Stories Behind Electricity in China

China's electricity sector has quite literally been the power behind the country's social and economic development. And just as the country at large has grown, so too has the sector; not without blemish or mishap, sometimes slowly and sometimes frantically, but never without a story.

The story in the past has been one of central planning, of blurred institutional boundaries between state and industry, and of cycles of under and overinvestment leading to supply shortages and supply surpluses. The story today is one of environmental pressure; of geographic disconnect between the location of resources and the centres of demand; and of uncertain steps towards real and meaningful reform. Yet, the story of tomorrow will likely have both more and less in common with the rest of the world than many might expect. More because, despite China's complexity, the root problems are not so different from those found elsewhere, nor the possible solutions - even if those solutions reflect the inevitable adaptation of "Chinese characteristics".

In TLG's recently published book on *China's Electricity Sector* (Palgrave Macmillan, 2018) we, together with five regional scholars, take a closer look at the issues and how they must resolve.

Key Points

- A major story for China's power sector has been its size and the speed of its growth, but there are other stories too. The country's reliance on coal has hinged on its ample domestic coal reserves and the much lower cost of building coal-based generation capacity in China compared to the rest of the world. Its rapid economic growth has more than once led to supply shortages that have since swung to major oversupply. A constant constraint has been the distance between resources and centres of demand, complicating China's quest to improve environmental outcomes. Another has been the comparative lack of low cost accessible natural gas.
- An unexpected story has been the electricity sector's legacy of reform. Far from static, the governance, regulation, fuel mix, technology and ownership structure of the electricity sector have all changed through various rounds of reform. Central planning - never quite so central as might more commonly be thought - has struggled to resolve disparate and often conflicting objectives. Stakeholders have been corporatized, coal's dominance has been diminished, technological efficiency has been improved and direct state interference has been reduced. Yet change has not been all one way: there are still clear examples of state interference and price signals and market structures, though stronger than ever before, are still in places obfuscated.

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- Stories of Chinese exceptionalism are misleading. The headline-grabbing challenges facing the country's power sector - rapid growth, overcapacity, and environmental fragility - are hardly new, albeit never before on the same scale. Nor are the underlying causes likely to be materially different from what economic theory tells us to expect. Where we will see China's uniqueness is in how it implements its chosen solution and in how it arrives at its chosen set of compromises. It's the voyage, not the destination, where we will most likely see reforms with "Chinese characteristics".

State, Industry and Inefficiencies

The growth in China's electricity sector has been phenomenal and, for many, is the single overarching story of China in general and of its electricity sector in particular. Commentators like to remind us that the sector is the largest in the world with a generating capacity of 1.6TW and supply reaching 6,142TWh in 2016, up 840-fold from a total capacity of just 1.9GW in 1949. They remind us too that the country uses half the world's annual coal supply and has the world's third largest coal reserves. But a closer inspection gives a more nuanced story. Domestic coal reserves are ample, but those of water, oil, and gas are far more constrained. Growth in power capacity was high – with the equivalent of three new 600MW power plants being brought online every week between 2005 and 2012 – but at times it still lagged growth in actual demand. The nine percent annual growth rates of the mid-1980s were not enough to keep pace with double digit GDP growth; rapid GDP growth again outstripped the growth in power from 2003 to 2007. In both cases the country was left struggling with supply shortages.

China's energy sector is the largest in the world but it drives an economy that is mostly found in the east, far from the resource rich west.

Besides scale, there have been other stories too. The Hu Huanyong Line, which runs across China in a diagonal form northern Heilongjiang to western Yunnan, splits the country into two rough geographical halves, with 43 percent of the land to the east and 57 percent lying to the west. Yet that smaller eastern half contains around 94 percent of both the country's population and its GDP, and a very approximate 80 percent of its total power demand. In contrast, it is the land to the west of the line that is wealthiest in energy resources. So, the story of China's economic development and power sector growth has been a lopsided story: a story of geographic disconnect between resource and demand and of the growing importance in the bulk transport of energy, be it by rail, road, or electricity transmission line.

But the story has also been one of regulatory and policy inefficiencies within the sector. Chief among these inefficiencies have been blurred institutional boundaries, a lack of a level playing field for industry stakeholders, and limited information disclosure. First, the institutional boundaries: in the country of the Party-State these were always fuzzy. State ownership could be explicit in the form of national or provincial state-owned enterprises, but it could also be implicit, through Party links or just the more general state direction of the economy that led to administrative tools picking industrial winners and losers or distorting price signals. Second, the lack a level playing field: part and parcel of state involvement was preferential regulation, pricing and financing for chosen industry participants (be they state-owned or of preferred technology). Some companies were discriminated against, not because of economic viability (with or without pricing in any environmental externalities) but because of administrative fiat. Third, the limited information disclosure: often a complaint of commentators and analysts, the limited availability of reliable, timely and transparent data can discourage private investors and weaken participant responses to market changes.

Three sources of inefficiency with the sector are blurred institutional boundaries, a lack of a level playing field, and limited information disclosure.

Some of the problems caused by these inefficiencies can be seen in the cycles of supply shortage and surplus. Before 1997 there were persistent power shortages. For much of the 1980s, the growth in installed generating capacity lagged GDP. In 1985 the

country began allowing foreign companies to build and operate power plants in China, but there were additional, wider schemes to promote all manner of investment in the sector. A "Three Guarantees" policy aimed to attract investors with a mix of minimum utilisation rates, minimum on-grid pricing and minimum return on investment. The result was an uptick in capacity, falling average utilisation rates, and an end to supply shortages: a seeming success story. Unfortunately, inconsistent planning and approval systems allowed much of the new capacity to be small-scale and inefficient, built without regard to either fuel availability or environmental consequences. In any case, overcapacity was short lived: the economic slowdown of the Asian Financial Crisis was briefer than the constriction of capacity approvals. By 2002 the country was once again suffering supply shortages. A new wave of capacity expansions followed and to such an extent that utilisation levels fell markedly, foreign investment was chased out and overcapacity began to exact a heavy financial toll on existing generators.

Inconsistent planning and approval systems have led to cycles of overcapacity and undercapacity, but now coal power is being squeezed by both a surplus in thermal capacity and growing renewables.

This time there was a twist. In among the changing regulatory dynamics, by the end of the first decade of the twenty-first century, policymakers had begun to promote renewable energy such as wind and solar as an alternative to coal. Coal-fired generation still accounts for around 70 percent of total supply, but there is increasing competition from low carbon alternatives that have have benefitted from favourable policies. Coal utilisation rates were squeezed not just by a surfeit of coal, but also by the newly growing renewable sector, as well as by further additions of hydro and nuclear capacity.

Yet here again, inefficiencies in the system – through too much market strength vested in particular entities and insufficiently transparent information – placed bumps in the road for what was otherwise a remarkable transition. Just as renewable energy could claim to be squeezing out coal, emerging transmission grid constraints and slowing electricity demand growth have forced curtailment of even renewable energy resources. The planning environment has become too complicated, with opaque processes and signals, and incentives that do not adjust fast enough.

Reform

Governance, regulation, fuel mix, technology and ownership structure of the electricity sector have changed – or perhaps fluctuated – almost continuously since the People's Republic of China was formed in 1949. Some of this change has flowed from power struggles internal to the apparatus of the state, some from the tension between the "market economy" and the "socialist economy", and some from the changed demands and expectations placed upon the industry.

Document Number 9 continues the unfinished business of reform of the power sector.

All eyes are now on ***Document Number 9***, the reform-oriented plan published in March 2015. Taking the long view, this was really a continuation of unfinished business started by the ***Document Number 5*** of 2002. This in turn can be fitted into a history of reform and governance restructuring that has gone on for as long as modern China has been around. Between 1949 and 1998, the Ministry of Power Industry and its successor bodies were repeatedly created and dismantled, merged and demerged. The current National Energy Administration was rebuilt in 2013 in the ashes of the State Electricity Regulatory Commission, itself set up in 2003. Much of these bureaucratic reformations have been the product of shifts in power between elements of the Communist Party itself, between different organs of the state, and between different industrial players such as the enormous State Grid.

Alongside these changes, there has been more linear progress through a succession of energy related laws: the ***Electricity Law*** (1995), the ***Coal Industry Law*** (1996), the ***Energy Conservation Law*** (1997) and the ***Renewable Energy Law*** (2006). Attempts at an overarching Energy Law and at an amended Electricity Law have both failed.

These laws have been important in driving other changes in the sector. In the last quarter of the twentieth century, China's generation fuel mix was almost entirely thermal and hydro. Since the passage of the ***Renewable Energy Law***, low-carbon fuels have expanded their footprint substantially, and though a little over 67 percent of power is still coal-fired, the percentage is declining. Although hydropower has grown, its share has also fallen. The result has been a substantial fall in the carbon and pollutant intensity of the sector (carbon intensity fell 21.6 percent in the years 2005 to 2016). These falls have also been helped by a shift in technology. The inefficient and polluting small-scale plants of earlier days have been to a great extent replaced with one of the most modern generating fleets in the world, helped along by the 1999 and 2006 campaigns "Shutting down Small Thermal Power Plants" and "Replacing Small Units with Larger Ones". Having commissioned its first 1GW ultra-supercritical coal plant in 2006, by 2016 there were 96 such power stations. Again, by 2016, 10.3 percent of coal-fired capacity lay in 1GW+ units, with 36.4 percent in 600MW+ units. The result of all this has been improving efficiency: coal use per kWh generated has fallen from 471 grams in 1978 to 392 grams in 2000 and 312 grams in 2016.

Originally bundled up within the ministries, the major electricity stakeholders, such as the two national grid companies and the five national generating companies, are all now owned by SASAC (the State-owned Asset Supervision and Administration Commission). From ministry adjuncts to stand-alone enterprises to more commercially sensitive corporations; it would appear to have been a simple trajectory. Government interference has been reduced and operations have been increasingly left to professional managers. The sector's ownership structure is profoundly different today from what it was twenty years ago. Yet things are not so neat in detail: government interference is still present from such things as the appointment (or removal) of senior executives to the forced merger of energy companies (for example, the coal miner Shenhua was recently merged with the power generator Guodian to create a massive integrated company). Foreign ownership, once welcomed, has since either been frozen out or has lost interest in what has become a highly uncertain and financially risky environment for investment and operation.

Although there has been a trend towards corporatisation and reduced government interference, the merger of two major power sector stakeholders shows that the government remains ready to intervene.

China's story of reform has deep roots then, with the sector undergoing change – sometimes slowly and sometimes quickly – throughout its history. Often reforms have been trialled through pilots, such as the 1998 market reforms piloted in six provinces, which sought to separate generation from transmission and distribution. Sometimes reforms have stalled because of changing macroeconomic conditions, such as the 2002 attempt to create competitive markets and market-based pricing mechanisms for electricity. As concerns over sustainability, both environmental and economic, have risen among political priorities, so new reforming regulations have been pushed on the sector. But, as with the story of government interference or investment cycles, reform hasn't been a story of constant, linear progress. There have been times of stasis and of backtracking too; in this sense, reform has had compromise rivetted to its heart.

Solutions with Chinese Characteristics

China's size and complexity have garnered a lot of interest, but stories of Chinese exceptionalism are likely overblown. The country's power sector has grown extremely fast, but other countries have also undergone rapid growth: the USA experienced persistent annual rates of power demand growth of 7 percent for decades before the 1970s. The country is suffering from massive overcapacity – enough to power half of Europe – but it isn't the only country with too much capacity: most markets have seen supply and demand swings. The country's air is infamous, but so too was that of 1950s London, 1970s Los Angeles, and even contemporary Delhi. The problems might be of a different scale, but they are not of a fundamentally different kind.

China's current environmental and investment situation has been seen in similar fashion - and solved - elsewhere.

So too with the underlying causes: slow to adjust incentives can lead to surpluses; inadequate incentives and inefficient or opaque processes can lead to underinvestment; and poor information can lead to misdirected effort. These are the same causes of the same problems as found elsewhere across the world. The lesson again is that China need not be thought of as so very different from elsewhere, but it also means that familiar solutions already exist.

And this should lead us to expect both that China will solve its current set of troubles – just as other countries have brought investment into balance and improved their environmental footprint – and that it will do so in ways that are ultimately familiar. Enhancing regulatory processes for both project approval and operationalisation is an obvious step in the right direction. Instead of administrative tools blocking or mandating particular projects, approvals could be tied to clear, transparent, objective and demonstrable needs. Economic frameworks with clear price/return signalling can encourage or choke back investment in self-correcting fashion. This happens already in China, witness the situation in Hong Kong: far from being globally novel, such a solution isn't really new even to China.

The ongoing investment in long distance ultra-high voltage transmission shows that China already understands that some solutions will require greater rebalancing across China's diverse regions. It is only the next logical step that China drop trying to balance demand and supply within individual provinces – treating them to a greater or lesser extent as a series of islands – and establish more robust interconnections – physical and regulatory – in the creation of a national network. Settling the trade-offs between provincial autonomy and centralised control may not be simple, but both the USA (with its dual system of state and federal regulation) and the EU (as it works towards an integrated supranational energy network) provide example paths.

Again, in its turn towards the market, China is not turning towards a solution unknown elsewhere in the world or even within itself. China has long run an electricity market in the sense that investors have to take fundamental supply and demand-related risks without the guarantee of long term power purchase agreements such as those found in Vietnam or Indonesia. Even as dispatch has been allocated administratively, the allocation cycle itself exposes investors to risk. Extending this risk exposure to more nuanced market signals may help the country better accommodate private investors, regularise investment cycles, and even mitigate some of the misdirected investment China analysts have commented on.

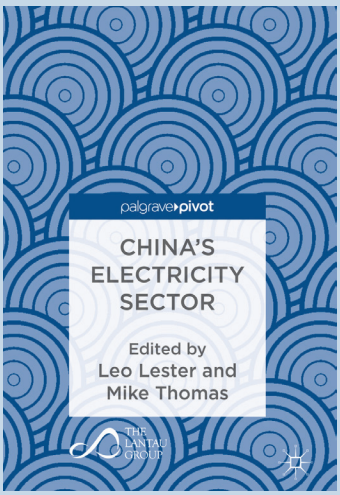
In other contexts, it has been said that there is nothing new under the sun and so too here. China's power sector has gown prodigiously and accomplished feats of engineering and economic development, it has struggled with confused institutional frameworks and has run up against environmental constraints, but in the end its achievements, its problems and its potential solutions are less likely to be qualitatively different than they are quantitatively different. The message here is that scale should not be confused with fundamental novelty.

While the causes and solutions of economic problems may be similar across the world, the precise set of compromises settled on will reveal "Chinese characteristics".

But perhaps where China's electricity sector will show its true difference is in how the solutions are implemented. It is in the trade-offs and compromises between power sector stakeholders that we can expect to see solutions with "Chinese characteristics" emerge. It is likely here that the next story in the evolution of the country's electricity sector will be found.

About the Book

Figure 1: Book Cover Image



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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:

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