Technologies and Policies for Sustainable Automotive Energy Transformation in China

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China’s Population & Urbanization

![Graph showing population and urban proportion over years from 1978 to 2010]
China’s Economic Structure

[Graph showing the economic structure from 1978 to 2010 with trends for Primary Industry, Secondary Industry, and Tertiary Industry.]
Vehicle production and sales in China

China’s domestic vehicle situation (2010):
Production: 18.26 million
Sales: 18.06 million
Number of newly registered vehicles in China

Abbreviations
PV: passenger vehicle
PPV: private passenger vehicle
BPV: business passenger vehicle
HDB: heavy duty bus
MDB: medium duty bus
STT: Semi-trailer towing truck
HDT: heavy duty truck
MDT: medium duty truck
LDT: light duty truck
MT: mini truck

LDB: light duty bus

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China in Global Oil Consumption

Source: Statistical Review of World Energy 2011

Growth rate 2000-2010: Global 1.2% vs. China 6.7%
China’s Incremental (Year-on-Year) Oil Consumption Relative to Global Consumption

**Increased Oil Consumption 2000-2010**

Global: 456Mt
China: 204Mt (44.7%)

Source: Statistical Review of World Energy 2011
Oil Production and Consumption in China

*Dependence on imported oil has increased*

<table>
<thead>
<tr>
<th>Year</th>
<th>Oil Production (Million tons)</th>
<th>Dependence on Foreign Oil %</th>
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<tbody>
<tr>
<td>2005</td>
<td>182</td>
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<td>2006</td>
<td>318</td>
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<td>2007</td>
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<td>2008</td>
<td>370</td>
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<tr>
<td>2009</td>
<td>186</td>
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<td>2010</td>
<td>448</td>
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CO₂ Emission from Fossil Fuel Combustion
Our projection of China’s vehicle population

The vast majority of new vehicles are private passenger vehicles (PPV)

Projection – million vehicles (private passenger vehicles)
2020: 270 (240)
2030: 440 (400)
2050: 590 (550)
Reference Scenario (RS)

• **Technology commercialization:**
  - Biofuels after 2020
  - EVs and PHEVs after 2030
  - FCV after 2040

• **Market conditions:** No significant changes under current policies
Passenger Vehicle Propulsion System Portfolio in the Reference Scenario

Total passenger car population in 2050: 550 million
Bus Propulsion System Portfolio under RS

Vehicle Population (10,000s)

Year

2010
2020
2030
2040
2050

RS

FCV
EV
Natural Gas vehicle
Gasoline vehicle
Diesel vehicle

CAERC
Truck Propulsion Portfolio under RS

Vehicle Population (10,000s)

- Natural Gas vehicle
- Gasoline vehicle
- Diesel vehicle

Year: 2010, 2020, 2030, 2040, 2050
Automotive Fuel Consumption under RS

- H2
- Electricity
- Coal-based fuel
- Natural Gas
- Biofuel
- Diesel
- Gasoline

0.1 billion toe

2010 2015 2020 2025 2030 2035 2040 2045 2050

RS
GHG Emission under RS

0.1 billion tons CO$_2$-eq
Summary of Reference Scenario Results

- 95.5% of passenger vehicles, 98.4% of trucks, and 99% of buses would still be powered by conventional propulsion technologies in 2050.

- Gasoline and diesel would continue to dominate China’s automotive energy supply mix (93% in 2020, 91% in 2030 & 88% in 2050).

- Biofuels would only meet 1.5% in 2010, 2.4% in 2030 and 3.4% in 2050 of automotive energy consumption, respectively.

- WTW oil consumption would exceed 500 million tons in 2050, and 80% of the oil used for automotive fuels have to rely on import;

- CO2 from China’s automotive transport would hit 1.5 billion tons in 2050.

- The chances would be very small for China to upgrade her automotive energy industry.
Integrated Policy Scenario (IPS)

• Technology:
  – Alternative fuels (biofuels, CtL, GtL)
  – Automotive technology innovations (EV & FCV)

• Transport & energy: Demand management

• Policy:
  – R&D (e.g. subsidies)
  – command-and-control instruments (fuel economy standards)
  – Market-based instruments (carbon tax, vehicle tax)
Passenger Vehicle Propulsion Portfolio under IPS
Bus Propulsion Portfolio under IPS

![Graph showing the vehicle population (10,000) for different years (2010 to 2050). The graph includes categories for FCEV, EV, Gas vehicle, Gasoline vehicle, and Diesel vehicle.](image)
Truck Portfolio under IPS

![Graph showing vehicle population over years with categories: FCV, Gas vehicle, Gasoline vehicle, Diesel vehicle.](image-url)
Automotive Fuel Consumption under IPS
(Final energy only)

If energy use associated with electricity generation is included, electricity energy share increases significantly.
GHG Emission under IPS

0.1 billion ton CO$_2$-eq

2010 2015 2020 2025 2030 2035 2040 2045 2050

WTW
Direct
Summary of IPS Results

• 76% of passenger vehicles, 57% of buses, and 36% of trucks would be powered by new propulsion technologies (EV, FCV & PHEV) in 2050.

• Automotive energy supply would be significantly diversified in 2050 with gasoline and diesel supply declining to 50% and biofuels supply rising to 16%.

• WTW oil consumption would peak in 2030 and then decline to 180 million tons in 2050 with a 64% reduction compared to RS.

• CO₂ emission from China’s automotive transport would peak in 2030 then decline to 1 billion tons in 2050 with a 60% reduction compared to RS.

• Per-unit passenger transport cost would be reduced by 39% and per unit freight transport cost by 27% relative to RS in 2050 (due to long-term decreases in vehicle cost at scale and rising cost of imported petroleum-based fuel in the RS).
Sources of reductions in total automotive energy consumption in the IPS relative to reference

Transportation demand management
Fuel economy improvement
EV efficiency improvement
FCEV efficiency improvement
Resulting energy use under IPS
Sources of reductions in automotive oil-based fuel consumption in the IPS relative to reference
Source of well-to-wheels GHG emissions reductions in the IPS relative to reference
Concluding Remarks

• Energy and vehicle technology innovations together with transport demand management (TDM) are key to a sustainable automotive energy transformation in China.
• EVs, PHEVs, FCVs and second generation biofuels are long-term solutions while increasing vehicle energy efficiency and TDM provide near and mid-term solutions.
• R&D for EVs, PHEVs, FCVs and second generation biofuels is needed to enable a significant future contribution.
• Several policies currently under consideration may help enable a transformation:
  - Market-based policy instruments: carbon tax, licensing tax & levy, parking fee
  - Command-and-control instruments: mandatory biofuel standards, fuel economy /carbon standards
  - Institutional arrangements: coordinated regulation of the energy industry and automotive industry, innovative business models
New Climate Policy for the 12th Five-Year Plan
Could help support an automotive energy transformation

• Introduced the carbon intensity reduction as a legally binding target
• Disaggregated the carbon intensity reduction target by province
• Capped national energy consumption, and disaggregated a national energy consumption cap by province
• Intensified efforts in promoting development and utilization of non-fossil fuels:
  ▪ 100GW wind & 20 GW solar PV to be added during the 12th FYP
  ▪ 40 GW nuclear & 120GW hydro power under construction
• Low carbon development pilot areas
• Carbon ETS Pilots – 5 cities and 2 provinces
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Thanks for your attention!

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