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Avoiding Pitfalls in China’s Electricity Sector Reforms[†]

Michael R. Davidson^{*} and Ignacio Pérez-Arriaga^{**}

China has recently reinvigorated reforms to its electricity sector, focusing on increasing the role of markets and improving regulation. While restructuring an electricity sector is difficult and can require years of detailed planning, China’s approach relies upon broad central guidelines with many details and initiatives left to provincial governments. We assess the current state of reform efforts through the lens of five “pitfalls” based on well-established regulatory economics literature and international lessons, focusing on contract structure, system operation, and regulation. We find that while market efforts are likely to achieve efficiency gains with respect to the planned system, they may fall short of crucial functions of a market, such as incentivizing flexibility given increasing renewable energy penetrations. Making markets work will likely require a stronger centralization of market design and regulatory oversight authorities.

Keywords: market liberalization, electricity restructuring, renewable energy, China

JEL Codes: D47, L94, O14, Q41

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1. INTRODUCTION

In March 2015, China's highest-level policy-making body, the State Council, inaugurated a new round of electricity reforms with the goals of enhancing market-based competition, establishing trading mechanisms for a variety of products, reducing retail electricity prices, and improving regulation of grid monopolies (State Council 2015). This renewal of central-level changes to electricity sector management—the first major overhaul since unbundling of the former vertically-integrated State Power Corporation in 2002—was precipitated by political directives to increase the role of market-based pricing and reduce direct government planning throughout the Chinese economy (CPCCC 2013). It also follows failed attempts in the Northeast and East China grids in the early 2000s to create wholesale electricity markets along international designs (Andrews-Speed 2013).

In the absence of competitive markets, the majority of electricity production has been assigned annually by local governments with tariffs determined by the central planning agency. While central pressure for reforms waned, some provincial governments gradually created various forward physical contract markets (annual and monthly) between large suppliers and consumers, an approach that forms the basis for the current round of reforms. With renewed high-level support for market-based initiatives, building on over a decade of post-unbundling regulatory experience and these medium-term markets, moods are high.

However, as is well-documented, building efficient electricity markets entails a vast number of institutional changes, which can be particularly challenging in industrializing countries without sufficient market and independent regulatory experience (Joskow 2008; Jamasb 2006; Jamasb, Nepal, and Timilsina 2017). Fully restructuring can require years of detailed planning, and the best-laid plans can be modified and delayed as a result of market experiences and changing political preferences. In non-OECD Asia, countries have generally fallen short of reform ideals, pointing to the need to examine how individual reform steps generate outcomes (Sen, Nepal, and Jamasb 2018).

China's reforms, relying upon broad central guidelines without a detailed roadmap of timetables and new institutional structures, leave many details and initiatives

up to the provinces (Zhang, Andrews-Speed, and Li 2018; Pollitt, Yang, and Chen 2017).¹ Furthermore, China's market approaches are often uniquely crafted for national or local contexts, differing in fundamental ways from standard international designs (Li, Zhang, and Andrews-Speed 2019). This complicates analysis of the reform's progress toward efficient markets, requiring thorough examination of *de jure* and *de facto* market processes. Existing literature has examined political obstacles to reform and is beginning to make recommendations aimed at ameliorating deficiencies in specific implementations (Dupuy et al. 2018).

In this paper, we examine government plans and numerous market implementations at the provincial level, building on interviews conducted with grid and market operators, regulators and generation firms, conducted in 2015, 2016, and 2018. We find several warning signs that the current round may fail to achieve its broader aims, which have been highlighted in various forms in the literature. Our organization of these into "pitfalls" grounded in basic regulatory economics results and supporting international lessons provides a concise and comprehensive treatment that we believe can help focus future academic discussion on the reforms, and which has direct relevance to policymakers. It extends existing work summarizing progress or prescribing fixes for specific provincial contexts by creating a general framework of ultimately measurable metrics applicable to various reform efforts. We conclude that effective restructuring in China will most likely require enhanced centralization of institutional design and substantially strengthened independent regulatory powers.

2. BACKGROUND

Similar to many other countries, for much of its history China's electricity system was owned and operated by a single vertically-integrated utility (VIU) within a government ministry. The scope of this ministry varied over the years, encompassing at

¹ For example, supplementary documents to State Council (2015) set general targets such as moving all commercial loads to market-based mechanisms by 2020, and list a range of allowable market types including bilateral contracts, one-sided auctions and two-sided markets, without specifically requiring a certain market design (NEA 2016; NDRC and NEA 2016a).

times all energy sectors, but its responsibility for electricity included all aspects of planning, investment and operation. By the 1980s, central government budget constraints led to massive energy shortages just as China's economic liberalization reforms gained steam. This prompted investment to be opened up to local governments and enterprises, in some cases backed by foreign loans, with pricing roughly based on rate-of-return regulation determined plant by plant (Zhang and Heller 2007).

Expanding investment essentially eliminated electricity scarcity by the mid-1990s, but restructuring continued as a result of pressure from international institutions for complete marketization based on early reforms elsewhere; political leadership that embraced corporatization and privatization of state-led production; and complaints of discriminatory access and dispatch for new non-VIU generators (Yeh and Lewis 2004; Ma and He 2008; Xu 2016). Over 1998-2003, China put in place much of the international model, including separating business from government functions through new state-owned grid companies, unbundling generation from the network, and establishing a new independent regulator. It also called for an "open, competitive and orderly electricity market" to be created, and began to experiment with various wholesale markets (State Council 1998; Andrews-Speed 2013).

Over the 2000s, progress in these reforms slowed, including the failure of several market pilots, and a partial liberalization of the generation sector persisted. In particular, province-wide benchmark tariffs for generators—intended as an interim measure—became a key lever of macro-economic planning, and in the absence of market signals of production costs, dispatch followed general principles of maintaining "equal shares" across generators and ensuring revenue sufficiency (Ma 2011; SERC 2003). Throughout this period, the system followed a quasi-"single buyer" model where the integrated transmission-distribution grid companies had a monopoly of supply to customers and energy purchases from generators, which has been pursued as an interim setup toward liberalization in other countries (Besant-Jones 2006). Measures such as "energy-efficient dispatch" and priority dispatch for renewable energy attempted to integrate cost principles into production decisions, with varying degrees of success (NDRC et al. 2007; SERC 2007; Zhong et al. 2015). The independent regulator was abolished in 2013 and its

authorities subsumed by larger government planning bodies, indicative of the broader hurdles of implementing standard market designs (Lin and Purra 2018).

Failures to meet central objectives such as efficient operation and renewable energy integration led to the current round of reforms, which broadly focuses on fostering price competition in generation and retail, enhancing regulation of grid costs and services, expanding inter-regional transmission, and strengthening overall government planning in the sector (State Council 2015; Zeng et al. 2016).

The new round, the focus of this paper, will need to address many of the entrenched institutions that have developed over three decades of reforms, ranging from eliminating the quota to reforming pricing and grid dispatch procedures (Zeng et al. 2016; Kahrl and Wang 2014). In terms of key elements of “textbook” reforms, China faces numerous obstacles, in many cases owing to large provincial government influence (Pollitt, Yang, and Chen 2017). Furthermore, market institutions crafted at the provincial level for local contexts exhibit a striking amount of diversity (Li, Zhang, and Andrews-Speed 2019; Cheng et al. 2018). These raise questions about the effectiveness of these market-based approaches, which has led to some tailored recommendations designed to ameliorate deficiencies for specific provinces and designs (Dupuy et al. 2018).

In the following section, we elaborate on issues of the *de facto* system of regulation, operation and markets, and identify key “pitfalls” where the reforms as currently designed and/or initially implemented diverge from well-established regulatory principles.

3. PITFALLS

Five pitfalls were identified through a careful review of the available literature on China’s market reforms and reform experiences globally; market design and market outcome documents of Chinese experiments (where available); and a large number of interviews mostly in Mandarin Chinese with stakeholders in government agencies, regulators, grids, generation companies, and research organizations. Interviews (77, in

total) were conducted in 2015, 2016 and 2018 in 9 Chinese provinces² as part of studies into dispatch practices, wind integration issues, and the market design process at central and provincial government levels.

Space does not permit treatment of all markets—virtually every province has established some competitive elements in its electricity sector. Examples of cases were thus selected as illustrations of various pitfalls. It is indicated where these are commonplace—and thus more representative—as well as where these cases are somewhat unique, but possibly growing in importance.

3.1 Physical Contracts Rather Than More Flexible Financial Contracts

3.1.1 Basic Rationale

Due to the instantaneous matching of electricity supply and demand, physical constraints on electricity production, and non-linear interactions of network flows, the marginal cost of delivering an additional unit of electricity can vary substantially over short-time periods and distances. Production and consumption decisions based on the intersection of marginal supply and demand curves thus lead to short-term locational “spot” prices fundamental to any electricity market design (Joskow and Schmalensee 1983; Hunt 2002).

Nevertheless, all major electricity systems allow for contracts between specific suppliers and consumers to be made in advance and without knowledge of real-time system conditions in order to hedge price risks (Bushnell, Mansur, and Saravia 2008). If the system operator (SO) considers these contracts when determining dispatch (i.e., fixing injections and withdrawals according to the contract), these are considered *physical contracts* (or “inflexible”). If they are not considered in dispatch, they are *financial contracts* (“flexible”) and are used to calculate ex-post transfers.

The most important distinction between the two arises from out-of-merit-order dispatch efficiency losses, when a physical contract mandates dispatch of a generator

² Interviews were conducted in Beijing, Gansu, Guangdong, Heilongjiang, Inner Mongolia, Jilin, Liaoning, Shaanxi, and Yunnan.

when infra-marginal options are available in the spot market (Cicala 2017). Some—though not all—negative aspects of physical contracts can be mitigated if they are tradeable up to short timescales, such as in the British Electricity Trading Transmission Arrangements (BETTA), where bilateral trading occurs up to 24 hours in advance, and multiple centralized exchanges for physical contracts occur up to 1 hour before real-time (National Grid 2011). The potential benefits of generators “self-scheduling” through physical contracts largely rest on replacing market power in the pool with presumably more competitive decentralized bargaining relative to centralized pools (Newbery 2005; Sioshansi, Oren, and O’Neill 2008).

A second distinction arises in securing physical transmission rights, necessary because physical contracts can cause network congestion (Joskow and Tirole 2000). Assigning or purchasing these rights cannot be as efficient as a real-time dispatch that co-optimizes transmission allocation for a large group of generators (Hogan 2003). With financial contracts, a hedge against price risk associated with congestion can be created in the form of financial transmission rights (FTRs), forward contracts whose value is equal to the realized difference in prices (Hogan 2003). Neither financial energy contracts nor FTRs affect the flexibility of the SO to determine the most efficient dispatch and flows.

Physical contracts have arisen naturally for many vertically-integrated utilities (VIUs) who sign physical “wheeling” contracts with independent power producers or neighboring regions, under which the VIU supplies as much demand as it likes through its own generators and contracts out the remaining demand and available transmission capacity (Hunt 2002). This two-tier arrangement is inherently discriminatory and inefficient in the case owned generation is given preference over less expensive alternatives. The gains from abolishing these physical contracts can be substantial (Mansur and White 2012).

Physical contracts have been justified for security of supply reasons. For example, if two regions have made a forward contract but both face scarcity in real-time, the exporting region may choose for political reasons not to curtail local loads, which is why physical contracts are incorporated into the Southern African Power Pool (Promethium Carbon 2016). However, equivalent guarantees can be accomplished by replacing physical contracts with more efficient financial contracts for energy and transmission

treated as “contracts-for-differences” (CfDs) except in the case of supply scarcity, when they are considered in dispatch (Rose, Stoner, and Pérez-Arriaga 2016).³ Another justification for physical forward contracts has been the prevalence of long-term “take-or-pay” contracts that set prices and minimum quantities for buyers to purchase and sellers to deliver certain fuels. These have been seen as an efficient risk-sharing measure during early resource exploration periods, but as supply has become more liquid, buyers increasingly prefer to purchase in short-term markets or incorporate flexibility in long-term contracts in terms of quantities and prices (Neumann and von Hirschhausen 2015).

3.1.2 Situation in China

In China, up until very recently, virtually all electricity has been contracted through an annual government-run production planning process that assigns quotas to generators based on projected demand, creating essentially physical contracts between generators and the grid company. Energy quantities are the result of negotiation based on principles of fairness as well as average generator efficiency.⁴ Provincial “benchmark tariffs” are fixed by the central National Development and Reform Commission based on expected returns, inflation and other socio-economic concerns (Kahrl, Williams, and Hu 2013). These medium-term forward physical contracts typically specify monthly breakdowns, and at roughly monthly intervals, the grid companies make centralized commitment schedules and adjust dispatch to meet these contracts, with some flexibility to “roll-over” a limited amount of scheduled plans between months. This system of inflexible scheduling and quotas causes efficiency losses and is a leading contributor of high wind curtailment rates (Davidson and Pérez-Arriaga 2018).

Recent market reforms have largely focused on shifting medium-term government allocations of conventional coal and hydropower generation to similar length contracts

³ Similar proposals have been raised for cross-border capacity remuneration mechanisms in the EU, where security of supply directives nominally require that cross-national contracts be honored even in cases of scarcity (Mastropietro, Rodilla, and Batlle 2015).

⁴ The equity principle, sometimes referred to as *sangong* (roughly translated as “fairness, equity and transparency”), is a legacy of the planning era (SERC 2003). The efficiency principle, sometimes referred to as “energy-efficient dispatch”, calls for preferential allocations to more efficient generators. Actual practice is somewhere between these two outcomes (Zhong et al. 2015).

with large (typically, industrial) consumers, either bilaterally negotiated or in multilateral exchanges. The contracted amounts are added to monthly allocations for grid company scheduling, and meeting the contracts typically takes precedence over the quota, lacking the explicit “roll-over” flexibility for grid dispatch.⁵ Government documents on “opening up” the quotas to markets—the predominant market creation mechanism currently—link contracts with the physical delivery of electricity (NDRC 2015a; NEA 2016; NDRC and NEA 2017b). Guidelines further encourage inclusion of power profiles in forward contracts, which would move China closer to a “self-scheduling” system (NDRC and NEA 2016a). High-level market design documents also allow for a “centralized” market setup with financial CfDs (NDRC 2015b). However, Chinese markets have so far not stood up financial contracts—whether for energy or transmission rights.

In all locations where these medium-term contracts exist, prices have fallen with respect to benchmark tariffs, sometimes up to 30% for coal power (CEC 2017). This gap is, first, attributable to government benchmark industrial tariffs set above the cost of production, a feature that has been maintained, among other reasons, to subsidize small consumers such as households (Lin and Liu 2013). Second, electricity generating capacity has grown much faster than demand in recent years (see **Figure 1**), stimulated by the decentralization of coal plant permitting, and leading to highly competitive forward contract markets (Yuan et al. 2016).

Some market experiments on smaller timescales and with other fuel types, on the other hand, have softened the physical nature of the contracts through the unclear connection between settlement and dispatch. For example, exchanges for “excess wind” and other renewable energies are nominally designed to take otherwise curtailed generation and, by lowering the price, encourage integration. If all of the generation contracted through these exchanges is indeed “additional” (i.e., otherwise curtailed), then system efficiency is increased. Furthermore, to ensure this, central regulations stipulate that these market transactions should only take place above a minimum renewable generation quota paid at the full feed-in-tariff (FIT) (NDRC and NEA 2016b). However,

⁵ Interview, provincial dispatch operators in Southern Grid, October 2016.

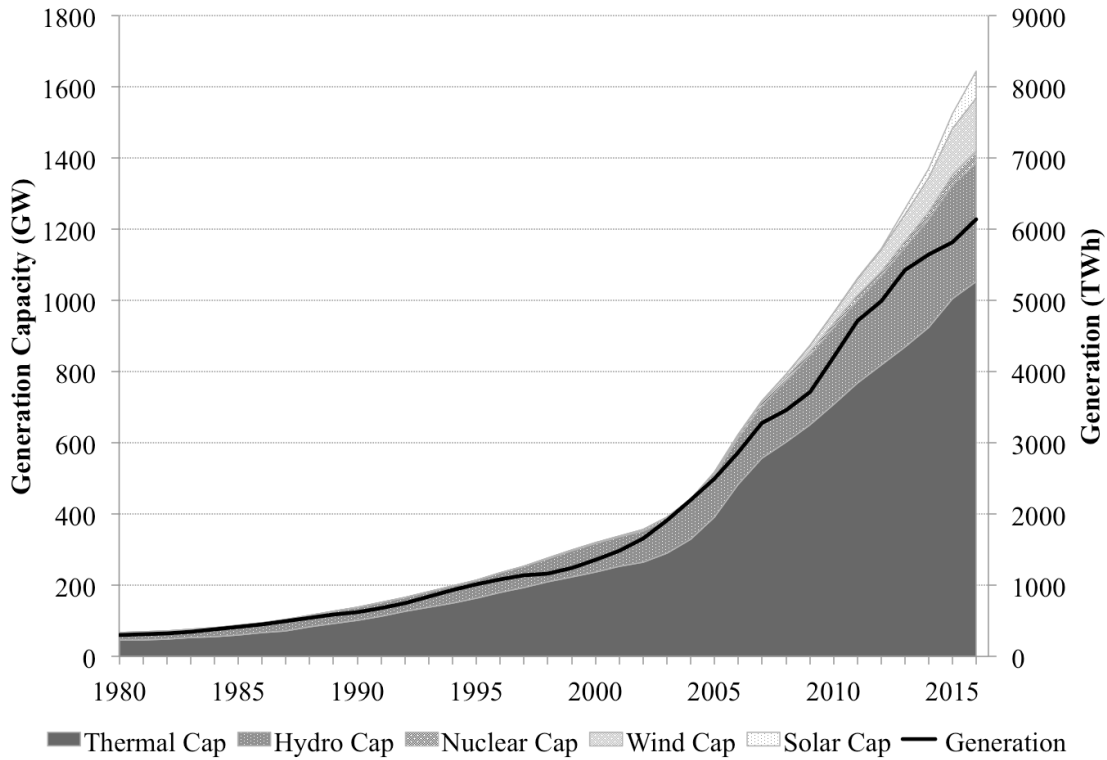
most provinces failed to meet these quotas in 2016.⁶ Some provinces met the quotas in 2017, but only when adding up both FIT and market-priced generation (NEA 2018). No comprehensive data exist on payments to renewable energy generators, but one survey indicates roughly 20% of hydro, wind, and solar were sold at below-FIT prices, indicating that these full-tariff minimum quotas were likely unmet (CEC 2017). This has left renewable energy generators wondering how much these markets are providing additional integration space as opposed to simply helping local consumers avoid paying the full tariff. In the absence of a merit order-based dispatch, it is difficult to model the counterfactual. On short time frames, such as in the country's only day-ahead energy exchange in Yunnan province, the contracts are essentially financial means to avoid costly default tariffs, discussed in the next section.

While the Chinese system is predominantly “single buyer”, the quota system differs from other single buyer arrangements in several ways. When plants are permitted, instead of explicit long-term purchase agreements, governments provide implicit guarantees to set quotas that allow generators to recover costs, though terms are frequently renegotiated: quantities on an annual basis and tariffs at slightly less frequent intervals. China's “single buyer” purchase agreements are not the result of competitive auctions. Furthermore, there are, in fact, multiple “buyers”: besides the grid company, several levels of government can be involved in approval processes and, hence, the implicit guarantees.

China also has mixed experiences with making physical contracts tradeable. For the physical quota (the result of government planning), the standard approach is referred to as “generation rights trading” (GRT), wherein one generator has a guaranteed purchase agreement with the grid (i.e., quota) and it enters into a contract with another generator to produce on its behalf, typically on monthly or longer periods (SERC 2008). This was primarily expanded when helping achieve mandatory early retirement of small and inefficient generators by allowing them compensation for up to three years (NDRC and NEWG 2007).

⁶ In 2016, only three provinces met the minimum wind capacity factor targets of 21-23%, and only parts of four provinces met the solar targets of 15-17% (NEA 2017). Reports do not specify how much of this was paid at full tariff.

Figure 1. Electric Capacity and Generation in China, 1980-2016



Source: China Electricity Council.

When viewed as compensation for early retirement, the government has a strong incentive to force trades that make the small generator whole. However, under high and volatile coal prices with flat benchmark generation tariffs, large generators may refuse to sign contracts even if smaller generators would pay them to take on the quota (Liu 2013). During such as a spike in 2011, some generators refused to generate as contracted, and even faked outages because their marginal profits were negative (Zeng et al. 2013).

More importantly, GRT may not completely mitigate the out-of-merit-order problem under economic dispatch if not all generators are required or able to buy quota, as is the case going forward since only a portion of total generation is through the quota.⁷

⁷ For example, the marginal production cost of a more efficient generator is raised by the price of the GRT permit, which might be pushed out of merit order by less efficient generation that does not purchase permits.

Nevertheless, some recommendations for market-based reforms in China advocate expanding GRT through, e.g., establishing power curves and deviation settlement mechanisms for these tradeable permits—akin to elements of some standard energy markets—while ignoring key distinctions between the two relating to efficient merit order (Li, Zhang, and Andrews-Speed 2019).

3.2 Forward or Specialized Markets Prior to Standard Spot Market

3.2.1 Basic Rationale

Efficient pricing of contracts, whether physical or financial, relies on underlying spot prices determined with sufficient granularity in time and location. For forward contracts to be used as risk hedging against price spikes, an expectation of the mean and distribution of spot prices is essential. Similarly, on an even longer horizon, it can be shown that investment decisions will be efficient (i.e., revenue sufficient and socially optimal) when remuneration is precisely equal to spot prices given by system marginal costs (Schweppe et al. 1988; Pérez-Arriaga and Meseguer 1997). Another benefit of forward contracts is to reduce the ability and incentive for generators to exercise market power through withholding in the spot market, though crucially, this does not diminish the need for a spot market (Green 1999).

The combination of the first (physical contracts) and second (absence of spot market) pitfalls locks in portions of dispatch before short-term conditions are known, and the further from real-time these contracts are determined the greater the chance is for out-of-merit-order dispatch. For example, system conditions may change following forward contract signing through a reduction in fuel input costs, decongesting a corridor, or an influx of low-variable cost renewables. While standard spot market design calls for a bid-based economic dispatch, an intermediate configuration where generator's marginal bids are replaced with audited costs has been implemented in several contexts (typically, hydro-dominated systems or where local market power is expected), and may be an interesting transitional structure to full bidding despite its numerous pitfalls (Munoz et al. 2018).

As mentioned above, with respect to the BETTA in England and Wales, some of the drawbacks of physical contracts can be mitigated with fluid secondary markets. At the same time, changes in generation mix and government policy particularly toward decarbonizing the power sector have revealed flaws in the BETTA design. Forward physical contracts are best suited for predictable fossil fuel generators who can plan output a year or more in advance and adjust to changes in conditions in a 24-hour period. Intermittent renewable energy cannot participate in these long-term markets and cannot freely change output in real-time; instead, its revenue would be entirely dependent on prices in the much smaller balancing markets (House of Commons 2011). Recognizing that physical contracts alone are insufficient, the UK government implemented auctions of (financial) CfDs which guarantee rates to renewable energy providers similar to a feed-in-tariff (DECC 2015).

3.2.2 Situation in China

As noted above, virtually all energy in China is contracted on monthly or longer horizons, whether through government quota planning or various market-based contracts. At sub-monthly intervals, the grid companies schedule and dispatch subject to these physical contract constraints, and attempt to enhance efficiency with the limited remaining flexibility by, e.g., taking on as much renewable energy as possible. However, no short-run energy prices or system marginal costs are formed,⁸ which would create the basis for efficient dispatch as well as contract pricing.

Two prominent pilot spot markets were attempted in 2004-2006, both failing. In the Northeast Grid, the proximate cause of failure was a rise in coal prices that increased generation costs in northern provinces while retail prices in the larger, southern province of Liaoning remained fixed. The grid company, which collected only the difference between retail and wholesale tariffs, lost 3.2 billion CNY in 16 days (~\$400 million in US\$2006) (Dai 2013). In the East China grid, two trial simulations (i.e., no actual

⁸ Based on interviews with numerous dispatch operators at the provincial and regional grid levels, the primary day-ahead and real-time functions are to meet the pre-specified output levels modifying as necessary to integrate variable renewables. Commitments are determined on a weekly or monthly basis, and not as the result of a unit commitment and economic dispatch optimization.

financial settlements) were conducted for a total of ten days in 2006. The outcome was largely favorable for the grid company as fuel prices were lower than average during the trial period. Nevertheless, according to one account, the grid company, provincial governments and generation companies were united in opposition: recent experiences in the Northeast weighed heavily on the East China grid; provincial governments did not want to give up autonomy over planning decisions through a regional market; and risk-averse generation companies had already grown accustomed to the guaranteed revenue streams under the quota system (Wen 2014).

In the 2015 reform document and subsequent opinions, emphasis is placed on moving quotas to medium-term contracts (either bilateral or through a common exchange), defined as time periods of a year down to a week (State Council 2015; NEA 2016). Spot markets have been deemed “supplementary” (NDRC 2015b). Eight provinces have been chosen to pilot spot markets, each at varying stages of planning and designs (NDRC and NEA 2017a). Guangdong in the Southern Grid is the furthest along, having established guidelines for comment, and trials expected in 2019-2020 (NEA 2018b).

In the absence of a spot market, gains from shifting forward production quotas to more competitive forward contracts may saturate as monthly-settled physical contracts create additional constraints on short-term dispatch. Grid operators will increasingly rely on “rolling over” quota generation between months so that market-based contract totals can be met. For example, Guangdong defines a “basic” electricity amount outside the market that allows for balancing, prioritizes intermittent renewable energy, and restricts some market contracts based on generator heat rates and system security (GD EIC 2017). Some dispatch operators worried that forward physical contracts exceeding 30% could create difficulties for balancing and reliability.⁹

Without any established spot markets to explore, we examine two other short-term market experiments: Yunnan’s day-ahead energy exchange (operating since 2016) and the Northeast load-following (“peaking”) ancillary services market (operating since 2014).

⁹ Interview with dispatch operator, 2016.

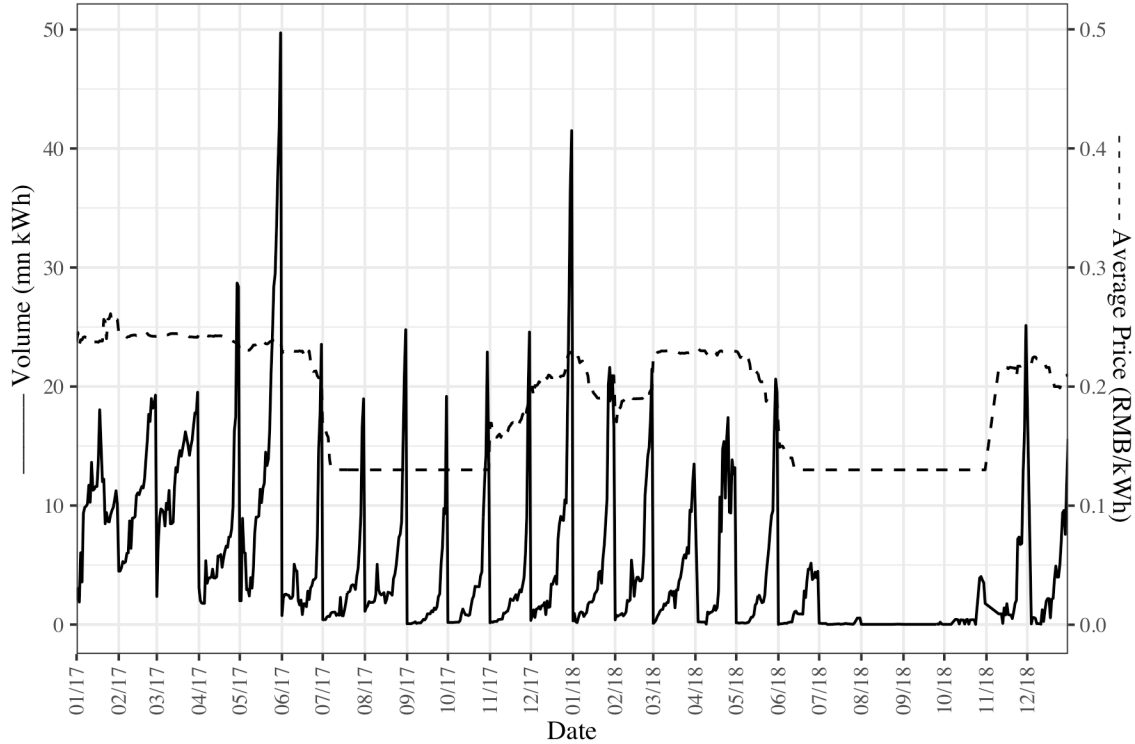
Yunnan's day-ahead exchange (DAX) matches pairs of bids from consumers and generators on a once-daily basis using a clearing mechanism similar to securities or foreign exchange trading and with no analogue in electricity systems of which we are aware. The market matches the lowest priced supply bidder and the highest priced demand bidder, with the transaction quantity equal to the smaller of the two bid quantities. There are no standardized quantities, but DAX bid quantities may not exceed the generating capacity and expected demand of supplier and consumer, respectively, after monthly and annual contract totals are deducted. Once this matched pair is removed, any unmatched quantity of either supply or demand carries over and the next pair is matched and repeated. The supplier receives a price equal to its bid plus 10% of the difference to the matched demand bid price, the consumer receives its bid minus 10% of the difference, and the remainder goes into a balancing mechanism for reimbursing generators for unmet contracts or other services (YN IIC 2017). The DAX diverges from centralized day-ahead auctions found in integrated markets, as well as the BETTA balancing mechanism in terms of timescales (day-ahead vs. hour-ahead in BETTA), and pricing (pay-as-bid vs. average prices of marginal bidders).¹⁰ Because different bidders receive different prices, the DAX can encourage parties to bid away from their marginal price (Pollitt, Yang, and Chen 2017).

According to Yunnan's monthly settlement procedures, the cumulative DAX quantities are subtracted from total generation/consumption, followed by other market contracts, and lastly the remainder is charged at unfavorable rates: for coal and hydro generators, the lowest cleared monthly supply bid; for consumers, the highest cleared monthly supply bid or 20% above the previous year's average, whichever is larger (YN IIC 2017). Based on published DAX volumes (see **Figure 2**), firms appear to use this market as a means to "top-up" market totals prior to monthly settlement and avoid unfavorable rates. In virtually all months besides January (when the Chinese New Year depresses demand), the largest bidding occurs on the last day of the month. Prices follow monthly supply availability, falling to the floor of 0.13 RMB/kWh during the rainy

¹⁰ For a description of the integration between power exchanges and the pay-as-bid balancing mechanism in the UK, see (Konstantinidis and Strbac 2015).

summer season. The DAX appears to be a purely financial instrument tied to an arbitrary monthly settlement period, whose value is quite distinct from projected day-ahead conditions as in other day-ahead markets.

Figure 2. Yunnan Day-Ahead Exchange Volumes and Prices, 2017-2018



Source: Kunming Power Exchange.

The Northeast peaking ancillary services (PAS) market was created to solve wind curtailment during low-demand hours by compensating coal generators to go below administratively-set minimum outputs, which range from 48-50% (Northeast ERO 2016). Under the scheme, coal plants may bid day-ahead a price (subject to floors and ceilings) required to reduce output, and the quantity is determined up to the needed wind integration space or the supplier bids, whichever is smaller. Payments into the scheme are taken from all generators proportional to their output *above* their administrative minimums: e.g., above 48-50% in the case of coal generators, 0% for wind, and 77% for nuclear (Northeast ERO 2016).

In practice, cleared PAS bids are frequently at the price caps¹¹—currently, 400 RMB/MWh (\$63/MWh), for the lowest tier—indicating that demand for integration space is high, and there is either generator market power or a perceived high opportunity cost of participating. This ties directly to the ambiguity between settlement and dispatch: if generators were guaranteed their quota and contract hours regardless of peaking participation, then the efficient price should be the marginal cost increase associated with part-loading, no more than 10-20% (Zhong et al. 2015). If generators felt risk that they would receive fewer hours as a result, then they should bid their higher opportunity costs. These two examples—DAX and PAS—demonstrate the peculiarity of short-term markets currently being experimented, which either flow from long-term settlement prices—not the reverse, as the regulatory economics literature suggests—and/or do not resemble at all typical spot price formation.

3.3 Retail Competition Prior to Efficient Wholesale Market

3.3.1 Basic Rationale

In some—not all—restructured electricity systems, the privileged status of the monopoly supplier that interfaces directly with the consumer is reduced, but rarely eliminated, and retail suppliers are allowed to compete for access to customers. Efficient retail electricity rates should be based on spot market prices to ensure efficient consumption and appropriate locational signals (Hunt 2002). In regulated retail markets—and through default tariffs in many competitive retail markets—the regulator should set tariffs according to these spot market prices, though in practice, political preferences can distort efficient tariffs (Batlle 2013).

There continues to be substantial debate over the benefits of retailing: in one view, costs of retailing (which include marketing, billing, etc.) are a small fraction of total costs (a few percent), and competitive retailing cannot do much better than a straight pass-through of the market price into a well-designed classical tariff, while

¹¹ Interviews, government official, June 2016, grid company official, July 2018.

simultaneously adding complexity and transaction costs (Joskow 2000). Another view holds that retailing can more effectively hedge risks through various forward contracts, open up new undiscovered areas of competition, reduce market imperfections, and in the process also reduce political interference in below-cost rate-setting (Bushnell, Mansur, and Saravia 2008; Littlechild 2009).

Nevertheless, in both views—whether customers access the wholesale market directly, indirectly through average regulated rates, or indirectly through a retailer with both long and short-term positions—price-discovery provided by the spot market is still paramount.

The most common justifications for poor results in competitive retail markets are the failure to properly unbundle and regulate VIUs, and that governments have shielded customers from the full cost of electricity by having regulators offer subsidized default tariffs (Joskow 2008; Batlle 2013). If subsidization is implemented (for poverty alleviation or other political goals), then the least distortive method is to subsidize fixed network and regulated costs while allowing energy prices to pass through (Batlle 2013).

3.3.2 Situation in China

Historically, China’s electricity sector has operated under a quasi-“single buyer” model, where grid companies purchase and resell all electricity (with government involvement through quota and price-setting). Electricity tariffs include customer differentiation and capacity charges based on peak demand for large consumers (see **Table 1**).

China’s government retail rate-setting process differs from typical cost-based tariff designs wherein retail tariffs equal the generation costs plus other regulated charges. The current system of grid compensation is “difference-based”: retail and generation rates are determined based on numerous cost and political factors, and the remainder is given to the grid company (Ma 2011). This leads to a lack of separation between competitive and regulated activities of the grid company, explored below in Pitfall #4.

Table 1. Retail tariffs in Western Inner Mongolia

	Energy (RMB/MWh)	Capacity (RMB/kW/month)
Residential	430	-
Agricultural	428	-
Commercial & Small Industry	633	-
Large Industry	430	28 (peak load) + 19 (transformer)

Source: (IM DRC 2016).

Notes: Only a subset of prices, for selected voltages, is shown. Residential: <1kV, first 170kWh/month; higher consumption is charged at tiered rates. Agricultural: <1kV. Commercial & small industry: 1-10kV. Large industry: 110-220kV; separate capacity charges for peak load and transformer capacity.

Any under-recovery of costs associated with politically-motivated retail tariff design appears to be covered by high cross-subsidization from commercial and industry customers. Early attempts at a wholesale market in China were abandoned to a large extent owing to grid company losses caused by this retail tariff structure (Xu 2016).

At the same time, consumers excluded from wholesale contracts can increasingly participate in markets through retail companies, of which as many as 6000 were registered as of early 2017 (NDRC 2017c). These are natural extensions of the wholesale markets, focusing on monthly to annual contracts between large generators and retail companies aggregating smaller consumers. Current rules generally limit participation to commercial and small industry, which are the only ones incentivized to switch, while household and agricultural consumers currently cannot and anyways have no incentive at present to abandon favorable government rates (Zeng et al. 2016).

Let us examine Guangdong province, one of the early adopters and most advanced in retail competition. At the end of 2017, there were 136 active retail companies serving 4,562 consumers through both bilateral negotiations and multilateral

trading (Guangdong Electricity Exchange 2018). Of the roughly 7 billion RMB (\$1.1 bn) in savings, 80% was captured by users and the remaining 20% by retail companies, resulting in an average reduction in consumer tariffs of 52 RMB / MWh (\$8.2 / MWh). The tariff reductions are taken off uniformly from the tiered peak/normal/valley prices, equating to roughly 8% off the normal period commercial prices (GD EIC 2017).

Large values associated with retail pricing thus appear to come primarily from reducing distortions from government-set pricing, a feature noted by retail competition proponents typically in the opposite context of removing subsidies for favored consumers (Littlechild 2009). Given the uniform load profiling (i.e., constant reductions in tiered prices) and modest transaction costs with the generation side (annual bilateral negotiations or monthly auctions), retail companies capture substantial rents from the increasingly competitive generation sector.

A little over half of Guangdong's retail companies are also generators (EPower Online 2018). Elsewhere, these vertical arrangements have been shown to make wholesale spot markets more competitive by committing generators to slow-moving retail rates, in essence a forward contract (Bushnell, Mansur, and Saravia 2008). Given the absence of a spot market and the prominence of bilateral negotiations, there may be reasons to worry about anti-competitive practices in Guangdong's retail market. As centralized monthly auctions dominate, however, the retail side may simply serve to help generators recapture some rents that would otherwise go to large consumers in the case of direct contracts. Guangdong, with only small penetrations of low-marginal cost generators (e.g., solar, wind, hydro) and natural gas excluded from market competition to date, is also one of the easier cases in China to stand up markets. It remains to be seen how retail and wholesale markets will fare under competition among many fuels.

3.4 Inadequate Attention to Conflicts of Interest in System Operation

3.4.1 Basic Rationale

Well-functioning wholesale electricity markets require non-discriminatory system and market operation that considers only efficiency and grid reliability. Fair network and

market access to all generators, thus, has arguably been the foundational issue of market regulation (Joskow 2008; O’Neill et al. 2006). Given the size and complexity of electricity systems, there are multiple ways in which network monopolists could give preference to specific market actors. This has motivated the general rule of legally separating competitive activities from the regulated monopolists.

System operators (SO) and network providers are natural monopolists, and market operators (MO) can be monopolists under certain situations such as mandatory pooling. When any or all of these are financially connected to generation, unfair and inefficient dispatch can result from explicit discriminatory arrangements such as “wheeling” with VIUs or implicit and difficult to identify “vertical foreclosure” of upstream competitors (Hunt 2002; Gómez-Ibáñez 2003).

Historically, most countries have chosen to separate at least one of these three functions, with models of the independent system operator (ISO) that is divested from network ownership, or the transmission system operator (TSO) that is separated from market operations. However, assuming a well-regulated environment, there is no fundamental reason why the SO, MO and network provider cannot be a single entity.¹²

Typically, economic regulation of the monopolist—focused on trading off incentives to increase efficiency and reduce rents—is considered a distinct topic from eliminating conflicts of interest. Grid remuneration should be based on “rate-of-return” regulation covering *ex-post* costs, “incentive regulation” allowing *ex-ante* costs, or a combination thereof. Even though an unbundled monopoly network company no longer has incentives to vertically foreclose on certain generators, the choice of regulation can still indirectly influence wholesale markets through the quality of the network and platforms for trading (Joskow 2014).

The second component of monopoly regulation is allocating grid costs through tariff structures. The most common form is a uniform charge on all users based on connected capacity and/or actual usage, colloquially known as the “postage stamp” (Rivier, Pérez-Arriaga, and Olmos 2013). When passing between wholesale pricing

¹² The key task is to eliminate any incentive for preferential treatment to certain generators (FERC 1999). In distribution systems, an analogous separation of distribution and retailing will likely be necessary if agents compete to provide distribution-level services (MITEI 2016).

zones, additional tariffs are frequently considered—although this is an error and may render trade uneconomical—with the simplest based on the agreed-upon contract path. The former has no locational signal and the latter assumes incorrectly that actual flows match contractual flows and that line utilization is the appropriate method of cost allocation. In fact, actual flows may differ from the contract path, thereby leading to inefficient network signals (Hogan 2003). Transmission charges should not depend on commercial transactions, as explicitly acknowledged in the EU Internal Market regulation and increasingly in other regional markets (MIT 2011). A more economically precise measure makes “beneficiaries pay” for each network investment in proportion to the benefits received from the project, though is rarely implemented in practice (Rivier, Pérez-Arriaga, and Olmos 2013).

3.4.2 Situation in China

China’s grid companies combine transmission and distribution network ownership and system operation. Reforms call for the creation of “relatively independent” electricity exchanges—replacing in most cases offices by the same or similar name in the grid company—to operate centralized auctions and act as clearinghouses for bilateral contracts (State Council 2015). Grid companies retain complete or majority control of these market exchanges. In more diversified exchanges, such as Guangdong, the grid company has 70% ownership and the remainder is with five large generator or retail companies (Guangdong Electricity Exchange 2018).

While the meaning of “relative” independence given majority grid ownership can be debated, proper incentives for system operation can still be maintained if competitive activities are separated from regulated ones. China’s grids have formally unbundled from generation,¹³ but the potential for conflicts of interest affecting efficiency persists through the regulation of grid revenues and tariff structures.

¹³ Some generation, primarily hydro, has been retained by various grid companies nominally for balancing purposes, and, while a small fraction, has raised questions of dispatch favoritism by some market participants, such as with the State Grid-owned Liujiaxia hydro plant in Gansu. (Interview, wind generation company, 2016)

First, grid company revenues come primarily through an energy (volumetric) tariff on the difference between selling and buying prices, as introduced in Pitfall #3. It is not directly the result of a cost-based or “incentive”-based regulatory process. The prices at both ends have historically been set with different policy objectives and in some cases by different levels of government. This bears directly on the success of unbundling: one of the proximate failures of the early 2000s wholesale market experiments was that grid companies lost revenues when retail rates were unable to rise with generation prices (Andrews-Speed 2013). Furthermore, within each of the provincial wholesale price zones, this tariff structure creates partiality toward certain transactions (i.e., between high-tariff consumers and low-tariff generators) and can lead to excess rents and diminished locational signals.

Second, inter-jurisdictional transmission charges (between provinces, and larger grid regions) are set administratively based on contract path with a fixed volumetric price.¹⁴ Without an *ex post* cost accounting or an *ex ante* revenue cap, this generates more revenue from transactions that utilize expensive lines, such as long-distance ultra-high-voltage (UHV) lines. As transmission costs are primarily sunk, this is also a profit-maximizing decision. As grid company officials have ardently promoted these long-distance networks, there is also a political incentive to show high utilization rates (Xu 2016). Within more meshed regional grids, these tariffs, to the extent they represent some annualized interconnection cost, also distort locational signals by focusing on contract paths instead of the geographical location and value of the injections and withdrawals.

Bilateral and multilateral wholesale market pilots generally add the prevailing difference benchmark of grid costs on top of the negotiated generation price (NDRC 2015a). The grid company may also take extra revenues from the wholesale contracts, such as in the Yunnan DAX in Pitfall #2 above, where each side is roughly pay-as-bid and 80% of the difference goes into a grid company-administered fund for other services (YN IIC 2017).

¹⁴ Transmission tariffs, particularly for newer and larger lines, are determined *ex ante* according to total cost and designed utilization, which could be up to 70% (Interview, grid company planning engineers, August 2016). Older tariffs are sometimes updated explicitly in concert with changes in sending and receiving region wholesale rates (e.g., NDRC 2015c).

At the end of 2017, virtually the entire country's provincial grids had begun piloting transmission and distribution tariff reforms aimed at establishing cost-of-service remuneration with some additional performance incentives. On a three-year cycle, expected costs are converted into tariffs based on expected demand, and at the end, savings will be shared 50/50 between grid company and consumers (NDRC 2017a). Preliminary estimates by the main industry association claim 48 billion RMB (\$7.6 bn) reduction in grid company revenues (CEC 2018). There are no reports yet on the *ex post* savings adjustment.

Proposed changes to inter-jurisdictional lines are more idiosyncratic: transmission projects are first separated by function into “interconnection” lines that provide reserve services and “transmission” lines that presumably transmit more constant flows (NDRC 2017b). The costs of the former are recouped via a capacity charge shared proportional to the jurisdictions' historic peak loads. The latter is the traditional volumetric contract path tariff with this key penalty: if actual line utilization falls below 75% of the government-approved design utilization, capital recovery rates can be reduced. Some special renewable energy auctions can also get reduced transmission tariffs. This approach aims to curb over-investment in new long-distance lines, but does not eliminate grid company interests toward specific market transactions and generators. The effectiveness of both the provincial cost-of-service and the long-distance line regulation will largely rest on the strength of the regulator to properly audit and oversee operations, discussed next.

3.5 Insufficient Commitment to Strong, Independent Regulator

3.5.1 Basic Rationale

An independent regulator is an “underappreciated component to successful reforms” (Joskow 2008, 13). To appropriately audit costs and services of regulated monopolists, the regulator should have sufficient authority and expertise to overcome information asymmetries and potential “capture” (Joskow 2014; Laffont and Tirole 1993). Where competition is introduced, the regulator (or possibly multiple regulatory

bodies) must also enforce open access requirements on monopolists and monitor agents for abuses such as exercising market power (Batlle and Ocaña 2013).

There are also good reasons for fostering *political independence* of the regulator from other relevant government agencies: mitigating short-term political influence on regulatory activities (e.g., controlling inflation through energy prices) and, where state ownership is prevalent, avoiding conflicts of interest between roles as regulator and owner (Batlle and Ocaña 2013). Nevertheless, allocations of authorities among different government agencies vary according to different pressures to foster or restrict political independence and owing to historic strong central planning traditions (Jamasp 2006).

The most prominent critique of the primacy of the independent regulator model comes from the “developmental state” literature, which seeks to explain phenomenal growth rates in predominantly East Asian countries without a strong regulatory state. In Japan, the first to be studied, an elite bureaucracy at arms length from parliament was responsible for industrial policy focused on bolstering certain sectors and closely cooperating (including exchanges of leadership) with key companies (Johnson 1982). Far from a conventional electricity regulator mindset, this approach concentrates vast economic powers—including electricity tariff-setting—into key ministries for which efficiency was secondary to meeting central strategic goals (Johnson 1982). Another caveat for full regulatory independence is if the newly minted regulator is too small to counter industry capture (Batlle and Ocaña 2013).

3.5.2 Situation in China

China’s electricity sector was regulated for much of its history by policy-making ministries variously overseeing power, water resources, and economic planning. Starting in 1992 with the financial sector, China began to adopt regulatory state approaches in a handful of key sectors (Pearson 2005). In electricity, international institutions together with Chinese reformers constructed a blueprint for China, which was essentially followed over the coming years, including the establishment of an independent regulator, the State Electricity Regulatory Commission (SERC) (Shao et al. 1997).

Since its creation in 2003 until it was closed in March 2013, SERC had mandates to carry out several functions, including: inspecting markets and regional trading;

proposing tariffs; granting permits for new generation, transmission and distribution companies; and supervising policy implementation (Tsai 2014). However, SERC was frequently undermined by more powerful government planning and energy agencies that carried explicit abilities to set tariffs and direct sector planning (Tsai 2014; Wang and Chen 2012). It was also accused of capture: for example, the SERC shared its offices with its largest regulated entity, State Grid Corporation of China (Chen 2010).

In 2013, the functions and personnel of SERC were absorbed into the National Energy Administration (NEA), with expanded authority over project and market design approvals, but still lacking price supervision (Pu and Luo 2013). The NEA Office of Market Supervision publishes reports highlighting good and bad practices of provinces and average prices of the sector. Local offices, however, complain that they lack any real authority over local governments that make permitting decisions and design and direct electricity markets, and lack models and data to properly evaluate grid company operations.¹⁵ Provincial governments have strong political incentives to promote specific (energy-intensive) industries through favorable electricity tariffs, and also strong fiscal disincentives toward certain energy types, namely renewables, because of centrally-mandated tax breaks (Zhao et al. 2013).

Furthermore, the broader conditions that resulted in divergence from the independent regulator model—resilience of supra-regulatory bodies and ambiguity and contestation of specific regulatory authorities—do not appear to align well with tenets of the “developmental state” either (Pearson 2007). Namely, China’s state economic policy-making demonstrates uneven commitments to property rights, and in contrast to other East Asian states, its interventions are not generally “market-conforming” in the sense of basically “making prices right” (Hsueh 2011). Under these conditions, the emergence of a fair arbiter protecting a level playing field is difficult. Further study is required on precisely how these arrangements distort both regulated and competitive activities.

¹⁵ Interview, NEA provincial market supervision office official, June 2016.

4. DISCUSSION OF POTENTIAL REFORM PATHWAYS

China's end-state of electricity sector reforms is currently unknown. Based on the progress toward addressing these five pitfalls, we identify three possible reform pathways. Based on current trends and with mostly incremental changes, the first is a pathway toward "stalled markets" that falls short of a dominant short-term market and must rely on enhanced non-market or non-standard market-based measures. To achieve efficient short-term market signals, there are broadly two approaches: a "self-scheduling" pathway dependent on liquid secondary markets, and a "centralized-scheduling" pathway with high shares of financial contracts.

4.1 Stalled Markets with Enhanced Administrative and Idiosyncratic Measures

It is clear that current reforms will eliminate some of the medium- to long-term distortions from the inefficient government-led price and quantity-setting over the past decades. While these benefits are accrued (primarily to large industrial interests, their local government backers, and commercial customers through retail competition), few changes to dispatch are required. In this scenario, proper short-term markets have no clear champion if provinces have no appetite for more complex reforms to scheduling and dispatch. Further modeling studies might identify additional benefits attractive enough for industry to pursue deeper reforms (Pollitt, Yang, and Chen 2017).

In the absence of functional short-term markets and to address growing flexibility challenges, Chinese officials may instead opt to pursue greater mandates (e.g., requiring specified retrofits of coal plants) or various specialized market mechanisms (e.g., "peaking ancillary services"). Layering on these mechanisms creates complicated sets of incentives for generation, demand, and grid companies, and will certainly guarantee efficiency losses relative to standard markets.

4.2 Self-Scheduling with Liquid Secondary Markets

As provinces and regions of China design short-term markets together with the constraints of contracts, a choice about scheduling must be made. Maintaining and enhancing physical contracts might gradually replace energy-denominated contracts with power profiles, as encouraged in some government documents (e.g., NDRC and NEA 2016a), leading to a “self-scheduling” approach. In this scenario, grid company dispatch centers must establish an imbalance mechanism, preferably market-based, that creates appropriate incentives for efficient contracting.

There are several necessary conditions to achieve this structure. With large shares of forward physical contracts, there will be a need for liquid secondary markets, which currently do not exist, and these markets must have increasing sophistication as more renewable energy enters the market. Some have recommended augmenting generation rights trading with power profiles (Li, Zhang, and Andrews-Speed 2019). However, this would arguably be even more complicated with the inclusion of another party and would still suffer from potential out-of-merit-order dispatch (see footnote 7, p. 16). The dominance of these exchanges for scheduling would dramatically reduce the centrality of the grid company, much beyond what current reform documents have laid out. As regional imbalances increase, greater coordination across all levels of dispatch and a strong central regulator will be required.

4.3 Centralized-Scheduling with Large Financialization

If, on the other hand, centralized scheduling were asserted, a successful reform pathway would rely on heavy financialization of forward contracts. In this scenario, forward physical contracts move generation tariffs closer to average competitive rates, which helps lessen the dislocation and volatility associated with introducing spot markets. At high shares, some of these forward contracts then should become financial to ensure sufficient dispatch flexibility, with fewer requirements for liquid secondary exchanges.

Necessary conditions for this pathway include central agencies asserting greater control in implementing regional experiments and a stronger central regulator to oversee

the grid company and monitor markets. As the grid's company centrality is retained, this pathway may be easier to achieve politically. However, as some generation quotas will move from physical to financial allocations, this approach must include robust discussions on transition mechanisms in order to make difficult decisions on large, explicit compensations to inefficient generators. It may be tempting to push for an intermediate audited cost-based dispatch as has been implemented in some other contexts (Dupuy et al. 2018). Market designers should go into such an approach with eyes wide open as this setup runs into fundamental information asymmetries and may induce various generator-specific requests for adjusting costs or dispatch order (Munoz et al. 2018).

5. CONCLUSION

China's electricity restructuring experience over the last three decades demonstrates the complexity of rearranging economic and political institutions away from a single integrated utility. The current reform efforts include various changes in regulated activities and a proliferation of primarily province-level market experiments, though many aspects are still in flux. Nevertheless, persistent aspects of China's system regulation and operation, as well as market approaches adopted to date, do provide some useful insights on where to go from here. This paper examines these ongoing efforts and presents a set of five clear, well-supported, and ultimately measurable elements against which future reforms can be evaluated.

Whatever market approaches they take, Chinese policymakers need to be careful to properly incentivize flexibility. In developed markets, this has been primarily achieved via a well-functioning spot market or imbalance mechanism. Monthly physical contracts alone are insufficient, and could erode system efficiency gains as they increase. At the same time, spot markets have been difficult to implement in China due to the changes required in scheduling, settlement, and regulation.

China's challenge in increasing efficiency and flexibility amidst institutional preferences for physical contracts is mirrored in the restructuring difficulties of other developing countries. India's power sector is predominantly locked into 25+ year

contracts with two-part tariffs that include sunk fixed cost payments (Kumar and Chatterjee 2012). Short-term transactions through traders and exchanges are still a small fraction (6%) of total energy (CERC 2017). Physical contracts in the Southern African Power Pool cause significant out-of-merit-order costs (Rose, Stoner, and Pérez-Arriaga 2016).

Current reforms rightly recognize the importance of better regulation of grid company costs and performance. However, a stronger regulatory regime than currently available will be required to overcome the substantial information asymmetries. Additionally, eliminating persistent conflicts of interest—e.g., grid company partiality toward certain market transactions—is under-emphasized. Current efforts on economic regulation of intra-provincial networks, if successful, can diminish some of these conflicts, but volumetric remuneration for inter-provincial transmission without revenue caps will continue to create distortions.

The efforts by some to reduce the political power of large grid companies has so far not been translated into successful horizontal restructuring, and this must be carefully balanced with the strong gains from centralization in the sector. Local capture and ineffectiveness of regulators remain significant problems and have been exacerbated in current rounds of wholesale market design and implementation. An enhanced central regulatory bureaucracy and regional markets are ways to address local capture, large grid companies, and potential market power concerns (Zhang, Andrews-Speed, and Li 2018; Lin and Purra 2018). However, current reforms do not propose any significant institutional changes in this regard.

Finally, transition mechanisms and transition costs need to be openly discussed. All reforms will create winners and losers, and arrangements made under previous regulation should be honored or appropriately compensated to the extent possible. Clarifying the property rights made (and still being made) under benchmark pricing is critical to encourage proper market behavior.

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