University *of Ljubljana*
Faculty *of Mechanical Engineering*

Vodik kot eden izmed pomembnih dejavnikov zelenega prehoda - Sodelovanje različnih deležnikov v NAHV

Tomaž Katrašnik in ekipa LICeM

Univerza v Ljubljani

Fakulteta za strojništvo

Laboratorij za motorje z notranjim zgorevanjem in elektromobilnost - LICeM

http://lab.fs.uni-lj.si/LICeM/

Agenda

- The role of academic partners in NAHV project
- University of Ljubljana - Project references
- Sector coupling
- Electrochemical devices
- Observers and SoX Prediction
- Model based planning and design of advanced energy systems
- LCA

WP2

Work package number	**2**
Work package title	**Hydrogen Valley System Definition**

Task 2.4 Digital twin. TL: FBK, PP: UNITS, UNIRI, UL, HSE . [D: M6 – M55]

WP2

Task 2.5 Monitoring TL: UNI TS, PP: UNIRI, FBK, UL [D: M8 – M72]

WP7

Work package number	7
Work package title	Communication, Education and Dissemination

Task 7.3 EDUCATION. TL: UNIRI, PP: UNITS, UL [D: M1 – M72]
Education related activities will be addressed to promote the training of future professionals and experts in the field of hydrogen technologies.

7.3.1 Vocational training programs Sub TL UNIRI, PP: ALL [D: M12– M72]

7.3.2 Macro-Regional Competence Center for Hydrogen Research and Education TL: UNIRI. PP: GITONE, UNITES, UL [D: M1 – M72]

Task 7.3.4 Itinerant summer/winter school PhD students. Sub TL:UNIRI. PP UNITS, UL[D:M1–M72]

WP9

Work package number	**9**
Work package title	**Inter-regional hydrogen R&D&I development joint action plan and North Adriatic Hydrogen Valley master plan & business model**

T9.2 Information gathering and needs' analysis: field and desk. **TL**: AREA. **PP**: ECUBES, UNITS, UL, UNIRI **[D M4-29 M60-M72]**

WP10

Work package number	**10**
Work package title	**Technical demonstrator plants monitoring, identification and assessment of social, economic and environmental impacts, including water utilization**

Task 10.1 Methodology TL: UNITS. PP: UR, UL [D: M1-M18]

Task 10.2 Monitoring of the production system TL: UNITS. PP: UR, UL [D: M36-M72]

WP10

Task 10.3 Monitoring of the storage system TL: UR, PP: UL, UNITS [D: M36-M72]

Task 10.4 Monitoring of the distribution system TL: UL, PP: UNIRI, UNITS [D: M36-M72]

Task 10.5 Monitoring and analysis of the final user hydrogen demand profile and energy efficiency TL: UNITS, PP: UR, UL [D: M36-M72]

WP10

Task 10.6 Environmental impact assessment (e.g. including LCA) TL: UL, PP: UNITS, UNIRI [D:M6-M72]

Task 10.7 Social impact analysis TL: UNIRI, PP: UL, UNITS [D: M12-M72]

WP10

Task 10.8 Cost-benefit analysis TL: UNIRI, PP: UL, UNITS [D: M12-M72]

WP11

Work package number	11
Work package title	NAHV EXPLOITATION AND REPLICATION ACTIVITIES

Task 11.5 Replication package & laboratories TL: FHA PP: FBK, UNITS, UNIRI, UL [D: M25-M72]

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University of Ljubljana - Project references

2023-2029:	EC - Horizon Europe (HORIZON-JTI-CLEANH2-2022-2): NAHV - NORTH ADRIATIC HYDROGEN VALLEY
2023-2026:	EC - Horizon Europe (HORIZON-JTI-CLEANH2-2022-03-01): RealHyFC - REliable durAbLe high-power HYdrogen fueled PEM Fuel Cell stacks
2023-2026:	EC - Horizon Europe (HORIZON-JTI-CLEANH2-2022-03-02): MEAsureD - Advanced MEAs ensuring high efficiency HDV
2022-2025:	European Defence Agency: INDY - Energy Independent and Efficient Deployable Military Camps
2022-2024:	CEA (Le Commissariat à l'énergie atomique et aux énergies alternatives) – ARRS: Multiscale modelling of degradation phenomena in membrane electrode assemblies of proton exchange membrane fuel cells produced of advanced materials
2021-2024:	EC – FCH-JU – H2020: MoreLife - Material, Operating strategy and REliability optimisation for LIFEtime improvements in heavy duty trucks
2018-2024:	Christian Doppler Research Association, Austria: Christian Doppler Laboratory on Efficient Control and Monitoring of Automotive Powertrain Components with the lead institution TU Vienna

University of Ljubljana - Project references

2023-2027:	EC – Horizon Europe (HORIZON-JTI-CLEANH2-2022-2): HYScale - Economic green hydrogen production at scale via a novel, critical raw material free, highly efficient and low-capex advanced alkaline membrane water electrolysis technology
2023-2026:	EC – Horizon Europe (HORIZON-JTI-CLEANH2-2022-01-04): PilotSOEL - Advanced Processes Enabling Low cost and High Performing Large Scale Solid Oxide Electrolyser Production
2023-2026:	EC – Horizon Europe (HORIZON-JTI-CLEANH2-2022-02-04): SINGLE - Electrified Single Stage Ammonia Cracking to Compressed Hydrogen
2021-2024:	EC – Horizon Europe (H2020-JTI-FCH-2020-1): eGHOST - Establishing Eco-design Guidelines for Hydrogen Systems and Technology

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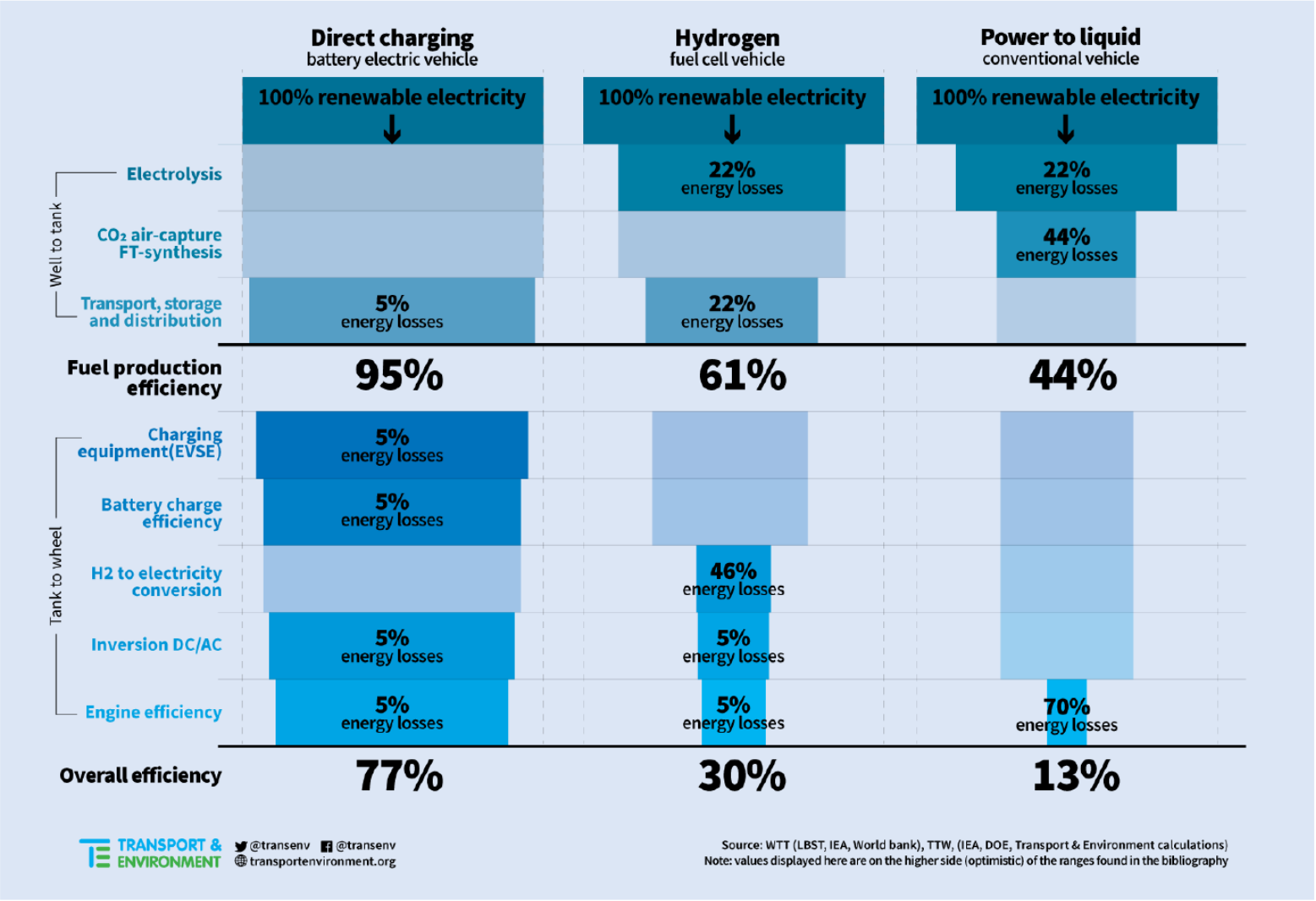
Electricity-to-Wheel



European Federation for Transport and Environment AISBL: Roadmap to decarbonizing European Cars

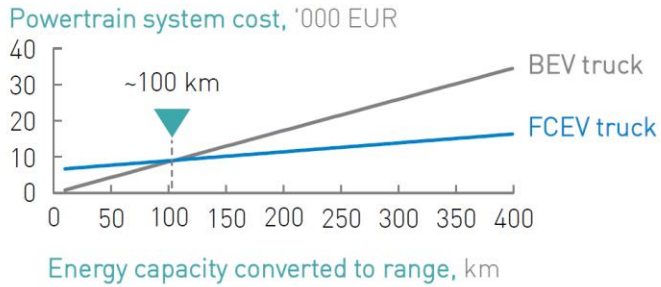
Figure 5: Efficiency of different passenger cars technology pathways based on renewable electricity. Details of assumptions to produce this graph in Appendix 3.

Why H_2 in heavy duty transport?

EXAMPLE FOR TRUCKS: HYDROGEN FUEL CELL POWERTRAINS ARE A TECHNICALLY ADVANCED ZERO EMISSION TECHNOLOGY AND COST COMPETITIVE FOR HEAVY TRANSPORT

FUEL CELLS FOR HEAVY TRANSPORT

1. FCEV powertrains for trucks are cost competitive with BEV from 100 km range



2. Hydrogen refueling is 15 times faster than fast charging

After 10 minutes refueling/recharging time

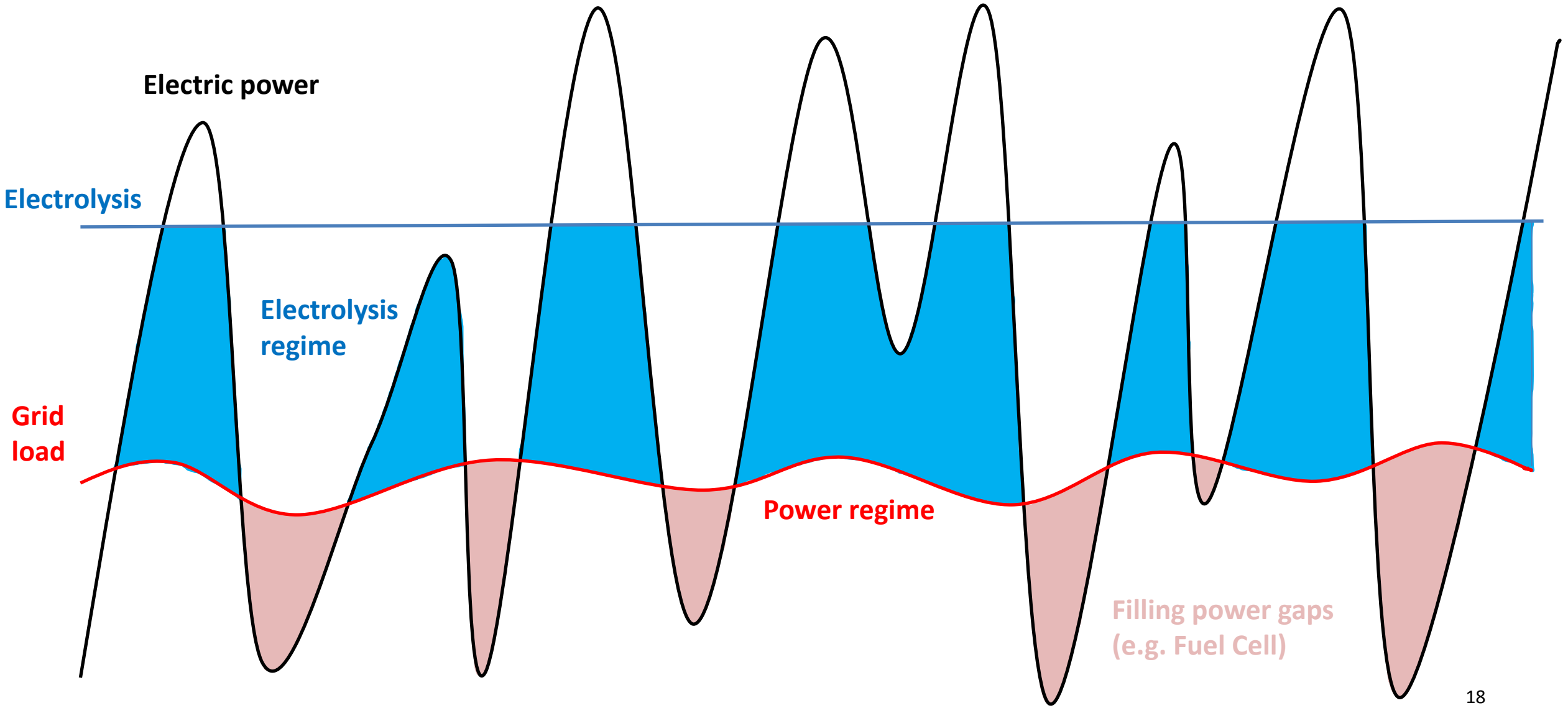
90% FCEV truck vs. 10% BEV truck of ~1000 km range

3. Recharging infrastructure ...

requires 10-15x less space and creates flexible instead of peak load

PAGE 5

A selected example of grid balancing



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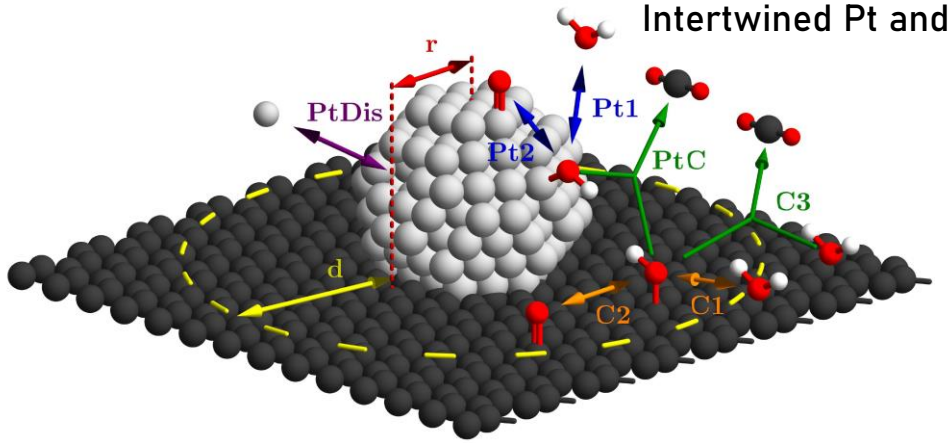
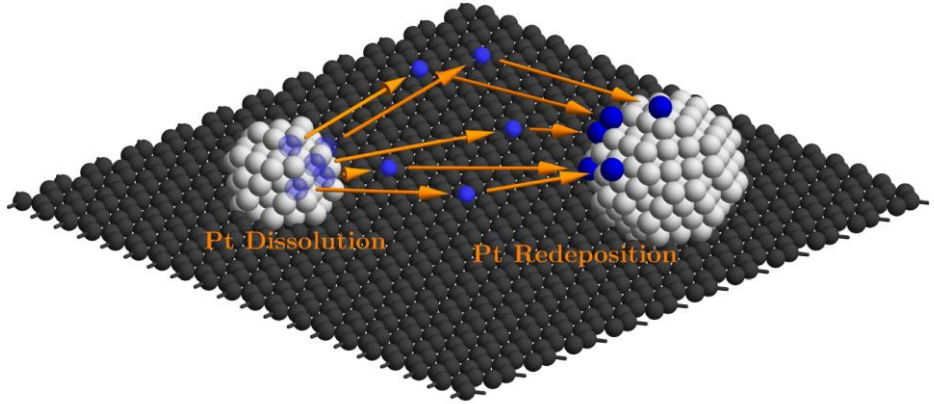
A few examples of FC degradation – impact of harsh environment?

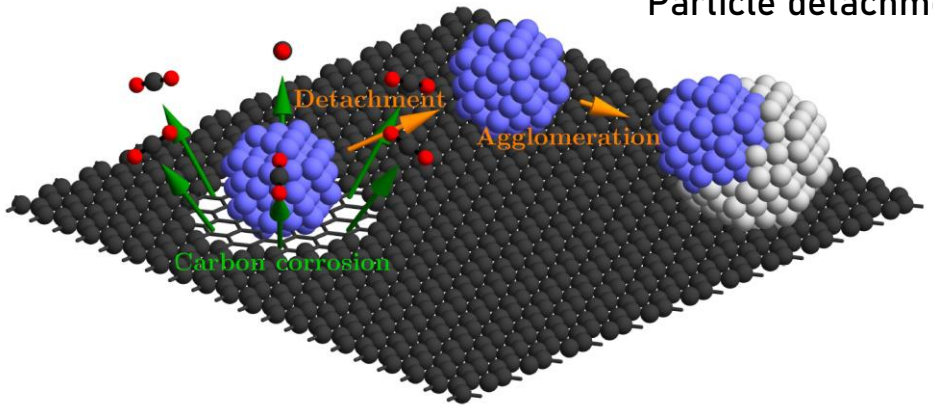
Intertwined Pt and carbon surface oxidation



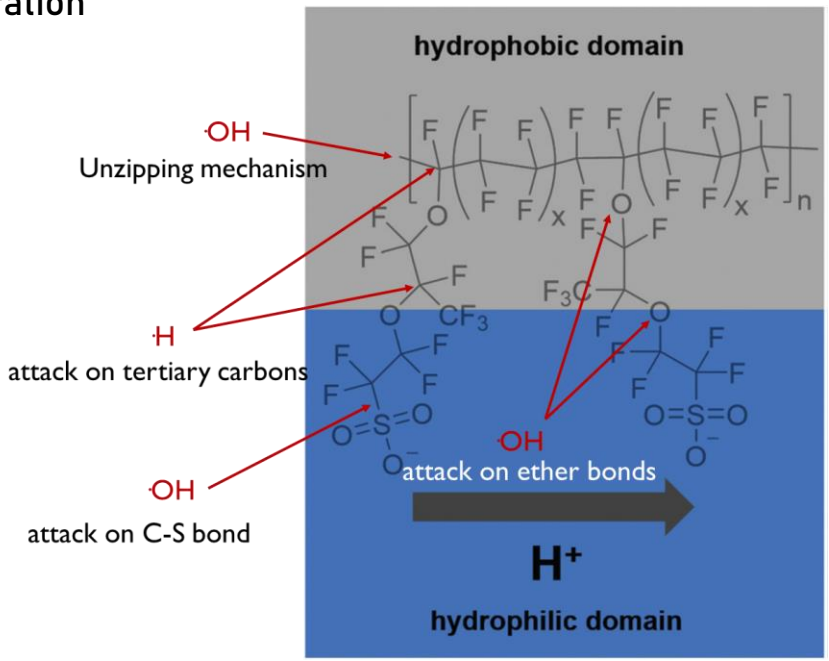
Pt dissolution and redeposition



Particle detachment and agglomeration



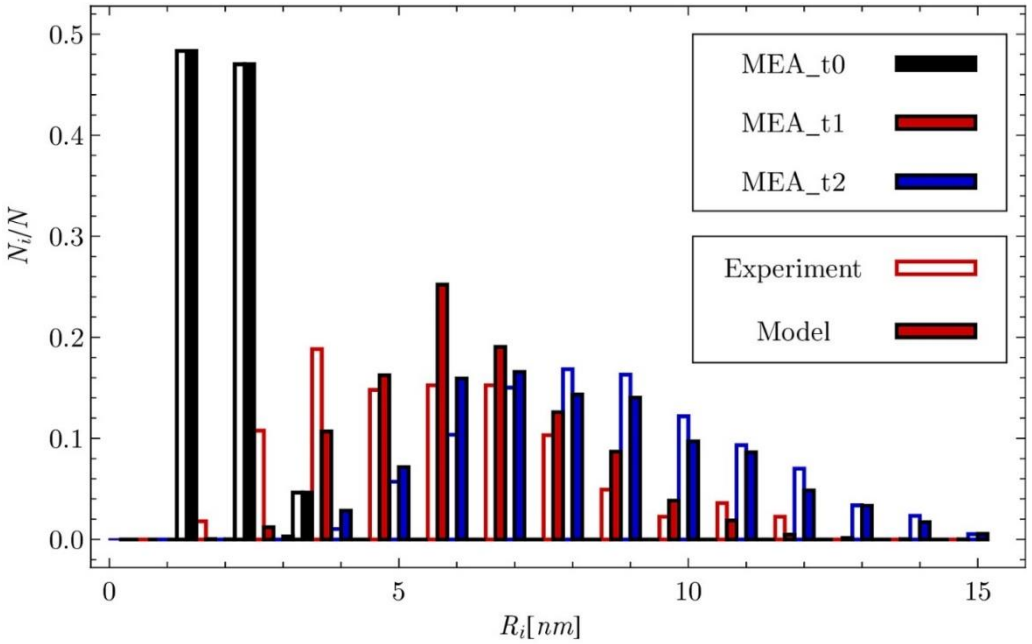
Chemical membrane degradation



Frühwirt P, Kregar A, Törring JT, Katrašnik T, Gescheidt G. Holistic approach to chemical degradation of Nafion membranes in fuel cells: modelling and predictions. *Phys Chem Chem Phys* 2020;22:5647–66. doi:10.1039/C9CP04986J.

KREGAR, Ambrož, … KATRAŠNIK, Tomaž. Temperature dependent model of carbon supported platinum fuel cell catalyst degradation. *Journal of power sources*, Dec. 2021, 514, 1-11, doi: 10.1016/j.jpowsour.2021.230542

Catalyst degradation



Experimental and modelled data of catalyst particle growth

KREGAR, Ambrož,... KATRAŠNIK, Tomaž. Applied energy. 2020, vol. 263, 17. https://www.sciencedirect.com/science/article/pii/S0306261920300593, DOI: 10.1016/j.apenergy.2020.114547

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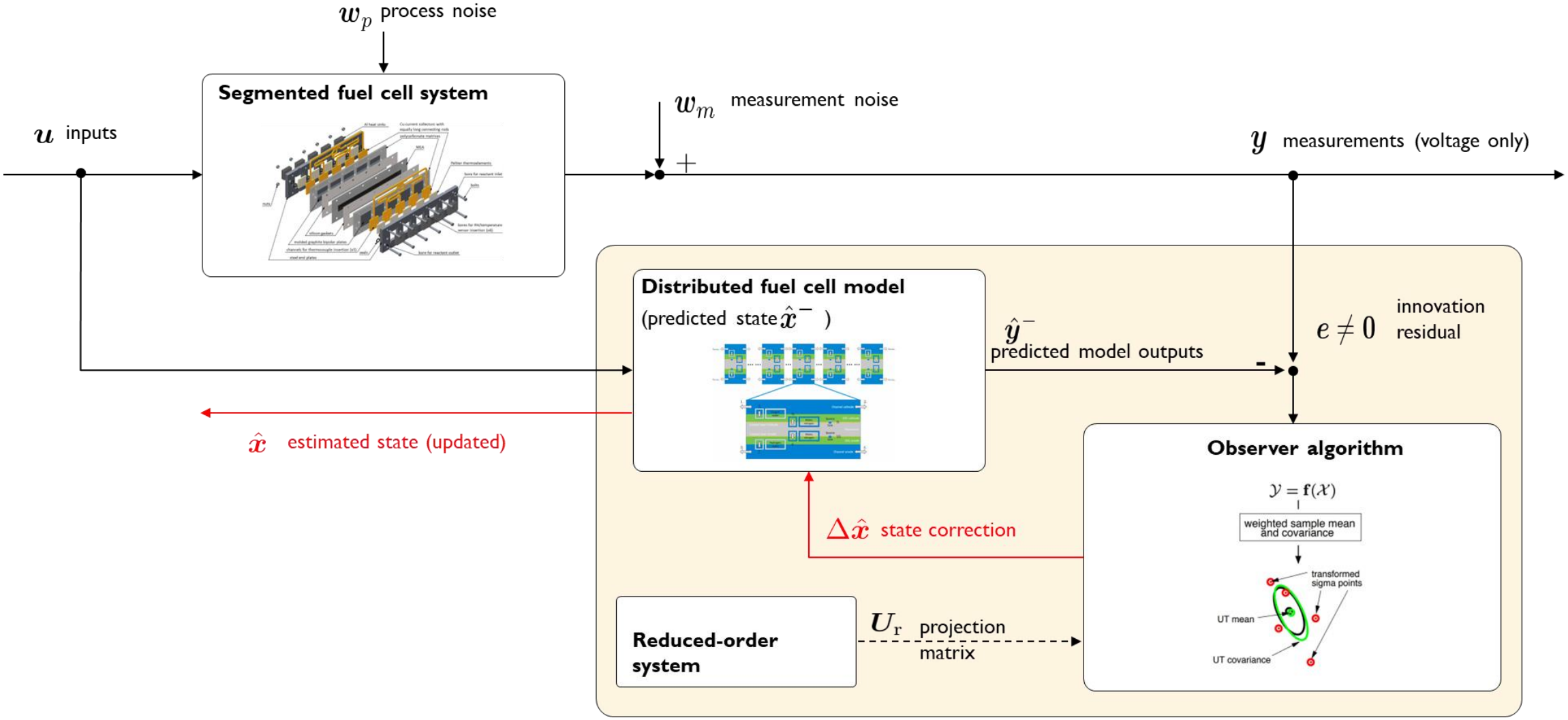
State observer: How it works (enablers for model based digital shadows and twins)



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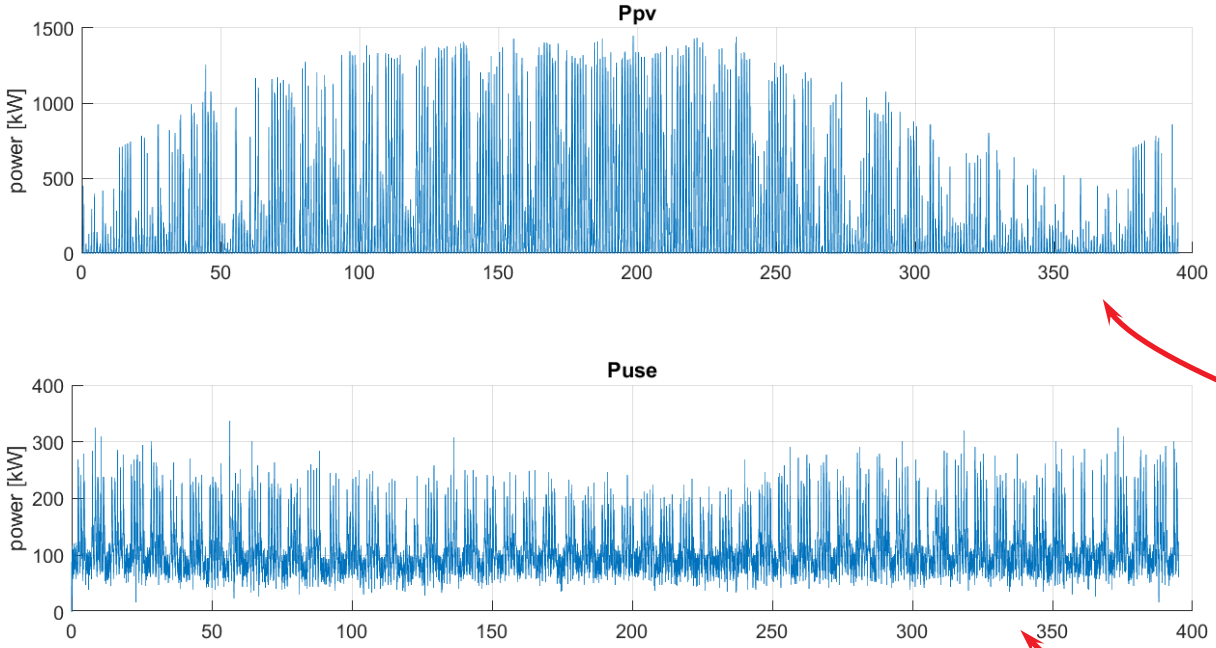
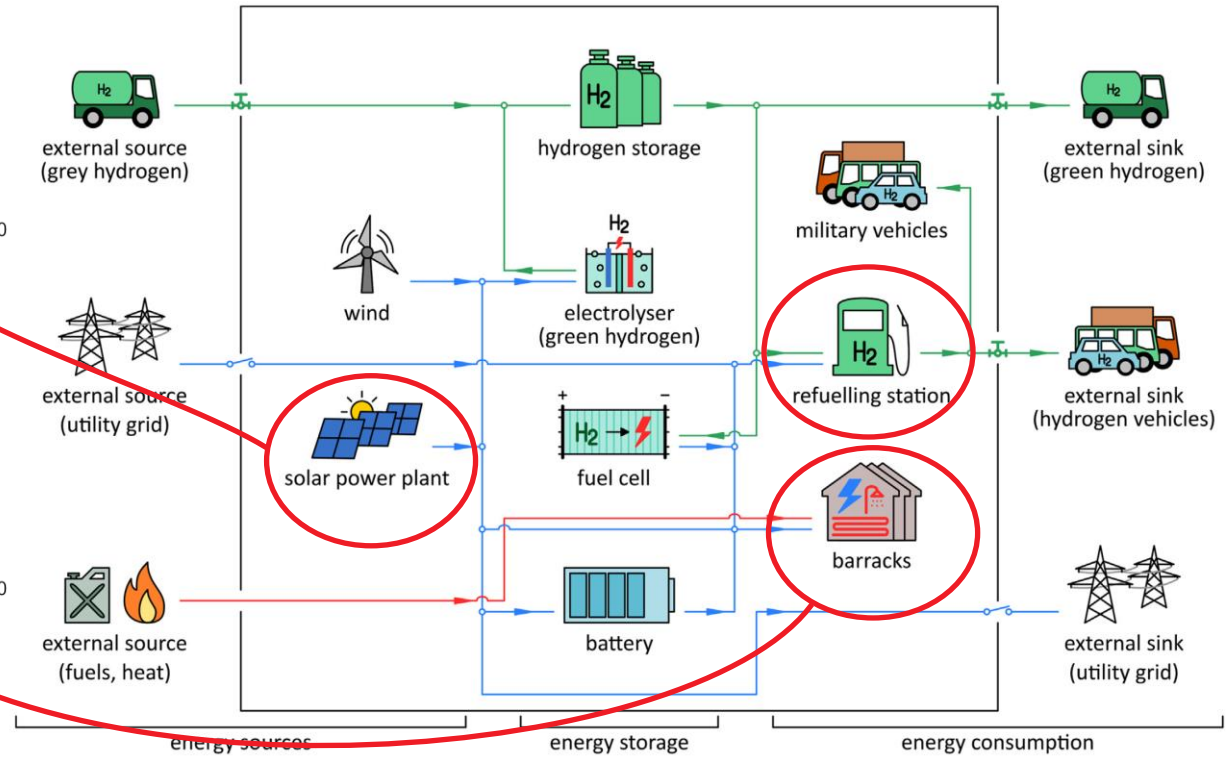
Advanced energy system





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Carbon footprint

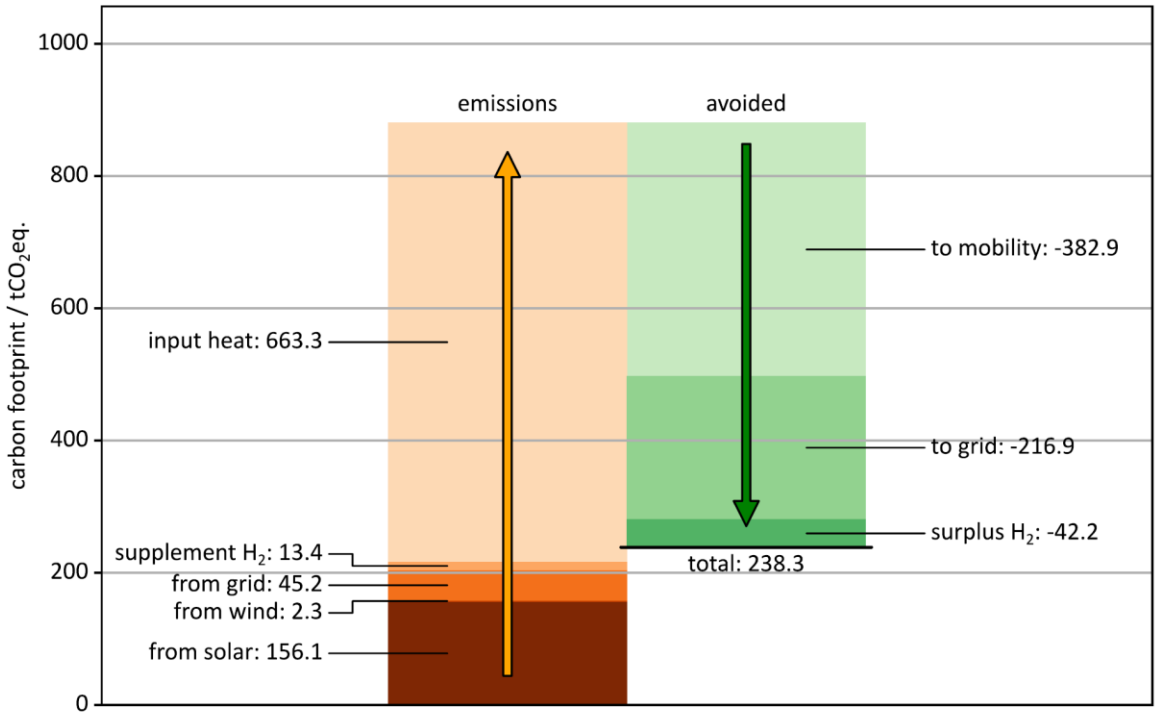
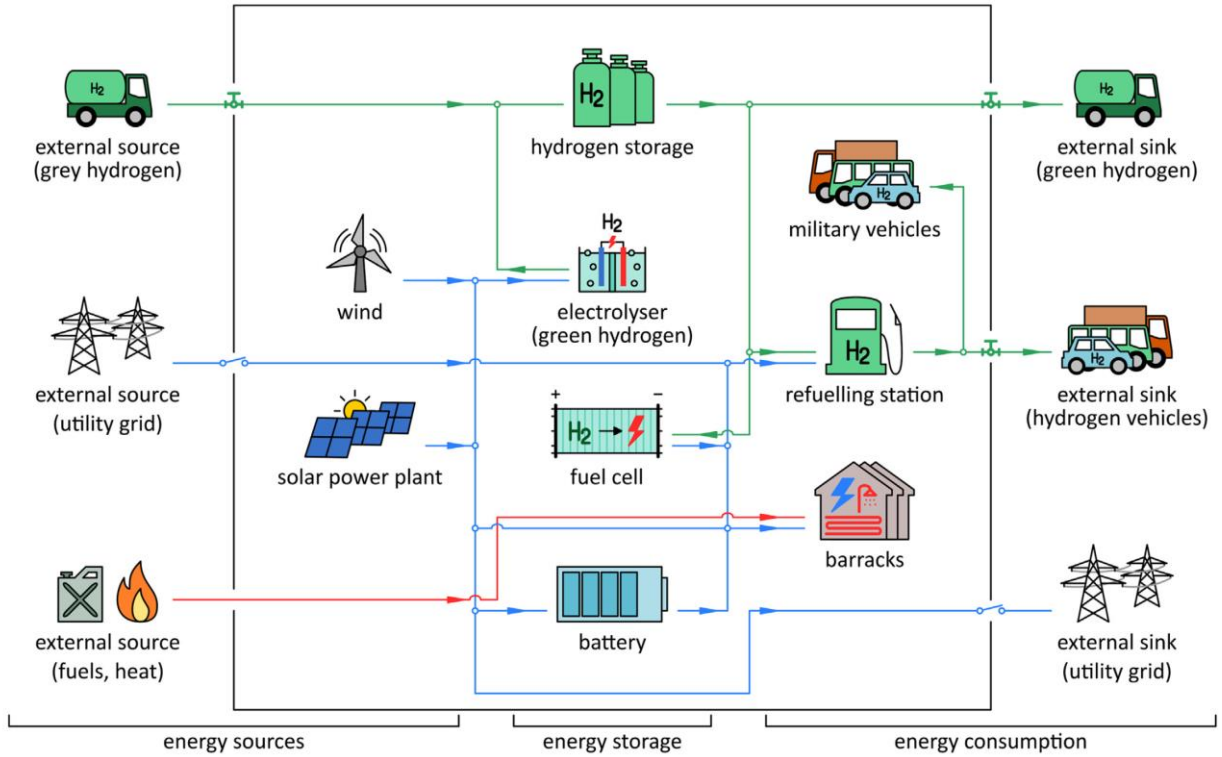


Fig. 9 – Carbon footprint of individual technologies.



Thank you for your attention