Considerations on using hydrogen as a fuel in road freight transport

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Electric, hydrogen, gas?
Development options for heavy duty vehicles
22 November 2021

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The ICCT: mission and activities

The mission of ICCT is to dramatically improve the environmental performance and efficiency of cars, trucks, buses and transportation systems in order to protect and improve public health, the environment, and quality of life.

- Non-profit research organization
- Air pollution and climate impacts
- Focus on regulatory policies and fiscal incentives
- Activity across modes including aviation and marine
- Global outreach, with special focus on largest markets

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Levers for reducing the climate impacts of on-road transport

Setting the scene

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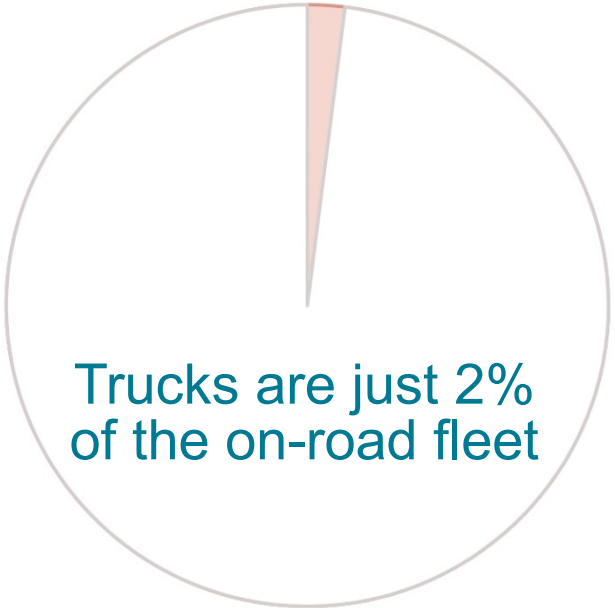
Trucks are responsible for about a quarter of CO_2 emissions from road transport in Europe.

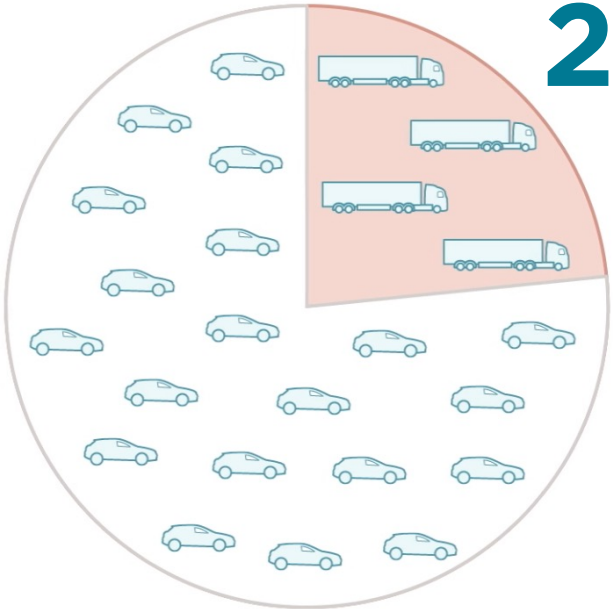
2%



But consume

24%

of fuel



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Kaya identity: Challenges and usefulness of WTW accounting

Kaya identity:

$$CO_2 = \frac{CO_2}{Energy} \times \frac{Energy}{GDP} \times \frac{GDP}{Population} \times Population$$

Professor Yoichi Kaya, “Impact of Carbon Dioxide Emission Control on GNP Growth: Interpretation of Proposed Scenarios”, Paper presented to the IPCC Energy and Industry Subgroup, Response Strategies Working Group, Paris, 1990 (mimeo)

Kaya identity modified for freight transport:

$$CO_2 = \frac{CO_2}{Energy} \times \frac{Energy}{Freight\ Activity} \times \frac{Freight\ Activity}{Population} \times Population$$

Fuel carbon

Freight efficiency

Decoupling, Modal shift

Demographics

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Vehicle efficiency
AND
Carbon intensity of fuel

Into the details…

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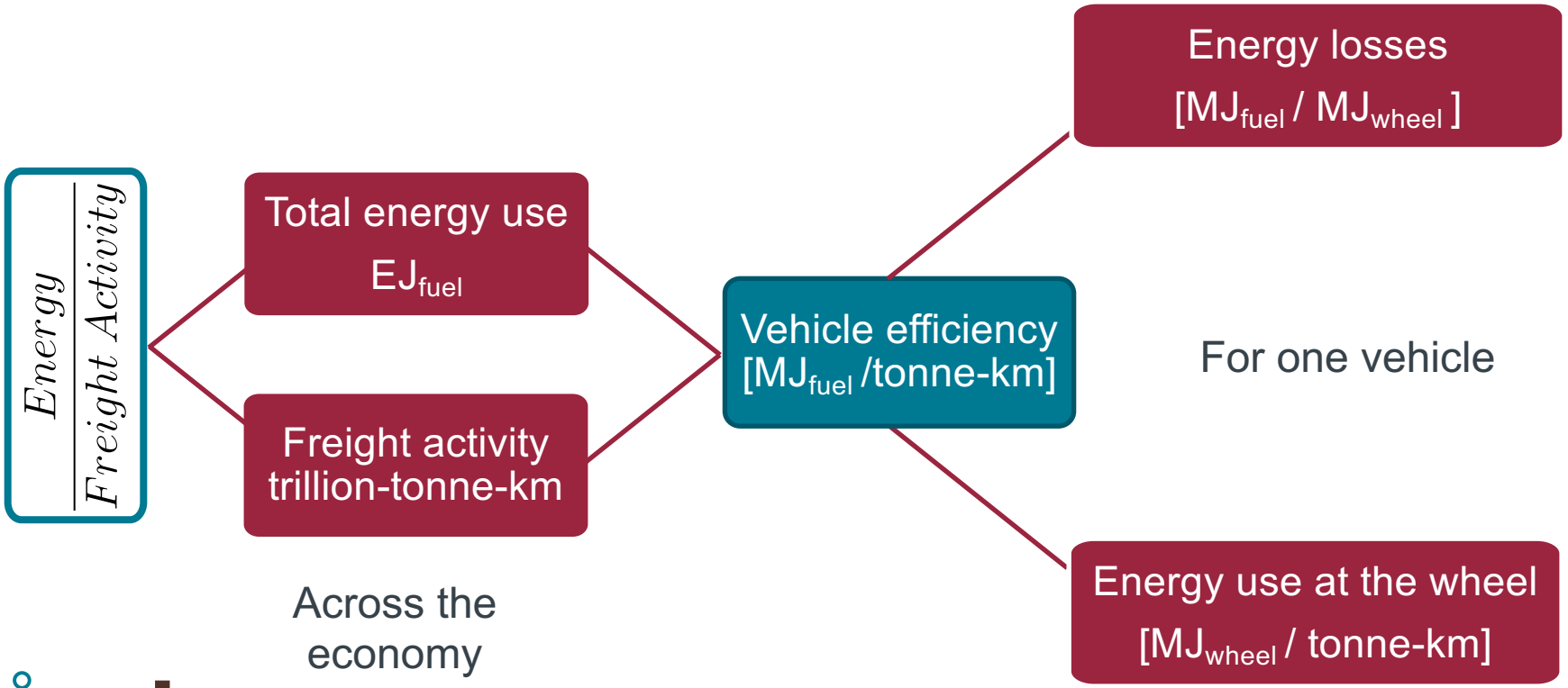
Energy intensity of on-road freight transport

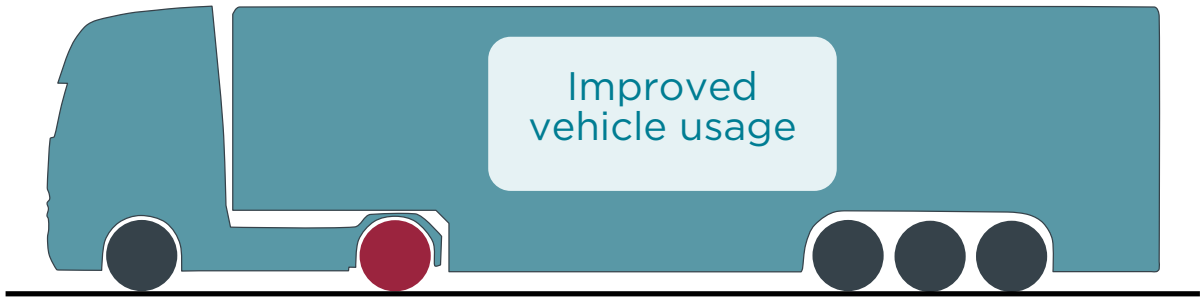


Improve energy consumption at the wheel per tonne-kilometer

Enhanced aerodynamics

Telematics, intelligent controls, and driver aids

Weight reduction



Regenerative braking

Reduced rolling resistance tires and inflation control systems

Reduced auxiliary loads

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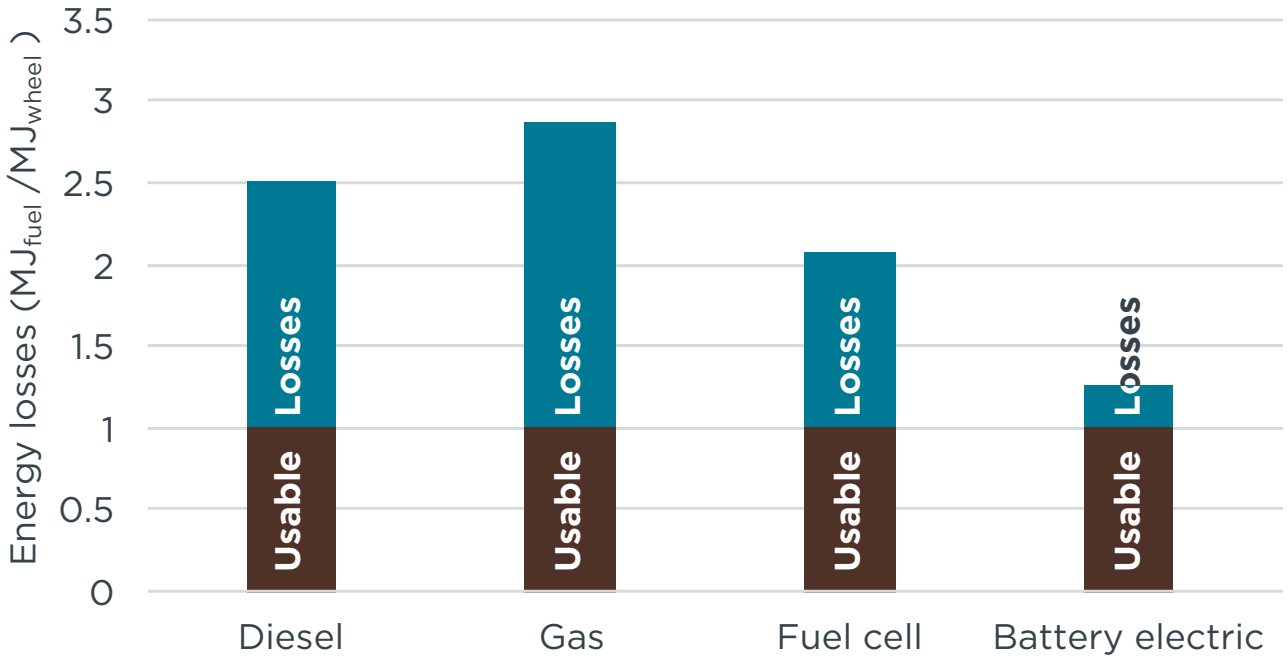
Energy conversion losses – primary energy vs. usable energy



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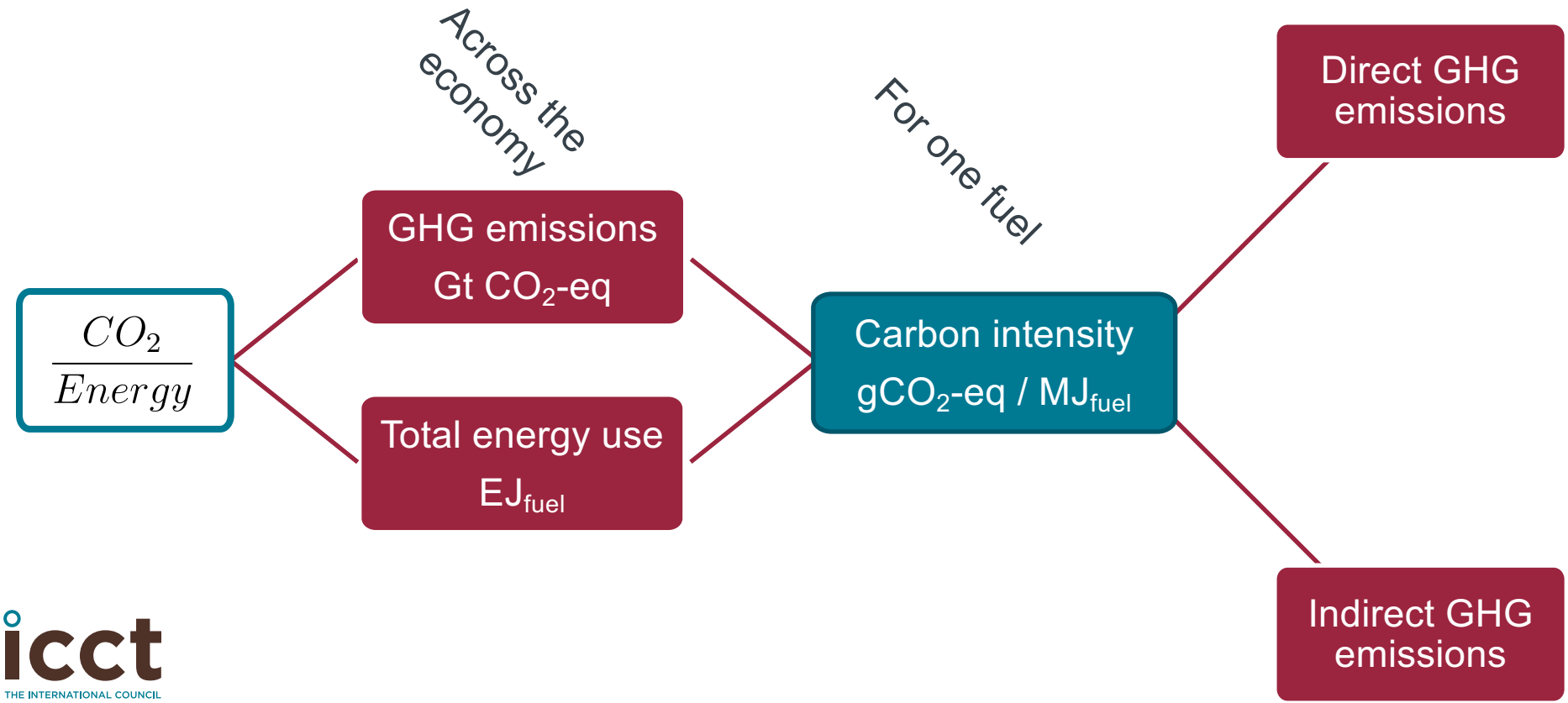
Well-to-wheel carbon intensity of road fuels



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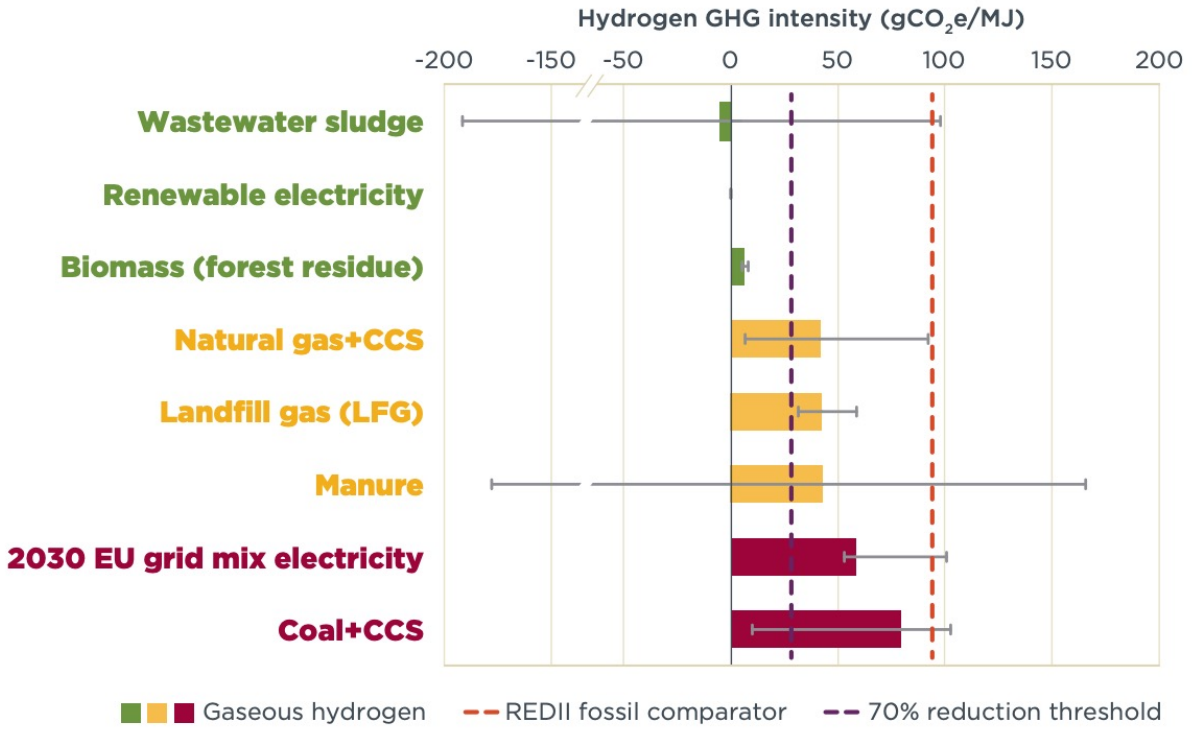
GHG emissions from H_2 production in Europe

8 hydrogen pathways:

- H_2 from green electricity and forest residues has low GHG.
- H_2 from electrolysis using EU grid has high-GHG. Additionality issue!
- Fossil-based H_2 (from NG or coal), even with CCS has a limited role in GHG reduction. Currently, CCS only gets to 50% of capture rate.



https://theicct.org/publications/lca-biomethane-hydrogen-eu-oct21

But what about the cost?

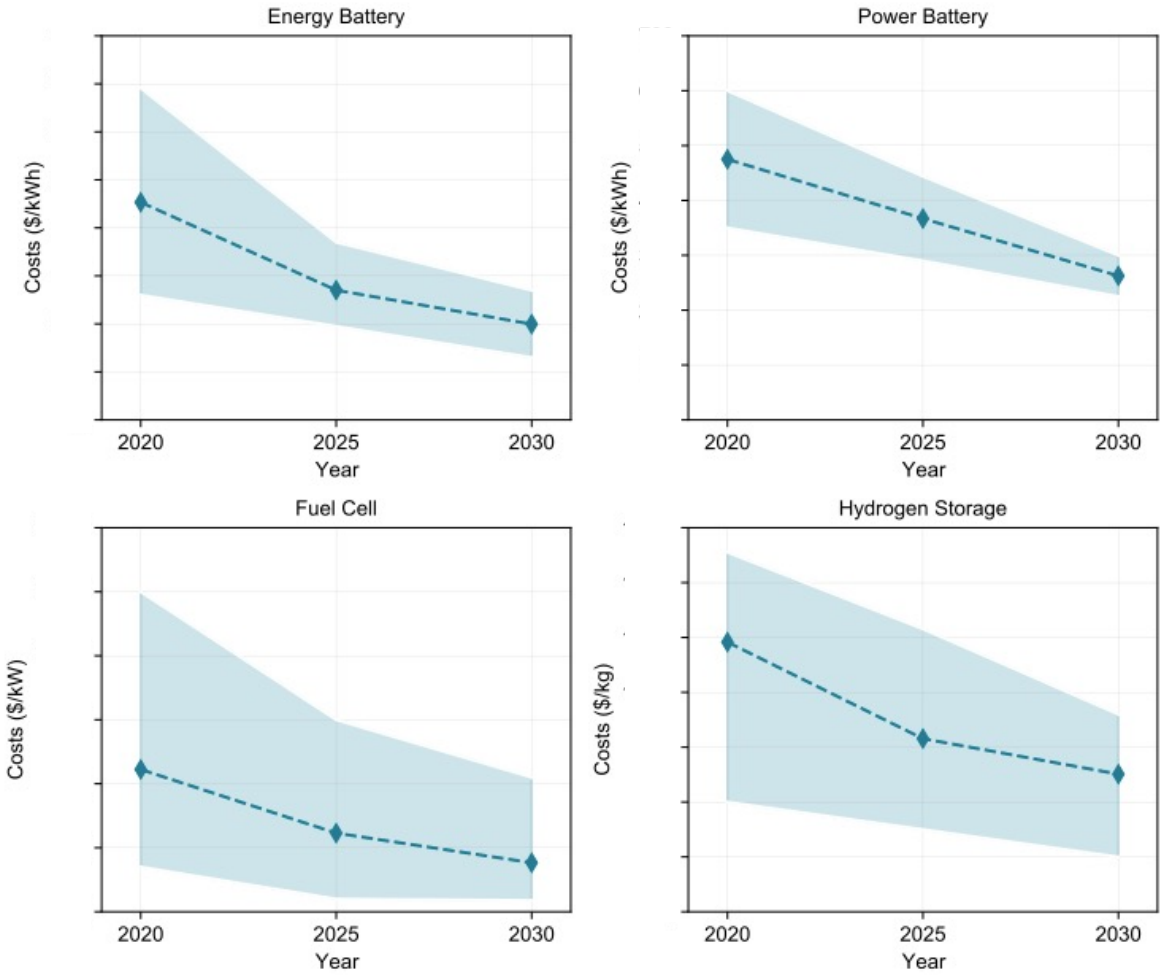
Fuel-cell truck cost vs. battery

Battery costs are dropping rapidly thanks the LDV sector

Fuel cell and H_2 storage costs will not benefit from LDV learning effects and economies of scale.

Uncertainty ranges are still big. These trucks are not in the market!

If production costs do drop, expect a similar price between fuel-cell and battery electric trucks by 2030



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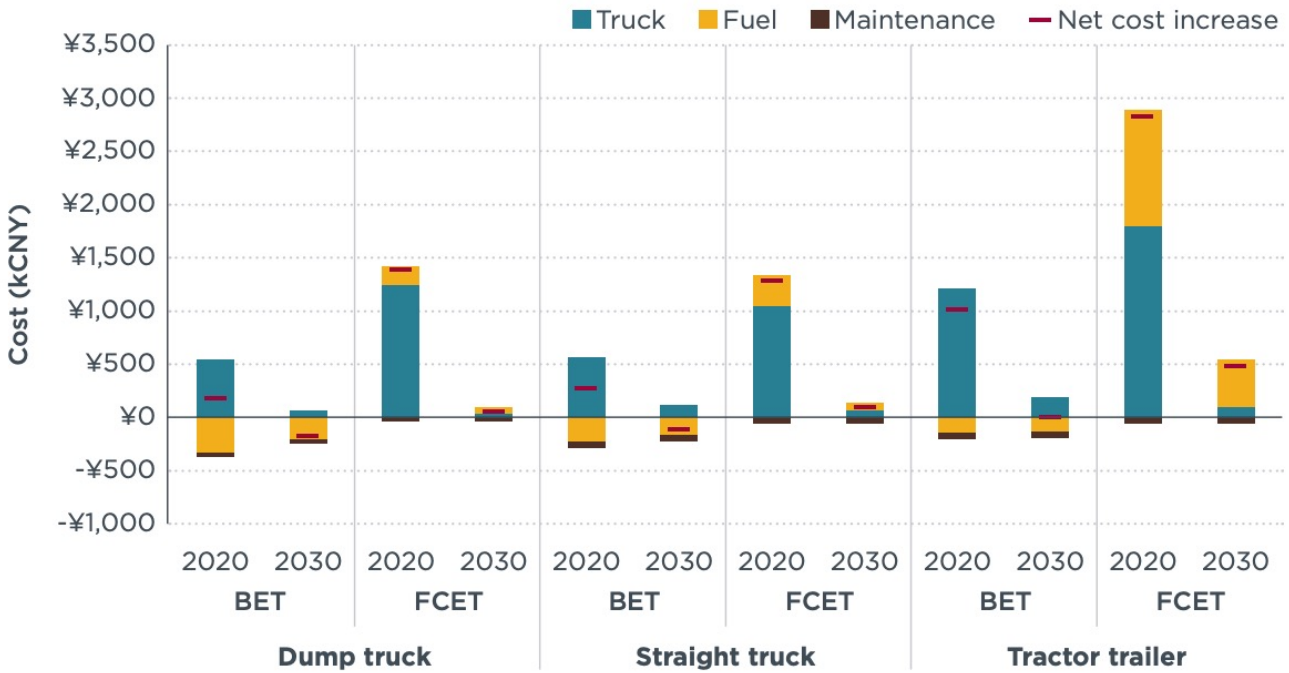
Preliminary findings.
Do not quote, do not cite.

Total cost of ownership in China

Fuel cell trucks are invariable more expensive to own and operate **in China**, compared to battery electric.

However, they can achieve the same cost as diesel by 2030 in some use cases.

Analysis for Europe, including specific numbers for Poland, is in the works.



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In summary…

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H_2 fuel-cell trucks can be a low carbon option, but…

- Are less efficient than battery electric trucks
- Can be more expensive than battery electric trucks now and will not benefit from economies of scale with LDVs.
- Will reach TCO parity with diesel at a later point. Highly dependent on the cost of H_2, which is uncertain at this point.
- Must be **fueled with green hydrogen**, that is produced with **ADDITIONAL** renewable energy capacity
- Can have advantages vs. battery electric trucks in applications with high payload, high distances, and unpredictable routes.

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