# Overview of NGV in China & Research Status of CAERI

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# Outline

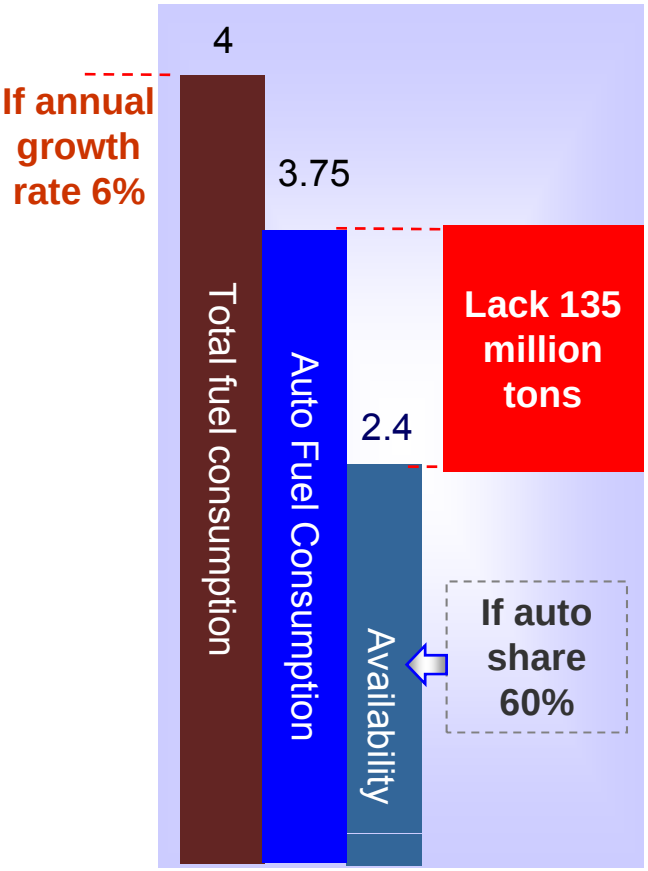
1 Automotive and Energy Environment

2 Development of NGV in China

3 Research Status of NGV in CAERI

# 1. Automotive and Energy Environment

- In 2012, China produced more than 19 million autos, auto population exceeded 120 million
- 250 million tons of petrol and diesel has been consumed, auto shared over 60%
- In 2020, auto population maybe reach 250 million , even fuel consumption of each car lower 20%, fuel supply will be still lack of 60 million tons




Fuel consumption gap estimation in 2020 (100 million tons)

Development of Auto in China Closely Relate to Energy Supply

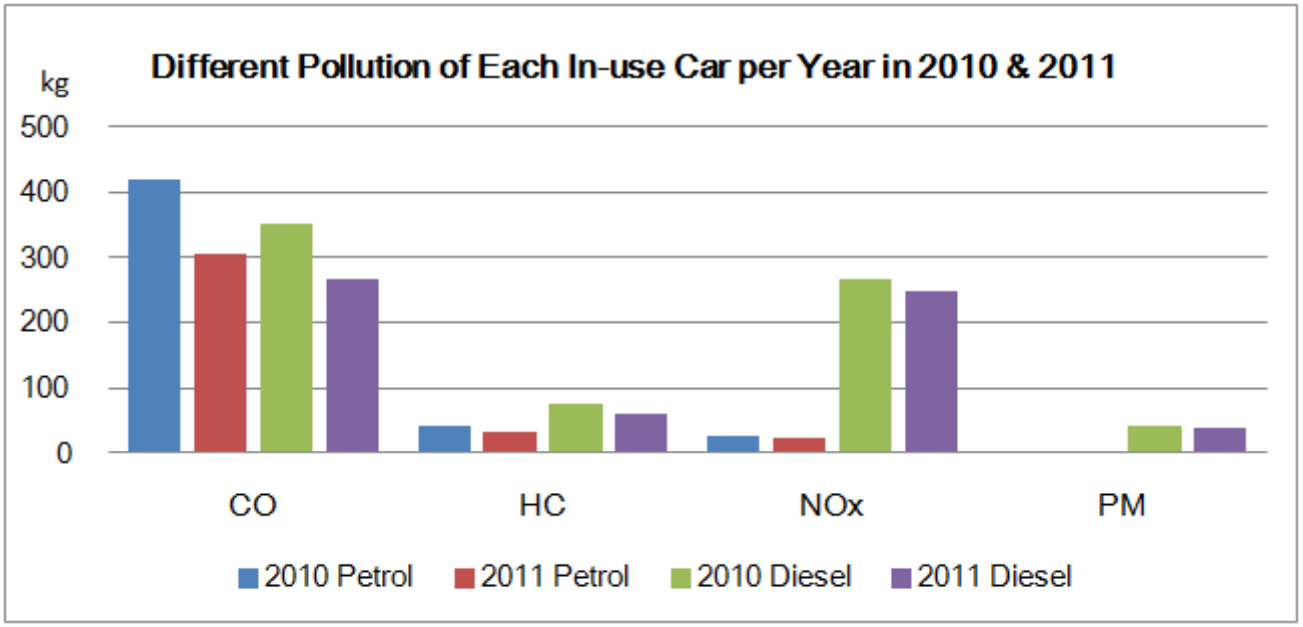
# 1. Automotive and Energy Environment

## Achievement of auto pollution control is remarkable(2011)

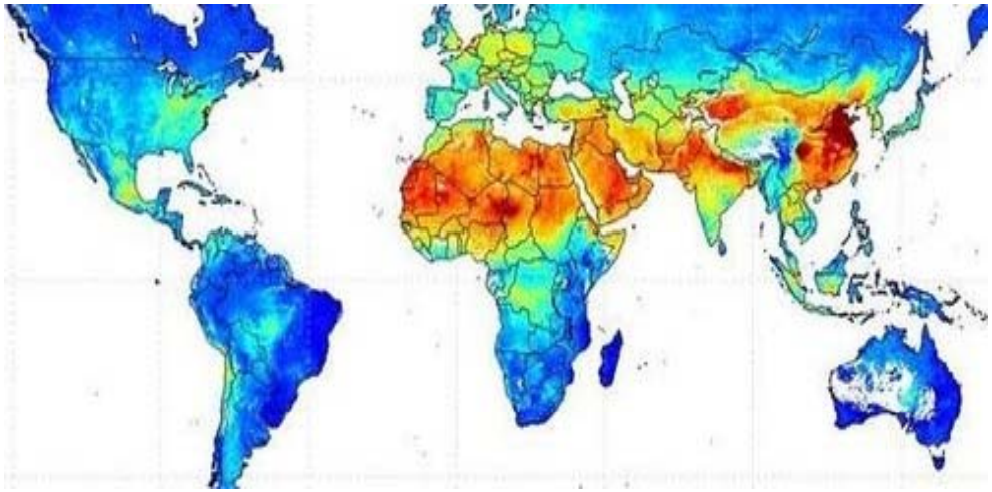
- 54% In-use cars met Euro 3/4/5, auto population ↑20%, but CO&HC ↓12%&7%
- Different pollution of each petrol car↓ 15%~27% , ↓ 11%~25% for diesel car

## Task of auto pollution control is still deep-going way(2011)

- Total $NO_x$ emission, more than 24 million tons(↑ 30%), auto shared 24%(↑ 7%)
- PM of each diesel car ↓ 11% , but total amount ↑ 4%



# 1. Automotive and Energy Environment



Fog and haze in Beijin

Fog and haze in Shanghai

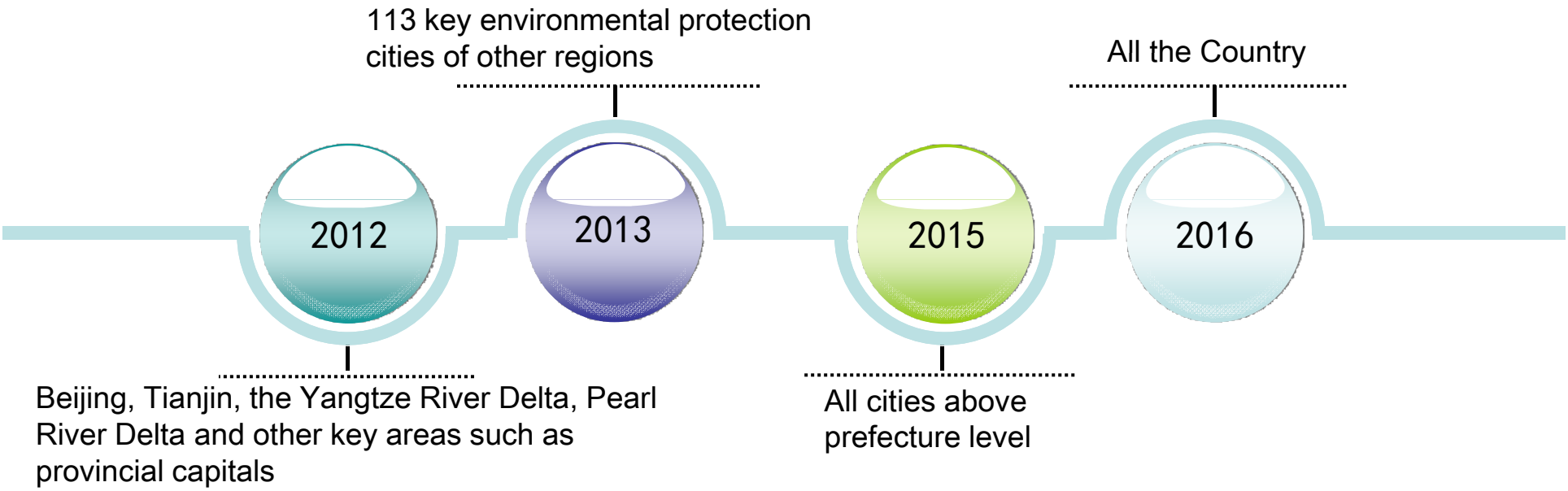
- The most serious PM pollution happened in north & east of China
- In the begin of this year, thick fog and haze weather covered 1/4 area
- Auto becomes the biggest source of PM2.5 in Beijing, shared 22% in total

Reduction of PM Becoming New Attractive Field for All Over China

# 1. Automotive and Energy Environment

## What's The Plan of Monitoring & Controlling PM 2.5 in China

- End of 2011, Ministry of environmental protection published 'PM2.5 national monitoring schedule'
- In Sep 2013, State Council published 'Prevention Action Plan of Atmospheric Pollution' , China will take comprehensive measures to reduce PM2.5 such as improving the quality of fuel. Now, more and more cities has used Euro 4&5 diesel



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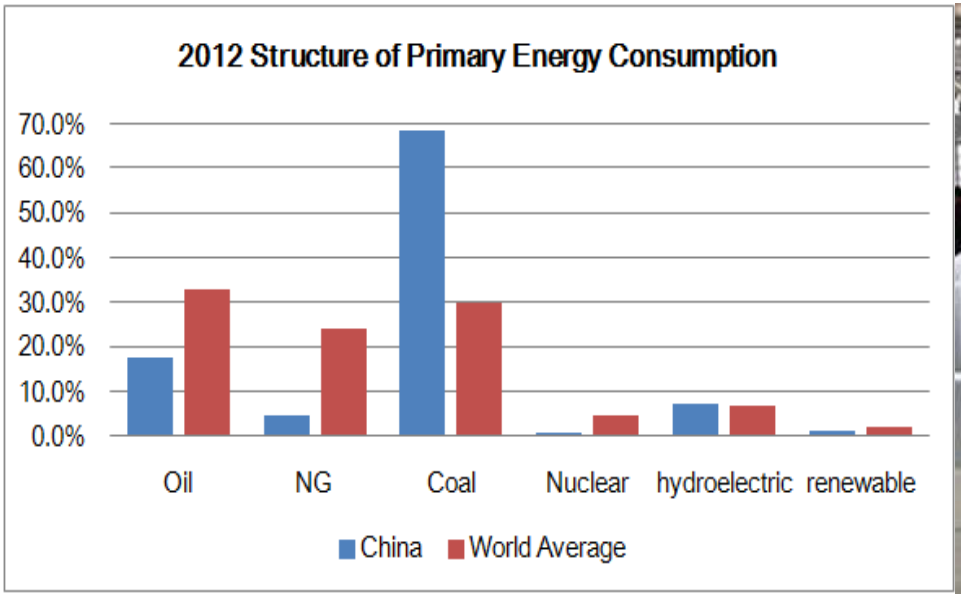
# 2. Development of NGV in China

## External & Internal Motivation of NGV Development

◆NG, environmental friendly, almost all the 12th five year plan of environment protection & energy development programmed to improve the proportion of NG in primary energy up to 7.5%

◆NGV, primary energy utilization, higher efficiency of WTW than petrol & diesel, also internal combustion theory, mature tech & industrial chain, much lower fuel price




Structure of Primary Energy 2012


Advertisement of CNG Car About Saving Money

# 2. Development of NGV in China

◆Much lower HC, $CO_2$, $NO_x$ and $SO_x$ than petrol & diesel, frees of PM, lead & benzene

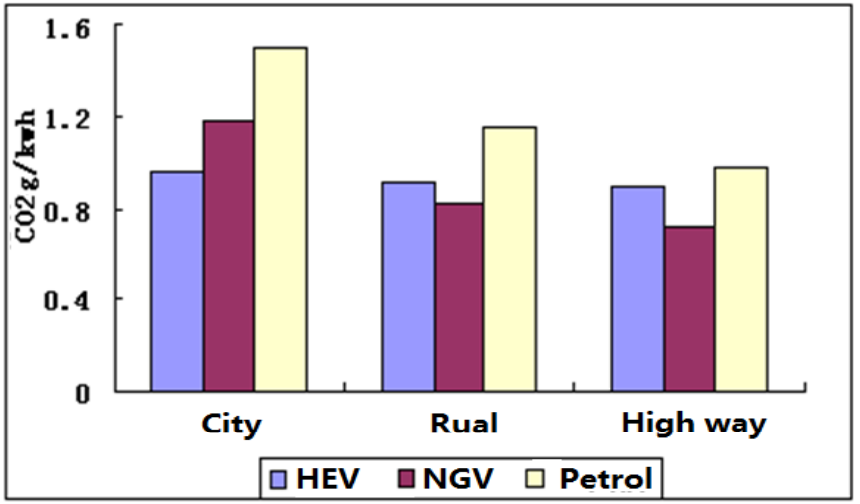
◆Good to reduce fog & haze weather, e.g. in case a large city in China has 10,000 diesel buses of Euro Ⅲ, when changed to NGV, 600 tons/year of PM will be reduced

◆Even compared with HEV, still lower $CO_2$ emission on rual road & high way

NGV is one of effective solution of energy & environment auto issue

| (g/mile) | HC | $CO_2$ | CO | $NO_x$ | $SO_x$ |
|---|---|---|---|---|---|
| **Petrol** | 1.747 | 451 | 11.166 | 1.187 | 0.382 |
| **Diesel** | 0.616 | 333 | 0.617 | 2.284 | 0.261 |
| **LPG** | 0.925 | 340 | 9.487 | 1.016 | 0.222 |
| **NG** | **0.482** | **304** | **8.476** | **0.847** | **0.030** |

Emission Comparison of Diff Fuel within WTW




$CO_2$ Emission Comparison of NGV & HEV(FOEN)

# 2. Development of NGV in China

## Overview of NGV in China

◆32 provinces applied NGV, 4000 gas stations, 3000 for CNG, 1000 for LNG & L-CNG

◆3 million NGVs, population ranking No.5 in the world, LNGV increased rapidly in recent years, its population exceeded 100,000

◆Alternated 20 million tons/ year of petrol & diesel, reduced 12 million tons/year of $CO_2$


LNGv Entered to Tibet


Ranking as Population(Color Deeper, More NGVs)

# 2. Development of NGV in China

## Status of NGV Products

- More than 60 OEMs, 400 car models, engine power ranges from 35~400kW
- 200,000 NGVs/year from OEM, Euro Ⅴ for commercial car, EuroⅣ for passenger car

FAW-Volkswagen CNG Sedan

JAC CNG Sedan

Lifan 620 CNG Sedan

CHANG'AN CNG Mini-van Truck

HENGTONG CNG Bus


Shaanxi LNG Heavy Duty Truck

# 2. Development of NGV in China

## Status of Supply Chain

- Annual production capacity of 2 million gas tanks from domestic companies
- Domestic key components such as ECU, pressure regulator can be used for OEM
- Equipment such as compressor and fueling machine produced by domestic companies

Furui LNG Cylinder


Zhongcai CNG Cylinder

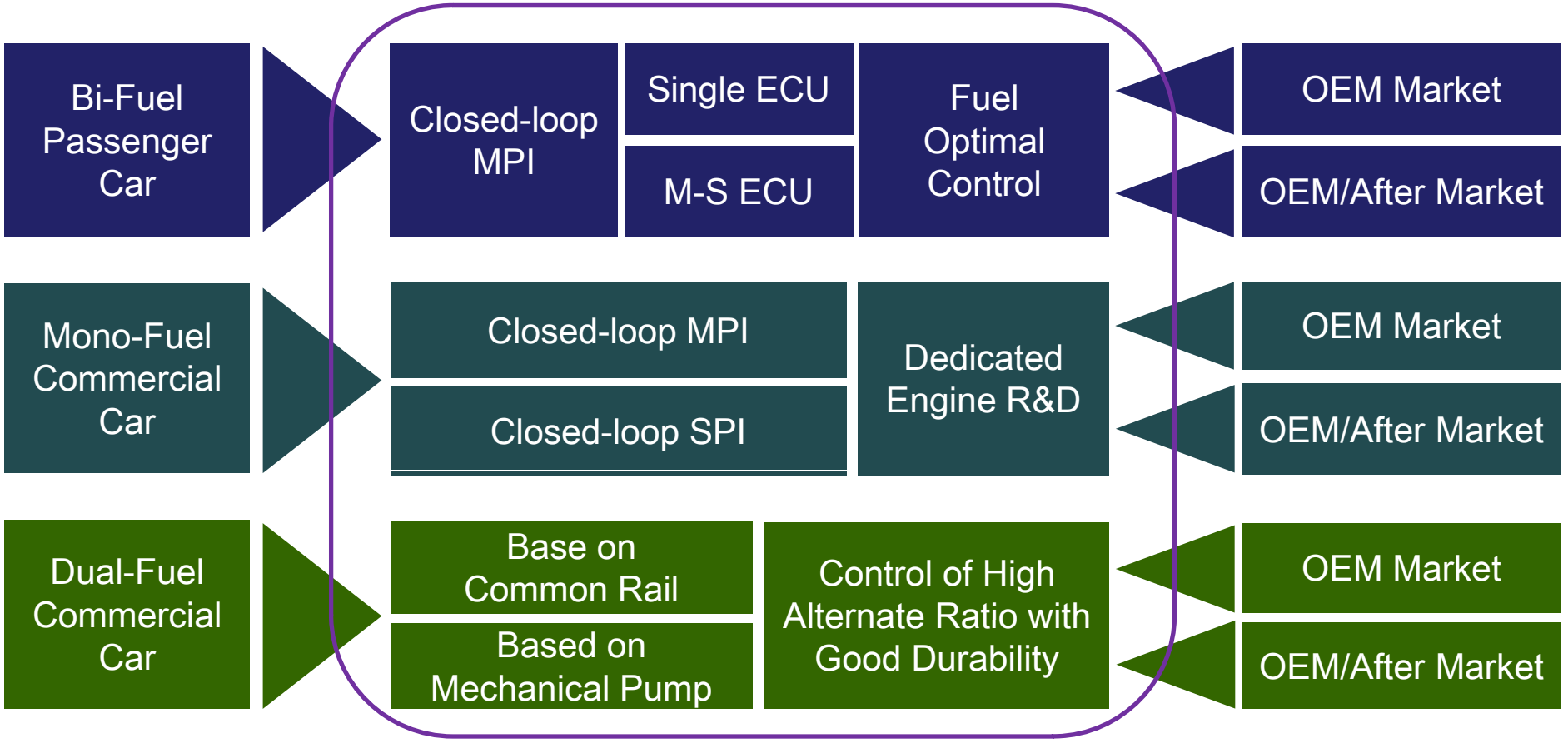
Qiangsheng CNG Compressor

Kongfen LNG Fueling Machine

CAERI Engine ECU, Injector and Pressure Regulator

# 2. Development of NGV in China

## Key Technology Types According to Application



# 2. Development of NGV in China

## Why LNGV grows very rapidly in recent years

**Advantegies**

- Easier fuel transportation
- Lower invest and energy consumption
- Longer driving distance, faster fueling, more cleaner, and more safer

**From State**

- Efficient utilization of resource from import & distributed energy
- Reduction pollution of commercial car

**From Market**

- More frequent diesel shortage
- Trucks is more sensitive to fuel cost

# 2. Development of NGV in China

## Incentive Policy from Goverment

| Guiding Principles | Industry/Tech. | Resource & infrastructure |
|---|---|---|
| ➢ The 12th Five-Year Plan for National Economic and Social Development of P.R.China<br>➢ The National Medium- and Long-Term Program for Science and Technology Development (2006-2020) | ➢ Middle- and Long-Term Plan for Conserving Energy(up to 2020)<br>➢ Energy-saving and new-energy auto industry development plan（2012—2020）<br>➢ Chinia National Programme for climate change | ➢ The 12th Five-Year Plan for NG development<br>➢ The 12th Five-Year Plan for Coal-bed Methane Exploitation and Utilization<br>➢ Development Plan for Shale Gas (2011-2015)<br>➢ The 12th Five-Year Plan for Urban Gas development |

# 2. Development of NGV in China

## Supporting Conditions of Future Development

- Conventional gas 32 trillion $m^3$, shale gas 25 trillion $m^3$, CBM 14 trillion $m^3$, and significant flammable ice
- Before or after 2015, gas supplying will be more than consumption 46 billion $m^3$ ( supplying 276 billion $m^3$, consumption 230 billion $m^3$)
- In 2025-2030, maybe oil and gas will be the same share in prime energy consumption
- in 2015~2016, length of urban gas pipeline will increase from 350,000 km to 600,000 km, there will be more than 5000 gas stations

First Shale Gas Well in Sichuan


West-East NG Transmission

# 2. Development of NGV in China

## Prospects of NGV

**Population**

- Population will be more than 4 million in 2015, consuming 30 billion $m^3$ NG, alternate 26 million tons petrol & diesel and reduce 16 million tons $CO_2$ per year
- Population will be more than 8 million in 2020, consuming 60 billion $m^3$ NG, alternate 52 million tons petrol & diesel and reduce 32 million tons $CO_2$ per year

**Extended Area**

- Faster development in South & East of China because of much better gas supply
- Faster development in small cities because of more and more gas stations

**Car types**

- For passenger car, taxi increase steadily, private car and mini van grow rapidly
- For commercial car, city bus increase steadily, intercity bus & trucks grow rapidly

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# 3. Research Status of NGV in CAERI

## Overview of China National Gas Vehicle Engineering Research Center

- Organized by CAERI, the 1st national engineering center of the whole auto industry
- R&D core tech., also supply tech. service & consultation to enterprise or government
- Cooperated with oversea institutes & companies, Toyota, Delphi, Bosch & SwRI
- CAERI set up a son company for commercialization of R&D achievements, more than 80,000 NGVs per year use CAERI's EMS products

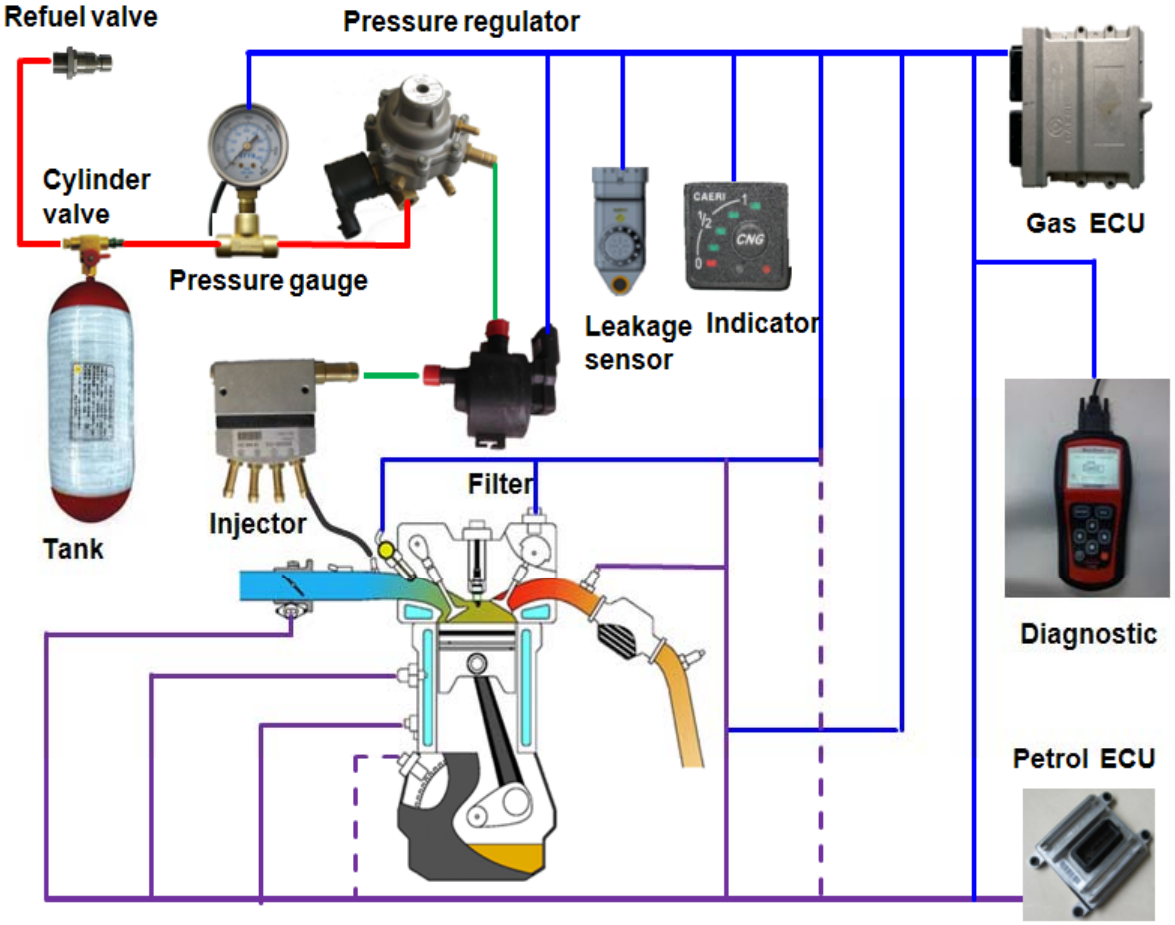
Delphi Visit CAERI for Cooperation of ECU R&D

Toyota Visit CAERI to Cooperate with Development of Bi-fuel Sedan


CAERI Visit KEIHIN for Cooperation of Key Components

# 3. Research Status of NGV in CAERI

## Bi-fuel Technology of Passenger Car




Gasoline/NG bi-fuel system diagram

- Meet Euro IV¥V
- Optimal gas ignition control on each engine working point
- OBD for malfunction of gas leakage
- ISO-15765 protocol
- CCP calibration tool
- AutoSAR software design

# 3. Research Status of NGV in CAERI

## Application of Bi-fuel System

- Developed more than 60 car models for more than 20 domestic and oversea OEMs
- Some car models have realized mass production

Grate Wall Bi-fuel Pick-up

Suzuki SX4
Bi-fuel Sedan

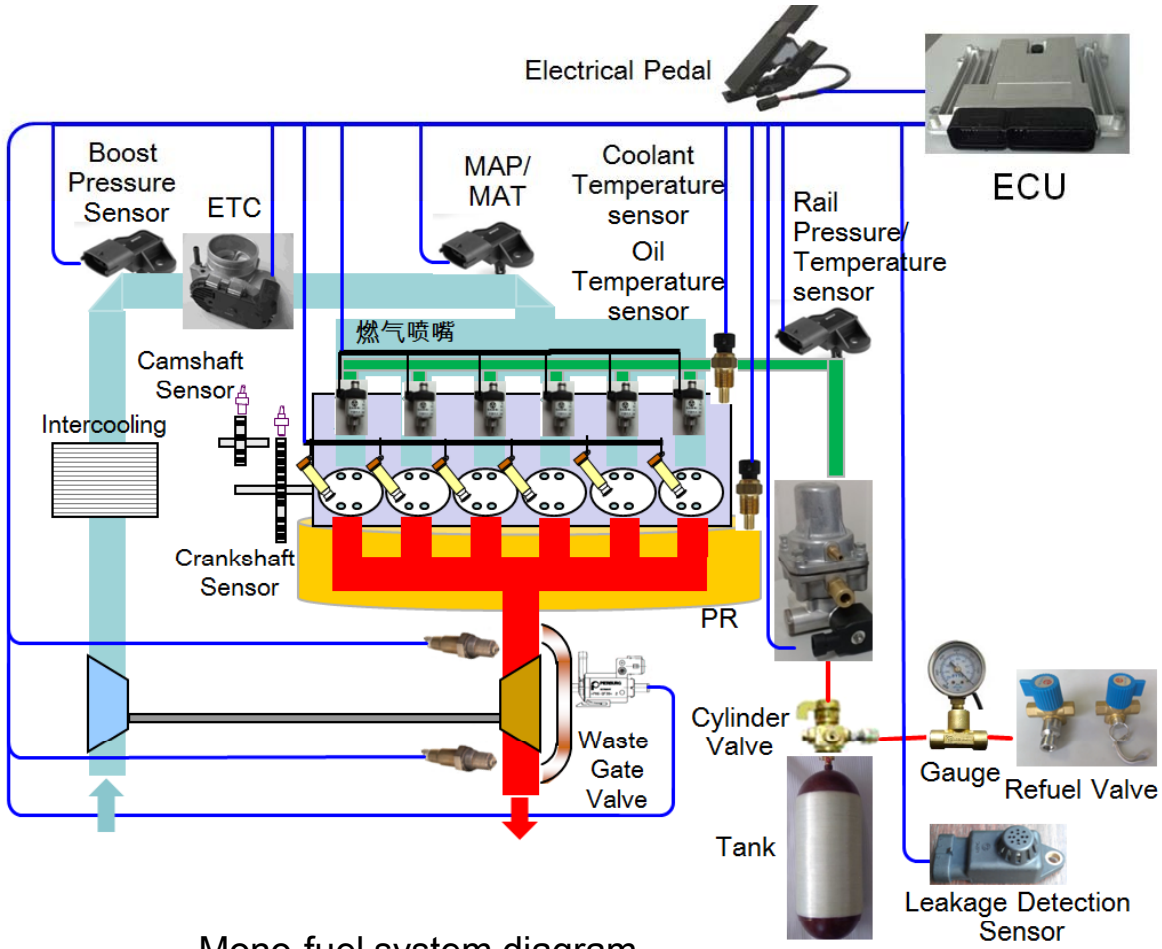
Mitsubishi Lancer
Bi-fuel Sedan

Toyota corolla
Bi-fuel Sedan for Thailand

DFM Funshion
Bi-fuel MPV for Iran

# 3. Research Status of NGV in CAERI

## Mono-fuel Tech. of Commercial Car




Mono-fuel system diagram

- Meet Euro Ⅴ/Ⅵ
- Sequential Injection/Ignition
- 154-Pin, 32-bit MCU
- Torque based control
- Compatible with lean-burn or stoichiometric
- Closed-loop Boost Control
- Support EGR control
- Diagnostic based on SAE J1939

# 3. Research Status of NGV in CAERI

## Application of mono-fuel system


Foton CNG light-duty truck

Yutong LNG Bus

FAW LNG Bus

Heli Fork truck

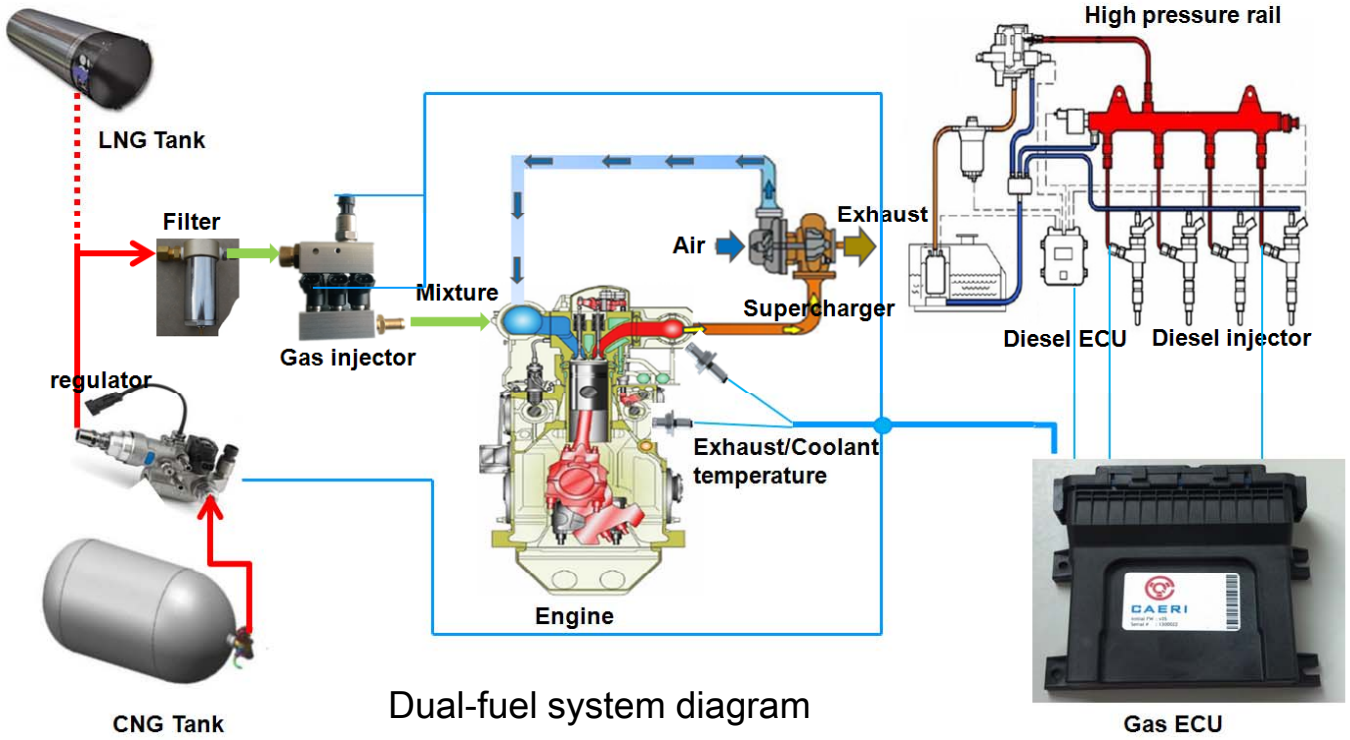
Bonluck CNG Bus


Zhongtong LNG Bus

Mono-fuel system has been widely used on trucks, buses and fork trucks.

# 3. Research Status of NGV in CAERI

## Dual-fuel Tech. of Commercial Car




Dual-fuel system diagram

- Same engine power output as pure diesel
- Smoking control logic
- More than 65% substitution of diesel, saving 1 RMB/km
- Protection of thermal load, such as exhaust temperature and coolant temperature

# 3. Research Status of NGV in CAERI

## Application of Dual -Fuel System

- Applied for CNPC's trucks in Qinghai oilfield, running on the 3500~4000m altitude
- 70%~75% substitution of diesel by road test

YUCHAI 6J engine 160kw

BEIBEN with WP10 213kw


HOWO with HINO T11C-UH

SAG with WP12 279kw

**Breath in Much Cleaner Air**

**Smile in Lower Carbon Life**

# Thank you for Attention

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