VEHICLE ELECTRIFICATION’S ROLE.

THE NEXT STEP OF EVOLUTION IN AUTOMOBILITY.
BMW Group’s drive strategy provides a broad technology spectrum for today and the future.

**TODAY**
- Optimisation of fuel consumption and emissions.
- Lightweight construction.
- Full and mild hybrid vehicles.
- Initial step towards electrification of the drivetrain.
- Plug-in Hybrid drive-trains.

**NEAR FUTURE**
- First limited electric vehicle production in 2008.
- MINI E on the road since 2009.
- BMW ActiveE in 2011.
- Introduction BMW i3 in 2013.

**FUTURE**
- Commitment to and validation of technology.
- Optimisation of BMW H2 ICE.
- Improvement of hydrogen storage and efficiency.

BMW Group’s drive strategy provides a broad technology spectrum for today and the future.
THE FUTURE OF MOBILITY.

CONTRIBUTING FACTORS

Environment
Climate change and the subsequent effects

Urbanisation
By 2030, over 60% of world population will live in cities

Politics and Regulations
CO2 - and fleet regulations, Restrictions on imports

Economics
Shortage of resources, increase in the price of fossil fuels

Culture
Sustainable mobility as part of a modern urban lifestyle

Customer Expectations
Changing values
Internal combustion engines will continue growth until 2020-30.

- The percentage of electrification will steadily increase.

- In 2020, the proportion of new registrations for electrified vehicles is estimated at 5 – 15%.

Source: United Nations, Global Insight, Credit Suisse, BMW calculations.
Significant increase in customers awareness as a result of:
- the climate change debate.
- significant volatility in fuel prices during recent years.
- but also: debate about and success of alternative drive trains.

Sustainability is increasingly becoming the focus of attention. But: differing levels of awareness with respect to preferences, motives for action and embedding sustainability is a priority with customers.
AN ELECTRIC VEHICLE REQUIRES A NEW, PURPOSE-BUILT VEHICLE ARCHITECTURE.

<table>
<thead>
<tr>
<th>Mild Hybrid</th>
<th>Full Hybrid</th>
<th>PHEV parallel power-split</th>
<th>PHEV REX Serially combined</th>
<th>BEV</th>
</tr>
</thead>
<tbody>
<tr>
<td>= 0 km</td>
<td>~ &lt; 5 km</td>
<td>~ 16 - 50 km</td>
<td>~ 50 -100 km</td>
<td>&gt; 160 km</td>
</tr>
</tbody>
</table>

**Degree of electrification**

**Increase in battery size**

**Typical range of electric vehicle**

- Mini E, BMW ActiveE conversions
- System limit
- Purpose-built electric vehicle architecture
CFRP – A STAND-OUT MATERIAL FOR USE IN CAR BODIES.

- CFRP is a composite material out of carbon fibres and a synthetic matrix.
- Extremely durable and extremely light.
- At least 30 % lighter than aluminium and 50 % lighter than steel for identical component use.
- Outstanding suspension and high level of energy absorption in a crash.
- Resistant against corrosion, acids and solvents.
- Shows no fatigue over a long service life.
- Allows customisation of component properties thanks to the material's unique anisotropy.
THE INTEGRATION OF THE ELECTRIC DRIVETRAIN.

Implementation of complete vehicle architecture with LifeDrive
- Easy development of derivatives.
- Weight reduction through light-weight materials.
- Specific structure to accommodate for batteries.

Batteries in underbody
- Low point of gravity.
- Area for crash protection.
- Level ground of vehicle interior.

Drive: Aluminium spaceframe incl. Batteries

Life: Carbon fiber structure with Exterior Shell
The LifeDrive concept with **aluminium chassis** and **CFRP passenger cell** breaks the weight spiral for electric vehicles.

- **Comparable vehicle with combustion engine.**
- **System-related extra weight of the electric drive unit.**
- **LifeDrive Concept with aluminium and CFRP offsets the extra weight of the electric drive unit.**
- **MCV electric vehicle**
MINI E AND BMW ACTIVE E SERVE AS KEY LEARNING PROJECTS FOR THE BMW i3.
102EX – THE PHANTOM EXPERIMENTAL ELECTRIC.

- A one-off, experimental electric test car from Rolls-Royce;
- The first application of the technology in the super luxury segment and the largest battery pack ever fitted to a passenger car;
- An opportunity to showcase experimental technologies and processes such as ‘wireless’ induction charging, Atlantic Chrome finish and vegetable-tanned leather interior;
- Launched at Geneva, followed by media drives in March, then customer test programme, commencing April;
- A market research tool that will tour extensively throughout 2011.
BMW i8 AND BMW i3.
OVERVIEW OF SCIENTIFIC PROJECTS WITH LEADING PARTNERS WORLDWIDE.

<table>
<thead>
<tr>
<th>Government</th>
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<tbody>
<tr>
<td>Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit</td>
</tr>
<tr>
<td>Technology Strategy Board</td>
</tr>
<tr>
<td>SEEDA</td>
</tr>
<tr>
<td>CA Air Resources Board</td>
</tr>
<tr>
<td>NDRC MOST MIIT</td>
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<table>
<thead>
<tr>
<th>Scientific monitoring</th>
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</thead>
<tbody>
<tr>
<td>Chalmers University of Technology</td>
</tr>
<tr>
<td>Eco-Institut e.V.</td>
</tr>
<tr>
<td>Oxford Brookes University</td>
</tr>
<tr>
<td>UC Davis University of California</td>
</tr>
<tr>
<td>China Automotive Technology and Research Center</td>
</tr>
<tr>
<td>INRETS</td>
</tr>
<tr>
<td>Waseda University</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>Field trial</th>
</tr>
</thead>
<tbody>
<tr>
<td>50 Units, 40 Private / 10 Fleet</td>
</tr>
<tr>
<td>40 Units, 20 Private / 20 Fleet</td>
</tr>
<tr>
<td>450 Units, 246 Private / 204 Fleet</td>
</tr>
<tr>
<td>50 Units since 03/2011</td>
</tr>
<tr>
<td>50 Units, 25 Private / 25 Fleet</td>
</tr>
<tr>
<td>20 Units since 03/2011</td>
</tr>
</tbody>
</table>

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<thead>
<tr>
<th>Infrastructure and energy</th>
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<tbody>
<tr>
<td>Vattenfall</td>
</tr>
<tr>
<td>Scottish and Southern Energy</td>
</tr>
<tr>
<td>Diverse regionale Energiepartner</td>
</tr>
<tr>
<td>State Grid, Southern Grid</td>
</tr>
<tr>
<td>EDF</td>
</tr>
<tr>
<td>TEPCO</td>
</tr>
</tbody>
</table>

1.) Not included the MINI E field trial with Siemens and the SWM in Munich 09/2010.
Today the range achieved is already sufficient for the majority of user needs. In Germany the average distance driven per day is 40 kilometres.

The ranges of electric powered vehicles for example the MINI E are therefore sufficient. 80% of the distance driven per year is within a close urban proximity. 20% of annual distances driven are for recreational purposes.

Through series production of automotive batteries, economies of scale and competition among providers will bring down costs significantly in the medium and long term.

E-Drives:
- open up a new, high-quality drivetrain experience.
- offer a strong competitive advantage.
- are very dynamic and agile.
- are highly efficient and boast zero local emissions.
**ECOLOGICAL RELEVANCE.**

<table>
<thead>
<tr>
<th>Country</th>
<th>Private Users Assess Renewable Energy for Charging Electric Vehicles</th>
<th>Users Agree EVs Should Be Charged Exclusively with Renewables</th>
<th>Users Agree EVs Are “Environmental Friendly” It is Not Necessary to Charge an EV with Renewable Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Germany:</strong></td>
<td>96%</td>
<td>72%</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Great Britain:</strong></td>
<td>89%</td>
<td>22%</td>
<td>17%</td>
</tr>
<tr>
<td><strong>USA:</strong></td>
<td>96%</td>
<td>20%</td>
<td>75%</td>
</tr>
</tbody>
</table>

Source: User Survey Berlin, UK and USA.
The Challenge ahead for industry and government: Shares of the overall impact on the environment between Well-To-Tank (WTT) and Tank-to-Wheel (TTW) differ massively.

- Car manufacturers thereby lose control of the impact on the environment.
- Customers want assurance that driving electrically is a sustainable choice.

<table>
<thead>
<tr>
<th>Gasoline</th>
<th>Well-To-Tank (oil industry, power generation)</th>
<th>Tank-To-Wheel (automobile industry)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVs</td>
<td>Need to address politically</td>
<td>0 g/mi</td>
</tr>
<tr>
<td></td>
<td>Already addressed by GhG standards → EV: 0 g/mi</td>
<td></td>
</tr>
</tbody>
</table>

Definition

- Governments need to ensure the “net benefit” of the overall chain.
- Additional demand for EVs need to be generated without fossil fuels.
ENABLING SUSTAINABLE MOBILITY.

The REC Solution.

All grid-tied renewable-based electricity generators produce two distinct products, physical electricity (kWh) and Renewable Energy Certificates (RECs). A renewable energy certificate represents the property rights to the environmental, social, and other non-power qualities of renewable electricity generation.

A REC, and its associated attributes and benefits, can be sold separately from the underlying physical electricity associated with a renewable-based generation source.

**RECs provide buyers flexibility:**

- In procuring green power across a diverse geographical area.
- In applying the renewable attributes to the electricity use at a facility of choice (this could be a vehicle).
THANK YOU FOR YOUR ATTENTION.
Development of urban population.
Mega cities as a worldwide trend.

In **2007** humanity reached a significant demographic milestone: For the first time in history more people lived in cities than in the countryside.

**By 2030, over 60 % of the population will live in cities.** The growth rate is particularly rapid in the so-called mega cities, with more than 10 million inhabitants. The mega cities listed by the UN already have a total population of around 280 million inhabitants.

The mega cities are increasingly the growth engines of their respective national economies. One key issue is the burden that growth is placing on urban infrastructure and mobility.
**BMW i – BORN ELECTRIC. SUSTAINABILITY DEFINES THE PRODUCT LIFE CYCLE.**

<table>
<thead>
<tr>
<th>New vehicle concepts</th>
<th>New materials and recycling</th>
<th>Production concept of the future</th>
<th>New electric drivetrain</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="New vehicle concepts" /></td>
<td><img src="image2" alt="New materials and recycling" /></td>
<td><img src="image3" alt="Production concept of the future" /></td>
<td><img src="image4" alt="New electric drivetrain" /></td>
</tr>
</tbody>
</table>

**Integrated approach of BMW i**

<table>
<thead>
<tr>
<th>New processes</th>
<th>Employees</th>
<th>Pioneering design</th>
<th>New customers</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image5" alt="New processes" /></td>
<td><img src="image6" alt="Employees" /></td>
<td><img src="image7" alt="Pioneering design" /></td>
<td><img src="image8" alt="New customers" /></td>
</tr>
</tbody>
</table>
BMW i – BORN ELECTRIC. GLOBAL WARMING POTENTIAL IN THE PRODUCT LIFE CYCLE SIGNIFICANTLY LOWER.

CO$_2$e = carbon dioxide equivalent
BMW i – BORN ELECTRIC.
GLOBAL WARMING POTENTIAL IN THE PRODUCT LIFE CYCLE SIGNIFICANTLY LOWER.

CO$_{2e}$

100%

66%

BMW 118d

BMW i3 concept*

* EU 25 electricity mix
BMW i – BORN ELECTRIC. GLOBAL WARMING POTENTIAL IN THE PRODUCT LIFE CYCLE SIGNIFICANTLY LOWER.

- BMW 118d: 100%
- BMW i3 concept*: 66%
  * EU 25 electricity mix
- BMW i3 concept**: 50%
  ** Electricity from renewable sources
BMW i – BORN ELECTRIC.
BREAK-EVEN IN PRODUCT LIFE CYCLE ASSESSMENT AT LESS THAN 50,000 KM.

<table>
<thead>
<tr>
<th>Mileage km</th>
<th>T CO₂e</th>
<th>Recycling</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW 118d</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMW i3 concept*</td>
<td>EU 25 electricity mix</td>
<td></td>
</tr>
<tr>
<td>BMW i3 concept**</td>
<td>Electricity from renewable sources</td>
<td></td>
</tr>
</tbody>
</table>

* EU 25 electricity mix
** Electricity from renewable sources
COMPARISON OF CO2 FLEET REDUCTIONS IN EUROPE. BMW HAS ALREADY ACHIEVED A GREAT DEAL – AND WILL ALSO MEET FUTURE TARGETS.

ACEA, 1995-2009: approx. - 25 %

BMW Group, 1995-2009: approx. - 29 %

Ggf. nur Folie internationale challenges in the future
Fleet objectives require a global reduction in CO₂ emissions. The BMW Group will reduce the CO₂ emissions of their new fleet of cars worldwide more than 25% between 2008 to 2020.
CONNECTED DRIVE AND MOBILITY SERVICES.
DRIVER ASSISTANCE SYSTEMS.

Increasing demands on drivers in all spheres of life

Growing complexity of urban mobility

Rising social pressure due to environmental concerns and safety

BMW i driver assistance systems for enhanced comfort and safety
BMW GROUP SUPPORTS FUEL ECONOMY OR CO\textsubscript{2}-BASED TAXATION SYSTEMS.

European states take various measures of taxation:

- Registration tax upon purchase and registration
- Annual road tax
- Registration and annual road tax

- 16 of EU 27 member states have implemented a CO\textsubscript{2}-based taxation scheme. However, no scheme is similar to another.
- Putting a transparent price tag on the CO\textsubscript{2} emissions or fuel economy encourages the demand on fuel efficient cars in every car segment.
- CO\textsubscript{2}-taxes have a built-in positive effect on EVs economically and in terms of perception.