BMW GROUP’S ELECTRIFICATION PATHWAY.

PIONEERING
- Building-up expertise
- Technology innovation
- Project i

ELECTRIFICATION OF CORE PORTFOLIO
- Roll-out i Performance
- Upgrade BMW i3
- MINI BEV
- BMW X3 BEV

SCALABILITY AND FLEXIBILITY
OVER 100,000 ELECTRIFIED BMW VEHICLES SOLD YTD 2016.

* Only available in China
Figures are for cumulative sales of BEV and PHEV vehicles

BMW Group Technology Workshops – E-Mobility
CUSTOMERS ARE WARMING UP FOR E-MOBILITY. FIRST TIME CUSTOMERS OF BEV AND PHEV ARE CONVINCED.

### Favored powertrain next car: 2014 vs. 2016 (Driver conventional car, 1st choice)

<table>
<thead>
<tr>
<th></th>
<th>PHEV</th>
<th>BEV (+REX)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2014</td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>2016</td>
<td>2016</td>
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<tr>
<td></td>
<td>15</td>
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<td>17</td>
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<td></td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>

### Re-Purchasing Interest EV: 2014 vs. 2016 (BEV and PHEV driver)

<table>
<thead>
<tr>
<th></th>
<th>PHEV owner</th>
<th>BEV owner</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2014</td>
<td>2014</td>
</tr>
<tr>
<td></td>
<td>34</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>2016</td>
<td>2016</td>
</tr>
<tr>
<td></td>
<td>57</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>36</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>25</td>
<td>78</td>
</tr>
</tbody>
</table>

Source: Powertrain Study 2014/16 | June 2016
HOW DO WE DETERMINE THE IDEAL PORTFOLIO FOR E-MOBILITY?
SIGNIFICANT NUMBER OF ELECTRIFIED MODELS ARE ALREADY ON THE STREET.

BATTERY ELECTRIC VEHICLES
- BMW i3 60 Ah
- BMW i3 94 Ah
- MINI BEV
- BMW X3 BEV
- BMW iNEXT

PLUG-IN HYBRIDS
- BMW i8
- BMW 530Le*
- BMW 225xe iPerformance
- BMW X1 xDrive25Le iPerformance*
- BMW i8 Roadster
- BMW X5 xDrive40e iPerformance
- BMW 330e iPerformance
- BMW 5 Series iPerformance
- BMW 740e iPerformance
- MINI Cooper S E Countryman ALL4

* Only available in China
FLEXIBILITY IS KEY FOR E-MOBILITY.
FUTURE OF ELECTRIFICATION.

PIONEERING

- Building-up expertise
- Technology innovation
- Project i

ELECTRIFICATION OF CORE PORTFOLIO

- Roll-out i Performance
- Upgrade BMW i3
- MINI BEV
- BMW X3 BEV

SCALABILITY AND FLEXIBILITY
SCALABILITY AND FLEXIBILITY – FUTURE ELECTRIFICATION BASED ON A MODULAR ARCHITECTURE.

BEV Integration into the BMW Group vehicle architecture

2013 – 2020

PHEV Integration into the BMW Group vehicle architecture

LUXURY

COMPACT

BMW Group Technology Workshops – E-Mobility
This document contains forward-looking statements that reflect BMW Group's current views about future events. The words "anticipate," "assume," "believe," "estimate," "expect," "intend," "may," "can," "could," "plan," "project," "should" and similar expressions are used to identify forward-looking statements.

These statements are subject to many risks and uncertainties or may be affected by factors outside BMW Group's control, including adverse developments in global economic conditions resulting in a decline in demand in BMW Group's key markets, including China, North America and Europe; a deterioration in credit and financial markets; a shift in consumer preferences affecting demand for BMW Group's products; changes in the prices of fuel or raw materials; disruption of production due to shortages of materials, labor strikes or supplier insolvencies; the effective implementation of BMW Group's strategic goals and targets; changes in laws, regulations and government policies, particularly those relating to vehicle emissions, fuel economy and safety; and other risks and uncertainties, including those described under the heading "Report on Risks and Opportunities" in BMW Group's most recent Annual Report.

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E-MOBILITY

STEFAN JURASCHEK
VICE PRESIDENT RESEARCH AND DEVELOPMENT E-POWERTRAIN

December 2016
ZERO EMISSION VEHICLE STRATEGY. CONCERNING VEHICLE SIZE AND OVERALL RANGE.

<table>
<thead>
<tr>
<th>Vehicle size</th>
<th>Range</th>
<th>Potential portfolio extension</th>
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</thead>
<tbody>
<tr>
<td>small</td>
<td>low</td>
<td>BEV</td>
</tr>
<tr>
<td>medium</td>
<td>medium</td>
<td>PHEV</td>
</tr>
<tr>
<td>large</td>
<td>high (700 km)</td>
<td>FCEV</td>
</tr>
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IN-HOUSE DEVELOPMENT & PRODUCTION OF KEY COMPONENTS.

Technology lead: Lighter, faster, more powerful and more flexible than the competitors.

GOALS OF THE INHOUSE STRATEGY.
- Downright top performance by the use of new technologies.
- Flexibility in the choice of technologies and suppliers.
- Cost structure transparency.
- Modular kit: flexible and scalable.
- Key factor: considerable acceleration of development & production.

Example: BMW 225xe

Power & charging electronics
Development (Build to Print)

E-Machine
Development & Production

HV Battery
CURRENT BMW GROUP PLUG-IN HYBRID & BATTERY ELECTRIC APPROACH.

### PHEV (Plug-in Hybrid Electric Vehicle)

- **PHEV with coaxial hybrid system**
  - (BMW 740e, 330e, X5 40e, ...)
- **PHEV with electric drive axle**
  - (BMW i8, 225xe, X1 CN, ...)

### BEV (Battery Electric Vehicle)

- **BEV (with REX*)**
  - (BMW i3)

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<table>
<thead>
<tr>
<th>Legend:</th>
<th>C</th>
<th>Charger</th>
<th>G</th>
<th>Combustion engine</th>
<th>HV-B</th>
<th>High-Voltage Battery</th>
<th>G</th>
<th>Generator</th>
<th>I</th>
<th>Inverter</th>
<th>EM</th>
<th>E-Motor</th>
<th>—</th>
<th>Power path</th>
</tr>
</thead>
</table>

*REX (Range extender) optional.
BMW GROUP BEV AND PHEV E-POWERTRAIN COMPONENTS.

<table>
<thead>
<tr>
<th></th>
<th>BMW i3</th>
<th>BMW i8</th>
<th>BMW X5 xDrive 40e</th>
<th>BMW 330e</th>
<th>BMW 740e</th>
<th>BMW 225xe</th>
<th>BMW X1 CN</th>
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<td><strong>Power Electronics</strong></td>
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<td><img src="image" alt="Power Electronics" /></td>
</tr>
<tr>
<td><strong>E-Machine</strong></td>
<td><img src="image" alt="E-Machine" /></td>
<td><img src="image" alt="E-Machine" /></td>
<td><img src="image" alt="E-Machine" /></td>
<td><img src="image" alt="E-Machine" /></td>
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<td><strong>HV Battery</strong></td>
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<td><img src="image" alt="HV Battery" /></td>
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<td><img src="image" alt="HV Battery" /></td>
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BENEFITS HIGH INTEGRATION. FUTURE GENERATION OF E-POWERTRAIN.
ENERGY DENSITY HAS AN IMPORTANT ROLE IN THE SUCCESS OF ELECTRIC MOBILITY.

<table>
<thead>
<tr>
<th></th>
<th>Combustion engine</th>
<th>Electric powertrain</th>
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<tbody>
<tr>
<td><strong>Efficiency [%]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Movement</td>
<td>33%</td>
<td>&gt; 90%</td>
</tr>
<tr>
<td>Emission</td>
<td>33%</td>
<td></td>
</tr>
<tr>
<td>Loss</td>
<td>33%</td>
<td>Loss &lt; 10%</td>
</tr>
<tr>
<td><strong>Energy density [Wh/l]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diesel</td>
<td>~ 10000</td>
<td></td>
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<tr>
<td>Petrol</td>
<td>~ 9000</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td><strong>Energy density [Wh/l]</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>&lt; 500</td>
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</tbody>
</table>
CHALLENGE TO FULFIL ALL REQUIREMENTS. FROM BATTERY PACK LEVEL TO ACTIVE MATERIAL PROPERTIES.

- Peak Power
- Energy Density
- Specific Energy
- Temperature Performance
- Charge Current
- Lifetime
- Cost
- Safety

BMW Claim "Best in Class"

Main technical Target

Anode
Separator
Cathode
BMW GROUP STRATEGY: GLOBAL NETWORK AND IN-HOUSE RESEARCH.

Universities
TU München
ZSW Ulm
Uni Münster
Hanyang Uni Seoul
Tsinghua Uni Beijing
Nanyang Uni Singapore
Argonne National Lab
MIT
Wildcat Discovery
...

Institutes

Start-Ups

Material Supplier

Cell Supplier

OEM

BMW GROUP

total value chain
Li-ion cell
development/production
MATERIAL DEVELOPMENT AND CELL ROADMAP.

Energy Density

<table>
<thead>
<tr>
<th>Year</th>
<th>Material</th>
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<tbody>
<tr>
<td>Today</td>
<td>NCM 111/C</td>
</tr>
<tr>
<td>&gt; 2018</td>
<td>NCM 622/C</td>
</tr>
<tr>
<td>&gt; 2021</td>
<td>NCM 811/C</td>
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<tr>
<td>&gt; 2024</td>
<td>NCM 811/Si-C</td>
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<tr>
<td>&gt; 2026</td>
<td>NCM 811/Li solid state electrolyte</td>
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</tbody>
</table>

Cell Costs

<table>
<thead>
<tr>
<th>Year</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Today</td>
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</tr>
<tr>
<td>&gt; 2026</td>
<td>NCM 811/Li solid state electrolyte</td>
</tr>
</tbody>
</table>

NCM: Nickel, Cobalt, Manganese

Research I Pre-development I Series development I
Pre-development I Series development II
ca. 10 years

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PRODUCTION NETWORK WITH STRATEGIC EXTENSION OPTIONS ON THREE CONTINENTS.

**SPARTANBURG**
- High-voltage battery for NAFTA

**LANDSHUT**
- Electric machine

**Munich**
- Planning and technology development
- Electric powertrain
- Prototype electric machine, High-voltage battery, Battery cell, Fuel cell

**RAYONG**
- Final assembly PHEV

**DINGOLFING (lead plant)**
- High-voltage batteries for ECE, Electric machine for global plants

**SHENYANG**
- High-voltage battery for China

**Rayong**
- PHEV
ADAPTIVE PRODUCTION SYSTEM FOR VOLUME-INDUCED CAPACITY.

“Flexible response and speed“ in adaptive production system

Volume induced capacity

- **Reaction time < 12 months**
  - Doubling production capacity until peak-quantity

- **Minimal initial investment**
  - Scalability with manual specification

- **Reduction of manufacturing costs and investments**
  - Compared to predecessor

- **Significant cost reduction**
  - Electric machine & High-voltage battery