HiPE

High Performance Power Electronics Integrations

Coordinator Message

Third HiPE Newsletter April 2026

NEWSLETTER CONTENT

HiPE Consortium at Ford Otosan

Funded by the European Union

Farewell message

As the **HiPE project** comes to an end, we would like to take a moment to reflect on our shared journey over the past three years. What began as an ambitious initiative to develop a new family of **highly energy-efficient, cost-effective, modular, compact and integrated wide-bandgap power electronics solutions** for the next battery electric vehicle generation has grown into a successful and dynamic collaboration between **13 partners across Europe**, combining expertise, creativity, and commitment to achieve a common goal.

Over the course of this project, our consortium has delivered **integrated wide-bandgap (WBG) solutions** — from **scalable and modular traction inverters (400 V to 1200 V, 50 kW–250 kW)** to **bidirectional on-board chargers** and **high-voltage ancillary systems enabled by GaN technology**. These developments were supported by deep innovation in **cooling methods**, **circuit topologies**, **stray-inductance reduction**, **data-driven control**, and **digital-twin methodologies**, achieving significantly improved **power density**, **specific power**, and **system efficiency** compared to the state of the art.

Beyond the technical results, HiPE has created a **lasting network of experts and stakeholders** in the automotive power-electronics field — a foundation upon which future **projects, spin-offs and industrial adoption** will build. The **tools, models and methodologies** we developed will continue to have impact, enabling future progress in the **electrification of vehicles** and the wider transition to **sustainable mobility**.

We extend our sincere gratitude to all **project partners**, **contributors**, **supporting organizations** and above all the **European Commission** for the trust and support throughout this journey. The **commitment**, **collaboration** and **shared ambition** of everyone involved have transformed an ambitious vision into **tangible outcomes**.

Although this marks the official completion of the **HiPE project**, our collective efforts will continue to resonate — through **publications**, **demonstrations**, **industrial uptake** and the **partnerships we formed**. Thank you for being an essential part of this journey.

The HiPE Consortium

1 Project Highlights

Throughout the HiPE project, several moments stood out as particularly **meaningful** and helped shape the **collaboration**, **visibility** and **progress** of the consortium. While the technical results are captured in the **Key Achievements** section, the following highlights offer a broader look at memorable **activities**, important **milestones** and successful **outreach efforts** that accompanied the project's development. These moments reflect not only what HiPE achieved, but also **how the consortium worked together**, engaged with the community and contributed to the wider landscape of **European innovation**.

Kick-off Meeting & General Assembly Meetings

With **13 consortium partners** spread across Europe, every HiPE meeting felt like a **special occasion**. Each gathering brought together diverse expertise and perspectives, creating a setting where the project could be discussed in depth and challenges could be addressed collaboratively. The **Kick-off Meeting** set the foundation for the project's direction, while the recurring **General Assembly Meetings** ensured ongoing alignment, efficient decision-making and clear communication across all work packages. Their international character made these gatherings an opportunity to exchange perspectives across disciplines, industries and countries. Beyond the formal agenda, they strengthened interpersonal connections and fostered a collaborative culture built on trust and mutual respect – a key factor in delivering HiPE's ambitious goals.

E-VOLVE Cluster Cooperation

HiPE was actively involved in the **E-VOLVE Cluster**, a network of European projects working together to advance the future of **electric mobility**. Through this collaboration, HiPE contributed to joint dissemination efforts and cross-project exchanges, including public **webinars** organised by the Cluster. The first HiPE webinar, held on **15 March 2024**, focused on *Toolchains in Vehicle-Level Simulation*, while the second HiPE webinar on **22 November 2024** showcased *Advanced Chassis Actuators with 400 V GaN Power Electronics*. Both sessions offered valuable insights and helped strengthen the visibility and outreach of the Cluster as well as HiPE's own results.

E-VOLVE CLUSTER

The **recordings** of both webinars can be found here: [Videos - HiPE.]
E-VOLVE Cluster Website: [E-VOLVE CLUSTER – Electric Vehicle Optimized for Life, Value and Efficiency]

Launch of HiPE Website & Communication Activities

The launch of the **HiPE website and its accompanying social media channels** was one of the first major highlights of the project. These platforms immediately **strengthened the project's public visibility**, providing a central point for sharing updates, results and events with a broad audience. They also created a direct communication channel for stakeholders, industry partners and interested readers, making it easier to **follow HiPE's progress** and engage with its developments. Throughout the project, the website and social media presence played an essential role in disseminating news, publications and achievements, helping to ensure that HiPE's impact extended well beyond the consortium itself.

Release of the HiPE White Paper

Another major milestone of the project was the release of the **HiPE White Paper**, which marked a significant step in communicating the project's **technical vision** to the wider community. The document brings together key insights on **wide-bandgap technologies**, **advanced gate driving**, **packaging concepts**, **thermal management**, and future trends shaping next-generation power electronics (PE). By compiling this knowledge in a clear and accessible format, the White Paper supports **industry**, **researchers**, and **stakeholders**, while strengthening the long-term **impact** and **visibility** of HiPE. Its publication represents a central achievement in the project's **dissemination strategy** and a valuable contribution to the transition towards **efficient and sustainable electric mobility**.
For details, please refer to the **chapter "Creation of White Paper"** (chapter 3)

2 HiPE's Key Achievements

Over the course of the HiPE project, each technical **Work Package** played a crucial role in turning our joint vision into **concrete results**. The **Key Achievements** summarised below offer a clear overview of what has been accomplished — from **technical breakthroughs** to innovative **tools, models** and **demonstrators**. Together, these outcomes show how the coordinated efforts of all partners contributed to advancing the **next generation of high-performance power electronics**.

WORKPACKAGE 3 – Digital Twins for Modular and Scalable Power Electronics Architecture, Functional Safety, Reliability, and Predictive Health Monitoring

WP3 focused on **modelling and simulation** of HiPE **WBG-based (SiC and GaN) power electronics solutions**, including an **800 V traction inverter** integrated with an **800/48 V DC/DC converter**, a **bidirectional on-board charger** integrated with a DC/DC converter for the **800 V and 24 V batteries**, and a **400 V drive for the levelling suspension system**. High-fidelity **digital twins** of these units—together with models of **traction motors**, the **levelling system**, **HV/LV batteries**, HVAC and auxiliary loads, and associated controls—were developed to accurately reproduce electrical and electromechanical behaviour, in close collaboration with WP4. **Reduced-order electro-thermal models** were also created to capture **junction-temperature evolution** under varying cooling and power-dissipation conditions, informed by detailed CFD results from WP6. These models supported the analysis of **TIM** and **wire-bond degradation**, from which **lifetime models** for both SiC and GaN devices were derived.

To enable efficient **vehicle-level studies**, these detailed models were reduced to **surrogate forms** using efficiency look-up tables and first-order dynamic representations. Two **vehicle simulation platforms**—MATLAB/Simulink with AVL VSM and GT-Suite—were developed for **component optimisation**, **performance validation**, and **reliability assessment**, with passenger car, van, and truck models implemented to ensure broad applicability. Extensive simulations were conducted on these platforms. **Optimisation studies** varied key configuration parameters—including the number of traction motors, battery sizing, DC-link voltage, transmission ratios, gearshift strategies, and levelling heights—enabling comparative analyses of driving-cycle **energy use**, **range**, **acceleration**, and gradeability, and supporting the selection of optimal design parameters. Dynamic vehicle simulations further evaluated **active levelling control** for improved energy efficiency and stability, and **active thermal management** of the traction inverter, demonstrating reduced inverter power losses and significantly improved **lifetime** without compromising speed-tracking performance.

WORKPACKAGE 4 – Integrated WBG-based Power Electronics: Key Achievements and Innovations

WP4 continues to drive innovation for **electric vehicles** and **sustainable mobility**. Remarkable progress has been made across all key objectives: the **design, development, and prototyping** of **high-performance WBG-based power electronics** for vehicles and chassis components.

A vital milestone for WP4 has been the successful **assembly and testing of the two-speed transmission prototype** as part of **Task 4.1**. Leveraging **SiC inverter integration** into an eAxle, the team advanced the **modular design for the Skoda Enyaq**, directly addressing industry demands for more efficient and compact powertrains. Challenges related to clearance, tolerance, lubrication, and clutch actuation were swiftly resolved, reflecting robust engineering collaboration. The prototype's completion has paved the way for next-stage activities, including **software fine-tuning**, **control calibration**, and **WLTP measurement campaigns** to validate real-world performance.

Progress unfolded under **Task 4.2**, focused on advanced chassis actuators with **400 V GaN power electronics**. This phase saw the design, characterization, and prototyping of a **GaN-based inverter** for vehicle suspension systems, supplemented by the implementation of **nonlinear model predictive controllers** to enhance ride comfort and stability. Simulation studies with the **Audi e-tron** and **Toyota CHR** models demonstrated that these control strategies consistently minimized acceleration deviations, improving handling and passenger comfort despite suspension-level changes.

Steady advancement in **Task 4.3** led to the completion of **design and simulation verification** for both the **HV/LV DC-DC converter** and the **bidirectional On-Board Charger (Bi-OBC)**. The team finalized **component selections**, completed schematics, and initiated **hardware procurement**. Magnetic components underwent rigorous validation, and development of the required **hardware and control software** was successfully concluded. With layout studies nearing completion, WP4 is preparing for targeted testing to ensure these critical energy-conversion units meet performance and reliability expectations in demanding automotive environments.

Meanwhile, **Task 4.4** brought significant progress in **high-performance inverter and DC/DC system development**. All subcomponents underwent comprehensive characterization; assembly and integration of the full **800 V SiC inverter** were completed alongside the DC-DC converter. **Embedded software**, a **dedicated test bench**, and advanced measurement instrumentation ensured precise assessment of performance, efficiency, and thermal management. Mechanical simulations using **finite element methods** validated robustness under vibrational and mechanical stresses, while **power spectral density analysis** confirmed compliance with automotive safety standards. Pioneering simulations using **nonlinear model predictive control** demonstrated reduced inverter thermal stress and extended lifetime without compromising drivability.

To round out these achievements, **Task 4.5** focused on integrating **gate drivers and power modules** — addressing efficiency, reliability, manufacturability, and safety. Deliverables are in finalization, and strategic **risk mitigation**

measures are in place to counter technology supply uncertainties, reflecting WP4's commitment to **industrial scalability**.

Collectively, these results position WP4 as a **linchpin** for the HiPE Project's vision: delivering **next-generation EV components** that promise higher efficiency, modularity, and long-term durability. Moving forward, the consortium focuses on **final validation**, **knowledge exchange**, and broad dissemination through joint publications, presentations, and collaboration with the **E-VOLVE Cluster**.

WORKPACKAGE 5 – Testing, Evaluation & Demonstration

WP5 covered the **testing**, **evaluation** and **demonstration** activities of the technologies, systems and components developed for all the four use cases of the HiPE project in order to compare them against **baselines and benchmarks**, defined in **Task 5.4**, and to showcase the project achievements and the **improvements of the novel HiPE power electronics solutions.**

Task 5.1 focused on **system level validation** and demonstration in means of laboratory-based and emulated environments. For the **400 V SiC-Inverter** (UC1) the validations yielded an **increased efficiency level** compared to the state of the art, leading to less energy consumption in automotive applications. The **800 V HV/LV DC-DC and 22 kW On-Board Charger** (UC3) are experimental characterised on established laboratory test benches by performing a series of tests at representative operation points, whereby the electrical performance, switching behaviour, and functional operation were considered as main aspects. For the HV/LV DC-DC the results present **consistent efficiency performance**, stable and **high performance HV/LV conversion** as well as **robust HV/LV energy transfer capability**. The results of the testing regarding the On-Board Charger show **minimised conduction and switching losses**, **thermal stability** as well as e**xcellent signal integrity** demonstrating the **reliability for demanding charging requirements** of electric vehicles. The **validation** of the system functionality of the **vehicle levelling system** (UC4) under loaded conditions, conducted on different test benches, showcases an **advanced overall system performance** thanks to the integration of novel **WBG-based power electronics**.

In scope of **Task 5.2 virtual and vehicle-based evaluation of the HiPE technologies** have been performed using **vehicle demonstrators** as well as **vehicle models** to demonstrate the project achievements at vehicle level. The vehicle demonstrator for UC1 was equipped with the **400 V e-axle integrated with the multiple-speed transmission**, developed in scope of WP4, and tested on a chassis dynamometer using WLTP cycle measurements, which present **significant reduction of energy consumption**. A second vehicle demonstrator was set up to demonstrate the **advanced chassis actuators with 400 V GaN power electronics** as part of a **vehicle levelling system** including one actuator at each of the four vehicle corners. The validations have yielded satisfactory results in the form of **low level of energy consumption and thermal losses** and that the overall performance of the levelling system meets the corresponding project objectives. To demonstrate the achievements regarding UC2, a virtual vehicle demonstration based on a co-simulation platform, developed within WP3, has been performed with a vehicle model containing the **800 V electric axle integrated with the novel SiC inverter**. A **significant improvement regarding energy efficiency** is just one of the achievements. A real-world implementation of **model predictive control strategies for powertrains** based on **real vehicle test** measurements, conducted for **different demonstrator vehicles**, show improvements in ride comfort and the potential for **increased user acceptance** through the reduction of longitudinal oscillations. Moreover, a virtual demonstration of full vehicle scalable thermal-management-system, take into account the HiPE technologies, present **less thermal losses leading to increased energy efficiency**.

Task 5.3 considered the **cost assessment for all four use cases** of the HiPE project take into account impacts on both system/component-level and vehicle level. The results present that the application of **HiPE technologies leads to improvements** regarding **operational costs** and **emission-related costs** as well as **Total Cost of Ownership** partially. The findings of the cost assessment underpin the **potential of HiPE technologies** to contribute to **more efficient and economically competitive power electronics systems** in automotive applications, which in turn **positively affects the total costs of BEVs** and thus leading to **increased user acceptance**.

WORKPACKAGE 6 – Thermal Management and Co-Simulation of System

WP6 focused on advancing **thermal management** strategies for **WBG-based power electronics**, ensuring high efficiency, reliability and compact integration in automotive applications. Its work spanned the development of **cooling concepts**, **thermal models** and **predictive control strategies** that together enhance the performance of SiC/GaN systems.

In the first phase (T6.1–T6.2), several cooling concepts — including direct, indirect and impingement cooling — were investigated, with particular emphasis on optimising **pin-fin arrangements in heatsink designs**. A heatsink prototype with a pin-fin structure was built and experimentally tested, and the results were successfully validated against **CFD simulations** performed in OpenFOAM. The prototype achieved a thermal resistance of approximately **0.024 K/W**, while maintaining pressure drops within automotive limits, confirming the feasibility of this approach for high-power SiC modules.

Building on these results, T6.3 developed integrated **thermal-system models** in MATLAB Simscape, covering **complete e-axle cooling loops with pumps, fans and heat exchangers**. These models were used to evaluate thermal layouts and component sizing for both passenger vehicles and light commercial vehicles under WLTC driving cycles. The studies identified optimal heat-exchanger and fan configurations that **reduced auxiliary energy consumption by up to 14%**, without compromising thermal safety.

In T6.4, the focus shifted to **predictive thermal and powertrain management**. Three strategies were developed and tested: Model Predictive Control (MPC), a vector-based control method, and an integrated model approach. Simulations under WLTC cycles demonstrated that predictive control leveraging future heat-generation forecasts can **reduce thermal-system energy consumption by up to 49%** for BEV truck applications. While **MPC** provided the **highest cooling stability**, it also introduced significant computational complexity. In contrast, the vector-based approach offered a simpler implementation while still delivering comparable thermal benefits.

These developments significantly **advance state-of-the-art thermal management** for WBG power electronics, enabling:

- **Higher power density** and reliability through efficient cooling of SiC/GaN devices.
- **Reduced system size and cost** via optimized layouts and predictive control strategies.
- **Energy efficiency gains** in electric vehicles by minimizing auxiliary loads, supporting extended range and sustainability goals.

A validated digital engineering framework combining experimental data, CFD, and 1D/3D co-simulation for rapid design iterations.

Together, WP6 outcomes **provide a strong foundation** for next-generation e-powertrain architectures, aligning with HiPE's mission to deliver compact, high-performance, and thermally robust solutions for future mobility.

3 Creation of White Paper

To make the **core results of HiPE accessible to a wider audience**, the consortium created a **White Paper** that summarises the **technological progress made in the project**. It explains where power electronics are heading, which innovations matter most, and how new materials and design approaches can shape cleaner and more efficient mobility. Below you can find a condensed version of its main insights:

The future of clean and efficient mobility depends heavily on how well we can convert and manage electrical energy. The European project **HiPE – High Performance Power Electronics Integrations** brings together partners from industry and research to develop a new generation of electronic systems that are **more efficient, smaller, and more reliable**. These systems are especially important for electric vehicles and other modern mobility solutions.

A central focus of the project is the use of **Wide Bandgap (WBG) semiconductors**, especially **Silicon Carbide (SiC)** and **Gallium Nitride (GaN)**. These materials go far beyond traditional silicon technology. They can handle **higher temperatures, higher voltages, and faster switching speeds**. As a result, they can reduce energy losses, improve performance, and make power electronics more compact.

The in HiPE created White Paper gives an overview of the current technology landscape. Some of the key insights include:

- **SiC devices** are very stable at high temperatures and are well suited for high-power applications such as electric vehicle inverters.
- **GaN devices** switch extremely fast, making them ideal for compact and lightweight systems.
- Both technologies require advanced **gate driver circuits** to control their behaviour safely and efficiently. Features like controlled switching, protection functions, and precise voltage management play an important role.

Another important aspect covered in the White Paper is **packaging and thermal management** — in other words, how the components are built and how heat is removed. Different substrate materials, such as printed circuit boards and ceramic bases, affect performance and durability. Modern approaches like **PCB embedding** help reduce unwanted electrical effects, while concepts such as **top-side cooling** allow heat to be taken directly from the top of the chip for better temperature control.

The overall message of the report is clear: the next generation of power electronics will be created through a combination of **new semiconductor materials, smarter driver technology, and innovative packaging solutions**. By bringing these areas together, HiPE aims to develop systems that offer **better efficiency, reduced size, and improved reliability**, helping Europe stay at the forefront of clean and sustainable mobility.

The White Paper is **available** here: HiPE D4.8 General Concepts

4 Scientific and Academic Outputs

During the course of the HiPE project, all partners were committed to sharing their findings with the public through **papers and theses.** Our goal was not only to develop advanced power-electronics solutions, but also to **make the knowledge behind them available** to everyone interested in the field. By openly communicating our results, we hope to inspire future research, support industrial innovation, and strengthen the wider community working on sustainable mobility. Here is an **overview** of the publications that shaped the scientific footprint of HiPE.

Scientific Papers

Over the course of the HiPE project, our researchers and technical teams worked tirelessly to capture their findings in **scientific publications**. These works present the **core results, methodologies, and insights** that emerged throughout the project. They reflect the collaborative effort across all partners and ensure that our contributions remain accessible to the wider scientific and industrial community.

I&M, Tenneco (SSI 2024): "Design of a Smart Actuation for a Fully Electrified Suspension System"
This paper presents the design of a fully **electrified suspension levelling system** developed within HiPE. The authors propose a high-voltage electromechanical actuator that adjusts a vehicle's ride height to **improve**

efficiency, aerodynamics, and driving comfort. To support the development process, mechanical and electronic subsystems were modelled using system-level simulations, enabling optimisation of motor drive technology, power losses, and thermal behaviour. The study **highlights the advantages** of wide-bandgap devices—particularly GaN—for improving efficiency and reducing heat generation. Initial simulation results show promising performance, demonstrating the potential of high-voltage smart actuators for future electric vehicles.
The paper is **available** here: (PDF) Design of a Smart Actuation for a Fully Electrified Suspension System

I&M (EMC Compo 2024): "Measurement of PCB-Related Commutation-Loop Inductance Using a Vector Network Analyzer"

This paper introduces a **practical method** to measure the **stray inductance of PCB traces in power-electronics applications** using a Vector Network Analyzer (VNA). Since PCB layout often contributes the largest share of commutation-loop inductance—impacting switching behaviour, efficiency, and EMI—the **authors compare two PCB versions** to assess design improvements. By applying the shunt-through measurement method, they successfully extract inductance and resistance values across the relevant frequency range. The **results show clear differences between the two layouts**, with the improved ground-plane version significantly reducing parasitics. The study demonstrates that VNA-based measurements are reliable, repeatable, and well-suited for comparing PCB designs early in development.
The paper is **available** here: EMCCompo_CommutationLoopInductanceWithVNA.pdf

E-VOLVE Cluster (TRA 2024): "Increasing Innovation Efficiency to Support the Transition Toward Sustainable e-mobility"

This paper presents the mission and ongoing work of the E-VOLVE Cluster, a group of European R&D projects supporting the **transition toward sustainable e-mobility**. It highlights how **initiatives** such as HiPE, HighScape, RHODaS, SCAPE, EM-TECH and Multi-Moby complement one another by **addressing key challenges** defined in the ERTRAC roadmap. The cluster collectively advances wide-bandgap power electronics, innovative motor technologies, modular converter topologies, advanced control strategies, and circularity concepts. Through this **coordinated approach**, the projects accelerate innovation efficiency, improve component performance, and contribute to safe, affordable and environmentally sustainable electric vehicles across multiple application domains.

The paper is **available** here: E-VOLVE Cluster: Increasing Innovation Efficiency to Support the Transition Toward Sustainable e-mobility | SpringerLink

I&M (PCIM 2025): "Optimization of a High Power-Density Inverter for Automotive Applications by Means of Top-Side Cooled Power Devices"

This paper investigates how **top-side cooled (TSC) power devices** can improve the thermal performance of a high-voltage inverter used in HiPE's electro-mechanical leveling system. Through detailed thermal modelling and CFD simulations, the authors **compare several commercial TSC packages** and show that Nexperia's CCPAK1212i offers the lowest thermal resistance and best power-density performance. The study then extends the analysis to a full ECU model, demonstrating that **TSC technology enables reliable operation** under air-cooling constraints and keeps junction temperatures well below critical limits—even during prolonged activation. These findings confirm that TSC packages are a key enabler for compact, efficient inverter designs in automotive applications.
A public-facing **article** summarising these findings was also published on Power Systems Design under the title "A Top-Side Cooled Package to Best Dissipate Heat".
The paper is **available** here: (PDF) Optimization of a High Power-Density Inverter for Automotive Applications by Means of Top-Side Cooled Power Devices

University of Surrey (IECON 2025): "Lifetime-aware nonlinear model predictive speed control for electric vehicle power converters"

This paper presents a **nonlinear model predictive control (NMPC) strategy** that incorporates thermal lifetime awareness into electric-vehicle speed tracking. The controller uses real-time damage estimation and prediction - based on thermal cycling of the inverter module - to dynamically adjust its behaviour as component degradation progresses. By balancing speed-tracking accuracy with reduced thermal stress, the proposed NMPC approach significantly **lowers peak temperatures, temperature swings, and cumulative damage**. Simulation results on a Fiat E-Doblo under WLTC and ARTEMIS cycles show that the damage-aware controller extends component

lifetime while maintaining acceptable tracking performance.
The paper is **available** here: Lifetime-aware nonlinear model predictive speed control for electric vehicle power converters | IEEE Conference Publication | IEEE Xplore

I&M (THERMINIC 2025): "Toward Real-Time Junction Temperature Estimation with a Physics-Informed Attention Lstm"

This paper presents a **physics-informed LSTM approach** for real-time junction-temperature estimation in automotive power electronics. By combining data-driven learning with simple thermal-model constraints, the method **achieves significantly higher accuracy and better calibration** than both plain LSTMs and traditional lumped models. On real automotive drive cycles, prediction errors are reduced by up to 18-57%, while confidence intervals remain reliable without adding computational cost. The **results** show that lightweight physics-guided sequence models can **improve temperature prediction robustness** and are suitable for onboard deployment in electric vehicles.
The paper is **available** here: Toward Real-Time Junction Temperature Estimation with a Physics-Informed Attention Lstm | IEEE Conference Publication | IEEE Xplore

Fraunhofer, I&M (EMPC 2025): "Investigation of thermal performance of various thermal interface materials used in top-side-cooled MOSFETs"

This paper compares the **thermal and mechanical reliability** of two silicone-based **thermal interface materials (TIMs)** - SE35 and TC4025 - for top-side-cooled MOSFETs under harsh automotive conditions. **Power cycling tests** with temperature swings of 100°C and 130°C show that TC4025 maintains stable thermal resistance and voltage drop, while SE35 degrades significantly, exhibiting void formation and increasing Rth over time. Thermal shock testing reinforces these findings: SE35 fails after around 100 cycles with >20% Zth increase, whereas TC4025 shows only minimal degradation. Simulations further validate the experiments, highlighting that delamination dramatically increases junction temperatures. Overall, **TC4025** demonstrates superior long-term stability, making it the more reliable TIM choice for top-side-cooled power devices in automotive environments.
The paper is **available** here: Investigation of Thermal Performance of Various Thermal Interface Materials Used in Top-Side-Cooled MOSFETs | IEEE Conference Publication | IEEE Xplore

Theses

Several students contributed significantly to HiPE through their **bachelor's and master's theses**. Their work not only **supported key project developments** but also helped shape the next generation of experts in high-performance electronics. The following theses highlight how deeply involved young researchers were in advancing our objectives.

Corrado Sudano (Politecnico di Torino): Master Thesis "Design and characterization of a modular GaN-based power stage for automotive applications"

This thesis focuses on the **design and characterization of a modular GaN-based power stage** for automotive three-phase inverters. Developed during an internship at **Ideas & Motion** in collaboration with **Politecnico di Torino**, the work aims to create a **compact, efficient and reliable inverter** suitable for high-power electric-vehicle applications. After outlining the motivation behind transportation electrification and the advantages of **wide-bandgap devices**, the thesis presents the architecture of the **GaN inverter**, key design decisions and **PCB layout considerations**. The experimental validation confirms **high efficiency**, **stable operation**, and the ability to handle demanding **voltage and current levels**, demonstrating the strong potential of **GaN technology** for next-generation automotive power electronics.
The thesis is **available** here: Design and characterization of a modular GaN-based power stage for automotive applications - Webthesis

İlyas Aslan (Yildiz Technical University): Master Thesis "Analysis and Design of Wireless Charging System for Electric Vehicles"

This thesis investigates and compares **wireless power transfer (WPT)** concepts for electric-vehicle charging,

focusing on different **coil structures** and **compensation topologies**. Key performance indicators such as **efficiency**, **power capability**, **misalignment tolerance**, and system size are examined to highlight the strengths and limitations of each approach. Based on these insights, a **1.5 kW wireless charging system operating at 85 kHz** is developed using a **series–series compensation topology**, aligned with **SAE standards**. **Circular coils** are used on both transmitter and receiver sides to ensure stable and efficient power transfer. The work demonstrates the growing relevance of **wireless charging** for EVs, offering greater convenience, reduced maintenance, and improved safety.
It should be mentioned that the thesis is fully in **Turkish language**.
The thesis is **available** here: tez.yok.gov.tr/UlusalTezMerkezi/tezSorguSonucYeni.jsp

Antonio Saporita (Politecnico di Torino; visiting student at University of Surrey): Master Thesis "Ride Comfort Optimisation via Nonlinear Model Predictive Control: Active Suspension and In-Wheel Motor Integration"
This thesis explores a novel approach to improving **ride comfort in modern electric vehicles** by introducing a **Nonlinear Model Predictive Control (NMPC)** strategy capable of coordinating two actuators simultaneously: a **linear electromechanical actuator** for active suspension and an **in-wheel electric motor**. By relying on a **single predictive model**, the method reduces system complexity while maintaining high control performance. Two controller variants were developed — one with a **fixed-step prediction horizon** and one designed for **real-time implementation** using a variable-step horizon. Both were tested in **MATLAB/Simulink** using a half-car model with detailed tire dynamics generated through **Siemens MF-Swift**. Comparative simulations showed that this integrated control strategy delivers **significant improvements in ride comfort**, achieving notable reductions in key performance indicators across a variety of road conditions.
For novelty reasons there is an **embargo** on the full thesis text. Nevertheless, the abstract of the thesis is available here: Ride Comfort Optimisation via Nonlinear Model Predictive Control: Active Suspension and In-Wheel Motor Integration - Webthesis

5 Final Event:
From Research to Application – Final HiPE Results

The final HiPE-event involving all partners to communicate the outcome of the project to a broader audience and to close the project was absolved on April 28, 2026.

HiPE Project partners presented their work on:

- Inverter design and thermal modelling
- Model predictive control
- Lifetime modelling
- Integrated onboard charging solutions

and gave an overview of how HiPE's results can be applied in practice and what they mean for future developments in power electronics. Different use cases and their demonstrators have been presented via online presenters and via video podcasts.

This event was announced through different represenative communities and channels:

- HiPE Social Media platform
- HiPE website
- Evolve Cluster social media platform, EARPA, 2ZERO and A3PS

6 Conclusion

The HiPE project concludes after three years of intensive collaboration, technological breakthroughs, and successful knowledge exchange across the consortium. Throughout the project, partners jointly developed next-generation wide-bandgap power-electronics solutions, advanced modelling and simulation frameworks, innovative thermal-management strategies, and high-performance demonstrators. These achievements not only reflect the strong interdisciplinary cooperation within the consortium but also provide a solid foundation for future research and industrial maturity.

Beyond its technical outcomes, HiPE strengthened Europe's innovation ecosystem through active dissemination, academic contributions, and close engagement within the E-VOLVE Cluster.

The final HiPE-event involving all partner to communicate the outcome of the project to a broader audience and to close the project was absolved on April 28, 2026. HiPE Project partners presented their work on "Inverter design and thermal modelling", "Model predictive control", "Lifetime modelling" and "Integrated onboard charging solutions" and gave an overview of how HiPE's results can be applied in practice and what they mean for future developments in power electronics. Different use cases and their demonstrators have been presented via online presenters and via video podcasts.

The project's publications, white paper, webinars, and demonstrators ensure that HiPE's impact will continue to grow beyond its formal end, supporting ongoing advancements in sustainable mobility and high-efficiency electric-vehicle technologies.

As HiPE transitions from a research initiative to a source of long-lasting technological value, the tools, methods and insights developed within the project position partners — and the wider community — to leverage these results in future projects, commercial applications and follow-up innovations. The consortium's collective efforts mark an important contribution toward Europe's progress in clean, efficient and reliable power-electronics systems.

7 Looking Ahead

Although the HiPE project has officially come to an end, its impact will continue well beyond its duration. Several **conference papers**, **journal publications** and a **PhD thesis** are currently in preparation, ensuring that HiPE's scientific contributions will keep growing in the coming months. In addition, the knowledge, tools and demonstrators developed within the project will serve as a strong foundation for **future research activities**, enabling partners to explore new concepts, optimise next-generation systems and pursue follow-up innovation initiatives.

Beyond research, HiPE's results also hold significant value for **industrial development**. Partners will continue to build upon the project's findings to advance **products**, **components** and **services** that support the transition toward more efficient and sustainable electric mobility. The collaborations, methods and insights formed through HiPE will therefore remain active and influential — fostering continued **progress** long after the project's formal completion.

General Project Information

More information on HiPE is available on our website: hipeproject.eu

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Project Partners

Coordinated by

Partners

Project Facts

Project Coordinator: Bernhard Brandstätter
Company: Virtual Vehicle Research GmbH
Website: www.hipeproject.eu

Project Start: 1st November 2022
Project Duration: 36 Months
Consortium: 13 partners
Project Funding: 5,481,274 Euro

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