Estimation of the environmental impacts of propelling trucks with hydrogen: a Swedish analysis

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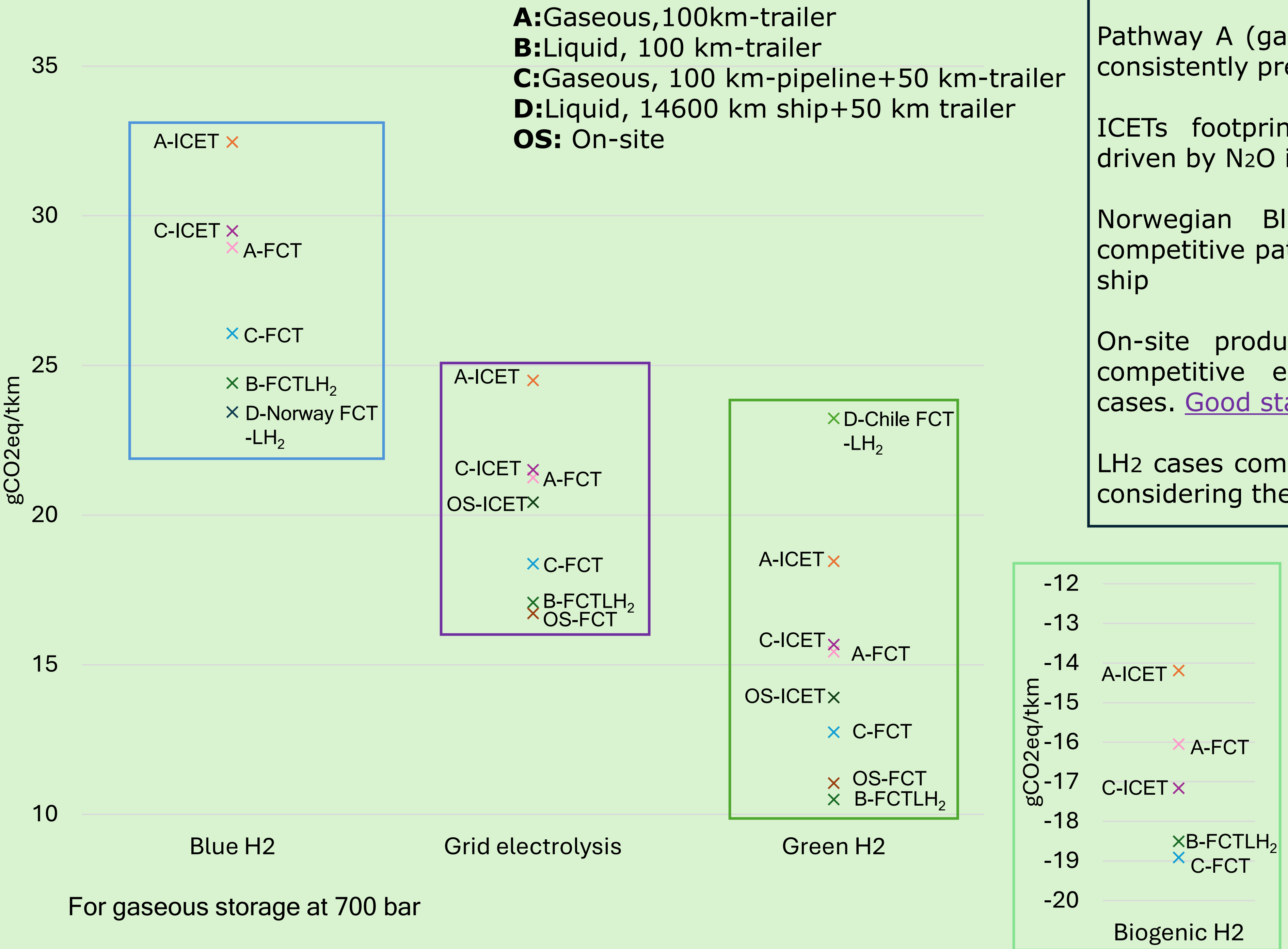
Chalmers University of Technology

interreg-baltic.eu/project/HyTruck



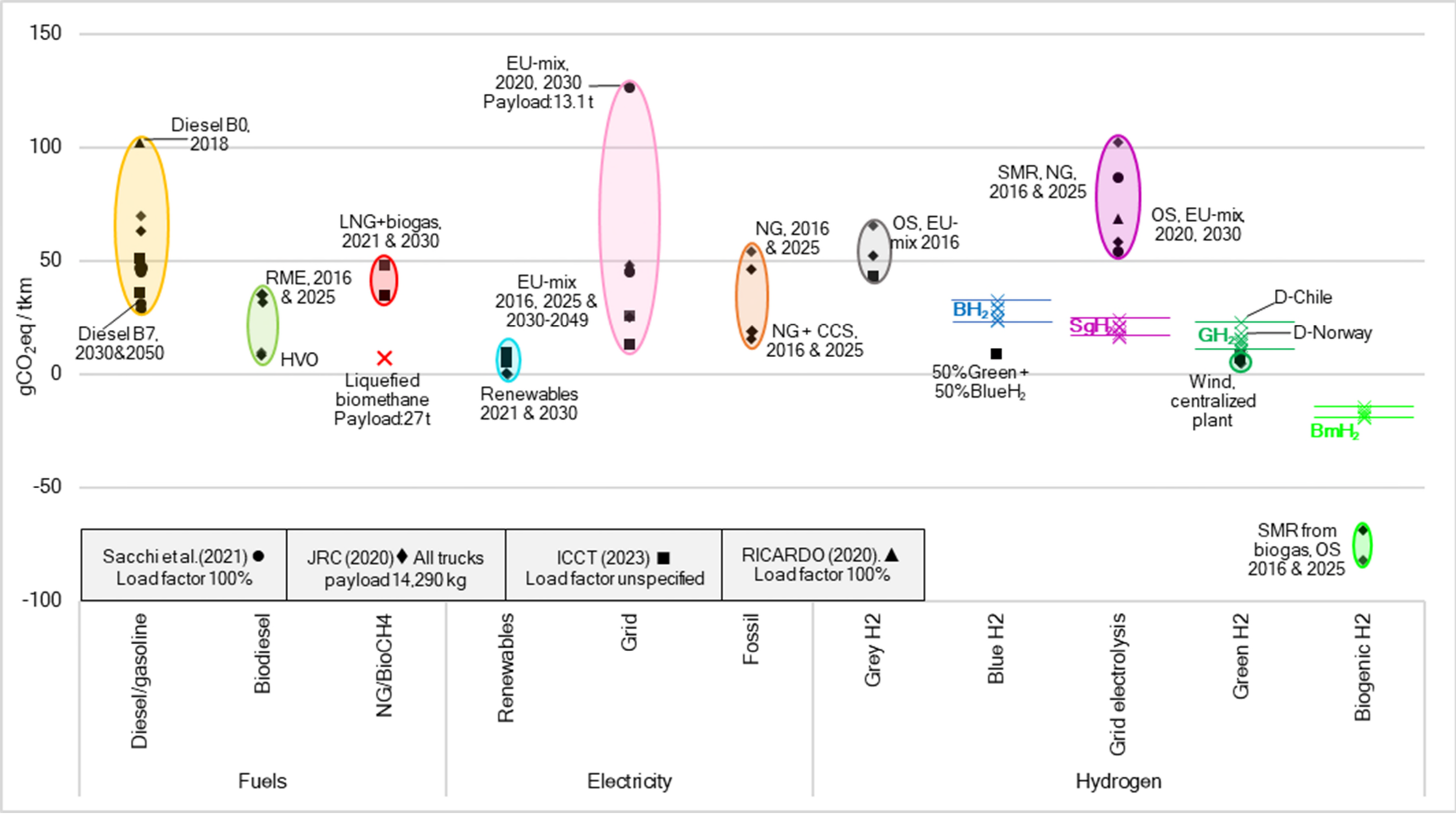
Pathway A (gaseous transport, early market) consistently presenting highest impacts

ICETs footprint appears larger than FCTs driven by N_2O in tailpipe and more tanks

Norwegian Blue hydrogen as the most competitive pathway even with current tanker ship

On-site production suggested to be very competitive even against mature market cases. Good starting point

LH_2 cases competitive even for early markets considering the low carbon mix



150
100
50
0
-50
-100
gCO2eq / tkm
Diesel B0, 2018
Diesel B7, 2030&2050
RME, 2016 & 2025
HVO
LNG+biogas, 2021 & 2030
Liquefied biomethane Payload:27t
EU-mix 2016, 2025 & 2030-2049
Renewables 2021 & 2030
EU-mix, 2020, 2030 Payload:13.1t
NG, 2016 & 2025
NG + CCS, 2016 & 2025
OS, EU-mix 2016
BH2
50%Green + 50%BlueH2
SMR, NG, 2016 & 2025
OS, EU-mix, 2020, 2030
SgH2
GH2
D-Chile
D-Norway
Wind, centralized plant
BmH2
SMR from biogas, OS 2016 & 2025
Sacchi et al.(2021) ● Load factor 100%
JRC (2020) ♦ All trucks payload 14,290 kg
ICCT (2023) ■ Load factor unspecified
RICARDO (2020). ▲ Load factor 100%
Diesel/gasoline
Biodiesel
NG/BioCH4
Renewables
Grid
Fossil
Grey H2
Blue H2
Grid electrolysis
Green H2
Biogenic H2
Fuels
Electricity
Hydrogen

Takeaway messages- Swedish case

- High competitiveness of onsite production supported by Swedish grid despite the lower well-to-efficiency of hydrogen
- Carbon footprint of different truck versions varies up to 50 tCO2eq
- Swedish grid electrolysis appears more competitive than blue hydrogen
- For high leakages scenarios (~30%), climate change impacts of green hydrogen, per tkm, increase twofold
- High transportation footprint of Chilean green hydrogen nullify renewable electricity benefits causing similar impacts to onsite production at the refueling station. In contrast, Norwegian blue hydrogen remained competitive

Lessons beyond Sweden…

Electrolysis pathways depend on how the electricity is generated (Swedish grid has very low carbon intensity)

Blue hydrogen only available when aquifers are nearby

On-site production OK if based on low carbon electricity

Use for hydrogen for long-haul goes beyond FCs

ICETs in artic regions avoid degradation of Li-ion batteries

ICETs would work well with reforming of biomass-based compounds (low purity hydrogen)

Long distance transport still presents high impact for gaseous hydrogen and challenges for liquid hydrogen

Battery evolution is the BIG ELEPHANT in the room

Hydrogen should be used in NO REGRET applications

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Vehicle-oriented and Sweden-framed life cycle assessment: Hydrogen for long-haul trucks

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Affiliations & Notes Article Info

Highlights

- Life cycle assessment with a robust technical approach in Swedish conditions
- Hydrogen trucks offer decarbonization when compared to fossil counterparts
- Biofuels & electric trucks potentially offer more decarbonization than hydrogen
- Hydrogen leaks jeopardize the carbon mitigation obtained by renewable hydrogen

Summary

Hydrogen trucks are an alternative for decarbonizing the long-haul segment. However, the environmental footprint benefits depend on how hydrogen is produced, transported and used but also in truck manufacturing. We conduct life cycle assessment to quantify the impacts per ton-km. For centralized production we included electrolysis and steam reforming cases, with dedicated transportation pathways, but also included production on-site. We evaluated fuel cells and combustion

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