LEANCAT

Recent hydrogen history in our region
seen with our eyes,
with a look into the future

Presenter: Petr Seghman

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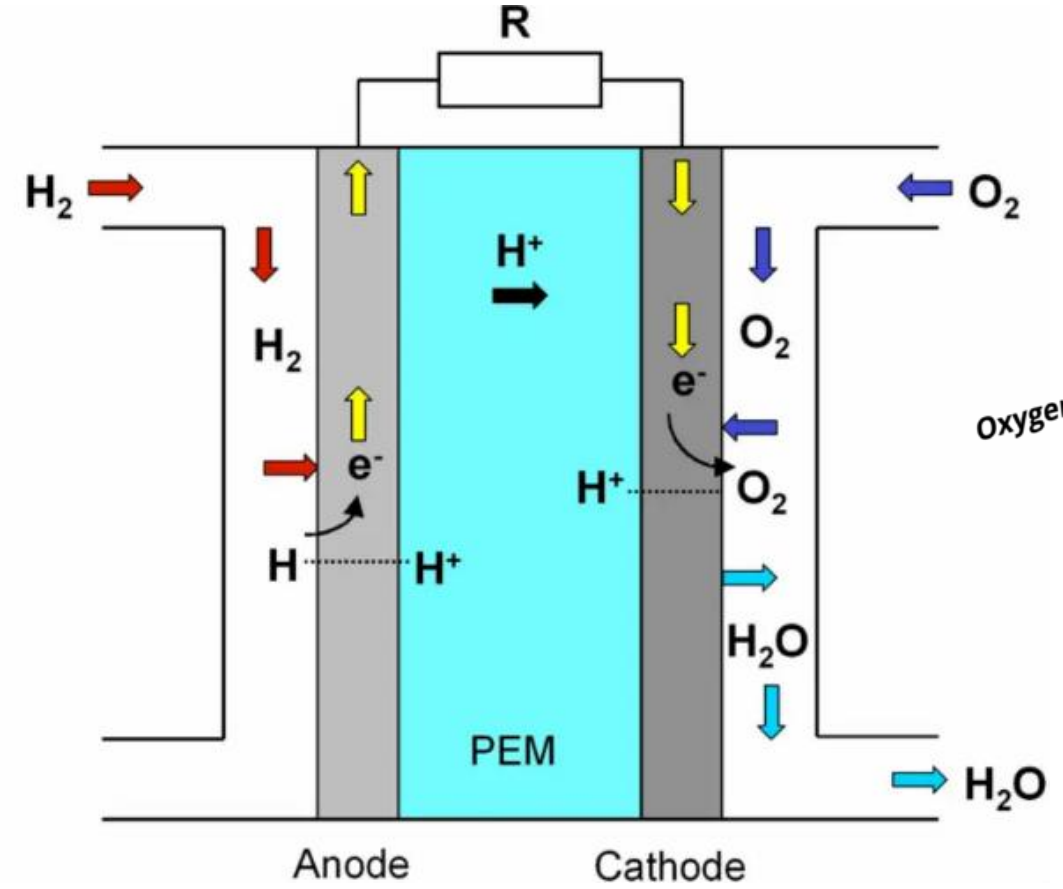
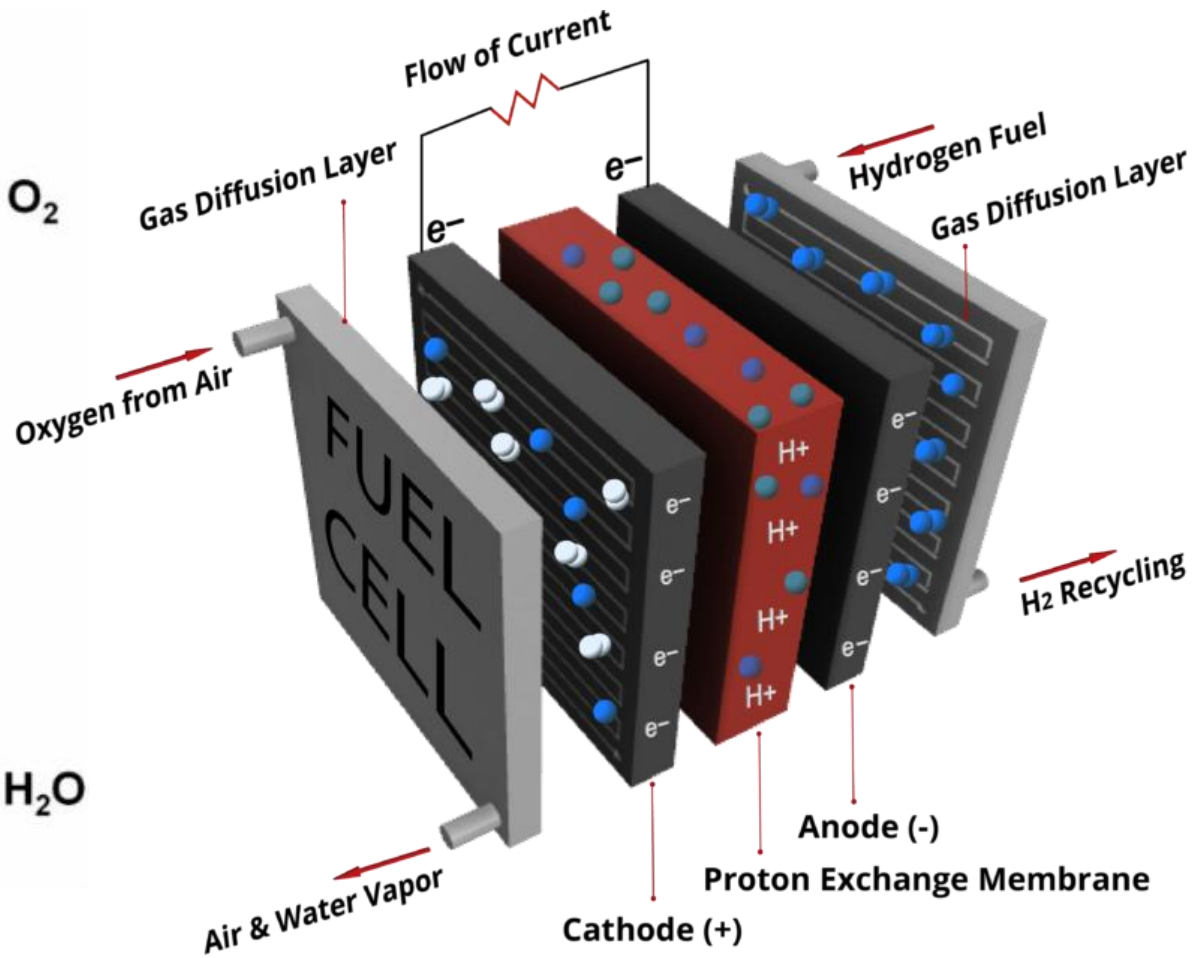
INTRODUCTION

- LEANCAT was founded in 2016
- Since then we witnessed a few shifts in hydrogen field
- Many shifts in company steering caused by industry situation

Let‘s revisit the journey!

FUEL CELL INTRODUCTION





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https://grz-technologies.com/wiki/fuel-cell-technology/
https://powerup-tech.com/the-abc-of-fuel-cells/

FOUNDING IN 2016

- Why the name – LEANCAT

  Lean catalyst: producing catalysts for fuel cells with low Pt consumption

- Prof. Vladimír Matolín‘s patented invention (MFF UK): lean catalysts
- Co-founder: Dalibor Dědek (Jablotron Group) -> application of the patent
- Market not ready for mass production where the savings would make (enough) sense
- Pivot: Let‘s help the industry in another way!
  - Focus on test stands

TEST STATION PRODUCTION IN 2017

- First station, with serial number TS1
  - Delivered end of 2016
  - PEM Fuel cell testing device
  - Customer: ESFR – European Synchrotron Radiation Facility
- Slowly growing interest in fuel cell testing
- Hydrogen trade fairs on the rise

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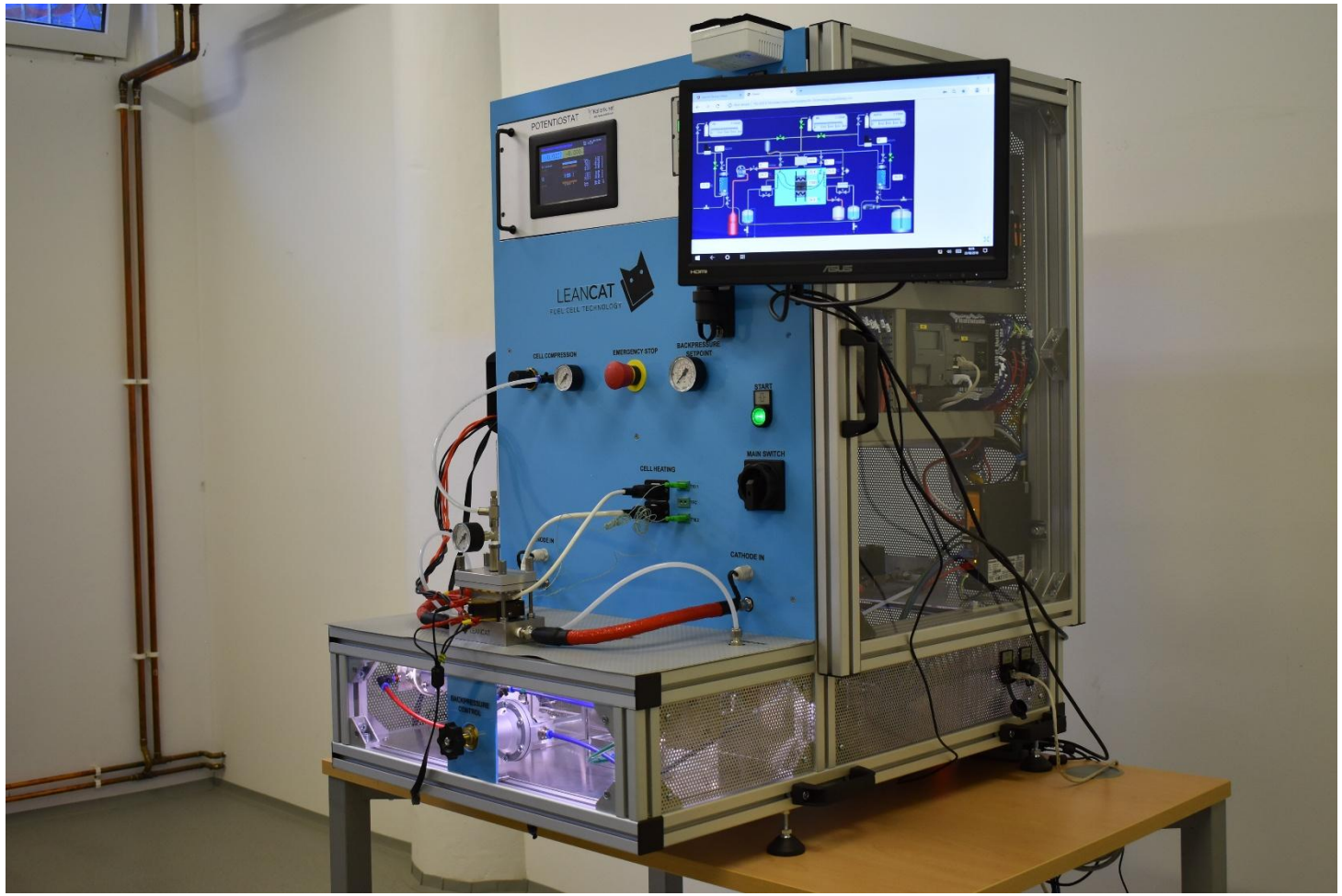

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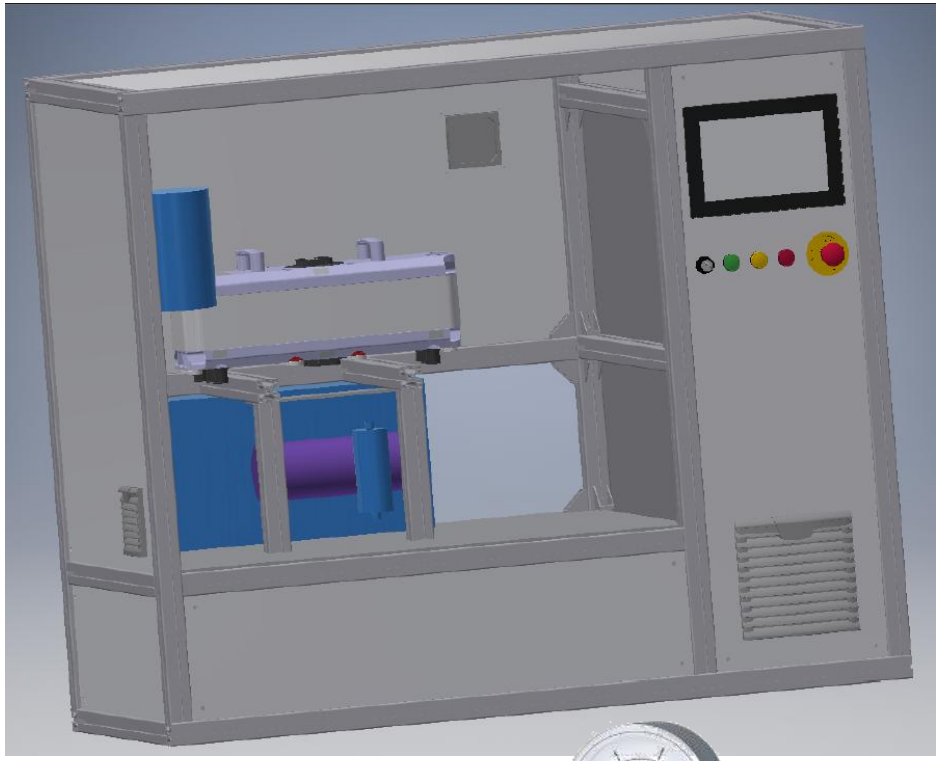
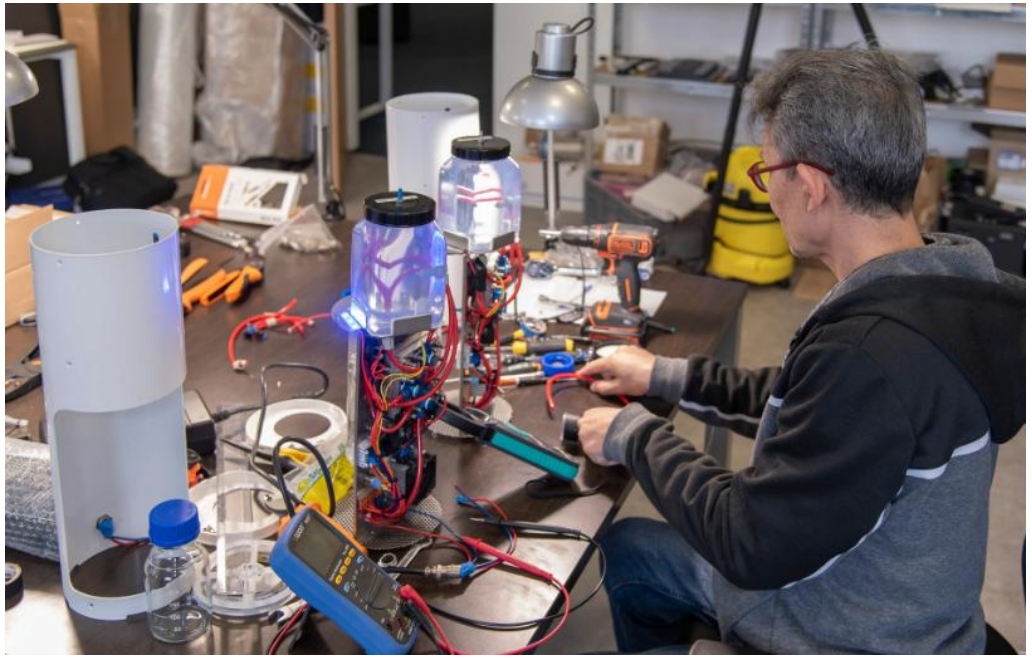
BRANCHING OFF ERA: 2017-2021

- Many hydrogen side-routes besides test benches:
  - Hydrogen powered fork-lift
  - „Hot-box“
  - Hydrogen bar (hydrogenized water)
- Company based on public funding and investments, many dead-ends
- Industry torn, many weird „prodigical“ projects, many H_2 prophets





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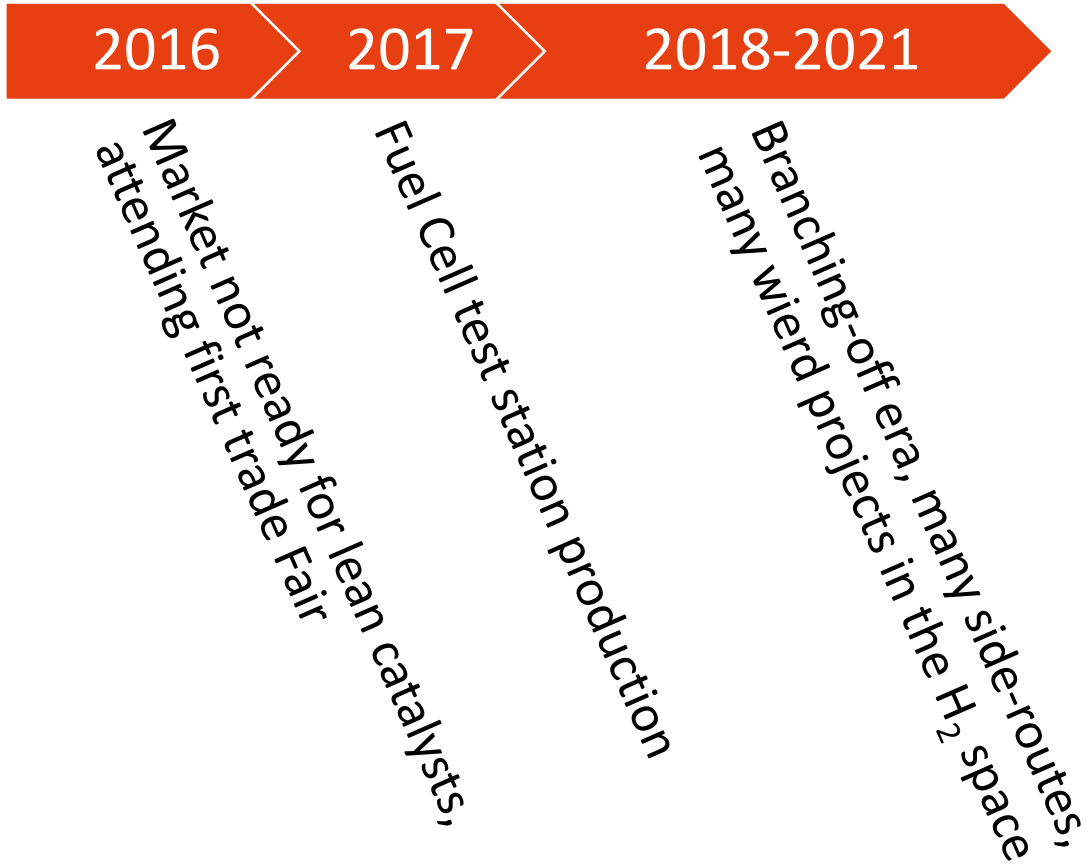
TIMELINE



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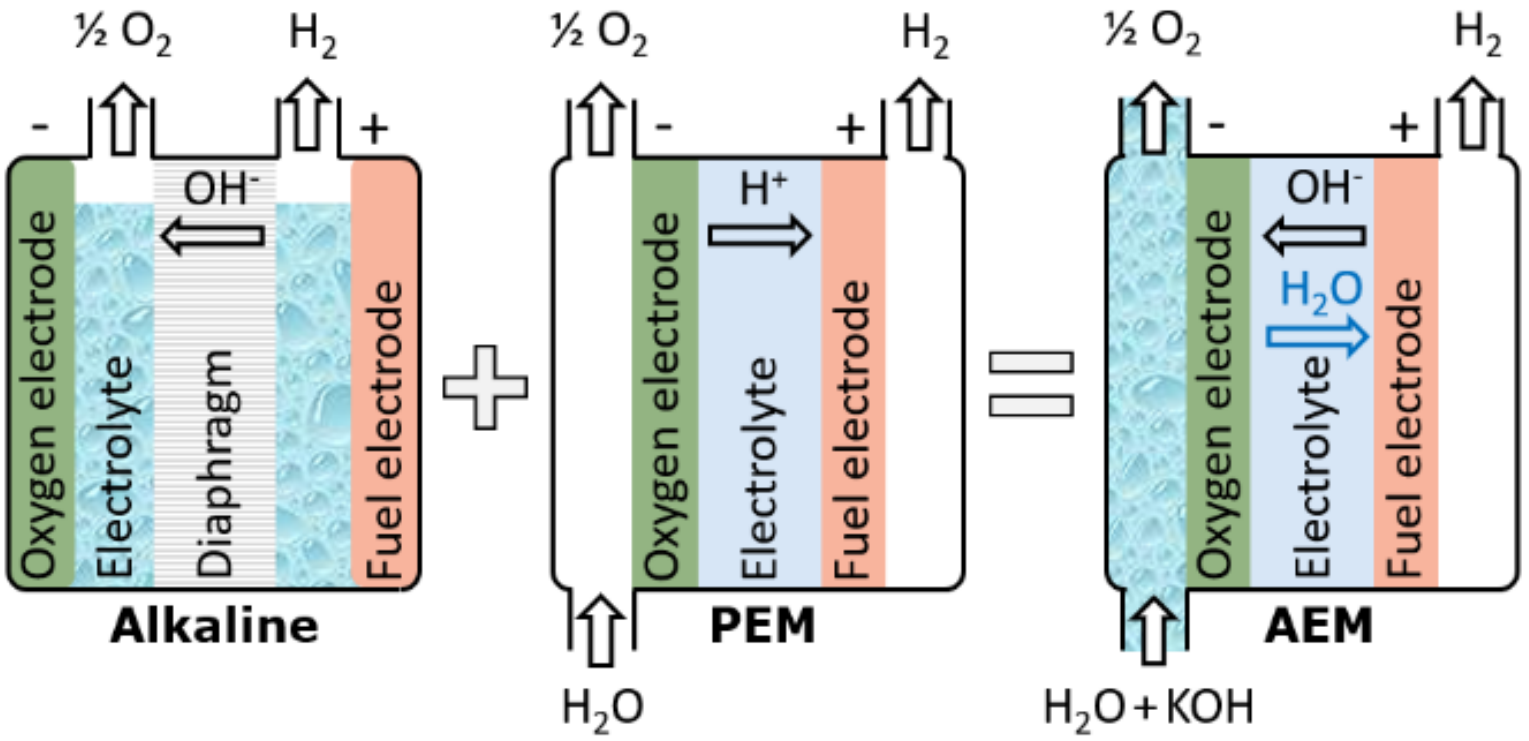
ELECTROLYSIS INTRODUCTION



https://ammoniaenergy.org/articles/technology-status-anion-exchange-membrane-aem-electrolysis/https://powerup-tech.com/the-abc-of-fuel-cells/

2022: PEM electrolyzers on the rise!

- First requests about Electrolyzer test benches appear
- Requests and funding for PEM electrolyzers developement
  - LEANCAT starting its own developement of small PEM electrolyzer
  - Initial designation: medical industry
  - LEANCAT starts developing its own TS for electrolyzers: Its first EMT (to be rebranded later to ETS)
- First mentions of AEM electrolysis as well

TIMELINE

Market not ready for lean catalysts, attending first trade Fair

Fuel Cell test station production

Branching-off era, many side-routes, many wierd projects in the H_2 space

PEM electrolysis: the new GOAT!

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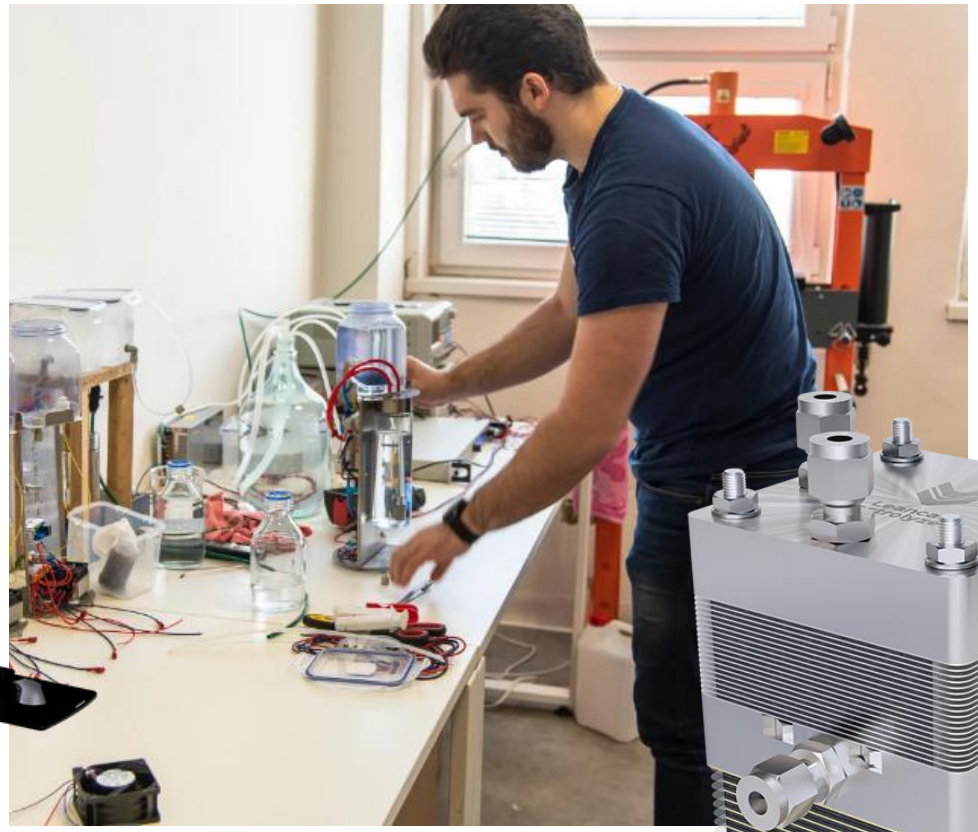
2023: PEM fuel cells: Stretching the limits

- Fuel cells renaissance
  - Cumulation of requests for PEM FC testing
  - Extreme, specific conditions and requests (impurities, temperatures…)
  - Restarted production of PEM FC test stands: PTS family
- Along with that, the electrolysis wave still strong
  - PEM electrolyzer developement
  - Multiple electrolyzer test stand leads
- Home backup systém
- Electrolyzer as a heart of a device: H_2 generators



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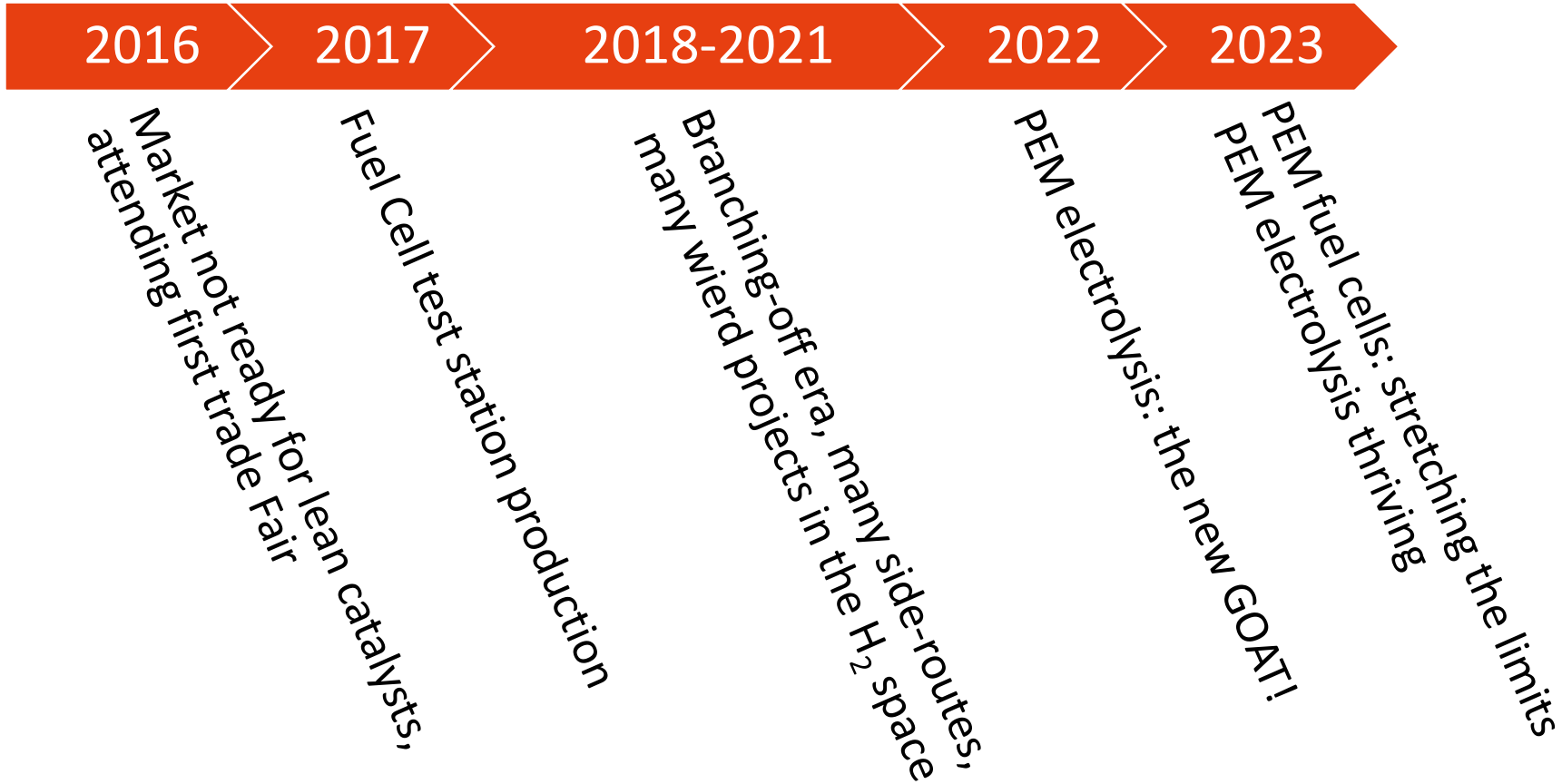
TIMELINE



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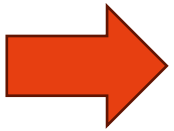
2024: TEST STATIONS vs. APPLICATION

- Year of important descision: Test stations or Electrolyzers?



Both, but separately

- Splitting of Leancat Electrolyzers s.r.o. from LEANCAT
- LC-WE: production of stacks, generators, integration…
- LC: production of only test stations and test equipment
  - Additional manufacturing capacity in Interkov
  - Consolidation of expenses
  - Process optimization

Manufacturing Facility

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2025: COMPANY GROWTH

- More than 70 test stations since 2016

- Divestment of LEANCAT ELECTROLYZERS
- Number of employees drops from 23 to 15
- Jablotron's exit, Jakub Matolin owns 80% of LEANCAT
- Production outsourced to Interkov
- New ERP, Integration of EPLAN and Autodesk

- Delivery of first ETS-1
- First distributors

- Beginning of LEANCAT founded by prof. Matolin
- Collaboration between academia and industry

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Electrolyzer Test Stations

ETS-1
1 kW

ETS-10
10 kW

ETS-100
?

?

But we are ready!

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Fuel Cell Test Stations

PTS-1
100 W

PTS-10
1 kW

PTS-100
10 kW

PTS-500
50 kW

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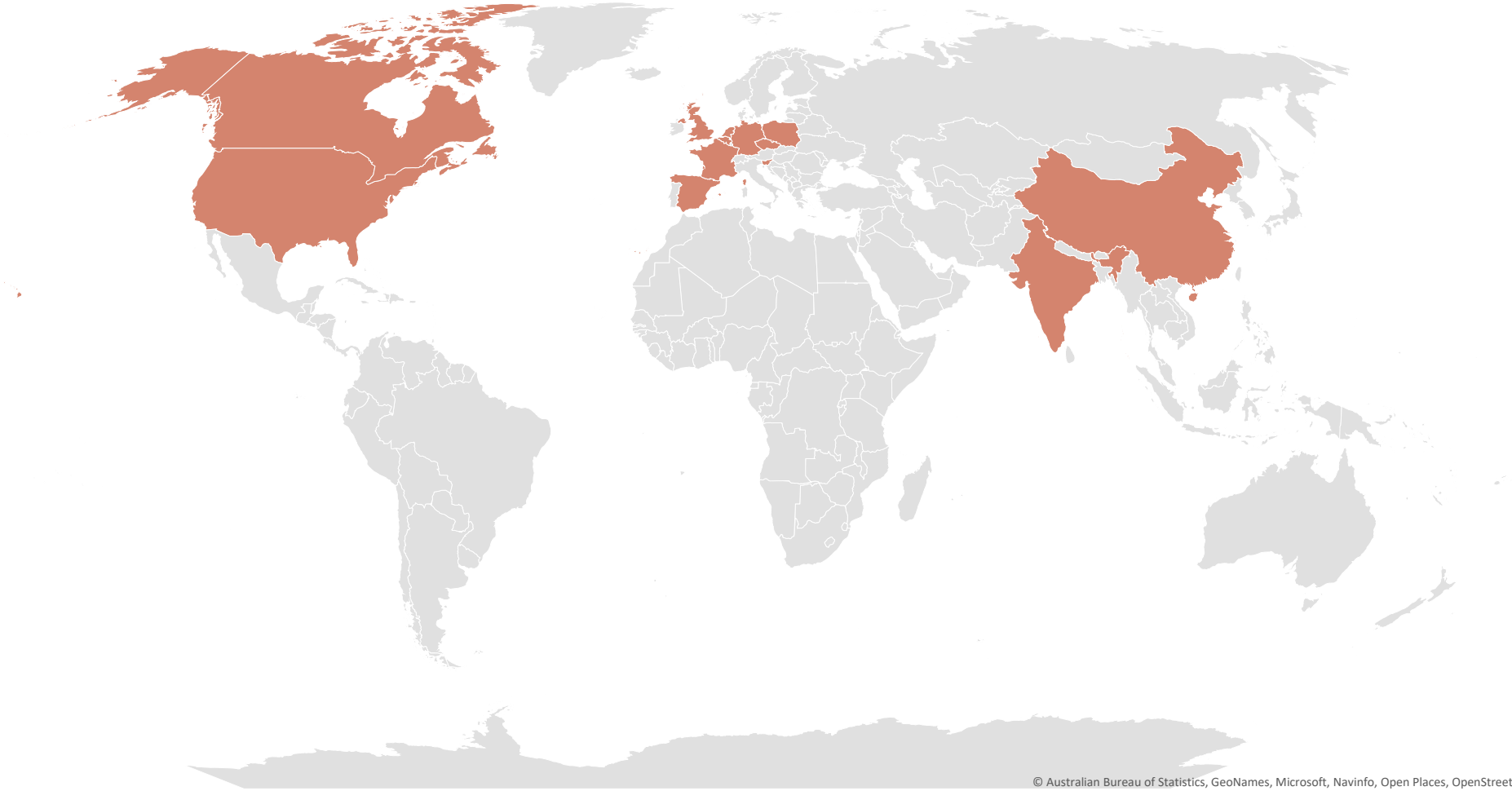
LEANCAT test stations



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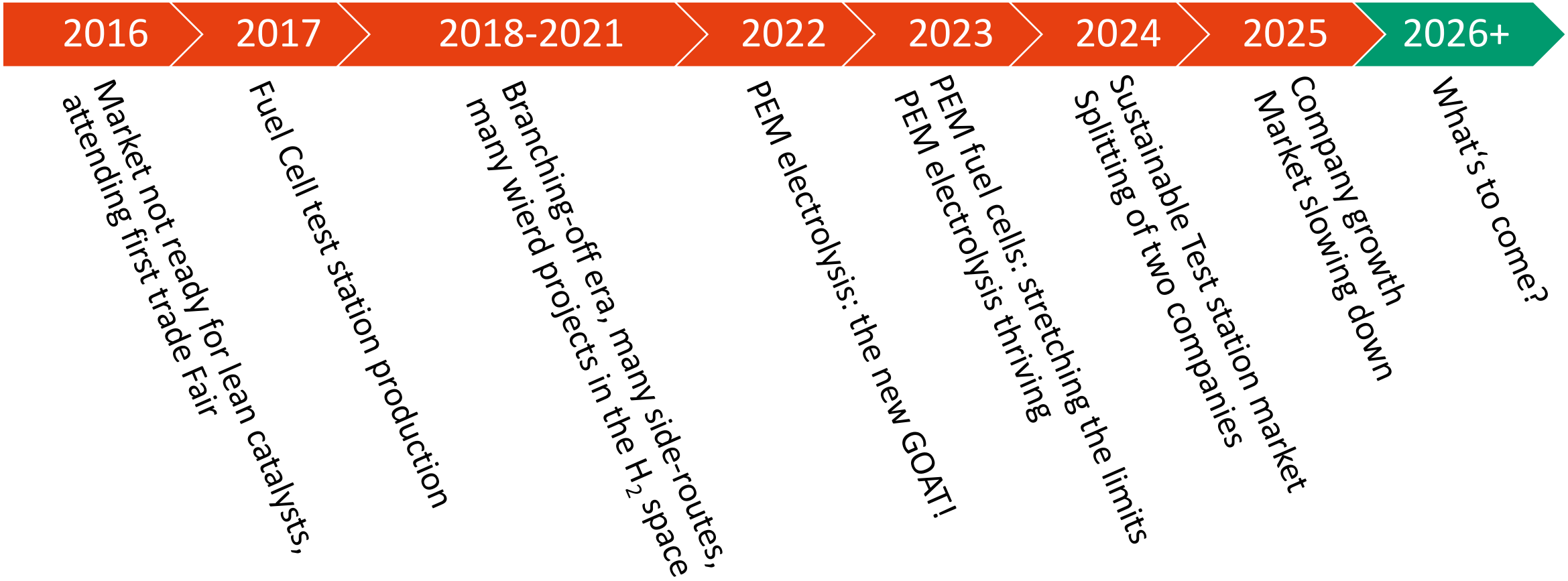
TIMELINE



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2026 and BEYOND: requests, trends

- Electrolyzer test stations:
  - High pressure on anode – up to **120 °C PEM**
  - Higher KOH concentrations > 1 M for AEM
  - Introduction of catalytic poisons (CO, H2S, NH3, H2 mixture on anode)
  - Fully Fe-free (iron-less) stations for AEM due to impurities in KOH
  - Multi-line simultaneous testers for 5+ parallel cells
  - High-current/High voltage EIS (Electro-Impedance Spectroscopy)

For some, probably the most interesting slides…

2026 and BEYOND: requests, trends

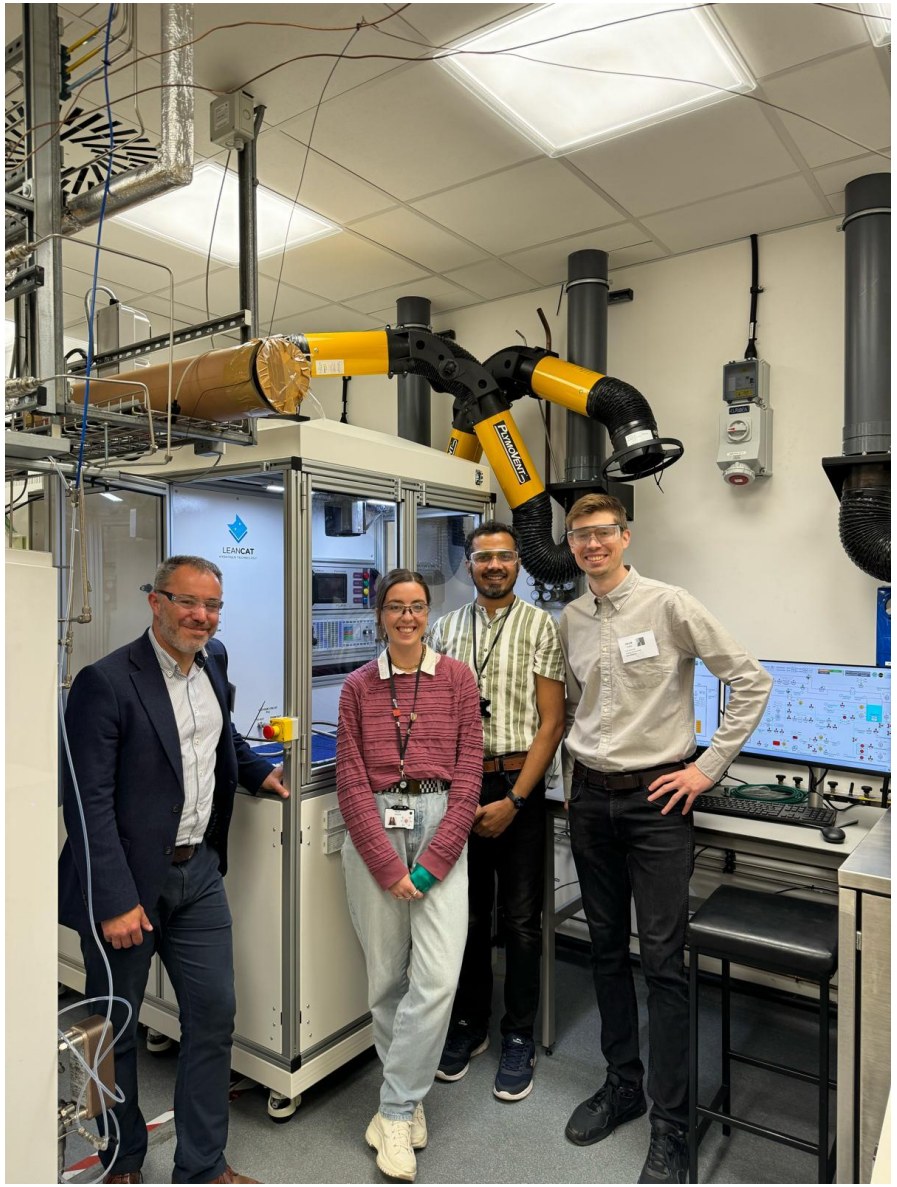
- Fuel cell test stations:
  - Oxidant composition control: O_2-to-N_2 ratio (-> altitude)
  - Quick humidity controls: simulation of water depletion
  - High temperature fuel cells (Asian market): > 180 °C
  - High dewpoint temperature
    (above 120 °C, record to be build in 2026: **150 °C!**)
  - DUT conditioning: High temperature cooling circuits (120 °C)

References

- Technical University in Chemnitz (DE)
  - Delivered 04/2022
  - PEM Fuel Cell Test Station
  - Max. power 20 kW
  - Dynamic humidification (mixing of 3 gas lines)
  - High current up to 1200 A
  - Contamination module for the testing of poisoning gases

References

- National Physical Laboratory (UK)
  - Delivered 05/2024
  - PEM/AEM electrolyzer test station
  - Max. power 1 kW
  - Pressure rating up to 50 bar
    - Both anode and cathode
  - Advanced analytics, sensors for pH, conductivity, H2 in O2, O2 in H2



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Other references

- PTS:
- Technical university of Liberec
- Polytechnique Montréal
- Imperial College London
- University of Freiburg
- University of Braunschweig
- Tianjin University
- Gdansk University of Technology
- Instituto Technológico de la Energía

- ETS:
- Technical University of Ostrava
- Centro Tecnológico de Eficiencia y Sostenibilidad Energética
- University of Poitiers

References in academia

- 1. Energies, 16(14), 5434. https://doi.org/10.3390/en16145434
- 2. ECS Transactions, 80(8), 225. https://doi.org/10.1149/08008.0225ecst
- 3. ECS Transactions*, 80(8), 839. https://doi.org/10.1149/08008.0839ecst
- 4. Journal of Applied Crystallography, 53(4), 546. https://doi.org/10.1107/s1600576720005464
- 5. Energies, 16(14), 5434. https://doi.org/10.3390/en16145434
- 6. Charles University: https://dspace.cuni.cz/handle/20.500.11956/175729
- 7. SSRN Electronic Journal, https://doi.org/10.2139/ssrn.4720420
- 8. SSRN Electronic Journal, https://doi.org/10.2139/ssrn.4788947
- 9. Rhine-Waal University, https://opus4.kobv.de/opus4-rhein-waal/frontdoor/index/index/docId/773
- 10. SIMON FRASER UNIVERSITY, https://core.ac.uk/download/pdf/269020373.pdf
- 11. Leibniz University Hannover, https://www.repo.uni-hannover.de/bitstream/handle/123456789/12762/220805_Dissertation_Pablo_Radici.pdf?sequence=1&isAllowed=y
- 12. Journal of Power Sources, 2019, 226906. https://doi.org/10.1016/j.jpowsour.2019.226906
- 13. EPJ Web of Conferences, 264, 01026. https://doi.org/10.1051/epjconf/202226401026
- 14. International Journal of Hydrogen Energy, 2018, 12.206. https://doi.org/10.1016/j.ijhydene.2018.12.206
- 15. International Journal of Energy Research, 2019, 5245. https://doi.org/10.1002/er.5245
- 16. International Journal of Hydrogen Energy, 2019, 05.186. https://doi.org/10.1016/j.ijhydene.2019.05.186
- 17. International Journal of Hydrogen Energy, 2019, 04.216. https://doi.org/10.1016/j.ijhydene.2019.04.216
- 18. Journal of Power Sources, 2023, 232904. https://doi.org/10.1016/j.jpowsour.2023.232904
- 19. Journal of Materials Chemistry A, 2023, 27.20a. https://doi.org/10.1039/d3ta02720a
- 20. Journal of Materials Chemistry A, 2023, 27.20a. https://doi.org/10.1039/d3ta02720a
- 21. Journal of Materials Chemistry A, 2023, 58.27a. https://doi.org/10.1039/d3ta05827a

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Thank you for attention!

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