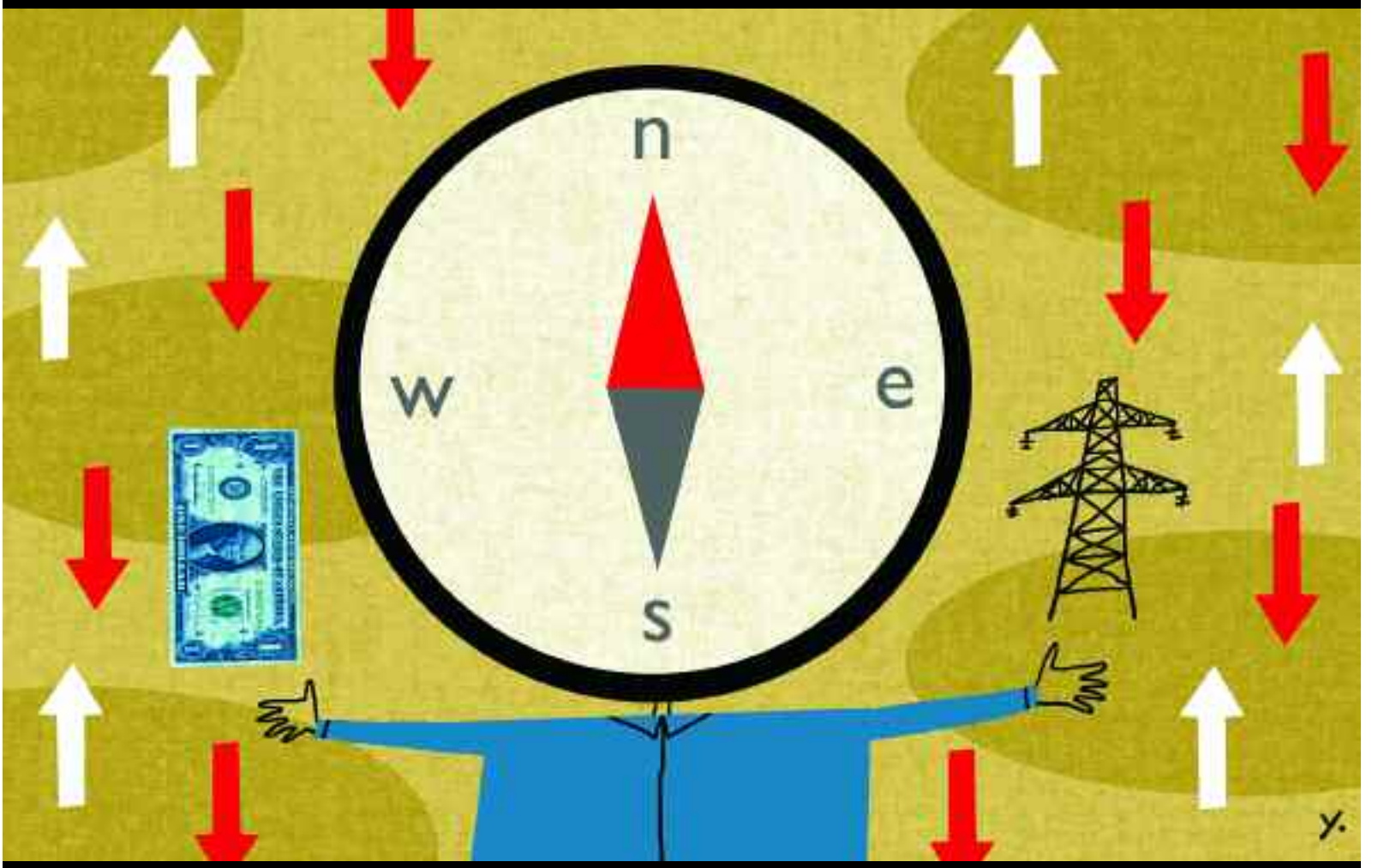
LMP Electricity Markets

Market Operations, Market Power and Value for Consumers



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Editor's note: Consumers in wholesale electric markets are troubled by locational marginal pricing (LMP) approaches. The ostensible purpose of this pricing mechanism is to generate revenues in local areas where electricity supplies are constrained to support construction of needed new generation. The theory has increased prices, but it has not led to construction of new generation. The American Public Power Association hired Synapse Energy Economics of Cambridge, Mass., to examine the effect of LMP on electricity markets.

The American Public Power Association asked Synapse Energy Economics to review two particular aspects of locational marginal pricing that are crucial to producing efficient markets and returning benefits to customers.. These are: (1) the effectiveness of LMP markets in delivering the market efficiencies and investments it was designed to produce, and (2) competitiveness, market power, and market monitoring issues in LMP markets.

We have focused this report primarily on the PJM Interconnection, and to a lesser extent on the New England ISO (ISO-NE). PJM, founded as the Pennsylvania-Jersey-Maryland market operator, now runs electricity markets as the regional transmission organization (RTO) in some or all of 13 states and the District of Columbia. It is the largest centrally dispatched electricity system in the world, and has been operating electricity markets under the LMP system since 1997. ISO New England has been operating LMP markets since the spring of 2003 and has operated a centralized market since 1999.

To address the effectiveness of LMP markets, we reviewed the theory and goals of the LMP construct and held them up to the several years' worth of experience in LMP markets. We asked the following questions:

- Does security-constrained dispatch and LMP pricing work as well in the real world as it should in theory?
- Have the price-signaling aspects of LMP produced the desired outcomes in terms of investments in electricity infrastructure?
- Have the LMP markets been workably competitive, or is market power and price manipulation a concern?
- Have power production costs come down as a result?

One primary goal of LMP, articulated by the Federal Energy Regulatory Commission in approving LMP implementation in PJM, is to produce efficient, accurate economic signals that would spur investment in both electricity market infrastructure and demand-response programs where and when they are needed. As part of our review, we evaluated whether the LMP price signals have in fact produced generation and transmission investments and demand-response programs where and when needed, leading to the intended benefits for consumers. To the extent that the markets have fallen short of this standard, we have reviewed what obstacles remain, either structural or related to market design, that have limited the effectiveness of this approach.

In reviewing market power and competitiveness issues in LMP-based electricity markets, we investigated whether there are opportunities for exercise of market power, if there is evidence of anticompetitive behavior, and if so, whether this behavior is reflected in market prices. We asked the following questions:

- In these large, complex, dynamic markets, what safeguards can be used to ensure that market outcomes are not distorted by the exercise of market power?
- Have these safeguards been vigorously applied and, if so, are they effective?
- Do they support competition and open access to markets?
- Conversely, are there still ways that market participants can apply market power in LMP markets, and have these been exploited?

In particular, we delved into the history, market rules, market outcomes, investment histories, and operational data of two of the oldest LMP-based markets in the United States, those administered by the PJM RTO and by the ISO New England RTO. We reviewed how these two market administrators operate the mathematical foundation of LMP, and how that implementation compares to theory. We reviewed the history of generation, transmission and demand-side resource investments since the onset of LMP pricing in these markets to determine if there is a recognizable relationship with price signals. Where these have diverged, we have investigated the causes.

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We have reviewed and audited public data on energy bids to characterize these data, identify opportunities for the exercise of market power, and highlight examples of anomalous bidding behavior. While we cannot reach firm conclusions about the competitiveness of energy markets in this analysis, we have used the data to raise questions that have not been adequately addressed in market monitor reports. Where our conclusions differ from those of the market monitor in this area, we reported on the differences. We have also highlighted areas where we feel the market monitor should focus more attention in the future.

Based on our review, we conclude that the LMP approach to electricity pricing generally supports the efficient operation of existing resources, if the LMP pricing and dispatch are based on the short-run marginal cost (SRMC, discussed below) associated with each resource. Under these circumstances, we find that LMP provides an accurate quantification of the need for and value of potential generation

and transmission enhancements, as well as valuable diagnostic information regarding needed investment, market performance, and structural opportunities for the exercise of market power. In terms of dispatch, we find that LMP probably represents the best approach available for operating large, interconnected power pools efficiently and reliably.

However, the reality of LMP implementation in deregulated electricity markets is not exactly as described by theory, in large part because electricity markets are bid-based, not cost-based, and electricity markets are not perfectly competitive. To the extent that there is any type of collusion—explicitly or tacit—prices will not reflect the SRMC and some of the value of LMP in market operations may be lost. Simply implementing LMP does not guarantee competitive markets, nor does it prevent the abuse of market power. Because the opportunity for exercising market power is not diminished (and is sometimes enhanced) in LMP-based markets, the role of market monitor remains crucial for assessing and maintaining competitive conditions and successful market operations in conformity with the "just and reasonable" standard of the Federal Power Act.

In terms of investment signals, we find that LMP has not been successful in providing the necessary incentives for socially optimal investment in generation or transmission infrastructure, nor does it ensure the high levels of reliability demanded by consumers. There is simply no evidence that the price signaling associated with LMP has been an effective spur to investment in generation, transmission or demand-response initiatives, and some evidence to the contrary. We conclude that the LMP price signals are overwhelmed by other factors in these areas, such as structural barriers to entry, competing economic incentives, and the lack of a clear mechanism for assuring return on investment in certain types of projects.

Lastly, we found that whatever production cost savings may have occurred as a result of LMP-driven efficiencies, this benefit has not been realized by consumers. In states where temporary retail price caps have expired, consumers face large and burdensome increases in the price of electricity. While this is partly due to recent increases in fuel costs, specifically gas, it is also largely the result of short-term contracting for electricity in a dominant wholesale market in which power is priced at the margin. Pricing electricity based upon the short-run marginal cost exposes load-serving entities (LSEs), and ultimately consumers, to a much greater degree of price volatility than would be experienced under cost-of-service regulation, or under a portfolio-based procurement approach that included a large proportion of long-term supply components. The only recourse to protect consumers in such an environment is a greater reliance on

long-term contracts, but the trend since deregulation has gone in the other direction. In this sense, consumers have lost the economic benefits of fuel and technology diversity, as prices are completely determined by whatever fuel happens to be on the margin.

Although complementary longer-term procurement options are available in all electricity markets today, these have proven to be an insufficient hedge since the introduction of the shorter-term RTO spot energy market structure. As a result, pricing for many consumers is closely linked to short-term marginal-priced structures of the RTO-administered spot energy markets, illustrating the failure of market mechanisms and/or state and regional-level policy to insulate consumers from short-term price fluctuations. Combined with recent increases in the cost of natural gas, this dynamic has led to much higher costs for consumers and windfall profits for owners of base load generation assets. This is not necessarily a failure of the LMP construct per se; it is merely one example of the ways in which the operational benefits of LMP markets are not sufficient to produce just and reasonable prices for consumers.

In fact, LMP appears to be a useful, perhaps necessary, but certainly not sufficient, component of deregulated, competitive electricity markets. Effective market designs must include both market-based and administrative elements, to ensure that public goods, such as electric reliability and efficient transmission investments, are provided even when not produced by market forces. Regulatory intervention has been and will continue to be crucial for rectifying the shortcomings of LMP in these areas. Attempts to rely on market solutions where regulatory ones are more appropriate does not lead to socially optimal investments, but to higher prices for consumers.

Operational efficiency. We find that while LMP generally favors the lowest cost dispatch, given a broad set of market conditions, there are a large number of differences between LMP theory and the implementation of LMP in practice. In particular:

• LMP was originally envisioned as a cost-based optimization algorithm for regulated, vertically integrated utilities. However, in practice it has been implemented as a bid-based pricing and dispatch scheme in deregulated electricity markets. While this may have only a modest effect on dispatch, it opens the door for exercise of market power under certain conditions, which compromises the operational benefits of LMP and results in additional costs for consumers;

• LMP is implemented based on an approximation of system conditions, most significantly because system constraints and operational parameters are based on proxy methods and estimates that tend to underutilize full transmission system capacity. This renders the outcome suboptimal to some extent in any operating period;

• The LMP dispatch and prices for any

given period are dependent on system conditions and operator decisions that are not necessarily co-optimized with dispatch. These include unit commitment in general, requirements for ancillary services, ramping constraints, minimum up- and down-times, and other factors;

• Because a significant portion of load in PJM is served "out of market" by units selected for operating reserve and voltage support reliability reasons, LMP-based dispatch is not actually solved for system-wide optimization. However, such actions can be socially beneficial and should not be rejected out of hand merely because they are not market-based.

Price signaling—A frequently stated goal of locational pricing is to provide economically accurate signals to stimulate investment when and where it is needed. LMP, in particular, is designed to provide the incentive for generators to build generation in areas that are short of generation relative to demand; and/or for merchant transmission investment to relieve transmission constraints. However, infrastructure investment decisions are based on a large number of considerations in addition to locational prices. In addition, the price signal is retrospective and short-term in nature, while investment decisions are prospective and long-term. This leads to a serious disconnect, especially given the significant volatility of the electricity markets and the many ways they can evolve over time. Our review of the effectiveness of price signaling found that:

• While a large number of generators have been built since the onset of the LMP market structure in PJM, there is no clearly discernable causal link between these investments and the presence of

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locational marginal pricing. It is not clear that the level or locations of generation investment would have been any different had an LMP-based structure not been in place;

• There has also been a significant level of retirements in PJM which, like new generation, have borne no discernible relationship to price signals in either timing or location;

• There has been no significant merchant transmission activity within PJM, demonstrating that market signals alone are inadequate to produce such investments. The reasons for this are well understood. First, the presence of new transmission would reduce or eliminate the congestion costs (price signal) upon which the new transmission would depend, at least in part, to recover its embedded costs. Second, the benefits of such investments in terms of reduced transmission congestion are widely shared, and individual entities are reluctant to shoulder the burden themselves if there is no straightforward mechanism for sharing the cost;

• Demand response resources, a key element of improved reliability of electric systems, have not developed appreciably in response to deregulation and the LMP market structure.

Competitiveness in markets—As noted earlier, the LMP system was designed to produce optimal dispatch and price signals based on generator marginal cost for each market interval. In a deregulated, bid-based marketplace, generator offer prices are substituted for generator costs, based on the presumption that these will reflect marginal cost if the markets are sufficiently competitive; however, LMP itself provides no guarantee of this condition. We reviewed both market rules in PJM and in the ISO-NE to investigate how market monitors evaluate market conditions under the LMP. In addition, we investigated the available generator offer data in both markets to explore whether they appear to be consistent with a presumption of competitive market conditions. Our findings are:

• While PJM does not restrict generation bidders in unconstrained areas, it does have the strictest bidding rules of any U.S. LMP-based market for constrained locations, generally requiring an offer cap of 110 percent of production costs, as determined by the market monitor. The New England and MISO markets have less strict provisions that allow for greater increases in offer prices above marginal cost for constrained areas (50 percent increase above marginal costs in New England; and an increase tied to annual congestion hours and annual fixed costs of a peaking unit in MISO);

• Even in PJM's constrained regions, there are significant opportunities to deviate from cost-based bidding; bid adders of up to 10 percent above cost are accepted by the PJM market monitor without review and many newer resources are exempt from bid mitigation in constrained regions if they pass a pivotal supplier mitigation test;

• While the PJM market monitor has generally concluded that the exercise of market power is minimal and the spot energy markets are "competitive," we are not convinced that this is supported by the data. Further, even the allowable 10 percent bid adders result in clearing prices that exceed competitive levels by at least a few percentage points, which could result in significant transfers of wealth from consumers to producers;

• Our investigation of bid data has revealed both the opportunity to exercise market power and examples of anomalous bidding behavior, impacting the generation supply curve, that appear to reflect either market manipulation or attempts to "learn," which could lead to exercise of market power;

• The lack of significant and/or persistent short-term demand-side price response calls into question the fundamental premise that the spot markets are able to exhibit competitive behavior during periods when the system supply curve becomes relatively more inelastic (i.e., gets steeper);

• We know of no comprehensive examination of the potential to exercise market power in the forward bilateral markets that comprise much of the volume of transactions in the PJM region.