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THE BOTTOM LINE

Although feed-in tariffs are now the cornerstone of China's renewable energy policy, auctions have played and continue to play a role in identifying market prices for renewable energy in the country. Experience with the auctioning of wind and solar concessions enabled the Chinese authorities to modify auctions over time to yield accurate information about the costs of generation from renewable sources, allowing them to set feed-in tariffs at efficient levels.

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Promoting Renewable Energy through Auctions: The Case of China

Why is this case interesting?

China has set aggressive renewable energy targets and introduced policy incentives for rapid market development

China's experience with the design and deployment of price- and quantity-setting policy instruments to support renewable energy development provides valuable insights on how to design, sequence, and customize different regulatory and market-based mechanisms to develop renewable energy markets. Feed-in tariffs are the cornerstone of the Chinese renewable energy policy framework, while the auctioning of concessions has played the critical role of establishing appropriate feed-in tariff levels.

China is an energy giant. Over the last decade, the country has made extraordinary investments in generation and transmission, more than doubling its installed capacity in just six years (from 519 GW in 2005 to 1,073 GW in 2011) and dramatically expanding access to grid-connected electricity for its 1.3 billion inhabitants. Although China still relies heavily on conventional electricity sources, particularly coal, for its expansion, programs to promote renewable energy have gained increased traction, to the point that the country is currently the world leader in total wind power capacity (75 GW at the end of 2013) and ranks third in total solar photovoltaic capacity (18 GW at end 2013) (REN21 2013). Moreover, China's renewable energy sector has grown very quickly over a short period of time (table 1).

The electricity market in China has passed through several stages, evolving from a vertically integrated monopoly to a system in which generation is separated from transmission and distribution. In 2007, the market exhibited a diverse and thriving generation segment, with five large generation groups owning 40 percent of total installed capacity and more than 4,000 smaller generation companies owning the rest. The transmission segment is characterized by large regional monopolies dominated by large grid companies, with the State Grid Corporation accounting for 80 percent of the system. The distribution segment has a complex structure, with more than 3,000 companies at the provincial, prefectural, and county levels, a third of which are affiliated with the two largest grid

Table 1. Evolution of Chinese installed capacity and future targets, 2000–2020

Capacity (GW)	2000	2005	2010	2015 targets	2020 targets
Hydropower	79	117	216	290	420
Wind power (on-grid)	0.34	1.26	31	100	200
Biomass energy	1.1	2.0	5.5	13	30
Solar photovoltaic	0.02	0.07	0.8	21	50
% of renewable energy in total primary energy	—	7.0%	8.8%	9.5%	15%

Source: 12th Five-Year Plan, Chinese National Energy Administration 2012.

a. The 15 percent target for 2020 is for non–fossil fuel primary energy. Renewable energy likely makes up the vast majority of this total.

companies. It is in this context that the renewable energy market has evolved.

The rapid growth of renewable energy in China followed from the 2005 Renewable Energy Law, one of the first in the developing world. The law, which took effect in 2006, set a solid foundation for achieving the ambitious goals of increasing the share of non–fossil fuel generation (including both renewable and nuclear energy) to 15 percent of primary energy supply by 2020. Although the law was initially intended to support the use of a feed-in tariff, key stakeholders could not agree on the tariff level, and an auction-based concession scheme was adopted to establish market-based tariffs.

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The aggressive scale-up of renewable energy continued under the 12th Five-Year Plan (2011–15), with special focus on increasing the competitiveness of the renewables industry through a combination of regulatory policies and market-based mechanisms.

The 12th Five-Year Plan laid out eight priority renewable energy programs, with emphasis on (i) planned large-scale wind power bases (each with an installed capacity of 5–10 GW) in the North, Northeast, and Northwest regions; (ii) off-shore wind development; and (iii) large-scale grid-connected solar photovoltaic bases in desert areas. Complementing the large-scale development of grid-connected renewable energy, the plan has also made renewables-based distributed generation a priority, particularly in a hundred planned "New Energy Cities" and 200 planned "Green Counties."

In addition, the National Energy Administration is preparing a decree to set mandatory non-hydro renewable energy quotas for provinces, grid companies, and large-scale renewable energy developers.

What challenge did China face?

Initial renewable energy prices showed significant variation, and the government's targets were not achieved prior to 2005

The most important milestone in the development of renewable energy in China was the 2005 Renewable Energy Law, which established a clear roadmap and goals for the development of the industry and cemented the current structure of incentive mechanisms based on auction schemes as a price-discovery mechanism to support the setting of feed-in tariffs.

Introduced partly to respond to growing pressure from the international community to take action to slow climate change, the law was motivated primarily by local environmental concerns and by national industrial development policy.

Before the 2005 law, under the 9th and 10th five-year plans, China had failed to meet official targets for expansion of renewable energy. A first auction to award wind power concessions was organized in 2003. Before that date, a few isolated wind power initiatives had been undertaken at prices set by local governments with a great degree of variation; most of these projects benefited from concessional finance provided by international donors and did not go through international competitive bidding (figure 1). Before the enactment of the 2005 law, it was unclear who would cover the incremental costs between renewable energy and energy generated from fossil fuels.

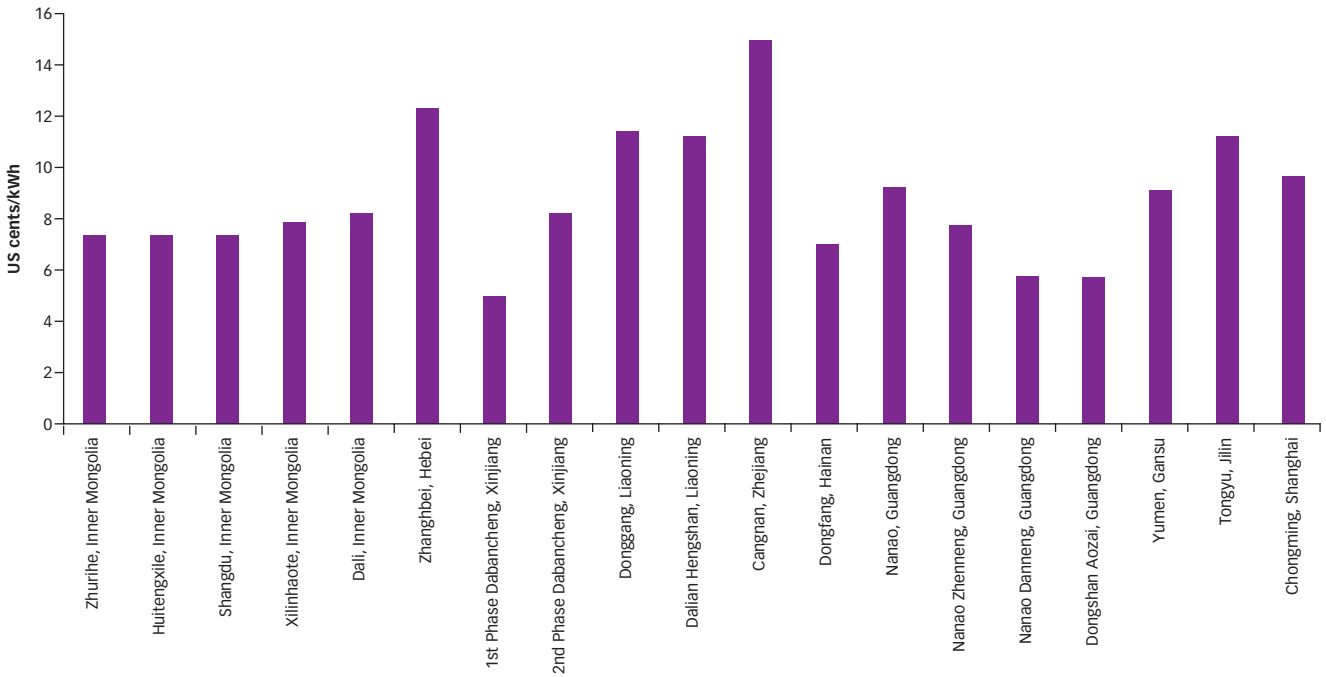
In the early rounds of concessioning, the prices bid were lower than the actual costs of production. As a result, some of the contracts awarded were not implemented. This outcome reflected the participation of inexperienced bidders (and the related absence of sufficiently stringent procedures to qualify bidders), as well as the fact that large state-owned enterprises wishing to enter the wind-power business bid very low prices without fear of being outbid, knowing that they could cross-subsidize their wind-power activities from their coal-based generation business.

The lower-than-cost bidding prices had the effect of slowing the expansion of wind power in China, sending the wrong market signals and discouraging wind-power developers as well as companies in the supply chain of wind power manufacturing.

Despite these problems, however, the auctions were effective in revealing costs and establishing cost benchmarks for the setting of more appropriate and economically efficient feed-in tariffs. In 2009, the government issued a "Notice of Improved Feed-in Tariff for Wind," with geographically differentiated feed-in tariffs in four different regions depending on wind-resource potential, ranging from 0.51 to 0.61 Y/kWh (≈0.07 to 0.09 US$/kWh).

The development of solar photovoltaic followed a similar path—evolving from concessions to feed-in tariffs. The government issued feed-in tariffs for grid-connected solar photovoltaic at 1.0 Y/kWh in 2011 (≈0.015 US$/kWh), based on the concession results, then later

Figure 1. Mean electricity prices for wind power generation projects operational at the end of 2006 (before the auctioning of concessions)



Source: Junfeng, Pengfei, and Hu 2010.

"Despite problems, auctions were effective in revealing costs and establishing cost benchmarks for the establishment of more appropriate and efficient feed-in tariffs."

moved to lower, geographically differentiated feed-in tariffs in three regions reflecting their solar resource potential. The regional feed-in tariffs ranged from 0.9 to 1.0 Y/kWh in 2013 (≈0.015 US$/kWh).

Feed-in tariffs for biomass were revised several times during the implementation of the policy. There were two reasons for the revisions. First, the prices paid by many biomass-fired plants for fuel (notably straw from agriculture residues) turned out to be much higher than originally anticipated owing to fuel price volatility. As a result, feed-in tariffs for biomass were raised to factor in the fluctuation of biomass fuel prices. Second, feed-in tariffs for biomass were originally designed to yield a fixed premium of 0.25 Y/kWh (0.03 US$/kWh) to top up baseline prices (based on coal-fired power plants) in each province, which resulted in wide discrepancies in biomass tariffs in different parts of the country. Learning from these lessons, the government reset the feed-in tariff for biomass at a fixed level of 0.75 Y/kWh (≈0.01 US$/kWh).

What solution was adopted?

China has applied successive adjustments to concessions auctions to improve their usefulness in setting appropriate feed-in tariffs

The ability of auction schemes to attract international players, foster competition among investors, and enable the rapid development of nascent economic sectors makes them attractive as a price-discovery mechanism for generation technologies for which feed-in tariffs have not been established (Elizondo-Azuela and Barroso 2014). The use

"The Chinese authorities had learned that prequalification criteria, as well as penalties for noncompliance and nonperformance by the winning bidder, are critical to the success of auctioned concessions."

of auctions enabled the government to gather cost information from renewable energy project developers in order to set appropriate feed-in tariffs, with the auction price being used as a proxy for the actual project cost. In theory, of course, the more competitive the environment, the closer the bidding price will be to the actual costs. By improving the competitiveness of concessions auctions, the government was eventually able to find a reasonable price benchmark for power generated from specific technologies (Qiu and Anadon 2012).

While early experience with auctions as price-discovery mechanisms had been generally positive (as evidenced by their continued role under the Renewable Energy Law), concerns persisted that the lowest bids received in the auctions were in fact below marginal investment costs. The issue of aggressive bidding was clearly unacceptable, as ultimately investors needed to be adequately remunerated to ensure the long-term sustainability of the market, as well as the achievement of the national targets. When winning bids in early auctions of concessions proved too low, the minimum price criterion was supplemented with other criteria designed to discourage irrational bidding behavior, to reward technological innovation, and to take into account bidders' previous experience. The Chinese government also added local content requirements, intending to promote its wind power manufacturing industry and to reduce costs. In the auction launched in 2005, the price criterion made up 40 percent of the index used to compare bids; in the 2006 auction it represented only 25 percent. Even with the addition of the other criteria, the winning bids were still those that offered the lowest prices.

In the 2007 auction, the price criterion was completely redesigned, so that the advantage would go not to the lowest bidder, but to the bidder that was closest to the average price resulting from all bids, after excluding the highest and lowest bids, which were considered outliers (GWEC 2007). This practice was designed to screen out wild cards (irrational or inexperienced, poorly informed bids).

Ultimately, however, this approach was not retained. In subsequent auctions for solar plants and offshore wind power generation capacity the minimum price criterion was restored as the basis for selecting the winning bid.

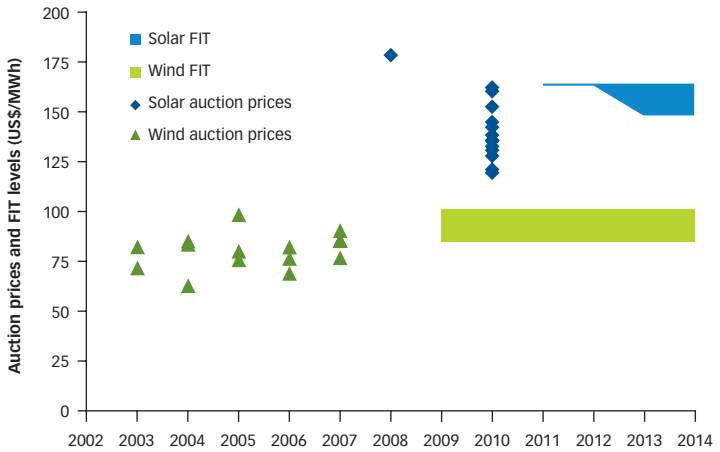
In the meantime, the Chinese authorities had learned that prequalification criteria, as well as penalties for noncompliance and nonperformance by the winning bidder, are critical to the success of auctioned concessions.

Although feed-in tariffs are now the cornerstone of Chinese renewable energy policy, auction mechanisms continue to play a key role in identifying market prices for renewable energy. Since the initial burst of renewable energy auctions in 2003–07 (a period in which five wind power tenders were carried out), tenders for solar photovoltaic have been carried out (in 2008 and 2010), for offshore wind power (2011), and solar thermal (2011).

Feed-in tariffs are now regarded in China as better suited for rapidly expanding renewable capacity than the auction-based schemes. Feed-in-tariff policies provide the same price certainty to investors, while also minimizing bureaucracy and transaction costs (Elizondo-Azuela and Barroso 2014). They do this by including a purchase obligation and rules on how, and how often, prices are modified. If these modifications are made through auctions, investors need to know the frequency and schedule of the auctions.

Today, feed-in tariffs for various technologies in China are competitive and comparable to international benchmarks (Wang and Wu 2013). The levels of FITs in both wind and solar reflect the prices that resulted from auctions (figure 2).

Figure 2. Comparison between Chinese FITs and auction results, 2003–14



Source: Authors.

Note: An exchange rate of 6.1 Y/US$ was assumed. FITs for wind power were established in 2009 and vary between 0.51 and 0.61 Y/kWh depending on the wind region. FITs for solar power were initially established in 2011 at 1 Y/kWh (constant throughout the country); in 2013 they were revised to vary between 0.9 and 1.0 Y/kWh, again, depending on region.

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What is the key lesson?

Auctioning of concessions was an effective price-discovery mechanism for the determination of feed-in tariffs

Auctioning of concessions has played an important role in China's scale-up of renewable energy, particularly as a price-discovery mechanism for the determination of feed-in tariffs.

The use of auctions for price discovery in China has significantly reduced the likelihood of feed-in tariffs being set above market equilibrium prices, thus avoiding excessive additions of renewable energy capacity and the heavy surcharge on consumers that excess capacity has entailed elsewhere (Elizondo and Barroso 2014). Of course, in China, the risk of excess capacity is mitigated through the country's very fast load growth and the ease of diluting renewable energy costs in consumers' electricity bills. Presently, renewable energy costs are passed through to consumers in the form of a surcharge of 0.008 Y/kWh (≈0.0013 US$/kWh).

The chief lesson from China's experience with auctioning of concessions is that winning bid prices that are lower than actual costs wind up deterring the development of renewable energy. Some of the winning bidders during the first and second rounds of China's wind-concession auctions were inexperienced players whose goal was to get into the promising wind market first rather than to maximize profits. Some of them did not fully understand the wind-power business, having failed to conduct high-quality feasibility studies and thus lacking sufficient data on the potential of the wind resource. In the later rounds of the wind concessions, large, state-owned power generators dominated the tenders, but their core business was coal-fired power generation, which they used to cross-subsidize the marginal wind business. Even after the government adjusted its criteria for choosing the winners of wind-concession auctions, the winning bids in most cases were still those that had offered the lowest prices. Therefore, careful design of the concession scheme is necessary to ensure the success in the performance of auctions.

China's policy for the development of renewable energy policy has reflected the country's specific needs and characteristics (including the size and rapid growth of its energy market). Simply replicating another country's successful policies with insufficient regard to underlying circumstances is not likely to lead to the most effective choice. The Chinese government is used to regulating prices under its traditional planned economy; in other countries where the government has not refined its price-setting power to the degree seen in China, auctions may be the right choice even if they do not help to perfect a system of efficient feed-in tariffs.

References

Elizondo-Azuela, Gabriela, and Luiz Barroso. 2014. "Promoting Renewable Energy through Auctions: Overview." Live Wire 2014/12, Energy Practice, World Bank, Washington, DC.

GWEC (Global Wind Energy Council). 2007. *China Wind Power Report*. Beijing: China Environmental Science Press.

Junfeng, L., S. Pengfei, and G. Hu. "2010 China Wind Power Outlook." Chinese Renewable Energy Industries Association, GWEC, Greenpeace, 2010.

Qiu, Yueming, and Laura D. Anadon. 2012. The Price of Wind Power in China during Its Expansion: Technology Adoption, Learning-by-Doing, Economies of Scale, and Manufacturing Localization. *Energy Economics* 34(3): 772–85.

REN21. 2013. *Renewables 2013 Global Status Report.* Paris: REN21 Secretariat.

Wang, Xiaodong, and Yun Wu. 2013. "China's Renewable Energy Development Story." Unpublished paper, East Asia and Pacific Region, World Bank, Washington, DC.

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