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Integrating Renewable Energy Into Power Systems in China: A Technical Primer

Electricity Planning

October 2015

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Acronyms

AC	Alternating current
CEEC	China Energy Engineering Group Corporation
CHP	Combined heat and power
CSG	China Southern Grid Company
DC	Direct current
FERC	U.S. Federal Energy Regulatory Commission
NDRC	National Development and Reform Commission
NEA	National Energy Administration
SERC	State Electricity Regulatory Commission
SGCC	State Grid Corporation of China

Introduction

This paper is part of a series of primers on the economic, institutional, political, and technological challenges of integrating renewable energy into power systems in China. Each paper in the series is designed to stand alone and focus on a different theme: electricity planning, power system operations, and electricity pricing. These three themes are intimately interlinked, and each of the papers draws and builds upon the others. The series was motivated by an assessment that, despite a voluminous literature on renewable energy in China, there is still very little understanding of basic institutions and practices in China's power sector, and how they shape the constraints faced by industry and regulators in expanding and integrating renewable energy into power systems.

This paper focuses on electricity system planning—the process through which businesses, regulatory agencies, and system operators plan electricity generation and transmission investments to meet reliability, cost, and environmental goals.[1] The text is divided into four main sections:

- *Overview*, which provides a summary of the paper;
- *Industrial Policy and Planning Processes*, which examines the different electricity planning processes in China, centered around five-year planning, and their links to national industrial policy;
- *Project Approval*, which describes the approval process for generation and transmission projects, and how it became disconnected from electricity planning processes; and
- *Challenges for Renewable Energy*, which outlines the key challenges that current electricity planning practices create for renewable energy, and identifies key reform areas that could address those challenges.

Although the focus in this series is on renewable integration, the descriptions and many of the conclusions have broader relevance. Each paper assumes that the reader has a basic knowledge of renewable energy developments in, and the organizational structure of, China's power sector.

[1] Longer-term system planning here is distinct from "operations planning," which typically focuses on a timescale ranging from real time to one year. Operations planning is covered in a separate paper. See Kahrl, F., and Wang, X. (2014). *Integrating Renewable Energy Into Power Systems in China: A Technical Primer — Power System Operations.* Beijing, China: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/7459.

1. Overview

Internationally, electricity system planning takes different forms in different industry structures and local contexts. Across these different structures and contexts, there are two commonly found planning processes: (1) generation adequacy planning, which attempts to ensure that generation capacity will be adequate to reliably meet expected demand at least cost;[2] and (2) transmission reliability planning, which attempts to ensure that the transmission system will be able to reliably deliver power to consumers. These processes have important implications for the development and integration of renewable energy. They determine the flexibility of the electricity system, how much transmission capacity is available to deliver and integrate renewable energy, and, in some cases, how much new renewable generating capacity is built.

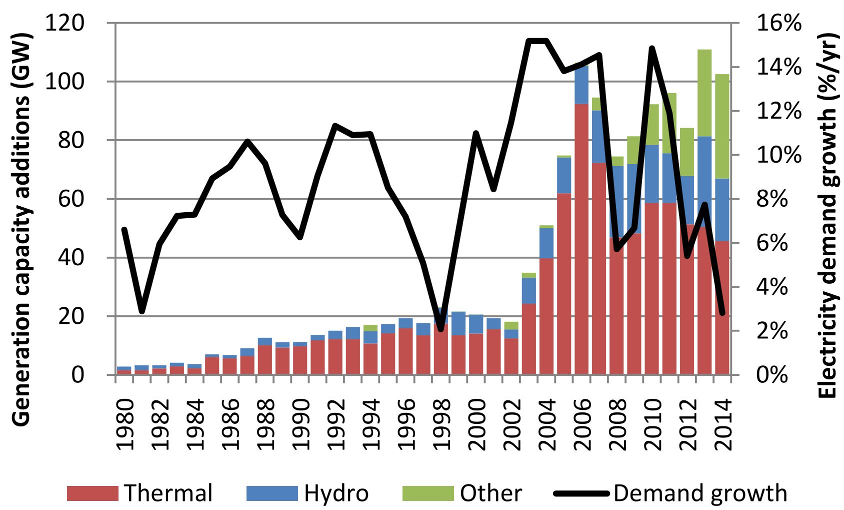

Figure 1: Generation Capacity Additions by Resource Type (Thermal, Hydro, Other) and Electricity Demand Growth in China, 1980-2014[3]

Electricity planning in China differs significantly from this international paradigm. The primary vehicle for planning in China's electricity sector is the five-year planning process, a comprehensive, hierarchical, nation-wide effort that enumerates policy directions and key investment projects across the entire economy. Generation and transmission investments in the five-year planning process are not based on reliability or cost metrics. Instead, over the last 15 years, with demand growth exceeding ten percent per year, electricity planning became subservient to breakneck capacity expansion (**Error! Reference**

[2] In many parts of North America and Europe, long-term supply (adequacy) planning also incorporates demand-side resources and is referred to as "resource adequacy planning." The use of the term "generation adequacy planning" here is intended to cover a broader range of planning approaches.
[3] "Other" here includes nuclear power and renewable energy. Data from 1980-2013 are from China Electricity Council. (2014). *Basic Electricity Statistics for 2013* (2013 年电力统计基本数据一览表). Retrieved from http://www.cec.org.cn/guihuayutongji/tongjxinxi/niandushuju/2015-03-06/134849.html. Data from 2014 are from China Electricity Council (2015). *Electricity Sector Performance in 2014* (2014 年电力工业运行简况). Retrieved from http://www.cec.org.cn/guihuayutongji/gongxufenxi/dianliyunxingjiankuang/2015-02-02/133565.html

source not found.).[4] Between 2000 and 2014, China added 1 terawatt (TW) of new generating capacity, equivalent to the generating capacity of the entire U.S. electricity system.[5]

More recent developments—slowing electricity demand growth, worsening air quality, rising CO_2 emissions, concerns over high costs—are highlighting shortcomings in electricity planning in China, similar to what the U.S. experienced in the 1970s.[6] These shortcomings have already created a number of challenges for renewable energy. For instance, the lack of a generation adequacy planning process has led to an overbuilding of inflexible coal-fired generation capacity relative to physical and economic need, and subsequently to significant wind curtailment. The lack of coordination between generation and transmission development through the transmission planning process has created generation "pockets," where local wind and hydropower generation must be curtailed because there is insufficient transmission capacity to export it.

Renewable energy has also yet to be treated as a serious mitigation measure for meeting air quality goals. In response to the mounting severity of its air quality problems, China's central government announced an Air Pollution Control Action Plan 2013, with provincial and sub-provincial level governments responsible for implementation. As described below, in the electricity sector these plans focus primarily on traditional smokestack pollution controls for coal-fired generating units. There is significant scope for further emission reductions in the electricity sector through regional planning that identifies cost-effective renewable generation and transmission projects.

Efforts to improve electricity planning in China will need to overcome political economy obstacles. In 2004, the central government consolidated project approval authority for most generation and high-voltage transmission projects, due to concerns that the provinces were approving too many inefficient, high-polluting power plants. However, the central government has not had a national five-year plan for the electricity sector since the early 2000s, following partial reforms that unbundled the sector into corporate titans but stopped short of the creation of wholesale markets. The consequent lack of objective criteria for determining how much new capacity and what kinds of projects to approve created an impasse between the central government and its industrial policy and environmental priorities, on one side, and local governments and the corporate sector concerned primarily about growth, on the other. Resolving this tension is critical to developing more meaningful planning processes.
For renewable energy, improving planning processes to better support its integration into power systems will require changes in four main areas:

- *Generation planning:* ensuring a better match between generation investment and the generation capacity needed to reliably meet demand, and facilitating a more flexible, lower cost generation mix;

[4] Ten percent is an annual average. From 2000 to 2014, electricity demand grew by an annual average of 10.5 percent per year, though as the figure illustrates demand growth fell sharply to 6–7 percent in 2008 and 2009 and has fallen below ten percent since 2011.
[5] More precisely, China added 1.06 TW of new capacity between 2000 and 2014. The U.S. electricity system had 1.06 TW of installed capacity in 2012. Data for China are the same source as used in **Error! Reference source not found.**. U.S. data are from the Energy Information Administration website, http://www.eia.gov/beta/international/.
[6] For more on how these drivers affected electricity planning in the U.S., see Kahn, E. (1988). *Electric Utility Planning and Regulation.* Washington, DC: American Council for an Energy-Efficient Economy.

- *Transmission planning:* better integrating generation planning into transmission planning, and encouraging a more economically efficient expansion of the transmission system;
- *Environmental planning:* better integrating environmental goals into electricity planning and resource procurement; and
- *Organizational capacity and information access:* strengthening the capacity and expertise of regulatory organizations, and encouraging greater transparency and wider access to information that will assist in decision-making.

The remainder of this paper is organized as follows. Section 2 provides an overview of different electricity planning processes in China, describing the hierarchy of processes and how they are shaped by national industrial policy. Section 3 describes the evolution of the project approval process for electricity infrastructure and how this process intersects with electricity planning. Section 4 examines the challenges that current planning practices create for renewable energy, and identifies priority reform areas for addressing these challenges.

2. Industrial Policy and Planning Processes

The importance of a coordinated approach to electricity sector planning has long been recognized in China. The 1995 Electricity Law (电力法 | dianli fa) explicitly notes that electricity planning should strive to ensure: rational resource use, coordinated generation and grid development, improved economic efficiency, and environmental protection.[7] It stipulates that new electricity projects should be consistent with electricity plans and guided by national industrial policy.[8]

As in other sectors, electricity planning in China is carried out primarily through the five-year development planning process. This process is guided by national industrial policy, which lays out development priorities and longer-term policy directions. Five-year planning follows a loose hierarchy, both within sectors and across different levels of government. Environmental planning has historically also been done in five-year plans. Thus, in principle, the coordination necessary for aligning electricity investment with economic, reliability, and environmental goals occurs primarily in the five-year planning process.

At a provincial and sub-provincial level, electricity planning is complicated by the existence of multiple planning agencies, in some cases with overlapping responsibilities. In this paper, the term "planning agencies" refers to Development and Reform Commissions (发展改革委员会 | Fazhan Gaige Weiyuanhui, or 发改委 | Fa Gai Wei), Economic and Information Commissions (经济和信息化委员会 | Jingji he Xinxihua Weiyuanhui, or 经信委 | Jing Xin Wei), and Economic and Trade Commissions (经济贸易委员会 | Jingji Maoyi Weiyuanhui, or 经贸委 | Jing Mao Wei).

2.1 Industrial Policy

National industrial policy (产业政策 | chanye zhengce), and in particular its national "development direction" (发展方针 | fazhan fangzhen), is intended to work in concert with and provide a vision and framework to guide five-year development planning. Industrial policymaking is embedded within the five-year planning process and industrial policies are typically described in the opening sections of five-year plans, rather than in separate documents. This approach to national planning dates back to China's first Five-Year Plan in 1953. In the electricity sector, industrial policy covers generation, transmission, and distribution capacity expansion, reflecting a mix of concerns ranging from economic development, to the environment, to energy security and geopolitics.

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[7] Standing Committee of the National People's Congress of China. (1995). Electricity Law of the People's Republic of China (中华人民共和国电力法). Article 10. Retrieved from http://www.lawinfochina.com/display.aspx?lib=law&id=117&CGid=. The original Chinese is "电力发展规划，应当体现合理利用能源、电源与电网配套发展、提高经济效益和有利于环境保护的原则."

[8] Article 14 of the Electricity Law. The original Chinese is "电力建设项目应当符合电力发展规划，符合国家电力产业政策."

Time Period	Policy (Chinese)	English Translation
1953-1958	火主水辅	Focus on coal generation, less focus on hydropower
1958-1961	水主火辅	Focus on hydropower, less focus on coal generation
1961-1973	水火并举，因地制宜	Focus on coal generation and hydropower, appropriate to the location
1973-1980	水火并举，在有水力资源的地区多搞水电	Focus on coal generation and hydropower, in hydropower-rich regions develop more hydropower
1980-2000	大力发展水电, 积极发展火电，适当发展核电	Vigorously develop hydropower, actively develop coal generation, appropriately develop nuclear
2001-2005	积极发展水电，优化火电结构，适当发展核电，因地制宜发展新能源发电	Actively develop hydropower, optimize coal generation structure, appropriately develop nuclear, develop new energy resources in appropriate locations
2006-2010	在保护环境和做好移民工作的前提下积极开发水电，优化发展火电，推进核电建设；大力发展可再生能源	Actively develop hydropower so long as the environment is protected and resettlement is appropriately carried out, optimally develop coal generation, accelerate nuclear development, vigorously develop renewables
2011-2015	积极有序发展水电，高效清洁发展煤电，安全高效发展核电，加快发展风能等其他可再生能源，有序发展天然气发电	Actively and systematically develop hydropower, develop efficient and clean coal generation, safely and efficiently develop nuclear, accelerate development of wind and other renewables, systematically develop natural gas generation

Table 1: Industry Policy for Generation Resource Development in China, 1953 to Present[9]

[9] Policy from 1953 to 1980 are from Zhang, 2010. Policy from 1980 to 2000 is from Chen, 2004; although there appear to be minor variations in policy during this period, it does not appear that overall policy changed significantly. Policies from after 2001 are taken directly from five-year plans. See Chen, W. (2004). Recommendations on Electricity Industry Policy and Development Planning (关于电力工业产业政策和发展规划的建议). *China Economic Times*. Retrieved from http://www.ma-china.com/chinese/news/detail.asp?id=12604.

For electricity generation, initial development directions throughout the 1950s, 1960s, and 1970s focused on the balance between thermal (coal) and hydropower development, and were intimately intertwined with China's political history.[10] Over time, these guidelines have evolved to include a larger number of resources, including renewable energy, and their language has become more nuanced (Table 1). For instance, for hydropower and coal-fired generation, they have increasingly focused on environmentally and socially sustainable development, rather than simply the level of investment effort. Renewable energy has been a key focus of China's electricity industry policy since the 11th Five-Year Plan in 2006.

The grid, and the bulk (high voltage) transmission system in particular, has become an increasingly important element in China's electricity industry policy since the 2000s. This has largely focused on developing interregional transmission to facilitate power transfers from resource-rich regions in the country's west and north to load centers in its east and south.[11] The 12th Five-Year Plan (2011-2015) also includes a mandate to accelerate the construction of a smarter grid, focusing on improving the ability to accommodate new energy resources, distributed energy resources, and electric vehicles.

In June 2014, President Xi Jinping announced a directive outlining an "energy production and consumption revolution" (能源生产和消费革命 | nengyuan shengchan he xiaofei geming). This directive aims to dramatically improve the efficiency of energy consumption, diversify primary energy sources and strengthen energy distribution networks, promote innovation in energy technologies, and further institutional reform.[12] How this directive will be translated into electricity development planning remains to be seen, though it is viewed by at least some corporate actors as signifying a "new direction" for the electricity industry.[13]

2.2 National Five-Year Planning

Guided by industrial policy objectives, electricity planning in China — including the planning of new generation and transmission facilities, longer-term resource planning, and target-setting for the sector's environmental performance — has traditionally been part of the five-year planning process. This process includes a hierarchical layering of government plans that provide different levels of detail on policy priorities, targets, and individual projects. At the highest level, the national five-year plan creates a "planning framework" (规划纲要 | guihua gangyao) that lays out broad brush principles, priorities, and targets for the entire economy, but provides few specifics.

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[10] For instance, the shift in focus to hydropower in 1958 was part of the Great Leap Forward's emphasis on rapid industrial development. The failures of hydropower development over this time period led to a shift back to coal. See Zhang, B. (2010). Explaining China's Hydropower Policies (中国水电政策解读). *China Three Gorges*. Retrieved from http://wenku.baidu.com/view/7ea5c51cc281e53a5802fff3.html

[11] This includes both the "West to East" (西电东送 | Xi Dian Dong Song) and "North to South" (北电南供 | Bei Dian Nan Gong) transmission projects.

[12] See, for example, Xinhua. (2014). *Xi Jinping: Driving China's Revolution in Energy Production and Consumption* (习近平：积极推动我国能源生产和消费革命). Retrieved from http://news.xinhuanet.com/politics/2014-06/13/c_1111139161.htm

[13] This is, for example, Huaneng's position. See Cao, P. (2015). China Huaneng: Promoting Huaneng's Sustainable Development through Transition (中国华能：以转型推进能源企业的可持续发展) [Excerpt]. *Qiushi*. Retrieved from http://www.cnmim.com/detail_gzyw.jsp?article_id=6130&column_no=090303

Planning Framework
• non-fossil fuel energy accounts for 11.4% of primary energy consumption • 16% reduction in energy intensity • 17% reduction CO_2 intensity • 8% reduction in total SO_2 emissions • 10% reduction in total NO_x emissions

Energy Development Plan		
Energy Consumption and Efficiency		
Primary energy consumption	4 Gtce	Expected
Share of non-fossil energy consumption	11.4%	Binding
Total electricity consumption	6.15 PWh	Expected
Energy intensity	0.68 (-16%)	Binding
Net heat rate for thermal generation	323 gce/kWh	Expected
Transmission line losses	6.3%	Expected
Energy Production and Supply		
Total primary energy production	3.66 Gtce	Expected
Coal supply	4.1 Gt	Expected
Oil supply	0.2 Gt	Expected
Gas supply	156.6 Bcm	Expected
Non-fossil fuel energy supply	0.47 Gtce	Expected
Electricity Development		
Total installed capacity	1,490 GW	Expected
Coal installed capacity	960 GW	Expected
Hydropower installed capacity	290 GW	Expected
Nuclear installed capacity	40 GW	Expected
Natural gas installed capacity	56 GW	Expected
Wind installed capacity	100 GW	Expected
Solar installed capacity	21 GW	Expected
Environmental Protection		
Economy-wide CO_2 Intensity	-17%	Binding
SO_2 emission factor for coal generation	1.5 g/kWh	Binding
NO_x emission factor for coal generation	1.5 g/kWh	Binding
Livelihood Improvements		
Per capita electricity consumption	620 kWh	Expected
Green energy demonstration counties	200 projects	Expected
Persons with natural gas access	250 million	Expected

Table 2: Moving from the 12th Five-Year Plan for Economic and Social Development to the 12th Five-Year Plan for Energy Development

Based on the national planning framework, specialized plans (专项规划 | zhuanxiang guihua) outline principles, targets, priorities, and implementation strategies for specific sectors across the economy.[14] For the energy sector, the National Energy Administration (NEA) develops a five-year energy development plan that establishes: basic principles (e.g., prioritize conservation),[15] key binding (约束性

[14] More specifically, specialized plans are meant to provide deeper and more concrete plans in areas of central government focus, perceived weak areas, and problems that have implications for the broader economy.

[15] In the 12th Five-Year Energy Development Plan, the eight principles included: prioritizing conservation (节约优先), emphasizing domestic resources (立足国内), diversifying development (多元发展), protecting the environment (保护环境),

| yueshuxing) or expected (预期性| yuqixing) targets (Table 2), priority tasks for the energy sector (e.g., strengthen domestic resource exploration and development),[16] implementation strategies (e.g., improve fiscal and financial policies), and responsibility for implementation. All five-year plans share this general administrative and substantive format. They are required to be consistent with, and to expand on and concretize, the plans in the hierarchy above them.

In addition to a five-year plan for the overall energy sector, the NEA issues five-year development plans for specific energy resources, including coal, natural gas, hydropower, nuclear power,[17] and renewable energy. Within the 12th Five-Year Plan for Renewable Energy Development, the NEA also published individual development plans for biomass, solar, and wind energy, which are the lowest level in the planning hierarchy. For instance, the 12th Five-Year Plan for Solar Energy Development was developed "according to the 12th Five-Year Plan for Economic and Social Development, the 12th Five-Year Plan for Energy Development, and the 12th Five-Year Plan for Renewable Energy Development."[18]

In principle, national planning agencies should also develop a five-year development plan for the electricity sector. However, China has not had a formal national five-year plan for the electricity sector since the 10th Five-Year Plan (1995-1999),[19] coinciding with reforms in the electricity sector in 2002 that separated generation, grid, and industry service functions. These reforms created powerful state-owned corporations, led by CEOs with ministerial and vice-ministerial rank, that dominated planning and investment decisions.[20] Reforms also corporatized a significant portion of the sector's planning capacity.[21] The NEA reportedly plans to release a national electricity development plan for the 13th Five-

deepening reforms (深化改革), promoting science and technology innovation (科技创新), strengthening international cooperation (国际合作), and improving livelihoods (改善民生).

[16] The 12th Five-Year Energy Development Plan specifies nine priority tasks: (1) strengthening domestic resource exploration and development (加强国内资源勘探开发), promoting a transition toward efficient, clean energy (推进能源高效清洁转化), promoting energy supply transformation (推动能源供应方式变革), accelerating construction of energy storage and transport facilities (加快能源储运设施建设), implementing "energy livelihood" projects (实施能源民生工程), controlling total energy consumption (控制能源消费总量), deepening energy industry reforms (深化能源体制机制改革), promoting technology advancement (提升能源科技和装备水平), deepening international cooperation (深化能源国际合作).

[17] Nuclear power has not had specialized plans in recent planning cycles, but will have one for the 13th Five-Year Plan.

[18] NEA. (2012). 12th Five-Year Plan for Solar Energy Development. Retrieved from http://www.gov.cn/zwgk/2012-09/13/content_2223540.htm

[19] See, for instance, Jiang, S., (2014). Shedding Light on the Direction of Electricity Planning in the 13th Five-Year Plan (揭秘"十三五"电力规划方向). Retrieved from http://www.wusuobuneng.com/archives/7359. The lack of a formal government plan did not mean that there were no plans. For instance, the China Electricity Commission, an industry association representing generators, developed a plan during the 12th Five-Year Planning cycle entitled *Research Report on the 12th Five-Year Plan for the Electricity Industry*, 《电力工业"十二五"规划研究报告》.

[20] Jiang, 2014.

[21] One of the four pillars of the 2002 reforms was "separating primary and secondary businesses" (主辅分离), which referred to the separation of planning, surveying, engineering, construction, and manufacturing from the erstwhile State Power Corporation. This included four large conglomerates (四大辅业集团 | si da fu ye jituan): China Power Engineering Consulting Group Corporation (CPECC, 中国电力工程顾问集团公司), China Renewable Energy Engineering Institute (CREEI, 水电规划设计院), China Gezhouba Group Corporation (CGGC, 葛洲坝集团), and Sino Hydro Corporation (水利水电建设总公司). A new CPECC was created in 2002 by creating an umbrella organization that houses the original CPECC, the Electric Power Planning & Engineering Institute (EPPEI, 电力规划设计总院), and six regional planning institutes (六大区域电力设计院). In 2011, the large four conglomerates were reorganized into two large consulting firms: China Energy Engineering Group Corporation (CEEC,

Year Plan, with the plan produced by the National Electricity Planning and Research Center — an independent center within the China Energy Engineering Group Corporation (CEEC) created in early 2012 to provide planning expertise to national energy agencies.[22]

Separate from a five-year electricity development plan, for the 12th five-year planning cycle the NEA was tasked with publishing the first five-year specialized plan for grid development, focusing on expanding the high-voltage transmission system. (Lower voltage (< 330 kV) planning is done at a provincial level.) The NEA never produced this plan, due to differences of opinion between external experts and the State Grid Corporation of China (SGCC).[23] The National Development and Reform Commission (NDRC) had, in previous five-year plans, reportedly acted as a rubber stamp for the grid companies' internal five-year plans, but the NEA sought to reclaim planning authority in its 12th five-year specialized plan, requiring approval from an expert panel.[24] Differences of opinion encountered in the planning process have largely centered over the appropriate scale and voltage of the transmission system, and in particular the SGCC's plans to create ultra-high voltage alternating current (AC) interconnections linking at least three of the regional grids into a multi-region synchronous system. As a result of this impasse, the de facto national plan for the high voltage transmission system is reportedly the grid companies' longer-term (2013-2020) plans.[25]

Since the 11th Five-Year Plan, the State Council has issued a Comprehensive Energy Conservation and Emission Reduction Strategy (节能减排综合性工作方案 | Jieneng Jianpai Zonghexing Gongzuo Fangan) as part of the five-year planning process. This plan, a collaboration among 15 organizations led by the NDRC, specifies binding targets for energy intensity reductions, SO_2 emissions, and NO_x emissions for each of the provinces.[26] The Strategy includes specialized plans for the industrial and transportation

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中国能源建设集团有限公司), which includes CPECC and CGGC, and Power Construction Corporation of China (PCCC, 中国电力建设集团有限公司), which includes CREEI and Sino Hydro. Together, these organizations provide a significant amount of the Chinese electricity sector's analytical expertise.

[22] The National Electricity Planning and Research Center (国家电力规划研究中心) is part of EPPEI.

[23] This divergence of opinion has its roots in SGCC's 2005 "national grid" (全国一张网 | quanguo yi zhang wang) proposal, which laid out plans to create an ultra-high voltage (UHV) backbone consolidating the regional power grids into a national network. SGCC's plan was based on its belief that it would be more cost-effective to transport electricity than to transport coal, and a key focus of the plan was in delivering power from resource-rich western China to load centers in the east. The first UHV demonstration project was completed in 2006, stretching across 645 km and linking Pudongnan (晋东南) in Shanxi Province and Jingmen (荆门) in Hubei Province. The 1,000 kV line performed significantly below its expected 500 MW transfer capability. An expert panel reviewing the project, the State Electricity Regulatory Commission (SERC), and the Chinese Academy of Engineering raised concerns over the line, with the latter two organizations arguing for a more comprehensive economic and engineering assessment of SGCC's UHV plan. In 2008, SGCC was forced to downscale its national grid plan to the "three hua" region, including the North (华北 | Huabei), Central (华中 | Huazhong), and East (华东 | Huadong) power grids. Even this has continued to meet with opposition. For a history of this debate, see Lu, Y. (2013). *Wavering on the 12th Five-Year Plan for Grid Development, Debate Continues on the Electricity Superhighway* (电网十二五规划踟蹰 电力高速路仍存争议). *21st Century Business Herald*. Retrieved from http://money.msn.com.cn/industry/20130618/04391576171.shtml

[24] See Wang, Y. (2013). NEA Rescinds State Grid Corporation's Planning Authority, 12th Five-Year Plan for Grid Development is Delayed (能源局怒收国家电网规划权 因起电网"十二五"规划拖沓未出台). *21st Century Business Herald*. Retrieved from http://cnenergy.org/yw/zc/201307/t20130719_215007.html

[25] Ibid.

[26] Less relevant to the electricity sector, this plan also stipulates targets for chemical oxygen demand, and ammonia-nitrogen discharge.

sectors, but not for the electricity sector.[27] Although their targets are binding, these plans do not enter into the energy planning hierarchy; none of the plans shown in Figure explicitly reference the Strategy.

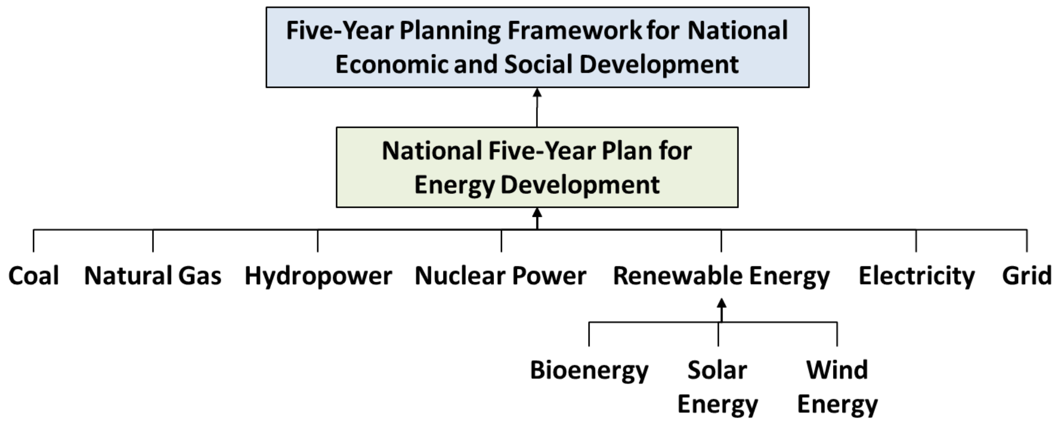

Figure 2: Five-Year Planning Framework Relevant to the Electricity Sector

As Figure 2 shows, the hierarchy of five-year development plans does not currently facilitate explicit horizontal linkages among resource sectors (coal, natural gas, hydropower, nuclear power, renewable energy) or between them and the electricity sector as a whole.[28] The Five-Year Plan for Energy Development could ostensibly provide a mechanism to coordinate among plans but currently does not. The absence of more explicit horizontal linkages creates a structural challenge for planning: Without an electricity development plan that is higher in the planning hierarchy than the resource and grid development plans, there is no process for matching electricity demand, supply, and delivery while meeting cost, reliability, and environmental objectives for the sector.

2.3 Other National Planning

In addition to five-year plans, other national planning processes serve to guide the development of generation resources, two of which are most relevant here: (1) long-term generation resource planning, and (2) medium-term environmental planning. The former provides strategic guidance on the longer-term development of new technologies, while the latter provides a framework for mobilizing local governments to identify and implement measures that improve air quality.

In 2007, the NDRC developed medium- and long-term strategies for both renewable and nuclear energy, covering the 2005-2020 period. These plans outline long-term goals; identify priority development areas; provide high-level estimates of investment needs and, for the renewable energy plan,

[27] Specifically, the Ministry of Transport developed a *12th Five-Year Plan for Energy Conservation and Emission Reductions for Road and Water Transport* (公路水路交通运输节能减排“十二五”规划); the Ministry of Industry and Information Technology developed a *12th Five-Year Plan for Energy Conservation and Emission Reductions for the Industrial Sector* (工业节能“十二五”规划). The latter does not include the electricity sector.

[28] There was no plan for nuclear power development in the 12th Five-Year Plan, though there is expected to be one in the 13th Five-Year Plan.

environmental benefits; and high-level thinking on potential implementation measures.[29] They are approved by the State Council, but are visionary documents and do not explicitly enter the hierarchy of five-year planning. The 12th Five-Year Plan for Renewable Energy Development, for instance, makes no mention of the NDRC's Medium- and Long-term Plan for Renewable Energy Development.

In 2013, the State Council released an Air Pollution Control Action Plan, covering the 2013-2017 period, which sets nationwide concentration targets for larger particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$) for the Jing-Jin-Ji, Yangtze Delta, and Pearl River Delta regions.[30] This action plan, the first of its kind in China, stipulates: targets for the share of coal (65 percent) and non-fossil energy (13 percent) in the national primary energy mix; restrictions on the development of new coal mines; a goal of reducing coal use and a moratorium on approval for non-combined heat and power (CHP) coal units in the three key regions; a 50 GW installed capacity target for nuclear power; and a call to further develop geothermal, wind, solar, and bioenergy. Local government agencies are responsible for compliance, and thus more specific planning has occurred at a local level. It is not clear how the action plans will be integrated into the 13th Five-Year Plan.

2.4 Provincial Five-Year Planning

At a provincial level, planning agencies draft provincial five-year plans for electricity development (电力发展规划 | dianli fazhan guihua) that lay out provincial priorities and goals. These provincial plans continued to be drafted over the 11th and 12th five-year planning cycles, despite the fact that there was no formal national plan. Provincial plans typically include: an enumeration of core principles; an analysis of key challenges for the next five years; generation development goals, including total installed capacity and capacity mix; grid development goals, focusing on the expansion of key transmission links; peak load and energy demand forecasts; and, more recently and in some provinces, a high-level assessment of five-year and longer-term "electricity balance" (电力平衡 | dianli pingheng). There is considerable diversity in both the format and content of provincial electricity development plans. Neither the drafting process nor their methods for assessing investment needs and decisions is transparent.[31]

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[29] See NDRC. (2007). *Medium- and Long-term Plan for Renewable Energy Development*《可再生能源中长期发展规划》. Accessible at http://www.ccchina.gov.cn/WebSite/CCChina/UpFile/2007/20079583745145.pdf; and NDRC. (2007). *Medium- and Long-term Plan for Nuclear Power Development*《核电发展中长期规划》. Retrieved from http://ghs.ndrc.gov.cn/ghwb/115zxgh/200711/P020071120526590289907.pdf

[30] Specifically, all cities at a prefecture level and above should reduce PM_{10} concentrations by 10% below 2012 levels by 2017; the Jing-Jin-Ji, Yangtze Delta, and Pearl Delta regions should reduce $PM_{2.5}$ concentrations by 25%, 20%, and 15%, respectively, below 2012 levels by 2017; Beijing should reduce $PM_{2.5}$ concentrations to around 60 μg/m^3 by 2017. See State Council. (2013). *Air Pollution Control Action Plan* 《大气污染防治行动计划》. Retrieved from http://www.gov.cn/zwgk/2013-09/12/content_2486773.htm

[31] The material in this section is based on recent plans for Beijing, Guizhou, Hebei, Shanghai, and Shanxi that were available online. Beijing Municipal Government. (2005). *Eleventh Five-Year Electricity Development Plan for Beijing* (北京市"十一五"时期电力发展规划). Retrieved from http://zhengwu.beijing.gov.cn/ghxx/sywgh/t833158.htm; Guizhou Provincial Government. (2011). *Twelfth Five-Year Electricity Industry Development Plan for Guizhou Province* (贵州省电力产业十二五发展规划的通知). Retrieved from http://www.cpicorp.com.cn/flgz/gfxwj/201301/ P020130105510722507752.pdf; Hebei Provincial Government. (2010). *Twelfth Five-Year Electricity Development Plan for Hebei Province* (河北省人民政府关于印发河北省电力"十二五"发展规划). Retrieved from http://www.cpicorp.com.cn/flgz/gfxwj/201301/P020130105510724374541.pdf; Shanghai Municipal Government. (2011). *Twelfth Five-Year Electricity Development Plan for Shanghai Province* (上海市电力发

Electricity balances in provincial electricity development plans are not intended to be precise measures of generation adequacy, for capacity expansion planning purposes. Rather, these electricity balances are a high-level, indicative estimate of future generation capacity needs, calculated using a variety of approaches and methods. For instance, Guizhou and Hebei are net exporters. Their plans begin with a demand forecast, add an arbitrary planning reserve margin, and add expected net exports to arrive at a total capacity need at the end of the five-year planning period (Table 3). Shanghai and Beijing are net importers. For each year in the five-year period, Shanghai's plan calculates a capacity surplus or shortage, and de facto reserve margin, as peak demand minus local generation and imports net of transmission losses. Beijing's plan also shows annual balances, but calculates an "import demand" (外送电力需求 | waisong dianli xuqiu) as the difference between peak demand and local generation, with no reserve margin.[32] Shanxi's plan does not include an explicit analysis of electricity balances.

Province	Method
Beijing	Calculates annual import demand as: Import demand = peak demand – local generation
Guizhou	Calculates 2015 capacity need as: Capacity need = peak demand * (1 + PRM)[A] + net exports
Hebei	Calculates 2015 capacity need as: Capacity need = peak demand * (1 + PRM) + net exports
Shanghai	Calculates annual capacity shortage as: Capacity balance[B] = peak demand – local generation – imports – import losses
Shanxi	Not explicitly treated

[A] *PRM refers to planning reserve margin.*
[B] *Capacity balance in this case could be a surplus or a deficit of capacity.*

Table 3: Approaches to Calculating Electricity Balances for Beijing, Guizhou, Hebei, Shanghai, and Shanxi

For purposes of generation adequacy, renewable resources are treated differently across provinces. In the plans examined here, some appear to use a "de-rate" factor to reduce the amount of nameplate renewable generation capacity counted toward maximum available generation capacity. Only Hebei's plan is transparent about what that factor is; it uses an across-the-board ten percent value to de-rate the installed capacity of wind, solar, and run-of-river hydropower capacity. The coarseness of this approach — these resources make very different contributions to reliability, varying with system needs[33]

展"十二五"规划). Retrieved from http://www.shanghai.gov.cn/shanghai/node2314/node2319/node10800/node11407/node25262/ u26ai30307.html; and Shanxi Provincial Government. (2012). *Twelfth Five-Year Electricity Industry Development Plan for Shanxi Province* (山西省电力工业发展"十二五"规划). Retrieved from http://www.shanxigov.cn/n16/n1203/n1866/n5130/n31265/n16849070.files/n16849091.doc

[32] As the capital, Beijing has special status and is not subject to electricity rationing during peak demand periods.

[33] Capacity values vary both within and between these resources, and generally decline with increased penetration. See, for example, California Public Utilities Commission. (2014). Effective Load Carrying Capacity and Qualifying Capacity Calculation

— illustrates the indicative function of electricity balances. As yet, they are not directly used to make financially binding decisions about the total amount or composition of generation investment.

Provincial government agencies undertake a number of other planning efforts related to five-year planning in the electricity sector, ranging from Inner Mongolia's *Wind Development and Grid Interconnection Plan*, to Anhui's *Biomass Generation Industry Plan*, to Shanxi's *Structural Adjustment and Revitalization Plan for the Electricity Sector*.[34] In some instances, such as Inner Mongolia's wind plan, these are lower in the planning hierarchy than electricity development plans; in other cases, such as Shanxi's structural adjustment plan, they are higher in the hierarchy.

Planning agencies also develop five-year energy conservation and emission reduction plans, as implementation plans for national energy intensity and emissions targets. The provincial plans, which vary by name and format among provinces, typically include: overall targets for energy intensity, CO_2 intensity, SO_2 emissions, and NO_x emissions; extensive lists of measures to reduce energy consumption and emissions in key sectors, including the electricity sector; and implementation strategies. The targets and measures are not explicitly linked. That is, the measures are not a compilation of what is deemed to be necessary and most cost-effective to meet targets, based on quantitative assessment. Instead, they are a largely qualitative assessment of what priority actions should be. As at a national level, some provinces also have separate energy conservation and emission reduction plans for the industrial and transportation sectors, but not the electricity sector.[35]

Renewable electricity generation is treated ambiguously and sometimes separately from the electricity sector in these energy conservation and emission reduction plans. In Jiangxi Province's *12th Five-Year Plan for Energy Conservation and Emission Reductions*, for instance, renewable energy is considered to be a conservation strategy, and is listed separately from the electricity sector (Table 4). In Hebei Province's *12th Five-Year Plan for Energy Conservation and Emission Reductions*, renewable electricity generation is not explicitly included as either an energy-conserving or emission-reducing measure.[36]

Methodology for Wind and Solar Resources. Resource Adequacy Proceeding R.11-10-023. Retrieved from http://www.cpuc.ca.gov/NR/rdonlyres/D05609D5-DE35-4BEE-8C9A-B1170D6E3EFD/0/R1110023ELCCandQCMethodologyforWindandSolar.pdf

[34] See Inner Mongolia Autonomous Region Government. (2011). *Wind Development and Grid Interconnection Plan* (内蒙古"十二五"风电发展及接入电网规划). Retrieved from http://wenku.baidu.com/view/c1efa4a4b0717fd5360cdc12.html?re=view; Anhui Provincial Energy Agency. (2014). (安徽省"十三五"农作物秸秆发电产业规划); Shanxi Government. (2009). *Structural Adjustment and Revitalization Plan for the Electricity Sector* (山西省电力产业结构调整和振兴规划). Retrieved from http://www.shanxigov.cn/n16/n8319541/n8319612/n8321663/n8322644/n8335604/n8337351/9183881.html

[35] For the industrial sector, these plans typically only cover energy conservation.

[36] This plan mentions renewable energy in three contexts: (1) as a strategy for "structural energy conservation and emission reductions" (结构节能减排), as part of a target to achieve 6% of energy consumption from non-fossil fuel resources; (2) as part of a qualitative strategy to promote building-integrated renewable energy; (3) as a strategy for rural energy. See Hebei Government. (2012). *Hebei Province 12th Five-Year Plan for Energy Conservation and Emission Reductions*《河北省节能减排"十二五"规划》. Retrieved from http://fgw.hengshui.gov.cn/fzgh/2014/11/04/content_312325.shtml

Area	Category	Targets or Strategies
Targets	Energy conservation	• Reduce heat rates for coal-fired units to below 315 gce/kWh • Reduce own-use for coal-fired generators to below 6.2% • Reduce grid line losses to below 7.25%
	Emission reductions	• Reduce SO_2 emissions by 42,500 tons, or 22% below 2010 levels • Reduce NO_x emissions by 60,600 tons, or 29% below 2020 levels
Energy conservation strategies in key sectors	Electricity sector	• Reduce heat rates and own-use for coal-fired units • Develop combined heat and power (CHP), gas-fired combined cooling, heat, and power (CCHP) • Accelerate smart grid deployment • Reduce grid line losses • Promote demand-side management and improve demand-side efficiency
	Renewables sector	• Accelerate renewable deployment, achieving installed capacities of 4.97 GW of hydropower, 1 GW of wind, 0.7 GW of biomass, 0.2 GW of solar by 2015
Emission reduction strategies in key sectors	Electricity sector	• Remove flue gas bypass on 9.72 GW of coal units[37] • 9.3 GW of NOx controls, add 0.86 GW of low NOx burners • Achieve overall 90% efficiency for SO_2 removal, 70% for NO_x removal

Table 4: Electricity Sector-Relevant Targets and Strategies in Jiangxi Province's *12th Five-Year Plan for Energy Conservation and Emission Reductions*[38]

2.5 Other Provincial Planning

In response to the national *Air Pollution Control Action Plan*, environmental bureaus at the provincial and municipal level develop annual implementation plans. These plans appear to share more of a common format across provinces, though they differ from the five-year energy conservation and emission reduction plans primarily in their substantive and geographic scope (focus in emissions, greater focus on cities); their timeframe (one year and a 2017 target date rather than five years and 2015 and

[37] Flue gas desulfurization (FGD) systems are often built with an optional flue gas bypass, for bypassing the scrubber in situations in which not all of the flue gas is required to be treated to meet SO_2 emission standards. Use of the bypass reduces energy requirements for the FGD unit, but also reduces SO_2 removal efficiency.

[38] Jiangxi Government. (2012). *Jiangxi Province 12th Five-Year Plan for Energy Conservation and Emission Reductions*《江西省节能减排“十二五”规划》. Retrieved from http://news.bjx.com.cn/html/20130418/429451.shtml

2020 target dates); the key planning and coordination agency (environmental bureaus rather than planning agencies); and in their level of ambition. Like the five-year energy conservation and emission reduction plans, however, the provincial action plans are compilations of measures rather than assessments of how targets can be achieved (Table 5).

Category	Electricity Sector Measures	
	Shanghai	Inner Mongolia
1. Expand pollution controls and reduce emissions	• Add NO_x controls on 15 generating units and high (removal) efficiency PM controls on 13 units	• Add NO_x controls on 121 generating units (34.79 GW), remove SO_2 gas bypass on 58 units (22.03 GW), expand SO_2 controls on 74 units (15.65 GW)
2. Improve industry structure and location; promote clean production	• None	• Create list of key enterprises for clean production audits in six sectors, including electricity sector • Develop circular economy in key sectors, including electricity sector
3. Accelerate changes in energy mix; increase clean energy supply	• Develop strategy for controlling coal use; increase natural gas supply and electricity imports • Restrict the sale of coal with an ash content greater than 16% and a sulfur content greater than local standards	• Increase installed (interconnected) capacity of wind (1.5 GW), solar (0.9 GW), and biomass (0.03 GW) generation; promote distributed rural wind and solar electricity • Increase share of washed coal to 55% in Western Inner Mongolia; restrict use of high ash and sulfur coal in cities

Table 5: Air Pollution Plan Measures Relevant to the Electricity Sector, Shanghai and Inner Mongolia[39]

2.6 Regional Electricity Planning

Regional electricity planning in China has historically focused on interprovincial transmission interconnections and, to a lesser extent, regional economic development. The latter appears to have been limited to one instance. In 2005, the NDRC conducted a *Medium- to Long-term Development Plan*

[39] See Shanghai Municipal Government. (2014). *Action Plan for Controlling Air Pollution in Shanghai Municipality: 2014 Implementation Plan* 《上海市大气污染防治行动计划: 2014 年度实施计划》Retrieved from http://www.sepb.gov.cn/fa/cms/upload/uploadFiles/2014-11-24/file1807.pdf; and Inner Mongolia Autonomous Region Government. (2014). *2014 Implementation Plan for Controlling Air Pollution in Inner Mongolia Autonomous Region*《内蒙古自治区 2014 年度大气污染防治实施计划》. Retrieved from http://www.nmg.gov.cn/xxgkml/zzqzf/gkml/201408/t20140829_341781.html

for the Northeast Region, in which it conducted a high-level assessment of demand, generation resources, and regional transmission from 2005 to 2020 and identified priority investment areas.[40]

Over the past decade, regional transmission planning has been under the jurisdiction of regional grid companies, largely subsumed within SGCC's ambitions for a national grid. Six regional grid companies were created as part of reforms in 2002. These six regional grid companies are responsible for planning the development of regional grids, including the development of medium- and long-term regional grid plans. Five of the regional grid companies are under SGCC jurisdiction, and their plans are developed in accordance with SGCC strategic plans.[41] China Southern Grid Company (CSG), the sixth regional grid, is not subject to SGCC oversight. Its 13th Five-Year Plan (2013-2020) was organized and compiled by NEA, with inputs by CSG.[42]

More recently, the *Air Pollution Control Action Plan* has spurred greater efforts at regional transmission planning, directed by NEA. These plans have focused on building transmission corridors to ensure sufficient electricity import supply to the Jing-Jin-Ji, Pearl River Delta, and Yangtze River Delta regions, which are not permitted to build new coal generation under the *Action Plan*. However, transmission planning prompted by the *Action Plan* is not part of a new, comprehensive regional generation or transmission planning process to determine regional compliance strategies. A study conducted by the Electric Power Planning & Engineering Institute (EPPEI) for NEA evaluating transmission projects for the Jing-Jin-Ji region, for instance, reportedly followed the SGCC's long-term transmission plan and did not assess whether exporting provinces would be able to meet their emission targets under the *Action Plan*.[43]

[40] NDRC. (2005). *Medium- to Long-term Development Plan for the Northeast Region* (东北地区电力工业中长期发展规划). Retrieved from http://www.sdpc.gov.cn/fzgggz/fzgh/ghwb/115zxgh/200709/P020070927315764173601.pdf

[41] See, for instance, North China Power Company. Company Overview (公司简介). Retrieved from http://www.nc.sgcc.com.cn/template/gsjj/index.shtml

[42] China Southern Grid. (2013). China's First 13th Five-Year Grid Plan Unveiled (国内首个"十三五"电网规划出炉). Retrieved from http://www.csg.cn/index/dbt/201309/t20130916_66692.html.

[43] This study is entitled *Research Report on Key Transmission Projects for the Air Pollution Control Action Plan*《大气污染防治行动计划重点输电通道研究论证报告》. For background on the study, see Li, C. (2014). EPPEI Plans Electricity Development in the Jing-Jin-Ji Region (电规总院全面规划京津冀电力建设). Retrieved from http://paper.people.com.cn/zgnyb/html/2014-04/14/content_1415420.htm. For a critique of this report, see Zeng, D. (2014). Using High Voltage AC to Address Pollution Challenges Lacks a Scientific Basis (交流特高压治雾霾缺乏科学依据). Retrieved from http://epaper.dfdaily.com/dfzb/html/2014-03/27/content_875850.htm

3. Project Approval

Since the early 2000s, project approval has often superseded planning, in determining the level and composition of investments in generation and transmission in China. In other words, generation and grid projects are not approved through a planning process that identifies need, or based on the willingness of project developers to accept the risk of revenue shortfalls. Instead, government agencies have historically approved new projects without any transparent, objective criteria for determining how much and what kind of generation and transmission capacity to build, and where to build it.

In many ways, this outcome was a consequence of institutional arrangements: ultimate responsibility for electricity reliability lies at a provincial level, most project approval authority is concentrated at a national level, the central government has lacked a national planning process for the electricity sector, and investors do not receive sufficient cost or price signals to efficiently guide new investments. As a result, there is an ongoing disconnect between electricity supply and demand, and between policy goals for the sector and actual investments.

3.1 Project Approval Process

Electricity generation, transmission, and distribution projects are all subject to government approval. The approval process consists of government review (审批制 | shenpi zhi), project approval (核准制 | hezhun zhi), and project registration (备案制 | beian zhi) systems, which apply to different kinds of projects and are carried out by different levels of government, depending on project type. In addition, new projects are required to obtain permits from different government ministries for land (siting), water, and environmental impact assessment.

The allocation of responsibility for project approval across different levels of government has evolved in the context of a struggle between national industrial and economic policy and local government development priorities. Before 2004, investment projects were reviewed by different government agencies on the basis of their investment size, with larger projects reviewed by the central government and smaller projects reviewed locally. Because of the arduousness of the central-level approval process, a slowdown in central government power project approvals in the wake of the Asian Financial Crisis (1997–1998), and acute power shortages in 2003 and 2004, local governments supported a large number of small-scale coal-fired power plants, as well as larger-scale plants that were never approved and were technically illegal.[44]

[44] See, for instance, Oster, S. (2006). Illegal Power Plants, Coal Mines In China Pose Challenge for Beijing. *Wall Street Journal.* Retrieved from http://www.wsj.com/articles/SB116718773722060212

Power Generation				
Generation Type	**2004**		**2013**	
	Classification	**Approval Authority**	**Classification**	**Approval Authority**
Reservoir Hydropower	Major river, ≥ 250 MW	NDRC	Major river	NDRC
	Other hydropower	Local investment planning agencies	Other hydropower	Local governments
Pumped hydropower		NDRC		NDRC
Thermal	All central station	NDRC	Central station	NDRC
			Distributed natural gas	Provincial governments
CHP	Coal	NDRC	Back pressure coal-fired[45]	Provincial governments
	Other CHP	Local investment planning agencies	Other coal-fired	NDRC
			Non coal-fired	Local governments
Wind	≥ 50 MW	NDRC		Local governments
	< 50 MW	Local investment planning agencies		
Nuclear		State Council		State Council

Electricity Transmission and Distribution				
2004		**2013**		
Voltage Level	**Approval Authority**	**Jurisdiction**	**Voltage Level**	**Approval Authority**
≥ 330 kV	NDRC	Interregional, interprovincial	≥±400 kV DC, 500 kV AC	NDRC
		Provincial	≥±400 kV DC, 500 kV AC	NEA
< 300 kV	Local investment planning agencies	Provincial	< 500 kV AC	Local governments

Table 6: Approval Authority for Different Kinds of Electricity Infrastructure Projects in the 2004 and 2013 State Council Investment Catalogues[46]

45 Back pressure turbines are used primarily in process steam applications.

In 2004, the State Council issued its *Decision on Investment System Reform* ("*Decision*"), which stipulated three main changes to the project approval system.[47] First, projects that are not funded by the central government do not require government review (审批| shenpi), and projects that receive direct subsidies, on-lending,[48] or preferential interest rates only require review of their funding applications. Second, only large and "restricted" projects require government approval, with the scope of approval authority at different levels of government spelled out in an "investment project catalogue" (投资项目目录 | touzi xiangmu mulu). Third, projects that do not require government approval at any level are required only to be registered with local planning agencies, based on rules set by provincial governments. In practice, most new electricity infrastructure projects do not receive central government funding and so do not require review, but do require government approval.

Investment project catalogues are published both by the central government and local governments, assigning approval authority for different kinds of investment projects to different agencies. In 2013, the State Council revised the national catalogue, nominally decentralizing approval authority for wind, distributed generation, some combined heat and power (CHP) generation, and within-province higher voltage AC transmission to local governments, while centralizing some approval authority for hydropower.[49] This change was part of a larger effort to "simplify government and decentralize authority" (简政放权 | jianzheng fangquan). Table 6 on the previous page shows the national catalogue for electricity generation and grid projects for 2004 and 2013.

As part of the approval process, new projects are required to submit a project application (项目申请书 | xiangmu shenqing shu) and six accompanying reports: a feasibility study (可行性研究报告 |kexingxing yanjiu baogao), a system interconnection report (接人系统报告 | jieru xitong baogao), an environmental impact assessment report (环境影响评价报告 | huanjing yingxiang pingjia baogao), a report demonstrating water resources (水资源论证报告 | shui ziyuan lunzheng baogao), a geological assessment report (地质评价报告 | dingzhi pingjia baogao), and an earthquake safety assessment report (地震安全性评价报告 | dizhen anquanxing pingjia baogao). These documents must be prepared by a "qualified" (有资质 | you zizhi) engineering consulting firm. In practice, most are completed by subsidiaries of the CEEC.

[46] Solar energy was not explicitly included in the 2013 catalogue but falls in the same category as wind. NDRC in this table refers to the "State Council investment managing department" (国务院投资主管部门 | guowuyuan touzi zhuguan bumen). The table is based on State Council, 2004, and State Council. (2013). *Investment Catalogue for Investment Approval* (政府核准的投资项目目录（2013 年本）). Retrieved from http://www.gov.cn/zwgk/2013-12/13/content_2547379.htm

[47] State Council. (2004). State Council Decision on Reforming the Investment System《国务院关于投资体制改革的决定》. Retrieved from http://www.gov.cn/zwgk/2005-08/12/content_21939.htm

[48] On-lending loans are preferential loans from foreign governments and financial institutions.

[49] For wind power projects, the 2004 catalogue had granted approval authority for projects less than 50 MW to local governments, which led to a large number of 49.5 MW projects. The 2013 catalogue grants approval authority for all wind projects to local governments.

Project (year)	Type	Capacity	Arguments for Necessity
Qianxi (2014)	Coal	2 x 660 MW	• Development of western Guizhou Province • Relieving chronic power shortages in Chongqing Municipality • Implementing strategic agreement between Guizhou and Chongqing • Conserving coal resources (as a minemouth project)
Wujianfang (2013)	Wind	49.5 MW	• Growing industrial energy demand in Liaoning Province • Overcoming fuel bottlenecks in Liaoning • Environmental and grid benefits of wind • Wind industry development
Yuhuan Expansion (2013)	Coal	2 x 1000 MW	• "Large replace small" (上大压小 | shang da ya xiao) project for Huaneng • Meet electricity demand in Zhejiang, maintain grid safety • Relieve supply constraints in the Wenzhou grid, increase grid operating safety • Increase energy consumption efficiency, consistent with national policy • Relieve pressure on supplies caused by delays in nuclear plants in Zhejiang • Efficiently use land resources
Jinggang Expansion (2013)	Coal	2 x 660 MW	• Relieve power shortages in southern Jiangxi • Improve the balance of thermal and hydro generation • Relieve north-south congestion in Jiangxi • Improve regional development

Table 7: Necessity Arguments for Example Projects[50]

[50] See Southwest China Electric Power Design Institute. (2014). Environmental Impact Assessment Report (Official Version): Huarui Electric Mine-Mouth Qianxi Coal Plant (2 x 660 MW) Project (环境影响报告书 [送审版]: 华润电力煤电一体化黔西电厂 [2 x 660 MW] 新工程). Retrieved from http://hps.mep.gov.cn/jsxm/xmsl/201401/W020140925363509362993.pdf; Kang Ping County Wujianfang (49.5 MW) Wind Project (康平县五间房 [49.5MW] 风电场建设项目), Retrieved from http://www.syxmw.com/UploadFiles/UpFiles/康平县五间房电场项目_20130619090431.doc; Huaneng. (2013). Yuhuan Phase 3 Expansion Project Site Selection Report (华能玉环电厂三期"上大压小"扩建工程规划选址研究报告). Retrieved from http://jst.zj.gov.cn/jsxx/ygghold/hnyh0205/hnyh0205.doc; Jiangxi Development and Reform Commission. (2013). Notes from

In their applications and reports, all projects are required to demonstrate "necessity" (必要性 | biyaoxing) and access to sufficient water and fuel resources. In project approval documents, necessity is not determined through the planning process. It typically includes two main components: (1) qualitative consideration of nearer- and longer-term expected peak demand, and (2) consistency with local and national policy (see Table 7). The former may, but does not always, include load-resource balance projections and projected shortfalls at five-year planning intervals. The latter typically includes resource and environmental policy and, to a lesser extent, strategic agreements between provinces.

Although the 2004 *Decision* was intended, in part, to reduce the onerousness of central government review and streamline the approval process, it did not lead to substantial changes in practice. To reduce the investment risks of the lengthy approval process, along with the 2004 *Decision* the State Council created a "pass" (**路条** | lutiao) system for generation and transmission projects, whereby projects were required to receive permission from the NEA before beginning the formal approval process.[51] This pass was, in effect, an indication of intent to approve. The pass system granted vast discretionary authority to the NEA. This combination of unchecked decision-making power and the lack of a transparent process and criteria for making those decisions facilitated large-scale corruption, with the head of the NEA and several members of its senior leadership arrested in 2013 and 2014.[52] In addition, because of the difficulty of obtaining an NEA pass, provincial governments continued to support construction of large coal-fired generation projects without NEA approval.[53]

In mid-2014, the NEA announced that it would make changes to the approval process for coal-fired generation, simplifying and linking it to a national planning process. Under this approach, the NEA determines new annual coal generation capacity needs for each province over a five- to seven-year time frame, and each year provincial governments decide which projects to approve and submit the entire portfolio of projects to the NEA for review and approval, using transparent criteria to evaluate different

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Review Meeting on Huaneng Jinggang 2 x 660 MW Expansion Initial Feasibility Report (华能井冈山电厂三期扩建 2 台 66 万千瓦机组工程初步可行性研究报告评审会议纪要). Retrieved from http://www.jxdpc.gov.cn/departmentsite/nyj/tztg/gztz/201311/t20131120_101137.htm

[51] Under this system, projects are first required to submit a project application and initial feasibility study to provincial government agencies, to obtain a "small pass" (小路条 | xiao lutiao). Provincial agencies and the project financer then submit a project application to the NEA, receiving a "big pass" (大路条 | da lutiao) if the project is successful. Once the project receives a big pass, it can begin the six afore-mentioned reports. In effect, the pass system required representatives from provincial governments to heavily lobby the NEA to obtain approval for new projects. Because this required frequent trips to Beijing, this process of lobbying was often referred to as "running for the pass" (跑路条 | pao lutiao).

[52] See, for instance, Wang, X. (2013). Liu Tienan Incident Reveals Rent Seeking Opportunities all along Project Approval Process (刘铁男案暴露能源审批利益链：每个环节都有寻租空间) *21st Century China Business Herald.* Retrieved from http://jingji.21cbh.com/2013/8-22/2MNjUxXzc0Nzg2MA.html; and Li, F. (2014). Which NEA Department is Most Corruptible: Three Recently Sacked Officials were Involved with Electricity Project Approval (能源局哪个部门更易腐败：近期落马 3 官员均曾涉电力审批). *China Economic Weekly.* Retrieved from http://energy.people.com.cn/n/2014/0722/c71661-25313820.html

[53] This was referred to as the "build without approval" (未批先建 | wei pi xian jian) problem. Partly as a reconciliation measure in the wake of corruption scandals, in 2013 the NEA reportedly approved nearly 8 GW of large (≥ 600 MW) coal-fired units that had circumvented the formal approval process. See, for instance, Wang X. (2014). Reforms in Coal Generation Project Approval: NEA Bundles Passes (火电核准变革：国家能源局将打捆发"路条"). Retrieved from http://jingji.21cbh.com/2014/6-11/zNMDA2NTFfMTE5NjUzNg.html

projects.[54] This model is still evolving and remains controversial.[55] Importantly, it focuses only on coal-fired generation projects, and it is unclear whether the NEA will conduct a more comprehensive generation adequacy planning process to identify the need for coal units as part of a broader portfolio of resources.

For other generation resources, planning and approval is also still in flux. For instance, despite nominally decentralizing approval authority for wind projects to local governments, as a stopgap measure the NDRC and NEA still conduct an annual approval plan (年度核准计划 | niandu hezhun jihua) through which new wind projects are approved. The rationale for maintaining project approval at a national level centers around the central government's desire to: (1) control the pace of wind development, to maintain a better balance between the pace of development and the fund maintained by the Ministry of Finance to pay a portion of wind generators' feed-in tariff; and (2) better optimize wind project siting and address wind curtailment.[56]

[54] The NEA described this new approach as having five characteristics: (1) national supply-demand balancing, (2) central government determines scale (need), (3) local governments choose the optimal mix of projects, (4) consulting firms support decision-making, (5) regulation guarantees successful implementation (全国衔接平衡、国家确定规模、地方优选项目、咨询支持决策、监管保障实施). See NEA. (2014). National Energy Agency's New Coal-Fired Unit Review Mechanism, Simplifying Government and Decentralizing Authority (国家能源局简政放权创新燃煤火电项目审批机制). Retrieved from http://www.nea.gov.cn/2014-01/30/c_133085359.htm

[55] Commonly cited concerns include the lack of checks on local governments for overbuilding generation capacity, potential new opportunities for rent seeking behavior among national agencies, moral hazard and incentives for local governments to exceed NEA-determined need amount, and the ability to coordinate planning between central and provincial government agencies. See Xiao, Q. (2014). Does Letting Go Mean No Checks? NEA Devolves Approval Authority for Coal-fired Power Plants, Regulation Could Be a Difficulty (国家将下放全部火电审批权力，监管或成难题放手意味着放弃把关吗？). *China Environment News*. Retrieved from http://www.cenews.com.cn/qy/cyxw/201410/t20141009_781749.html

[56] Currently, the portion of renewable feed-in tariffs in excess of the benchmark price for coal generation is paid for through a national surcharge on electricity, managed and reallocated by the Ministry of Finance. If renewable development is more rapid than anticipated, the surcharge rate and funds available to pay renewable generators will be too low. See Qu J. (2014). The Co-Existence of Decentralized Wind Project Approval and Annual Planning is a Stopgap Measure (风电放权和计划管理并存是权宜之计). *Science and Technology Daily*. Accessible at http://digitalpaper.stdaily.com/http_www.kjrb.com/kjrb/html/2014-02/26/content_248823.htm?div=-1.

4. Challenges for Renewable Energy

For renewable energy, shortcomings in electricity planning have most visibly manifested themselves in high levels of wind and hydropower curtailment — output that is effectively discarded.[57] Wind curtailment in the "Three Norths" (三北 | San Bei) region, where the bulk of China's wind output is generated, was 18 percent of estimated potential generation in 2012 and 15 percent in 2014.[58] Hydropower curtailment has been concentrated in Yunnan Province, reportedly reaching more than 25 percent of potential generation in 2013.[59]

High levels of curtailment have multiple causes, but these have often been framed as problems of insufficient "absorption" (消纳 | xiaona) capacity — a lack of sufficient demand to consume the expected output of wind and other generators. For wind, a 2012 study by the erstwhile State Electricity Regulatory Commission (SERC), *Report on Wind Absorption in Key Areas*, identified five main causes of high curtailment, all of which are related to breakdowns in current planning processes:[60]

1) *Lack of coordination between wind generation and transmission planning.* Wind development in some areas was much larger and faster than specified in five-year plans, causing transmission congestion as interconnection and network upgrades could not keep pace. Additionally, in some areas, little consideration was given to electricity demand in approving wind projects.
2) *Mismatch between project approval and transmission planning timelines*. Wind developers circumvented rules in order to push projects; for instance, developers separated large wind projects into a number of small (mostly 49.5 MW) projects to be under the 50 MW threshold for local project approval. Given transmission projects' longer planning and construction cycles, transmission development struggled to catch up with wind development.
3) *Lack of local demand or transmission export capacity*. Although SERC believed that wind generation should, in principle, be consumed provincially, in the Northeast and Northern grids wind output was higher than provincial, and, in some cases regional, absorption capacity. The Northeast already had a surplus of thermal generation. The Northeast, North, and Northwest grids lacked sufficient transmission export capacity to export surplus wind to other regions.

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[57] Delays in wind interconnection are also a manifestation of planning failures, but are not dealt with here.

[58] This includes the northeast (Liaoning, Jilin, Heilongjiang Provinces and eastern Inner Mongolia), northern (Beijing and Tianjin Municipalities, Hebei, Shanxi, Shandong Provinces, and western Inner Mongolia), and northwest (Shaanxi, Gansu, Qinghai, Provinces and Ningxia, Xinjiang Autonomous Regions) grid regions. Curtailment data for 2012 are from SERC. (2012). Report on Wind Absorption in Key Areas (重点区域风电消纳监管报告). Retrieved from http://www.eeechina.cn/upload/file/电监会重点区域风电消纳监管报告.pdf. Data for 2014 are from NEA. (2014). Wind Industry Continued to Maintain Stable Development in 2013 (2013 年风电产业继续保持平稳较快发展势头). Retrieved from http://www.nea.gov.cn/2014-03/06/c_133166473.htm

[59] Energy curtailment estimates are reportedly uncertain, though according to news reports 20 TWh is likely conservatively low. Yunnan reportedly had 52.873 TWh of hydropower generation in 2013, which would imply a curtailment rate of potential generation of 20/(20 + 52.873) = 27%. For curtailment estimates, see Zhang, H. (2013). Yunnan Hydropower Curtailment Investigation: What Conflicts are Driving this Strange Phenomenon. *Energy*. Accessible at http://finance.sina.com.cn/chanjing/cyxw/20130708/125816049114.shtml. For Yunnan 2013 hydropower generation, see China Wind Power Center. (undated). China Wind Curtailment Report (中国风电弃风限电分析报告). Retrieved from http://www.cwpc.cn/cwpp/cn/services/cwpc-news-service/609/

[60] SERC, 2012.

4) *Lack of balancing resources, despite increased need*. Higher penetrations of wind increased the need for balancing resources, but regions with higher penetrations of wind generation have few balancing resources (e.g., hydro, pumped storage, gas) and too much inflexible coal-fired generation. For instance, the share of inflexible combined heat and power (CHP) capacity in total capacity was too high, leading to wind curtailment in the winter when CHP units were being operated to provide heat.
5) *Lack of flexible pricing mechanisms and optimized dispatch*. The current energy-only benchmark price for coal units created conflicts between coal generators, which needed to operate a planned number of fully-loaded hours to recover their fixed costs, and wind generators, which wanted to generate whenever possible to earn the feed-in tariff. When coal and wind units came into financial conflict and some units needed to be curtailed, there were no competitive or environmental criteria for identifying which units these should be.

High levels of hydropower curtailment in Yunnan have similar causes. A 2013 analysis by the Yunnan Power Grid Company, *Report on Hydropower Absorption Problems*, identified three causes of high curtailment:[61]

1) *Scheduling conflicts.* Four major hydropower units (2.8 GW) came online before originally planned.
2) *Wind generation*. More than 1.5 GW of new wind projects came online in 2013, "squeezing generation space" (挤占发电空间 | jizhan fadian kongjian) for hydropower during the rainy season.
3) *Delayed transmission projects*. A planned 1.5 GW DC transmission corridor intended to export power to Guangxi has yet to be approved.

There are, however, two more fundamental root causes: (1) lack of planning or market mechanisms to align supply and demand, and (2) the political economy intersection between local generation and regional transmission planning. Beginning in the late 2000s, a large number of new hydropower projects began construction in Yunnan, were expected to increase the province's total hydropower installed capacity from 34 GW in 2012 to nearly 65 GW in 2015. Yunnan is itself projected to have a 30 GW peak demand in 2015, and peak hydropower output during the summer monsoon season will likely exceed both local demand and transmission export capacity.[62] In other words, supply grew much faster than demand, not because of an incorrect demand forecast, but rather because new projects were built without regard to demand.[63] This mismatch between supply and demand stems in large part from the

[61] These are cited from Zhang, H., 2013. The Chinese title of the report is 云南水电消纳问题.

[62] For instance, in normal precipitation years gross capacity factors for hydropower in Southwest China are typically in the range of 60-70% from June through September. Assuming minimal own use and operating and planning reserves provided by thermal units, this implies a need for between 8 and 15 GW of export transmission capacity just to balance hydropower output (i.e., not including wind and coal output). Yunnan peak demand data are cited from Zhang, H., 2013. Hydropower capacity factors are from Kahrl, F., Williams, J.H., Hu, J. (2012). The Political Economy of Electricity Dispatch Reform in China. *Energy Policy* 53: 361-369.

[63] As described by an official from the Yunnan Provincial Energy Agency, "Currently in Yunnan's hydropower development there have been problems in linking production and absorption, they have been out of step" (目前，我省水电的发展，在生产和消纳衔接上确实暴露出一些问题，出现不同步的情况). Cited from Zhang, H., 2013.

lack of more rigorous provincial, regional, and national planning processes for generation adequacy and transmission reliability.

Regional generation adequacy and transmission planning are themselves embedded in regional political economy. Yunnan’s primary market for electricity exports has been Guangdong Province. Neighboring Guangxi Province could potentially increase its electricity imports from Yunnan, but a proposed direct current (DC) transmission line from Yunnan to Guangxi has been held up in dispute. The traditional approach to building cross-provincial transmission for electricity exports in China has been through the use of point-to-network DC lines, where power flows only from a large generator to the importing province and not through the exporting province’s transmission system. Yunnan’s government reversed its stance on the proposed DC line to Guangxi, stating that it supported a network-to-network AC line instead, which would give Yunnan an option to consume future hydropower output itself.[64] It argued that Yunnan is being forced to bear the human and environmental cost of dams, while importing provinces are being provided access to inexpensive power imports that do not reflect those costs. The regional grid company (China Southern Grid) and NEA, alternatively, argued that a point-to-network DC line would be less expensive and present fewer operational challenges.[65] There is currently no formal process or methods for resolving these kinds of disputes in China.

4.1 Four Key Planning Challenges

These high levels of wind and hydropower curtailment are symptoms of more fundamental failures in institutions that determine how much and what kind of generation and transmission capacity to build, and where to build it. Addressing these failures will require tackling planning challenges in three areas:[66]

- *Generation planning*: ensuring a better match between generation investment and the generation capacity needed to reliably meet demand, and facilitating a more flexible, lower cost generation mix.
- *Transmission planning*: integrating generation planning into transmission planning, and encouraging a more economically efficient expansion of the transmission system.
- *Environmental planning*: integrating environmental goals into electricity planning and resource procurement.

Central to improving planning in these three areas is a fourth challenge: strengthening organizational capacity and information access.

[64] In other words, with a dedicated DC line the hydropower facilities were slated for permanent export, whereas if they were interconnected into the Yunnan bulk transmission system they could be used for near-term export, and then potentially for consumption in Yunnan at some point in the future.

[65] This narrative is based on Zhang, H., 2013.

[66] This section focuses on the nature of planning challenges. For more on how they might be resolved, see Regulatory Assistance Project. (2013). *Recommendations for Power Sector Policy in China Practical Solutions for Energy, Climate, and Air Quality*. Beijing, China: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/6869; and Regulatory Assistance Project. (2014). *Low-Carbon Power Sector Regulation: International Experience from Brazil, Europe, and the United States*. Beijing, China: Regulatory Assistance Project. Retrieved from http://www.raponline.org/document/download/id/7432

4.1.1 Generation Planning

In North America, generation planning typically includes two elements: (1) a generation adequacy planning process, and (2) mechanisms, whether regulatory or market-based, to facilitate a least-cost mix of generation resources. In China, generation planning has traditionally been carried out as part of the five-year planning process, a nationwide effort that spans the entire economy. For more than a decade, however, China has not had a national five-year plan for the electricity sector, even though project approval authority for most kinds of generation has been controlled by the central government. Although provincial governments have continued to conduct five-year electricity plans that include supply-demand balance analyses, these are not used in generation investment decisions (Section 2). As a result, investment decisions and project approval have been disconnected, to a significant degree, from the planning process (Section 3). Although the NEA has recently made efforts to reconnect planning and investment (Section 3), there are still no comprehensive generation adequacy processes, nor are there mechanisms for encouraging a least-cost mix of resources.

This lack of more formal, comprehensive, and rigorous generation adequacy planning processes has led to an overbuilding of both conventional and renewable generation relative to electricity demand, resulting in higher than necessary costs and emissions. The lack of mechanisms and a process to encourage a least-cost portfolio of generating resources also results in generation mixes that are operationally incompatible, leading to renewable curtailment and higher costs and emissions. For instance, the rapid development of wind and inflexible CHP units in the Northeast grid led to what should have been foreseeable operating conflicts between them.

Improving generation planning will require addressing a series of fundamental questions, including:

- Should generation planning be provincial or regional, and which organization or organizations should be responsible for the process?
- How should central government objectives and policies guide and be reflected in provincial or regional plans?
- Should generation adequacy be implemented through capacity obligations on load serving entities, or through some other means?
- How should compliance with generation adequacy requirements be enforced?
- How should the contribution of renewable resources to generation adequacy be treated?
- In the near and longer term, how can central and provincial government agencies encourage a more economic mix of generation resources?

There is a strong rationale for a regional approach to generation planning, given the high spatial concentration of hydropower, wind, and solar resources in China. This would require closer coordination among provinces, and a national or regional organization with a formal process to set regional capacity targets, assess the amount of generation capacity in different areas that counts toward those targets, and monitor compliance.

4.1.2 Transmission Planning

New transmission projects in North America are typically evaluated by grid companies and regulators using reliability and, in some cases economic and environmental, criteria, which ensures that transmission expansion faces benefit-cost constraints and follows growth in load and generation. In

China, there are no formal, objective criteria through which transmission projects are evaluated, making it difficult to rationalize transmission investment. The lack of a more formal generation planning process means that generation and transmission expansion are often uncoordinated, as the above Three Norths and Yunnan examples illustrate.

New transmission is critical for cost-effectively integrating renewable energy into China's power systems. Without it, China will continue to have areas with surplus renewable energy relative to demand, and higher curtailment rates, costs, and emissions than necessary. Ensuring that renewable generation and transmission develop in concert will require mechanisms to better integrate generation planning into transmission planning. It will also require new planning and regulatory tools that allow the NEA to assess the reliability, economic, and environmental benefits of transmission projects.

As with generation planning, there is a strong rationale for a more joint, regional approach to transmission planning. China already has the organizational infrastructure for regional transmission planning, and both SGCC and China Southern Grid develop regional and interregional transmission plans. However, the focus of regional transmission development has been on interconnecting individual generating facilities with provincial grids rather than on facilitating greater interconnection among provincial grids. The latter could bring a number of benefits, including increased reliability and reduced curtailment, costs, and emissions, but it requires negotiation of how transmission and operating costs would be allocated among provinces.

4.1.3 Environmental Planning

Although the electricity sector is the largest source of emissions in China, there is no process to determine what the sector's contribution to criteria pollutant and CO_2 emission reductions should be, in the nearer and longer term. As a result, renewable energy may be undervalued as an emission reduction strategy. Historically, renewable energy has not been explicitly considered as an emissions reduction strategy. Instead, the electricity sector's focus has been primarily on heat rate improvements and emission controls on coal-fired units.

Given regional renewable resource disparities in China, optimal use of renewable resources for reducing emissions is likely to be regional or interregional. For instance, the three regions that are the focus of air quality improvements under the Action Plan —Jing-Jin-Ji, the Yangtze Delta, and the Pearl River Delta — can achieve their air quality goals by increasing imports and "outsourcing" their emissions to export provinces. However, this may lead to export provinces exceeding their own emissions goals. As a regional strategy, renewable energy could play an important role in achieving air quality goals throughout China, allowing resource-constrained regions to meet their goals without pushing exporting regions out of compliance. This would require regional environmental planning processes focused around the electricity sector.

4.1.4 Organizational Capacity and Information Access

The smooth functioning of electricity planning depends on well-designed and managed processes, with clear allocation of roles and responsibilities (who does what), clear schedules (by when), transparent methods and standards (how), and adequate information to support decisions (on what basis). Adequately staffed and funded implementing organizations are critical to effective planning.

In China, energy agencies are often understaffed relative to their mandates. For instance, NEA currently has a staff of 240 persons to plan, oversee, and regulate China's entire energy sector.[67] The U.S. Federal Energy Regulatory Commission (FERC), by contrast, has a staff of 1,500 people to regulate a more limited part of the U.S. energy industry.[68] A key lever in improving electricity planning in China is increasing the staffing and improving the organizational capacity of energy agencies.

In general, China's electricity industry is in need of greater transparency, to support coordination among planning processes and improve investment decision-making. Currently, government agencies and industry participants lack access to basic data that should be used in decision-making. For instance, data that have historically been withheld as corporate secrets, such as load data, need to be made available, either publicly or on a non-disclosure basis, to allow government agencies and industry participants to better plan and make more informed decisions.

4.2 Prioritizing Institutional Innovation

Improving electricity planning in China will require the political will to design, implement, and adapt new planning institutions. The challenges that planning failures present for renewable energy have been recognized for more than five years, but policymakers have not yet demonstrated the political will to make significant institutional changes.[69] Instead, the focus of problem-solving for renewable integration thus far has been on piecemeal fixes. For instance, the response to high levels of wind, solar, and hydropower curtailment has been to accelerate approval and construction of cross-province transmission projects and limit wind and solar development in provinces with surplus generation, rather than to improve planning processes.[70]

The need for innovations in electricity planning institutions occurs as China is entering a new round of electricity reforms. The appropriate design of those institutions is, to some extent, dependent on industry structure and reform pathways, and the redesign of planning processes should be a focus of reforms. However, a number of more fundamental changes needed to support improved planning, such as organizational capacity and improved transparency, are path independent. In both cases, improvements in planning institutions will require long-term focus and commitment; they are not a necessary outcome of, nor are they obviated by, reforms.

[67] NEA. A Brief Overview of NEA (国家能源局简介). Retrieved from http://www.nea.gov.cn/n_home/n_nyjjj/index.htm

[68] See FERC website: http://www.ferc.gov/help/faqs/about.asp.

[69] For instance, these challenges were explicitly recognized in the Revisions to the Renewable Energy Law in 2009.

[70] See, for instance, China Electricity Council. (2014). China Electricity Council Releases Analysis and Forecast of Third-Quarter National Electricity Supply and Demand (中电联发布 2014 年前三季度全国电力供需形势分析预测报告). Retrieved from http://www.cec.org.cn/guihuayutongji/gongxufenxi/dianligongxufenxi/2014-11-02/129461.html