

The Electric Car



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Outline

- History
- Pros
- Cons
- Lithium-ion battery: How green is it?

The First Electric Car



COURTESY: GENERAL MOTORS

Who Killed the Electric Car?

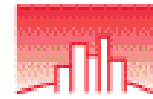






Electric vs. Gasoline

No Tailpipe Emissions



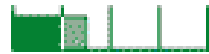
Greenhouse Gases/Pollution

Utility Company



OPEC

100+/- Mile Range



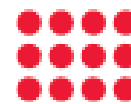
300+ Mile Range

Hours to Recharge

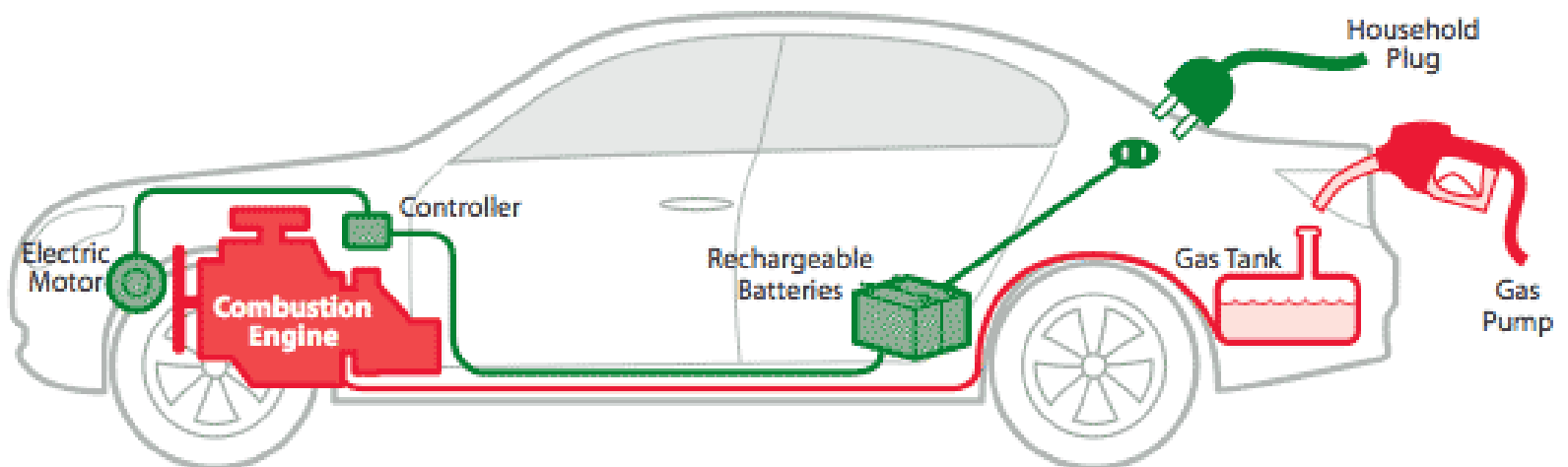


Minutes to Refuel

2 cents per mile



12 cents+ per mile



Criticism

- Not cost efficient
 - Batteries are expensive to make
 - A battery-only vehicles cost \$4,819 more than gasoline-powered cars over the life of the car
 - plug-in hybrid cars are \$5,377 more expensive
 - Prices will average out when gasoline hits \$4.50-\$5.50/gallon or when battery prices decrease and range increases

Assumptions:

Fuel Price per Gallon: \$3.75

Battery Pack Cost (\$/kWh): \$600

Miles Driven Per Year: 12,000

Price of Electricity (\$/kWh): \$0.12

Expense	Conventional	HEV	PHEV	BEV
Glider	\$15,280	\$15,280	\$15,280	\$15,280
Engine	\$3,710	\$2,190	\$2,190	\$1,200
Transmission	\$2,400	\$2,290	\$2,290	
Motor/Inverter	\$770	\$770	\$770	
Battery		\$2,400	\$8,205	\$14,815
Charging Plug & 220V install			\$1,500	\$1,500
Total Powertrain	\$6,110	\$7,650	\$14,955	\$18,285
Feebate/Tax Treatment				
Total Purchase Costs	\$21,390	\$22,930	\$30,235	\$33,565
Fuel	\$6,453	\$4,106	\$616	
Electricity			\$1,365	\$1,606
Maintenance	\$5,019	\$6,023	\$6,023	\$2,509
Total Operating Costs	\$11,471	\$10,129	\$8,004	\$4,115
Net Ownership Benefits			\$0	\$0
Battery Recycle Credit			\$0	\$0
Total Net Present Cost	\$32,861	\$33,059	\$38,239	\$37,680
Cost Differential with Conventional Car	-	\$197	\$5,377	\$4,819

Future Costs – Base Case – 2025: \$300 per kWh; \$4.50 per gallon; \$0.15 per kWh

	Conventional	HEV	PHEV	BEV
Total Net Present Cost	\$34,152	\$32,680	\$34,601	\$30,674
Cost Differential with Conventional Car	---	(\$1,472)	\$449	(\$3,478)

Future Costs – High Gasoline Prices – \$6 per gallon

	Conventional	HEV	PHEV	BEV
Total Net Present Cost	\$36,733	\$34,323	\$34,847	\$30,674
Cost Differential with Conventional Car	---	(\$2,411)	(\$1,886)	(\$6,059)

Future Costs – High Discount Rate – 30%

Conventional	HEV	PHEV	BEV	
Total Net Present Cost	\$29,251	\$28,475	\$31,349	\$28,940
Cost Differential with Conventional Car	---	(\$776)	\$2,097	(\$312)

Future Costs – Low Battery Costs – \$150 per kWh

	Conventional	HEV	PHEV	BEV
Total Net Present Cost	\$34,152	\$32,080	\$32,549	\$26,971
Cost Differential with Conventional Car	---	(\$2,072)	(\$1,603)	(\$7,181)

Future Costs – High Electricity Prices – \$0.24 per kWh

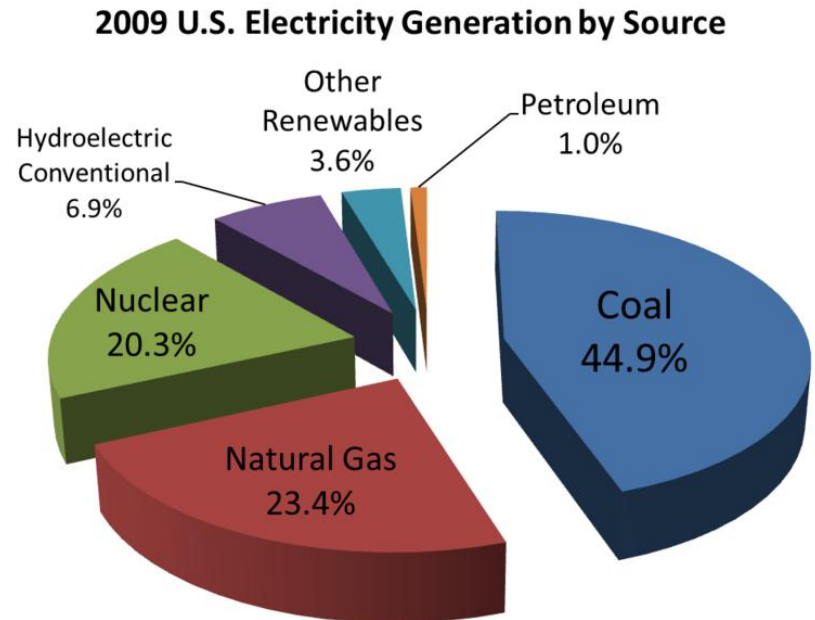
	Conventional	HEV	PHEV	BEV
Total Net Present Cost	\$34,152	\$32,680	\$35,624	\$31,897
Cost Differential with Conventional Car	---	(\$1,472)	\$1,472	(\$2,273)

Future Costs – Higher Fuel Efficiency – 75 MPG

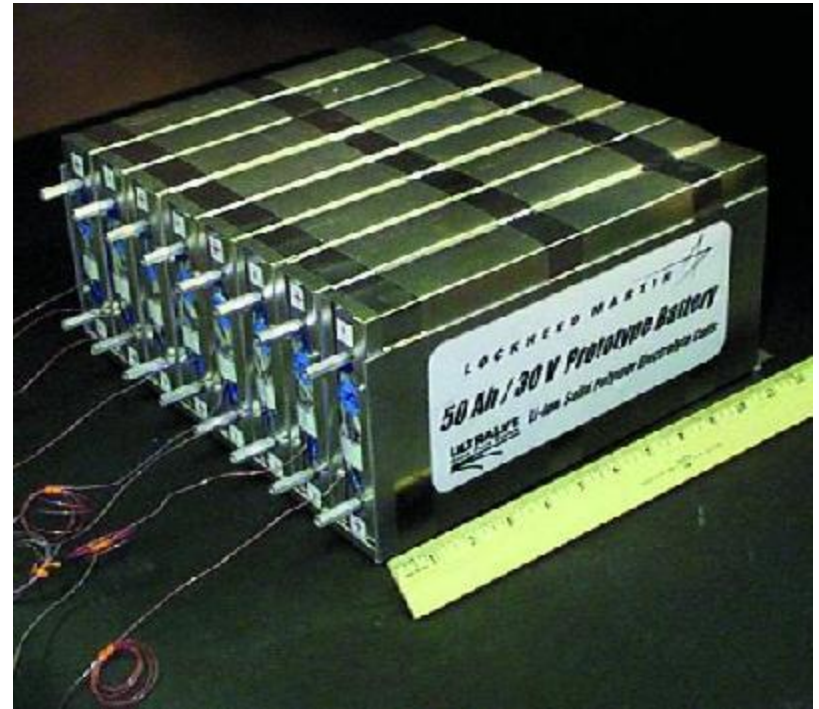
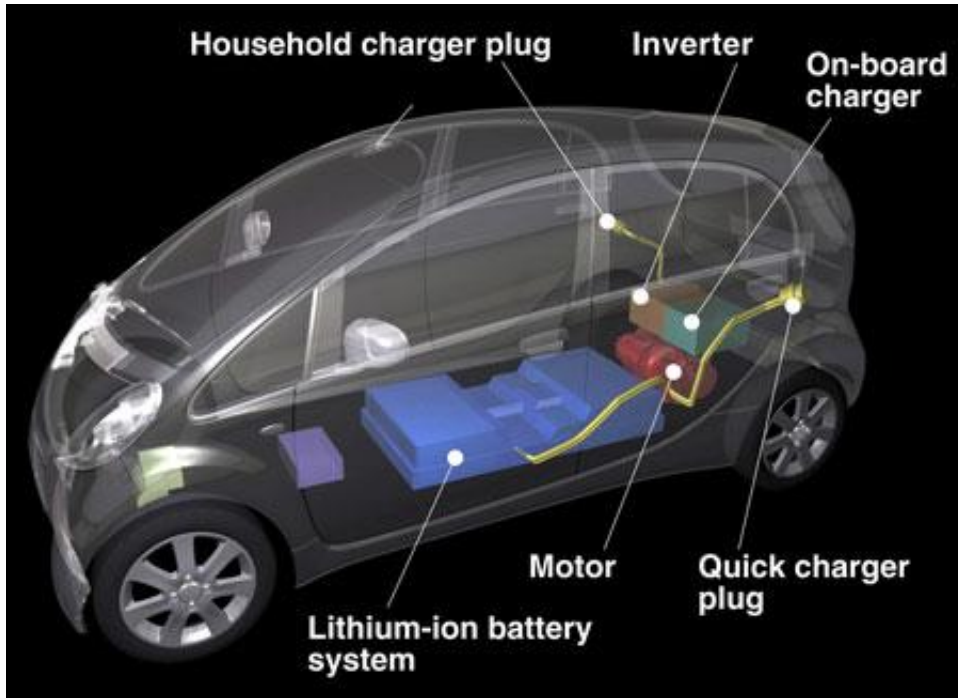
	Conventional	HEV	PHEV	BEV
Total Net Present Cost	\$31,829	\$31,366	\$34,403	\$30,674
Cost Differential with Conventional Car	---	(\$463)	\$2,574	(\$1,155)

Criticism

- Not energy efficient
- Generates green house gas emission
 - EEVs – Emission Elsewhere Vehicles
- Few or no charging stations

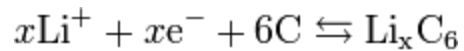
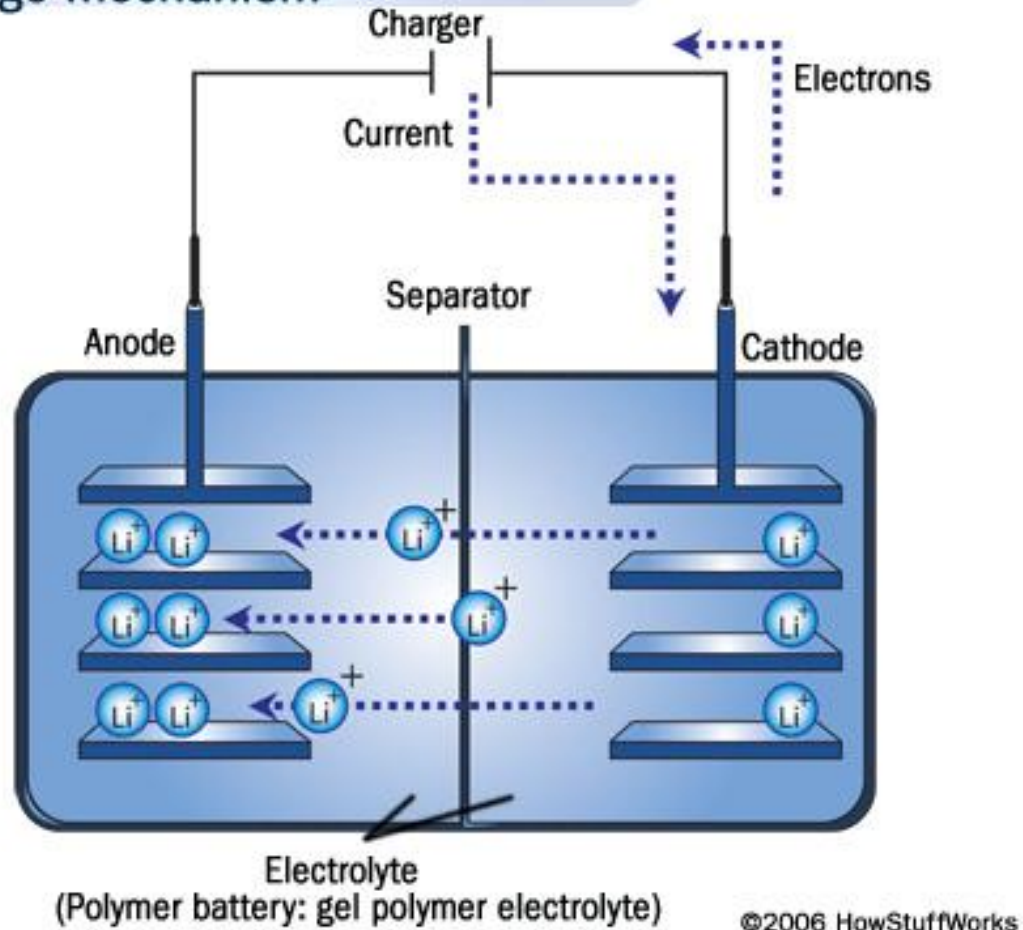


Lithium-Ion Battery



Lithium-ion rechargeable battery

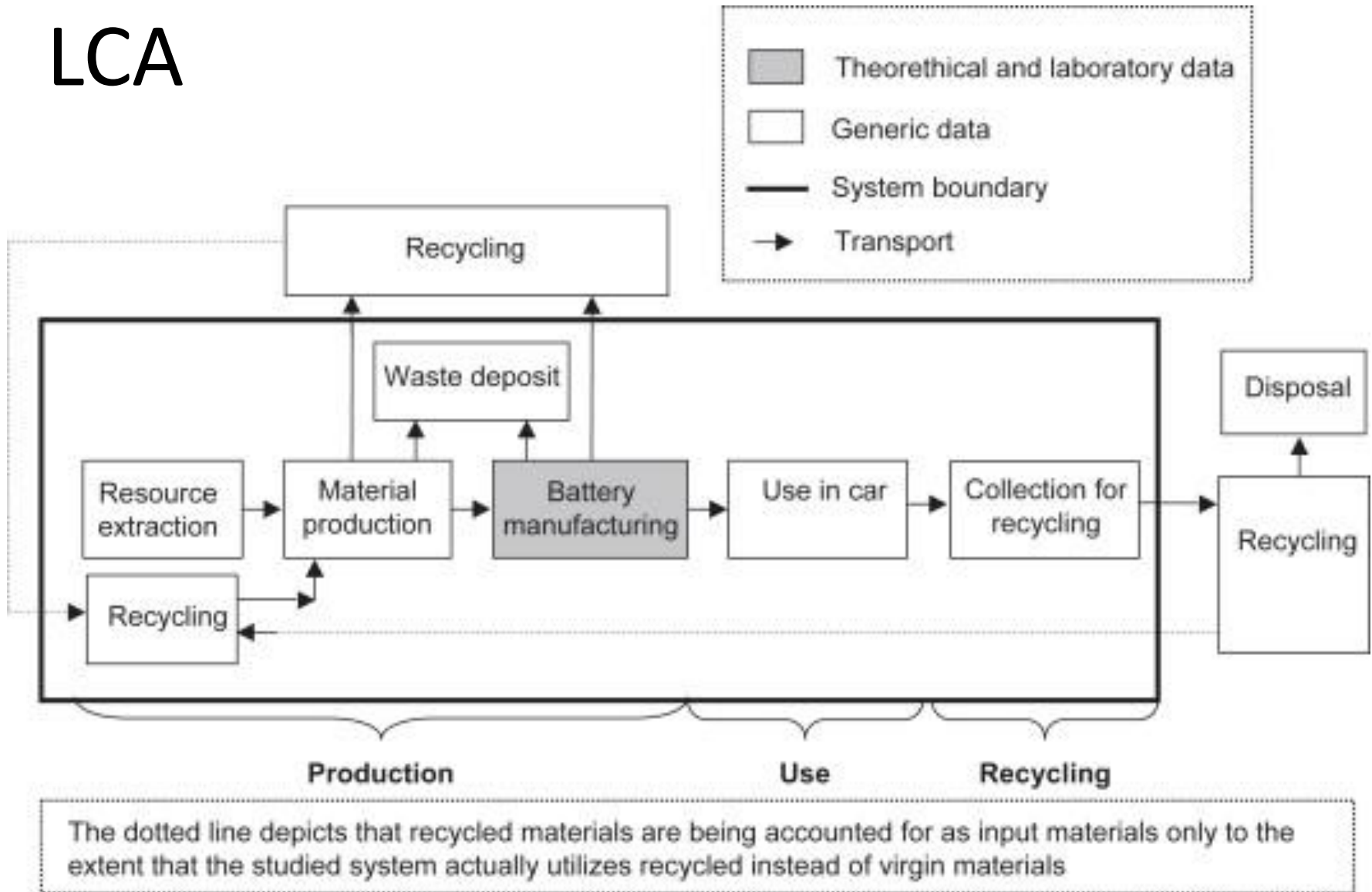
Charge mechanism



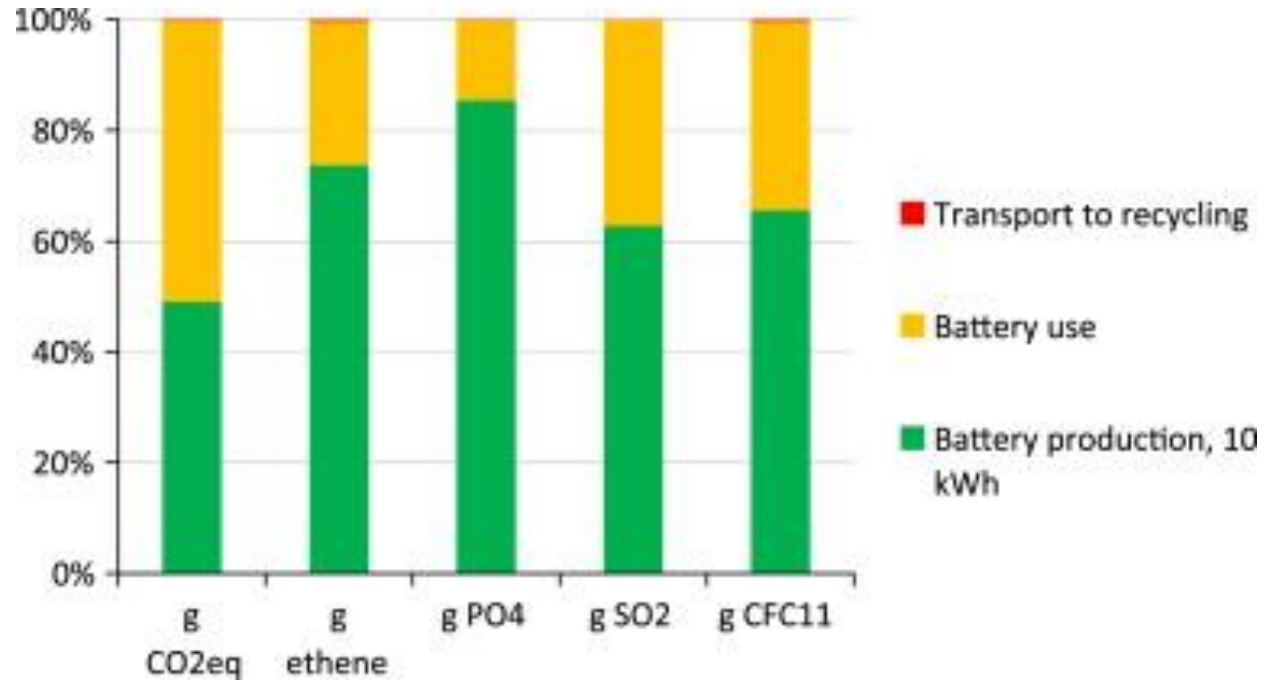
Research

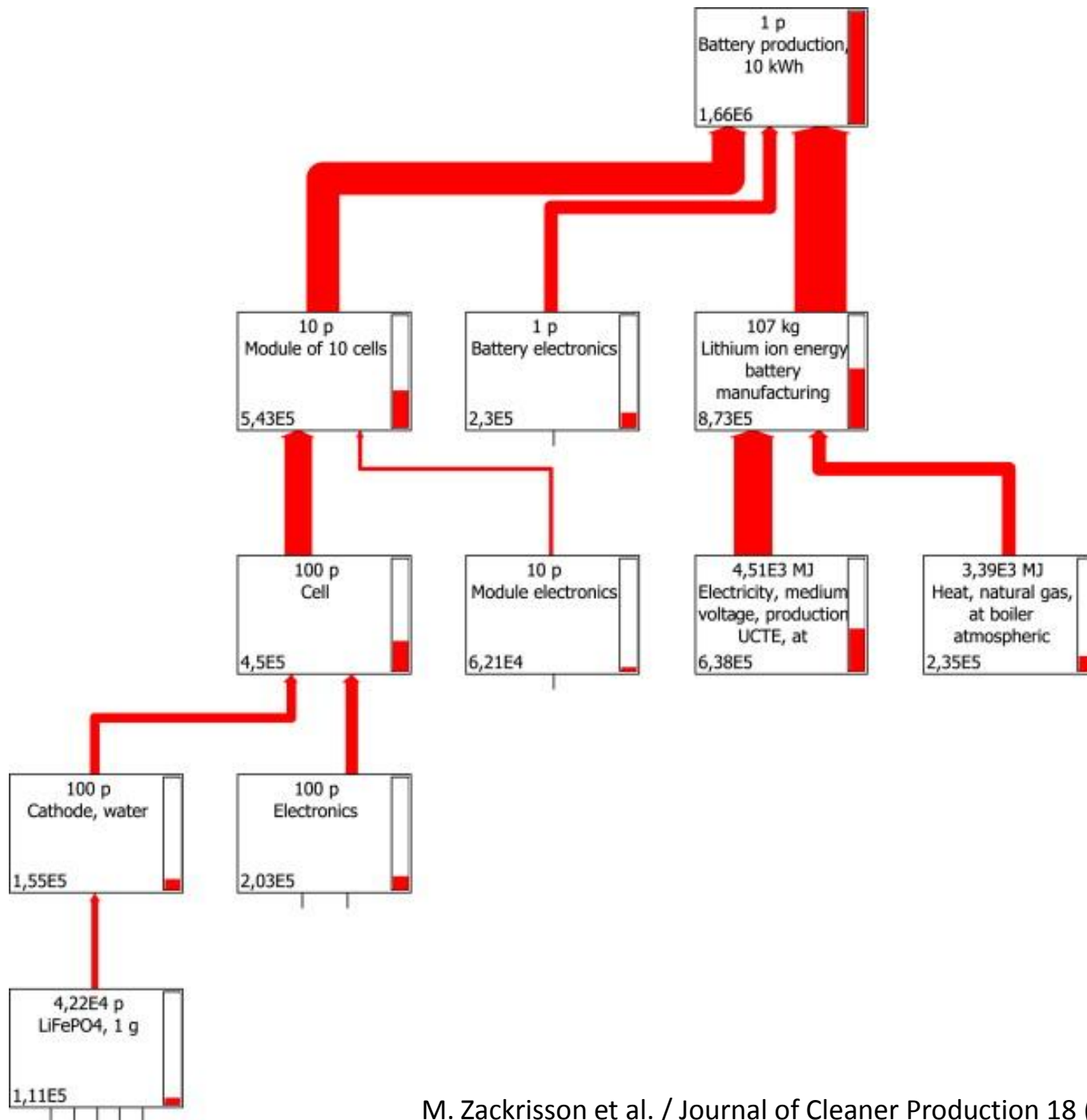
- High-voltage redox systems
 - Through highly positive electrode materials
 - Create fewer cells
- High-energy density systems
 - Increase the capacity of either the positive or negative electrode
 - To reduce the size of the cells

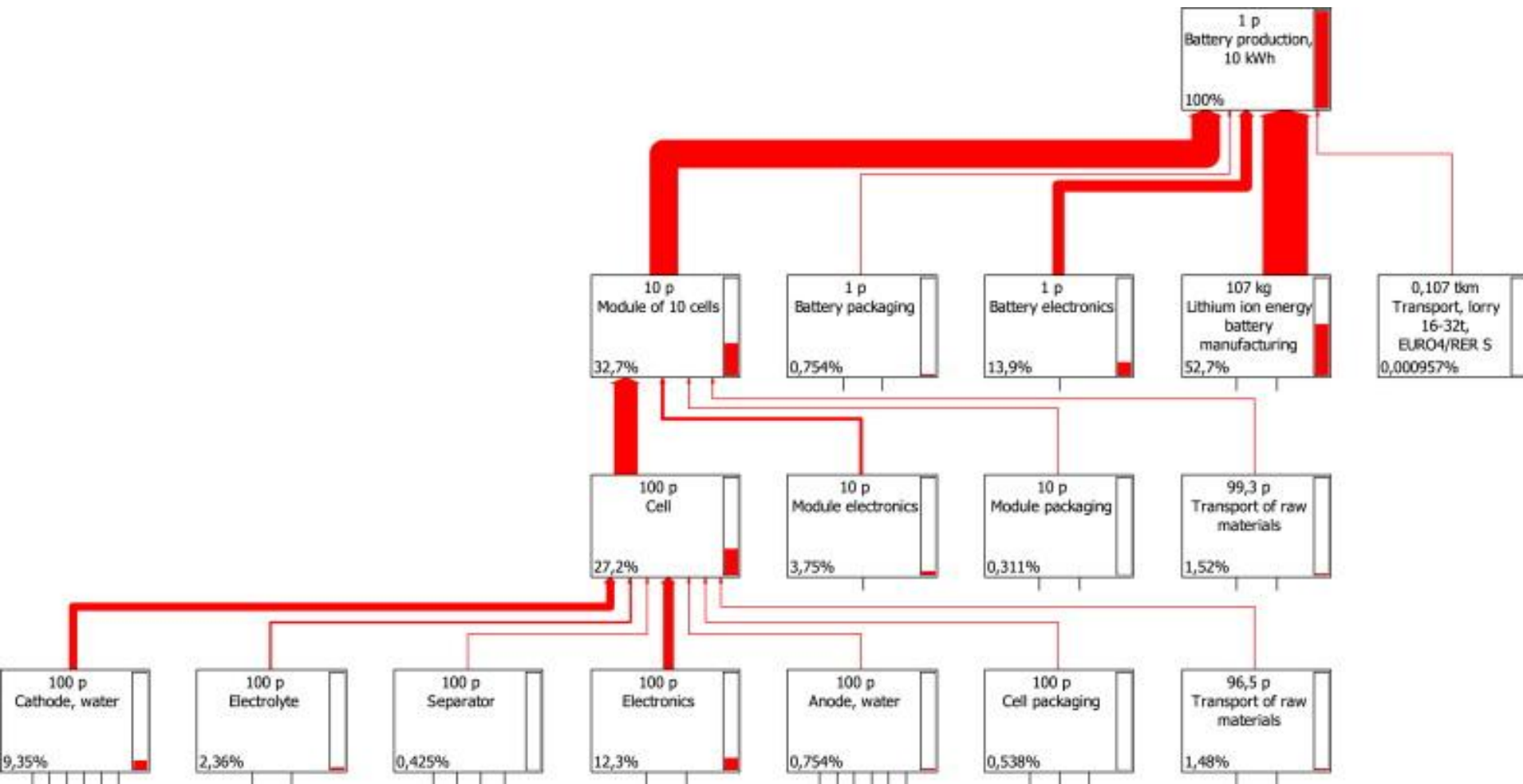
LCA

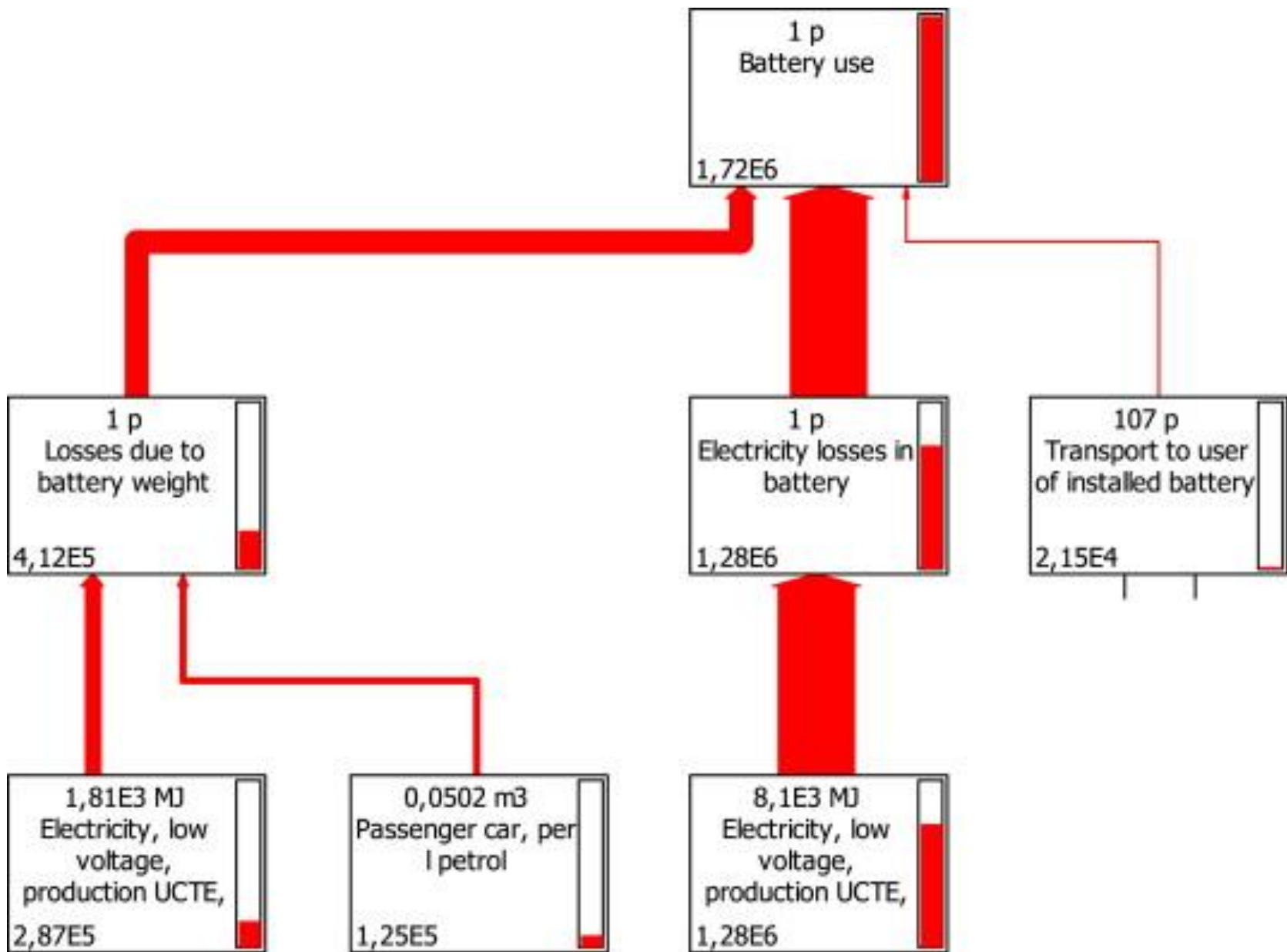


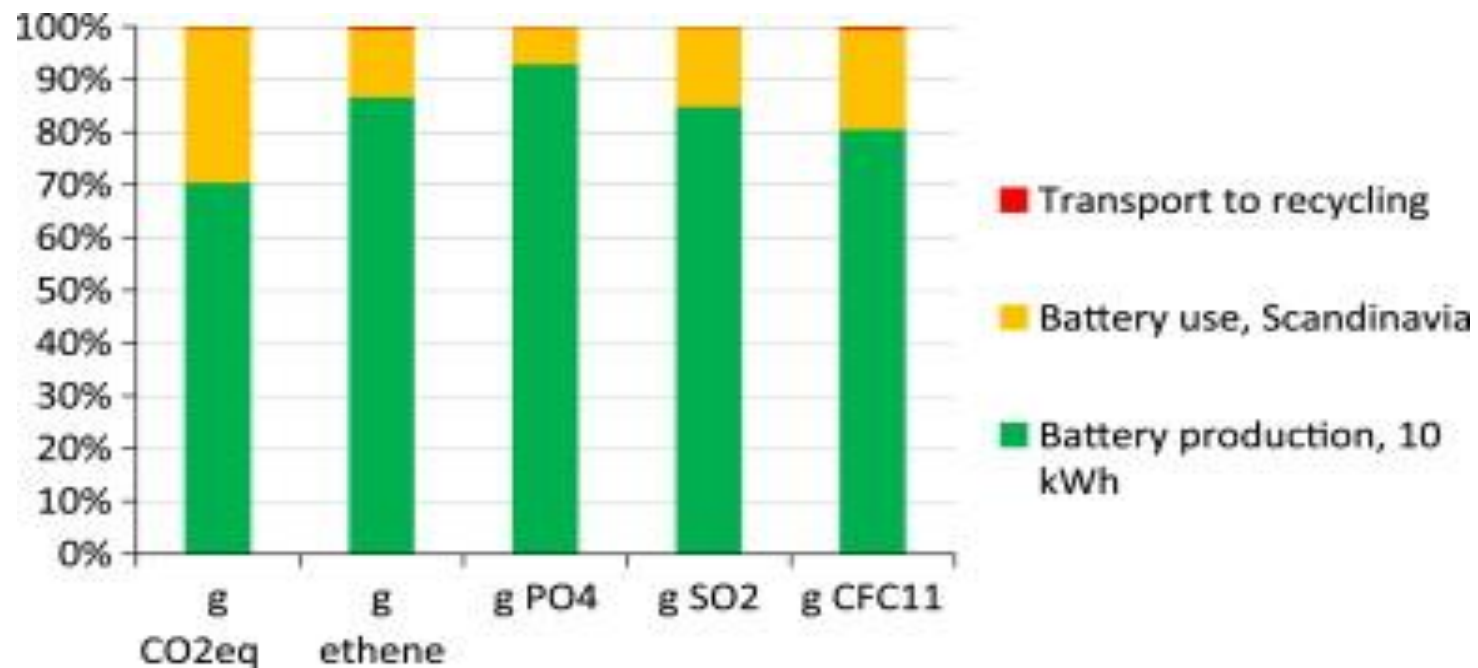
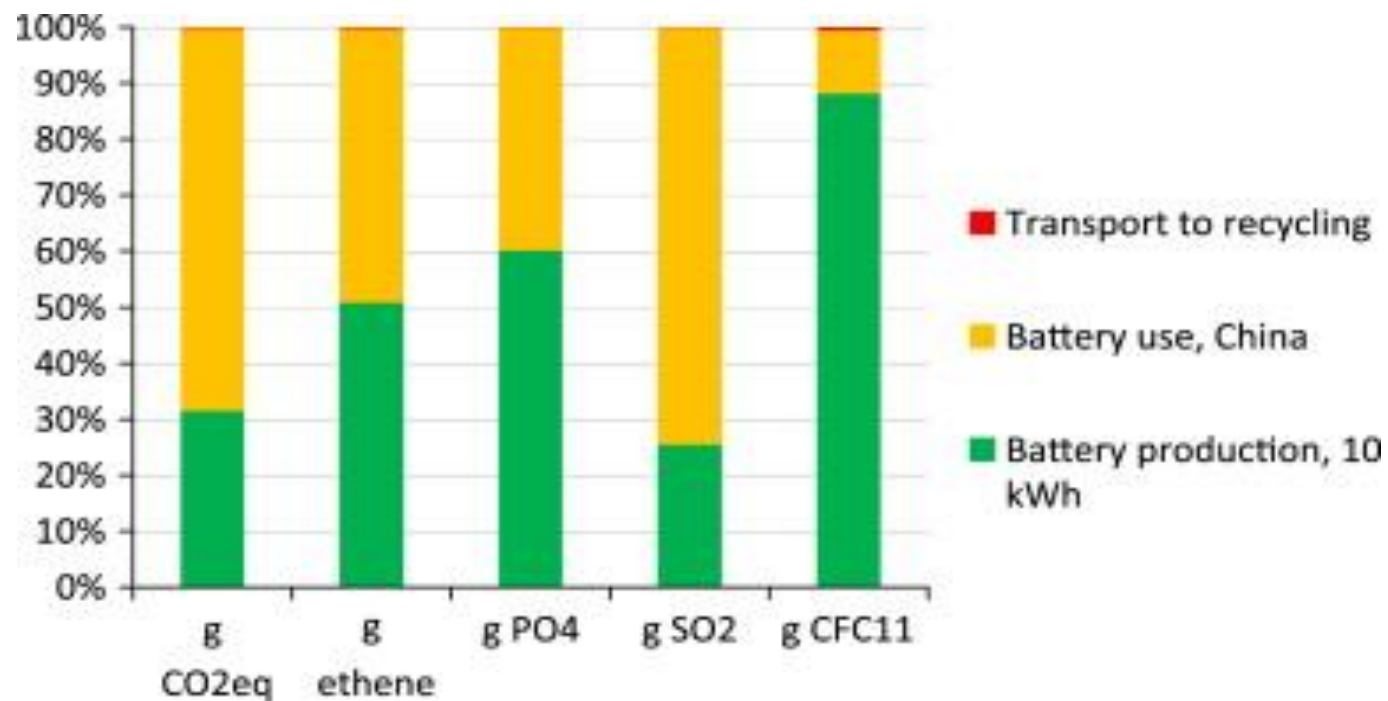
- Global warming
- Photochemical smog
- Eutrophication
- Acidification
- Ozone depletion





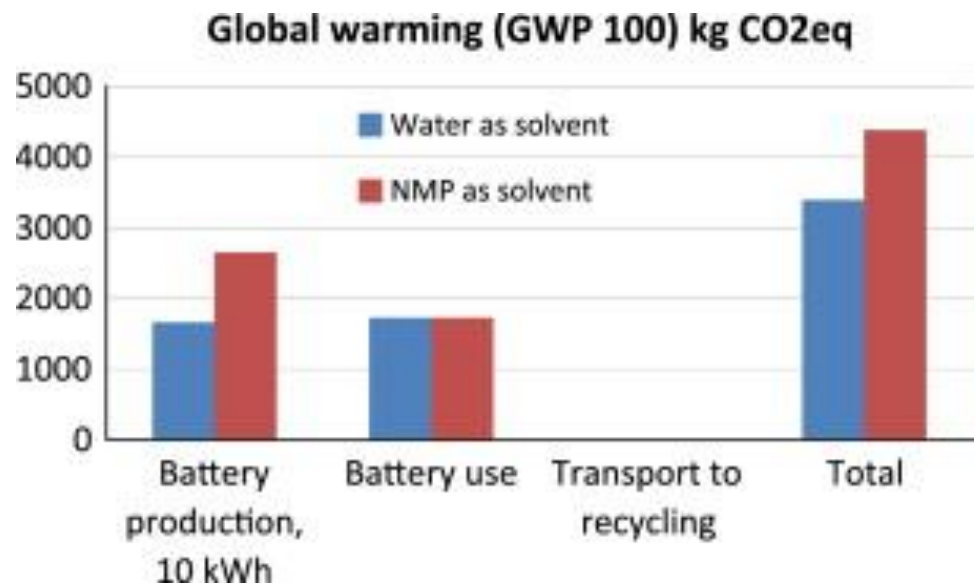






LCA

- Battery production and battery use require energy and produce greenhouse gases
- Depends on location
- Certain solvents are more environmentally friendly than others
 - Water versus NMP





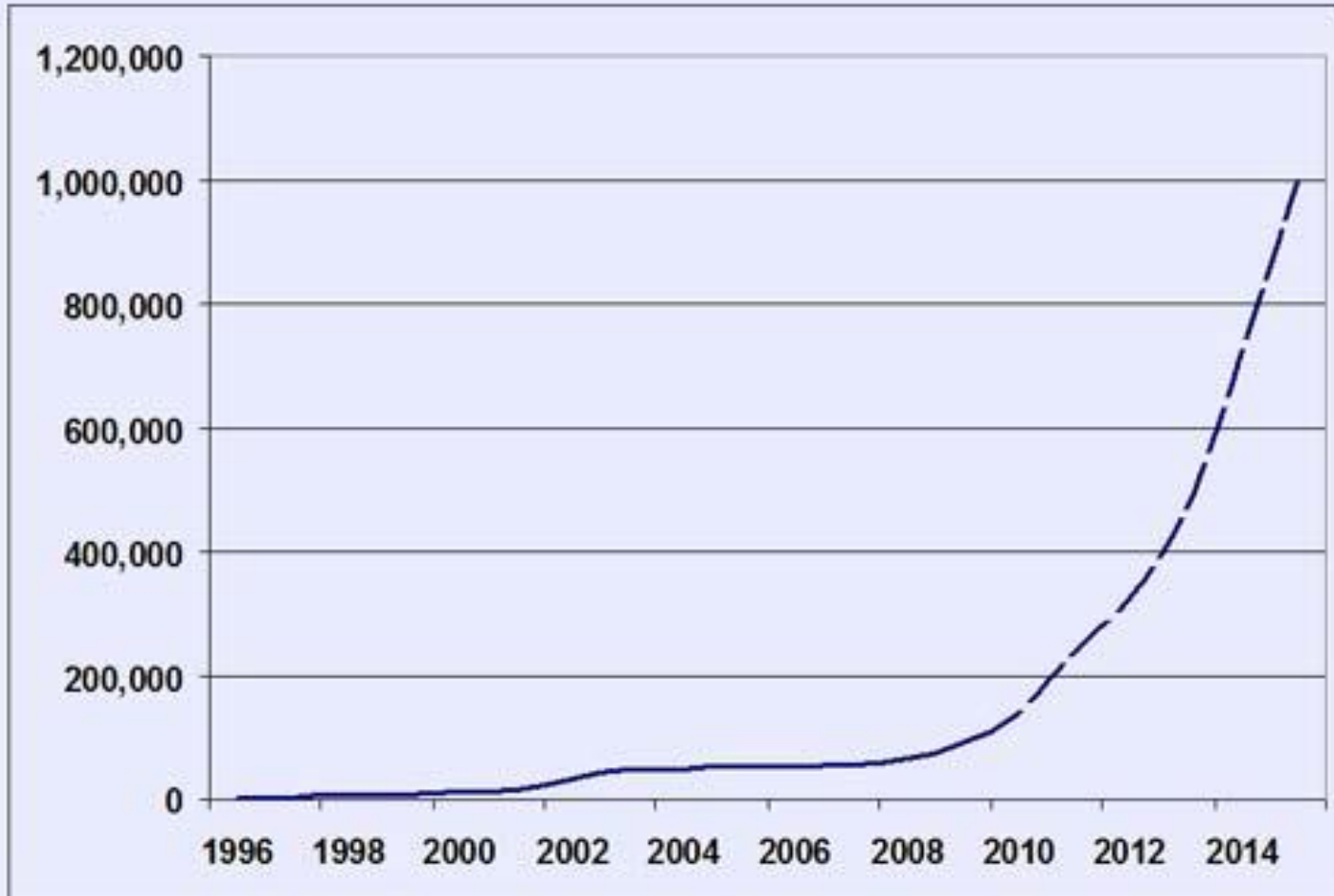
CNN Breaking News

- Nov 25, 2011: National Highway Traffic Safety Administration are investigating fires following tested crashes of the Chevrolet Volt
- Most likely caused by the lithium-ion battery



Outlook

NUMBER OF ELECTRIC VEHICLES (USA)



SOURCE: U.S. DEPARTMENT OF ENERGY

“You can’t go from 850 million to 2 billion cars without an environmental car.”

-Carlos Ghosn, Nissan CEO

Conclusion

- Need to make the lithium-ion battery more energy efficient, lighter, and safer
- Need to use renewable sources for electricity

Thank You