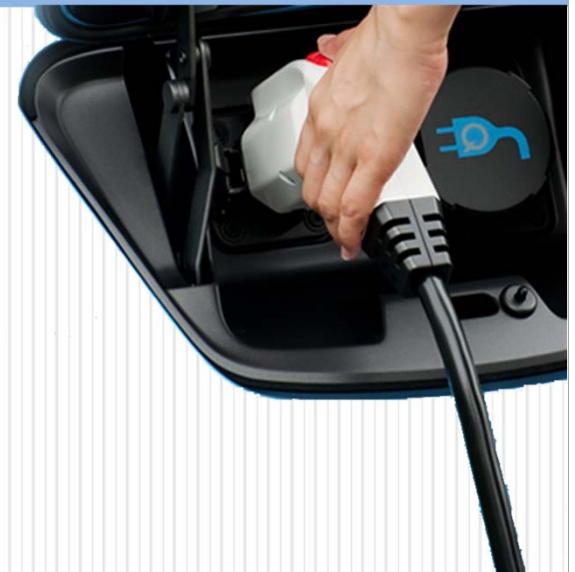


Progress in Battery Swapping Technology and Demonstration in China



Jianfeng Hua
Email: huajf@tsinghua.edu.cn
Tel: 010-62789570

Outline

Background

Battery Swapping Demonstration in China

Conclusion

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



AC Charging



DC Charging



Battery Swapping

How to refuel for Electrical Vehicle?

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

Infrastructure or Vehicle?

- When it comes to electrical vehicle , which should be developed or constructed at first, infrastructure or vehicle?

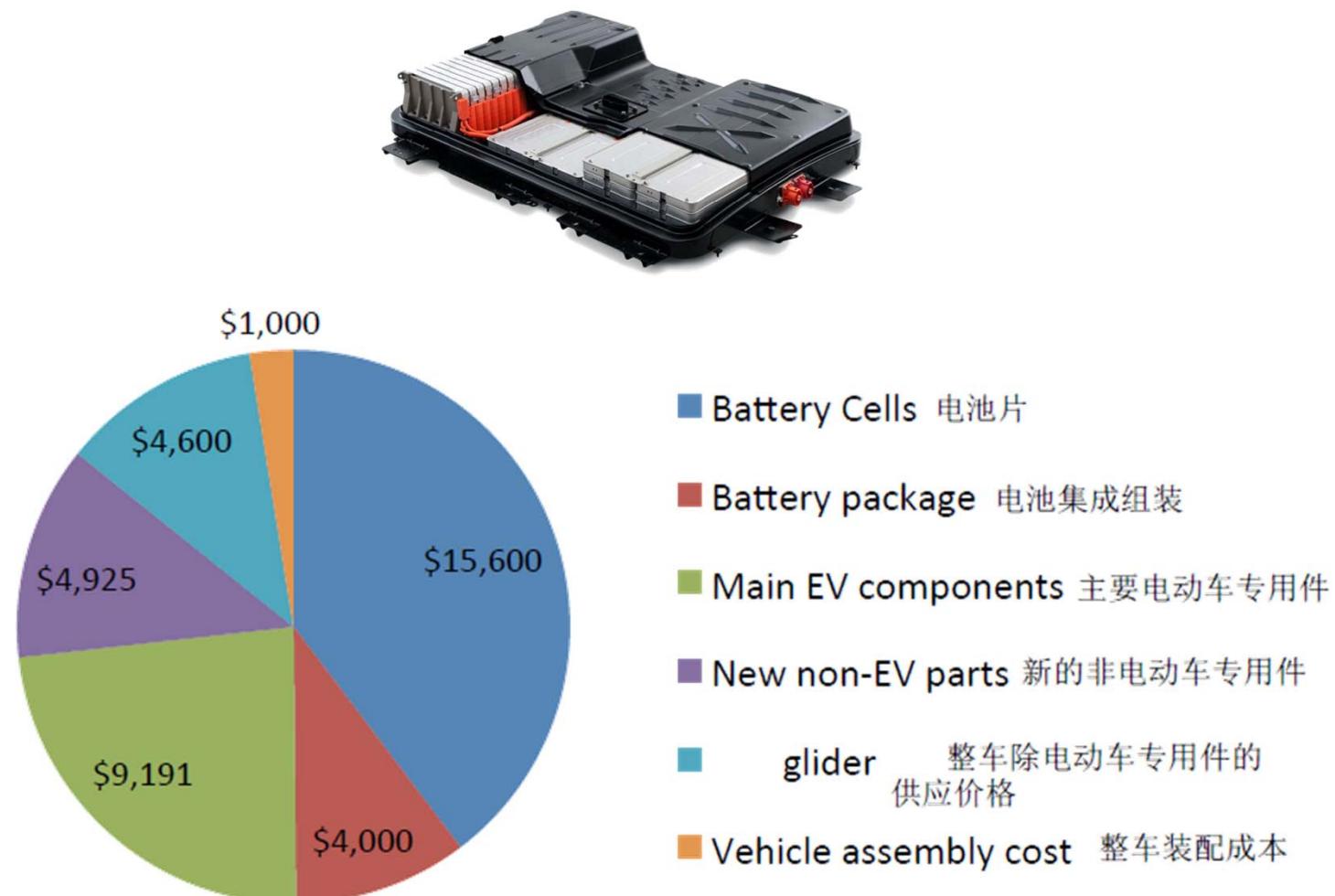


V.S.



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

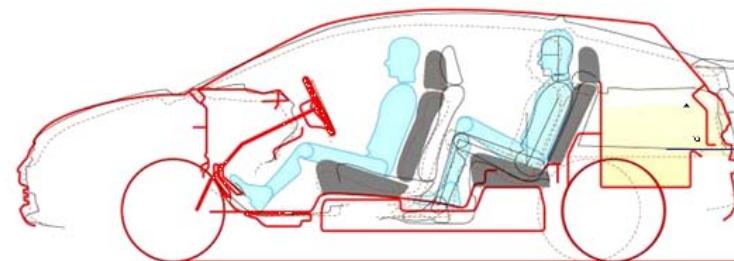
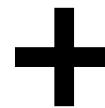


China State Grid's Strategy

- 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



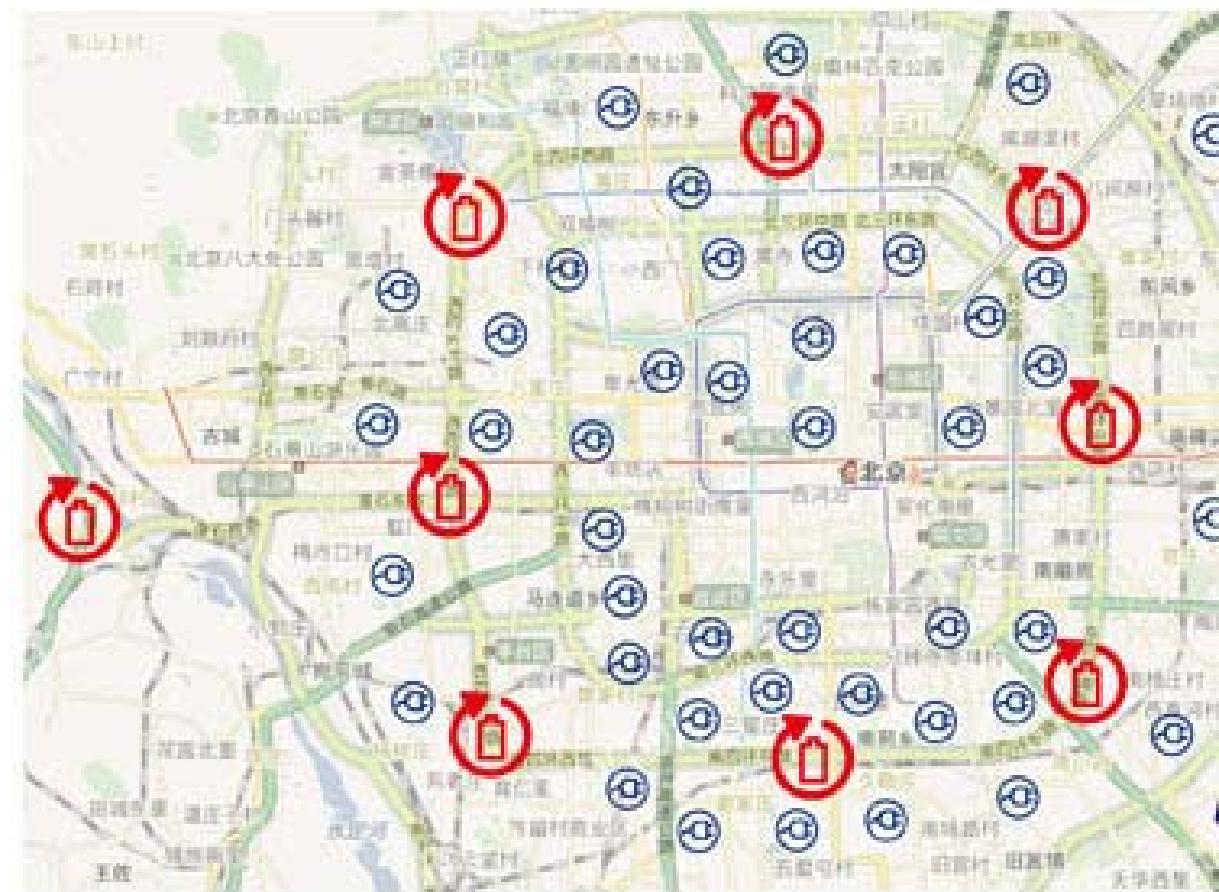
Renting from State Grid



Buy from OEM with low price

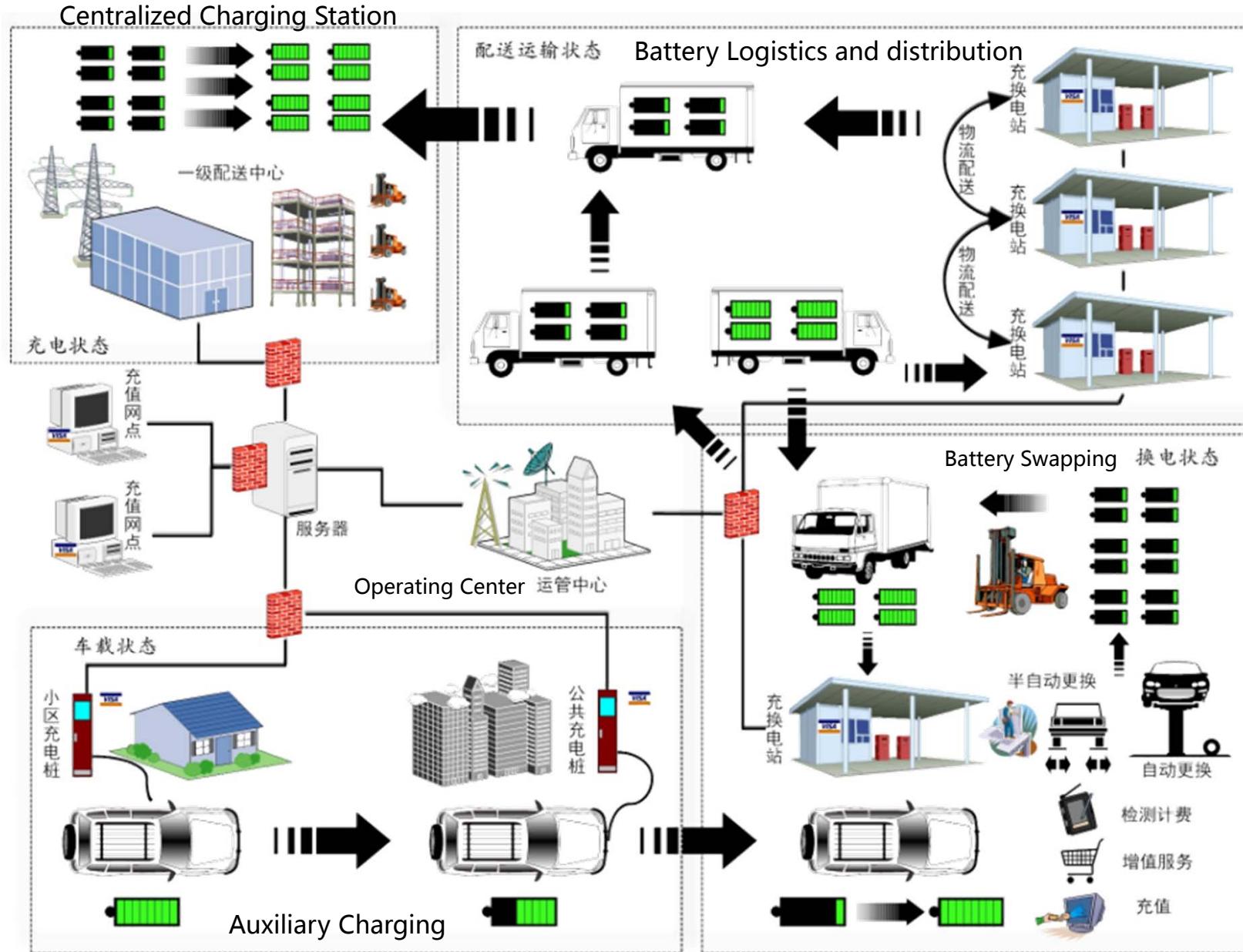
Distribution of Battery Charging and Swapping Station(planning)

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



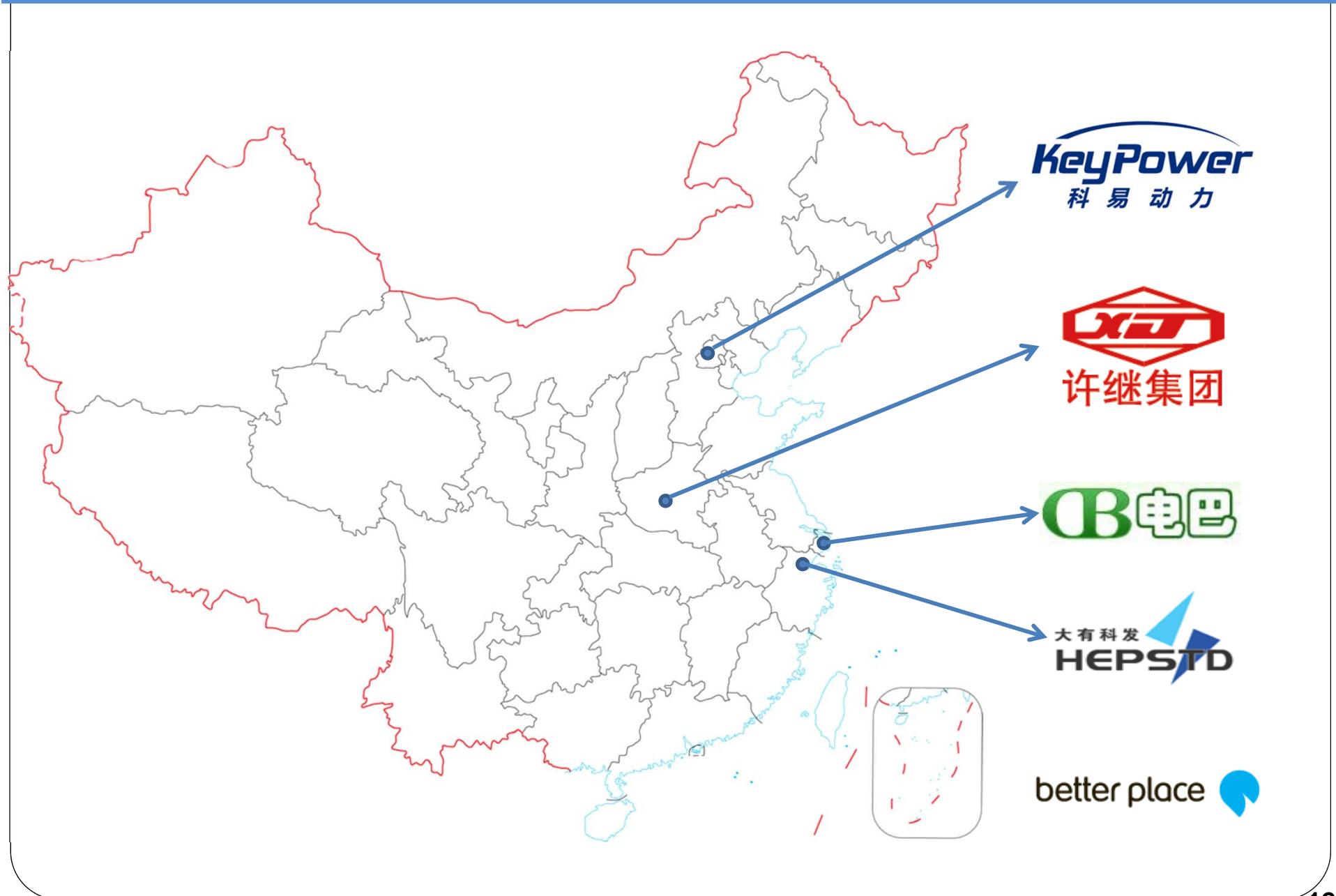
Outline

Background

Battery Swapping Demonstration in China

Conclusion

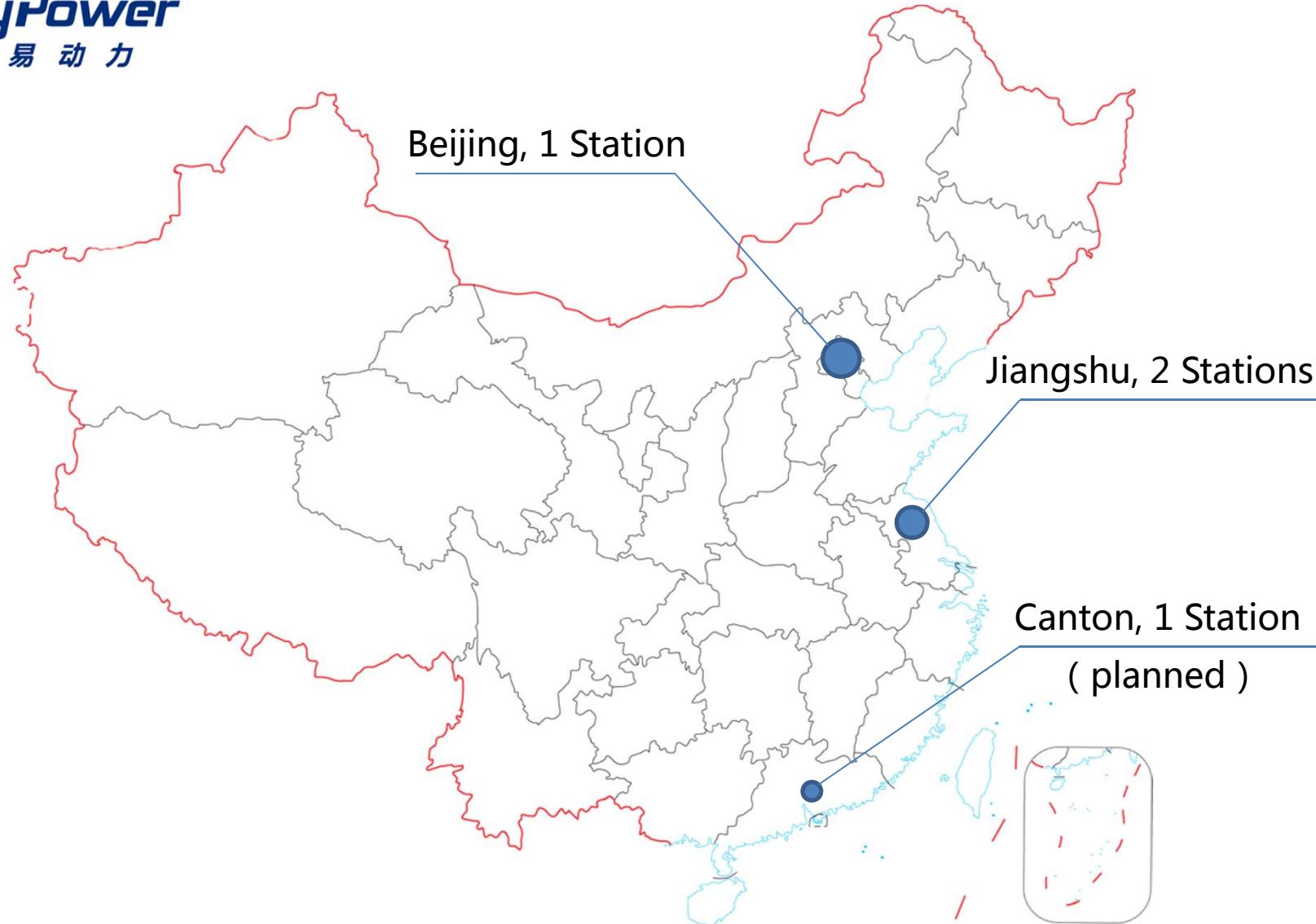
Battery Swapping Technology Suppliers in China



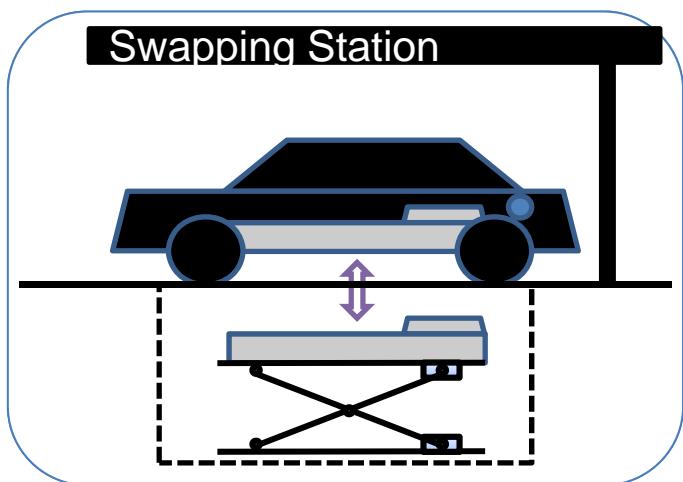
Battery Swapping Technology Suppliers in China

Company	Logo	Belongs to	Battery Swapping Tech. Provide	Cooperator
Key Power Tech.		Independent	For Passenger Vehicle	   东风日产
XJ Group		Belongs to State Grid	For Bus	
DB Tech.		Independent	For Commercial Vehicle	 
HEPSTD		Belongs to State Grid	For Passenger Vehicle	  海马汽车  ZOTYE AUTO
Better Place		Independent	For Passenger Vehicle	  中国南方电网 CHINA SOUTHERN POWER GRID RENAULT  北京汽车

KeyPower Battery Swapping Demonstration Stations in China



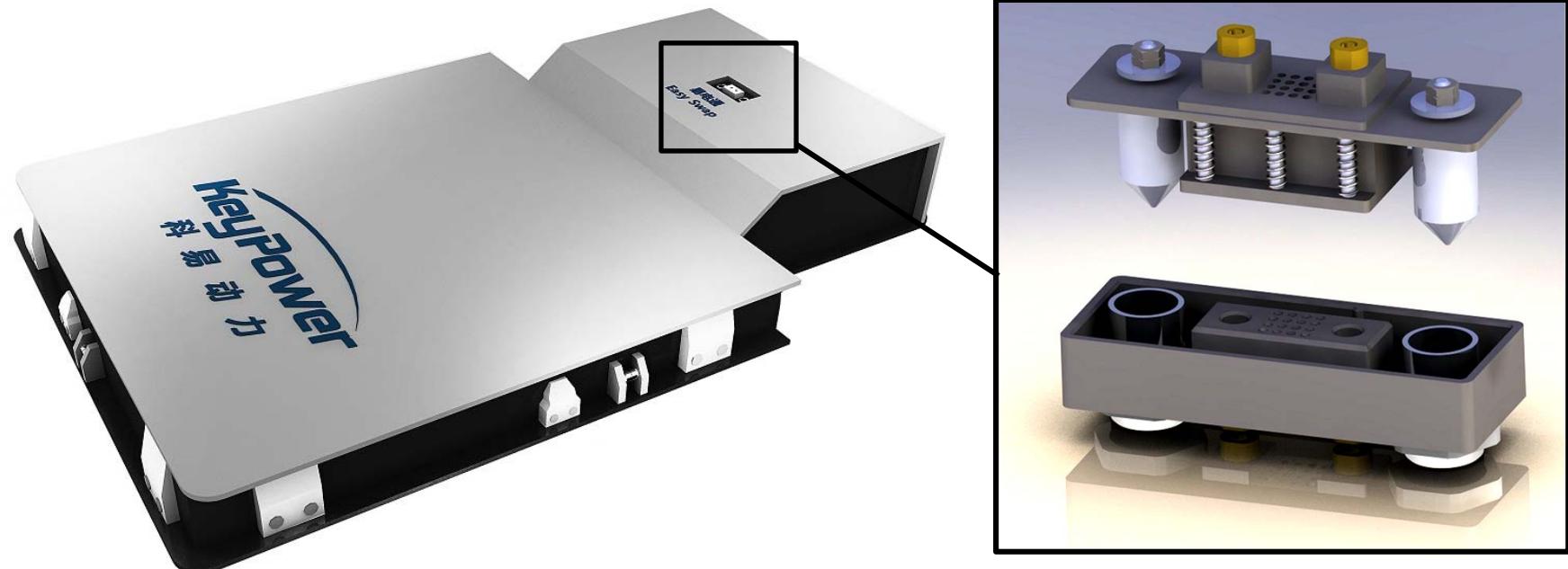
Swapping System: The Key Equipment for EV Infrastructure



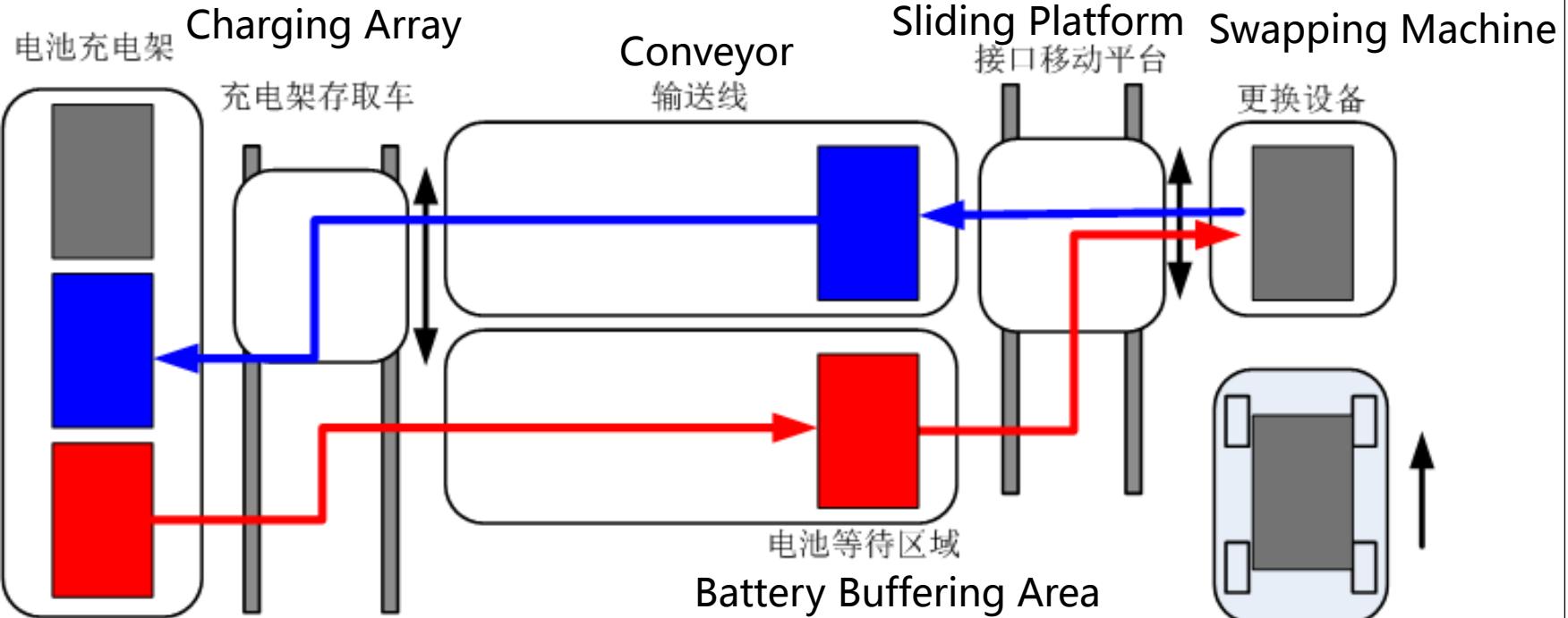
- Swapping finished in 2 min., the only practical way of rapid refilling
- Battery is located underneath car floor, the only practical location
- Swapping equipment can adapt all types of cars
- Battery are standardized in four category, to adapt for various car sizes

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

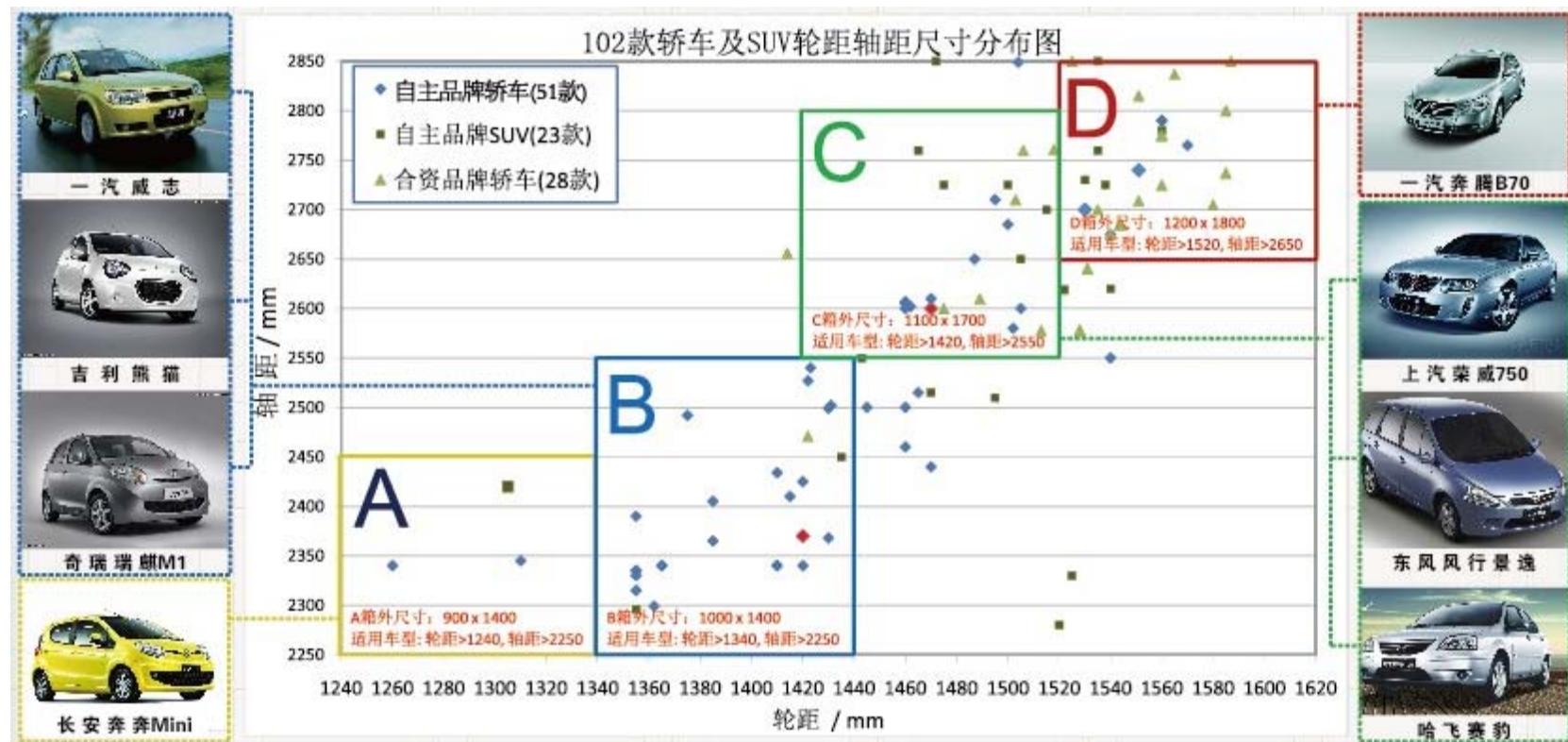


- Inter-Area for Battery Buffering
- Multiple Battery Area for Different Type of Battery
- Multiple Conveyor for faster Battery Swapping

Standard Battery Pack + Smart Equipment

Two steps to achieve standardization

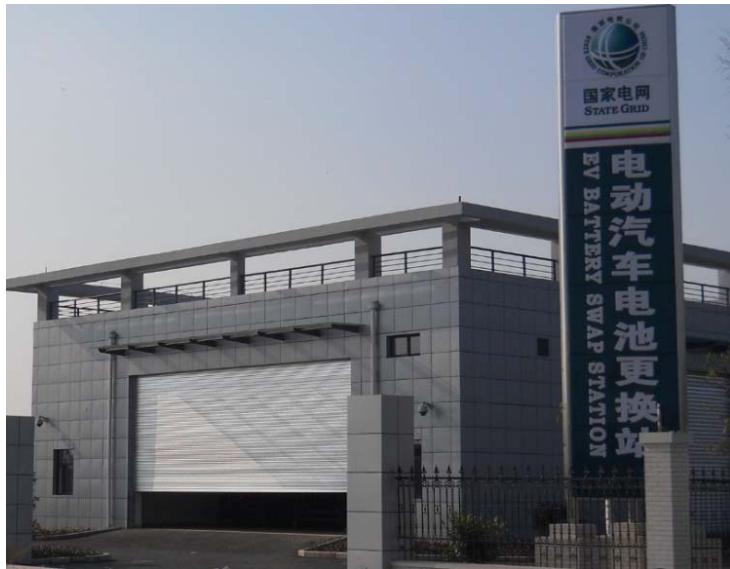
- Standard battery pack: four categories to standardize dimension, connector, locker and communication protocol
- Smart equipment: automatic vehicle positioning and installing



Application Demo-Vehicle

Application Demo-Vehicle

KeyPower Battery Swapping System Projects in China



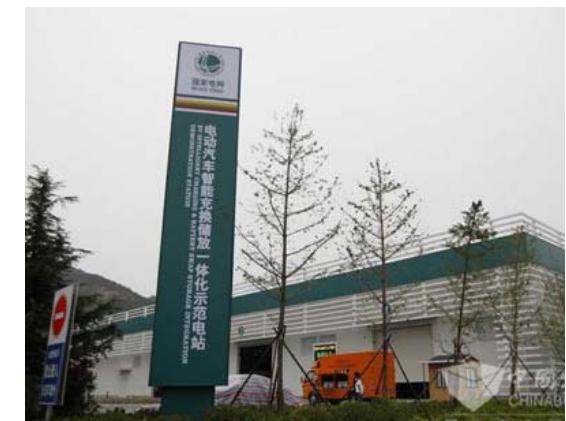
XJ Group Battery Swapping Demonstration Stations in China



XJ Group Battery Swapping Demonstration Stations in China



The Shuttle Bus



The Station

XJ Group Battery Swapping Demonstration Stations in China



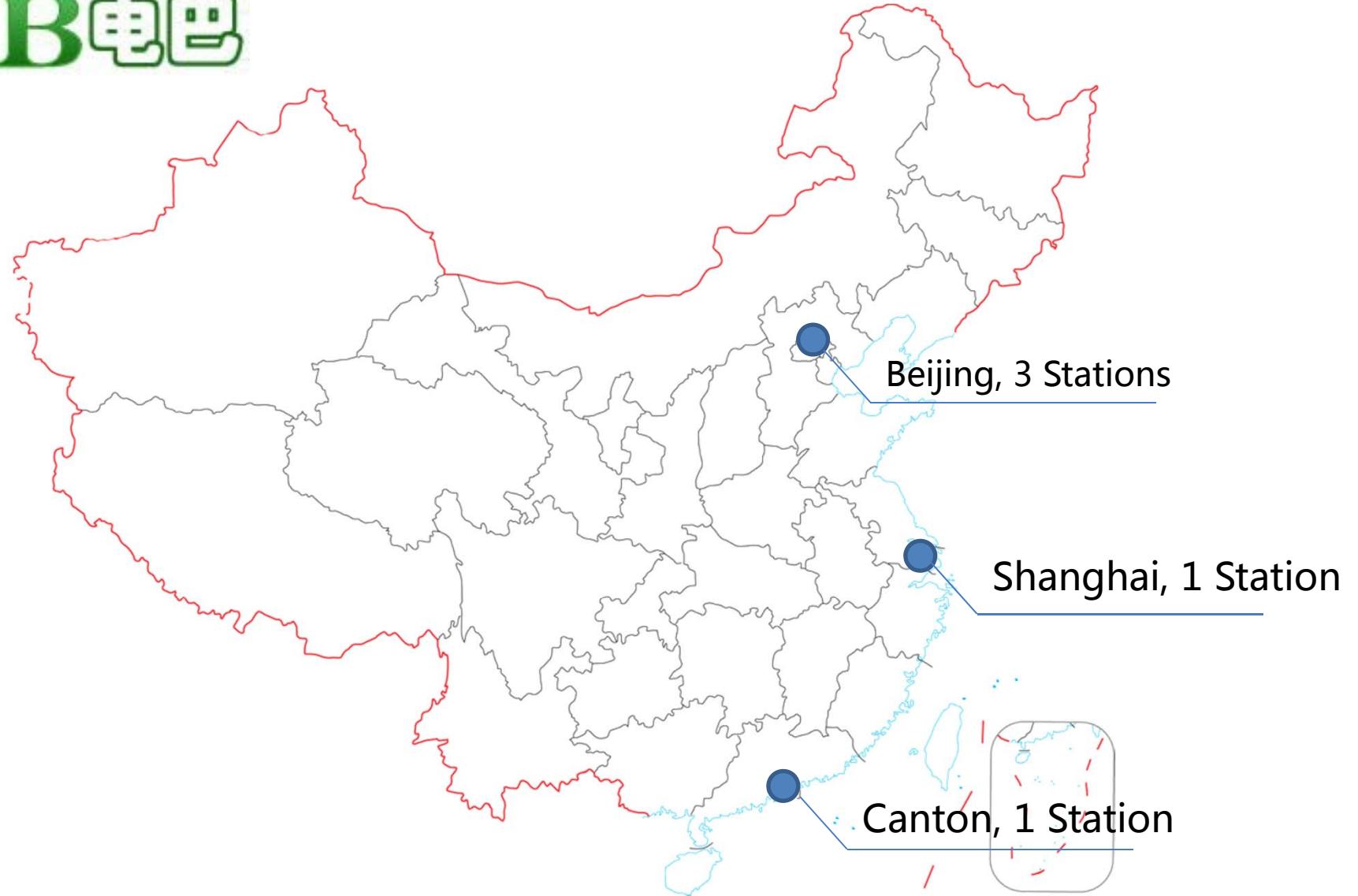
Connector for Swapping

[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



HEPSTD Battery Swapping Demonstration Stations in China



HEPSTD Battery Swapping Demonstration Stations in China

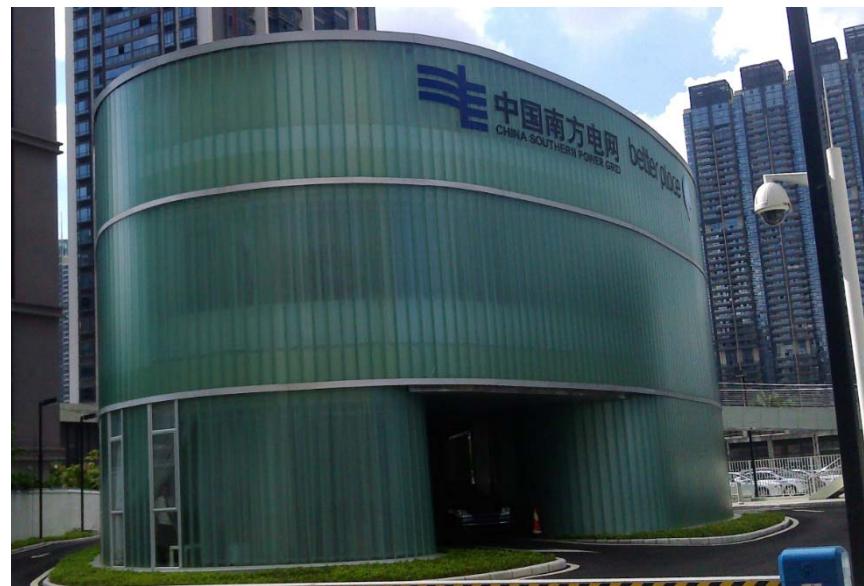
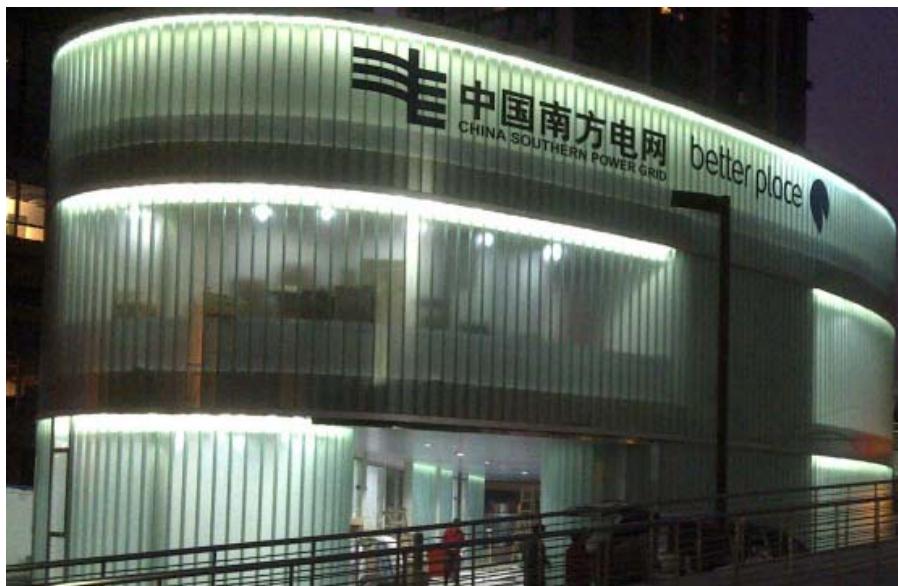


BP Battery Swapping Demonstration Station in China

better place



BetterPlace Battery Swapping Demonstration Stations in China



Outline

Background

Battery Swapping Demonstration in China

Conclusion

Conclusion

- 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