July 2024

Market Monitoring

A policy brief for RAP's India Regulatory Knowledge Centre

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Abstract

This brief[1] discusses the need for and approach to fulfilling the market monitoring function in competitive wholesale electric markets. As competitive wholesale markets are rapidly developing in India, it is worthwhile for regulators and policymakers to examine the approaches used to monitor the market in functioning competitive wholesale electric markets around the world. This brief provides examples from the United States. It discusses the role and scope of various market monitoring entities, provides a description of markets in general and market power in electric wholesale markets, and surveys the tools used by market monitors to monitor markets.

[1] The author acknowledges the input provided by other RAP colleagues in preparing this brief.

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Section 1. Introduction

There is already competition in the electric market in some countries, and it is in the process of being introduced in others now, at wholesale and retail levels. Competition produces various benefits including increased efficiency in the sector, better allocation of risks between sellers and buyers, innovation, and increased consumer choice. However, unless the competitive market is robust or at least 'workably competitive,'[2] consumers could be put at a disadvantage. Electricity is a critical necessity for consumers and businesses. It is essential that safeguards are put in place as the market in electricity is opened to competition to ensure consumers are protected from abuse of market power, particularly given the susceptibility of electricity markets to anti-competitive conduct. The safeguards should also address 'buyer-side' market power and provide confidence to investors that there will be a level playing field for all competitors and that their legitimate commercial interests will be protected.

The more competitive and robust the markets are, the less need there is for regulatory intervention. In well-functioning competitive electric markets, one or more entities are assigned responsibility for analysing the structure and behaviour of market participants to ensure they are following the market rules and not abusing them to advance their self-interest. The entity or entities oversee the day-to-day behaviour of market participants, the long-term effectiveness of market rules and the competitiveness of the market. They also assess the ability of the market to attract new economic entrants, retain existing economic assets, and facilitate the timely exit of non-economic assets. Market monitors also typically evaluate the conduct of market operators, which can be just as important given the significance of the operators' actions in market outcomes.

This chapter of RAP's regulatory knowledge centre discusses the role of market monitoring in competitive electric wholesale markets and examines how it is structured and carried out, with examples from the United States. As India advances its electric wholesale markets, it needs to ensure that the market monitoring function is also robust in order to protect consumers and increase consumer and investor confidence.

[2] While competition may not be perfect, without 'workable competition' there could be manipulation of prices by participants who have market power. For a detailed discourse on this topic, see Hogan, W. (1993). *A Competitive Electricity Market Model*. Harvard Electricity Policy Group. https://scholar.harvard.edu/whogan/papers.

Section 2. Overview of market monitoring in India

Two entities in India have responsibility for monitoring the wholesale electric market: the Central Electricity Regulatory Commission (CERC) and the Central Electricity Authority (CEA).

CERC scope

After granting permission for power exchanges where electricity could be bought and sold, the CERC initiated market monitoring in 2008.[3] In 2019-2020, power exchanges had about 1,400 buyers and 300 sellers. The scope of CERC market monitoring includes preparing monthly and annual reports on short-term electricity transactions, overseeing the functioning of the power exchanges, and disseminating market information. It reports on the following:

- Trends in volume and price of electricity
- Competition among market players
- Effect of congestion on volume and price of electricity transacted through power exchanges
- Major buyers and sellers of electricity who have made transactions through traders and power exchanges
- Trading margins charged by traders
- Cross-border trade of electricity
- Volume and price of Renewable Energy Certificates

CEA scope

On the request of the Ministry of Power (MoP) in 2019, the CEA initiated a cell for market monitoring. The focus of the cell is on monitoring short-term electricity transactions. The CEA prepares monthly reports.[4] The reports contain details that include the volumes and prices of electricity transacted, transmission congestion and real-time curtailment on the Day Ahead Market (DAM), the Real Time Market (RTM) and the Term Ahead Market (TAM) in both of India's power exchanges (IEX and PXIL).

[3] Prasad, U.R. (2020). *Electricity Market Monitoring in India (A Regulator Perspective)*. Central Electricity Regulatory Commission. https://ens.dk/sites/ens.dk/files/Globalcooperation/e-learning/w1_cerc_market_monitoring_in_india_16.9.2020_1.pdf

[4] Central Electricity Authority (CEA). (n.d.). *Creation of Market Monitoring Cell (Electricity Markets)*. https://cea.nic.in/creation-of-market-monitoring-cell-electricity-markets/?lang=en

Section 3. Markets and market power

Section 3A. Definition of electricity markets

In many parts of the world, electric utilities are either owned by the government or owned by private investors and regulated by the government. In some places, however, the paradigm has changed in the last two decades. In these locations, the ownership of generation assets rests with private investors, and wholesale prices for electricity are not set by cost-based regulation but are determined by a competitive wholesale market.[5]

In this report, 'market' is used to define a place where buyers and sellers interact in buying and selling their goods. This interaction determines the market clearing price. Buyers and sellers put in, respectively, bids and offers for how much they want to buy or sell and at what price. Typically, the price of the last winning bidder selected to meet the demand sets the market clearing price that gets paid to all winning bid sellers. This is called a 'pay-as-cleared' market as opposed to a 'pay-as-bid' market; both studies and experience have tended to demonstrate that pay-as-cleared is the best choice for power markets.

There are many different forms of market in the world.[6] These include:

Spot (cash) versus forward/futures: In spot markets, goods are exchanged on the spot and the buyer pays the seller on a cash-equivalent basis. A simple example is customers buying groceries in a grocery store. In forward markets, commitments are made by buyers and sellers to exchange a given quantity of the product sometime in the future for an agreed price. Futures markets are like forward markets but offer more standardised products from organised market makers. An example would be a grain producer selling their harvest well in advance to secure a fixed price for their output, and a bread maker purchasing that grain well in advance to lock in an input price to make their bread. There are several differences between forward and future markets — including their liquidity, counter party risk, etc. — that readers can explore in a finance textbook.[7] One of the most popular futures markets is the New York Mercantile Exchange (NYMEX).

Physical versus financial: In physical markets, goods are physically exchanged. An example would be a power plant (buyer) purchasing coal for its needs and a coal mine owner (seller) delivering that coal to the power plant. In financial markets, there is typically no expectation that physical goods will be exchanged on the delivery date — the transaction simply fixes a price for an agreed quantity of the goods at an agreed future date, with one party compensating the other to the extent the spot market price on the agreed delivery date

[5] In many of these regions, competition has been introduced in retail supply as well, with varying degrees of success. This brief examines only the assurance of competition in wholesale power markets.

[6] Only basic concepts of relevance to electric markets are presented here. The reader must refer to a finance textbook for more details. There are other distinctions, such as money markets versus capital markets, but they are beyond the scope of this brief.

[7] A useful example is Kane, A., Marcus, A., & Bodie, Z. (2024). *Investments*. McGraw Hill. https://www.mheducation.com/highered/product/investments-kane-marcus/M9781264412662.html

differs from the contract price.[8] In the case of the coal example above, the power plant owner would make separate arrangements for coal to be delivered to the power plant, with the financial contract providing ex ante assurance of what the net cost of the agreed quantity of coal would be to the buyer.

Primary versus secondary: Primary markets are where goods typically are traded for the first time. An example would be a corporation issuing debt or equity and raising capital in the market for the first time. The proceeds from these sales go to the corporation issuing the debt or equity. A secondary market is where these debt and equity instruments are traded again and again in the marketplace. The proceeds of these transactions do not go to the corporation but remain between the buyers and sellers of the instruments.

Geographic area: The market for the product could be limited to a very local geographic area or could encompass international markets. Electric markets are relatively local whereas oil markets are global in nature.

Organised versus informal: Some markets, such as the NYMEX, are well organised and have standardised products. Informal markets are where buyers and sellers engage in private bilateral transactions.

Electricity markets are where sellers (generators) can sell their output to buyers (distribution companies [DISCOMs], direct end-use customers and other intermediaries). While prices are determined by supply and demand as well as other factors, the markets themselves are governed by a set of market rules, devised collectively by regulators and market participants. Maintaining the reliability of the complex electric system concerned remains a high priority in this set up. Different electric markets offer different products.[9] A menu of electric products includes:

- Energy (note that this is the focus of this brief)
    - Hourly day-ahead market
    - Real-time market[10]
- Installed capacity
    - Monthly
    - Six-month biannual
    - Annual
    - Forward (three to five years ahead)

[8] Financial contracts typically serve risk management functions for both buyers and sellers. For example, buyers and sellers can get price certainty into the future, for a given quantity, through a financial contract.

[9] For a detailed discussion of various electric submarkets, see Stoft, S. (2002). *Power System Economics: Designing Markets for Electricity*. IEEE Press, Wiley InterScience Publications.

[10] For a discussion of locational marginal pricing, see Ott, A. (1998). *Locational Marginal Pricing* [Presentation]. https://www.pjm.com/training/training-resources

- Ancillary services
    - Regulation
    - Spinning reserves
    - Non-spinning reserves
- Financial transmission rights

Section 3B(i). Definition of market power

There are many definitions of market power. In this brief, it is defined as follows: market power is the ability of a firm or a group of firms to unduly raise prices above the competitive level, inconsistent with a competitive market outcome, in order to improve profits.

This definition raises several questions:

- Raise prices by how much? For how long a period of time?
- How is a competitive price level identified?
- Can the impact of actions of one entity be isolated?
- What are the consequences of transitional price spikes?
- What are the costs and benefits of intervention?
- Are the costs of intervention for a transient price increase greater than the benefits?

There is no quick textbook answer to these questions, but the market monitor needs to address them. Monopsony power (many sellers, but only one buyer), on the other hand, is exercised by buyers to help lower the market clearing price. It must also be noted that there is a distinction between having an opportunity to exercise market power versus actually exercising it.

Section 3B(ii). Implications of exercising market power

The exercise of market power adversely affects efficiency, fairness and confidence in markets. It distorts the competitive price and level of output, which could ultimately lead to higher production and investment costs. Both sellers and buyers can possess and exercise market power — in the former case there can be a wealth transfer from consumers to producers when a producer drives the market clearing price higher than it would be in a competitive market, while in the latter case the wealth transfer is in the other direction when a buyer can and does force prices lower than they would be in a competitive market. In essence, the exercise of market power leads to an increase in price above the short-run marginal cost despite the absence of genuine resource scarcity, or a decrease in price below the short-run marginal cost despite the absence of genuine resource surplus.

It is important to note that prices rising above or falling below short-run marginal costs are not necessarily evidence of the exercise of market power, and indeed such price volatility under appropriate market conditions (of actual resource scarcity or surplus) is essential to the

proper functioning of an efficient market. In particular, as the share of production from variable resources increases, such price volatility is the primary market signal for the increasing value of demand flexibility (often referred to as 'price elasticity'), both down (shifting flexible consumption away from hours when the price of a kWh of electricity would be well above its value to the consumer in delivering a given energy service) and up (shifting flexible consumption to hours when the price would be well below its value to the consumer). In a competitive market this dynamic is both necessary and, as should be evident, self-correcting. Where demand is not yet sufficiently price-responsive, regulators and market operators have adopted a range of mechanisms intended to serve as proxies for the value market participants attribute to increments of supply and demand under conditions of genuine scarcity or surplus.

The price and volume risks inherent in genuine scarcity and surplus pricing are also essential to efficient long-run market entry and exit. An increase in the frequency and duration of very high-price hours should induce new economic entrants into the market, thereby dampening volatility, whereas an increase in the frequency and duration of very low-price hours should induce higher-cost producers to leave the market. The price and volume risks inherent in genuine volatility — incidences of very high prices for buyers, and very low prices for producers — are an essential driver for the mutually beneficial forward contracting needed to underpin new economic entry. However, while incidences of very high and very low prices are needed to drive economic entries and exits, market monitors and regulators must review whether they are due to the exercise of market power rather than genuine scarcity or surplus. Market monitors have the primary responsibility to differentiate between the two. While from this point onward this brief will discuss monitoring and mitigation of seller or producer market power abuse, it is important to remember that buyers can also possess and exercise market power, and independent market monitors must identify and recommend mitigation measures to address buy-side market power as well.

It should be noted that there is a distinction between market power (which may stem from the specific nature of the rules themselves) and market manipulation (which requires a demonstration of intent to manipulate prices). The market monitor has an interest in both, but the remedy might be different in each case. For example, we don't necessarily penalise companies for exercising market power if their market power is due to the way in which the market is designed. In such cases, we instead look to rapidly change the market design. This is a subtle distinction. The Federal Energy Regulatory Commission's (FERC) Office of Enforcement is largely focused on market manipulation. The exercise of market power is generally addressed through rule changes proposed by the regional transmission organisation (RTO) in response to calls from the market monitor or others.

Section 3B(iii). Types of market power

Market power can be described in terms of vertical market power (VMP) or horizontal market power (HMP). A subset of HMP is the exercise of market power in load pockets.

Vertical market power

Vertical market power is possible if one entity owns both generation assets and delivery (transmission/distribution) assets. This entity can artificially raise the price of the commodity by exploiting ownership of the delivery system.

The following are examples of how the exploitation can occur when generation is competitive and delivery is a monopoly service performed by an affiliated entity:

- The owner of the delivery system could provide preferential pricing/service to customers who also take its commodity.
- There could be cross-subsidies between competitive and monopoly functions.
- The delivery company could raise the price for its commodity by intentionally not building sufficient transmission/distribution infrastructure where that infrastructure would harm its affiliate's competitive position.

Horizontal market power

Horizontal (producer) market power arises when there is not enough generation supply to meet the demand ('scarcity'). When a scarcity of resources arises legitimately, the marginal producer has market power and may be able to exercise it if consumers cannot or do not respond flexibly to an increasing cost for incremental demand. This form of market power is constrained by increasing the flexibility of demand and/or ex ante setting constraints on the prices that can be offered under conditions of scarcity. Where there is a lack of diversity in the ownership of generation, a dominant producer can create artificial scarcity by withholding production. This could lead to the market price being set by a resource with a higher short-run marginal cost than would otherwise be the case, or it could lead to an opportunity to bid into and clear the market at an inflated margin above short-run marginal cost (assuming, as noted above, insufficiently flexible price demand), in either case increasing the aggregate inframarginal rent collected by the dominant producer. This form of market power exercise is the result of anti-competitive activity and is the primary target of ongoing mitigation activity by market monitors.

A simple example of the exercise of horizontal market power is given below:

- If producer X offers 100MW into the market and receives a market clearing price of $50/MWh, then revenues for that hour are $5,000 (100 x $50).
- Now assume it has the ability to exercise market power. If it only offers 80MW into the market and receives $70/MWh market clearing price (the higher clearing price is due to X either withholding lower-cost production or creating and exploiting artificial scarcity by withholding capacity), then revenues for that hour are $5,600.
- Even though X produces less, it receives more in revenues by withholding. This could mean an increased cost to consumers.

Load pocket

Load pocket is a geographic area where transmission capability is limited, hence the affected area may experience periods of scarcity even as the overall control area is adequately supplied. A local generator in the load pocket may have market power at least in some hours of the year.

Section 3B(iv). Exercise of market power

The following are some methods of exercising market power. Unlike structural market power, which can be addressed through the building of more infrastructure or by tariff rule changes, these actions are undertaken with the intent of manipulating markets — and as a result represent market manipulation schemes, given the entity's ability to exercise market power.

Physical withholding: By not offering all of the generation supply to the market, even though it is available for operation and is likely to clear the market; falsely declaring that the unit is out of service; operating at a level lower than instructed by the market operator.

Economic withholding: By offering all or part of the generation into the market but doing so at an artificially inflated price, so that it fails to clear the market.

Typically, for both the above categories of withholding, numerical or quantitative thresholds can be agreed upon to indicate unwarranted behaviour.[11] Detecting economic versus physical withholding can be difficult. For example, an increase in the offer price of a generator from $50 to $55 per MWh may not appear high, whereas withholding half the output may be more dramatic. It is possible, though, that both actions produce the same price impact. The market monitor must be vigilant in detecting market power.

Creating barriers to entry: By acting to prevent competitors from entering the market, so the existing owners can exercise market power.

Section 3C. Primary structural defects leading to potential market power

Structural defects generally refer to core problems associated with both buyers and sellers in the marketplace that are not necessarily susceptible to easy quick solutions.

[11] For quantitative examples, see Goldman, C., Lesieutre, B., & Bartholomew, E. (2004). *A Review of Monitoring Activities at U.S. Independent System Operators*. Lawrence Berkeley National Laboratory. https://smartersmallbuildings.lbl.gov/publications/review-market-monitoring-activities. Also, see Federal Energy Regulatory Commission (FERC). (2014). *Staff Analysis of Energy Offer Mitigation in RTO and ISO Markets*. https://www.ferc.gov/ferc-staff-reports-and-papers-electric-2014-1998 and Graf, C., La Pera, E., Quaglia, F,. & Wolak, F. (2021). *Market Power Mitigation Mechanisms for Wholesale Electricity Markets: Status Quo and Challenges*. Freeman Spogli Institute for International Studies. https://fsi.stanford.edu/publication/market-power-mitigation-mechanisms-wholesale-electricity-markets-status-quo-and

- **Lack of demand response:** Lack of demand response to changing prices is a major impediment to controlling market power. Typically, customers do not see the price signals on a real-time basis. Even monthly, customers are generally priced only on an aggregate load weighted average market price basis. If customers do not respond to increases in prices by decreasing consumption, generators may have an opportunity to exercise market power. A good demand response would help reduce market power opportunities significantly.
- **Generation is location-specific and time-dependent:** A specific generator may be needed for reliability purposes in a given geographic area for a certain time period that gives it local market power.
- **High concentration of ownership:** If ownership of generation is concentrated in a few owners, it increases the potential for market power.
- **Lack of sufficient forward contracting:** If enough generation is tied up in forward contracts with loads (customers), the incentive for those generators to exercise market power may decrease (depending on the nature of the forward contracts).
- **Lack of entry from new players:** If there is a credible possibility of entry from new players that could undercut the market share of existing generators, the incentive and the ability of existing generators to exercise market power would be lower.

Section 3D. Measurement of market power

As noted above, even in a market with a workably competitive supply side the marginal producer can have market power under conditions of scarcity if demand is not sufficiently elastic. This calls for ex post measures which in the United States generally fall into one of two categories: tests of structural market power in a given market; or tests that look at specific producer *conduct* and market *impact* to determine if market power is being exercised. Ex ante and ex post mitigation measures can be employed. There is variation in U.S. market monitors' views as to whether to focus more on structural or behavioural (e.g. conduct and impact) tests for detecting the potential for the exercise of market power. The dimensions for measuring market power that arise from ownership of a dominant market share involve *structure* tests that consider the product, geography and time, in addition to *conduct* and *impact* tests to determine if structural market power is being exercised. Key measures of *structure, conduct* and *impact* that provide screening guidelines to assess market power include the Herfindahl-Hirshman Index (HHI), the Lerner Index, the Residual Supplier Index, and price elasticity of demand.

- **The Herfindahl-Hirshman Index** is a structure test that measures concentration of suppliers. It is defined as the sum of squares of market shares of all firms in a defined market, and thus works as follows:
    - If a firm has 100% market share, then HHI is 10,000 [100^2x1].
    - If there are 10 firms each with 10% market share, then HHI is 1,000 [10^2x10].
    - If there are 100 firms each with 1% market share, then HHI is 100 [1^2x100].
    - The higher the HHI, the higher the potential to exercise market power.

  - FERC recommends the following interpretation:
    - HHI >1,800 = highly concentrated
    - HHI 1,000-HHI 1,800 = moderately concentrated
    - HHI <1,000 = unconcentrated
- **The Lerner Index** is an impact test that measures how high price is relative to the marginal cost. It is defined as (P-MC)/P, where P is price and MC is marginal cost.
- **The Residual Supplier Index** is a structure test that measures the transient concentration of pivotal players.
  - RSI = (Total Supply-Largest Seller's Supply)/(Total Demand)
  - If RSI <1, it implies that the largest supplier has dominant market share and the ability to exercise market power.
- **Price elasticity of demand** measures the change in quantity for a given change in price.
  - Elasticity = - (dQ/dP)/(Q/P); [%change in quantity/%change in price, where d = delta/derivative/slope.]
  - If elasticity <1, demand for electricity is inelastic; the closer to 1 it gets, the less inelastic the market is and the less risk there is of market power; the closer to zero it gets, the more inelastic it is and the more risk there is of market power.

Section 3E. Measures for mitigating market power

Some of the mitigation measures for market power include the following.

- **Use of offer caps:** Under this approach the offer amount of a generator or generators deemed to have market power is capped at a predetermined level. This effectively could control the clearing price for all generators. Caps could be applied to units that the market monitor identifies as having market power potential, such as the marginal unit in a constrained area. The generator, however, still receives market clearing price. The basis for generating unit-specific offer caps could be either past accepted competitive bids or a cost formula (such as fuel costs + variable operating & maintenance costs + opportunity costs). This capped level is also commonly referred to as 'reference level.' Typically, some variance from the reference level (either in absolute cost terms or in percentage terms) is tolerated to account for uncertainties.
- **Use of safety net caps:** This is a measure that could be applied generically to all generators on the offer levels. The offer cap could be at a relatively high level, reflecting something approaching value of lost load.[12]

[12] In most cases a generic 'value of lost load' has been determined administratively, typically in the range of $15,000 to $20,000/MWh (though different customers attach a wide range of values to serving a given load at any given time). Maximum offer caps have ranged from approximately $15,000/MWh in Australia and $9,000/MWh in Electric Reliability Council of Texas (ERCOT) (neither of which incorporate forward capacity markets, and ERCOT's cap has recently been reduced to $5,000/MWh) to $1,000/MWh or less in some markets where a forward capacity mechanism of some type has been adopted to top up the money 'missing' from the energy market as a result.

- **Automatic mitigation procedures (AMP):** Under this approach, bids are mitigated based on preset formulas. AMP is a selective bid mitigation mechanism that is automatically activated when conditions are not workably competitive. The mitigation is automatic once the predetermined trigger levels are reached.[13] AMP may not be needed for every region within the market but may be adopted if the market monitor's analysis determines it is needed.
- **Increased demand-side response:** Typically, prices are highest at peak load hours. There can be an opportunity for the marginal generator to exercise market power in those hours as the load is very high and most of the supply is needed. If demand is reduced, particularly in those hours, the ability of generators to exercise market power is reduced. Some of the competitive markets have already introduced market-based demand-side response. For example, along with suppliers, demand-side resources can bid into the market stating how much load they will reduce and at what price.
- **Increased forward contracting:** If most or all the generator's output is tied up in contracts with loads for a given period, then an increase in spot market prices may not provide sufficient incentive for them to attempt to exercise market power (depending on the nature of the contracts).

Section 3F. The process for mitigating market power

The following steps make up a possible process for mitigating market power.

- An initial analysis must be performed by the market monitor and a mitigation plan must be filed with the regulator. It could be updated periodically.
- Market rules must be known to the participants upfront, otherwise there is a potential to increase regulatory risk to investors in generation assets.
- An agreement is needed between the market operator and generators with market power stating that they must offer their supply through bilateral or spot markets.
- When a market monitor identifies a violation of market rules, it must work with the relevant parties to rectify the situation. The 'abuser' will frequently be very happy to cooperate with the market monitor to avoid being publicly shamed as a rulebreaker — this is generally a major deterrent.
- As abuses are identified and root causes understood, the market monitor must make recommendations to fix the market rules that led to the abuse. The market operator and the relevant regulators bear ultimate responsibility for implementing market rule changes and enforcing punishments, if any, for violations.

[13] For example, see NYISO. (2021). *Automated Mitigation Process (AMP)*. https://www.nyiso.com/documents/20142/1391917/automated_mitigation_process.pdf/4157be5f-b4d7-e0d4-ff76-52099ff1e429

Over-mitigation: Mitigation measures must be designed to minimise interference with a competitive market. It is important to ensure that long-term competitive prices offer generators the opportunity to recover their fixed costs as well as the short-term variable costs of producing power. If not, plants may be retired and new investment may not come in because investors in generation will not have a reasonable expectation of recovering their costs. If markets are over-mitigated, there will be less of an incentive for buyers to engage in bilateral transactions as they seek lower prices in spot markets, which could lead to volatility in spot prices. This is one purpose served by various conduct tests adopted in many markets, to avoid the distortion of interventions in the market where there is no evidence that anti-competitive behaviour has occurred.

Section 4. Role of various entities in market monitoring: International experience

This section covers the different entities that perform the function of market monitoring in the United States, their roles and responsibilities, and their organisation. While there are some differences across the balancing areas (control areas), the following is a generic description.

Section 4A. Different entities performing market monitoring

There could be as many as four layers of oversight on the wholesale market. The first is the market operator itself internally reviewing the actions of the market players to ensure they are following market rules. The second one could be in the form of an external market monitor or advisor. An external advisor is an independent entity that reports to the market operator's board and is engaged to review the competitiveness of the wholesale market on a routine basis. The market monitor also reviews the market rules, the efficiency and the overall competitiveness of the market, the adequacy of price signals to attract investment and to retain existing economic assets, etc., and provides recommendations to the market operator and the regulators. For example, in the United States there is an external market monitor for each of the seven competitive control (balancing) areas.

In terms of regulatory oversight, the central or federal regulator has a statutory duty to oversee competitive wholesale markets and approve their tariffs, as the wholesale transactions typically span multiple states. The market monitors report their findings to the market operator and the regulator. The market monitor also has the ability to refer instances of market manipulation to the regulator for investigation. Based on the results of that investigation, the regulator has the power to impose penalties on errant market participants. While the federal regulator has the authority and responsibility to oversee wholesale competitive electricity markets, the state electricity regulators can also play a role given that their distribution companies will be purchasing from the competitive wholesale market and

those prices will be passed on to retail customers. State regulators want to ensure that the final prices their consumers are paying are reasonable, and the wholesale supply price is a major component of the final price. They typically participate in wholesale market stakeholder deliberations and are also involved in the proceedings of the federal regulator. Nevertheless, the ability to investigate and penalise market participants for market manipulation lies exclusively with the wholesale market regulator. Neither state regulators nor the market monitor have this authority.

Section 4B. Organisation of internal and external market monitoring entities

While each balancing area/control area is unique, an illustrative example is provided below using the New York Independent System Operator (NYISO).

NYISO Market Mitigation and Analysis (MMA) group

The group has 27 full-time employees and reports to the chief executive officer. Funding, along with funding for the external market monitoring unit, comes essentially through a levy on customers. The internal market monitor is responsible for:

- Daily screening of energy and ancillary services market outcomes.
- Daily screening of energy and ancillary service offers from generators.
- Establishing baseline reference levels (discussed below).
- Reviewing capacity market offers and outcomes.
- Reviewing virtual market (convergence bidding) outcomes and behaviour.
- Performing mitigation and assessing penalties when manipulation is detected.

External market monitor

The external market monitor is chosen on a competitive basis for a period of (typically) four years. It reports directly to the NYISO Board, and its annual budget is around $5 million. The functions performed by the external market monitor include:

- Ensuring that the markets administered by the NYISO function efficiently and appropriately.
- Protecting consumers and market participants by identifying market violations, market design flaws and market power abuses.
    - Reviewing and reporting on the performance of the wholesale markets that the NYISO administers to the NYISO's Board, the NYISO's regulators, and market participants. Such reporting includes:
        - Producing annual and quarterly state-of-the-market reports assessing the performance of the New York electrical markets.
        - Regularly attending meetings with NYISO stakeholders.

- Evaluating existing and proposed market rules, tariff provisions and market design elements, and recommending proposed rule and tariff changes to the NYISO Board, to FERC, and to market participants.[14]
- Notifying FERC staff and, where permitted, the NYISO of instances in which the Market Monitoring Unit has identified behaviour that may require investigation, or has identified a perceived market design flaw that could be effectively remedied by rule or tariff changes.
- Responding to information and data requests from FERC and other regulatory agencies.
- Advising the NYISO Board.
- Attending board meetings on a quarterly basis, or as requested by the Board.
- Advising the NYISO's internal market monitor on market monitoring functions, including the following:
    - Providing advice on the development and maintenance of reference levels, going forward costs, and retrospective mitigation.
    - Reviewing the NYISO's application of prospective mitigation.
- Reviewing periodic system planning studies and advising on whether market rule changes are required to address forthcoming system needs, and/or how the actions recommended by the studies would impact markets.

The external independent market monitor for the NYISO is an entity called Potomac Economics, which is also the monitor/advisor for several other markets (ERCOT, Midcontinent Independent System Operator (MISO), and Independent System Operators of New England (ISO-NE)).[15] It employs 30 professionals and some small subcontractors to perform the monitoring in the four markets it oversees. These include economists, engineers, application programmers and IT specialists. Potomac Economics is a relatively 'flat' organisation, in that all its employees work collaboratively and often work on multiple markets. Another firm, Monitoring Analytics, acts as the market monitor for the PJM market.

[14] The NYISO's tariff specifies that the monitor is "not responsible for systematic review of every tariff and market rule; its role is monitoring, not audit."

[15] U.S. Agency for International Development (USAID). (2020). *Market Monitoring in the Electricity Industry: International Experience* [Presentation]. https://pdf.usaid.gov/pdf_docs/PA00X88P.pdf

Scope of market monitoring

Market monitoring addresses a broad array of competitive and efficiency issues, including:

- **The existence of market power:** evaluating competitive issues and the effectiveness of market power mitigation measures.
- **Abuses of market power:** identifying attempts by participants to exercise market power.
- **Market manipulation:** detecting attempts to influence market outcomes or settlements through fraud or manipulation.
- **Market performance:** determining whether market rules and procedures provide effective incentives and lead to efficient market outcomes.

Central regulator market monitoring

In the United States, the central electricity regulator is the Federal Energy Regulatory Commission. FERC has an active market monitoring function. The Division of Energy Market Assessments (DEMA) within FERC examines, analyses and reports on the structure and operation of the electric and natural gas markets, providing information to the Commission and the public on significant market events and trends.[16] The DEMA observes market operations and performance to inform the development of policies that promote the competitiveness and efficiency of the wholesale energy markets. The functions of the DEMA include:

- Analyses market performance and trends, and issues periodic reports of its findings to the Commission and the public.
- Conducts market research and collects information and market data for analysis.
- Prepares and presents public reports on the state of energy markets, such as the annual state of the markets report and seasonal market assessments.
- Collaborates with other Commission offices to develop policies to improve the operation and economic efficiency of wholesale energy markets.
- Conducts outreach and communications with stakeholders, including governmental entities and the market monitors of the organised wholesale electricity markets.

Further, FERC approves individual balancing area market monitoring plans, which the market operators and its market monitors abide by. For example, *NYISO Services Attachment O* describes the market monitoring plan approved by FERC.[17] The plan contains the roles, responsibilities and governance arrangements of the market monitoring units.

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[16] Federal Energy Regulatory Commission (FERC). (n.d.). *Office of Energy Policy and Innovation (OEPI)*. https://www.ferc.gov/office-energy-policy-and-innovation-oepi

[17] See for illustration the New York Independent System Operator (NYISO), Docket # ER12-2414-004, Plan on May 1, 2015. https://www.nyiso.com/documents/20142/1399264/agenda%204%20MST%20Section%2030.4%20-%204%20Year%20DCR%20with%20Updates%20Redline%20v1.pdf/44edc17f-fc35-35f9-636b-a4e4d689db81

Section 4C. Attributes of the market monitor

A robust market monitoring unit requires dedicated professional staff including economists, engineers, data analysts and information technology experts. It must also have the following attributes:

- **Independence:** The market monitor should have no affiliation with any of the market participants, in order to avoid conflicts of interests or even the perception of a conflict. It should have a direct reporting line to the Board of the market operator and to the regulators. This is especially important because the market monitor may find poor implementation practices by the system/market operator, who may be more focused on reliability than cost. Notably, the actions of a market operator could have a larger impact than those of any single market participant.[18]
- **Accountability:** The market monitor should produce reports periodically, presenting them to stakeholders and explaining its findings. The monitor should stick as closely as possible to a market monitoring plan approved by the regulators, so people can be confident that it is not coming up with arbitrary assessments. The plan must be adapted as lessons are learned, again with the approval of the regulators.
- **Transparency:** The market monitor's reports should be transparent about the competitiveness of the market, as well as about weaknesses and opportunities for improvement. Any confidential data must be handled per the norms to ensure that no commercial interests are compromised.

Section 4D. Data needs and access to data

Market monitors will also require certain resources in order to be effective.

- **Data needs:** The market monitor typically relies on a number of screens and quantitative indicators to evaluate market conditions and outcomes and to plan actions accordingly. To this end, the monitor is likely to need the ability to download, process and interpret a variety of market data in various timeframes, ranging from real-time (every five minutes) to annually. Market monitors in the United States have developed an extensive system that interfaces with ISO systems to download data on a near-continuous basis. Typical data used for market monitoring includes: (a) market data such as day-ahead and real-time market prices for various products, settlement data, individual unit commitment and dispatch schedules, financial transmission rights positions, operator actions, etc.; (b) generators' characteristics such as capacity, lower and upper operating limits, efficiency, emissions limits, operating costs and ramp rates, etc.; and (c) non-electricity market data such as gas prices, oil prices, emissions allowance prices, fuel consumption, gas availability and gas market conditions, etc.

[18] In the United States, the independent grid operator (RTO) has the responsibility to maintain a market monitoring function. Although the external market monitor performs a valuable function in providing information and recommendations to the Board, the nature of the Board's oversight role over the market monitor is not always clear. For example, in a typical long-term consulting arrangement, the Board would have certain performance requirements, and would oversee and review the consultant's performance and its fiscal responsibility. This role, however, can get blurred given the need to respect the independence of the market monitor while ensuring fiscal responsibility and effective fulfilment of the independent grid operator's responsibility to ensure effective market monitoring.

- **Access to data:** A key aspect of ensuring the effectiveness and independence of a market monitor is to provide it with sufficient access to the data required to carry out its responsibilities. The market monitors in the United States typically have access to required ISO databases as specified in tariffs. In addition, the market monitor can request access to several different categories of data from market participants, provided it offers an explanation of the need for such data. For instance, in the context of NYISO, the market monitor can request information about supplier production costs (actual and opportunity costs), generator status logs, agreements with third parties regarding bidding/capacity, ownership and affiliations data, etc.
- **Analytical tools/software required:** Market monitors employ a variety of analytical tools to detect and investigate issues related to market competitiveness and efficiency. For example, the NYISO and MISO market monitors utilise custom-developed market monitoring software systems that are capable of interfacing with the ISO's databases, calculating and reporting on the quantitative screens of interest, and producing alerts in real time, among other functions. In addition to the real-time monitoring software, market monitors rely on a variety of analytical software for specific investigations into behaviour, the evaluation of market design, and the periodic production of market reports. The software could include a product as simple as MS Excel or scale to more complex analytic software, such as SAS, Python, MATLAB or Power BI; the proper application will depend on the nature and scope of the analysis.
- **Skills/human resources required:** Independent market monitoring entities in the United States tend to be relatively small (20-30 individuals), with some personnel working across markets. The market monitoring function requires a team of experts drawing from multiple disciplines and typically includes economists, power system engineers, data analysts and software developers.

Section 5. Market monitoring tools

Section 5A. Actions of the market monitor

On a routine basis, the market monitor must review the following:

- Generator bidding behaviour, including trends
- Possible economic and physical withholding behaviour by generators (especially during peak load windows and in constrained locations)
- Actions that may adversely impact market operations
- Uneconomic overproduction by generators
- Offer patterns for various products
- Generator outage data and patterns
- Posted clearing prices
- Compliance by market participants with market rules

On a periodic basis, the market monitor[19] must review the following:

- Prices — hourly, daily, monthly and annual
- Supply/demand gap
- Supply availability, concentration of generators
- Input fuel prices
- Load duration curve
- Price duration curve
- Implied heat rates
- Day-ahead and real-time price convergence
- The drivers of price changes
- Market rules to see whether changes are warranted
- Possible changes to improve the marketplace

The market monitor must also recommend steps to substantially reduce the risk and mitigate the consequences of any uncompetitive actions.

Section 5B. Analytical market monitoring tools and examples

The following are some analytical tools that the market monitor could use.

Concentration measures (often referred to as structure tests)

Quantifying market concentration using the HHI index is a standard approach to assess individual generator market power potential on a longer timeline. Pivotal supplier tests of various types are a standard approach to assessing the potential for market power on a more transient timeline.

Conduct and impact tests

The market monitor must mitigate offers and prices in line with agreed-upon conduct and impact test rules. Accordingly, the conduct of the market players must be reviewed and the impact of any violations by the generators must be studied. To illustrate the application of conduct and impact tests, consider the following example. The total load to be served in the region is 100MW. Assume that there are no constraints, and any generator can be dispatched to meet this requirement. The assumed reference levels/prices (i.e., the actual estimated marginal cost, the sum of all variable costs including fuel, operations and maintenance and emissions allowances, etc.) and the capacities of the four units in this area

[19] For example, see Patton, D., LeeVanSchaick, P., Chen, J., & Coscia, J. (2023) *2022 State of the Market Report for the New York ISO Markets*. Potomac Economics. https://www.nyiso.com/documents/20142/2223763/2022-State-of-the-Market-Report.pdf/617e9176-cb4b-de7d-1026-af57175c4a8e?t=1684329150469

are as shown in Table 1 below. Further assume that the thresholds for conduct and impact tests in this example are $10/MWh and $15/MWh, respectively. In the following example, if the units were to offer based on their reference prices, the clearing price would be $60/MWh in the given hour. Table 1 also shows two other scenarios where the units deviate from their reference prices as shown.

The clearing price when all units offer based on their reference prices and when they offer as shown in Scenario I is $60/MWh (the competitive market outcome), whereas the clearing price under Scenario II is higher at $80/MWh. The following observations may be made about each of the generators in this example:

- Unit A fails the conduct test in Scenarios I and II as the difference between its offer and the reference price exceeds the conduct threshold. However, the clearing price is not impacted by Unit A's offer. Accordingly, it does not violate the impact test.
- Units B and D offer per their reference prices and do not violate the conduct or impact tests.
- Unit C's offer in Scenario I is higher than its Reference Price, but the difference is less than the conduct threshold. Hence, it does not violate the conduct test in Scenario I. However, its offer in Scenario II ($80/MWh) violates the conduct threshold, and since it drives up the clearing price by more than the impact threshold, Unit C also violates the impact test.[20]

Table 1. Illustration of conduct and impact test scenarios

Generator	Quantity offered (MWh)	Reference price ($/MWh)	Offer ($/MWh)	
			Scenario 1	Scenario 2
A	20	$20	$40	$40
B	35	$35	$35	$35
C	30	$40	$45	$80
D	40	$60	$60	$60
Clearing price →		$60	$60	$80

Market behaviour

The market monitor needs to assess whether generators are engaging in physical withholding or economic withholding. Physical withholding could include derating a unit or not offering a unit when it is economic to do so. Economic withholding results from generators bidding at a higher price to raise the market price. The following tools can be used to analyse whether withholding is occurring.

[20] It should be noted that under a structural market power test, the market would fail the three pivotal supplier tests in this illustration.

'Withholding supply' analysis

It is important for the market monitor to differentiate strategic withholding from competitive conduct. In other words, it must determine whether a forced outage is legitimate or whether it is a strategic attempt to withhold. Generally, under competitive conditions, generators would want to sell the maximum output at peak periods when prices are high enough for its generation to clear the market, to maximise profits. A generator with market power might find withholding profitable at peak periods if it has other generation that would benefit from the resulting higher clearing price.

- Analyse the percentage of time a participant sets the market clearing price.
- Analyse the relationship between peak demands and measures of potential withholding.
- Analyse periods when generation that would otherwise clear the market is not offered into the market ahead or is not generating in real time.

Economic withholding

Review the relationship between capacity not available (offers far exceed base costs) and load during peak load periods.

Physical withholding

Review the relationship between load and capacity derating during peak periods.

Attraction of new entry and retirement of existing generation

It is important for the market monitor to analyse whether the profits from the markets are sufficient to entice economic new generation and to keep the existing economic generation from closing. The market monitor must analyse various revenue streams to generators, review cost elements, and determine net revenues to generators.

Conclusion

As wholesale markets develop, it is essential to have a robust market monitoring function in place to ensure that the market behaves in a competitive fashion and the resulting prices in the market are competitive. There are several approaches for how a market monitoring function could be structured and implemented. Every market will likely have structural impediments to implementing a competitive market; they need to be addressed. Further, the behaviour of market participants should be monitored to ensure they comply with the market rules and do not abuse the system. This brief provides a few examples of the market monitoring structures, the structural impediments to competitive markets, and the monitoring tools used by market monitors in the U.S. market.

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