U.S.- China Green Energy Council Transportation Seminar Series

Green Vehicles Overview

"Where is the opportunity for Plug-in Hybrid Electric Vehicles"

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UCGEC Transportation Working Group

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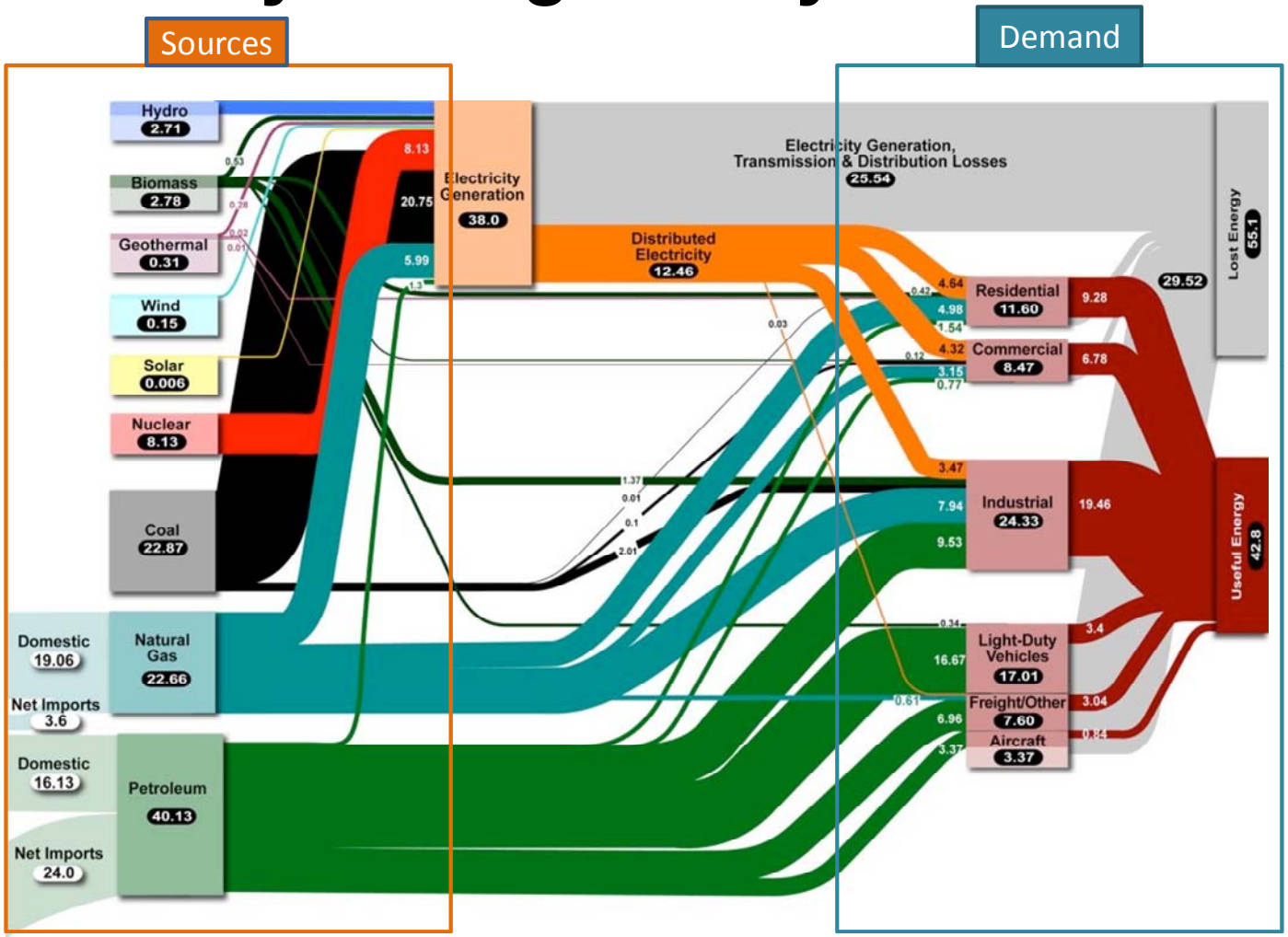
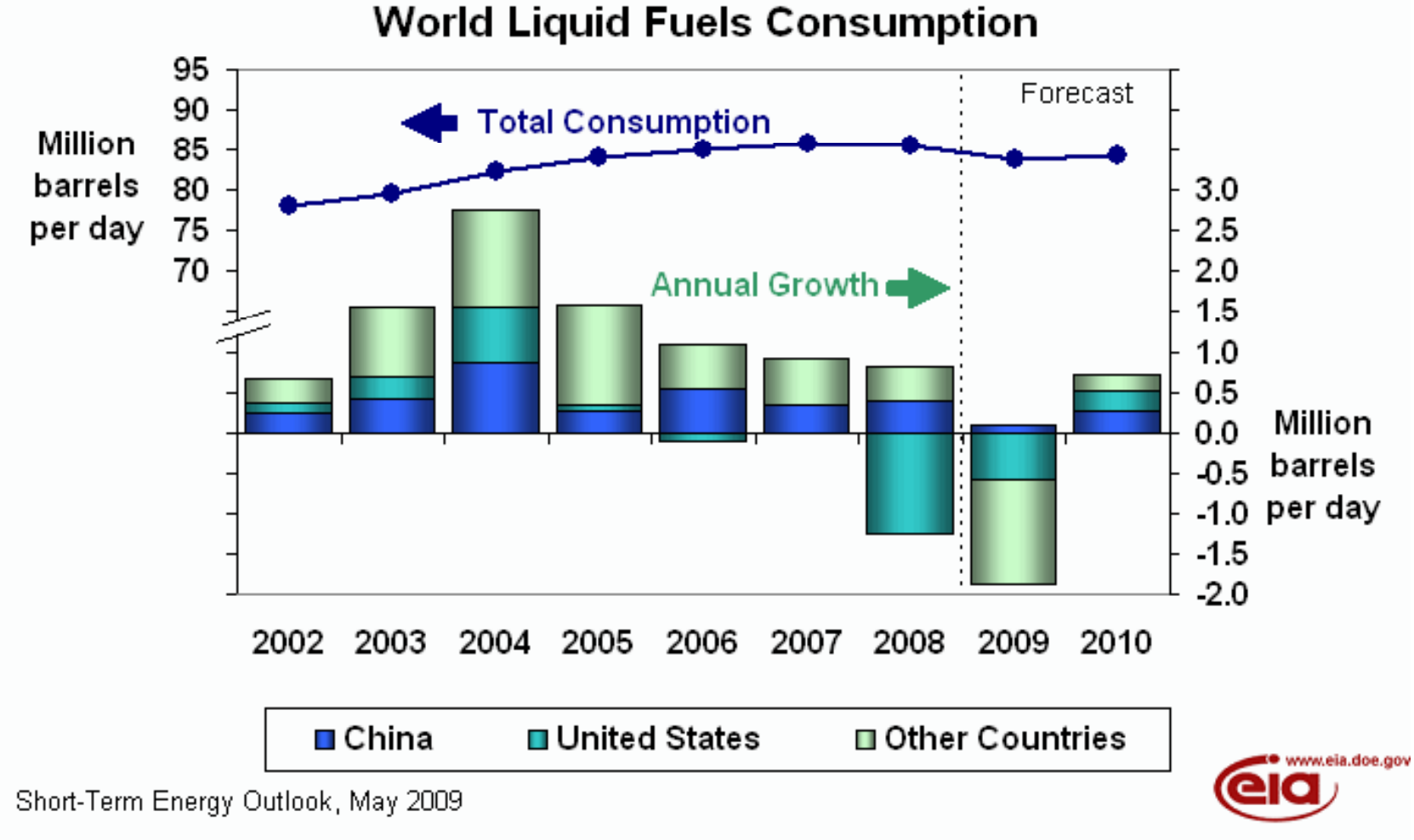
U.S. uses 8.7+M Barrels of Oil Daily for Light Duty Vehicles

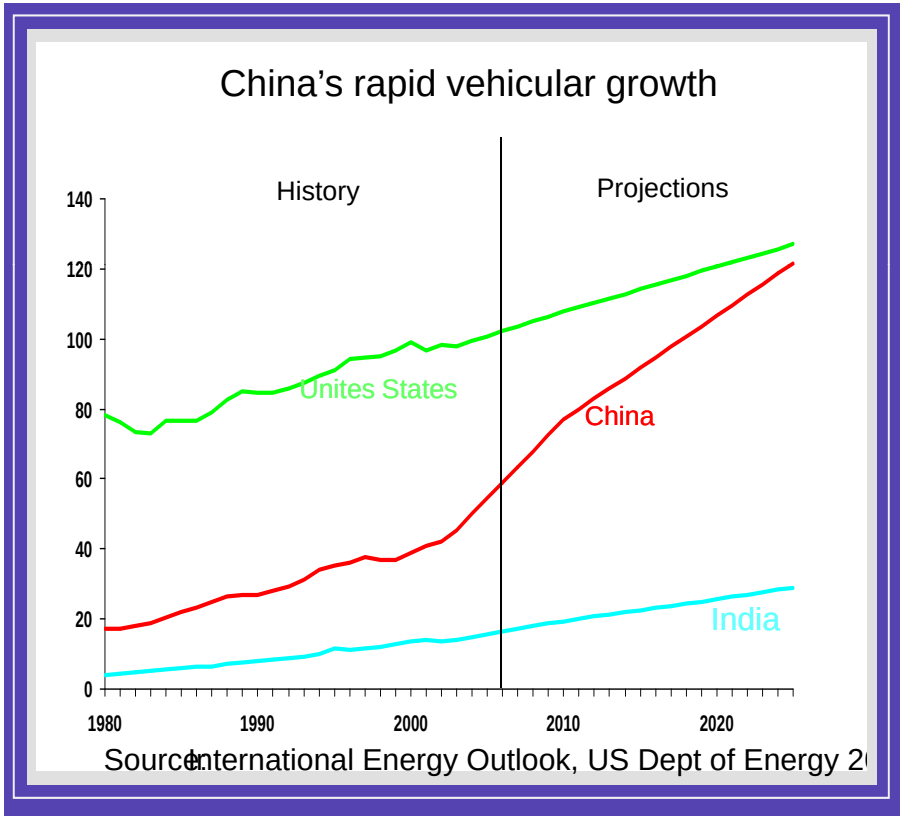


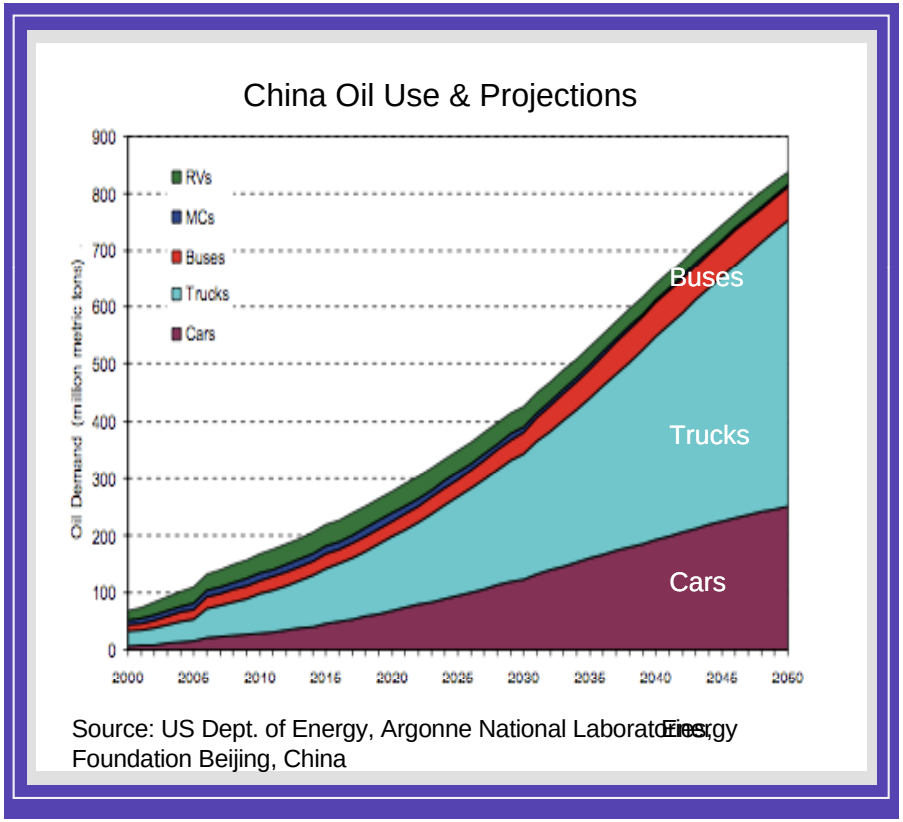
Source: Mamjundar- Global Energy presentation, Lawrence Berkeley

China's Consumption of Fuel Oil Will Grow vs. USA….

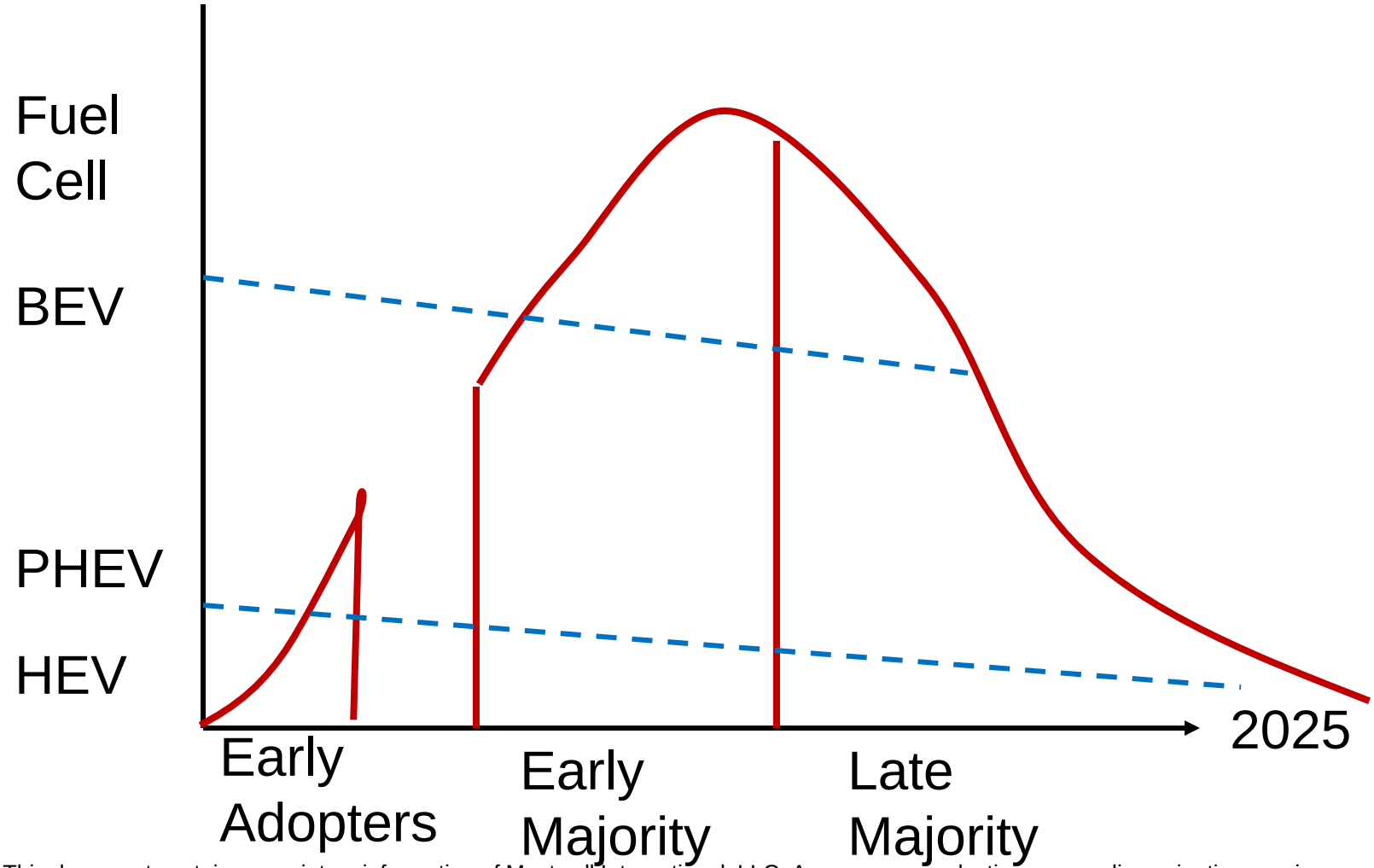


…Putting Pressure on Availability of W/W Oil Supplies (~83M Barrels/Day)





Mostwell's HEV Adoption Prediction – U.S. + China + India



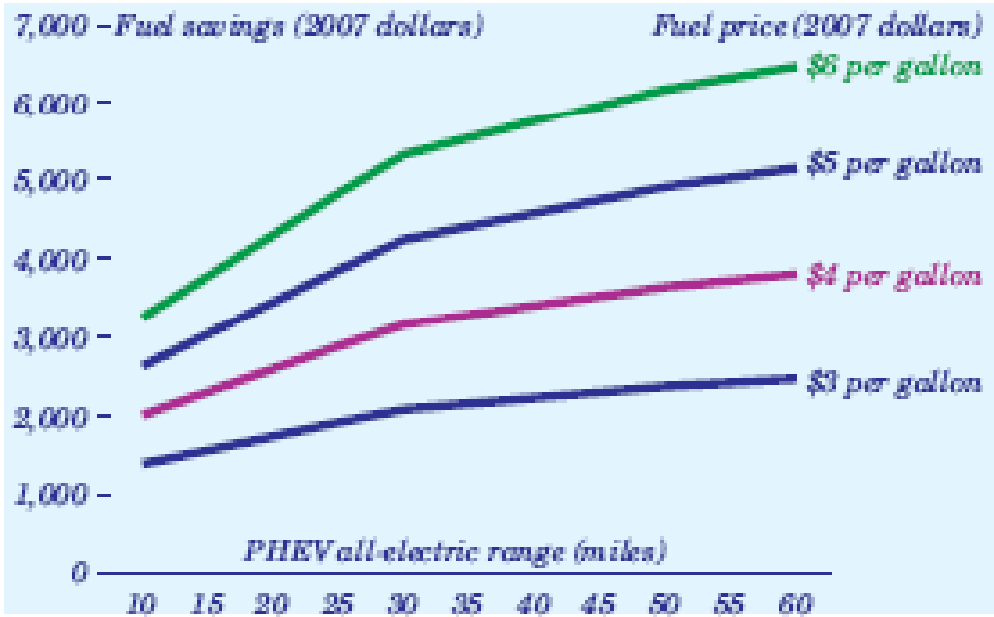
Movement Towards PHEV in U.S.

"PHEVs are particularly well suited…to reduce petroleum consumption both through fuel economy gains and by substituting electric power for gasoline use."

"On a gasoline-equivalent basis a PHEV's charge depleting battery system gets on average about 105 mpg, well above even the most efficient petroleum-based ICE."

– DoE-EIA Annual Energy Outlook, March 2009

Figure 7. Value of fuel saved by a PHEV compared with a conventional ICE vehicle over the life of the vehicles, by gasoline price and PHEV all-electric driving range



U.S Legislation Subsidizes PHEVs

Table 7. Conventional vehicle and plug-in electric hybrid system component costs for mid-size vehicles at volume production (2007 dollars)

Vehicle component	Conventional ICE	PHEV-20
Engine/exhaust	2,357	1,370
Transmission	1,045	625
Accessory power	210	300
Electric traction	40	1,542
Starter motor	40	—
Electric motor	—	893
Power inverter	—	528
Electronics thermal	—	121
On-vehicle charging system	—	460
Other battery/storage costs	30	809
Fuel storage (tank)	10	10
Accessory battery	20	15
Pack tray	—	170
Pack hardware	—	500
Battery thermal	—	114
Total	3,682	5,106
PHEV incremental cost	—	1,424

- 2008 Energy Improvement & Extension Act provides up to $7,500 tax credit thru 2014
- 2009 American Recovery & Reinvest-Ment Act increases the total number of qualified HEVs *per manufacturer* for tax credit eligibility
- The breakeven point between PHEV cost increase verses fuel savings is estimated to be $6 per gallon of fuel
- CAFÉ 2020 > 35 mpg standard
- California Low Carbon Fuel Standard to reduce Greenhouse Gases by 10% by 2020

HEV Standards Progress

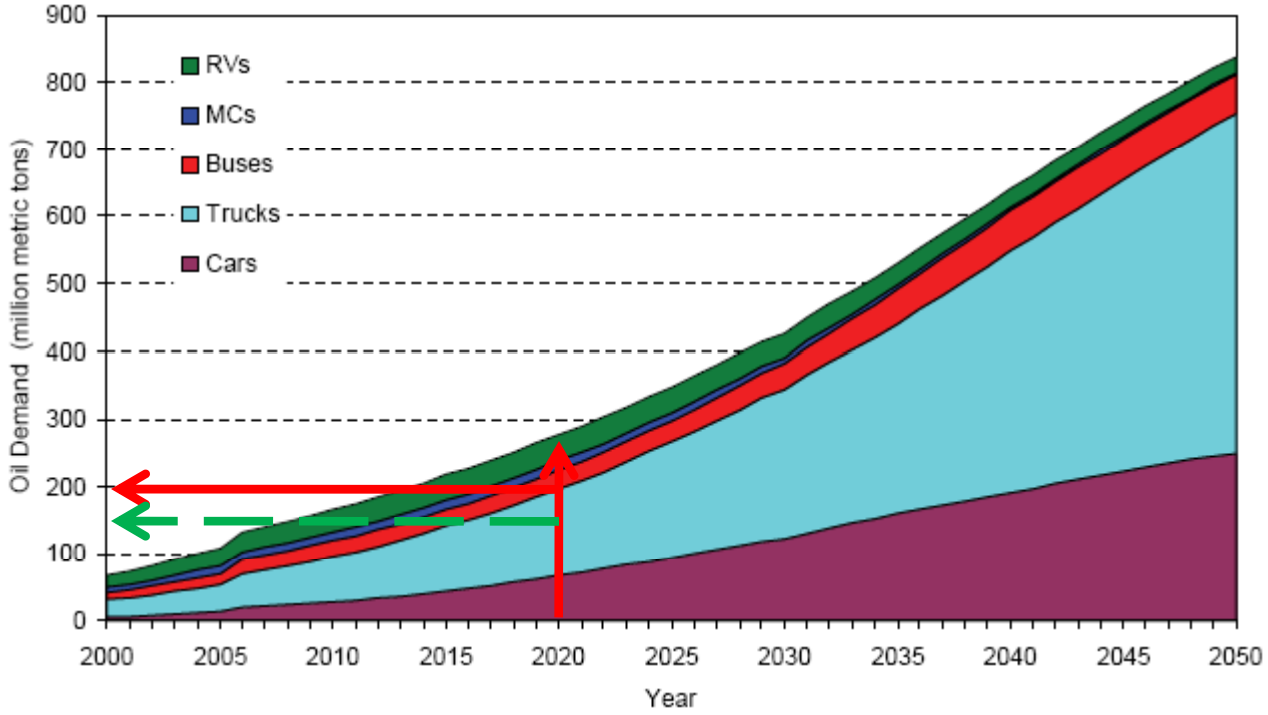
US

- Society of Automotive Engineers > 16
  - Various topics

China

- China Automotive Technology & Research Center > 4 (2006)
  - 3 for advanced batteries
  - 1 for ultracapacitors

Is It Enough?



- Vehicles by 2020:
  - China > ~200M Trucks & Cars
  - 20% PHEV fleet
  - Reduce demand by ~40 M tons

Annual Chinese Oil Demand by Chinese Motor Vehicle Type
Mid-vehicle Growth Scenario, Moderate Fuel Economy Improvement
Source: Argonne National Lab

References

- DoE Annual Energy Outlook, March 2009
- Short Term Energy Outlook, May 2009, DoE Energy Information Administration
- Projection of Chinese Motor Vehicle Growth, Oil Demand, and CO_2 Emissions Through 2050, Argonne National Lab report ANL/ESD/06-6, May 2006.
- 2007 Automotive Industry in China, China Automotive Technology & Research Center, China Association of Automobile Manufacturers.

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