新能源汽车能耗与排放全生命周期分析
Life cycle energy and emissions for electric vehicles

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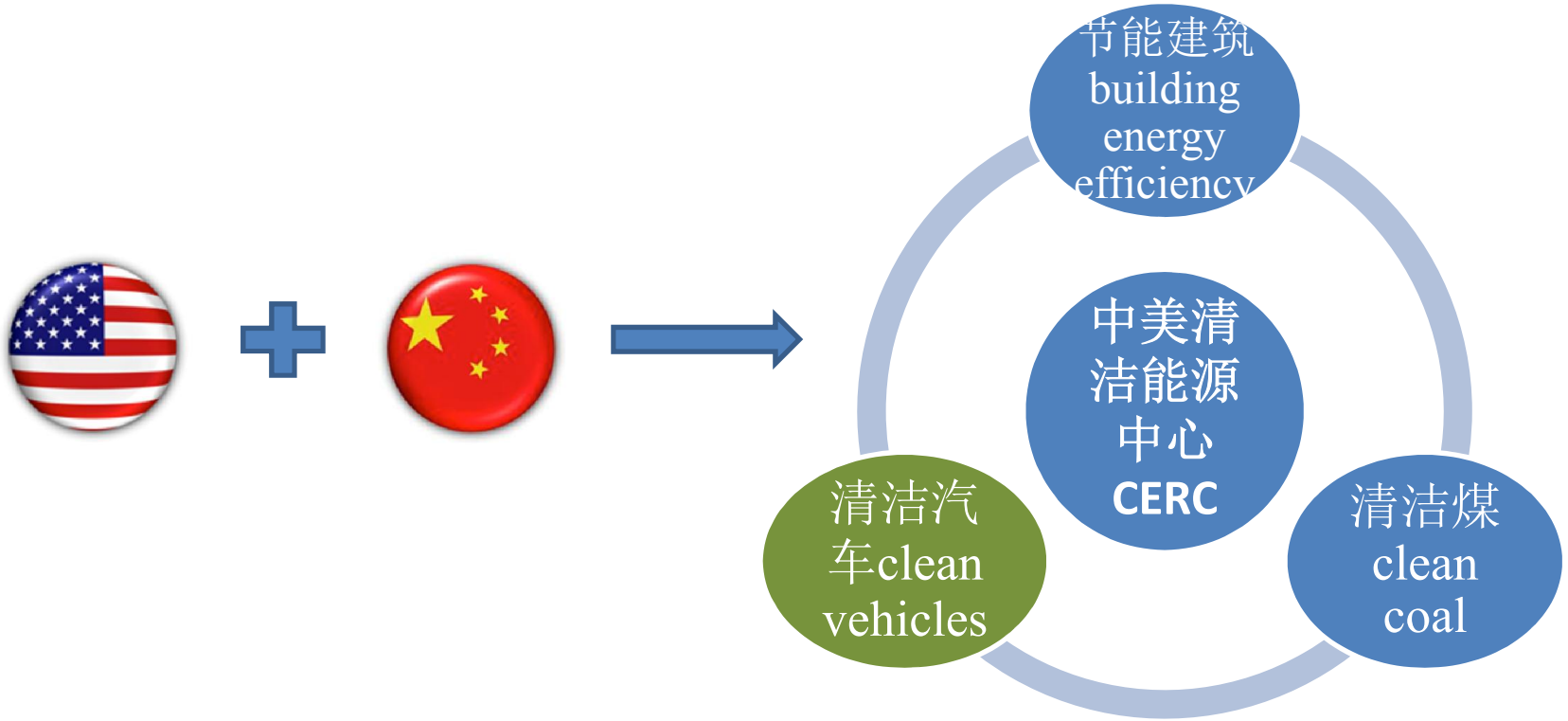
中美电动汽车国际合作项目：

面向中美清洁能源合作的电动汽车前沿技术研究

Collaboration on Cutting-Edge Technology Development of Electric Vehicle



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电动公交车无线充电和有线充电的生命周期分析

Life Cycle Assessment of Plug-in and Wireless Charging for Electric Buses

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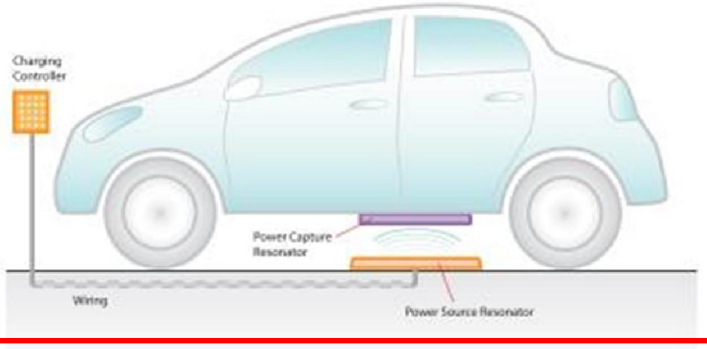
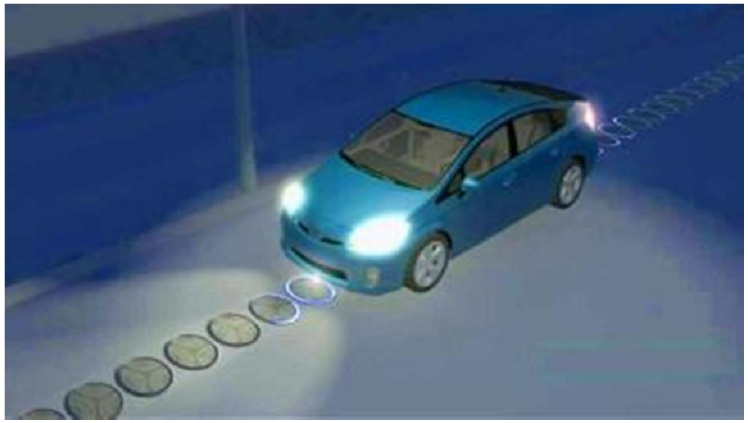
Introduction of Wireless Charging

- Solutions for Plug-in Electric Vehicles

Static



Dynamic



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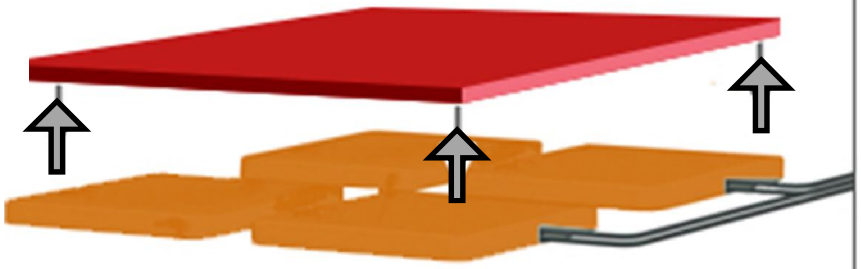
On-board Wireless Charger

Off-board Wireless Charger



End of bus route

Charging station

Charging station

Electric Bus equipped with wireless charger

Charging station

Charging station

Start of bus route

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Bus System Simulation

- **Bus System Summary**

  21 routes with 67 Buses = 67 batteries = 67 on-board WCs

  844 bus stops, 352 off-board WCs

- **Details**

Table 1. Routes Details

	Blue	Red	Green
How many routes	13	4	4
Miles/loop	10	16	10
Stops/loop	42	64	42
Loops/weekday	14	10	14
Loops/Sat or Sun	7	5	7
Hour/loop	1	1.5	1
Buses/route	3	4	3
Suburb: stops (2-direction)	28	32	28
Suburb: off-WCs (2-direction)	8	10	8
Suburb: time of charging (hour)	0.005	0.005	0.005

Table 2. Downtown Details

	Ann Arbor	Ypsilanti
Number of bus stops	160	80
Number of off-WCs	80	40
Time of charging (hour)	0.01	0.01

Table 3. Transit Centers Details

Transit Ctrs	BTC	CCTC	Hospital	Union	YTC
Number of off-WCs	10	4	4	2	6
Time of charging (hour)	0.08	0.01	0.01	0.01	0.08

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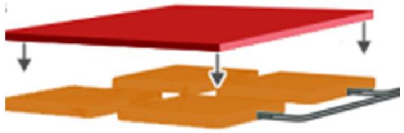
Life Cycle Assessment

	Plug-in Charging System	Wireless Charging System
Chargers	Plug-in Chargers 	On-board Chargers  Off-board Chargers
Batteries	Batteries (larger) 	Batteries (smaller) 
Electricity	Electricity (more) 	Electricity (less) 

Assumption:

- manufacturing of plug-in and wireless charging bus shell is the same.
- Time horizon: 12 years (= life of a bus)

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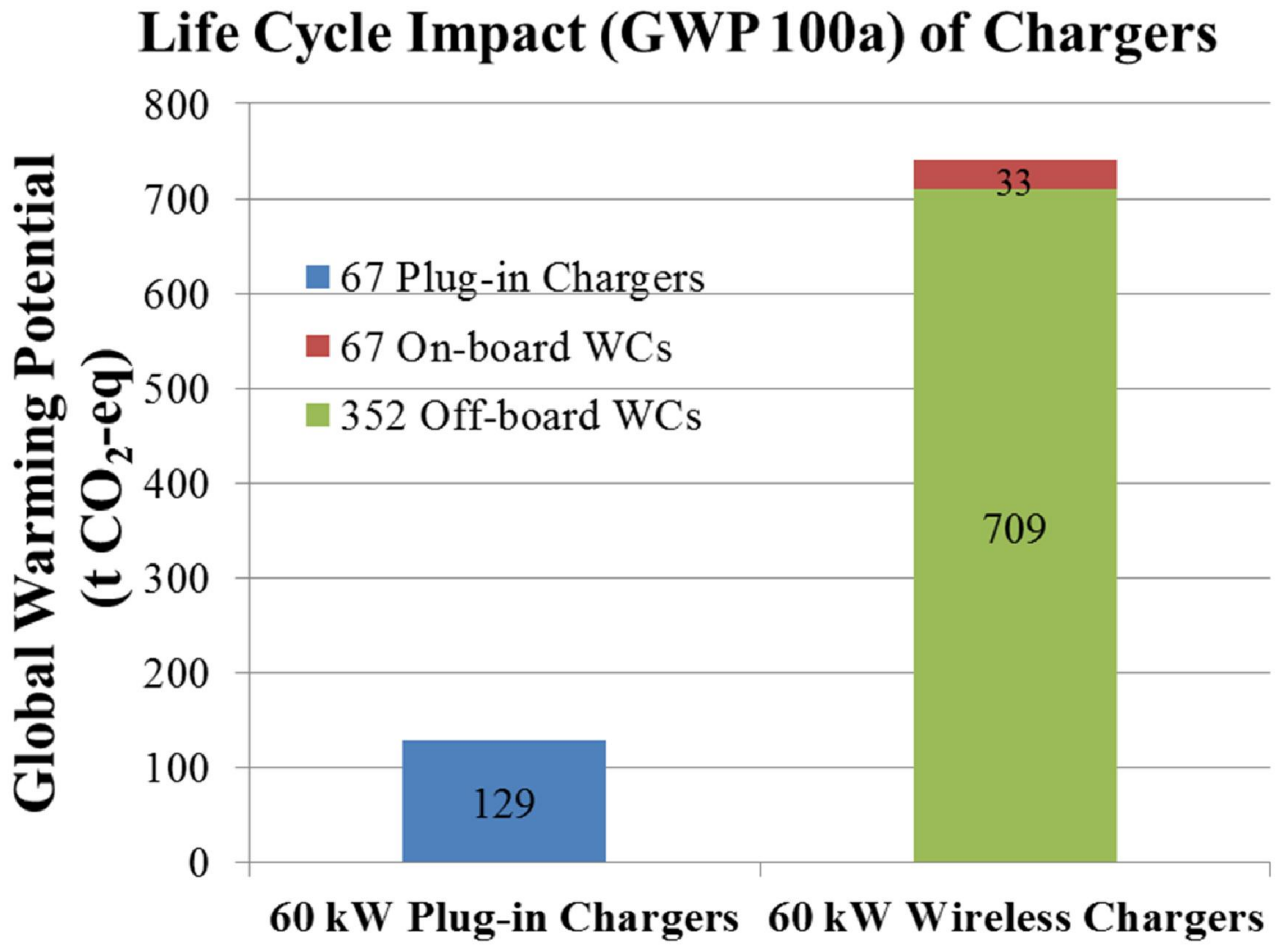
Chargers



Assumptions:

Chargers can last twice as long as the bus (24 years).

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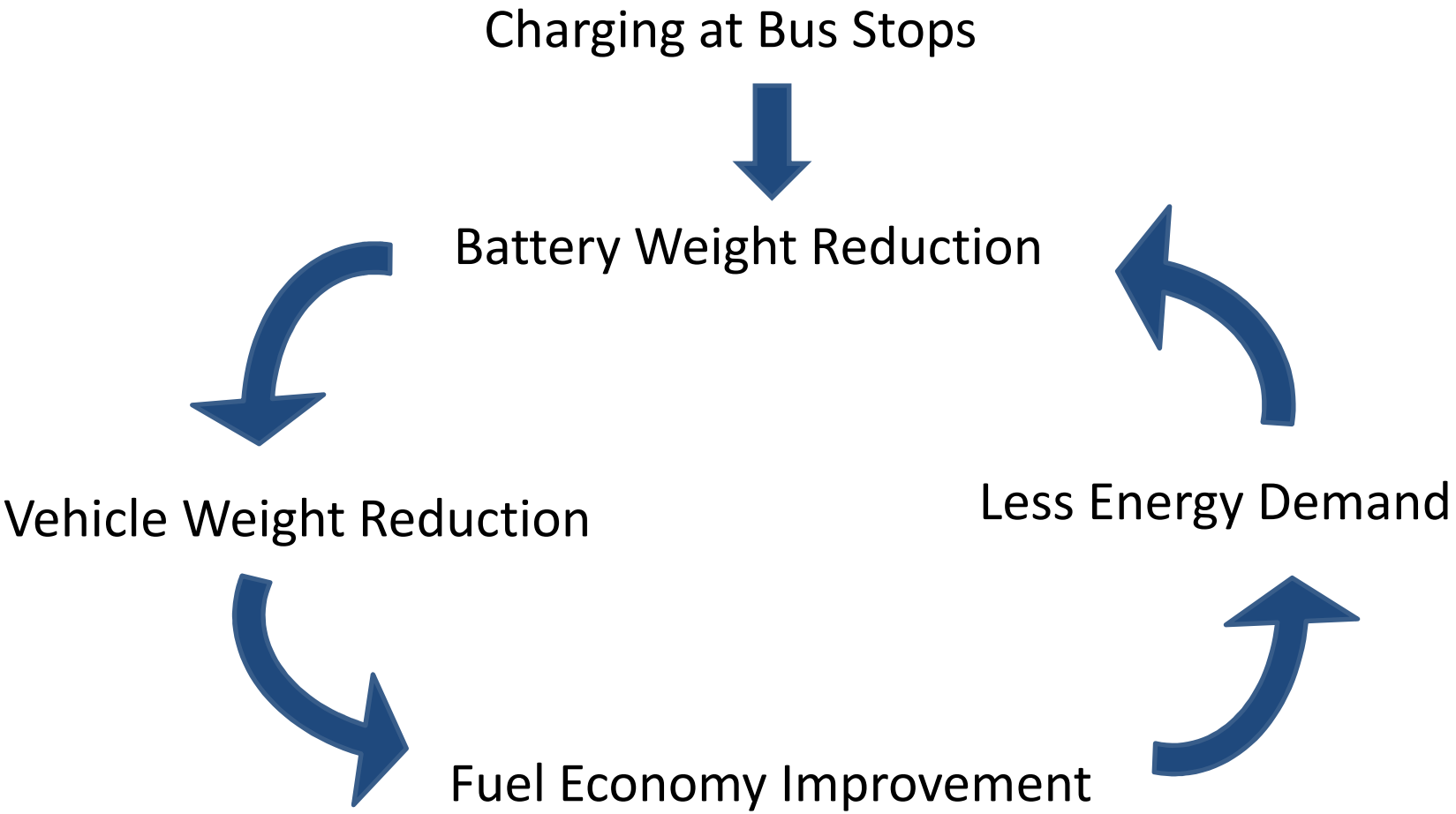
Batteries



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Lightweighting Correlation
vehicle mass ~ fuel consumption

Sedan:

10% vehicle mass reduction

→ ICEV: fuel reduction of **6-8%**

→ **EV**: fuel reduction of **4-7%** (for many EV models)

Source: Hyung Chul Kim, Ford Motor Co.

Bus:

10% vehicle mass reduction

→ Conventional Bus: fuel reduction of **6.24%**
(Argonne National Lab: Autonomie Model)

→ **Pure Electric Bus**: fuel reduction of **5%**
(assumption for the baseline model)

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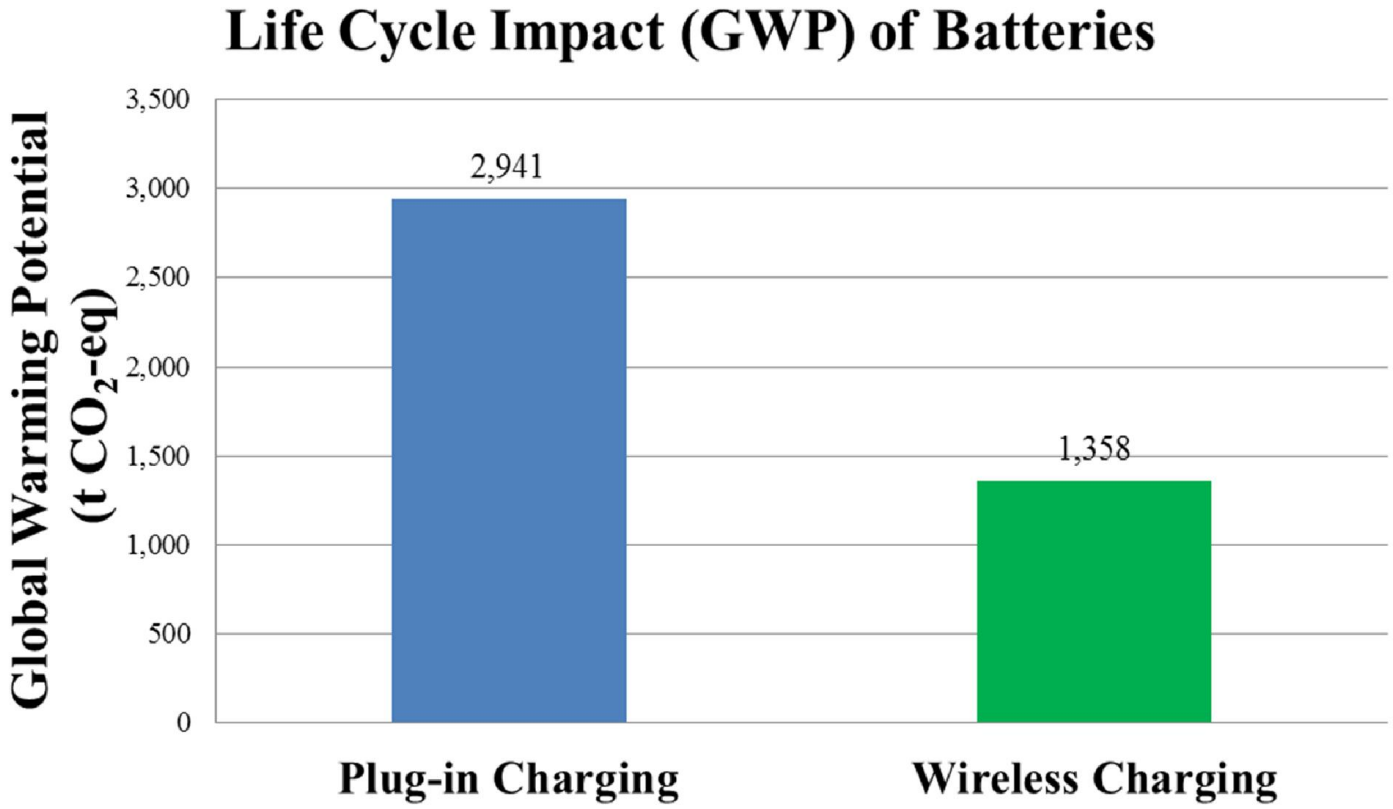
Batteries



Assumptions:

1. For both plug-in charging and wireless charging, there is 1 replacement of battery during 12 years.
2. For wireless charging battery, frequent charging won't affect the life of battery very much.

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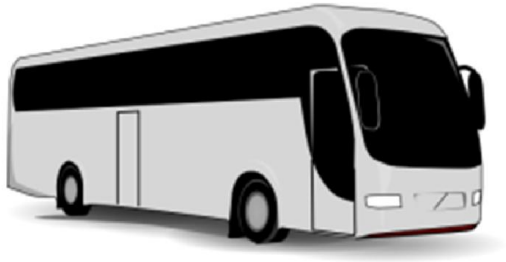
Electricity

3.8 t

1.9 ~ 2.6 t

1.2 ~ 1.9 t

15 t



1.9 ~ 2.6 t

12.4 ~ 13.1 t

1.92 kWh/mile

1.77 ~ 1.81 kWh/mile

more

less

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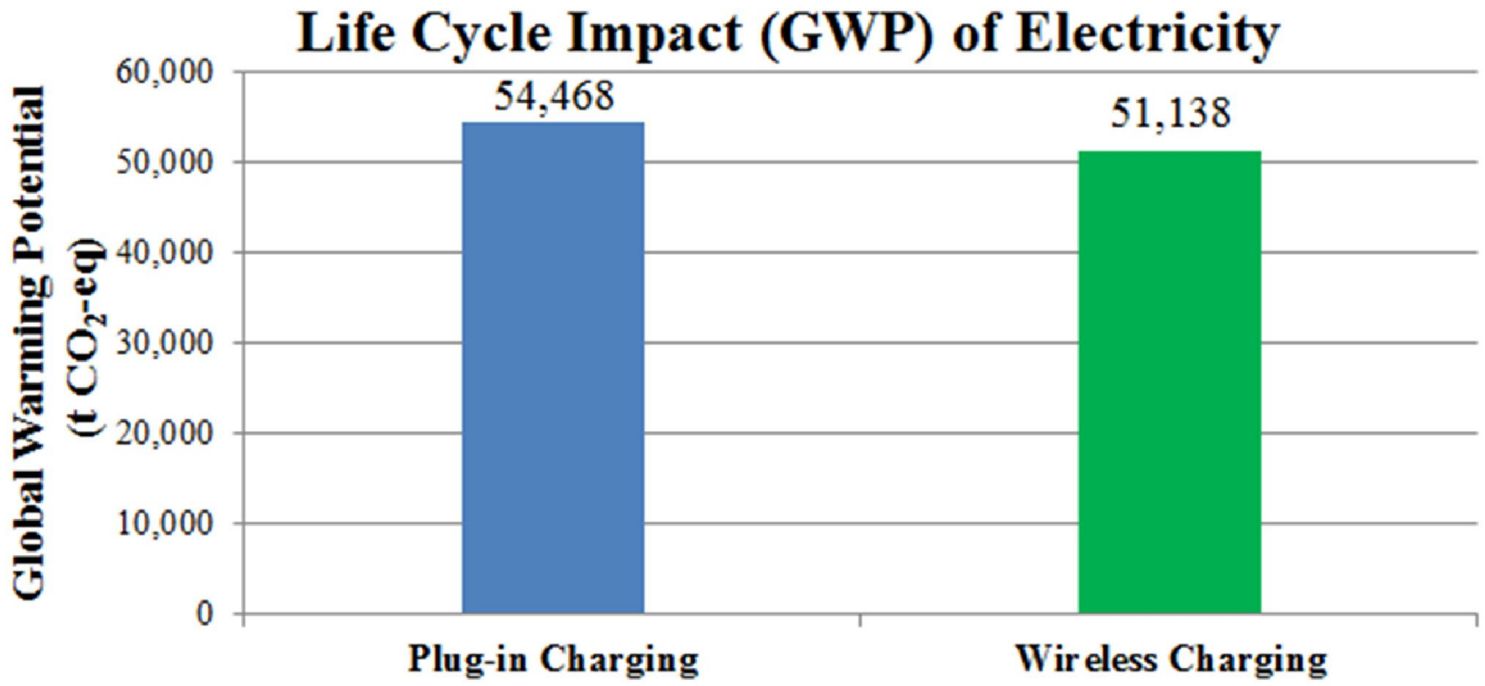
Electricity



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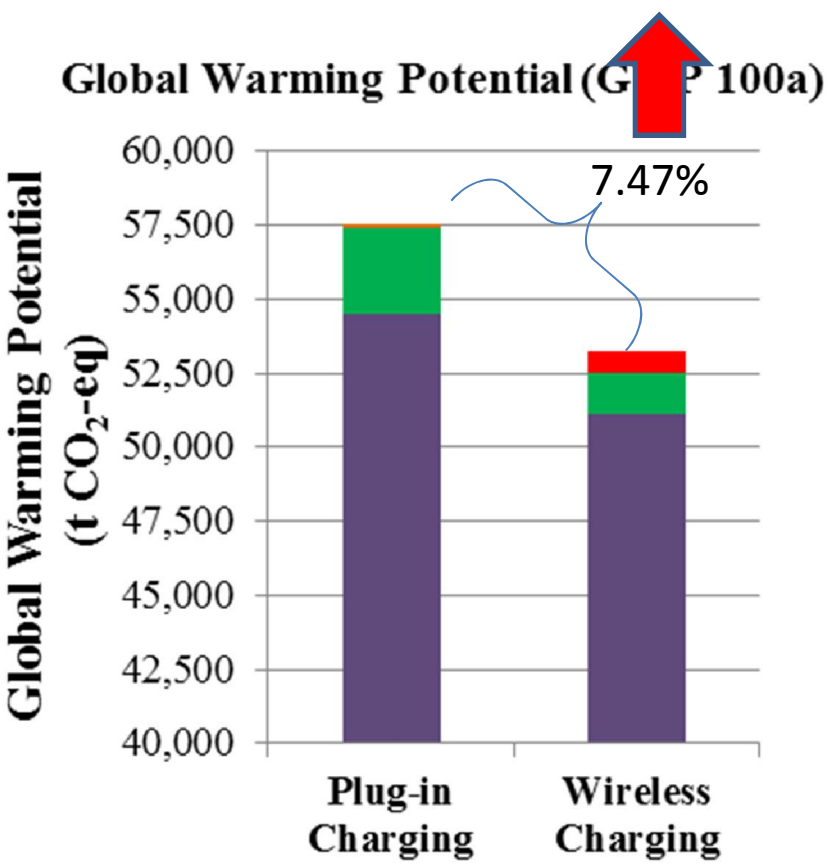
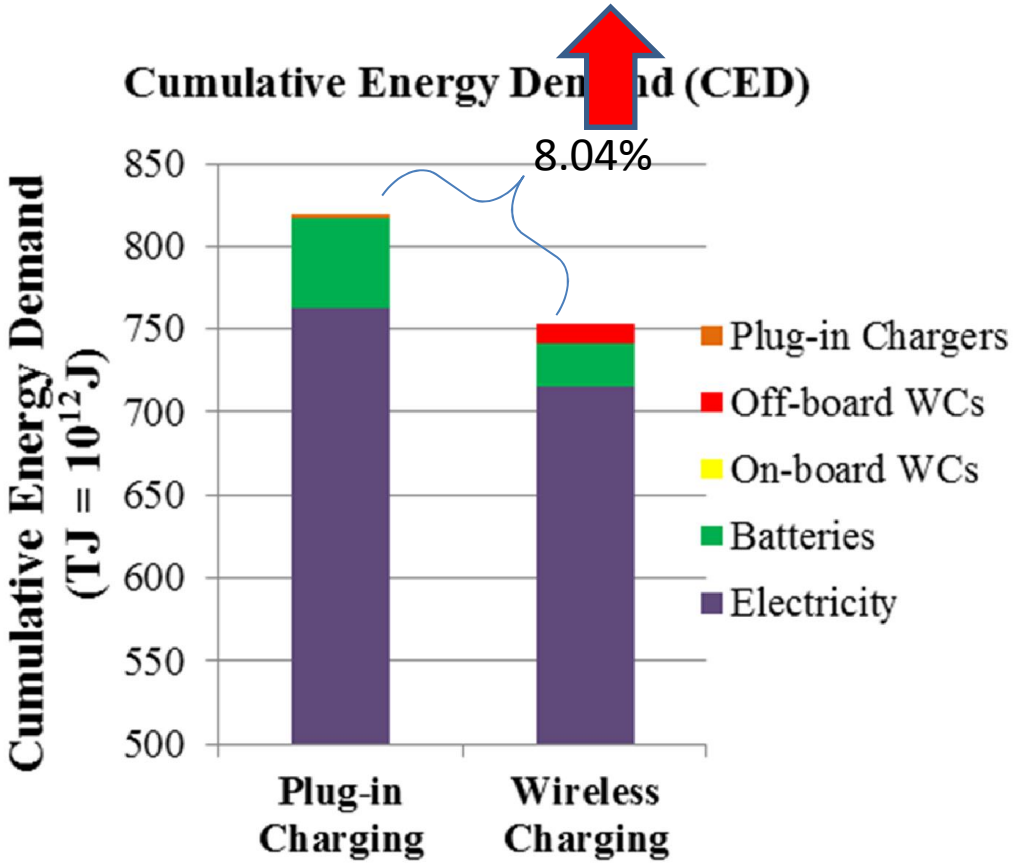
Total Life Cycle Impacts

Saves 4,299 tons of GHG emission 65,858 GJ of Energy over 12 years





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中国电动卡车技术现状与生命周期分析

Electric Truck Technology Status and Life Cycle Assessment in China

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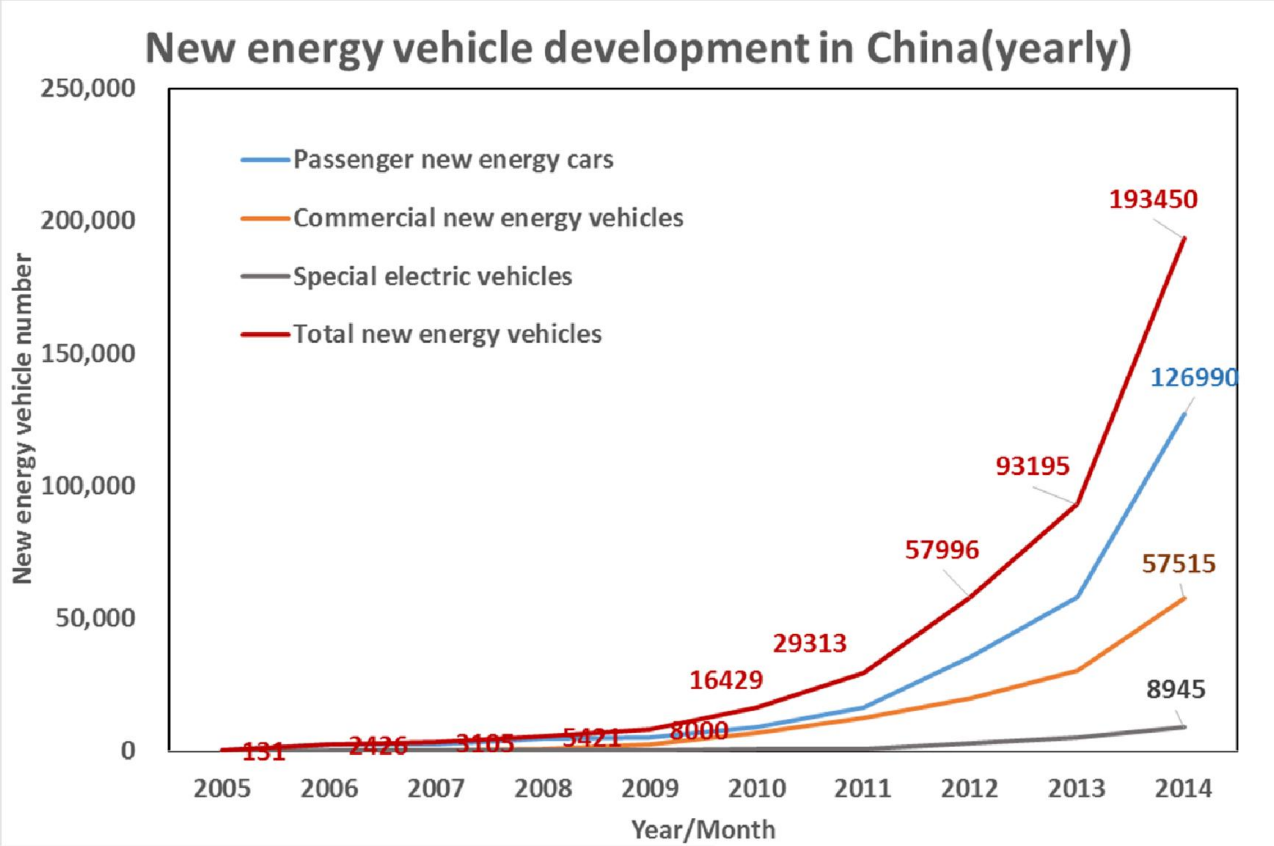
Current products, technology & key players

NEV development (Fleet in the stock)

- From 2009 to 2014, the NEV fleet doubled per year, more than 190 thousand in the end of 2014.
- The passenger cars accounted for 66%, buses 30%, truck & special vehicles 4%.
- In 2014, 100k NEVs were produced, in which, passenger car 69%, Buses 27%, truck & special vehicle 4%



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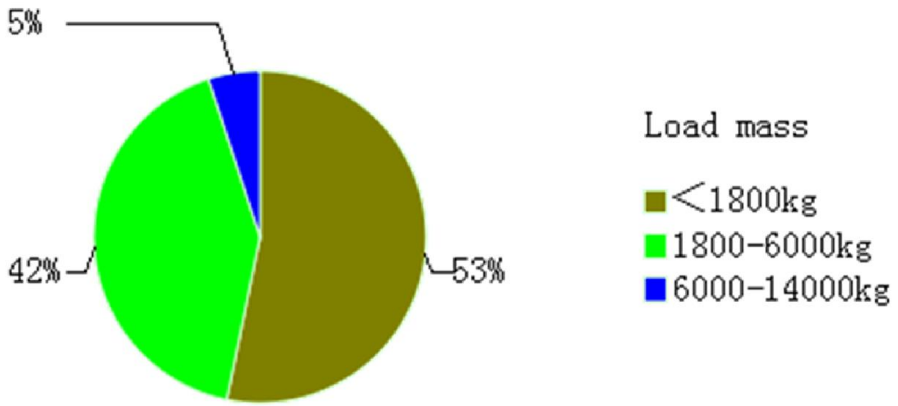
Current products, technology & key players

EV truck & Special Electric Vehicles

- In 2014,the production of EV truck and special electric vehicle was 1357
- EV truck (Load mass > 6000kg) was only 34, just a small part. HD EV truck (Load mass > 1400kg) was 0.

2014 EV truck & Special EV production



Electric Truck, (wt. 5625kg)

Electric Sweepers,(wt.7495kg)

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Life cycle analysis

Electric Truck

Diesel Truck

	Electric Truck	Diesel Truck
Model	CDW5070XXYH1PEV	CDW5070XXYHA1A4
Weight with full equipments （kg）	3900	3360
Load mass （kg）	6630	7355
Maximum speed（kg/h）	80	90
L×W×H	5995×1980×2900	5980,6180×2200,2110,2010×2700,2850
Power battery type	Lithium iron phosphate storage battery	
Fuel consumption	54kwh/100km	15.2L/100km

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Thank you!

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