



# TLG On



## An Edited Volume: China's Electricity Sector

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*TLG On* is The Lantau Group's in-house journal addressing current energy issues, and their policy and economic implications, facing the Asia Pacific region.

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The Lantau Group is proud to announce the publication, by Palgrave Macmillan, of its first book, *China's Electricity Sector*. This edited volume brings together seven chapters written by TLG experts and China-focused academics that discuss The Lantau Group's current thinking on developments in the world's largest power market.

Three themes emerge that cut to the heart of the story behind China's power sector: huge imbalances and uncertain direction, tentative but increasing use of price signals, and the growing importance of environmental protection policies. These are the topics of this article.

### Key Points

- Despite a history of change, the governance of China's power sector remains riven with compromise and contradiction. Political favour seems to waver between the "market economy" and the "socialist economy", with neither being given free reign. Ministries of power have been created and dismantled multiple times, with authority currently being dispersed across a number of ministries, departments and agencies, most notably the National Development and Reform Commission. The result has been a series of compromises with the competing interests of various stakeholders balanced against each other. Yet with a power sector characterised by massive imbalances of supply and demand and huge distances between resource location and resource use, it is becoming important to set out a more robust direction.
- Despite rising end-user tariffs and preferential on-grid tariffs for renewable energy generators, price signals remain weak, confounding attempts to shift the electricity industry onto a more efficient and sustainable footing in terms of both supply and demand-side management. End-user tariffs are regulated for the residential and agricultural sectors. Different provinces maintain different tariff structures. The current reform process may help strengthen price signals and there is some evidence to suggest a long-term trend towards greater marketisation, but the government's comfort with administrative tools remains clear.
- Despite clear political attention to reducing the sector's environmental footprint, coal use in China remains extremely high. True, energy and carbon intensity levels have fallen, small and inefficient plants have been closed, and efficiency levels have risen as pollution levels have fallen. True, the renewable sector – especially wind and solar – have experienced spectacular growth to become the largest in the world. However, a confusing policy framework and weak market structure have led to stubbornly high levels of curtailment (wasted energy) along with under-developed ancillary services and transmission bottlenecks. Work remains to be done to fully realise the potential benefits of low-carbon energy sources. Current reform efforts outlined in *Document Number 9* will be pivotal in this regard.

China's power sector can be seen as both a story of success and one of persistent challenges. The Lantau Group worked with academia to publish an introductory guide to help students and analysts understand these contradictions better.

The power sector has expanded at breakneck speed, especially since the turn of the century, but growth and development have not always been smooth.

The electricity sector's bureaucratic governance has been reshaped multiple times throughout its history but remains confused even now.

## An Industry Like No Other

China is the world's largest electricity system, and its current state confounds attempts at easy encapsulation. The country's apologists will point to its successful abolition of supply shortages, they will point to what is now the world's largest renewable capacity, and they will point to unprecedented growth coupled with significant improvements in environmental performance. In contrast, critics will latch onto stubbornly high coal demand, massive overcapacity, and disappointing levels of curtailment of its renewable energy. Do China's successes mean that its power sector is efficient even if not economically so, or do its successes disguise a deeper malaise, one which reminds us of the inescapability of economics?

In 2017, The Lantau Group set itself the task of working with academia to produce an introductory guide to China's electricity sector that might help students and analysts of the country understand it better. Drawing together seven essays that discuss the industry's governance, stakeholders and current reform, wind and solar sectors, environmental legislation, and finance, the result has been published by Palgrave Macmillan, a leading international publisher in the social sciences.

## Imbalance, Compromise, and Contradiction

The successes of China's power sector are undeniable. Juggling with periodic supply shortages, generating capacity grew at over 10 percent for at least the years 2000-13; in the years 2011-15 alone, RMB3.9 trillion was invested. From 1.94 GW in 1949, capacity had reached 1,646 GW by the end of 2016; at its height, China was bringing on stream the equivalent of three 600 MW power plants every week. Unlike India, which still has electrification rates under 80 percent, China declared full electrification of its people in 2012. The economy, and its demands on the sector, grew at breakneck speed and the system seems to have responded.

Yet this story is far from complete. Growth has come in spurts, with the country lurching from shortage to excess. The investment climate has proven volatile, with foreign firms at one point encouraged to invest (witness the 'Three Guarantees' policy of the 1980s-90s, which guaranteed minimum utilisation rates, minimum prices and minimum returns on investment), and at other times frozen out through risk profiles that favoured domestic, state-owned enterprises (the current environment sees capped prices, falling utilisation, and volatile input costs). Carbon intensity has been reduced, but the sector still gobbles coal while curtailing renewables.

Contradictions and inconsistencies permeate the industry and extend to the heart of China's system of governance. Through the history of China's post-1949 Party-State, a ministry of power has been created and destroyed three times; strategic bodies have been set-up and absorbed; and lines of responsibility have been centralised and divested. The current roles and responsibilities of the National Development and Reform Commission (NDRC: setting overall macro-economic goals) and the National Energy Administration (NEA: recommending development plans for the energy sector) were restructured when the State Electricity Regulatory Commission was abolished – in part because of the belated realisation that there was no proper functioning power market for it to regulate.

Even the current governance arrangement is not as tidy as this simple NDRC/NEA dichotomy would suggest. Despite holding responsibility for power sector development (in terms of project approval) the NEA has no control over price: that rests with the Department of Price within the NDRC. There are also multiple other national bodies whose bureaucratic and policy functions affect the sector: the Ministry of Environmental Protection (which sets environmental standards), the Ministry of Land and Resources (which oversees China's natural resources), SASAC (through which the government

The result has been policies replete with compromise and price signals that remain weak.

The retail sector is opening up to competition and environmental externalities are to be priced through markets and tax, but household tariffs remain regulated and much environmental regulation is delayed.

owns the state-owned enterprises), and – within the NDRC – various departments such as the departments of Basic Industry, Resource Conservation, or Climate Change, to name just a few. Administrative authority also blurs between national and provincial lines: with parallel administrative structures, provincial governments have been able to subvert the central government's policy intent through local implementation. Blurred responsibilities can extend into the enterprises themselves. China's nomenklatura system makes senior executives of the major SASAC-owned companies political appointees whose priorities may not always be completely aligned with conventional profit-maximising corporate wisdom.

The result has been a set of bureaucratic structures and policies that has oscillated between a more market-oriented economy and a more socialist-oriented economy as political power struggles have played themselves out.

This has often resulted in policies that are themselves balancing acts. For instance, despite a general trend of government disengagement from active daily management, the mandated merger of Shenhua (a major coal producer) and Guodian (one of the big five generating companies) reveals a state still ready to pull levers and create a consolidated state-owned giant. Despite attempts to inject greater competition into the retail sector, the new arrangements for power trading under the current reform programme still leave the grid companies with immense market power as the sole authorised providers of settlement services. Despite emerging market mechanisms, cross-subsidies and regulated residential and agricultural end-user power tariffs undermine any true price signal, weakening attempts at demand-side management.

## Prices or Signals?

Everything has a price, and every price is a signal, but to whom, and for what? Price signals, or rather the weaknesses reflected within them, have become a recurrent theme in China's reforming power sector. Plans to base power dispatch on cost-structures and offered prices were put forward in 2002's *Document Number 5*, but little happened: dispatch remained controlled by the grid companies and highly politicised, guaranteeing set hours to individual power plants. 2015's *Document Number 9* again set out the deregulation of dispatch, but again the power of true marginal cost dispatch was muddled through the prioritised dispatch of low-carbon energy – for ostensibly sound environmental reasons. On-grid tariffs themselves remain mostly regulated, with the National Development and Reform Commission setting benchmarks that vary by fuel.

End-user tariffs have risen gradually over time, but they remain highly regulated whatever is happening upstream. For a long time, tariffs for heavy-industry, agriculture and households were held below cost. The situation has improved since the early days of the People's Republic, but there are still large and complex cross-subsidies, with often big differences between provinces. The retail sector is meant to be opening up to competition, increasing the size of the deregulated market, but households and agriculture remain price protected.

An Environmental Protection Tax Law was signed in 2016 and became effective from 1 January 2018. Regulation supporting the law's implementation was released in December 2017 but was both simplistic and lacked enforceable details. China has been the world's largest carbon dioxide emitter since 2006 and has committed to reducing carbon dioxide emissions through a combination of administrative and market-based measures, including a carbon tax (under discussion for years) as well as tradable pollution permits and green certificates. A nationwide carbon trading market – which would be the largest in the world – was notionally launched at the end of 2017, a milestone in marketisation for the sector. But the initial carbon trading mechanism only covered the power sector, a much narrower coverage than expected and needed, and the consequences of the carbon price on other sectors is not yet certain.



Regardless of emerging market structures, China's preference has long been for administrative tools and targets.

Environmental performance is high on government priorities.

This tentative, on-off approach to markets is understood within the country's traditional preference for, and reliance on, administrative tools. The country's Five-Year Plans famously set generation, capacity and energy/carbon targets. Over the last thirty years, nine laws and over 50 regulations have been passed to bolster environmental protection, but virtually all outlined targets, caps and constraints. For instance, there was a 1999 campaign to close 'Small Thermal Power Plants' and a 2006 one 'Replacing Small Units with Larger Ones'. A whole set of limits are in place for 2020: coal use needs to be under 5 billion tonnes, and both sulphur dioxide and nitrogen oxide emissions under 15.8 million tonnes. There are even targets for average coal consumption for upgraded power plants (under 310 g/kWh) and newly built plants (under 300 g/kWh).

In other words, they were primarily administrative: direct interventions from government – often relying on financial support from state-owned banks – rather than an adjustment of market incentives. There are even examples of perverse interventions for the sake of targets: it was reported in 2010 that certain local governments ordered the temporary shutdown of factories simply in order to meet energy intensity targets by specific dates. If there is talk of a move to market practices in China, it must be interpreted carefully. Without true price signals for end-users, there can be no real market; and there are no true price signals.

But price mechanisms are emerging, albeit tentatively. On-grid tariffs, though regulated, do favour renewable energy sources with higher prices, encouraging continued investment. Since March 2017, power stakeholders have been encouraged to decide their own prices via negotiation or through power exchange centres. Current reforms are intended to at least partially simplify cross-subsidies. The issue is that these moves are not enough to make a real difference and without a proper set of clear price signals stretching all the way from generators to end-users the sector is unlikely to shed itself of its inefficiencies.

## Green Power

Despite the apparent diffidence in introducing proper market reforms, the government has continued to push its environmental agenda – of massive importance in a country where in 2016 over three quarters of cities failed to meet national air quality standards. Both the eleventh and twelfth Five-Year Plans contained several targets to improve the environmental footprint of the country's power sector. Across both, small and inefficient capacity was closed and replaced with more modern and efficient units. As a result, over 32 percent of coal-fired capacity is in units larger than 600MW, the number of ultra-supercritical units has increased sharply and millions of tonnes of coal, sulphur dioxide and carbon dioxide are being saved annually. The Thirteenth Five-Year Plan continued with these trends, setting a series of 2020 targets (decrease of per GDP carbon intensity by 40-45% compared to the 2005 level, and increase the share of non-fossil fuel in primary energy consumption to 15% by 2020); moreover, as discussed above, coal use is capped at under 5 billion tonnes of standard coal, and sulphur dioxide and nitrogen oxides emissions are each capped at below 15.8 million tonnes.

Various other policy and legislative documents contain further targets and constraints, including development targets for hydro, nuclear, wind, solar and biomass capacity. In total, by the end of 2020, non-fossil fuel sources of electricity are to account for 39 percent of capacity and 31 percent of generation (though that still leaves coal with a 60 percent share of capacity). Within coal-fired generation, coal consumption and polluting emissions are both to be brought down.

There are now targets to reduce carbon intensity, raise the share of low-carbon generation, ban coal-fired units in large cities and set up tradable emission rights.

The renewable sector has been the fastest growing and, in its pursuit of investment funds, the most financially innovative.

Renewable energy curtailment has proven persistent, caused by transmission bottlenecks and within-province balancing, but new reforms may help reprioritise dispatch.

Beyond the various administrative targets being imposed on the power sector, the government has also introduced (or declared the intention to introduce) a series of environmental management systems including development approvals contingent on environmental upgrades of existing units, the banning of coal-fired units in large cities, pollution discharge permits, and tradable pollution and carbon emission rights.

The result has been the gradual improvement of coal-fired generation in terms of emissions and coal use, and a 29 percent drop in investment in coal power from 2016 to 2017 along with growth in the proportion of clean energy generation for each of the five main generating companies. Small and inefficient units have been replaced with larger and cleaner units; direct coal use has been phased down through increased electrification; and the investment in wind and solar power has rocketed.

Since the passage of the Renewable Energy Law in 2006, the amount of installed wind capacity was grown from under 2 GW to 169 GW, contributing to 4 percent of generation in 2016; solar capacity has likewise reached 78 GW. Alongside capacity targets, the government has also published policies and regulations for grid connection, minimum guaranteed utilisation, special on-grid tariffs, and cost-sharing mechanisms for renewable energy, designed to support the sector's long-term growth. It is a policy environment that has enabled tremendous growth, with the renewable generating sector the fastest growing and most innovative sector within China's power industry, sucking up (along with nuclear power) 18 percent of total investment during the years 2006-15. This growth, coming largely as it has from outside the state-owned mega energy enterprises, has encouraged innovative approaches to corporate fundraising. Moving beyond bank lending, the power sector is increasingly turning to bond finance, equity, and even securitisation (through asset-backed securities).

Despite these various and obvious signs of success, China's power sector is still highly dependent upon coal, carbon emission levels remain stubbornly high; and the benefits of renewable energy have been undermined by widespread curtailment.

Curtailment describes the situation where output from renewable generating assets is below their potential given the wind/solar resources available at the time. This happens when potential supply outstrips demand and generation has to be throttled back. In 2016, the national average curtailment rate hit 21 percent, the highest level since at least 2011. In the period 2011-16, wind curtailment rates alone averaged 15 percent, leading to the loss of 145.5 TWh of clean energy, at the cost of almost RMB73billion.

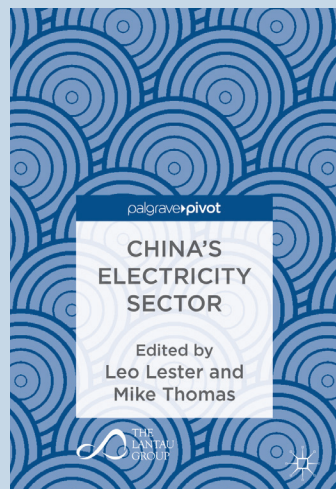
The main causes of curtailment are the geographic mismatch between resource rich provinces and major load centres, coupled with within-province balancing and transmission bottlenecks; China has been poor at dispatching renewable energy to where it can be used. In addition, the dominance of under-utilised coal-fired assets with lack of flexible generation assets, means that coal-fired power is sometimes given dispatch priority over renewable energy despite the letter of the law: another tension in the power sector's confusing and contradictory legislative framework. What is more, an under-developed ancillary services market that denies the providers of ancillary services proper compensation for the costs of provision, has undermined the sector's ability to absorb and manage the growth in renewable generation.

The current reforms outlined in 2015's *Document Number 9* should go part way to alleviating curtailment by reprioritising generation for renewable energy and relaxing the old system of centralised dispatch plans that favoured coal-assets; establishing an ancillary services market with cost-sharing mechanisms to encourage its development; and regulation captive power plants to encourage their participation in the wider power sector, while also allowing distributed generation to enter the retail sector.

Yet the story of China's battle with renewable energy curtailment brings together all three of the themes discussed in this newsletter and in the book in general. Despite a clear policy prioritising the dispatch of renewable energy, legacy governance structures mean that coal plants are often guaranteed minimum hours that can lead to renewables being shunted down the dispatch order. Despite the clear intent to encourage the renewable sector evident through preferential pricing, the lack of a fully functioning power market means that the necessary ancillary services have failed to develop alongside this renewable capacity, hamstrung as they are through insufficient pricing incentives. Despite the increasing political attention being placed on improving China's environmental footprint, and despite the improving levels of efficiency inherent across the sector, coal is still prevalent and pollution still problematic.

## About the Book

Figure 1: Book Cover Image



Source: Palgrave Macmillan

China's Electricity Sector, edited by Leo Lester and Mike Thomas, is published by Palgrave Macmillan (ISBN 978-981-10-8191-0). It has been designed as an introductory guide for students and analysts of China's electricity sector, with chapters on governance, stakeholders and reform, wind and solar power, environmental legislation, and power sector financing. The chapters were written by TLG's Xinmin Hu and Mike Thomas and the following academics:

- *Philip Andrews-Speed* is a Senior Principal Fellow at the Energy Studies Institute, National University of Singapore. His main research interest is the political economy of energy and resource governance.
- *Huadong Dai* is a Master by research student at the Southwestern University of Finance and Economics. His research interest is electricity market and financing issues.
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## About the Authors

Leo specialises in Asia's political energy economy, and brings a decade of international energy experience, having worked in the UK, India, Thailand and Saudi Arabia. Leo holds degrees from the Universities of Oxford (MA) and Reading (PhD), and is a Global Research Fellow at the Institute of Asia and Pacific Studies. He has numerous publications and was editor of *Energy Relations and Policymaking in Asia*, published by Palgrave Macmillan in 2016. He is a CFA charterholder and a certified Financial Risk Manager.

Mike has advised energy sector stakeholders on sensitive regulatory, commercial, and strategic matters for over 25 years. He is an expert in the rigorous analysis of energy sector decisions including: how or whether to regulate; how and when to rely on market forces; and what value to place on opportunities and risks. Prior to co-founding The Lantau Group in 2010, he headed the Asia Pacific Energy & Environment practice of a global consulting firm. Mike has an MPP from Harvard Kennedy School and a BA in economics from Carleton College.

Xinmin is an expert in the Chinese power sector and energy economics having advised clients on generation, transmission and energy supply issues as well as regulatory developments and cost trends. He is a former lecturer at Jilin University in Changchun and at Zhongshan University in Guangzhou. He combines his knowledge of China's power sector with over a decade of experience as a consultant in the Australian and other power markets and as an associate director of RepuTex (AU) focusing on environmental and greenhouse gas emission issues. He is a regular reviewer for several international energy, operations research and optimization journals. He holds a PhD in operations research with a minor in economics from the University of Melbourne and an MSc in Applied Mathematics from Jilin University of Technology, China.

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