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Regulating Electricity Markets

Experience From the United States and Perspectives for China

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1. Introduction

At a conceptual level, electricity markets can be thought of as tools that can help achieve policy goals, including improving dispatch, reducing costs, lowering emissions and sending rational signals for investment. But markets can help do these things only if they are designed and regulated well. Electricity markets in the United States and around the world are embedded in — and wouldn't function without — detailed rules for market regulation.

This policy brief discusses several important aspects of electricity market regulation: market monitoring, market power mitigation, and methods to ensure efficient market and dispatch outcomes.[2]

Electricity markets can be particularly susceptible to manipulation by generators. For instance, an individual market participant (or group of market participants) may be able to achieve monopoly status in a part of the grid. Even if this monopoly status lasts only for an hour at a time, a market participant may be able to exploit this monopoly status — that is, may be able to exercise market

1 The review team for the paper included Ruth Hare, Fredrich Kahrl and Frederick Weston. Helen He managed the translation and production of the Chinese language version of this paper, and Wang Xuan contributed to ensuring the accuracy of the translation.

2 This brief builds upon previous RAP publications about these topics. For analysis in the context of the current round of China's market reform, see Dupuy, M., Kahrl, F., Weston, F., Shen, B., Satchwell, A., Capperset, P., et al. (2018). *Power consumption, demand and competition cooperation: Recommendations for the pilots in Guangdong, Jilin, Jiangsu, and Shanghai*. Available in English and Chinese at https://china.lbl.gov/news/article/power-demand-report. For discussion of these issues in the context of the effort to implement wholesale markets in China in the early 2000s, see Regulatory Assistance Project. (2003). *Market power and market monitoring: Critical issues for SERC and competitive wholesale markets*. Retrieved from https://www.raponline.org/knowledge-center/market-power-and-market-monitoring-critical-issues-for-serc-and-competitive-wholesale-markets/

power — to increase prices substantially and cause significant harm to consumers. This may also cause higher system emissions. Markets are susceptible to manipulation in part because:[3]

- Electricity supply and demand must be matched on a second-by-second basis, given that storage capacity is still limited. This means that, unlike other commodity markets, there is no stored reserve that can come into the market when competition becomes weak.
- Transmission constraints may isolate a market participant (or a group of participants) from other competitors.
- Demand for electricity is typically inelastic. End users typically do not respond to changing conditions on the grid, partly because most end users face a price that does not vary according to time. Even when supply suddenly becomes tight, typical end users have no incentive to reduce consumption and suppliers may be able to exploit their leverage.

Accordingly, the issues of market monitoring and market power have long been important topics in market policy, regulation and design in the United States, European Union and other countries.

The importance and challenges of developing efficient wholesale electricity markets in China are arguably more profound, given the particular history of the power sector in that country. For many years, China's power sector suffered from inefficient system operations (dispatch) and inefficient planning and investment processes that led to unnecessarily high costs and high emissions.[4] China's State Council launched a power sector reform effort in 2015, which included an emphasis on "market-oriented reform," and eight provinces have subsequently worked to implement new wholesale spot markets.

Market monitoring includes not only day-by-day and hour-by-hour scrutiny of the behavior of market participants, but also ongoing efforts to identify changes to market rules that will promote economic efficiency and competition and will support policy goals (including for clean energy).

In China, market monitoring will be especially important to help 1) ensure new markets are producing fair, cost-effective and rational operational results, including least-cost economic dispatch; 2) fine-tune market rules as experience with markets accumulates; 3) grapple with the challenge of integrating variable renewable generation, storage and distributed resources; and 4) improve price signals to help rationalize both investment in new resources and the retirement of unneeded and inefficient resources. In fact, authorities overseeing several of these spot markets have called for further development of market monitoring and market power mitigation policies. We hope that this policy brief will be a useful resource in this effort.

This brief identifies several topics that are particularly important in the context of China's current

3 Joskow, P. (2008). Lessons learned from electricity market liberalization. *The Energy Journal.* Retrieved from https://economics.mit.edu/files/2093

4 Regulatory Assistance Project and Natural Resources Defense Council. (2017). *Electricity wholesale markets: US experience and recommendations for China.* Available in English and Chinese at https://www.raponline.org/knowledge-center/electricity-wholesale-markets-us-experience-and-recommendations-for-china/. See also Kahrl, F., and Wang, X. (2014). *Integrating renewables into power systems in China: A technical primer - power system operations*. Available in English and Chinese at https://www.raponline.org/knowledge-center/integrating-renewables-into-power-systems-in-china-a-technical-primer-power-system-operations/

power sector reform situation. In addition, the brief provides detailed references guiding interested readers to relevant detailed examples and documentation that can be useful in designing market monitoring approaches. The three topic areas that we emphasize in this brief are:

- Institutional structure, authority and rules for market monitoring, including establishment of independent market monitoring units.
- Procedures for day-to-day screening and mitigation of market power.
- Frameworks for collecting and assessing information about the operational costs of individual generators and other resources.

The brief concludes with some specific suggestions for next steps with market monitoring in the context of the ongoing reforms in China.

2. Market Monitoring: Structure, Authority and Institutional Roles

The spot markets under development in several Chinese provinces have a rough parallel in the independent system operator/regional transmission organization (ISO/RTO) markets that cover about two-thirds of the United States.[5] Market monitoring has been an important topic in the ISO/RTO markets, and approaches to market monitoring have developed since the first establishment of these markets in the 1990s. The topic attracted strong attention in the wake of the California crisis of the early 2000s, in which certain owners of generation resources were able to exercise market power, which disrupted the market and led to widespread blackouts.[6, 7]

The Federal Energy Regulatory Commission (FERC) sets the broad requirements and ultimately oversees market monitoring and related mitigation and enforcement issues. However, most of the day-to-day market monitoring responsibility is carried out by the ISO/RTO entities that serve as system operator and market operator in each of the regional wholesale markets. In an order issued in 1999, FERC required that each ISO/RTO establish a detailed action plan for market monitoring, subject to review and approval by FERC.[8] Each ISO/RTO has subsequently complied with the FERC

5 For more information on ISO/RTO markets, see Hurlbut, D., Zhou, E., Porter, K., and Arent, D. (2015). *'Renewables-friendly' grid development strategies: Experience in the United States, potential lessons for China* (NREL/TP-6A20-64940). National Renewable Energy Laboratory. Retrieved from https://www.nrel.gov/docs/fy16osti/64940.pdf (and available in Chinese at https://www.nrel.gov/docs/fy16osti/66729.pdf). Also see Federal Energy Regulatory Commission. (2015). *Energy primer: A handbook of energy market basics.* Retrieved from https://www.ferc.gov/market-oversight/guide/energy-primer.pdf

6 See Wolak, F. (2003). *Lessons from the California crisis*. Center for the Study of Energy Markets. Retrieved from https://ei.haas.berkeley.edu/research/papers/CSEM/csemwp110.pdf

7 Caps on market prices have also been used historically in ISOs/RTOs as an approach to limiting market power, but this can lead to inefficiencies in market outcomes.

8 Federal Energy Regulatory Commission, Docket No. RM99-2-000, Order No. 2000, Regional Transmission Organizations, December 20, 1999. Retrieved from https://www.ferc.gov/legal/maj-ord-reg/land-docs/RM99-2A.pdf

order, and each has periodically updated its plan in filings with FERC.[9]

A 2008 FERC order elaborated on market monitoring and emphasized the role of independent market monitoring units (MMUs). The rule specifically requires that ISOs/RTOs have MMUs that operate independently of ISO/RTO management. In the rule, FERC also set out some core functions of the independent MMUs:[10]

1. Evaluating existing and proposed market rules and market design elements and presenting recommendations for rule changes to ISO/RTO management, FERC, market participants and other stakeholders. The independent MMUs play this role and contribute to the ongoing discussions and rule changes within each ISO/RTO. This is important because market rules need to be constantly reevaluated in light of market performance and changing circumstances. To cite just one example, in recent years, as the cost of electricity storage resources have fallen and storage resource capabilities have increased, the independent MMUs, the ISOs/RTOs, FERC and various stakeholders have engaged in detailed discussion about how market rules should be changed to ensure that capabilities of these resources are fully valued by the market. Important market rule changes have emerged from this process that are intended to help support a level playing field for storage resources to compete with traditional generators.[11]
2. Publishing detailed reports on the performance of the ISO/RTO markets on (at least) a quarterly basis. In addition to informing discussions about market rule changes, the reports are important sources of information about market conditions for existing and prospective market participants and help to increase the transparency and efficiency of the market. Typically, the reports discuss the competitiveness of markets (including the number of cases where hourly market power was detected and addressed), trends in vital variables (including prices, costs and system conditions) and key topics such as developments with distributed and renewable resources. The reports also summarize the independent MMU's recommendations regarding market design and rule changes and discuss progress the ISO/RTO has made in meeting previous recommendations. Table 1 below includes information about where to find the reports issued by each MMU.
3. Providing inputs to the market power mitigation processes in each ISO/RTO. The independent MMUs typically play a role in the automated processes that constantly screen for noncompetitive bids (see Section 3). This may include assessing which parts of the grid

9 The Electric Reliability Council of Texas (ERCOT) is different from the other ISOs/RTOs in that it is not subject to FERC jurisdiction, given that FERC's powers are related to interstate energy trading under the Federal Power Act. ERCOT's footprint is entirely within Texas' borders, and ERCOT is not synchronously interconnected with grids in other states. See Federal Energy Regulatory Commission. (2018, December 20.) *ERCOT* [Webpage]. Retrieved from https://www.ferc.gov/industries/electric/indus-act/rto/ercot.asp. However, the ERCOT experience parallels the other ISOs/RTOs: Texas state legislation requires ERCOT to monitor markets, and ERCOT has adopted detailed market monitoring and mitigation procedures with many similarities to other ISOs/RTOs.

10 Federal Energy Regulatory Commission, Order 719 on October 17, 2008, pp.169-247. Retrieved from https://www.ferc.gov/whats-new/comm-meet/2008/101608/E-1.pdf

11 Dupuy, M., and Porter, K. (2018). *Leveling the playing field for storage resources in China's electricity markets: A view from the U.S.* Regulatory Assistance Project. Available in English and Chinese at https://www.raponline.org/blog/leveling-the-playing-field-for-storage-resources-in-chinas-electricity-markets-a-view-from-the-u-s/

are isolated by constraints and whether those constraints warrant closer monitoring and stricter tests for market power. It may also include assisting in determining the "reference level" costs for specific generators and other resources, which provide a key yardstick for detecting and mitigating market power (see Section 4).

4. Identifying suspected rule violations on the part of market participants or the ISO/RTO management. Although the independent MMUs do not have the power to levy penalties for market manipulation or other wrongdoing, they have the responsibility to search out infractions and report these to FERC for further investigation and enforcement.

The detailed market and operational rules of each ISO/RTO, which are subject to FERC approval,[12] include language ensuring the independent status of the MMUs. Several ISOs/RTOs (as part of FERC-approved market monitoring plans) outsource the independent monitor function to consulting firms with specialized experience[13] (see Table 1).

In cases where the MMU is staffed by employees of the ISOs/RTO — not consulting firm staff — it is referred to as an internal independent market monitor.[14] However, the management of the ISO/RTO still does not have control or authority over the internal MMU. For example, in the ISO/RTO known as the Southwest Power Pool (SPP), where there is an internal MMU, the FERC-approved governing rules specify, "The Market Monitor shall be granted complete independence to perform those activities necessary to provide impartial and effective market monitoring …"[15] Furthermore, according to the SPP rules, "The Market Monitor shall have complete independence in developing and producing reports, and no person or entity may screen, alter, delete or delay the Market Monitor's findings, conclusions and recommendations."[16]

12 These FERC-approved rules for each ISO/RTO are referred to (for historical and legislative reasons that are not very important here) as the ISO/RTO open access transmission tariff (OATT). Despite this seemingly narrow title, the OATT covers all major aspects of ISO/RTO functions, including rules for system operations, rules for market operations, plans for market monitoring, rules for market mitigation, and other issues. Each ISO/RTO tariff typically is several thousand pages in length. The current version for each ISO/RTO is publicly available on each ISO/RTO website.

13 The firm Monitoring Analytics has a contract to play the independent MMU role for PJM. The company's website is https://www.monitoringanalytics.com. For all other ISOs/RTOs that outsource their independent market monitoring, the firm Potomac Economics currently holds the contract. Potomac Economics' website is https://www.potomaceconomics.com/practice-areas/rto-market-monitoring/.

14 Each ISO/RTO also has non-independent staff (that is, staff that report to the management of the ISO/RTO) who are assigned to interact with the independent market monitor, provide data to the independent market monitor and assess similar issues.

15 Southwest Power Pool. (2010; updated most recently February 5, 2020). *Market protocols: SPP integrated marketplace, revision 75,* Section 8.1.3. Retrieved from https://www.spp.org/spp-documents-filings/?id=18162

16 Southwest Power Pool, 2020, *Market protocols,* Section 8.1.7.

Table 1. Independent market monitor unit structure

ISO/RTO	MMU structure	Website for MMU reports
California ISO	Internal (ISO staff)	http://www.caiso.com/market/Pages/MarketMonitoring/MarketMonitoringArchive/Default.aspx
Electric Reliability Council of Texas	External (consulting firm)	https://www.potomaceconomics.com/markets-monitored/ercot/
Midcontinent Independent System Operator	External (consulting firm)	https://www.misoenergy.org/markets-and-operations/independent-market-monitor2/
ISO New England	Internal (ISO staff) and external (consulting firm)	https://www.iso-ne.com/markets-operations/market-monitoring-mitigation/
New York ISO	External (consulting firm)	https://www.nyiso.com/market-monitoring
PJM	External (consulting firm)	http://www.monitoringanalytics.com/reports/PJM_State_of_the_Market/2019.shtml
SPP	Internal (ISO staff)	https://www.spp.org/markets-operations/market-monitoring/

FERC's 2008 order also requires that ISOs/RTOs "provide MMUs with access to market data, resources and personnel sufficient to carry out their duties."[17] In particular, ISOs/RTOs must develop rules (again, subject to FERC approval) "to provide the MMU complete access to the [ISO/RTO] databases of market information."[18] In practice, this means that independent MMUs have full access to detailed data from market participants and regarding system operator functions. To cite the SPP example again, the governing rules state that this includes:[19]

- Full data on all individual offers/bids in markets.
- All data on individual export interchange transaction bids and import interchange transaction offers.
- "Actual commitment and dispatch of [generation and other] resources …"
- Locational marginal prices and market clearing prices at all nodes for every period.
- Detailed balancing area operational data.
- "Conditions or events both inside and outside the SPP Balancing Authority Area affecting the supply and demand for, and the quantity and price of, products or services sold or to be sold …"

17 FERC Order 719.

18 FERC Order 719.

19 Southwest Power Pool, 2020, *Market protocols,* Section 8.1.4.2.

- "Information regarding transmission services and rights, including the estimating and posting of Available Transfer Capability or Available Flowgate Capability … the operation and maintenance of the transmission system …"
- "Information regarding the nature and extent of transmission congestion."[20]

Although the independent MMUs access and analyze confidential information and data relevant to the MMU's mandate, confidentiality provisions in ISO/RTO rules prevent public disclosure of information attributable to individual market participants. In addition, the independent MMUs typically report on issues relevant to their mandate using data that is sufficiently aggregated so that individual market participants are not identifiable.

3. Procedures for Detecting and Mitigating Market Power

ISO/RTO rules include provisions for detecting and mitigating (i.e., correcting) market manipulation in advance. These detailed rules are intended to immediately correct the behavior of market participants that submit — or are in the position to submit — offers, or bids, that exploit market power. This process allows the ISO/RTO to immediately require that such offers or bids be "mitigated" down to an appropriate level, in line with predefined rules.[21] These processes are intended to mitigate market power before the market clearing prices are affected. In addition, FERC has authority to investigate and penalize market participants who have exercised market power in the past.[22]

To this end, each ISO/RTO publishes rules, subject to review and approval by FERC, that specify what tests it uses to screen for market power and the specific measures to be taken if those tests are positive. ISO/RTO market monitoring rules require an elevated level of scrutiny and stricter standards for mitigation in chronically constrained areas of the grid.

Assessing Market Power

The two major ways of assessing market power are the structural approach and the "conduct and impact" approach.[23] Most ISO/RTO emphasize one or the other, although the approaches can be

20 SPP rules further stipulate that market participants must retain all relevant data and information (including the list cited here) "for a minimum of three years and will promptly provide any such Data and Information to the Market Monitor upon request." Southwest Power Pool, 2020, *Market protocols,* Section 8.1.12.3.

21 For example, CAISO's OATT states that "the Mitigation Measures authorize the mitigation only of specific conduct identified through explicit procedures specified below." Mitigation is done before the final run of the model that finalizes dispatch and locational marginal prices. California Independent System Operator. (2019, September 28). *Fifth replacement FERC electric tariff,* Section 39.1. Retrieved from http://www.caiso.com/rules/Pages/Regulatory/Default.aspx (as "Combined Conformed Tariff").

22 SPP's OATT says, "Correcting market inefficiencies and preventing the exercise of market power in advance rather than punishing offenders afterward shall be the preferred approach." Southwest Power Pool, 2020, *Market protocols,* Section 8.1.1.

23 Federal Energy Regulatory Commission. (2014). *Staff analysis of energy offer mitigation in RTO and ISO markets.* Retrieved from https://www.ferc.gov/legal/staff-reports/2014/AD14-14-mitigation-rto-iso-markets.pdf

used in combination.[24] These tests define a supplier as an entity that owns resources such as generation. A company that owns multiple generation units, for example, would be considered as a single supplier.

Potential for Market Power ("Structural")

Assessing for structural market power involves deciding when particular market participants have the potential to exercise market power. Some ISOs/RTOs consider aggregate structural indicators, such as the Herfindahl-Hirschman Index, that quantify the degree of concentration of generation ownership in an ISO/RTO market or its subregions.[25] However, the Herfindahl-Hirschman Index does not account for real-time fluctuations in supply and demand that can affect opportunities to exercise market power — and thus is of limited usefulness in monitoring market power.

A more sophisticated approach is to assess whether a given supplier, at a particular time, is "pivotal." Pivotal suppliers typically emerge in places and times where demand is high and the grid is constrained in a way that isolates local resources from competition that would otherwise be provided by resources located in other parts of the grid. Pivotal supplier tests are built into software that runs constantly and automatically, in parallel with market and operational software. (That is, the tests are not administered by staff on an ad-hoc basis.)

A supplier is pivotal when it is needed to manage a constraint or to satisfy load in a constrained area. For example, SPP defines a pivotal supplier as follows:

> A supplier is pivotal when the energy output or provision of operating reserves by any of its resources, or some of its resources jointly, must be increased or decreased to resolve the binding transmission constraint … during some or all hours.[26]

Other RTOs, including PJM, apply a stricter version that tests the degree to which the three largest suppliers in a constrained area are *jointly* needed to meet demand.[27] Applying this test, the Midcontinent Independent System Operator (MISO) *2018 State of the Market Report* assessed that a supply resource was "frequently pivotal" in constrained areas and that "results indicate that local market power persists … and that market power mitigation measures remain critical."[28]

Observed Behavior ("Conduct and Impact")

Conduct and impact tests involve assessing each resource's offer relative to the cost-based reference level calculated for that resource. Offers are subject to a screen that assesses 1) whether the offer

24 This section focuses on market monitoring and mitigation in the day-ahead and real-time energy markets. ISOs/RTOs also have monitoring and mitigation procedures for capacity markets and other ancillary services markets.

25 A recent MISO independent MMU report, for example, found that the Herfindahl-Hirschman Index for MISO as a whole was low, but high in certain subregions. Potomac Economics. (2019). *2018 State of the Market Report for the MISO Electricity Markets*. Retrieved from https://www.misoenergy.org/markets-and-operations/independent-market-monitor2/

26 Southwest Power Pool, 2020, *Market protocols,* Section 8.2.2.7.1.

27 Bowring, J., and Josyula, S. (2015, July 22). *Overview of three pivotal supplier test* [Presentation]. Monitoring Analytics. Retrieved from https://www.pjm.com/-/media/committees-groups/task-forces/gofstf/20150722/20150722-item-02-imm-tps-education.ashx

28 Potomac Economics, 2019, pp. 87-88.

exceeds the reference level by a preset threshold ("conduct"); and 2) whether the offer will have an effect on the (local) market price that exceeds a preset threshold ("impact"). If the answer in both cases is yes, the offer is mitigated.[29] The conduct and impact approach applies stricter thresholds in chronically constrained areas, although the details vary across ISOs/RTOs in the methods used to evaluate and categorize constraints and in the level of the thresholds.

Mitigating Market Power

In principle, mitigation is "designed to cause a market participant to offer as if it faced workable competition."[30] Both the structural and conduct/impact approaches call for reducing offers to a certain level if a supplier fails a screening test. Mitigation involves replacing an offer with an adjusted offer. The mitigated offer is based on estimated reference levels that reflect the resource's operating costs. The details of calculating these reference levels are discussed in the next section.

Detecting and Mitigating Market Power: Summing Up

To recap, in ISOs/RTOs there is an emphasis on preventing market manipulation rather than punishing it afterward. That is the idea behind market power mitigation: to adjust offers from participants who have failed predefined tests (the structural approach) or whose bids fail screens for "conduct and impact." However, rules are also in place for investigating the exercise of market power if it has already happened. As noted in the previous section, independent MMUs are responsible for identifying suspected rule violations on the part of market participants or the ISO/RTO management and reporting these to FERC. Although the independent MMUs do not have the power to levy penalties for market manipulation or other wrongdoing, they have the responsibility to search out infractions and report these to FERC for investigation and enforcement.

It is worth noting that most markets that apply the "conduct and impact" approach typically report little evidence of attempts to exercise market power.[31] This should not be construed to mean that market monitoring and the establishment of mitigation measures are not important. It is reasonable to think that participants would take advantage of the structural opportunities in the absence of a good monitoring and mitigation regime.[32]

4. Establishing Cost Assessment Framework

ISOs/RTOs collect data to make estimates (i.e., reference levels) of the operational costs of generation units. The ISOs/RTOs use these reference levels to judge whether the market is competitive and whether any generators are exercising market power. The estimates are also used

29 Federal Energy Regulatory Commission, 2014.

30 Midcontinent Independent System Operator. (2020, February 10). *FERC electric tariff*, Section 65.2.1. Retrieved from https://www.misoenergy.org/legal/tariff/

31 For example, see Potomac Economics, 2019.

32 The mitigation methods described in this section are not the only methods that have been employed in the United States (or other countries) to deal with market power and market inefficiencies. The broader picture has included — in various jurisdictions at various times — price ceilings, antitrust law and efforts to reduce the market share of dominant generation owners, sometimes by requiring sell-off of these assets. The plusses and minuses of these are beyond the scope of this paper.

to establish the level to which offers are mitigated. Below is an overview of the data collected.[33]

The basic approach is similar across ISOs/RTOs and involves calculating the determinants of generator operating cost described in the text box. However, there is significant variation in approach. Data associated with individual generators are typically not made public, although in aggregate form they may be used in public market monitoring reports.

Generator operating cost components

Net heat rate curve:

- Shows a generator's net thermal efficiency at different levels of output.

Fuel price:

- Fuel prices may be based on a contract delivered price, or a reference spot market fuel price plus transport costs.
- Fuel prices should be on an energy basis (e.g., in China in yuan per kCal terms).
- Determination of fuel costs for coal-fired generation is relatively straightforward. Other resources like pumped hydro have more complex cost determinants.

Variable operating and maintenance costs:

- Includes other costs that vary with output, including noncapital expenditures for regular maintenance and the cost of chemicals, water and other inputs used in operation.

Startup cost and no-load costs:

- Cost of fuel, chemicals, water and other inputs required to start a generating unit.
- For steam units, startup costs depend on the condition of the boiler (hot, cold, etc.).
- No-load, or minimum load, costs are the fuel cost required to maintain the unit's minimum level of output.

Emissions rates:

- Average level of emissions (e.g., grams of sulfur dioxide or carbon dioxide) for a given level of net output or for startup.
- Emissions vary with a unit's level of net output, defining an emissions rate curve.
- Emissions rates can be calculated from continuous emissions monitoring devices or using a fuel emission factor (e.g., grams of sulfur dioxide per kCal of coal) multiplied by the net heat rate curve.

Emissions price:

- The price of emission permits or fees, in terms of cost per unit of emissions (e.g., dollars per ton of carbon dioxide).

5. Conclusions and Recommendations for China

An effective regulatory structure will be important for ensuring that the new spot markets can deliver meaningful benefits: reduced operational costs (improved dispatch), better investment decisions and lower emissions. This regulatory structure will likely need to be adjusted and refined over time. Some of the spot market pilot provinces have already taken important steps in this regard.

33 ISOs/RTOs publish detailed rules on this topic. For example, see PJM. (2019). *PJM Manual 15: Cost development guidelines.* Retrieved from https://www.pjm.com/~/media/documents/manuals/m15.ashx

Here are some suggestions for the next steps:

- Consider setting a "basic principle" that market regulation and market monitoring should be focused on supporting least-cost dispatch and a level playing field for clean energy resources.
- Establish independent market monitors, with clearly stated authority, responsibility and access to data. Guangdong Province has already made announcements regarding selection of an independent market monitor for the provincial spot market. The key will be to clearly define the roles and responsibilities of the independent market monitors and ensure that the monitors have resources to carry out their tasks. In particular, it would be useful for a market monitor to publish regular reports on market and operational outcomes in each province. These reports should include an assessment of market competitiveness (including analysis of constrained areas of the grid) and dispatch efficiency. The reports should also include recommendations for any market rule changes needed to ensure a level playing field, including for distributed energy resources and demand-side resources (including demand response).
- Develop and publish a detailed structure and authority for the collection of data on operating costs and the creation of reference levels for each resource that are calculated and updated based on that data. Again, Guangdong has started down this path, but more work remains.
- Develop and publish detailed rules for market power screening and mitigation procedures. In short, it should be very clear how and when a generator's bid will be mitigated to the reference levels, and these reference levels should be clearly linked to the operating cost of the generator. Having these procedures in place will be particularly important in the initial years of spot market operation, when insufficient competition and market design problems may be severe. For example, policies to encourage a dominant state-owned "champion" generation owner in any particular province or region may lead to weak competition — but this problem could be alleviated, in part, by adjusting the bids of the dominant generator according to well-designed reference levels.
- Think beyond establishing market concentration thresholds and restrictions on the share of capacity owned by one generator. Shandong Province has moved in this direction. But this is not enough, given the risk of temporary local market power when constraints are present. More precise tests are needed, such as the "pivotal supplier" or "conduct and impact" tests this paper describes.

The United States has made much progress over decades on these topics but nevertheless continues to struggle with the many details of getting market regulation right — and sometimes takes steps in the wrong direction. Market regulation will also be an ongoing challenge for China, and there will be much to be learned on both sides by continuing to compare experiences in this area.

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