



## **OPTEMUS Newsletter, Issue 1 (2016)**

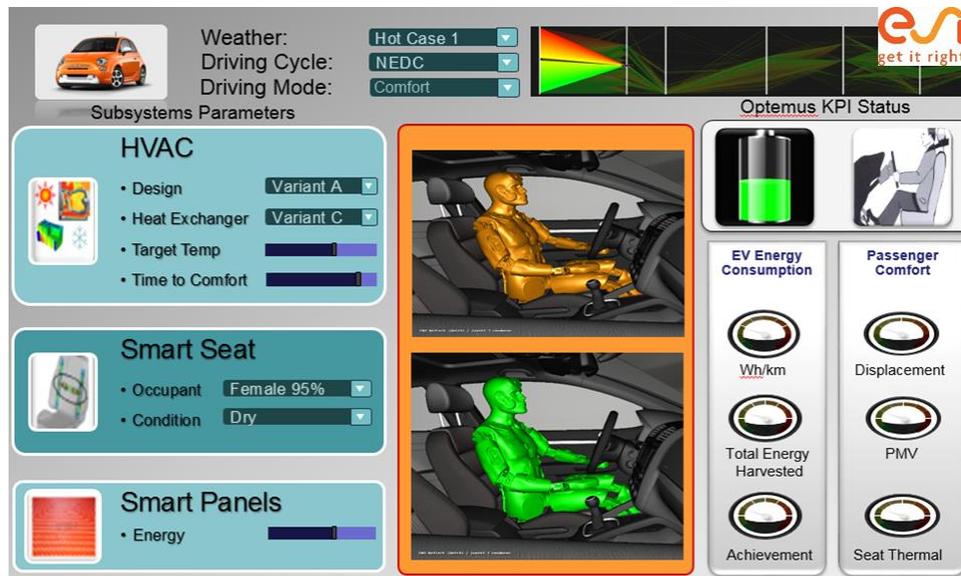
Dear Sir or Madam,

the OPTEMUS project has now almost finished the first 1 ½ years. The definition of use cases and scenarios has been finished, which forms the basis for the design of different components and systems that will be developed by the OPTEMUS partners. Further, the “baseline measurements” – a thorough evaluation of the Fiat500e (the reference and demonstrator vehicle) in the climatic chamber - has finished in order to refine the benchmarks. The development of the OPTEMUS technologies to reach the ambitious targets for the reduction of energy consumption is ongoing and is summarized below, where a short overview of the progress in the technical workpackages is given. Additionally, the dissemination and exploitation activities so far will be described.

### Workpackage 1 - System simulation and assessment of vehicle-related quality attributes:

In WP1, the use cases for the reference measurements and the final evaluation of the demonstrator vehicle have been defined: use case 1 represents hot ambient conditions (+ 35 °C), use case 2 cold ambient conditions (- 10 °C) and use case 3 the homologation conditions (+ 23 °C). These three will use the NEDC (New European Driving Cycle) as reference cycle. Further, a fourth use case is considered as optional, with a temperature of 14 °C and the WLTP (Worldwide Harmonized Light-Duty Vehicles Test Procedure), which will be the future test cycle in the European Union.

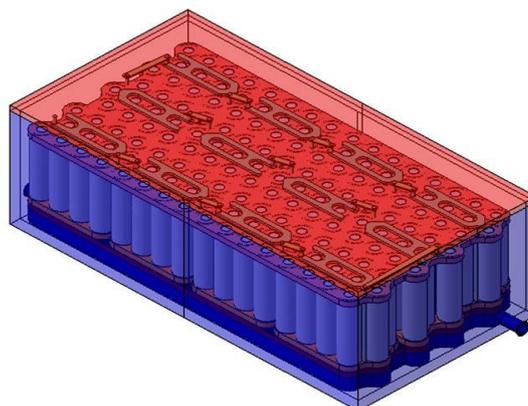
For the assessment of the OPTEMUS technologies via Virtual Prototyping specifications and a coordination plan have been set up. Additionally a methodology for the 1D and 3D simulation has been set up and the collection of necessary simulation data is ongoing at the moment.



In addition, the data collection for the cost analysis (cost benefit analysis and total cost of ownership) has been started, in order to get also an economical view on the developed technologies.

### Workpackage 2 - Advanced thermal management components and technologies:

In the first research line of WP2 an internal thermal management for battery modules is developed. For the battery modules a smart housing will combine the function of protection, cooling and heating (thermal isolator) as well as the possibility of heat storage. The conceptual design of the housing foresees the implementation of novel polymer composites and phase change materials (PCM), which will provide increased heat storage capacities of the battery. Additionally, the use of novel plastics will allow cost-efficient manufacturing technologies such as injection molding. Different concepts of PCM integration have been analyzed considering leakage as well as thermal performance and manufacturability.

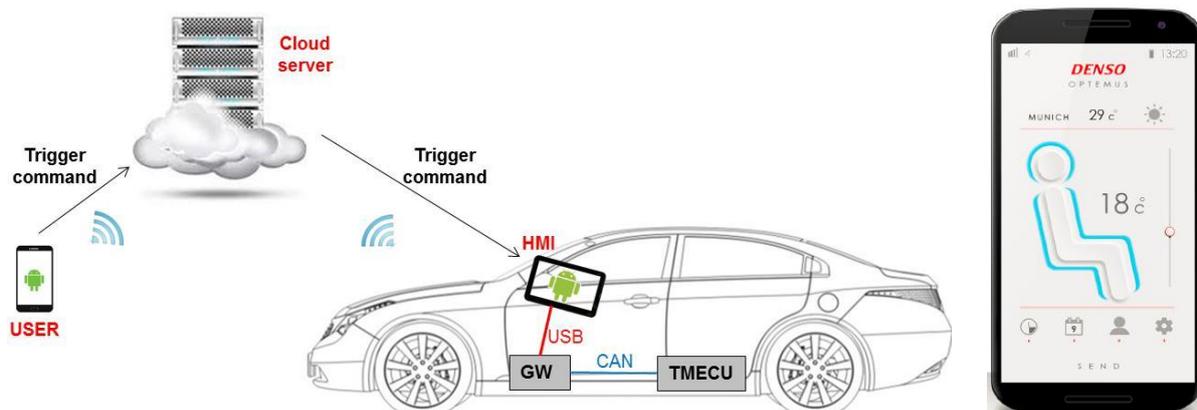


The second research line in WP2 addresses the development of a compact refrigeration unit, which uses a natural gas as refrigerant. It will provide hot and cold coolant, that can be redirected in the demonstrator vehicle for all heating and cooling purposes including conditioning of the passenger cabin and other vehicle components (e.g. the battery). Based on simulations the components (compressor, heat exchangers etc.) have been dimensioned and packaging investigations for the demonstrator vehicle have been started. Further, the definition of the new layout architecture for the coolant cycle has been finished, which has the capability to provide all the desired functions (heating/cooling/preconditioning) in order to minimize energy consumption.

In the third research line the focus is on interior technologies for passenger comfort. A smart seat (heated or cooled via Peltier elements) will contribute to the generation of a comfortable (micro-) climate around the passenger. Therefore, a market analysis has been conducted and simulation models for the thermoelectric modules have been developed to analyse their effects on the seat and cabin. The second technology to create the mentioned micro-climate around the passenger are the smart cover panels. On the one hand radiation heating will improve comfort in cold conditions and on the other hand the panels should be able to transfer excessive heat away from the interior in hot conditions with solar radiation. Different panel concepts have been created comprising different materials and designs. They will be tested in a small scale vehicle interior test station, which has been built up.

### Workpackage 3 - Energy management architectures & operation strategies:

In WP3 a preconditioning strategy is developed, that provides a custom conditioning for the passengers and an enhancement of the battery life duration. It exploits a novel concept, using the available energy in the vehicle in the most efficient way by predicting the driver's behavior (i.e. the approach to the vehicle), and providing a custom conditioning of the cabin room according to the personal user profiles (temperature), which are saved in the user's smartphone (OPTEMUS app). The vehicle's preconditioning system dialogs with the user/driver (smartphone) via an HMI (tablet) and also communicates with the CAN bus and the Thermal Management control (TMECU).



The vehicle HMI will also provide a link to the eco-routing web service. Eco-routing navigation aims to find the most energy-efficient route in a road network to travel from an origin to a destination. It may be seen as an optimization problem, where the function to be minimized is the vehicle energy consumption. Therefore, an algorithm to find the energy-optimal sequence of segments to drive from the desired origin to the desired destination has been developed. The presence of negative energy weights, due to regenerative braking, has been addressed by using an optimal path-searching algorithm. The eco-routing system has been tested during a first experimental campaign conducted with the demonstrator vehicle in Turin at CRF.

Further, the work on Eco-driving strategies has been started as well. Therefore, the Android app “Geco” has been set up for the OPTEMUS project. It will evaluate the driving style during the trip and give suggestions how to improve the drive style by showing simple scores and indexes.

Real time Eco-coaching – GECO for OPTEMUS



**GECO**  
OPTEMUS



Android Application

- evaluates the driving style during the trip
- suggests how to improve driving style by showing simple scores and indexes

Consumption Score



Acceleration Index



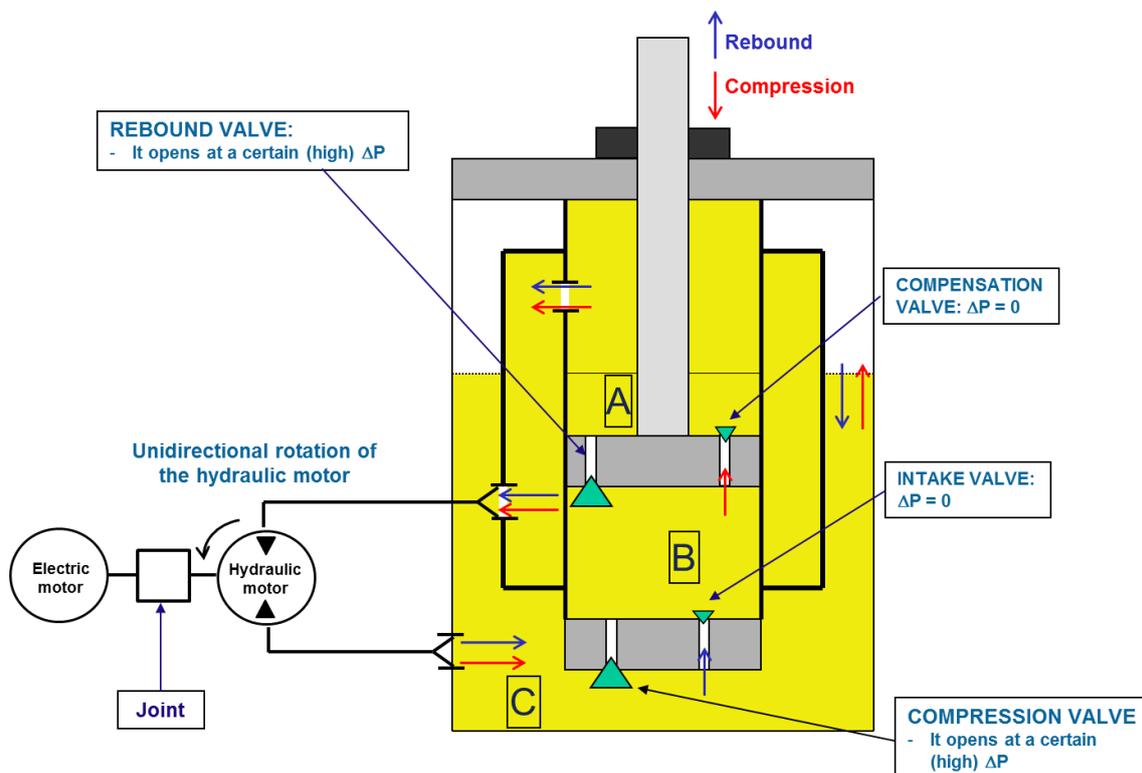
Speed Analysis





In the field of energy harvesting, the work on the photovoltaic panels and regenerative dampers is ongoing. For the photovoltaic panels one innovative solution is tested at the moment. It is based on the control of different PV modules by means of a dedicated DC/DC converter with a centralized MPPT (Maximum Power Point Tracking) algorithm that changes the operating points of the PV modules one at a time, in sequence, repeatedly, to the aim of maximizing the current injected into the battery. Simulations and microchip low cost microcontroller programming have been performed in Simulink in order to have fast prototyping and the easiest way of changing the control strategy. Test results using three Solbian 50 W modules and DC/DC switching converters prototypes are encouraging.

The work on regenerative dampers started with an extensive analysis about different technologies that can convert kinetic energy into electricity by using suspension components. Based on this, the architecture has been chosen: an electromechanical rotary hydraulic damper, in which the piston movement produces a pressurised oil flow through a hydraulic motor, which in turn moves an electric generator. This architecture has been presented at the 8th International Conference on Advanced Suspensions System 2016, held in Mainz (Germany) in March 2016.



For the chosen architecture, the concept design and components dimensioning have been performed. A detailed lumped parameter dynamic model of the regenerative damper has been also set up, using the tool Simulink SimHydraulics, which is able to predict hydraulic, electric and mechanical dynamic phenomena. The first physical prototype of Regenerative damper has been also manufactured, by hydraulically coupling the body of a three-tubes damper to a hydraulic motor, which in turn has been mechanically coupled with a three-phases brushless electric motor.

#### Workpackage 4 - System integration demonstrator vehicle and validation:

In the frame of WP4 several testing campaigns were carried out with the reference vehicle according to the evaluation criteria defined in WP1 to assess energy consumption and thermal comfort. The vehicle measurements were carried out in the climatic chamber and on a rolling bench, complying with the relevant standards.



For this purpose the P.A.C.O. manikin, carrying 16 comfort sensors and 8 temperature and humidity sensors, has been used for the measurements in order to evaluate thermal comfort. The obtained results form the basis for the development of the mentioned OPTEMUS technologies in WP2 and WP3.



### Dissemination & Exploitation:

A dedicated dissemination and exploitation strategy for the OPTEMUS project has been elaborated, where the target groups to which the project results will be communicated have been defined and measures regarding dissemination (corporate identity, dissemination materials, target conferences etc.) have been set. Further, rules for the management of knowledge and exploitation plans have been defined.

### Some of the first project findings and results have already been disseminated:

- Fouad El-Khaldi (ESI) and Thilo Bein (Fraunhofer) took part at an internal brokerage event of the European Green Vehicles Initiative Association (EGVIA) and presented the OPTEMUS project.
- A poster of the OPTEMUS project was presented at the “The European Project Day”, which took place in December 2015 in Brussels in the framework of the “European Battery, Hybrid and Fuel Cell Electric Vehicle Congress”.
- Andrés Caldevilla (Denso) presented the paper “The DENSO roadmap to a safe and healthy society”, at the European Battery, Hybrid and Fuel Cell Electric Vehicle Congress (EEVC, Brussels, December 2015) and the conference “The Future of Electric Vehicles” (Frankfurt, May 2016). It mentions the OPTEMUS project as one of DENSO’s roadmap projects to a safe and healthy society.



- Giordano Greco (Magnetit Marelli) participated at the 8th International Conference on Advanced Suspensions Systems (Mainz, March 2016). He presented the paper “An efficient architecture for a hydraulic regenerative

shock absorber” and explicitly mentioned the OPTEMUS project as the context in which this research activity has been carried out.



- The paper “A Model-Based Eco-Routing Strategy for Electric Vehicles in Large Urban Networks” by Giovanni De Nunzio, Laurent Thibault and Antonio Sciarretta (IFPEN) will be presented at the IEEE conference on Intelligent Transportation Systems (Rio de Janeiro, November 2016)
- A book chapter on the OPTEMUS ECO routing results are accepted for publication in "Comprehensive Energy Management" (Springer Briefs) - B. Brandstätter & D. Watzenig (eds.) to be published in Spring 2017

Further, the first clustering event will take place in November 2016 in Bologna, Italy. There, three EU-funded projects (JOSPEL, XERIC and OPTEMUS) have decided to organise a one-day event to share their insights on the latest trends and technologies to improve energy efficiency in electric vehicles.

The next OPTEMUS newsletter will be published in September 2017 - in the meanwhile the latest news and updates can be found on the website:

[www.optemus.eu](http://www.optemus.eu)

Best regards,

Alois Steiner



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