Low carbon transport scenario in China

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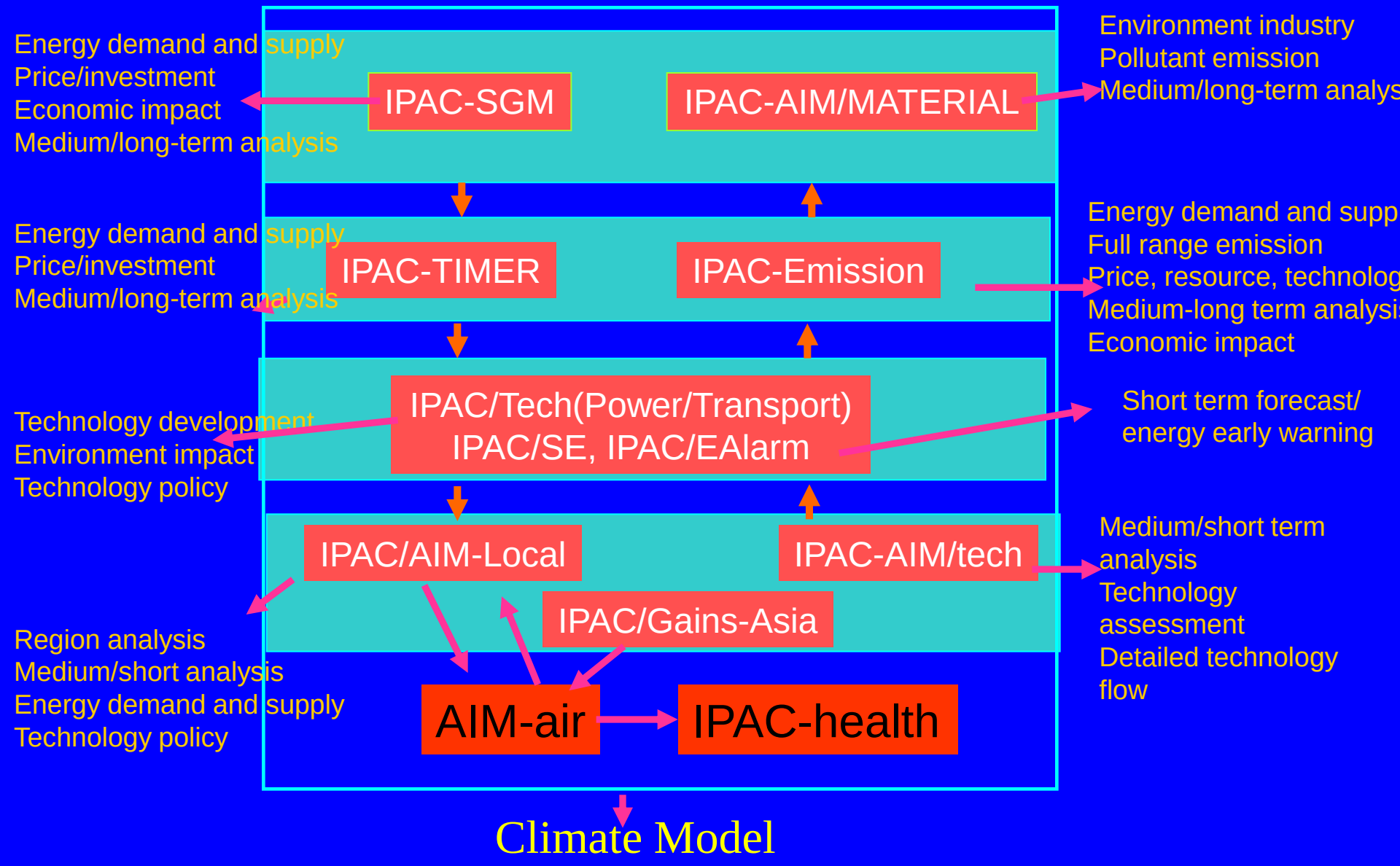
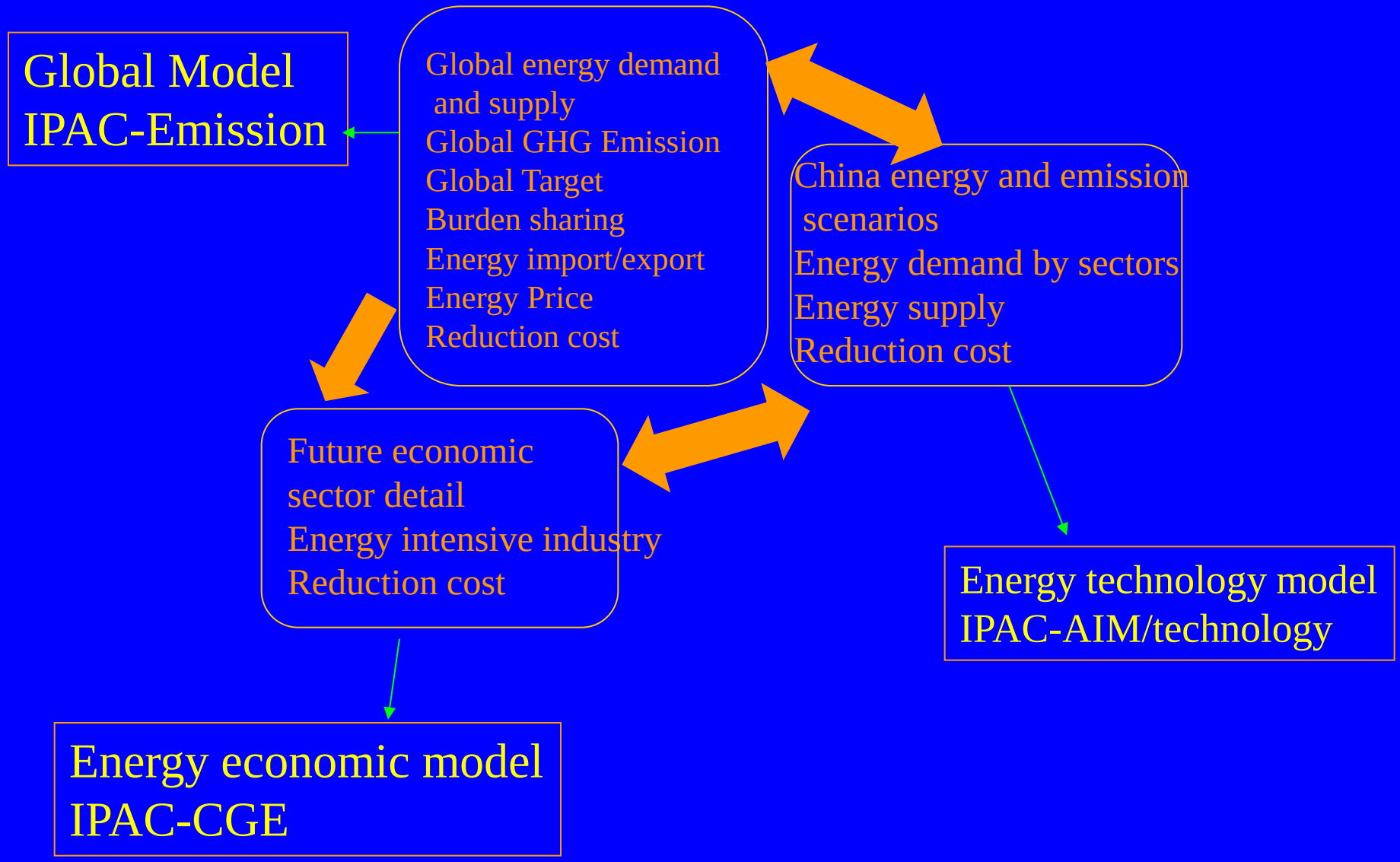
Our Studies on Low Carbon for China

- Energy and CO2 emission scenario by 2050
- Technology roadmap
- Policy roadmap: electric car etc.
- Transport policy for Beijing, Shanghai, Taiyuan, Hangzhou, Langfang etc.

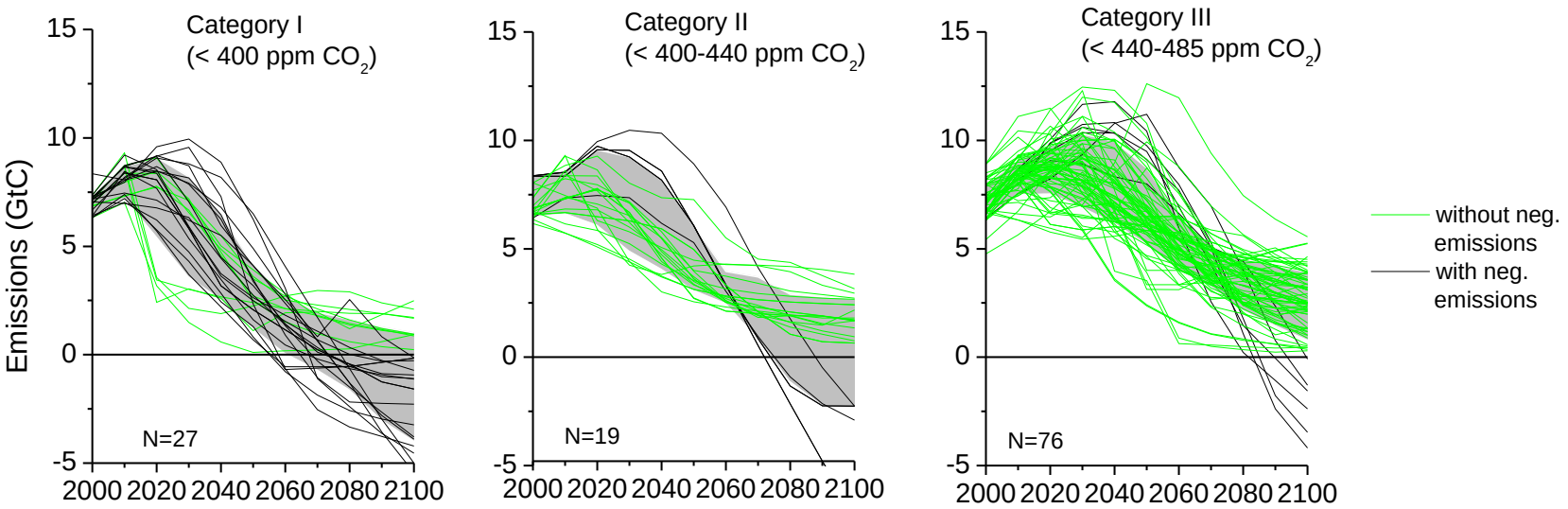
Framework of Integrated Policy Model for China (IPAC)



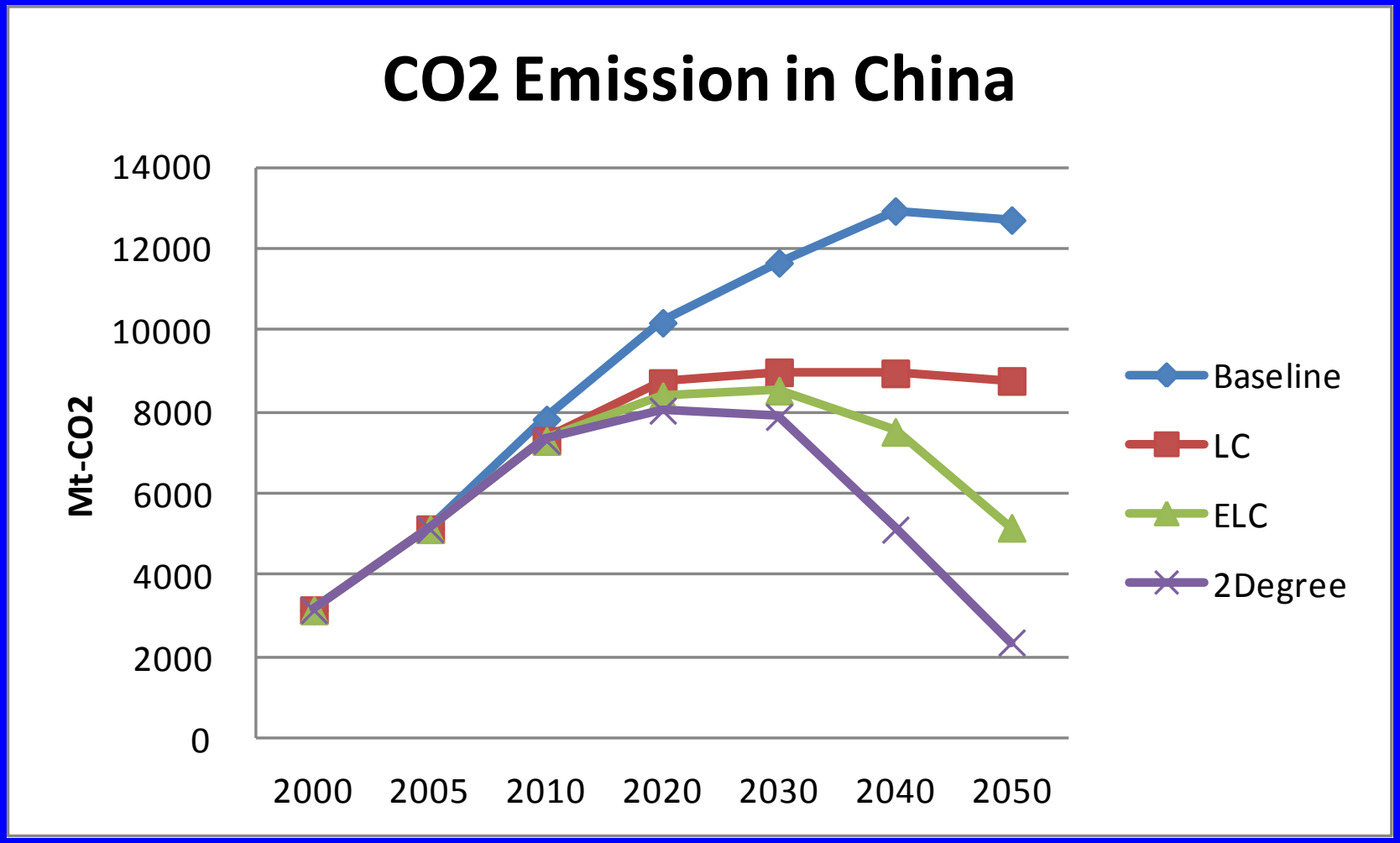
IPAC 2050 scenario modeling framework

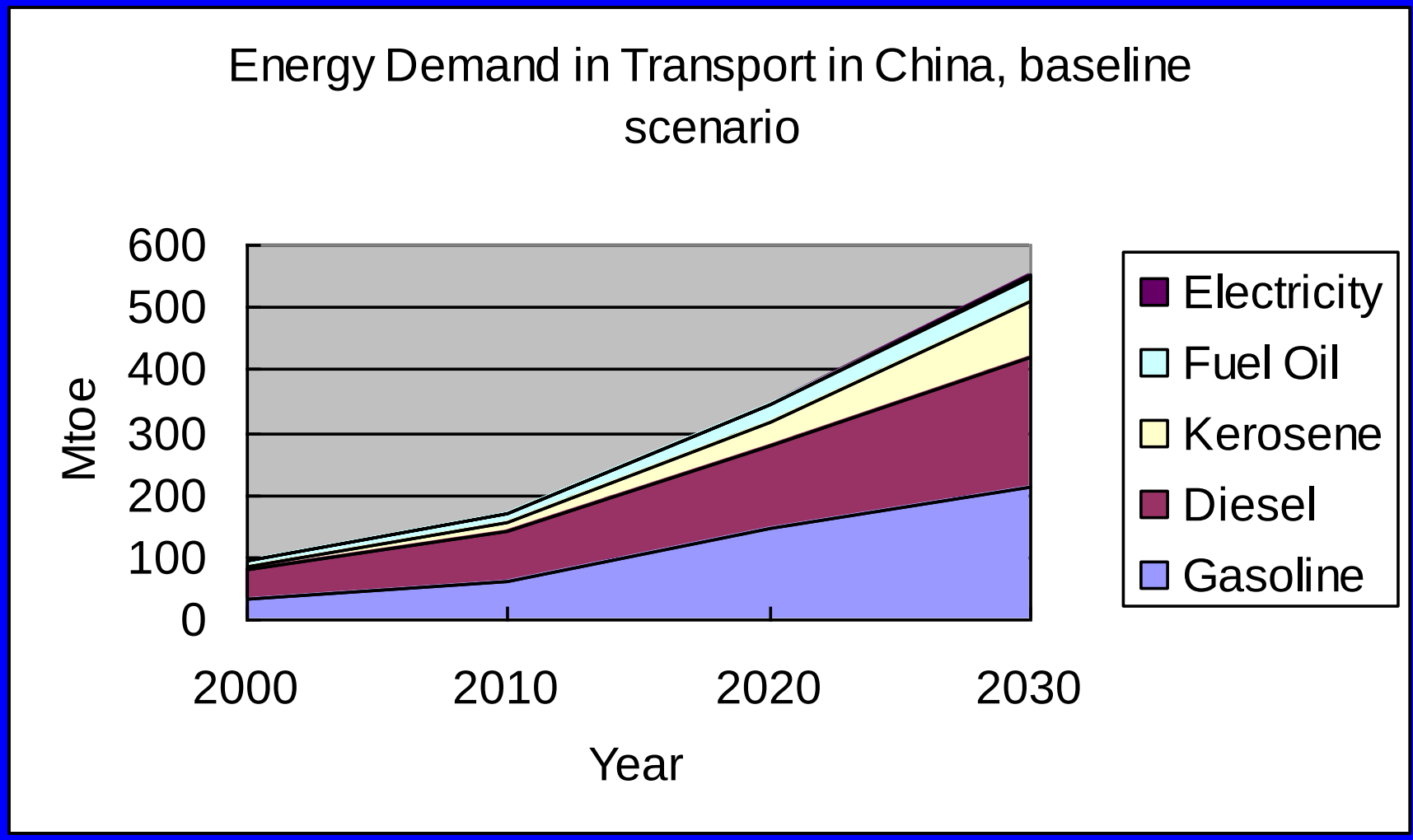


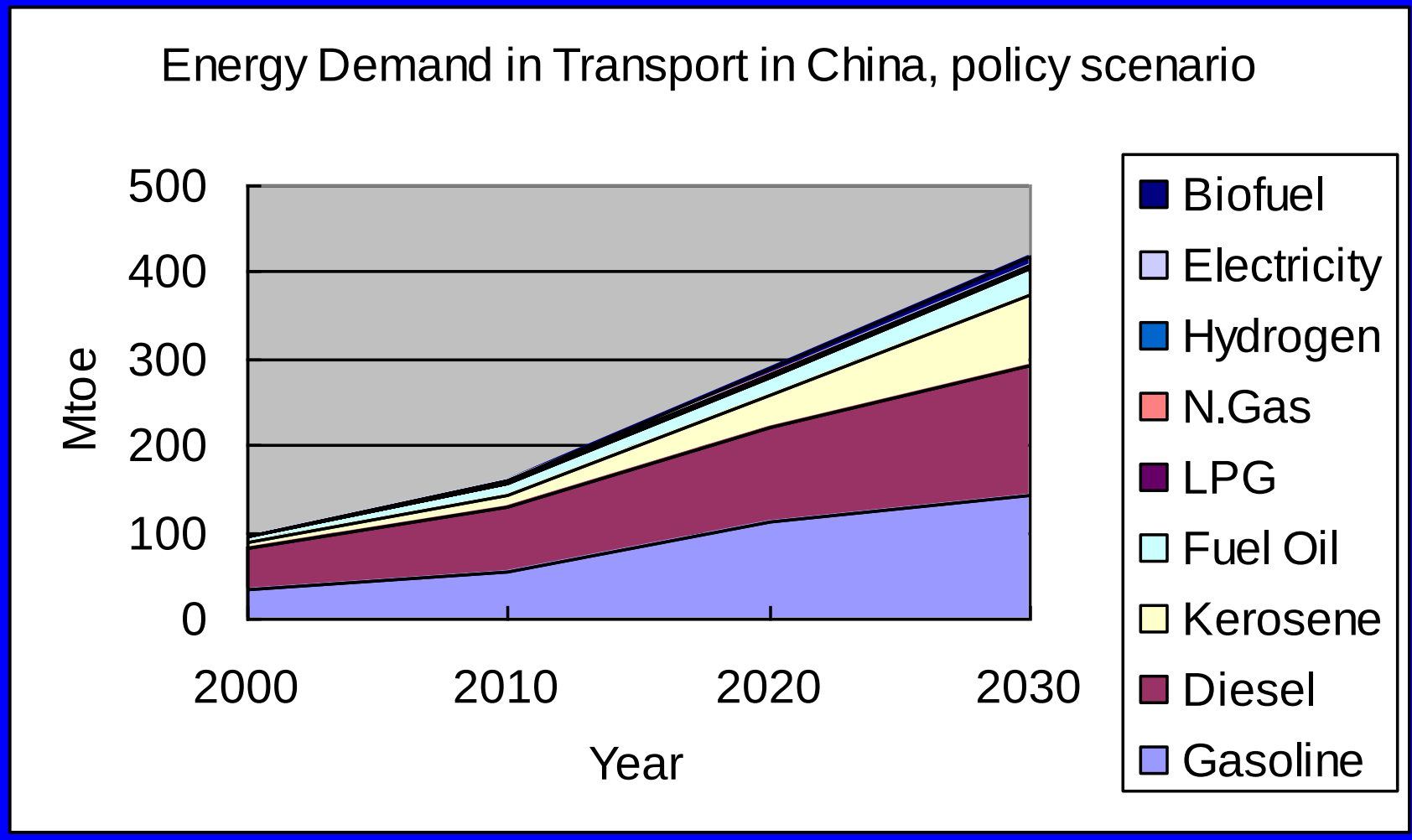
Keyword: Transition – mitigation to reach some climate change targets



Transformation: CO2 emission, a rapid change



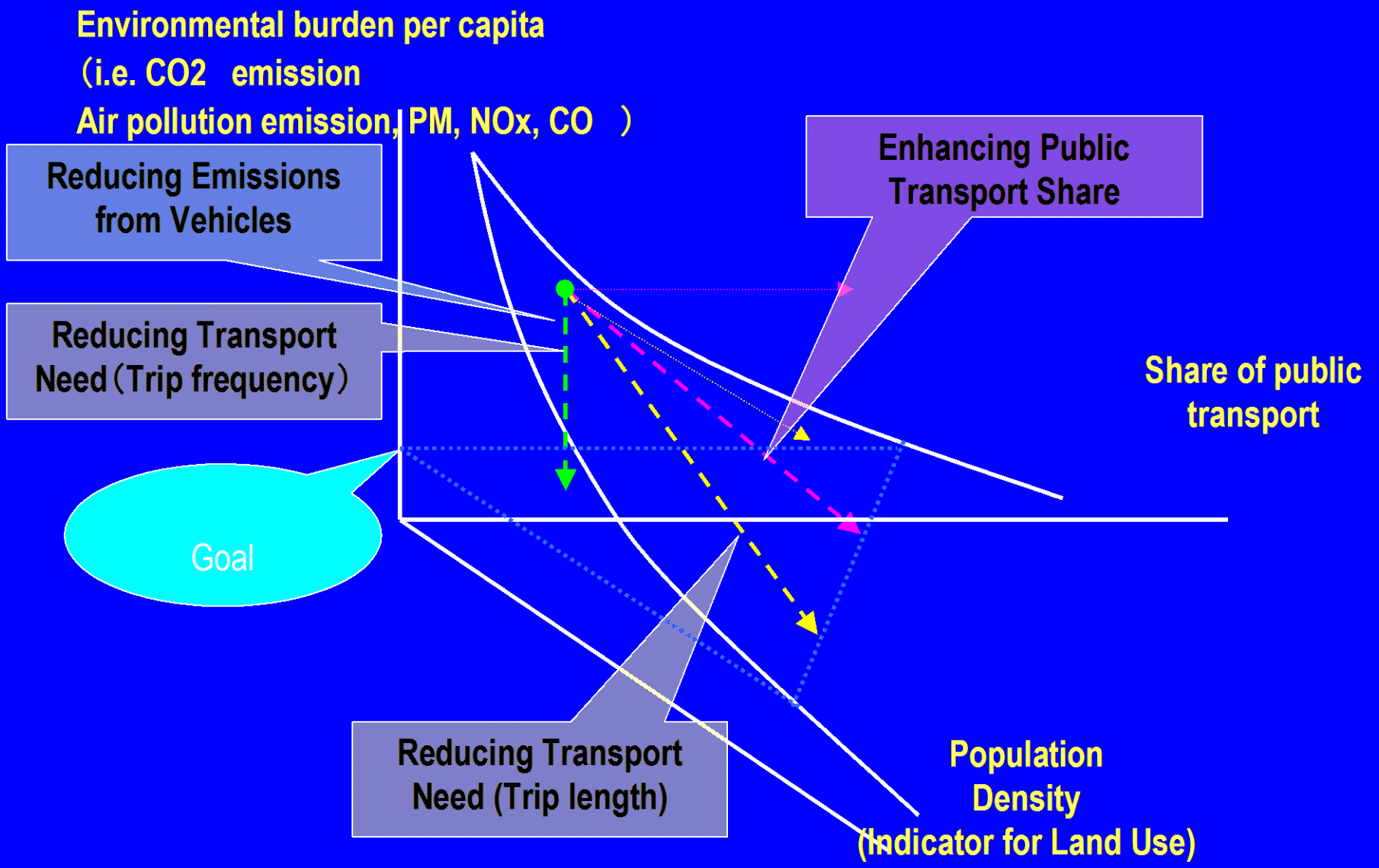

Energy Demand in Transport in China, baseline scenario
600
500
400
300
200
100
0
Mtoe
2000
2010
2020
2030
Year
Electricity
Fuel Oil
Kerosene
Diesel
Gasoline


Energy Demand in Transport in China, policy scenario
500
400
300
200
100
0
Mtoe
2000
2010
2020
2030
Year
Biofuel
Electricity
Hydrogen
N.Gas
LPG
Fuel Oil
Kerosene
Diesel
Gasoline

Technologies for Transport in IPAC-AIM/tech

- 58 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

Strategies and Environmental Impact

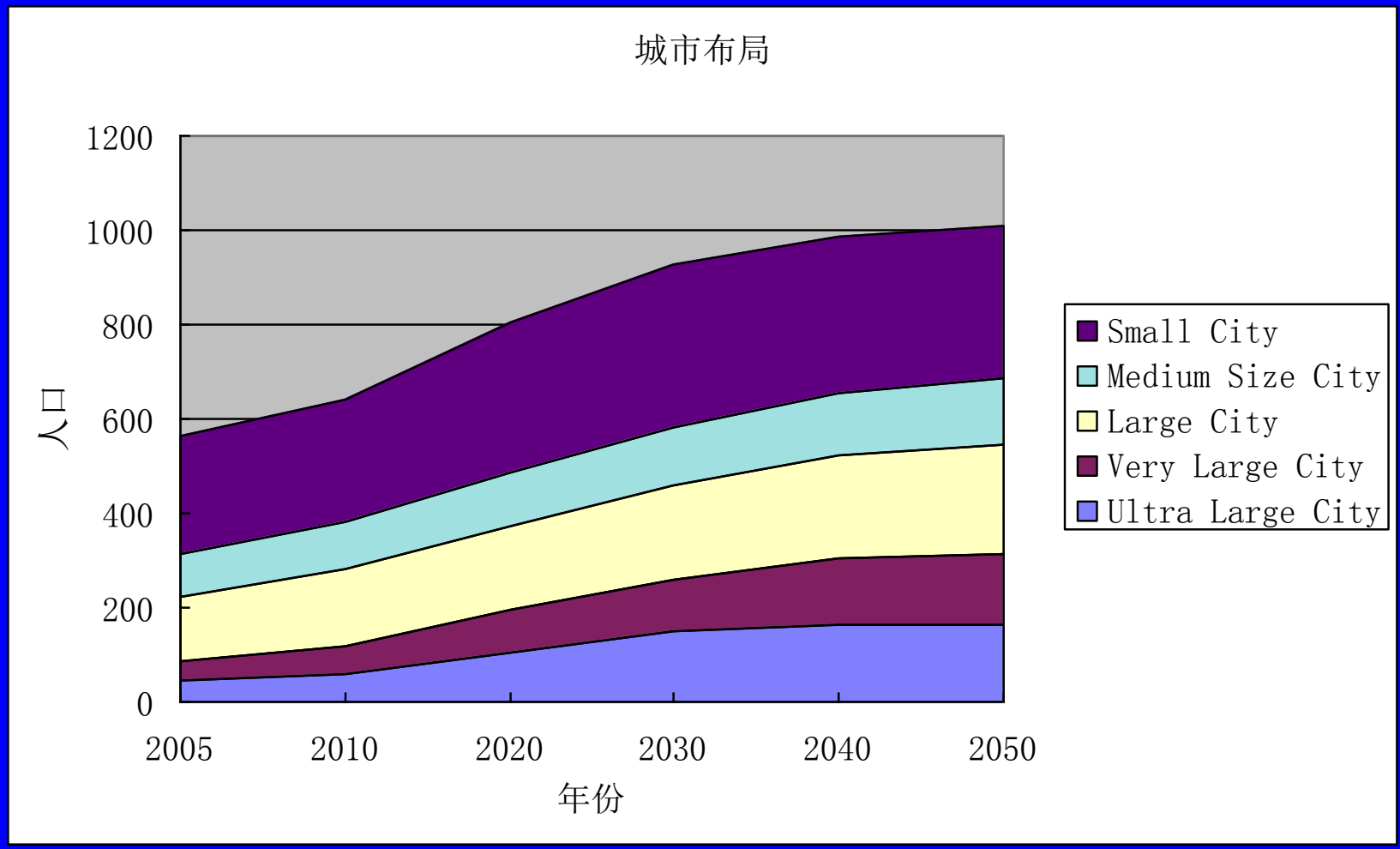


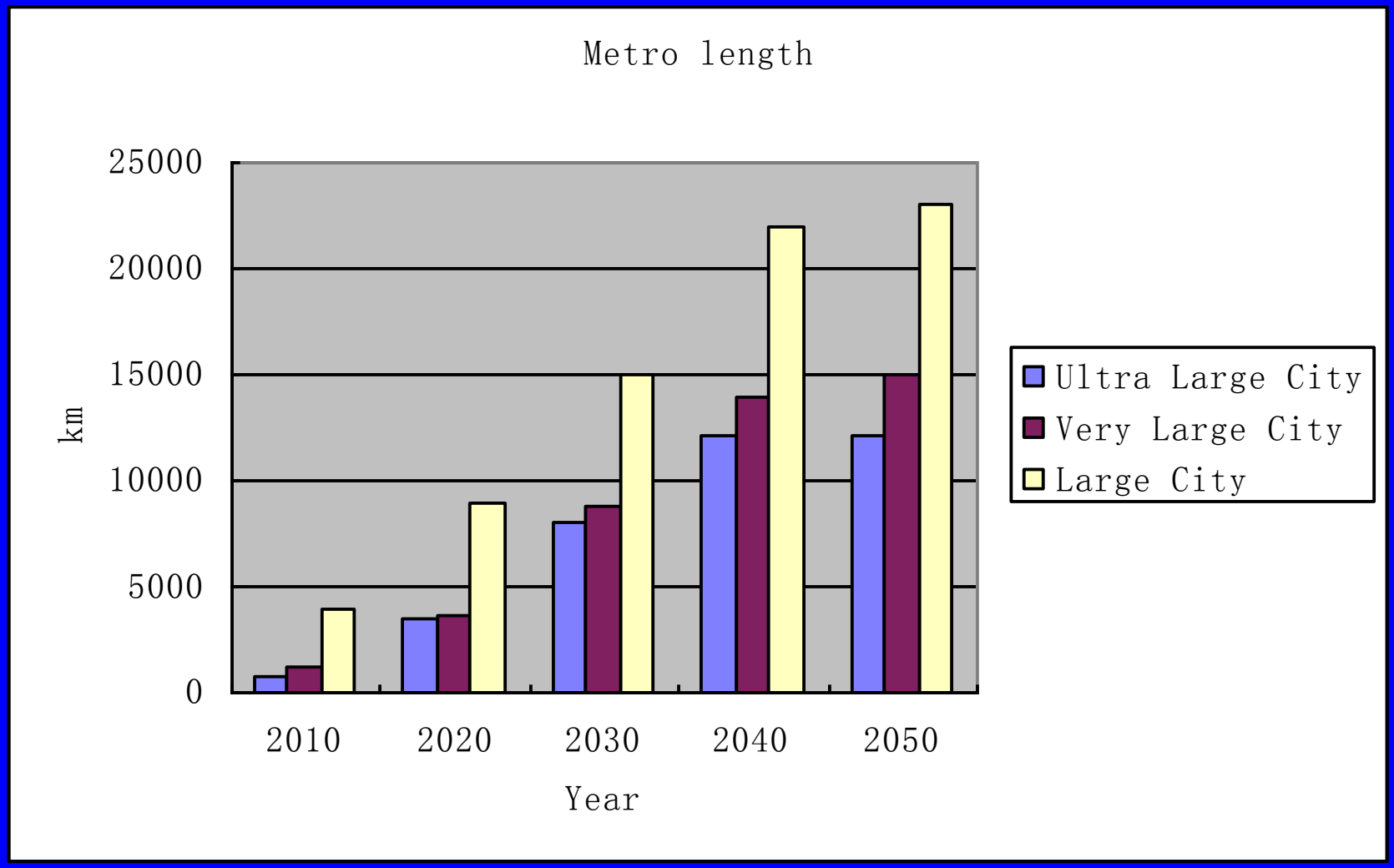


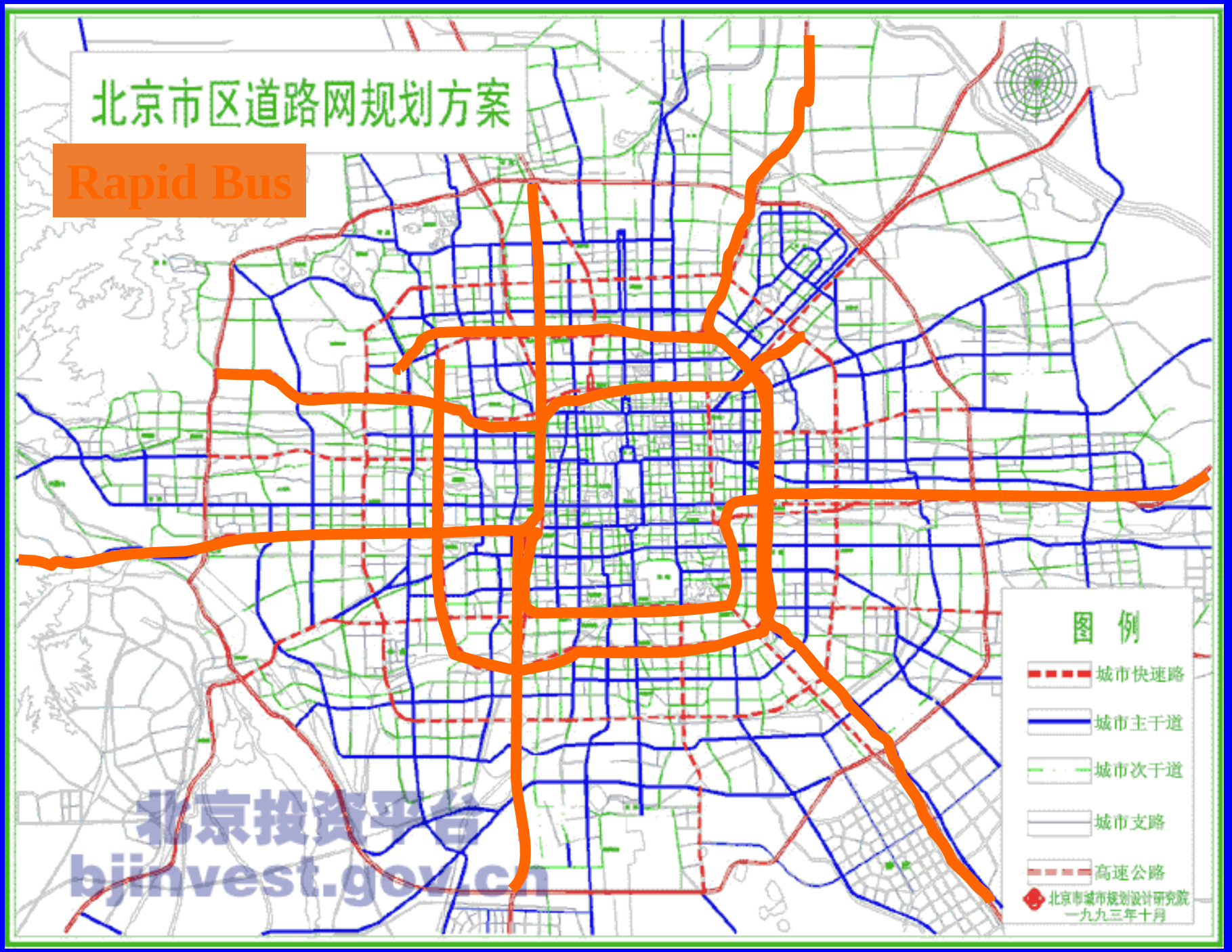
城市发展的理念：道路

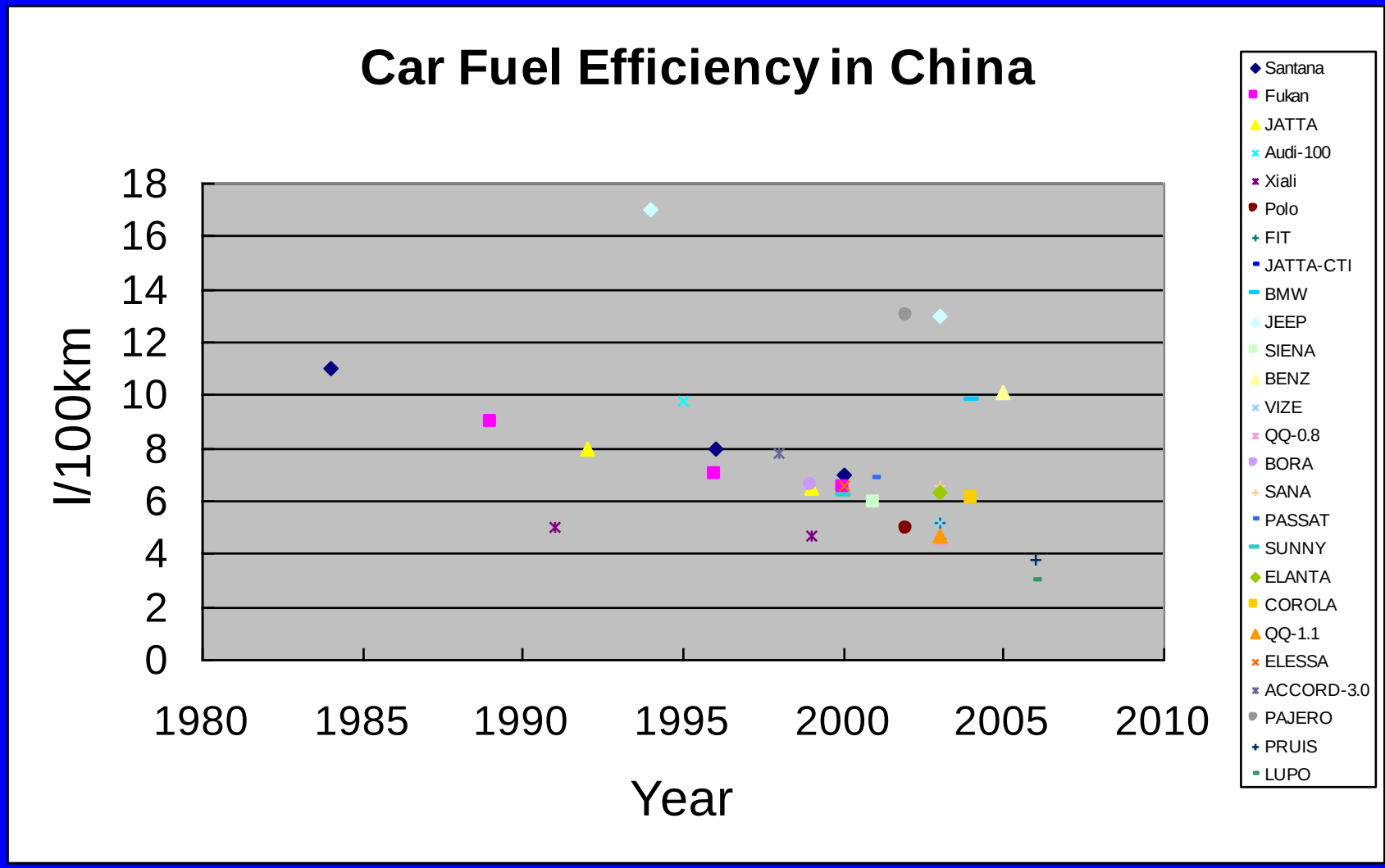
Planning scheme of Rail-based transit system in Beijing's urban area

By 2015, 500km, by 2030 1100km, 210km by 8 June, 2010, 11 metro lines under construction, more than 60 metro lines under construction in China

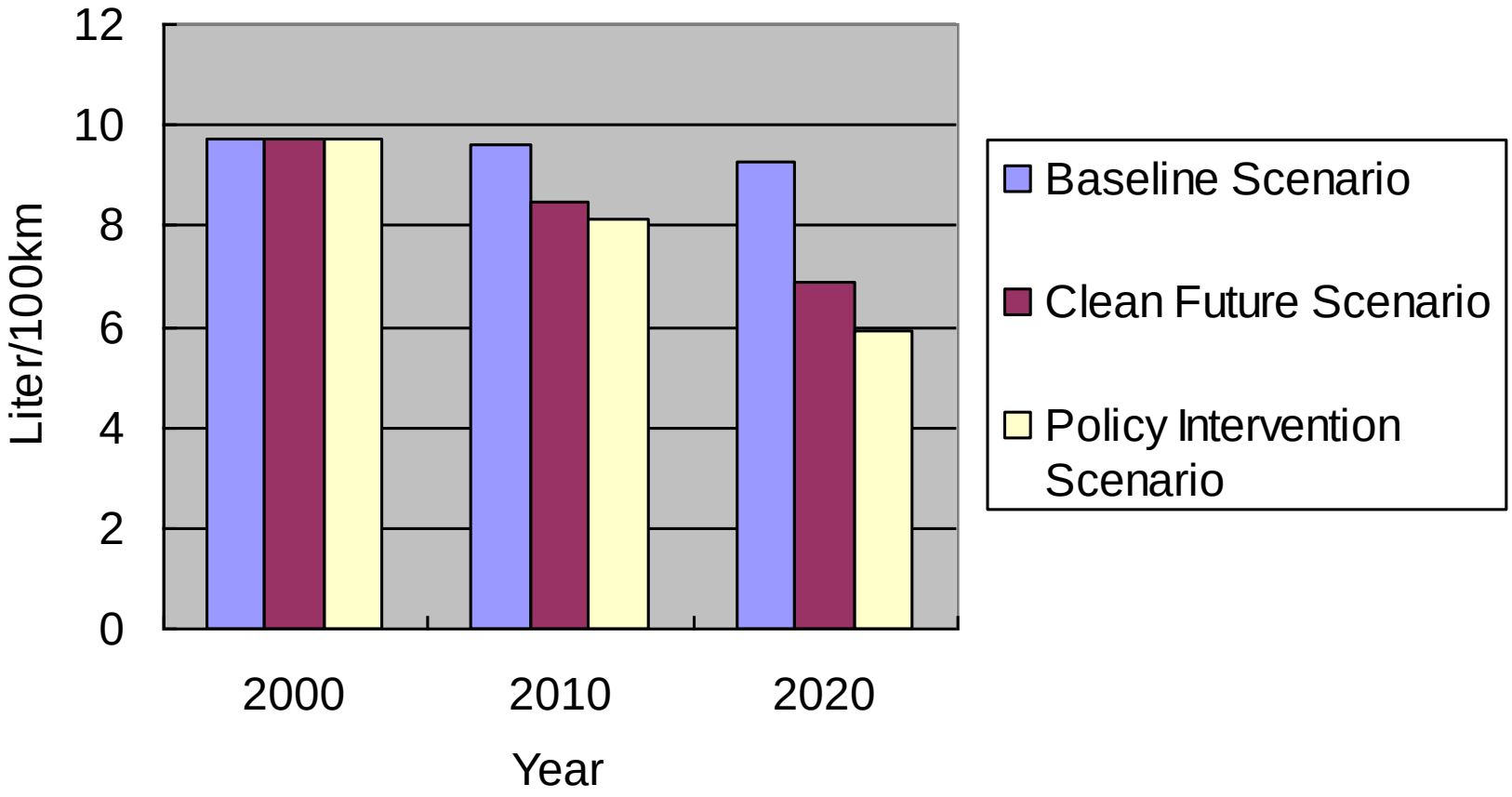

城市布局
1200
1000
800
600
400
200
0
人口
2005
2010
2020
2030
2040
2050
年份
Small City
Medium Size City
Large City
Very Large City
Ultra Large City


Metro length
25000
20000
15000
10000
5000
0
km
2010
2020
2030
2040
2050
Year
Ultra Large City
Very Large City
Large City


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
l/100km
18
16
14
12
10
8
6
4
2
0
1980
1985
1990
1995
2000
2005
2010
Year
Santana
Fukan
JATTA
Audi-100
Xiali
Polo
FIT
JATTA-CTI
BMW
JEEP
SIENA
BENZ
VIZE
QQ-0.8
BORA
SANA
PASSAT
SUNNY
ELANTA
COROLA
QQ-1.1
ELESSA
ACCORD-3.0
PAJERO
PRUIS
LUPO

Average Fuel efficiency for cars in Beijing

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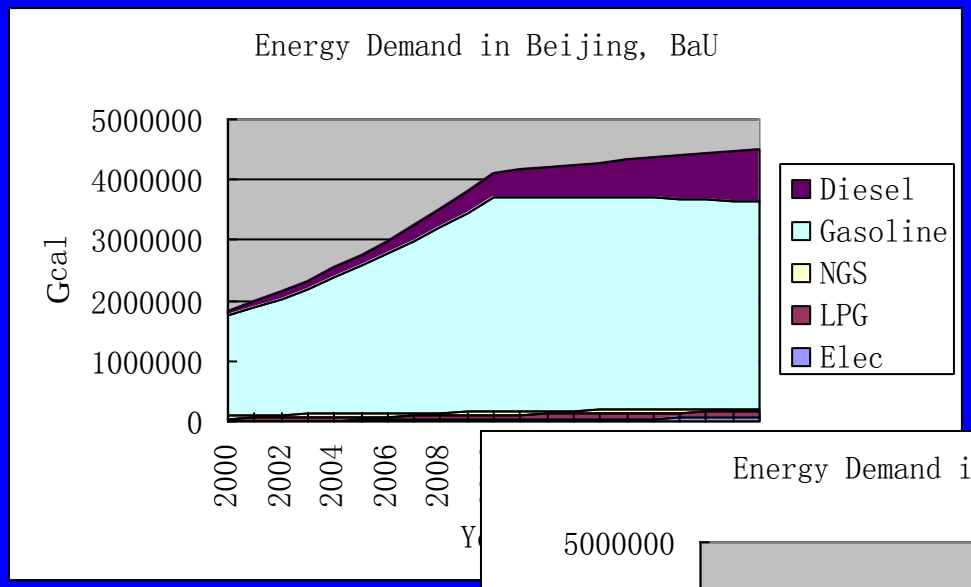
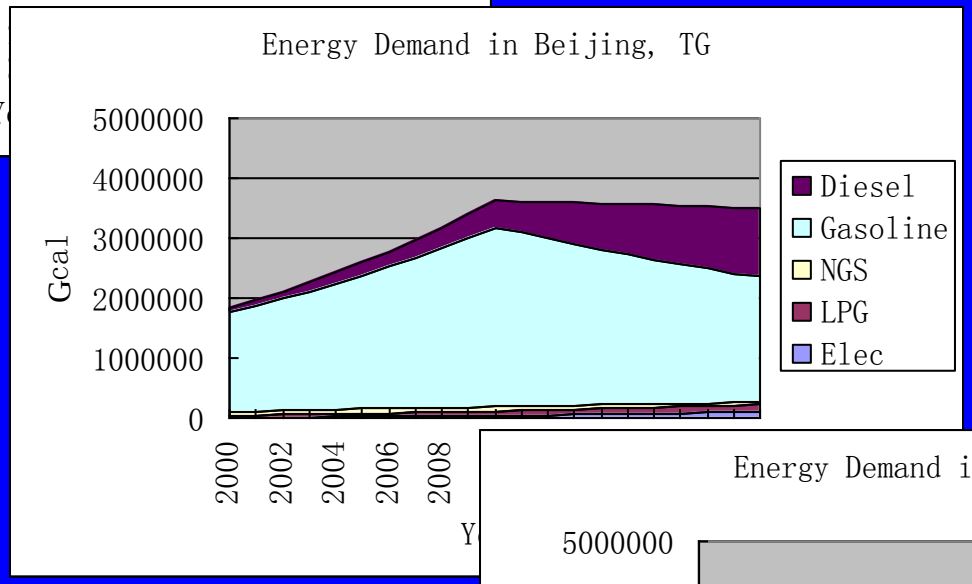
MICHELIN
6
ALLEE
6200
BYD
F3 DM

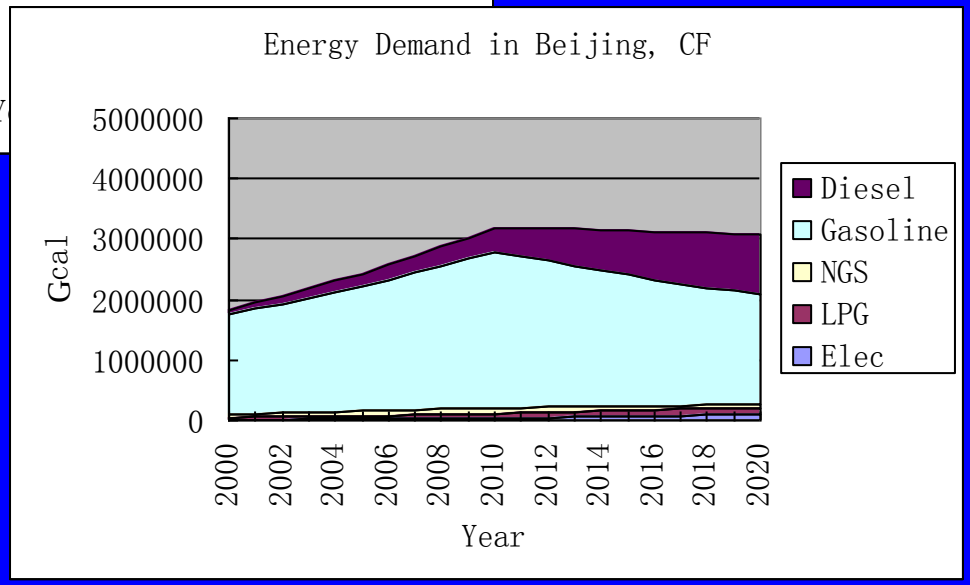

BLUEBIRD


杰勋

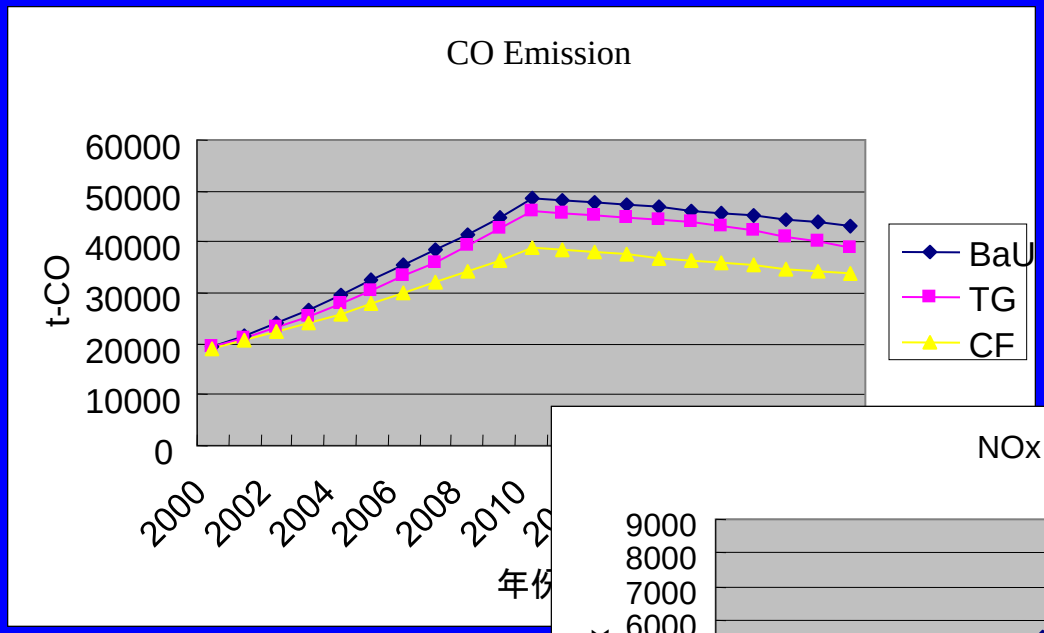
斯德歌尔摩:在欧洲许多城市，自行车、步行在逐渐形成主要交通方式

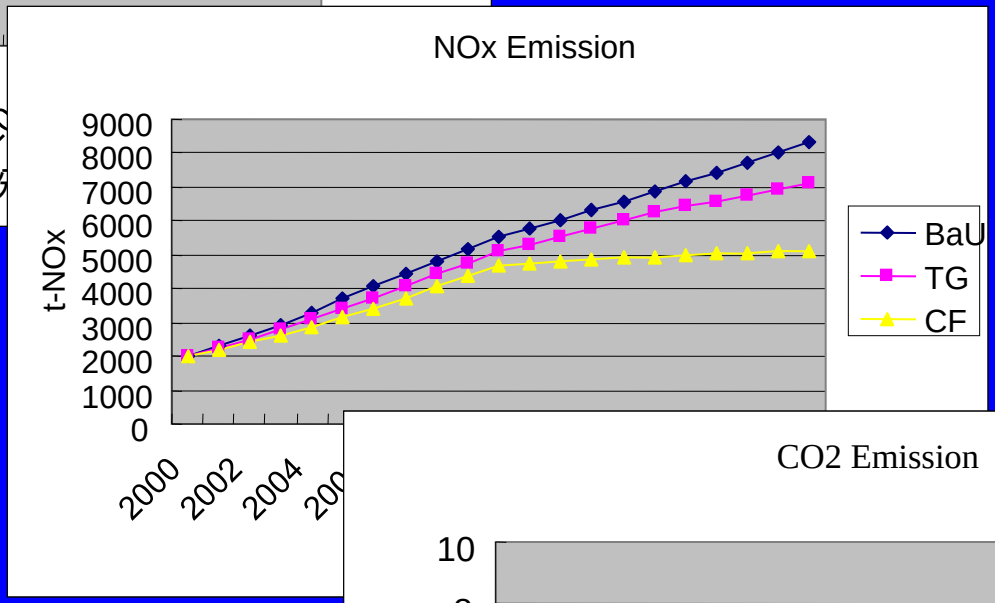


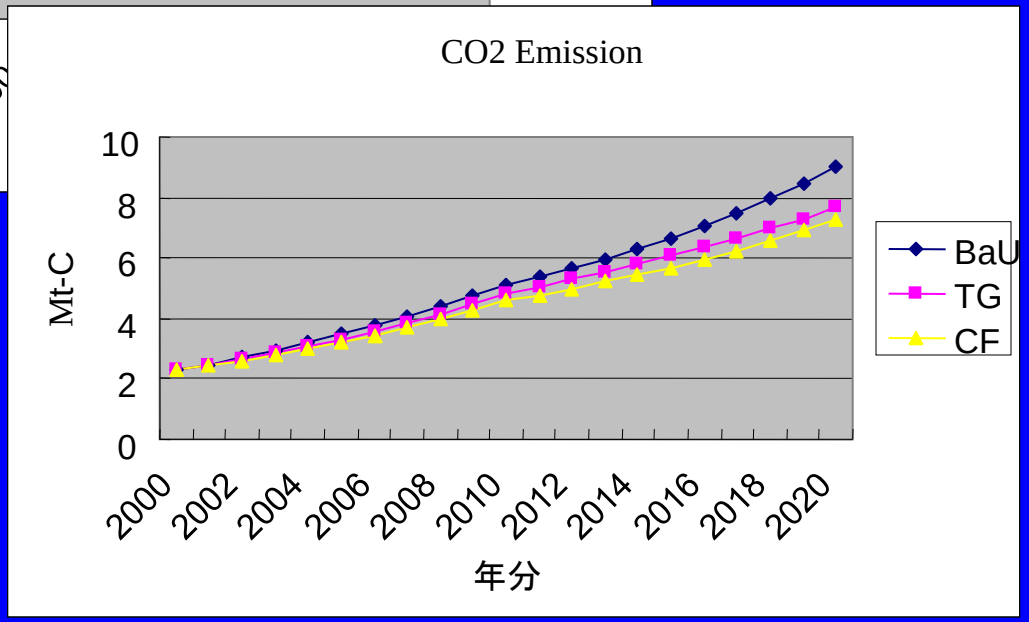


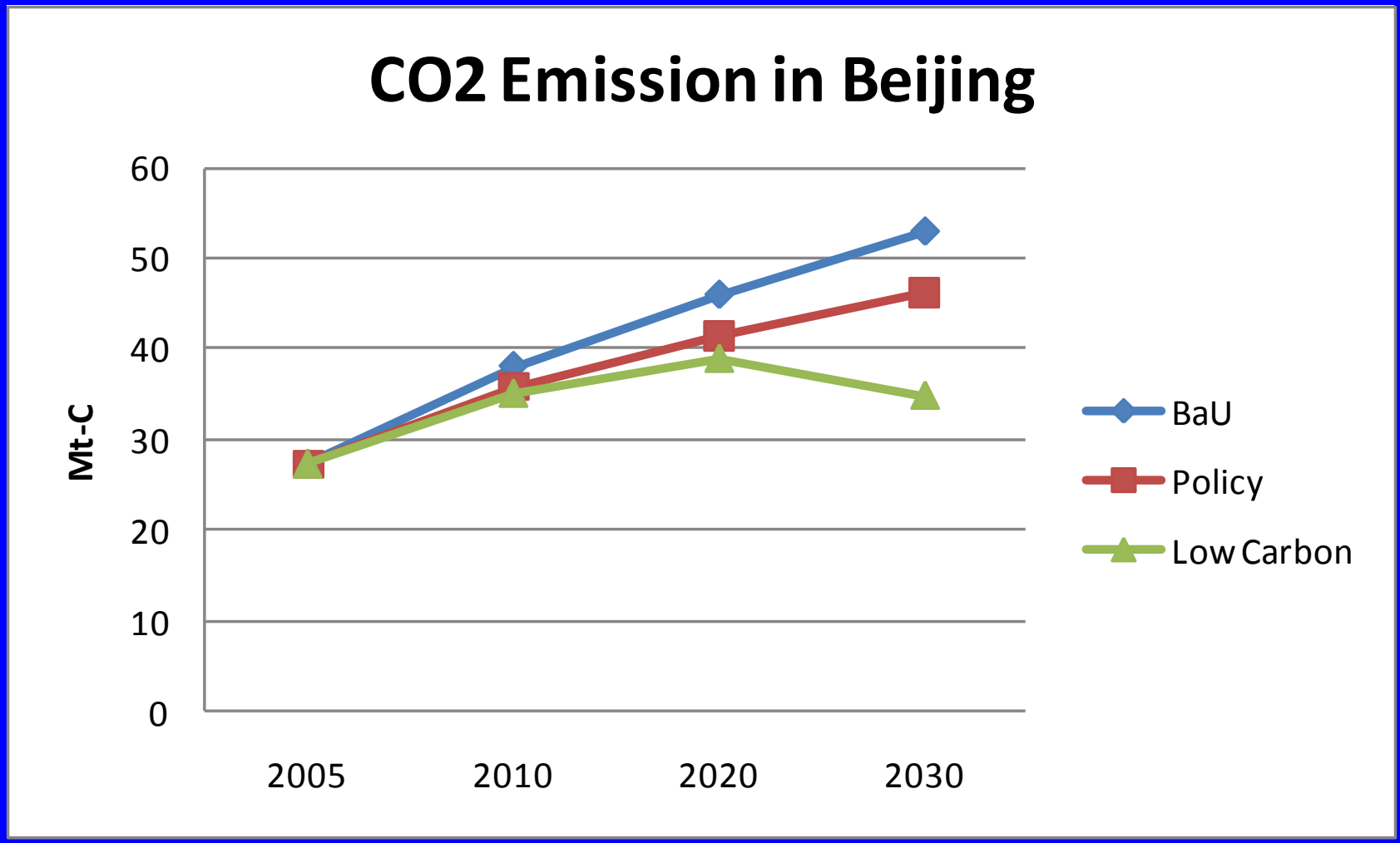


Energy demand of transport in Beijing could be nearly stable after 2010 even though vehicle number will increase a lot

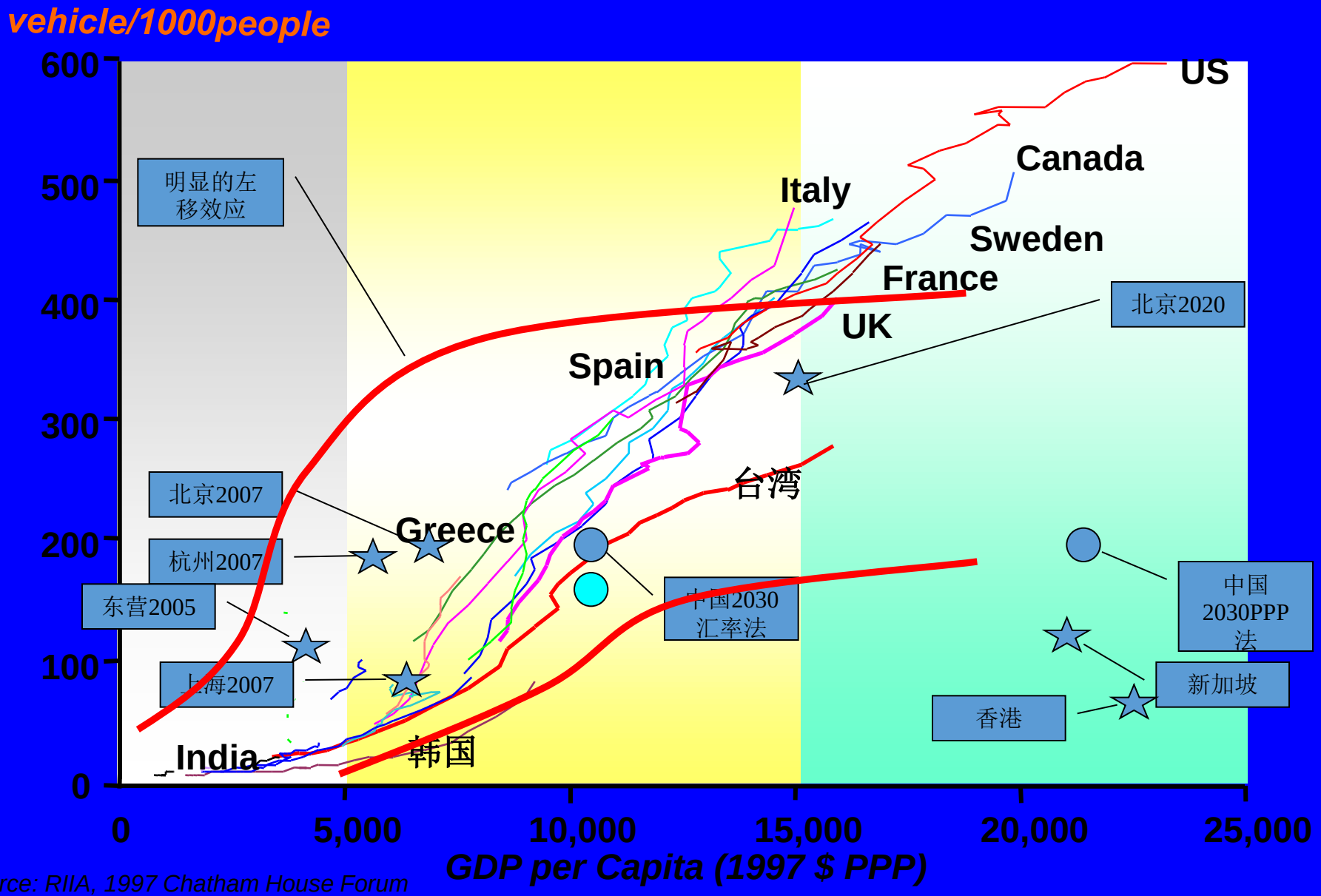

CO Emission
t-CO
60000
50000
40000
30000
20000
10000
0
2000
2002
2004
2006
2008
2010
BaU
TG
CF


NOx Emission
t-NOx
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2000
2002
2004
BaU
TG
CF


CO2 Emission
Mt-C
10
8
6
4
2
0
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
年分
BaU
TG
CF


CO2 Emission in Beijing
60
50
40
30
20
10
0
Mt-C
2005
2010
2020
2030
BaU
Policy
Low Carbon

Ownership of Vehicle

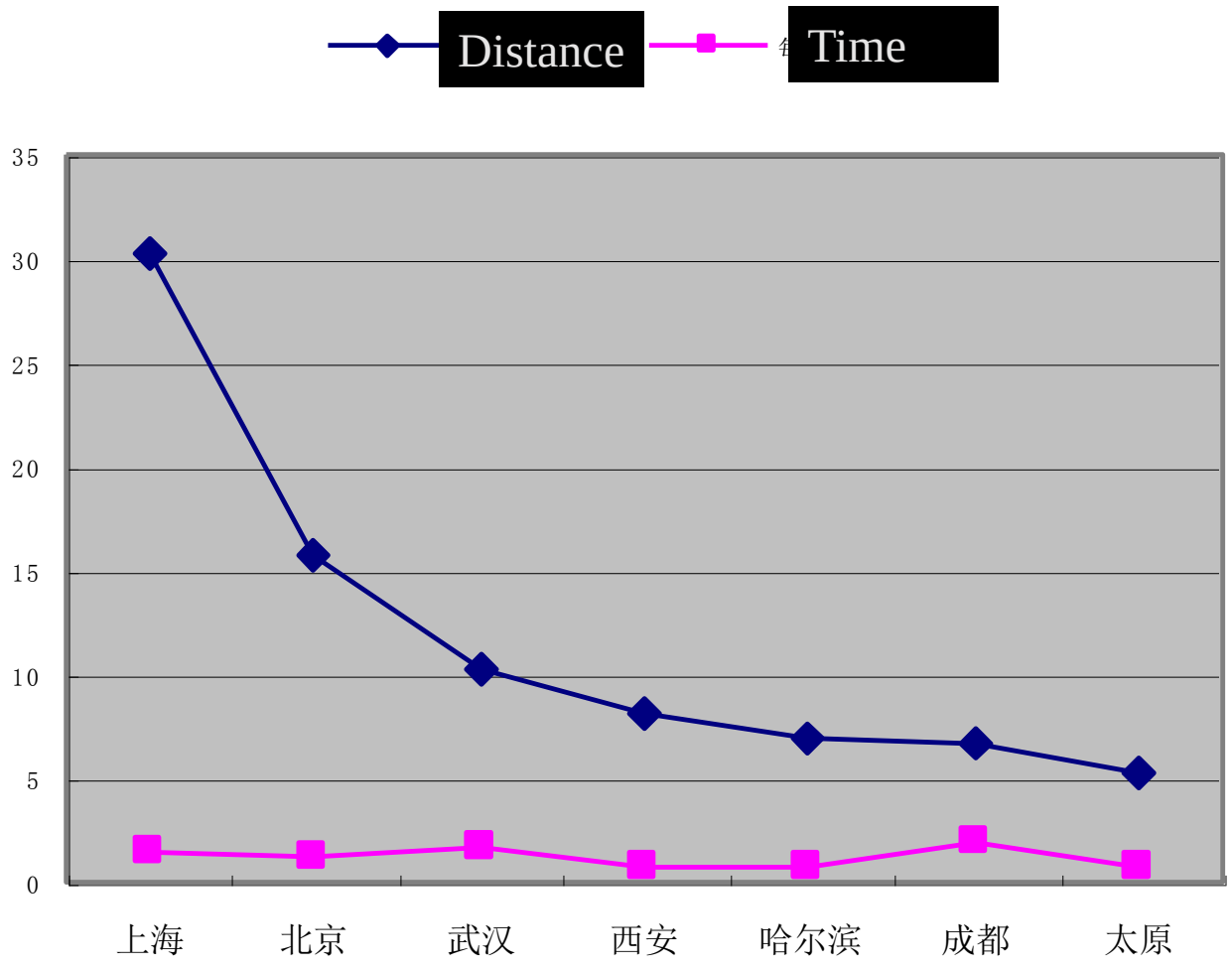


Source: RIIA, 1997 Chatham House Forum

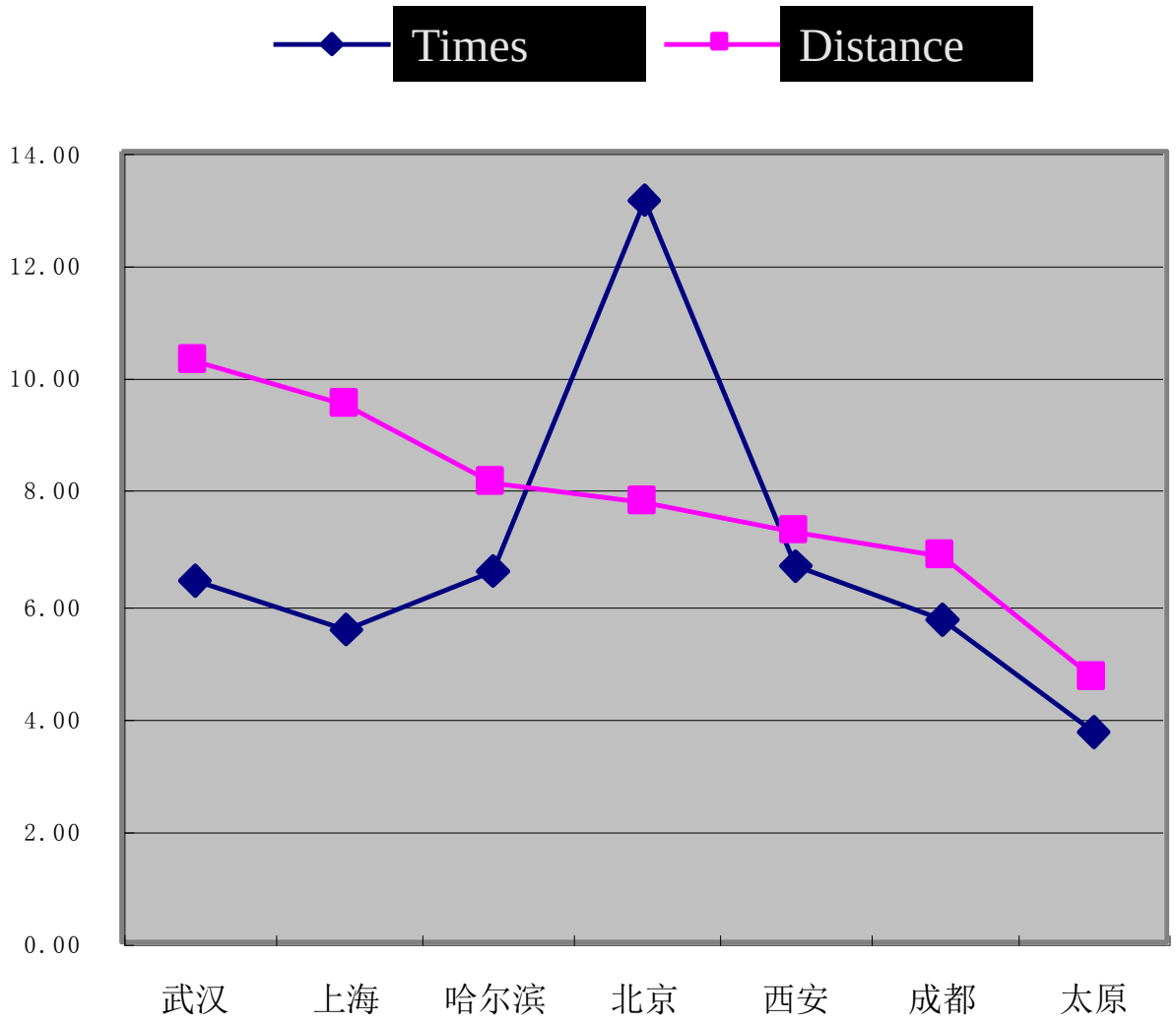
Vehicle fleet, Low Carbon scenario, 10000

	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

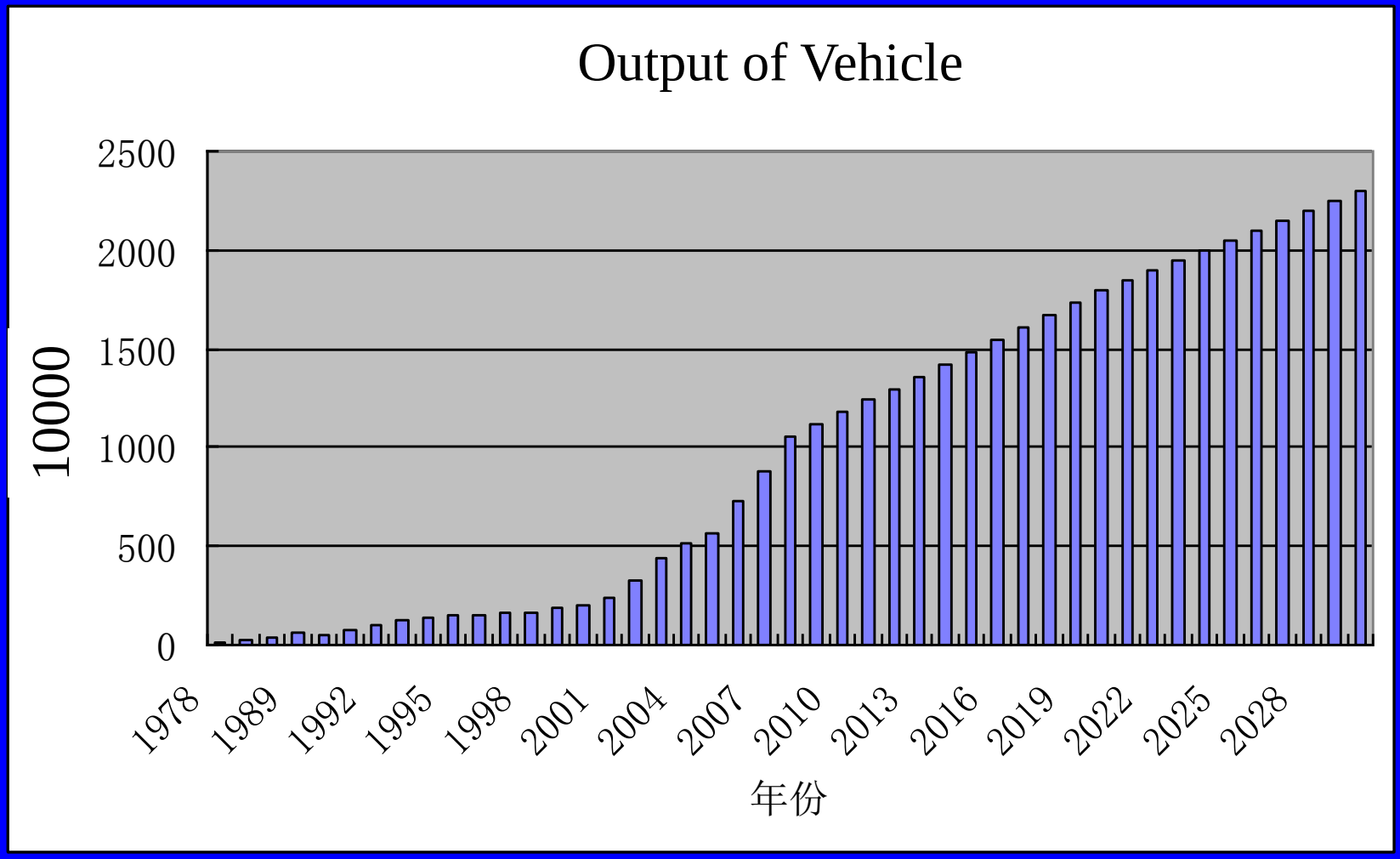


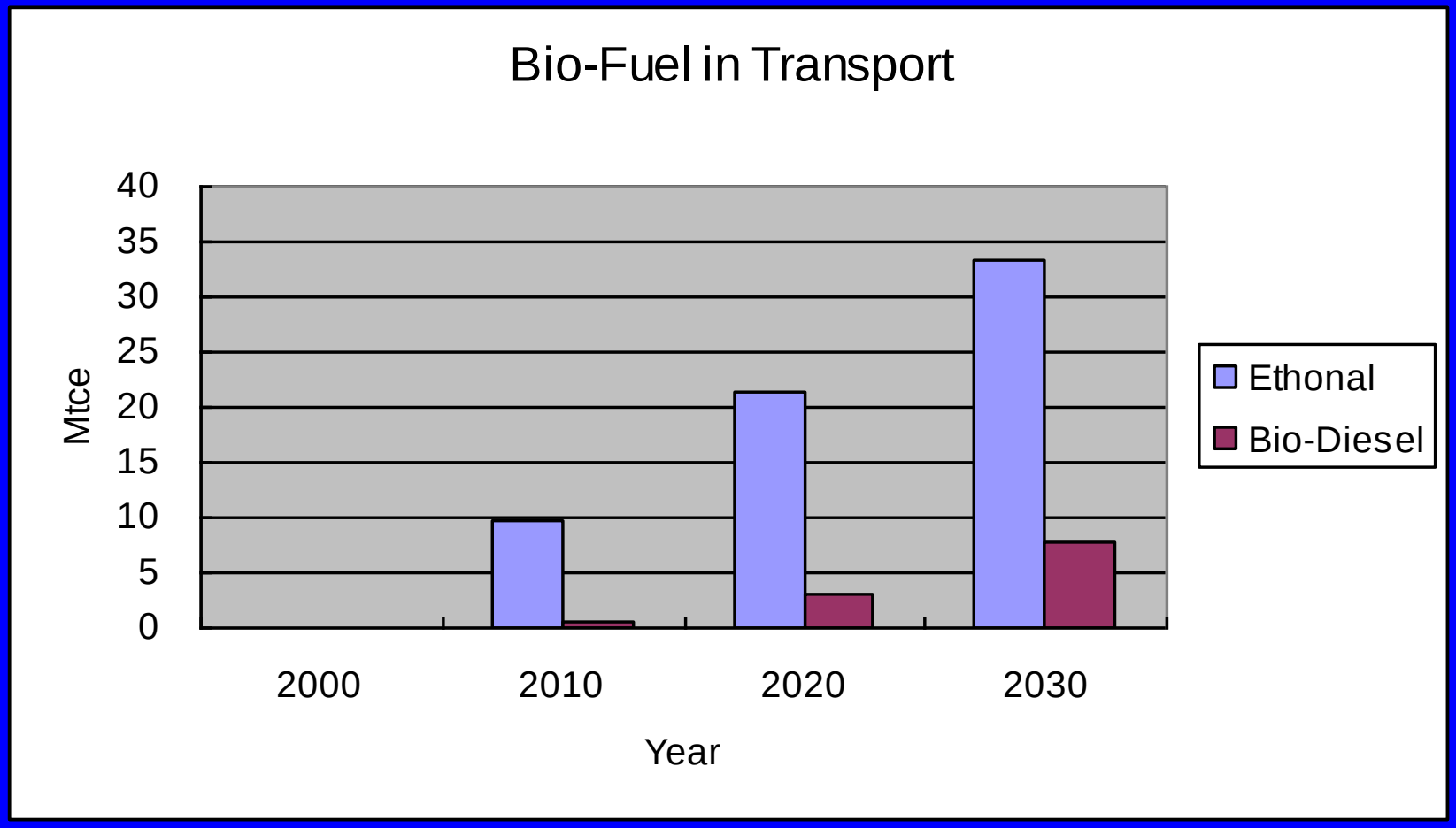
Times to take vehicle and distance， per week



Transport, Low carbon scenario

		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 engin size of family cars, litter		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
10000
2500
2000
1500
1000
500
0
1978
1989
1992
1995
1998
2001
2004
2007
2010
2013
2016
2019
2022
2025
2028
年份


Bio-Fuel in Transport
40
35
30
25
20
15
10
5
0
Mtce
2000
2010
2020
2030
Year
Ethonal
Bio-Diesel

28 key technologies in the enhanced low carbon scenario in China

No.	Sector	Technology	Description	Note
1	Industry technology	High energy efficiency 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 tecnologies	Recycle, reuse, reducing material use		

Roadmap for Electric Car

		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

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

Way for charge: parking log charge, charging station

Way to use battery: plug-in, changing battery

Electric control system: advanced system

New model: next generation electric car

Energy efficiency

Cost of Battery

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

	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

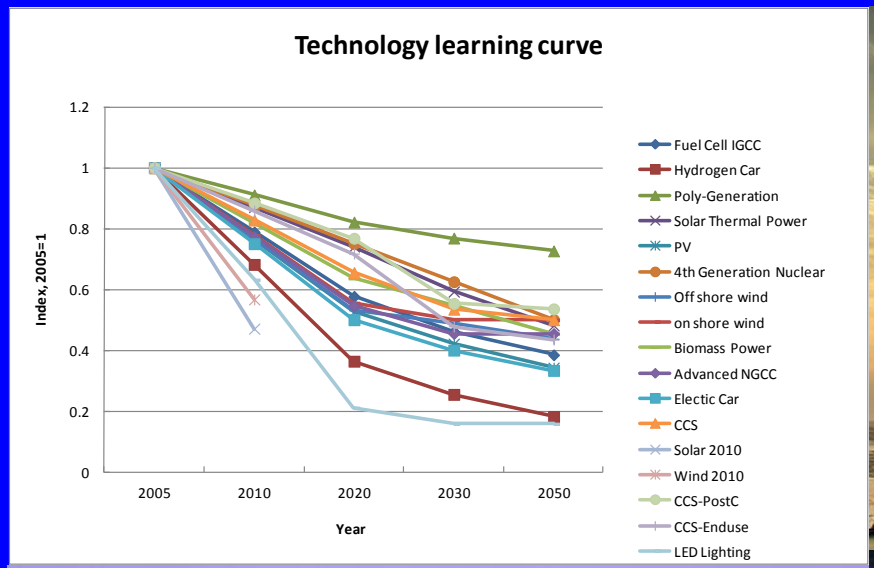
the outlook of electric vehicle sales market

	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

	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



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

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 20000number plates per month),