Detailed Modeling of Inland Transport of Synthetic Fuels

Dhakshain Balaji Venkatesh*, Thushara Addanki, Thomas Hamacher

Technical University of Munich, Chair of Renewable and Sustainable Energy Systems, Lichtenbergstrasse 4a, 85748 Garching b. München, Germany

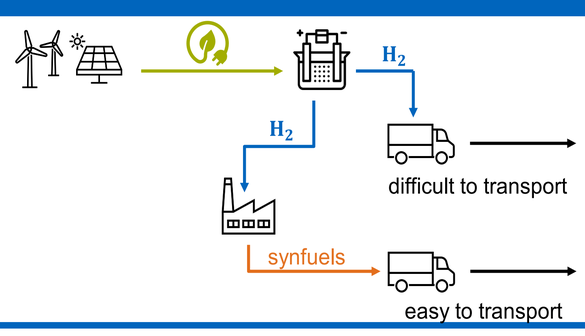
Role of synfuels in the energy transition

Countries around the world are transforming their energy systems to make their energy mixes greener. Renewable energy is used to generate green electricity, electrolyzed into hydrogen and processed into carriers like synthetic fuels for storage and transport.

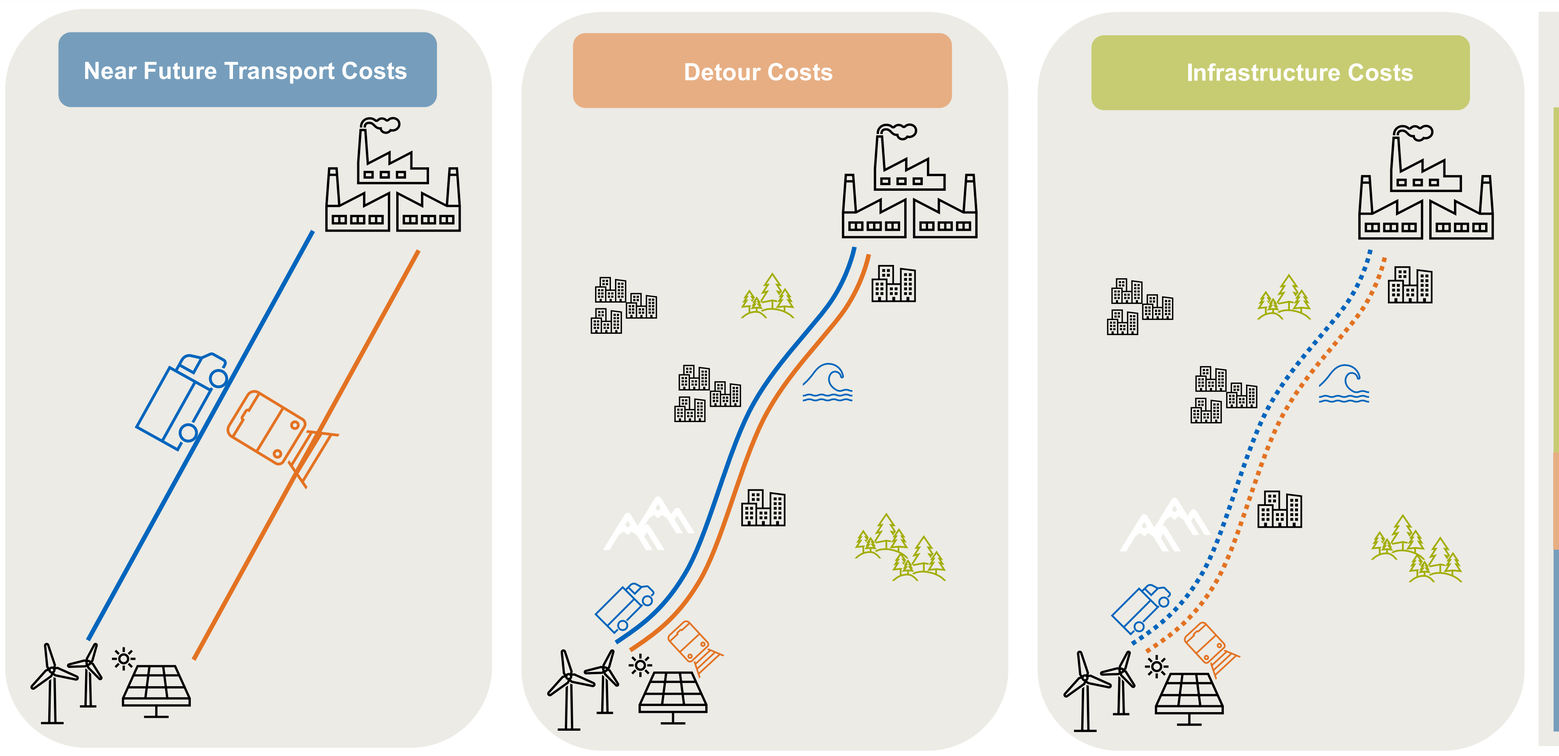
Energy Transition around the world

Synthetic fuels are easier to transport than liquid hydrogen. They can be transported using existing diesel trucks and train tankers.

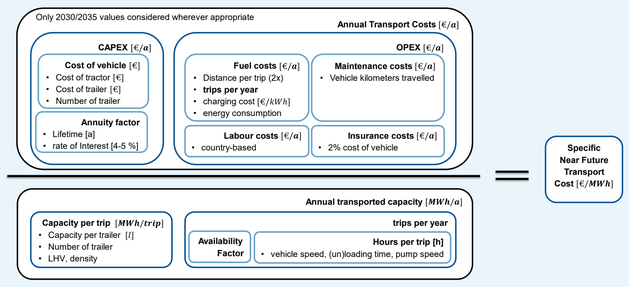
Inland transport costs are calculated at 1-2% of supply costs [1], based on assumptions – estimated distances and pre-existing transport infrastructure – that do not accurately reflect the total transport costs.



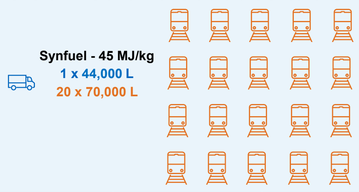
The real costs of future synfuel transport



Method: Costs were calculated for transporting synthetic fuels in battery-electric trucks or trains along a linear path on existing roads and railroads using the following formula:

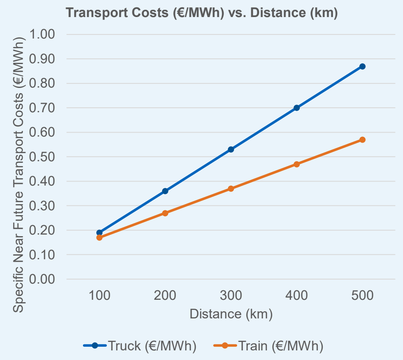


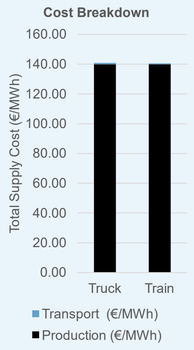
Parameters defined and set at suitable values:



Parameter	Truck	Train
Cost [€]	200,000.00	8,000,000.00
Lifetime [a]	10	30
Speed [km/h]	80	140

Results: Future transport costs amount to <1% of total supply costs.





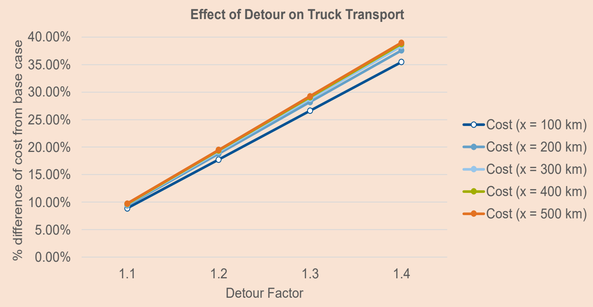
0.4 and **0.6**% of total supply cost respectively

Method: Detour refers to any difficulty in transportation along a path imposed by the transport network.

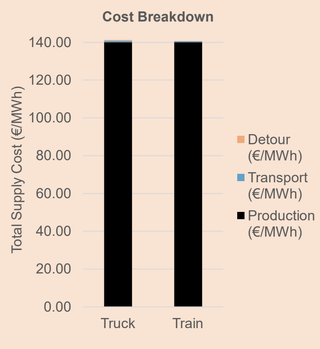
Based on the literature [2-4], for regions with existing transport infrastructure, detour factor set at: **1.10 – 1.40.** Distances adjusted using: $x'[km] = detour\ factor * x\ [km]$

Results:

1. A 10-40% increase in distance, increased transport costs by 8.9-39% respectively.



2. Transport and detour costs combined amount to <1% of total supply costs.

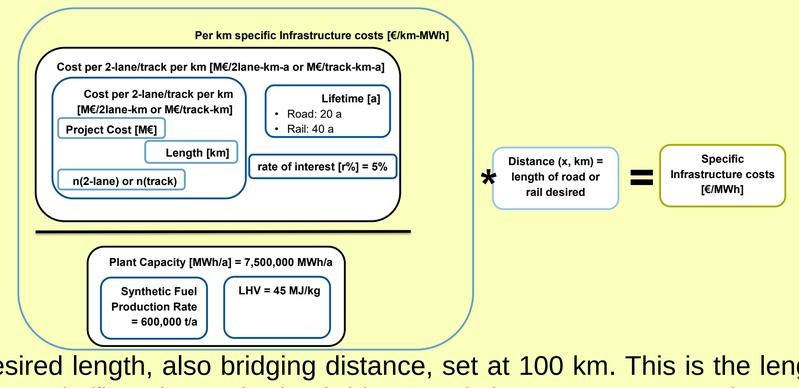


0.55 and **0.85**% of total supply cost respectively

Method: As transport infrastructure costs are highly region-specific, five countries were chosen based on the criteria:

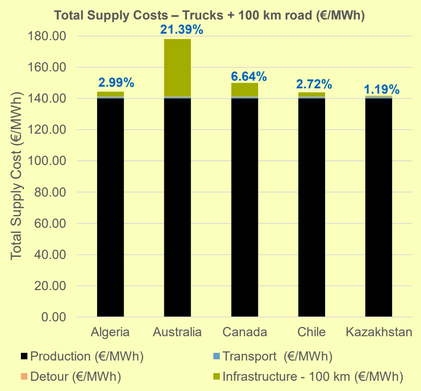
1. renewable energy (RE) potential
2. land available for RE expansion
3. non-extensive transport network

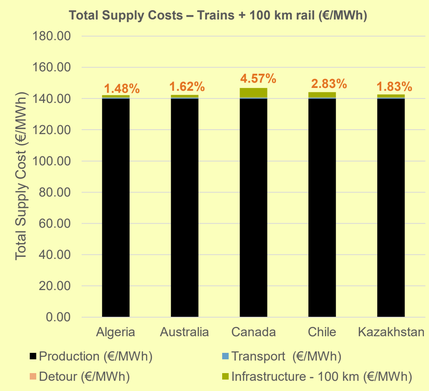
Cost details for road and rail infrastructure projects were collected for all cases. Costs per 2-lane-km road and per track-km rail were computed using the formulas below:



Desired length, also bridging distance, set at 100 km. This is the length of new (rail)roads required to bridge to existing transport network.

Results: Transport costs, including detour and infrastructure, amount to <3% of total supply costs for both modes in medium economies..





Conclusions

1. Near-future transport costs are higher for trucks than trains, as they transport 32 times less volume/trip. This cost component is only 0.4 and 0.6% of total supply costs.
2. With max. detour: 1.40, the transport cost components amounted to 0.55 and 0.85% of total supply costs for trains and trucks.
3. For bridging distance: 100 km, total transport costs were <3% in both modes for medium economies (Algeria, Chile, and Kazakhstan).
4. Infrastructure costs were higher for larger economies (Australia, Canada), mainly due to differences in labour and equipment costs.

Based on these insights, power plant project planners can make informed decisions about including infrastructure costs in their budgets.

Future research should analyse the costs of transport via autonomous vehicles.

*Contact: ge87hed@mytum.de | +49 163 628 4683

References:
1. P. Buchenberg *et al.*, *energies*, vol. 16, 2023.
2. B. Zgonc *et al.*, *European Transport Research Review*, vol. 11, 2019.
3. F. Héran, *Flux*, vol. 76, no. 2, pp. 110–121, 2009.
4. R. H. Ballou *et al.*, *Transportation Research Part A: Policy and Practice*, vol. 36, no. 9, pp. 843–848, 2002.