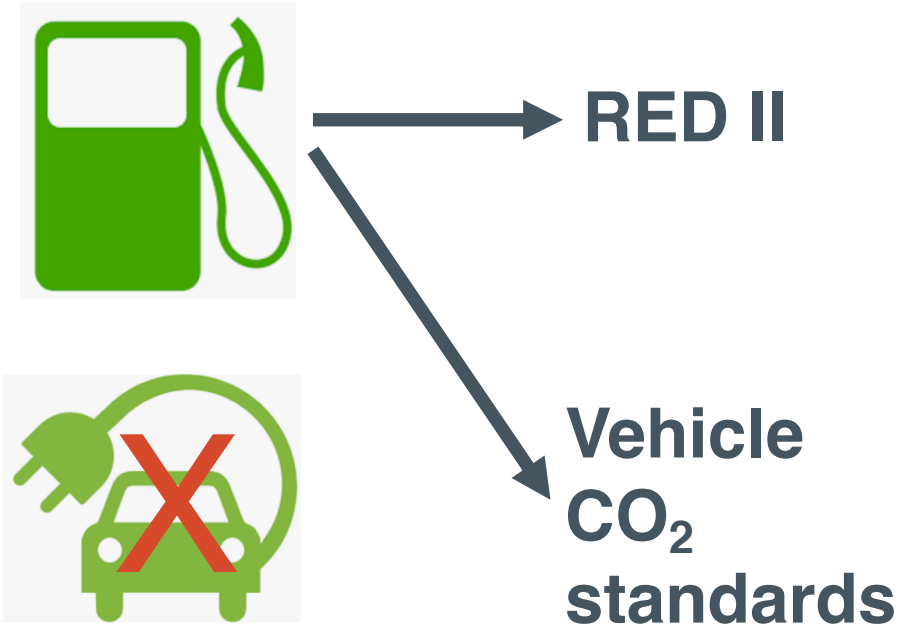
- Scenario 2C: €300 per gram CO_2e/km reduction
  - Compare to noncompliance penalty: €95/gCO_2e/km
- Low carbon fuels already incentivized by Renewable Energy Directive (RED/RED II)
  - If all low carbon fuels eligible, will be mostly biofuels
  - Fuel GHG reductions counted towards vehicle CO_2 standards will not be additional – no real CO_2 savings achieved

Additionality

Fuel lifecycle GHG reductions **NOT** counted in vehicle CO_2 standards

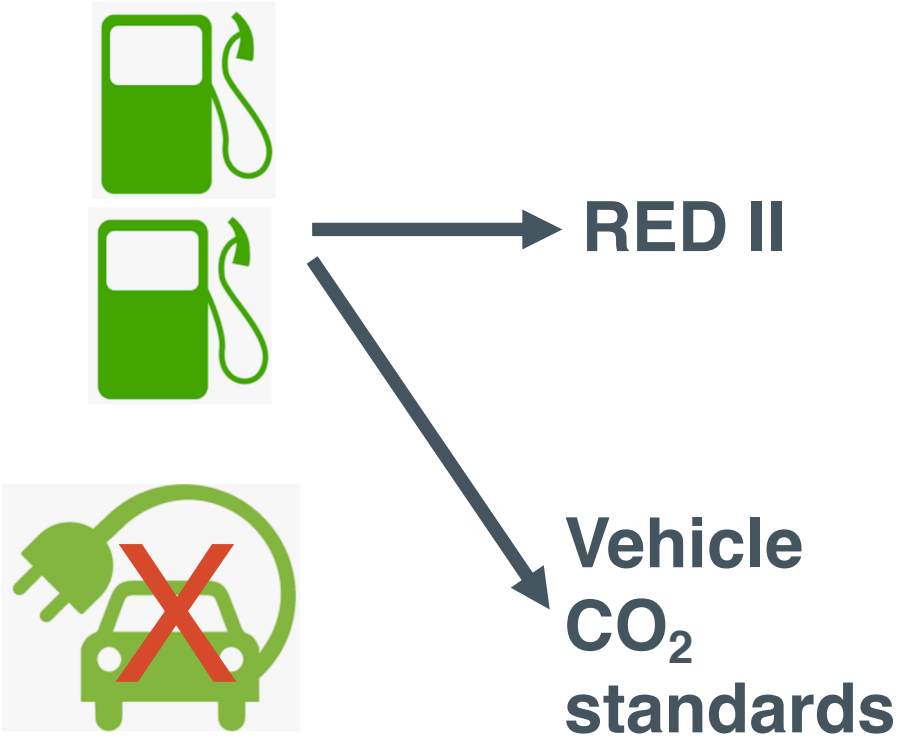


Fuel lifecycle GHG reductions counted in vehicle CO_2 standards



Will double policy support incentivize MORE low carbon fuels?

Fuel lifecycle GHG reductions counted in vehicle CO_2 standards



- Maybe, but:
  - It's not likely to be electrofuels: 3x more expensive than noncompliance penalty
  - The vast majority of alternative fuels in EU today are food-based biofuels
  - All food-based biodiesel/ HVO has worse climate impact than petroleum

Vehicle CO_2 standards

- Scenario 2C: €300 per gram CO_2e/km reduction
  - Compare to noncompliance penalty: €95/gCO_2e/km
- Low carbon fuels already incentivized by Renewable Energy Directive (RED/RED II)
  - If all low carbon fuels eligible, will be mostly biofuels
  - Fuel GHG reductions counted towards vehicle CO_2 standards will not be additional – no real CO_2 savings achieved
- Recommendation
  - Don't allow low carbon fuels in vehicle standards
  - If allowed, require certification that not used for RED; include ILUC accounting

Key questions

- What is the future potential for electrofuels?
  - Limited contribution to transport energy mix
    - Less than 1% in 2030
    - Up to 5% in 2050
- How much will it cost?
  - A lot, at least €2.50-3.00 in policy incentives
- Do electrofuels offer GHG benefits?
  - It depends on RED II implementation
  - Yes, if no displacement impacts on renewable energy
  - No, if fuel already counted towards RED II is also counted towards vehicle CO_2 standards
- How should we incentive electrofuels to maximize climate mitigation?
  - Each liter only counts towards one policy target
  - Count towards RED II on basis of fuel energy, not electricity input

Thanks!

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