OPTEMUS

Optimised Energy Management and Use

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Projektpartner

Challenges and Goals

Optimised energy management and use (OPTEMUS) represents an opportunity for overcoming one of the biggest barriers towards large scale adoption of electric and plug-in hybrid cars: range limitation due to limited storage capacity of electric batteries.

The OPTEMUS project proposes to tackle this bottleneck by leveraging low energy consumption and energy harvesting through a holistic vehicle-occupant-centred approach, considering space, cost and complexity requirements. Specifically, OPTEMUS intends to develop a number of innovative core technologies (Integrated thermal management system comprising the compact refrigeration unit and the compact HVAC unit, battery housing and insulation as thermal and electric energy storage, thermal energy management control unit, regenerative shock absorbers) and complementary technologies (localised conditioning, comprising the smart seat with implemented TED and the smart cover panels, PV panels) combined with intelligent controls (eco-driving and eco-routing strategies, predictive cabin preconditioning strategy with min. energy consumption, electric management strategy).

The combined virtual and real-life prototyping and performance assessment in a state of the art, on-the-market A-segment electric vehicle (Fiat 500e) of this package of technologies will allow demonstrating a minimum of 32 percent of energy consumption reduction for component cooling and 60 percent for passenger comfort, as well as an additional 15 percent being available for traction, leading to an increase of the driving range in extreme weather conditions of at least 44 km (38 percent) in a hot ambient and 63 km (70 percent) in a cold ambient.

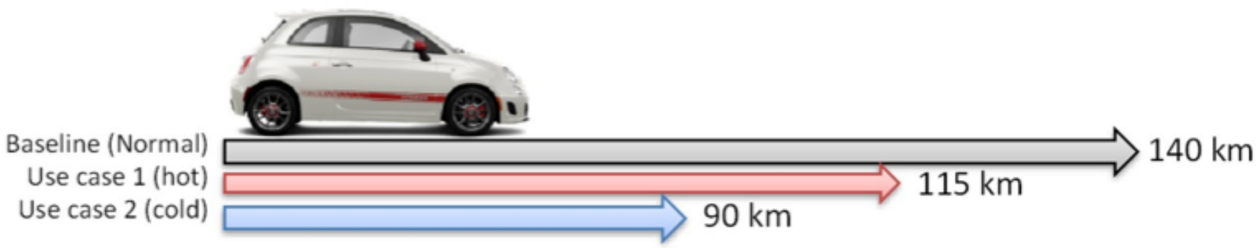

Figure 1: OPTEMUS baseline vehicle performance

Objectives

System simulation and assessment of vehicle-related quality attributes

The project starts with definition of use cases based on the reference vehicle Fiat 500e, which will be defined with the detailed requirements for the European market for normal operational scenarios at two extremes:

- Hot/dry: +35 C 40 percent r.H.
- Cold/wet: -10 C 90 percent r.H.

These conditions will form the basis for the design of different components and systems which will be developed by the OPTEMUS partners. The aim of this work package is to develop methodologies and associated tools to manage efficiently the complex interactions and iterations also between the different partners representing different stakeholders in a real industrial supply chain.

The proposed Virtual Prototyping solution based on modelling & simulation will enable efficient support for decisions and inter-discipline trade-offs between different stakeholders along the product lifecycle. Moreover the VP methodology should ensure a competitive product within the defined targets: quality and market window and cost/price. The VP chain, which is currently widely used in the automotive industry, is mainly focusing on the ICE segment, and hence requires significant investment in order to support efficiently the industry to meet the PHEV challenges (competitiveness, acceptance, etc.).

The OPTEMUS project represents well the complex interactions and iterations in a typical supply chain, which is gearing up to face the challenges and opportunities, which will be afforded by PHEVs in the future.

Virtual Prototyping methodology and associated tools will be developed in order to support typical HPVE vehicle design and to ensure typical integration of the different components and systems. The integrated Virtual Holistic Prototype will enable the trade-offs to reach the conflicting requirements energy / autonomy / safety & comfort.

A virtual demonstrator will be developed for some selected representative systems and components (within the budget limit). Also, it will be used as showcase with 3D immersive experiences: on board and on the road to assess the performance and acceptance KPI. The virtual prototype technologies to be developed include the accurate simulation of thermal management components in the forms of battery thermal management, battery life enhancement, and energy efficient HVAC systems along with further simulation and integration of system interactions from energy harvesting systems in form of energy harvesting technologies. The virtual prototype simulation will be contextualised through the use of KPIs to assess the issues relating to cost, safety, reliability, and standardisation with respect to determining the feasibility of the solutions proposed. In particular, since cost is a major driver in this specific context, the projected cost of the overall vehicle will be continuously assessed in order to verify the economic viability of the solutions considering the cost of the sub-system and their integration along the life cycle.

Advanced Thermal Management Components and Technologies

Reflecting the state-of-the-art three research lines for thermal management of electric vehicles were identified to increase the range and to minimise the energy consumption for passenger comfort. The first research line addresses the advanced thermal management of battery modules and their heat storage capacity. The objective is to develop a smart housing for the battery module, which combines the function of protection, cooling and heating (if needed) of the battery modules keeping the thermal conditions of the battery modules always at an optimum as well as of the heat storage. Initial simulations indicate that with a smart internal thermal management a significant increase in range and lifetime can be achieved through better use of recuperated energy, higher charging levels, reduced ageing, etc. A preconditioned battery used as heat storage will significantly reduce the energy consumption for comfort (in combination with a refrigeration unit used as heat pump) at cold ambient temperatures. At hot ambient temperatures, the battery can be used as heat sink, reducing the energy consumption for component cooling.

The second research line addresses the temperature control of the interior to limit the energy needed ensuring a desired passenger comfort. The research focuses on solution for preconditioning the interior and for microclimates. For both strategies a combination of smart heated seats with radiating panels (smart cover panels) is assumed to be the most promising approach allowing for at least 5–7 °C lower interior temperature at the same passenger comfort. At the same time, the smart cover panels can be designed in such a way, the heat due to solar radiation is dissipated to areas where the cabin air is not heated up.

Both tasks are linked together through an advanced, compact refrigerator unit for electric vehicles (CRU, research line 3), which serves as heating and cooling device for the battery as well as for the interior. Simulation models of the considered technologies will be provided for the virtual full vehicle model. In view of Energy Management Architectures & Operation Strategies the underlying physical technologies for a thermal management strategy on vehicle level will be provided.

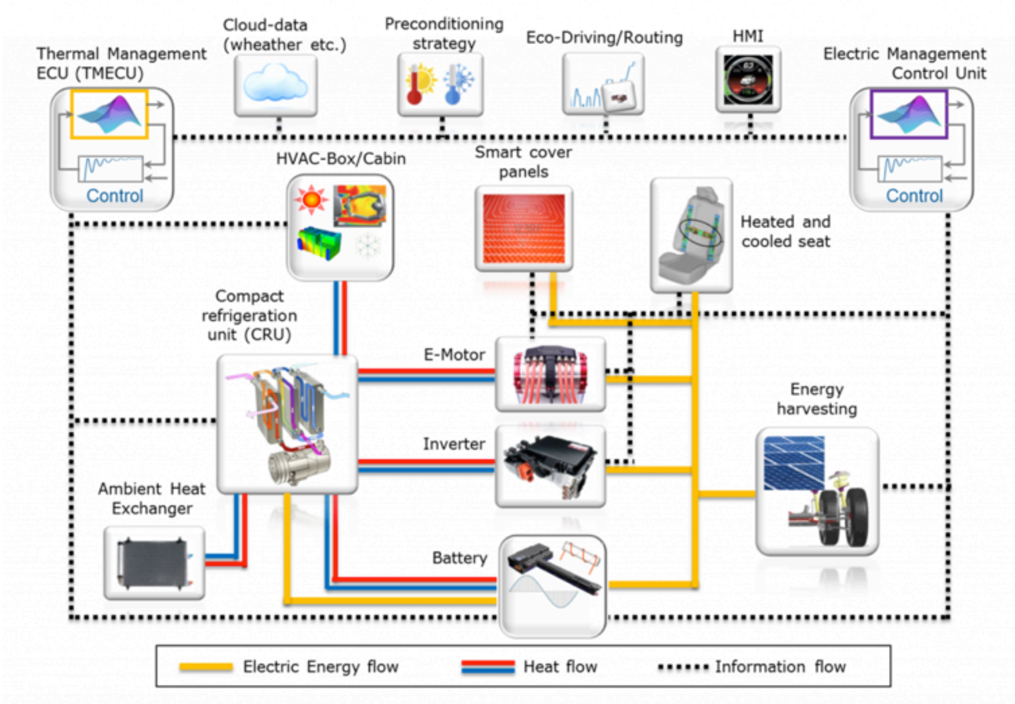

Figure 2: OPTEMUS core technologies

Energy Management Architectures & Operation Strategies

The general objective of this work package is to develop an innovative energy management architecture and operating strategy that exploits the developed technologies at their best. The developed energy management strategy will coordinate the local controllers of the newly developed subsystems among each other and with the main traction control already existing on the baseline vehicle. Moreover, specific actions to reduce energy demand for comfort and for traction (preconditioning, eco-routing, eco-driving) are addressed in this WP. The novel energy management architecture will be focused on energy harvesting technologies such as shock absorbers and photovoltaic panels, as well as their functional integration in the overall architecture.

Application, utilization of results and contribution to energy storage issues

The OPTEMUS system and components will be integrated in a prototype vehicle, a Fiat Group A-segment electric vehicle and experimentally validated. The first part of this process is devoted to the systems on-board integration and optimisation. The system will be installed on the reference vehicle. After the set-up, tuning and optimisation phases, the vehicle will undergo to the assessment procedures so to measure the performances in agreement with the procedures defined in the previous development process. This data will be compared to the ones of the original vehicle. Besides the vehicle realization, this process represents the last element of an optimisation loop that will lead to the achievement of the target performances. The OPTEMUS battery will demonstrate an advanced thermal management concept, which guarantees less driving range variation in extreme weather conditions. The battery concept will be validated on battery testbench for both usecases.

The vehicle will constitute the most advanced example of thermal systems and thermal management and a reference in terms of fuel economy for the vehicle class considered.

Figure 3: OPTEMUS targeted vehicle performance

OPTEMUS will communicate its results to a wide range of target groups, making use of a set of target-group adapted and tailor-made communication tools.