Projection of Chinese Motor Vehicle Growth and CO_2 Emissions through 2030 with Different Propulsion/Fuel System Scenarios

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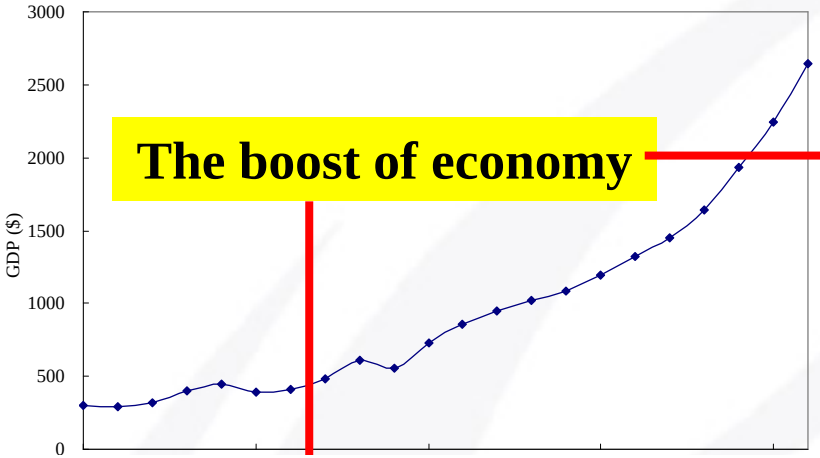
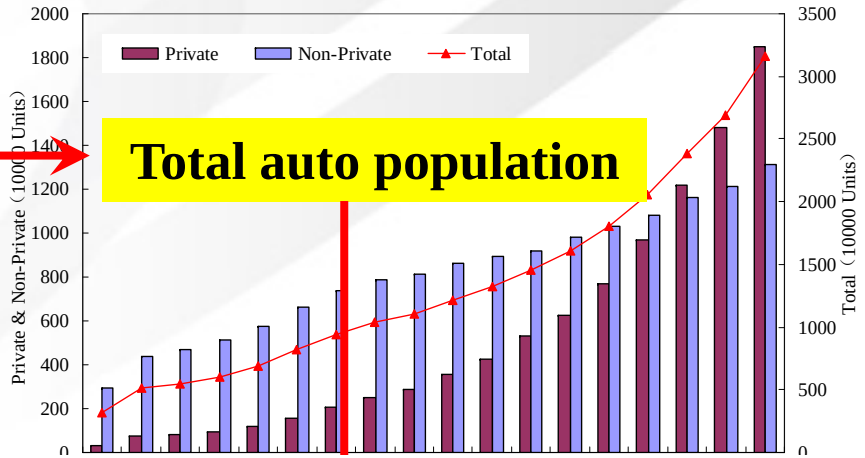
Background

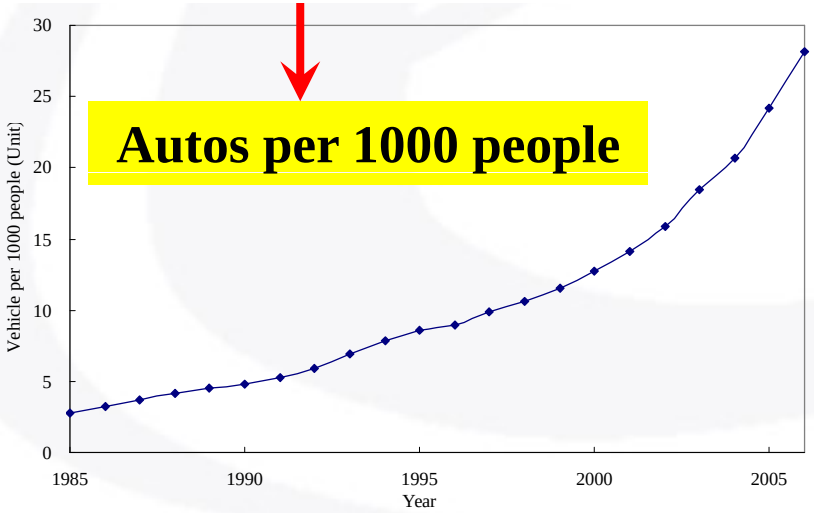


The boost of economy

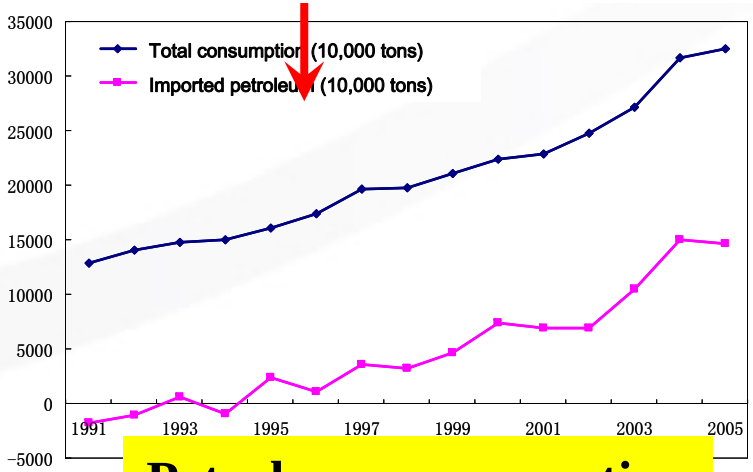


Total auto population

中国经济的持续发展导致机动车保有量快速增长，对能源安全、温室气体排放和城市空气质量带来巨大挑战！

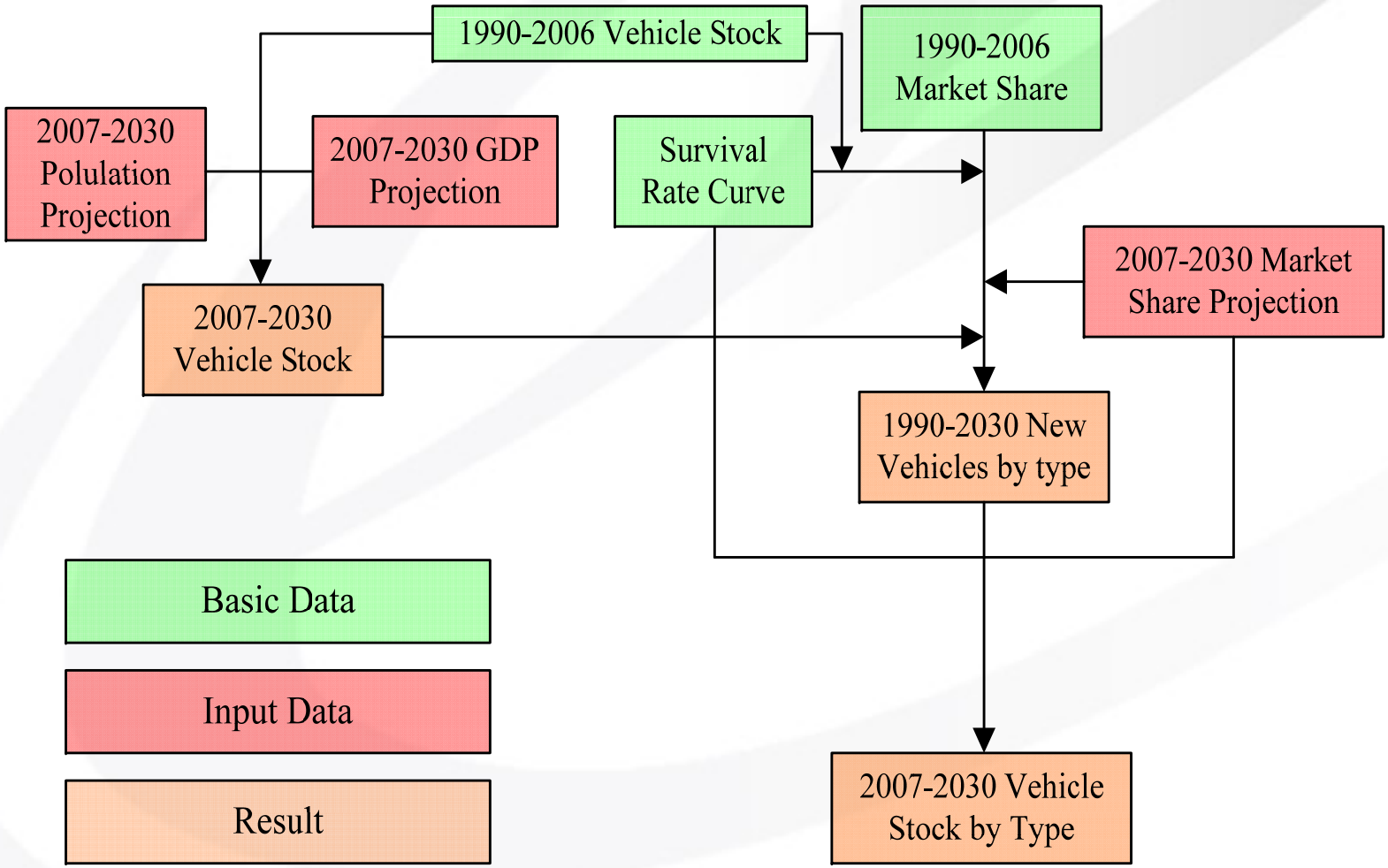


Autos per 1000 people



Petroleum consumption

Projection of China's Vehicle Stock through 2030



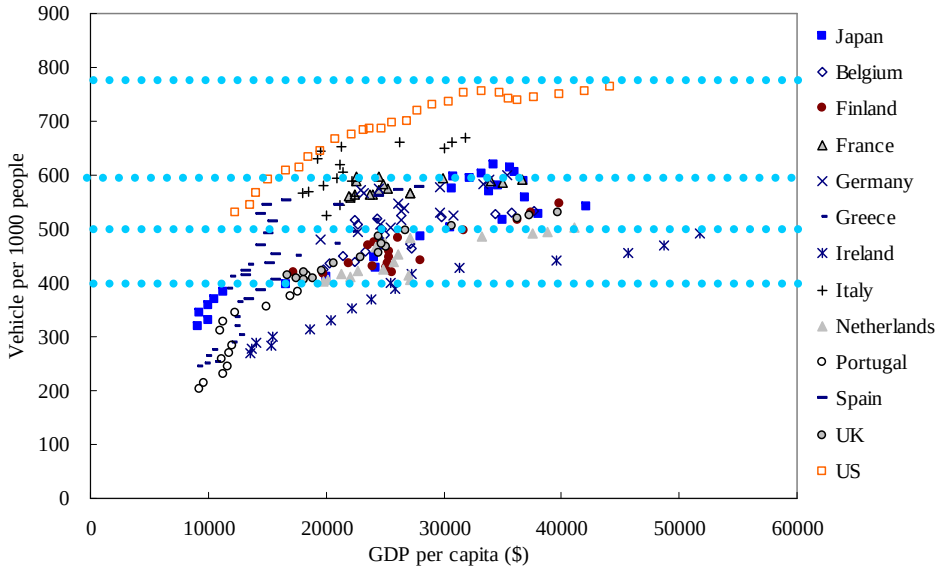
Projection of China's Vehicle Stock through 2030

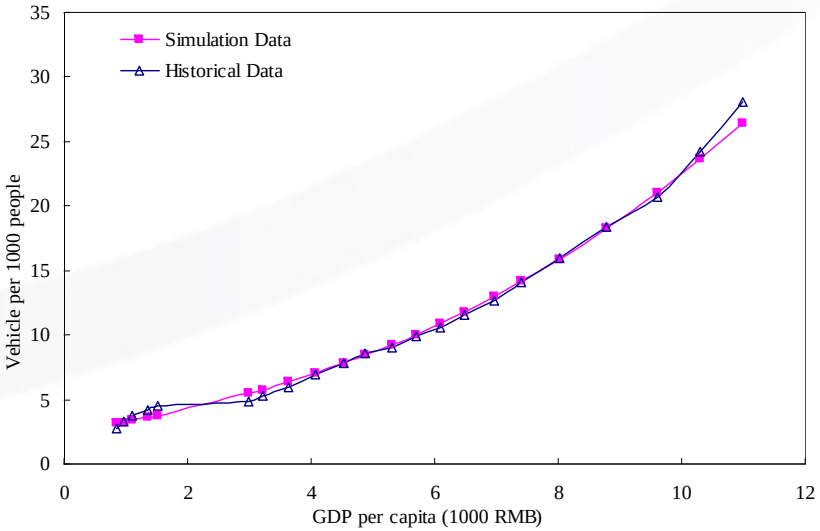
- ***Gompertz* Function**

$$V_i = V^* \times e^{\alpha e^{\beta EconomyFactor_i}}$$

- **S-shaped Curve**

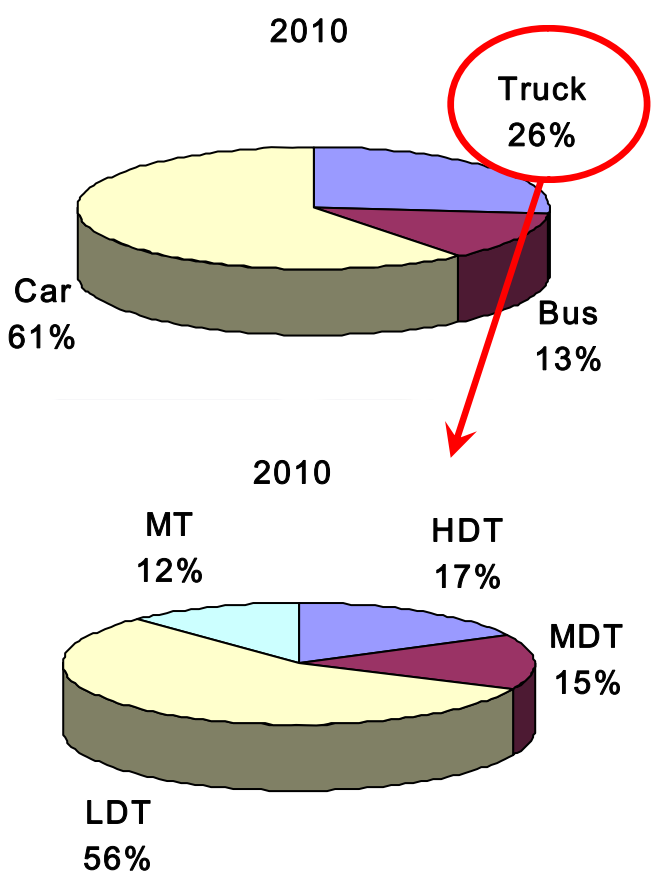
- **Key Parameters**
  - GDP
  - Population
  - Saturated vehicle ownership
- **Saturated vehicle ownership**
  - 600 (Europe)
  - 500 (Japan)
  - 400 (South Korea)

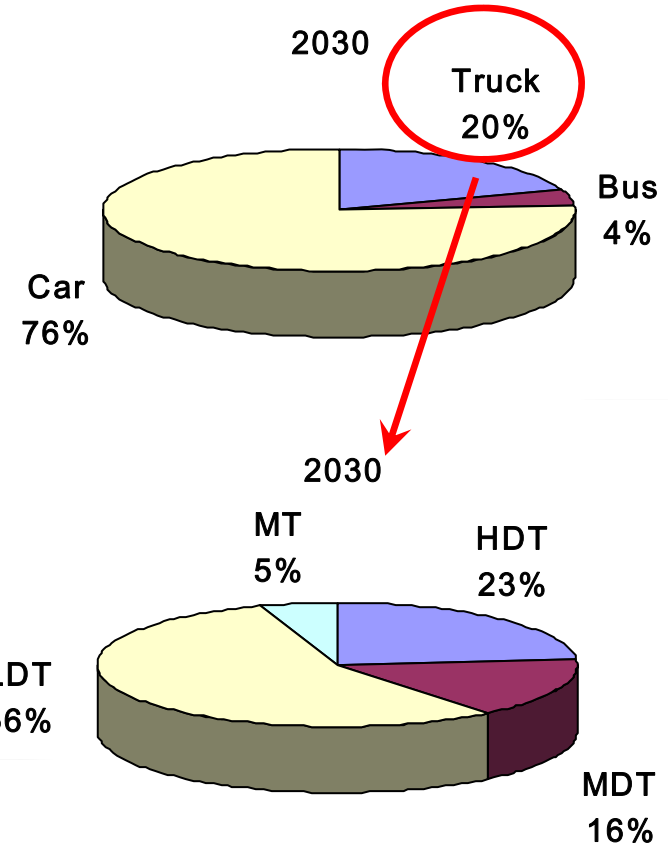




Projection of China's Vehicle Stock through 2030

- The share of each major vehicle category to total new vehicles up to 2030 is projected

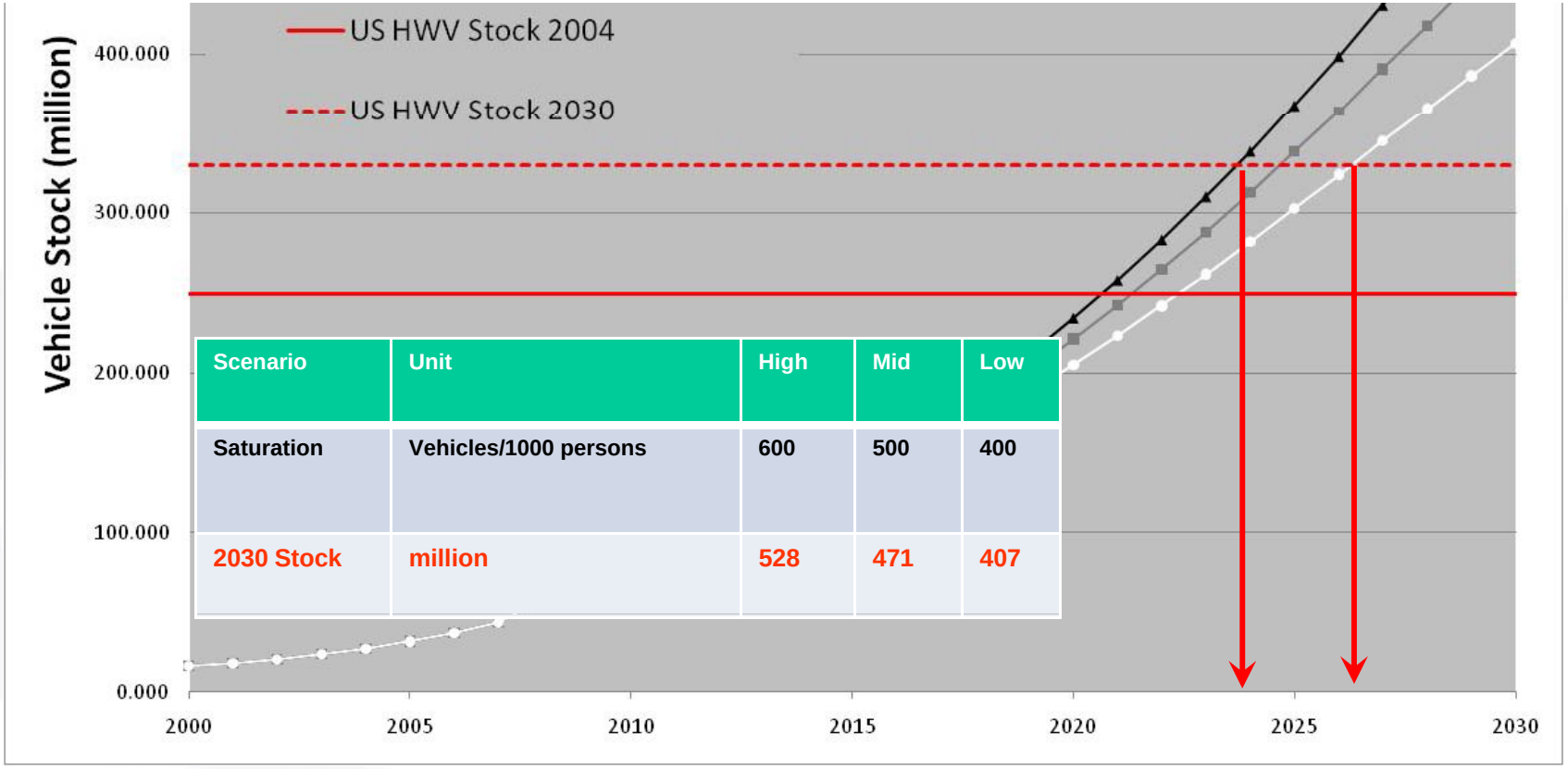




Projection of China's Vehicle Stock through 2030

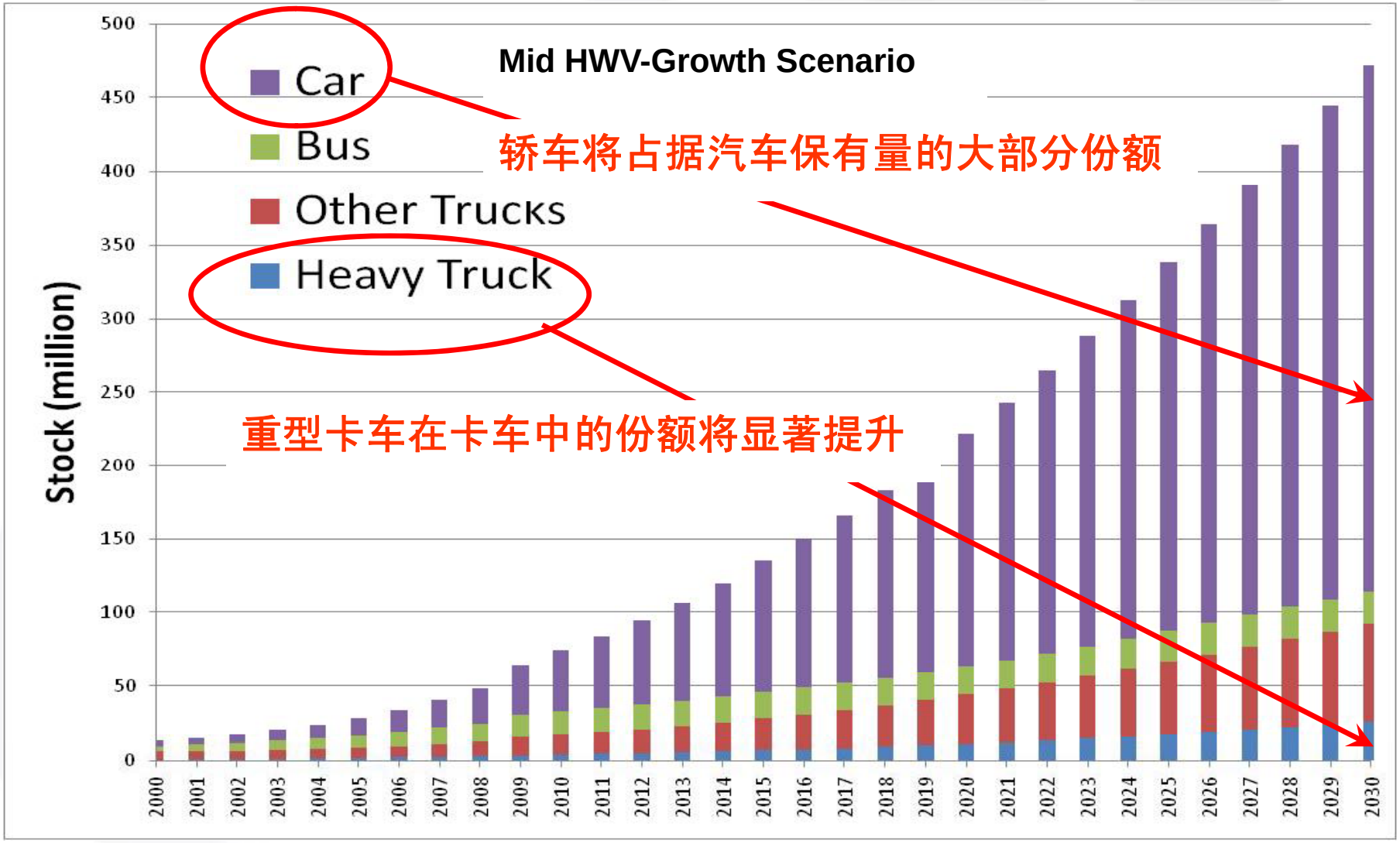
不论是哪种汽车保有增长方案，2025年前后我国汽车保有量都将超过美国2030年的汽车保有量预测水平！

2030年我国汽车保有量将是2005年的13.0-16.8倍！

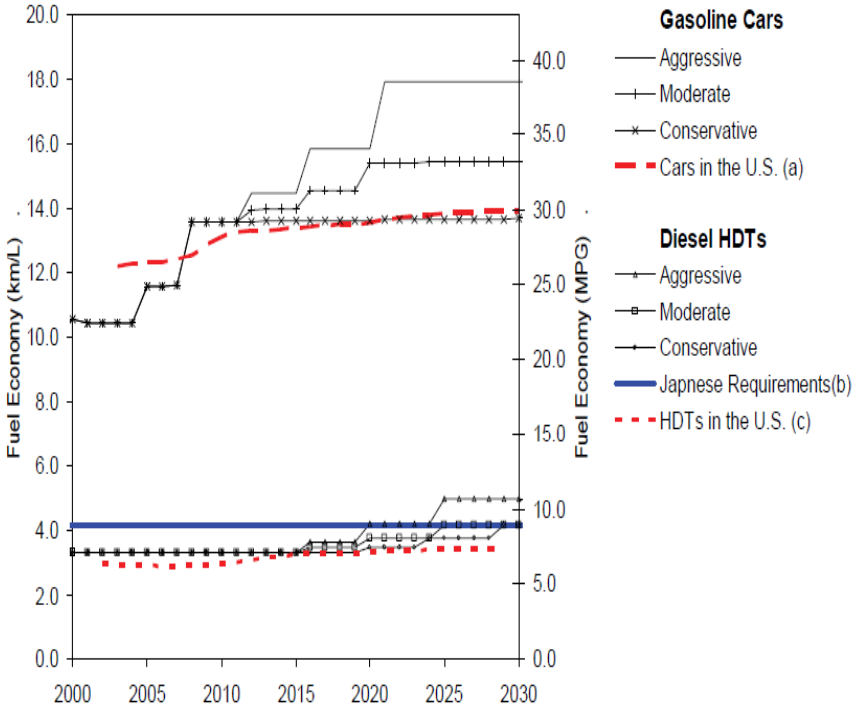


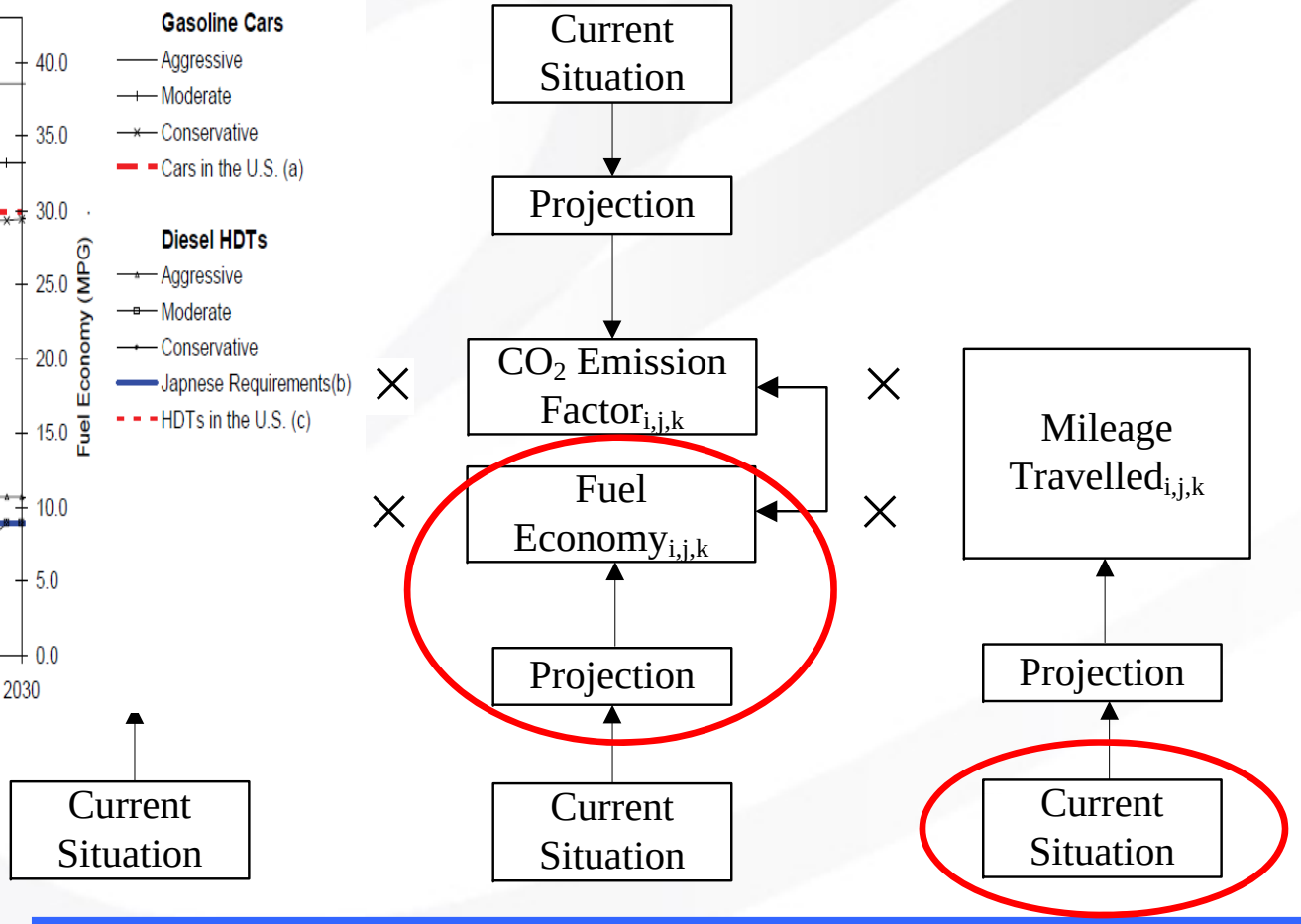
Scenario	Unit	High	Mid	Low
Saturation	Vehicles/1000 persons	600	500	400
2030 Stock	million	528	471	407

Projection of China's Vehicle Stock through 2030



The Logistics for Calculating Energy Use and CO2 Emissions from China's Vehicle Fleet





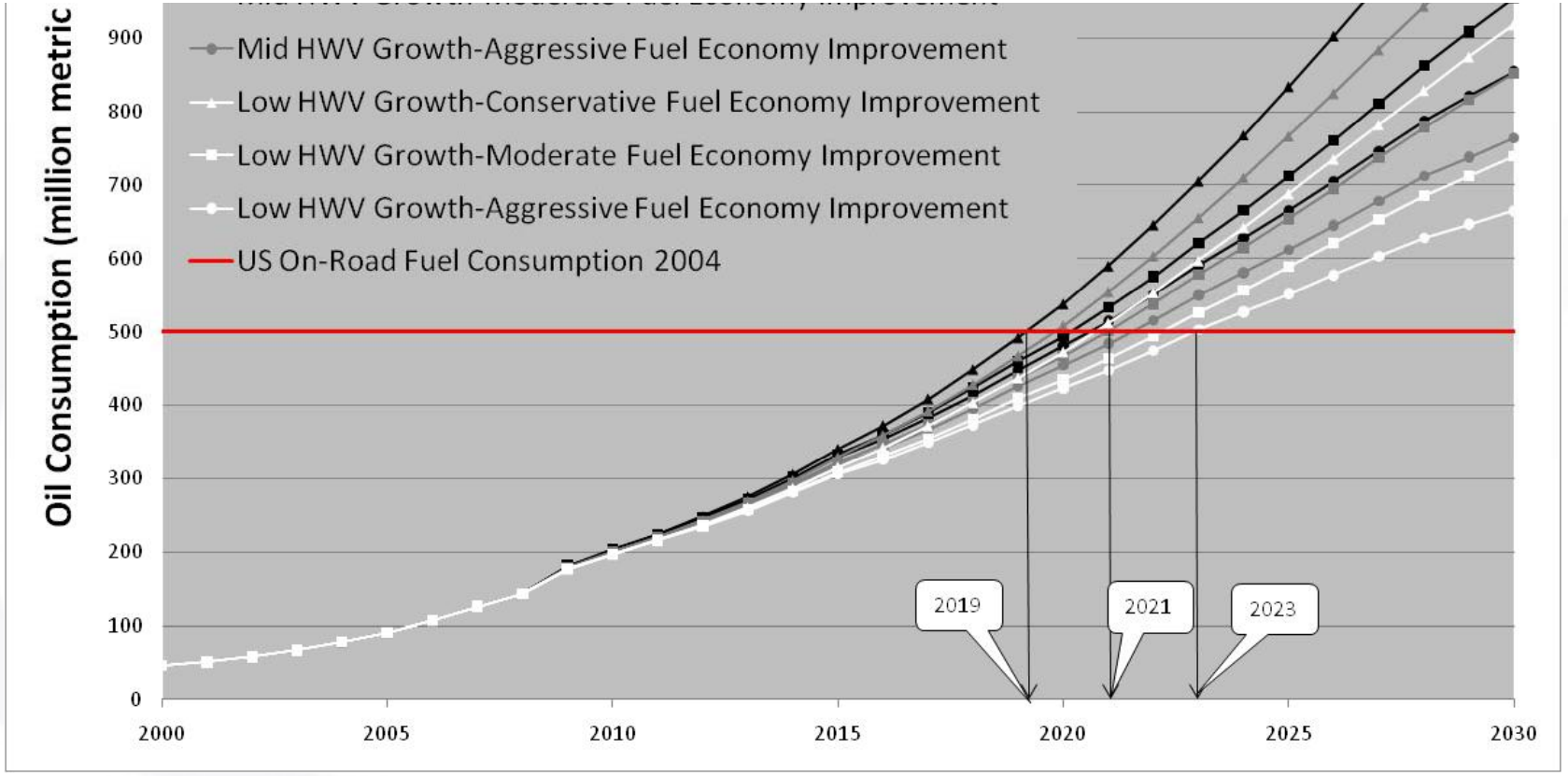
VMT in 2005 in this study (Unit: 1000km)

Year	HDT	MDT	LDT	miniT	HDB	MDB	LDB	miniB	Car
2005	60.0	24.5	20.6	21.0	40.0	25.0	32.5	20.0	21.0

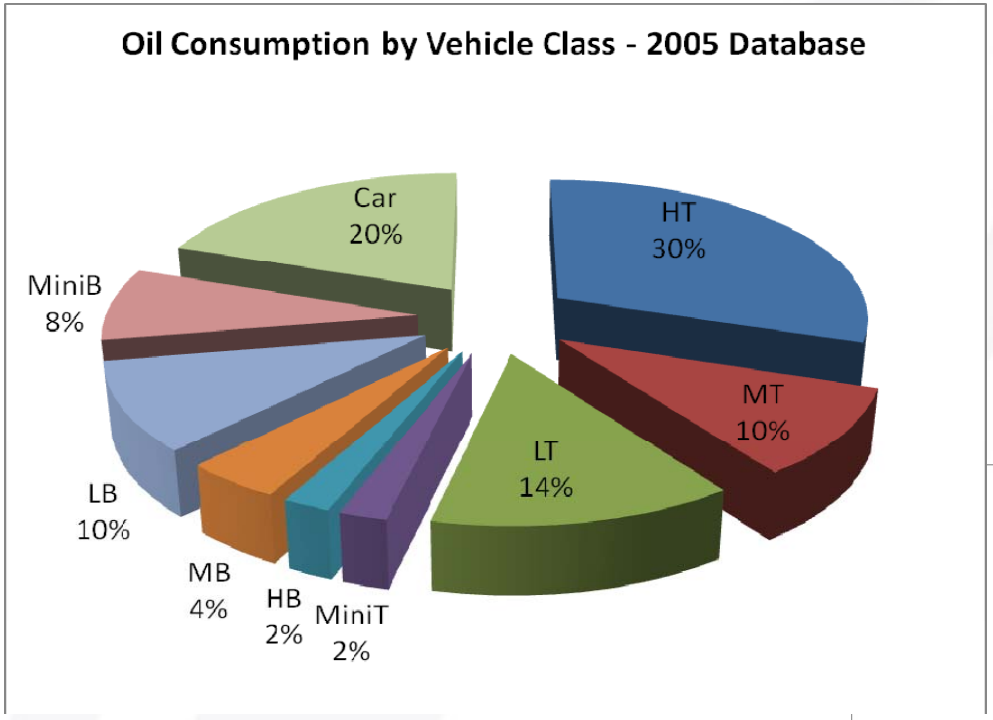
Projection of Oil Consumption through 2030

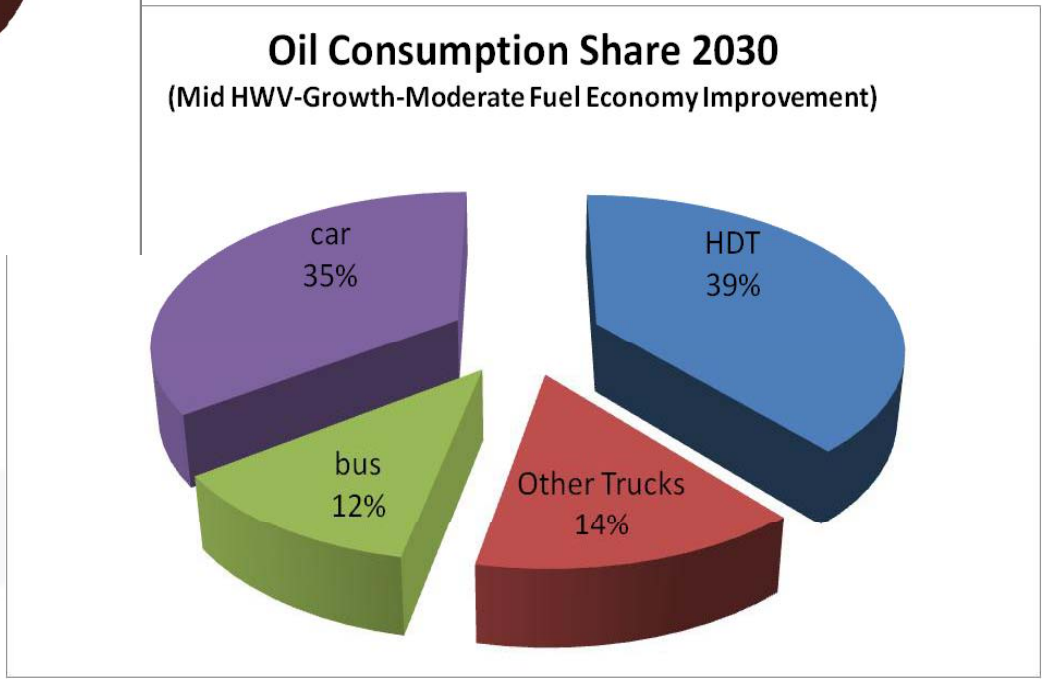
在不考虑引入先进动力系统/替代燃料的常规方案下，2030年我国汽车的汽柴油消耗将达到6.7-11.9亿吨，相当于原油消耗7.3-12.9亿吨！

如果维持国内原油产量水平不变（~2亿吨/年），仅考虑汽车消耗的原油（未考虑其他交通运输消耗原油）就将使得2030年进口原油依存度高达73-84%！



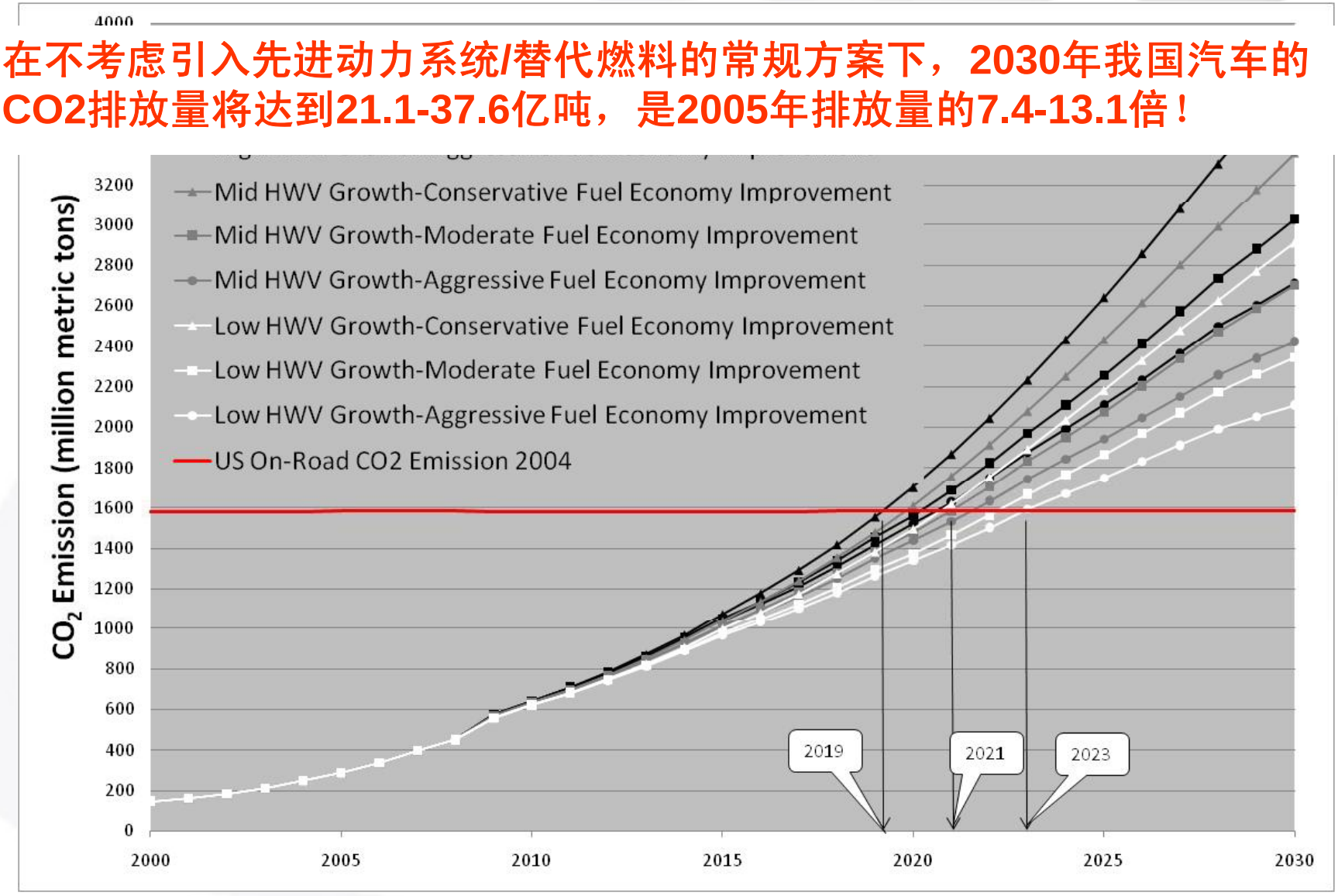
Projection of Oil Consumption through 2030





Projection of CO2 Emissions through 2030

在不考虑引入先进动力系统/替代燃料的常规方案下，2030年我国汽车的CO2排放量将达到21.1-37.6亿吨，是2005年排放量的7.4-13.1倍！



Without penetration of advanced propulsion/fuel systems, the trend of fast increase of oil consumption and CO2 emissions from automobiles in China is inevitable no matter how aggressive the technology improvements of conventional gasoline/diesel vehicles are!

在中国汽车高速增长的背景下，无论传统汽/柴油车辆技术多么进步，未来中国汽车石油消耗和CO2排放量将不可避免的快速增长。引入先进动力/替代燃料系统（例如混合动力/插电式混合动力技术、生物燃料技术等等）将是削弱这种快速增长趋势的关键选择！

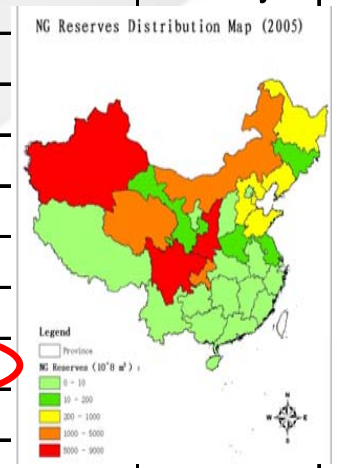
Potential Propulsion/Fuel Systems Involved in the Scenarios Are Many

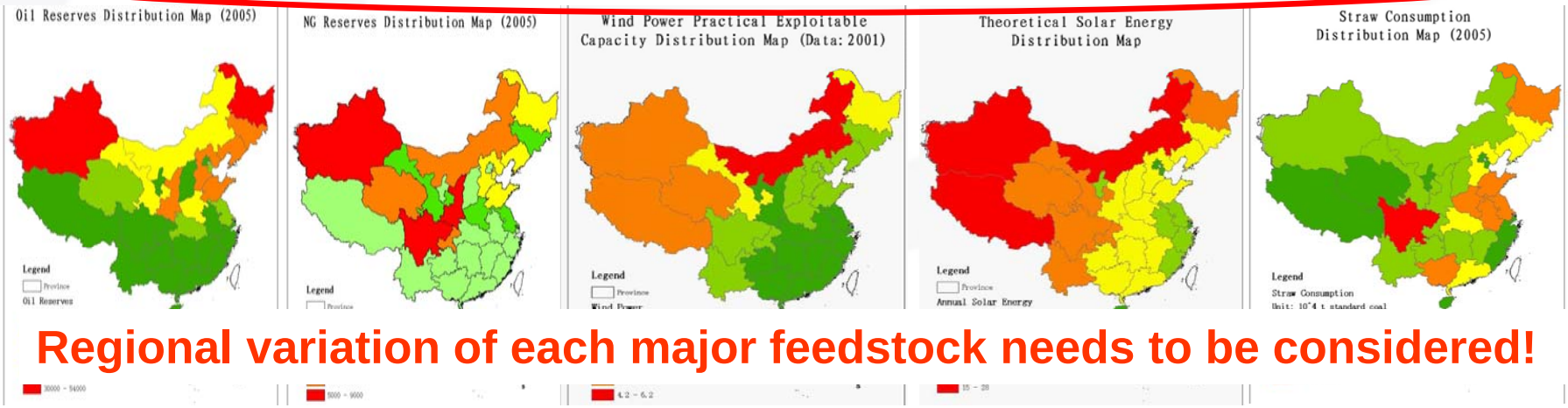
	Light-Duty Vehicles							
	SI ICE	DI ICE	SI GI HEV	DI GI HEV	FCV	SI GC HEV	DI GC HEV	EV
Gasoline	√		□			□		
Diesel		√		□			□	
Ethanol	◿		□			□		
Biodiesel		□		□			□	
FT Diesel		□		□			□	
DME		□		□			□	
CNG	◿		□			□		
LPG	◿		□			□		
Methanol	◿		□			□		
Hydrogen					□			
Electricity						□	□	□
	Heavy Duty Vehicles (including buses)							
	SI ICE	DI ICE	SI GI HEV	DI GI HEV	FCV	SI GC HEV	DI GC HEV	EV
Gasoline	√		□			□		
Diesel		√		□			□	
Ethanol	◿		□			□		
Biodiesel		□		□			□	
FT Diesel		□		□			□	
DME		□		□			□	
CNG	◿		□			□		
LPG	◿		□			□		
Methanol	◿		□			□		
Hydrogen					□			
Electricity						□	□	□
	Motocycles and Scooters							
	SI ICE	DI ICE	SI GI HEV	DI GI HEV	FCV	SI GC HEV	DI GC HEV	EV
Gasoline	√							
Electricity								□

√	Current Vehicle/Fuel System (Already included in the vehicle stock database)
◿	Current Vehicle/Fuel System (To be included in the vehicle stock database)
□	Future Vehicle/Fuel System (To be included in various scenarios)

Resource Availability in China for Selected Auto Fuels Needs to Be Carefully Considered

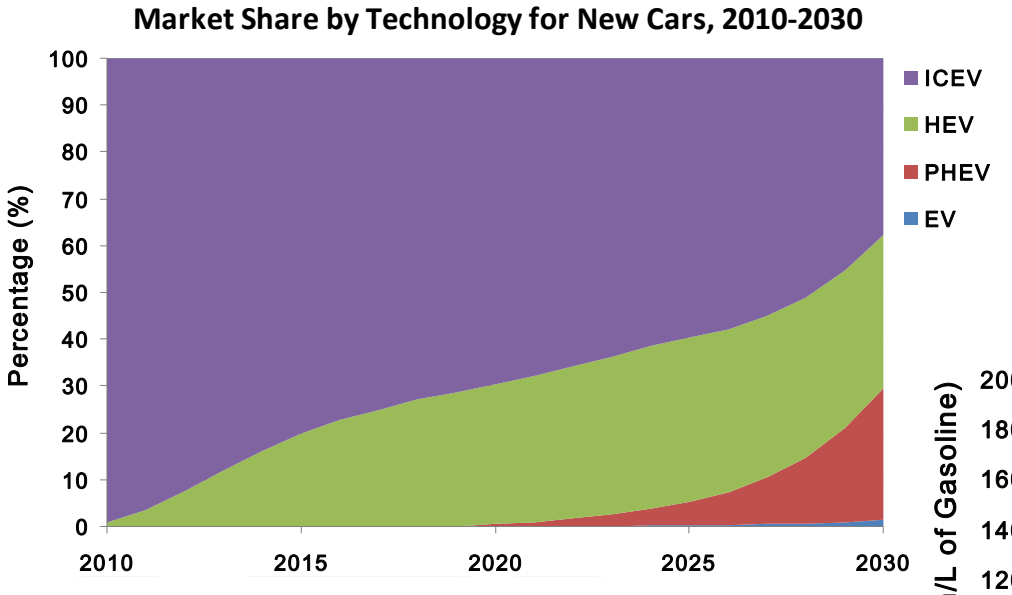
	Conventional Crude	Oil Sands /Super-Heavy Crude	Food (e.g., corn)	Biomass (e.g., woody)	Coal	NG	Nuclear	Wind, Solar and Hydro	Others (e.g., COG)
Gasoline	√	√							
Diesel	√	√							
Ethanol			√	√					
Biodiesel			√						
FT Diesel				√	√	√			
DME				√	√	√			
CNG						√			
LPG	√					√			
Methanol					√	√			
Hydrogen				√	√	√	√	√	√
Electricity	√	√		√	√	√	√	√	√



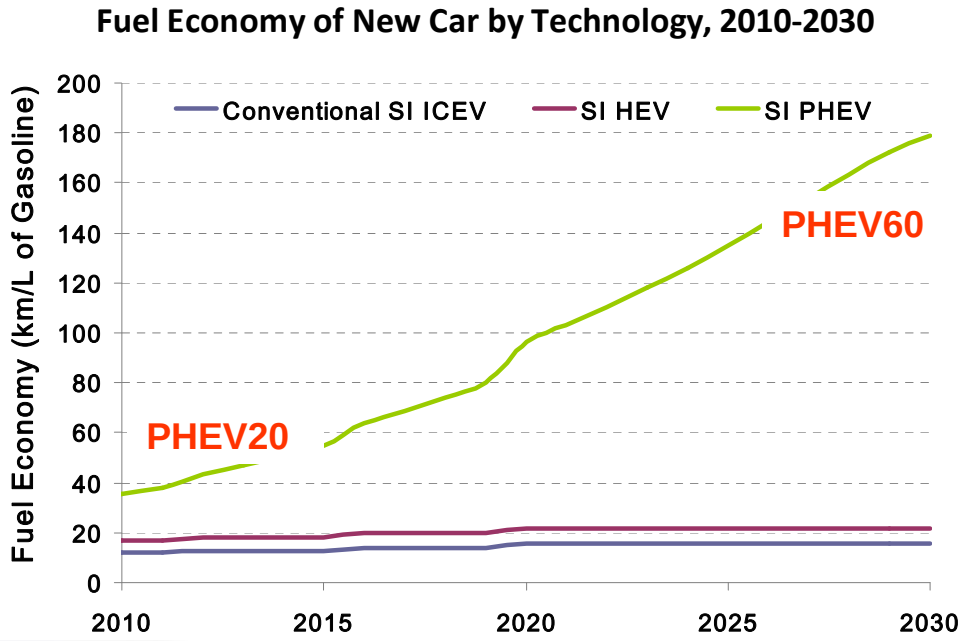


Regional variation of each major feedstock needs to be considered!

The Impacts of a HEV/PHEV/EV Scenario Are Being Evaluated



ICEV: 传统汽油/柴油车
HEV: 混合动力车
PHEV: 插电式混合动力车
EV：纯电动车



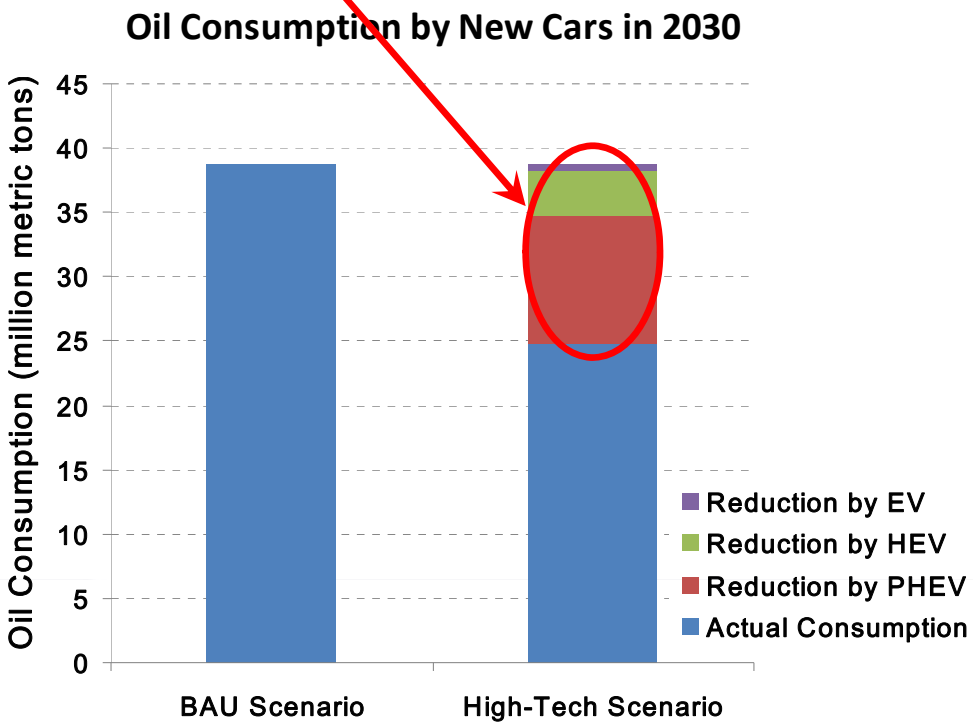
Sources of HEV/PHEV/EV scenario：

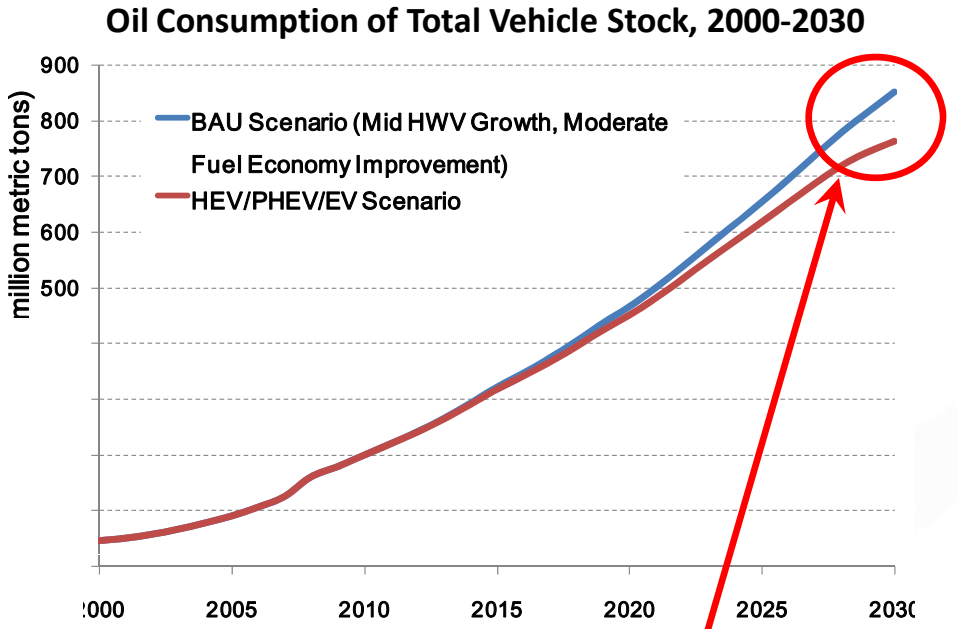
1）USDOE AEO2009; EPRI 2007; RMI 2008; CALCARS 2009, ANL 2009；

2）国内新能源汽车发展规划等

The Impacts of a HEV/PHEV/EV Scenario Are Being Evaluated

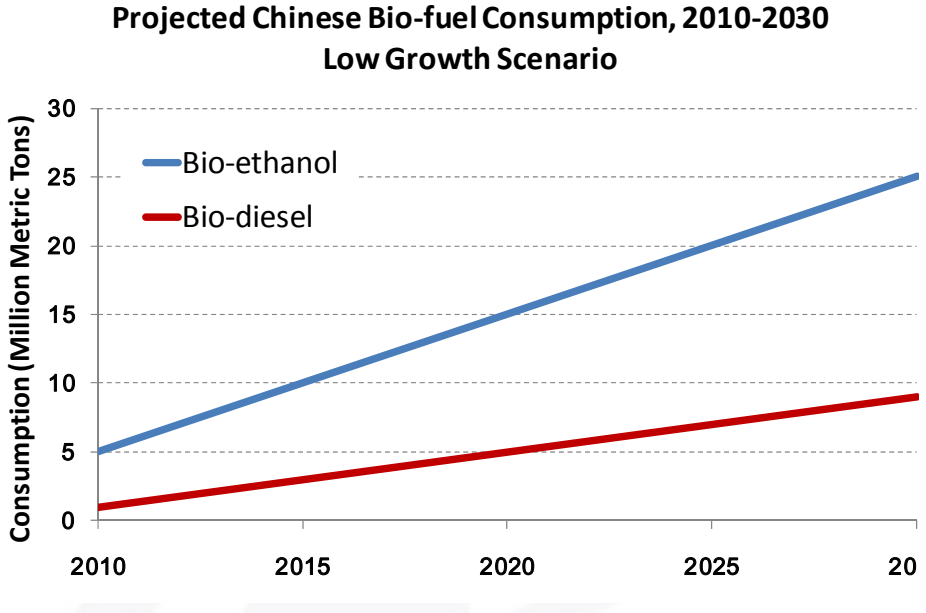
在HEV/PHEV/EV方案下，2030年销售的轿车新车的平均油耗可下降36%，削减效益主要来自PHEV的贡献。





HEV/PHEV/EV方案对中国汽车整体油耗的削减效益具有滞后性，与常规方案（中车辆保有-中燃油经济性方案）相比，2030年整体油耗可下降10%。

The Impacts of Bio-fuel Scenarios Are Being Evaluated



Bio-ethanol feedstock includes:

-Sweet sorghum (甜高粱),
-Manihot esculenta (木薯)
-Sweet potato (甘薯),
-Cellulosic biomass, etc.

Bio-diesel feedstock includes:

-Shinyleaf yellowhorn (文冠果)
-Jatropha curcas (麻疯树或小桐子), etc

Sources of Bio-fuel scenarios:

1) Governmental plans (Low Growth Scenario)

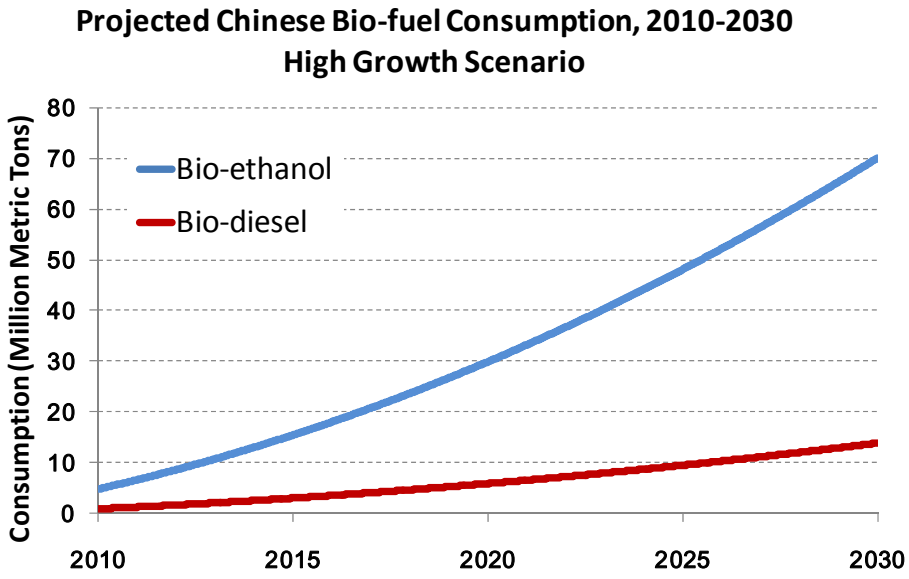
-11th 5-year-planning, etc.

2) Bio-fuel companies and public reports (High Growth Scenario)

-Novozymes, etc.

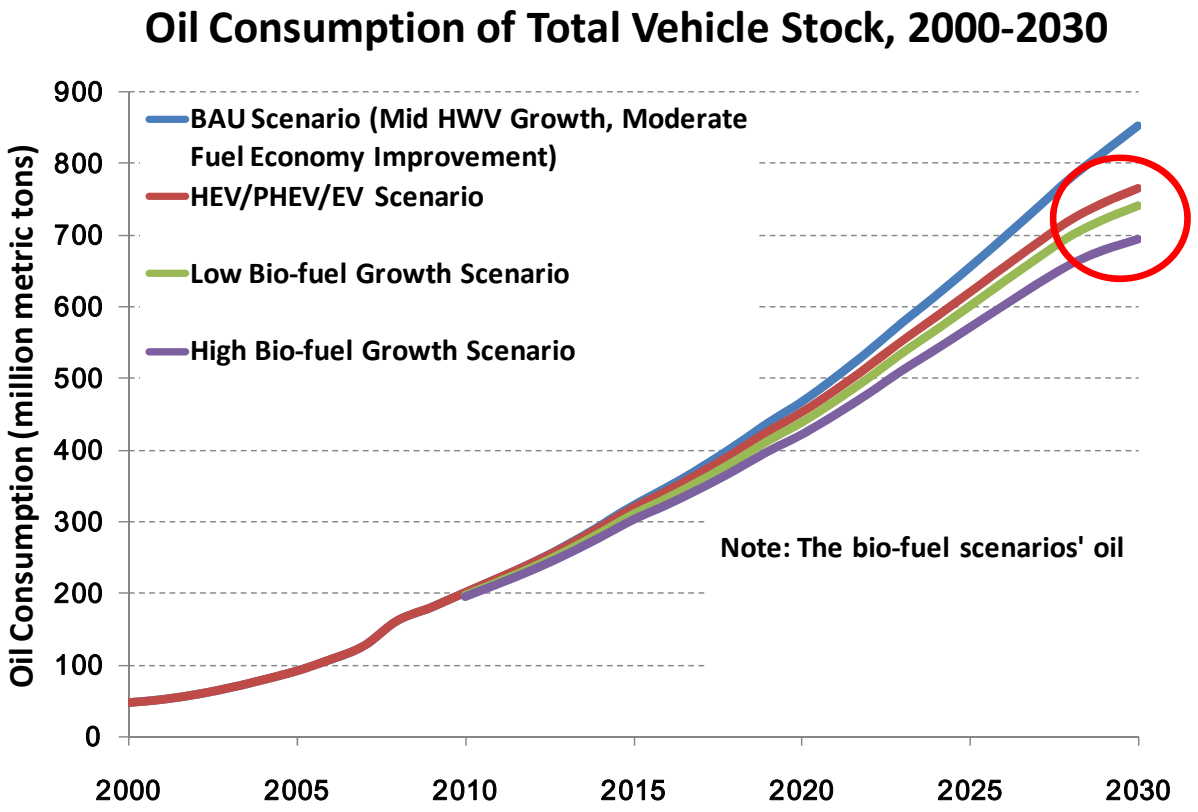
3) Resource availability for bio-fuels

-Tsinghua University, etc.



The Impacts of Bio-fuel Scenarios Are Being Evaluated

在高生物燃料情景方案下，2030年生物燃料可以替代约5600万吨的汽/柴油；在低方案下，可替代约2300万吨的汽/柴油。



与常规方案（中车辆保有-中燃油经济性方案）相比，生物燃料的推广将在2030年进一步削减3-8%不等的燃油消耗。

Preliminary Conclusions 初步研究结论

- 我国汽车保有量在未来20年间将持续快速增长，2030年预计汽车保有量将达到4.1-5.3亿辆，是2005年的13.0-16.8倍。

  Total automobile population in China will continue to increase with a rapid growth rate within the next two decades, and will reach 410-530 million units, about 13.0-16.8 times of 2005's data.

- 在不考虑引入先进动力系统/替代燃料的常规方案下，2030年我国汽车的汽柴油消耗将达到6.7-11.9亿吨，相当于原油消耗7.3-12.9亿吨，进口原油依赖度将不可避免的加剧。

  Without penetration of advanced propulsion/fuel systems, oil consumption will reach as high as 0.67-1.19 billion tons (0.73-1.29 billion tons of crude oil equivalent), and trigger a much higher dependence with imported oil.

- 在不考虑引入先进动力系统/替代燃料的常规方案下， 2030年我国汽车的CO2排放量将达到21.1-37.6亿吨，是2005年排放量的7.4-13.1倍。

  Without penetration of advanced propulsion/fuel systems, CO2 emissions will reach as high as 2.11-3.76 billion tons, about 7.4-13.1 times of 2005's data.

Preliminary Conclusions 初步研究结论

- 引入先进动力/替代燃料系统是削弱我国汽车石油消耗和CO2排放快速增长趋势的关键选择。本研究的大规模应用混合动力/插电式混合动力/纯电动技术方案的初步结果表明，2030年新车平均油耗可进一步下降36%。但是对整体车队的油耗削减则有一定的滞后性，2030年削减比例在10%左右。生物燃料的推广则将在2030年进一步削减3-8%不等的燃油消耗（削减比例以本研究的中保有量-中燃油经济性方案为基准）。

  Penetration of advanced propulsion/fuel systems could help mitigate the trend of fast increase of oil consumption and CO2 emissions from automobiles. Our preliminary results show that oil consumption of new car fleet in 2030 could further reduce by 36% by HEV/PHEV/EV scenario, and the scenario could reduce the oil consumption of total vehicle fleet in 2030 by about 10%. Bio-fuel scenarios could reduce the oil consumption of total vehicle fleet in 2030 by about 3-8% (Reduction ratios are based on the median vehicle population growth-moderate fuel economy improvement scenario).