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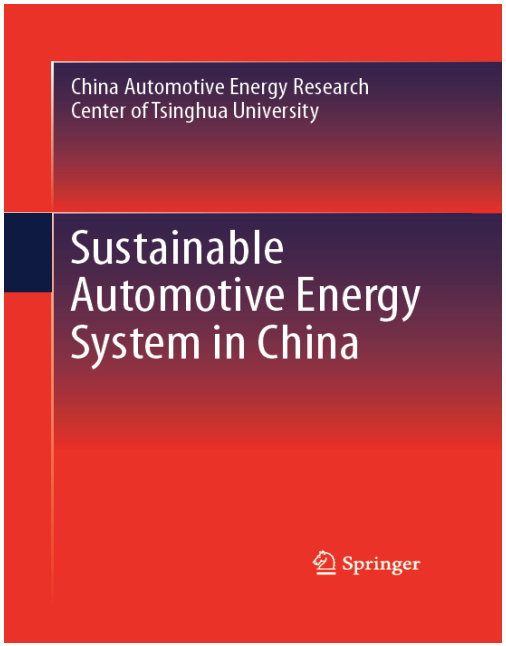
清华大学中国车用能源研究中心

CHINA AUTOMOTIVE ENERGY RESEARCH CENTER

TSINGHUA UNIVERSITY

Technologies and Policies for Sustainable Automotive Energy Transformation in China



Zhang Xiliang & Ou Xunmin

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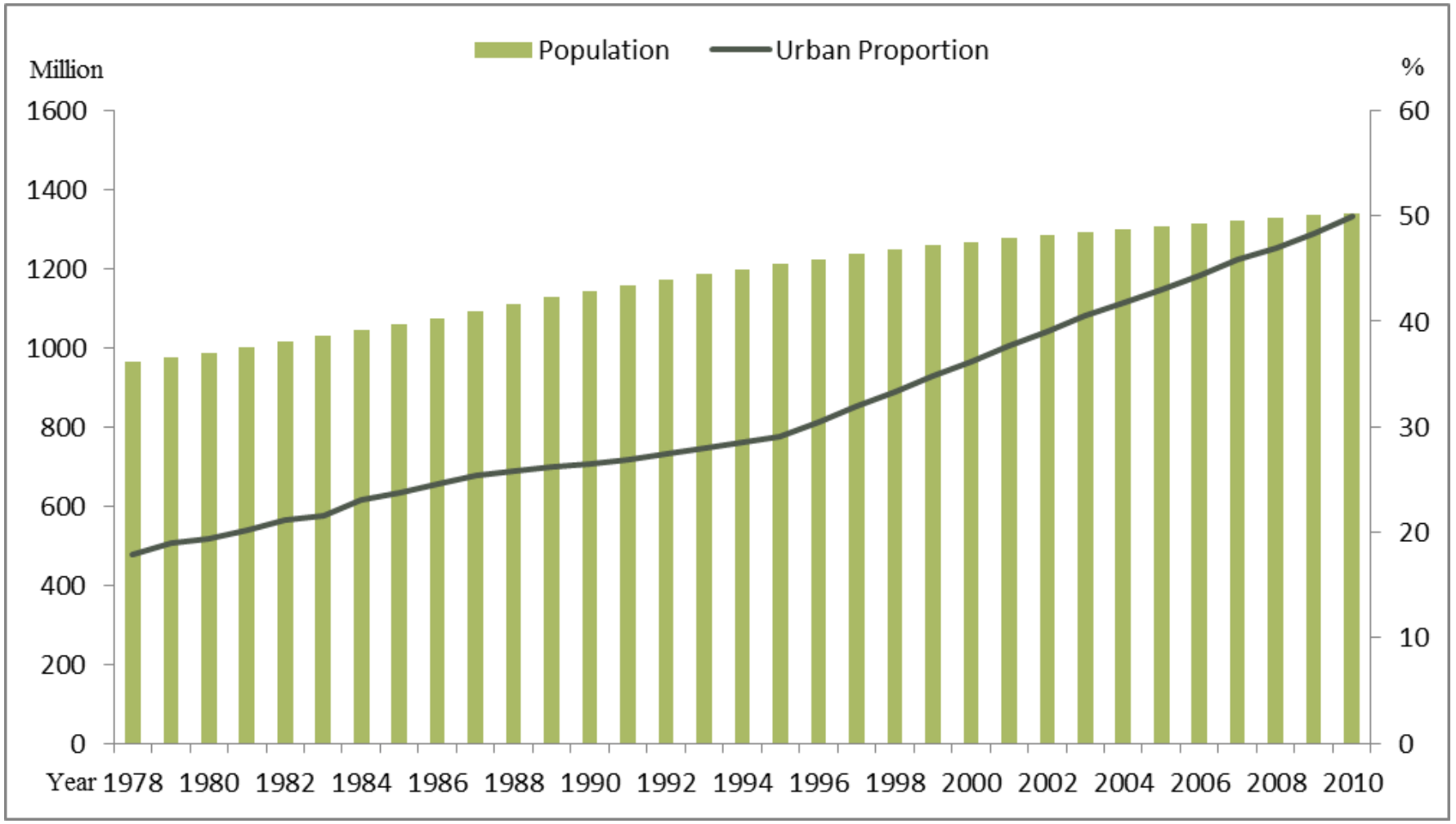
China's Population & Urbanization



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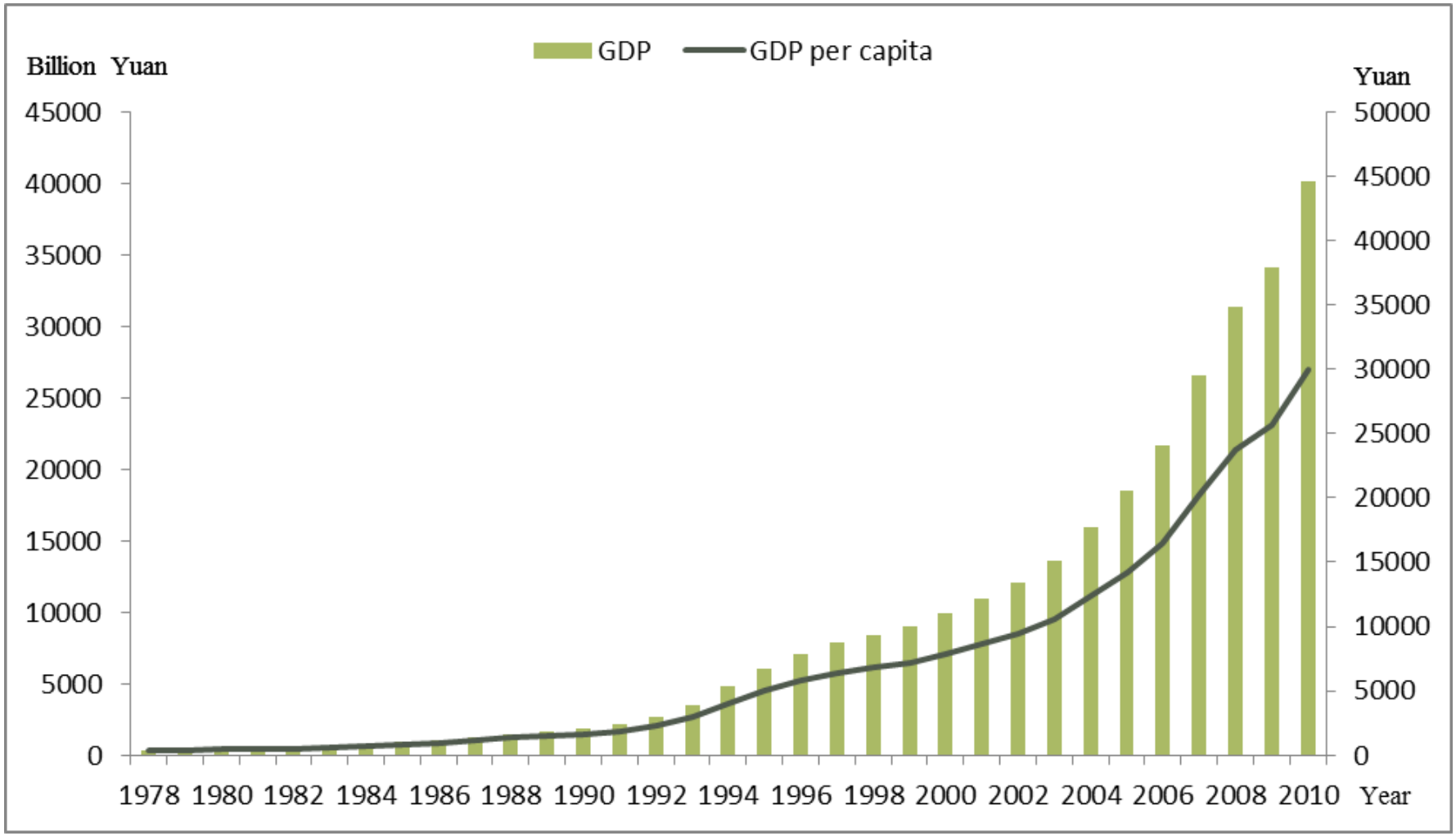
China's GDP Growth



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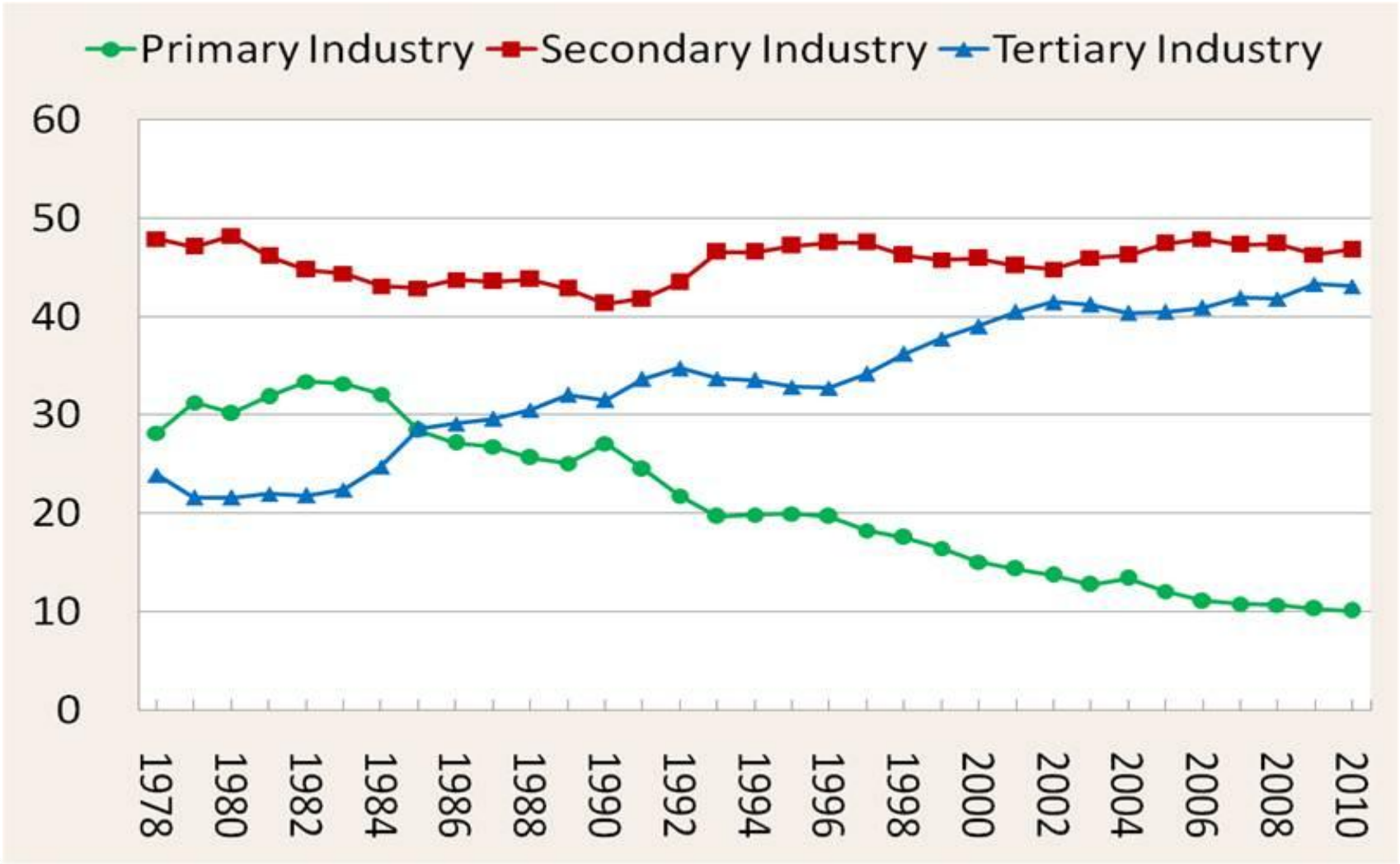
China's Economic Structure



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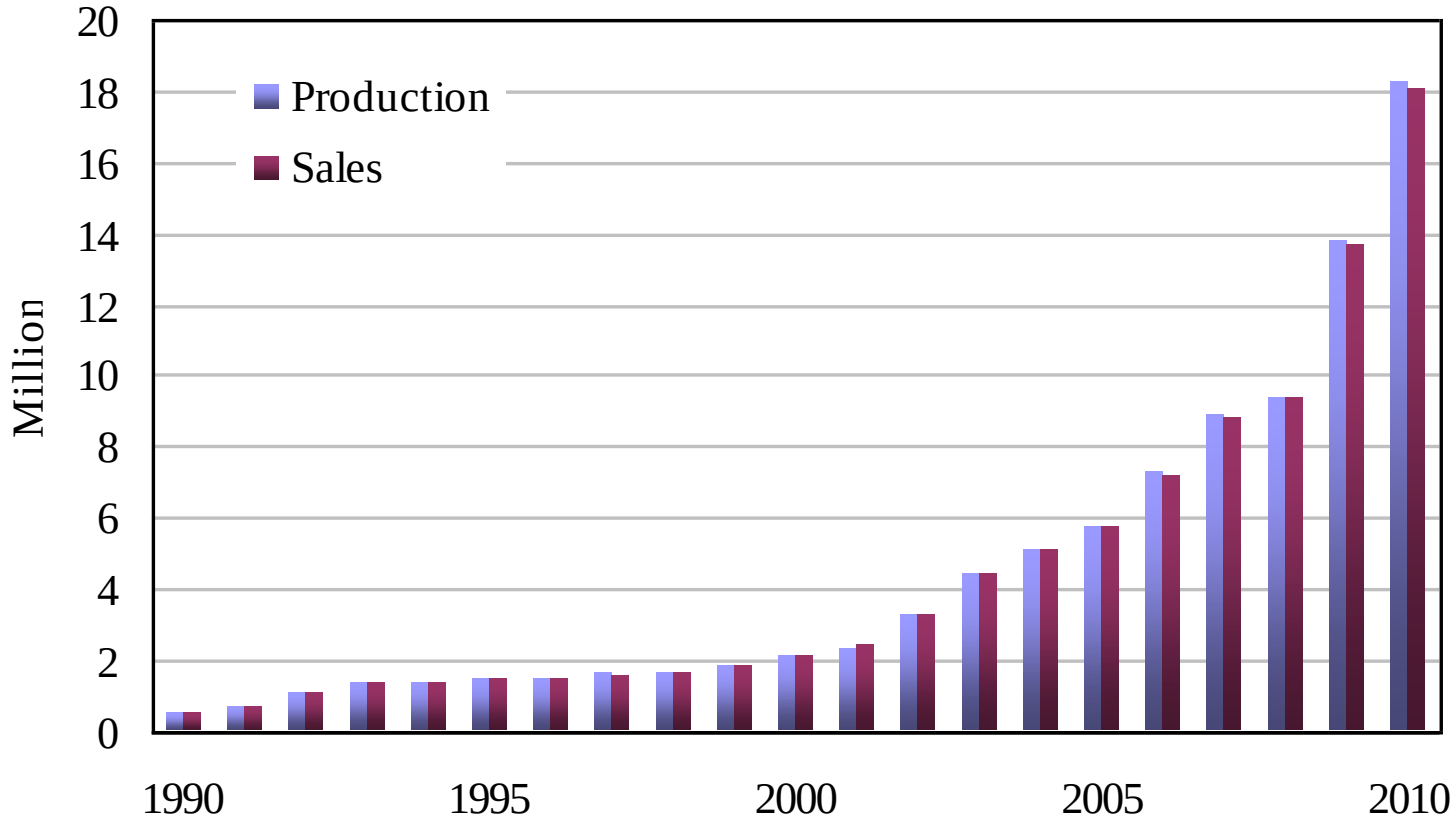
Vehicle production and sales in China

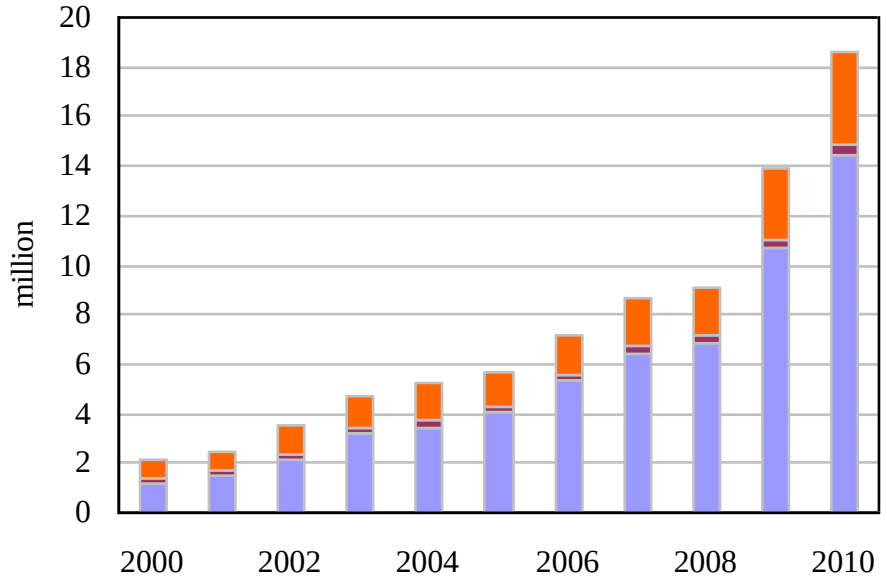


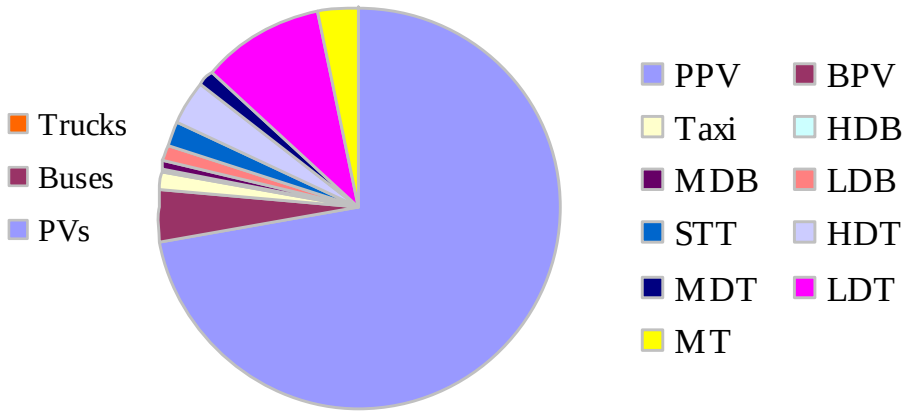
China's domestic vehicle situation (2010):

Production: 18.26 million

Sales: 18.06 million

Number of newly registered vehicles in China





Abbreviations

PV: passenger vehicle
PPV: private passenger vehicle
BPV: business passenger vehicle
HDB: heavy duty bus
MDB: medium duty bus
LDB: light duty bus
STT: Semi-trailer towing truck
HDT: heavy duty truck
MDT: medium duty truck
LDT: light duty truck
MT: mini truck

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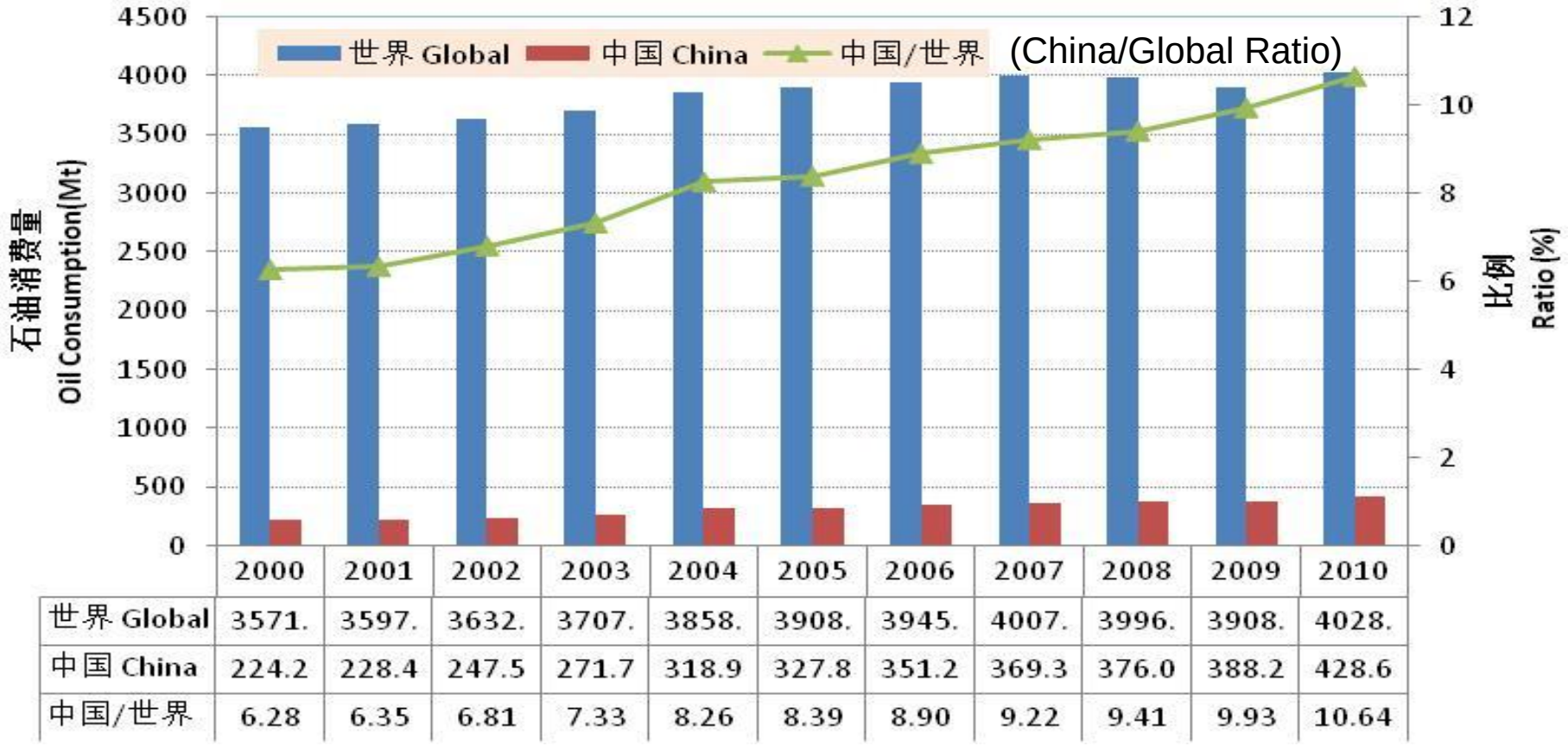
China in Global Oil Consumption

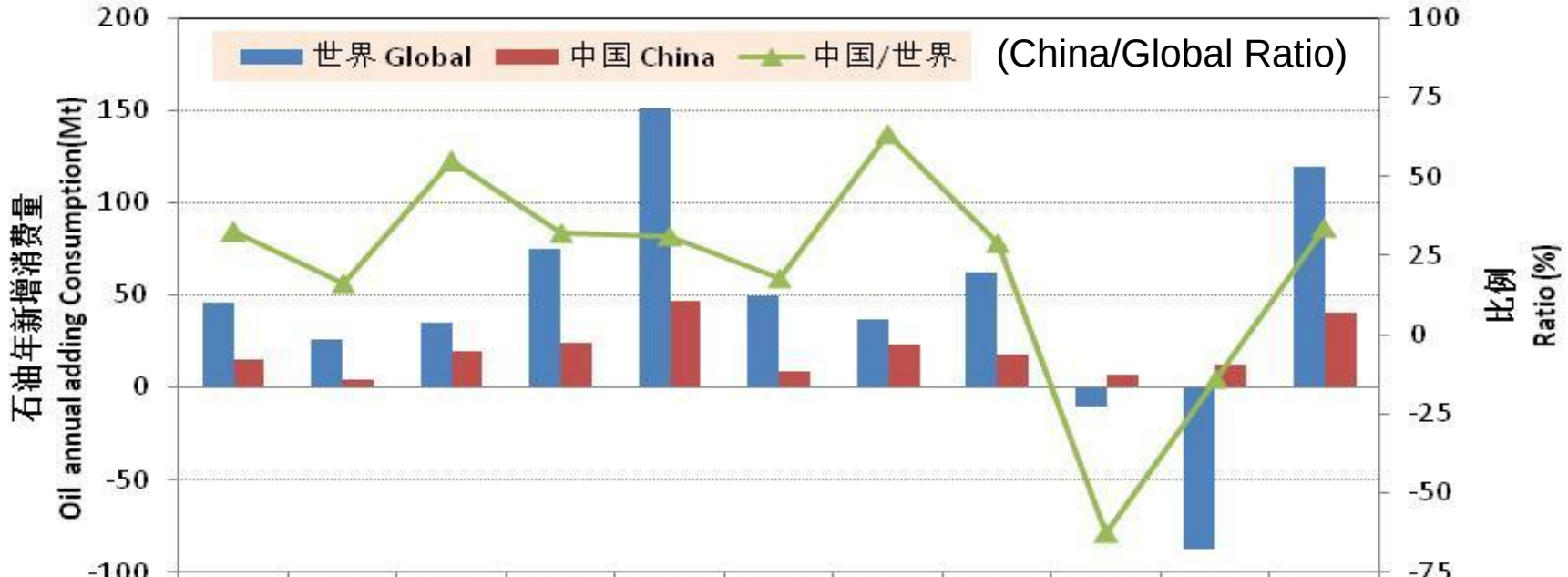


	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
世界 Global	3571.	3597.	3632.	3707.	3858.	3908.	3945.	4007.	3996.	3908.	4028.
中国 China	224.2	228.4	247.5	271.7	318.9	327.8	351.2	369.3	376.0	388.2	428.6
中国/世界	6.28	6.35	6.81	7.33	8.26	8.39	8.90	9.22	9.41	9.93	10.64

Source: Statistical Review of World Energy 2011

Growth rate 2000-2010: Global 1.2% vs. China 6.7%

China's Incremental (Year-on-Year) Oil Consumption Relative to Global Consumption



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
世界 Global	45.6	25.6	35.0	75.2	151.3	49.7	36.9	62.0	-10.8	-87.8	119.4
中国 China	14.89	4.19	19.12	24.20	47.16	8.95	23.41	18.03	6.75	12.14	40.39
中国/世界	32.62	16.33	54.62	32.19	31.17	18.00	63.51	29.10	-62.52	-13.82	33.82

Increased Oil Consumption 2000-2010

Global: 456Mt

China: 204Mt (44.7%)

Source: Statistical Review of World Energy 2011

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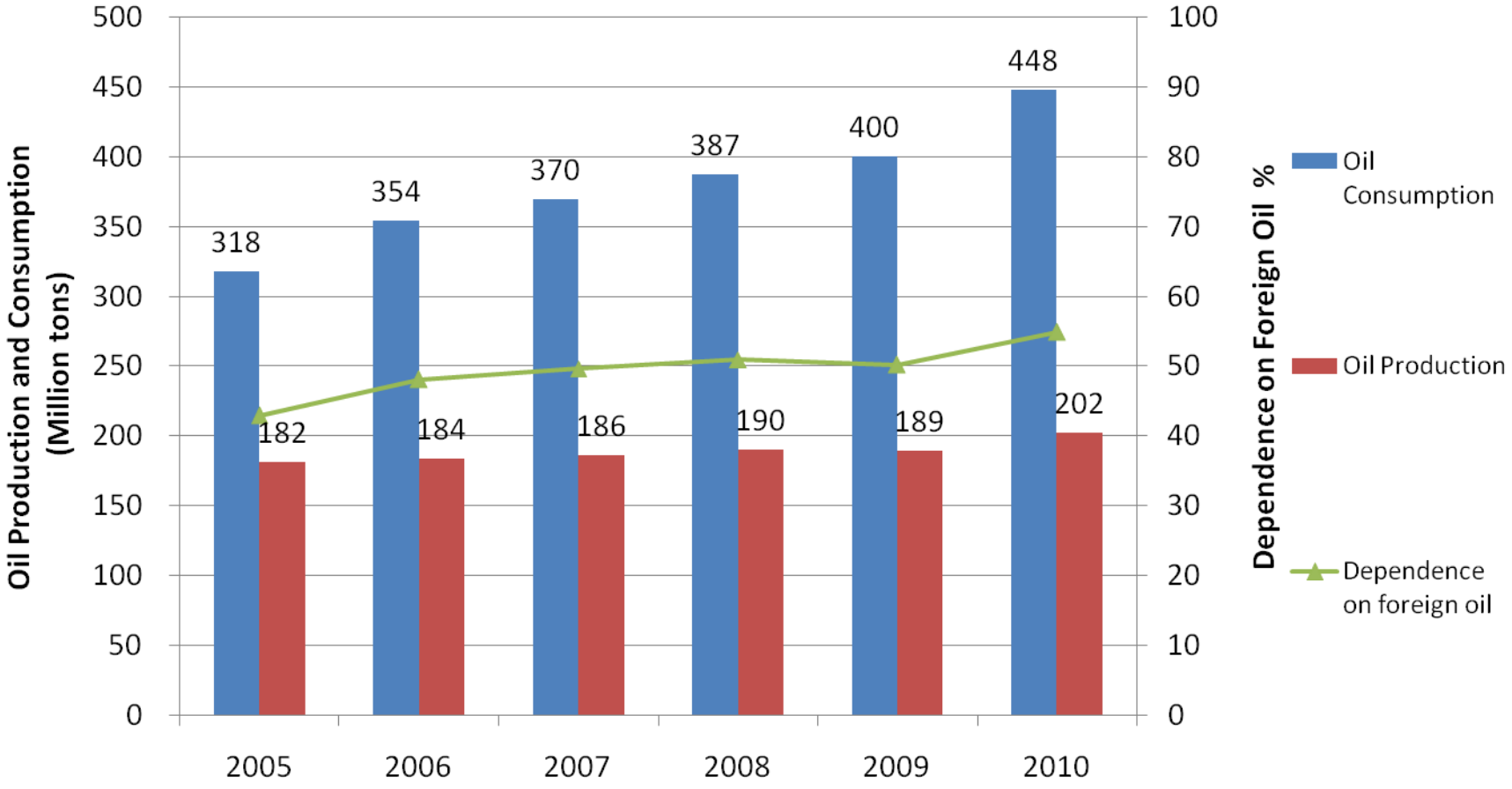
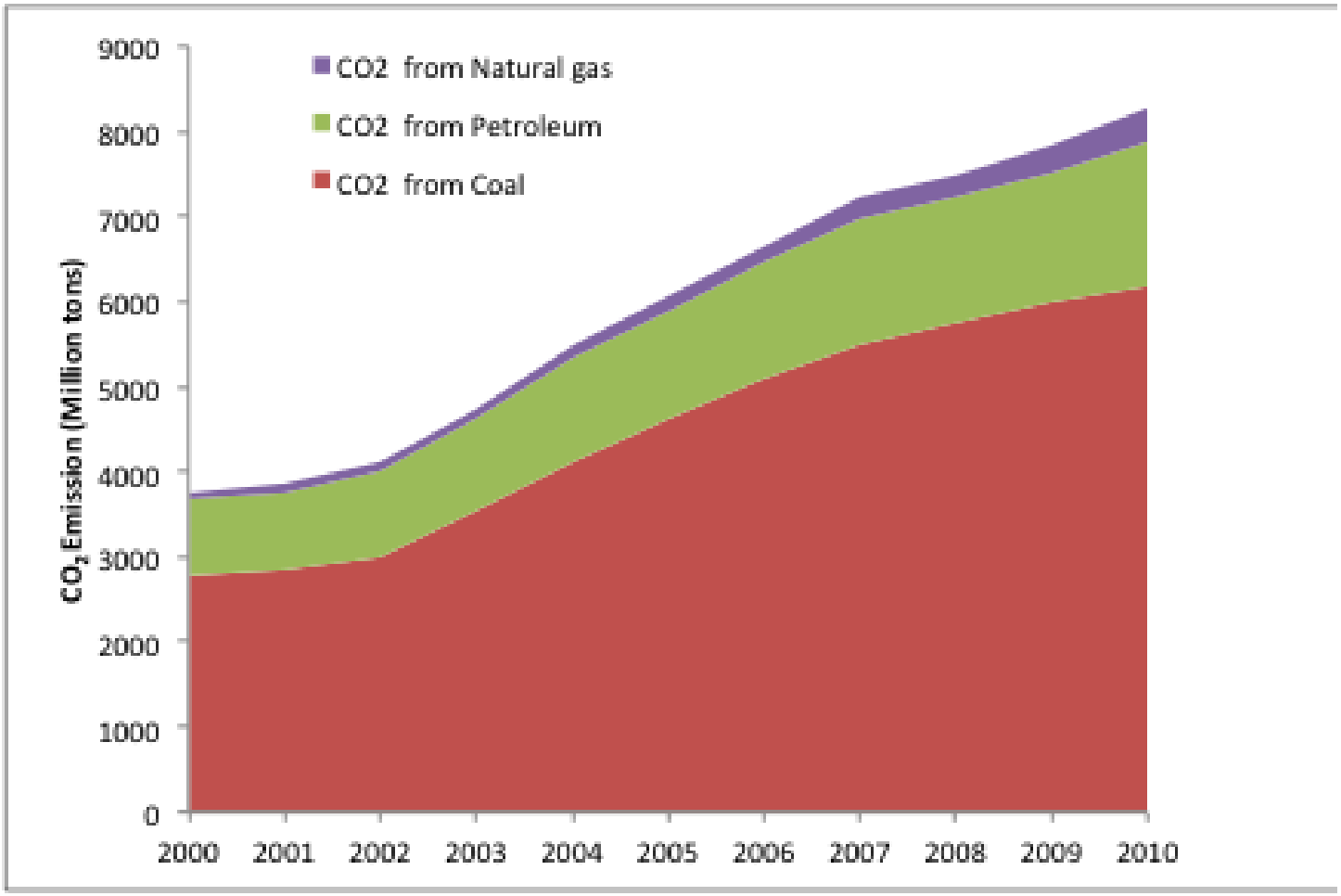
Oil Production and Consumption in China

Dependence on imported oil has increased

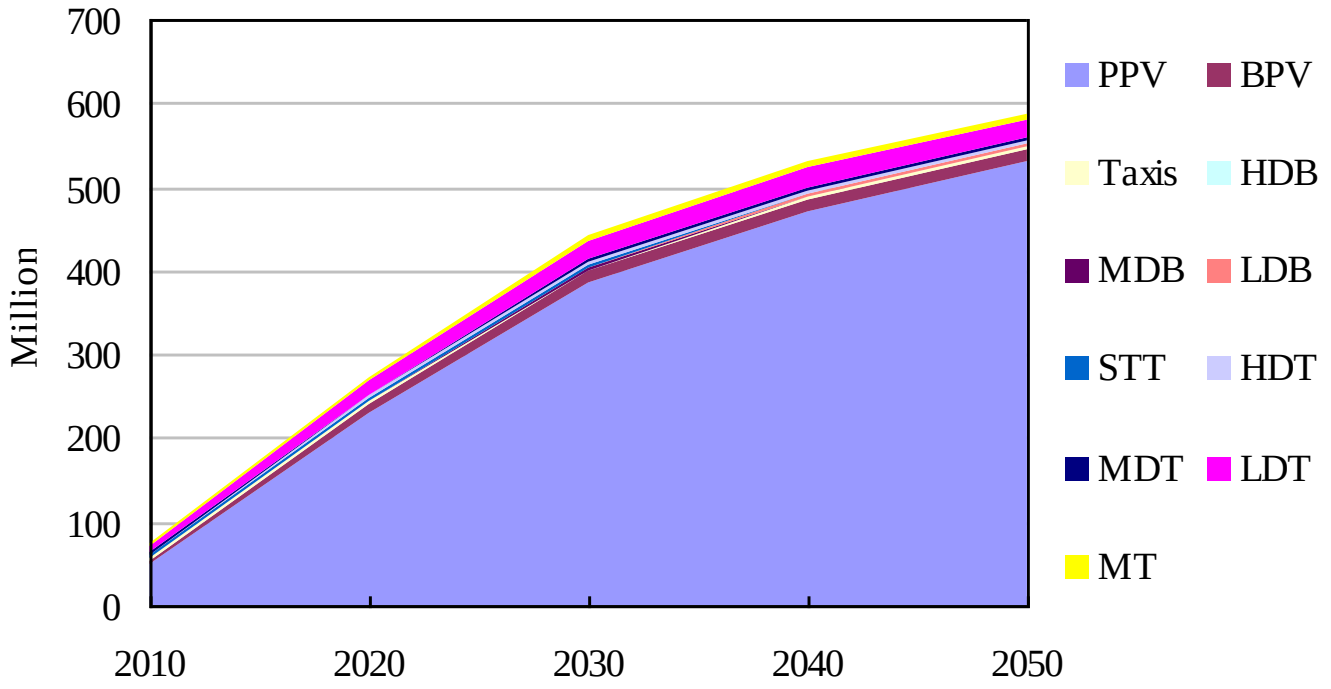


CO_2 Emission from Fossil Fuel Combustion



Our projection of China's vehicle population

The vast majority of new vehicles are private passenger vehicles (PPV)



Projection – million vehicles (private passenger vehicles)

2020: 270 (240)

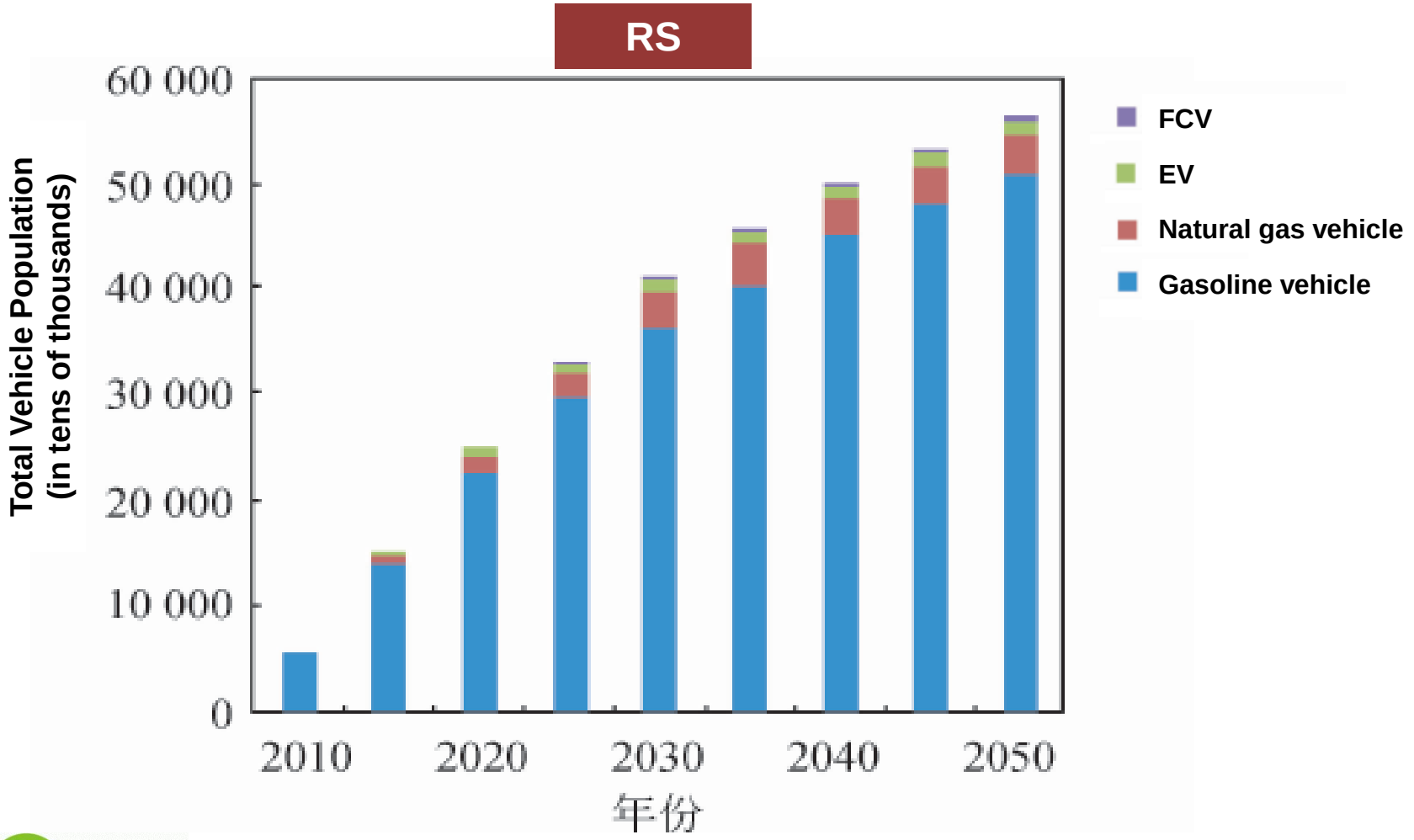
2030: 440 (400)

2050: 590 (550)

Reference Scenario (RS)

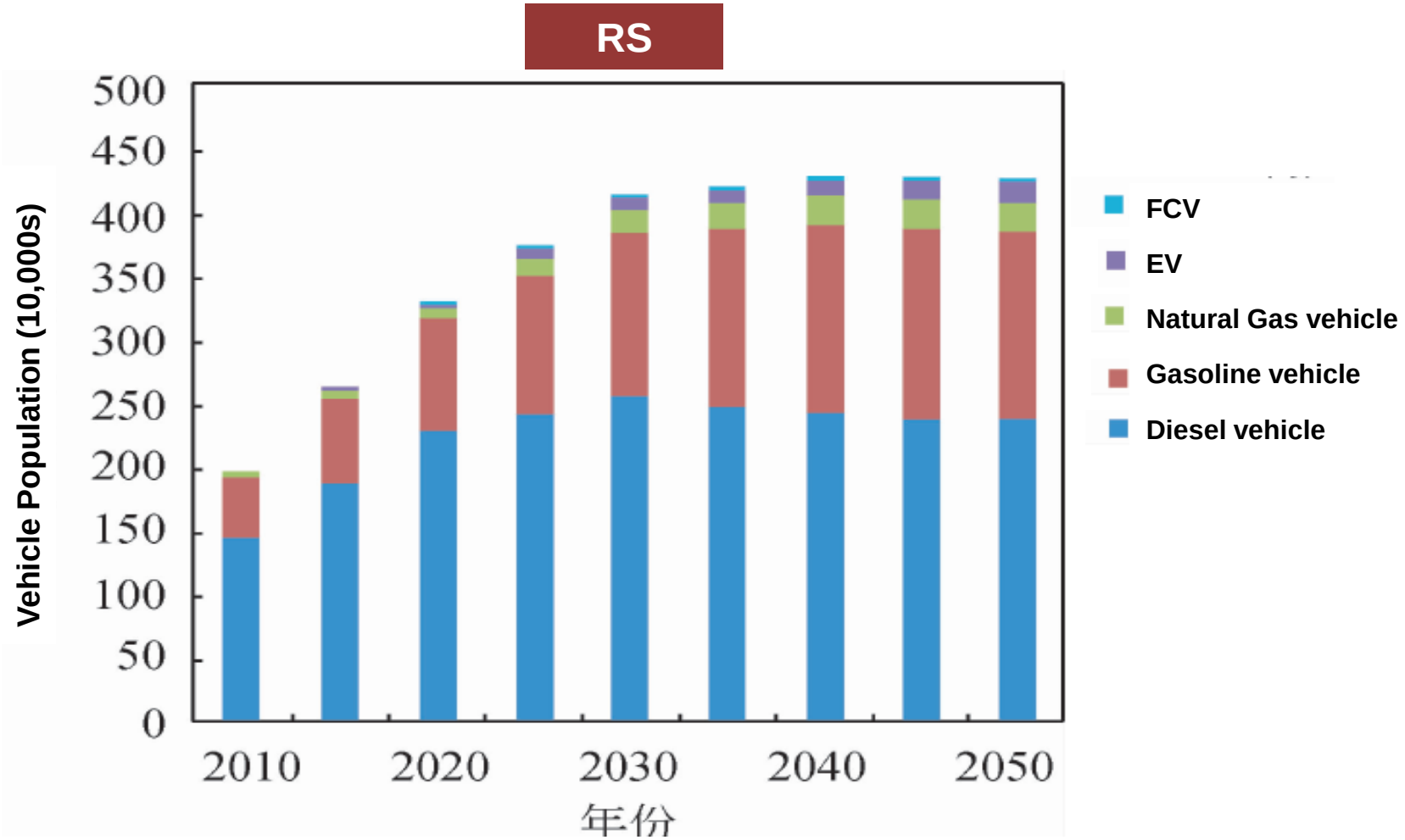
- **Technology commercialization:**
  - Biofuels after 2020
  - EVs and PHEVs after 2030
  - FCV after 2040
- **Market conditions:** No significant changes under current policies

Passenger Vehicle Propulsion System Portfolio in the ***Reference Scenario***

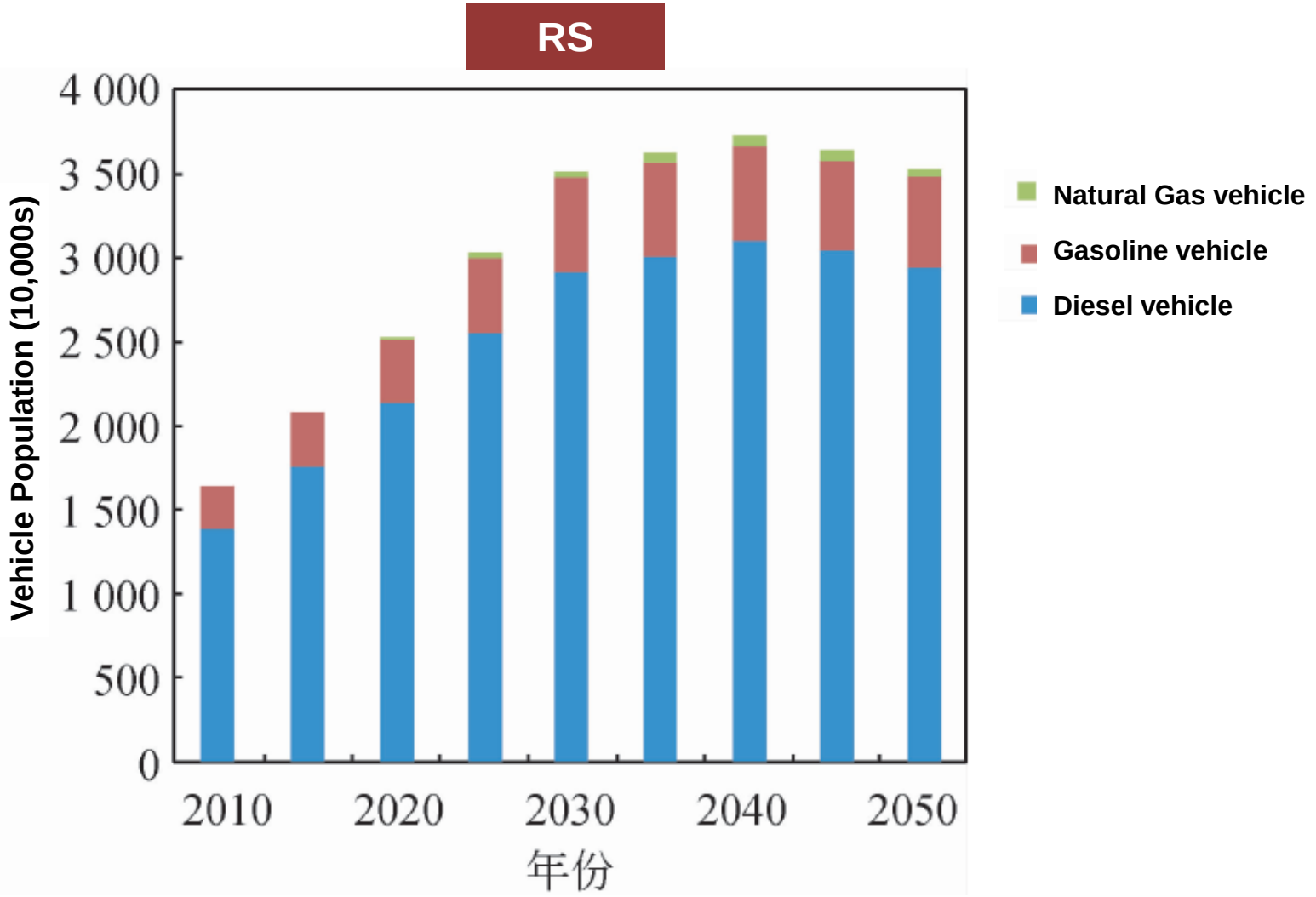


Total passenger car population in 2050: 550 million

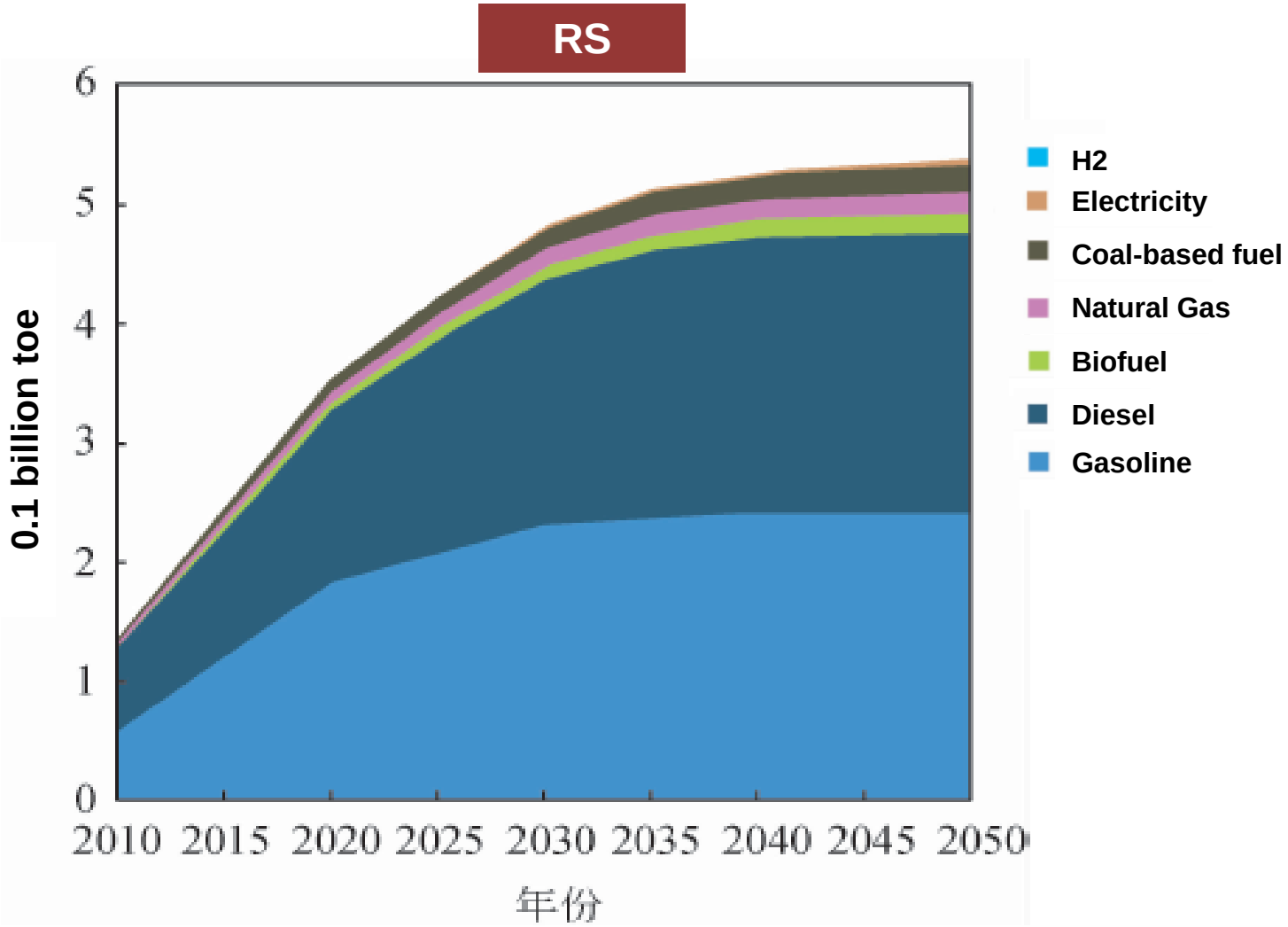
Bus Propulsion System Portfolio under RS



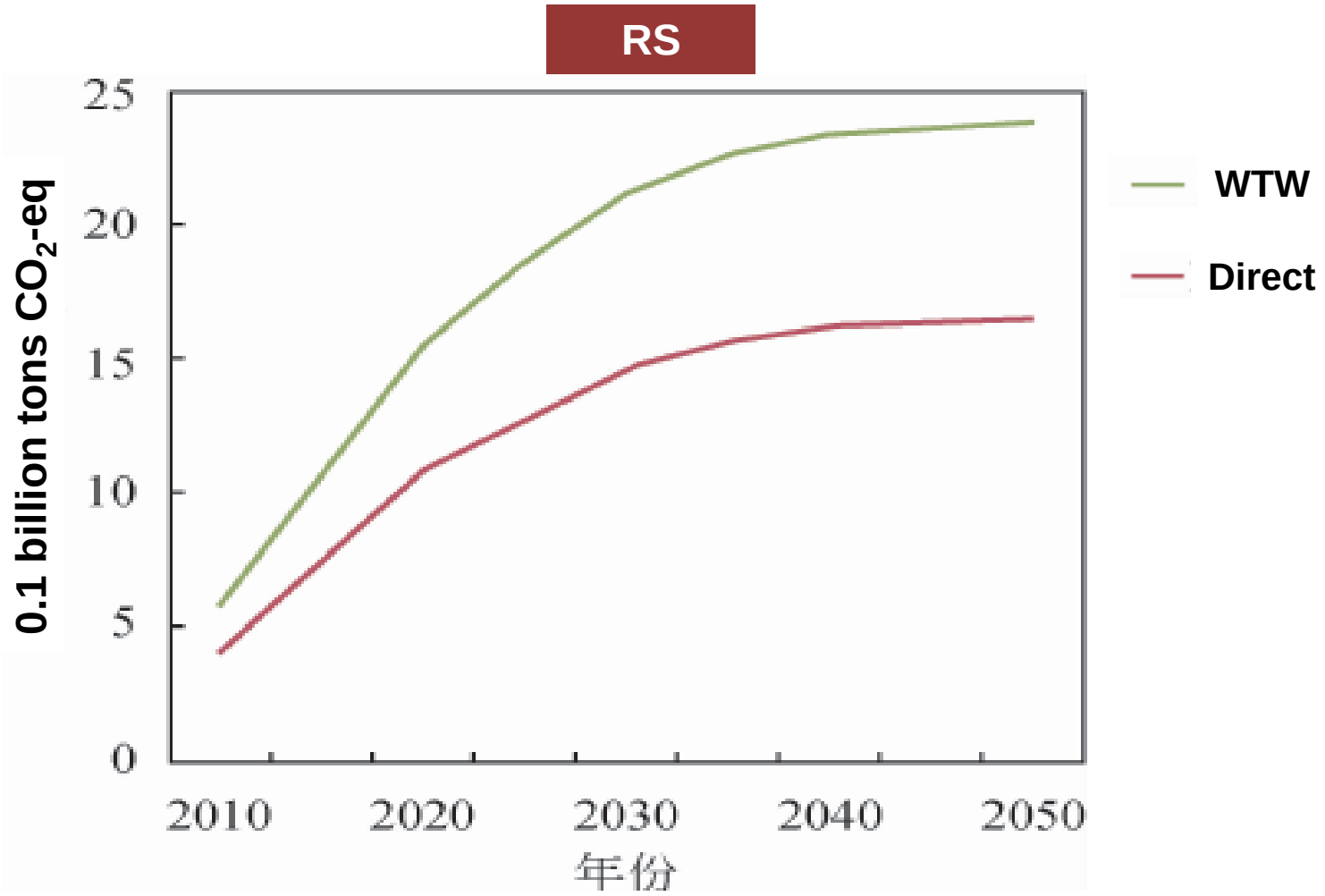
Truck Propulsion Portfolio under RS



Automotive Fuel Consumption under RS



GHG Emission under RS



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Summary of **Reference Scenario** Results

- 95.5% of passenger vehicles, 98.4% of trucks, and 99% of buses would still be powered by conventional propulsion technologies in 2050.
- Gasoline and diesel would continue to dominate China's automotive energy supply mix (93% in 2020, 91% in 2030 & 88% in 2050).
- Biofuels would only meet 1.5% in 2010, 2.4% in 2030 and 3.4% in 2050 of automotive energy consumption, respectively.
- WTW oil consumption would exceed 500 million tons in 2050, and 80% of the oil used for automotive fuels have to rely on import;
- CO2 from China's automotive transport would hit 1.5 billion tons in 2050.
- The chances would be very small for China to upgrade her automotive energy industry.

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Integrated Policy Scenario (IPS)

- Technology:
  - Alternative fuels (biofuels, CtL, GtL)
  - Automotive technology innovations (EV & FCV)
- Transport & energy: Demand management
- Policy:
  - R&D (e.g. subsidies)
  - command-and-control instruments (fuel economy standards)
  - Market-based instruments (carbon tax, vehicle tax)

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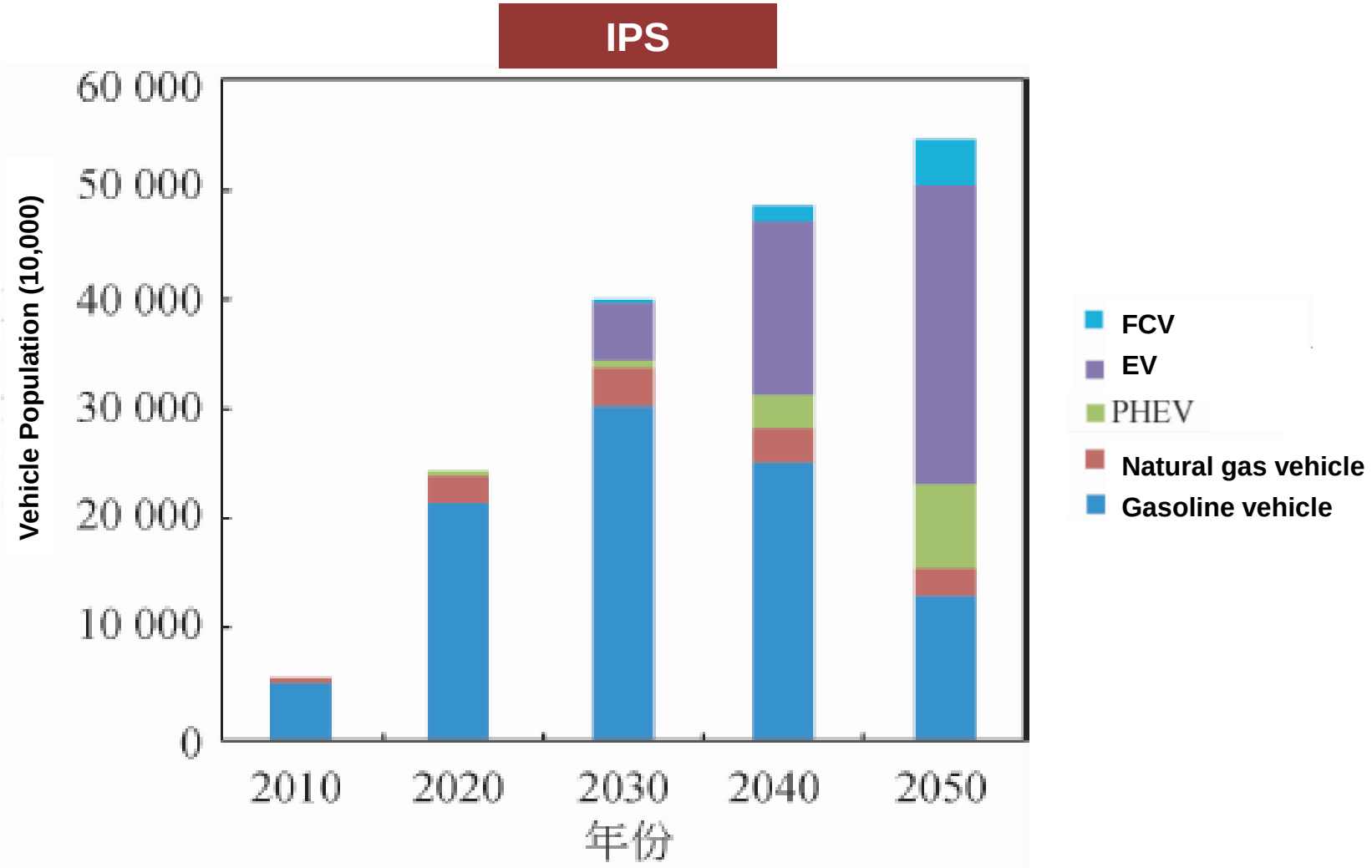
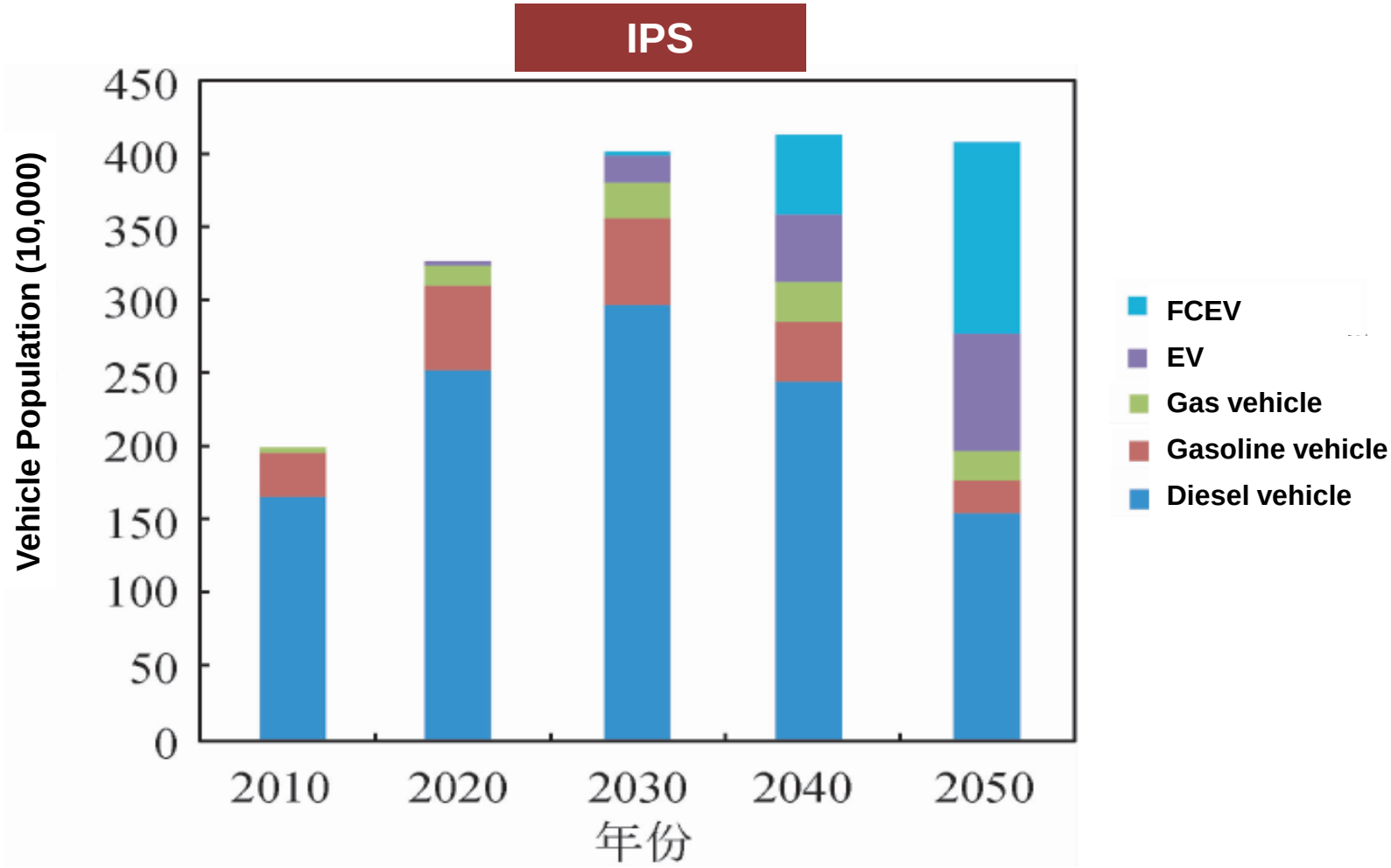
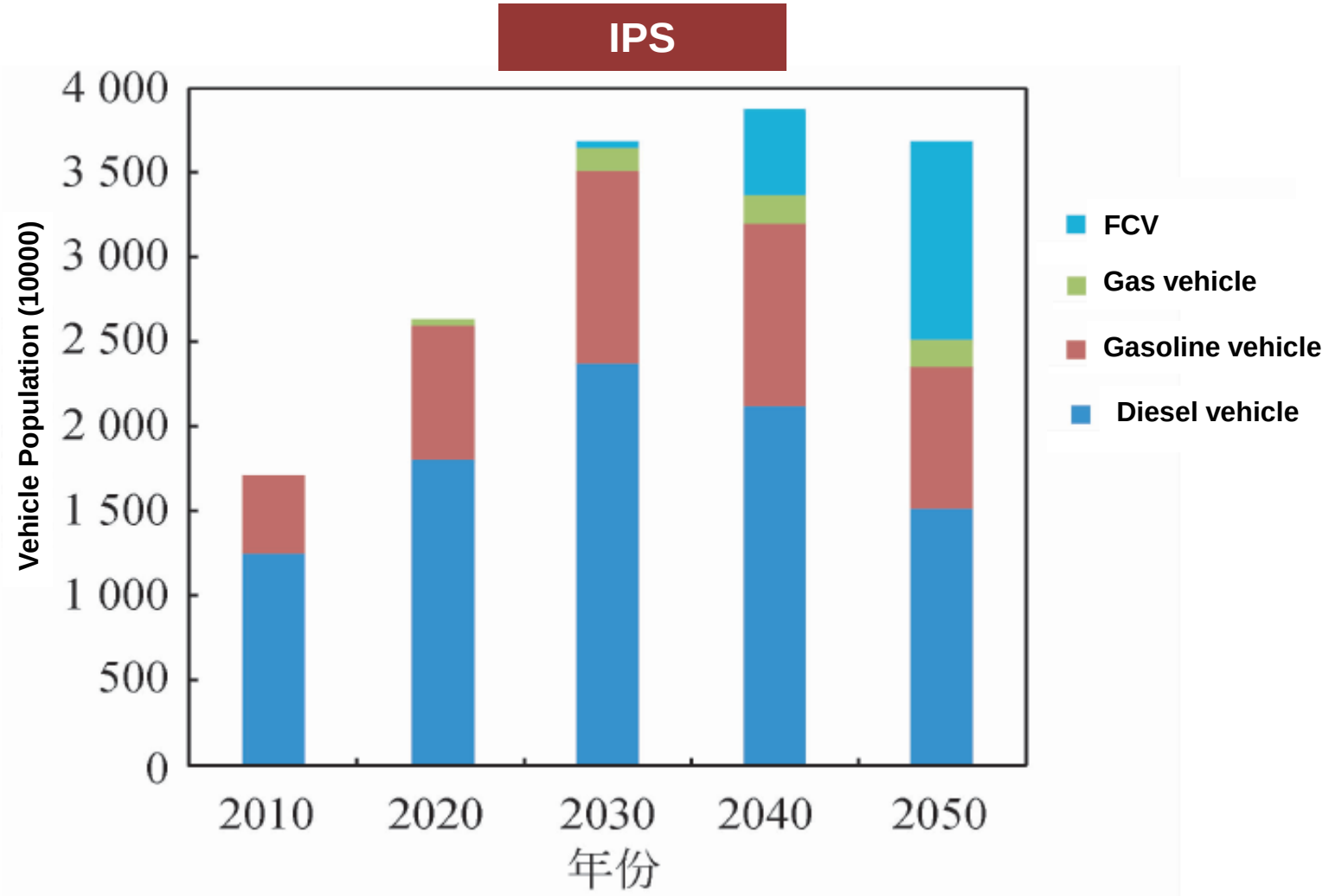
Passenger Vehicle Propulsion Portfolio under IPS



Bus Propulsion Portfolio under IPS

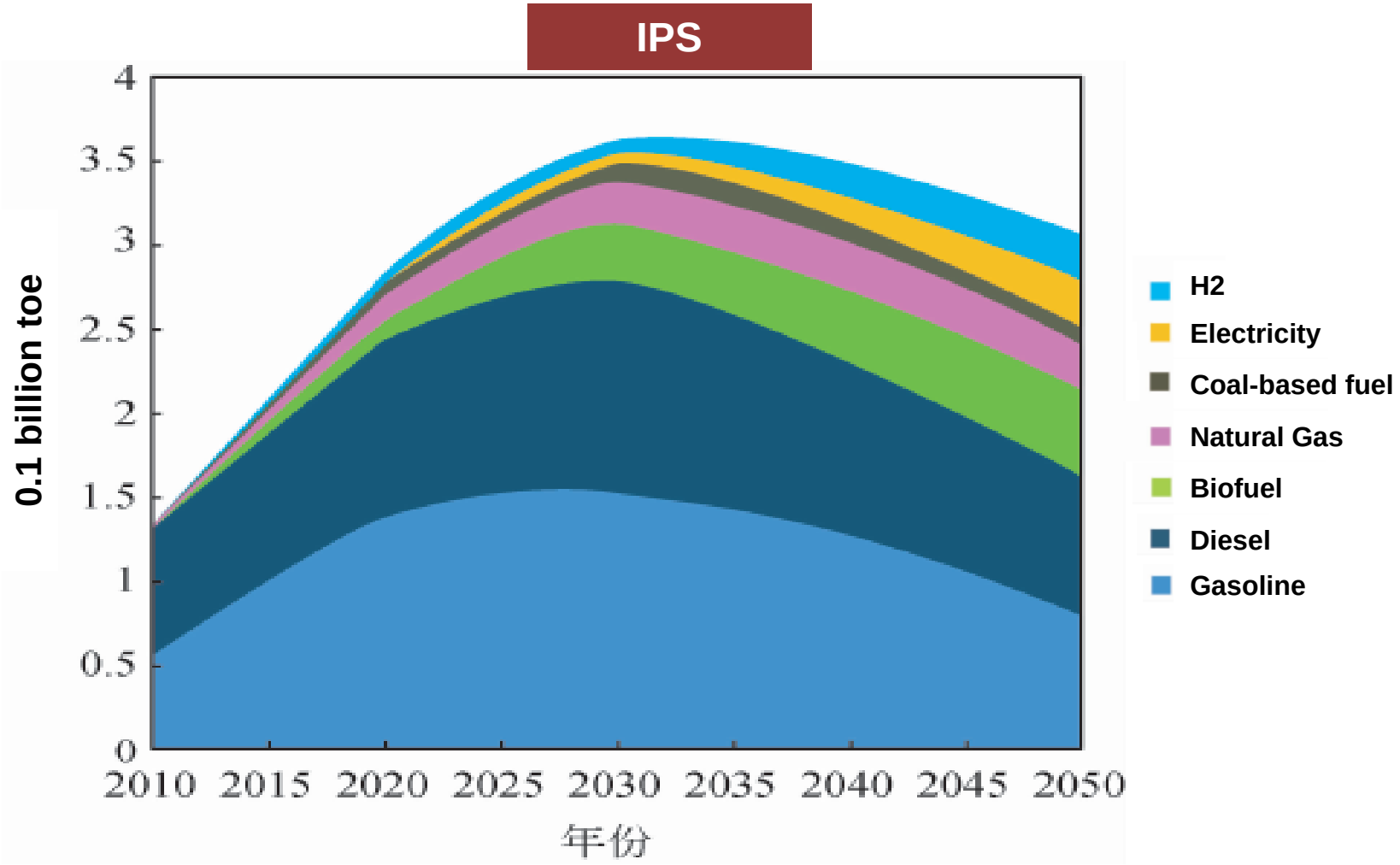


Truck Portfolio under IPS



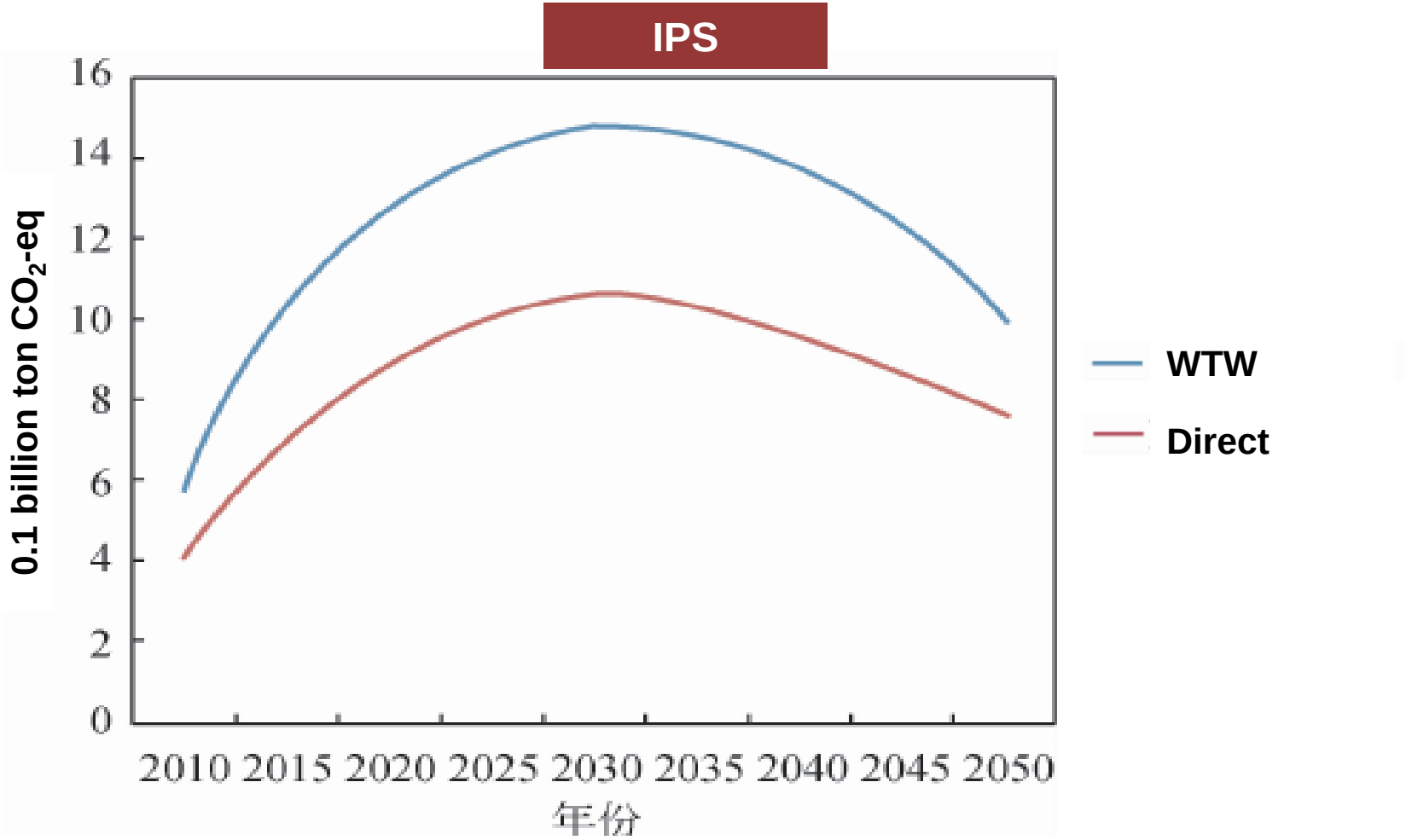
Automotive Fuel Consumption under IPS

(Final energy only)



If energy use associated with electricity generation is included, electricity energy share increases significantly.

GHG Emission under IPS



Summary of IPS Results

- 76% of passenger vehicles, 57% of buses, and 36% of trucks would be powered by new propulsion technologies (EV, FCV & PHEV) in 2050.
- Automotive energy supply would be significantly diversified in 2050 with gasoline and diesel supply declining to 50% and biofuels supply rising to 16%.
- WTW oil consumption would peak in 2030 and then decline to 180 million tons in 2050 with a 64% reduction compared to RS.
- CO_2 emission from China's automotive transport would peak in 2030 then decline to 1 billion tons in 2050 with a 60% reduction compared to RS.
- Per-unit passenger transport cost would be reduced by 39% and per unit freight transport cost by 27% *relative to RS in 2050* (due to long-term decreases in vehicle cost at scale and rising cost of imported petroleum-based fuel in the RS).

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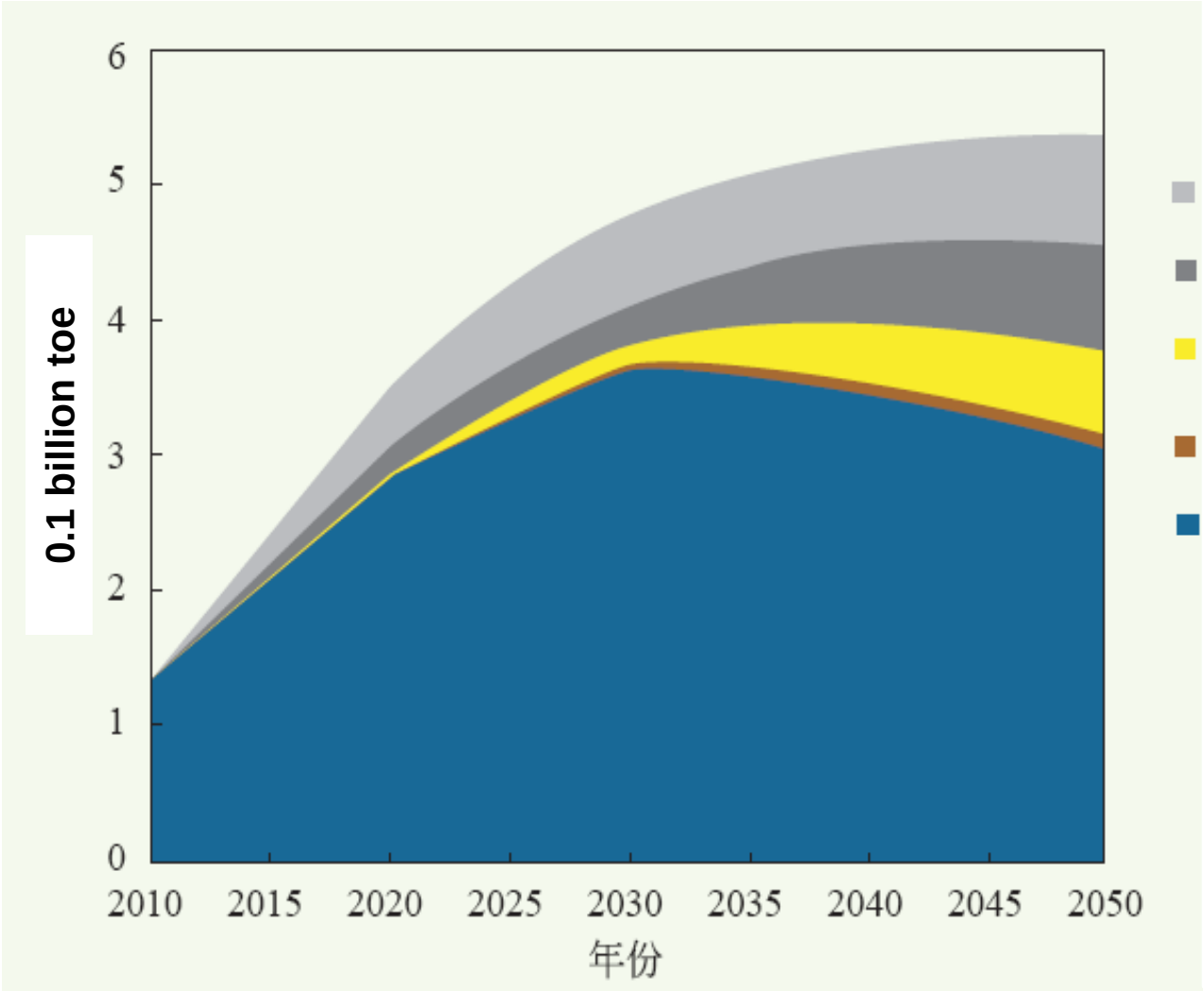
Sources of reductions in total automotive energy consumption in the IPS relative to reference



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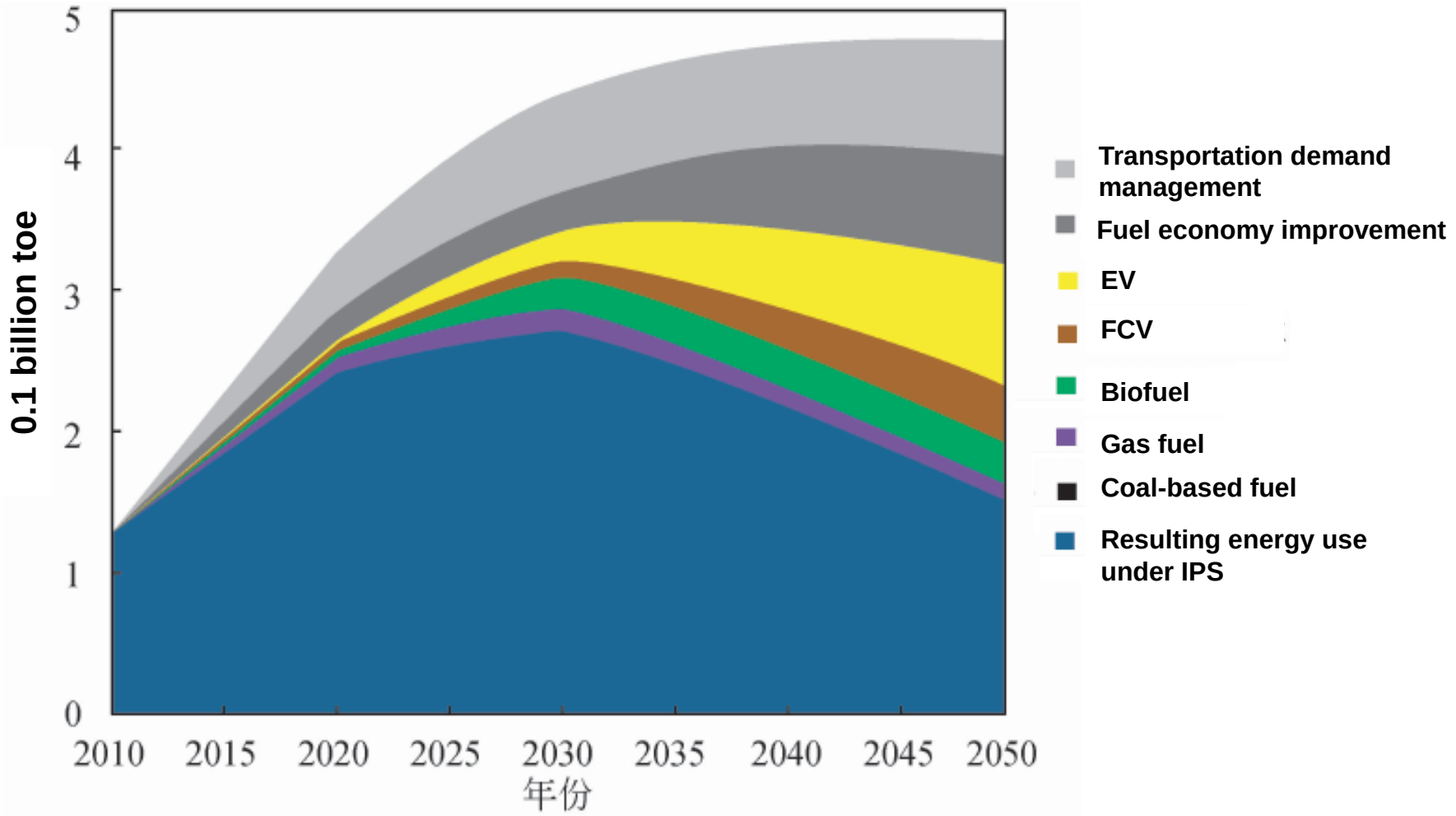
Sources of reductions in automotive oil-based fuel consumption in the IPS relative to reference



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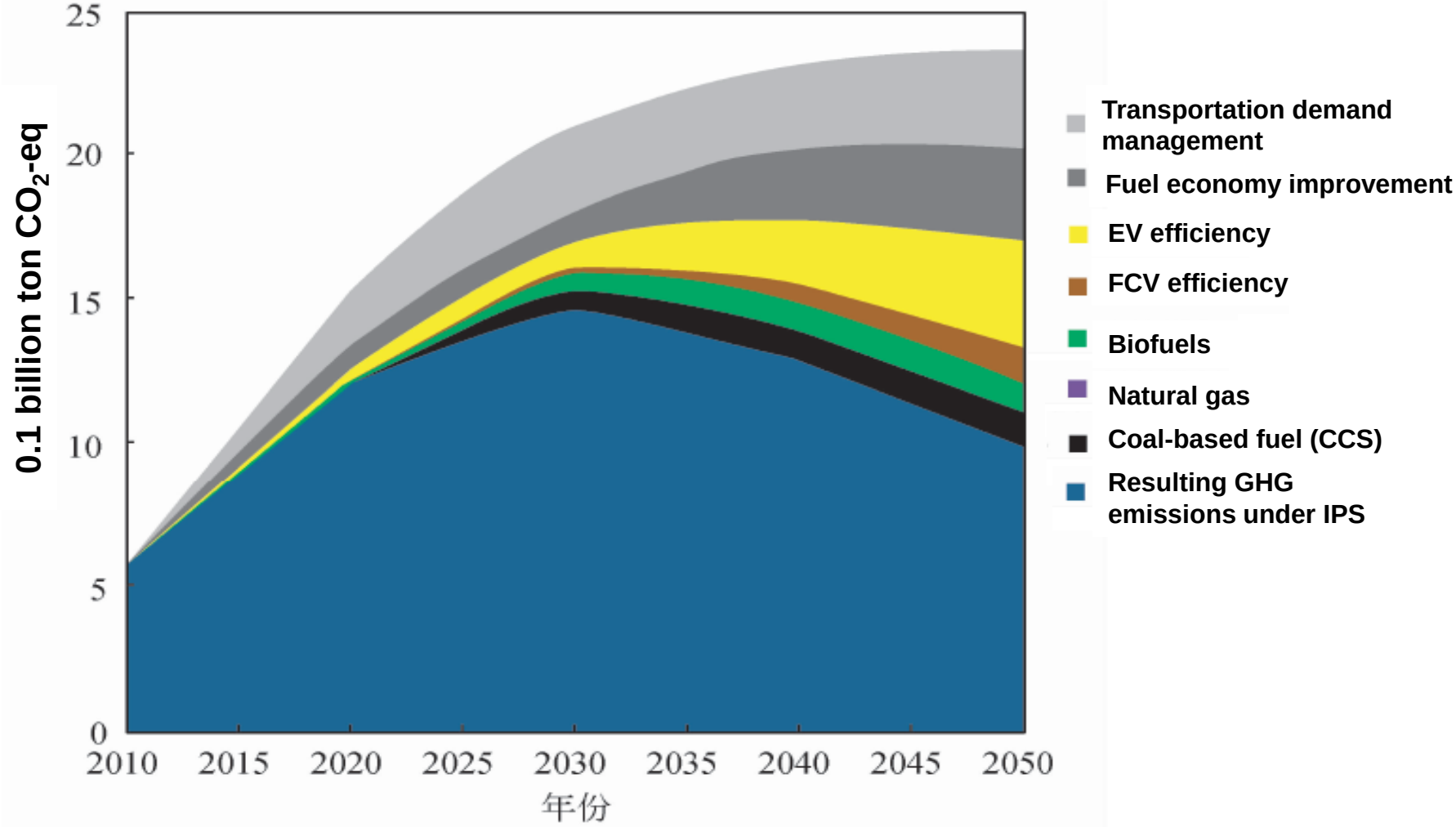
Source of well-to-wheels GHG emissions reductions in the IPS relative to reference



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Concluding Remarks

- Energy and vehicle technology innovations together with transport demand management (TDM) are key to a sustainable automotive energy transformation in China.
- EVs, PHEVs, FCVs and second generation biofuels are long-term solutions while increasing vehicle energy efficiency and TDM provide near and mid-term solutions.
- R&D for EVs, PHEVs, FCVs and second generation biofuels is needed to enable a significant future contribution.
- Several policies currently under consideration may help enable a transformation:

  - **Market-based policy instruments:** carbon tax, licensing tax & levy, parking fee

  - **Command-and-control instruments:** mandatory biofuel standards, fuel economy /carbon standards

  - **Institutional arrangements:** coordinated regulation of the energy industry and automotive industry, innovative business models

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New Climate Policy for the 12th Five-Year Plan

Could help support an automotive energy transformation

- Introduced the carbon intensity reduction as a legally binding target
- Disaggregated the carbon intensity reduction target by province
- Capped national energy consumption, and disaggregated a national energy consumption cap by province
- Intensified efforts in promoting development and utilization of non-fossil fuels:
  - 100GW wind & 20 GW solar PV to be added during the 12th FYP
  - 40 GW nuclear & 120GW hydro power under construction
- Low carbon development pilot areas
- Carbon ETS Pilots – 5 cities and 2 provinces

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Thanks for your attention!

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