SPECTRUM

30 years FEV

Plug-In E-Vehicle
with and without Range Extender

Mobility is an essential factor for economic development. Now more than ever before, the automotive industry is

SUMMARY

confronted with the challenge of making mobility globally sustainable, affordable and environmentally safe. Competition between the various powertrain concepts is at an all-time high, due to the turmoil caused by global climate change, the world financial crisis and their impending impact on the world economy.

It is one of FEV's prime objectives to support our customers in the development of these future-oriented technologies. It is likely the vast number of differing requirements will give rise to an equally vast number of individual technical solutions. One example of this can be found in the development of hybrid drivetrains, where technical solutions range from simple start/stop systems to power-branched full hybrids, with variable transmission ratios. Some of these systems have already been launched in the marketplace or already represent the state of the art in hybrid technology.

Recent discussions on the use of electricity as a secondary power source have arisen, not only because of the CO_2

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FEV

Preface

Dear Readers

The international financial markets, especially those in the US, are facing a period of historic volatility and uncertainty. The defaulting mortgage sector, combined with the tightening of credit and unstable energy costs, has influenced all business sectors, with the automotive and transportation-related industries experiencing likewise historic declines.

During uncertain times, flexibility and diversity of business markets is critical to a company's ability to weather such an economic storm. These characteristics have been an integral part of FEV's strategic planning, such that today, we can respond to almost any of our customer's requests for product development support. Our proven technical capabilities range from next generation passenger vehicle powertrains, full vehicle integration services, and electronics and controls, to heavy-duty emissions calibration and aftertreatment system development, specialty vehicle or marine applications. As a result, flexibility and diversity are central to our business culture and are a critical factor in our continued strength.

As the transportation industry worldwide embraces new energy efficient, technologies, especially plug-in hybrids, FEV is strongly positioned to support our customers in an increasingly wide range of products and services. In North America, FEV continues to grow and can supplement project staffing, assume complete product design and development responsibility, or transfer technology to organizations burdened with increasing technical challenges and reduced engineering headcount.

The challenges ahead are daunting, but FEV's technical competence, flexibility and its diverse customer base assure our ability to weather this storm and support our industry partners as they chart their course for the future.

Yours faithfully

Gary Rogers

Executive Vice President, FEV Motorentechnik GmbH President & CEO, FEV, Inc.

debate, but also because of a complete view of energy management in the mobility sector. The development of e-traction could bring about convergence between the two worlds of energy supply for stationary users (electricity and gas) and that for mobile users (petroleum-based fuels). The plug-in hybrids are set to play a particularly important part in changing mobility. The term 'plug-in hybrid' is used to refer to vehicles fitted with a battery that can be charged from an external source and have both an electrically-operated drive system and a combustion engine. The developmental goal of these plug-in hybrids is to leverage advantages in terms of the well-to-wheel CO_2 balance and the diversification of the primary energy source, which are two aspects that promote or rather secure the future of independent mobility.

Battery technology plays a key role in the development of these hybrid vehicles. Due to its limited energy density, the NiMH technology that was introduced to the automotive market is not a model for the future. Lithium ion batteries provide a much more promising technology for the future. Great efforts are currently being made to develop battery systems that are suitable for motor vehicles. As specialists in vehicle integration, with expertise in the areas of design, packaging, high-voltage and functional safety, cooling and battery management systems, FEV is rising to this challenge. In particular, FEV assists its customers with the development of production-ready lithium ion batteries. The 'LiionMan' battery management system developed by FEV (s. Fig. 1) combines all of the required functionality with maximum flexibility.

However, as the current state of battery technology pushes its limits, it creates problems that may not be possible to solve in the short term, but will need to be skillfully addressed and controlled. This includes ensuring that the battery retains the ability to store a certain charge or supply a certain amount of energy for driving and heating the passenger compartment, even under extreme ambient temperatures.

A cost-effective solution for dealing with operational limits of this nature can be made available in the form of a range extender module. Range extender modules are small generators operated by a combustion engine, which operates only when needed. The specifications of these modules are adapted to the specific operating conditions, e.g. by means of higher NVH demands, less critical requirements in terms of start-up and response time, reduced life expectancy, etc. This solution produces a number of advantages and is the reason why such potential technologies as external combustion or low-vibration space-saving rotary piston engines are currently being considered.

As a result of this complete evaluation of the system, FEV is developing a plug-in hybrid range extender ve-
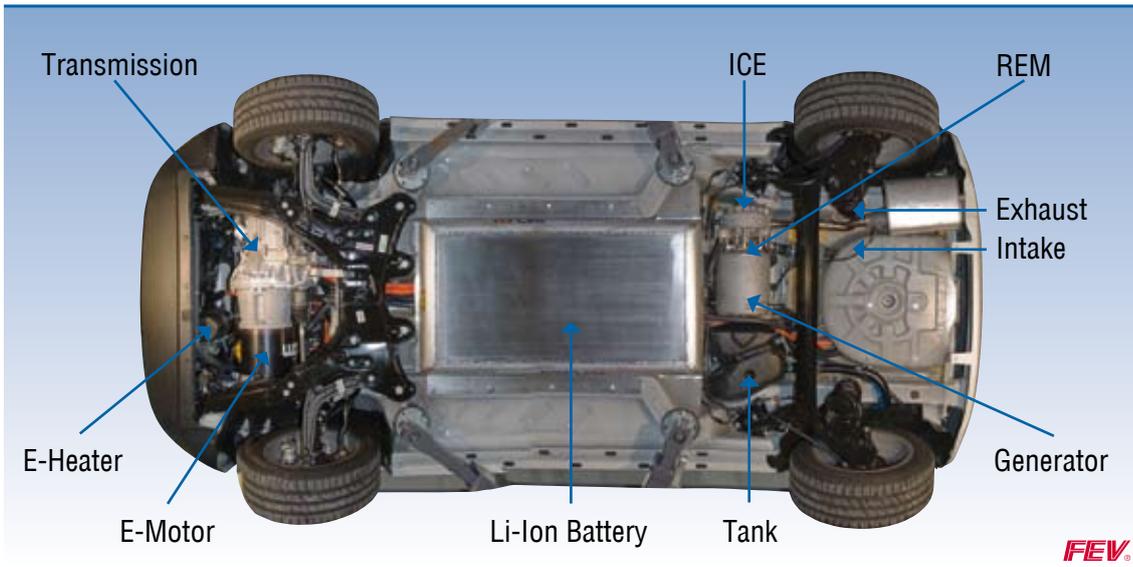
Fig. 1: FEV LiionDrive – Underfloor View, Component Placement

hicle specifically for urban driving, to be called the 'FEV LiionDrive'. The vehicle is equipped with a 12 kWh battery mounted underfloor (s. Fig. 1, center), which gives a purely electrical range of 100 km for urban driving. A greater range can be achieved by using the built-in (20 kW) range extender module (s. Fig. 3, right). A rotary engine is used to improve acoustics and reduce the amount of space required for the module. This provides an unlimited range (through refueling) at a reduced top speed. The other performance parameters are better than those of the baseline vehicle. The electrical drive motor has an output of 45 kW (s. Fig. 1, left). The high-performance electronics, battery charger and other elements are fitted above the power unit inside the engine compartment (s. Fig. 3). The presentation of a production-ready plug-in hybrid of this type is currently a major focus of development
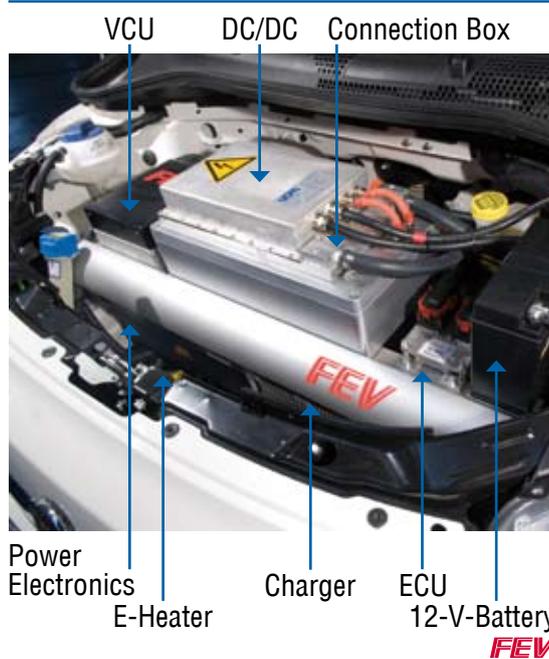

Fig. 3: FEV LiionDrive – Underhood View

at FEV. Work has already started on assembling all the test equipment required, including suitable battery testing stations. Therefore, FEV can offer to set up small fleets of trial vehicles or to retrofit production cars to show that the concept is ready for large-scale implementation.

FEV is a highly competent partner in the automotive industry, with the ability to put future concepts on the road in a professional manner and in an extremely short period of time. If you would like to take a major step toward the future of developing automotive concepts, please contact us.
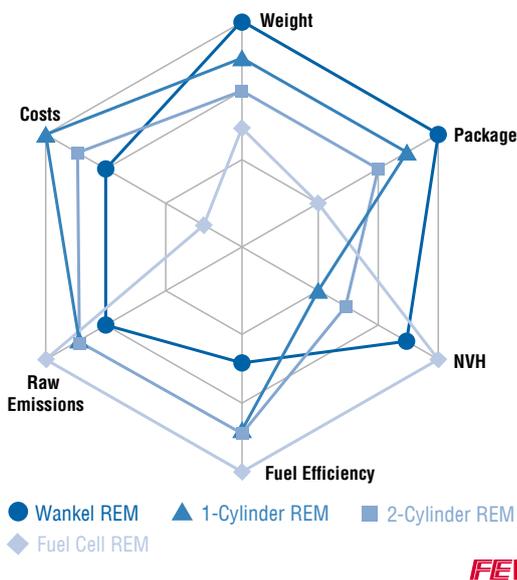
kemper@fev.de

Fig. 2: Comparison of the Characteristics of Different Range Extender Modules