Progress in Battery Swapping Technology and Demonstration in China

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How to refuel for Electrical Vehicle?

- Due to the limited driving range of electrical vehicle, the refuel for a long distance driving is an essential prerequisite for EV Development.
  - AC Charging: Easy but Slow
  - DC Charging: Hi-power, impact to both battery and grid
  - Battery Swapping: Standardization dilemma

100~200km, not Enough
## How to refuel for Electrical Vehicle?

<table>
<thead>
<tr>
<th></th>
<th>AC Plug-in Charging</th>
<th>DC Fast Charging 0.3C</th>
<th>DC Fast Charging &gt; 1C</th>
<th>Battery Swapping</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Time to finish</strong></td>
<td>8~13h</td>
<td>3~4h</td>
<td>&lt; 1h</td>
<td>2min</td>
</tr>
<tr>
<td><strong>Grid Networks</strong></td>
<td>Home Plug</td>
<td>16 vehicles/spot</td>
<td>48 vehicles/spot</td>
<td>720 vehicles/station</td>
</tr>
<tr>
<td><strong>Infrastructure Cost</strong></td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Operating Cost</strong></td>
<td>Low</td>
<td>Low</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Driving Range/km</strong></td>
<td>100~200</td>
<td>100~200</td>
<td>100~200</td>
<td>100~200</td>
</tr>
<tr>
<td><strong>Maintenance Cost</strong></td>
<td>-</td>
<td>-</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Battery Maintenance</strong></td>
<td>-</td>
<td>-</td>
<td>Fast Charging shortens the life of batteries</td>
<td>Centralized charging and maintenance, longer life of batteries</td>
</tr>
</tbody>
</table>
Infrastructure or Vehicle?

- When it comes to electrical vehicle, which should be developed or constructed at first, infrastructure or vehicle?
Who pay for the battery?

- The battery cost including packaging is approximately 50% of the overall BOM
- Inappropriate Maintenance will shorten the life of battery
China State Grid's Strategy

- 换电为主、插充为辅、集中充电、统一配送
  - Battery swapping as main energy-refuelling
  - Plug charging as auxiliary energy-refuelling
  - Centralized charging for batteries
  - Dynamic distribution of batteries to stations
- Batteries renting for customers, OEM provide vehicles without battery
- The State Grid own the batteries and is responsible for maintenance and recycling

Renting from State Grid + Buy from OEM with low price
Distribution of Battery Charging and Swapping Station (planning)

Battery Swapping Station: located in suburbs and between two cities.

Charger Spot: located in community, official building and commercial center.
Operating Mode of Battery Swapping
V2G Model of Battery Swapping Station

Battery Swapping Station will be used as electricity energy storage station for grid power adjustment
Outline

Background

Battery Swapping Demonstration in China

Conclusion
Battery Swapping Technology Suppliers in China

KeyPower
许继集团
电巴
HEPSTD
better place
## Battery Swapping Technology Suppliers in China

<table>
<thead>
<tr>
<th>Company</th>
<th>Logo</th>
<th>Belongs to</th>
<th>Battery Swapping Tech. Provide</th>
<th>Cooperator</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key Power Tech.</td>
<td><img src="image" alt="Key Power Logo" /></td>
<td>Independent</td>
<td>For Passenger Vehicle</td>
<td><img src="image" alt="KIA" /> <img src="image" alt="东风日产" /></td>
</tr>
<tr>
<td>XJ Group</td>
<td><img src="image" alt="XJ Group Logo" /></td>
<td>Belongs to State Grid</td>
<td>For Bus</td>
<td><img src="image" alt="东风日产" /></td>
</tr>
<tr>
<td>DBTech.</td>
<td><img src="image" alt="DBTech Logo" /></td>
<td>Independent</td>
<td>For Commercial Vehicle</td>
<td><img src="image" alt="东风日产" /> <img src="image" alt="东风汽车" /></td>
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<tr>
<td>HEPSTD</td>
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<td>Belongs to State Grid</td>
<td>For Passenger Vehicle</td>
<td><img src="image" alt="东风日产" /> <img src="image" alt="众泰汽车" /></td>
</tr>
<tr>
<td>Better Place</td>
<td><img src="image" alt="Better Place Logo" /></td>
<td>Independent</td>
<td>For Passenger Vehicle</td>
<td><img src="image" alt="东风日产" /> <img src="image" alt="众泰汽车" /></td>
</tr>
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</table>
KeyPower Battery Swapping Demonstration Stations in China

- Beijing, 1 Station
- Jiangshu, 2 Stations
- Canton, 1 Station (planned)
Swapping System: The Key Equipment for EV Infrastructure

- Swapping finished in 2 min., the only practical way of rapid refilling
- Battery is located underneath car floor, the only practical location
- Swapping equipment can adapt all types of cars
- Battery are standardized in four category, to adapt for various car sizes
Special Connector for Battery Swapping

- Patented special connector for battery swapping
  - Long Durability: >2500/5000 times, 2 times rated power/30s
  - Temperature Range: -40~85°C
Key Power Station Configuration

- Inter-Area for Battery Buffering
- Multiple Battery Area for Different Type of Battery
- Multiple Conveyor for faster Battery Swapping
Standard Battery Pack + Smart Equipment

Two steps to achieve standardization

- Standard battery pack: four categories to standardize dimension, connector, locker and communication protocol
- Smart equipment: automatic vehicle positioning and installing
KeyPower Battery Swapping System Projects in China
XJ Group Battery Swapping Demonstration Stations in China

Shandong, 1 Station
XJ Group Battery Swapping Demonstration Stations in China

Tsing Dao Jiaozhou Bay Tunnel

Battery Swapping Station for Tunnel Shuttle Bus

The Shuttle Bus

The Station
XJ Group Battery Swapping Demonstration Stations in China

Connector for Swapping

Video

Battery Swapping Machine
DB Battery Swapping Demonstration Stations in China

- Beijing, 3 Stations
- Shanghai, 1 Station
- Canton, 1 Station
DB Battery Swapping Demonstration Stations in China
HEPSTD Battery Swapping Demonstration Stations in China

Zhejiang, 3 Stations
HEPSTD Battery Swapping Demonstration Stations in China
HEPSTD Battery Swapping Demonstration Stations in China
BP Battery Swapping Demonstration Station in China
BetterPlace Battery Swapping Demonstration Stations in China
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- Battery Swapping is a transitional solution for electrical vehicle energy refueling
  - It is very suitable for public transportation application, like taxi, shuttle bus, and etc. before the higher energy density battery is applied.
- The State Grid promoted the battery swapping station construction and application because of controlling main valuable chain of EV
- The compromise between State Grid and Auto Maker is even more important than the technology solution
- The safety issue of Battery Swapping is also a key factor for being accepted by public, especially the connector
Thank You