Human Centered Energy Efficiency

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EFFEREST has received funding from the European Union's Horizon Europe research and innovation programme under Grant Agreement No. 101138266.

Funded by the European Union

Motivation

Publicly perceived limitation of electric vehicle

The New York Times

Electric Car Owners Confront a Harsh Foe: Cold Weather

In freezing temperatures, the batteries of electric vehicles can be less efficient and have shorter range, a lesson many Tesla drivers in Chicago learned this week.

auto motor sport

ELEKTROAUTOS IM WINTER

E-Reichweite bricht teils um die Hälfte ein

Der ADAC hat Verbräuche und Reichweiten von 15 Elektroautos bei Minusgraden getestet – die Ergebnisse sind teilweise ernüchternd. Nur wenige Modelle schlagen sich im Winter besser als erwartet.

Markus Schönfeld

Veröffentlicht am 18.01.2024

Foto: Volkswagen AG

ADAC Mitgliedschaft Reise & Freizeit Rund ums Fahrzeug Versicherungen & Finanzen Services Verkehr Der ADAC

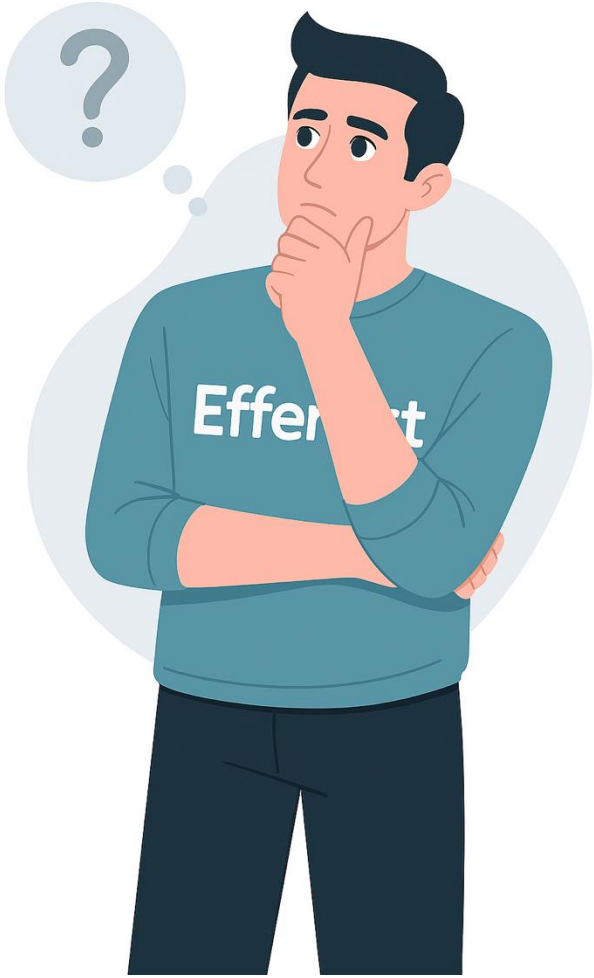
Elektroauto im Winter: So sinken die Reichweiten bei Eis und Schnee

20.11.2024 • Lesezeit: 10 Min.

Im Video: Bloggerin Marie und ADAC Experte Matthias Vogt über E-Autos im Winter • Bild: © ADAC, Video: © ADAC e.V.

Im Winter benötigen Elektroautos deutlich mehr Energie als im Sommer. Doch wieso eigentlich? Und wie kann man den Energieverbrauch optimieren? Erklärungen, Messwerte, praktische Tipps.

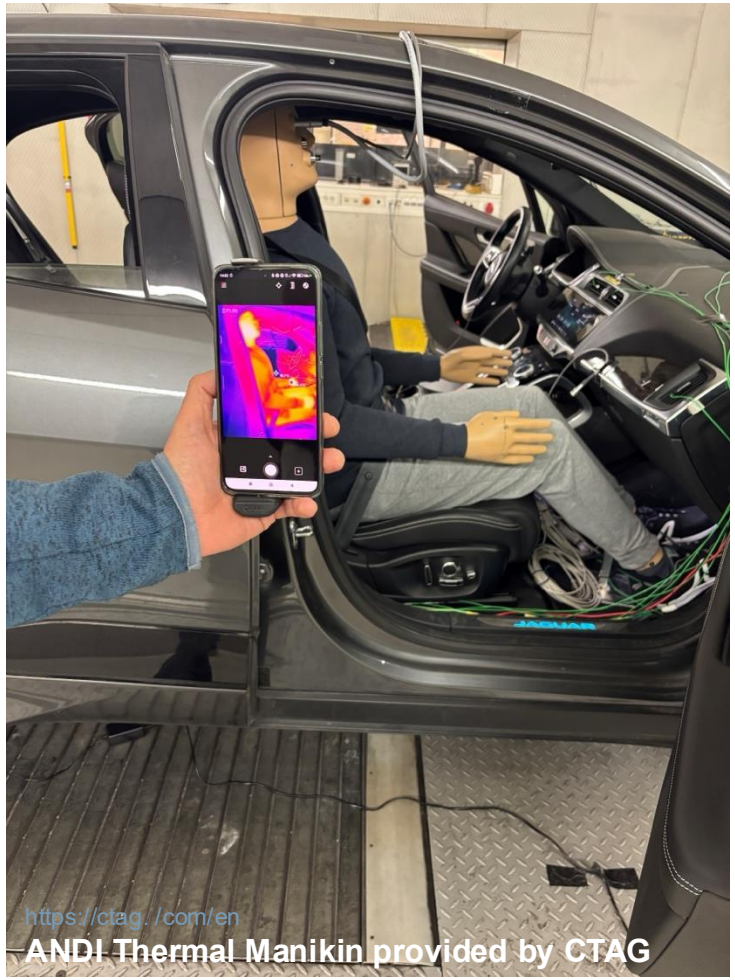
- **Heizung für Batterie und Innenraum zehren am Akku**
- **Auf Kurzstrecken 70 Prozent mehr Verbrauch**



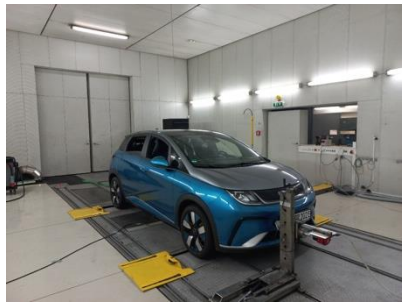
Source: https://www.auto-motor-und-sport.de/tech-zukunft/alternative-antrieb e/elektroauto-reichweite-bei-kaelte-test/
https://www.adac.de/rund-ums-fahrzeug/elektromobilitaet/laden/elektroauto-reichweite-winter/
https://www.nytimes.com/2024/01/17/business/tesla -charging-chicago-cold-weather.html

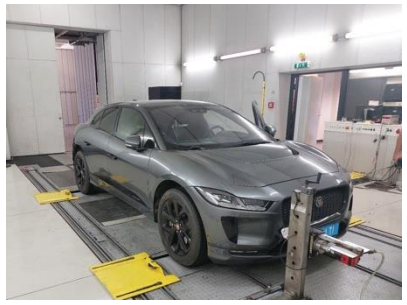
Start with: WHY?

Benchmark tests for efficiency and thermal comfort on MAGNA chassis dyno:



ANDI Thermal Manikin provided by CTAG





Magna Engineering Center Steyr
https://www.magna.com/products/complete-vehicles/commercial-vehicle-engineering

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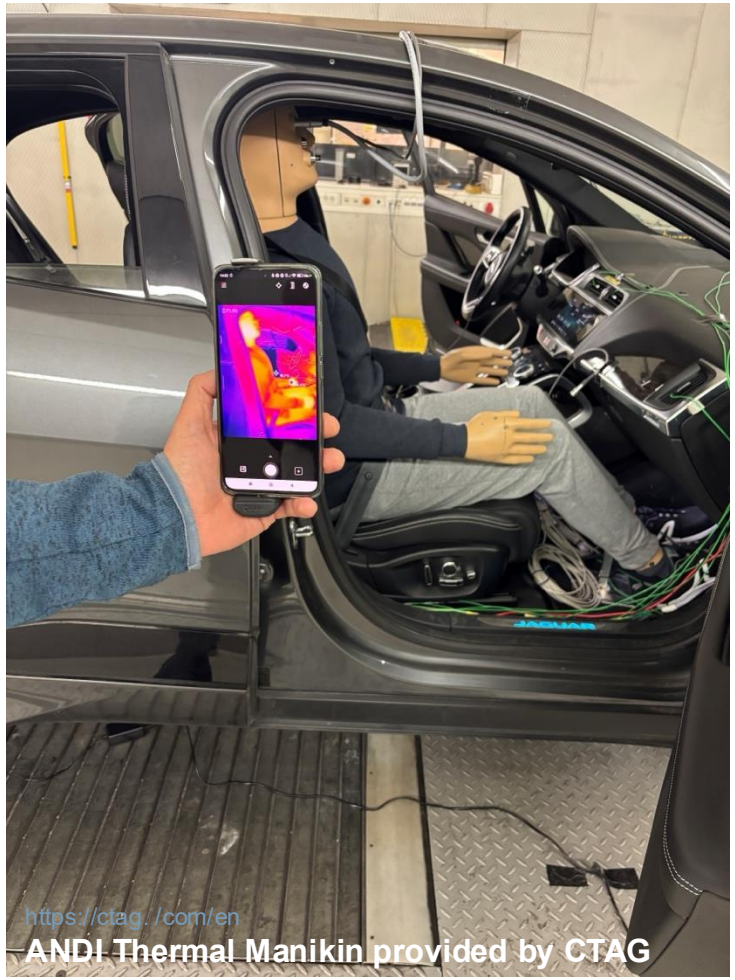

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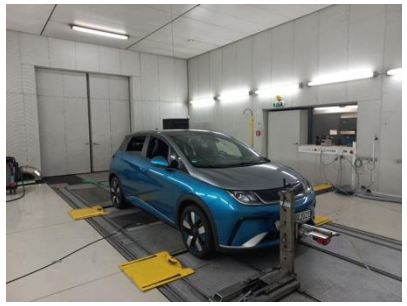
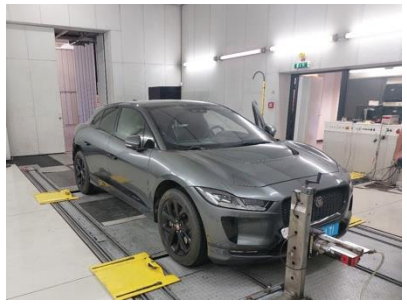


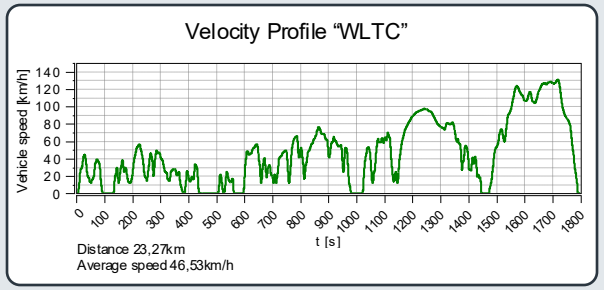


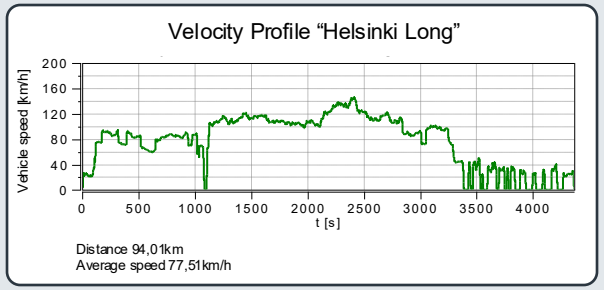
Magna Engineering Center Steyr
https://www.magna.com/products/complete-vehicles/commercial-vehicle-engineering

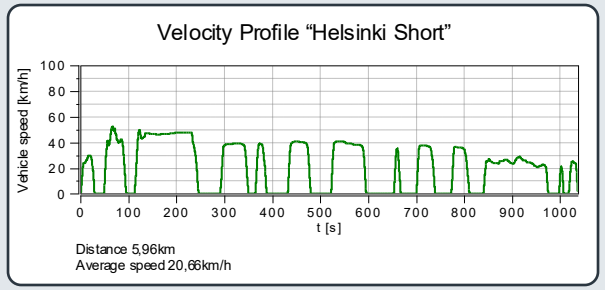
Benchmarking @ MAGNA Engineering Center Steyr

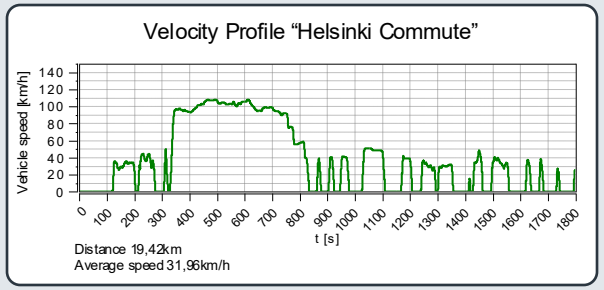
Chassis-dynamometer tests:

- 3 representative cycles from BOSCH and WLTC tested
- Tests in 0 °C, 20 °C and 35 °C ambient temperature conditions
- Cold start for all tests (vehicle soaked in ambient conditions)
- Same HVAC/cabin settings (22 °C Auto, no auxiliary heating)



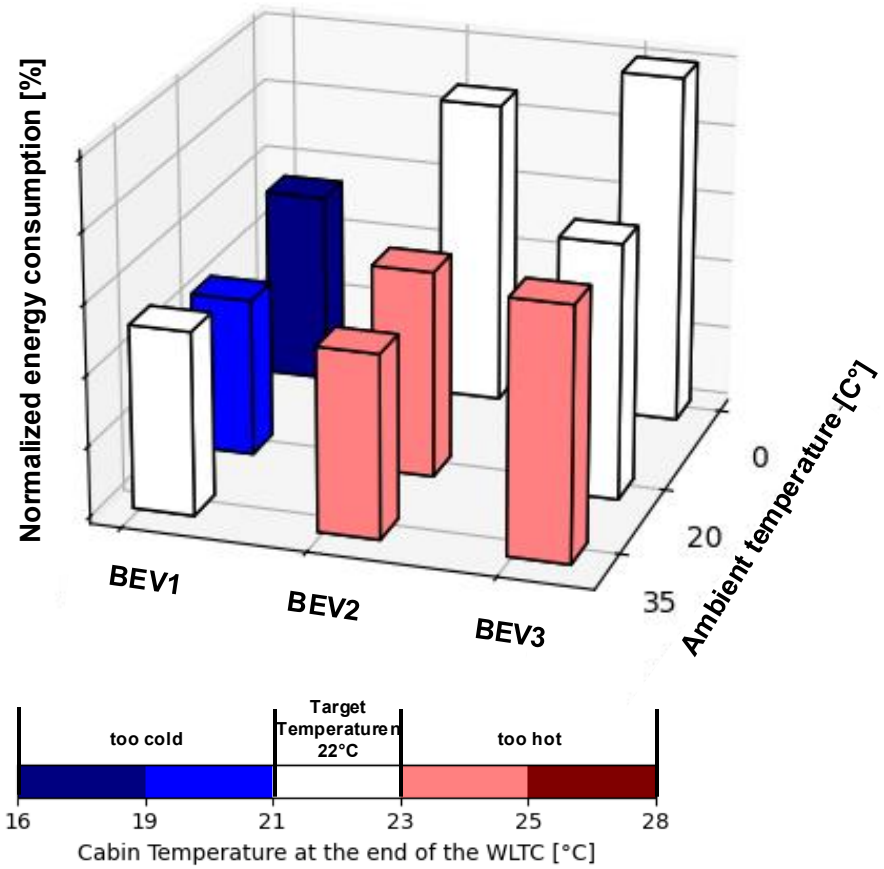






Key Findings

WLTC Comparison of 3 Benchmarked BEVs:



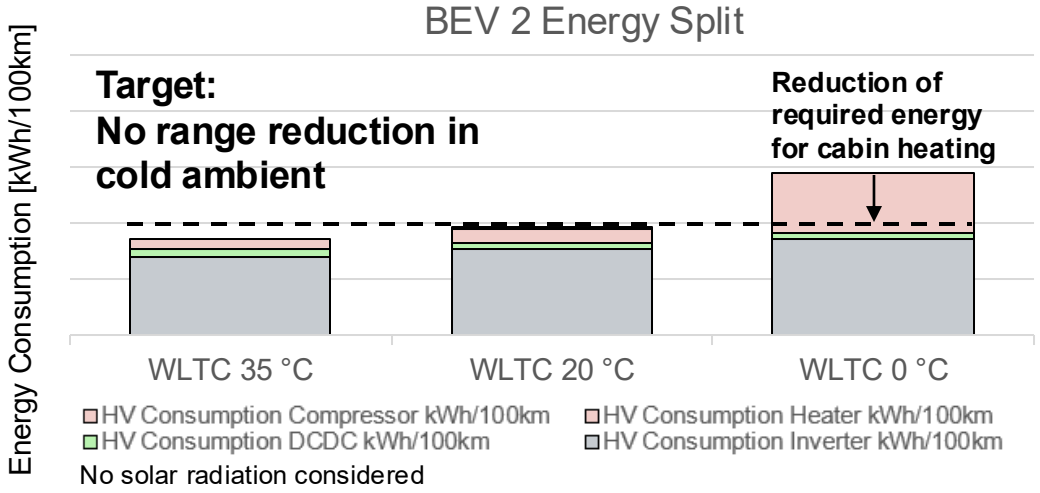
Key Findings:

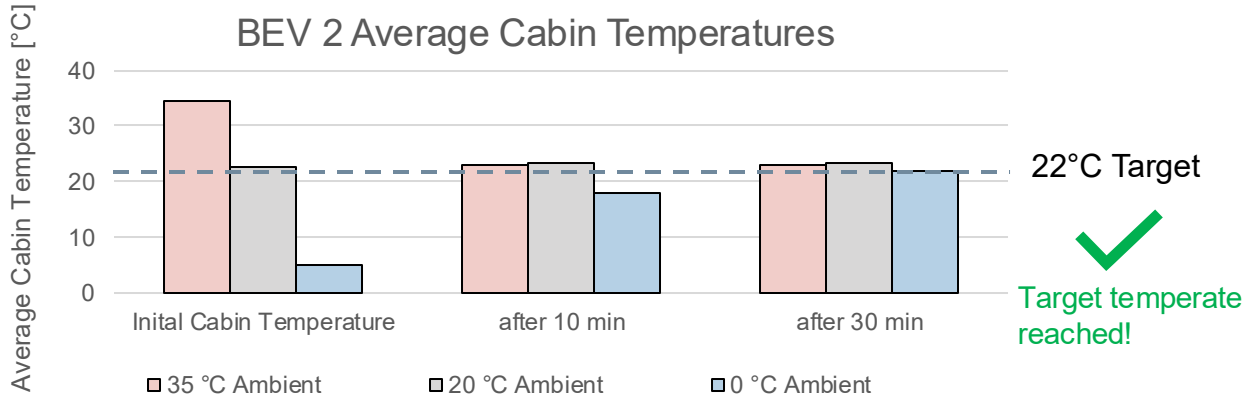
- **BEV1** has low baseline energy consumption (lighter vehicle), with minimal variation across ambient conditions → stable range
- **BEV1** limits heating → cabin stays up to 4 °C below target
- **BEV2 & BEV3** reach target temperature, but with higher energy use
- At 20 °C ambient temperature:
  - **BEV2 & BEV3** reheat cabin air to maintain comfort
  - **BEV1** mainly cools → results in lower cabin temperatures

Significant differences in thermal management strategies identified

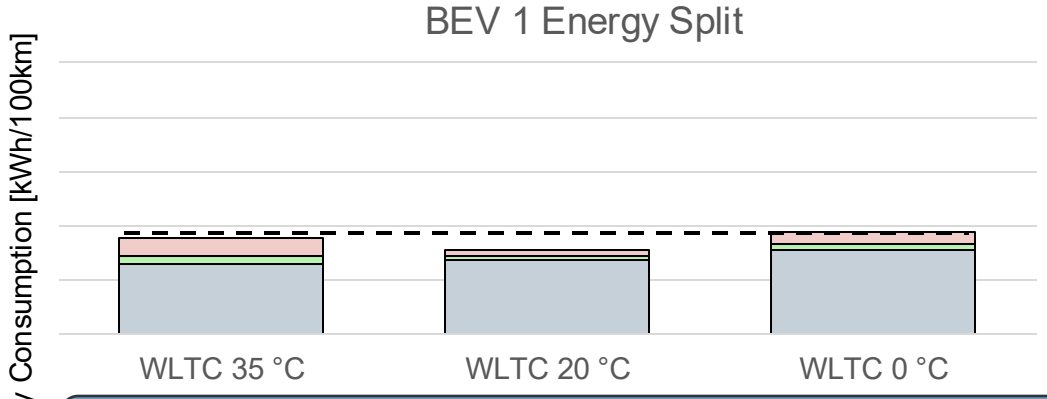
A closer look at the findings

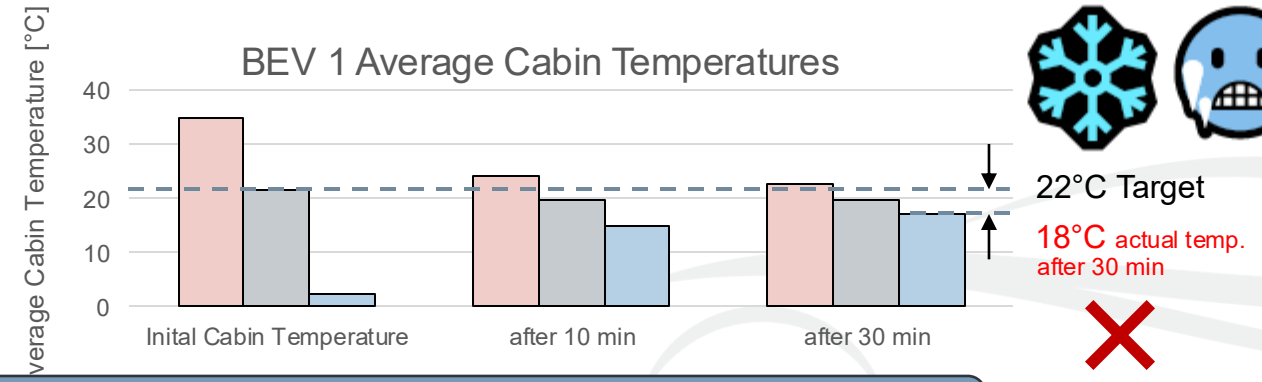
Results of BEV 2: Winter range reduced by 33%





Results of BEV 1: Issue already addressed by BEV 1





Consistent range, but compromised driver comfort → better solution required!

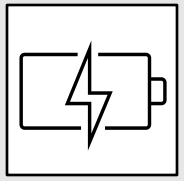
Optimization Domains to overcome thermal challenges

Vehicle Thermal Management (VTM) Hardware

Cabin system
- Heating, ventilation and air conditioning
- Heating Panels
- Seat/Steering Wheel Heating

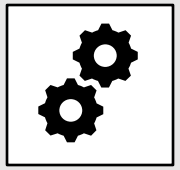
Thermal system
- Refrigerant circuits
- Coolant circuits
- Heat Management

Electric Drive Unit (EDU) cooling system

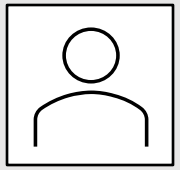


Battery conditioning system

Holistic control software



Holistic control of all inter-system functions



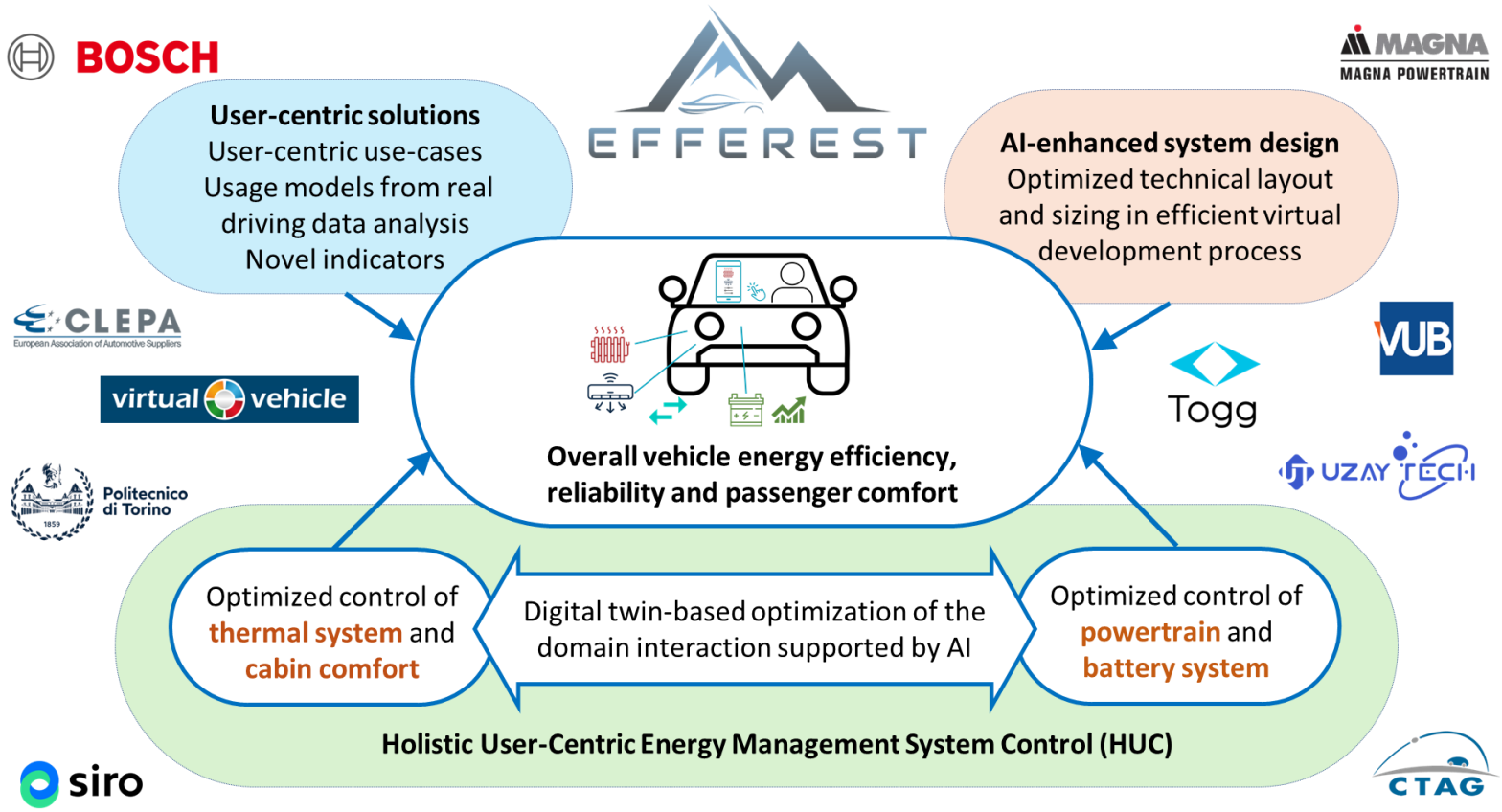
User-Centric Adaptions

Predictive Algorithms

Synergetic Optimization of hardware and software domains enables range extensions in BEVs without compromising comfort

EFFEREST Long titel

- EFFEREST targets a decisive leap forward in the **novel use of data** to achieve energy efficient electric vehicle (EV) designs, **matching enhanced user acceptance with efficient vehicle operation.**

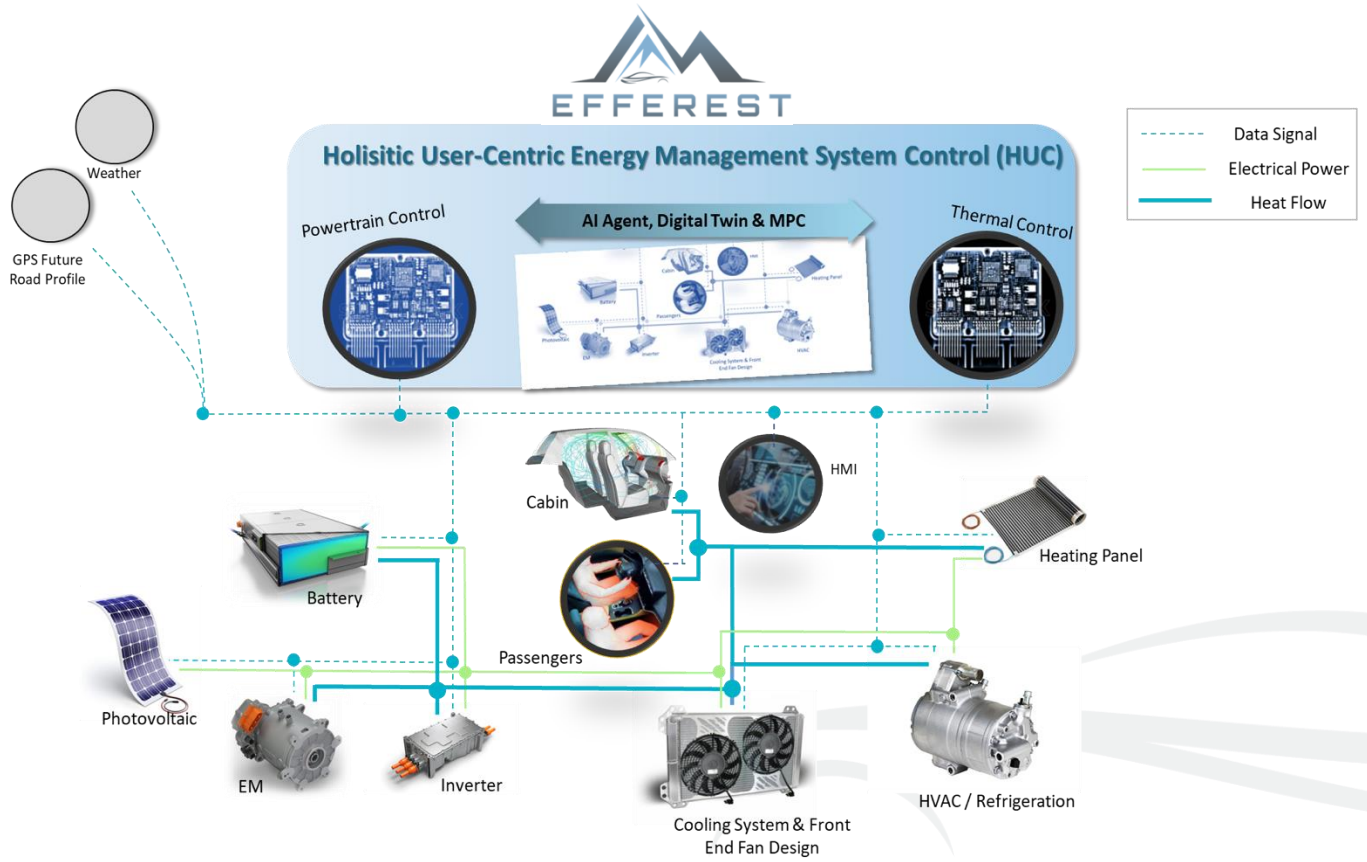


- HORIZON-CL5-2023-D5-01-01 - IA
  - User-centric design and operation of EV for optimized energy efficiency (2ZERO Partnership)
- 11 partners from industrial and research backgrounds (entire value chain)
  - Coordinator: Virtual Vehicle Research GmbH
- Duration: 36 Months (Jan. 24)
- Total project budget: 6,4 Mio EUR
  - Total project funding: 4,9 Mio EUR

EFFEREST Use Cases

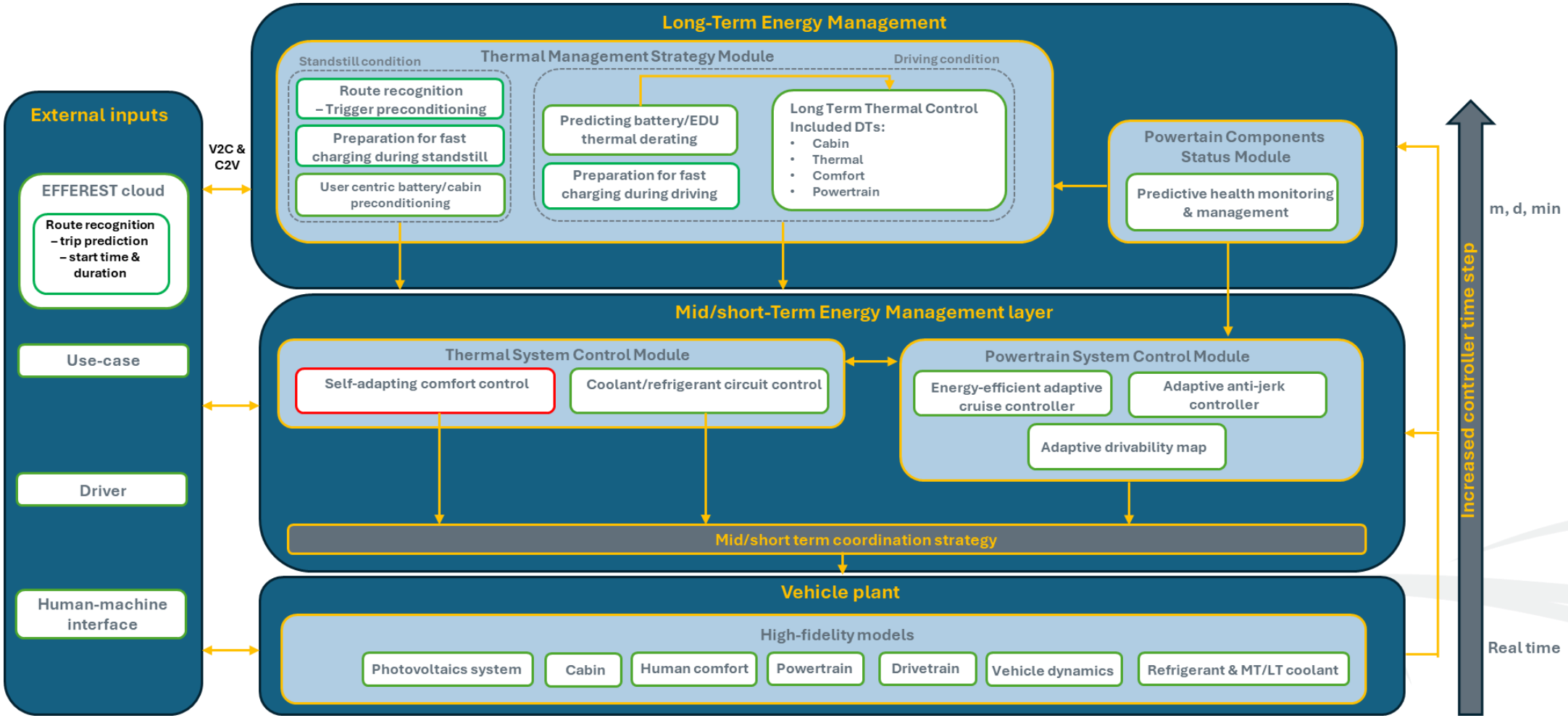
- Real demonstrator with HUC

- Virtual demonstrator with HUC, Photovoltaic and Nat. Refrigerants

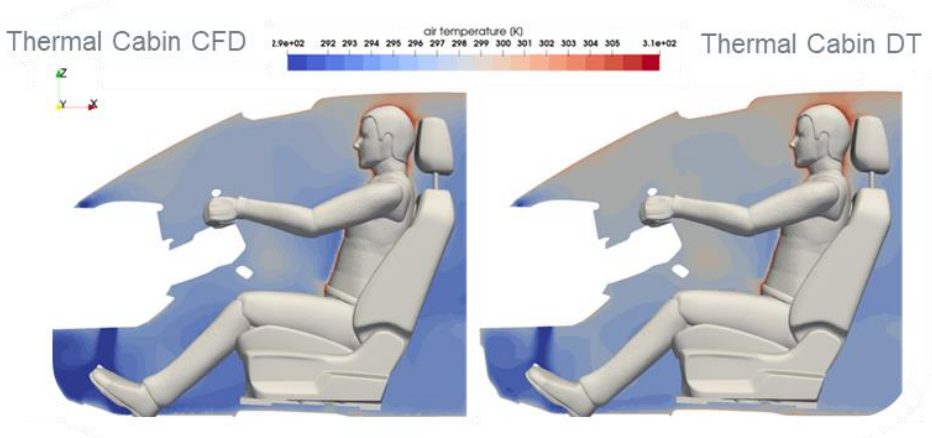


HUC

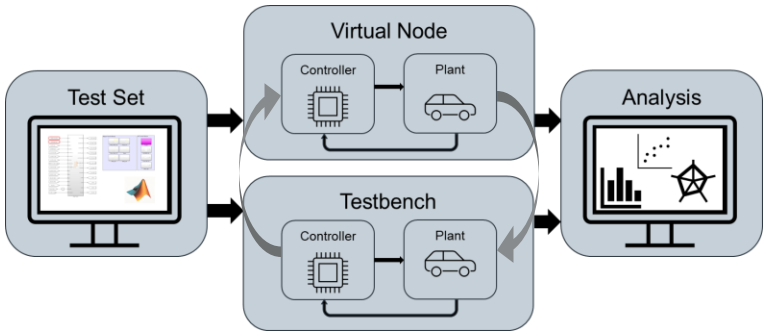
Holistic User centric energy management system Control



SACC - Self-adapting Comfort Control



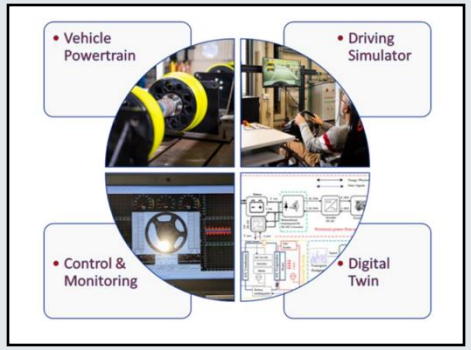
NEXT STEP: TRL6 Demonstration Platforms

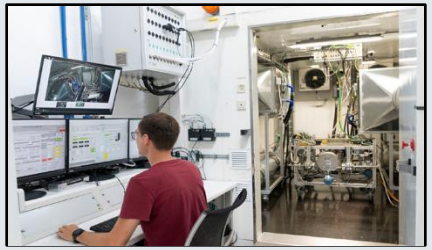


Testbench demonstration
of sub-systems / functions

VIF‘s Demonstration Platform

VUB EPOWER‘s Open vehicle powertrain platform



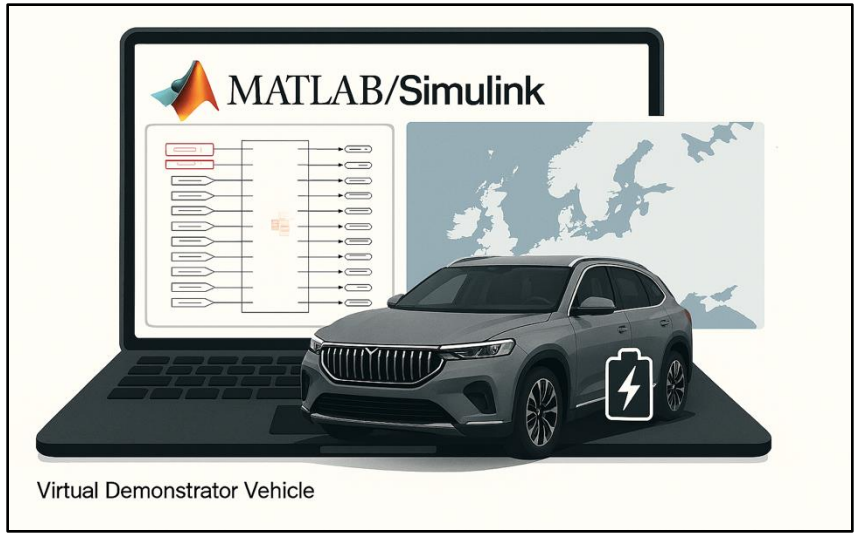


Magna ECS thermal testbench

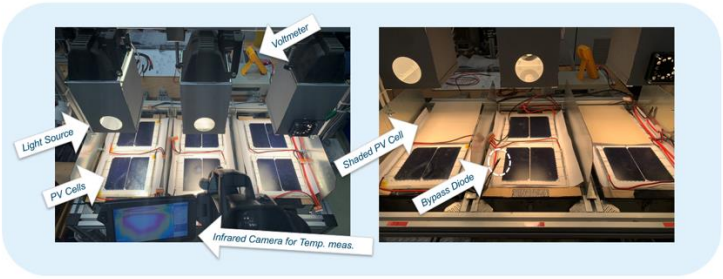
Demonstrator vehicle

NEXT STEP: Virtual Demonstration

Virtual Demonstrator used for year-round analysis & combined investigation



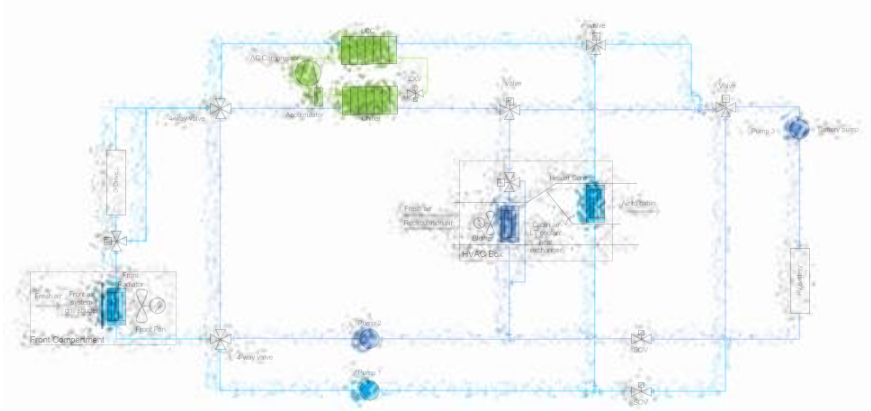
Vehicle Integrated Photovoltaics



SACC & HUC Control Software

Novel thermal system architecture

- Complexity & cost reduction with focus on competitiveness
- Future proof due to the use of natural refrigerants
- Holistic heat management

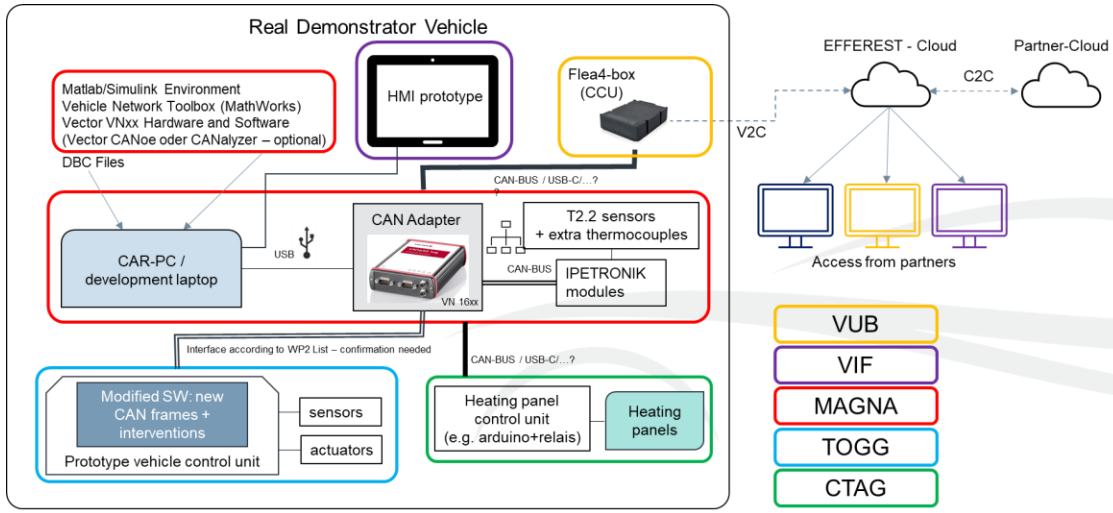


The virtual demo vehicle enables:

- Realistic year-round usage simulation
- Insights into long-term user behavior
- Evaluation of Vehicle Integrated PV and natural refrigerants
- Assessment of HUC efficiency as part of a combined system

Conclusion and Outlook

- Conclusion
  - Climatization of the cabine is still a huge consumer during cold temperatures
  - Benchmark EV vehicle did not show a satisfying solution
  - EFFEREST solutions:
    - HUC, user-centric use case, novel indicators, AI-enhanced system design
    - System level development & testing approach to ensure competitiveness & fast development
- EFFFEREST Outlook
  - Rightsizing loops and HUC control finalization
  - Integration of components and systems into the demo vehicle



THANK YOU

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