Advanced Lightweight Electric Vehicle Architectures

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Bax & Willems Consulting Venturing
Introduction

**Bax & Willems** works with clients from all around **Europe**

- Since 1987
- Public and private clients
- (Multi-stakeholder) projects in European and regional level
- (Open) innovation processes
- Innovation and industrial policy
- Startups & coaching
A selection of our clients
Our work and network in automotive and lightweight materials fields

- **1996-1999:** MULTEXCOMP
- **2000-2004:** TECABS
- **2005-2009:** SuperLight Car
- **2010-2013:** ELVA
- **2010-2013:** DELIVER
- **2010-2014:** HIVOCOMP
- **2012-2016:** ALIVE
- **2012-2016:** ENLIGHT
- **2012-2016:** MATISSE
- **2012-2016:** SAFE-EV
- **2013-2016:** EPSILON
- **2013-2017:** IMPROVE
Outline

• Setting the context
• Lightweight design for sustainable mobility
• The ALIVE project
• The ENLIGHT project
• The SEAM cluster
• How to keep in touch
• In the year 2050 more than 9 billion humans will live on Earth, of which more than 5 billion will live in cities. (UN)

• By 2030, there will be more than 500 cities in the world with populations of more than 1 million each; more than half will be in Asia. More than 27 will be megacities with over 10 million inhabitants.

⇒ Increasing demand on urban mobility
   ... with zero-emissions ideally

<table>
<thead>
<tr>
<th>Year</th>
<th>CO₂ Emissions (g CO₂/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2006</td>
<td>160</td>
</tr>
<tr>
<td>2012</td>
<td>130</td>
</tr>
<tr>
<td>2020</td>
<td>95</td>
</tr>
<tr>
<td>2025</td>
<td>70</td>
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www.cai.blogware.com

Organized by: Fira Barcelona
Hosted by: avele, AVERE, IRE
In collaboration with: Armentum de Barcelona
Supported by: EVAAP, EDTA, European Commission
Lightweighting can provide the solution!

Data from: Helms, LCA case studies – 2006
Barcelona has more than 600,000 vehicles, producing about half of all emissions.

A reduction of vehicles’ weight by 100 kg could lead to a total annual reduction of CO2 emissions in the city of Barcelona of some 30,000 tonnes of CO2 per year.

The substitution of perhaps 100,000 conventional vehicles in Barcelona with EVs would eliminate some 90,000 tonnes CO2 emissions annually, while save €28 million annually on environmental costs of the city.
Lightweighting helps reduce fuel consumption in ICE cars

✓ Lightweighting is necessary in order to meet the CO₂ targets of ICE-driven cars (-100 kg = 8.5 gCO₂/km)

...but with the same safety and comfort!

Base data: Affenzeller, AVL
Lightweighting helps improve the driving range

Source: Blaurock - Cologne University of Applied Science 2011
...or it can help reduce the size => cost of the battery

Lightweight materials & design

Primary weight savings

Secondary weight savings: +50%

Battery cost savings example

<table>
<thead>
<tr>
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<th>Baseline</th>
<th>Light</th>
</tr>
</thead>
<tbody>
<tr>
<td>km</td>
<td>150</td>
<td>150</td>
</tr>
<tr>
<td>kWh</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>€</td>
<td>13.000</td>
<td>9.500</td>
</tr>
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However, vehicle weight has been historically rising.

Main causes are the rising customer demands for additional:

- performance
- comfort
- safety
- electronics

Figure 1-1: Increasing trend in automobile curb mass since 1980.
Source: MIT, 21006

Example: http://www.bmw.com
Mix of advanced materials needed to lower vehicle weight

Source: M. Goede, VW Group Research, SLC
Relation with past projects

**SmartBatt**
- Fully integrated battery housing
- Lightweight battery concept
- New materials for battery systems

**SuperLIGHT-Car**
- Economic demonstration of multimaterial vehicle structures for high-volume produced combustion cars

**ELVA**
- Concept of light BiW for EV’s
- Space frame design
- Modularity in battery and BiW design

**ALIVE**
- High volume
- Low weight
- Low costs

Sources:
- Source: Fraunhofer LBF, „SmartBatt” project
- Source: „SuperLIGHT-Car” project, 2009
- Source: „ELVA” project, 2013

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Affordable weight reduction for electric vehicles

For an EV with 200 km range (and with battery capacity of 200 - 300 Wh/kg) the allowable costs of weight saving would be around €8/kg

More than 40% of weight reduction seems to be obtainable for that price.

Avoiding exponential cost increase for further weight reduction
Objectives

1. Significant reduction in weight
   - BiW with integrated battery housing: approx. 45% targeting 200 kg
   - Chassis: approx. 25%
   - Hang-on parts: at least 25%
   - Interior components: in the range of 30%

2. Cost-efficient application of a variety of advanced materials, mainly HS steel, aluminium and magnesium alloys

3. Development of design and simulation capabilities including LCA

4. Full scale demonstrator vehicle for showcasing and testing

5. Advancements in multi-material joining technologies for mass production

Source: M. Kurz, Volkswagen Group Research, K-EFFG/L, 2013
ALIVE will run from October 2012 until September 2016.

A full-scale demonstrator vehicle will be fabricated and showcased:
- covering BiW, hang-on parts, chassis and heavy interiors, including battery pack integration,
- innovative safety mechanism and
- several new materials and manufacturing technologies

Follow updates and results at: http://www.project-alive.eu
Objectives

- Development of highly innovative lightweight / low embedded CO₂ materials, mainly composite plastics and hybrids
- Design, manufacturing, simulation and joining capabilities, incl. LCA / LCC
- Affordable application in medium-volume automotive production (50,000 units/year).
- Aims at a further 20% weight reduction over ALIVE targets.

- Demonstration of the proposed solutions through the realization of 5 full scale demonstrator modules.

http://www.project-enlight.eu
The largest EU cluster of lightweight automotive design

**ALIVE**
Advanced high volume affordable lightweighting for future electric vehicles
Coordinator: Jens Meschke

**ENLIGHT**
Enhanced lightweight design by advanced lightweight materials
Coordinator: Thilo Bein

**MATTISE**
Modeling and testing for improved safety of key composite structures in alternatively powered vehicles
Coordinator: Roland Wohlecker

**SafeEV**
Safe small electric vehicles through advanced simulation methodologies
Coordinator: Andreas Teibinger

www.seam-cluster.eu
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