Value creation through electric vehicles

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Roland Berger
Strategy Consultants

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Objectives of the document

- Introduce our expertise and credentials in Electric Vehicles
- Review outlook and trends – common ground
- Share the perspective in the issue from a Government's point of view
- Debate the potential implications and options

Source: Roland Berger Strategy Consultants
1. Brief introduction of Roland Berger and credentials
2. Electric vehicles outlook and trends
3. The country and Government's perspective – case examples
4. Implications and options – debate
We are the leading management consultancy in Utilities

SELECTED EXAMPLES

IBERIA

Source: Roland Berger Strategy Consultants
The Automotive Competence Center advises leading companies in the automotive industry

Selected clients (1)

<table>
<thead>
<tr>
<th>OEMs</th>
<th>Suppliers</th>
<th>Services Providers</th>
<th>Financial Investors</th>
</tr>
</thead>
<tbody>
<tr>
<td>DAIMLERCHRYSLER</td>
<td>Visteon</td>
<td>SIXT</td>
<td>Deutsche Bank</td>
</tr>
<tr>
<td>NISSAN</td>
<td>Valeo</td>
<td>Siemens</td>
<td>Apax Partners</td>
</tr>
<tr>
<td>TOYOTA</td>
<td>SIEMENS</td>
<td>Johnson Controls</td>
<td>Permira</td>
</tr>
<tr>
<td>RENAULT</td>
<td>CONTROLS</td>
<td>DENSO</td>
<td>Deutsche Beteiligungs AG</td>
</tr>
<tr>
<td>GM</td>
<td>MAGNA</td>
<td>MAHAG</td>
<td>The Carlyle Group</td>
</tr>
<tr>
<td>FIAT</td>
<td>TRW</td>
<td>TOYOTA FINANCIAL SERVICES</td>
<td>The Blackstone Group</td>
</tr>
<tr>
<td>BMW</td>
<td>BROSE</td>
<td>NÜRNBERGER VERSICHERUNGSGRUPPE</td>
<td>PAI Partners</td>
</tr>
<tr>
<td>AUDI</td>
<td>FEURECIA</td>
<td>BERGÉ y Cía., S. A.</td>
<td>RHJ International</td>
</tr>
</tbody>
</table>

1) Clients which had made public our assistance

Source: Roland Berger Strategy Consultants
We are the leading Strategy Consultancy in Electric Vehicles – all major European efforts

E-MOBILITY CLIENTS

Enel, edp, RWE, Governo de Portugal, DaimlerChrysler, Italian car manufacturer, etc.

SELECTED E-MOBILITY ENGAGEMENTS

ELECTRIC UTILITIES

- Strategy and business model definition and quantification
- Cross industry technical standardization
- Implementation and execution of model/concept
- Joint pilot structuring and steering - development

OEMs

- Cooperation agreements and negotiations
- Partner and model solution

Governments

- Vision, architecture, concept and business case
- Network of partners - design and establishment

Source: Roland Berger Strategy Consultants
Fundamental framework in place and strong forces at work in favor of e-mobility

Customer acceptance

> High fuel prices lead to advantages in life cycle-costs for electric vehicles
> Cost differences of about 15 to 30% expected\(^1\)
> Rapidly increased acceptance – RB surveys

> New car manufacturers: Miles, Think!, Tesla
> New business models: Project Better Place, City of Westminster, Electric cars – now!

Political backing

> EU: strict fleet CO\(_2\) emission targets for car manufacturers
> USA: zero emission cars as condition for market access
> China: significant problems with traffic pollution

Battery technology innovation

> Li-ion technology is becoming ready for mass production
> Range extenders and battery swap stations solve limitations on range

New market players

Source: Roland Berger Strategy Consultants

1) Example for 2020 (EVs / PHEVs) in Germany, depending on country-specific price and tax framework
High share of CO₂ emissions by vehicles is triggering reductions measures across the World

### Anthropogenic CO₂ emissions (%; 2007)

<table>
<thead>
<tr>
<th>Source</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power plants</td>
<td>25.0%</td>
</tr>
<tr>
<td>Domestic fuel and small consumers</td>
<td>23.0%</td>
</tr>
<tr>
<td>Industry</td>
<td>19.0%</td>
</tr>
<tr>
<td>Combustion of biomass</td>
<td>15.0%</td>
</tr>
<tr>
<td>Trucks</td>
<td>6.0%</td>
</tr>
<tr>
<td>Passenger cars</td>
<td>5.5%</td>
</tr>
<tr>
<td>Air traffic</td>
<td>3.0%</td>
</tr>
<tr>
<td>Other traffic</td>
<td>2.0%</td>
</tr>
<tr>
<td>Ships on open sea</td>
<td>1.5%</td>
</tr>
</tbody>
</table>

In Europe: Road transport ~ 20%, passenger cars ~ 12%

Source: VDI; EU; Rew Center on GLobal Climate Change; Roland Berger Strategy Consultants
The willingness to spend more on a car with reduced CO₂ emissions has grown over the last two years – Roland Berger Survey 09

How much extra would you be willing to spend on a new car in order to make an active contribution to cutting carbon emissions?

**Germany [%]**
- 2007: x>2,000 = 14%
- 2009: x>2,000 = 20%

**France [%]**
- 2007: x>2,000 = 10%
- 2009: x>2,000 = 16%

**UK [%]**
- 2007: x>2,000 = 15%
- 2009: x>2,000 = 17%

Source: Roland Berger Strategy Consultants customer survey
The EU is supporting this trend by introducing aggressive CO₂ fleet emissions targets.

### EU CO₂ car emissions (As is / Target in g/km)

- **2008** Target: 161 g/km
- **2012** Target: 152 g/km
- **2020** Target: 95 g/km

#### STATUS QUO

- **Engagement** of ACEA to reduce CO₂ emissions to 140 g/km in 2008 and to 120 g/km in 2015.
- The EU commission is asking the EU 27 members to reduce emissions to no more than **130 g/km in 2012**
  - (5.2 l Petrol, 4.8 l Diesel)
- **Target for 2020**: 95 g/km
  - (4.0 l Petrol, 3.6 l Diesel)
- **Possible scenario** <Target is 70 g/km starting from 2025 (2.9 l Petrol, 2.6 l Diesel)

1) EU15
2) Additional 10 g/km through tires and air conditioning improvements; overall, the emission has to be lower or up to 120 g/km.

Source: ACEA; Press; European Parliament; Roland Berger Strategy Consultants
Plug-in-hybrids (PHEV) and Electric Vehicles (EV) are the only chance to effectively reduce emissions in the M/T – L/T

Possible car portfolio with PHEV / EVs

Source: JD Power; BMW; Roland Berger Strategy Consultants

Size shows sales volume of about 20,000 units (2006), text shows the kind of motor (Gas = G; Diesel = D)
Electric vehicles are also far more energy efficient than vehicles with conventional engines – full cycle

Comparison of well-to-wheel efficiency – Conventional Engines and EV

<table>
<thead>
<tr>
<th></th>
<th>WTW² – Energy Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric Vehicle</td>
<td></td>
</tr>
<tr>
<td>(electricity from NG¹)</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>42% X 92% X 75%</td>
</tr>
<tr>
<td></td>
<td>NG Plant Transmission Motor</td>
</tr>
<tr>
<td>Electric Vehicle</td>
<td>24%</td>
</tr>
<tr>
<td>(electricity from Coal)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>35% X 92% X 75%</td>
</tr>
<tr>
<td></td>
<td>Coal Plant Transmission Motor</td>
</tr>
<tr>
<td>Conventional engine</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td>83% X 20%</td>
</tr>
<tr>
<td></td>
<td>Oil Refinery Motor</td>
</tr>
</tbody>
</table>

> The efficiency of an electric vehicle has a comparative advantage due to, mainly, the electric motor efficiency and the low grid transmission losses.

> Electricity to EV could be generated from other sources – more efficient than NG or Coal (hydro) –, or from renewable sources (wind, solar, etc.).

> Oil refining is efficient, though the energy efficiency of a typical internal combustion gas engine is low (17%-23% range).

1) NG: Natural Gas; 2) Well-to-Wheel

Source: Roland Berger Strategy Consultants
Technological advancements of Li-Ion batteries seem to have overcome all obstacles for mass production.

State-of-the-art of Li-Ion batteries technology

**KEY FACTS**

- **SECURITY**: The use of new materials (Iron phosphate and manganese) avoid "overheating".
- **DURABILITY**: The new batteries assure > 3,000 timecycles without significant load reduction – up to 400km in next years.
- **COSTS**: The use of new materials allow lower costs (Target: < 150 EUR/kWh in 2020).
- **AVAILABILITY**: Production has started already.

Source: CARB battery study 07, Roland Berger Strategy Consultants
By 2020 all established OEMs and a lot of new players will have entered the EV market in the EU

EU: Overview of estimated electric vehicle market penetration

<table>
<thead>
<tr>
<th>First Mover Wave</th>
<th>2008-2010</th>
<th>2011-2015</th>
<th>2016-2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited volume of &quot;a new type of EVs&quot;</td>
<td>Positive market response and volume ramp-up</td>
<td>Second Generation EVs at competitive costs and improved performance</td>
<td></td>
</tr>
<tr>
<td>New Prius Plug-in</td>
<td>Miles XS 500</td>
<td>&quot;Citycar&quot;</td>
<td>&quot;Second&quot; Movers benefit strongly from the first wave</td>
</tr>
<tr>
<td>Mitsubishi MiEV</td>
<td>Tesla Whitestar</td>
<td>All major players enter the EV market</td>
<td>Chinese and all other Players enter the market with comp. EVs</td>
</tr>
<tr>
<td>Opel E-Flex</td>
<td>MB EV Citycar</td>
<td>BYD</td>
<td>Miles 2. Gen</td>
</tr>
</tbody>
</table>

Source: Roland Berger Strategy Consultants
Many players are already actively moving – public cases

<table>
<thead>
<tr>
<th>Company</th>
<th>Activity</th>
<th>Announcement Date</th>
<th>Pilot Phase</th>
<th>Commercialization Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>RWE</td>
<td>Pilot with Daimler in Berlin</td>
<td>June 2008</td>
<td>2009</td>
<td>2011</td>
</tr>
<tr>
<td>DONG energy</td>
<td>Joint company with Project 'Better Place' in the course of incorporation</td>
<td>March 2008</td>
<td>2009</td>
<td>2011</td>
</tr>
<tr>
<td>EDF</td>
<td>Cooperation with local authorities and operators of shopping malls infrastructure tests in UK</td>
<td>June 2008</td>
<td>2009</td>
<td>2011</td>
</tr>
<tr>
<td>E.ON</td>
<td>Stake in consortium (amongst others VW for fleet test) with PHEVs in Germany (max. 25 cars)</td>
<td>July 2008</td>
<td></td>
<td></td>
</tr>
<tr>
<td>VATTENFALL</td>
<td>Cooperation of the Portuguese government with Renault Nissan (Partner of &quot;Project Better Place&quot; – supporting the development of infrastructure and fiscal benefits for EVs)</td>
<td>July 2008</td>
<td></td>
<td>4-months analysis for next steps</td>
</tr>
<tr>
<td></td>
<td>Cooperation with Saab, Volvo, ETC Battery and Swedish Energy Agency for tests with up to 10 PHEVs in Sweden</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooperation with BMW for a Pilot in Berlin</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Companies, Roland Berger Strategy Consultants analysis
Speed of market transition to electric vehicles per country depends on specific country framework

Market share of electric vehicles (illustrative)

- **Forced transition**
  - Legislation/regulation rules transition towards electric vehicles
  - Examples: ban of scooters with combustion engines from different Chinese cities

- **Commercial breakthrough**
  - E-mobility players actively develop market – including infrastructure offer
  - Speed for market penetration depends on specific framework (prices, taxes, road toll, etc.)
  - Attractive offers and price advantage vs. combustion engine drives transition

- **Customer movement**
  - Even without actively pushing the market some people will change
  - "Green issues" and early adopters drive market transition

Source: Roland Berger Strategy Consultants
Project Better Place addresses the issue of autonomy offering battery charging and replacement spots

Concept business model "E-Mobility": Project Better Place

Vehicle offer
- Focus on pure EVs ("Zero-Emission")
- Fast battery exchange to solve range issue
- Client owns vehicle or leases vehicle from OEM
- PBP own battery (part of mobility offering)

Infrastructure offering
- Offer to client to upgrade electric infrastructure at home (where necessary)
- Wide area infrastructure at public places
- Proprietary IT-Solution (without Com-Module no access)
- Wide area availability of battery exchange stations

Sales & Service
- Mobility offering similar to "Mobile communication" (incl. battery leasing and electricity supply) over own distribution channel
- Customer gets mobility contract directly from PBP (or in OEMK shop?)
- Fleet customers get at the beginning (or always?) the complete offer (vehicle/battery/electricity?) from PBP
- Own service network?

Distribution / Invoicing electricity
- "Large customer" contract with utility
- High share of renewable energies (to ensure positive CO2 figure "Well-to-Wheel")
- Invoicing / payment through proprietary IT-system

Source: PBP, Roland Berger Strategy Consultants
Some Governments have been defining key aspects of their E-Mobility model architecture

Key elements to be defined from a Government’s perspective

- **A** Value Chain
- **B** Players and business models
- **C** Charging infrastructures
- **D** Price (charging service and electricity)
- **E** Vehicle-to-Grid (V2G)

Main variables

- > Value chain configuration
- > Key activities
- > Players: Network operators, virtual or integrated retailers
- > Simple to integrated business models
- > “Open” / “Closed” electricity retail – RAB?
- > Payment and billing model
- > Universal / non-universal charging
- > Free vs. regulated electricity price
- > Maximum for charging service?
- > V2G implementation term
- > Which market conditions?

Source: Roland Berger Strategy Consultants
## Electric vehicles could offer several tangible value creation opportunities – need to clarify/quantify model?

### Direct advantages
- **Battery development** key for wind portfolio
- **Cars as batteries** for optimum dispatching
- Development of **smart grid network architecture**

### Energy distributor / infrastructure provider
- **Energy supply** for EVs / hybrids – **increased demand**
- **Operation of charging infrastructure** "at home" or in public places, Call / Billing (direct customer access)
- Provision of **fast-charging infrastructure** for surcharge

### B2B- (Location-) Partner
- **B2B- location partner** – build / operate charging infrastructure with investment of partners (parking lots, shopping malls, …)
- **B2B-fleet customers** – build / operate charging infrastructure for customers

### Grid-for-Vehicle (G4V)/ Vehicle-to-grid (V2G)
- **G4V – central charging control** EVs / hybrids
- As a future perspective – **V2G**
- Second use of old batteries to store electricity

### Additional B2C-Offerings
- **Combined products** – Smart Home & Drive, Customized Infrastructure – **package micro-generation**
- **Other billing models**, e.g. flat rate
- Additional **content based services**, e.g. parking guiding system

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**Clarification of business model and quantification needed**
- Positioning in value chain
- Implications for core business
- Our business plan
- Partnerships
- Value proposition

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Source: Roland Berger Strategy Consultants