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#RTR2026

EFFEREST

EFFicient user-centric EneRgy managEment SysTems for optimized EVs

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EFFEREST

2ZERO ERTRAC CCAM European Commission

With the support of BATT4EU Batteries European Partnership

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Overall project presentation

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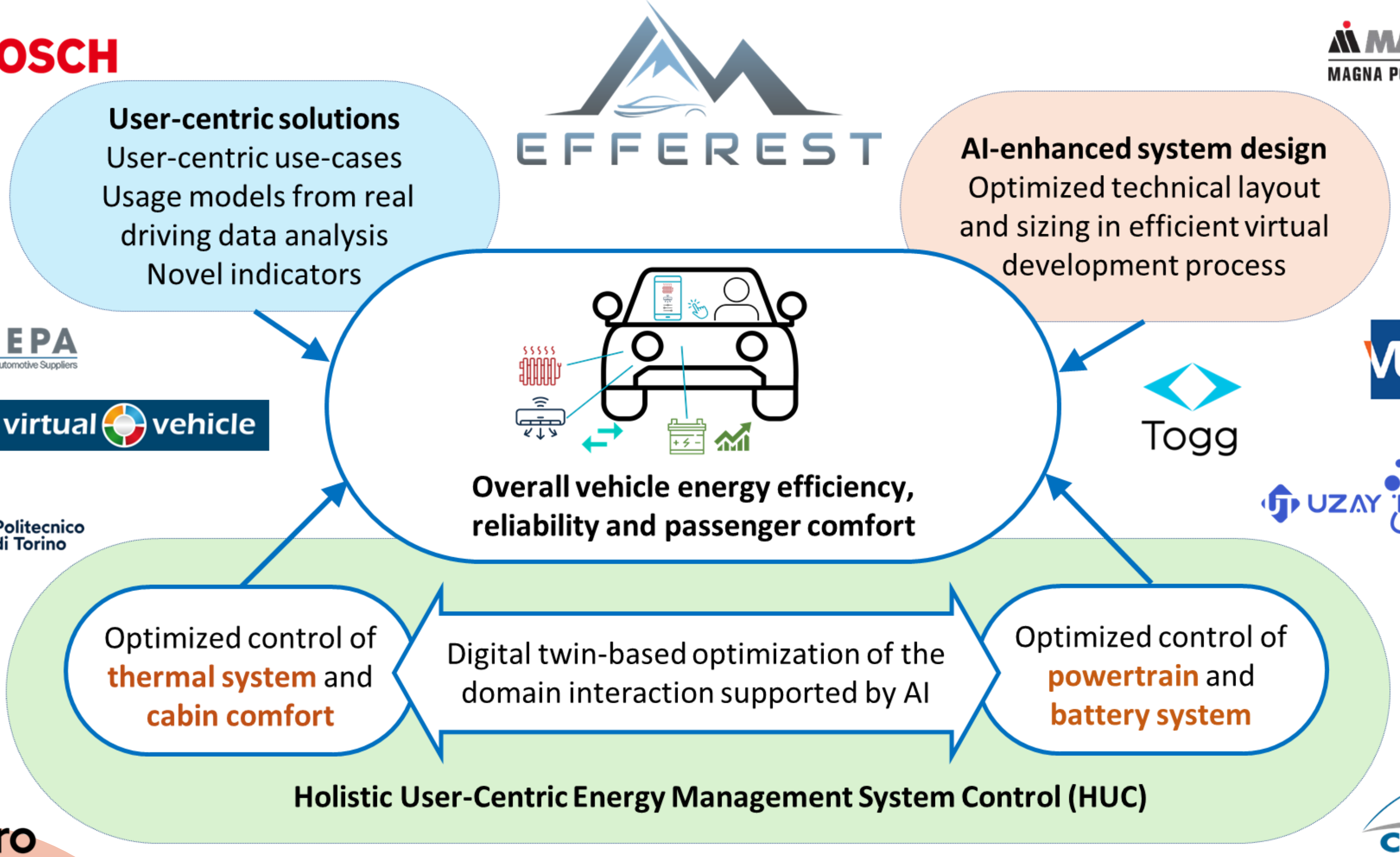
Project overview



- 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

Objectives

- **O1:** Achieve innovative and holistic user-centric solutions to make EVs more attractive for the mass market
- **O2:** Use of AI and digitalization to enhance design and operation of components and system
- **O3:** Reduced development time of highly efficient vehicle components and systems
- **O4:** Technology demonstrated in relevant environment (TRL6)
- **O5:** Dissemination and exploitation of the EFFEREST results

<table>
<tr><th>Obj.</th><th>Measurable improvements</th></tr>
<tr><td>O1</td><td><u>Effect on energy consumption of</u>: HVAC, thermal management (ThMgt), HUC, photo-voltaic system (PV), natural refrigerants adoption in the HVAC (Nat.Refr.), compared to different baselines (see also the Appendix below)
<table>
<tr><th rowspan="3">EFFEREST real-world consumption</th><th colspan="2">Baseline</th><th colspan="3" rowspan="2">Real demonstrator with HUC</th><th colspan="3" rowspan="2">Virtual demonstrator with HUC+PV+Nat.Refr.</th></tr>
<tr><th>Propulsion only</th><th>Propulsion + HVAC & ThMgt</th></tr>
<tr><th colspan="2">kWh/100km</th><th>kWh/100km</th><th>Energy savings %</th><th>Range increase %</th><th>kWh/100km</th><th>Energy savings %</th><th>Range increase %</th></tr>
<tr><td>Hot / 30°C</td><td>15</td><td>21</td><td>18</td><td>-16%</td><td>19%</td><td>15</td><td>-28%</td><td>39%</td></tr>
<tr><td>Normal / 15°C</td><td>18</td><td>20</td><td>18</td><td>-10%</td><td>11%</td><td>17</td><td>-15%</td><td>18%</td></tr>
<tr><td>Cold / 0°C</td><td>19</td><td>27</td><td>22</td><td>-19%</td><td>23%</td><td>21</td><td>-21%</td><td>27%</td></tr>
<tr><td>Cold / -10°C</td><td>21</td><td>36</td><td>28</td><td>-23%</td><td>30%</td><td>27</td><td>-25%</td><td>33%</td></tr>
</table>
Further range increases at low temperatures will be enabled by pre-conditioning with the EV connected to the grid</td></tr>
<tr><td>O2</td><td><u>ADTs and adaptive controllers</u>: >60% reduction of the variation of control performance with respect to (w.r.t.) state-of-the-art (SoA) non-adaptive controllers; <u>ADTs</u>: potential transferability of the ADT toolchain verified for ≥3 EVs; ADTs: online model implementation step size of ≤20 ms for powertrain, ≤50 ms for battery, ≤100 ms for HVAC, ≤100 ms for cabin, ≤250 ms for human thermal comfort DTs</td></tr>
<tr><td>O3</td><td><u>Streamlined co-design framework</u>: ~30% reduction of the overall development time within a transition period of only a few project cycles (i.e., roughly 5% due to better understanding of requirements, 5% due to faster decisions, 10% due to early implementation of functions, and 10% due to reduced testing with human subjects); ~30% reduction of associated development cost; <u>MPOL</u>: >15% reduction of the durability testing time</td></tr>
<tr><td>O4</td><td><u>Testing</u>: Implementation of the EFFEREST solutions on 1 physical EV; data provision from further 3-5 physical Evs</td></tr>
<tr><td>O5</td><td><u>Website</u>: >1000 unique visitors and ≥6 updates/year; <u>Social media</u>: >2 posts/month, >1500 views, >200 followers; <u>Clustering activities</u>: involvement of >5 EU projects of same/similar calls; <u>Events</u>: organisation of 4 workshops/webinars (≥10 external attendees) and participation to >20 events; <u>Scientific publications</u>: ≥10 conference papers ≥15 and journal papers; <u>Videos</u>: 2 project videos produced; <u>Patents</u>: >5 patent applications submitted; <u>Press releases/newsletters</u>: >6 publications; <u>PhD projects</u>: 2 projects set up independently from the project but still linked to its activity</td></tr>
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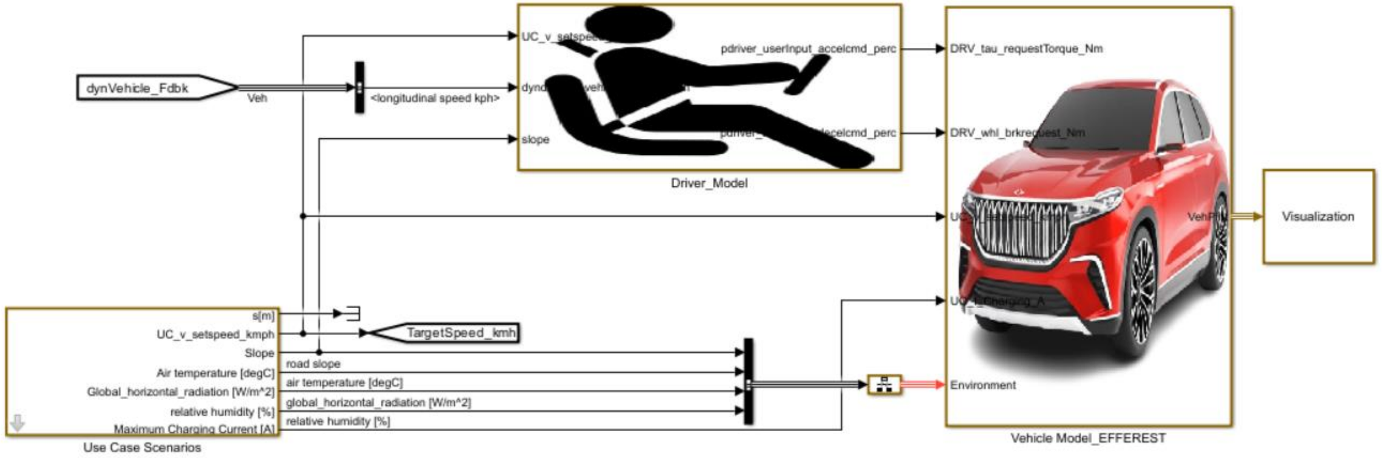
EFFEREST Use Cases

- Real demonstrator with HUC

- Virtual demonstrator with HUC, Photovoltaic and Nat. Refrigerants

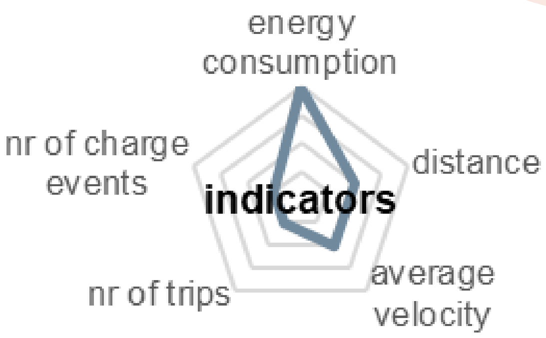


Results presentation

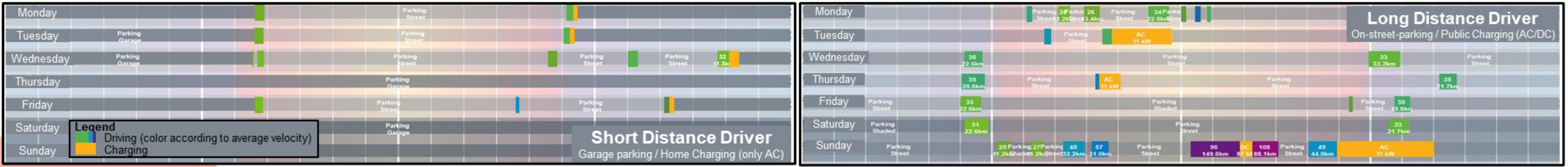
Real Driving Usage Pattern Analysis

BOSCH

- Preselection of **4 distinct vehicle usage-profiles** („Short / Long / Average Distance Driver / Commuter“) **according** to daily and annual **mileage** and **driving pattern** identification from vehicles monitored for ~1 year
- **Enrichment of base journals** with vehicle simulation model including **stochastic parking** data, **charging models**, and **climatic** data from regions (cold: Helsinki / average: Paris / hot: Athens)
  - Note: The combination of base journal, climatic region data, parking and charging models can be fully factorial. An exemplary combination is chosen for each base journal.
- Derivation of an **exemplary week of usage** from the annual usage profile to support fast simulation.
- **Approach**: exemplary week extrapolated to complete year matching closest to annual profile w.r.t. energy consumption, distance, average velocity, and number of trips and charging events.



Visualization of exemplary week for two distinct usage-profiles:



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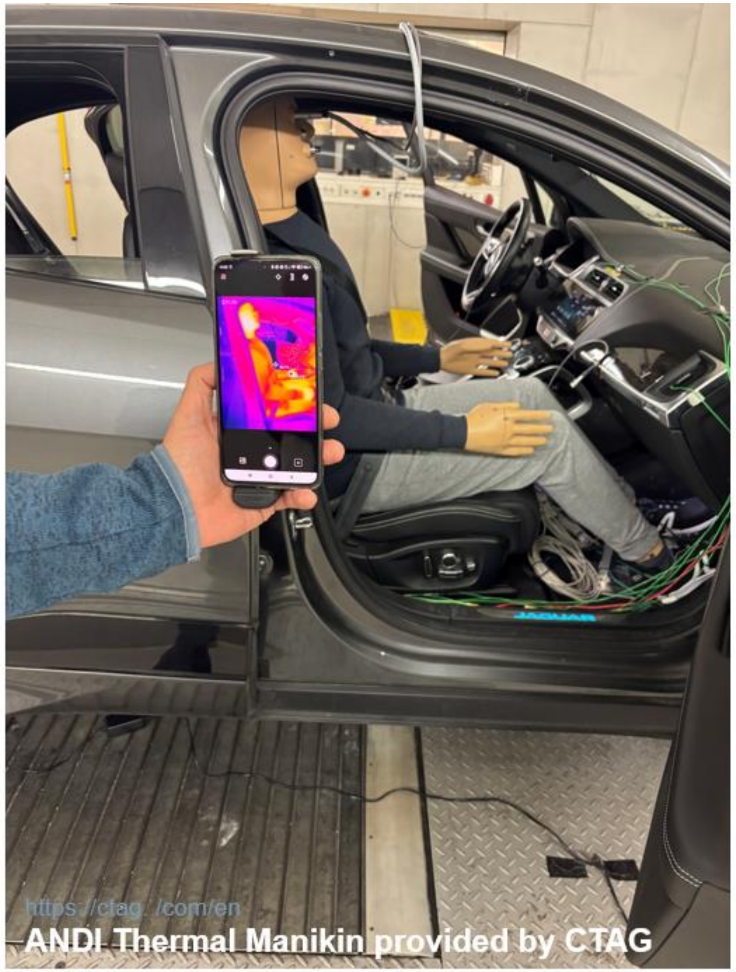
Benchmark tests for efficiency and thermal comfort on MAGNA chassis dyno

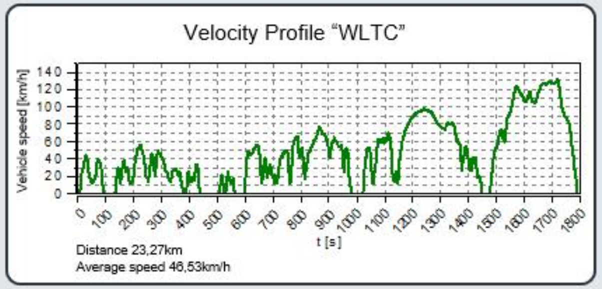


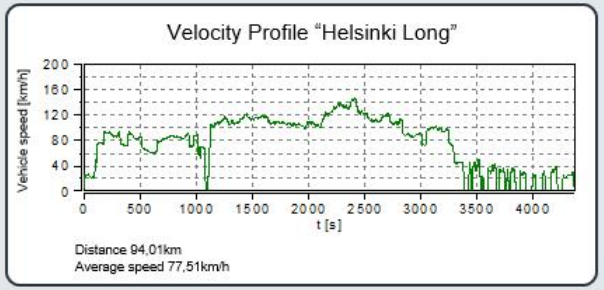
Magna Engineering Center Steyr
https://www.magna.com/products/complete-vehicles/commercial-vehicle-engineering

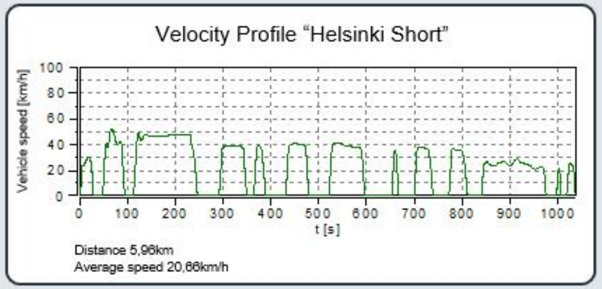
Benchmarking @ MAGNA Engineering Center Steyr

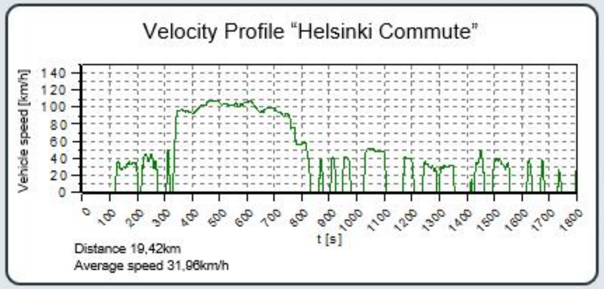
Chassis-dynamometer tests:

- 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)



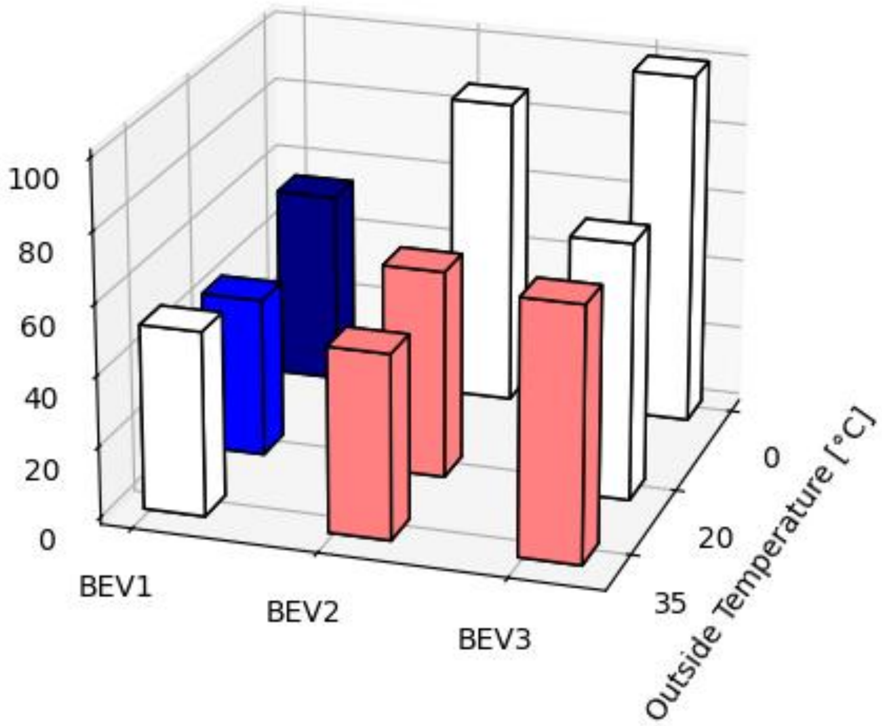






Benchmark tests for efficiency and thermal comfort on MAGNA chassis dyno

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

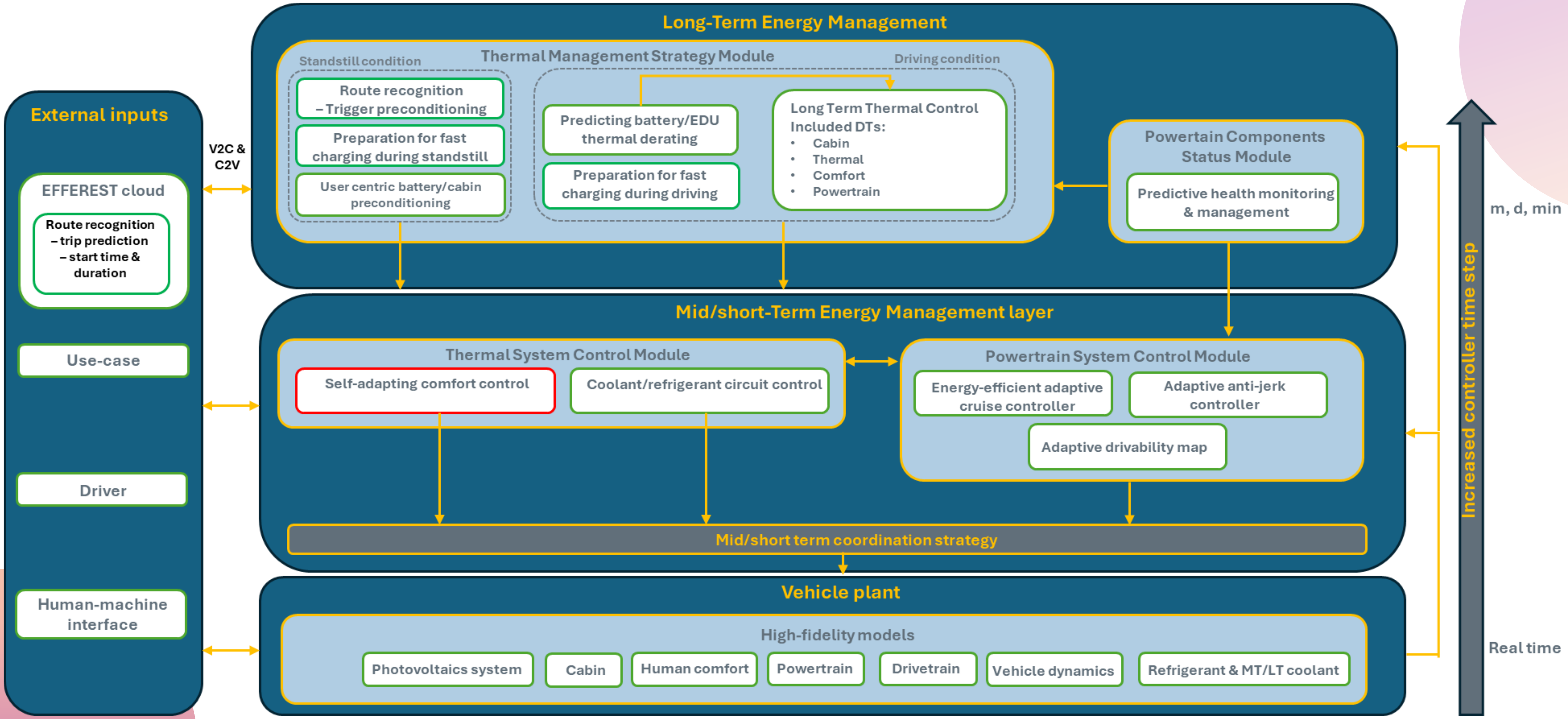
🔥 **BEV2 & BEV3** reach target temperature, but with higher energy use

❄️ At 20 °C ambient temperature:

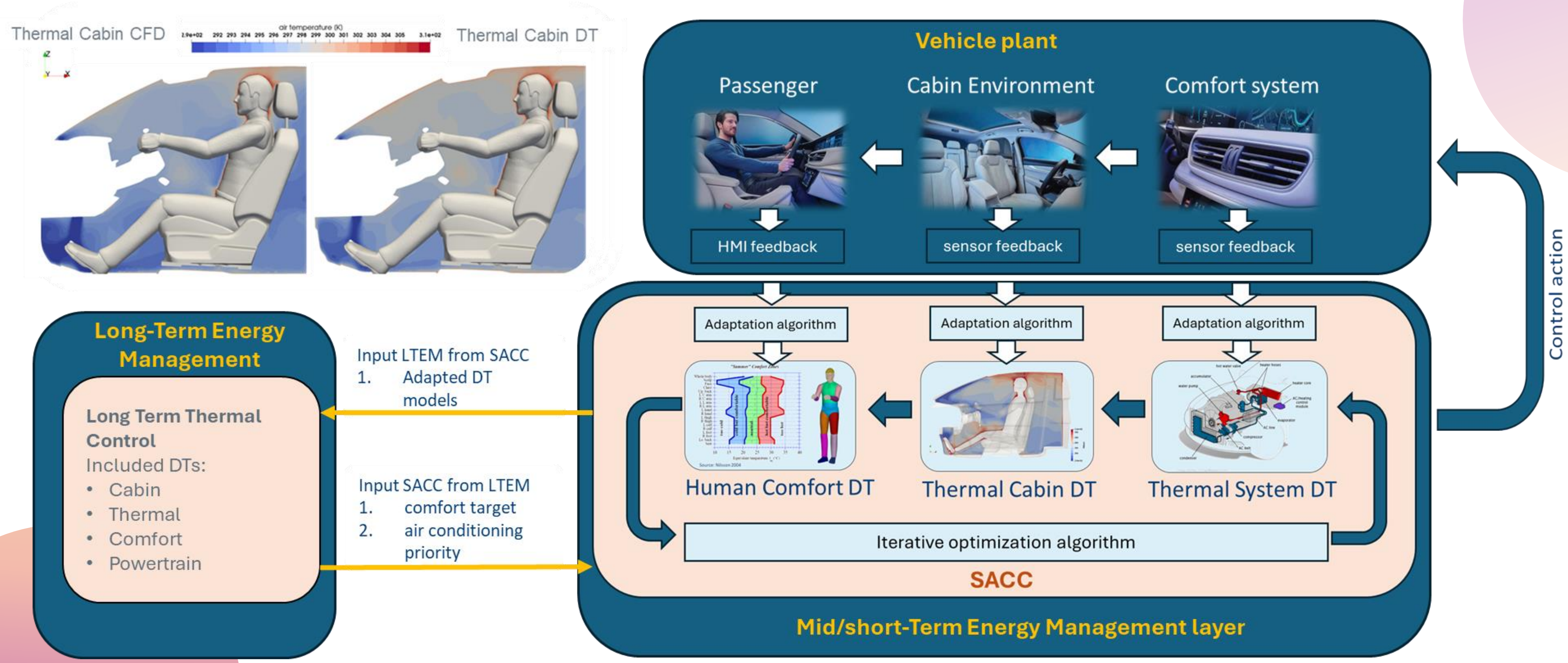
- **BEV2 & BEV3** reheat cabin air to maintain comfort
- **BEV1** mainly cools → results in lower cabin temperatures

Significant differences in thermal management strategies identified

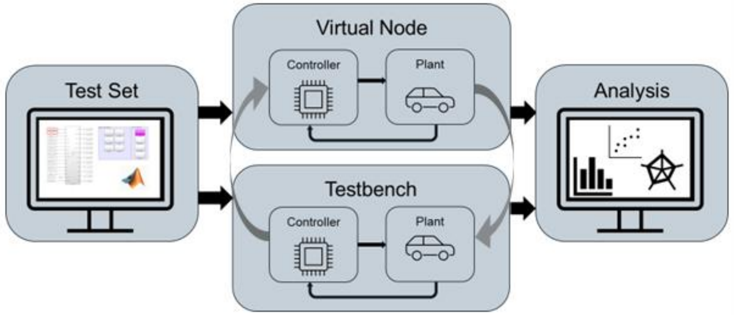
HUC – Holistic User centric energy management system Control



One control example
SACC Self-adapting Comfort Control



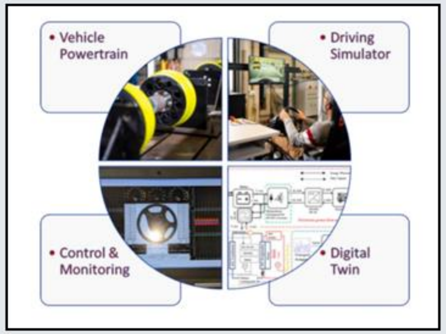
Demonstration



Testbench demonstration
of sub-systems / functions

VIF's Demonstration Platform

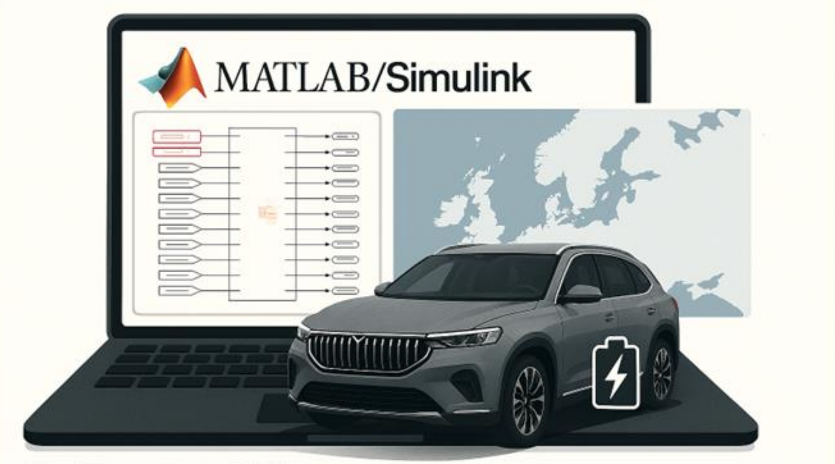
VUB EPOWER's Open vehicle powertrain platform



Magna ECS thermal testbench

Demonstrator vehicle

Virtual Demonstration

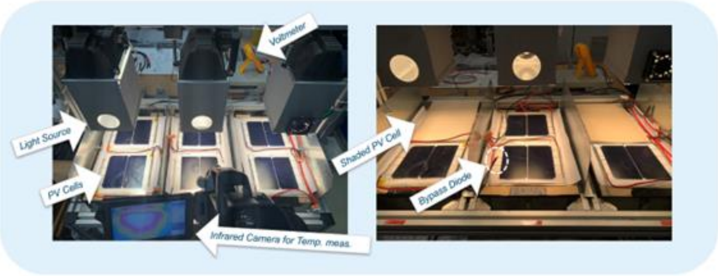


Virtual Demonstrator Vehicle

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

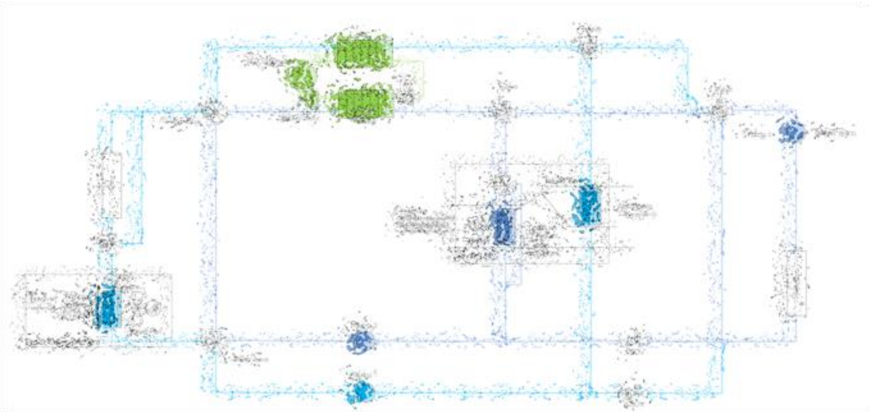
Vehicle Integrated Photovoltaics



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



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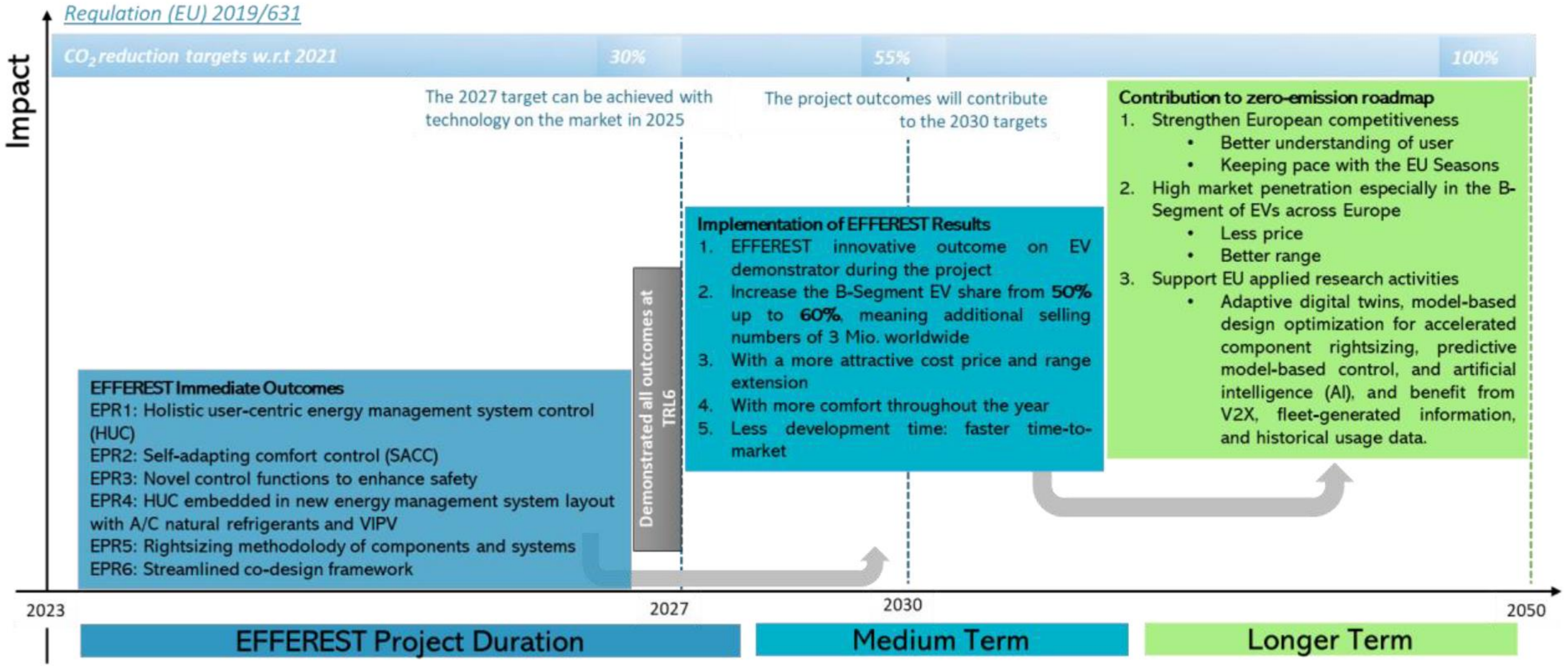
Mid to long term expected impacts of the project

EFFEREST pathway towards zero-emission roadmap



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With the support of