State of the Art and Trends in Vehicle Concept Development with Focus on Battery Technology

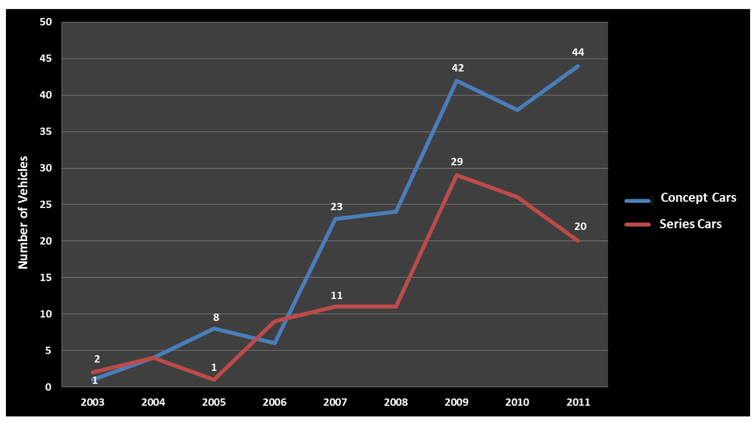
Kraftwerk Batterie

The German Aerospace Center's (DLR) Institute of Vehicle Concepts (Stuttgart, Germany) is carrying out an in-depth **MONITORING OF KEY TECHNOLOGIES IN THE FIELD OF ELECTRIC MOBILITY**.

Besides the state-of-the-art, also international trends in vehicle concept as well as key technology development are part of the analysis.

Thus, an extensive **VEHICLE CONCEPT DATABASE** is being designed to investigate all electrified passenger cars and technologies used over the last 10 years. Besides series Hybrid Electric Vehicles (HEV), Range Extended Electric Vehicles (REEV) and Battery Electric vehicles (BEV), also concept cars, design studies and close-to-production prototype vehicles are investigated, focusing on market- and technology-based parameters.

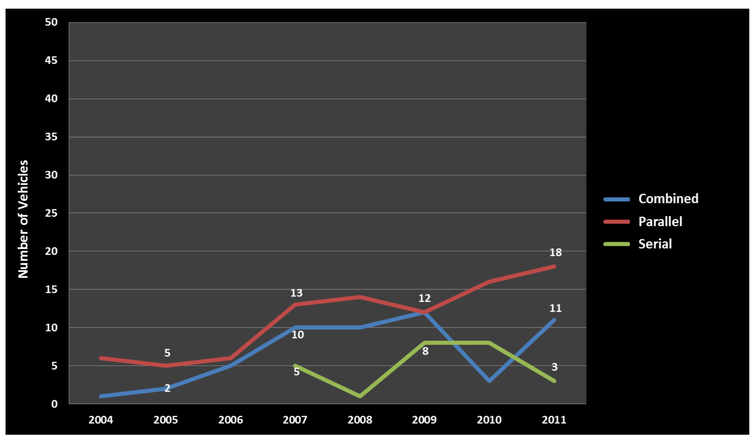
Development of Concept Cars and Series Vehicles



Between 2003 and 2011 the number of Hybrid and Battery Electric Vehicles in concept stage (blue line) was strongly increasing from 2 vehicles in 2003 to 44 in the year 2011. Following with a time lag of 2 to 4 years, a similar trend can be seen in the development of series vehicles (red line) until the year 2009. However, while prototypes increased from 33 vehicles in 2011 to 44 in 2012, series vehicles decreased from 26 in 2011 to 20 in 2012.

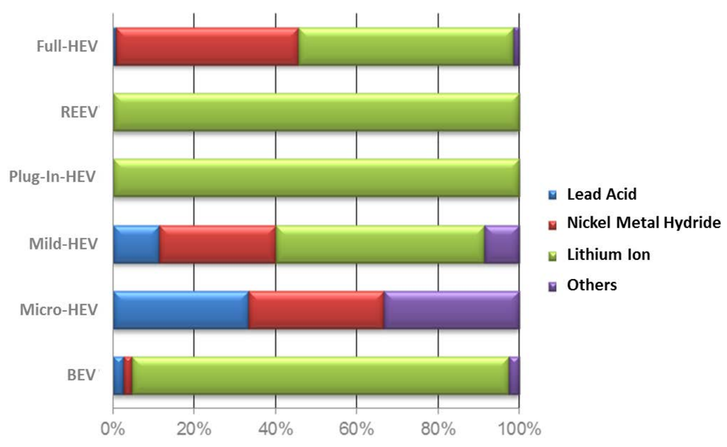
While for HEVs the number of concept cars stays steady at about 20 vehicles from 2007 on, BEV prototypes increase from 3 in the year 2007 to 23 in 2011.

Development of Hybrid Vehicle Powertrain Architectures



A clear trend can be seen when investigating the powertrain architectures used in Hybrid Electric concept and series Vehicles. The dominating architecture throughout the years 2003 - 2011 is the parallel one (red line), followed by the power-split architecture (blue line). The green line refers to a serial architecture as used in REEVs.

Battery Technology in Relation to the Degree of Electrification

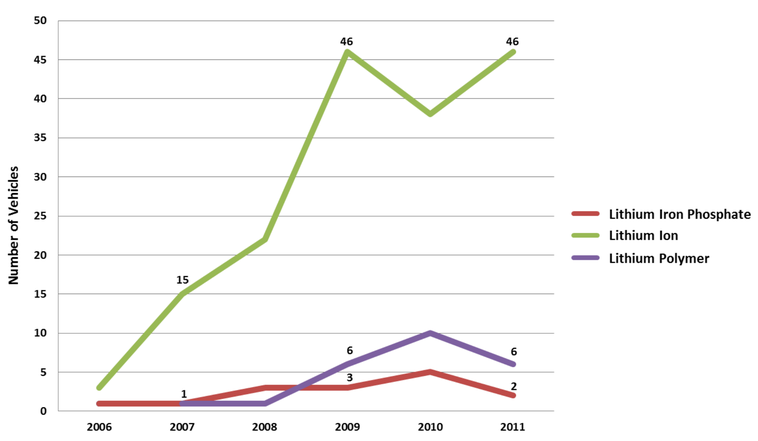


Lithium Ion (Li-Ion) battery technology (green) dominates Range Extended Electric Vehicles (REEV) and Plug-In Hybrid Electric Vehicles completely. For Battery Electric Vehicles (BEV). Li-Ion is the preferred battery technology for almost 95% of all analyzed vehicles.

Considering Full-Hybrid Electric Vehicles, Nickel Metal Hydride (Ni-Mh, red) and Li-Ion batteries have shares of almost 50:50.

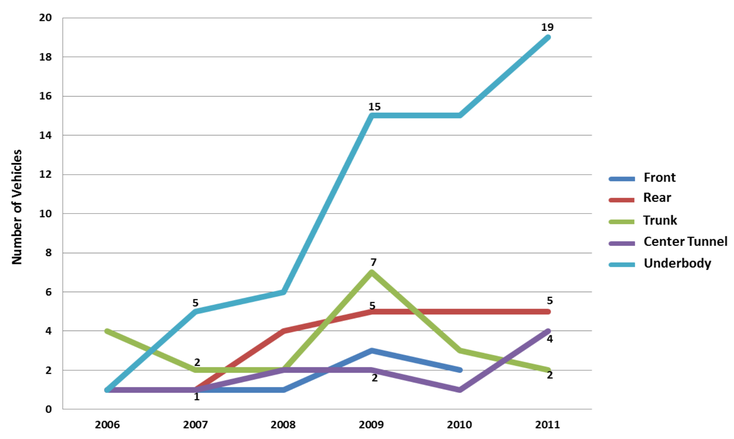
Considering Mild- and Micro-HEVs, also lead acid (blue) and other (purple) battery technologies are being used.

Development of HEV and BEV Battery Technology



From 2006 to 2011 a strong increase in Li-Ion battery technology (green line) can be investigated starting from only 3 prototype vehicles in 2006 to 46 in 2011.While the use of Lithium Iron Phosphate batteries (red line) remained constant in a range of 1 to 3 vehicles over time, Lithium Polymer batteries (purple line) were increasing from 2008 on, arriving at a peak of 10 vehicles in the year 2010.

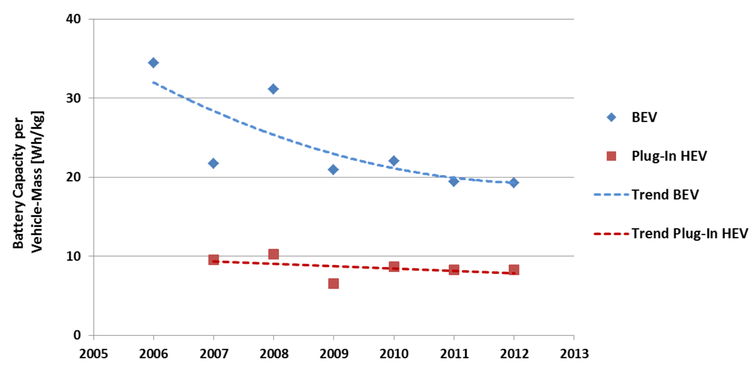
Development of Battery Installation Site



When investigating the installation site of the battery in Hybrid Electric Vehicles and Battery Electric vehicles, the underbody is by far the preferred location (light blue line).

In the year 2011, this is followed by the rear of the vehicle (red line) and the center tunnel (purple line), showing a strong increase from 2010 to 2011. The trunk (green line) as battery installation site was loosing relevance constantly from 2009 on. The front of the car (blue line) is playing a minor role throughout the years 2006 to 2011.

Development of Specific Battery Capacity for Plug-In-HEV and BEV



Over the years 2006-2012, the arithmetic mean of the specific battery capacity (Wh/kg) was decreasing. While the specific capacity of Plug-In HEVs (red line and dots) was reducing slightly, it was a significant process for BEVs (blue line and dots). The trend for BEVs suggests a capacity of around 20 Wh/kg vehicle mass over the next few years. For Plug-In HEVs, a capacity of around 8 Wh/kg vehicle mass seems to be probable.

Deutsches Zentrum für Luft- und Raumfahrt
German Aerospace Center

Institute of Vehicle Concepts
Pfaffenwaldring 38-40
70569 Stuttgart

Dipl.-Kfm. (t.o.) Benjamin Frieske
Phone: +49 711 6862 623
Fax: +49 711 6862 258
benjamin.frieske@dlr.de
www.DLR.de/fk

Dipl.-Ing. Matthias Klötzke
Phone: +49 711 6862 8092
Fax: +49 711 6862 258
matthias.kloetzke@dlr.de
www.DLR.de/fk