

Observations and Suggestions
观察与建议

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Electricity Sector Challenges and
Future Policy Directions

中国电力行业面临的挑战和未来
政策方向

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Abstract

摘要

- Although significant achievements have been made in the electricity sector development through the previous and ongoing reforms, it has to confront new issues and challenges such as optimization of resources, environmental constraints, and climate change and low-carbon imperatives.

虽然中国电力行业通过之前和现今的电力改革取得了很大的成就，但是也面临着一些新的问题和挑战，诸如：资源优化、环境保护、气候变化和低碳化转变。

- Given the magnitude of the above mentioned challenges, the underlying needs to move towards market mechanisms have become more compelling. The need for efficiency, competition, market-based pricing and independent regulator are key and common elements that have worked well internationally. These elements are present in the PRC's electricity sector but they need to be strengthened.

考虑到上述挑战的难度，向市场机制过渡已经成了难以抗拒的选项。效率、竞争、市场定价机制、以及独立的监管机构等要素是世界范围内电力市场建设的主旋律。中国电力行业已经有了这些要素，但是尚需加强。

- Looking ahead, the electricity sector has to pass through a very difficult phase of transformation to a low-carbon, highly efficient, and customer oriented system. This will require a suitable blend of sophisticated market-based policies together with smart regulations, some of which are recommended in this policy note.

展望未来，电力行业尚需经历一个艰苦的过程才能最终转变成一个低碳、高效、以用户为导向的系统。为了实现这一愿景，电力行业不仅需要有设计精巧的市场化政策也需要有明智的管理方法，此文涉及的政策建议只是这些政策中的一部分。

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I. INTRODUCTION

1. The electricity sector in the People's Republic of China (PRC) includes the technically most complex infrastructure that produces and delivers electricity just-in-time to almost the entire population across the country through wires. It has come a long way from an estimated less than 2 gigawatt (GW) of installed capacity in 1949 to more than 900 GW by 2010. After initial sluggish start, the sector has grown rapidly, particularly in the past two decades. During the 2001–2010 period alone, it has almost tripled its capacity.

2. But even with the rapid growth, the electricity sector has been in adjusting to the surging electricity demand. The summer peak demand and the winter peak, combined with transport difficulty for coal, stress the fragile demand-supply balance, which has often resulted in seasonal shortages. The under and overcapacity cycles—electricity shortages in 2003–2004 and 2010–2011, and surplus capacity in 2008–2009 are causing ripple effects throughout the economy.

3. The PRC's electricity sector has generally kept pace with the technological advancement and sophistication needed to plan, construct, operate, and manage such a complex infrastructure. While it had its share of stresses, it has performed remarkably well and managed to avoid catastrophic failures as experienced elsewhere on similar networks with comparable coverage and complexity.

4. Although significant achievements have been made in the electricity sector development through the previous and ongoing reforms, it has to confront new issues and challenges such as optimization of resources, environmental constraints, and climate change and low-carbon imperatives. These issues have become or will become key drivers for change and put pressure for further reforms and innovations. This policy note looks into major challenges and constraints in the electricity sector aiming at providing suitable policy recommendations to restore the sector's health as well as ensuring its long-term sustainability.

II. CHALLENGES AND CONSTRAINTS

5. **Unrestrained demand growth.** The unbalanced economic structure with significantly high proportion of energy-intensive industrial output combined with regulated low electricity prices have resulted in a surge of electricity demand. In 2010 alone, electricity demand grew by more than 15%. Although rebalancing the economy with greater role of less energy-intensive service sector is evolving, the overemphasis of supply-side measures to meet the growing demand is unsustainable in the medium- to long-term. The elasticity of electricity demand to gross domestic product, which has been consistently at above 1 for many years, needs to be brought down to below 1 in the near-term, and should gradually reach around 0.5–0.7.

6. **Distorted electricity pricing.** The current pricing mechanism is anchored on administrative measures of checks and balances, which do not capture market realities and fail to provide the right

incentives to potential investors and operators. This is evident from the conflict between the coal and electricity prices. While the coal prices have been liberalized since 2002, the price of coal-based electricity—which are highly sensitive to coal prices (every 1% increase in the price of coal requires corresponding 0.7% increase in electricity price)—are still tightly regulated and often do not fully reflect the increase in coal prices. When electricity prices are kept low, it becomes more difficult to encourage energy efficiency or electricity conservation.

7. **Limited private investment.** Most of the large investment needs (some \$100 billion annually) are currently met without much private investment. The huge investment needs in trillions of dollars over the next 20 years suggest a bigger role for private investments. Entry of private sector will trigger more competition, improve service quality to consumers and stimulate innovations. The renewable energy segment since 2006 has successfully demonstrated that transparent tariff setting with commercially sound long-term electricity off-take arrangement may attract private investment.

8. **Critical transmission bottlenecks.** Coal and hydropower provide more than 90% of electricity in the PRC. But compared to the major load centers in the south (Fujian and Guangdong) and east (Shanghai and Zhejiang), the major coal resources are in the north (Henan, Inner Mongolia, Shaanxi, and Shanxi) and north-east (Heilongjiang, Jilin, and Liaoning), and hydropower resources in the south-west (Sichuan, Tibet, and Yunnan). Likewise, major renewable energy resources—wind and solar—are located far away from major load centers. This geographical mismatch requires a national electricity grid to balance demand and supply across regions. While the PRC now invests more in transmission than in electricity generation, the historical lack of investment in transmission is still limiting the rapid development of the national electricity grid.

9. **Slower sector reforms.** The major structural reforms initiated in 2002 when the State Power Corporation was split into five generating companies and two grid companies have since stalled. But 10 years on, there is urgent need to revisit sector organization and critically examine the way forward. The creation of five generating companies was expected to provide much needed competition but due to slower progress on complementary reforms, such as electricity market, the competition and efficiency benefits from the restructuring were undermined.

10. **Limited policies to catalyze innovations.** The current sector policies with near-exclusive focus on price to ensure cost recovery, even for a new and innovative technology during its incubation, are serious impediments for fostering innovations. This approach coupled with limited risk sharing mechanisms (such as direct financing, loan guarantee, and tariff support) available from the government, potentially delays the introduction and deployment of innovative technologies.

11. **Lack of market-based mechanism.** The difficulties in achieving the ambitious 20% energy intensity improvements during the 11th Five-Year Plan (2006–2010) clearly suggest the limitation of administrative measures in achieving such objective. Moving ahead, the climate change mitigation efforts will intensify further, which will have a profound impact on the electricity sector, which is the largest contributor of greenhouse gases in the PRC. Hence, meeting expected carbon constrained

targets, will require the introduction of market-based mechanisms, including carbon price, carbon tax and cap-and-trade.

III. POLICY RECOMMENDATIONS

A. Near-term (1–2 years)

12. **Remunerative tariff for electricity generation.** The current distortion in tariff setting for coal-fired power plants will, in the short-term, accentuate the electricity shortages, and in the medium-to long-term, undermine investments in new capacity. A suitable price adjustment algorithm for fossil fuel (coal and natural gas) plants to reflect full pass-through adjustments may be developed and transparently applied. Such adjustments are universally applied across many developed and developing countries and are fundamental for plant operators and developers.

13. **Regulation and time of use tariff.** The electricity shortages are generally during few peak hours in a day. A mix of regulations and time-of-use tariff incentives can be considered to encourage bulk electricity consumers such as large industrial enterprises to move their production to off-peak time, thereby smoothing the intra-day electricity demand profile.

14. **Public outreach and education program.** International experiences show that when a message is well received by electricity consumers, it may lead to moderating the demand growth. A well directed public education program to conserve electricity should be mainstreamed by the government offices and publicly funded agencies. This program may also be used to sensitize consumers to inevitable increase in electricity prices.

B. Medium-term (3–5 years)

15. **Structural adjustments.** The current structure of five generating companies (generators) but no specific geographical focus and lack of competition needs to be revisited. These multiple generators have helped rapid capacity addition, especially since 2003. But looking ahead, a more coordinated approach in the selection of mega (i.e., 10 GW and higher) project sites and competitive-based concession will improve the overall planning, efficiency, and coordination.

16. **Improved sector planning and oversight.** Since the structural reforms of the 2002 (para. 9), there may be some disconnect between generation and transmission planning. While the planning is coordinated at individual project level, strategic harmonization on a longer time horizon is essential to overcome critical transmission bottlenecks and electricity shortages. The planning and regulatory functions are still together under one agency—National Development and Reform Commission. A separate regulatory agency, such as State Electricity Regulatory Commission should be strengthened to operate as an independent regulator.

17. **Negawatt rather than megawatt approach.** On the demand side, the current administrative approach to energy efficiency needs to be supplemented by a set of regulations and market-based incentives. For industrial consumers, a differentiated approach may be adopted with urgent graduation of most energy intensive industries to best practice levels. Setting benchmark efficiency standards, mandating enterprises to meet those standards and allowing trade can achieve quicker and sustainable results. In India, a similar approach through Performance, Achievement and Trade (PAT) is being implemented.

18. **Improve sector investment environment.** More sophisticated tariff regime with long-term price signal is essential sector-wide for sustaining investments. A gradual but time-bound approach to reflect market-based pricing is crucial. Phased removal of fossil fuel subsidy, an integral part of the current tariff regime, will free up resources to (i) incentivize low-carbon technologies, and (ii) implement measures to protect the poor household against the electricity price increase. A sliding scale approach for end user electricity tariff depending on the consumption, combined with time of day tariff may help reduce the electricity consumption and reduce the demand peak.

C. Long-term (over 5 years)

19. **Articulate sector vision.** It is essential to form a core stakeholder group—government, utilities, research institutions, manufacturers, suppliers, international industry experts, etc.—to develop a long-term vision for the sector up to 2050 with clear milestones and performance indicators. This would provide a clear direction to focus further reforms, actions and investments. Many developed countries have already launched such vision/set of scenarios that helped crystallize key constraints and identified possible pathways and appropriate policies.

20. **Wholesale and retail electricity market.** The piloting of electricity markets was abruptly terminated in the PRC in 2004 during the time of severe electricity shortages. These markets have worked in many countries with mixed results. To improve efficiency and competition, it would be important to revisit the electricity market concept, especially wholesale electricity market. This will require generators to compete and will truly reflect the demand-supply approach to electricity pricing.

21. **Mainstream innovations.** The PRC's electricity system has the scale, skilled manpower, well equipped research institutions and financial resources to unleash innovations and become a global technology leader. The need is to mainstream research and development both at enterprise and the government level and provide direct financial support and reward mechanism. For that purpose, and having the largest electricity sector in the world, it is imperative that more resources be allocated to research and development in forward looking technologies and their introduction and deployment is supported through direct public funding mechanism.

一、引言

1. 电力行业是中国技术最为复杂的基础设施,它为几乎全部中国人提供着实时的电力供应。从1949年的不到200万千瓦的装机容量到2010年的超过9亿千瓦,中国电力行业经历了一个辉煌的发展历程。在经历了初期的停滞,电力行业发展迅速,这在过去的二十年中表现明显。特别值得一提的是,在2001-2010的十年中电力装机容量增加了两倍以上。

2. 但即便是如此快速的装机容量增长也并未完全满足增长更加快速的电力需求。冬夏季的用电高峰,加上煤的运输困难,加剧了维持供需平衡的压力,这使电力供应经常处于季节性的短缺之中。周期性的装机容量不足和过剩,例如2003/2004和2010/2011年的电力短缺和2008/2009年的短期过剩,对整体经济的发展造成了波浪式的影响。

3. 从整体上说,中国电力行业跟上了电力技术发展的步伐,掌握了相关的规划、建设、运营和管理如此复杂的大系统的多种技能。面对诸多困难,中国电力系统一直表现良好,迄今为止避免了在其它规模和复杂性类似的电力系统中都发生过的大面积停电事故。

4. 虽然中国电力行业通过之前和现今的电力改革取得了很大的成就,但是也面临着一些新的问题和挑战,诸如:资源优化、环境保护、气候变化和低碳化转变。这些问题已经变成或即将变成推动未来电力改革和创新的力量。这篇短文简要分析了中国电力行业所面对的主要的挑战和制约因素,旨在为中国电力行业长期可持续发展提出一些适当的政策建议。

二、挑战和制约因素

5. **电力需求增长失控。**以高耗能产业为主的不平衡的经济结构和受管制的低电价造成了电力需求的急速增长。仅在2010年,电力需求就增加了15%以上。虽然政府现在已经采取了一些措施去推动低能耗的服务业的发展,但过分依赖供应侧的手段去满足电力需求增长从中长期看是不可持续的。GDP的电力弹性系数已经连续几年大于1,需要在近期内把它降低到1以下,以后逐步降到0.5~0.7左右。

6. **电价扭曲。**当前的电价机制从属于行政体制,不仅不能够反映市场实际和变化,也不能给潜在的投资者和运营商提供正确的投资激励。这点在“煤电价格之争”上表现的非常明显。从2002年后煤价被逐步放开,煤价随行就市。因煤电的成本对煤价非常敏感——煤价每上涨1%,煤电的成本大致要增加0.7%,但是因为煤电价格仍旧在严格规制之下,所以煤电价格经常性地不能够充分消纳煤价的上涨。同时因为电价一直偏低,所以它很难起到推动能效提高和节电的作用。

7. **私人投资不足。**每年大约1000亿美元左右的投资基本上没有私人资本的参与。预计在未来20年中,电力行业的发展仍需要海量的投资,私人资本在这个领域可以发挥更大的作用。私人资本的介入可以促进竞争,改善服务质量,刺激技术创新。2006年以来可再生能源领域的发展已经证明:透明的定价机制加上妥善的长期商业体制安排可以吸引私人投资。

8. **输电瓶颈严重。**煤电和水电占中国电力供应的90%以上。电力负荷中心大部分都位于南部（例如：福建、广东）和东部（上海和浙江），但煤炭资源大都在北方省份（河南、山西、陕西、内蒙）和东北（黑龙江、吉林和辽宁）；水电资源大部分都位于西南（四川、西藏和云南）。与此类似，主要的可再生能源资源（风和太阳能）分布也远离主要的负荷中心。这种资源和负荷分布空间上的不匹配要求中国电力行业必须在跨区域的范围进行电力供求平衡。虽然近年来中国在输电线路上的投资已经超过了在电源上的投资，但历史上对输电线路的投资欠帐仍然制约着电网的快速发展。

9. **行业改革进展缓慢。**上一次大的行业改革发生在2002年，当年国家电力公司被分拆成了五大发电集团和两大电网。十年之后的现在，有迫切的需要重新审视行业的组织方式和未来的发展方向。当初成立五大发电集团的目的是为了促进行业竞争，但因为配套的电力市场建设进展缓慢，重组后预期的市场竞争和效率提高并未完全实现。

10. **创新激励政策缺位。**现行的行业政策重点基本上都集中在成本回收定价方面，即使对一些新的、尚处于孵化期的开创性的技术也不例外，这严重地阻碍了技术创新。这种做法和不健全的政府风险分担机制（例如，直接融资、贷款担保、电价支持等）迟滞了创新型技术的引进和部署。

11. **市场机制缺位。**“十一五”期间在实现“20%能耗改进目标”的过程中遇到的困难充分说明了仅仅使用行政手段实现此类目标的局限性。展望未来，不断增强的减缓气候变化的措施也将会对电力行业（中国最大的温室气体排放行业）的发展产生显著影响。为了实现未来的碳约束指标，必须借助于适当的市场机制，包括：碳定价、碳税以及碳交易。

三、政策建议

A. 短期建议（1~2年）

12. **发电行业的盈利机制。**当前的煤电价格扭曲现象，在短期内将加重电力短缺的问题，在中长期内有可能削弱未来的电力投资。因此，有必要为火电企业（包括煤电和气电）制定一个合理的、透明的价格调整机制，有效地传递发电成本变化。类似的调整机制在很多发达和发展中国家都有，它对发电企业的发展和运营非常重要。

13. **用电管理和分时电价。**缺电现象一般只在每天的用电高峰时段出现。因此，可以考虑采用一些管理方法以及分时电价的激励措施鼓励大的电力用户，比方说大的工业企业，把生产安排的非用电高峰时段，平滑电网的电力需求曲线。

14. **公众教育和参与。**国际经验表明：电力用户的配合和参与可以在很大程度上减缓电力需求的增长。公众的节电教育应该被纳入政府部门和公共事业单位的主要议事日程。通过节电教育，可以向公众解释电价上涨在一定程度上是不可避免的。

B. 中期建议(3~5年)

15. **结构调整。**当前的以五大发电集团为主的行业结构——没有地域重点、缺乏竞争的运营方式——需要重构。虽然自2003年以来,这些发电集团共同推动了发电装机容量的快速增加。但是展望未来,在千万千瓦级电源选场和特许经营权招标方面,一个更加调和的方法可以改善行业整体的计划、效率和协调性。

16. **改善行业规划和监督。**自2002年的机构调整以来,在电源规划和输电线路规划上可能缺乏协调。行业规划只在项目层面上进行协调,更长时段上的行业发展战略是减少输电瓶颈和电力短缺问题所必需的。行业规划和管理的职能目前仍集中在国家发改委。独立的监管机构,例如电监会,的职能应该继续加强。

17. **需求侧能效提高。**在需求侧,当前的使用行政命令推动能效提高的方法应该辅之以市场化的管理和激励措施。对工业用户而言,可以采用有区别的方式来促使高耗能的产业向国际先进的能耗水平靠拢。可以通过设立能效参照标准、强制企业达标、以及允许企业交易完成的节能量等方法来推动企业实现更快、更可持续的结果。印度目前采用了与此类似的通过“执行、完成、交易”(Performance, Achievement and Trade (PAT))来实现节能的方法。

18. **改善行业投资环境。**设计完善的电价机制可以给市场提供明确的长期价格信号,吸引维持行业发展所需的资金。市场定价必需用渐进的、有时效的方式来反映。分阶段取消现存的化石能源补贴将会解放更多的资源,去激励低碳技术的发展,去采取措施补贴低收入家庭应对电价上涨。按用电量对用户实行“梯级电价”,辅之以“分时电价”,应该有益于减少电力消费、降低高峰时段电力需求。

C. 长期建议(5年以上)

19. **清晰的行业发展愿景。**有必要组成一个核心利益相关方集团——政府、供电部门、研究机构、制造商、供货商、国际专家等——共同商定一个2050年行业发展规划且有清晰的里程碑和考核指标。这将为行业的发展提供一个清晰的方向进行后续的改革、采取行动和组织投资。很多发达国家已经制定了类似的行业发展愿景规划,这对提前发现一些制约因素和辨别可能的发展道路、政策非常有利。

20. **电力批发和零售市场。**在2004年用电紧张期间,电力市场试点工作停止。很多国家都对电力市场做了实践,成功的经验和失败的教训都有。为了增加竞争、提高效率,有必要重新启动电力市场的建设,特别是电力批发市场的建设。这要求发电商竞价上网,让供求状况在电价中得以体现。

21. **创新制度化。**中国电力系统有规模效益,有训练有素的人力资源,有设备精良的研究机构,也有相应的资金来源,因此可以进行技术创新、成为全球的技术领袖。政府和企业都应该把技术研发制度化,为技术创新提供直接的资金支持和奖励机制。为了实现这个目的,作为世界上最大的电力行业,中国电力行业必须分配更多的资源给一些前瞻性的技术研发,并通过直接的资金支持实现这些技术的产业化。

About the Asian Development Bank 关于亚洲开发银行

ADB's vision is an Asia and Pacific region free of poverty. Its mission is to help its developing member countries substantially reduce poverty and improve the quality of life of their people. Despite the region's many successes, it remains home to two-thirds of the world's poor: 1.8 billion people who live on less than \$2 a day, with 903 million struggling on less than \$1.25 a day. ADB is committed to reducing poverty through inclusive economic growth, environmentally sustainable growth, and regional integration.

Based in Manila, ADB is owned by 67 members, including 48 from the region. Its main instruments for helping its developing member countries are policy dialogue, loans, equity investments, guarantees, grants, and technical assistance.

亚行的远景目标是实现没有贫困的亚洲和太平洋。亚行的工作旨在帮助其发展中成员显著地减少贫困，改善人民生活质量。尽管亚太地区发展迅速，但该地区的贫困人口仍然占全世界贫困人口总数的三分之二：18亿人口日均生活费用低于2美元，9.03亿人口挣扎在日均生活费1.25美元的贫困线以下。亚行致力于通过共享式经济增长、环境可持续的增长和区域融合等战略来减少亚太地区的贫困。

亚行总部在菲律宾首都马尼拉，现有67个成员体，其中亚太地区成员48个。它主要通过政策对话、贷款、股本投资、担保、赠款以及技术援助等手段向成员体提供帮助。

亚洲开发银行

Asian Development Bank
6 ADB Avenue, Mandaluyong City
1550 Metro Manila, Philippines (菲律宾马尼拉)
www.adb.org

亚洲开发银行驻中国代表处

北京朝阳区建国门外大街1号
国贸大厦（三期）17层
邮编：100004
adbprcm@adb.org
www.adb.org/prc
cn.adb.org

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