

# Hydrogen vs. Electric Cars in the Race for Zero Emissions

Energy Community webinar “Eternal Summer”, Session 2

Adam Enok  
1<sup>st</sup> of December 2020

# About the speaker

Clean technologies enthusiast with over 5 years of work experience in sustainable energy R&D

- Summer School alumnus from 2019
- Master's degree in materials science (chemistry + physics)
- Launched a private company operating 40 kW solar park in 2019



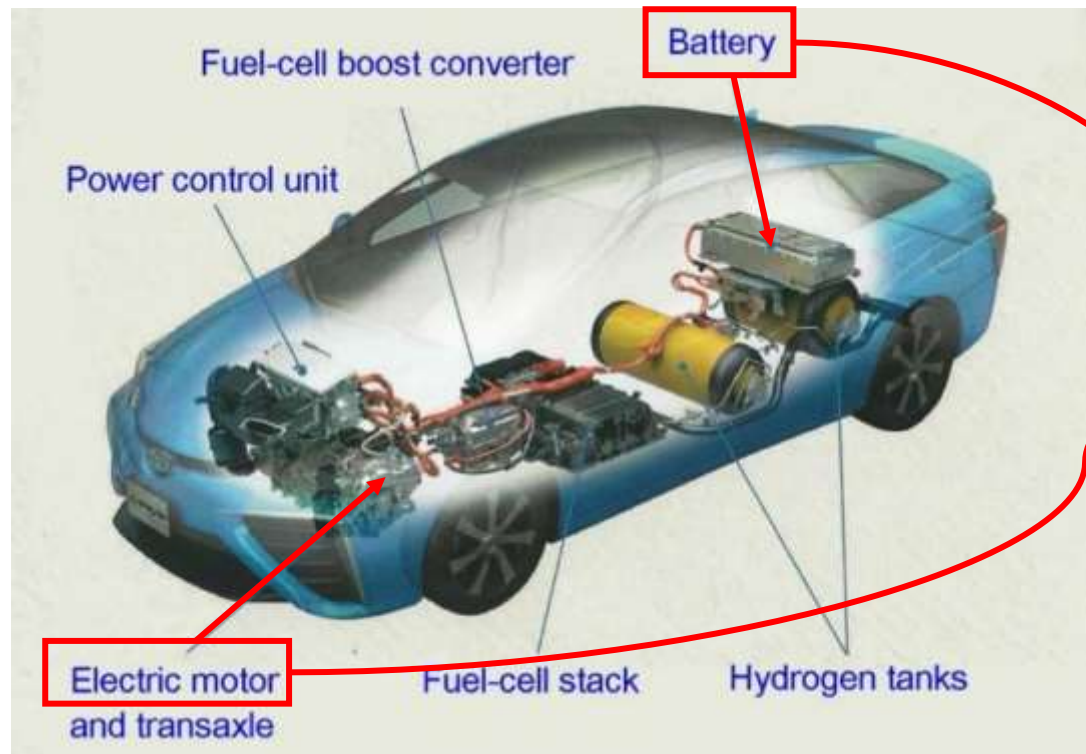
# Work experience

- Research specialist at Enefit (2018-2019)  
including market research on electric vehicles, hydrogen energy
- Electric vehicles charging network project manager at Eleport  
hands-on experience with electric vehicles (2019-2020)
- Product developer at Roofit Solar (2020-...)  
combining aesthetic solar roofs and electricity demand response



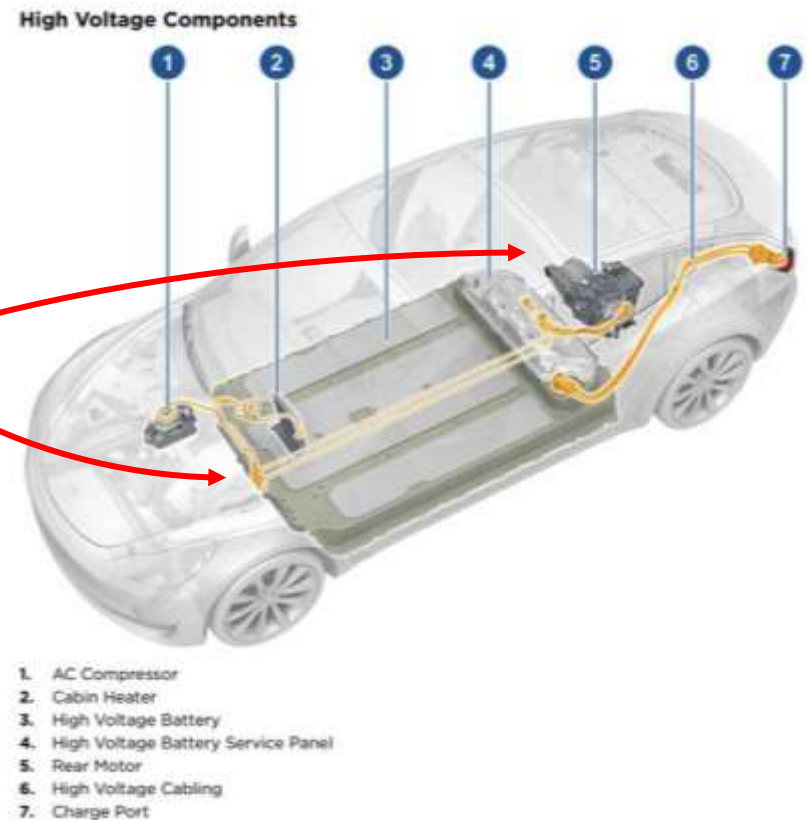
# Principles of the two cars

## Hydrogen vehicle



Toyota Mirai

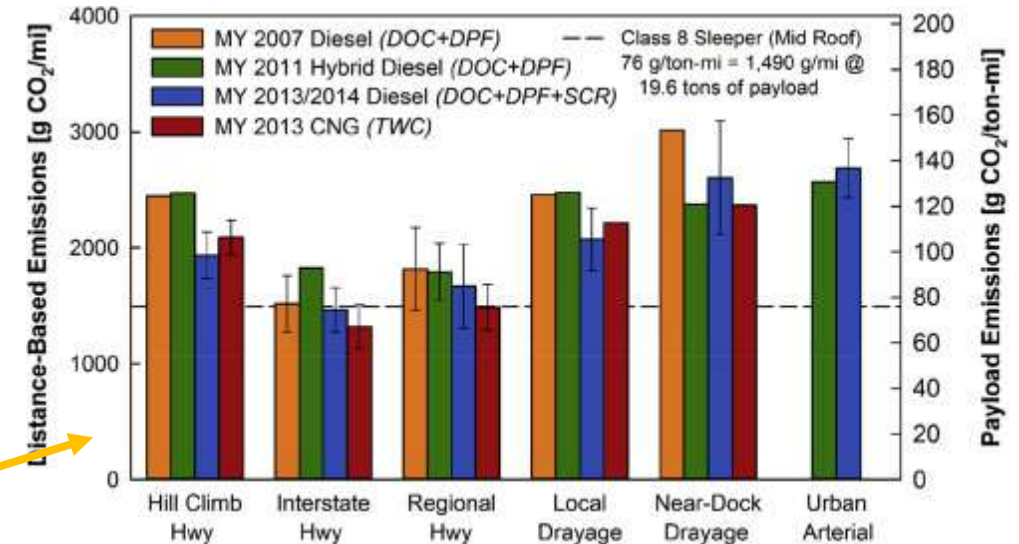
## Electric vehicle (EV)



Tesla Model 3

# What about biogas?

- Why we need zero emission vehicles?  
To have clean air in the cities!
  - Paris pollution: 'Like smoking 183 cigarettes a year' [1]
  - Over 50% of Europe lives in urban areas [2]
- Biogas is a subset of CNG. CNG pollutes like a diesel engine. Therefore it is not an option in the long run.

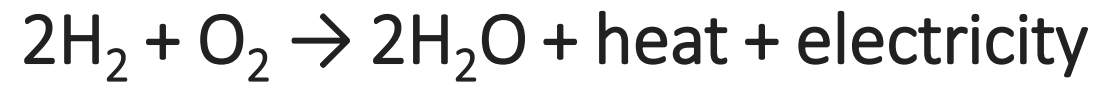


[1] <https://www.thelocal.fr/20180810/paris-pollution-like-smoking-183-cigarettes-a-year>

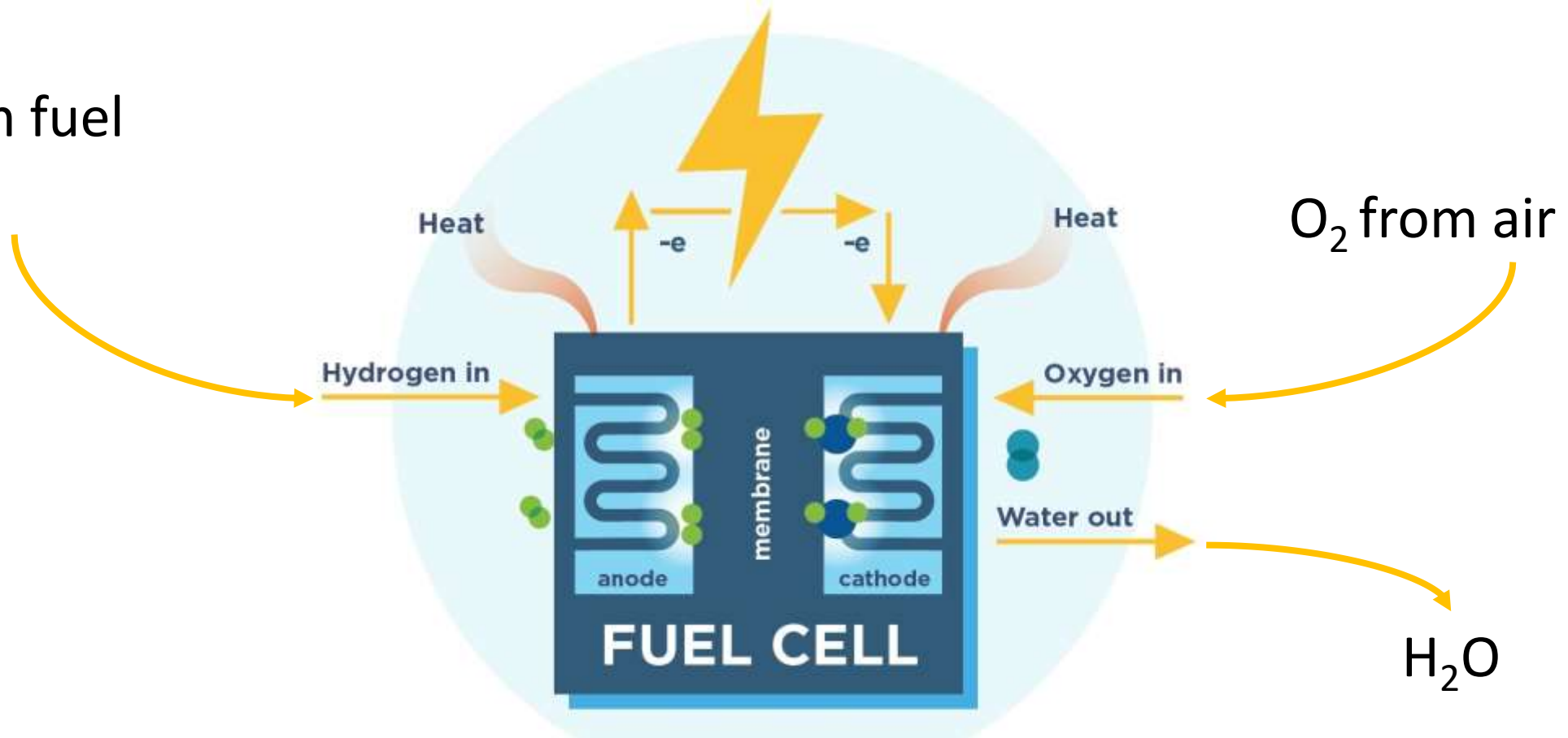
[2] [https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Share of urban and rural populations, 1950%E2%80%932050 \(%C2%B9\) \(%25 of total population\) Cities16.png](https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Share_of_urban_and_rural_populations,_1950%E2%80%932050_(%C2%B9)_(%25_of_total_population)_Cities16.png)

[3, chart] <https://www.sciencedirect.com/science/article/pii/S1352231017305794#fig3>

# Shortly on the fuel cell

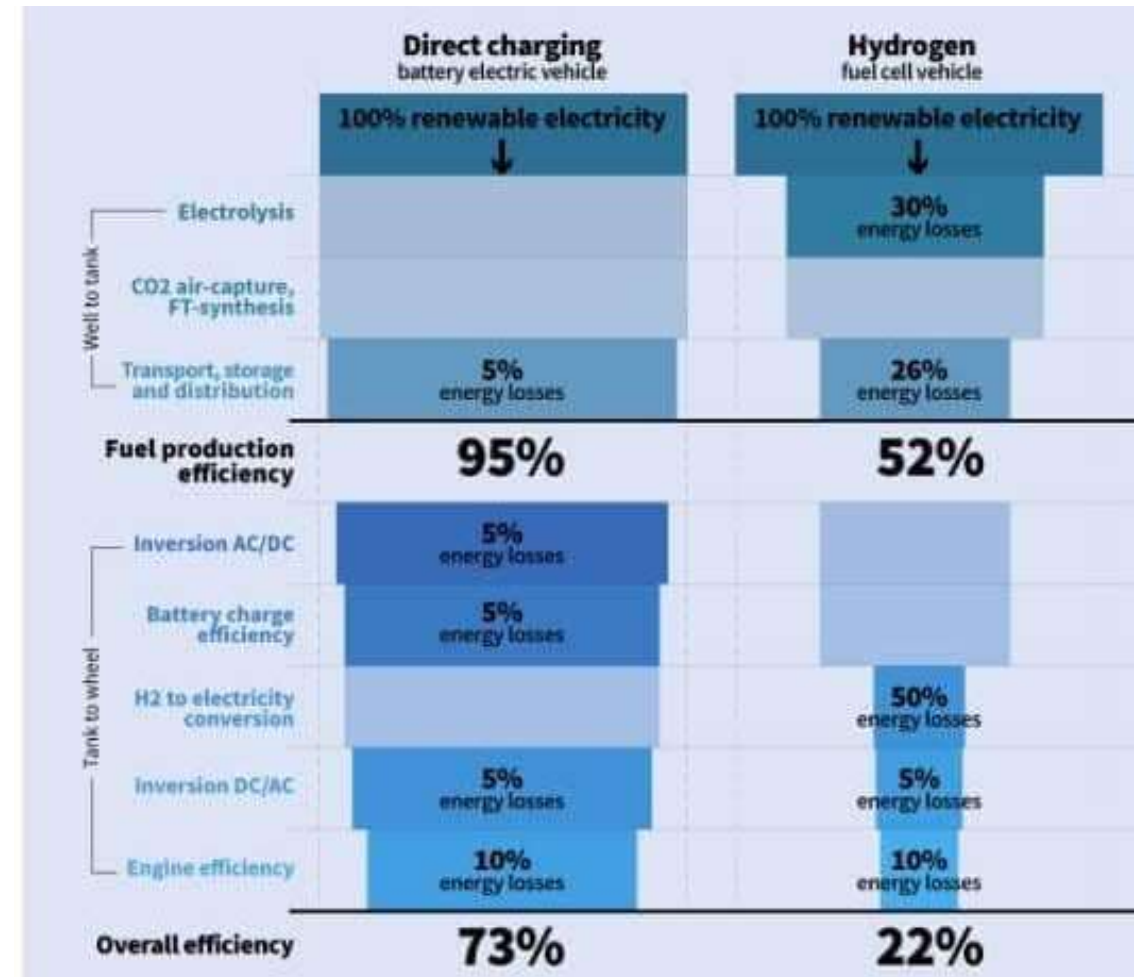


H<sub>2</sub> from fuel tank



# Efficiency comparison

- Green electricity to claim the title “zero emissions”
- Electric car has small energy losses down the “well to wheel” pathway, just 5% in most steps
- Hydrogen car has large losses:
  - 30% lost on fuel production
  - 50% lost to make electricity



# Comparing the numbers: Mirai vs Model 3

- Similar cost
- Similar driving range
- **Electric car** is ~3 times more energy efficient vs **hydrogen car**  
→ better for the environment
- Electricity is a cheaper fuel  
→ better for the consumer

**Electricity wins = end of webinar?**

	Toyota Mirai	Tesla Model 3 RWD Long Range
MSRP (\$US, pre-subsidy)	\$57,000	\$49,000
Curb weight	4079 lb (1850 kg)	3805 lb (1726 kg)
EPA range*	312 miles	334 miles
"Fuel" on board	5 kg H2 in 10,000 psig (700 barg) tanks	75 kWh in Li-NCA batteries
MPGe (EPA)	66	130
Efficiency	5 kg H2/312 miles	260 Wh/mile (from the wall)
Energy Onboard	165 kWh as H2 LHV	75 kWh
Grid Efficiency	94%	94%
Electrolyzer Efficiency	70%	N/A
Compression Efficiency	90%	N/A
Energy to recharge from source	276 kWh	92 kWh (charger and battery efficiency is already included in the 260 Wh/mile figure)
Efficiency From Source	884 Wh/mile	277 Wh/mile
Relative energy use from source	3.2 times	1
Cost to fill	\$75, at \$15/kg for retail H2	\$18 using \$0.24/kWh Tesla supercharger network \$14 using \$0.15/kWh average California retail electricity
Relative cost per mile	5.4 times	1

<https://insideevs.com/reviews/370654/tesla-model-3-vs-toyota-mirai/>



# Strengths of hydrogen vehicles

- Fast refueling: Mirai gets filled in 5 minutes [1]
- Fuel prices are forecast to fall significantly: ~10 times drop by 2050 [2]  
→ 5 times cheaper fuel means price parity with EV
- Mirai tanks 5 kg of hydrogen. Model 3 carries a ~500 kg battery.  
→ The larger the vehicle, the bigger the advantage of light weight of hydrogen. Option for heavy trucks, trains, ships!

[1] <https://newsroom.toyota.eu/toyota-delivers-its-first-hydrogen-powered-car-the-toyota-mirai-in-belgium-to-hydrogenics-2/>

[2] <https://www.spglobal.com/platts/en/market-insights/latest-news/coal/033020-green-hydrogen-costs-can-hit-2kg-benchmark-by-2030-bnef>

# EU Green Deal: the near future

- “The priority for the EU is to develop renewable hydrogen, produced using mainly wind and solar energy.”
- Hydrogen is currently produced from fossil sources “resulting in the release of 70 to 100 million tonnes CO<sub>2</sub> annually in the EU”
- “An immediate application in industry is to reduce and replace the use of carbon-intensive hydrogen in refineries, the production of ammonia, and for new forms of methanol production.”
- “Hydrogen fuel cells should be further encouraged in heavy-duty road vehicles, **alongside electrification**”

[https://ec.europa.eu/commission/presscorner/detail/en/ip\\_20\\_1259](https://ec.europa.eu/commission/presscorner/detail/en/ip_20_1259)

# EU Green Deal: foreign policy perspective

- “Europe is highly competitive in clean hydrogen technologies manufacturing and is well positioned to benefit from a global development of clean hydrogen”
- “Europe is fully dependent on the supply of 19 of 29 raw materials relevant to fuel cells and electrolyser technologies”
- “More broadly hydrogen could be mainstreamed in the EU’s international, regional and bilateral energy and diplomacy efforts, but also on climate, research, trade and international cooperation. ”

# Conclusion

- Battery **electric vehicles** are the more viable option for **passenger cars**  
→ higher efficiency + cheaper “fuel”
- **Hydrogen** fuel cell vehicles are very perspective for **heavy transport**  
→ fast refueling time, light weight = more cargo can be carried
- EU **Green Deal** aims to decarbonize the existing hydrogen consumers  
→ a **wise choice** to save the **environment** + encourage **R&D**
- Green Deal **investments** help to increase **security of supply**.  
→ good for the **economy** because “fuel” money will be spent locally

# Final words

- Feel free to reach out to me at LinkedIn:  
<https://www.linkedin.com/in/adamerkienok/>
- Energy Community will share the slideshow
- I do not own an electric car at the moment. I am waiting for a price drop :)

- Roofit.solar photovoltaic roof is “invisible”



# Questions & answers

Hydrogen vs. electric car?

**Both**



Is the Green Deal justified?

**Yes**

