

*Low carbon transport
scenario in China*

中国低碳交通情景

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Our Studies on Low Carbon for China 我们关于中国低碳的研究

- Energy and CO₂ emission scenario by 2050
- 2050年能源和CO₂排放情景

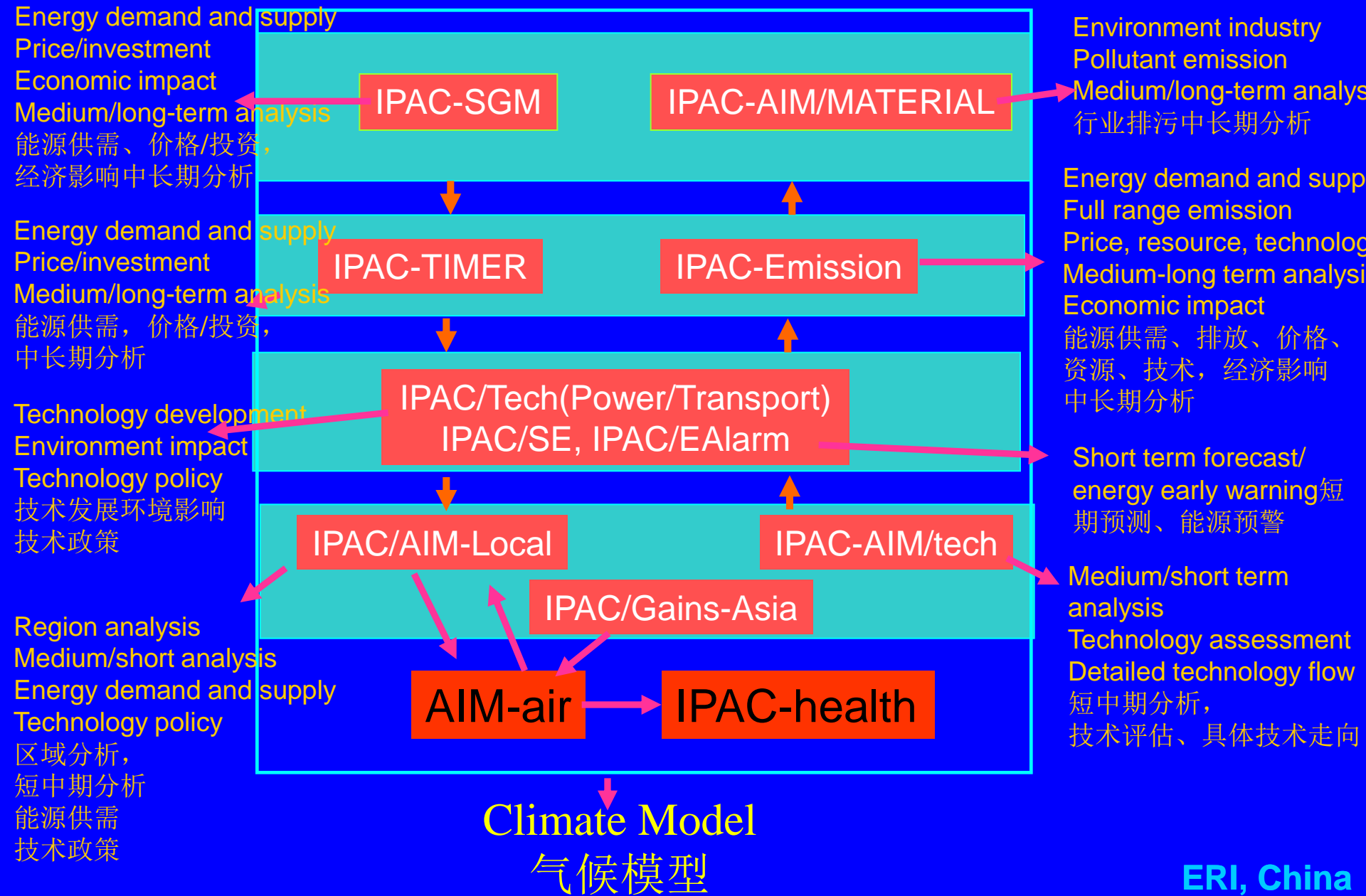
- Technology roadmap
- 技术路线

- Policy roadmap: electric car etc.
- 政策路线：电动汽车等

- Transport policy for Beijing, Shanghai, Taiyuan, Hangzhou, Langfang etc.
- 北京、上海、太原、杭州、廊坊等地的交通政策

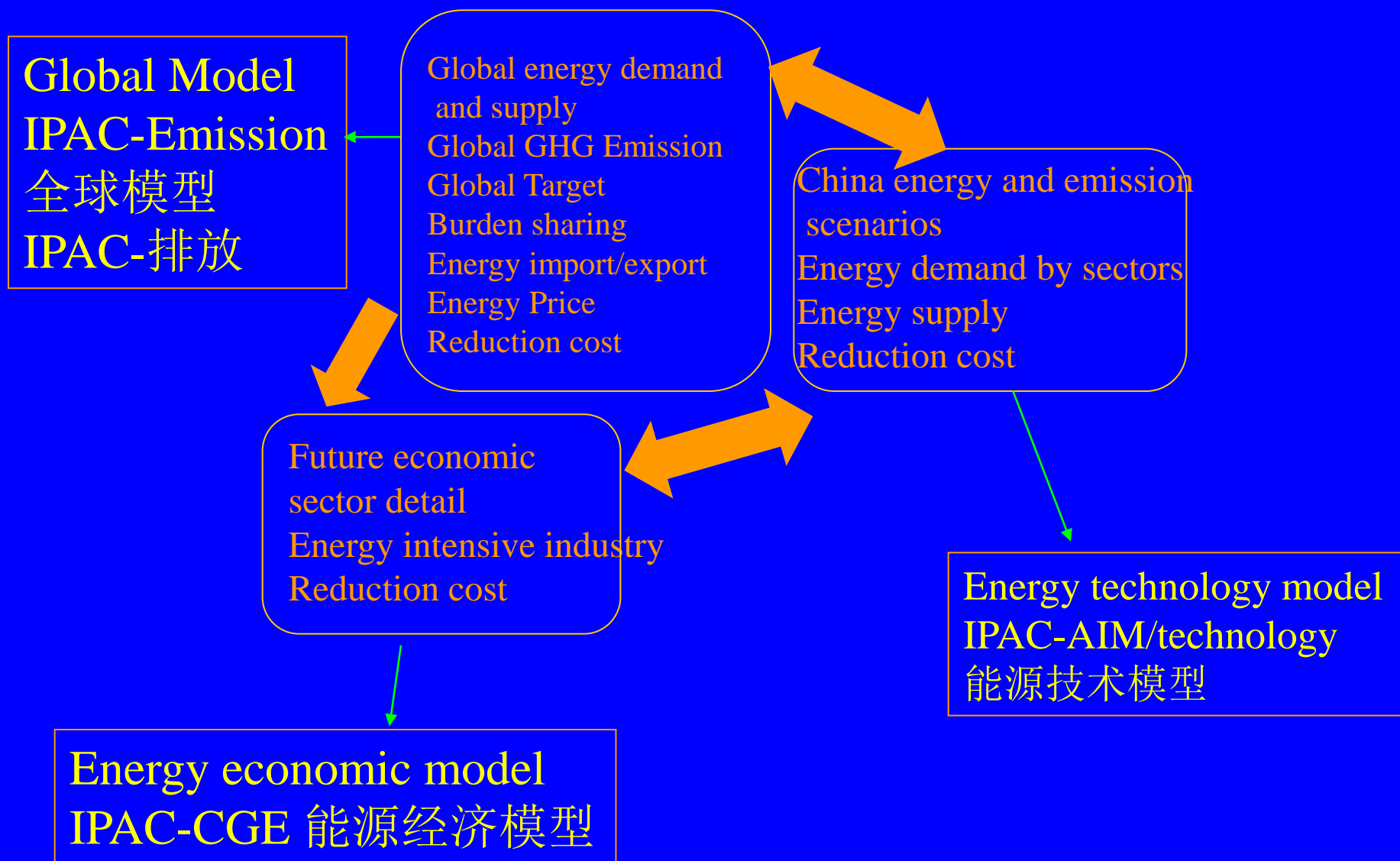
Framework of Integrated Policy Model for China (IPAC)

中国综合政策模型 (IPAC) 框架



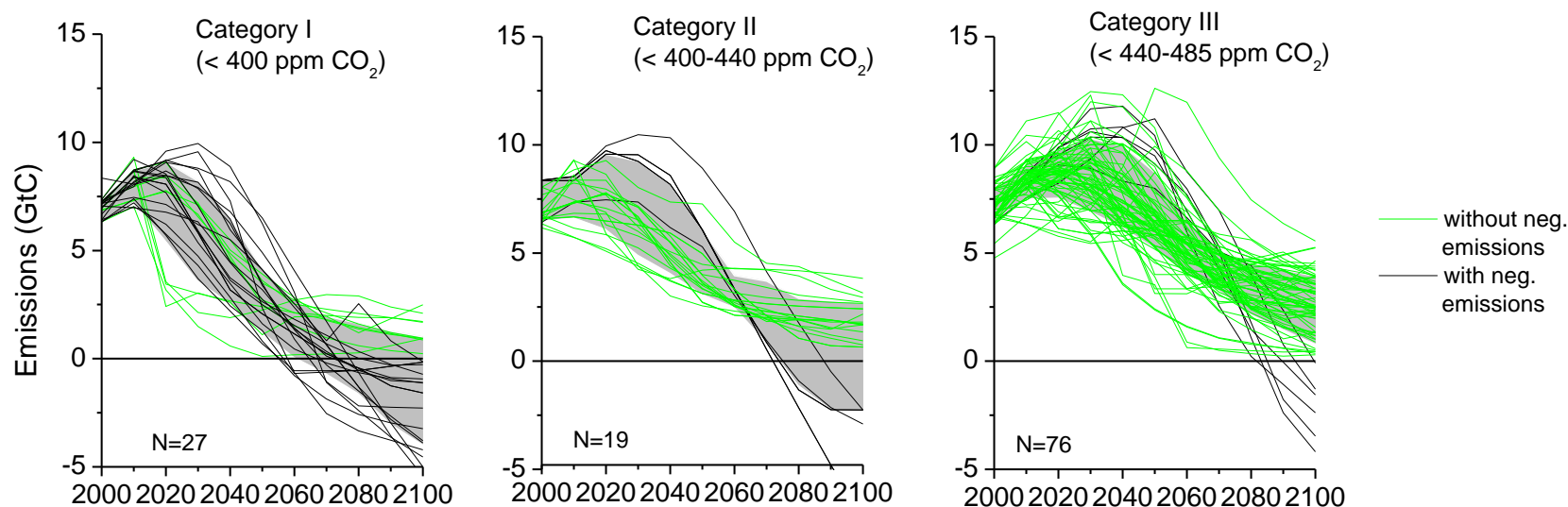
IPAC 2050 scenario modeling framework

IPAC 2050年情景模型框架



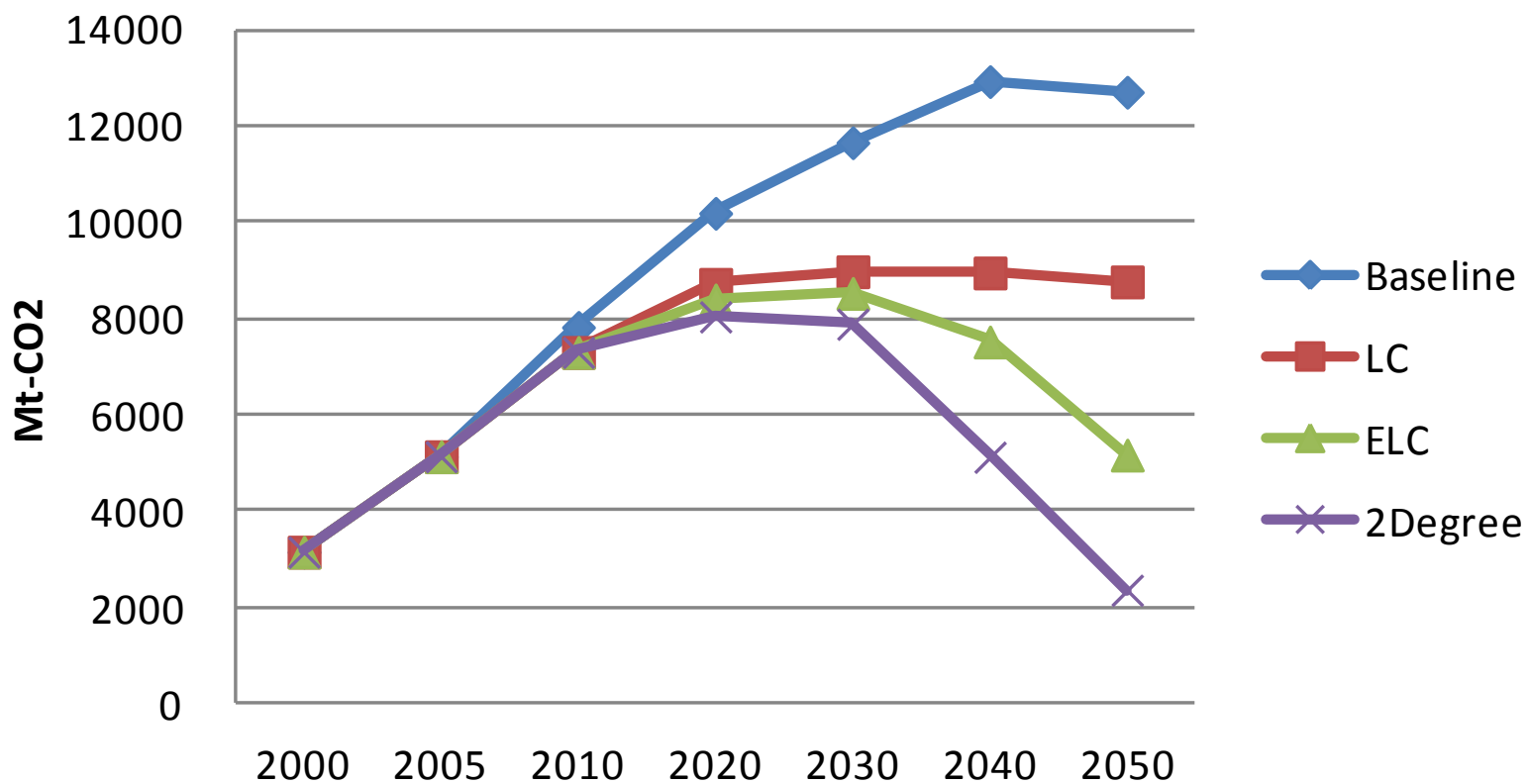
Keyword: Transition – mitigation to reach some climate change targets

关键词：过渡-减缓气候变化以达到气候变化目标



Transformation: CO₂ emission, a rapid change
转变: CO₂排放, 迅速的改变

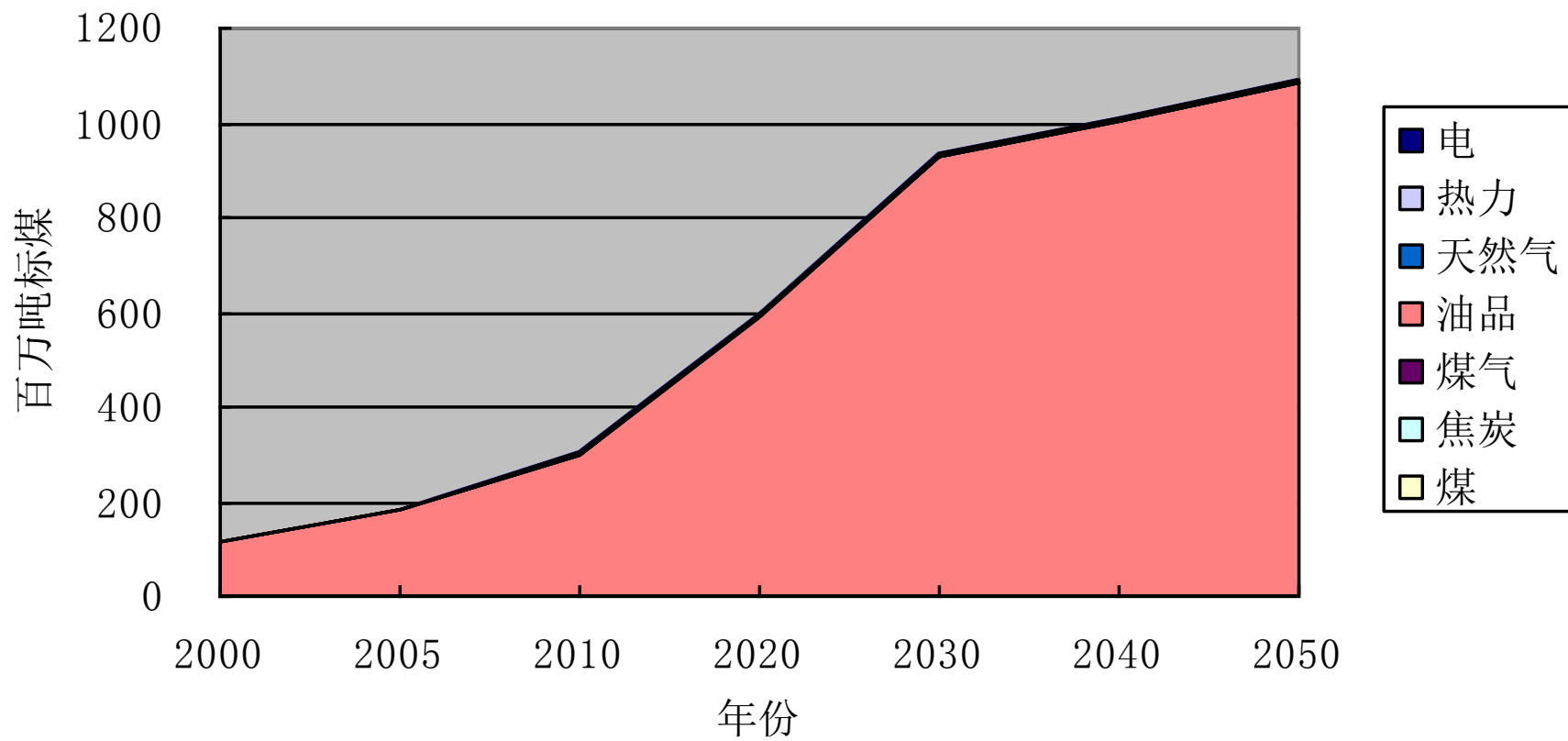
CO₂ Emission in China



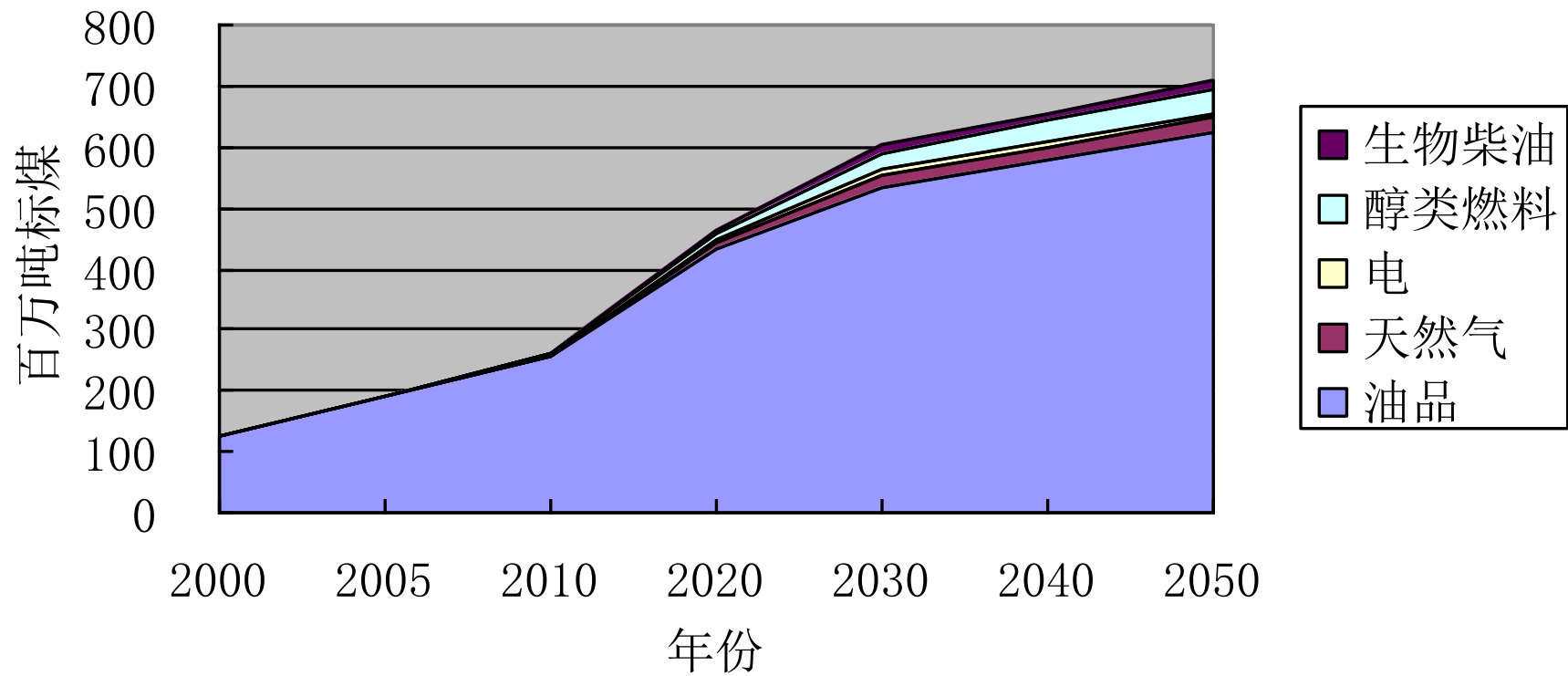
Final energy demand in Transport, BaU, Mtce

最终交通行业能源需求

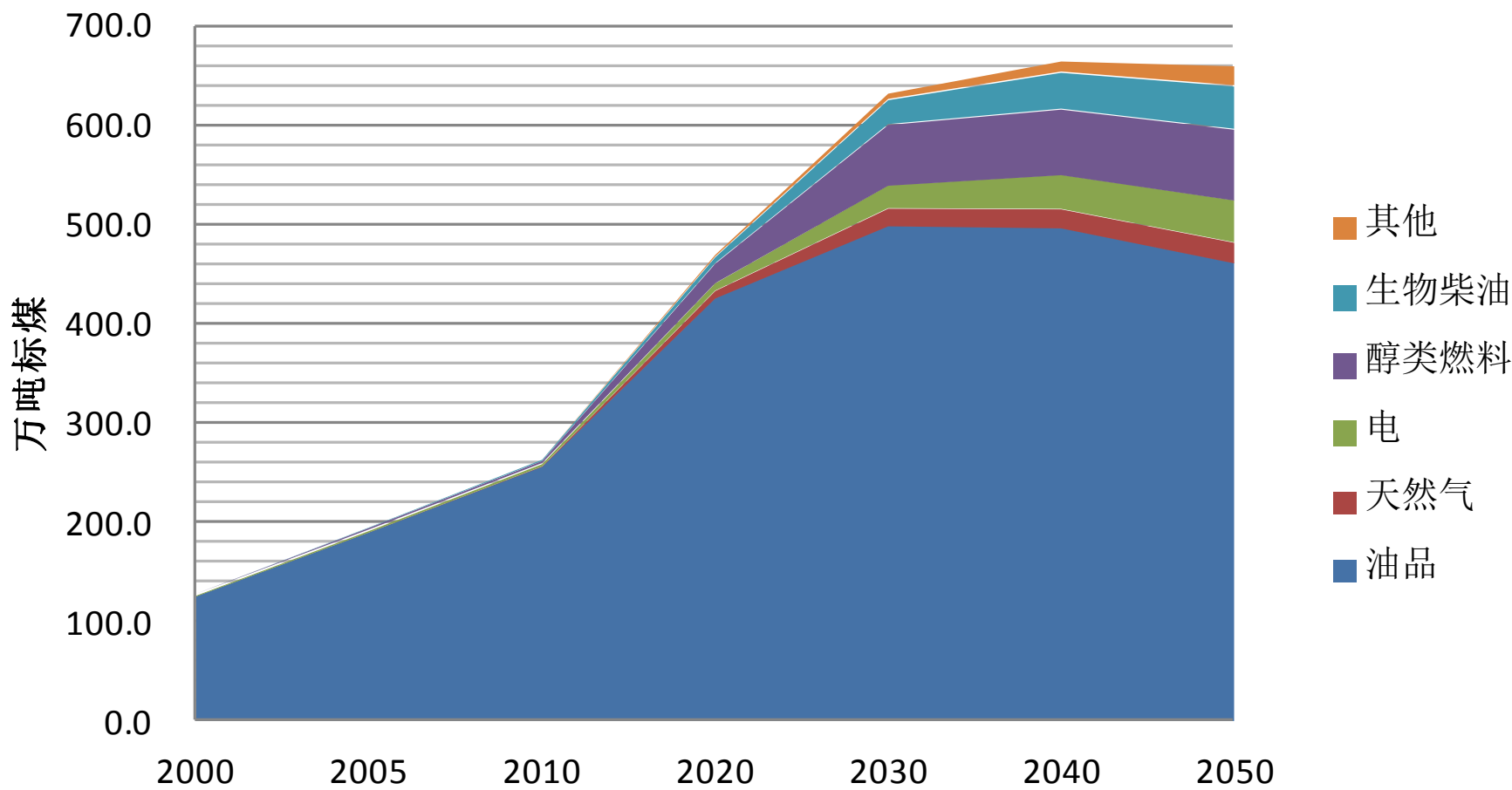
交通终端能源需求量，基准情景



交通能源需求，低碳情景



低碳交通能源需求



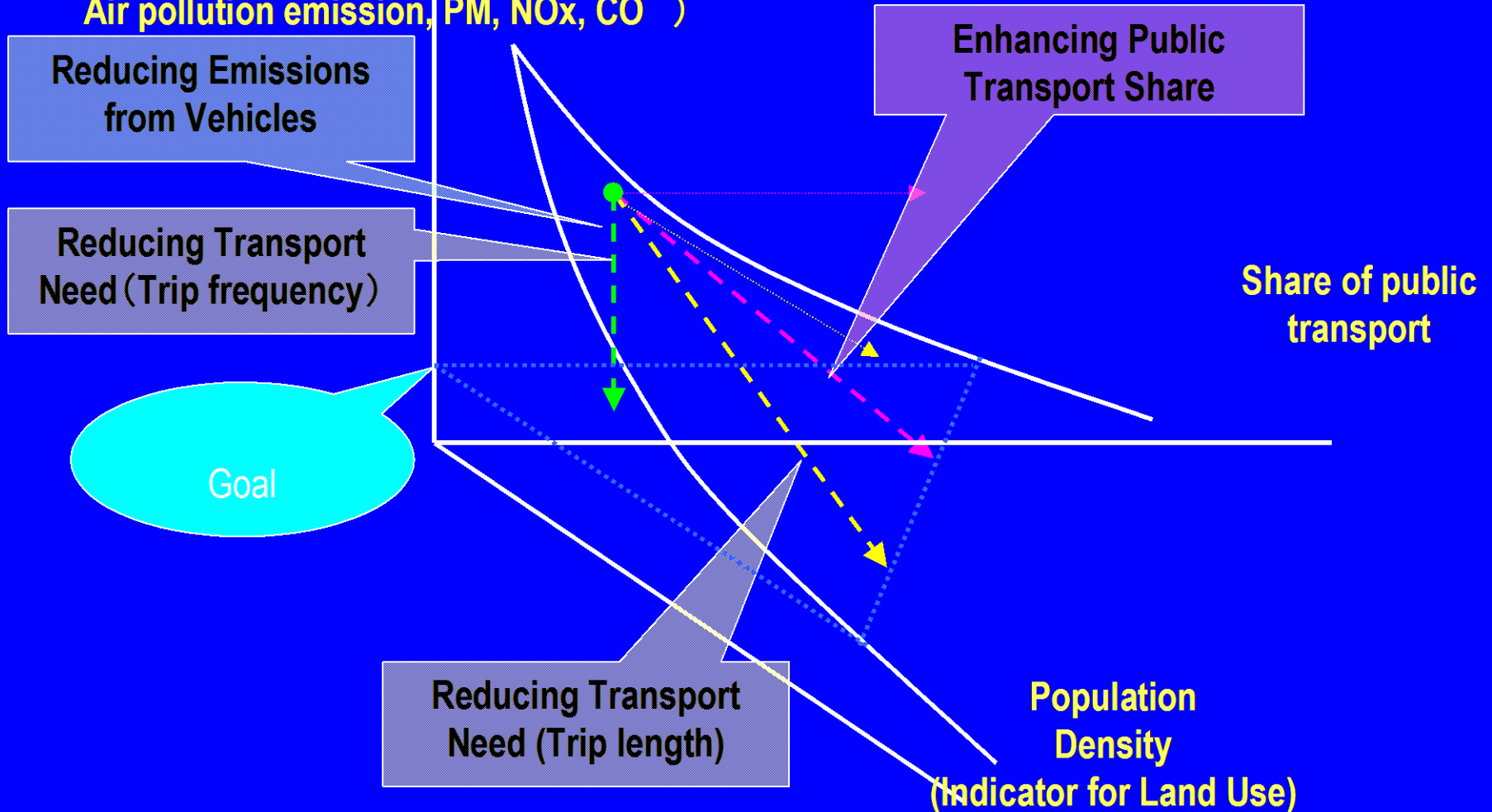
Technologies for Transport in IPAC-AIM/tech

IPAC-AIM/tech中的交通技术

- 65 technologies
- Transit bus (Gasoline, Diesel, CNG, LPG/Gasoline, Trolley; hybrid, electric bus);
- Taxi (Gasoline, LPG/Gasoline, Diesel; Hybrid, Electricity);
- Car (Gasoline, Diesel, Hybrid, Electricity, Fuel Cell etc.);
- MRTs
- Bicycle
- Trains: electric, diesel, advanced technologies, high speed train(350km.h)
- Airplane
- Ships
- 65 种技术
- 运输公交 (汽油, 柴油, CNG, LPG/汽油, 有轨车; 混合动力, 电动汽车);
- 出租车 (汽油, LPG/汽油, 柴油; 混合动力, 电动汽车);
- 汽车 (汽油, 柴油; 混合动力, 电动汽车, 燃料电池等);
- MRT
- 自行车
- 火车: 电车、柴油、先进技术、高速火车(350km/h)
- 飞机
- 船

Strategies and Environmental Impact

Environmental burden per capita
(i.e. CO₂ emission
Air pollution emission, PM, NO_x, CO)



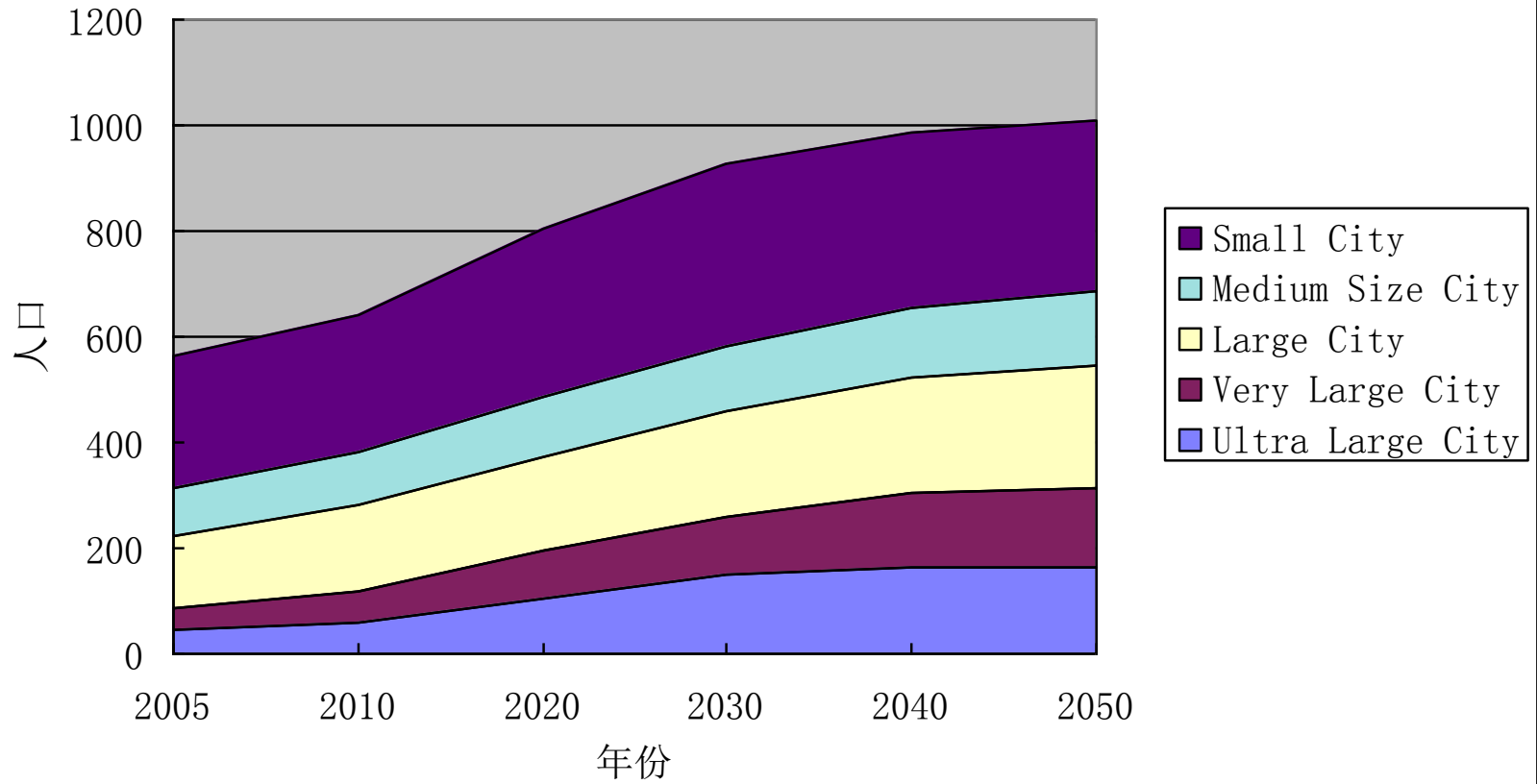


City development concept: road

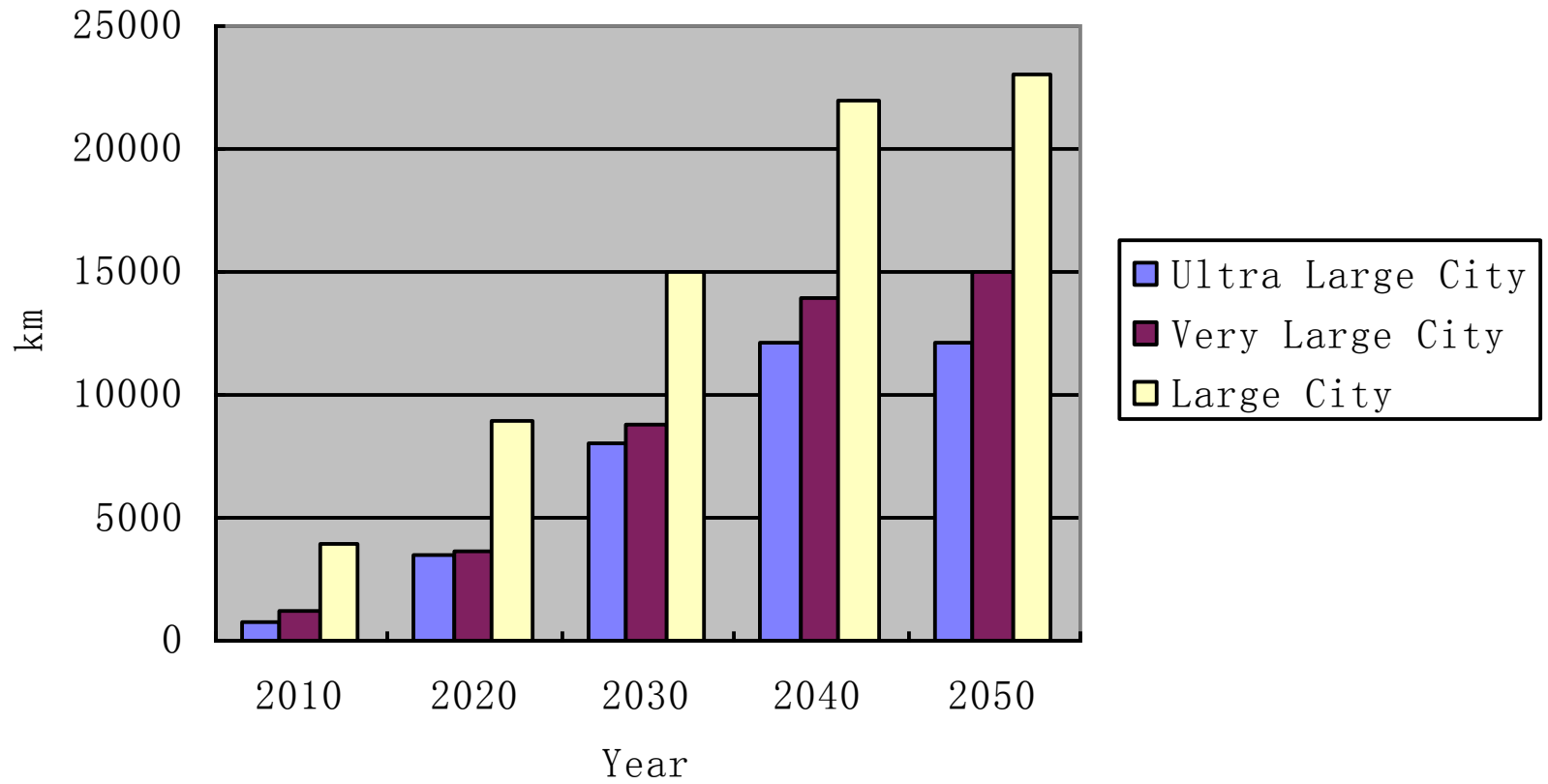
城市发展的理念：道路



城市布局

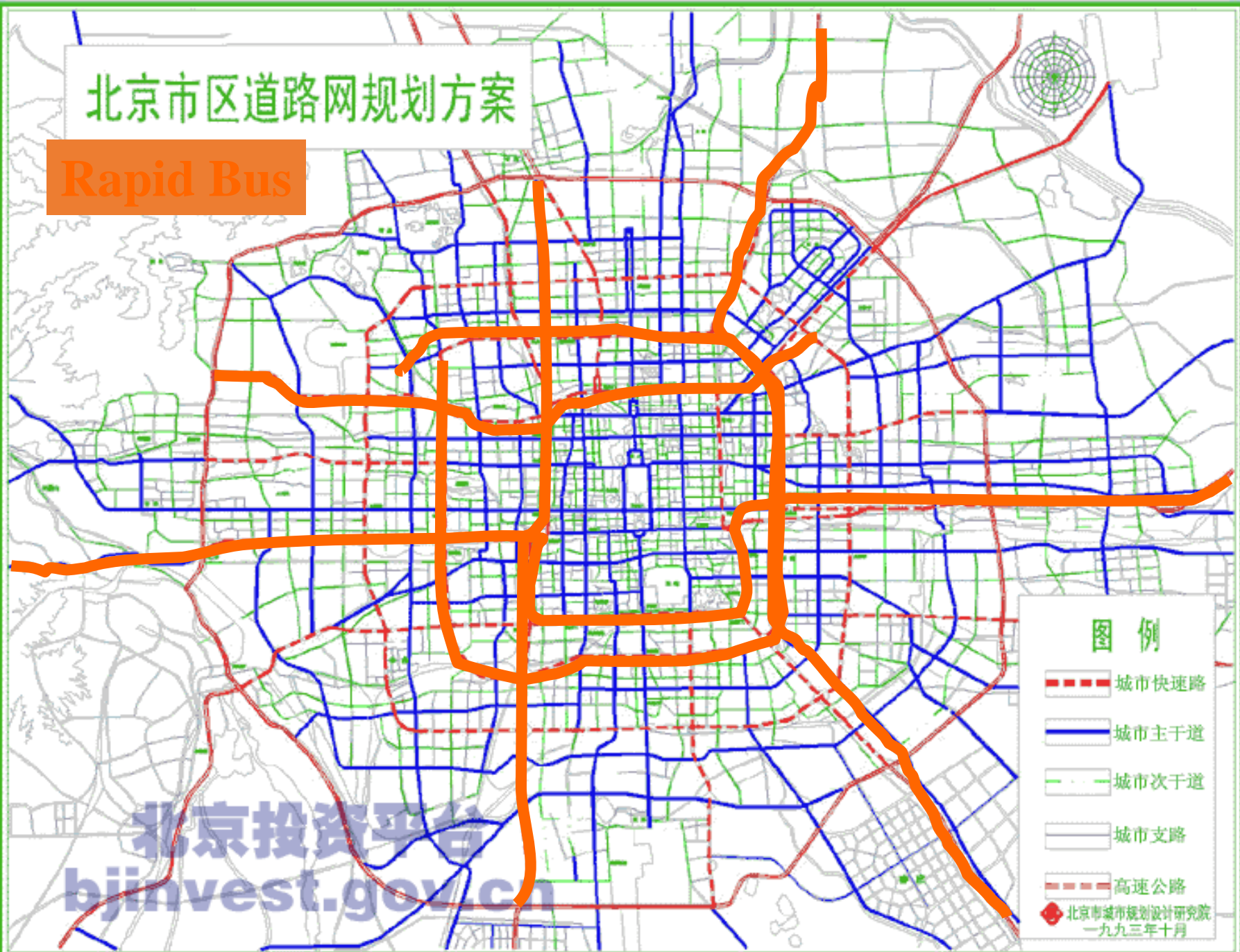


Metro length



北京市区道路网规划方案

Rapid Bus



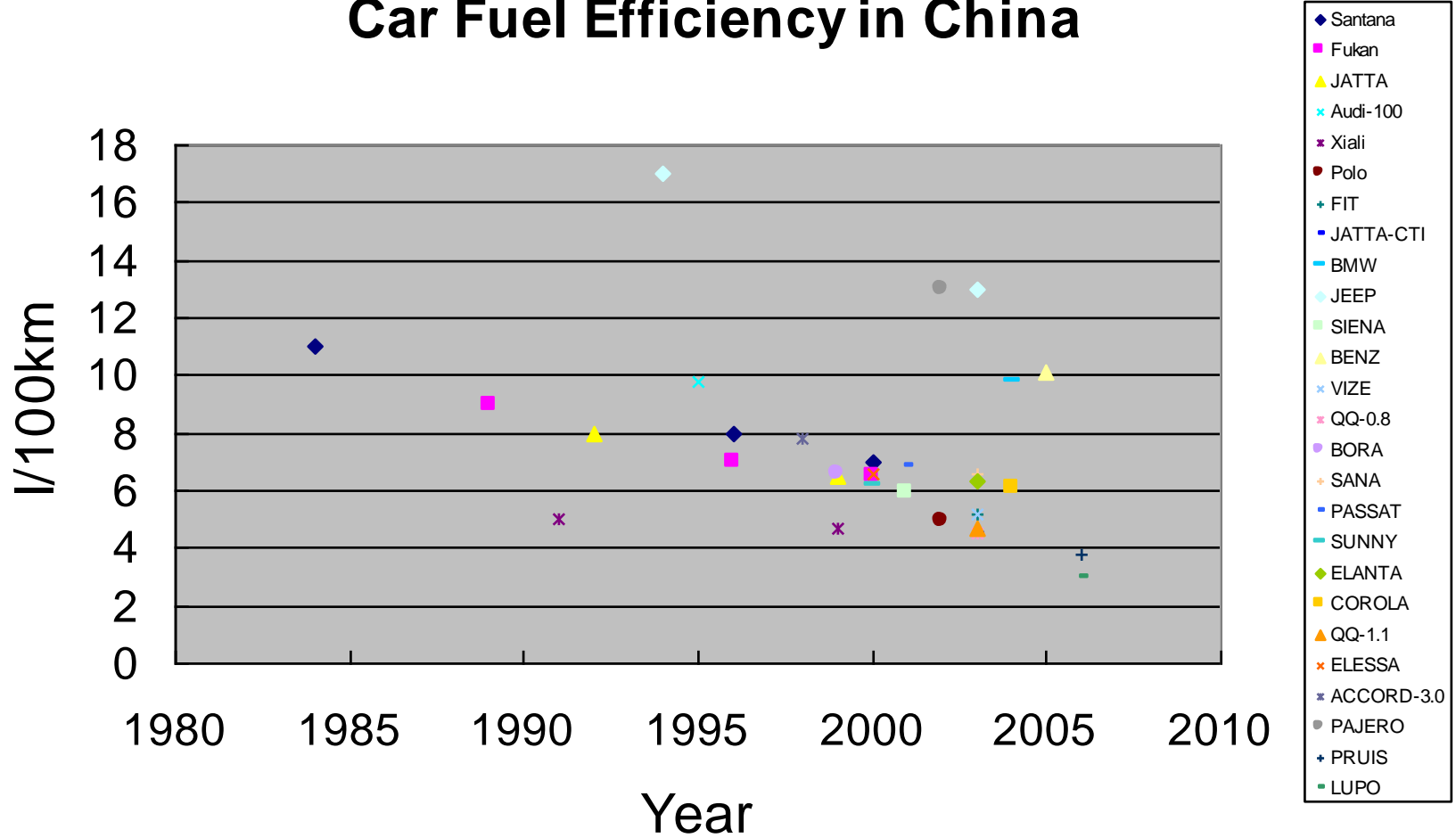
图例

- 城市快速路
- 城市主干道
- 城市次干道
- 城市支路
- 高速公路
- 北京市城市规划设计研究院
一九九三年十月

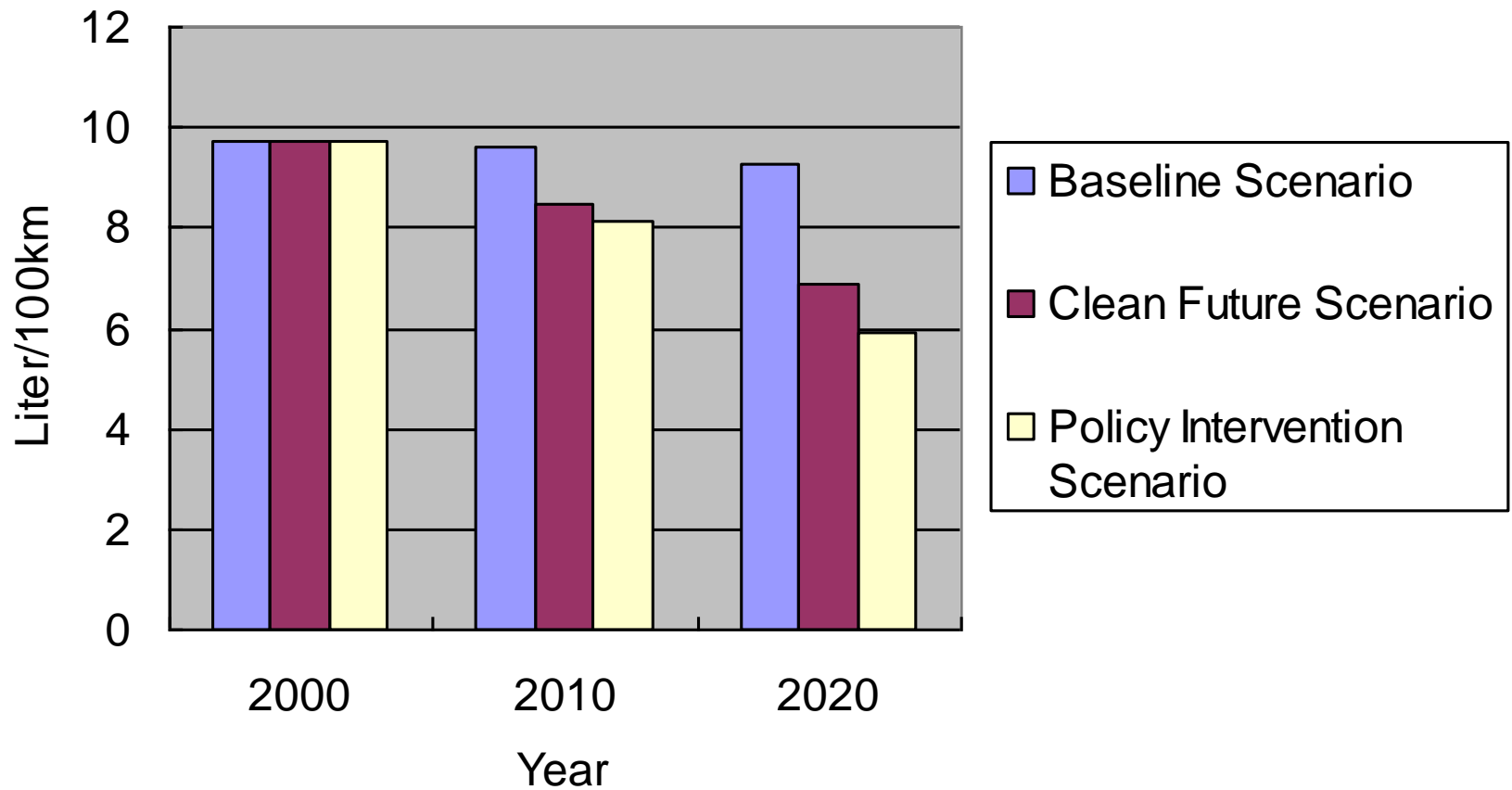
北京投资平台

bjinvest.gov.cn

Car Fuel Efficiency in China



Average Fuel efficiency for cars in Beijing

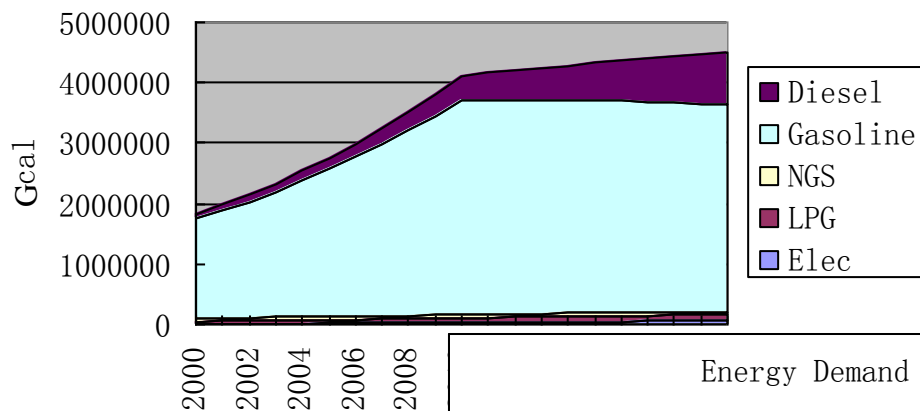




斯德歌尔摩：在欧洲许多城市，自行车、步行在逐渐形成主要交通方式
Stockholm: in many European cities, biking and walking gradually become the major transport methods

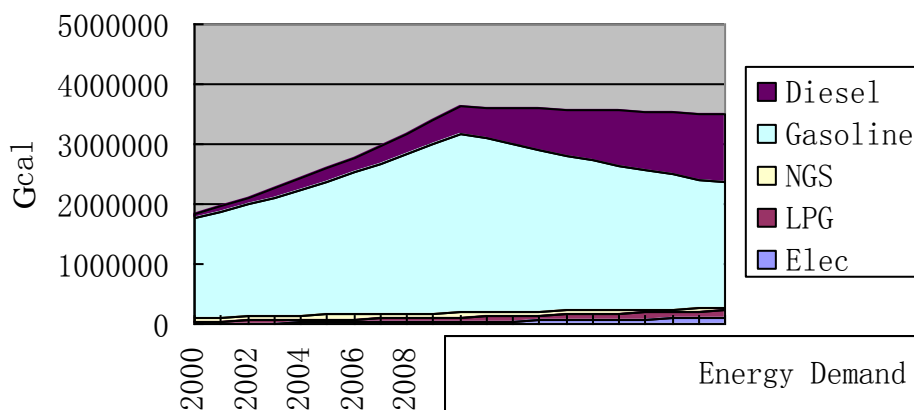


Energy Demand in Beijing, BaU

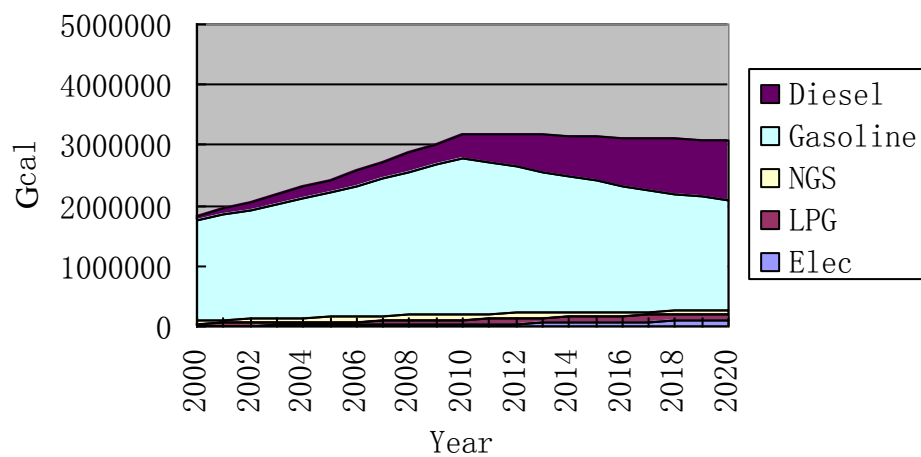


Energy demand of transport in Beijing could be nearly stable after 2010 even though vehicle number will increase a lot

Energy Demand in Beijing, TG

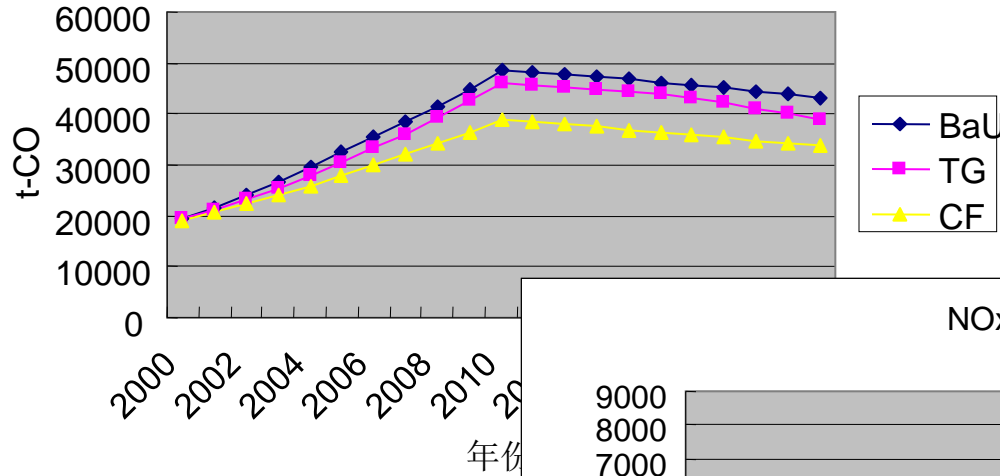


Energy Demand in Beijing, CF

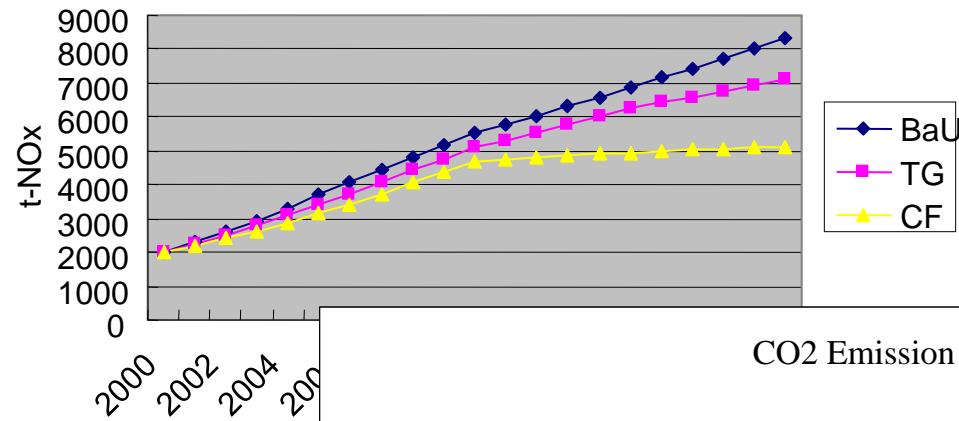


即使机动车数量剧增，北京交通的能源需求在2010年后基本保持稳定

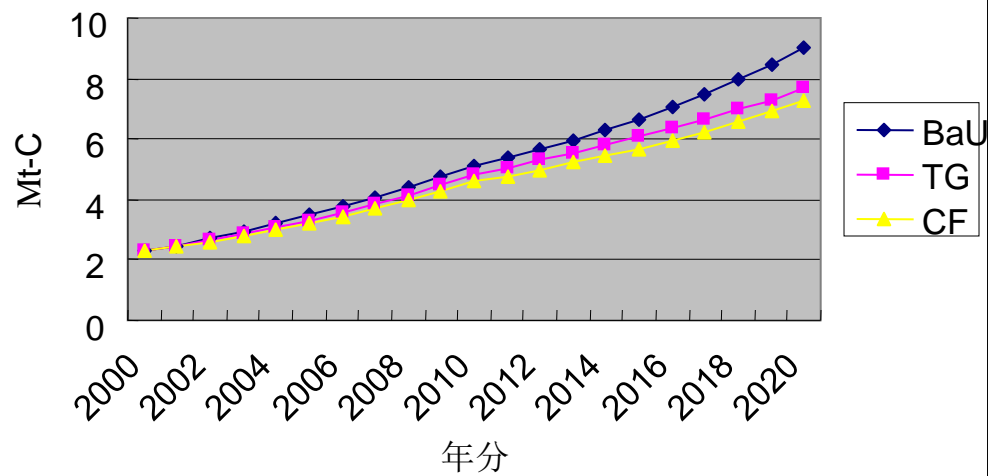
CO Emission



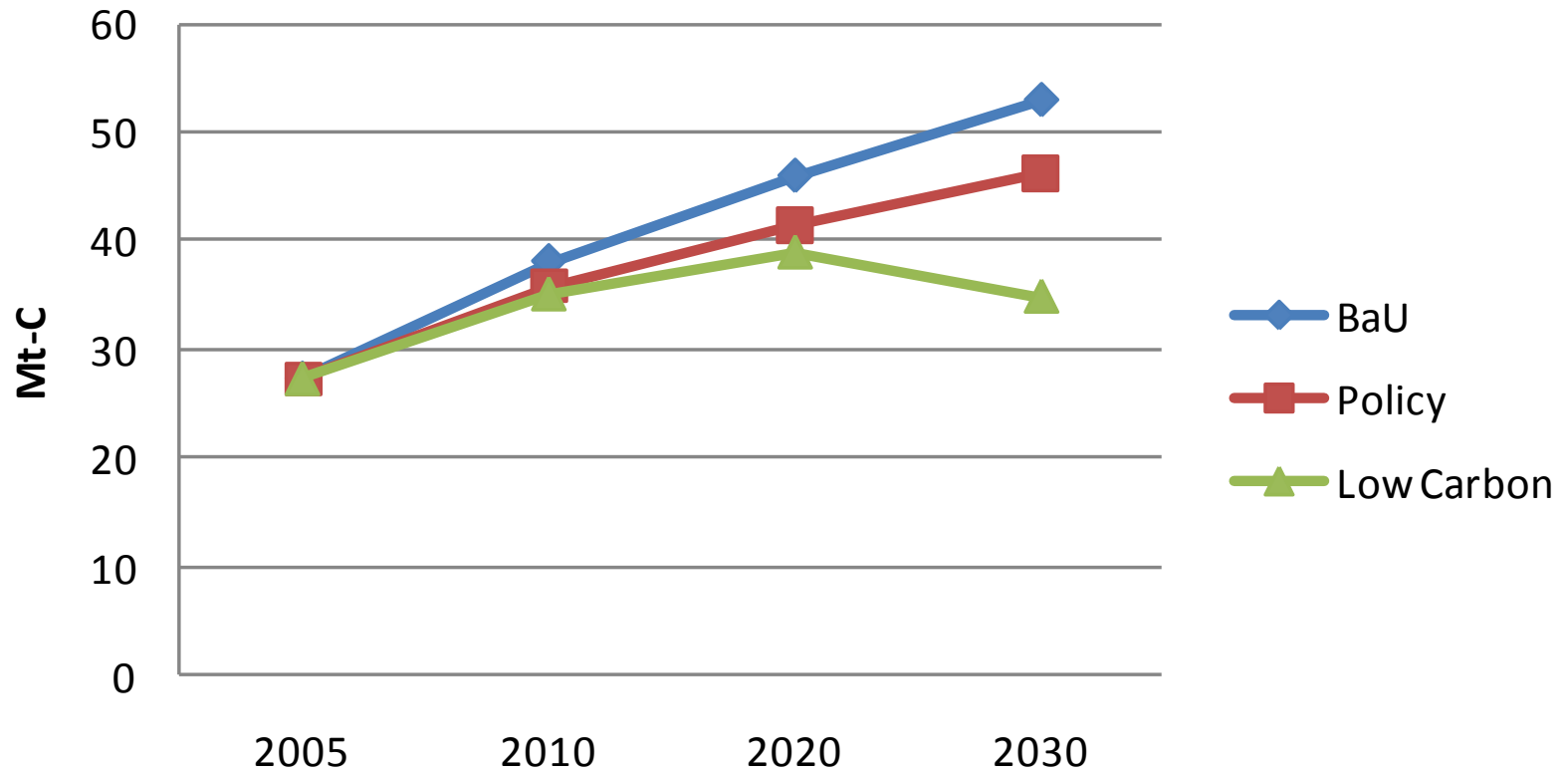
NOx Emission



CO2 Emission



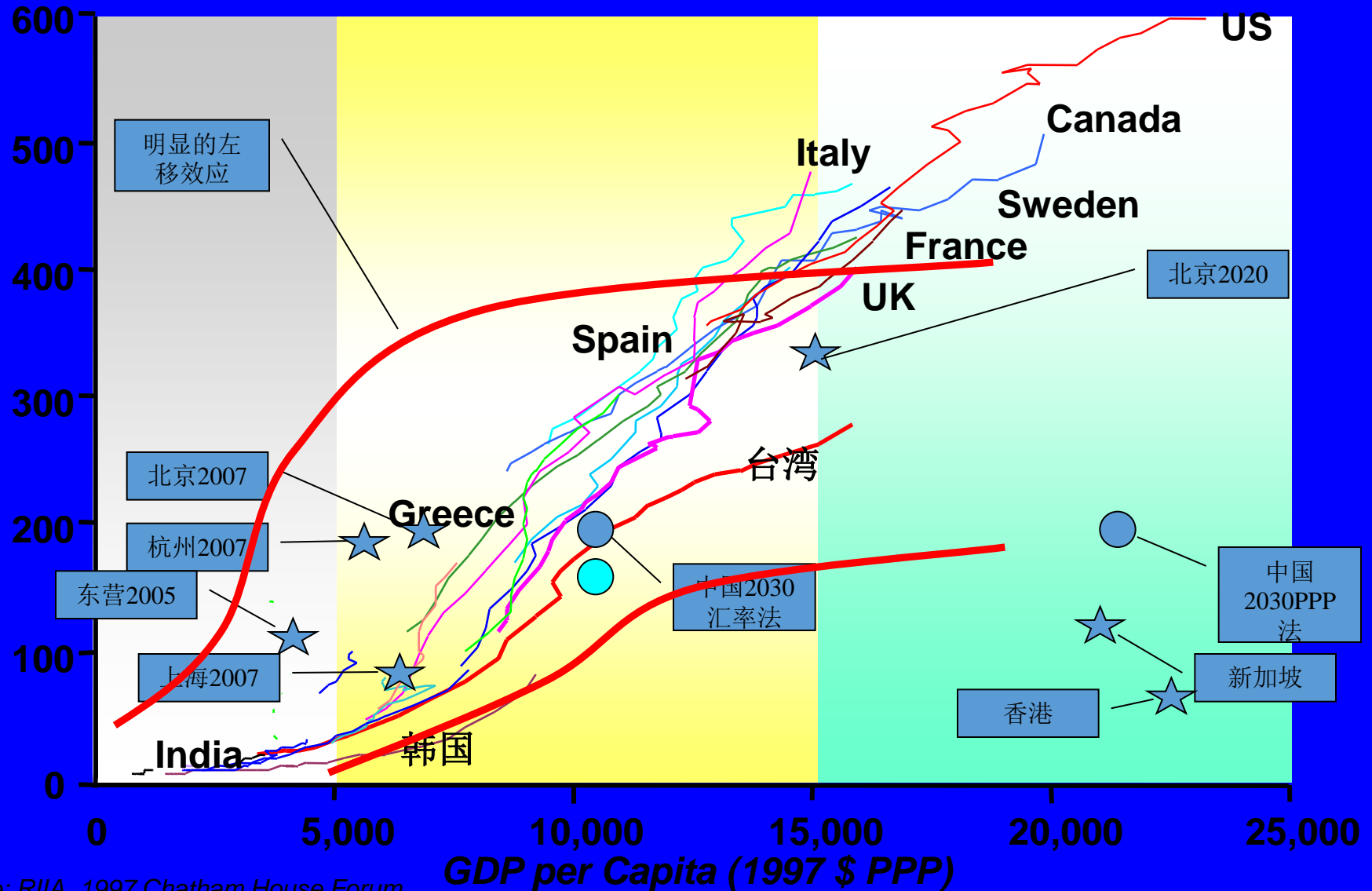
CO2 Emission in Beijing



Ownership of Vehicle

机动车保有量

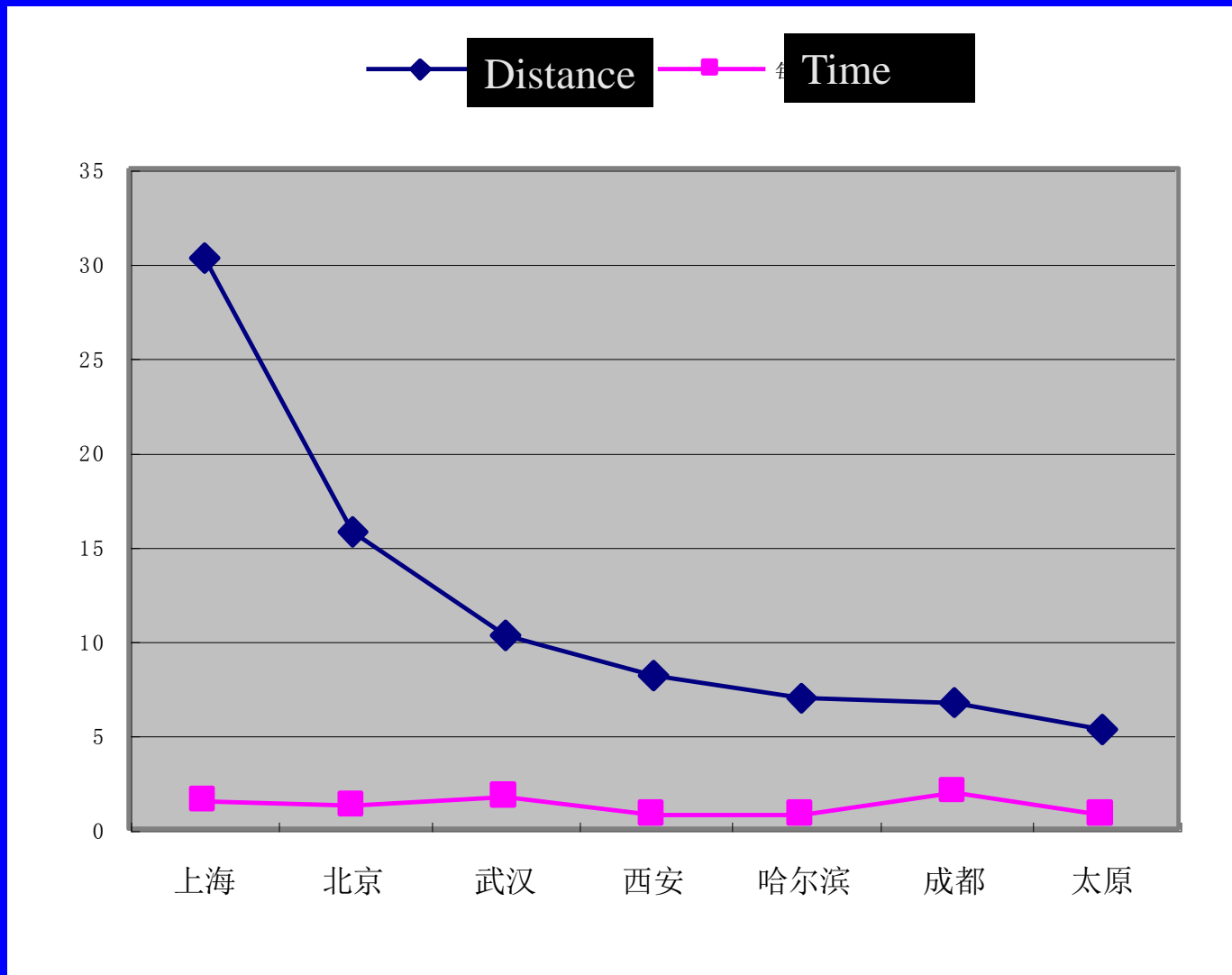
vehicle/1000people



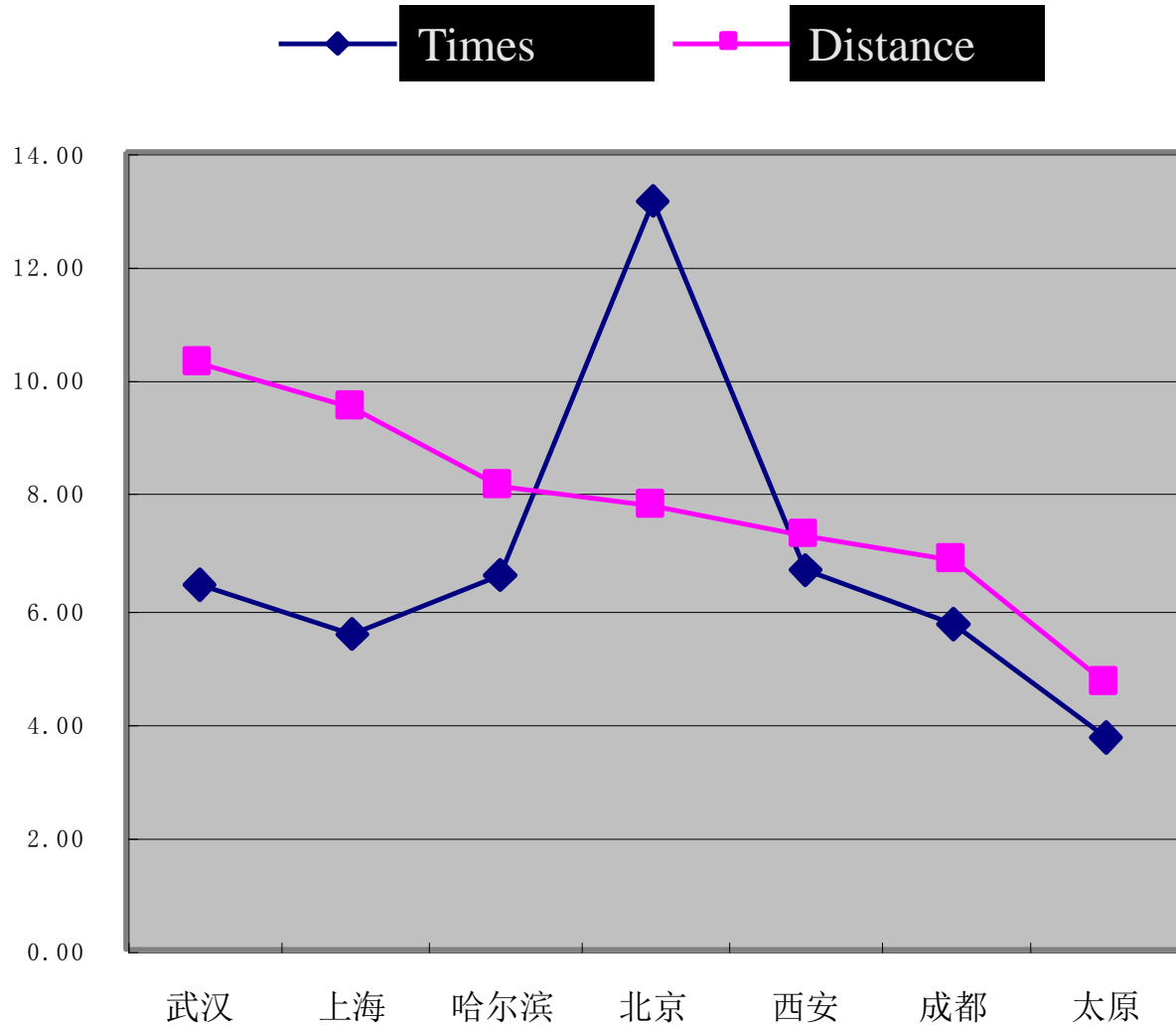
Vehicle fleet, Low Carbon scenario, 10000 机动车车队，低碳情景，10000

	2000	2005	2010	2020	2030	2040	2050
Total Vehicle	1609	3160	6227	18583	36318	51717	55810
Passenger	854	2132	4299	15504	32323	46083	48922
Freight	716	1027	1928	3079	3995	5634	6888
Car	670	1919	3921	14982	31558	45075	47662
Family Car	57	1100	3145	14032	30454	43675	46062
Other Car	613	819	776	950	1104	1400	1600
Mini-Bus	108	131	265	313	383	524	214
Large Bus	75.3293	82.3080335	113.4	208.8	382.5	483.84	1045.8
Bus	184	214	378	522	765	1008	1260
Motor Cycle	3771	6582	9848	10613	11193	11193	10634

Distance for commute and time 出行的距离和时间



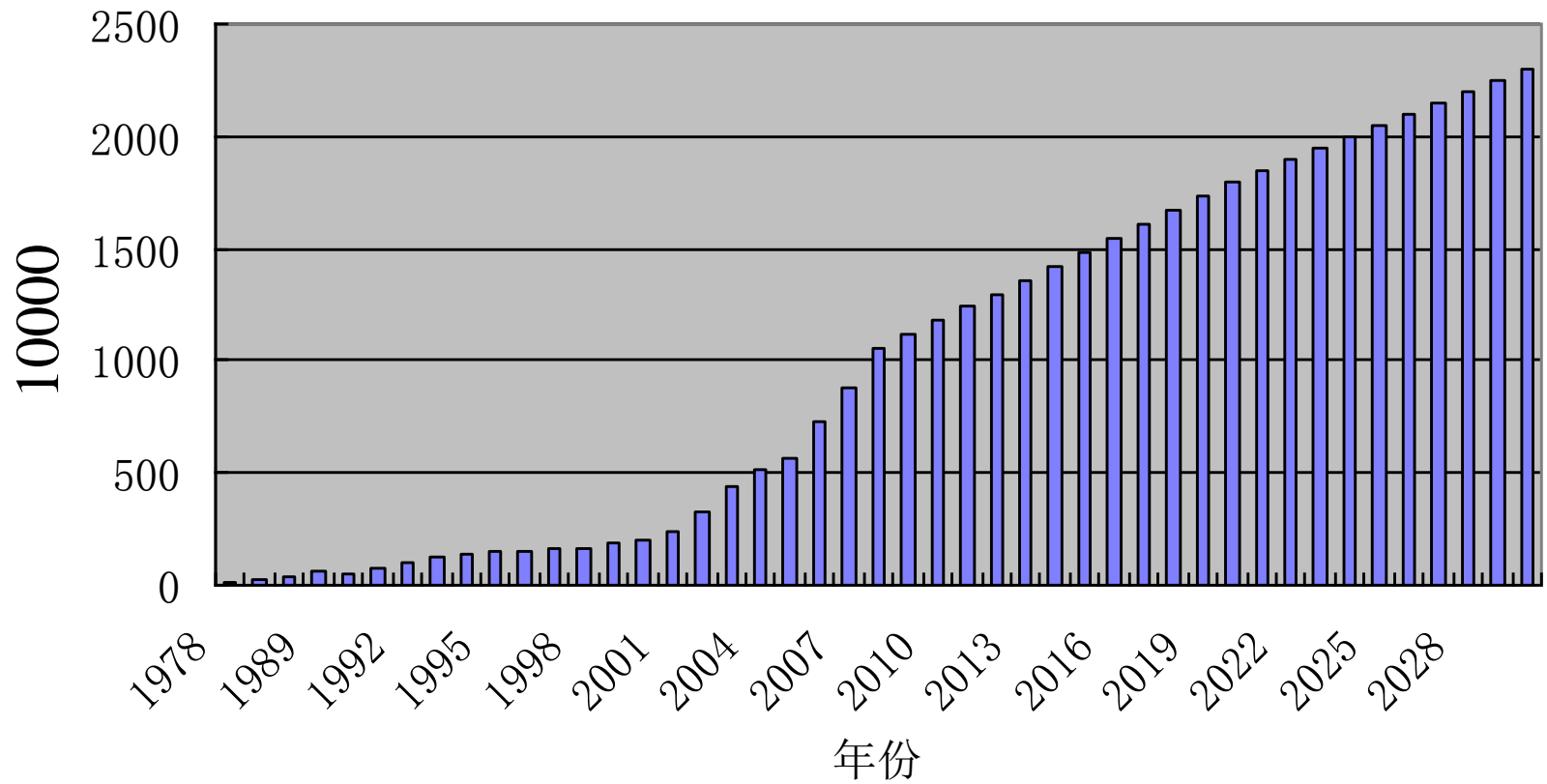
Times to take vehicle and distance, per week 机动车行驶时间与距离，每周



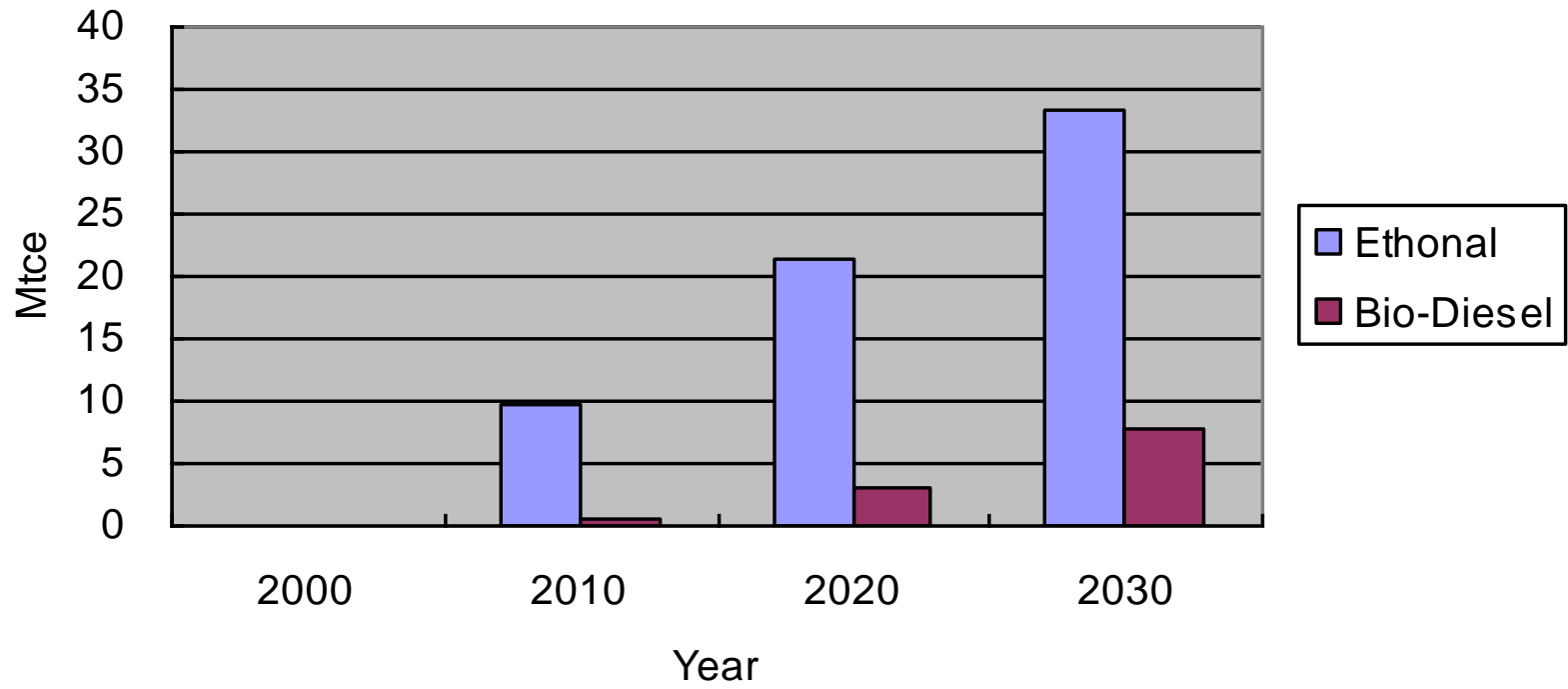
Transport, Low carbon scenario 交通，低碳情景

		2005	2010	2020	2030	2040	2050
Family car ownership, per 100HH	Urban	3.37	14	36	65	77	78
	Rural	0.08	0.2	8	38	70	90
Family car annual travel distance, km		9500	9500	9300	8635	8300	7480
Average engine size of family cars, liter		1.7	1.6	1.6	1.6	1.5	1.4
Fuel efficiency of car, L/100km		9.2	8.9	7.1	5.9	4.8	4.1
Share of MRT in total traffic volume, %		0.011	0.016	0.025	0.046	0.1	0.21
Share of Biofuel, %		1.10%	1.30%	4.1%	7.70%	12%	13%
Share of electric car, %		0%	0.12%	3.2%	6.80%	12.5%	19.8%
Share of fuel cell car, %		0%	0%	0.80%	1.60%	4.70%	7.90%

Output of Vehicle



Bio-Fuel in Transport



28 key technologies in the enhanced low carbon scenario in China

在中国强化低碳情境中 28种主要技术

No.	Sector	Technology	Description	Note
1	Industry technology	High efficiency energy equipment	High efficiency furnace, kiln, waste heat recovery system, high efficiency process technologies, advanced electric motor	Nearly in market
2		New manufacture process technology for cement and steel		
3		CCS	In cement, steel making, refinery, ethylene manufacture	
4	Transport	Super high efficiency diesel vehicle	Advanced diesel hybrid engine	
5		Electric car		
6		Fuel cell car		
7		High efficiency aircraft	30% higher energy efficiency	
8		Bio-fuel aircraft		
9	Building	Super high efficiency air-conditioner	With COP>7	
10		LED lighting		
11		In house renewable energy system	Solar PV/Wind/Solar hot water and space heating	
12		Heat pumps		Mature
13		High isolation building		Mature
14		High efficiency electric appliance		Mature before 2030
15	Power generation	IGCC/Poly-Generation	With efficiency above 55%	
16		IGCC/Fuel cell	With efficiency above 60%	
17		On shore Wind		Mature
18		Off shore wind		Mature before 2020
19		Solar PV		
20		Solar Thermal		
21		4 th Generation Nuclear		
22		Advanced NGCC	With efficiency above 65%	
23		Biomass IGCC		
24		CCS in power generation		
25	Alternative fuels	Second generation bio-ethanol		
26		Bio-diesel	Vehicles, ships, vessels	
27	Grid	Smart grid		
28	Circulating technologies	Recycle, reuse, reducing material use		

Roadmap for Electric Car 电动汽车路径

		2011-2015	2016-2020	2021-2025	2026-2030
Electric Car sale	million	0.25	0.8	5	9.4
Highest speed	km/h	120	140		
travel distance per charge	km	130	200	350	400
electricity use	kWh/100km	13-16	11-14	10-12	8-10
Battery energy density	Wh/kg	150	225	500	600
Battery energy	kWh	24	30	40-48	80
Battery life span	charges	1500			3800
Cost of Battery	US\$/kW	375	107	75	30
Charge station by national grid		4000	10000		35000
Charger by national grid		18700	24800		

Key Factors 主要因素

Battery: quality, time for charging, energy density, recycle, cost

电池：质量、充电时间、能源密度、回收、成本

Way for charge: parking lot charge, charging station

充电方式：停车场充电、充电站

Way to use battery: plug-in, changing battery

电池使用方式：插电式、电池更换

Electric control system: advanced system

电力控制系统：先进系统

New model: next generation electric car

新模型：下一代电动汽车

Energy efficiency

能源效率

Cost of Battery 电池成本

Trends of battery cost							
	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030	2031-2035	2036-2040
Mitsubishi “i-MiEV”	JYP4.599 million/per vehicle (RMB312700)						
FHI “Plug-in Stella”	JYP 4.725/per vehicle (RMB321300)						
IEA, 2009	USD750/kWh						
IEA, 2010		USD300/kWh					
The Climate Group, 2010		cost drop by half					
Toshiba		cost could drop by 20-30% (by technical progress)			A new generation of battery could reduce its cost to a few percent		
Toshiba		cost could be dropped to a few percent (by secondary use mechanism)					
A123 Systems Inc.		Cost of battery pack could drop by 9% each year					
BCG				USD270-330/kWh			
Japanese case (the Climate Group, 2010)		The cost is 1/2 of that in 2008	The cost is 1/7 of that in 2008	The cost is 1/10 of that in 2008		The cost is 1/40 of that in 2008	
Summary	USD750 /kWh	USD375/kWh	USD107/kWh	USD75/kWh			

Roadmap of Electric Car 电动汽车路径

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030
EVs					
total capacity (kWh)	16	24	48	80	112
Electric price (RMB/kWh)	0.48	0.60	0.75	0.94	1.18
Electric consumption per unit distance (kWh/km)	0.18	0.13	0.13	0.08	0.08
Electric cost per unit distance (RMB/km)	0.09	0.08	0.10	0.08	0.09
EVs fuel cost (RMB/vehicle)	43200	39067	48918	37694	47199
Cost of unit battery capacity (USD/kWh)	750	375	130	75	30
EVs pack cost (RMB/vehicle)	80400	60300	41808	40200	22512
pack life (year)	3.6	5	11	22	22
Replacement times of battery pack (times/whole lifecycle)	4.1	2.8	1,4	0.7	0.7
Usage cost of battery during EVs overall lifecycle (RMB/vehicle)	413256	226728	99503	67938	38045
Total costs of electric consumption and battery consumption during EVs overall lifecycle (RMB/vehicle)	456456	265795	148421	105632	85245
TCE					
Gasoline price (RMB/liter)	6.6	8.5	10.2	11.0	11.8
Diesel price (RMB/liter)	6.4	8.3	9.9	10.6	11.4
Gasoline consumption per unit distance (L/km)	0.050	0.039	0.031	0.024	0.020
Diesel consumption per unit distance (L/km)	0.047	0.038	0.030	0.024	0.020
Driving distance during the whole lifecycle (km)	500000	500000	500000	500000	500000
Fuel usage cost of advanced gasoline vehicle (RMB/vehicle)	165000	167550	158356	133574	117738
Diesel usage cost of advanced diesel vehicle (RMB/vehicle)	150400	155333	149317	128100	114170
Usage cost comparison (EVs Versus ICEs) RMB	291456	98245	-9935	-27941	-32494

the outlook of electric vehicle sales market 电动汽车市场销售展望

	2015	2020	2025	2030
Global annual sales market (the thousand)	130	400	2000	3390
Chinese annual sales market (10 000)	25	80	500	941
accounted for the proportion of the world %	19%	20%	25%	28%

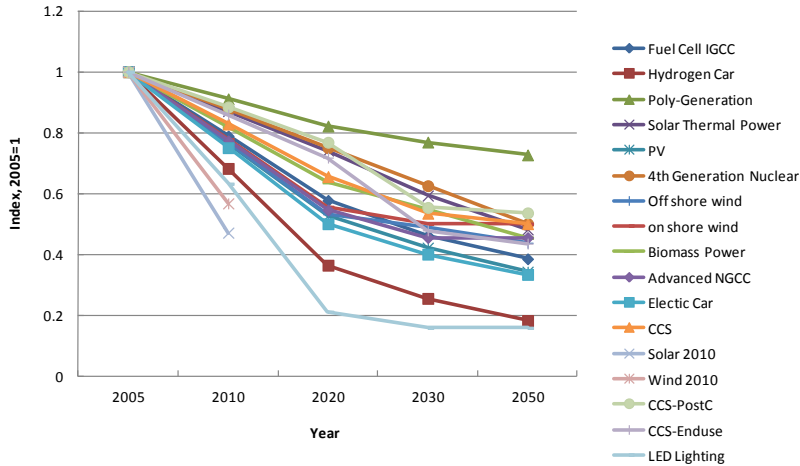
Roadmap for Electric Vehicle Development Technology

电动汽车技术发展路径

	2006-2010	2011-2015	2016-2020	2021-2025	2026-2030
Electric Vehicle Development Objective					
The Amount of Electric Vehicle(10,000)	Few	125	800	5,000	9,400
Quantity of Electric Vehicle Market Per Year(10,000)	Few	25	135	840	880
Electric Vehicle Technology Advance					
The Maximum Speed(km/h)	85	120	140	140	
Cruising Range(km)	112	130	200	350	400
Power Consumption Measuring on One-hundred-kilometer	16-18	14	13	8	8
Technology Advance					
Energy Density(Wh/kg, Wh/L)	90-125Wh/kg	150 Wh/kg;150 Wh/L	225 Wh/kg;200 Wh/L	500 Wh/kg;460 Wh/L	700 Wh/kg
Total Energy	16	24	40-48	80-93	112-124
Pack Lifespan	1000 times	1500 times	3000 times	3800 times	3800 times
Cost(Yuan/kWh)	5025	2513	717	503	200
Charging Station Technology and Construction Process					
Charging Station Development Planning(National Grid and South Grid)	325 new charging stations and 1,870,000 charging piles	4,325 new charging stations and 2,840,000 charging piles	10,000 new charging stations and 3,000,000 charging piles		
Charging Station System Construction Process	Conventional charging facility (charging piles)construction; battery replacement mode demonstration; mainly in residency districts or parking of large office buildings	Conventional charging as primary; fast charging and battery replacement demonstration; construct fast charging and battery replacement station mainly at the airport, railway station, hospital, shopping mall or petrol gas station and other public places	Conventional charging as primary; fast charging and battery replacement as supplementary to form an embryo for charging station network system	Improve charging station network system and lay out charging system on the charging cruising range of electric vehicle per time; solar energy charging station demonstration; mobile charging station demonstration	Controlled-charging technology makes electric vehicle be friendly-power consumption load; solar energy charging stations account for 5-10% of market share; mobile charging stations are applied.

Transformation: Technologies 改变: 技术

Technology learning curve



荣威E50的长/宽/高分别为3569/1551/1540mm, 其定位为A00级紧凑型车。



Price: US\$38000

Subsidy: US\$15000(Shanghai), no need to apply number plate(cost US\$10000)

US\$18000(Beijing), no need to apply number plate(By Oct. 2012, 1.1 million people apply for 20000 number plates per month),

By 2020, Wind 200GW to 250GW, Solar 50WG