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

Kraftwerk Batterie

Deutsches Zentrum für Luft- und Raumfahrt (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.

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.

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.

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.

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.