OPTEMUS Newsletter, Issue 2 (2017)

Dear Sir or Madam,

the OPTEMUS project has now almost finished 2/3 of the project and a lot of technical advancements have been achieved since the first newsletter. The final design of main technologies like the battery with integrated phase change material and the compact refrigeration unit is ready and the manufacturing process will start during the next months. Further, also the timeline for the integration of these technologies into the demonstrator vehicle(s) was set up. The project consortium has decided to build up two separate demonstrator vehicles – one for testing the thermal management system and one for testing the interior components (radiation heating and heat transfer panels, smart seat).

Some highlights of the technical work packages as well as from dissemination and exploitation are described in the following:

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

In work package 1 the system simulation for the thermal (see Figure 1) and electric system has been set up, using different simulation tools coupled through the Virtual Integration Platform “ICOS”.

Further, in order to assess the impact of the technologies related to passenger comfort a 3D-cabin model including a “virtual comfort dummy” (Figure 2) has been set up. These simulation models enable the investigation of different control strategies and their impact on the energy consumption of the vehicle.

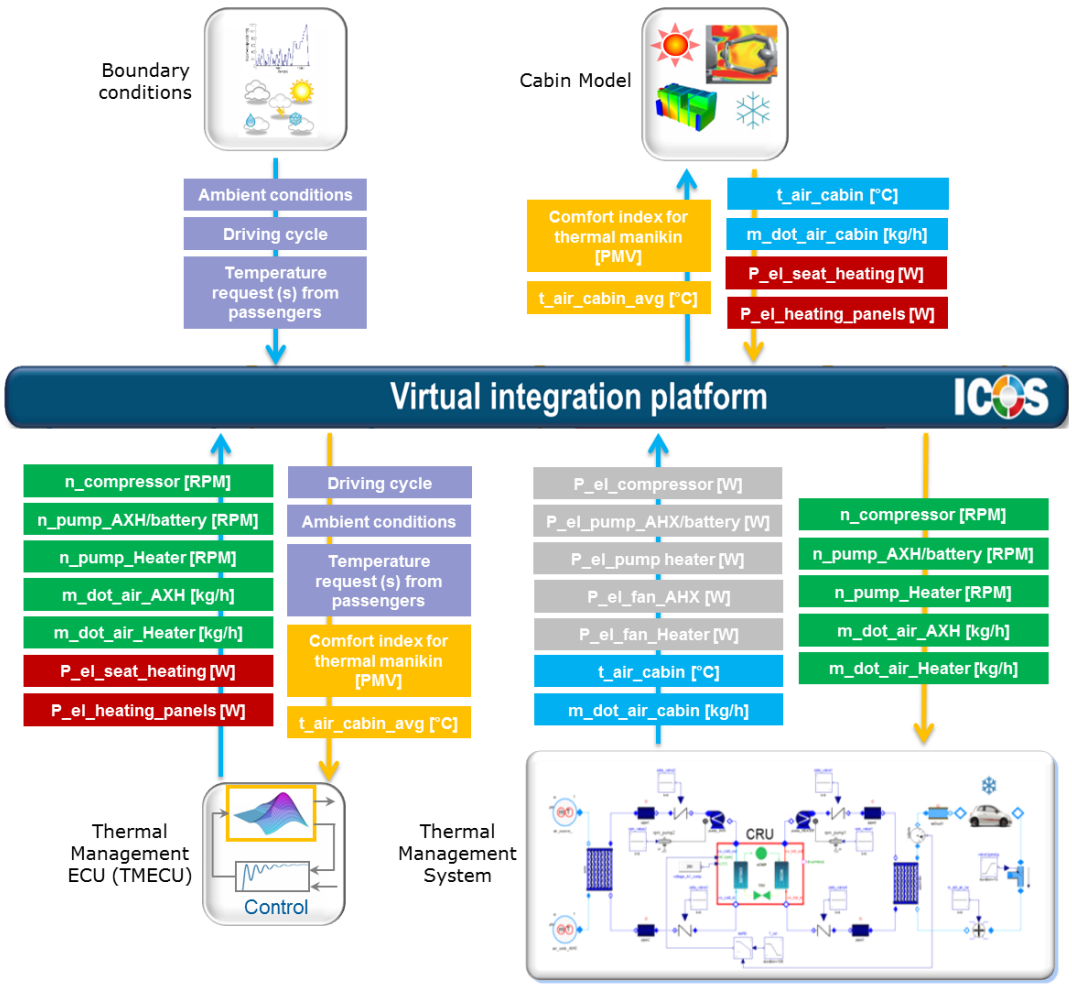

Figure 1: Schematic of the simulation architecture for the thermal management system

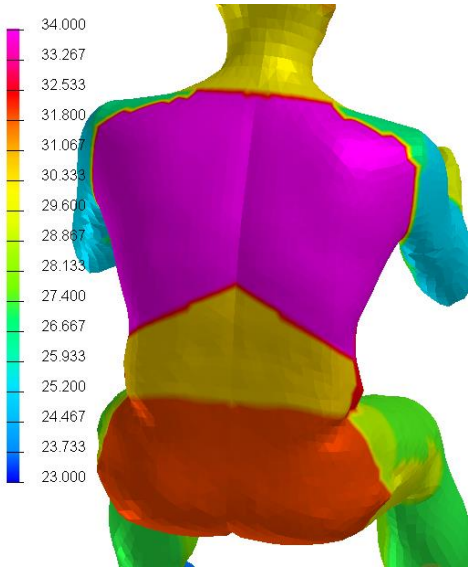

Figure 2: Virtual comfort dummy showing different temperatures in different body regions

Workpackage 2 - Advanced thermal management components and technologies:

In work package 2 the final design for the battery with integrated phase change material, the cooling plate and thermally insulating housing has been finished. Figure 3 shows a digital mock-up of the battery layout with the cooling plate on the bottom. As soon as the already ordered battery cells arrive, the assembly of the battery can start.

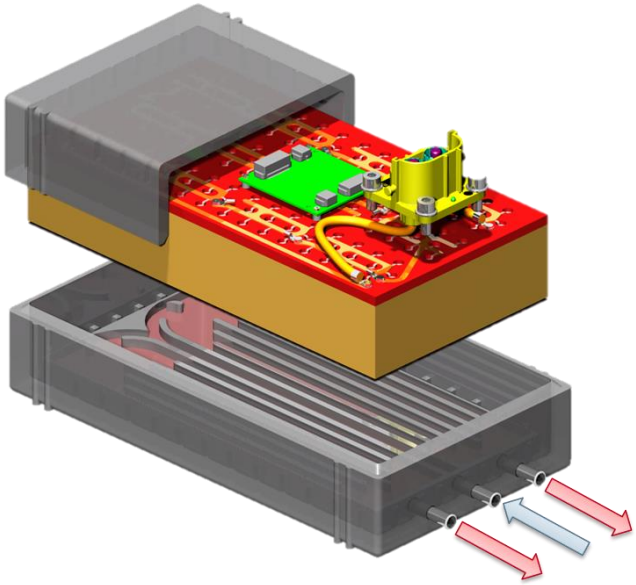

Figure 3: Battery layout with cooling plate and innovative housing

The compact refrigeration unit is a key subsystem of the project and aims to provide, efficiently, the required thermal energy to the components of the Fiat 500e that require active thermal management. The design of the compact refrigeration unit for an implementation in the demonstrator vehicle has been finalized (Figure 4).

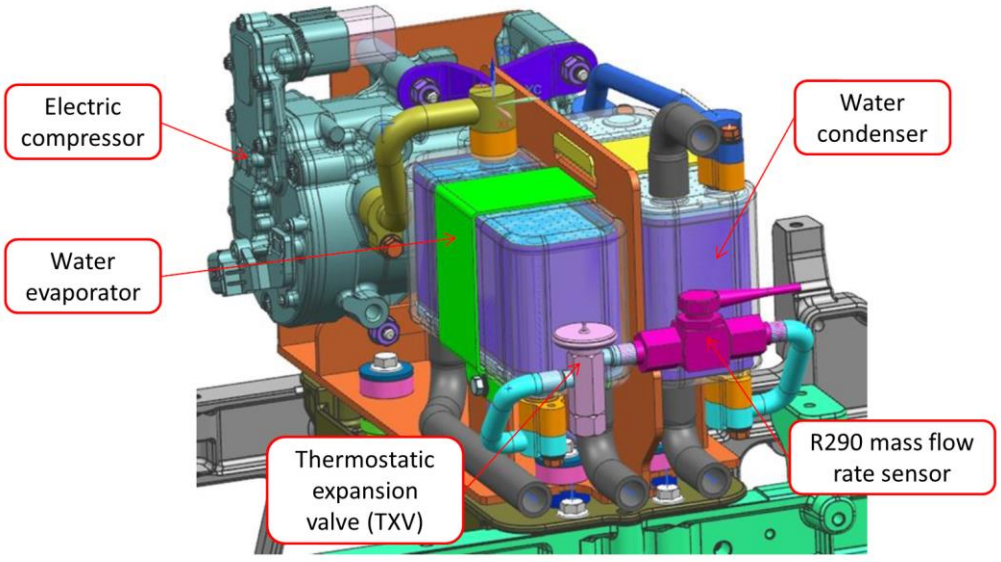

Figure 4: Compact refrigeration unit

Further technologies, which were developed in work package 2 are the smart cover panels as well as the heated and cooled seat (Figure 5). They are both dedicated to the reduction of energy consumption of interior thermal passenger comfort via the creation of a micro climate around the passengers. The final design for both technologies is ready and the assembly for testing in the demonstrator vehicle will start during the next weeks.

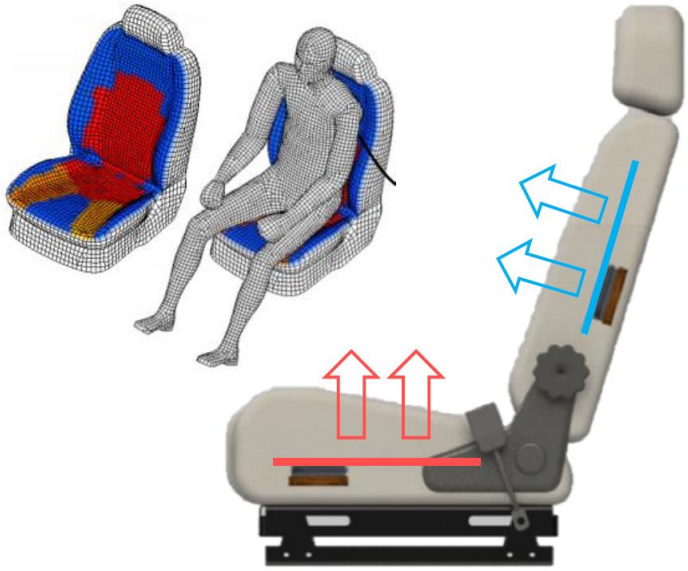

Figure 5: Heated and cooled seat with peltier elements

Workpackage 3 - Energy management architectures & operation strategies:

Work package 3 generally treats advanced energy management strategies, including technologies for energy harvesting. The preconditioning strategy exploits a novel concept, using the available energy in the vehicle in the most efficient way by predicting the driver's behavior (i.e. when (s)he approaches to the vehicle), and providing a custom conditioning of the cabin room according to the personal user profiles (temperature), which are saved in a user's smartphone (OPTEMUS app). Figure 6 shows a schematic of the preconditioning system, where the smartphone of the user is connected through a cloud server with the thermal management ECU (TMECU) of the vehicle.

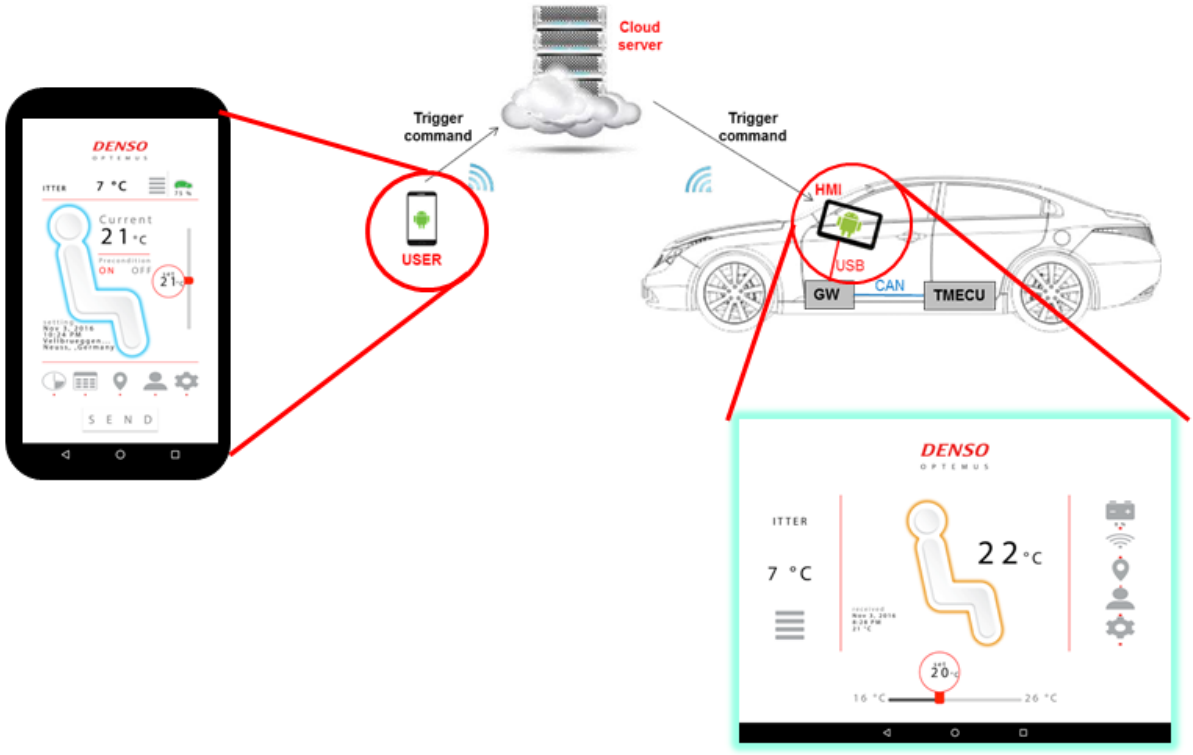

Figure 6: Schematic of the preconditioning system

Further, the eco-driving and eco-routing strategies have been developed. Figure 7 shows the calculated optimal speed profile compared to the measured one as well as an evaluation of the driving style via the cell phone application.

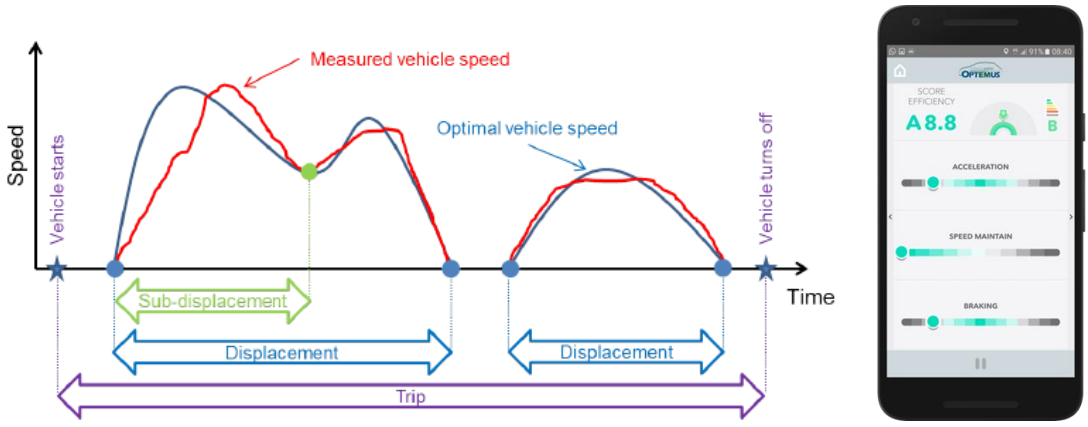

Figure 7: Eco-driving optimal speed profile and cell phone application

Both eco-driving and eco-routing have already been tested in a Fiat 500e, which has proven the energy savings of 10 % and 13 % respectively for the chosen routes in the city of Turin.

In order to optimize the operation strategy of the cooling and heating system, simulation results of the sophisticated Dymola/Modelica model have been used to train an artificial neural network (ANN) model (schematic see Figure 8). The latter has the advantage of very low calculation time, which enables the use of optimization tools, that try a high number of different combinations and choose the best ones in terms of energy consumption.

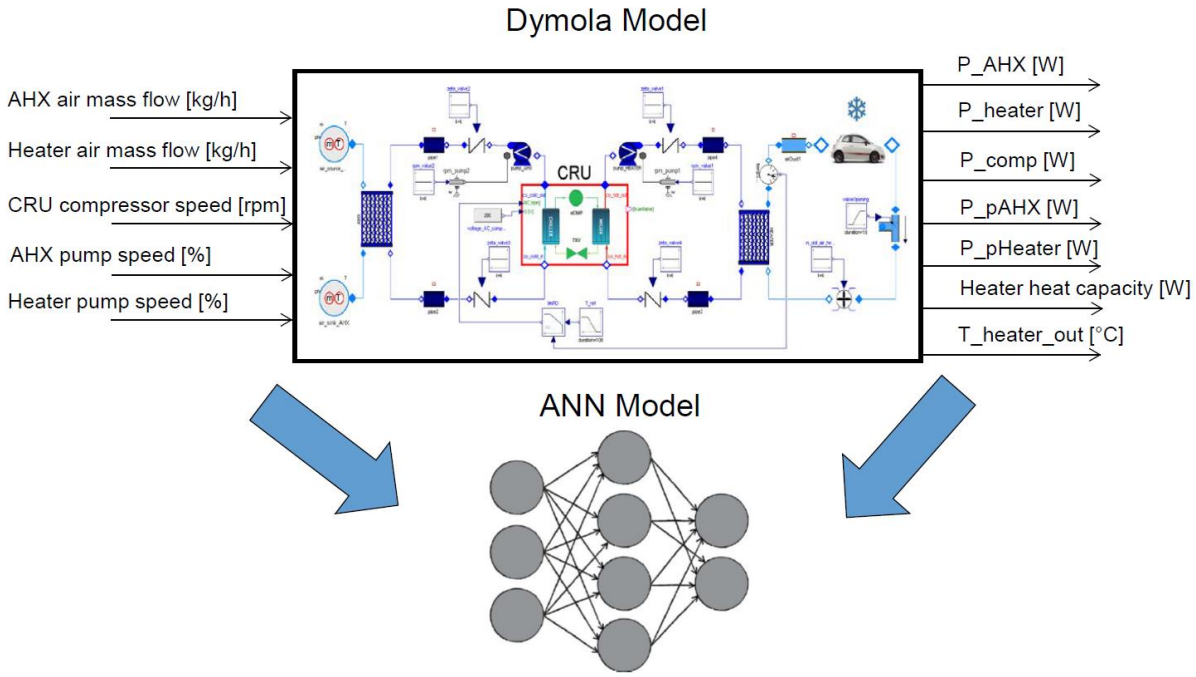

Figure 8: Schematic of the Dymola/Modelica model to train an artificial neural network (ANN) model

For both energy harvesting technologies (regenerative dampers and flexible photovoltaic modules – see Figure 9) prototypes have been assembled and tested. The ongoing work aims at estimating the harvested energy depending on different use cases as well as the design and the building of improved prototypes.

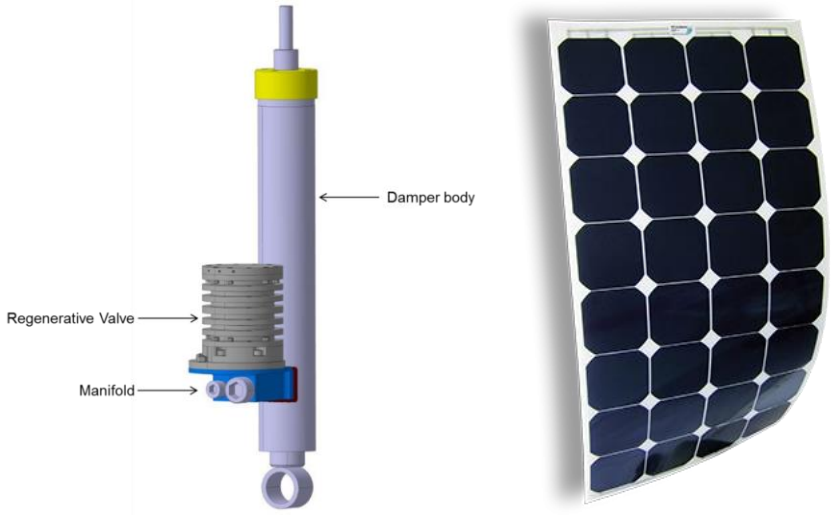

Figure 9: Regenerative damper and flexible photovoltaic modules

Workpackage 4 - System integration demonstrator vehicle and validation:

In work package 4 the second project period was devoted to the definition of the thermal management system for the OPTEMUS demonstrator vehicle. Therefore, the architecture was defined in terms of lay out, functions and components. Further, a packaging study was carried out considering dimensional and functional constraints of the assembly process of the demonstrator vehicle. Figure 10 shows the packaging study for the thermal management system in the vehicle.

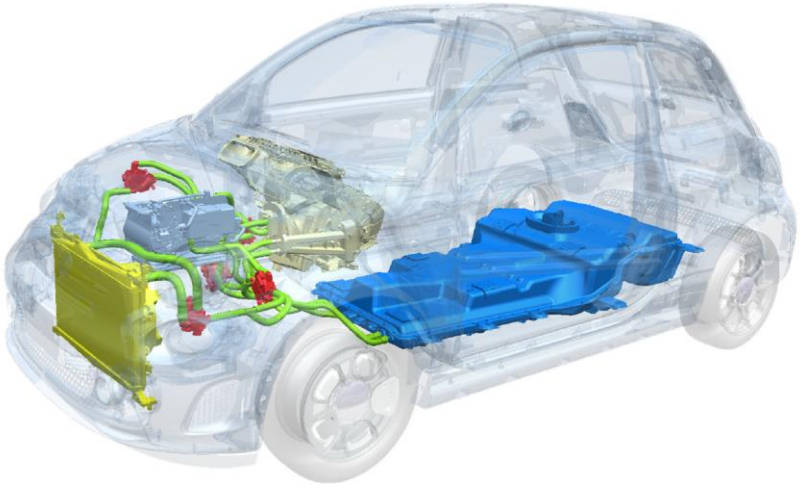

Figure 10: Packaging study for the thermal management system

The next steps are now the actual buildup of the thermal management system in the demonstrator vehicle (Fiat500e), which requires an adaption of the actual system for the installation of the new components in the vehicle engine bay and car cabin. Further, the installation of the Thermal Management Electronic Control Unit (TMECU) (including the control software) in the luggage compartment will be done.

Dissemination & Exploitation:

The dedicated dissemination and exploitation strategy for the OPTEMUS project has led to the following events and publications:

- The first clustering event took place in November 2016 in Bologna, Italy. There, 38 partners from 3 EU-funded projects (JOSPEL, XERIC and OPTEMUS) organised a one-day event to share their insights on the latest trends and technologies to improve energy efficiency in electric vehicles. The OPTEMUS project contributed with 3 presentations:
    - Alois Steiner (Virtual Vehicle Research Center): OPTEMUS project: Leveraging low energy consumption and energy harvesting
    - Andrés Caldevilla (DENSO): Preconditioning and Human Machine Interface
    - Felix Weidmann (Fraunhofer): How to create a micro-climate around the passengers to dispense with climatizing the entire cabin

- The Twelfth International Conference on Ecological Vehicles and Renewable Energies (EVER) was held on April 11-13 2017 in Monaco. The OPTEMUS team was well represented at the EVER Conference with the following presentations (Figure 11):
    - Alois Steiner (Virtual Vehicle Research Center): “Reducing the Energy Consumption for Comfort and Thermal Conditioning in EVs”
    - Andres Caldevilla (DENSO): “Efficient Cabin and Powertrain Preconditioning for EVs with a Water-to-Water Heat Pump System”
    - Felix Weidmann (Fraunhofer): “Insulating Sandwich Housing Structures for the Thermal Management of Battery Packs”
    - Gero Mimberg (IKA, RWTH Aachen): “Battery Concept to Minimize the Climate-Related Reduction of Electric Vehicles Driving Range”

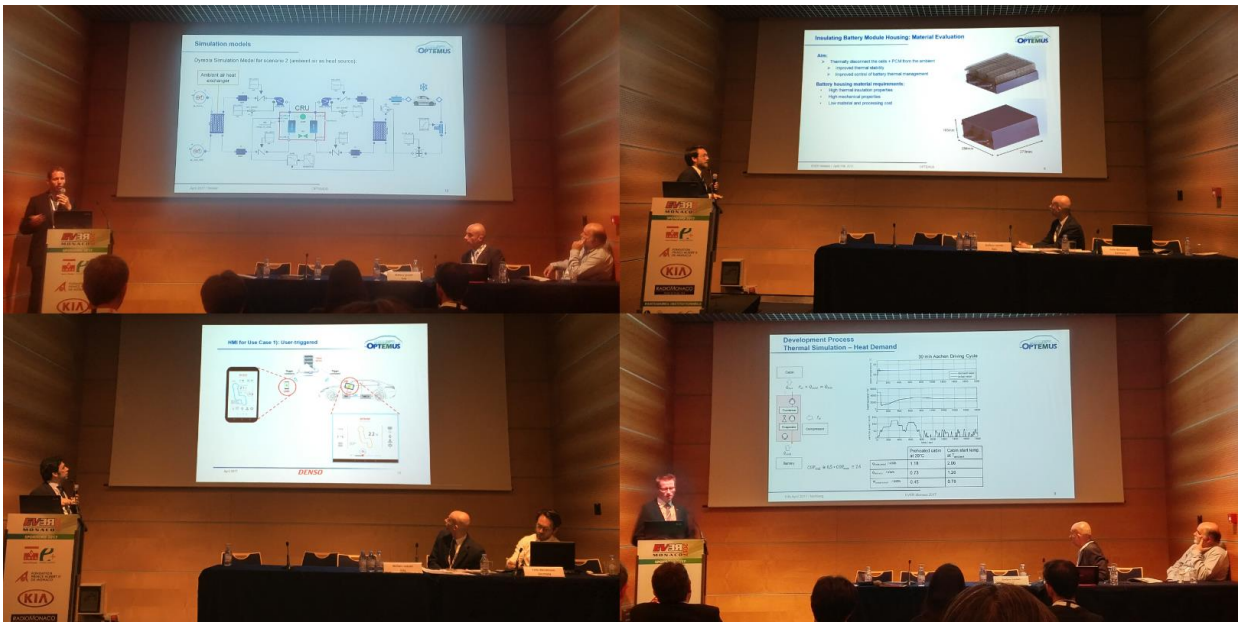

Figure 11: Presentations from the OPTEMUS project at the EVER conference

- Giovanni De Nunzio (IFP Energies nouvelles) presented a work entitled “A Model-Based Eco-Routing Strategy for Electric Vehicles in Large Urban Networks” at the IEEE 19th International Conference on Intelligent Transportation Systems (ITSC 2016) in Rio de Janeiro, Brazil, on November 4th 2016. A novel eco-routing navigation strategy and energy consumption modeling approach for electric vehicles were proposed in this work as a contribution to the OPTEMUS project.

- Giovanni Spagnuolo (UNISA) presented the Maximum Power Point Tracking system for the Photovoltaic energy harvester at the IEEE conference "ICCEP-2017" (IEEE International Conference on Clean Electrical Power, Figure 12) in Santa Margherita Ligure (Italy, June 27-29, 2017).

Figure 12: Presentations from the OPTEMUS project at the IEEE International Conference on Clean Electrical Power

- Andrés Caldevilla held a presentation with the title “Efficient cloud-based cabin preconditioning for EVs with a compact heat pump system” at the 30th International Electric Vehicle Symposium & Exhibition in Stuttgart (Germany, October 9-11, 2017)

The next OPTEMUS newsletter will be published in September 2018 - in the meanwhile the latest news and updates can be found on the website:

www.optemus.eu

Best regards,

Alois Steiner

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