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# CHINA'S STRATEGY TOWARDS A SUSTAINABLE MOBILITY

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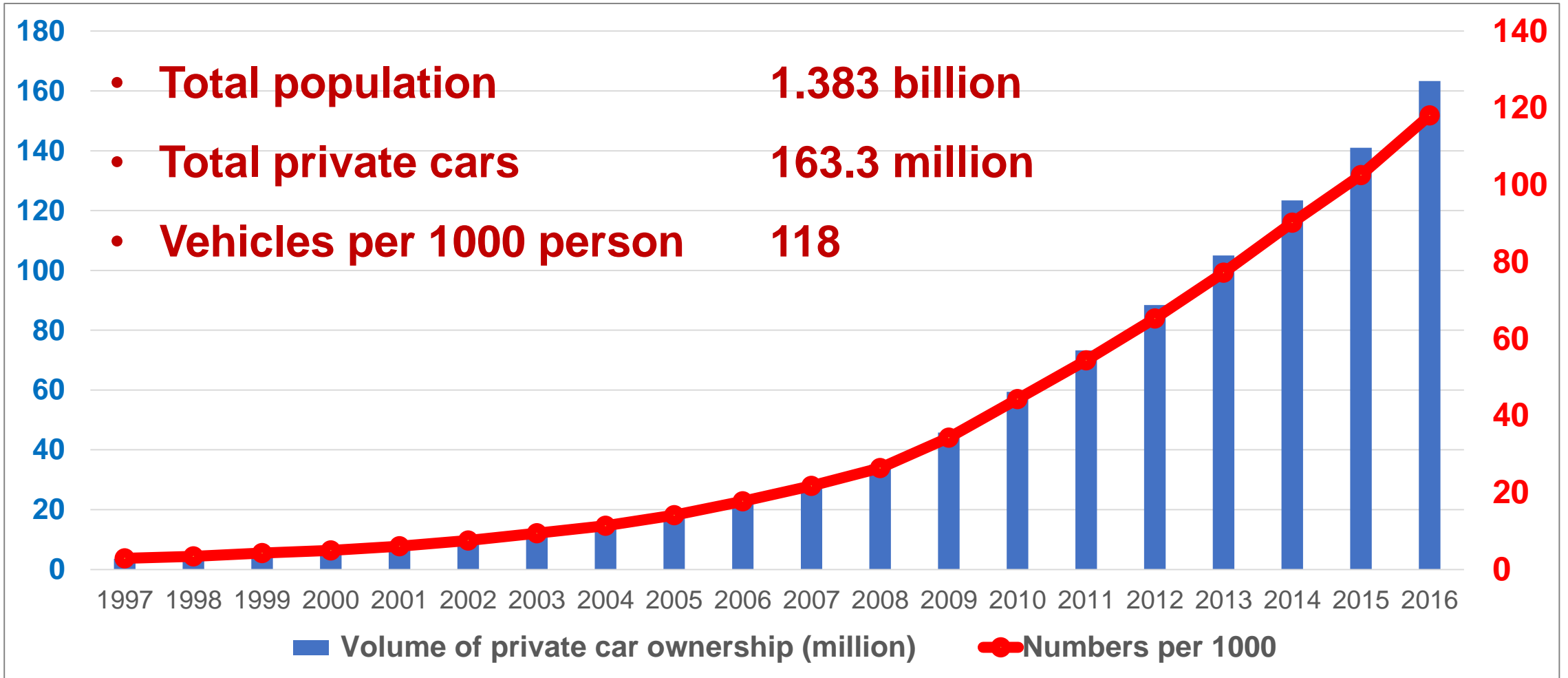
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# China is entering automotive society

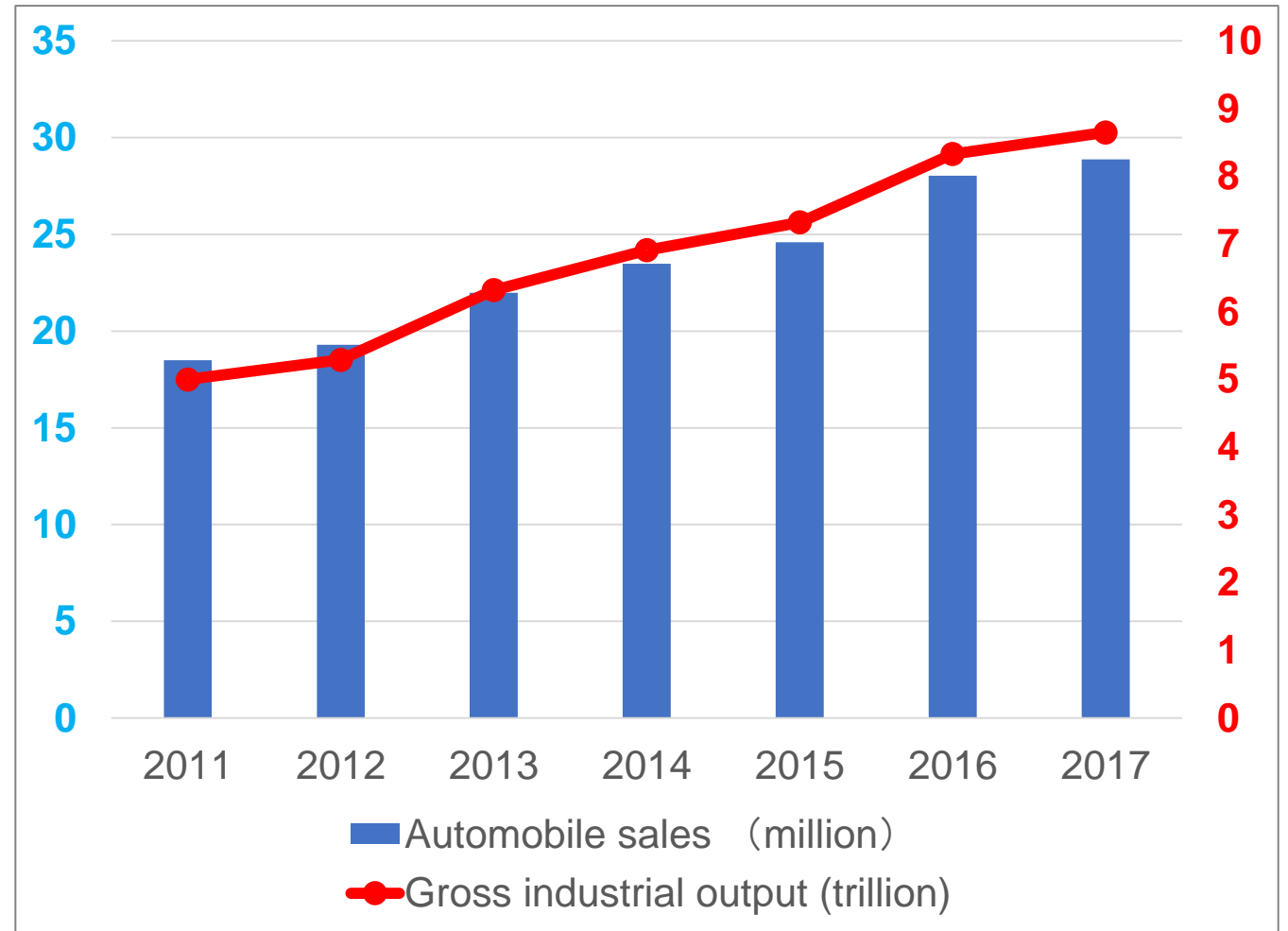


SOURCE: National Bureau of Statistics, <http://www.stats.gov.cn/>



# 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

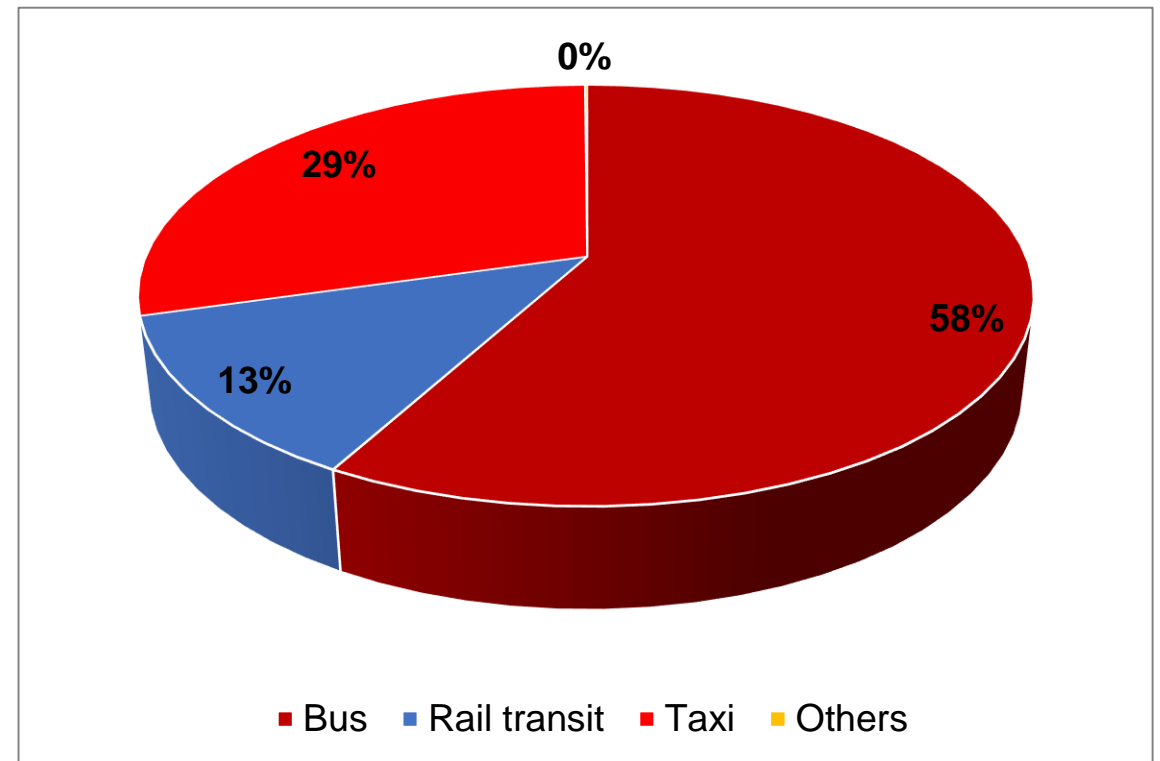
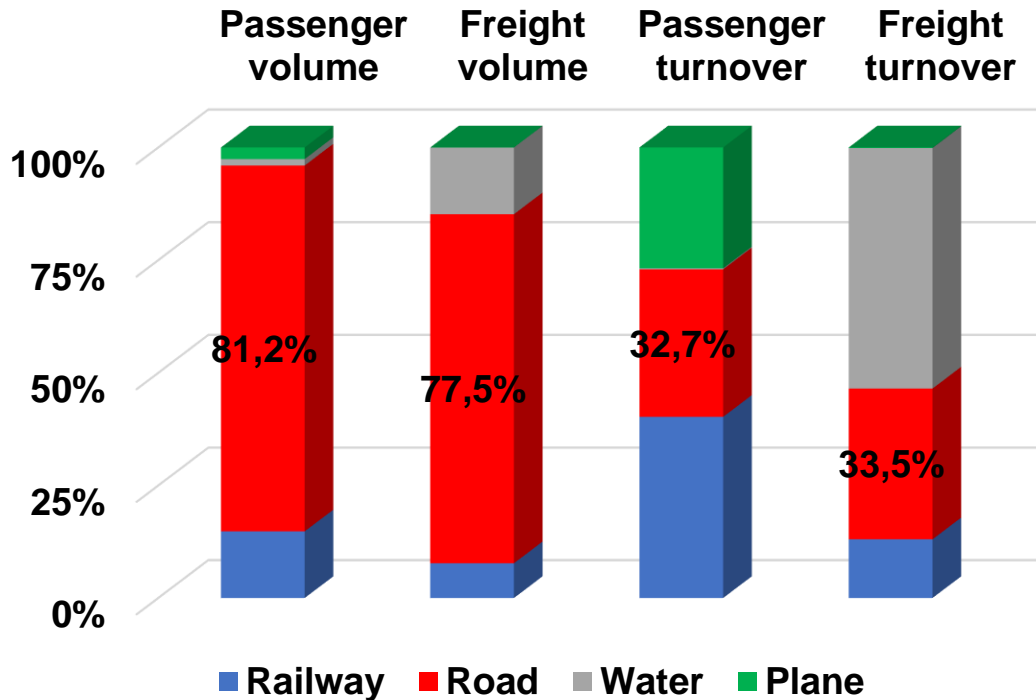


SOURCE: Ministry of Industry and Information Technology of P.R. China ,<http://www.miit.gov.cn>



# 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

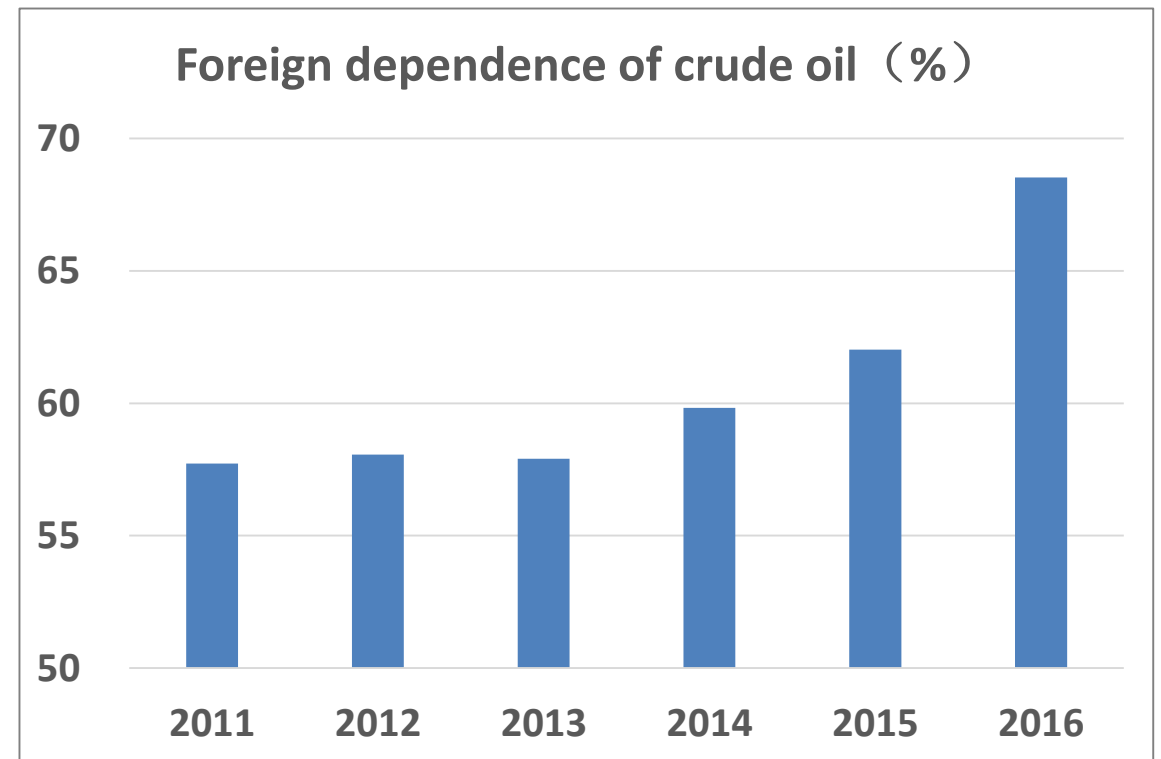
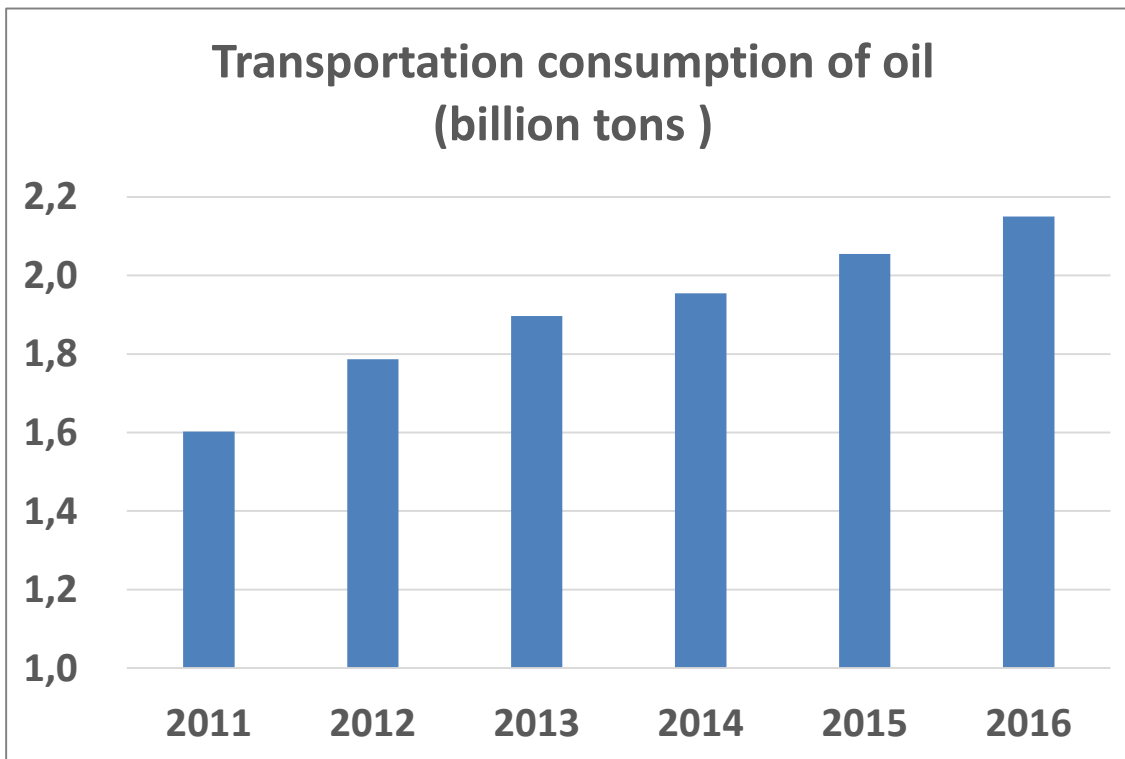


SOURCE: National Bureau of Statistics, <http://www.stats.gov.cn/>  
Ministry of Transport, P.R. China, 《Statistics Bulletin of Traffic and Transportation industry development, 2016》



# 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



SOURCE: National Bureau of Statistics, <http://www.stats.gov.cn/>



## Challenge 2 : Environment pollution

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

- Motor vehicles' emission is the main contributor of air pollution, including **80%** CO and HC, and **90%** NOX and PM.
- In 2016, total emission of motor vehicles is **44.7 million** tons, including about **34 million** tons of CO, about **4.22 million** tons of HC, **5.78 millions** tons of NOX, and **0.53 million** tons of PM.
- Automobile is one important contributor to Greenhouse gases, its percent is about **30%**

- In 2016, the ambient air quality of **75.1%** of 338 cities in China, did not meet the standard.
- In 338 cities, the number of severe pollution days are 2,464, serious pollution days are **784**.
- There are more than **30 days** of heavy pollution and above in 32 cities of Hebei, Shanxi, Shandong, Henan provinces.

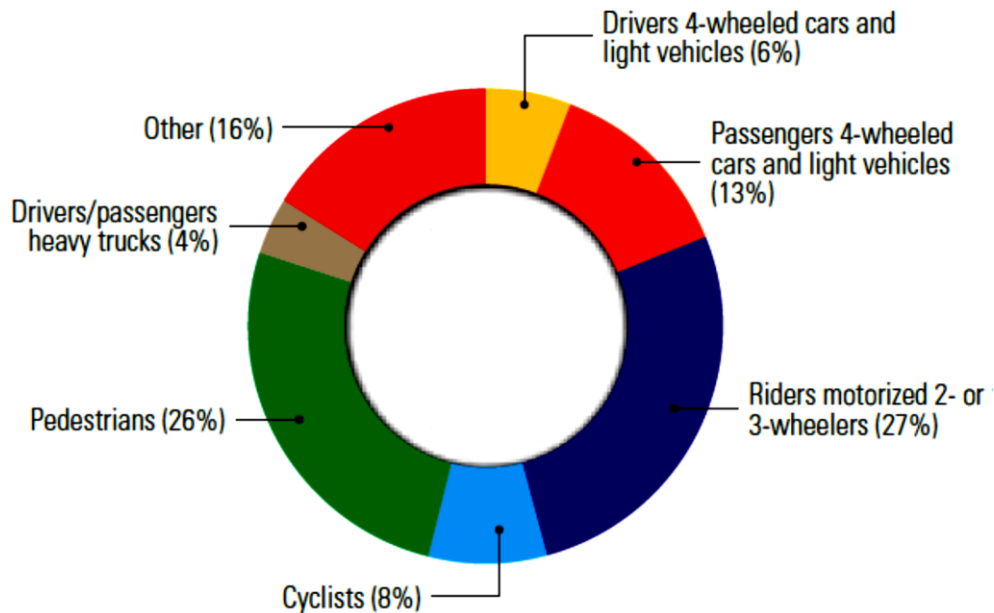
SOURCE: Ministry of Ecology and Environment, P.R. China , 《Bulletin of the State of environment in China, 2016》



# 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



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》



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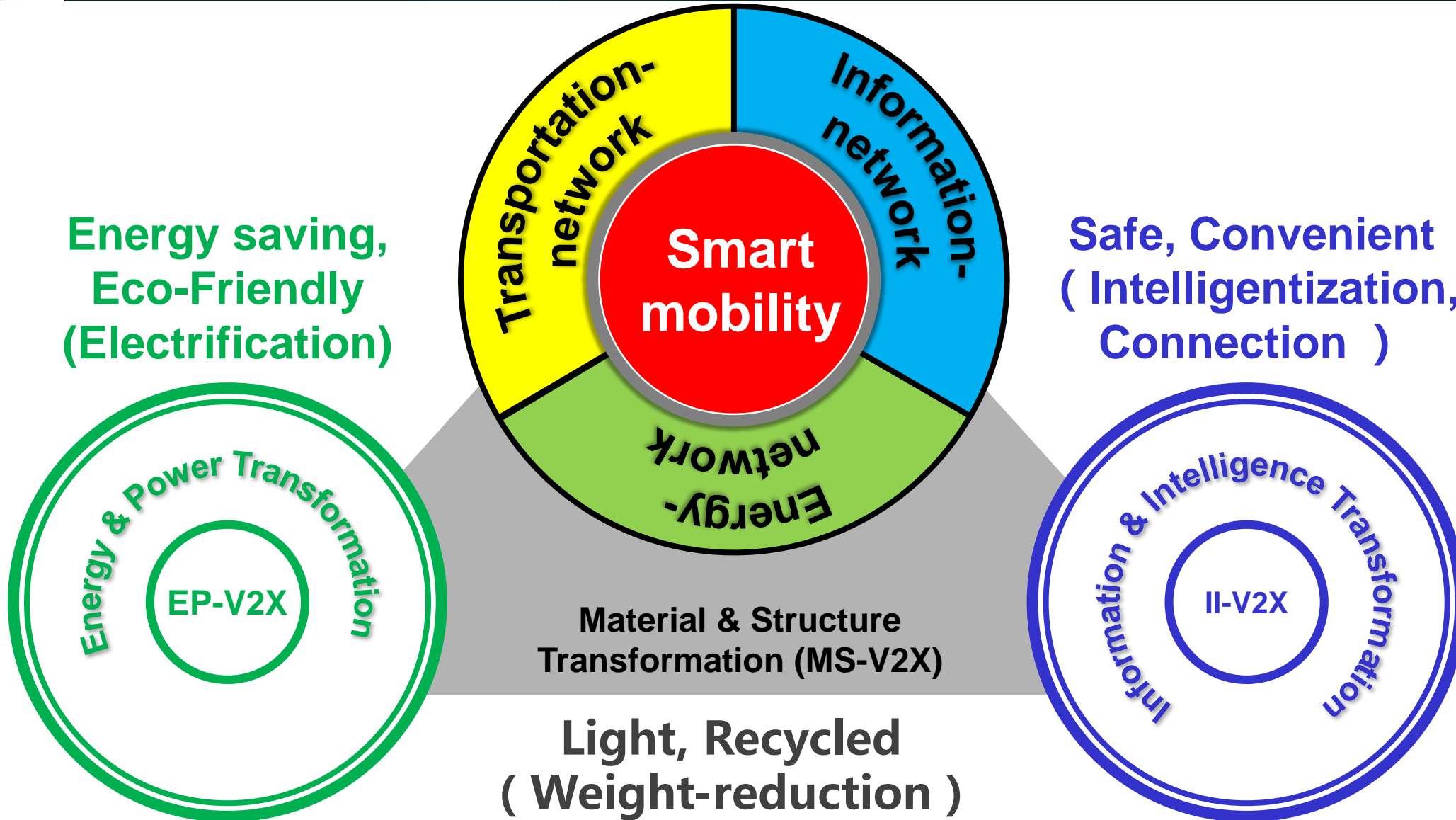
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# Sustainable mobility: global concept





# Sustainable mobility: global vision

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

## 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

## Sustainable automotive industry

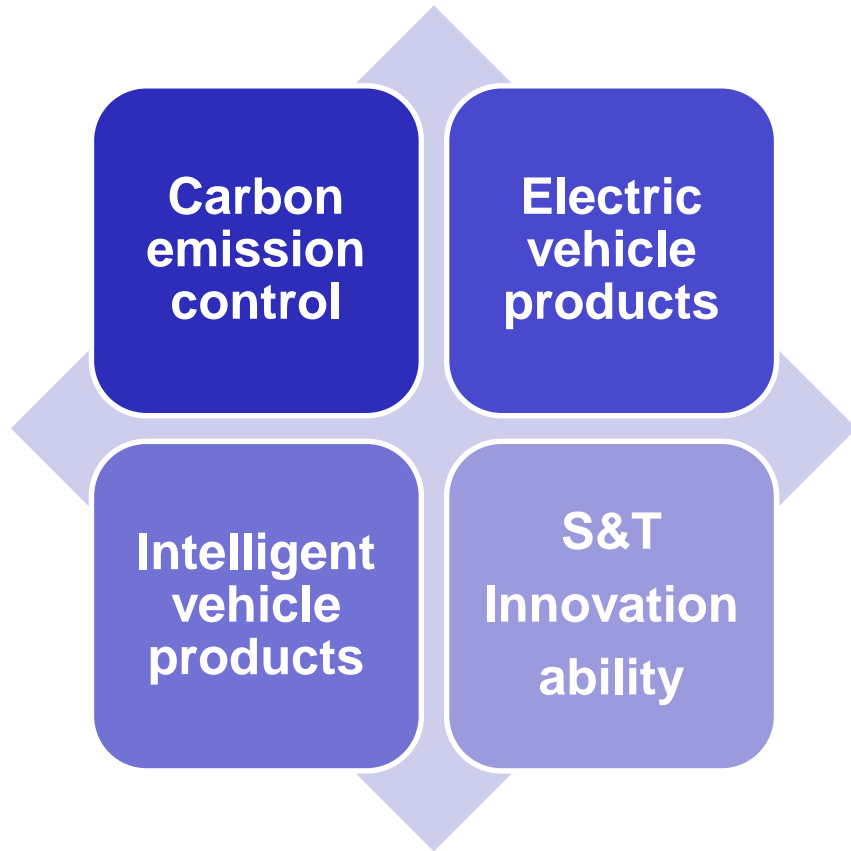
- To enhance technical capabilities
- To improve product quality
- To upgrade Industrial ecology
- To establish powerful competitiveness

## Sustainable mobility

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



# Sustainable mobility: global goals and key milestones (1)

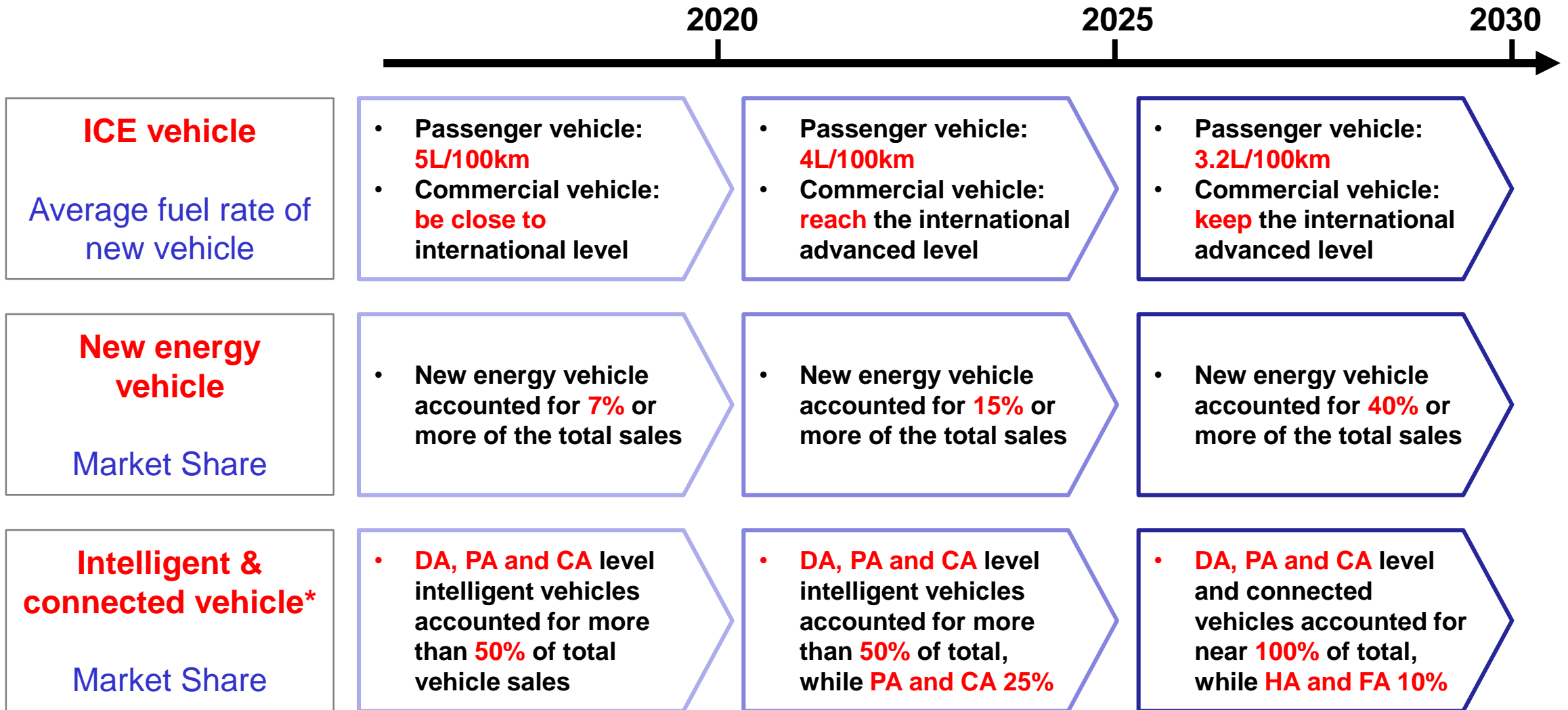


## Overall objectives

- **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)



\*: 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, 29<sup>th</sup> 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, 12<sup>th</sup> 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, 27<sup>th</sup> 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)

2020

2025

2030

## Market share of BEV & PEV

- **7%-10%** of the total vehicle sales

- **15%-20%** of the total vehicle sales

- **40%-50%** of the total vehicle sales

## Charge piles and charge stations

- **> 12,000** charge station
- **> 5 million** charge piles
- In urban agglomeration

- **> 36,000** charge station
- **> 20 million** charge piles
- All over China

- **> 48,000** charge station
- **> 80 million** charge piles
- All over China

## 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)

2020

2025

2030

## 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)
- power consumption **<10.8kWh/100km** (1200kg)

## BEV- CV Key performances

- power consumption **<3.5kWh/100km · ton**
- power consumption **<3.2kWh/100km · ton**
- power consumption **<3.0kWh/100km · ton**

## PEV Key performances

- equivalent acceleration capacity to ICE vehicle
- fuel saving rate **>25%** under hybrid mode than ICE vehicle
- fuel saving rate **>27.5%** under hybrid mode than ICE vehicle
- fuel saving rate **>30%** under hybrid mode than ICE vehicle



# Electric motor for BEV and PEV

2020

2025

2030

## Electric motor

- Power density  $>4\text{kW/kg}$  (PV)
- Torque density  $>18\text{Nm/kg}$  (CV)

- Power density  $>4.5\text{kW/kg}$  (PV)
- Torque density  $>19\text{Nm/kg}$  (CV)

- Power density  $>5\text{kW/kg}$  (PV)
- Torque density  $>20\text{Nm/kg}$  (CV)

## Electric motor power unit

- Power density  $>30\text{kW/L}$

- Power density  $>40\text{kW/L}$

- Power density  $>50\text{kW/L}$

### 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 battery for BEV and PEV

2020

2025

2030

## Power battery for Battery EV

- **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 BEV and PEV

2020

2025

2030

## Power battery for Plug-in EV

- Energy density
  - >200Wh/kg (cell)
  - >400Wh/L (cell)
  - >120Wh/kg (package)
  - >240Wh/L (package)
- Power density
  - >1500W/kg (cell)
  - >900W/kg (package)
- Life
  - >3000/10 years (pack.)
- Cost
  - <1.0RMB/Wh (cell)
  - < 1.5RMB/Wh (pack.)

- Energy density
  - >250Wh/kg (cell)
  - >500Wh/L (cell)
  - >150Wh/kg (package)
  - >300Wh/L (package)
- Power density
  - >1500W/kg (cell)
  - >1000W/kg (package)
- Life
  - >4000/12 years (pack.)
- Cost
  - <0.9RMB/Wh (cell)
  - < 1.3RMB/Wh (pack.)

- Energy density
  - >300Wh/kg (cell)
  - >600Wh/L (cell)
  - >180Wh/kg (package)
  - >350Wh/L (package)
- Power density
  - >1500W/kg (cell)
  - >1000W/kg (package)
- Life
  - >5000/15 years (pack.)
- Cost
  - <0.8RMB/Wh (cell)
  - < 1.1RMB/Wh (pack.)

### 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)

2020

2025

2030

## 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

2020

2025

2030

## 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**

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

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

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

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





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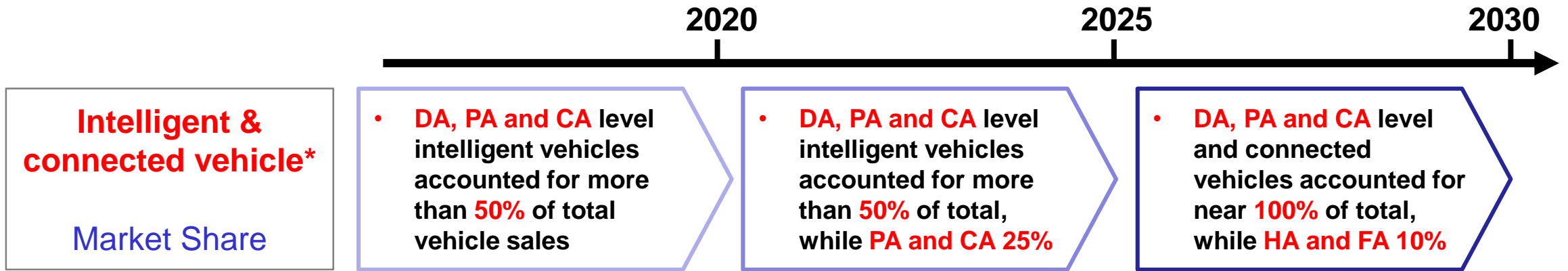
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# Key technologies for intelligent vehicles

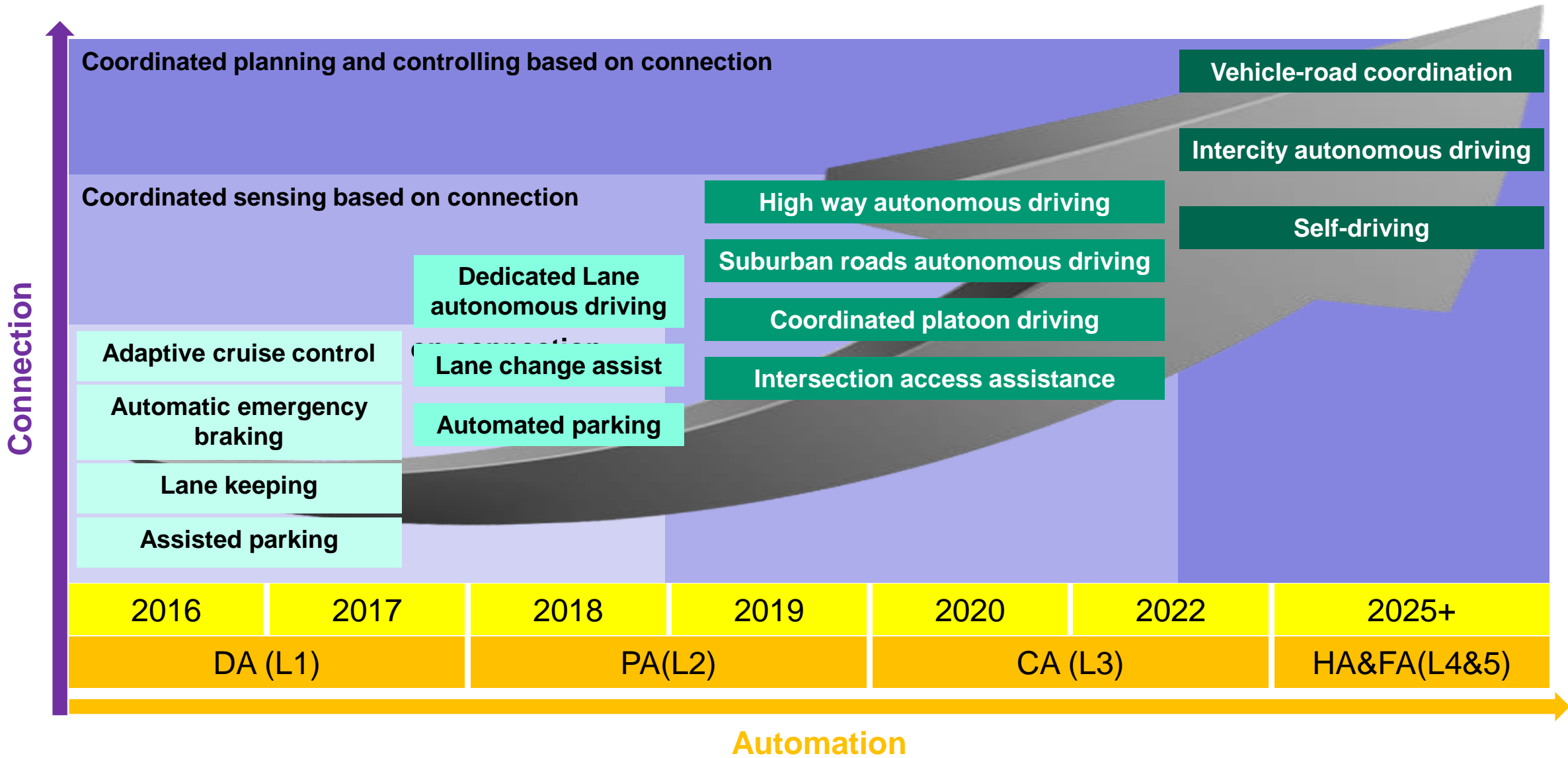


## Key technologies:

- 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

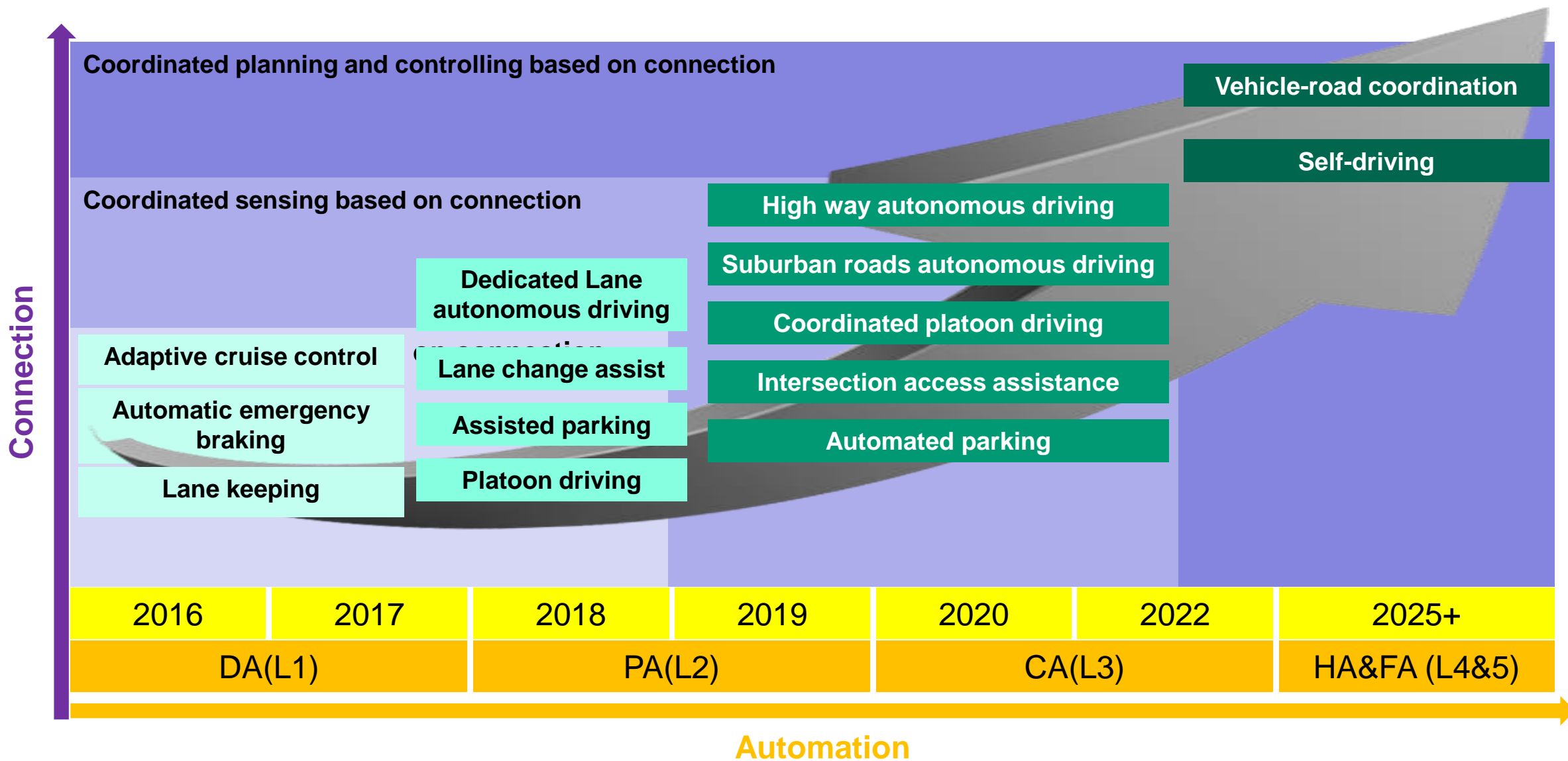


# Milestones of intelligent passenger vehicle





# Milestones of intelligent commercial vehicle





**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.**