E-VOLVE
EV FOR LIFE, VALUE, EFFICIENCY

NEWSLETTER 04/23

Welcome to our first E-VOLVE Cluster newsletter of 2023. A newsletter, we admit saying we are proud of as it reflects the transitions we have made in the last few months. When the cluster was founded under H2020,the founding projects started this activity with a lot of energy. With many of these projects concluding their activities by the end of 2022, the question of how to continue with the cluster activities came up. We were excited to announce during the TRA2022 in November, that the continuation of the cluster was ensured and that the promise made there turned into cluster reality in the meantime.

For us, this newsletter stands for closure of very successful projects, important milestones of ongoing projects and new members joining – all together exciting new innovations around every corner.

UPDATE ON KNOWN CLUSTER MEMBERS

Multi-Moby

The Multi-Moby project has been ongoing for almost 2.5 years, and three of the six Multi-Moby electric vehicles (EVs) have been completed as seen in Figure 1. The six vehicles include pick-ups, vans, and passenger vehicles with a 4-wheel-drive (4WD) on-board centralised powertrain architecture, with powertrain options of two 15

Figure 1: The Multi-Moby vehicles; from left: Multi-Moby pick-up, Multi-Moby van for food delivery, and Multi-Moby passenger vehicle.

kW 100 V air-cooled highly efficient powertrains based on permanent magnet assisted synchronous reluctance motors, two 9.5 kW 48 V air-cooled powertrains with belt transmissions, and two 15 kW 48 V liquid-cooled powertrains. All Multi-Moby EVs share the same body frame using Super High Strength Steels (SHSS), modular battery packs for 48 V and 100 V applications, electrically controlled steering systems, dashboard, suspension systems, E/E architecture, interfaces for automated driving functionalities, auxiliaries, as well as occupant safety features and vulnerable road user (VRU) protection.

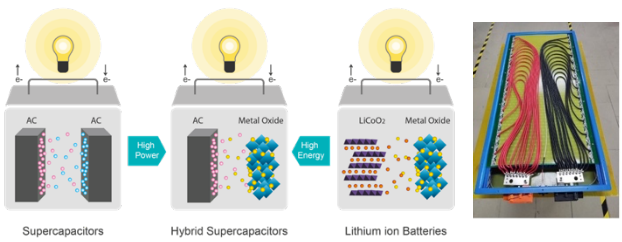

Figure 2: left - Simplified construction of a hybrid supercapacitor-battery cell; right - hybrid supercapacitor-battery cells assembled in the Multi-Moby vehicle battery compartment

Another major milestone is the completion of a 48 V battery pack using novel hybrid supercapacitor-battery cylindrical cells that pose no fire risk. The hybrid supercapacitor utilises one electrode from a supercapacitor and another electrode from a lithium-ion battery (Figure 2, left), combining the high power density of capacitive energy storage with the high energy density of batteries. The battery pack design activities have focused on: i) packaging the design to improve cabin space for passenger comfort; ii) optimising cell connections for minimising electric resistance; iii) thermal insulation and heat dissipation for reducing cell ageing and risk of damage, including a battery tray made of polymeric composites with thermal insulating properties (Figure 2, right); iv) customising the battery management system to improve battery life and performance; v) effective mechanical assembly; and vi) safety according to the UN/EC R100 regulations.

Further details about recent developments in the Multi-Moby project can be found in our TRA 2022 conference paper (Eichinger, et al., 2022). In the final six months of the Multi-Moby project, the focus will be on new solutions for automated driving through the use of gimbal payloads, which are intended to become a low-cost alternative to the widely adopted lidars and radars.

Follow the Multi-Moby project:

SELFIE

The SELFIE project is in its 5th year of development and in the final integration and validation phase of the battery pack with the novel thermal management system. SELFIE battery system and control schemes are being integrated into the Fiat Doblo demonstrator vehicle.

In details, last months' challenges with the integration of the components into the battery pack led to a project extension for an extra 5 months. During the new amendment (until July 2023), time is given to re-evaluate and re-design the battery pack in order to meet the objective of green vehicle call. Figure 3 shows the new system that is developed, with the focus on the system safety and robustness over time where the PCM heat buffer is now not included in the new design. Life cycle analysis is currently being conducted to assess cost-efficiency on the innovative components and the developed battery pack, from design to the full assembly. The cold storage device including PCM buffer, refrigerant pump and control strategy are being finalised and integrated into the car.

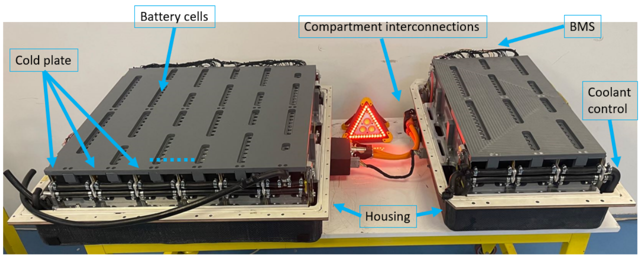

Figure 3: Big and Small box base part assembly

SELFIE participated in the RTR2023 conference and had the opportunity to disseminate the progress results. Learn more about research topics carried out in SELFIE during the last 4 years, in the list of scientific publications here.

Follow the SELFIE project:

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INTRODUCING NEW CLUSTER MEMBERS

EM-TECH

The EM-TECH project consists of partners from five different countries and is coordinated by the AVL List GmbH. It started on January 1st 2023 and will run for three years.

EM-TECH brings together 10 participants from industry and academia to develop novel solutions to push the boundaries of electric machine technology for automotive traction, through:

- innovative direct and active cooling designs;
- virtual sensing functionalities for the high-fidelity real-time estimation of the operating condition of the machine;
- enhanced machine control, bringing reduced design and operating conservativeness;
- electric gearing to provide enhanced operational flexibility and energy efficiency;
- digital twin based optimisation, embedding systematic consideration of Life Cycle Analysis and Life Cycle Costing aspects since the early design stages; and
- adoption of recycled permanent magnets and circularity solutions.

EM-TECH obtained the support of several car makers (AUDI AG and Changan UK R&D Centre Ltd) as well as a Tier 1 supplier (PUNCH Turino S.p.A.), which will strengthen the exploitation strategy.

Follow the EM-TECH project:

RHODaS

The RHODaS project has been funded under the EU call "Nextgen EV components: Integration of advanced power electronics and associated controls". It started on May 1st. 2022 and will end on October 31st 2025. The RHODaS project aims at developing a high-voltage, high-power electric powertrain consisting of the power converter and the electric motor. The first will use WBG semiconductor materials, as well as cutting-edge digital technologies to improve architecture efficiency, power density, reliability, cost and sustainability. Multi-disciplinary approaches of modular power electronics for Integrated Motor Drive (IMD) and ecodesign considerations are addressed to create compact solutions that can be integrated in a wide range of heavy-duty transport, enabling these electric vehicles to be more sustainable and autonomous throughout the entire lifecycle of their components.

The project's objectives are:

- Improve efficiency and performance of power converters while increasing affordability of powertrains for heavy-duty EVs;
- Reduce size and weight of the power converters;
- Integrate the power electronics and thermal management system in a modular and compact integrated motor drive;
- Apply digital technologies and sensors for advanced on-line monitoring and

prediction techniques using Big Data Analysis and Artificial Intelligence;

- Integrate ecodesign, material criticality and circularity considerations into the RHOdaS powertrain solution;
- Promote collaborative research and interaction between academia and industry throughout the entire supply chain.

Coordinated by Universitat Politècnica de Catalunya, the project has started in May 2022 and gathers 9 European partners.

Follow the RHODaS project:

HighScape

HighScape is a three year project that started on January 1st and is coordinated by AVL List GmbH.

Focused on BEV architectures with distributed multiple wheel drives, and, specifically, in-wheel powertrains, HighScape will explore the feasibility of a family of highly efficient power electronics components and systems, and including integrated traction inverters, on-board chargers, DC/DC converters, and electric drives for auxiliaries and actuators. The proposed solutions will be assessed on test rigs and on two differently sized BEV prototypes. The project will result in:

- component integration with the incorporation of the WBG traction inverters within the in-wheel machines to achieve zero footprint of the electric powertrain on the sprung mass; the functional integration of the traction inverter with the on-board charger, and the incorporation of the latter and the DC/DC converters within the battery pack; and the implementation of multi-motor and fault-tolerant inverter solutions for the auxiliaries and chassis actuators;
- novel solutions, including the implementation of reconfigurable winding topologies of the drive, as well as integrated and predictive thermal management at the vehicle level, with the adoption of phase changing materials within the power electronics components;
- the achievement and demonstration of significantly higher levels of power density, specific power and energy efficiency for the resulting power electronics systems and related drives;
- major cost reductions thanks to the dual use of parts, subsystem modularity, and model-based design to eliminate overengineering; and
- increased dependability and reliability of the power electronics systems, enabled by design and intelligent predictive health monitoring algorithms.

Through HighScape, the participants will establish new knowledge and industrial leadership in key digital technologies, and, therefore, directly contribute to Europe's Key Strategic Orientations as well as actively support the transformation towards zero tailpipe emission road mobility (2Zero).

Follow the HighScape project:

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HiPE

The HiPE project is part of the EU Call "HORIZON-CL5-2021-D5-01-02. Nextgen vehicles: Nextgen EV components: Integration of advanced power electronics and associated controls (2ZERO)" and aims to develop a new family of highly energy efficient, cost-effective, modular, compact and integrated wide bandgap (WBG) power electronics solutions for the next generation of battery electric vehicles (BEVs).

The project's outputs will be:

- A scalable and modular family of WBG-based traction inverters
- A family of integrated WBG-based bidirectional on-board chargers (OBCs) and HV/LV DC/DC converters
- Integrated, fault-tolerant and cost-effective GaN-based power electronics for high-voltage ancillaries and chassis actuators

For this, four experimental Use Cases (UCs) were developed covering the HiPE outputs:

- Integrated WBG-based traction inverters, HV/LV DC/DC converters and electric motors for high volume passenger vehicle up to 150 kW
- Integrated WBG-based traction inverters, HV/LV DC/DC converters and electric motors for light commercial vehicles
- Integrated WBG-based on-board chargers and HV/LV DC/DC converters
- Integrated and fault-tolerant power electronics (PEs) for ancillaries and chassis components

Follow the HiPE project:

SCAPE

A new promising player in powering sustainable e-mobility and promoting zero-emission transport is 'on the road'!
SCAPE brings together 9 innovation-driven partners in a 4-year EU-funded endeavor to revolutionise the design and implementation of power converters for next generation electric vehicles.
Moving away from traditional approaches in powering e-mobility, SCAPE aims to cater for the lack of standardization on the EV power conversion system designs across different vehicles and contribute both to a cost-reduction in the EV powertrain and to an increased performance of power electronics for NextGen electric vehicles.

SCAPE's main player, the Switching-Cell Array (SCA) concept, merged with wide bandgap (SiC and GaN) technologies promises both modularity, thus great cost reduction in powertrain implementation, and an improved EV performance in terms of efficiency, power density, reliability, and autonomy. SCAPE's work on advanced functionalities, such as prognosis and health management through online monitoring and digital twins, sets out to positively impact the EV user experience as well!

SCAPE's knowledgeable and inspired team, led by IREC - Institut de Recerca en Energia de Catalunya, includes:

- automotive industry experts,
- researchers in power converters,
- power electronics suppliers,
- specialists in modelling and control systems,

- e-mobility connoisseurs,
- experts in environmental life cycle assessment,
- innovation specialists,
- scientific communication strategists.

Qualified expertise brings 'Scapers' together on a shared Horizon Europe-sponsored mission to boost electrification in transport by exploring modular, scalable and cost-effective designs of power converters for EV application.

Follow the SCAPE project:

POWERDRIVE

With the purpose of transforming road transportation in Europe to zero-emission mobility, POWERDRIVE project, funded by the European Commission, aims at developing next generation, highly efficient, cost-effective, and compact power electronics solutions that integrate a portfolio of technologies for multi-objective optimisation of electric powertrains of battery electric vehicles.
These integrated solutions can be applied to both low and high-performance vehicles, and they will be suitable for diverse types of electric vehicles.

The concept of POWERDRIVE is that all the experience and expertise of the project partners in the development of electric drivetrain components is leveraged and lead into the integration of advanced power electronics solutions for an optimised powertrain.
This concept brings additional opportunities to strengthen Europe's supply chain in electromobility for road transportation and to achieve zero-emission road mobility:

- Developing compact electric powertrains of BEVs and in SiC traction inverters that will allow further conception of novel topologies and arrangements to achieve integration of components in motors and batteries.
- Improving and downsizing passive components, such as magnetics, cooling systems and interconnections, as well as integrating sensors and circuitry in semiconductor components. Both points are essential in achieving next generation EV components and in meeting the efficiency, cost, size, and weight targets.
- Using reliable surrogate models to integrate power electronics components in circuit/system level simulation.
- Transport modelling as well as analysing the human effect on the driving and load profiles experienced by a vehicle.

Follow the POWERDRIVE project:

COMING SOON

The next E-VOLVE Cluster newsletter of 2023 will offer you information about exciting projects successfully closing their activities.

The research leading to these results have received funding from European Union's Horizon Europe research and innovation programme H2020 (GA No. 824290, 101006953) and Horizon Europe (GA No. 101056760, 101096083, 101056824, 101056896, 101056781 and 101056857). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the funding authority. Neither the European Union nor the funding authority can be held responsible for them.

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