Systems Analysis of China’s Fuel/Vehicle Alternatives: Policy Implications for 2020

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Outline

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  2. Energy challenges
  3. Environmental challenges
  4. Alternative-fuel-vehicles

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  1. Fossil energy uses
  2. Greenhouse-gas emissions
  3. Cost estimates
  4. Screening

• Policy implications for 2020
  1. Clean diesel, coal-based fuels, HEV, fuel efficiency standards
  2. Systems approach

• Summary
Introduction: Automotive Growth

- 1949-1990, Chinese automotive sales were relatively stagnant
- 1990-2001, sales grew steadily (about 150,000 per year)
- Since 2002, sales have increased exponentially (about 1 million per year)

**Vehicles sales (millions)**

- **Aggressive**
- **Conservative**

**Year**

- **Surpass Japan to become #2**

**Sales Volume (2008)**

- 9,345,500 units
Introduction: Energy Challenges

Energy demand outpaces supply

1. Shortage of domestic crude oil
2. Dependence on imported oil
   - 1993, China became a net oil importing country
   - 2008, China’s imports were more than 50% of total crude oil consumption
   - By 2020, imports are projected to reach beyond 75% of total crude oil consumption
3. Limited refining capability
1. Demand for 2020 is projected as high as 800-900Mt

2. Supply for 2020
   - Domestic oil production will be about 200Mt
   - Maximum refining capacity will be 600Mt
   - Government supply goal is 450Mt
Imports are limited due to threats:

1. Most oil imports come through the Strait of Malacca, a passage vulnerable to war and political instability
2. The majority of suppliers are located in unstable regions or battle zones

Imported Oil Suppliers & Transport Paths
Introduction: Environmental Challenges

High green-house-gas (GHG) emissions

1. China has become the largest contributor to total GHG emissions in the world
2. In the following negotiations of Bali Roadmap, China will be required to reduce its emissions after 2012

Local air quality

1. Criterion pollutant standards
2. In-use vehicle inspection maintenance
3. Fuel quality issues
Introduction: Alternative Fuel Vehicles (AVF)

- China has pursued many types of AFVs
- Current focus is electric & hybrid
WTW Analysis: Fossil Energy Uses

Comparison of fuel/vehicle systems: Petrol, Natural Gas (NG), Coal, Bio, Electricity

MJ/km

Vehicle Fuel Feedstock

Petrol NG Coal Bio Elec.
WTW Analysis: GHG Emissions

Comparison of fuel/vehicle systems: Petrol, Natural Gas (NG), Coal, Bio, Electricity

![Diagram showing g CO₂eq/km for different fuel/vehicle systems comparison](image)
WTW Analysis: GHG vs. Ownership Cost*

Comparison of fuel/vehicle systems: Petrol, Coal, Bio

* Gasoline price estimated at 10 Yuan/litre

Ownership Cost (Yuan/km) vs GHG (g CO₂ eq./km)

- Gasoline
- Diesel
- M85: Coal
- M85: Coal CCS
- FTD: Coal CCS
- E85: Corn
- E85: Cellulose
- HEV: Gasoline
- PHEV: Coal IGCC CCS
- FCV: Coal to GH2 CCS

Petrol, Coal, Bio categories indicated in the legend.
Clean diesel and HEV are the most promising AFVs.
Only about 30% of diesel is used by diesel vehicles.

Diesel Consumption Structure (2005)

- 29% Diesel vehicle
- 11% Agricultural vehicle
- 21% Agriculture
- 9% Industry & Mining
- 6% Rail Transportation
- 6% Fishery industry
- 5% Water Way transportation
- 5% Commercial Applications
- 4% Construction
- 4% Power Generation
Policy Implications: Clean Diesel (cont.)

Policy to promote clean diesel has to address fuel pricing mechanisms, availability & quality, and vehicle emission control strategies.

1. Shortage of diesel fuel in the past few years will continue.
2. Slow improvements in diesel fuel quality have yet to support advanced diesel car technology.
3. Launch of production facilities for coal-derived diesel is behind schedule by at least 5 years.
Domestic coal reserves surpass other fuel sources. At current rates of extraction, coal reserves will last 4 times longer than those for crude oil, which will be exhausted in about 11 years.

How can coal be best utilized?

<table>
<thead>
<tr>
<th></th>
<th>Crude Oil (Mt)</th>
<th>Natural Gas (Billion NM³)</th>
<th>Coal (Mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identified Reserve (2007)</td>
<td>2117</td>
<td>1884</td>
<td>114500</td>
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<tr>
<td>Consumption (2008)</td>
<td>358</td>
<td>80.7</td>
<td>2740</td>
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<tr>
<td>Domestic Extraction (2008)</td>
<td>190</td>
<td>78.1</td>
<td>2793</td>
</tr>
<tr>
<td>Years to Depletion (at current rate of extraction)</td>
<td>11</td>
<td>24</td>
<td>41</td>
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</tbody>
</table>
Policy Implications: HEV

- In early 2009, the government launched a “new energy vehicle” demonstration program in 13 cities.
- Most HEV in the Chinese market are mild/moderate, except Toyota’s products.
- The government is trying to leapfrog from micro/mild hybrid to PHEV (serial) and BEV by 2020.
- Full HEV and BEV are currently too costly for the majority China market.
- Promotion of EV and HEV will erode demand for diesel cars.
Policy Implications: HEV (cont.)

Cost considerations for HEV
- Assuming payback period = 100,000 km and gasoline price = 10 Yuan/liter,
- Government subsidies are required when vehicle incremental cost exceeds tolerance within payback range.

![Graph showing fuel consumption reduction vs. vehicle incremental cost.](image_url)
Policy Implications: Stricter Fuel Efficiency Standards

Fuel Consumption (FC) & CO2 Emission Standards, 2001-2020

Based on government regulations, nationwide average fuel consumption of new cars will be 5.0L/100km in 2020, a 40% improvement over 2006.

<table>
<thead>
<tr>
<th>Year</th>
<th>Stage</th>
<th>FC (l/100km)</th>
<th>CO2 (g/km)</th>
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</thead>
<tbody>
<tr>
<td>2000</td>
<td></td>
<td>9.11</td>
<td>214</td>
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<tr>
<td>2005</td>
<td>Stage 1</td>
<td>8.06</td>
<td>189</td>
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<tr>
<td>2010</td>
<td>Stage 2</td>
<td>7.25</td>
<td>170</td>
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<tr>
<td>2015</td>
<td>Stage 3</td>
<td>6.16</td>
<td>145</td>
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<tr>
<td>2020</td>
<td>Stage 4</td>
<td>5.5</td>
<td>130</td>
</tr>
<tr>
<td></td>
<td>Stage 5</td>
<td>5.0</td>
<td>117</td>
</tr>
</tbody>
</table>
Policy Implications: AFV Development

Four Stages of AFV Development

- The two driving forces—Government & Market—differentially influence the stages of development, with government dominating in 1 and 2; market in 3 and 4.
- Six stakeholders are invested to different degrees at each stage

Six Stakeholders:
A. Research Organization
B. Auto company
C. Fuel Producer
D. Infrastructure Developer
E. Fleet Customer
F. Private Owner
Summary: Tough Choices

Energy Security vs. GHG Emissions

1. Gasoline consumption will increase several-fold by 2020. Stricter fuel-efficiency standards can only partially offset demand for crude oil. Energy security will continue to be a problem.

2. Clean diesel remains remote, unless challenges for fuel availability, quality, vehicle emission technologies, and pricing mechanisms are met.

3. Domestic coal reserves are greater than crude oil. However, coal-derived fuel produces the highest GHG emissions. Policies are needed to promote CCS technology.

4. GHG emissions will increase several-fold by 2020. Policies to reduce single-vehicle GHG emissions can only partially offset increases due to fleet growth.

5. HEV reduces gasoline consumption & GHG emissions. Vehicle incremental cost is high. Incentives will be required to introduce HEV to market.