CHINA'S STRATEGY
TOWARDS A SUSTAINABLE MOBILITY

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1. Status and challenges of Chinese automotive industry
2. Global strategy of sustainable mobility
3. Electric vehicle development roadmap
4. Intelligent vehicle development roadmap
China is entering automotive society

- Total population: 1.383 billion
- Total private cars: 163.3 million
- Vehicles per 1000 person: 118

Automotive industry is important economic engine for China

- No. 1 position of automotive production and sale in the world for consecutive 9 years
- Contribution to China's GDP has reached 11.2% in 2016
- Led to about 10% of the employed population

Automotive transport is very important for land transportation

- About **80%** volume contribution and **33%** turnover contribution to passenger and freight transportation
- About **90%** contribution to city transportation

**Bar Charts**

- Passenger volume: Railway 81.2%, Road 77.5%, Water 50%, Plane 0%
- Freight volume: Railway 29%, Road 13%, Water 0%, Plane 0%
- Passenger turnover: Railway 32.7%, Road 33.5%
- Freight turnover: Railway 0%

**Circle Chart**

- Bus: 58%
- Rail transit: 29%
- Taxi: 13%
- Others: 0%

Ministry of Transport, P.R. China, 《Statistics Bulletin of Traffic and Transportation industry development, 2016》
Challenge 1: Energy consumption

- Automotive transportation causes about **35%** of total oil consumption
- Import part reaches about **70%** of total oil consumption, energy security has been categorized as a domestic economic development issue

**Transportation consumption of oil (billion tons)**

- 2011: 1.0
- 2012: 1.2
- 2013: 1.4
- 2014: 1.6
- 2015: 1.8
- 2016: 2.0

**Foreign dependence of crude oil (%)**

- 2011: 50
- 2012: 55
- 2013: 60
- 2014: 65
- 2015: 70
- 2016: 75

### Challenge 2: Environment pollution

- The contribution of automobile pollution emissions is over 80%, which is the main source of air pollution and greenhouse effect.

<table>
<thead>
<tr>
<th>Source: Ministry of Ecology and Environment, P.R. China, 《Bulletin of the State of environment in China, 2016》</th>
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<tbody>
<tr>
<td><strong>Motor vehicles’ emission is the main contributor of air pollution, including 80% CO and HC, and 90% NOX and PM.</strong></td>
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<td>In 2016, total emission of motor vehicles is <strong>44.7 million tons</strong>, including about <strong>34 million tons</strong> of CO, <strong>4.22 million tons</strong> of HC, <strong>5.78 million tons</strong> of NOX, and <strong>0.53 million tons</strong> of PM.</td>
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<td>Automobile is one important contributor to Greenhouse gases, its percent is about <strong>30%</strong></td>
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<td><strong>In 2016, the ambient air quality of 75.1% of 338 cities in China, did not meet the standard.</strong></td>
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<td>In 338 cities, the number of severe pollution days are <strong>2,464</strong>, serious pollution days are <strong>784</strong>.</td>
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<td>There are more than <strong>30 days</strong> of heavy pollution and above in 32 cities of Hebei, Shanxi, Shandong, Henan provinces.</td>
</tr>
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Challenge 3: Traffic safety

- Road traffic fatalities is reported **58,539/year** by Ministry of Public Security.
- WHO estimated road traffic fatalities is **261,367/year**.

**DEATHS BY ROAD USER CATEGORY**

- Pedestrians (26%)
- Cyclists (8%)
- Drivers/passengers heavy trucks (4%)
- Drivers 4-wheeled cars and light vehicles (6%)
- Passengers 4-wheeled cars and light vehicles (13%)
- Riders motorized 2- or 3-wheelers (27%)
- Other (16%)

SOURCE: WHO, 《GLOBAL STATUS REPORT ON ROAD SAFETY 2015》
Challenge 4: Traffic congestion

- The city traffic congestion is unbearable, the travel is difficult, the loss is astonishing.

- In 2016, urban commuting of 1/3 of all cities is threatened by congestion

- In 400 cities, the average congestion Delay Index is 1.58, and the average vehicle speed is only 24.8km/h

- In 2016, the congestion loss of Beijing is 189.4 billion RMB, which is about 8.88% of Beijing’s GDP

SOURCE: 《Annual traffic Analysis report of major cities in China, 2016》, 《Smart Travel Big Data Report, 2016》
Sustainable mobility: global concept

Energy saving, Eco-Friendly (Electrification)

Safe, Convenient (Intelligentization, Connection)

Light, Recycled (Weight-reduction)

Transportation-network

Information-network

Energy-network

Smart mobility

Material & Structure Transformation (MS-V2X)

Energy & Power Transformation (EP-V2X)

II-V2X
Sustainable mobility: global vision

**Sustainable mobility**
- Energy sustainable and environmentally friendly mobility
- Safe and efficient intelligent transportation system
- Recycling and reusing of scarce resources

**Sustainable automotive industry**
- To enhance technical capabilities
- To improve product quality
- To upgrade Industrial ecology
- To establish powerful competitiveness

**Light-weight Engineering**
- Light-weight material
- Light-weight structure
- Light-weight manufacture

**Powertrain Engineering**
- Advanced ICE vehicles
- Battery electric vehicles
- Plug-in electric vehicles
- Fuel cell electric vehicles

**Intelligent & Connection Engineering**
- Automated vehicle
- Connected vehicles

Source: “Technology roadmap of energy-saving and new-energy vehicles”, SAE-China with 500 experts, entrusted by the Ministry of Industry and Information technology
Overall objectives

- **Carbon emission**: to make Chinese automotive industry reach its carbon emission peak in 2028, in advance to automotive industrial volume peak, and national 2030 carbon peak commitment.

- **Electric vehicle**: to make the new energy vehicles gradually become mainstream products, and realize electrified transformation of Chinese automotive industry.

- **Intelligent vehicle**: To develop a series of original science and technology achievements and apply them in the area of automated and connected vehicle

- **Innovation ability**: To establish independent technology innovation system with continuous innovation ability, and to make the parts industry with international competitiveness
Sustainable mobility: global goals and key milestones (2)

**ICE vehicle**

Average fuel rate of new vehicle

- Passenger vehicle: 5L/100km
- Commercial vehicle: be close to international level

**New energy vehicle**

Market Share

- New energy vehicle accounted for 7% or more of the total sales

**Intelligent & connected vehicle***

Market Share

- DA, PA, and CA level intelligent vehicles accounted for more than 50% of total vehicle sales

*: DA(L1), PA(L2), CA(L3), HA(L4) and FA(L5) are SAE levels of driving automation.
Subsidy policy for promotion of NEV development

- “Notice on adjusting the policy of popularizing financial subsidy for new energy vehicles” (〔2016〕No. 985), MOF, MOST, MIIT and NDRC, 29th Dec. 2016
- “Notice on adjusting and perfecting the policy of popularizing and applying financial subsidy for new energy vehicles”, (〔2018〕No. 18), MOF, MOST, MIIT and NDRC, 12th Feb. 2018

- To heighten the technical requirements of energy density of battery, fuel consumption rate of vehicle, range under electric mode.
- To consider the actual operating mileages (>20,000km), total subsidy can be gained only the vehicle reaches the required mileage.
- To reduce subsidy considering the cost reduction of EV and PEV, while maintain the subsidy level of fuel cell vehicles.
- Detailed information you can see the document of “New Energy vehicle promotion subsidy scheme and product technical requirements”.

Dual points policy for promotion of NEV development

“The method of parallel management of average fuel consumption and new energy vehicle points in passenger car enterprises” (No. 44), MIIT, MOF, MOC, GAC and GAQSIQ, 27th Sep. 2017

- **New energy vehicle**: plug-in/ range extender electric vehicle, battery electric vehicle and fuel cell vehicle
- **Traditional energy vehicle**: ICE vehicle or hybrid electric vehicles using gasoline, diesel and gas fuels
- To reduce energy consumption and emission of TEV, and to promote the mass production of NEV
- To balance the ratio of TEV and NEV to sustainable energy supply step by step.
- Detailed information can be seen in the file of “The method of parallel management of average fuel consumption and new energy vehicle points in passenger car enterprises”.

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Battery electric vehicle (BEV) and plug-in electric vehicle (PEV)

Market share of BEV & PEV
- 7%-10% of the total vehicle sales (2020)
- 15%-20% of the total vehicle sales (2025)
- 40%-50% of the total vehicle sales (2030)

Charge piles and charge stations
- > 12,000 charge station (2020)
- > 5 million charge piles (2020)
- In urban agglomeration (2020)
- > 36,000 charge station (2025)
- > 20 million charge piles (2025)
- All over China (2025)
- > 48,000 charge station (2030)
- > 80 million charge piles (2030)
- All over China (2030)

Key technologies:
- High performance battery and management technologies
- High performance electric machine and control technologies
- Low cost and high efficiency hybrid electric powertrain system
- Energy management and power control of powertrain system
- Advanced charging technologies (fast-charging, wire less charging)
Battery electric vehicle (BEV) and plug-in electric vehicle (PEV)

BEV Application areas
- PV: private car, home car, rental cars, business car etc.
- CV: bus, municipal freight vehicle, logistics truck etc.

BEV- PV Key performances
- power consumption <12kWh/100km (1200kg)

BEV- CV Key performances
- power consumption <3.5kWh/100km · ton

PEV Key performances
- equivalent acceleration capacity to ICE vehicle
- fuel saving rate >25% under hybrid mode than ICE vehicle

Key performances
- power consumption <10.8kWh/100km (1200kg)
- power consumption <3.2kWh/100km · ton
- fuel saving rate >27.5% under hybrid mode than ICE vehicle
- power consumption <3.0kWh/100km · ton
- fuel saving rate >30% under hybrid mode than ICE vehicle
Electric motor for BEV and PEV

Electric motor
- Power density >4 kW/kg (PV)
- Torque density >18 Nm/kg (CV)

Electric motor power unit
- Power density >30 kW/L

Key technologies:
- High density and high efficiency permanent magnet motor
- Close-to-wheel and in-wheel motor
- High voltage and high speed motor
- High reliable and low cost inverter
- Advanced chip technology and packaging technology for inverter
- Application of wide-band gap material in inverter

Power density and torque density targets for 2020, 2025, and 2030 are also shown in the diagram.
Power battery for BEV and PEV

- **Energy density**
  - >350Wh/kg (cell)
  - >650Wh/L (cell)
  - >250Wh/kg (package)
  - >320Wh/L (package)
- **Power density**
  - >1000W/kg (cell)
  - >700W/kg (package)
- **Life**
  - >4000/10 years (cell)
  - >3000/10 years (pack.)
- **Cost**
  - <0.6RMB/Wh (cell)
  - <1.0RMB/Wh (pack.)

- **Energy density**
  - >400Wh/kg (cell)
  - >800Wh/L (cell)
  - >280Wh/kg (package)
  - >500Wh/L (package)
- **Power density**
  - >1000W/kg (cell)
  - >700W/kg (package)
- **Life**
  - >4500/12 years (cell)
  - >3500/12 years (pack.)
- **Cost**
  - <0.5RMB/Wh (cell)
  - <0.9RMB/Wh (pack.)

- **Energy density**
  - >500Wh/kg (cell)
  - >1000Wh/L (cell)
  - >350Wh/kg (package)
  - >700Wh/L (package)
- **Power density**
  - >1000W/kg (cell)
  - >700W/kg (package)
- **Life**
  - >5000/15 years (cell)
  - >4000/15 years (pack.)
- **Cost**
  - <0.4RMB/Wh (cell)
  - <0.8RMB/Wh (pack.)

Power battery for Battery EV

2020 - 2030
Power battery for BEV and PEV

Key technologies:
- Battery safety and durability technologies (thermal run away etc.)
- Battery design and simulation, testing and validation technologies
- Battery cascade utilization, recycling and reuse technologies
- New material for power battery (Solid State Battery, Lithium Sulfur battery, Metal Air Battery)
Fuel cell electric vehicle (FCV)

Market share of FCV
- 5000 vehicles sales
- 50,000 vehicles sales
- 1 million vehicle sales

Key performances of FCV
- PV: 200,000 km durability, 300,000 RMB
- CV: 400,000 km durability, 1500,000 RMB
- PV: 250,000 km durability, 200,000 RMB
- CV: 800,000 km durability, 1000,000 RMB
- PV: 300,000 km durability, 180,000 RMB
- CV: 1000,000 km durability, 600,000 RMB

Hydrogen storage and stations
- Density >35g/L
- Cost <3000RMB/kg (H2)
- >100 stations
- Density >40g/L
- Cost <2000RMB/kg (H2)
- >300 stations
- Density >70g/L
- Cost <1800RMB/kg (H2)
- >1,000 stations

Key technologies:
- High performance key materials (MEA, Bipolar Plates etc.)
- High performance fuel cell stack (high power and high power density)
- High performance auxiliary systems (air compressor, hydrogen injection)
- High performance fuel cell engine system (cold start, durability etc.)
- High performance combined power system (fuel cell + power battery/Super Capacitor)
Fuel cell system for FCV

**Fuel cell system for passenger car**
- Rated power >60kW
- Max. efficiency >45%
- Power density >400W/L or >450W/kg
- Cold start -30°C
- Durability >5000h
- Cost <1500RMB/kg

**2020**
- Rated power >75kW
- Max. efficiency >50%
- Power density >600W/L or >550W/kg
- Cold start -40°C
- Durability >6000h
- Cost <800RMB/kg

**2025**
- Rated power >100kW
- Max. efficiency >55%
- Power density >850W/L or >650W/kg
- Cold start -40°C
- Durability >8000h
- Cost <200RMB/kg

**2030**
- Rated power >150kW
- Max. efficiency >55%
- Power density >500W/kg
- Cold start -40°C
- Durability >30,000h
- Cost <600RMB/kg

**Fuel cell system for commercial vehicle**
- Rated power >60kW
- Max. efficiency >45%
- Power density >300W/kg
- Cold start -20°C
- Durability >10,000h
- Cost <5000RMB/kg

**2020**
- Rated power >100kW
- Max. efficiency >50%
- Power density >400W/kg
- Cold start -30°C
- Durability >20,000h
- Cost <2000RMB/kg

**2025**
- Rated power >150kW
- Max. efficiency >55%
- Power density >500W/kg
- Cold start -40°C
- Durability >30,000h
- Cost <600RMB/kg

**2030**
- Rated power >200kW
- Max. efficiency >60%
- Power density >650W/kg
- Cold start -40°C
- Durability >40,000h
- Cost <800RMB/kg
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Key technologies for intelligent vehicles

Intelligent & connected vehicle*

Market Share

- DA, PA and CA level intelligent vehicles accounted for more than 50% of total vehicle sales
- DA, PA and CA level intelligent vehicles accounted for more than 50% of total, while PA and CA 25%
- DA, PA and CA level and connected vehicles accounted for near 100% of total, while HA and FA 10%

Key technologies:
- Deep cognition method for machine vision
- Dynamical high precision maps
- Environment perception and cognition based on self-sensing and connected-information
- Integrated motion control based on X-by-wire chassis system
- Informatization and intelligentization of transportation infrastructures
- Communication technologies for wireless V2X
- Detection and protection technologies for information security
- Cloud calculation for coordinated road-vehicle system
- Testing and evaluation of intelligent & connected vehicle
Milestones of intelligent passenger vehicle

**Coordinated planning and controlling based on connection**
- Vehicle-road coordination
- Intercity autonomous driving
- Self-driving

**Coordinated sensing based on connection**
- High way autonomous driving
- Suburban roads autonomous driving
- Coordinated platoon driving
- Intersection access assistance

**Connection**
- Adaptive cruise control
- Automatic emergency braking
- Lane keeping
- Assisted parking
- Dedicated Lane autonomous driving
- Lane change assist
- Automated parking

**Automation**
- 2016: DA (L1)
- 2017: PA (L2)
- 2018: CA (L3)
- 2020: HA&FA (L4&5)
- 2022:
- 2025+:
Milestones of intelligent commercial vehicle

- **Coordinated planning and controlling based on connection**
  - Vehicle-road coordination
  - Self-driving

- **Coordinated sensing based on connection**
  - High way autonomous driving
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- **Connection**
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- **Automation**
  - 2016: DA (L1)
  - 2017: PA (L2)
  - 2018: CA (L3)
  - 2020: HA & FA (L4 & 5)
  - 2022: Ha & FA (L4 & 5)
  - 2025+: Ha & FA (L4 & 5)
Thank you very much for your attention.

同心同德同舟楫 济人济事济天下

With one heart, with one dream and with the same future. For the people, for whole world and for the same planet.