



20 May 2013

Electric Vehicle Charging Models and Implementation in U.S. and China

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Electric Vehicles



	40 kWh	60 kWh	85 kWh	85 kWh PERFORMANCE
Estimated Range (at 55 mph)	160 miles	230 miles	300 miles	300 miles
EPA 5-Cycle (Certified Range)	tbd	208 miles	265 miles	265 miles
0 to 60 mph	6.5 seconds	5.9 seconds	5.6 seconds	4.4 seconds
Top Speed	110 mph	120 mph	125 mph	130 mph
Peak Motor Power	235 hp	302 hp	362 hp	416 hp
Peak Motor Torque	310 lb-ft	317 lb-ft	325 lb-ft	443 lb-ft
Battery Warranty	8 year 100,000 miles	8 year 125,000 miles	8 year unlimited miles	8 year unlimited miles

- Tesla Model S: Plug-in Electric Vehicle
- Motor Trend Car of The Year 2013
- Consumer Reports Highest-Ever Rated Vehicle
(99/100 score)



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Highway Charging: Tesla's Business Case

- Supercharger Stations along Interstate routes:
 - Los Angeles to Las Vegas; and
 - Los Angeles to San Francisco
 - Free (no cost to charge)
- Capable of delivering DC energy directly into the battery at rates of up to 80kW.
- Allows for an additional 220-250 km in range on a 30 minute charge.
- In negotiations to license charging technology to speed widespread adoption.
 - Mercedes Benz; Others





Solar-Assisted Electric Vehicle Charging Station at Oak Ridge Nat. Lab

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Other Pictures of Charging





Other Recharging Models: The Automatic Replacement System

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Other models for recharging include automatic battery replacement model (concept view from China shown here.)



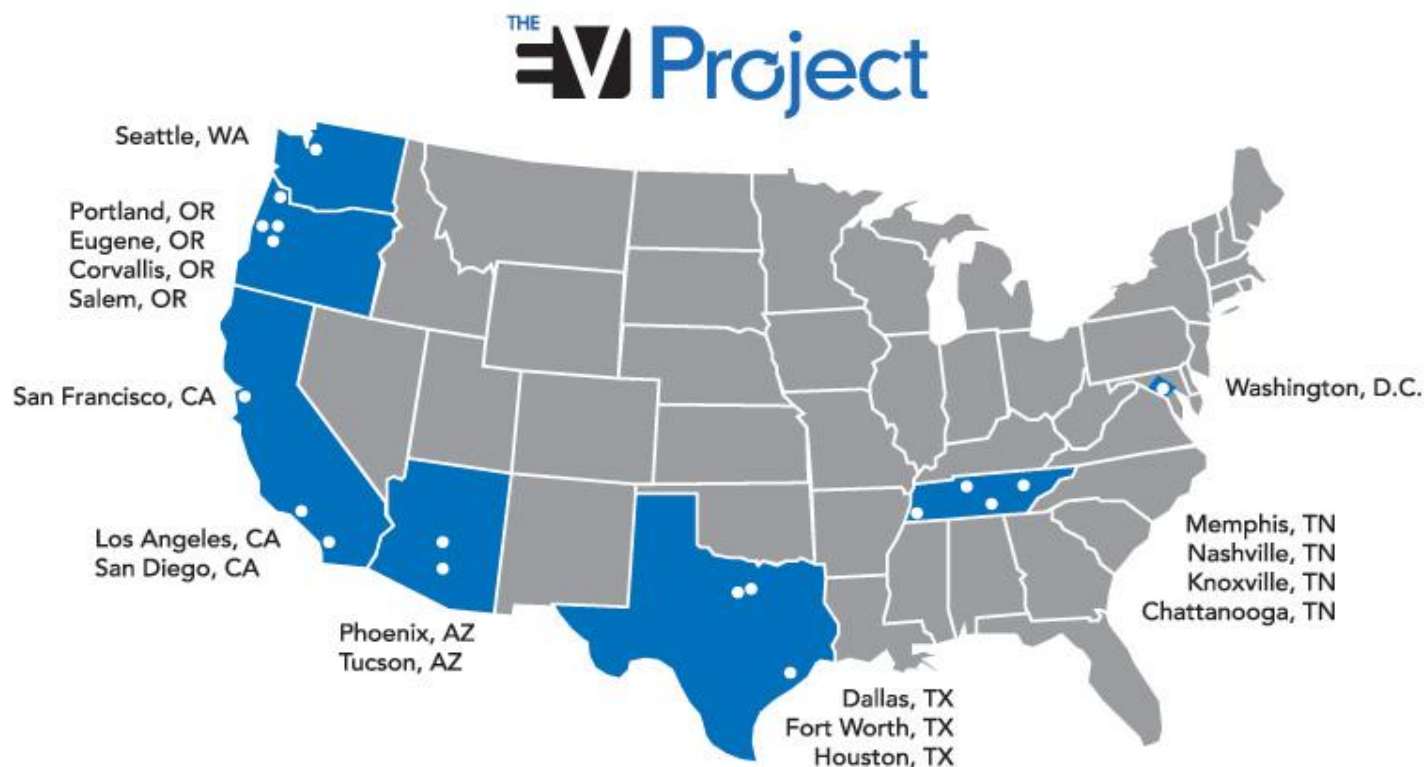
EV Demonstration Project

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The largest deployment of charge infrastructure in history

As of March 2013...

- Total vehicles (EV and PHEV) enrolled = 7,937
- 11,292 alternating current (AC) Level 2 chargers Installed
- 76 DC Fast Chargers Installed





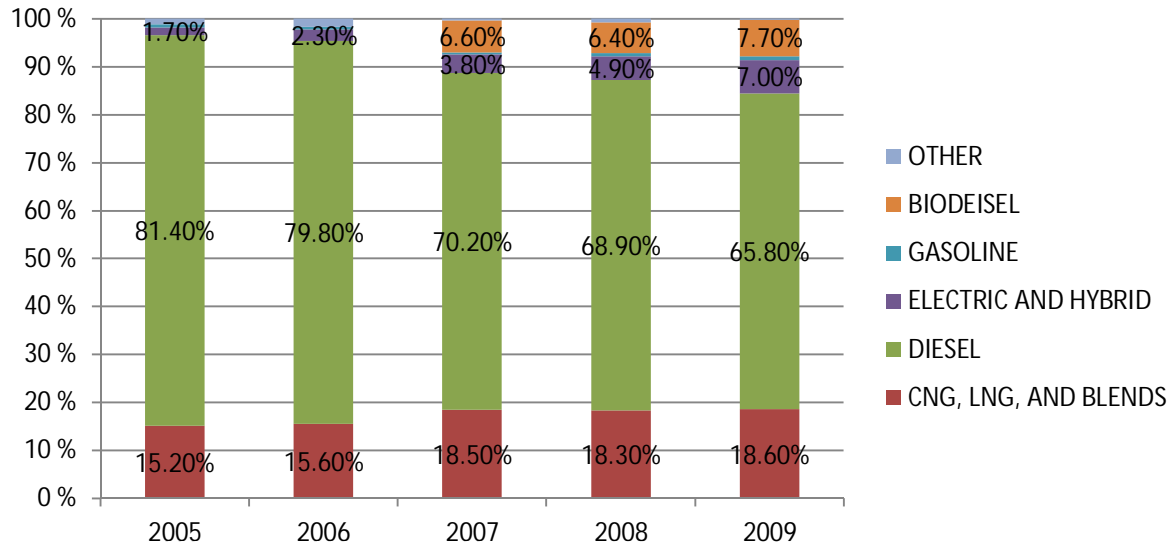
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Background: Electric Busses



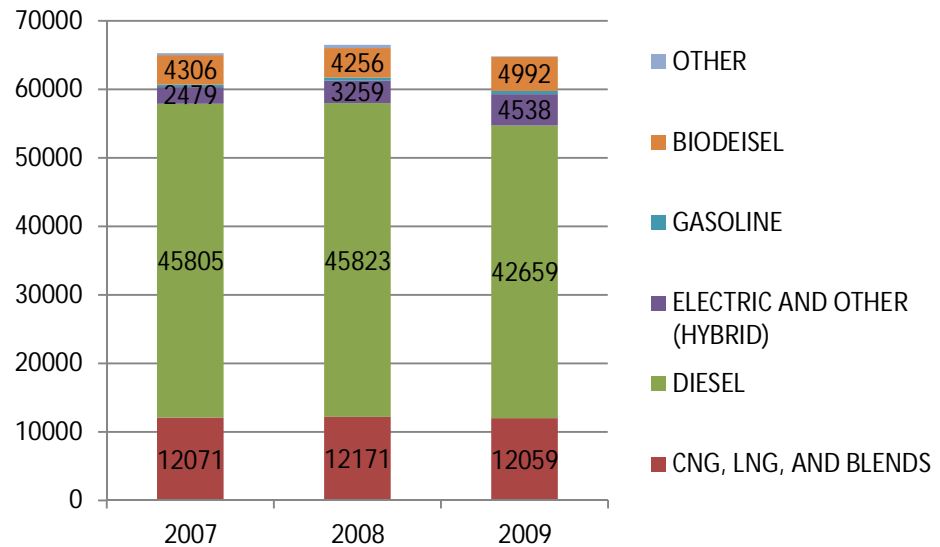


US transit bus power source mix



From 2005, the Mix has a large change, diesel fueled decreased from 81.4% to 65.8%; CNG fueled increased from 15.% to 18.6%, **hybrid increased from 1.7% to 7%**; while biodiesel accounted 7.7%

From 2007 to 2009, the bus amount using alternative power increased from 19444 to 22173, meanwhile the diesel bus decreased from 45805 to 42659. In the 2729 increased alternative power buses, **hybrid bus accounts 75%** (2059, from 2479 to 4538), biodiesel accounts 25%(686, from 4306 to 4992),and CNG almost keeps same.





Battery Models for Busses

For electric busses, several options are available to ensure maximum operational time.



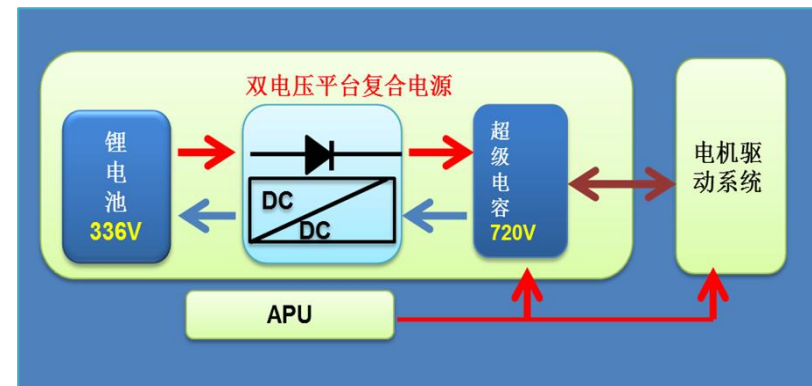
Battery swapping



Recharging



Quick-Recharging



Extended Range



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Drivers

- Market Size
- Improved Technologies



Driver: Market Size

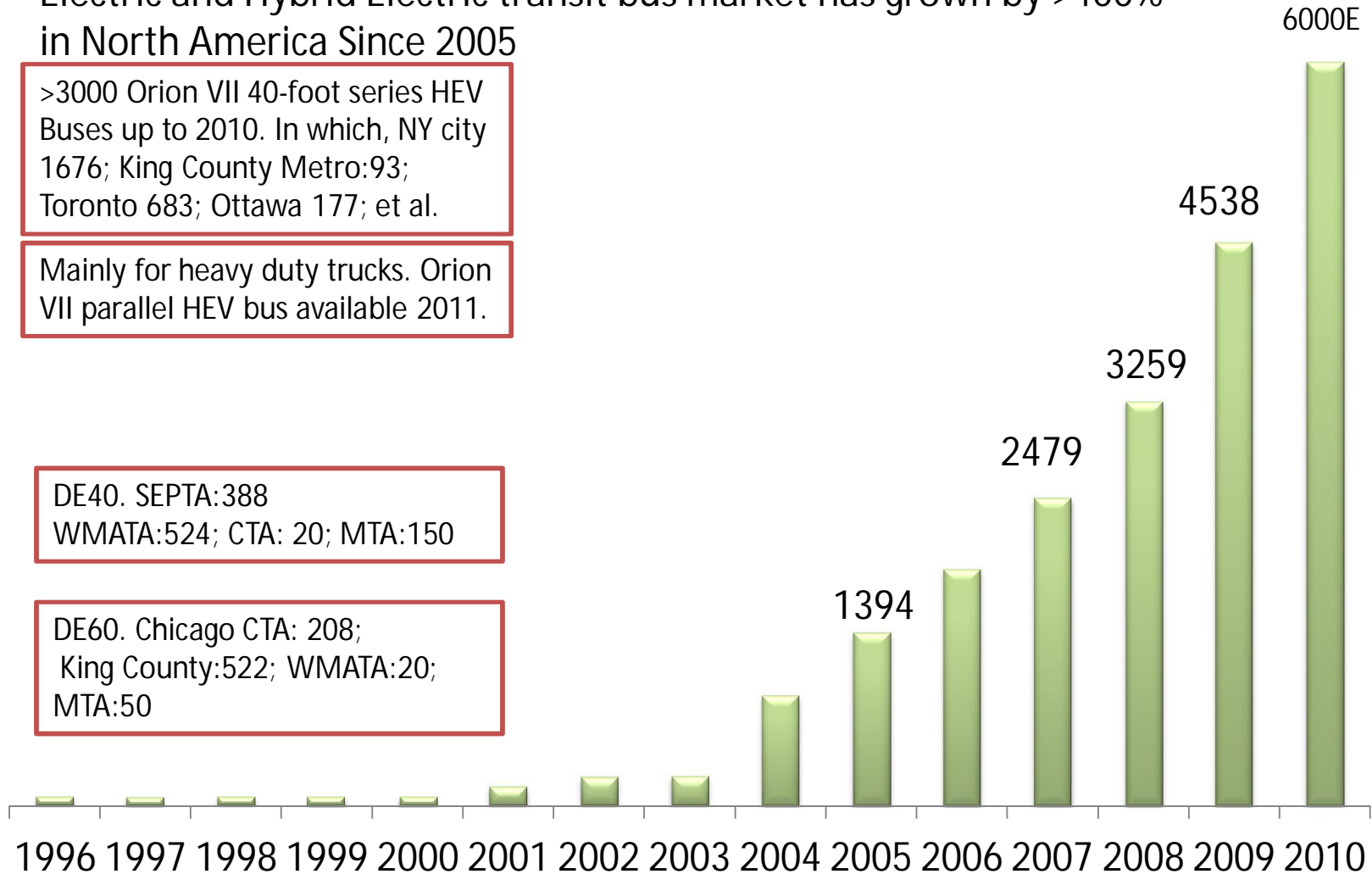
Electric and Hybrid Electric transit bus market has grown by >400% in North America Since 2005

>3000 Orion VII 40-foot series HEV Buses up to 2010. In which, NY city 1676; King County Metro:93; Toronto 683; Ottawa 177; et al.

Mainly for heavy duty trucks. Orion VII parallel HEV bus available 2011.

DE40. SEPTA:388
WMATA:524; CTA: 20; MTA:150

DE60. Chicago CTA: 208;
King County:522; WMATA:20;
MTA:50

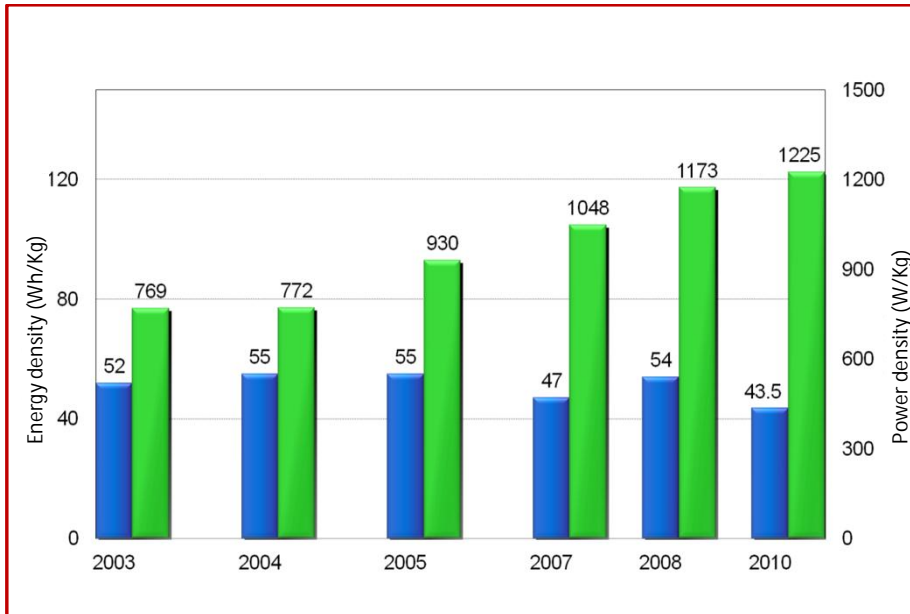




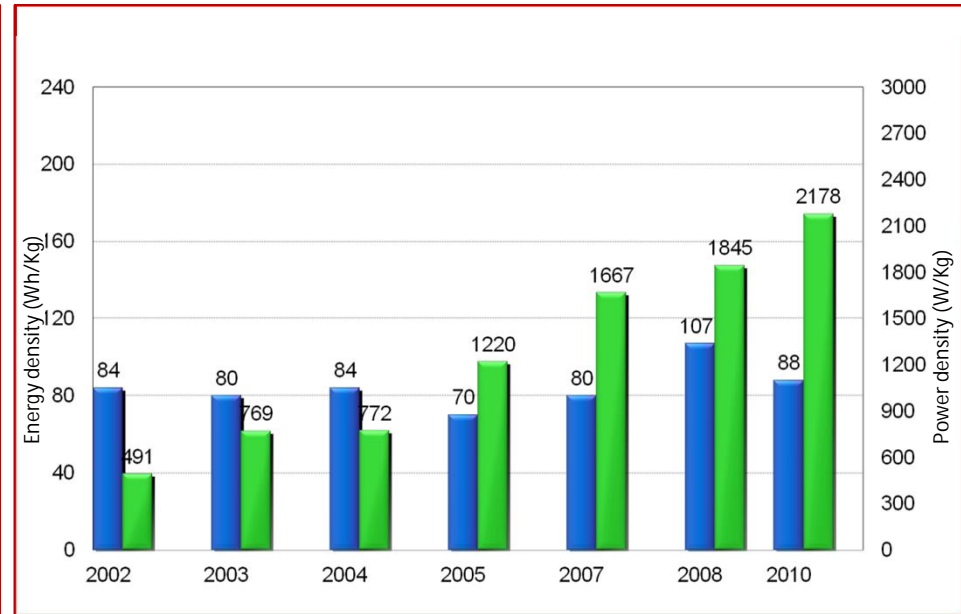
Driver: Improved Technology

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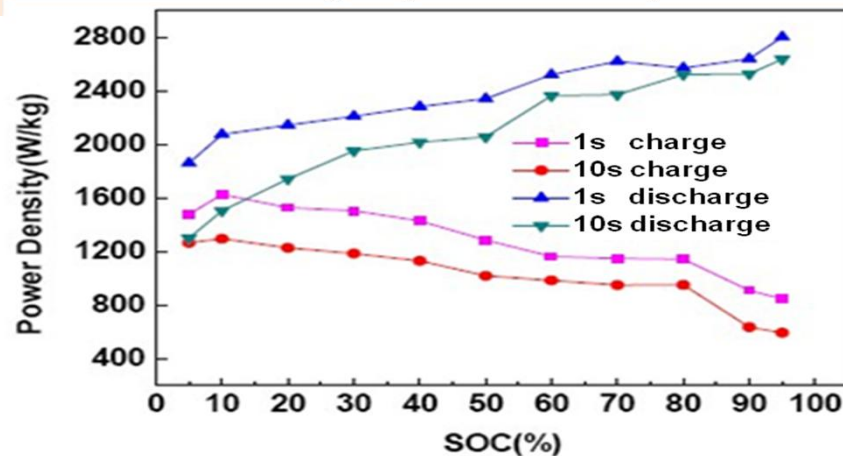
The technical progress of power battery for HEV



Power density of nickel-metal hydride battery is being improved steadily



Power density of Li-ion power battery has been improved greatly

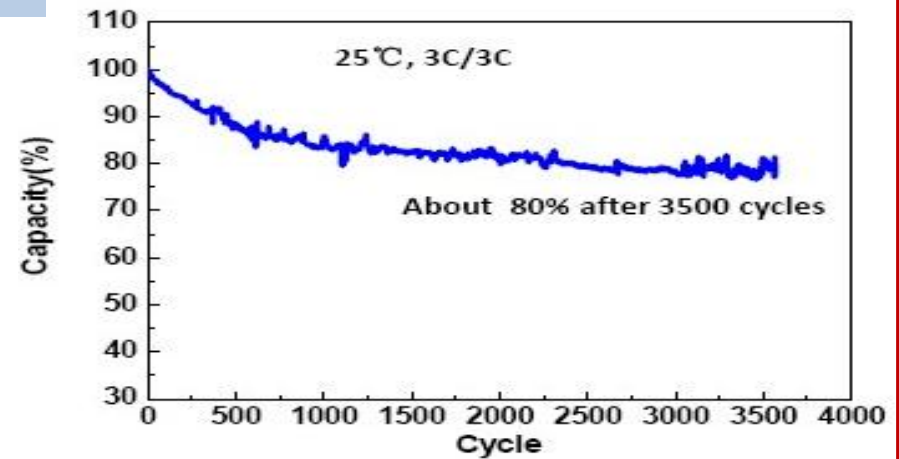
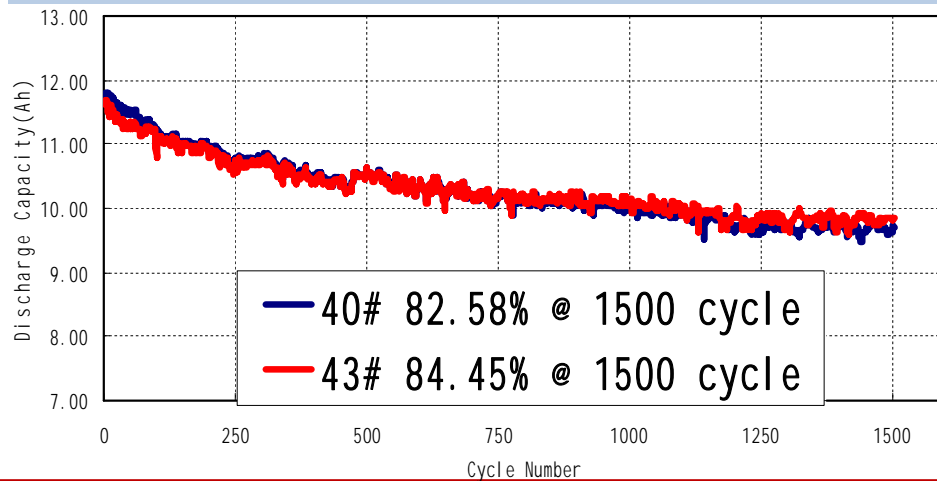




Increased Battery Power Density and Durability

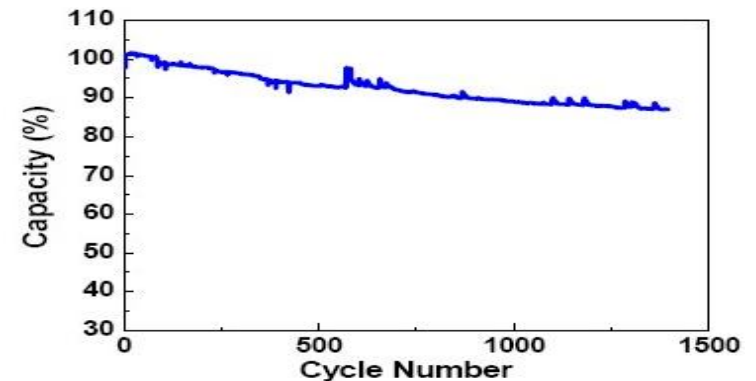
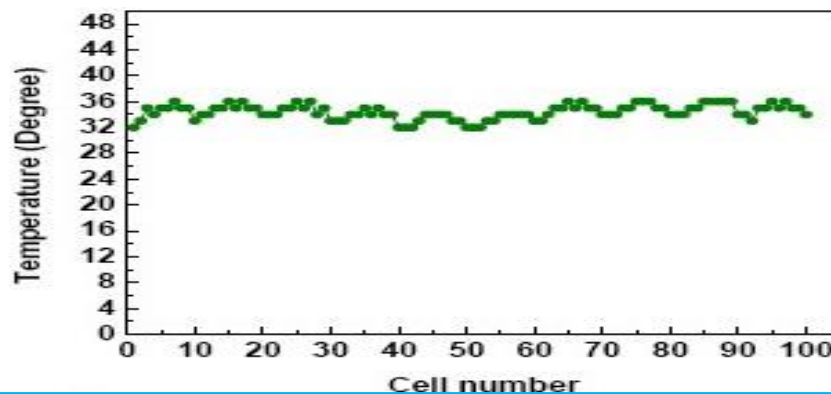
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LiFePO₄ battery (cell): increase from 1500 (the year 2010) to 2500-3500 (the year 2011).



LiFePO₄ battery pack: capacity is more than 87% after 1390 cycles

*Experiment condition: 25° C; 1C @ 100% DOD; serious connection with 100 cells; no balancing technique.



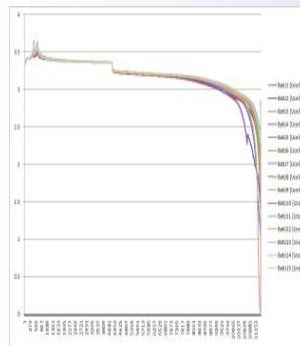


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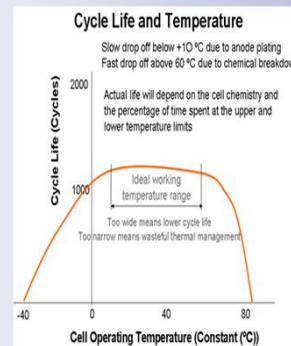
Performance Optimization of Power Battery System

Durability

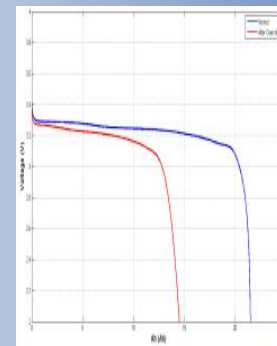
High-low temperature



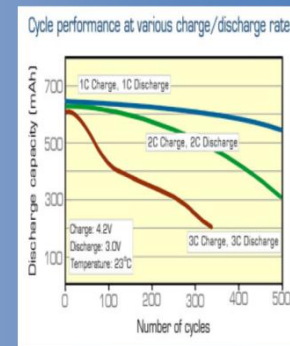
Overcharge and overdischarge



Charge and discharge with large current

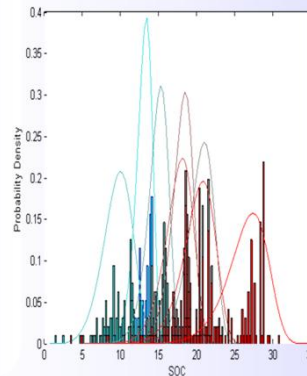


Other factors

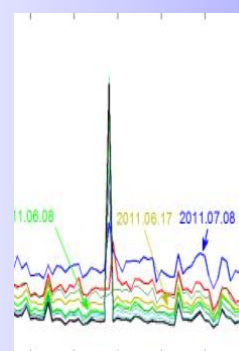


Uniformity

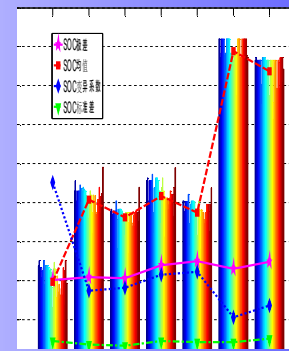
Capacity



Resistance

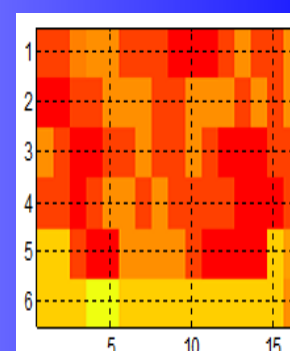


Self-discharge rate



Heat distribution

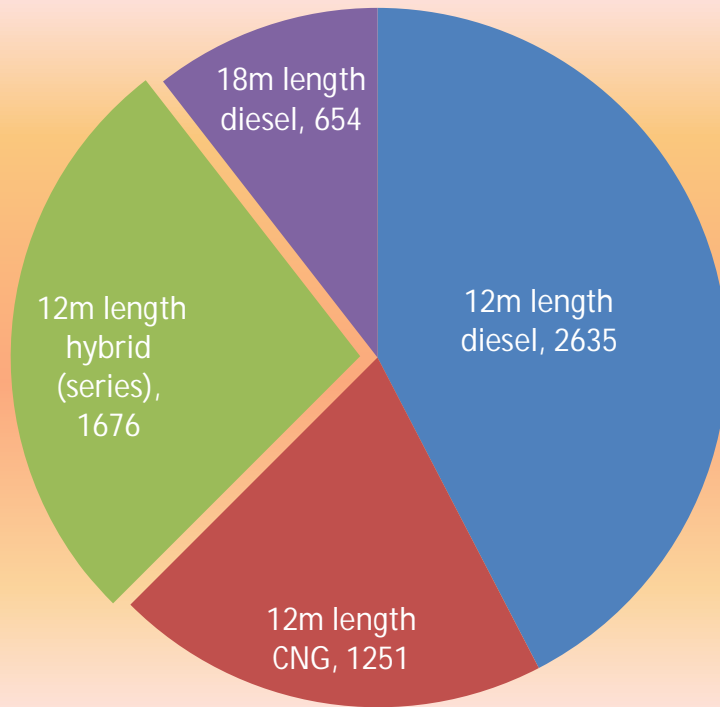
Other



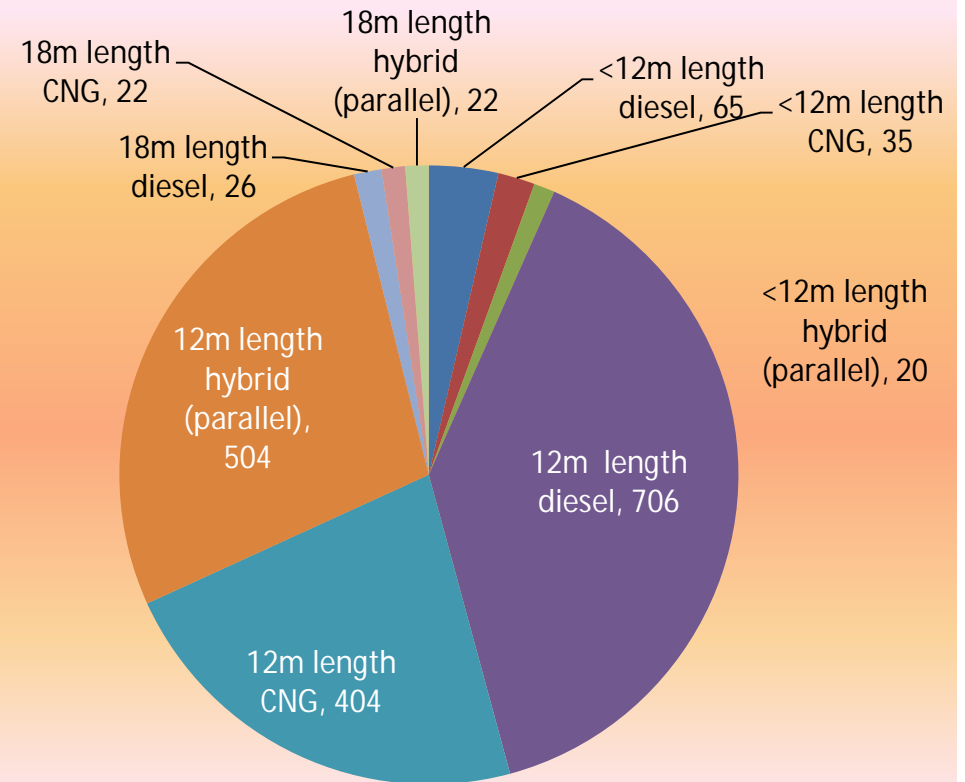


Busses in the US

New York MTA Transit Bus 2011 Chart



Washington Metro Transit Bus 2011 Chart



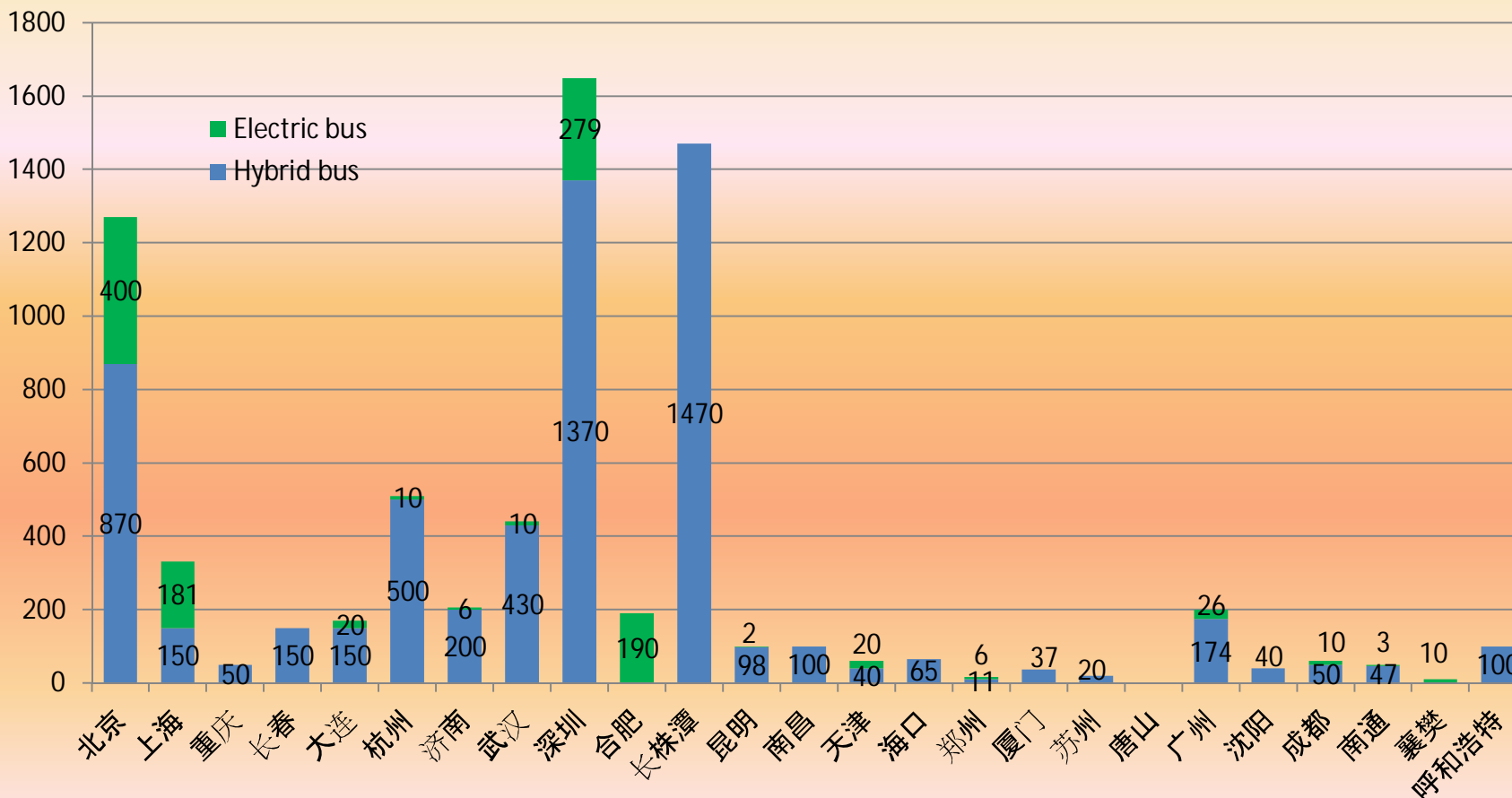


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Busses in China



Hybrid Bus use in Chinese Cities



There are 6 cities with 400 HEV bus fleet, in which ,Shenzhen is the largest one (1370), followed by Beijing(870) and Changsha(743)-Zhuzhou(627) ,and Hangzhou (500)

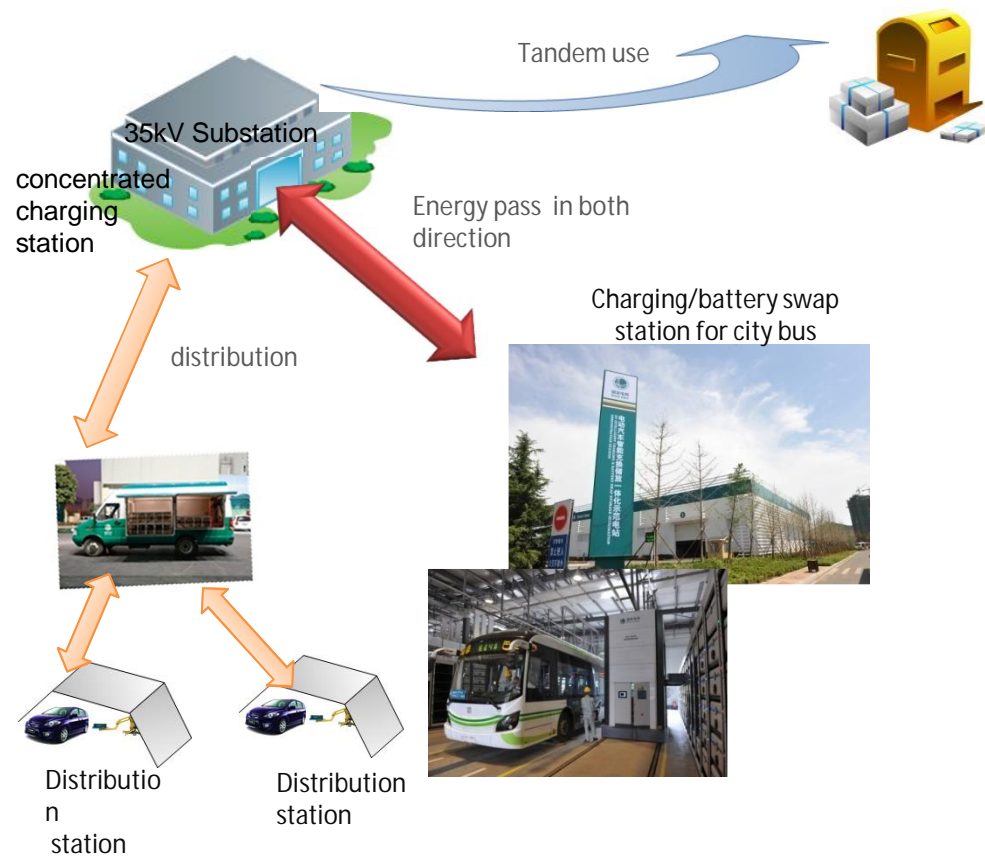


Power Supply Technology and Construction of EV Network in China

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Charging/battery swap storage integration station in Qingdao

2011 State Grid built a EV charging/battery swap station which allowed battery swaps on city busses, battery charging for passenger cars, and energy storage. The station can provide charging and battery swap for 280 electric buses, in addition to passenger cars.





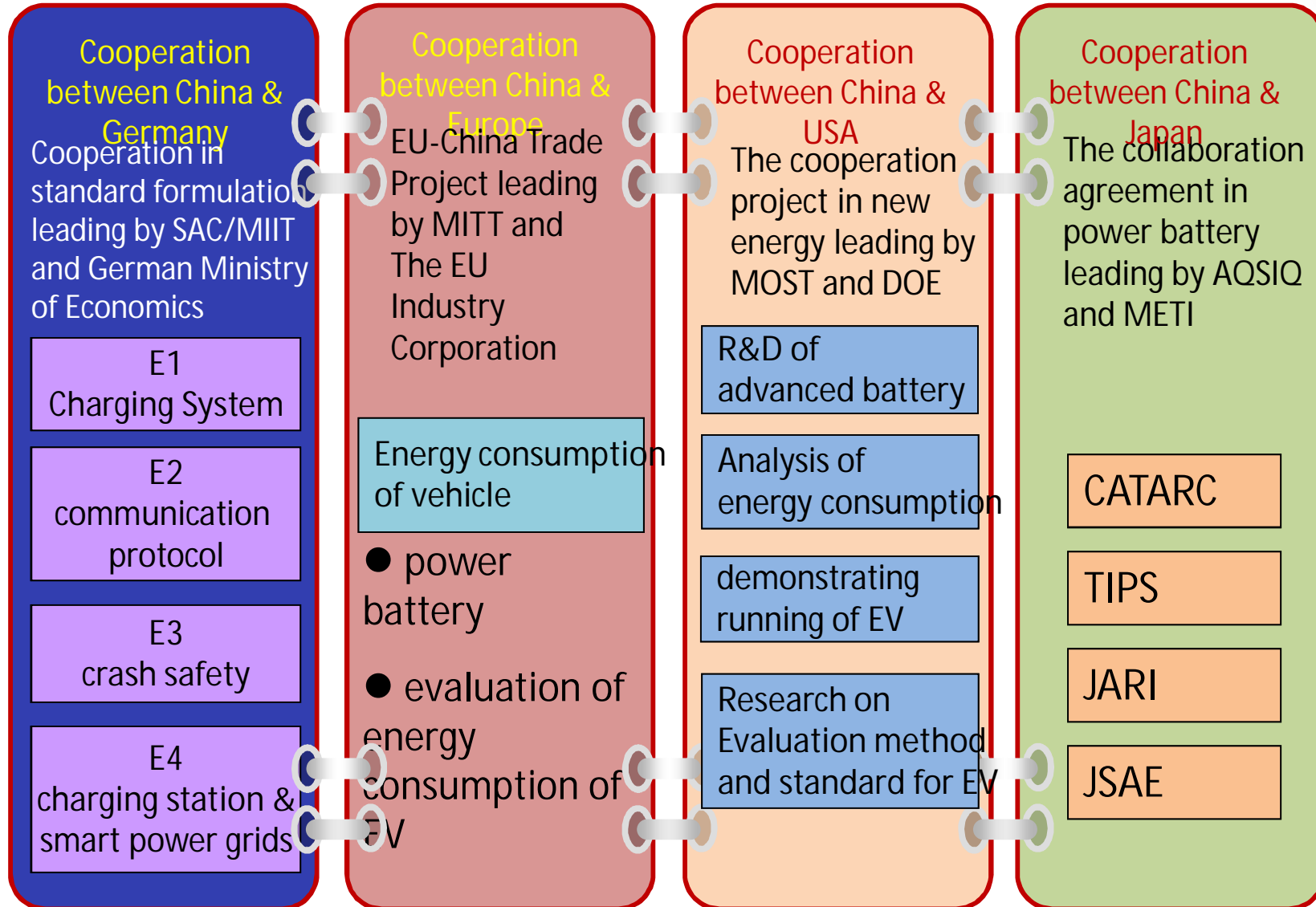
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International Collaboration



International cooperation of standard formulation

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Infrastructure



Smart Grid Support for Electric Vehicles: China

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China has taken the lead in total EV charging capacity, having the most equipment for EV charging/battery swap.

- 243 standard stations for charging/battery swap and
- 13283 AC charge spots has been established and put into use by State Grid.





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Power Supply Technology & Construction of EV Network in China

Interconnection project between Suzhou, Shanghai and Hangzhou

- 9 charging/battery swap stations in 5 service areas in 3 highways are involved in the preliminary stage of the project, and the operational system are built at the same time.
- The service of charging/battery swap between Suzhou, Shanghai and Hangzhou in different provinces.



Charging/battery swap station in Baiyanghu Service area



Charging/battery swap station in Fengjing Service area



Charging/battery swap station in Jiaxing Service area





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U.S. West Coast Green Highway – Between Canada and Mexico

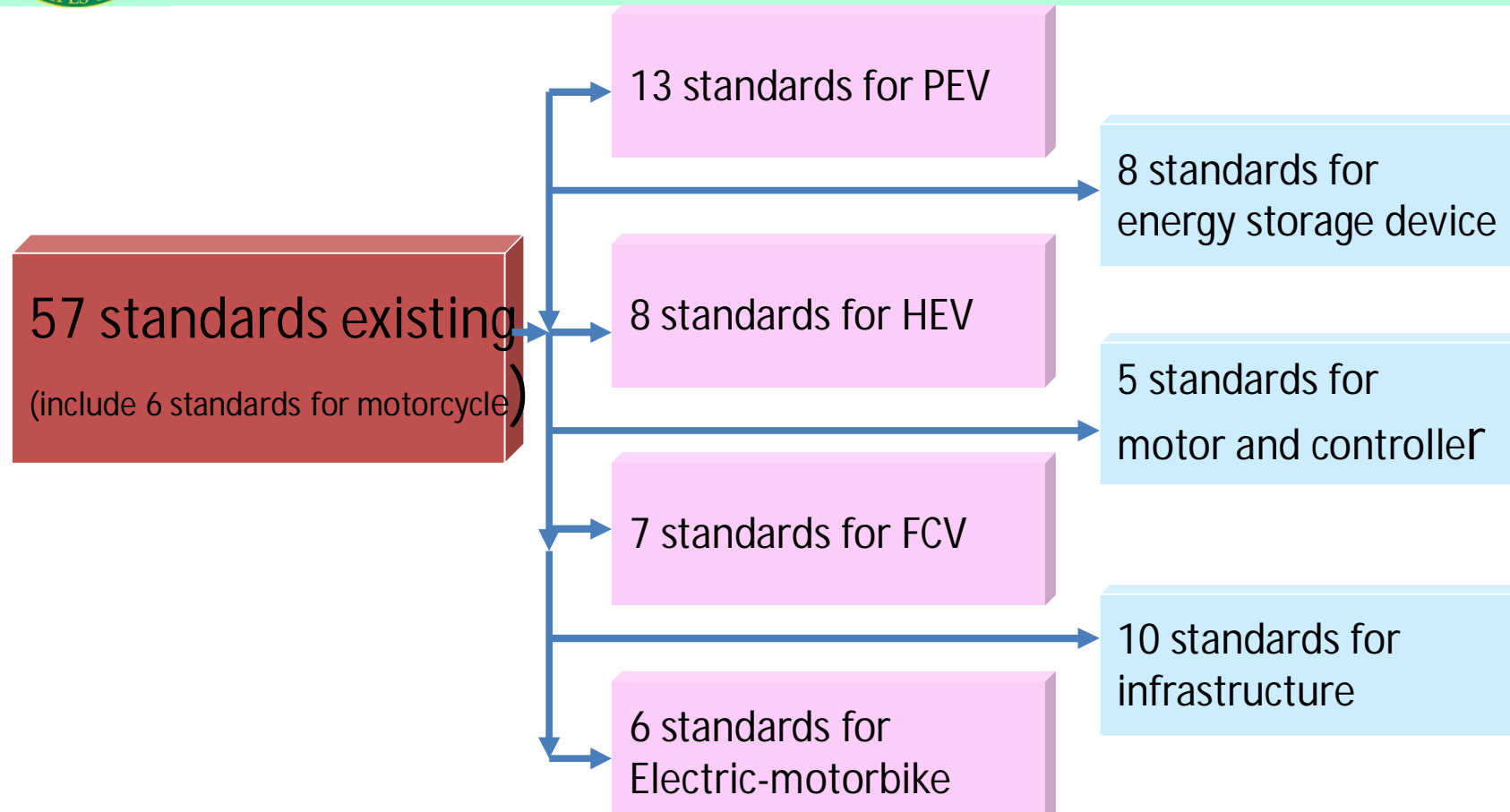


- From North to South – 1,300 miles
- Every 25-60 miles co-located with Level 2 and Fast Chargers
- 55 DC Fast Chargers Available
- Used for both local and regional trips, meeting weekday and weekend travel needs.
- Acts as the “ultimate range extender”
- Hydrogen Highway: learning from previous projects



The construction of standard system for electric vehicle

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There are 11 standards which have been revised and to be ratified, 14 standards being made or revised, and no standards to be re made. But 45 items of standards are needed in the industry, and the standard system for electric vehicle is the largest in both aspects of coverage and quantity around the world.



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International Collaboration



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China: Formulation of International Standards for Electric Vehicles

- ① The proposal of 9 core DC charging interface proposed by China has become one of the 3 DC charging interfaces in IEC62196-3 (the other two are CHAdeMo DC charging interface proposed by Japan and COMBO DC charging interface proposed by USA & Europe.)
- ② The proposal of Charging control guidance proposed by China has become one of the 3 DC charging interfaces in IEC62196-23 (the other two are the Joint Proposal proposed by Japan & USA and the Proposal proposed by Europe)
- ③ The proposal of communication protocol of DC charging using CAN proposed by China has become one of the 3 communication protocols of DC charging in IEC62196-24 (the other two are the communication protocol of DC charging using CAN proposed by Japan and the communication protocol of DC charging using PLC proposed by USA & Europe)
- ④ The proposal of the specification & dimension of lithium battery proposed by China has become part of the ISO/IEC PAS 16989 (19 of the 80 specification series of lithium battery are proposed by China, which has laid a good foundation for lithium battery products in China into the world's market.)



Adoption Process

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More than 500 vehicles have been put into operation, and the whole mileage has reached 15 million kilometers.



R&D and Experiment confirm

2006~2007

The mileage of 595 energy saving vehicles or new energy vehicles has reached 3.714 million kilometers, and the number of the passengers is more than 4.417million.



Beijing Olympics 2008

1147 new energy vehicles which carried more than 125 million passengers have been operating safely for 29.216 million kilometers.



Shanghai World Expo, Guangzhou Asian Games and Shenzhen Universiade

2009~2012

2011 Shenzhen Universiade

6 million people carried by 2011 electric vehicles.
58 charging/hydrogen stations and more personal charge spots

◆ In 2011, more than 10 thousands of vehicles have been put into demonstration operation.

◆ In 2010, 4402 vehicles have been put into demonstration operation.

◆ In 2009, 2566 vehicles have been put into demonstration operation.





Progress in EV Adoption

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Electric passenger vehicles begin to take shape, power consumption is obviously decreasing, some of which has reached 15kWh/100km



500 private E150EV in Beijing



300 BYD E6 electric taxis in Shenzhen



280 ZOTYE-HAIMA private cars and taxis with mode of charging or battery swap

1585 JAC-Tongyue private PEVs in Hefei

Vehicle quantity	585 Tongyue PEVs of the first generation	1000 Tongyue PEVs of the second generation
consumers	Consumers of designated terminal, include controlled customers such as JAC, HFUT, bus company, Power Supply Corporation	Consumers of designated terminal, customers in Hefei who has cooperation with the company
running	21 months till now	9 months till now

◆ Loading battery of 15.2kwh; maximum speed is 100km/h;
 ◆ Driving range is 100km in Hefei actual condition, consuming 15kWh of electricity

◆ Most of the customers use the EV for daily commute or for business. charging is usually finished at home or workplace (slow charge).

- ◆ Driving distance < 50km/day: 73.1%;
- ◆ 50km/day < Driving distance < 80km/day: 22.5%
- ◆ Driving distance > 80km: 4.39%;



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Barriers to Implementation



Safety

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Over-temperature
burning



Loose-contact



Abuse



Bloating-leakage





Some barriers to further EV charging deployment

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- Various regional standards for connectors, especially for DC fast charging.
- More important than connector type is achieving as much commonization as possible in major portion of the communications protocols

	CHAdeMO (Japan)	GB/T (China)	COMBO1 (US)	COMBO2 (Germany)
Connector				
Vehicle Inlet				
	CAN		PLC	



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Conclusions

- U.S. Administration's goal is 1 million electric vehicles on the road by 2015. It is both ambitious and inspiring.
- The attractions of EVs are many; buyers are responding.
- The U.S. hopes to have a production capacity of 1.2 million electric vehicles/year by 2015.
- While it appears that the goal may be within reach in terms of production capacity, initial cost, range, safety concerns, and charging infrastructure remain as significant barriers to widespread EV adoption.
- Regulations and State-level incentives have helped promote EV adoption in selected areas.
- Policy support remains important for deployment.