

Low Carbon Society Scenario up to 2050 for China

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Japan Low-Carbon Society Scenarios toward
2050 Project symposium

Scenario methodology

- Similar with IPCC emission scenarios
- Both forecasting and backcasting

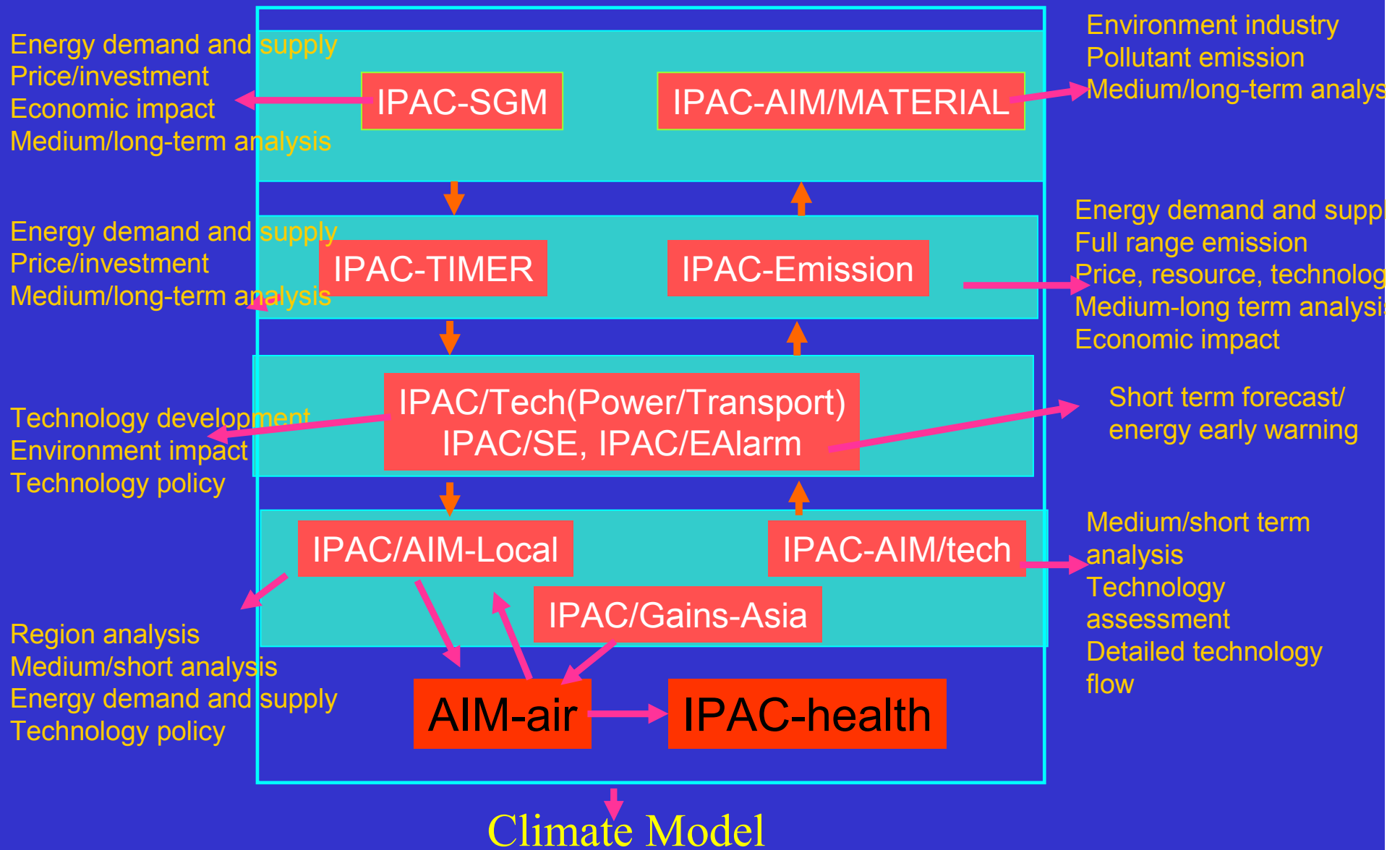
Emission range

- Energy activities: energy mining, energy utilization, energy transport
- Land use emissions: agriculture activities, forest, land use change
- Industrial processing emission
- Including CCS

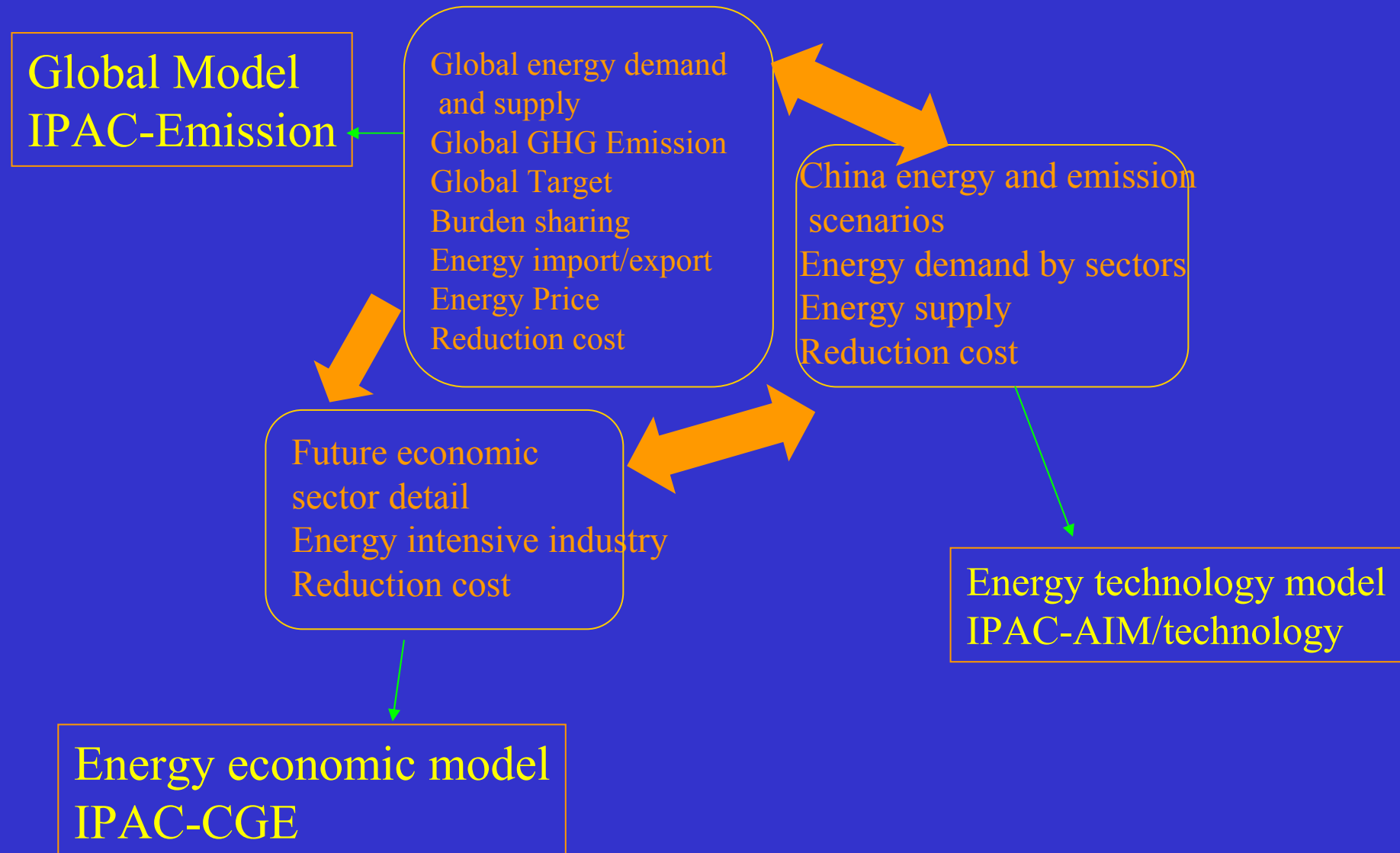
Pollutants and GHGs

- Local pollutants: SO₂, NO_x, CO, PM (PM₁₀)
- GHGs: CO₂, CH₄, N₂O, HFC, PFC, SF₆, NMVOC, black carbon

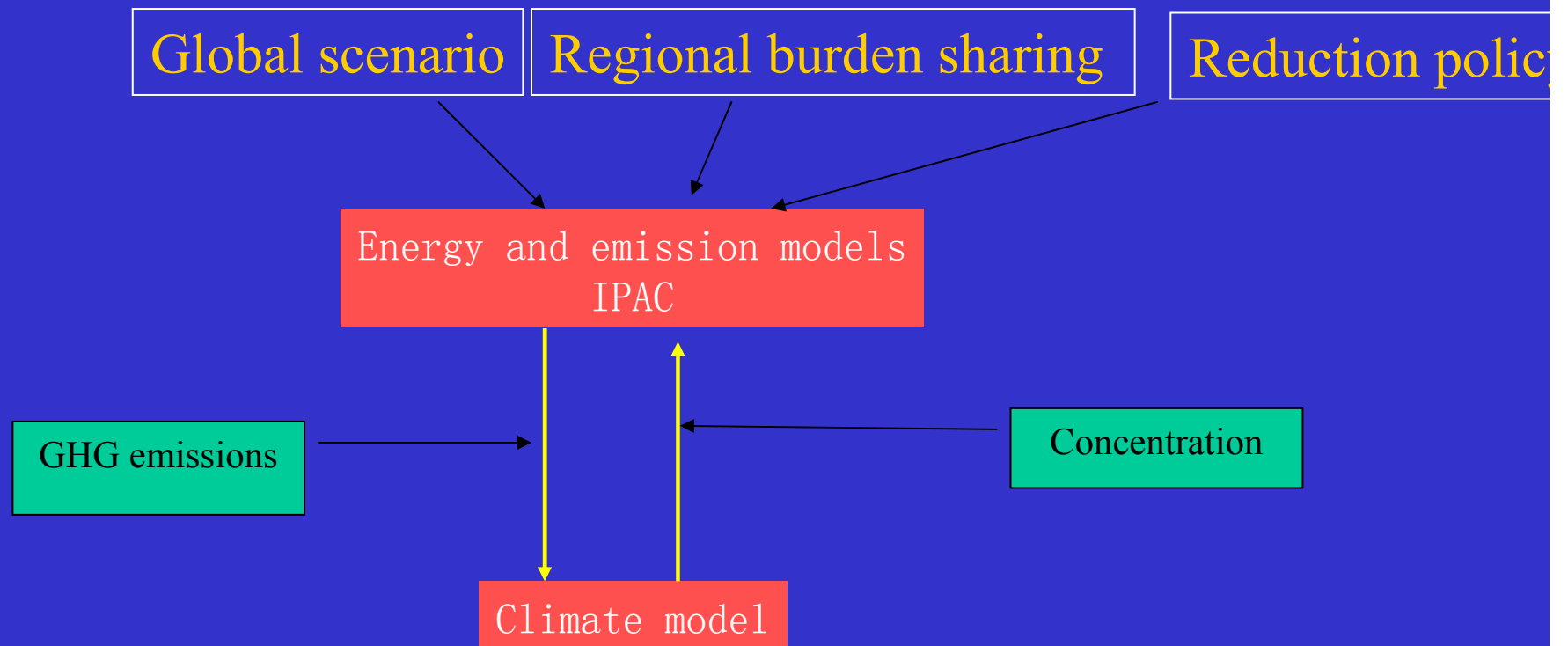
Framework of Integrated Policy Model for China (IPAC)



Methodology framework



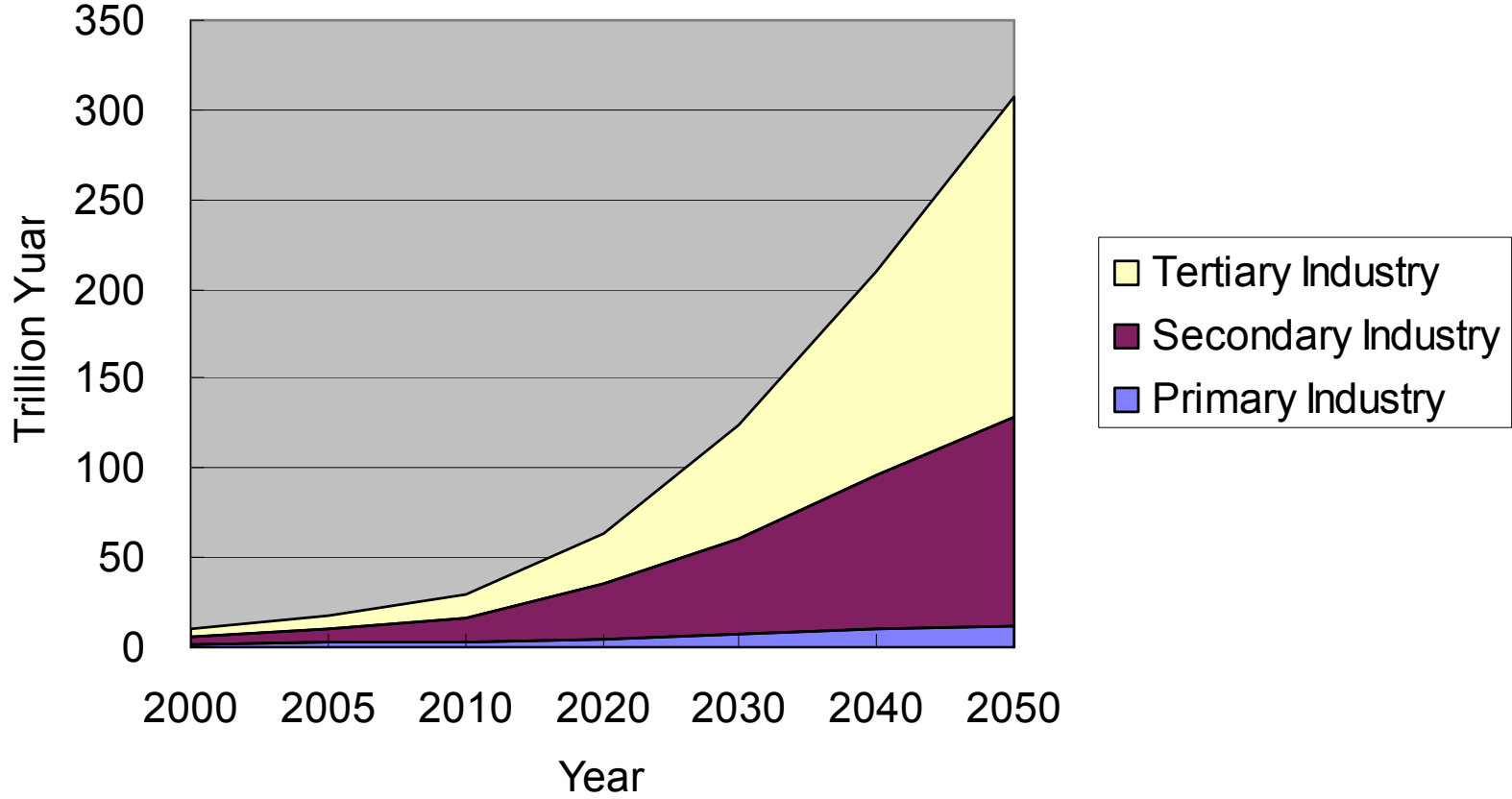
Linkage among models



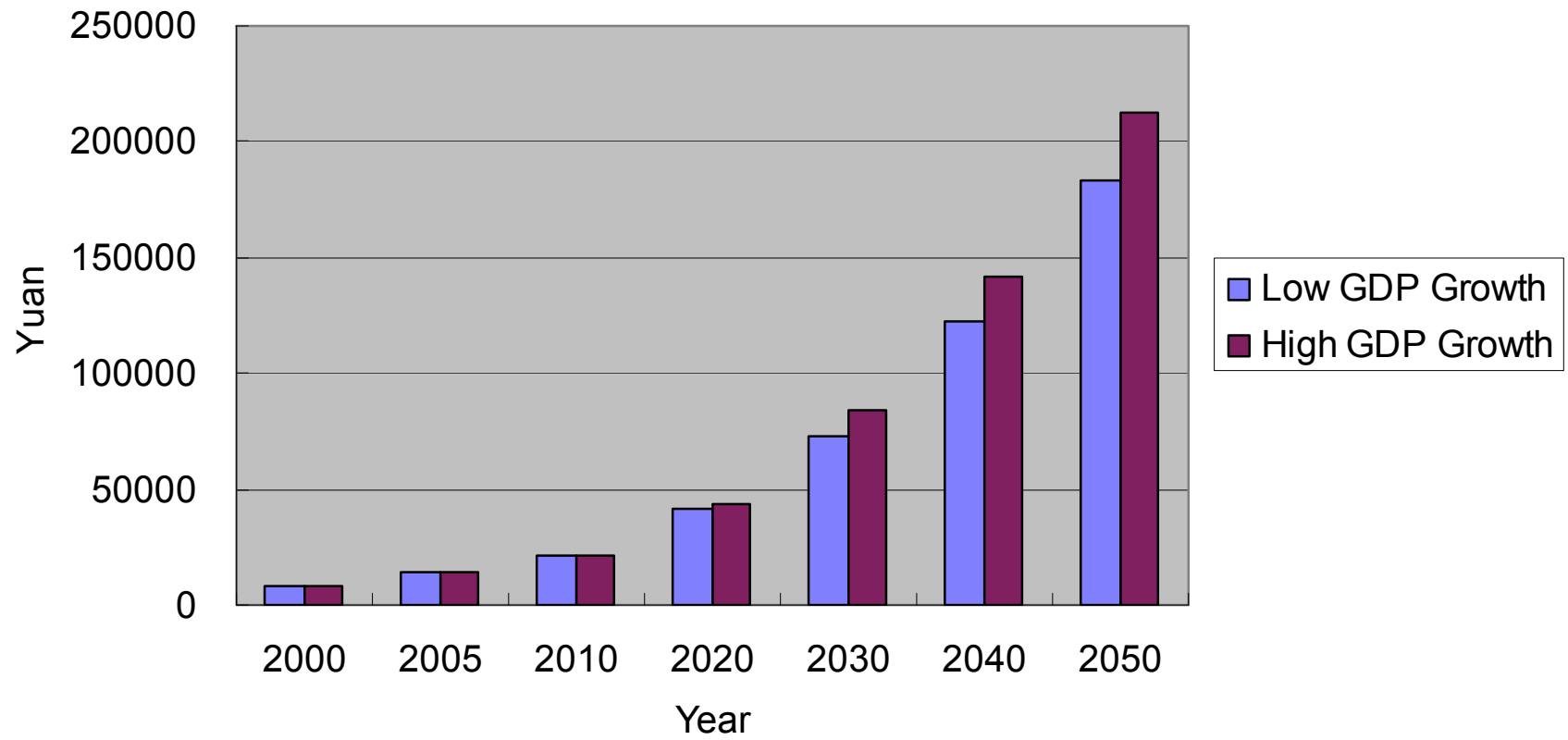
GDP growth rate: BaU

	2005– 2010	2010– 2020	2020– 2030	2030– 2040	2040– 2050
GDP	10.04%	7.67%	5.85%	4.09%	2.82%
Primary	4.12%	3.72%	2.60%	2.39%	2.06%
Secondary	10.99%	7.52%	5.22%	3.08%	1.86%
Industry	10.98%	7.47%	5.26%	3.11%	1.90%
Construction	11.06%	7.87%	4.96%	2.88%	1.55%
Tertiary	10.53%	8.59%	6.90%	5.11%	3.57%

GDP in China

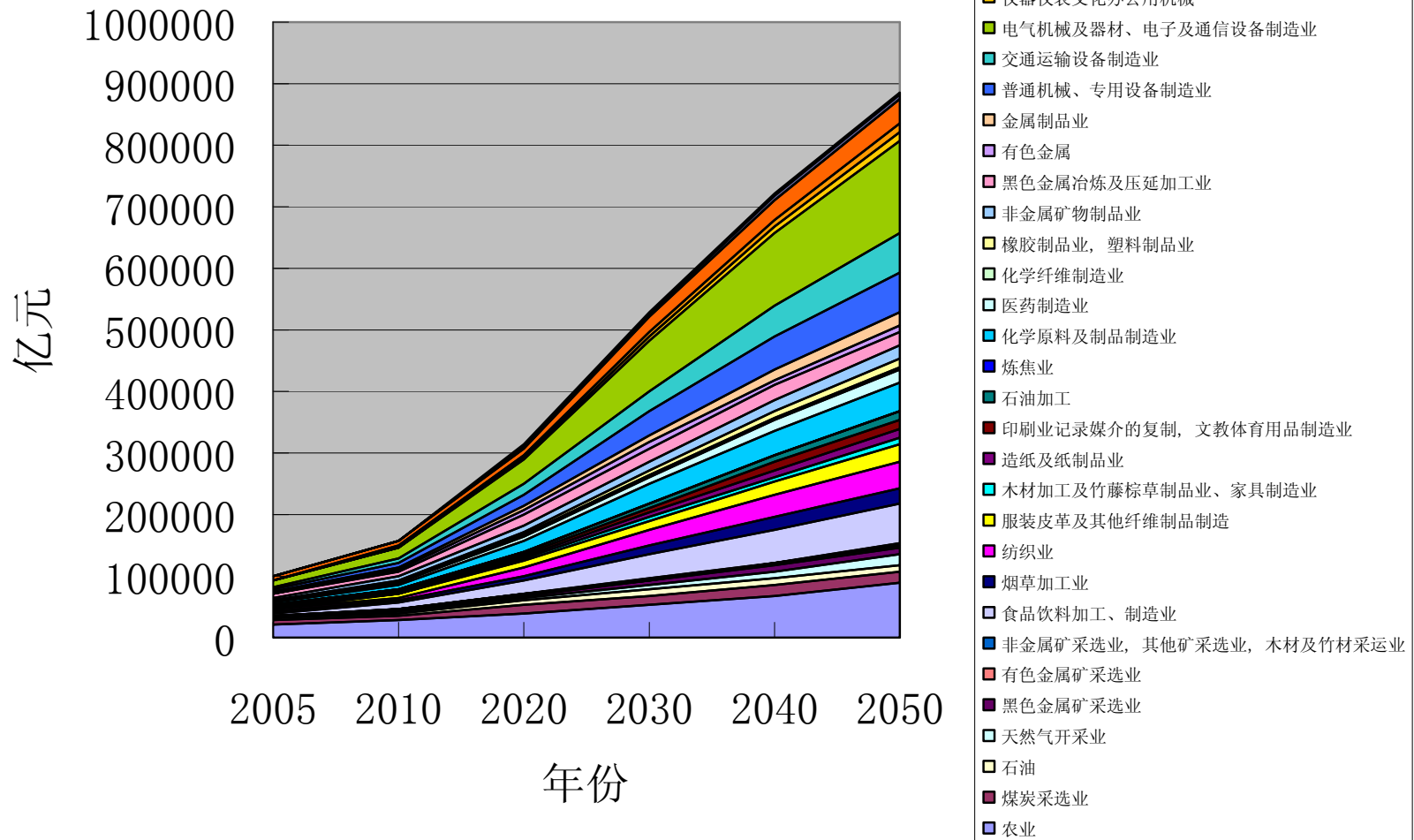


GDP per Capita, yuan

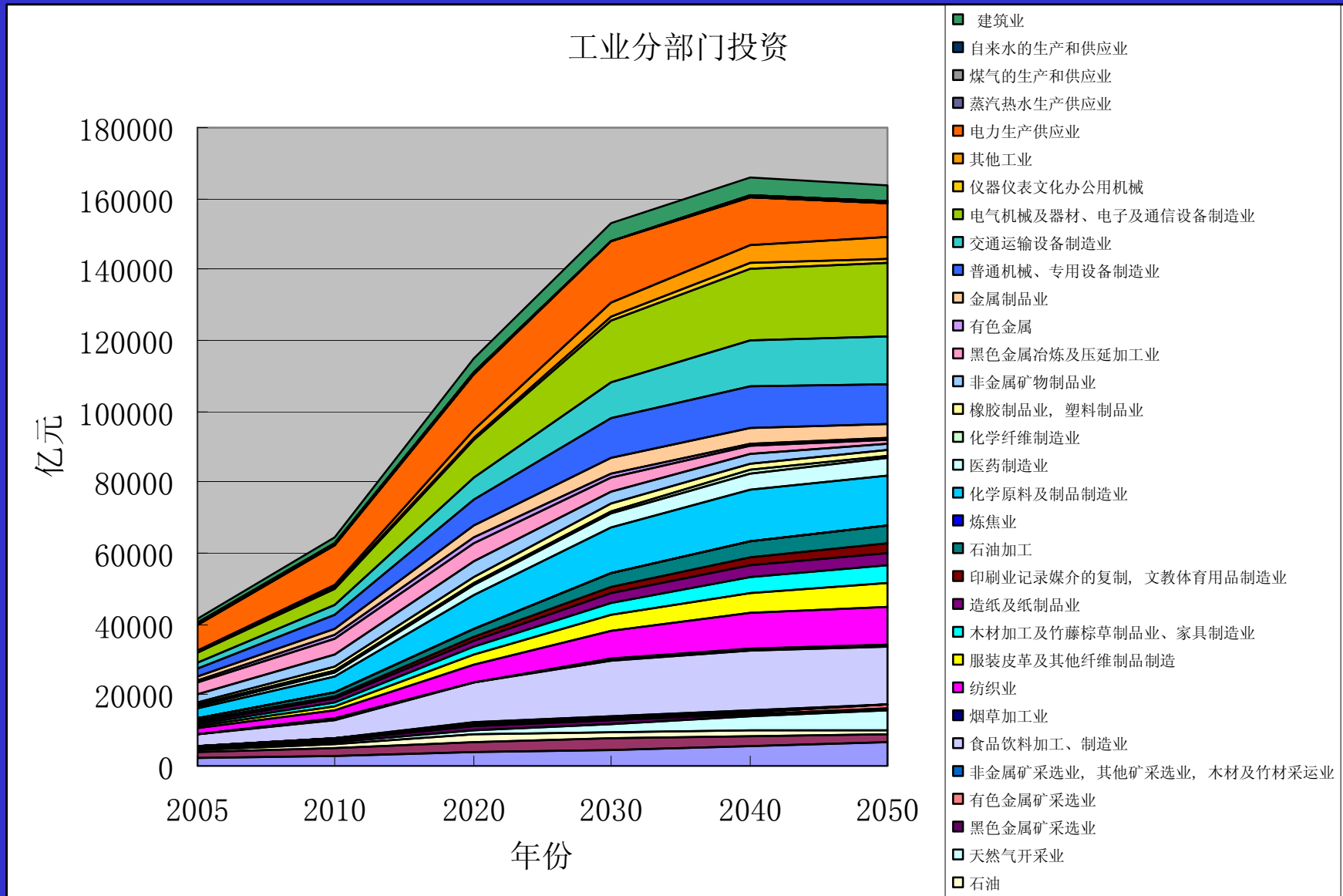


GDP by sectors

GDP部门结构



Investment by industrial sectors



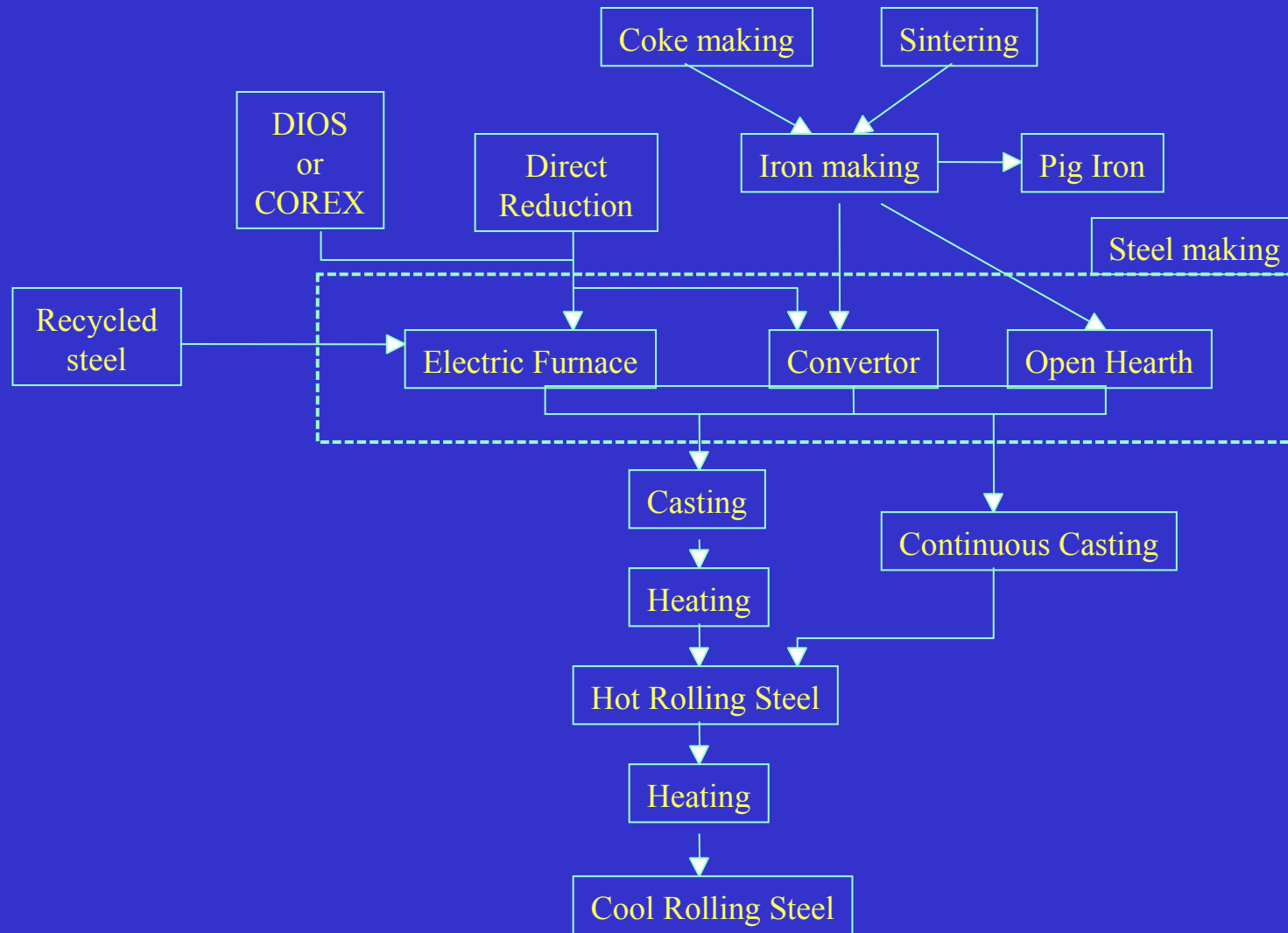
Products output in major sectors, BaU

	Unit	2005	2020	2030	2040	2050
Steel	Million ton	355	610	570	440	360
Cement	Million ton	1060	1600	1600	1200	900
Glass	Million Cases	399	650	690	670	580
Copper	Million ton	2.6	7	7	6.5	4.6
Aluminum	Million ton	8.5	16	16	15	12
Zinc&Lead	Million ton	5.1	7.2	7	6.5	5.5
Soda Ash	Million ton	14.67	23	24.5	23.5	22
Caustic	Million ton	12.6	24	25	25	24
Paper	Million ton	62	110	115	120	120
Fertilizer	Million ton	52.2	61	61	61	61
Ethylene	Million ton	7.56	34	36	36	33
Ammonia	Million ton	46.3	50	50	50	45
Calisium	Million ton	8.5	10	8	7	4

Population

	2005	2010	2020	2030	2040	2050
Population	1307.56	1360.00	1440.00	1470.00	1470.00	1440.00
Urbanization rate	43%	49%	63%	70%	74%	79%
Urban Population	562.12	666.40	907.20	1029.00	1087.80	1137.60
Person per Household	2.96	2.88	2.80	2.75	2.70	2.65
Urban Household	189.91	221.94	288.00	336.76	364.78	380.38
Rural Population	745.44	693.60	532.80	441.00	382.20	302.40
Person per Household	4.08	3.80	3.50	3.40	3.20	3.00
Rural Household	182.71	189.68	181.03	159.97	151.59	144.00

Steel production process in China



2050年的低碳住宅 舒适和节能

太阳能利用

光伏电池

(25-47% 的家庭拥有屋顶光伏电池，
转换效率接近30%)

生态生活教育

减少10-20% 能源需求

太阳热利用

普及率: 20-60%
(目前 6%)

能源检测系统 (家用电器)

超高效空调

COP = 8,
普及率 100%

待机电源耗电

降低1/3,
普及率100%

屋顶植被

高效照明 【如 LED照明】

减少50%照明需求，
普及率 100%

高效绝热

减少 60% 采暖需求，
普及率70%

燃料电池

普及率 0-20%

热泵采暖

COP=5
普及率 30-70%

向公众提供经济和环境
信息促使大家成为
低碳消费

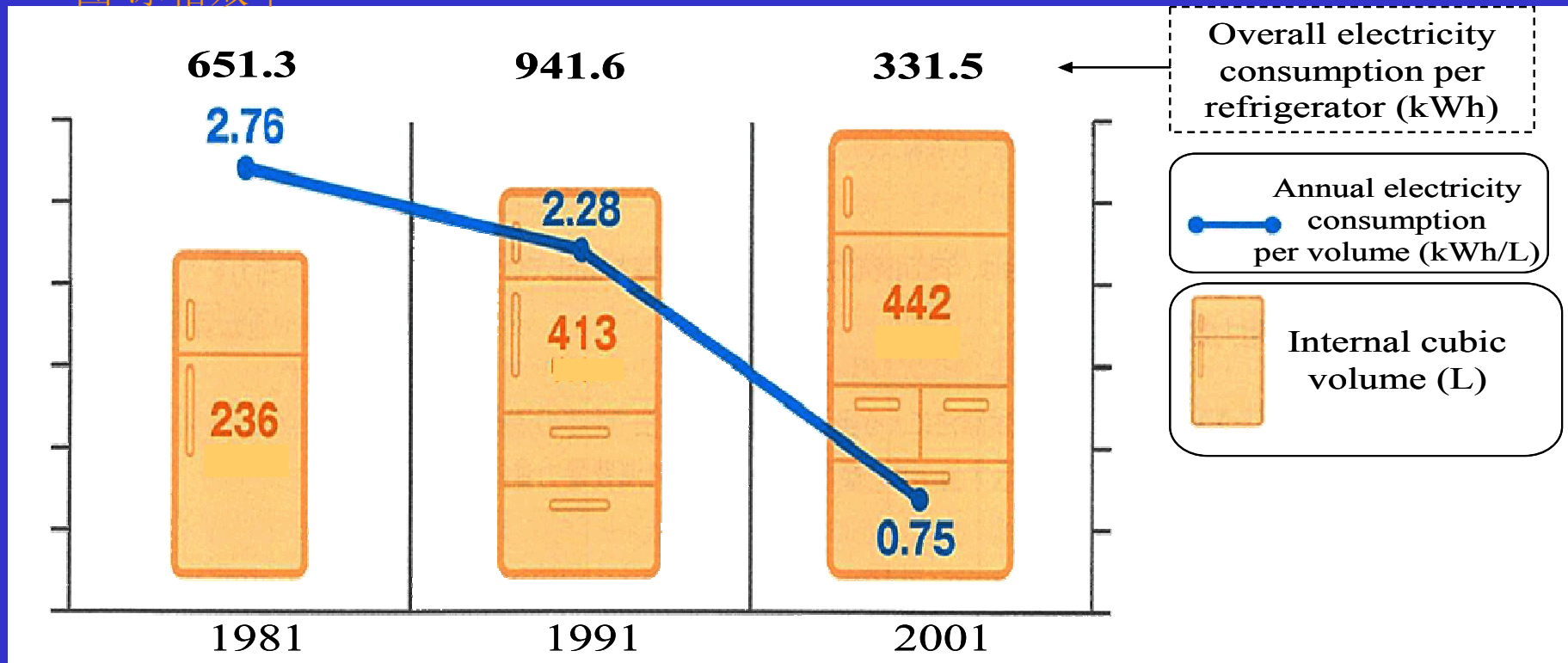
高效家用电器

减少能源需求，支持舒适和安全生活方式

日本领跑者项目：提高能源效率

- “领跑者项目已经实现
 - 刺激竞争和革新,
 - 促进现有节能技术普及
 - 增加经济竞争力
- 创造了“双赢”局面，进入良性循环.

图 冰箱效率



Parameter of Urban Household

Service	Unit	Service		
		2020	2030	2050
Household, million		288	336	380
Share of HH with space heating		42%	44%	48%
Index of space heating intensity, 2000=1		1.35	1.5	1.6
Index of space heating time, 2000=1		1.33	1.36	1.4
Share of building with 50% efficiency standard		20%	45%	65%
Ownership of Air Conditioner		130	180	260
Index of Air conditioner intensity, 2000=1		1.3	1.4	1.6
Index of air conditioner utilization time, 2000=1		1.6	1.8	2.2
Ownership of Refrigerator	per 100HH	100	120	130
Average space of refrigerator	L	250	310	390
Efficiency of Refrigerator		0.8kWh/天	0.8kWh/天	0.7kWh/天
Ownership of washing machine	per 100HH	100	100	100
times to use washing machine per week		5.4	8	8
Ownership of TV	per 100HH	180	220	290
Average Capacity of TV		320W	300W	280
Hours per TV per day		3.5	3.2	2.9
Penetration rate of CFL		100%	100%	100%
Light per HH		14	21	27
Ownership of Water heater	per 100HH	100%	100%	100%
Ownership of Solar heater	per 100HH	18%	25%	33%
Ownership of Electric cooking	per 100HH	130	140	260
Hours per day of electric cooking	Minutes	12	30	50
Capacity of other electric appliance	W	1500W	1800W	2300W
Hours of other electric appliance	Minutes	50	80	100

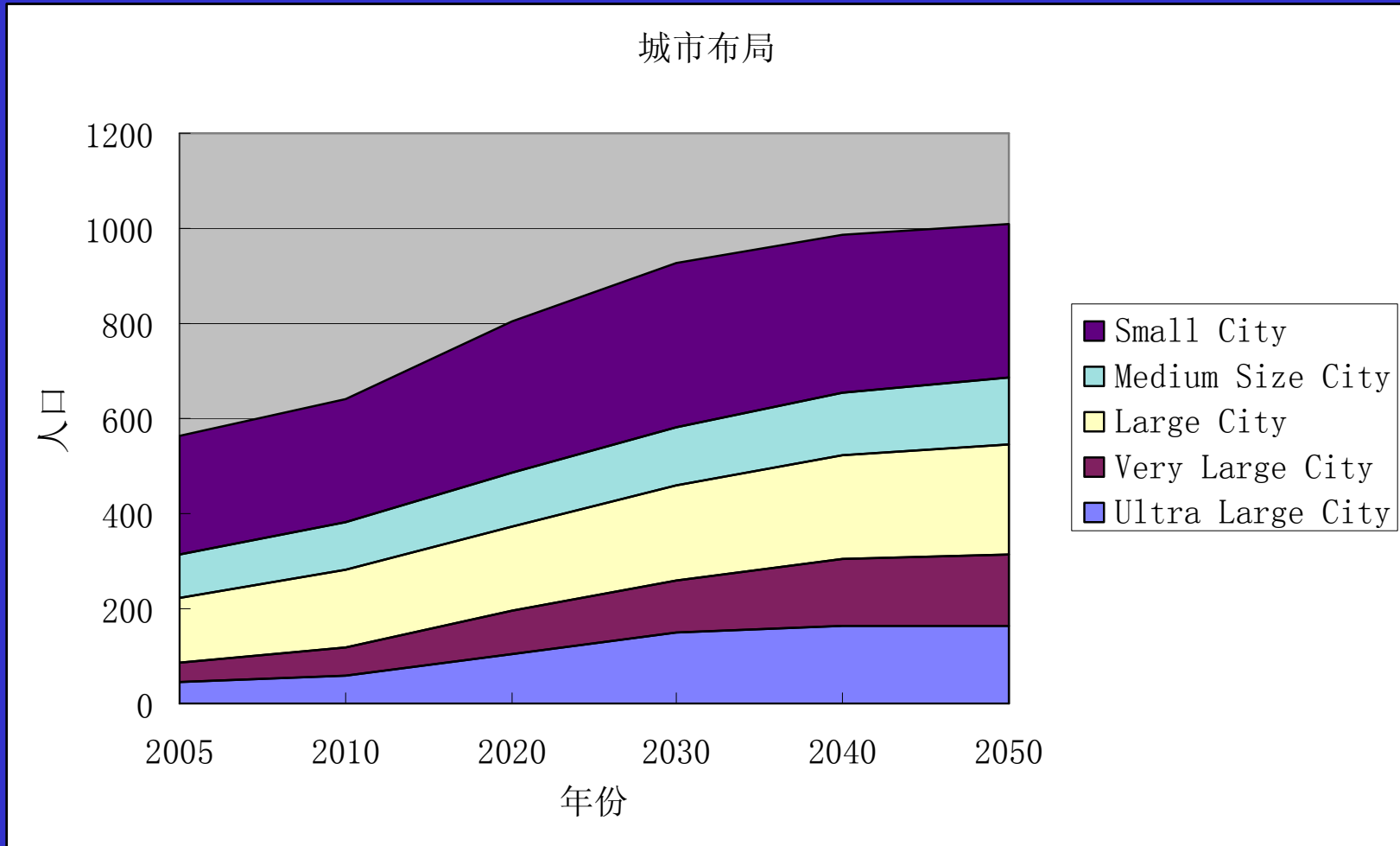
交通技术选择

Technologies in Transport

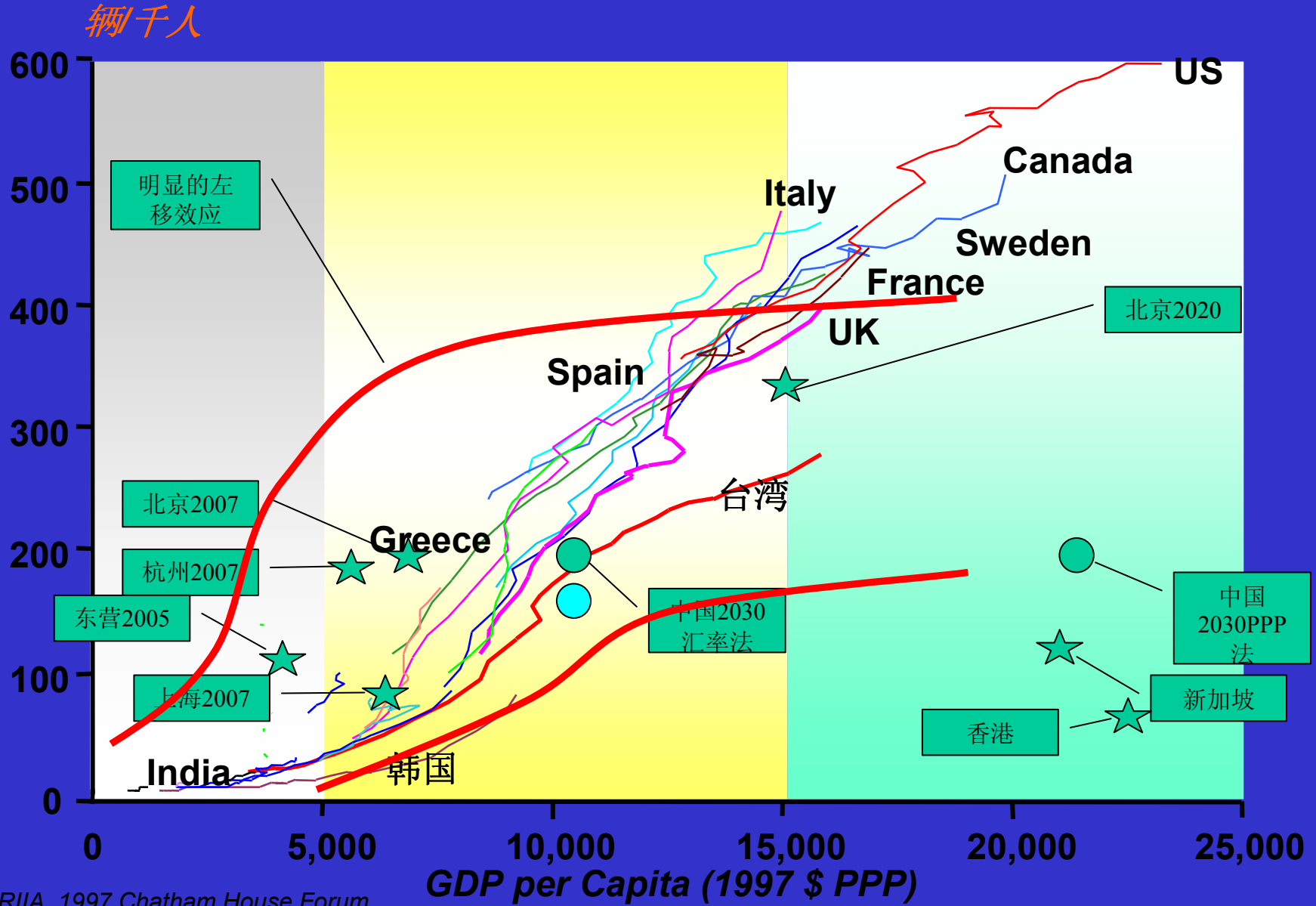
交通模式	子模式	技术	
公路公共交通	地铁		
	公共汽车	普通汽油公交车	
		先进汽油公交车	
		普通柴油公交车	
		先进柴油公交车	
		CNG公交车	
		LPG公交车	
公路个体交通	企业、私人小汽车	普通汽油汽车	
		低能耗汽油汽车	
		柴油汽车	
		先进柴油汽车	
		微型车	
		混合动力汽车	
		燃料电池汽车	
		先进燃料电池汽车	
		电动汽车	
		先进电动汽车	
		超低能耗汽车	
		出租车	LPG出租车
			汽油出租车
			低能耗汽油出租车
	柴油汽车		
先进柴油汽车			

Distribution of Cities in China

Population, million



机动车普及率



Source: RIIA, 1997 Chatham House Forum

Vehicle fleet, BaU, 10000

	2000	2005	2010	2020	2030	2040	2050
Total Vehicle	1609	3160	6836	19538	39672	56372	60524
Passenger	854	2132	4869	16330	35376	50314	53117
Freight	716	1027	1967	3208	4296	6058	7407
Car	670	1919	4589	15970	34866	49594	52217
Family Car	57	1100	3589	14770	33466	47994	50617
Other Car	613	819	1000	1200	1400	1600	1600
Mini-Bus	108	131	162	202	275	374	450
Large Bus	75.3293	82.3080335	117.6	158.4	234.6	345.6	450
Bus	184	214	280	360	510	720	900
Motor Cycle	3771	6582	9947	10942	12036	12036	11434
	0.2	3.0	9	31	67	93	97

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

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 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%

工业部门，主要产品单耗，低碳情景和550PPM情景

产品	单位	2005	2020	2030	2040	2050
钢铁	Kgce/t	760	650	564	554	545
水泥	Kgce/t	132	101	86	81	77
玻璃	Kgce/重量箱	24	18	14.5	13.8	13.1
砖瓦	Kgce/万块	685	466	433	421	408
合成氨	Kgce/t	1645	1328	1189	1141	1096
乙烯	Kgce/t	1092	796	713	693	672
纯碱	Kgce/t	340	310	290	284	279
烧碱	Kgce/t	1410	990	890	868	851
电石	Kgce/t	1482	1304	1215	1201	1193
铜	Kgce/t	1273	1063	931	877	827
铝	kWh/t	14320	12870	12170	11923	11877
造纸	Kgce/t	1047	840	761	721	686
火电	Gce/kWh	350	305	287	274	264

Identify efficiency promised technologies: fully used by 2020

Sector	Technologies
Steel Industry	Large size equipment (Coke Oven, Blast furnace, Basic oxygen furnace ,etc.), Equipment of coke dry quenching, Continuous casting machine, TRT Continuous rolling machine, Equipment of coke oven gas, OH gas and BOF gas recovery , DC-electric arc furnace
Chemical Industry	Large size equipment for Chemical Production, Waste Heat Recover System, Ion membrane technology, Existing Technology Improving
Paper Making	Co-generation System, facilities of residue heat utilization, Black liquor recovery system, Continuous distillation system
Textile	Co-generation System, Shuttleless loom, High Speed Printing and Dyeing
Non-ferrous metal	Reverberator furnace, Waste Heat Recover System, QSL for lead and zinc production
Building Materials	dry process rotary kiln with pre-calciner, Electric power generator with residue heat, Colburn process, Hoffman kiln, Tunnel kiln
Machinery	High speed cutting, Electric-hydraulic hammer, Heat Preservation Furnace
Residential	Cooking by gas, Centralized Space Heating System, Energy Saving Electric Appliance, High Efficient Lighting
Service	Centralized Space Heating System, Centralized Cooling Heating System, Co-generation System, Energy Saving Electric Appliance, High Efficient Lighting
Transport	Diesel truck, Low Energy Use Car, Electric Car, Natural Gas Car, Electric Railway Locomotives
Common Use Technology	High Efficiency Boiler, FCB Technology, High Efficiency Electric Motor Speed Adjustable Motor, Centrifugal Electric Fun, Energy Saving Lighting

IPCC Range

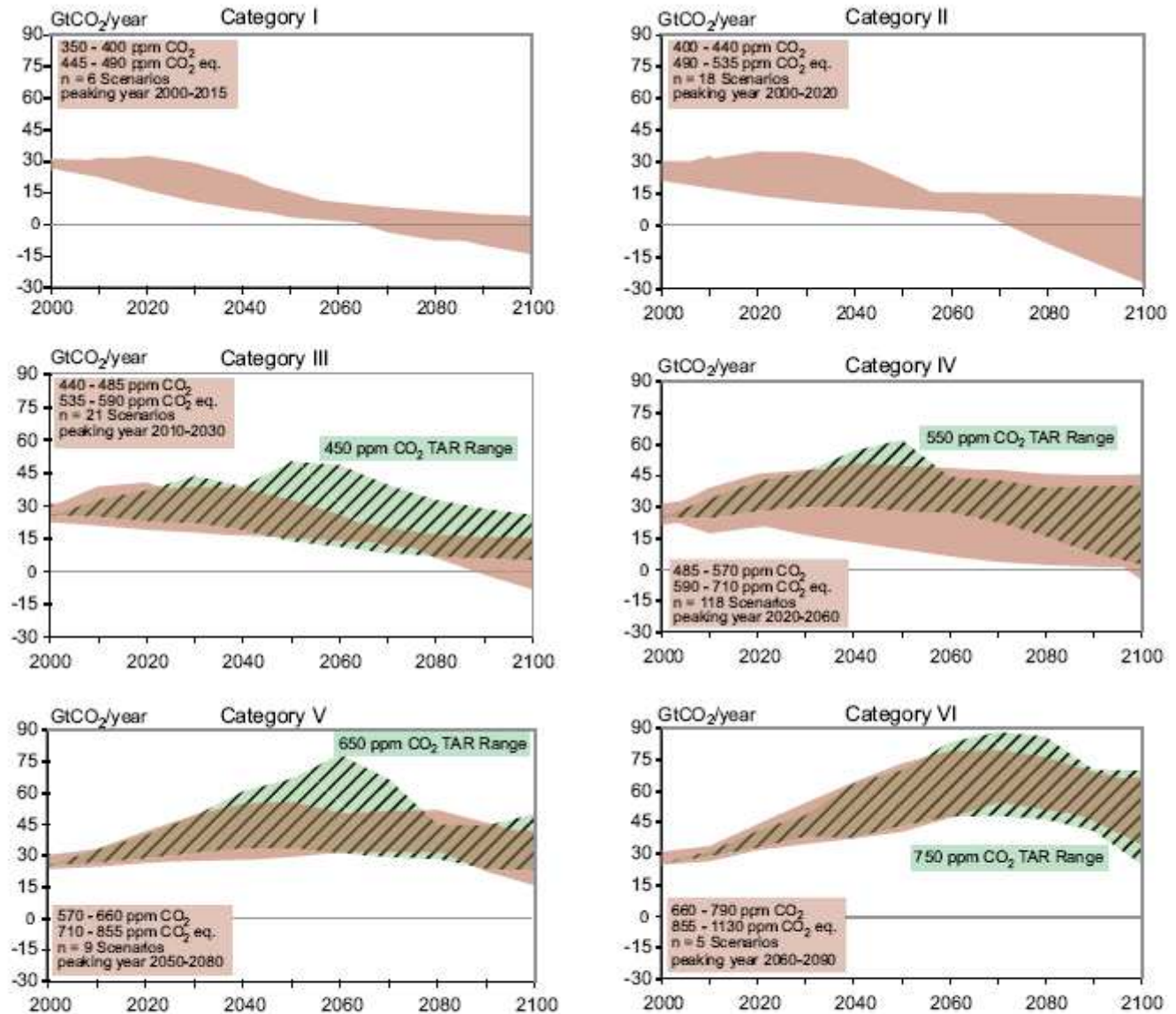
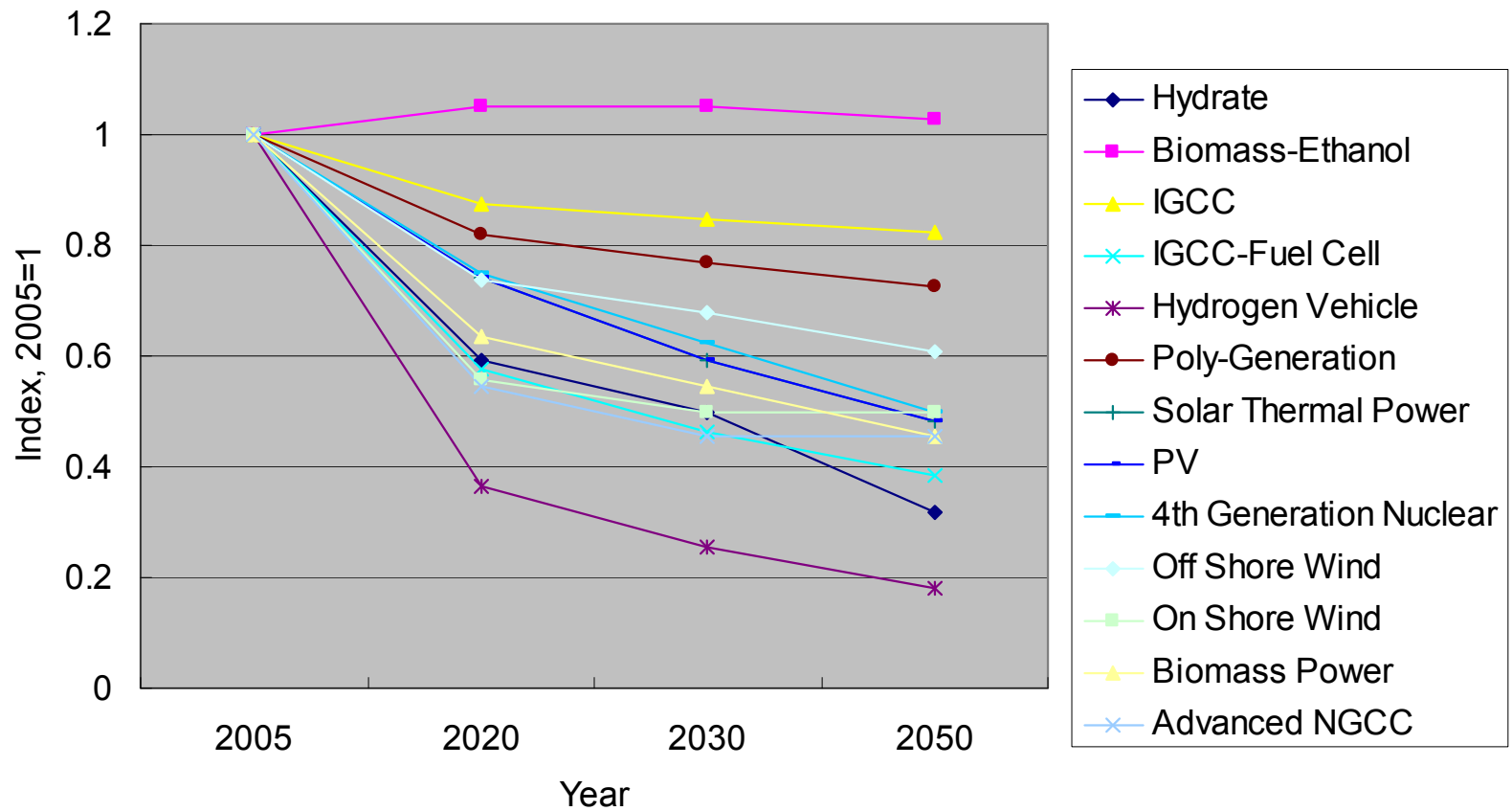
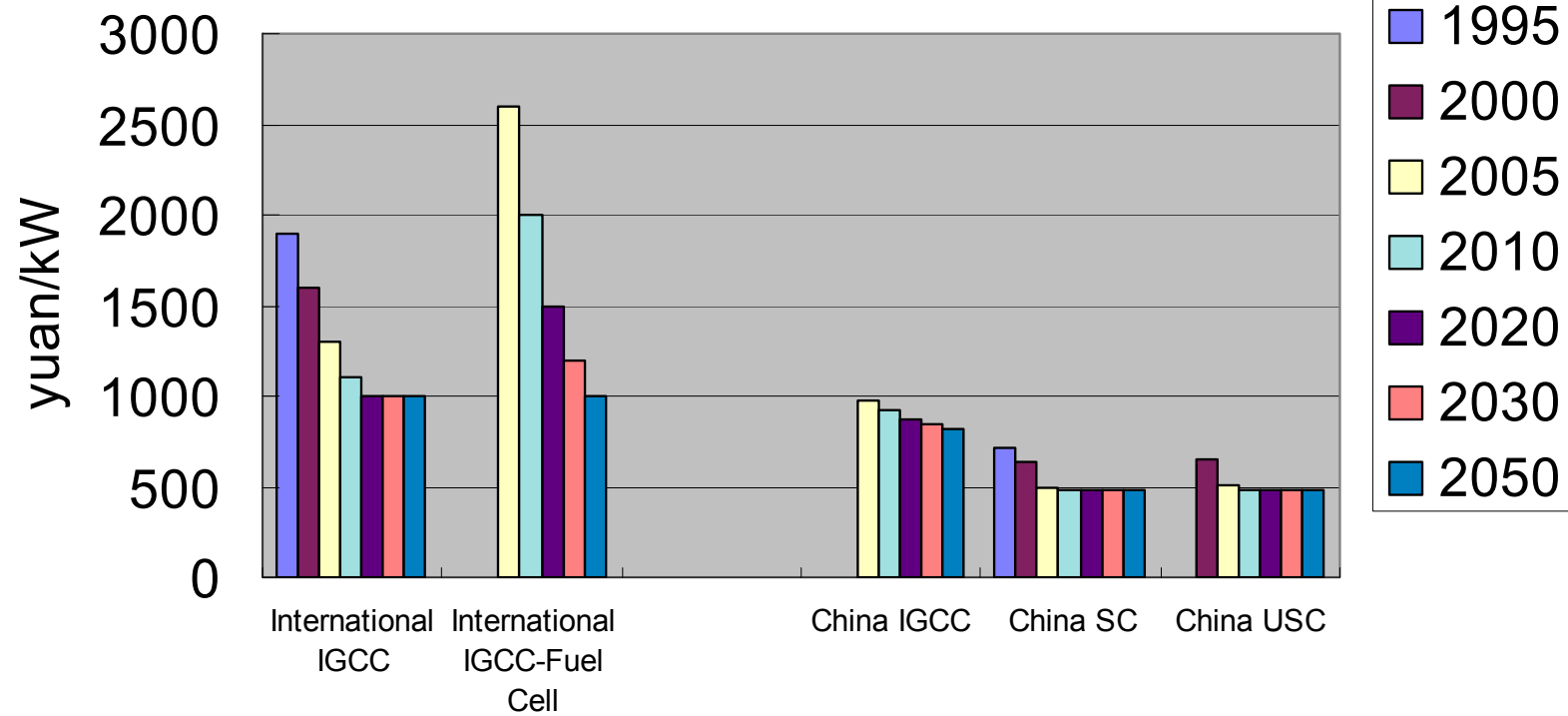


Figure SPM.7: Emissions pathways of mitigation scenarios for alternative categories of stabilization levels (Category I to VI as defined in the box in each panel). The pathways are for CO₂ emissions only. Light brown shaded areas give the CO₂ emissions for the post-TAR emissions scenarios. Green shaded and hatched areas depict the range of more than 80 TAR stabilization scenarios. Base year emissions may differ between models due to differences in sector and industry coverage. To reach the lower stabilization levels some scenarios deploy removal of CO₂ from the atmosphere (negative emissions) using technologies such as biomass energy production utilizing carbon capture and storage. [Figure 3.17]

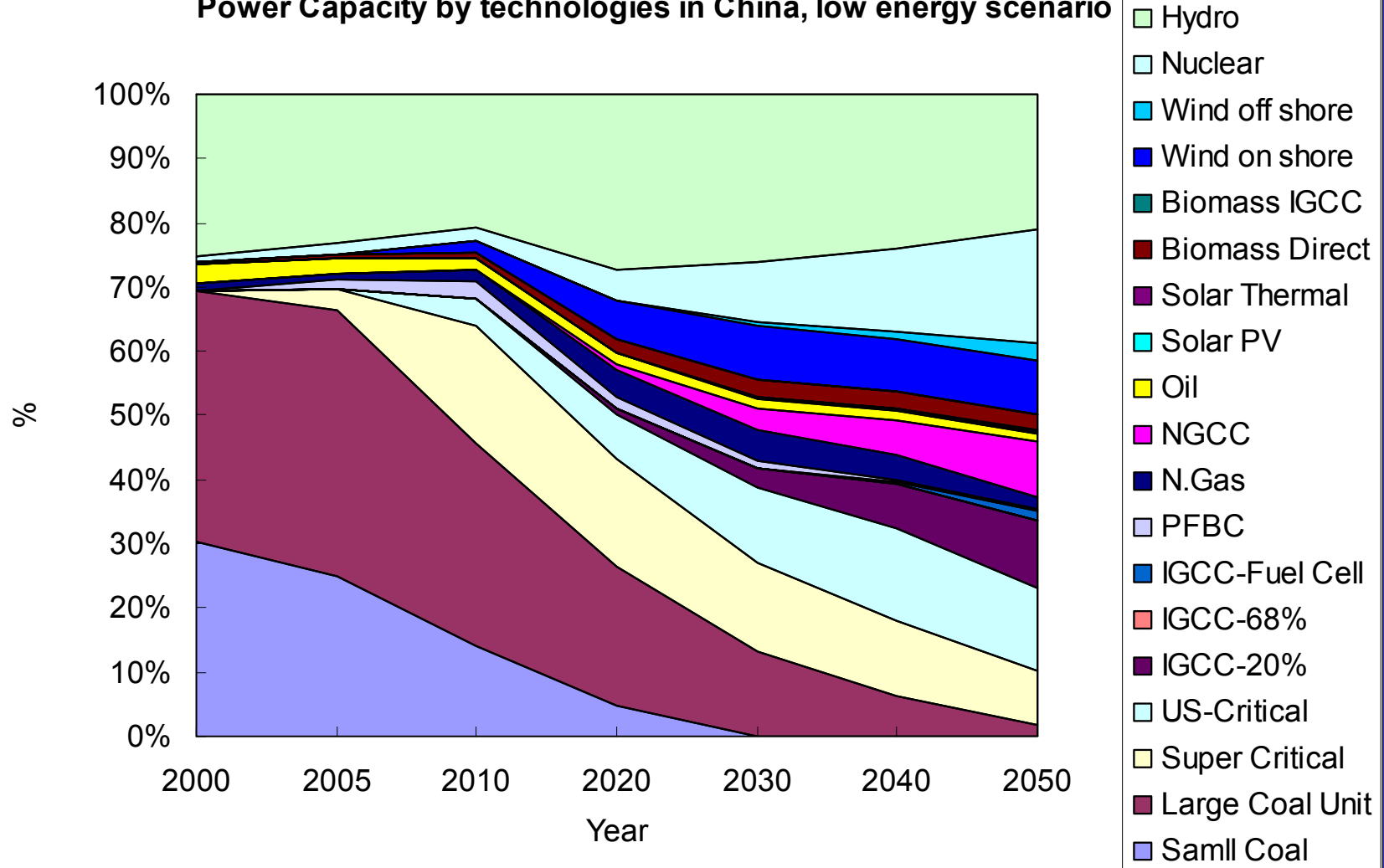
Technology learning curve



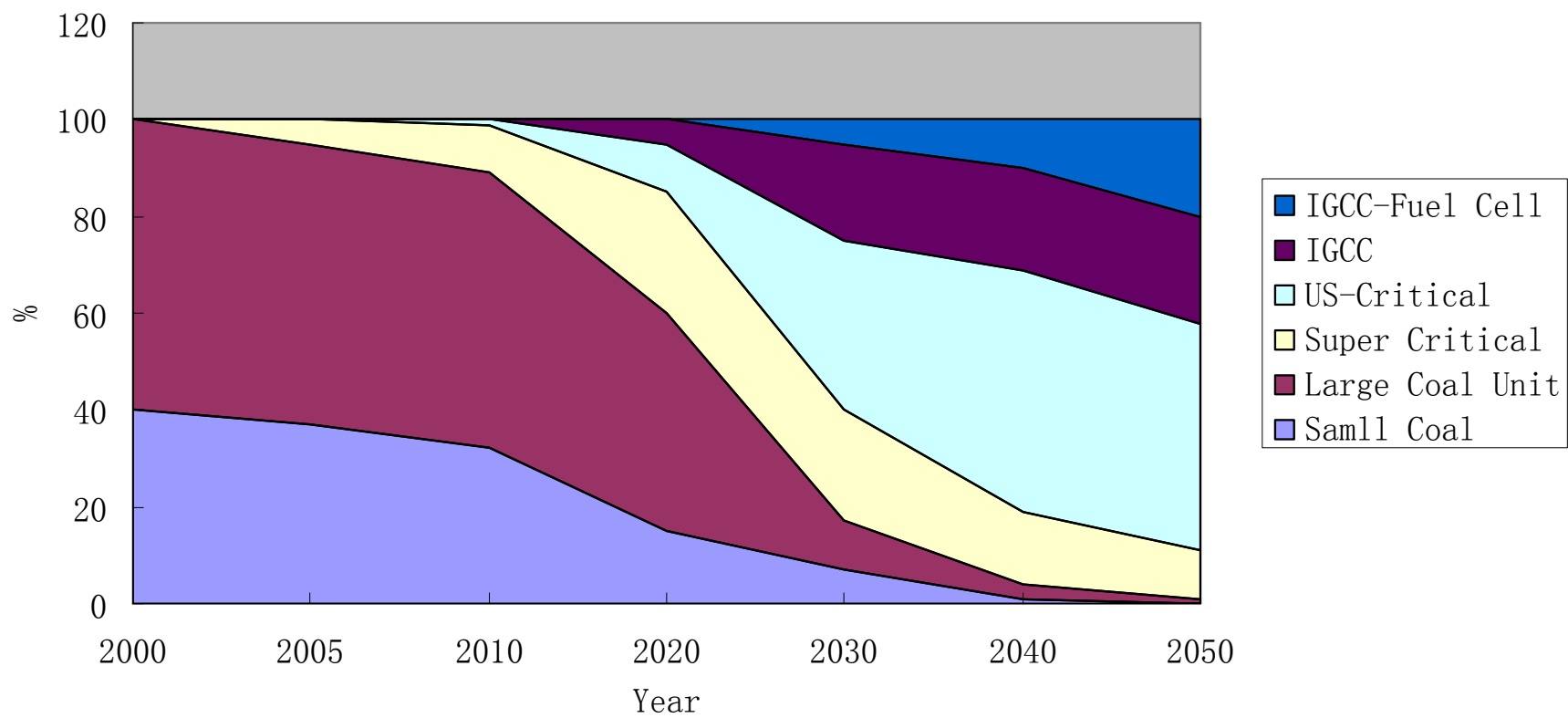
Fixed Unit Investment



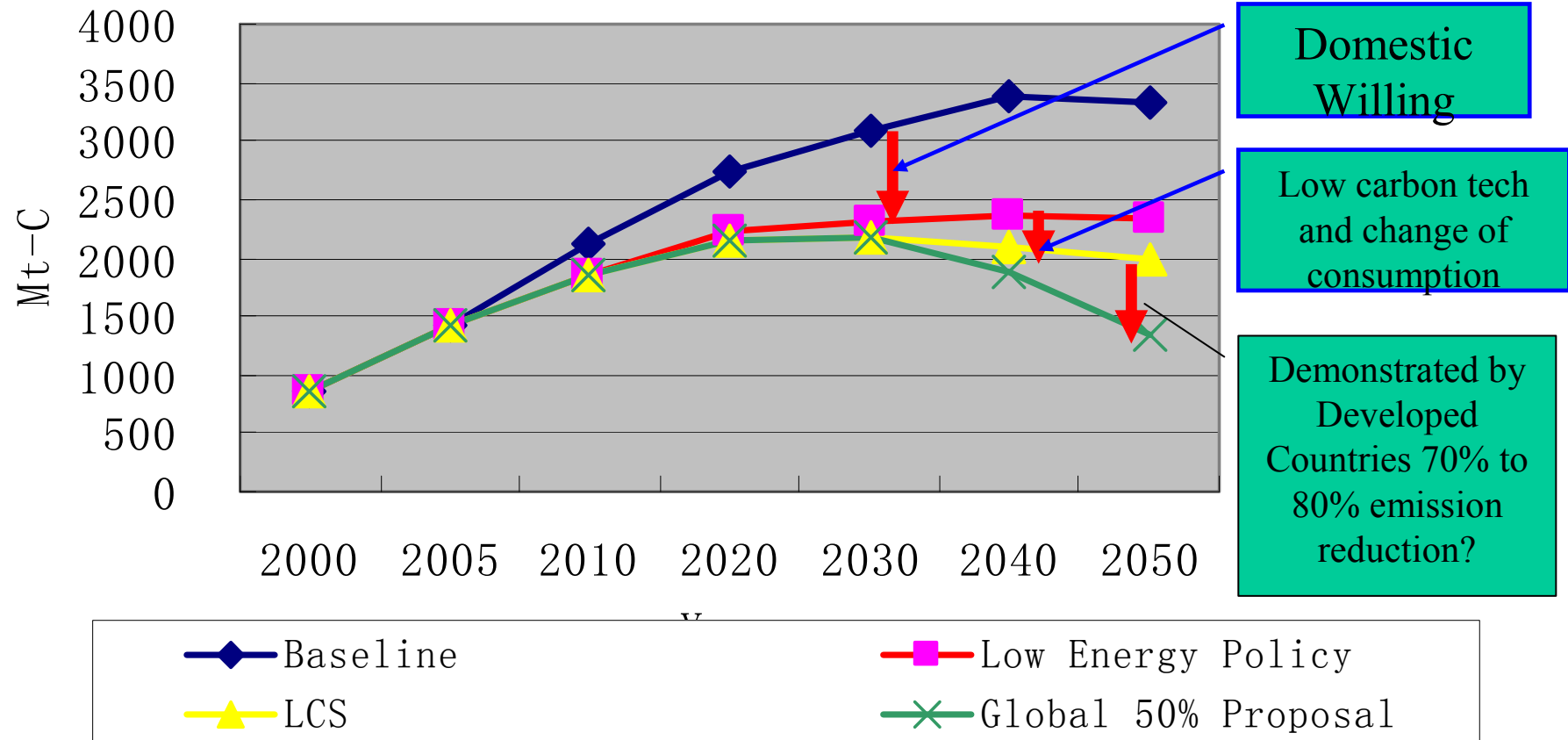
Power Capacity by technologies in China, low energy scenario



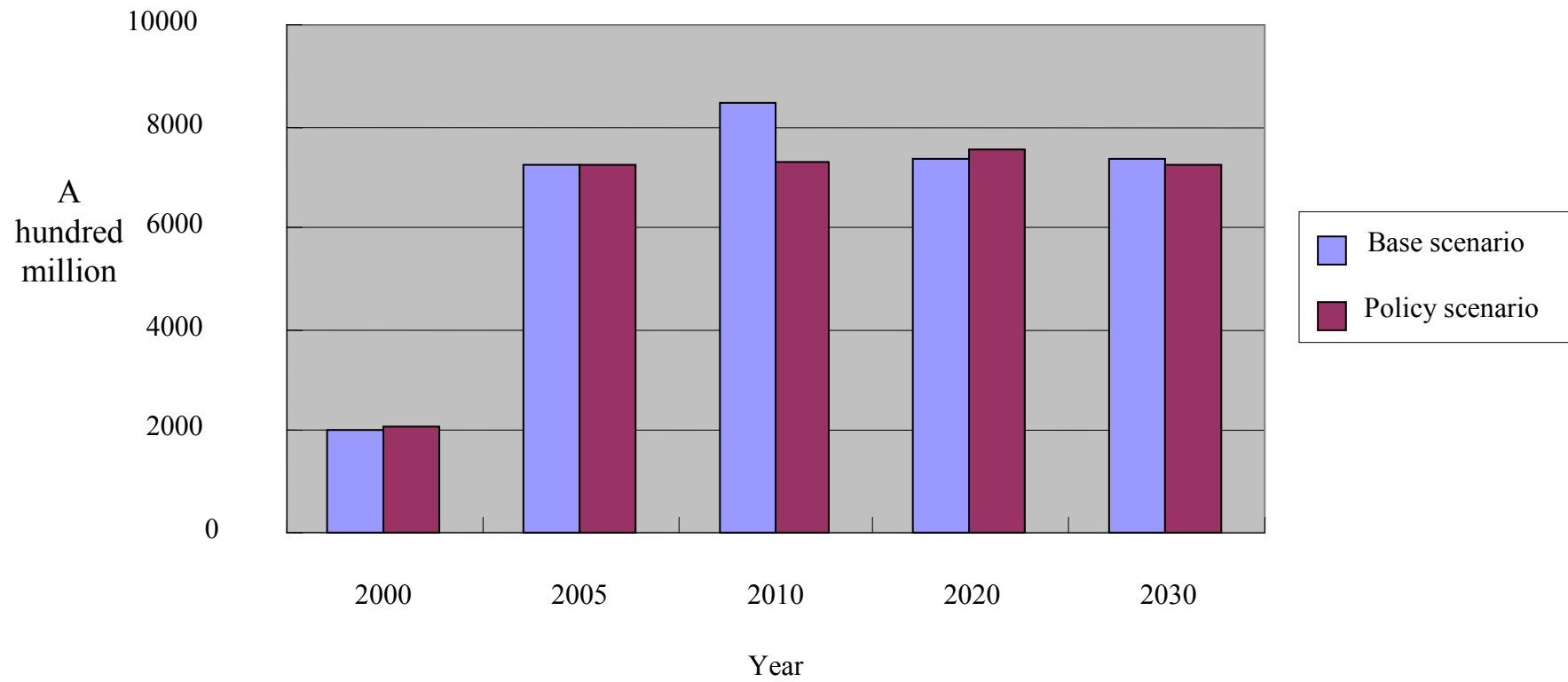
CCS future



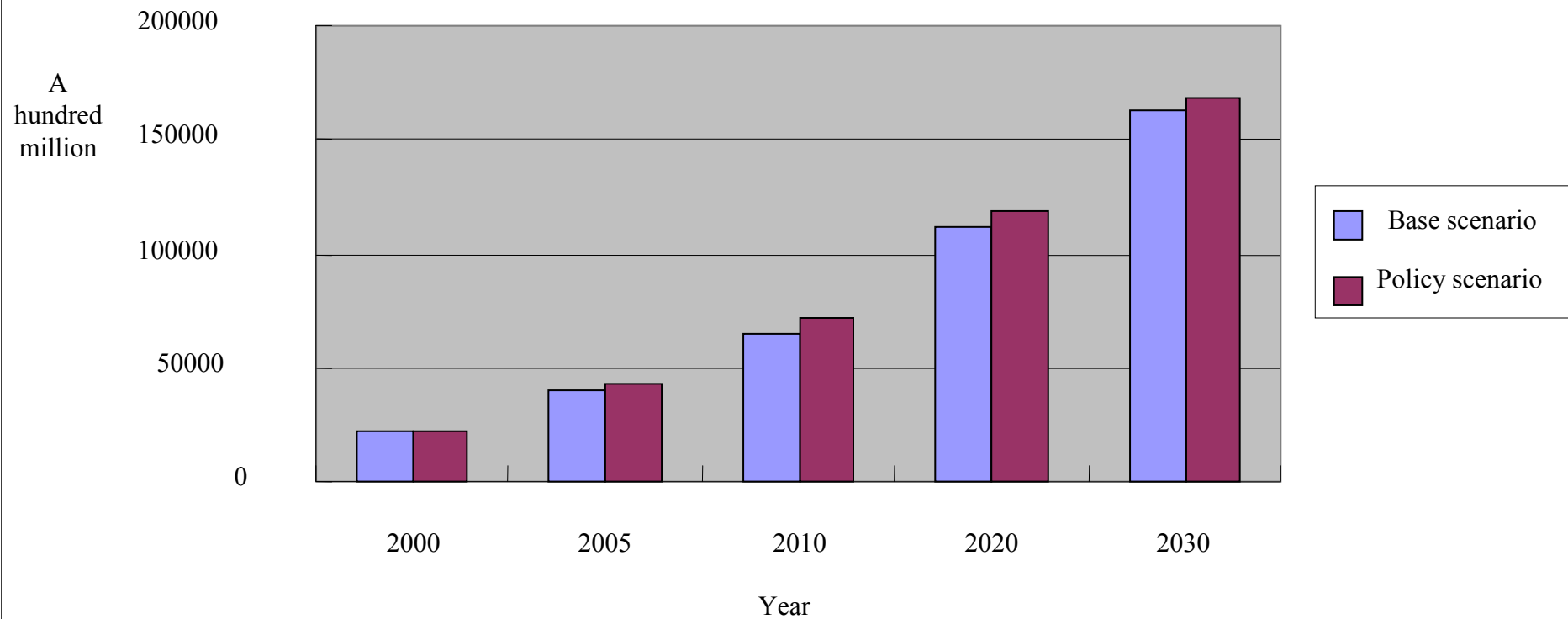
CO2 Emission from Energy Activities in China, IPAC Results



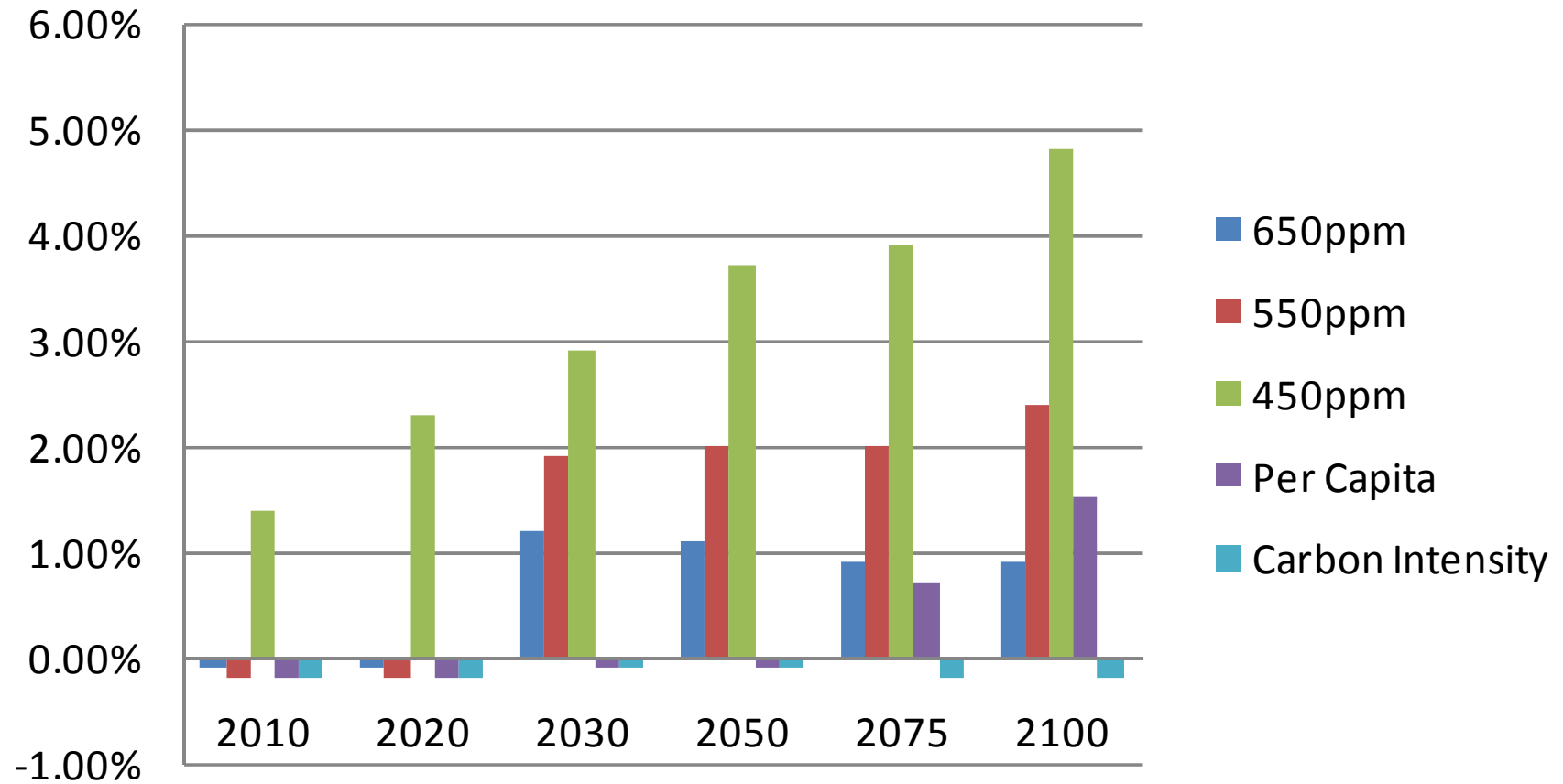
Investment Demand of Energy Industry



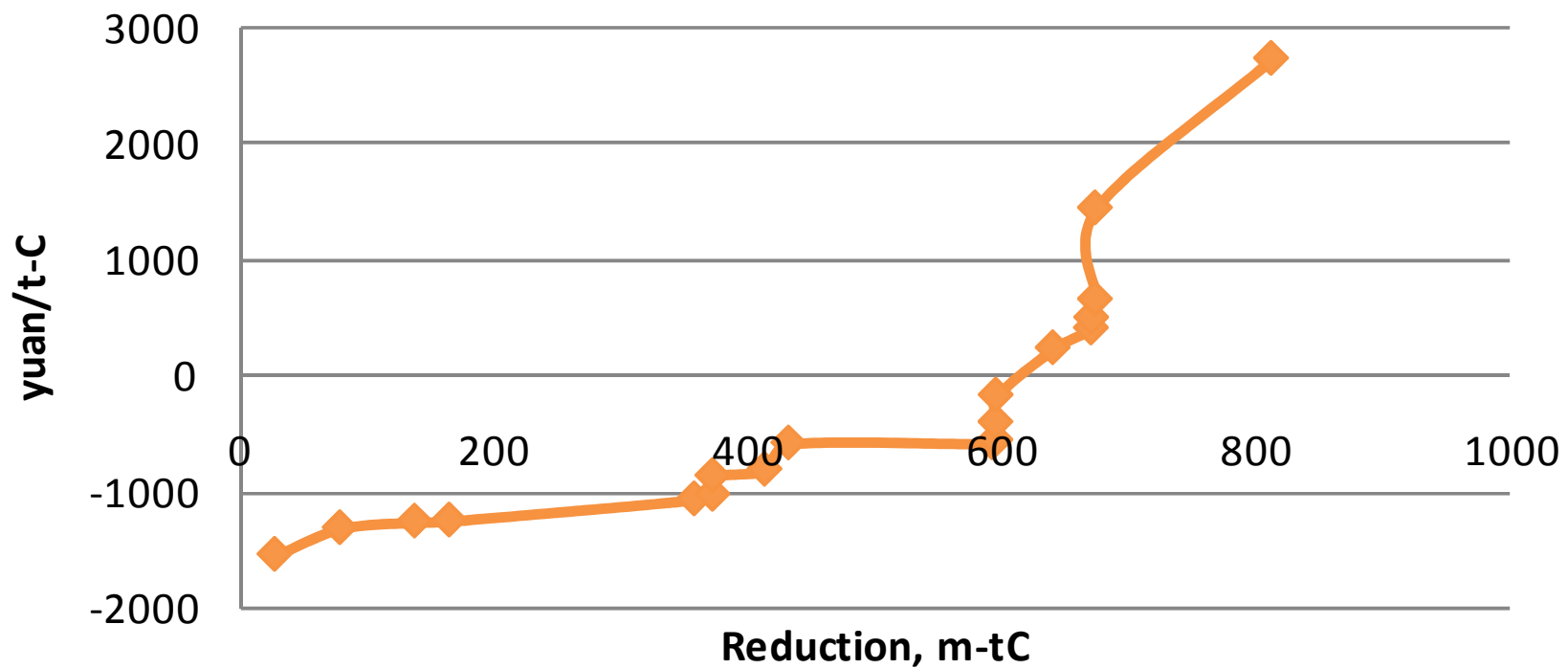
National Energy Expenses



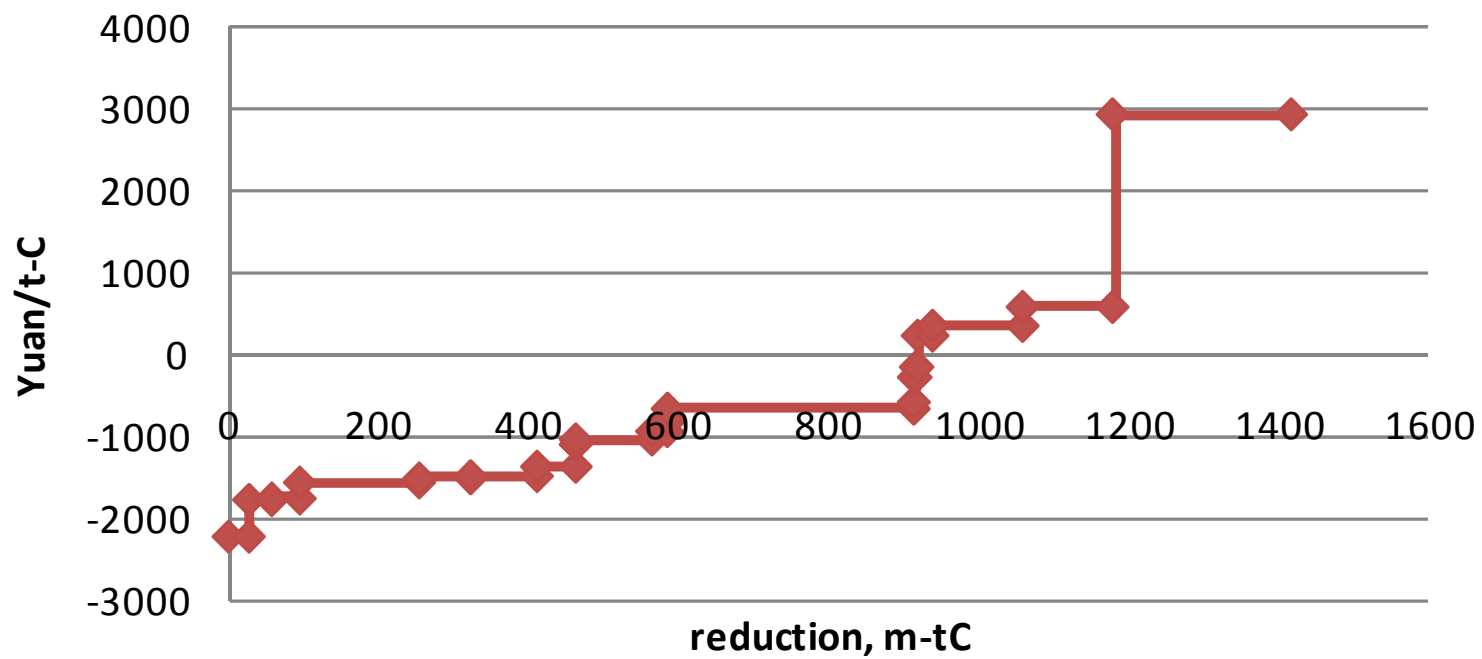
GDP Loss, %



Cost curve for power generation in China, 2030



Cost curve in power generation in China, 2050



基准情景与低碳情景的对比

技术	效率	2030年比例		2050年比例		说明
		基准情景	低碳情景	基准情景	低碳情景	
先进焦炉	11900Mcal/吨焦炭， 产气1340Mcal	58%	50%	77%	42%	完全国产化
新一代焦炉	1030Mcal/吨焦炭， 产气1420Mcal	17%	47%	23%	58%	
干熄焦	回收2.4Mcal/吨焦	80%	100%	90%	100%	国产化， 具有较好的市场普及潜力
国际先进烧结炉	390Mcal/吨烧结块， 节能42%	45%	85%	67%	90%	有待国产化
国际先进高炉	3750Mcal/吨铁水， 节能21%	40%	65%	64%	87%	
高炉气回收/TRT	回收热/电0.7Mcal/吨铁水	44%	70%	85%	100%	
连铸连轧	节能86%	90%	98%	85%	95%	
大型转炉（富氧、负压）	170Mcal/吨钢水，节能23%	34%	30%	60%	0%	
先进转炉（富氧、负压、转炉气回收）	218Mcal/吨钢水，回收286Mcal/吨钢水	37%	70%	40%	100%	
热装热送	节能44%	70%	95%	95%	100%	
水泥新型干法+余热回收	102公斤标煤/吨熟料	75%	100%	90%	100%	
铜先进熔融炉	0.5tce/吨	75%	100%	90%	100%	
氧化铝先进节能技术	节能8%	85%	100%	95%	100%	
铅锌冶炼新技术(SKS)	0.379tce/吨，节能21%	80%	100%	93%	100%	
大型合成氨	8500Mcal/吨，最先进6926Mcal/吨	70%	96%	85%	100%	
烧碱离子膜	3744Mcal/吨，节能34%	80%	98%	95%	100%	
乙烯原料和高效换热塔	6517Mcal/吨，节能38%	66%	95%	83%	100%	
RDH，连续蒸煮		80%	100%	95%	100%	

基准情景与低碳情景的对比

技术	效率	2030年比例		2050年比例		说明
		基准情景	低碳情景	基准情景	低碳情景	
节能建筑	节能50%	20%	30%	34%	20%	
	节能65%	16%	25%	25%	40%	
	节能75%	4%	15%	10%	30%	
节能冰箱	节能65%	85%	100%	100%	100%	
交流变频空调	节能30%	65%	20%	30%	0%	
直流变频空调	节能50%	15%	60%	45%	70%	
超级空调	节能75%	0%	20%	20%	30%	COP > 7
紧凑型节能灯	节能80%	80%	95%	90%	97%	
节能洗衣机	节能30%	80%	100%	100%	100%	
节能电器	节能40%	65%	95%	100%	100%	
太阳能热水器		9%	15%	30%	45%	
室内用能方式		少用能120 公斤标煤/ 户	少用能210 公斤标煤/ 户	少用能220 公斤标煤/ 户	少用能390 公斤标煤/ 户	
LPG/天然气灶	效率51%					
节能LPG/天然气灶	效率58%					
低能耗汽车	5.4升/百公里	56%	45%	50%	10%	
混合动力汽车	4.3升/百公里	20%	35%	40%	55%	
超高燃油经济性汽车	3升以下/百公里	0%	10%	8%	20%	
公共汽车	人公里能耗为小汽车的1/6左右					
地铁	人公里能耗为小汽车的1/22左右					
电动自行车	百公里耗电1.2 kWh					
超临界/超超临界发电	效率42%					
IGCC/多联产	效率45%，2030 54%		3%		25%	

政策选择

	基准情景	节约优先情景	550PPM情景
燃油税	2008年起实施	2008年起实施, 2020年提高到4-5元/升	同低碳情景
能源税		2012-2014年开始实施,以后逐步提高	同低碳情景
节能标准		明显提高, 产品准入。考虑采取日本先进技术作为标杆的方式, 逐步停止落后技术的生产; 同时也采用目前欧盟和加拿大的方式, 对一些产品的停止生产提出时间表(如白炽灯)	同低碳情景
出口税	遏制高耗能产品出	明显遏制高耗能产品出口	同低碳情景
节能投入		国家投入明显加大	同低碳情景
节能监管		成为日常工作	同低碳情景
国家投资政策		国家投入可持续发展建设, 城市基础设施, 地铁, 以及其他(教育、医疗、农村发展建设)。引导社会投资进入高附加值和低能耗行业。会明显对经济结构调整产生影响。	同低碳情景
国家投资引导政策		民间资本流向高附加值行业。	同低碳情景
可再生能源政策		国家规划和电价补贴	同低碳情景
地区发展政策		发达地区全面改变发展理念, 以日本和欧洲的环境发展为目标	同低碳情景
消费方式引导政策		公众购买低耗能 and 低排放产品, 从而影响市场和企业行为。如购买节能电器, 少使用塑料袋, 出行方式选择, 少使用一次性产品, 购买当地食品(减少交通能耗)	同低碳情景
循环经济政策		回收、再利用、减量化	同低碳情景
CCS		2020年开始	2015年开始进入实际操作
碳税		2020年开始	2015年开始
碳贸易		2020年开始	2015年开始
低碳合作		2010年	2010年
减排承诺			2020年开始承诺2030年的目标

工业部门，主要产品单耗，低碳情景和550PPM情景

产品	单位	2005	2020	2030	2040	2050
钢铁	Kgce/t	760	650	564	554	545
水泥	Kgce/t	132	101	86	81	77
玻璃	Kgce/重量箱	24	18	14.5	13.8	13.1
砖瓦	Kgce/万块	685	466	433	421	408
合成氨	Kgce/t	1645	1328	1189	1141	1096
乙烯	Kgce/t	1092	796	713	693	672
纯碱	Kgce/t	340	310	290	284	279
烧碱	Kgce/t	1410	990	890	868	851
电石	Kgce/t	1482	1304	1215	1201	1193
铜	Kgce/t	1273	1063	931	877	827
铝	kWh/t	14320	12870	12170	11923	11877
造纸	Kgce/t	1047	840	761	721	686
火电	Gce/kWh	350	305	287	274	264