Siemens eCar Powertrain Systems

Heading to a sustainable future with advanced components for e-mobility

Siemens PLM Software solution enables Siemens Powertrain Division to offer automakers the best solutions for the electrification of powertrains.

Making electromobility a reality

Our world is changing quickly. In 2013, the CO₂ concentration in the atmosphere was the highest in 800,000 years. From 2001 to 2010, scientists recorded the warmest decade ever. The Max Planck Institute for Meteorology says that only an immediate, drastic reduction of CO₂ emissions can keep global warming below 2°C until 2100. Moreover, an incremental growth of cities will affect worldwide demography: by 2025, the world will have 27 megacities with more than 10 million inhabitants, and roughly one in ten people will live in a megacity. By 2050, 70 percent of mankind will live in cities. Fossil fuel resources are becoming scarcer, driving an increasing focus on renewable energy. Therefore, efficient use of energy is the underlying imperative for future mobility.

Market forecasts confirm the trend towards electrification. Digital transformation, globalization, urbanization, and demographic and climate change are leading to new thinking about ways to innovate, design and produce, and paving the way for digitalization, automation and electrification. Technologically speaking, this means evolving from traditional power generation sources to advanced power transmission and distribution with smart grid technologies, and to efficient energy applications. Electromobility will be the only way to drive cars in the future, with hybrid cars in the interim.

Product
Simcenter

Business challenges
Develop innovative e-mobility solutions for automotive OEMs
Fulfill stringent functional and safety requirements
Deliver customized products

Keys to success
Deploy and refine model-based systems engineering methodology
Predict the efficiency of required components
Re-use knowledge capitalized from past work and experience

Results
Streamlined design and customization process for all e-mobility devices
Fulfilled market demands based on standardization and scalability
Shorter development cycles and lower costs

www.siemens.com/simcenter
Werner von Siemens developed the first electric railroad more than 130 years ago, and since then, electric drives from Siemens have been successfully applied in all industries. Siemens is now bringing its long history in electric drive technology to the electric car with innovative components for hybrid and electric vehicles – from motors to charging technology.

Within the Siemens Digital Factory Division, the Siemens eCar Powertrain Systems (Siemens eCar) business unit develops high-quality powertrain components and charging systems for serial production of electric and hybrid vehicles. After pioneering electric vehicles in the 19th century, Siemens is aiming at becoming a global system provider for low-emission electric mobility.

Facing different industry requirements
The ambition of Siemens eCar is to deliver to OEMs the right products with the best quality possible at the right costs. But this objective for excellence faces new engineering challenges raised by the very specific needs of the automotive industry. The company must fulfill stringent high-level requirements, and guarantee functional safety, traceability and transparency when developing components. Being a Tier1 supplier is very challenging due to the high expectations and quality standards of automotive OEMs. Streamlining design and collaboration processes at every stage of development and production requires precise traceability to anticipate components failures and correct them as quickly as possible. Delivering customized products makes the design and development process more complex, and usually requires additional development time. Siemens eCar needed to develop innovative products faster, and needed processes that shorten the development cycle, facilitate innovation, and control costs and quality.

Implementing a flexible development process
The Siemens eCar business unit markets high-quality components for the drive trains of hybrid and electric vehicles for sustainable mobility. The objective of the dedicated R&D department is to develop reliable products that fulfill customer-specific requirements. The eCar product portfolio comprises motors, inverters, voltage transformers and charging technology. For automobile manufacturers, the company offers high-quality powertrain components for hybrid and electric vehicles – motors, power electronics, inductive...
charging technology – for clean, sustainable, and above all, quiet mobility.

“Electric powertrains are critical components of the mobility of the future,” says Wolfgang Nebe, director of system technology at Siemens eCar. “With our expertise in developing powertrain components, we offer car manufacturers appropriate solutions for the electrification of their powertrains, whether they are cars or trucks, or hybrid or fully electric motors.”

To cope with their customization and flexibility challenges, Siemens eCar decided to use system simulation early in the development process, to validate technology decisions at each micro-step and avoid mistakes that could add costs and delay the delivery of projects.

“The systems-driven product development approach of Siemens PLM Software is the exact direction we want to take. The implementation of model-based systems engineering is driving our innovation platform, and enables us to combine architecture definition with simulation capabilities to validate technical choices early in the design cycle.”

Wolfgang Nebe
Director System Technology
eCar Powertrain Systems Business Unit
Siemens
The company decided to implement the Siemens PLM Software model-based systems engineering approach, and selected Simcenter Amesim™ software, which is used by world-leading innovative companies, enabling them to focus on the product engineering. The systems-driven product development methodologies and tools are exactly what Siemens eCar was expecting: an approach that turns complexity into a competitive advantage, and enables the company to aggressively innovate without increasing risk. The objective is to use simulation as a quality driver during the whole development process, with global processes and methodologies, from product requirements to product delivery.

Assessing the performance of electric components early in development

In electric vehicles, the drive system generally consists of electric motor, inverter, battery and charger. For the electric drive to propel the vehicle, the motor must be fed with an alternating current, which is supplied by the inverter. The inverter converts the direct current from the battery to an alternating current. The inverter also controls the vehicle’s speed, by increasing motor power as the driver accelerates. It is crucial to assess and optimize all these systems’ interactions to ensure the best efficiency and performance possible.

To assess the behavior of these components at the complete vehicle level for early architecture definition of hybrid and electric vehicles, Siemens eCar developed a comprehensive tool chain and simulation platform. The objective was to get a first insight of the vehicle performance when integrating Siemens’ electric components.

First, Siemens eCar engineers build the model of a vehicle, a super component and standardized architecture for the vehicle model (combustion engine, transmission, electric engine, driver, and other elements). Then they select the level of detail of the component to be simulated, based on the objective of the simulation and the use case. Finally, the engineers integrate the specific components such as the electric motor or inverter, parameterize these components, and analyze the performance of the complete vehicle in which they are integrated.

A flexible, multi-level approach is very important to enable the company to switch from component behavior for pre-sizing, to full vehicle assessment for performance and efficiency optimization. The engineers analyze whether the inverter and motor fit together, for example, and whether there is overload. They generate load profiles, check efficiency and component losses. Then they define the first requirements for the cooling system to enable optimal operating conditions. Simulation helps them to define requirements for detailed engineering of products, with more detailed models of the motor and the synchronous motors of inverter machines to analyze the inverter performance (power electronics and control electronics), bus bars, cooling and thermal behavior.

“...the right cost and at the right time.”

Wolfgang Nebe
Director System Technology
eCar Powertrain Systems
Business Unit
Siemens
Future development will benefit from a better understanding of the component behavior, and the company aims to implement the correct process to support the validation of the control strategies. The department’s objective is to push the edge of performance, and to determine the appropriate thermal behavior and derating strategies to avoid component overheating, lifecycle reductions and failures. Optimizing the components to their intended use helps ensure better quality.

**An optimal platform for model-based systems engineering**

Siemens eCar began using Simcenter Amesim tools as simulation became mandatory to support an optimized development process. The deployment of these tools enabled the company to predict the required component efficiency, and to support the development of a streamlined design and customization process for all e-mobility devices.

The unique multi-domain approach of Simcenter Amesim brought new dimensions and multi-physics capabilities. The multi-domain approach with validated application and physical libraries (hydraulic, thermal, combustion engine, transmission, and others) enabled the team to seamlessly model all the multi-physics aspects. The easy-to-use graphical interface for seamless and fast modeling and postprocessing tools enabled Siemens eCar to easily visualize energy flows.

A major advantage of the Siemens PLM Software approach is the model-based systems engineering thinking. Using the architecture definition and functional model, Siemens eCar can automatically generate architecture with stored models, and assess the performance of the architecture and selected configurations with appropriate simulations. Re-use of knowledge is also essential to further improve the development process, and Simcenter Amesim enables the company to benefit from past work and experience, thanks to its integrated smart model and data management solution.

By working with Siemens PLM Software, Siemens eCar acquired efficient software tools and a vision that totally fits with the daily challenges of the electric car project. The flexibility of the solutions and methodologies enable Siemens to fulfill many market demands based on standardization and scalability. The Siemens SIVETEC portfolio of motors, inverters, voltage transformers and charging technology is paving the way for electromobility, and the Siemens PLM Software approach will definitely support its evolution.
The mobility of the future definitely involves collaboration among all parties. We now have to stand not only as a component supplier, but as a system integrator, being able to develop products that fulfill customers’ requirements.”

Wolfgang Nebe
Director System Technology
eCar Powertrain Systems Business Unit
Siemens