Ready for the long ride

My experiences and findings with LH2 at Mercedes-Benz trucks

Profile Tim Vianen

Hydrogen & Mobility expert

- 21 years young
- Mechanical engineer at the HAN (University of Applied sciences)
- Passion for hydrogen
- Passion for trucks
- Freelancer light and sound for festivals
- Part of a student rally team

My first experiences

Technasium study project about the implementation of a hydrogen engine at Wagenborg Nedlift

Mechanical engineering study at the HAN (University of Applied Sciences)

Theme route Hydrogen

6 months project at Newes energy services.

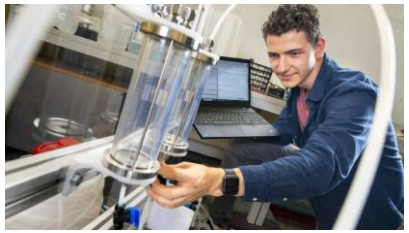
FEM analysis at a 350 bar electrolyser

Founder and active member of Young Nederlandse Waterstof en Brandstofcel Associatie (NWBA)

Motivating students in hydrogen sector

Bridge between company's and students

WAGENBORG NEDLIFT



NEWES NEW ENERGY SERVICES HYDROGEN

JONG NWBA

Internship at Daimler Truck

6 months internship at Daimler Truck in Stuttgart

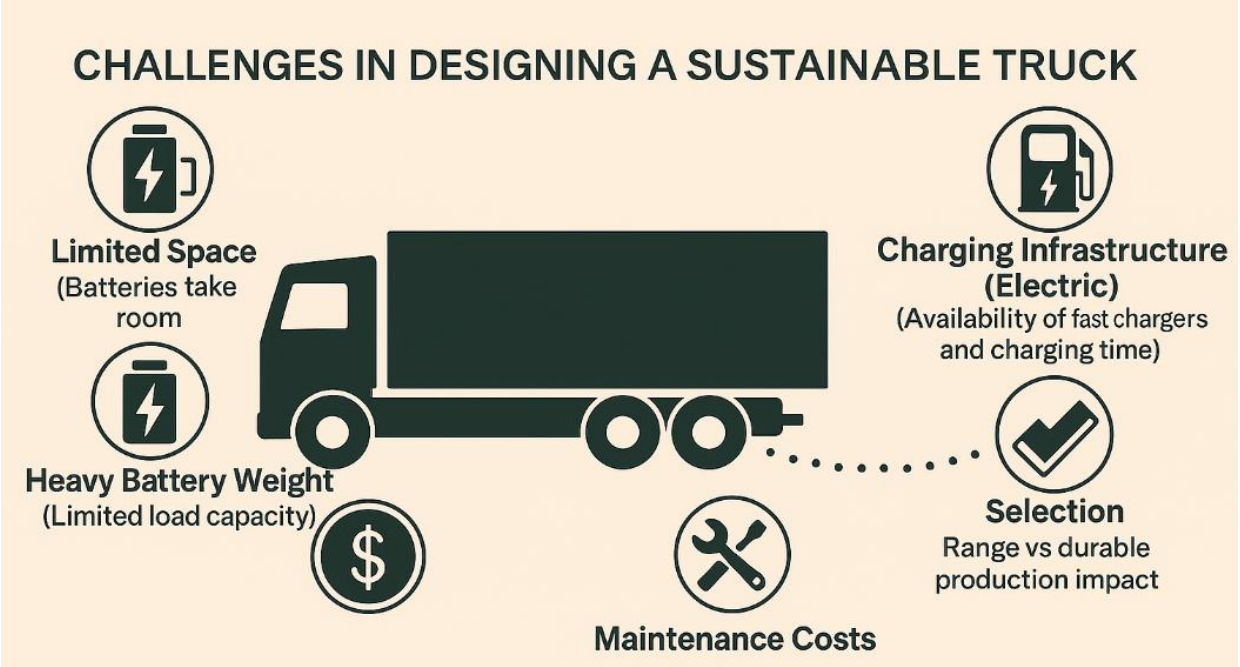
- LH2 truck development department
  - Project management for GenH2
- Research to Boil-off reduction
- Working in a great team
  - Lead by Stefan Huegin (Teilprojektleiter Fuel Cell Truck)
- Combination of their knowledge and the possibility to try and learn new things

Together we can do more!

Source: Safe, Fast and Simple: Daimler Truck and Linde Set New Standard for Liquid Hydrogen Refueling Technology | Daimler Truck North America

Challenges in truck design

- Limited packing space
- Difficult charging/refueling infrastructure
- High costs
  - Development costs
  - Costs of ownership
- Law and regulations
- Safety
- Independent of fuel type



Created by ChatGPT

Truck transport in numbers in the Netherlands (2023)

43% of the transport is done trucks

9 billion kilometers driven each year by trucks

26,9 Megaton of CO2 emissions

Around **151.000** new trucks registered in the Netherlands alone

4,58 billion liter diesel is used each year

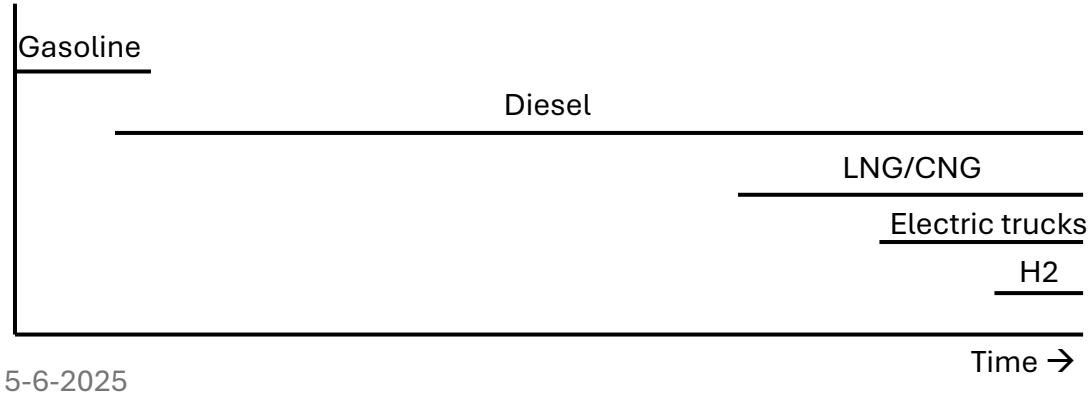
Sources: CBS

Developments in the Truck market

LNG

Electric

(L)H2



We are on the move

LNG trucks

- Seen as a transition fuel
- Mostly Volvo & Iveco trucks
- It is a fossil fuel but it is less harmful then many other fossil fuels
  - Around 15-20% fewer CO emissions compared to diesel
- Same range and performance as diesel

Electric trucks

- Seen as the next alternative step
- However, there are different challenges

Pro

- Quieter (more driver comfort)
- Cheaper in total costs of ownership

Con

- Vehicle space
- Vehicle Weight
- Loading infrastructure
- High purchase price
- Operational changeover time (planning around charging windows
- Companies cannot build charging infrastructure

Source: https://www.daimlertruck.com/en/newsroom/pressrelease/53071802

Generation 1 Electric trucks

Start of production: 2021
Range: 300-400 km

Start of production: 2019
Range: 300 km

Start of production: 2020
Range: 250 km

Start of production: 2024
Range: 400-500 km

Start of production: 2023
Range: 300 km

Start of production 2023
Range: 200- 500 km

Generation 2 Electric trucks

MAN eTGX

- Daily range of 800 km
- 750 kWh Battery capacity
- Megawatt charging possible
- Modulair battery concept
- Low deck

Daimler Truck eActros 600

- 500 km range
- 600 kWh battery capacity
- Megawatt charging possible
- Truckcharge

Volvo FH Aero Electric

- 600 km range
- 780 kWh battery capacity
- Megawatt charging possible
- 48 tonnes of payload
- Baby axle for weight support

Recap

- Currently, a lot of development is happening in the electric market
- There is still a infrastructure challenge
  - Local/ International

The market is moving in the right direction, but is slowed down by energy infrastructure

Hydrogen trucks

- Seen as the next step in innovation
- Mostly for high energy demand tasks or long-haul
- However, there are different challenges

Pro

- Quieter (more driver comfort)
- Faster refueling
- Lots of possibilities for vehicle layout

Con

- Building space in the vehicle
- Refueling infrastructure
- High purchase price

Source:https://www.daimlertruck.com/en/newsroom/pressrelease/52369346

Hydrogen drive possibilities

- Fuel Cell
- Internal Combustion Engine
- 350 bar
- 700 bar
- Liquid Hydrogen
- Cryo-compressed

Source:https://www.daimlertruck.com/en/newsroom/pressrelease/52369346

CHG met FC in de markt

Holthausen

- DAF chassis
- Up to 50 tons
- Range up to 400 km (depending on tanks)

- 4x2 rigid, 6x2 rigid or custom builds

Paul Nutzfahrzeugen

- Mercedes Benz Atego chassis
- Up to 24 tons
- Range of 450 km
- 85 kW fuel cell from toyota
- 30 kg of h2 storage

- 4x2 or 6x2

Hyundai

- First commercialist FC heavy duty truck (2020)
- 400 km range
- 180 kW max stack output
- 31 kg of H2 storage (350 bar)

- 4x2 or 6x2 rigid possible

Interesting trucks

Track 1000

- **D**eveloped by CASC's 101st Institute
- 100 kg LH2 tank
- 1000 km range
- FAW Fuel cell
  - 300 kw stack

MAN HTGX

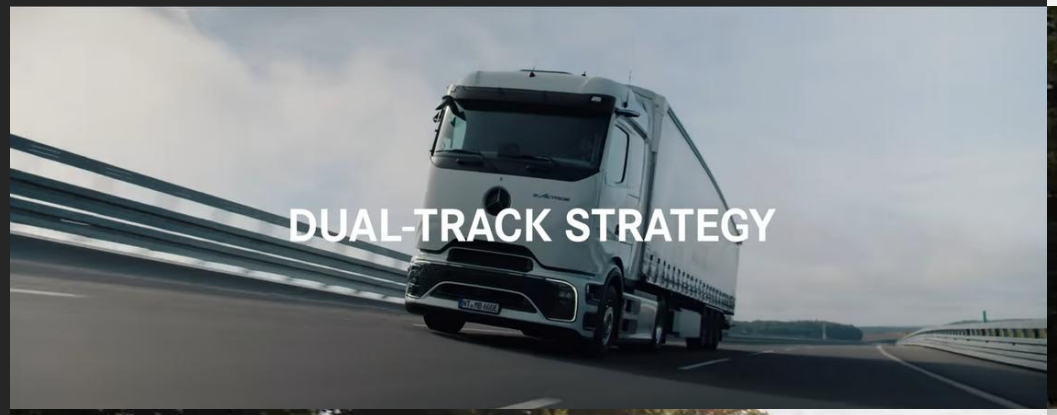
- Hydrogen combustion engine
- Tank: 700 bar Voith system
- 56 kg H2 capacity
- Range: 600 km
- 6x2-4, 6x4, 6x2=2

Hyundai Class 8 semi truck

- For North America
- European cab
- 720 km range
- 68,6 kg h2 storage
- 2 fuel cell stacks
- 8,7 meter long

The Daimler Truck strategy

We need both technologies but the question remains: What share will these technologies have?



Source:The CO2-neutral drive technologies of Daimler Truck – YouTube

Liquid hydrogen vehicles

- Daimler truck the first with LH2
- 50 ton heavy duty 4x2 tractor
  - With tech tower
- Carries 80 kg of LH2
- Range of 1000 km
- Refueling takes 10 to 15 minutes

Source: Safe, Fast and Simple: Daimler Truck and Linde Set New Standard for Liquid Hydrogen Refueling Technology | Daimler Truck North America

Mercedes-Benz GenH2 Truck

- Mercedes-Benz Actros Procabin
- Cellcentric fuel cell
- 80 kg LH2 storage
- First prototype complete
- 100 units
- Equiped with Predictive Powertrain Controls system

Source: https://www.daimlertruck.com/en/newsroom/pressrelease/53027304c

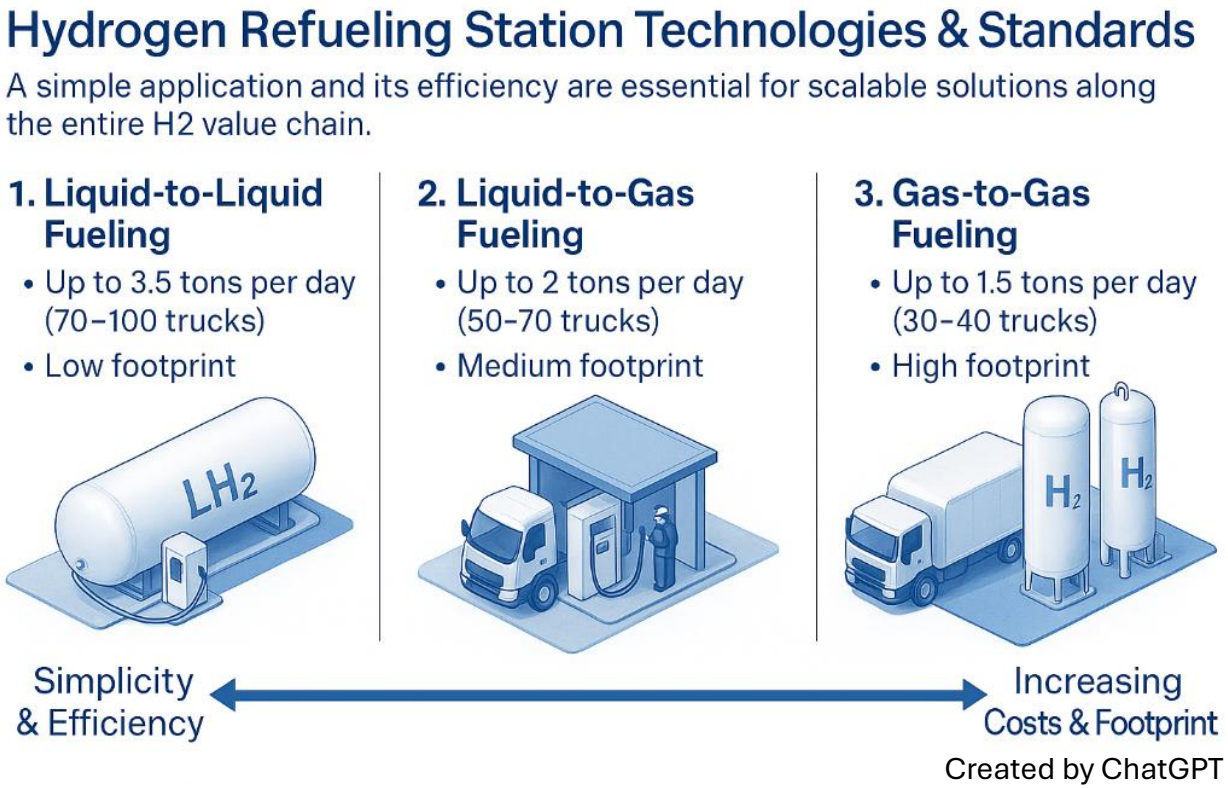
The first LH2 refueling station

- Collaboration between Daimler Truck and Linde
- First public sLH2 fueling station in Wörth am Rhein
- Pilot refueling station
- Capacity of 400 kg of LH2 per hour
- Power consumption of around 0.05 kWh/kg
    - This is approximately 30 times less then gaseous hydrogen refueling

Source: Safe, Fast and Simple: Daimler Truck and Linde Set New Standard for Liquid Hydrogen Refueling Technology | Daimler Truck North America

Role of LH2 in transport

- Second (mobile) LH2 refueling station is operated in Doesburg
- LH2 has a lot of posibilities for refueling stations
- However, the major problem is boil-off



Created by ChatGPT

My research on boil-off

- For further implementation of the LH2 truck, it is also important to look at infrastructure.
- Big problem with LH2 now is boil-off for filling stations (stationary tanks)
- Research on different boil-off systems
- Investigated costs and benefits for infrastructure purposes
- Designed a solution for the Boil-off

LH2 in the future

- High energy, Easy refueling
- Less spaced is needed
- Prices for LH2 are expected to be lower then CHG
- Many possibilities in mobility
  - Long-haul
  - Construction equipment
  - Distribution
- Still some time needed for the development


From ambition to action
Rising Interest in (L)H2 on global scale
Together we can do more!