

VEHICLE POWER ELECTRONICS



We Offer Advanced Vehicle Power Electronics with Innovative Solutions and Outstanding Performance

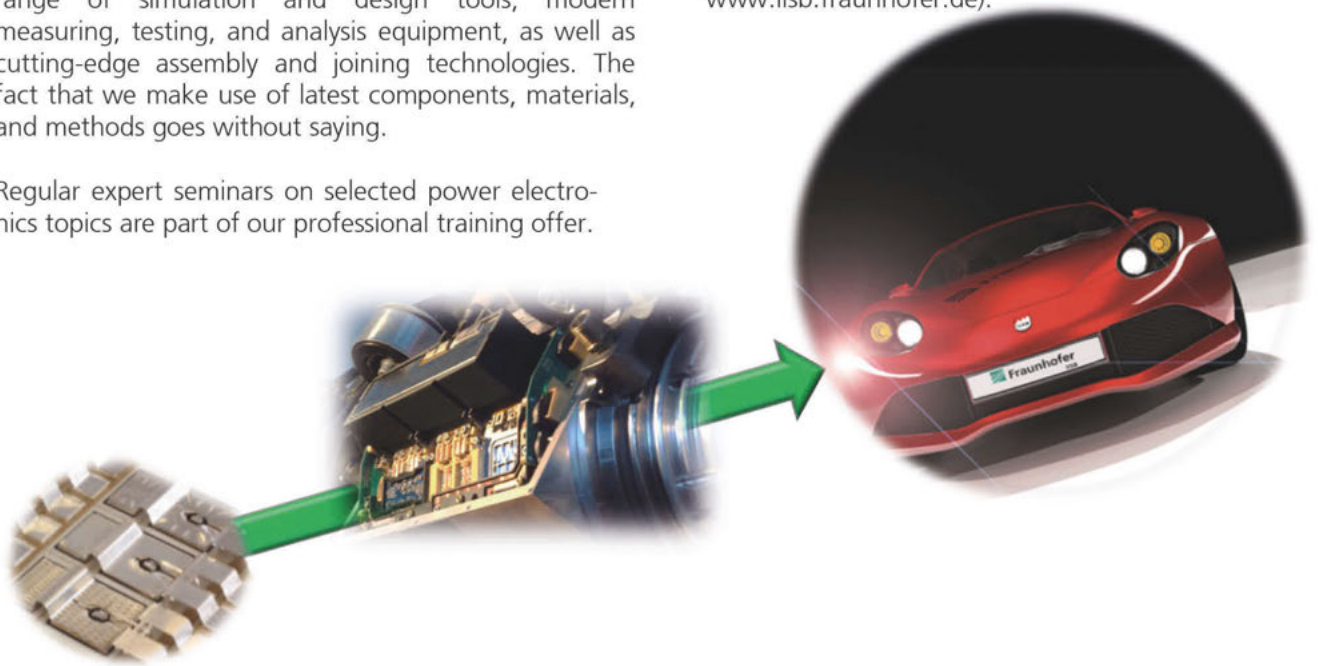
As an application-oriented research institute, our main interest is to advance into new ranges of system performance and to open up new fields of applications for high performance and cost efficient power electronic solutions. This is both a challenge and an incentive to us. To find creative solutions, we are ready to move off beaten track whenever necessary.

Research and development projects are carried out by highly qualified teams of engineers and technicians. All of these teams work in a number of well-equipped power electronics laboratories with access to a wide range of simulation and design tools, modern measuring, testing, and analysis equipment, as well as cutting-edge assembly and joining technologies. The fact that we make use of latest components, materials, and methods goes without saying.

Regular expert seminars on selected power electronics topics are part of our professional training offer.

Our partners are from small and medium sized enterprises, science and industry. As an ECPE Competence Center (www.ecpe.org), partner in the Bavarian Cluster "Leistungselektronik" (Power Electronics), the ENERGIEregion Nuernberg e.V., and the Fraunhofer Forum ElektroMobilität e.V. in Berlin, we cooperate on international and regional levels.

For an overview on all activities of our power electronics competence center please refer also to the brochures on energy electronics, devices, modules, and reliability (available from our homepage www.iisb.fraunhofer.de).



From semiconductor devices to high efficiency and power density systems for vehicle integration

Our Automotive Power Electronics Experts Teams

Drives and Mechatronics

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- Electric Drivetrains
- Inverter Development
- 3D Integration, Mechatronics
- E-Vehicle Test Center



AC/DC Converters

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- Vehicle to Grid
- Insulating Converters
- Modular Power Electronics
- Circuit Simulation



RF-Electronics and EMC

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- Inductive Power Transmission
- High Frequency SiC/GaN Converters
- EMC Test Site
- Semiconductor Characterization



DC/DC Converters

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- DC/DC Converter Systems
- Digital Control
- System Simulation
- System Integration



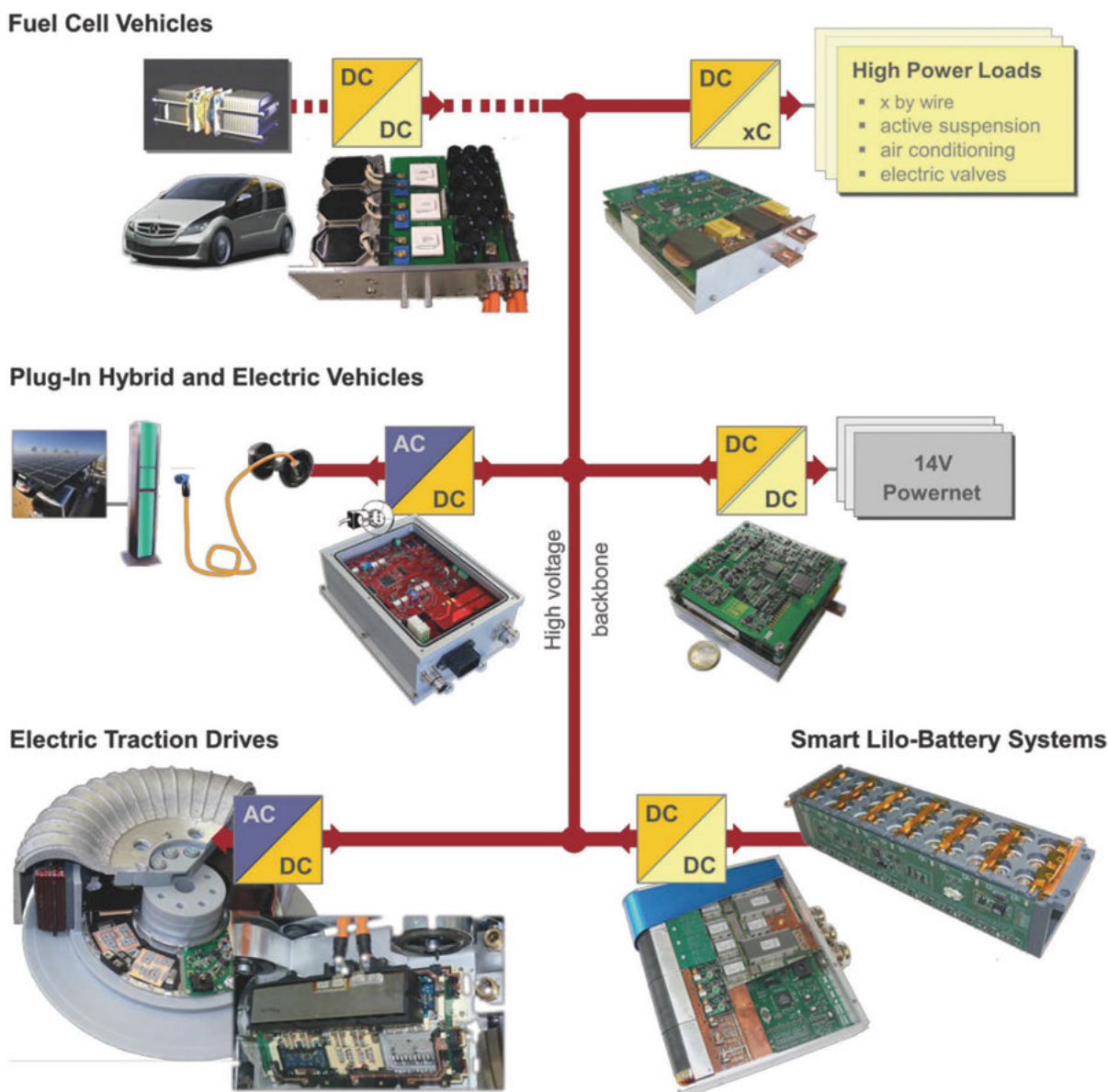
Power Electronics for Electromobility

Power electronic systems are key components for any hybrid or electric vehicle. All these vehicles – apart from some bikes and micro hybrids – require a high-voltage power net with a voltage above 60 V in addition to the traditional 14 V net. This high-voltage power net must be electrically isolated from the low-voltage net and vehicle chassis for safety reasons.

A high-voltage vehicle power net must contain an electrical energy storage and a traction drive inverter. Highly different vehicle concepts do exist, however, which include further high-voltage power electronic subsystems, such as DC/DC converters for supplying a low-voltage net, inverters for, e.g., an electric air-con compressor, oil or cooling water pumps, DC/DC converters for stabilizing the traction bus voltage, or AC/DC converters as an uni- or bidirectional vehicle-to-grid interfaces.

Fraunhofer IISB takes a top position internationally in the field of power electronics for electromobility. This is expressed in a variety of development projects with all large automotive manufacturers and suppliers. Many of the results have gained international attention.

We permanently strive to open up new applications and functionalities. The grid integration of electric vehicles, e.g., will gain more and more importance in the future. For avionic applications the new possibilities of modern power electronics will pave the way towards the “more electric aircraft”. This means powering many more actuators electrically in order to improve the overall fuel economy, and to reduce the maintenance efforts associated with hydraulic systems.

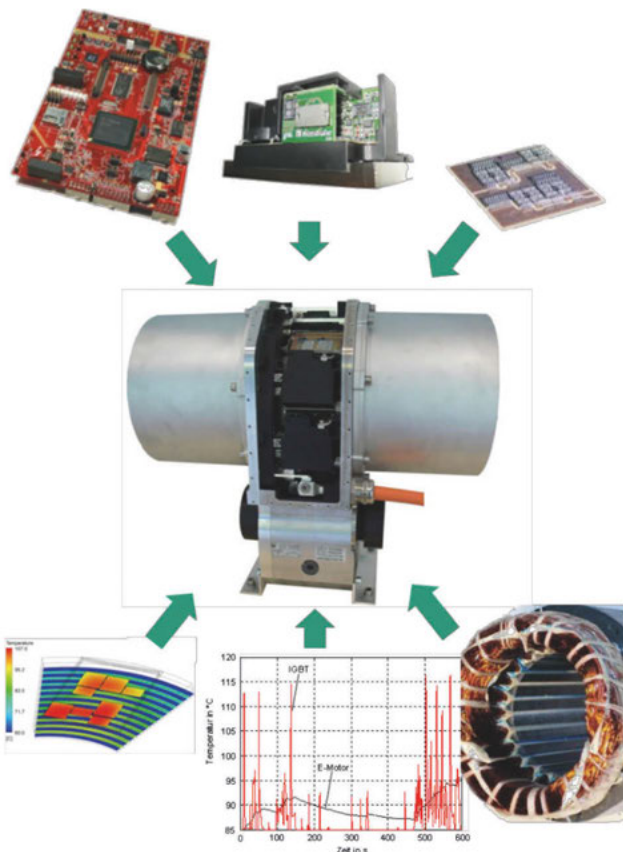


Our R&D focus: The whole spectrum of power electronic systems necessary for future vehicles

Smart Electric Drives

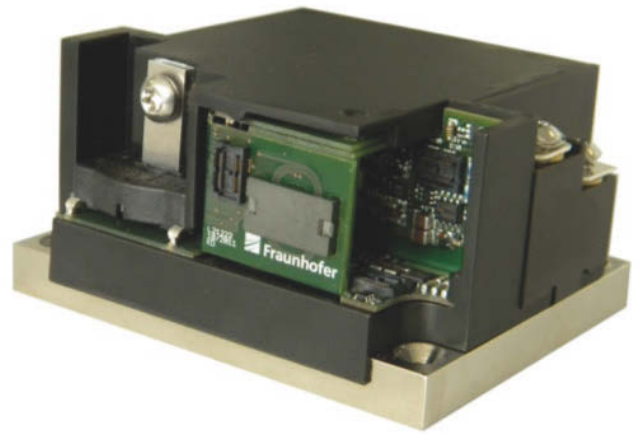
The development of efficient, highly integrated, and safe electric drive-systems plays a key role for the electrification of individual mobility. A few basic e-motor configurations cover most of the electric drive applications in hybrid and all-electric vehicles: one or two electric motors in a single housing and wheel-hub motors. For all these configurations, innovative, cost-effective, and space-saving solutions for a system integration of the power electronics into or close to the electric drives are developed at Fraunhofer IISB.

Following our smart drive approach, no complex HV harness is required for the electric power train - only a shielded DC-link cable connecting to the energy storage. EMC problems are reduced significantly by avoiding any AC cabling in the vehicle. This placement of electronics close to electric machines or even close to the internal combustion engine in hybrid cars leads to a higher level of thermal and mechanical stress. The use of common material concepts and innovative joining technologies, for example double-sided nano-silver-sintering of semiconductor devices, enables us to achieve the required robustness.



Single wheel axle drive with attached modular double-inverter

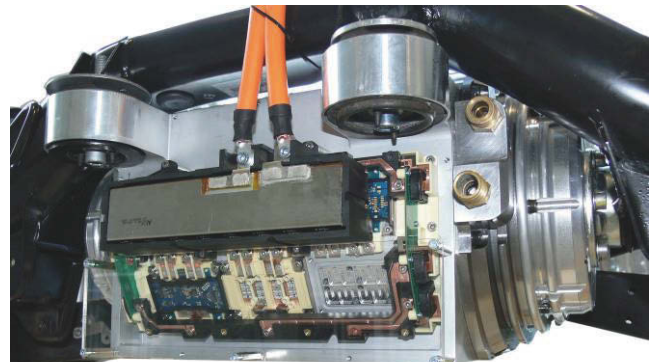
The axle drive-unit in the picture above includes two mechanically independent permanent magnet synchronous motors (PMSM) with reduction gear (7:1). Each motor has a peak-power of 80 kW and a continuous power of 30 kW. The chosen 'off-axis' concept allows flexible use in a variety of vehicle concepts, in small commercial vans, busses, or sports cars, for example.



Our Smart Power Module - a "Modular Inverter Building Block"

The motor control software is developed model-based with a direct link between Matlab/Simulink™ and our powerful 32-bit target processor. Hardware and software development is carried out under consideration of ASIL requirements.

The power electronic components are completely integrated into the electric drive. The double-inverter with a nominal phase current of 350 A_{rms} and a nominal DC-link voltage of 400 V is realized with six modular 'Inverter Building Blocks'. Many of the weak-points of today's power modules regarding interfaces, constraints for overall system design, assembly efforts, and reliability could be eliminated by this design.



Single-wheel axle drive with attached double inverter

Our services for smart electric drive developments

- Highly integrated drive solutions for hybrid or electric vehicles
- Complete in-house development and testing of inverter power electronics (incl. 3D integration)
- Vehicle integration of electrical drive and power management systems
- Field-oriented motor control development for various machines (e.g. PMSM, IM, SSM, etc.)
- Functional safety concept (ISO 26262, up to ASIL-D)

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Mechatronic System Integration

The trend towards miniaturization and system integration in power electronics is mainly driven by applications with severe space restrictions such as automotive, robotics, or avionic. Major challenges arise from the fact that the installation space in these applications is usually predefined by mechanical requirements with less consideration for power electronics needs. This often results in complex geometries and contamination in addition to high thermal and mechanical stress. However, the better use of space, the avoidance of expensive cables and failure prone connectors, and the reduction of EMI filter expense make it necessary to choose this path.



Wheel-hub-motor integrated drive inverter with 6 phases

Various concepts and solutions for the integration of electric motors and inverters into the drivetrain of passenger cars have been developed. Each design is adapted to the different locations of the e-drive within the drivetrain.

Non-Insulating High Power DC/DC Converters for Power Train Energy Management

Our high voltage, non-insulating, bidirectional converters are mainly used for traction energy management in case of recuperation, boost, the management of different power sources (e.g., fuel cell and battery), and fast charging. The converter covers a power range up to about 600 kW with efficiencies up to 99%

Combining the converter with drive inverters in terms of system integration is just as possible as an integration into the electrical energy storage. The type of cooling (air, water, or oil) is generally tailored to the specific application. A fully digital control and a CAN-bus interface for the communication with a vehicle control unit is standard.

We make use of the latest Si, SiC, and GaN devices. Our multi-phase concept makes it possible to shift the fundamental frequency of the DC link ripple voltage in the megahertz range, resulting in a considerable reduction of weight and volume of the passive components.

Experience with air, water/glycol and oil cooling is available. Vehicle-specific requirements, such as coolant temperatures up to 115°C and high vibrational loads are taken into consideration.

A mechatronic system integration requires more than just increasing power density. We are working on innovative integration concepts as well as on new device, interconnection, and cooling technologies that foster a 3D integration, increase ruggedness, and decrease costs of power electronics.

Our focus is on:

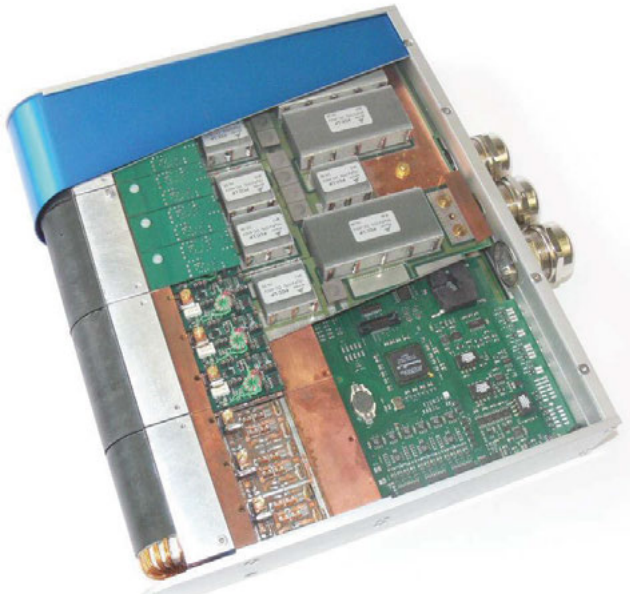
- Customized power electronic systems for vehicle applications (automotive, railway, avionic, etc.),
- Vehicle integration of electrical drive and power management systems,
- Mechatronic integration of power electronics into vehicle components (incl. 3D integration),
- Advanced thermal management,
- High voltage safety concepts
- EMC concepts and solutions,
- Traction energy storage,
- Simulation of power electronic systems within a vehicle environment,
- Studies on hybrid and fuel cell vehicle powertrain topologies with special emphasis on topics like overall performance, efficiency, and system costs.

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Robust and High-Speed 250 A, 450 V buck / boost DC/DC Converter for universal drive train applications

Within the latest high power, high voltage DC/DC converter development projects power densities of more than 80 kW per litre are achieved in 850 V high voltage full SiC technology.



100 kW DC/DC converter with a power density of 25 kW/dm³ and an efficiency exceeding 96% - enabled by using SiC technology

We build complete systems for our industrial partners, including high-power and bus connectors. Integrated in a sealed housing, these robust compact devices are used in R&D hybrid cars for evaluating the electric power train.

Insulating DC/DC Converters for connecting board grids and supplying auxiliary devices

Fraunhofer IISB develops all kinds of insulating DC/DC converters for mobile applications. This includes e.g. insulating high voltage (up to 850 V) to low voltage (commonly 14 V, 24 V or 48 V) converters in the power range from 10 W up to approx. 5 kW. With efficiencies of up to 97% and power densities up to 10 kW/dm³, they can be easily integrated into a small car, directly inside the high voltage battery system or the drive inverter. The photo to the right gives a closer look at how by using modern power devices, full digital control techniques, and mechatronic approaches, outstanding power densities and efficiencies are reached.

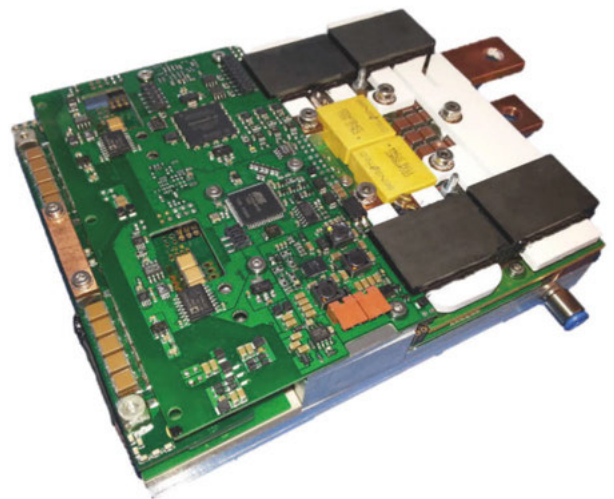
As with other Fraunhofer IISB vehicle electronics prototypes, insulating DC/DC converters can be developed for plug-and-play installation, as the example of a fully housed, insulated 5 kW DC/DC converter with automotive qualified connectors shows. It could be used within two different voltage ranges for applications in light or heavy trucks and can be controlled via CAN interface. Due to the serial connectable phases on the primary side, the use of automotive qualified Si power semiconductors with 600/650 V blocking voltage is possible to reach a DC-Link voltage up to 800 V

Efficiencies up to 99% over a wide range of load can be realized via a load-adaptive management of the number of active phases. All converter components including EMI filters, the control electronics, and the fluid cooler are generally included in our power density figures. The high power density and low power to weight ratio of our DC/DC converters make them especially suitable for demanding motor sports (KERS) and aircraft applications.

Key aspects:

- High efficient compact DC/DC converters
- Power up to 600 kW, 300 – 1000 A
- Typical voltage levels 450 / 850 V
- User specific housing, layout, communication and electrical power specification
- High Speed control loops for stability and save handling of load dumps
- Application specific liquid or air cooling techniques

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Insight of high power density insulating DC/DC converter

- Galvanic isolation
- Safe connection of high voltage and low voltage on-board grids
- Supplying of high power demand auxiliary devices in vehicles



Insulating 5 kW DC/DC converter from 750 V to 24 V for trucks

- Very high power density up to 5kW/dm³
- High efficiency up to 95 %
- Very high input voltages (up to 850 V)
- Modular Multi Level Design
- Automotive qualified (Si) power semiconductors

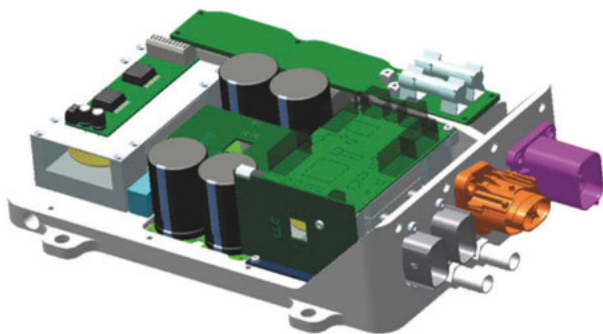
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Battery Chargers – Conductive & Inductive Solutions for Electric & Plug-In Hybrid Vehicles

In the field of conductive vehicle battery chargers, Fraunhofer IISB follows a modular design approach based on 3.7 kW galvanic isolated AC/DC converter units. With the modular circuit design approach, we are able to develop and realize a broad on-board charger product line for 3.7 kW, 7.4 kW, 11 kW and 22 kW demands.

tolerance, lightweight pick-up, and a minimal package volume compared to underbody systems.



Insight of high power density 3.7 kW battery charger



Positioning tolerant inductive charging solution



22 kW battery charger (developed in cooperation with Audi Electronics Venture GmbH (AEV) within the BMBF research project e performance)

Besides pure battery chargers we also provide chargers with extended functionalities, such as bidirectional energy flow for applications in vehicle-to-grid scenarios, or an integrated mobile power socket (e.g. 230 V_{AC}).

- High power density and high efficiency
- Wide input voltage range
- Supporting charging mode 2 and mode 3 according DIN EN 61851-1

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In the field of inductive charging systems we offer solutions with high transfer efficiency and small stray fields through minimal air gap, high positioning

Electro Magnetic Compliance – EMC Tests for Automotive and Industrial Applications

The EMC lab at Fraunhofer IISB offers pre-compliance measurements during the development process of our prototype systems and the components of our industrial partners. We offer a broad range of services from consulting in case of EMC problems via different measurements according to harmonized standards to very detailed circuit and layout optimizations.



EMC test set up of a HV DC/DC converter

In the EMC test chamber we can perform, e.g., conduct emission measurements on electric or hybrid cars with the vehicle's own radio antenna according to CISPR 25 as well as many standard tests on component level.

The immunity to electromagnetic interferences can be tested in our Fully Anechoic Room (FAR) according to industrial and automotive standards. These tests include all relevant pre-compliance measurements in the context of a homologation testing according to 2004/104/EG directive or ECE R10 Rev. 3 of the United Nations.

Our engineers have longtime experience in the field of electromagnetic compliance (EMC) and interference (EMI). They are working in several national standardization committees. We can thus guarantee competent expert advice and up to date information on EMC topics to our partners.

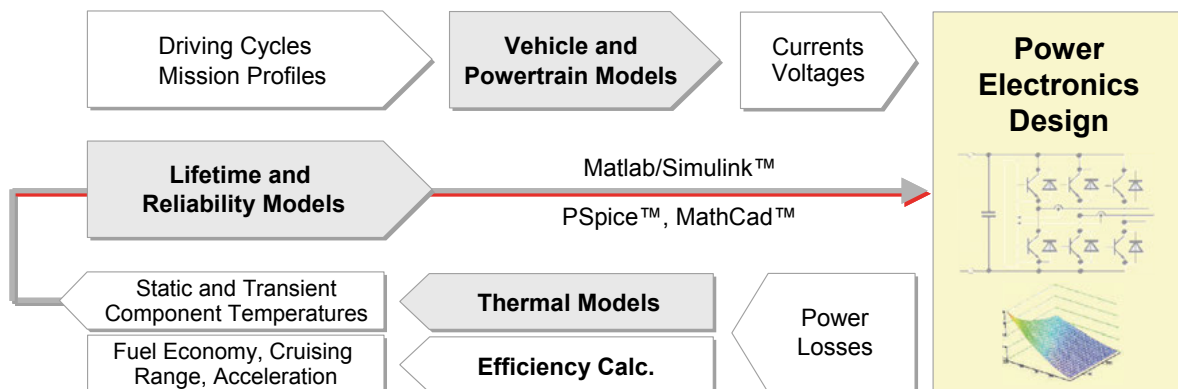
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Automotive System Simulations - From Vehicle to Chip Level

The automotive targets regarding cost, size, weight, and reliability cannot be met if either irrelevant maximum requirements are specified or unnecessary safety margins are designed in. A prerequisite for optimized, tailor-made designs are simulations of the entire powertrain under different driving cycles. Our special focus is on the resulting load conditions of the various power electronics components. In order to get realistic data about the transient temperature behavior necessary for lifetime and reliability analyses, thermal models are linked to all relevant power electronics components. For simulations we use a Matlab/Simulink™ environment. This enables us to perform analyses regarding parameters like e.g. powertrain efficiency, vehicle operating strategy, energy storage load, or cruising range. Standard and artificial driving cycles are used, as well as real ones measured with our GPS-based vehicle data recorder.

Ambient temperatures strongly influence the cruising range of electric vehicles due to the required energy for heating and cooling the passenger compartment and the battery system. New approaches investigate the use of heat pumps and thermally insulated cabins. In addition, thermal preconditioning of the vehicle, using existing thermal masses significantly reduces the required battery energy. An overall vehicle energy management, comprising thermal and electrical energy, allows efficient reuse of even minor losses in the electric drive-train for heating purposes.

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Automotive system simulation – a key competence for any application specific optimization of power electronic systems

Energy Storage Systems and Energy Management Solutions

Our focus is on fully customized cost efficient electric energy storage and management system solutions for mobile and stationary applications. Our activities range from development of embedded energy management software to the design of complex, high-power energy storage systems for electrically propelled vehicles (e.g., automobiles, bikes, motorcycles and other types of road vehicles, aircrafts, ships and submarine vehicles) and for smart grid applications in combination with renewable energies (i.e., in private household and industrial utilization).

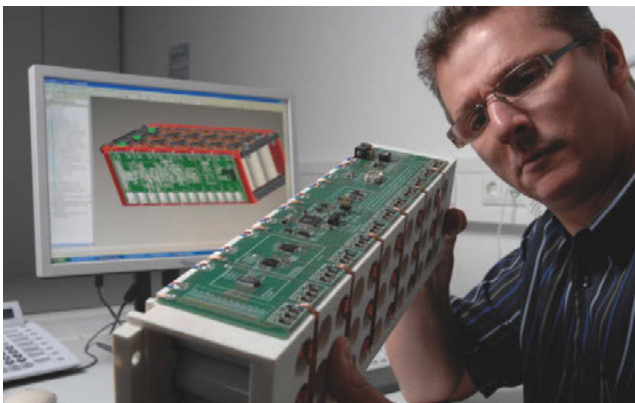
Full-custom Battery Systems

At Fraunhofer IISB, we develop highly innovative, cost-efficient energy storage systems, including battery monitoring and management hardware and its embedded software, battery module and pack modeling and design, as well as sensors and actuators for increased reliability and safety.



Smart battery system based on lithium-ion batteries for an high-performance electric vehicle

Throughout the engineering of traction energy storages, all necessary competences work together at Fraunhofer IISB. Especially with a view on modern lithium-ion battery cells supplying the power train in electrified vehicles, topics like internal and external hazards are of vital importance.



High performance modular lithium-Ion battery module with

Collaborating directly with globally renowned battery cell suppliers worldwide, we provide our experience in the fields of safety management and cell monitoring, passive and active cell balancing methods, charging and discharging controls. Assembly and interconnect, thermal management and cooling, as well as in interfacing and communicating between components are among our expertise, constituting a modern mobile or stationary cost-efficient electric storage system solution.

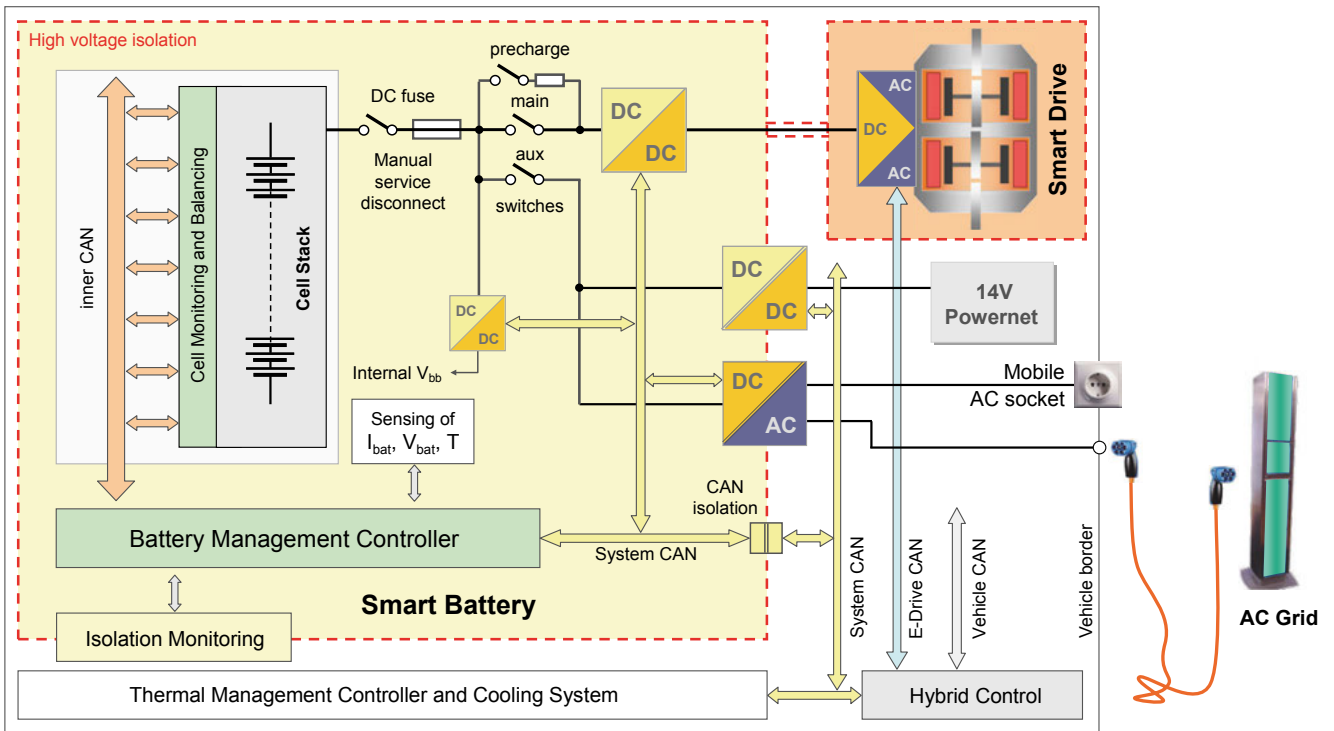


Full-custom battery system design, including mechanical, thermal and electrical engineering

So we can offer our customers the development and realization of state-of-the-art traction battery systems (BEV/HEV) – from the first concept to the in-house testing of the complete system:

- Electric specification, e.g. voltage-level and capacity, according to the customer requirements
- Use of the best fitting lithium ion cell technology (high energy-cells, high power-cells or combination)
- Adapted cell-monitoring and battery-management-systems
- Customer specific electrical (power/signal) and mechanical interfaces
- If required: implementation of additional power-electronic-components directly into the battery system (e.g. HV or LV-DC/DC-converters)
- Thermal management from system- to the cell-level (e.g. liquid- or air cooling, one-sided or double-sided cooling)
- 3D mechanical design development with individual vehicle integration
- Modular design approach for a cost-efficient later industrialization and a safe handling

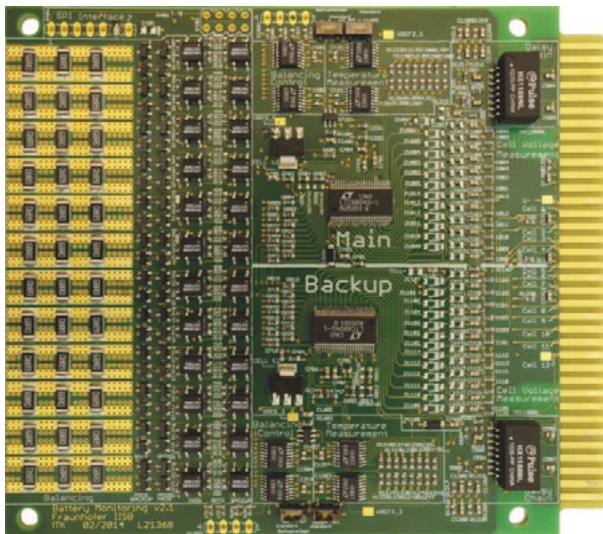
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Smart traction energy storage unit and its environment in a hybrid electric vehicle

Battery Management Systems

High performance monitoring and management systems for energy storage devices are developed at Fraunhofer IISB. The software is a key component in present storage systems and, as system complexity continues to increase, plays an increasingly central role. Voltages, currents, and temperatures are measured and logged for calculating the state-of-charge (SOC), state-of-health (SOH) and state-of-function (SOF) of the storage systems since these values are crucial for long lifetime and predictive maintenance. The development of these functions requires advanced know-how on system and on cell level. The Fraunhofer IISB brings this together.



High-end daisy chainable universal battery monitoring electronics with full redundancy for safety-critical high-availability applications offering $\pm 1.2\text{mV}$ accurate cell voltage measurement on 12 channels in an extended temperature range, NTC-based and sensorless temperature measurement, active or passive cell balancing with balancing status monitoring

Battery Modelling and Testing

At Fraunhofer IISB, we develop accurate electro-thermal battery models for battery system simulation and design. We also develop and implement compact models based on robust electro-chemical battery models. These models are used in battery state estimation algorithms based on Kalman filtering (e.g., adaptive extended Kalman filter). Following characterization methods and equipments are available:

- Electro-chemical impedance spectroscopy (EIS) up to 1 MHz and up to 30 A
- Charging and discharging tests on battery cell level between -1 V and 8 V and up to 440 A
- Testing of driving cycles on cell, module and system level up to $\pm 1000\text{ V}$, $\pm 1000\text{ A}$, 500 kW

New Sensors and Actuators for Safety

We develop and integrate sensors and actuators for improving safety and availability of battery systems.



Ultraflat printed temperature sensor



High-current (100 A) antifuse for bypassing

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Electric Drive Technology Platforms

Fraunhofer IISB is developing various research platforms for the evaluation and optimization of hybrid and electric vehicle powertrain components.

The hybrid vehicle platform is based on a conventional AUDI TT, the electric vehicle platform on a Citroen AX and an ARTEGA GT.



Electric vehicle test platform

In the case of our hybrid vehicle platform, the original front-wheel drive is untouched but supplemented by an »active rear axle«. This modular, easy to implement, through-the-road parallel hybrid concept allows a lot of attractive features to be realized:

- Recuperation of braking energy
- Boosting with additional torque
- Temporary electric four wheel drive (T-4WD)

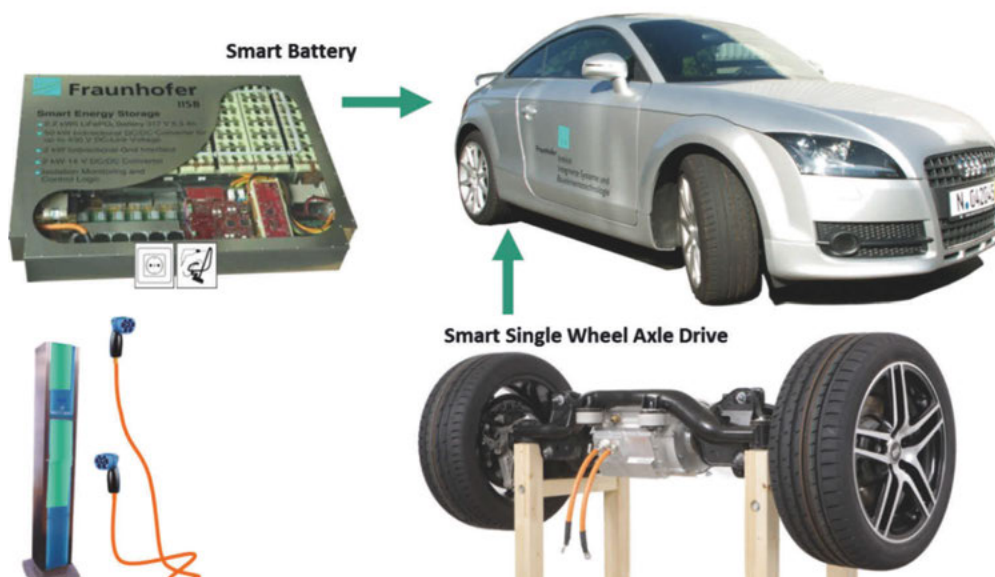
All converters necessary for electrical energy management, power supply, and charging are integrated into the energy storage, which therefore transforms into a smart battery unit. This kind of system partitioning follows the basic idea of a "site-of-action integration" and minimizes high voltage cable harness and system costs.

An innovative multiport DC/DC-converter is used in the electric vehicle platform for managing the high-voltage electrical system. This allows a flexible combination of different energy storages with different voltage levels (e.g., a traction-battery with additional supercap storage).

An integrated drive unit with two independent electric machines and a maximum power output of 2x 80 kW allows an independent torque allocation for each wheel of the rear axle.

Further research focuses within the vehicle project:

- Operational strategy with variable DC-link voltage for increase of part-load efficiency
- Position-tolerant inductive charging
- Model-based vehicle control system using Matlab/Simulink and dSpace
- Street legality



Fraunhofer IISB's evaluation platform for hybrid and electric powertrain components

Electric Vehicle Test Center

Vehicles with an electrical power train put completely new demands on test systems. The new vehicle test center at IISB is dedicated to electric vehicles and allows for the testing and characterization of all components of an electrical power train, as well as complete electric vehicles. The test center includes test beds for electric drives, traction batteries, system reliability, and electromagnetic compatibility (EMC).

Overall electric vehicle testing is possible in an air-conditioned dynamometer, including fully automatized road and driving cycle simulations. All labs of the test center include a powerful highly dynamic DC source (150 kW, 0 ... 800 V, 4Q), and a coolant conditioning system (-40°C to +115°C) for the operation of the system-under-test (SUT).



Fraunhofer IISB's electric vehicle test center

Electric Test Bed for single and dual Motor Traction Drives

Single motor drivetrains as well as two motor axle drives can be characterized with a test bed which was especially designed for electric vehicle drives. Two e-motors can load the SUT with arbitrary load profiles within a performance range up to:

- Torque: 1.400 Nm / 3.000 Nm (S1/S6)
- Breakdown torque: 4.500 Nm
- Power: 129 kW / 275 kW (S1/S6)
- Track width: 0...1.800 mm

A professional automation system combined with high-precision recording equipment for DC and AC currents, voltage, torque, and speed allow the measurement of:

- Inverter and motor efficiency characteristics
- Speed-torque characteristics, and provides
- Vehicle and road simulations.

A Matlab/Simulink™ interface sets a direct link to our vehicle simulation platform.



Electric drive test bed

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Air conditioned 4-Wheel Dynamometer

The achievable cruising range of an electric vehicle is not only a function of vehicle data, battery size, and driving cycle. Auxiliary systems, e.g., for air-conditioning or lighting, affect the cruising range, as well as the highly temperature-dependent properties of the traction battery.

Electric vehicles can be characterized using our 4x4 dynamometer without expensive test bed adaptations of the vehicle. The entire dynamometer is housed in a chamber that can be temperature-controlled from -25°C to $+45^{\circ}\text{C}$.

Preferred applications of the dynamometer are:

- Overall power train efficiency, energy consumption and cruising range characterizations
- Road and driving cycle simulations
- Evaluation and parameterization of simulation models
- Development of drivetrain control algorithms



The 4-WD dynamometer (4x 85 kW) in the vehicle test center

EMC Test Chamber

The electric energy converted in hybrid and all-electric vehicles is about two orders of magnitude above the



EMC test chamber for pre-compliance measurements

one processed in conventional cars, while EMC limits are nearly the same. The structure of the electric power net is also completely different due to safety requirements. EMC is therefore a central issue in the development of electric powertrain systems.

For pre-compliance measurements and immunity tests of electric powertrain components and entire vehicles, our test center includes an EMC test chamber, fully equipped with test and measurement systems up to 1 GHz. The EMC chamber can be passed with a mid-size passenger car. Walls, floor, and ceiling of the chamber are lined completely with ferrite absorbers, which qualifies the chamber for measurements in a wide frequency range.

The systems under EMC test can be supplied with coolant and with electrical energy via high power feed-through filters (690 V_{AC} , 250 A and $1000\text{ V}_{\text{DC}}$, 500 A).

Battery Test Center

Single battery cells as well as complete electric vehicle storage units - with a mass of up to several hundreds of kilograms - can be tested and characterized regarding their electrical and thermal properties.



Protected container for battery tests

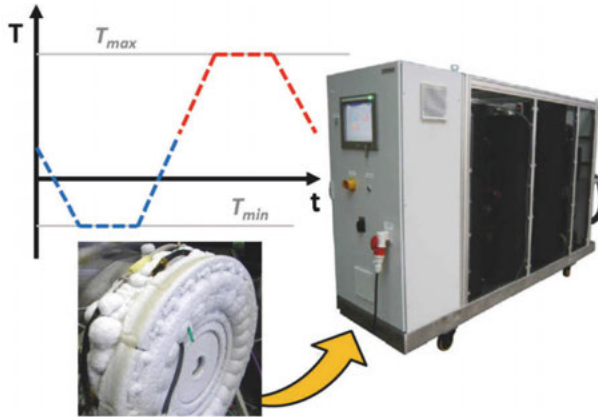
A multi-channel high-precision measuring system is used for cell characterization and model parameterization. Even large traction storage units can be tested in a temperature range from -40°C to $+115^{\circ}\text{C}$ and with a charging/discharging power of up to 150 kW. A special protected container, located outside the test center, allows for tests with the risk of damages to the battery or even destructive tests.

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(EMC Test Chamber)

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System Reliability

The IISB test center includes a customized thermal cycling system that is especially designed for large and heavy systems with a higher thermal capacitance. Complete power electronic systems – such as chargers or DC/DC converters, as well as electric drive and battery systems can be tested. Therefore the device is used for accelerated system life tests and thermal product validation processes (e.g. according ISO 16750 and IEC 60068).



Thermal cycling for system reliability tests (-40°C to 115°C)

Temperature cycling is realized via the coolant fluid, leading to a thermal stress quite close to that in the actual application. The temperature of the fluid can be set between -40°C and +115°C. The individually adjustable upper and lower temperature limits are defined by large coolant reservoirs allowing high dT/dt rates even for products with higher thermal masses. The temperature gradient in the system-under-test (SUT) is precisely controlled via a special mixer tap and a professional automation system. Any passive thermal cycling can individually be combined with an electrical loading of the SUT (active power cycling).

In addition to this system testing device, several active and passive temperature cycling test benches are available that are mainly used for reliability investigations at the device and board level.

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Promotion of Young Researchers in close Cooperation with FAU Erlangen

Well-educated and committed engineers are the basis of our success. This is why we are strongly dedicated to advertising the engineer profession, and supporting schoolchildren, students, and young engineers as far as possible.



Interesting jobs for research assistants, trainees, and guest scientists

The department 'Vehicle Power Electronics' of the Fraunhofer-IISB offers a lot of opportunities for young scientists and engineers:

- Jobs for engineers, scientists, and research assistants
- Topics for master and PhD theses (in cooperation with the University of Erlangen-Nuremberg)
- Taster traineeships and regular internships

An example for a successful cooperation with students from the University of Erlangen-Nuremberg is the 'TechFak EcoCar'. Within this project, the student-team

modified an outdated electric vehicle with up-to-date drivetrain components. For example a drive-unit, a lithium-ion traction-battery and a CAN-based vehicle control-system have been developed and integrated.

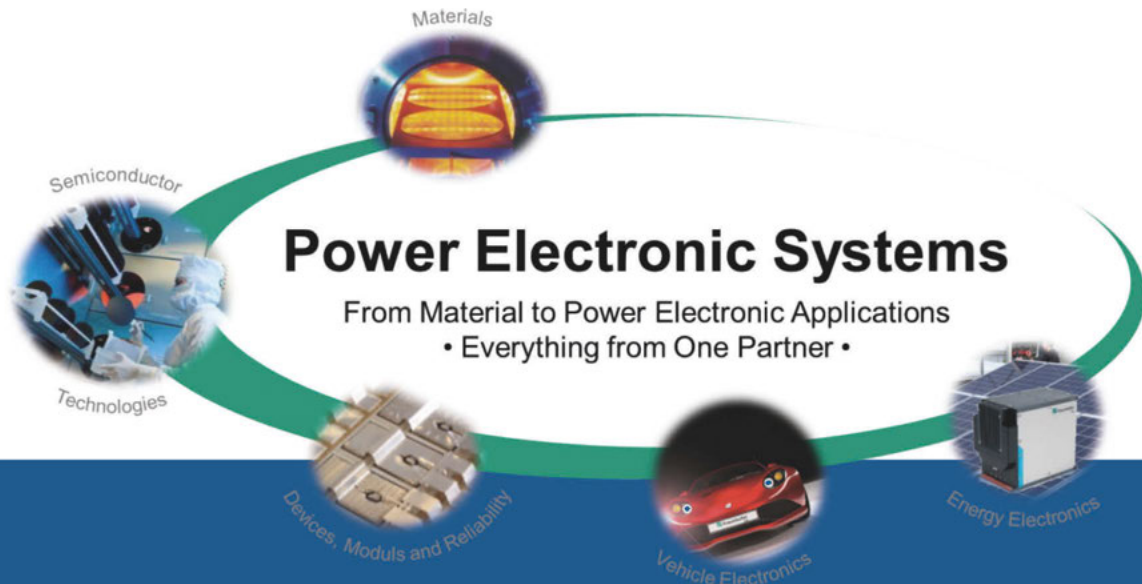
The Fraunhofer IISB supports the EcoCar-team with technical knowledge, components for the electrification, as well as laboratory equipment and testing facilities for the vehicle modification. For some students, the EcoCar-project was the starting point for a future career at the Fraunhofer IISB.

The public vehicle presentation in April 2014 was also the KickOff for the follow-up project – the development of an electric motorcycle.

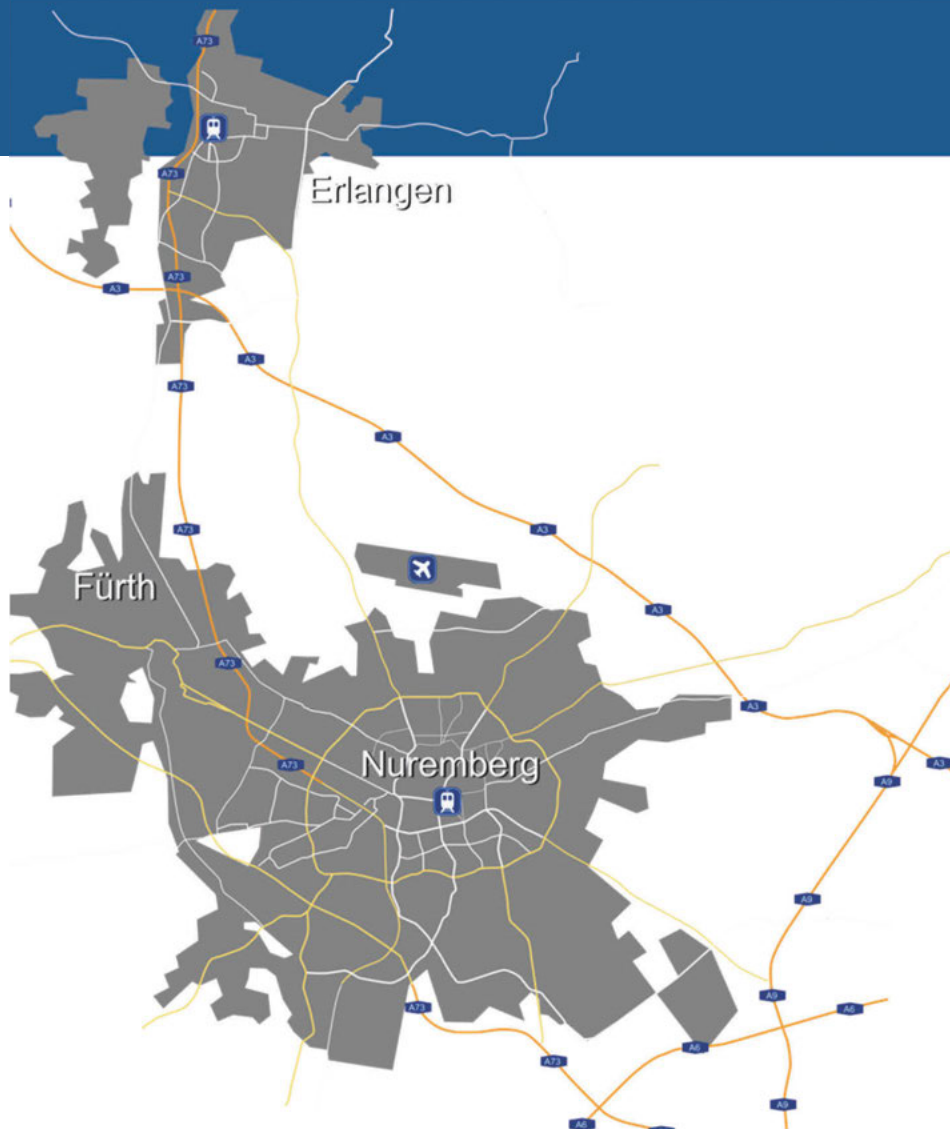


TechFak EcoCar: Close cooperation with students from the FAU-Erlangen

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