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CORDIS Results Pack on

electric vehicles

A thematic collection of innovative EU-funded research results

September 2023

Enabling a successful transition towards electric-powered road transport

Research and Innovation

Contents

Editorial

The EU has declared its clear intention to transition to a more sustainable and low-carbon economy; decarbonisation of the transport system is at the centre of this effort. Towards this goal, the electric vehicle revolution has been set in motion, and Europe is preparing to lead the way. This Results Pack on Electric Vehicles highlights 10 projects funded by the Horizon 2020 research and innovation funding programme delivering Europe's green mobility targets.

Transport is an essential component of robust societies, connecting people, underpinning trade, and fostering growth. However, it is a major environmental burden. In Europe alone, the transport sector is responsible for around one quarter of greenhouse gas emissions, significantly hindering the EU's goals towards climate neutrality.

The European Green Deal emphasises that transport must become 'drastically less polluting,' which translates into a 90 % emissions reduction by 2050 compared to current levels if genuine progress is to be made. Furthermore, the EU Sustainable and Smart Mobility Strategy, adopted in 2020, put European transport on track for a future with significantly reduced emissions.

The shift towards low- or even zero-emission mobility is a precondition for the success of Europe's carbon neutrality goals. Electrification of road transport vehicles is therefore a necessary step towards improving air quality and reducing CO_2 emissions in European cities, in line with European green policy objectives.

Accelerating the uptake of electric vehicles

Against this background, electric vehicles (EVs) are emerging as the solution that will help Europe reduce its reliance on conventional fuels. Sales of EVs soared in Europe in 2022, showing that Europeans are onboard with the effort to transition to a climate-neutral society via vehicle electrification. To get there, however, major barriers to wider EV adoption must be lifted – namely battery performance, affordability, and charging infrastructure.

The 10 EU-funded projects featured in this Results Pack represent a wide range of EU efforts to overcome the challenges facing EV uptake. They showcase the latest research and innovation, as well as developments and applications related to e-mobility, with results that plot a clear trajectory towards the envisaged clean, green transport sector.

Cobalt-free Li-ion battery technology for next-generation electric vehicles

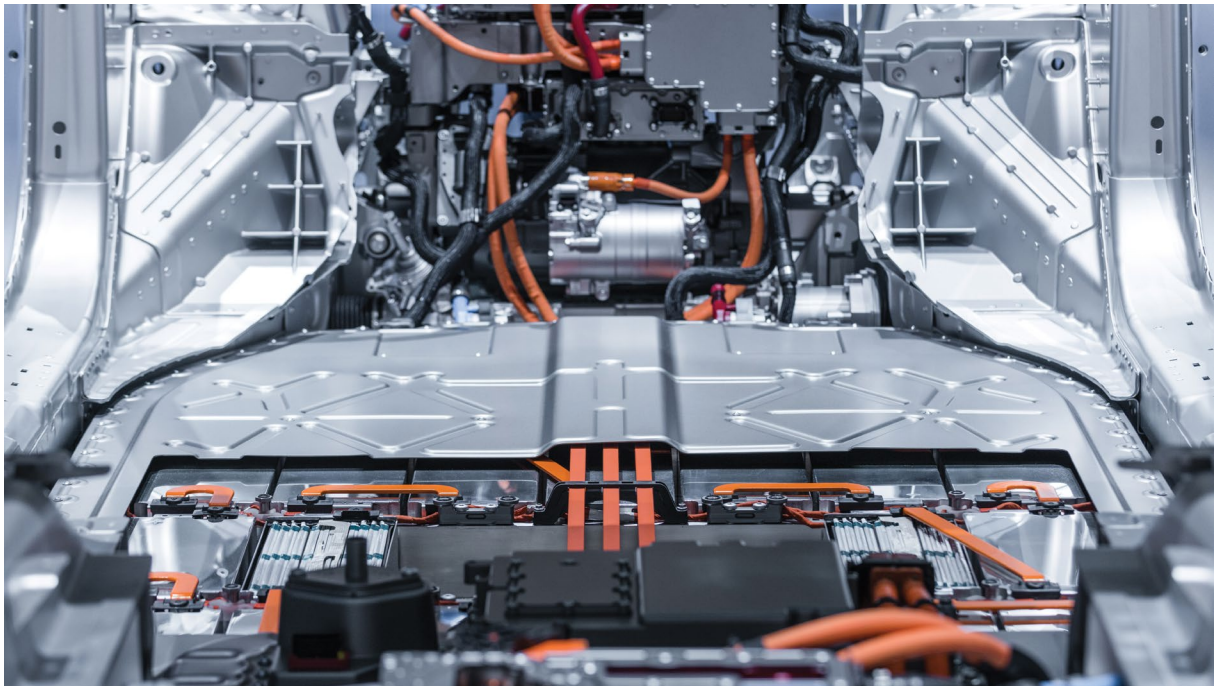
Electric vehicles have become increasingly popular, but the need for improved battery technology remains a critical challenge.

Electric vehicles (EVs) have come a long way in recent years, but there are still several shortcomings associated with their batteries. Limited driving range, long charging time and high cost are among the most significant issues.

As battery technology evolves, it is likely these issues will be addressed. The EU-funded COBRA project is set to shake up the world of EVs by developing a cobalt-free lithium-ion (Li-ion) battery technology for the next generation of electric cars.

According to Jordi Jacas, COBRA project coordinator, the project aims to introduce advanced and sustainable components for enhanced safety and performance, both at the cell and battery pack levels.

"Our goal is to develop a novel Li-ion battery technology that overcomes many of the current shortcomings of EV batteries," explained Jacas, who is a senior researcher at the Catalonia Institute for Energy Research battery section.



Sustainability, safety and performance

Cobalt, or Co, is an important ingredient in Li-ion battery cathode production. It accounts for a quarter of the cost of the battery. But since cobalt is scarce and prices are notoriously volatile, scientists are searching for ways to remove it from batteries.

COBRA was born from a need to create sustainable Co-free materials with improved cathode performance and an advanced battery management system for better battery safety and performance.

Combining these two characteristics led to the creation of COBRA, which worked towards the development of an innovative Co-free cathode technology with an increased capacity compared to current electrodes and operating at high voltages. The research team also looked at silicon-based composites obtained from waste stream recycling for long-life performance in the anode. Here the focus was on electrolyte stability and safety.

That's not all. COBRA also aimed to improve sustainability and performance while reducing costs at the cell level. The team conducted research at the battery pack level, which involved the integration of sensors, development of an advanced battery management system, and system testing and validation.

Jacas emphasised that COBRA's final goal is to deliver a demonstrator with a very specific cost target of no more than EUR 90 per kWh. "We have introduced life-cycle analysis studies at the early stages to ensure a minimal negative impact on the environment," he said.

"COBRA aims at improving all aspects of batteries, to create a competitive battery technology from a performance, cost, environmental and social perspective," added Jacas.

From suppliers and manufacturers to end users and certification bodies

"Implementing a project demands the collaboration of a multi-stakeholder consortium with a multidisciplinary approach, with players across the value chain, from material suppliers and manufacturers to end-users and certification bodies," he said. "The fact that all project partners are European will ensure that the knowledge, as well as commercialisation, remains in Europe."

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This will help to overcome critical disconnects between stakeholders and ensures that project outcomes will be utilised commercially – and the project's strategic importance for European competitiveness is evident.

"The main project outcomes will be fast implementation to launch competitive next-generation Li-ion generation 3b mass production, enhanced Li-ion battery safety, increased cell-level energy densities and much more," explained Jacas.

The COBRA project offers a promising future for EVs by making them safer and more efficient, and reducing their environmental impact.

PROJECT
COBRA – CObalt-free Batteries for FutuRe Automotive Applications

COORDINATED BY
Catalonia Institute for Energy Research, Spain

FUNDED UNDER
H2020-EU.3.4.

CORDIS FACTSHEET
cordis.europa.eu/project/id/875568

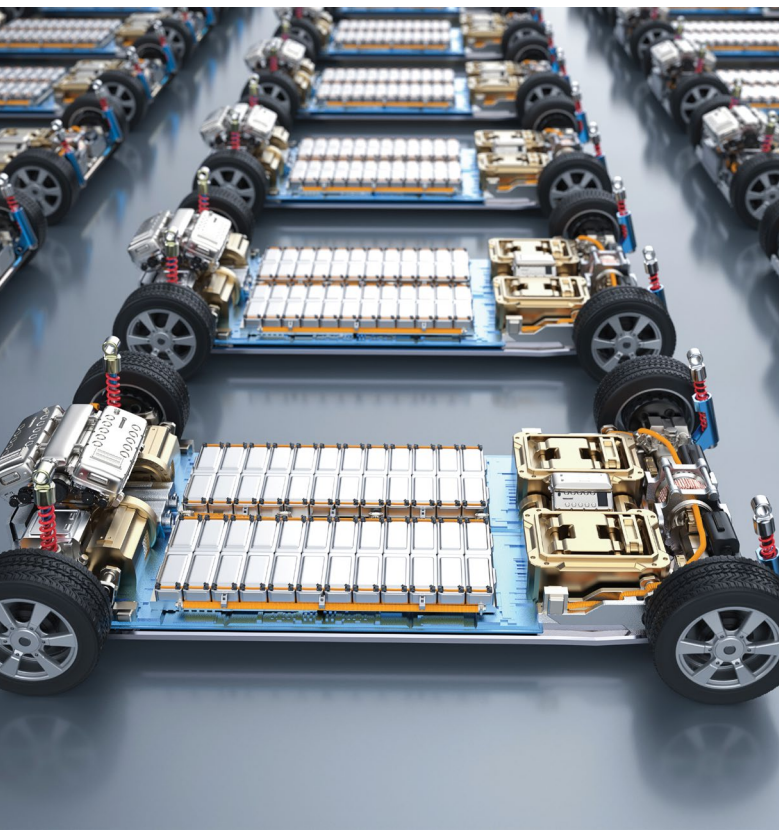
PROJECT WEBSITE
projectcobra.eu/

Driving down costs of electric vehicle batteries

At the forefront of electric vehicle innovation, the EU-funded DEFACTO project is leading the charge in battery cell innovation and cost reduction in Europe.

The transition to electric vehicles (EVs) has sparked a surge in demand for battery cells, and Europe is gearing up to become a major player in the manufacturing of these crucial components. With companies investing billions of euros in new factories and production facilities, Europe is poised to dominate the global market for EV batteries.

The EU-funded DEFACTO project set out to revolutionise the EV battery cell manufacturing industry in Europe. Inspired by the projected massive increase in the use of EVs, and driven by opportunities for a drastic reduction in costs and an increase in their functionalities, DEFACTO set out to make sure the path is as smooth as possible.



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Specifically, the project addressed the challenges of reducing the cost of battery packs, which currently account for 35 % of EV costs, by improving energy density and optimising the manufacturing process.

"The basic components of batteries, electrochemical cells, represent an important market for the European industry, estimated at EUR 250 billion in 2025," explained Elixabete Ayerbe, DEFACTO project coordinator. "A battery pack is composed of multiple modules, each of which contains between 6 and 12 cells. Cells are a cost-intensive element which represents near 70 % of battery packs' composition."

Multiscale models used to optimise cell design

To accelerate the battery cell manufacturing process chain, DEFACTO developed multiphysic and multiscale models to better understand the material, cell and manufacturing process behaviour. This was aimed at accelerating cell development and the research and innovation process and optimising cell design and functionality.

"Currently, companies incur significant laboratory and personnel costs to improve the cell design and manufacturing process of batteries," stated Ayerbe. "In this sense, DEFACTO has implemented a multidisciplinary method that combines laboratory work, prototyping and multiphysics multiscale models to boost and accelerate the battery cell manufacturing process chain."

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The project also contributed to the standardisation of measurement procedures, the creation of new market opportunities and the improvement of industry competitiveness.

The validated computational simulations will assist tailoring new optimum cell designs, optimising manufacturing steps of electrode processing and electrolyte filling, and shaping new-generation 3b materials.

New high-capacity Li-ion cell generation 3b battery

DEFACTO used two cell technologies for the automotive market. The first is a commercial NMC622/G cell taken from the product portfolio of one of the project partners. The second is a last-generation prototype (NMC-811/G-Si). The two cell chemistries correspond to the main interest of the market. In terms of market forecasts, a wide adoption of NMC-811 cathodes in the EV market is expected after 2025.

"The DEFACTO approach allowed developing a new high-capacity and high-voltage Li-ion cell generation 3b battery," explained Ayerbe. "This increased the understanding of multiscale mechanisms and their interactions, reducing R&D cell development resources, and therefore unlocking an innovation-led cell manufacturing industry in Europe."

By contributing to the development of the next generation of high-capacity and high-voltage Li-ion cell batteries, which are the major power source for EV batteries, the project has allowed for the acceleration of cell development and R&I process. DEFACTO works towards optimising cell design and functionality.

"Developing the DEFACTO workflow, a framework that mimics the main cell manufacturing steps such as the electrode processing and electrolyte filling and later predicts cells' performance and ageing, will turbocharge the development of next-generation Li-ion batteries," noted Ayerbe.

PROJECT
DEFACTO - Battery DEsign and manuFACTuring Optimization through multiphysic modelling

COORDINATED BY
Fundación CIDETEC, Spain

FUNDED UNDER
H2020-EU.3.4.

CORDIS FACTSHEET
cordis.europa.eu/project/id/875247

PROJECT WEBSITE
defacto-project.eu/

Innovations make 1 000 km EV trips feasible

The large-scale roll-out of electric vehicles is highly dependent on consumer acceptance and trust. EU-funded researchers have optimised components to ensure long-distance performance, helping to make electric cars a more attractive and reliable option.

Falling prices and technological breakthroughs have made electric vehicles (EVs) an increasingly affordable and viable option for many consumers. User acceptance however still remains an issue. In particular, consumers perceive a lack of recharging infrastructure, are put off by long charging times and worry about an EV's limited driving range. In addition, adapting automotive manufacturing methods to the specific needs of EV vehicles can be slow and costly, while many EV components are not as mature as internal combustion engine parts, and require further optimisation. This has led to growing recognition of the need for bespoke EV solutions to address these concerns, deliver manufacturing efficiencies and build vehicles with higher performance.

In-wheel technology

By migrating e-motors to the corners of vehicles, space is freed up for other purposes such as enhanced vehicle structures for improved safety, or increased passenger room.

One such innovation has been the integration of Elaphe in-wheel motors. These motors are located in the two rear corners of the vehicle, to directly drive the wheels. "In-wheel motors present high potential in terms of energy efficiency and vehicle dynamics," explains EVC1000 project coordinator Eric Armengaud. "By migrating e-motors to the corners of vehicles, space is freed up for other purposes such as enhanced vehicle structures for improved safety, or increased passenger room."

Optimised EV components

EVC1000, which brought together 10 partners from across Europe and was coordinated by AVL List in Austria, was set up to focus on optimising EVs with this innovative in-wheel drivetrain layout. In particular, the project looked at brake and suspension control, together with in-wheel drivetrain, to achieve better vehicle dynamics. The objective was to develop new EV components that could deliver significant advantages in terms of energy efficiency – and thus vehicle range – and target other areas where user acceptance is an issue, such as vehicle stability. These solutions would then be showcased in pilot vehicles.

The project began by creating a series of simulation models, to support design exploration and early validation of new components. These components were then designed and manufactured, including a dual inverter for more efficient control of several e-motors in parallel, as well as in-wheel motors for higher energy efficiency. "We also designed new chassis components, such as brake-by-wire systems and electro-hydraulic suspension with energy harvesting capabilities to provide a greater degree of freedom for advanced control strategies," says Armengaud. "We also developed a highly efficient electro-hydraulic suspension system using X-by-Wire technology to enhance vehicle dynamics behaviour without compromising comfort."

These innovations will now be integrated into two vehicle demonstrators, to showcase the potential benefits of these solutions for different market segments. "Long-distance daily trips will allow us not only to assess energy efficiency, but also to consider how we can further enhance the customer experience," adds Armengaud.

EV innovation ecosystem

The project team has been successful in prototyping and evaluating a number of new components, some of which have

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since been patented. This will open the door to the eventual mass production of highly efficient EVs, and boost Europe's competitiveness in this important field. As a contribution towards EV manufacturing and smarter, greener transport, EVC1000 has developed innovative components which are now on the path to industrialisation, and are expected to reach the market around 2024-2025. EVC1000 has further supported the creation of follow-up programmes including training and expert exchange, in order to create an innovation ecosystem to push cutting-edge EV technology in Europe.

PROJECT
EVC1000 - Electric Vehicle Components for 1000 km daily trips

COORDINATED BY
AVL List GmbH, Austria

FUNDED UNDER
H2020-EU.3.4.

CORDIS FACTSHEET
cordis.europa.eu/project/id/824250

PROJECT WEBSITE
evc1000.eu/en/

Novel e-axle for third-generation electric vehicles coming to European market

An EU-funded project contributes to unlocking the societal, environmental and economic benefits associated with the roll-out of third-generation electric vehicles.

The EU has set key targets to reduce CO_2 emissions from cars by 55 % and vans by 50 % by 2030. An increase in the uptake of electric vehicles (EVs) is crucial for achieving these goals. However, several challenges present. These include the development of new components, systems and architectures for the next generation of EVs that will meet end users' expectations in terms of cost, convenience of long-range travel and comfort.

To address the above, the EU-funded FITGEN project worked to develop a functionally integrated e-axle. "Specifically, we aimed at developing, prototyping and testing several key enabling technologies essential for the delivery of next-generation EVs," explains Michele De Gennaro, project coordinator. These components are a new, high-speed permanent magnet e-motor, a new inverter designed with the latest generation of silicon-carbide power switches for high efficiency, and a new transmission fit for the high-speed motor.

"The components have been designed to be physically and functionally integrated, sharing a common cooling circuit, and embedded in a novel failure-resilient 6-phase power architecture that makes use of an on-board DC/DC converter for flexible 400/800 V operation and for enabling super-fast charge on the vehicle," outlines De Gennaro.

Developing the functionally integrated e-axle

FITGEN results really make the e-axle a next-gen product. For one, it exceeded the initially set target of 18 000 rpm for motor

© Michele De Gennaro

The achieved maximum e-motor rpm is 28 % better than the best-in-class market-available technology in the year 2022 and it does allow for overcoming the gravimetric power index mark of 6 kW/kg.

speed by demonstrating 23 000 rpm of maximum rotational speed and sustaining 27 600 rpm in the overspeed test. "The achieved maximum rpm is 28 % better than the best-in-class market-available technology in the year 2022 and it does allow for overcoming the gravimetric power index mark of 6 kW/kg," highlights De Gennaro. The latter is one third better than 2022 state-of-the-art technology (SotA).

"These performances have been achieved by using only 1.35 kg of NdFeB magnets, i.e. – 40 % compared to the SotA, hence materialising a key cut in rare resources and costs," adds De Gennaro.

Furthermore, the inverter achieved the volumetric power index of 35 kW/l, doubling the SotA, and peak efficiency at 99 %. "Apart from these component-specific results, FITGEN achieved its best performance when integrated; the e-axle was mounted in a FIAT 500e and demonstrated a distance-specific energy consumption of 135 Wh/km when operated at 400 V and 123 Wh/km when operated at 800 V, overperforming the reference by 10 to 15 % in terms of energy efficiency," reports De Gennaro.

Bringing FITGEN technologies to market

The project expects that the technologies developed in FITGEN will land in the market between 2025 and 2030. These will comprise both stand-alone parts and components embedded in other products or as an integrated product.

"In the long term, I envision FITGEN to be an enabler for the automotive industry as a whole," highlights De Gennaro.

As for next steps, De Gennaro concludes: "There is a lot to do now, and we see FITGEN just as a starting point. From the consortium perspective, there are indications that the FITGEN e-motor might soon become a product, as well as that the FITGEN demonstrator, integrating a 6-phase e-axle, will be used as a platform for developing failure-resilient e-drive control algorithm, encompassing autonomous driving logic."

Project work and outcomes extend beyond EV development and market impact. A major aeronautics original equipment manufacturer has expressed an interest in the FITGEN portfolio of technologies for its general aviation aircraft line.

PROJECT
FITGEN - Functionally Integrated E-axle Ready for Mass Market Third GENeration Electric Vehicles

COORDINATED BY
AIT Austrian Institute of Technology GmbH, Austria

FUNDED UNDER
H2020-EU.3.4.

CORDIS FACTSHEET
cordis.europa.eu/project/id/824335

PROJECT WEBSITE
fitgen-project.eu/

Improving the electric vehicle user charging experience

Using neuroscience techniques, researchers examine electric vehicle users' unconscious preferences to adapt developments in charging technology to the users' subjective expectations.

Compared to their petrol or diesel equivalents, electric vehicles (EVs) are a sustainable alternative. However, the mainstream adoption of EVs is still low in many Member States, hindered by the lack of infrastructure availability, solutions and user apprehension.

This is where the EU-funded INCIT-EV project comes in. "We are developing an innovative set of charging technologies increasing the synergies with the electricity grid while easing EV adoption for users and with the ultimate goal of fostering the EV market share in the EU," outlines Miguel Zarzuela, project coordinator.

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To achieve this, INCIT-EV is combining different traditional (literature review, public data analysis, surveys, participatory techniques) and more innovative techniques to produce new insights on users' perceptions and factors of influence regarding charging options.

"One of the most relevant innovations will be the application, for the first time in the field of e-mobility, of neuroscience techniques combined with biosignals to identify users' unconscious preferences for charging options," explains Zarzuela. In particular, mobile sensor equipment will be used to measure the emotions of the users engaged in different project use cases and subsequently infer their unarticulated needs.

One of the most relevant innovations will be the application, for the first time in the field of e-mobility, of neuroscience techniques combined with biosignals to identify users' unconscious preferences for charging options.

Validating the inductive charging technology

"We have developed smart charging algorithms in place in more than 100 public locations which are now under the smart and bidirectional charging test phase, and will play a key role in the increasing intermittent renewable energy generation and congestion in grids," confirms Zarzuela.

INCIT-EV's charging technologies, including wireless and bidirectional charging, are designed to improve the user experience, making charging as easy as possible. "INCIT-EV has nine use cases, including three demonstrators validating the inductive charging technology," reports Zarzuela.

One of these is a wireless charging point for taxis in Zaragoza, Spain, that allows 50 kW charging while the taxi is waiting. A second demonstrator will test the technology in Paris on an inductive loading track, for charging at traffic lights. A third will be tested at a speed circuit near Versailles, France, allowing vehicles to charge at speeds up to 90 kW while driving on an inductive lane. On top of innovation, project partners collaborated to achieve full interoperability between all wireless chargers and vehicles.

The intelligent use of EVs will be a great ally in a scenario with high renewable energy penetration. "The use of bidirectional charging is expected to accelerate the development of electric mobility and redefine the concept of cars," adds Zarzuela.

During the last part of the project, three wireless inductive demonstrators will be deployed and tested in open streets with the aim of showing seamless and interoperable charging, including dynamic charging at highway speeds.

The road to transforming transportation and energy systems

"The long-term impacts of these developments are significant, as they will play a critical role in shaping the future of transportation and energy systems," notes Zarzuela.

Expected benefits include the acceleration of EV adoption. "The development of bidirectional charging and other innovative charging technologies will help to make EVs more convenient and accessible to a broader range of consumers. This, in turn, could accelerate the adoption of EVs, leading to a reduction in greenhouse gas emissions and air pollution," adds Zarzuela.

Bidirectional charging will also allow EVs to serve as energy storage devices, helping to smooth out the variability of renewable energy sources. "Furthermore, bidirectional charging could potentially reduce the overall cost of owning an EV by allowing owners to use their vehicles as a source of backup power for their homes or to sell excess energy back to the grid," concludes Zarzuela.

PROJECT
INCIT-EV - Large demonstratIoN of user CentrIc urban and long-range charging solutions to boosT an engaging deployment of Electric Vehicles in Europe

COORDINATED BY
CIRCE Foundation (Centre of Research for Energy Resources and Consumption), Spain

FUNDED UNDER
H2020-EU.3.4.

CORDIS FACTSHEET
cordis.europa.eu/project/id/875683

PROJECT WEBSITE
incit-ev.eu/

Modelling toolchain drives high-performance lithium-ion batteries

An EU-funded project has developed a new modelling toolchain that accelerates the development of next-generation lithium-ion batteries to speed up the adoption of electric vehicles.

Lithium-ion (Li-ion) batteries have revolutionised sustainable energy and become the preferred power source for various applications, including electric cars. This is mainly due to their high energy density, long cycle life, low self-discharge rates and high charging efficiency.

In order to further accelerate the development of Li-ion batteries with increased energy density, a group of European researchers has designed a modelling toolchain as part of the EU-funded MODALIS2 project implemented by a consortium of 15 partners. As expert users of battery simulation tools, they offered valuable input to improve the toolchain functionalities, better support industry players and address some of their challenges.

"Having a complete modelling toolchain is essential to account for all the relevant mechanisms, from the molecular and cellular levels to the final integration into the complete system. This will enable the industry to incorporate new and innovative materials in their next-generation Li-ion battery cells," explains Martin Petit, project coordinator.

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Driving the next-generation 3b and 4b batteries

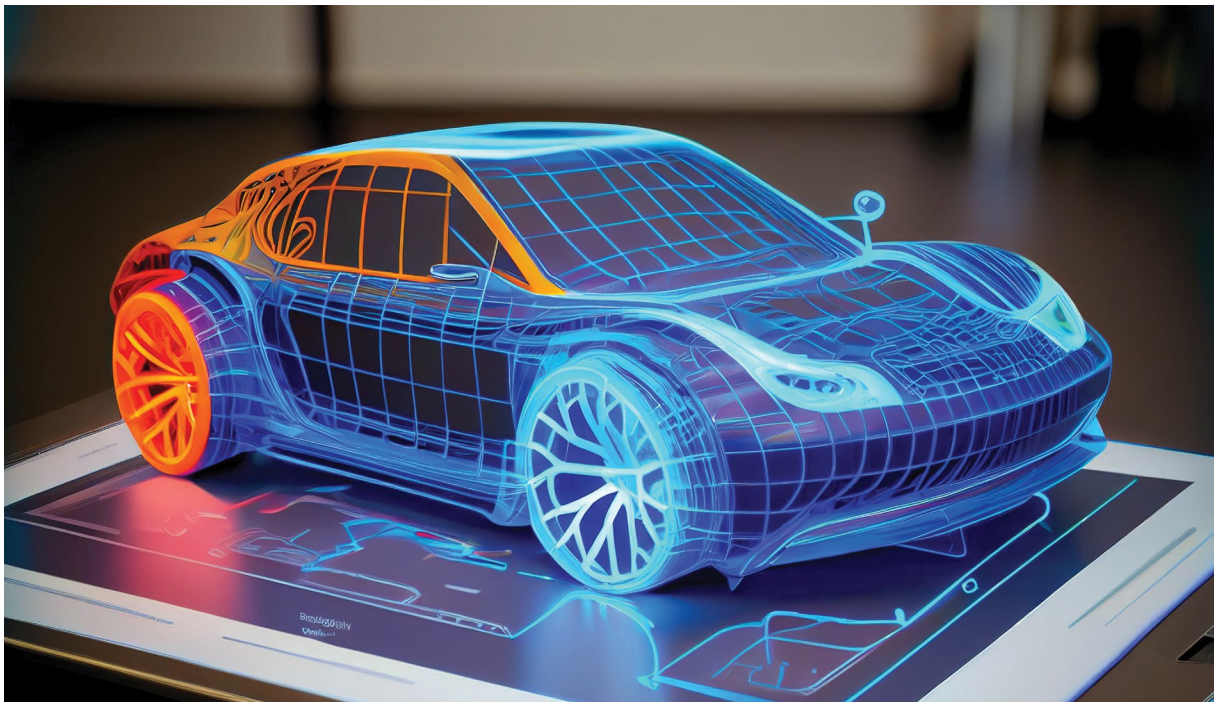
For the mobility sector, the primary focus is on Li-ion battery chemistries, particularly liquid-state batteries, classified as generation 3b, and solid-state batteries, classified as generation 4b. According to Petit, generation 3b can increase capacity for the positive and negative electrodes, while generation 4b uses solid-state electrolytes for improved safety and to facilitate the use of Li-metal for the negative electrode.

The MODALIS2 modelling toolchain provides an effective tool for understanding the advantages and drawbacks of new materials and the possible reliability of batteries built using these materials. "MODALIS2 offers degrees of flexibility in the cell and battery development processes, which enable effective solutions to the design challenges," Petit elaborates.

He also noted that the modelling approach is designed to reduce the costly and time-consuming trial and error process. For instance, the modelling toolchain allows for the faster integration of new and innovative materials within next-generation Li-ion battery cells, resulting in cost-effective, efficient and reliable electric vehicles.

Understanding the benefits and limitations of new materials

MODALIS2 addressed the challenges related to the mechanical effects of batteries. According to Petit, emerging battery technologies and materials, such as silicon-based negative electrodes and solid-state electrolytes, exhibit strong mechanically



induced failure phenomena. “This can include progressive degradation mechanisms, such as ageing, or critical failure, such as dendritic growth leading to short circuits,” he notes.

The MODALIS2 modelling tools were integrated into widely used commercially available software. Materials manufacturers, cell manufacturers, and original equipment manufacturers were trained in these tools and provided their feedback, resulting in a single modelling platform that encompasses all main battery value chain stakeholders’ development processes.

This new toolchain can accelerate the adoption of electric vehicles by enabling the industry to develop next-generation Li-ion battery cells more efficiently, paving the way for improved performance of electric vehicles.

PROJECT
MODALIS2 - MODelling of Advanced LI Storage Systems

COORDINATED BY
IFP Energies Nouvelles, France

FUNDED UNDER
H2020-EU.3.4.

CORDIS FACTSHEET
cordis.europa.eu/project/id/875193

PROJECT WEBSITE
modalis2-project.eu/en/

Active safety and low-cost manufacturing in sustainable urban mobility

An EU-funded project will soon bring to market a fleet of multi-passenger versatile electric vehicles manufactured with novel low-cost techniques.

© Multi-Moby

While the current electric vehicle debate focuses on batteries' and electric powertrains' efficiency, and consequently vehicle range, the automotive industry's major challenge remains the reduction of energy, time and costs in manufacturing body frames (chassis). The EU-funded Multi-Moby project has developed a scalable chassis so that its length or width can be varied by changing the size of only a few elements, enabling the more efficient production of multi-passenger and multi-purpose commercial vans.

Project partner I-FEVS has previously demonstrated modularity and scalability in several EU projects, such as WIDE-MOB, PLUS-MOBY and DEMOBASE. Multi-Moby expands on this work, resulting in an automated design process where construction of the chassis and motorised axles do not require moulds of any kind.

Thanks to the use of a robotised laser system to cut the high-strength steel tubes for welding of the complete chassis, there is no need for complex templates. Everything, including doors, axle systems, suspension arms and wheel hubs, can be performed in a microfactory floor of size 1 500 m².

A technology for safer vehicles in the future

The active safety systems developed by Multi-Moby partner University of Surrey make the vehicles future-proof in the context of vehicle-to-everything (V2X) connectivity. "For example, the cloud could elaborate the information from several

connected vehicles and determine the position of possible low tire-road friction patches, which would be transmitted to the approaching vehicles," explains project dissemination leader Aldo Sorniotti. "Therefore, preview-based active safety controllers could take advantage of such V2X information."

Three such active safety controllers have been developed. Firstly, a traction control system utilising data from the cloud identifies upcoming low-friction road patches, and pre-emptively prevents wheel spin. In addition, an antilock braking system (ABS) uses road friction data from the cloud to prevent wheel locking in advance. Finally, a pre-emptive braking function slows down the vehicle if the current speed is safety critical for the upcoming road curvature, again based on road friction data.

Optimisation of features to expand potential

"One of our goals, which is still work-in-progress, is to develop autonomous capabilities by adopting low-cost scanning and night vision functionalities, known as gimbals. However, after further studies, it was found that for safety and redundancy reasons, it was best to combine the gimbals with other sensors," notes Sorniotti.

The project's remaining 7 months will be focused on achieving advanced electrical electronic architecture with implemented secured procedures for remote updates and upgrades of the firmware. Moreover, the team aims to enhance autonomous capabilities by adopting the most on-the-road-experimented sensing and computational platforms, and advanced AI-based technologies for both longitudinal and lateral dynamics active safety systems.

After the project is complete, our ambition is to introduce food and medical delivery vans with autonomous capabilities to the market within 1 year.

"After the project is complete, our ambition is to introduce food and medical delivery vans with autonomous capabilities to the market within 1 year," states Sorniotti. Moreover, the techniques used for the manufacturing of the vehicles can be transferred to different applications, such as electric bicycle and moped production.

PROJECT
Multi-Moby - Safe, Secure, High Performing Multi-Passenger and Multi-Commercial Uses Affordable EVs

COORDINATED BY
Infineon Technologies Austria AG, Austria

FUNDED UNDER
H2020-EU.3.4.

CORDIS FACTSHEET
cordis.europa.eu/project/id/101006953

PROJECT WEBSITE
multi-moby.eu/

Innovation in lithium battery design supports growth of electric vehicle industry

Better battery design leads to improved performance and safety of electric vehicles (EVs). Innovations also create market opportunities for EU manufacturers.

If the EU is to reach its goal of reducing 2021-level greenhouse gas emissions by 30 % in less than 10 years, there will need to be many more electric cars on the road very soon. Lithium-ion (Li-ion) batteries are at the heart of EV technology, for which Asian manufacturers currently dominate the market.

The EU-funded SAFELiMOVE project has developed a Li-ion battery that will improve the performance of EVs and open the door to increased European production of these batteries.

According to project coordinator Maria Martínez: "SAFELiMOVE has delivered innovation in five main technology areas: development of nickel-rich layered oxide cathode materials; high specific capacity Li-metal anode materials; innovative hybrid ceramic-polymer electrolyte; deployment of optimisation techniques and study of different interfaces for effective Li transport; and know-how creation for the development of scale-up production of solid-state batteries."

Batteries, before and after

Rechargeable Li-ion batteries dominate the market for EVs. These batteries are composed of a graphitised material for the anode, a lithium transition metal oxide for the cathode and a carbon-based liquid for the electrolyte.

SAFELiMOVE has delivered innovation in five main technology areas: development of nickel-rich layered oxide cathode materials; high specific capacity Li-metal anode materials; innovative hybrid ceramic-polymer electrolyte; deployment of optimisation techniques and study of different interfaces for effective Li transport; and know-how creation for the development of scale-up production of solid-state batteries.

These batteries are energy-dense, but they present problems as well. For one thing, sourcing critical raw materials is bound to become increasingly difficult as the market for EVs grows. Also problematic are the deficiencies associated with the liquid electrolyte. The material is flammable, and exposure to too much heat is a hazard.

The main objectives of SAFELiMOVE targeted the drawbacks of Li-ion batteries. The project team designed a battery that is free of graphite, uses a reduced amount of cobalt in the electrodes and has a solid-state hybrid ceramic-polymer electrolyte that may guarantee a safer operation of the battery compared to liquid organic electrolytes.

A wealth of improvements

The innovative battery design produced by the project has several positive outcomes. In addition to the increased safety inherent in using a solid-state electrolyte, the changes introduced by this high energy density lithium metal

technology aims to increase the driving range of a vehicle by 300 km in a single charge. The future roadmap of SAFELiMOVE technology by 2030 envisions the decrease of the required time for the battery to recharge and the reduction of the overall cost of the battery.

The team delivered many technological breakthroughs in battery design. According to Martínez: "these actions have reached the first generation of 1 Ah solid-state prototype with an average gravimetric and volumetric energy density of 250 Wh/kg and 500 Wh/L, respectively." As future steps, before the end of the project, developers aim to manufacture a prototype with 10 Ah capacity and integrate it into a 24 volt battery module.

In addition to providing improvements for EV owners in the form of better performance and safety, SAFELiMOVE provided the research and development around materials and battery design to push EU industries forward. The project consortium included researchers, materials producers, battery manufacturers, and automotive makers.

High ambitions regarding sustainability goals have led to technological innovations across Europe. SAFELiMOVE is an excellent example of how such developments can simultaneously benefit the consumer, the manufacturer and the environment.

PROJECT
SAFELiMOVE - advanced all Solid stAte saFE LIthium Metal technology tOwards Vehicle Electrification

COORDINATED BY
CIC energiGUNE, Spain

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CORDIS FACTSHEET
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PROJECT WEBSITE
safelimove.eu/

Advanced algorithms improve electric vehicle efficiency

The integration of machine learning into simulated automobile tests leads to faster development of electric vehicles with improved efficiency and better safety.

In order to reach the EU's ambitious goal of climate neutrality by 2050, many new electric vehicles (EVs) will be hitting the road in coming years. The EU-funded UPSCALE project facilitated this development by designing AI software that improves the speed of simulated safety and performance tests.

Advancement through algorithms

Testing the performance of automobiles has long relied on the resolution of physics problems. This work can be time-consuming and tedious, and some problems are not feasibly solved using these methods. High-performance computing (HPC) and computer-assisted engineering (CAE) are growing fields essential to automotive development. Academic studies show that advances in machine learning, an application of AI, can improve automotive testing and thereby substitute data-driven solutions for physical ones.

The UPSCALE project has demonstrated the feasibility of substituting physics-driven solvers with data-driven solvers, reducing simulation times by 3 orders of magnitude, while keeping very high accuracy.

The UPSCALE team was inspired to apply machine learning in an industrial context and developed algorithms and processes from scratch. In the context of crash simulations and aerodynamics, Enric Aramburu, the technical coordinator for the project, states: "The UPSCALE project has demonstrated the feasibility of substituting physics-driven solvers with data-driven solvers, reducing simulation times by 3 orders of magnitude, while keeping very high accuracy."

Project work took place across three phases. The first involved defining and implementing machine learning frameworks for different applications. Next, researchers developed data sets and machine learning training at proof-of-concept level. Finally, the team applied simulation tools to real industrial situations.

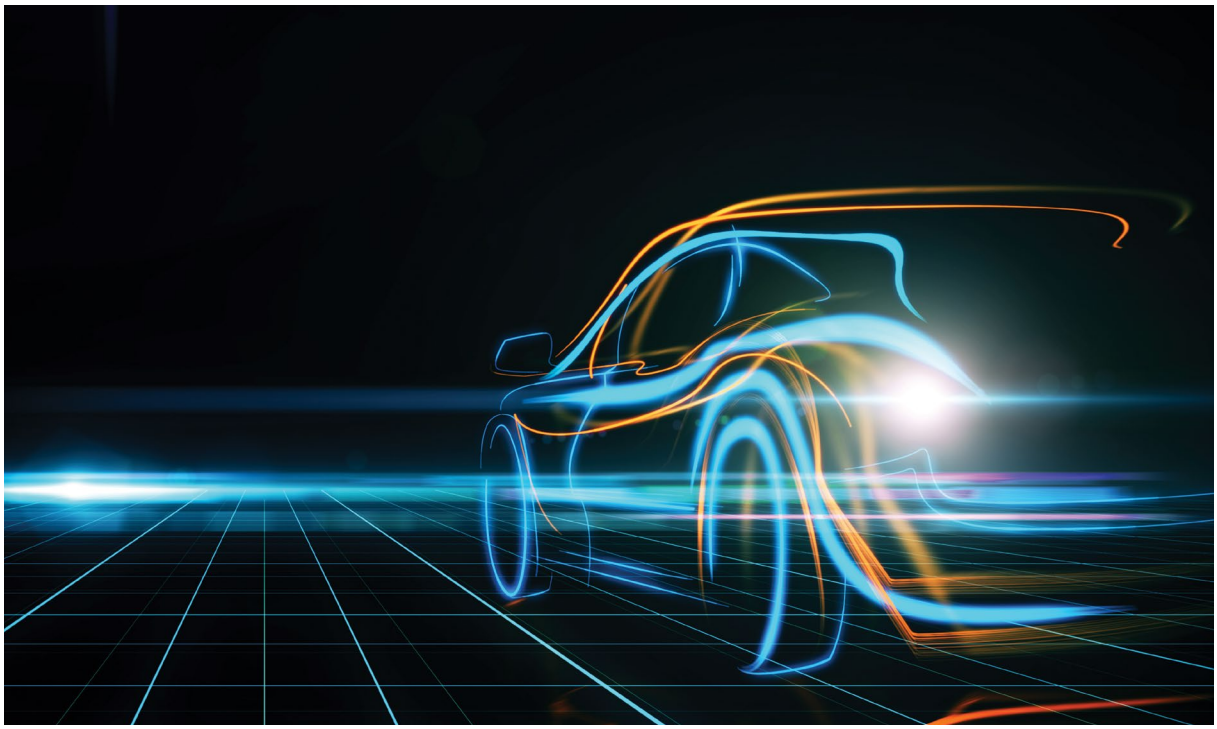
Essential case studies

To advance project objectives, researchers selected two case studies to investigate: crash modelling and aero-thermal modelling. Both types of modelling already use high levels (between 20 % and 50 %) of HPC, making them strong candidates for incorporating machine learning software.

Crash tests are essential for determining vehicle safety, and for EVs in particular they provide essential information about battery performance. Aero-thermal tests help determine the efficiency of a vehicle, enabling longer range and reduced environmental impact.

One of the project's main achievements was developing reduced order modelling (ROM) for both case studies. In particular, the ROM of battery performance is groundbreaking and allows for the rapid assessment of all battery cells in the vehicle. The team also used 3D autoencoder methods to reduce exterior auto designs to 20 parameters. This allowed for aerodynamic testing of vehicles of any shape.

The project's simulation software reduced time spent in vehicle development, which will ultimately put EVs on the road faster. Many of the simulation tools developed by UPSCALE are market-ready, and the consortium has received feedback from end users, including three vehicle original equipment manufacturers.



With these positive outcomes, the application of machine learning is here to stay. As researchers work to advance the efficacy of simulation tools, improved prediction in scenarios that diverge from training data sets and reducing the need for extensive data set training are important goals. According to Aramburu, "next steps should focus on developing more efficient solutions that need less training effort and can predict non-seen use cases as well."

The world is changing fast. Environmental challenges are critical, and technology is advancing at a dizzying pace. UPSCALE, with its innovative applications of machine learning software to the development of EVs, has helped ensure the automotive industry can keep up.

PROJECT
UPSCALE – Upscaling Product development Simulation Capabilities exploiting Artificial inteLligence for Electrified vehicles

COORDINATED BY
IDIADA Automotive Technology SA, Spain

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CORDIS FACTSHEET
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PROJECT WEBSITE
upscaleproject.eu/

A glimpse into the last-mile urban transport vehicles of the future

Last-mile delivery is a vital element in cities. An EU-funded project offers solutions for sustainable, zero-emission and fit-for-purpose urban logistics.

©Lamberto Salvan

Electrified logistics has emerged as an effective answer to the requirements of an on-demand economy in combination with the need for a liveable and accessible urban environment. The EU-funded URBANIZED project is working to future-proof cities with sustainable last-mile delivery by solving the trade-offs between 'one size fits all' and 'design for purpose' in the conception of adaptable and modular all-electric light commercial vehicles.

E-mobility solutions based on integration, modularity and connectivity

"We consider the URBANIZED innovations as key enabling technologies in the transition towards environmentally friendly, safe and less space-demanding urban logistics," says project coordinator Salvador Ruiz.

URBANIZED's originality stems from three different areas: the powertrain, the cargobody and fleet management solutions.

We consider the URBANIZED innovations as key enabling technologies in the transition towards environmentally friendly, safe and less space-demanding urban logistics.

Firstly, the project is developing a novel e-powertrain platform that is both scalable and modular and developed with component right-sizing. Part of the work can be found in the team's paper 'Electric Drivetrain Optimization for 48V Urban Vehicles'. Moreover, the adaptability of its easily swappable multipurpose modular cargo bodies means URBANIZED solutions conform to the fluctuating demands in logistics. Although not final yet, a prototype of the vehicle is ready, and the team is ensuring that it is fit for purpose.

Double modularity, through compartmentalised and swappable multipurpose cargo bodies,

offers the ease of use and flexibility needed to explore innovative logistics operations. This element enables an easy transfer of goods following the Physical Internet concept, new solutions for consolidating goods in parcel lockers and new urban logistic hubs, whilst reducing oversized fleets that serve fluctuating demands of different logistics streams. Additionally, improved e-powertrain and front cabin design enhance the energy efficiency and safety of the vehicle.

Lastly, an integrated multi-level energy management system optimises the cloud vehicle interconnection to maximise energy savings, occupant comfort and vehicle travel time in case of time-sensitive tasks. More information about this feature can be found in the project report on multi-layer energy management system architecture and interfaces.

When urban logistics and the automotive industry cooperate constructively

To achieve impactful results, strong synergies needed to be established between urban logistics providers and automotive partners. During project development, the URBANIZED management team purposefully created a consortium that strongly represents both worlds, in a bid to connect them.

"Automotive partners needed to learn about small urban electric vehicles, which are different from their usual electric vehicle target, passenger cars. Vice versa, the small electric vehicle market is still an emerging market in urban logistics, which requires logistics-oriented partners to consider the economic background of large-scale automotive players," explains Salvador Ruiz. "We are glad this challenge has been overcome and has created fruitful insights between partners."

URBANIZED is now in its testing and validation stage, aiming to have a fully tested demonstrator fit for operation in urban environments by the second half of 2023. The team aims to further explore the collaboration between partner organisations to maximise impact.

In parallel, the consortium will explore replicability and exploitation pathways for the results to benefit a variety of different urban logistics streams. The team will be sharing many results in the coming year. All updates will be published on the project's LinkedIn page.

PROJECT
URBANIZED - modUlaR and flexible solutions for urBAN-sIzed Zero-Emissions last-mile Delivery and services vehicles

COORDINATED BY
IDIADA Automotive Technology SA, Spain

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