POWER MARKET REFORM IN CHINA: DIVIDENDS, MARKET IMPACTS, AND TRANSITION OPTIONS

Jiang Lin, China Energy Group, Lawrence Berkeley National Laboratory, 510-495-8886, j_lin@lbl.gov
Fredrich Kahrl, Energy and Environmental Economics, fritz@ethree.com
Jiahai Yuan, North China Electric Power University, yuanjh126@126.com
Qixin Chen, Tsinghua University, qxchen@tsinghua.edu.cn
Xu Liu, China Energy Group, Lawrence Berkeley National Laboratory, 510-486-7602, xuliu@lbl.gov

Overview

China has embarked on reforms in its electricity sector that aim to introduce market mechanisms in wholesale pricing. This study provides a quantitative assessment of the impacts of electricity market transition in China on electricity costs and CO_2 emissions, as well as the net revenue impacts on individual classes of generators, focusing on Guangdong Province. This paper assesses the impact of electricity market reforms in Guangdong Province. Our analysis compares a market scenario, in which generators are dispatched at least-operating cost with a single market clearing price, to a reference scenario, which uses historical tariffs and an idealized, historical approach to operating generators. We find that market reforms deliver significant annual cost savings to the society, which are driven primarily by electricity price reduction, followed by fuel efficiency improvements for coal and natural gas generators and natural gas-to-coal switching.

Methods

The reference scenario represents an idealized benchmark, as historical operating practices may have deviated from our assumptions and, relatedly, some of the cost savings from market reforms may have already been realized through bilateral markets. Nevertheless, given the lack of publicly-available data on actual operations or bilateral market transactions we argue that the reference case still provides a useful benchmark against which to compare market savings.

The market scenario assumes that a wholesale market for generation — however designed and implemented — facilitates economic ("merit order") dispatch. This assumption is consistent with theory and practice, where forward contract prices and regulated prices converge on spot market pricing over time. Price convergence and the shift toward economic dispatch will likely not be immediate, and thus the analysis here represents a longer-term outcome. We developed three market scenarios, "Market Only" scenario, "Low scarcity and premium payments (SPP)" scenario and "High SPP" scenario, which represent a market without any form of scarcity payments to generators, a market where all generators and imports receive some form of a scarcity payment, and a market where all thermal generators within Guangdong receive a much higher scarcity payment, respectively.

We approximate economic dispatch in these market cases using a "stack" model. The stack model orders generators in each hour in order of operating (variable) cost to meet demand, ignoring generator and transmission constraints. This approach provides a reasonable, high-level estimate of changes in cost and intuition for structural drivers of change, without the need for more detailed operational data and assumptions.

Results

Economic dispatch in the market case scenarios leads to a significant reduction in total generation costs, a moderate reduction in production costs, and a small increase in CO_2 emissions (Table 1). Each generator

earns revenues in the energy market equal to the product of an hourly market clearing price and the generator's net output in that hour. Inframarginal generators — those whose costs are lower than the market clearing price — earn net revenues that contribute to fixed cost recovery. Fixed costs include fixed O&M costs, depreciation, debt interest, return on equity, and non-marginal taxes. Given reduced net revenues for generators, some form of side payments to generators may be needed to meet reliability, renewable energy, and emissions goals. Our results show that adding premiums for wind, solar, and nuclear generation and scarcity payments increases revenues for generators in the Low SPP and High SPP scenarios.

Table 1. Overeall Results

			Market Case Scenario		
Metric	**Units**	**Reference Case**	**Market Only**	**Low SPP**	**High SPP**
Total generation costs	Billion yuan (% reduction)	233	170 (-27%)	193 (-17%)	212 (-9%)
Production costs	Billion yuan (% reduction)	94	82 (-13%)	82 (-13%)	82 (-13%)
CO_2 Emissions	Million tons CO_2 (% reduction)	224	231 (+3%)	231 (+3%)	231 (+3%)

We also conducted sensitivity analysis by assessing the following four factors' impact on total generation costs, production costs, and CO_2 emissions in the Low SPP scenario: (1) the timing and level of net imports; (2) coal and natural gas fuel price levels; (3) the timing and level of hydro resources, and levels of solar and wind generating capacity; and (4) CO_2 prices.

Conclusions

We found that the economic dispatch of existing power plants, facilitated by reforms, reduced total (fixed and operating) generating costs by 21 to 63 billion yuan per year (9-27%), reduced production costs by 12 billion yuan per year (13%), and increased CO_2 emissions by 7 million tons (3%) for the year of this analysis (2016). Market reforms with a single market clearing price reduced net revenues for coal, natural gas, nuclear, wind, and solar generators. To address issues around generator solvency, reliability, and emissions, some form of payment for reliability and environmental attributes may be needed. Our analysis showed that electricity costs were very sensitive to CO_2 prices because of the large amount of coal generation (60 GW) in Guangdong's electricity system.

The largest benefits of market reforms in Guangdong are likely to be long term. Most of the potential short run cost savings associated with electricity reform in China are cost transfers from generators to consumers — the accumulated legacy of central planning and incomplete reforms. Going forward, and in the long run, the largest benefits of market reforms will be in improvements in operational and investment efficiency that result from having an economic framework for short-run operations and longer-term investment decisions.

References

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