DEVELOPMENT OF ELECTRIC VEHICLES IN CHINA

Ouyang Minggao

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Outline

Strategy choice of Chinese New Energy Vehicle

- Technology Strategy
- R&D Progress
- Industry Prospect
Background: China has become a large vehicle producing country

Vehicle industry in 2007
Output: 8.88M
Sales: 8.7M
Both increased 22%
The output is forecasted over 10M in 2009, and China will be the largest vehicle producing country in the next few years.

Vehicle: 42.29 Million
Rural vehicle: 14 Million
Tractor: 14.28 Million
Motor cycle: 87.09 million
Trailer: 0.87 million
Total autos: 160 million
Background: Chinese vehicle market has great potential

<table>
<thead>
<tr>
<th>Year</th>
<th>2005</th>
<th>2010</th>
<th>2020</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehicle Ownership (/1k person)</td>
<td>24.2</td>
<td>40.2</td>
<td>94.53</td>
<td>214.28</td>
</tr>
<tr>
<td>Vehicle Population (million)</td>
<td>31.60</td>
<td>53.48</td>
<td>132.06</td>
<td>312.85</td>
</tr>
<tr>
<td>Passenger car ownership (/1k)</td>
<td>16.4</td>
<td>23.2</td>
<td>67.72</td>
<td>183.04</td>
</tr>
<tr>
<td>Passenger car population (million)</td>
<td>21.44</td>
<td>30.75</td>
<td>94.61</td>
<td>267.24</td>
</tr>
</tbody>
</table>

Strategy choice of Chinese New Energy Vehicle
Background: Big Automotive Energy Consumption

In 2006
- Oil consumption is 346,550,000 tons
- Second biggest (USA first)
- Growth 12% per year

In 2008
- Auto consumes 60% of all fuel consumption in China

Strategy of New Energy Vehicle in China
New Energy Target: Strategy for Chinese Transportation Energy

- Development of Energy-efficient Vehicles
- Evolutional Strategy
- Revolutionary Strategy
- New Energy Target:
  - Strategy choice of Chinese New Energy Vehicle
- Evolitional Strategy
- Optimize existing vehicle energy powertrain system
- Development of Energy-efficient Vehicles
- Sustainable Development
- Revolutionay Strategy
- Develop a new type vehicle energy powertrain system
- Development of New Energy Vehicles
- Dual Strategy
Energy-saving Target: Automotive Energy-saving Development

Strategy of New Energy Vehicle in China

- Phase 1 Fuel Consumption Limit for Passenger Car 2006 – 2008
- Phase 1 Fuel Consumption for light business car From Feb 2008
- Phase 2 Fuel Consumption for passenger car From Jan 2009
- Phase 2 Fuel Consumption for light business car From 2011
- Phase 3 Limit for passenger car, business car and transportation truck being revised

In 2002, passenger car average fuel consumption is 9.11L/100km

In 2006, it falls down to 8.08L/100km

Reduce 4% per year Accumulate to 50% fall down till 2020

Reduce 11.5%

Reduce 40%

In 2002, it will fall down to 5L/100km
New Energy Target: Promote Chinese Transportation Energy Transition

Strategy choice of Chinese New Energy Vehicle

2020年：
- Substitute 20%, save gasoline and diesel consumption more than 30million tons
- Save and substitute more than 100million tons

CO₂ emissions reduction
1. Establish technology platform, make key technology breakthroughs, realize technology leapfrogging.

2. Establish R&D platform, form regular standards, construct innovative environment.

3. Establish products platform, cultivate industry eco-cluster, promote development of industry.
## Technology roadmap: Chinese Automotive Energy and Power system routines

### Strategy choice of Chinese New Energy Vehicle

<table>
<thead>
<tr>
<th>1. Highway Transportation (Commercial vehicle, sedam)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid fuel (gasoline, diesel to bio-mass substituted fuel) + Internal combustion engine (Esp.CIDI) + Fuel Vehicle and HEV to Plug-in HEV</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. City Public Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas fuel (NG, Syn-gas to H₂) + Internal combustion engine to Fuel Cell Engine + Gas fuel vehicle and HEV to Plug-in HEV</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>3. Personal Transportation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric (Coal-based electricity to renewable energy electricity) + Battery/Motor energy motivation system + Battery Electric Vehicle</td>
</tr>
</tbody>
</table>

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1. **Liquid fuel**: Gasoline, diesel to bio-mass substituted fuel
2. **Internal combustion engine**: CIDI
3. **Gas fuel**: NG, Syn-gas to H₂
4. **Internal combustion engine to Fuel Cell Engine**
5. **Commercial vehicle, sedam**
6. **Electric**: Coal-based electricity to renewable energy electricity
7. **Battery/Motor energy motivation system**
8. **Battery Electric Vehicle**
Technology Roadmap: HEV modularization

Strategic choice of Chinese New Energy Vehicle

Advanced ICE → Hybrid Engine → Plug in Hybrid

Electrification promoted by Modularization

- Series hybrid: 100/100 electric power
- Series-parallel hybrid: 50/100 electric power
- Parallel hybrid: 20/100 electric power
- Micro hybrid: 5/100 electric power
- Conventional engine vehicle

The ratio of electric power in output power

Time
Technology roadmap: downsizing of Battery Electric Vehicle

Strategy choice of Chinese New Energy Vehicle

Through downsizing to realize scale commercialization

- small displacement car
- range extender small electric car
- small battery electric car
- light electric vehicle
- micro electric car
- small battery electric car

(lithium battery + in-wheel motor + chassis electrolization + charge with household power)
Technology roadmap: Platform of FCEV

- Gas fuel vehicle energy source platform
- Hybrid vehicle powertrain platform
- Electric vehicle chassis platform

Strategy choice of Chinese New Energy Vehicle

Through unified-platform to realize energy diversity
Technology roadmap: integration of vehicle powertrain technology

Advanced ICE powertrain (30% - 40% oil saving)

- Series-parallel hybrid (include plug-in)
  - Have clutch
  - Small Parallel HEV (BSG/ISG)
    - ICE/motor assembly
  - Small Battery EV
    - Battery/Motor driving system

- Series hybrid (include plug-in R-E)
  - No clutch

- Have clutch

- No clutch

 downside modularization platform

- 4W mini-EV
- Electric motorcycle
- Electric bicycle

Integration Strategy choice of Chinese New Energy Vehicle

- Gasoline/Diesel Engine
- Hydrogen-electric hybrid Fuel Cell Engine
- Gas-electric hybrid
  - Gas Fuel Engine
- Oil-electric hybrid
  - Gasoline/Diesel Engine
Outline

R&D Progress of Chinese New Energy Vehicle

- Technology Strategy
- R&D Progress
- Industry Prospect
## Layout: National “The tenth Five-Year” EV key project

### Key parts of EV

- **FCEV**
  - Vehicle tech. of FCEV
  - Vehicle calibration and matching
  - FC Engine

- **HEV**
  - Vehicle tech. of HEV
  - Vehicle calibration and matching
  - Engine and Transmission

- **BEV**
  - Vehicle tech. of EV
  - Vehicle calibration and matching

### Policies, Standards and test center of country

- Policies, Standards and test center of country

### Energy management system

- Energy management system

### Motor drive system and control unit

- Motor drive system and control unit

### Battery and management system

- Battery and management system

- ISA/ISG Technology
- DC/DC Convertor
- Battery
Layout: National “The eleventh Five-Year” key project of energy-saving and new energy vehicle

R&D Progress of Chinese New Energy Vehicle

Construction of industrialization support platform (Policies, Standards, finance, etc.)

Vehicle
- Clean oil vehicle
  - HEV
  - PHEV
- Gas fuel vehicle
  - Gas fuel HEV
  - FCEV
- Micro-EV
  - Battery EV
  - Plug-in EV

Power
- Battery/motor/electric control
  - Advanced engine
  - Mechanical electric coupling power system
- Battery/Motor/Electric Control
  - Gas fuel engine
  - FC engine
- Battery/motor/electric control
  - Battery/motor drive system
  - Onboard charging device

Energy
- Clean gasoline & diesel
- Mixed fuel
- Liquid alternative fuel
- Gas fuel system and gas station
- Gas mixed fuel
- Hydrogen technology

Construction of R&D technology platform (Test, Information, Patent, Layout, Monitor)
Power System Platform: Mild HEV

R&D Progress of Chinese New Energy Vehicle

- A5 HEV
- Vehicle test
- Sale, after-sale
- A5 Assembly and lightening
- CAN Network
- Safety Design
- HEV Chassis Design
- Instrument

Motor

Engine for HEV

15KW Motor

144V
NiMH Battery

HCU

Accessory

Left front

Processing

Quality
Powertrain platform: BEV powertrain

State grid vehicle
Battery electric engineering vehicle (complete bulletin test)
Developed by Corporations vehicle
Changan SC7331 battery electric passenger car

Independent development vehicle
Wire vehicle
Mini-BEV(ET)

Battery electric service vehicle (on 173 bulletin)
Haima M1 battery electric passenger car

Battery electric official vehicle
Zotye JNJ6400 BESUV (on 179 bulletin)

R&D Progress of Chinese New Energy Vehicle

Powertrain platform

Wire vehicle
Mini-BEV(ET)

Battery electric engineering vehicle (complete bulletin test)
Developed by Corporations vehicle
Changan SC7331 battery electric passenger car

Independent development vehicle
Wire vehicle
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Battery electric official vehicle
Zotye JNJ6400 BESUV (on 179 bulletin)
Powertrain platform: Plug-in hybrid powertrain

R&D Progress of Chinese New Energy Vehicle

BYD PHEV

Engine

C1

C2

M1

M2

Driving wheel

Final drive
Power System Platform: Fuel Cell Hybrid Power System

R&D Progress of Chinese New Energy Vehicle
Propulsion system platform: energy diversified hybrid propulsion system

R&D Progress of Chinese New Energy Vehicle

ICE APU
Fuel cell APU
Gas Fueled ICE APU
APU
Converter
Motor and controller
Battery system
New energy city bus
Demonstration: Olympics Demonstration of New Energy Vehicle

R&D Progress of Chinese New Energy Vehicle

595 New Energy Vehicles
Run 3,714,000 Km
Took 4,417,000 Passengers
Demonstration: Battery Electric Vehicle on Olympics

R&D Progress of Chinese New Energy Vehicle
Demonstration: Fuel Cell Electric Vehicle on Olympics

R&D Progress of Chinese New Energy Vehicle
To promote a three-year long “10city---1000Vehicle” Large Scale Demonstration Program in selected cities

New energy vehicle are firstly applied in public transportation system

Subsidy from government to operation department is available to offset the price difference between new energy vehicle and traditional vehicle.

1、Examine the key components technology, popularize the independent research product, promote the quality of product.
2、to form a virtuous cycle of “policy support ←→ lower price ←→ market spread”.
3、to stride over the market cultivation phase and enter the fast growth phase.
Demonstration : SHANGHAI EXPO in 2010

R&D Progress of Chinese New Energy Vehicle

- Over 1000 new energy vehicle will serve the SHANGHAI EXPO in 2010.
- 300 BEV and 200 FCV will serve in the park to implement zero emission; 500 HEV will serve around the park.
- After the Expo, HEV and EV will join the Shanghai public bus team.
At the end of 2008, 1796 patents are applied based on research of ‘Energy-saving and New Energy Vehicle’ Program, including 940 invention patents.
In Nov.2007, China has published its laws on new energy vehicle production.

More than 100 types of new energy vehicles are allowed to scale production.
Outline

Industry Prospect of Chinese New Energy Vehicle

- Technology Strategy
- R&D Progress
- Industry Prospect
Chinese Transportation Structure

Structure of Points-lines-Areas

Points—larger city
- Public transportation
- Private car

Areas—town
- Public transportation
- Personal car and E-bike

Lines—city-city
- Railway
- Airline
- Commercial vehicle

Industry Prospect of Chinese New Energy Vehicle
Points-lines-Areas structure and transportation means choice

Industry Prospect of Chinese New Energy Vehicle

- Airline
- Railway
- Waterway
- Passenger car
- Transit bus
- Subway
- Micro EV
- Transit bus

km
Transportation development route

Industry Prospect of Chinese New Energy Vehicle

Railway is more convenient for the inter-city tour.

Traffic turnover by mode

Source:《China Statistics Yearbook》

Railway line

- Total length of the railway network will reach 0.12 million kilometers by 2020.
- The length of speedy railway will exceed 16 thousand kilometers.
Transportation development route

Big market of E-bike in China

- Up to 2008:
  - The population of E-bike in China is nearly 80 million.
  - The output each year is over 20 million.

- E-bike has become the most popular transportation in towns.
Mass commercialized vehicle model prediction in 5-10 years

Industry Prospect of Chinese New Energy Vehicle

1. **New energy city bus**

2. **Mild hybrid car**

3. **Micro/mini electric vehicle**
3 Steps Industrialization of New Energy Vehicle

Prospect of New Energy Vehicle in China

Step 1
- Demonstration in public transportation (HEV, EV, FCV), 60,000 vehicles

Step 2
- New Energy City Bus
- Micro/Mild HEV
- Mini/Small EV

Step 3
- HCCI Hybrid Engine Car
- PHEV
- FCV

Timeline:
- 2008
- 2010
- 2012
- 2015
- 2020
- 2030
Energy Diversification, Propulsion Electrification and Emission Reduction will promote China’s new energy vehicle industry Development.
Thank you!