China automotive growth

Vehicle Stocks (1,000 units)

Sales (1,000 units)

- Actual Sales
- Projected Sales
- Vehicle Population
- VP Forecast

2013 Sales: 22.0m
2013 Parc: 126.7m
Domestic coal reserves surpass other fuel sources.

At current rates of extraction, coal reserves will last 3 times longer than those for crude oil, which will be exhausted in about 10-15 years.

<table>
<thead>
<tr>
<th></th>
<th>Crude Oil (Mt)</th>
<th>Natural Gas (billion cubic meter)</th>
<th>Coal (Mt)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proved reserve (at end of 2013)</td>
<td>2,467</td>
<td>3,272</td>
<td>114,500</td>
</tr>
<tr>
<td>Consumption (2013)</td>
<td>489</td>
<td>169</td>
<td>3,625</td>
</tr>
<tr>
<td>Domestic extraction (2013)</td>
<td>208</td>
<td>121</td>
<td>3,700</td>
</tr>
<tr>
<td>Current R/P ratio</td>
<td>12</td>
<td>27</td>
<td>31</td>
</tr>
</tbody>
</table>
• BAU driving distance 15000 km/yr. RVMT driving distance reduced to 12000 km/yr in 2030
• RVMT & PHEV: Phase in PHEV-30 in 2015. PHEV new car market share less than 0.1%, increased to 50% in 2030, when PHEV accounts for 12.5% in the parc.
• Fuel consumption for average new cars in 2020 is 5.0 liter/100km, and 3.8 liter/100km in 2030
## China oil import origins (2013)

<table>
<thead>
<tr>
<th></th>
<th>Saudi Arabia</th>
<th>Angola</th>
<th>Oman</th>
<th>Russia</th>
<th>Iraq</th>
<th>Iran</th>
<th>Venezuela</th>
<th>Kazakhstan</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume (Mt)</td>
<td>53.90</td>
<td>40.01</td>
<td>25.48</td>
<td>24.45</td>
<td>23.51</td>
<td>21.44</td>
<td>15.75</td>
<td>11.98</td>
<td>65.62</td>
</tr>
<tr>
<td>Percentage</td>
<td>19.1%</td>
<td>14.2%</td>
<td>9.0%</td>
<td>8.7%</td>
<td>8.3%</td>
<td>7.6%</td>
<td>5.6%</td>
<td>4.2%</td>
<td>23.3%</td>
</tr>
</tbody>
</table>

**Imported Oil Transport Paths**

- **Hot War Zone**
- **Unstable Country**

- ~40% Hormuz
- ~85% Malacca
Policy trends

**LDVs' Fuel Demand**

\[
\text{LDVs' Fuel Demand} = \text{Fuel Consumption} \times \text{Vehicle Miles Travelled} \times \text{LDV Stocks} + \text{Other Use}
\]

**Crude Oil Demand**

\[
\text{Crude Oil Demand} = \frac{\text{Oil Products Demand}}{\text{Oil Products Yield Rate}}
\]

**Gasoline Supply Limit**

Gasoline Supply Depend on:
- Domestic Oil Production
- Oil Import Potential
- Gasoline Refinery Capacity

**DECREASE**
- Fuel consumption
  - Engine efficiency
  - Light weighting
  - Hybridization

**INCREASE**
- Alternative fuel supply
  - Bio-fuel
  - CNG/LPG
  - Coal based fuels
  - Methanol fuel
  - Electricity
  - Diesel

**Gap between Demand & Supply**

**Sale control**
- Registration control
- Retirement incentive

**Annual miles travel control**
- Public transportation
- Fuel price hike
- Permit to enter city
- Parking fee

**CHALLENGES**
Targets of fuel consumption of new cars

- **2010-2015**: 12% improvement on fuel economy, less than that (18%) during 2002-2010.
- **2015-2020**: another 40% improvement, very tough challenge to the auto industry.

<table>
<thead>
<tr>
<th>Year</th>
<th>Fuel Consumption (L/100km)</th>
<th>MPG</th>
<th>CO₂/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>9.1</td>
<td>26</td>
<td>215</td>
</tr>
<tr>
<td>2010</td>
<td>7.7</td>
<td>31</td>
<td>180</td>
</tr>
<tr>
<td>2015</td>
<td>6.9</td>
<td>34</td>
<td>162</td>
</tr>
<tr>
<td>2020</td>
<td>5.0</td>
<td>47</td>
<td>117</td>
</tr>
</tbody>
</table>
New car ownership restrictions

• License plate auction
  – In Shanghai since 1994

• License plate lottery
  – In Beijing and Guiyang since 2011

• Combination of license plate auction and lottery
  – In Guangzhou since 2012, and in Tianjin and Hangzhou since 2014
  – Guangzhou: EV lottery: car lottery: car auction=1:5:4
    (120,000 plates per year)
  – Tianjin: EV lottery: car lottery: car auction=1:5:4
    (100,000 plates per year)
  – Hangzhou: car lottery: car auction=8:2
    (80,000 plates per year)
Average driving distance trend

- Annual driving distances in Beijing and China

Data Source: Beijing Transportation Annual Report; Huo, 2011
Current focus remains on electrification
Electricity mix in different grids

NorthWest
- 71.5%
- 4.5%
- 23.2%
- 0.8%

North
- 94.2%
- 0.7%
- 4.2%
- 0.8%

NorthEast
- 90.0%
- 4.9%
- 5.1%

Northwest
- 63.7%
- 36.0%
- 0.1%
- 0.1%

North
- 57.3%
- 33.9%
- 3.9%
- 0.6%

Central
- 57.3%
- 33.9%
- 3.9%
- 0.6%

East
- 78.7%
- 4.2%
- 6.1%
- 0.7%

South
- 57.3%
- 33.9%
- 3.9%
- 0.6%

Central
- 57.3%
- 33.9%
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Central
- 57.3%
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- 3.9%
- 0.6%

East
- 78.7%
- 4.2%
- 6.1%
- 0.7%

Challenges:

- Hydro
- Nuclear
- Wind/Solar
- NG
- Coal-USC
- Coal-SC
- Coal-SubC
- Coal-VHP
- Coal-HP
WTW GHG emissions

CHALLENGES

- PI: gasoline
- DI: gasoline
- DC: diesel
- Grid-off HEV: gasoline
- BEV-North
- BEV-NorthWest
- BEV-East
- BEV-Central
- BEV-South
- BEV-Beijing
- BEV-Shanghai
- BEV-Pearl River Delta

Emissions data for years 2012 and 2020.

Wei Shen,‡§ Wei Jian Han,‡ and Timothy J. Wallington§

†Asia Pacific Research, Ford Motor Company, Unit 4901, Tower C, Beijing Yintai Center, No. 2 Jianguomenwai Street, Beijing 100022, China
‡Research and Advanced Engineering, Ford Motor Company, Village Road, Dearborn, Michigan 48121, United States
§Supporting Information

ABSTRACT: China’s oil imports and greenhouse gas (GHG) emissions have grown rapidly over the past decade. Addressing energy security and GHG emissions is a national priority. Replacing conventional vehicles with electric vehicles (EVs) offers a potential solution to both issues. While the reduction in petroleum use and hence the energy security benefits of switching to EVs are obvious, the GHG benefits are less
### Emission standards adopted for new vehicles

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<td>Euro VI</td>
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<td>Euro VI (LEV III?)</td>
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<td>Beijing (Buses)</td>
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### Improvements in fuel quality

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<td>Euro V</td>
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</table>
Air quality becomes critical

71 out of 74 cities failed to meet air quality attainment of China (annual average under 35 µg/m³) in 2013.
• Beijing Environment Protection Bureau (EPB) reported automobile emissions contribute to 22% to 31% of the total PM2.5 concentration.

• Although this has been widely quoted by media, details of the study methodology, data assumptions were not published in a public report or journal paper.
Ford-Tsinghua study

(Preliminary Results)

January
- Residential: 56%
- Industry: 24%
- Vehicle: 5%
- Power: 7%
- Others: 8%

July
- Residential: 17%
- Industry: 47%
- Vehicle: 12%
- Power: 9%
- Agriculture: 12%
- Others: 3%

Note:
1. Heavy-duty diesel vehicles and off-road engineering machineries contributed 3 times more to PM2.5 pollution than gasoline vehicles do.
2. Residential includes cooking, heating and other applications of local residents.
Take away points

• Vehicle parc will approach 400 million in China, and vehicle density will be close to 300 units per 1000 population.

• Average travel distance of a LDV per year will continue decrease. It could be between 9,000 and 12,000 km per year.

• Peak of oil demand in China will occur around 2025, import of oil will be 70-80% of total oil consumption.

• Tough fuel economy standards imply that HEV/PHEV and BEV may become main stream products.

• Vehicle electrification in China by 2030 could be effective solution to energy security, not necessary to total CO₂ reduction.
Car dieselization: A solution to China’s energy security?

Yanjun Ding, Wei Shen, Shuhong Yang, Weijian Han, Qinhu Chai

HIGHLIGHTS

- Econometric approach is employed to forecast fuel and oil demand.
- Dieselization is a potential policy option to improve China’s oil security.
- In favorable conditions, dieselization will cut more than 200 Mt oil import in 2020.
- In some cases; however, dieselization may have limited effect on oil saving.
Coal-based synthetic natural gas (SNG): A solution to China’s energy security and CO₂ reduction?

Yanjun Ding, Weijian Han, Qinhua Chai, Shuhong Yang, Wei Shen

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* Ford APA Research, Ford Motor Company, Unit 4901, Tower C, Beijing Yintai Center, No. 2 Jianguomenwai Street, Chaoyang District, Beijing 100022, PR China

**HIGHLIGHTS**

- We evaluated life-cycle energy efficiency and CO₂ emissions of coal-derived SNG.
- We used GREET model and added a coal-based SNG and an end-use modules.
- The database was constructed with Chinese domestic data.
- Life-cycle energies and CO₂ emissions of coal-based SNG are 20–100% higher.
- Coal-based SNG is not a solution to both energy conservation and CO₂ reduction.
Thanks

Questions?