2014 **"Toward More integrated Northeast Asia Energy Cooperation"**:
Korea-China-Japan Joint Energy Conference

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中国电力网络发展及东北亚电力网络展望

Prospect on Chinese Power Network Development and Power network in Northeast Asia

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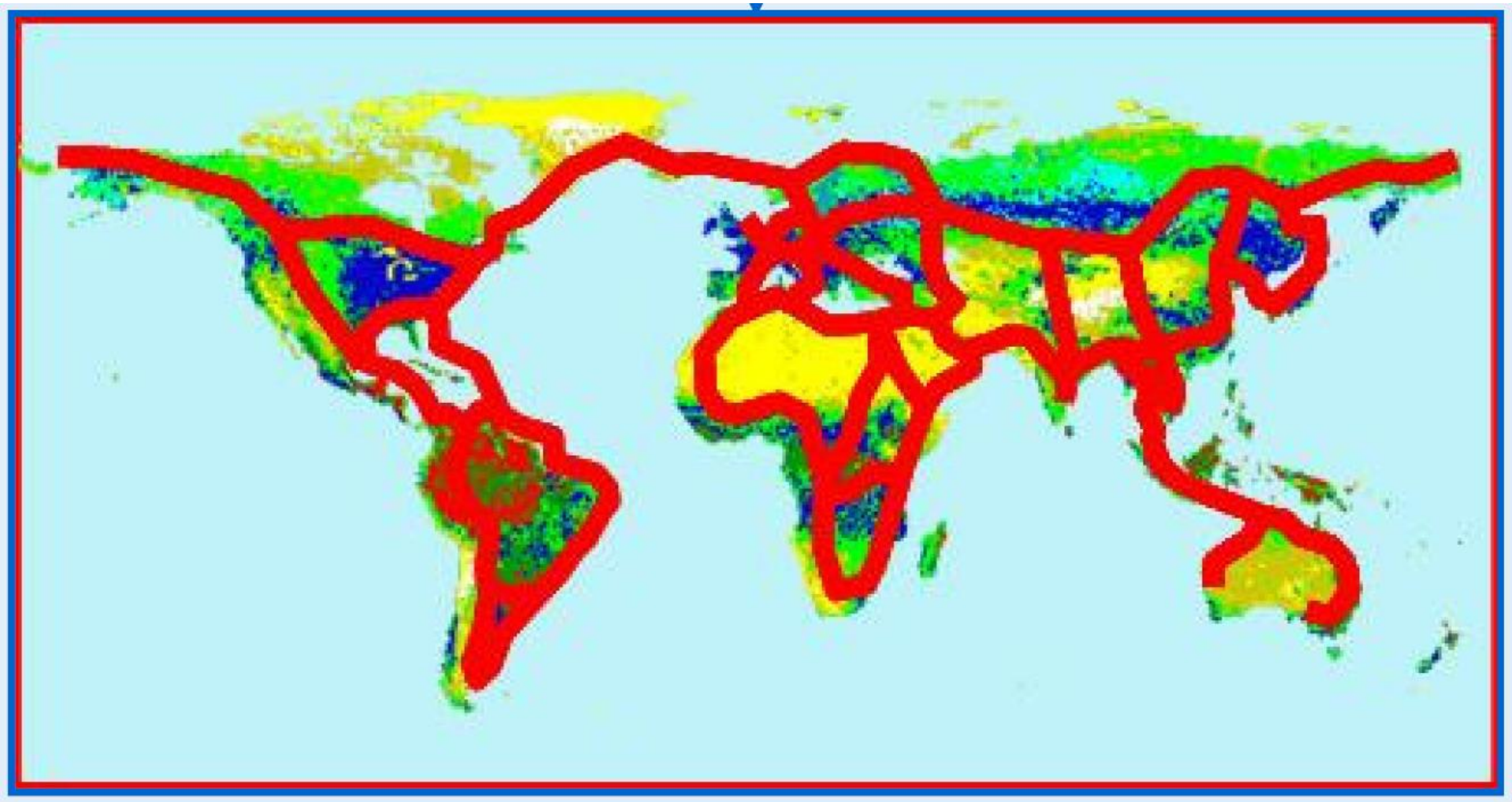
Center for Renewable Energy Development
Energy Research Institute of NDRC, China
Sep. 25, 2014

科学论证是实现雄心壮志的基础条件——中国案例
Scientific demonstration is a basic condition for achieving ambitious - Chinese Case



IEA全球同步电网设想

IEA Global Synchronous Grid Vision

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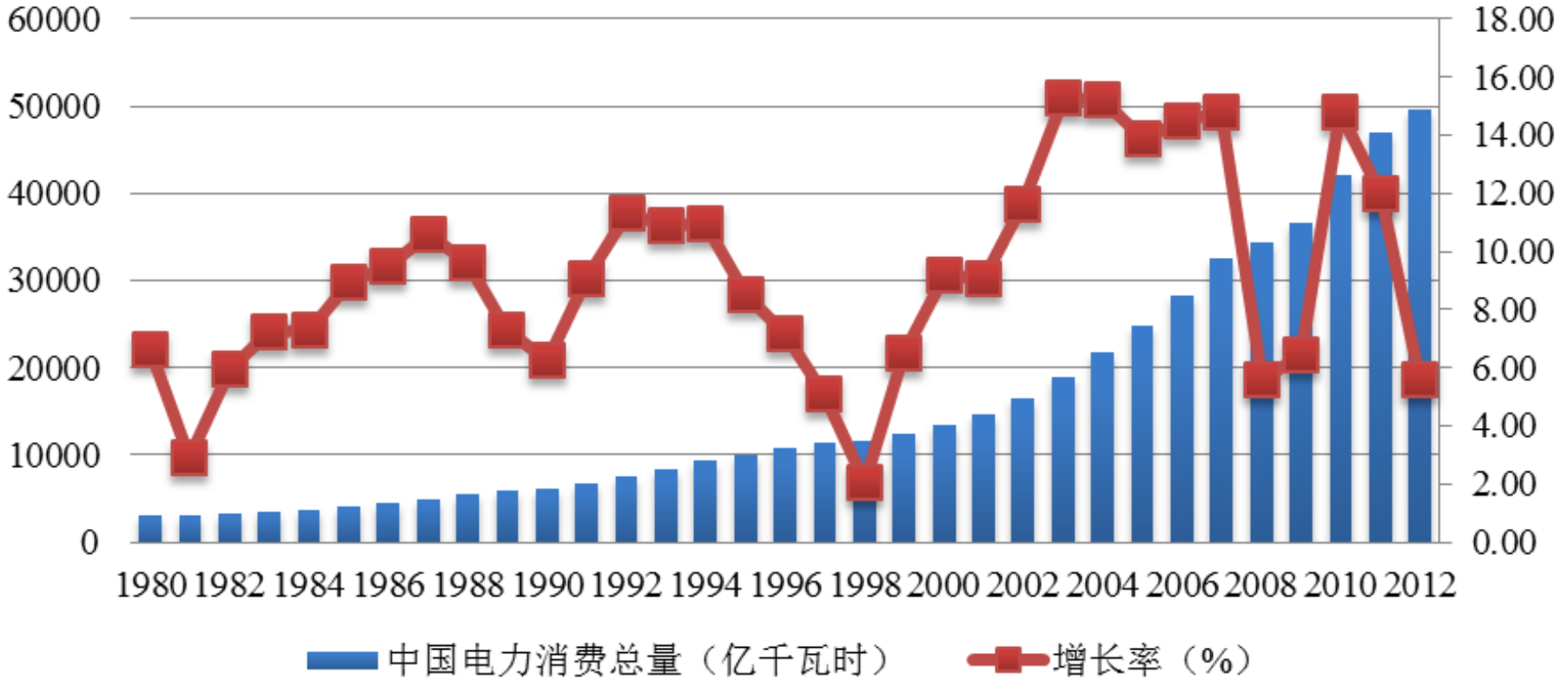
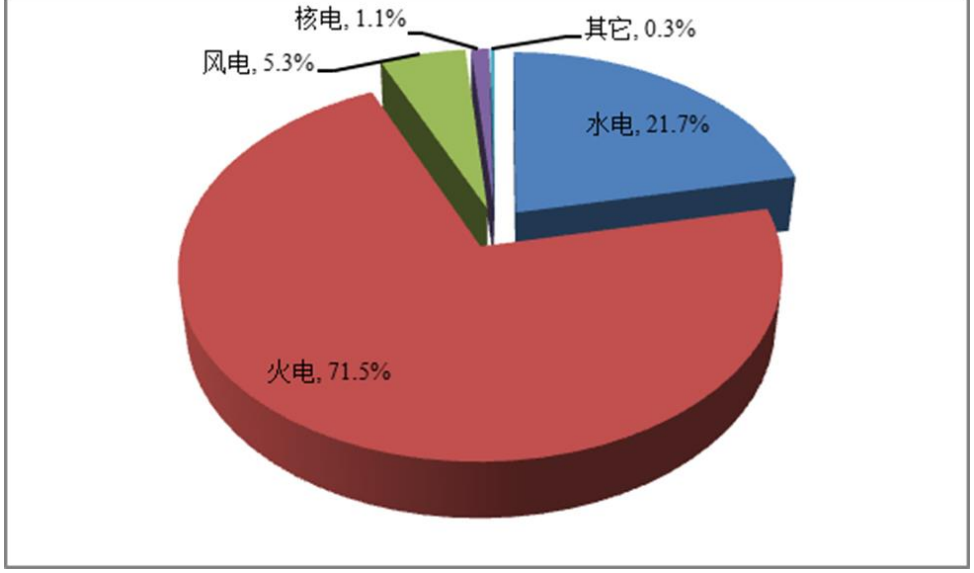
中国电力系统发展现状
Development of Chinese Power System

国家发展和改革委员会能源研究所

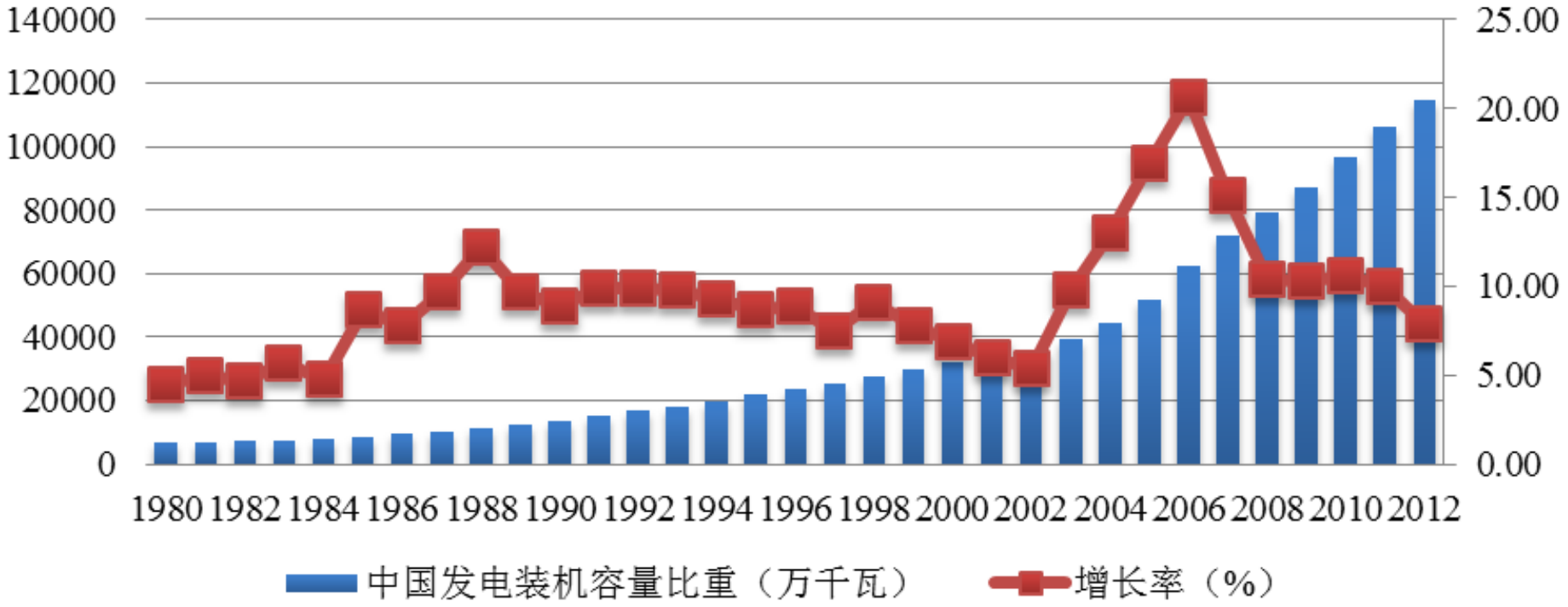
Energy Research Institute National Development and Reform Commission



Chinese total annual electricity consumption and growth 1980-2012



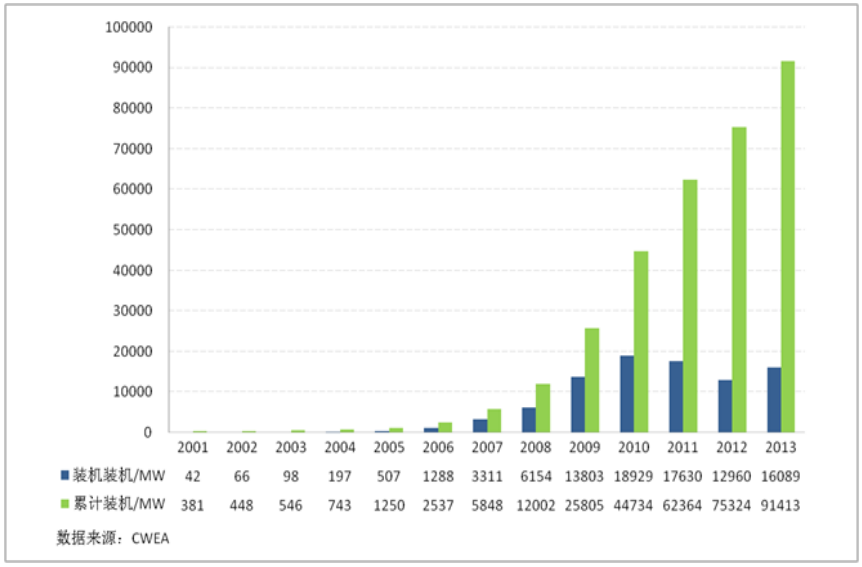
National Power installed structure 2012
2012年全国电源装机结构



中国1980-2012年电力装机容量及增速
Chinese installed capacity and annual growth rate 1980-2012

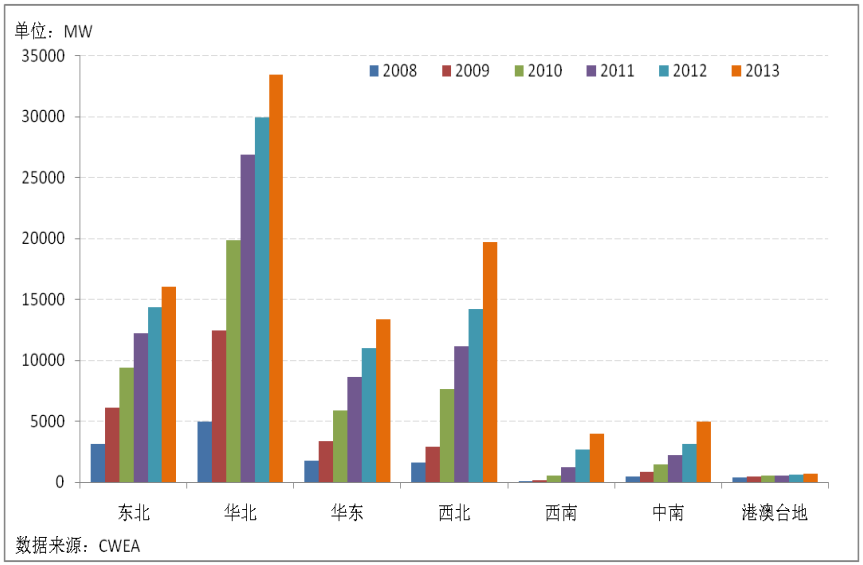
跨区互联及电力流现状

Interconnection and cross-flow status quo



2001-2013年中国新增及累计风电装机容量

2001-2013 new install and cumulative installed wind power capacity



风电分地区装机容量

Sub-regional capacity

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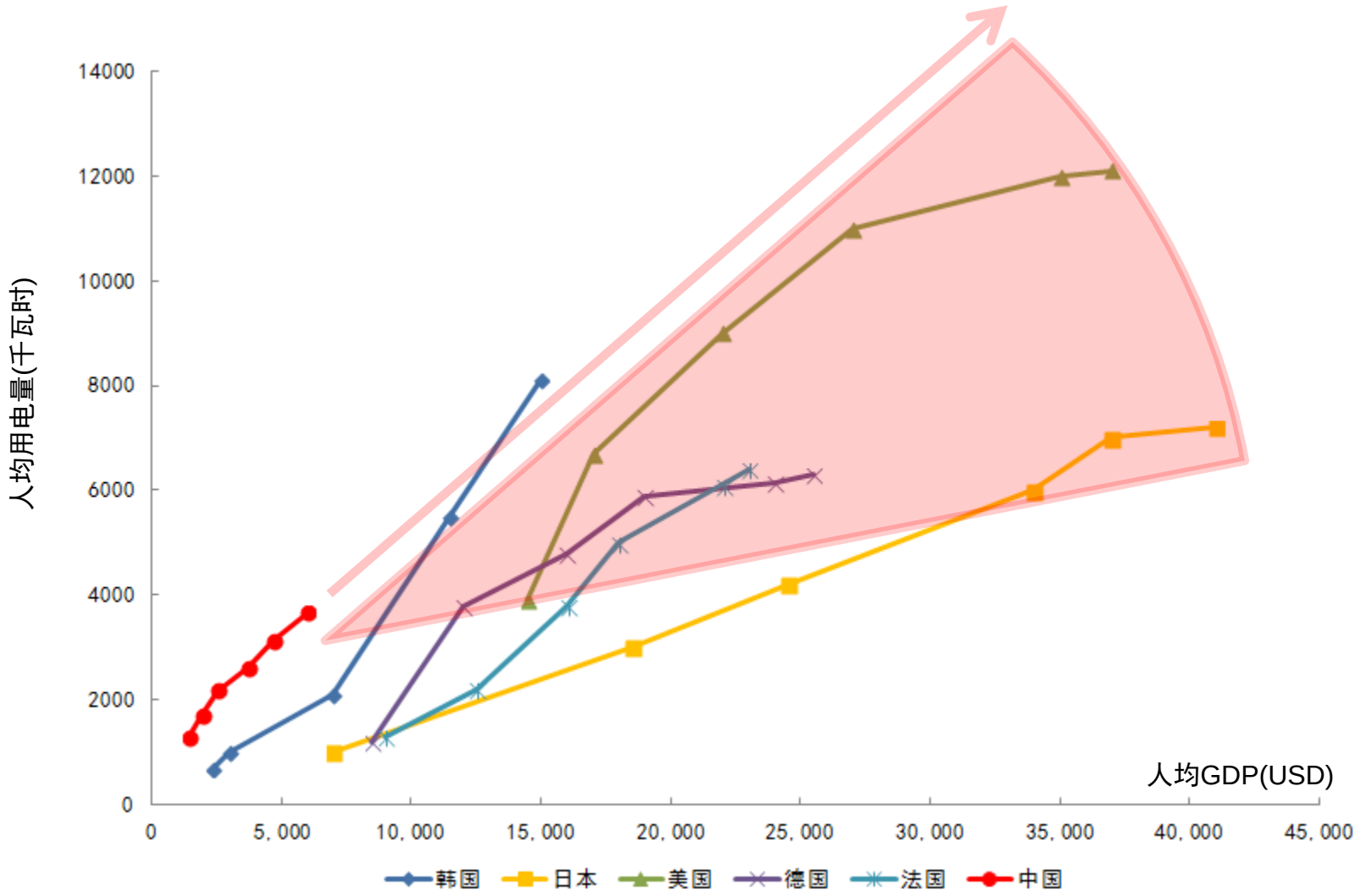
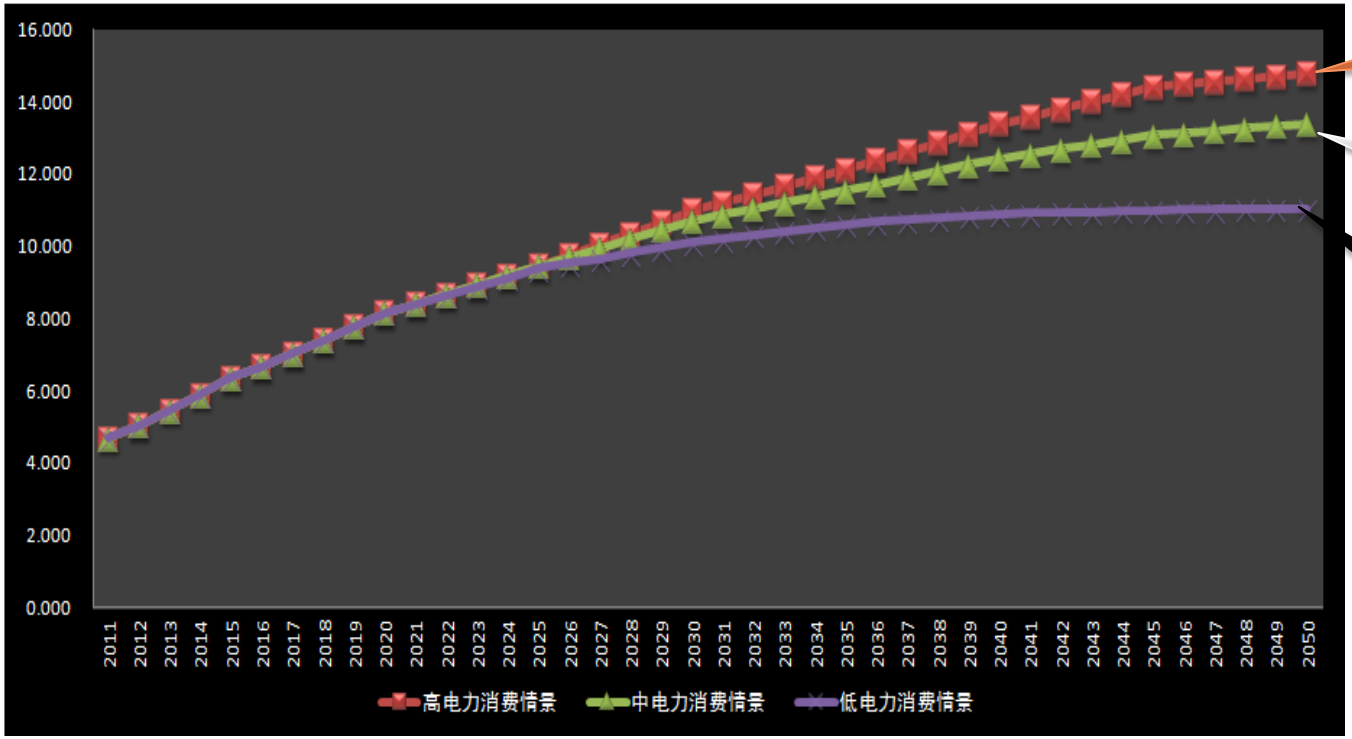
中国电力需求趋势
Chinese power demand trends

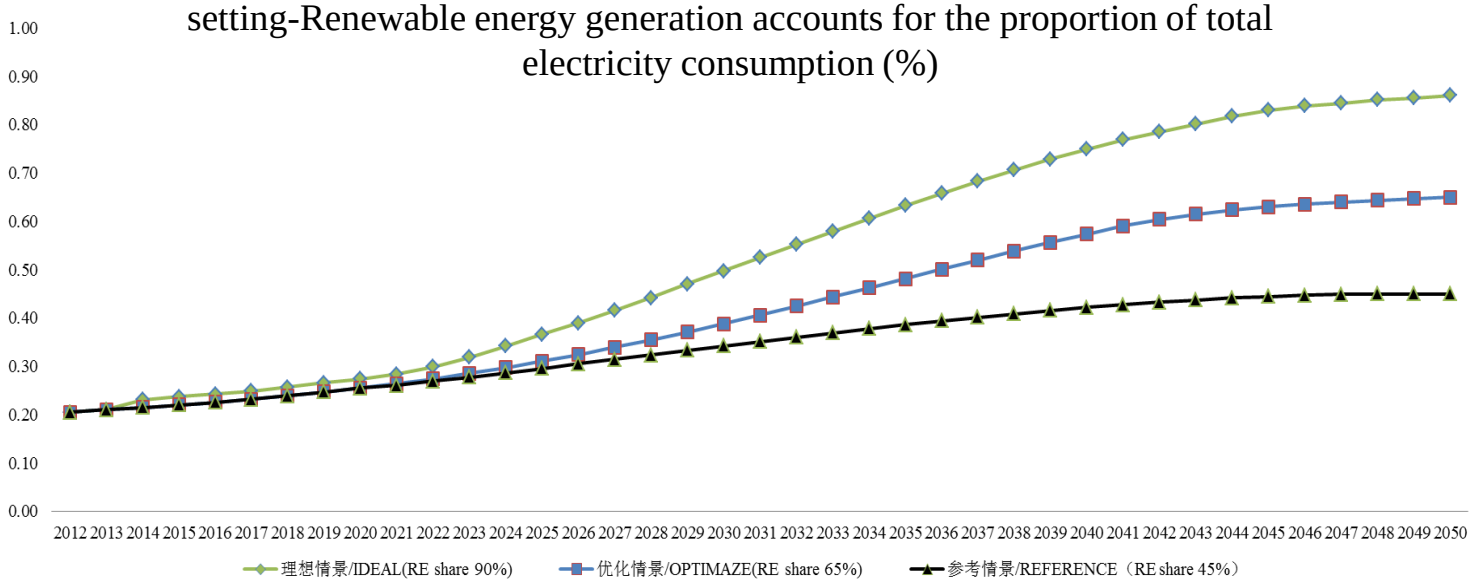
Per capita electricity consumption is an important indicator to judge a country's stage of economic development.



Per capita GDP and Per capital electricity trend



情景设定——可再生能源发电量占全社会用电量比例（%）Scenario setting-Renewable energy generation accounts for the proportion of total electricity consumption (%)



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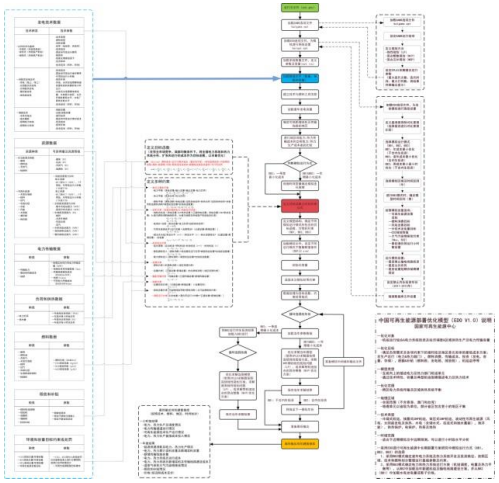
电力系统发展展望—中国案例
Chinese Power System Development Outlook

国家发展和改革委员会能源研究所
Energy Research Institute National Development and Reform Commission

研究方法——为什么要对电力发展情景建模
Why build a model for analysis power system development trends



- 需要对中国电力系统发展的潜在影响进行评估
- Need assessment on the potential impact on the development of the power system

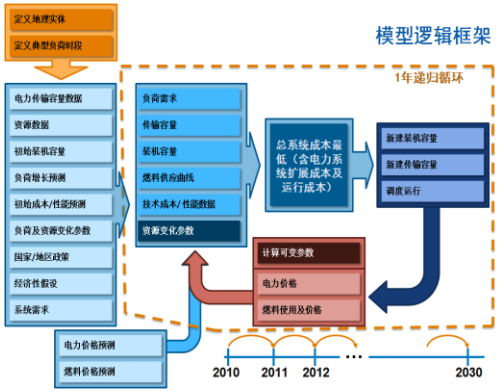
涉及到2010年至2050年电力生产、运输和使用方式作出不同的假设、设置，要分析不同情景或方案，确定不同地区各情景下的总成本和发展特点。

Related to the 2010 to 2050 power production, transport and use make different assumptions, settings, to analyze the different scenarios or scheme, determine the total cost of different area under different scenarios and development characteristics.

- EDO（Electricity Deployment Optimization ）模型原理

1、一个复杂的工具软件/ A complex software

2、通过小时尺度平衡供需条件的简单设定，对中国电力发电和输电扩容和使用情况进行仿真模拟。/ By simply setting for hours level, balance of supply and demand, do the simulation on China‘s power generation and transmission expansion.

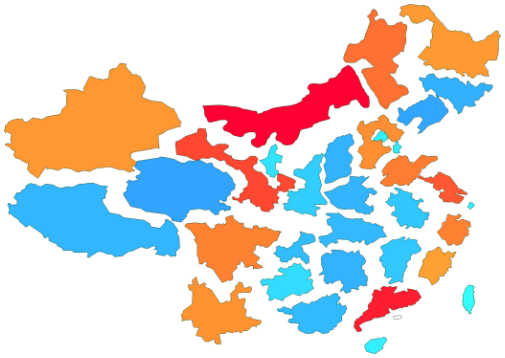


- 评价标准/Evaluation criterion

1、技术可行性：资源是否充足？商业化成熟技术是否存在？规定的比例是否实现？运行约束是否满足？/technical feasibility: enough resource? Commercial? The designed proportion is realized or not? Operation constraints?

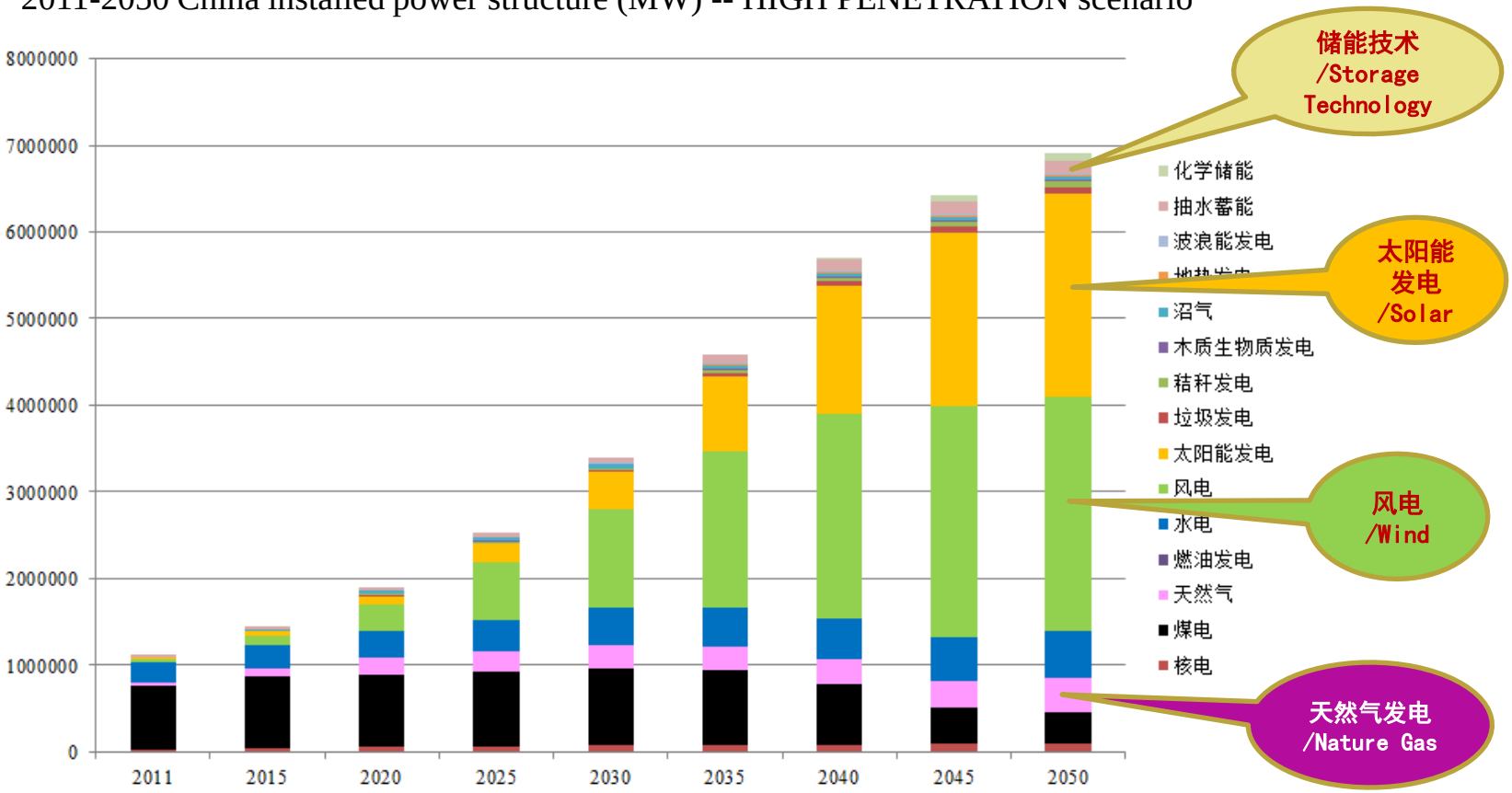
2、经济性：测算全系统建设运行维护成本，并将“成本”作为优化目标/ economy：calculate the whole system operation cost, and “cost” is the target of optimum

3、环境影响：是否满足环境约束/ Enviroment influence



2011-2050年 中国电源装机结构情况（兆瓦）——高比例情景

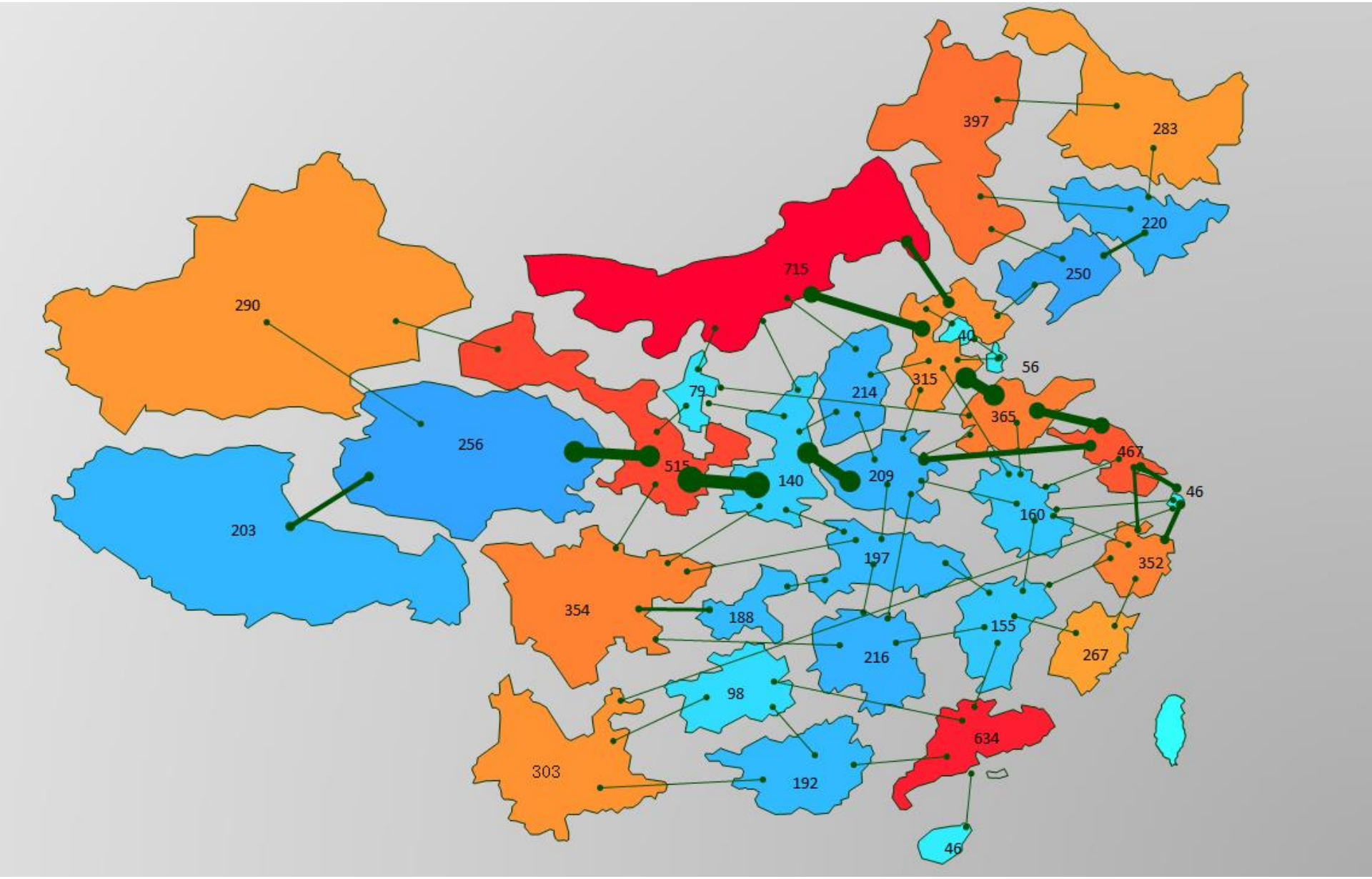
2011-2050 China installed power structure (MW) -- HIGH PENETRATION scenario



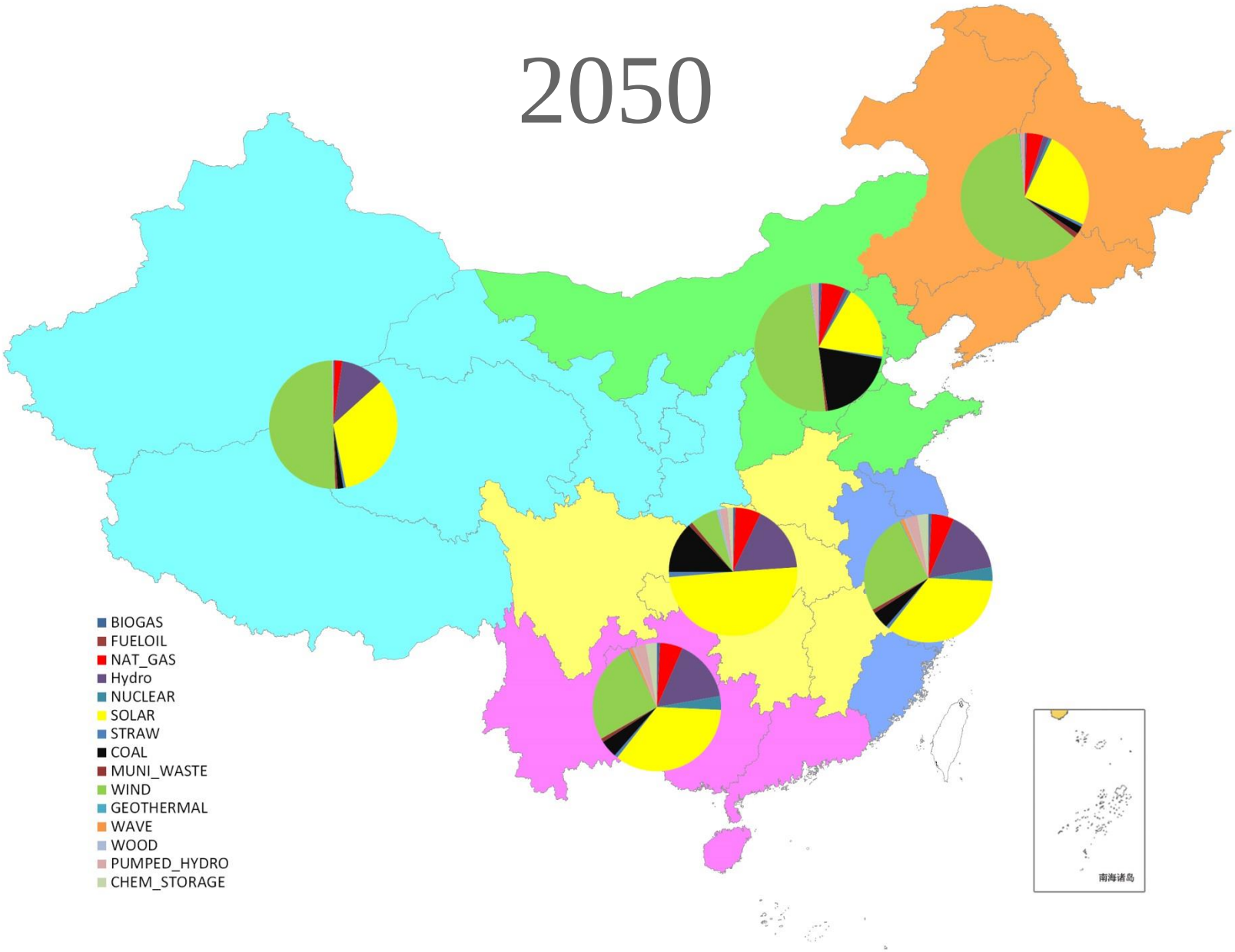
	核电	煤电	天然气	燃油发电	水电	风电	太阳能发电	垃圾发电	秸秆发电	木质生物质发电	沼气	地热发电	波浪能发电	抽水蓄能	化学储能
2011	12570	749062	32649	1224	230670	48350	3763	2011	3402		382			29608	
2015	42790	821961	93632	1166	267099	116806	42025	5040	6797	1100	17602			29876	
2020	50500	844082	186051	1139	313973	293989	107025	8400	11250	1980	39306	1255		41325	
2025	64000	866208	218088	1098	372363	672072	204244	12574	15573	3221	39306	9678		42717	
2030	66000	900860	256510	1012	430752	1151375	421618	18900	24435	4955	39306	11250	9994	57382	
2035	69000	872734	276204	862	450800	1793396	870340	33484	38345	12867	39304	11250	20000	89459	
2040	78000	703145	284305	493	471881	2368742	1465978	54215	50110	13746	37634	11250	20000	125860	24647
2045	85000	421982	299161	108	512000	2668553	1998647	72544	58084	23445	39306	11250	20000	138062	82614
2050	100000	355319	388048	15	554140	2698274	2343238	80857	61063	26280	39306	11250	20000	141170	98857

2050年中国电源装机和跨地区输电能力（GW）——高比例情景

2050 Chinese power installed capacity and inter-regional transmission capacity (GW) - High proportion scenarios

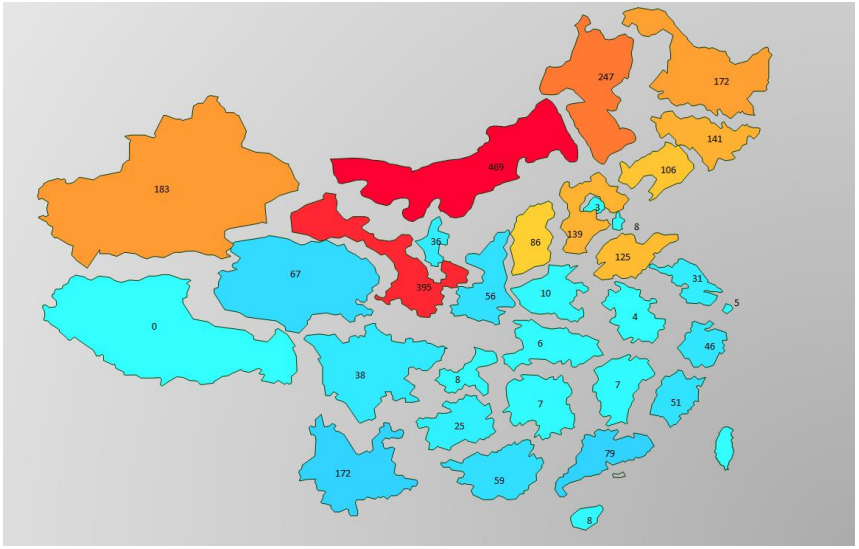


中国电源装机结构——高比例情景
Power installed structure - High proportion scenarios

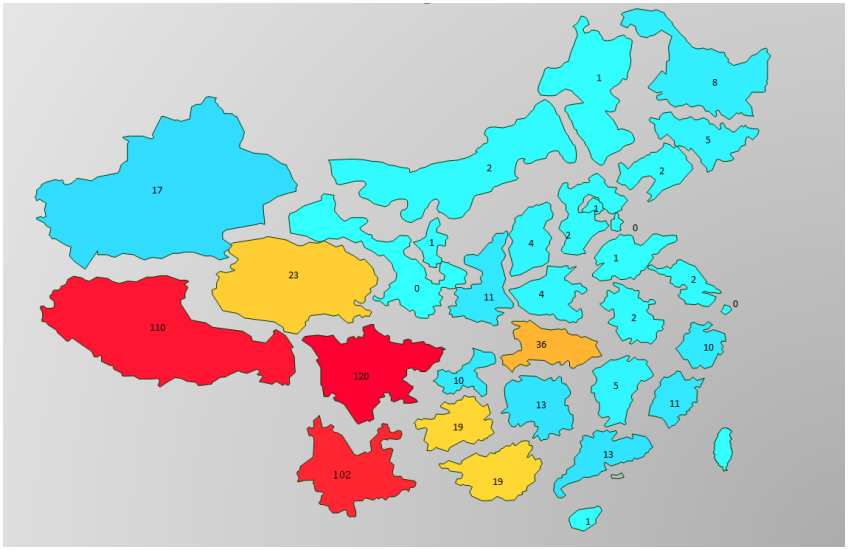


2050年可再生能源技术发展布局

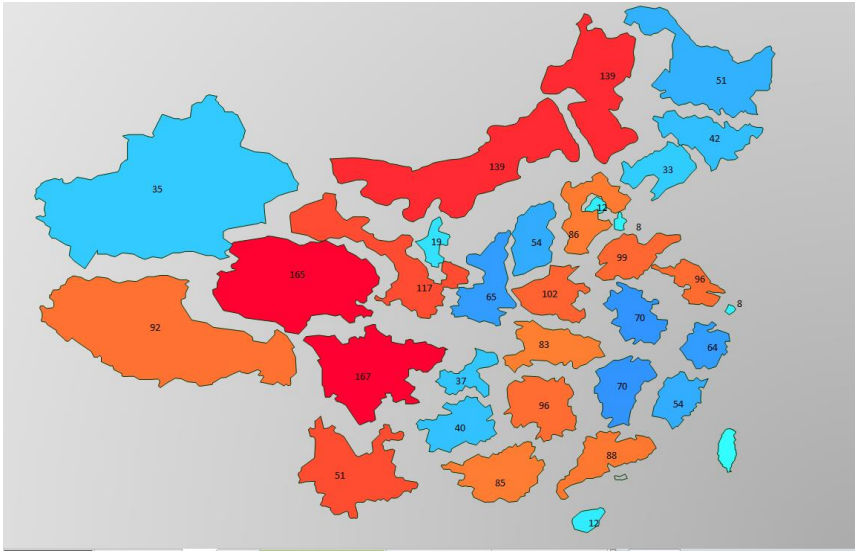
2050 layout of renewable energy technologies development



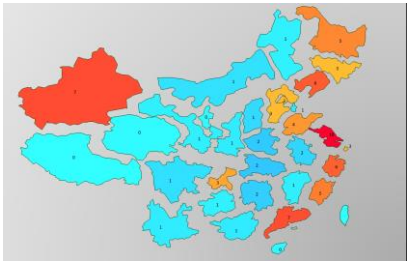
2050年风电发展布局/Wind



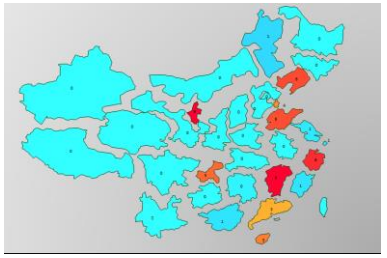
2050年水电发展布局/Hydro



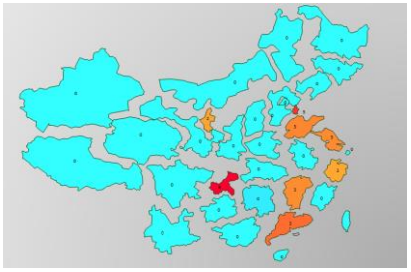
2050年太阳能发电发展布局/Solar



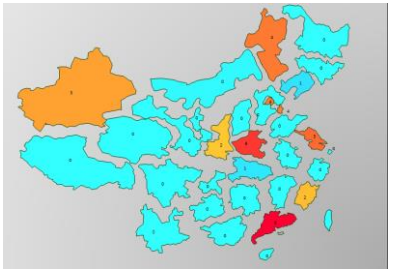
2050年垃圾发电发展布局/Waste



2050年秸秆发电发展布局/Straw

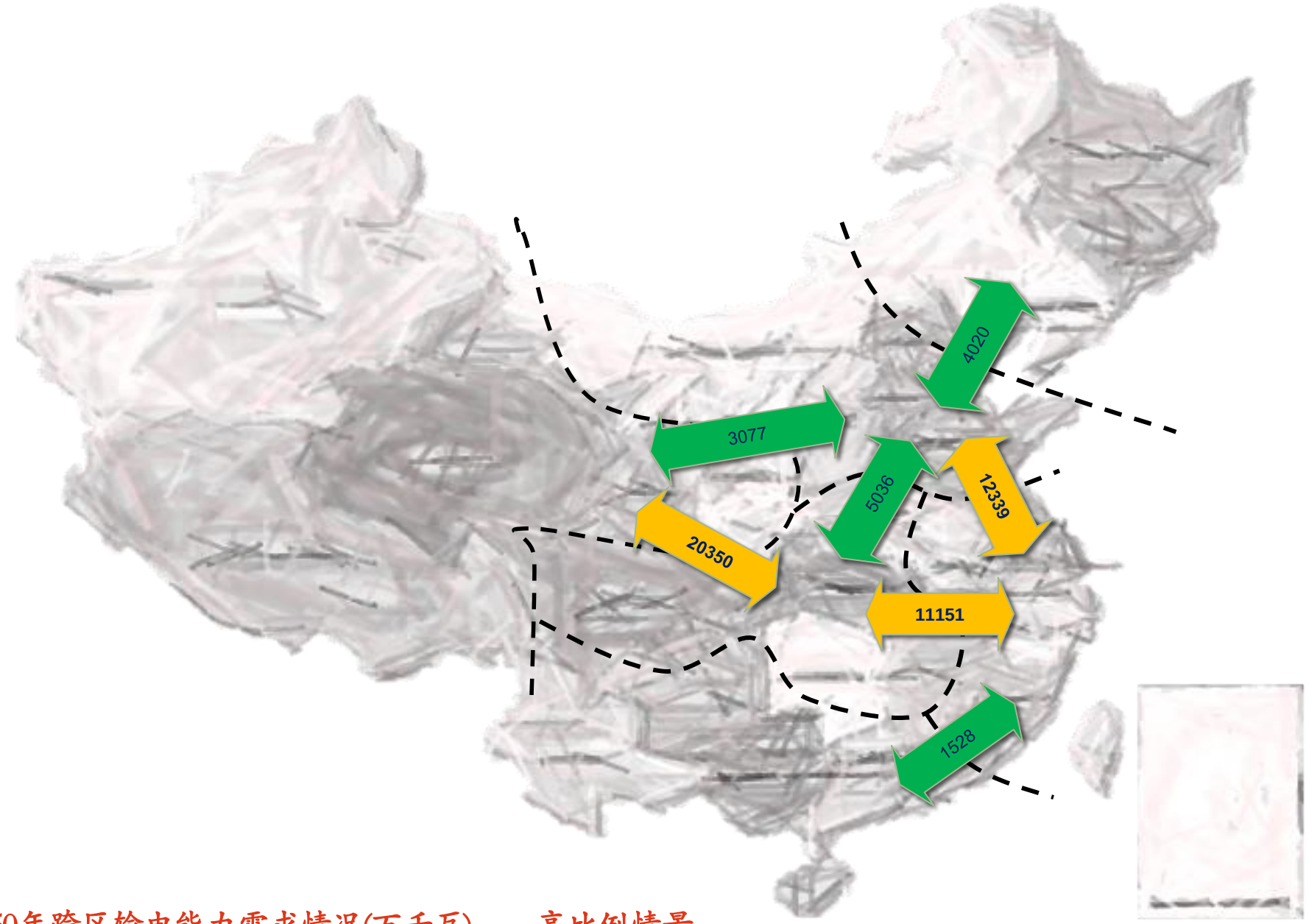


2050年木质生物质发电发展布局/Wood



2050年沼气发电发展布局/Biogas

跨区域电力输送/Transmission



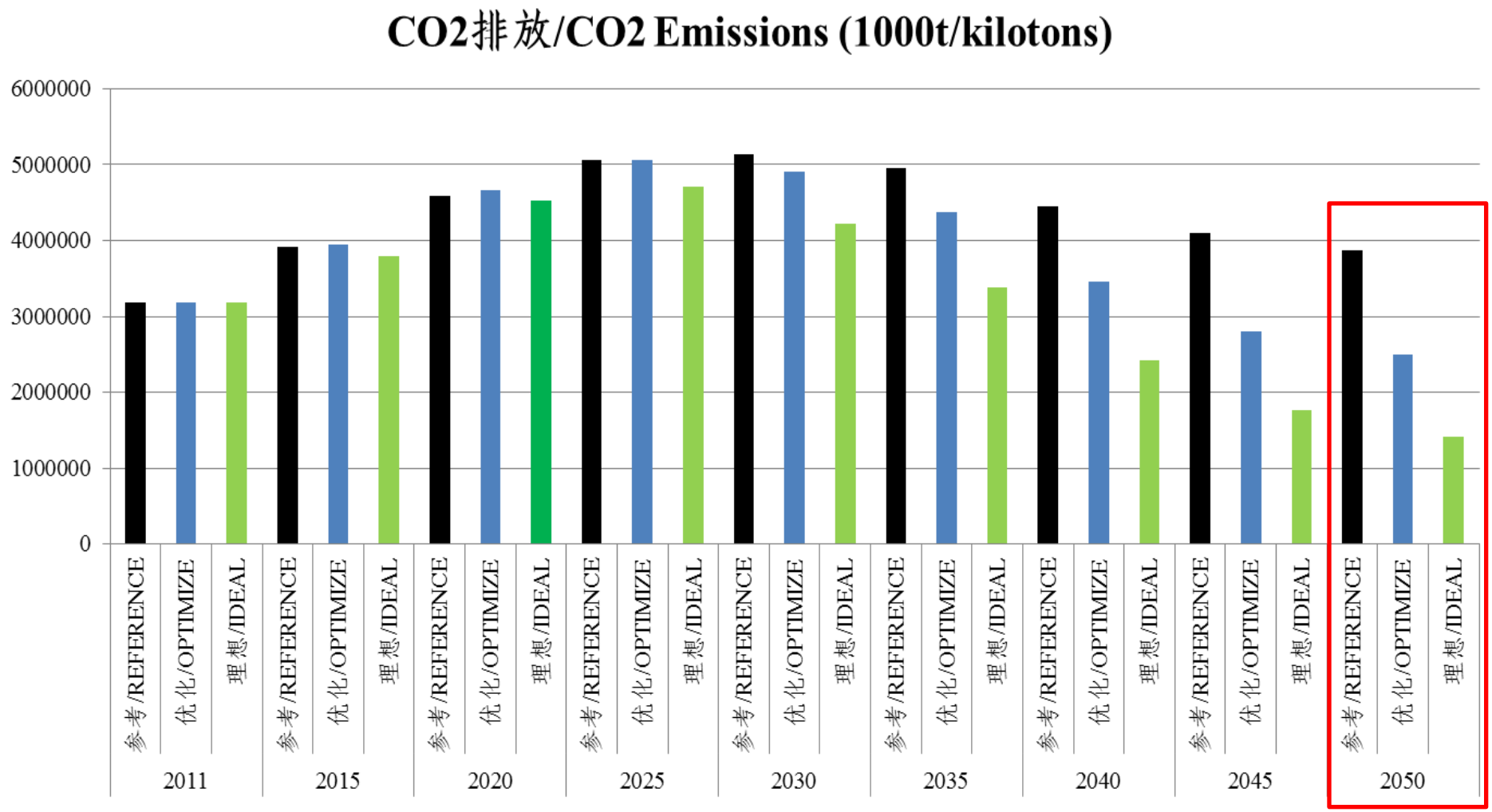
2050年跨区输电能力需求情况(万千瓦)——高比例情景

2050 cross-area transmission line demand (10MW)—HP scenario

2050年跨区输电能力需求情况(万千瓦)——高比例情景

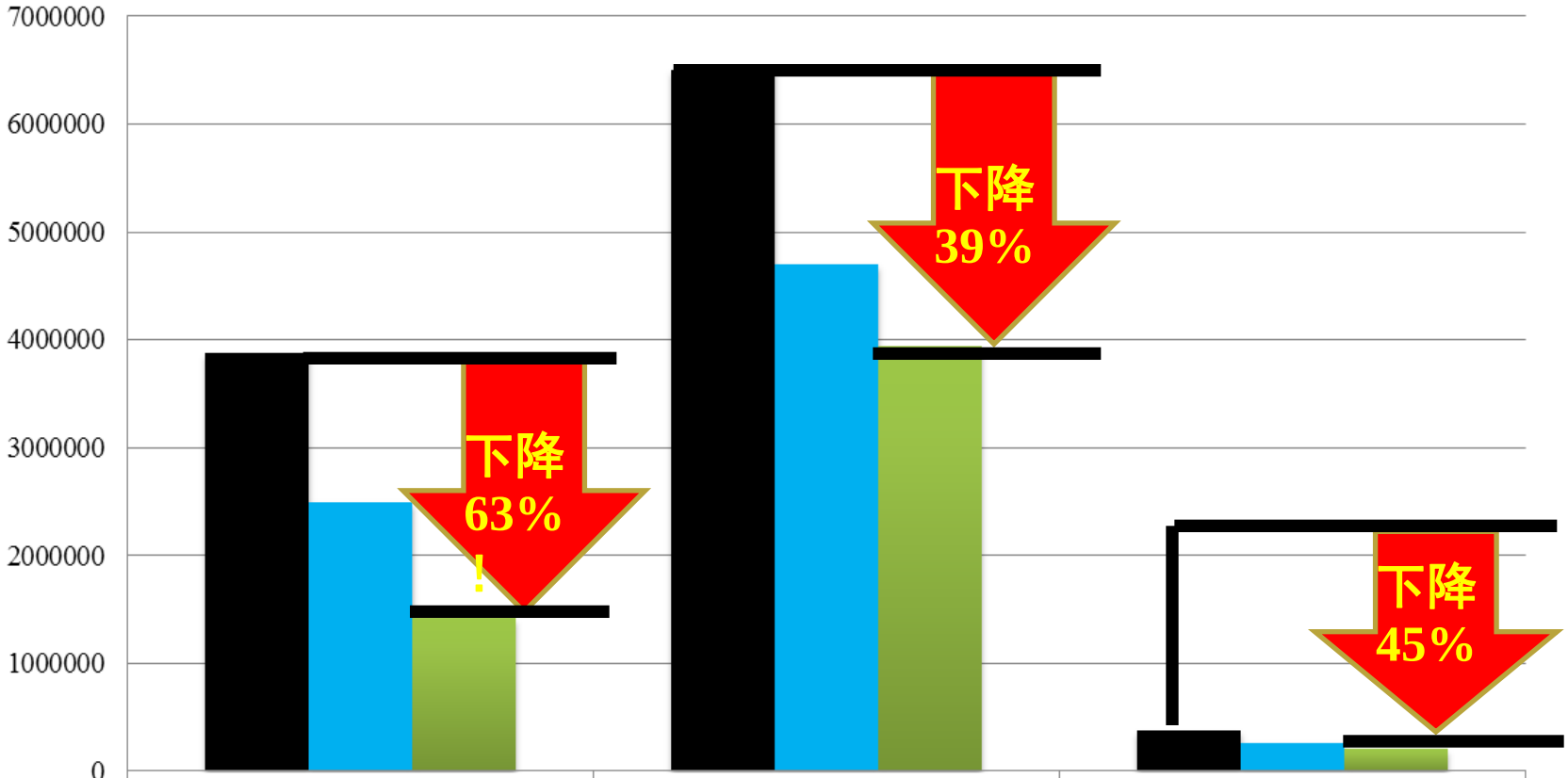
2050 cross-area transmission line demand (10MW)—HP scenario

污染物排放/High proportion RE influence on emission



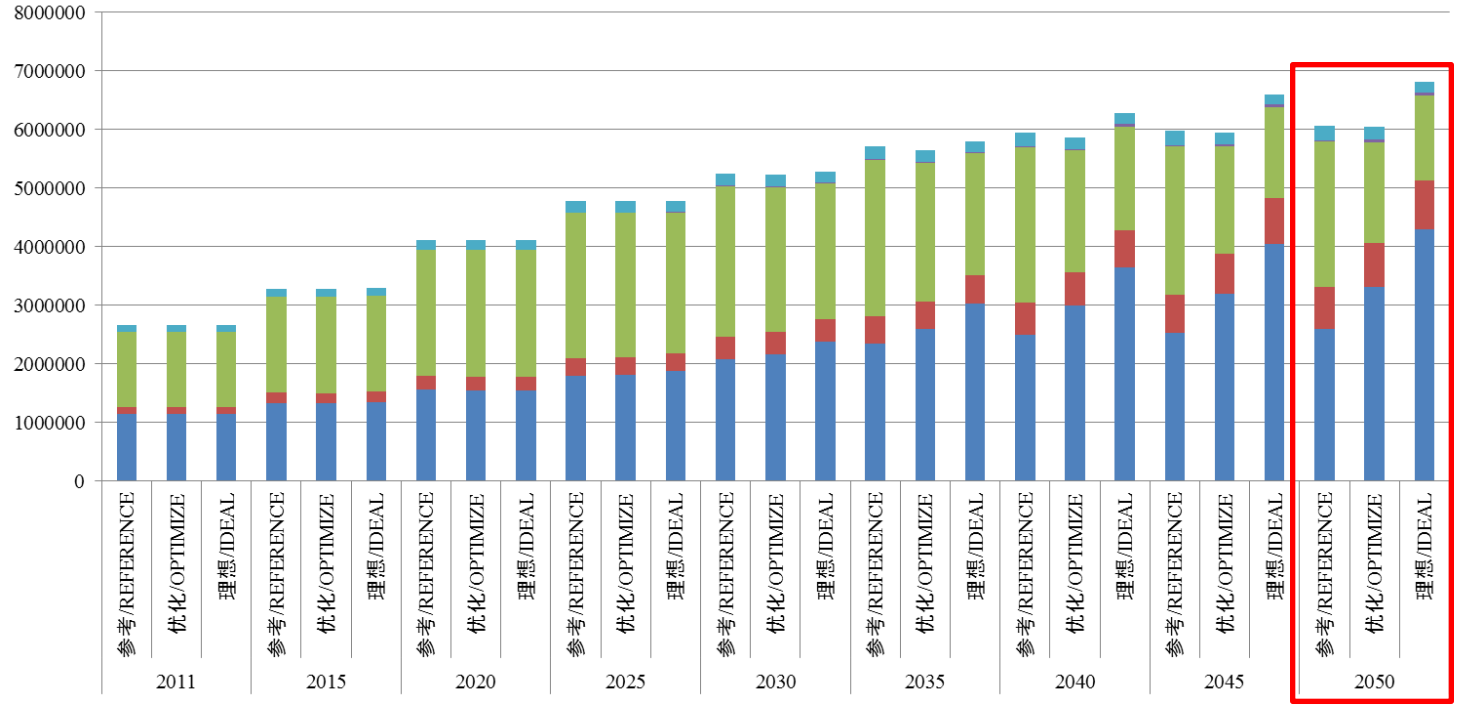
中国电力系统碳排放情况

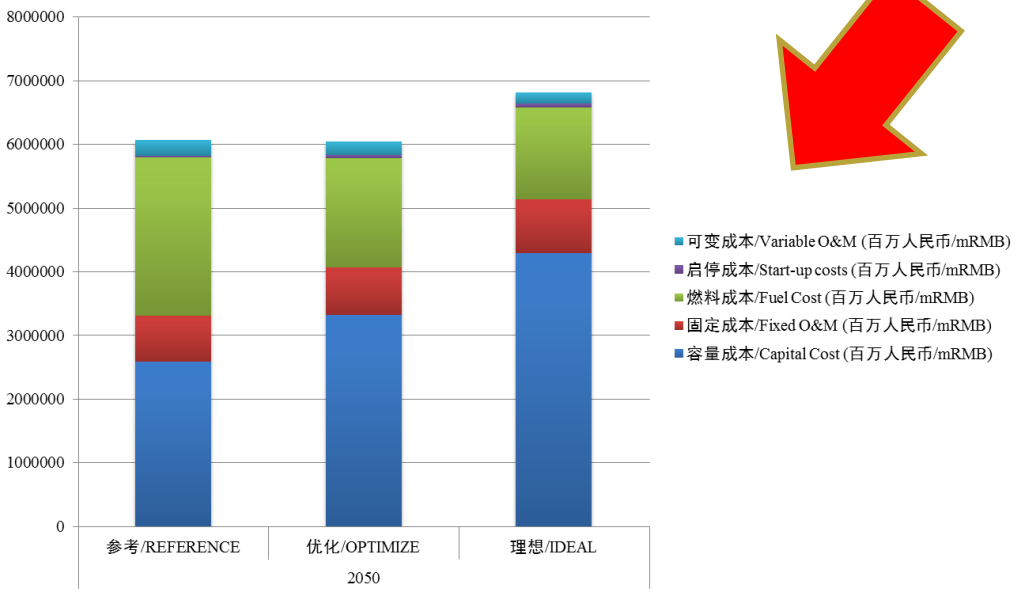
Chinese carbon emissions from the power system



	CO2排放/CO2 Emissions (1000t/kilotons)	NOX排放/NOX Emissions (吨/tons)	SO2 排放/SO2 Emissions (吨/tons)
■2050 参考/REFERENCE	3876889	6510129	377281
■2050 优化/OPTIMIZE	2499877	4703149	262864
■2050 高比例情景/HIGH PENETRATION	1416596	3939060	208966

系统成本/Economy Analysis

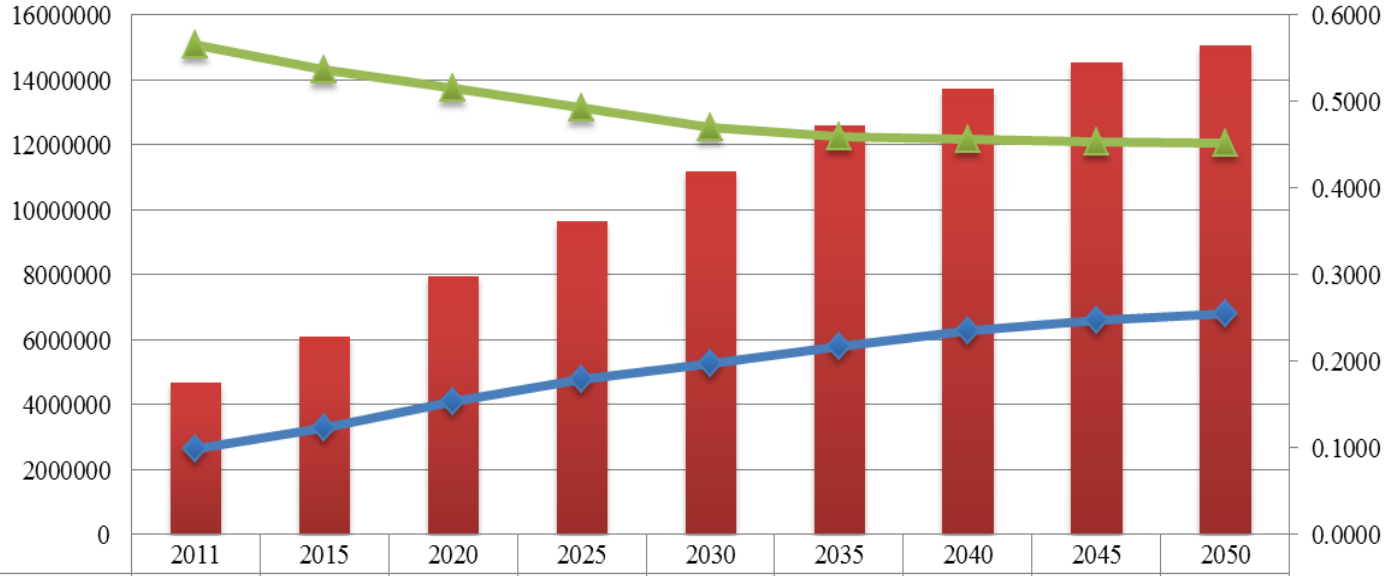




系统成本/Economy Analysis

理想情景/IDEAL	2050年
容量成本/Capital Cost (百万人民币/mRMB)	4289049
固定成本/Fixed O&M (百万人民币/mRMB)	844688
燃料成本/Fuel Cost (百万人民币/mRMB)	1444070
启停成本/Start-up costs (百万人民币/mRMB)	56799
可变成本/Variable O&M (百万人民币/mRMB)	183874
合计/Total(百万人民币/mRMB)	6818480

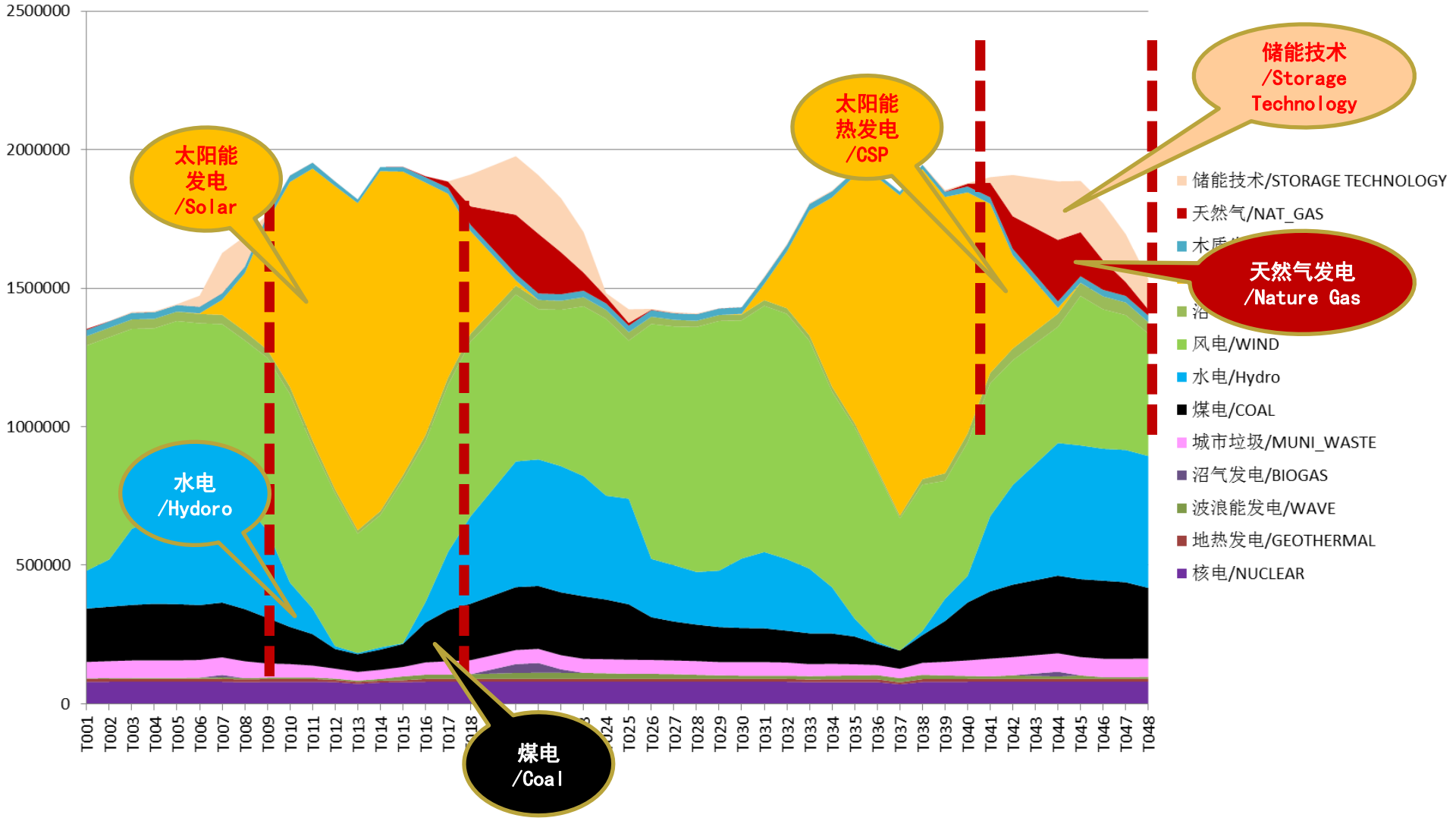
中国电力系统2011至2050综合度电成本——高比例情景
2011 –2050 The electricity cost- /HIGH PENETRATION



	2011	2015	2020	2025	2030	2035	2040	2045	2050
总发电量（百万千瓦时/MkWh）	4697043	6124724	7978424	9683385	11217796	12606130	13737931	14542352	15066956
总成本(百万人民币/mRMB)	2654604	3287454	4114573	4777387	5279597	5803132	6273485	6601374	6818480
度电成本/Specific cost（RMB/kWh）	0.5652	0.5368	0.5157	0.4934	0.4706	0.4603	0.4567	0.4539	0.4525

典型周电力系统运行平衡（2050年，48h）——高比例情景

48h operation of the power system equilibrium– HP scenario

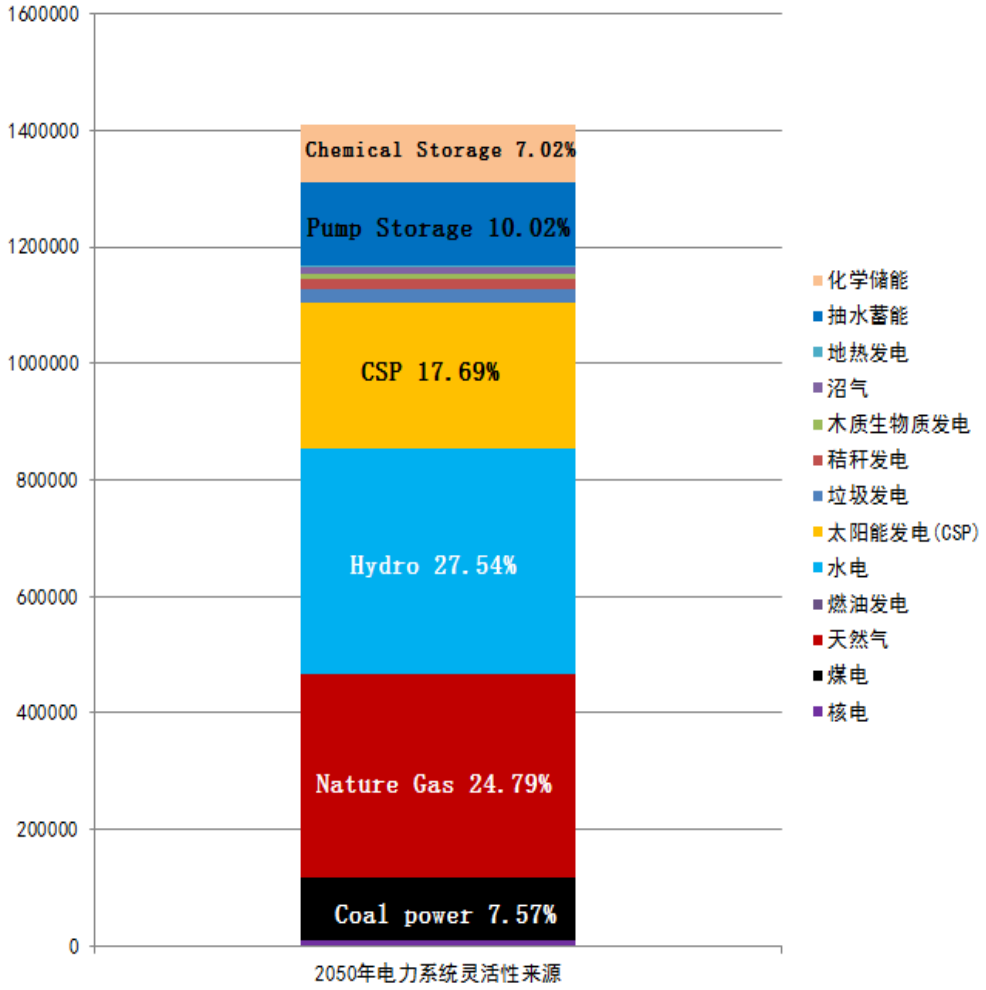


高比例可再生发电情景中，需要电力系统提高灵活性以实现供需平衡

In high proportion RE Scenario，need improve flexibility of power system

灵活性提高可以通过供给侧和需求侧的多种方式获得，包括：

Flexibility improvement can have many ways in supply side and demand side. such as：



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东北亚电力网络建设的主要工作
The main work of Power network in Northeast Asia

近期工作
Short-term work

1、深入研究可能的建设方案——确定输电和发电方面的最佳技术组合

1， Depth study of the possible building planning - to determine the best combination of technologies of transmission and power generation

2、加强技术性及经济性研究

2， Strengthening the technical and economic studies

3、科学量化经济、社会和环境效益

3， Science quantify the economic, social and environmental benefits

4、制定较为详细的行动计划

4，Develop a more detailed plan of action

5、选择区域内、国家内和双边的小规模项目，进行技术及政策潜力评估

5，Select the regional, national and bilateral small-scale project to assess the potential of technology and policy

长期工作
Long-term work

1、制定东北亚统一的能源发展战略

1， Developing an unified Northeast Asia energy development strategy

2、分析整体政策框架并找出存在的薄弱环节额（包含技术转让及融资途径）

2， Analysis of the overall policy framework and identify weaknesses (including technology transfer and financing)

3、建立促进跨区域电力交易的国际化平台

3，Established international platform to promote inter-regional electricity trading

4、完善各国法律，保障所有参与国、投资者和其他利益相关者的权益

4，Improve national laws to protect the rights and interests of all participating countries, investors and other stakeholders

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Thank you!