Generation, Transmission, and the Load Pocket Problem

By Richard Benjamin*

Introduction

Restructured electricity markets present several problems not present in traditional electricity markets. Particularly thorny is the question of how to efficiently manage load pockets. In traditional electricity markets, vertically integrated firms internalize this problem, choosing the mix of generating and transmission assets, subject to state commission planning review. In a restructured electricity market, price signals would ideally do the job.[1] However, as load pockets become sufficiently small, maintaining enough generation plus transmission capacity to support a competitive market becomes prohibitively inefficient. In absence of competitive prices signaling the need for transmission and generation expansion, the regulator must design a framework in which these decisions are made. This paper examines the regulator's problem in developing such a framework. The first section reviews the methods PJM, ISO-NE, and California use to manage load pockets, and their attendant incentives for transmission and generation expansion. The second section discusses frictions facing individual load-pocket generation and transmission projects. The third addresses issues considered in evaluating the desirability of generation versus transmission in alleviating load-pocket congestion. The fourth section proposes an alternative means to mitigating load-pocket market power problems and for providing incentives for generation and transmission in load pockets. The fifth concludes.

RTO Load-Pocket Practices

FERC's Order on the CAISO's Market Redesign and Technology Upgrade (MRTU)[2] mitigates generation market power through incrementally increasing caps on suppliers' bids into the CAISO's real-time markets. At MRTU's effective date, the real-time bid cap will be $500, rising to $1,000 over a period of two years. With respect to load pockets, the CAISO conducts an annual assessment of all transmission paths, finding them to be either "competitive" or "non-competitive."[3] It uses this assessment to determine units subject to local market power mitigation. Those units whose dispatch level increases from a dispatch algorithm run taking into account only constraints over "competitive" transmission paths to a run incorporating all constraints in the Full Network Model are subject to the CAISO's local market power mitigation measures.[4]

Both the CAISO and the CPUC play roles in ensuring adequate supply of power in load pockets. The CPUC exercises its constitutional authority over resource adequacy by requiring California's investor-owned utilities to file their long-term procurement plans before the CPUC. The CPUC has also instituted a resource adequacy requirements program to ensure adequate resources are available.[5] The CAISO mitigates load-pocket market power while ensuring load-pocket adequacy by awarding one-year reliability-must-run (RMR) contracts to generation needed for reliability within load pockets.[6]

PJM also calls on units to run for reliability purposes. PJM determines which units to call based on facility outages or other system conditions which may give rise to a transmission constraint, requiring the facility's operation to maintain reliability.[7] With certain exceptions, PJM places caps on the offer prices of any generation resources dispatched out of economic (merit) order to maintain reliability. The level of these offer caps depends on the frequency with which PJM caps the unit. The offer cap increases with the frequency with which the unit is capped.[8]

PJM uses scarcity pricing as well as must-run designations in dealing with load pockets. While must-run and offer capping ensure reliable service at reasonable prices, scarcity pricing signals the need for generation and transmission additions. When load in a PJM scarcity pricing region[9] gets high enough to trigger a scarcity condition, PJM implements scarcity pricing. When a scarcity condition exists inside of a scarcity pricing region, PJM determines the locational marginal price (LMP) at all nodes in a scarcity pricing region based on the highest market-based offer price of all units operating according to PJM's directions to supply either energy or reserves on a real-time dispatch basis. Generation operating under scarcity pricing is subject only to PJM's maximum offer cap of $1,000/MWh. PJM uses its regional transmission expansion planning protocol to decide on transmission projects to improve grid configuration, and locational capacity pricing in capacity markets to signal the need for generation in load pockets.[10]

ISO-NE names geographic areas in which it regularly calls on resources owned by a limited number of suppliers to relieve transmission constraints as

* Richard Benjamin is an economist with the Federal National Regulatory Commission. He may be reached at dr_rbenj@yahoo.com The opinions and conclusions of the author do not necessarily reflect those of the Federal Energy Regulatory Commission, its Staff, or any of its Commissioners.

See footnotes at end of text.

Designated Congestion Areas (DCAs). ISO-NE then negotiates reliability agreements with those resources whose operation it deems necessary to maintain reliability within the DCA.[11] It mitigates these units by compensating them with the greater of the applicable LMP, a cost-based rate, or the lower of their supply offer or the applicable reference level when it calls on them for reliability purposes. ISO-NE uses zonal capacity requirements and locational reserve requirements for reserve zones to provide the incentive for generation expansion for local reliability purposes.[12] ISO-NE's Regional System Plan evaluates the efficacy of different resources (e.g., generation, distributed generation, transmission, and demand-side projects) in determining the optimal load-pocket expansion strategy.[13]

Frictions Facing Load-Pocket Resource Additions

Load pockets invariably comprise densely-populated regions, often involving geographically isolated areas. Generation construction in these areas typically faces strong resistance (the not-in-my-backyard, or NIMBY effect), due to health, environmental, and aesthetic concerns. In San Francisco, for example, both the abandoned Potrero Unit 7, which Mirant abandoned when it faced bankruptcy, and the San Francisco Electric Reliability Project have faced stiff opposition.[14] Thus politics may be more important than efficiency concerns in siting load-pocket generation.

RTOs' load-pocket market power mitigation measures may also frustrate efforts to build new generation. Chao et al. (2005) maintain that low price caps, combined with centralized unit commitment by RTOs, which depresses the price for offline reserve capacity, give insufficient revenues to support new combustion turbines.[15] Lave et al. (2004) contend that the uniform price auction overpays baseload generation during peak periods while simultaneously discouraging new investment. They state that because high-cost peaking units would receive only their marginal cost of generation in a competitive market, investors in new units would have to be offered an incentive equal to fixed costs to induce them to build.[16]

Adding transmission to alleviate load pockets is also problematic. Overhead lines are a "non-starter" in heavily-populated areas, and even underground lines face opposition. Several community groups vociferously opposed the Jefferson-Martin line,[17] raising issues with respect to both the overhead and underground segments. Among the complaints regarding proposed routes for the underground section of the line were that it ran through residential neighborhoods, past schools, by professional and medical office buildings, and presented unacceptable construction impacts such as noise, traffic, emergency access and business losses, and would entail residential EMF exposure.[18] Many economists also argue that financial transmission rights (FTRs) create an underincentive for grid expansion because new investment in transmission diminishes the value of existing FTRs.[19]

Coordinating Generation and Transmission Additions

Not only does individually building generation or transmission individually in load pockets present problems. An equally daunting task is how to arrive at the right mix of the two assets. This problem has both spatial and temporal dimensions. Spatially, the loss of vertical integration of utility planning leaves entities with differing incentives making uncoordinated locational investment decisions. Chao et al. (2005) argue that generation builders prefer to locate in load pockets (due to high prices there). He concludes that regulators must step in because transmission expansion may be more efficient.[20]

A central temporal problem arising in transmission siting decisions is that transmission takes much longer to build than generation. According to Joskow and Tirole (2003), this allows a generation investor to strategically preempt a competing transmission project, even if the transmission project is more socially valuable.[21] Brennan (2006) thus reasons that "efficient transmission investment and competitive generation requires the design and solution of a multistage game among the transmission provider and generators that can choose to build earlier or later."[22] He is, therefore, skeptical regarding the prospects for adequate transmission investment in restructured markets.

The other major temporal consideration is the long life spans of both generation and transmission. Chao et al. (2005) note that private generation investments depend on the supporting transmission infrastructure. Because LMPs depend on grid topology, the profitability of generation is subject to future transmission investment decisions. Thus, private generation investors need reliable forecasts of grid topology in order to make informed decisions on where to locate new plants.[23] Calviou et al. (2004) concur that deciding on the optimal generation/transmission mix is a complicated by the long planning horizon necessitated by the long lives of the assets.[24]

Determining the optimal generation-transmission mix requires consideration of various factors. Pratt (2003) argues that transmission enhancements ought not to be favored over other solutions, but that planning authorities should compare transmission enhancements or expansions against market proposals such as generation, merchant transmission, and demand response. He argues that transmission planning rules should be designed to select the most efficient and cost-effective solutions.[25] Calviou et al. (2004) add that in comparing transmission and generation, one should recognize that transmission reduces the market power of load-pocket generators more effectively than new generation. The authors argue that load pockets are analogous to protected markets. They reason that a new generator in a load pocket simply competes for marginal demand against the least efficient unit, but that an increase in transmission is tantamount to a reduction in trade barriers.[26]

Alternative Regulatory Mechanisms for Load Pockets

Lave et al. (2004) conjecture that the cost of additional generation and transmission needed to support a competitive market might be so great as to render competitive electricity markets inefficient.[27] No where is this hypothesis more true than in geographically isolated population centers like San Francisco, with a peak load of approximately 2,000 megawatts. The basic problem is that economies of scale render competition in small markets inefficient, especially in electricity where hourly auctions, with even a moderate number of participants, facilitate tacit collusion[28] and local generation is needed for voltage support. Therefore, mitigation in load pockets seems inevitable.

The question is what approach regulation should take in this case. I would argue that restructuring has put the cart before the horse here. Before opening up transmission-constrained population centers to competition, one ought to have an "end game" in mind. If that end game is just mitigation, then one should think carefully before prescribing competition in these areas. The basic problem is that in the face of inelastic demand, an imperfectly competitive firm's profit-maximizing strategy is to raise prices. This is antithetical to the mandate that FERC ensure that wholesale electricity prices are just and reasonable.

The question then becomes whether continuation of VIU operation in load pockets would have been a more efficient option than mitigation of merchant generation. More formally, this alternative would have entailed VIUs retaining all load-pocket generation. This generation would then receive its marginal cost in the wholesale electricity market, with fixed costs recovery in retail rates. The generator would be free to bid into any markets in which it had market-based rate authority.

I believe continued VIU operation in load pockets would be preferable to restructuring in load pockets for a few reasons. The first is the problem of incentives. Because demand for electricity is generally quite inelastic, generation owners can be expected to withhold generation either physically or economically, provided the probability of detection is low enough. Even in PJM, which mitigates bids in load pockets, generators still receive the LMP (based on their mitigated bids). Thus physical withholding might still be profitable. The VIU does not have the same incentive. Since the generator earns only marginal cost in the wholesale market, it has no incentive to block rival generation coming into the load pocket by withholding transmission. Further, it has the incentive to run its generation whenever doing so is the least-cost strategy, because its retail rates are fixed in the short run.

The second reason is the start-up cost associated with adopting a new regulatory regime. In the case of U.S. electricity restructuring, this involved the incremental time spent training Office of Enforcement personnel This involves the marginal time required to train personnel with regard on load-pocket issues, as well as losses from imperfect detection of market manipulation in load pockets as employees are still learning their jobs.

In order to justify these costs, the regulator must find at least commensurate benefits. In hindsight, these benefits have not been realized. In the short term, load pocket mitigation in restructured markets cannot be any more efficient than cost-of-service regulation. In fact, it will have been less so, if load pocket generators have been able to practice physical or economic withholding. In the long run, whether restructured markets or VIUs will bring more efficient load-pocket expansion is an open issue. PJM and ISO-NE have gone through multiple policy revisions in trying to give merchant generators the incentive to locate in load pockets. As merchant transmission may loosen up load-pocket constraints regardless of the competitive structure inside the load pocket, it is not an issue.

Let us repeat that even if the benefits of load-pocket restructuring are not sufficient to justify its implementation, we need not conclude that we are stuck in the pre-Order 888 world where VIUs use transmission constraints to starve their competitors' access to customers. Provided that the VIU generation earns only marginal cost in the load pocket, it has no reason to discriminate in the short run. The regulator's chief concern is then attaining long-run efficiency. Once again, we are faced with the Averch-Johnson effect. In addition to Averch-Johnson, though, the introduction of FTRs/auction revenue rights (ARRs) creates an additional incentive for inefficient utility operations.

To illustrate this effect, I consider a simplified load-pocket example. Denote by K the amount of transmission capacity coming into a load pocket over a single transmission line, so as to ignore loop flow. In the load pocket there are two generators, A and B, both owned and operated by the incumbent utility. A and B are assumed to have fixed marginal costs of generation, with $MC_A < MC_B$. That is, B is the older, less efficient, and thus more polluting plant. As described above, load-pocket generators would receive their variable costs in the wholesale energy market. Denote the relevant portions of the supply curves for imports, generator A, and generator B by S_I, S_A, and S_B, respectively. Assume further that load pocket demand is perfectly inelastic at quantity Q_L, and that B has excess capacity at this load, so that the LMP (for purposes of calculating FTR revenues) is P_L. In this case, imports supply quantity K at price P_I, generator A supplies quantity (Q_2 – K), and receives its marginal cost, equal to P_A. Generator B supplies quantity (Q_L - Q_2) at its marginal cost, P_L. Graphically, see Figure 1.

Now consider the VIU's decision as to whether to keep the old plant running or shut it down and replace it with an equivalent amount of new generation or transmission capacity.[29] If the utility builds new generation, its profit increases by the difference in the return to capital of the two plants. Since the old plant will be highly depreciated, this favors building.[30] Society is better off provided that the social benefit from building the new unit (that is, the change in redispatch cost, equal to the area Z in Figure 1) is greater than the cost of the new plant.

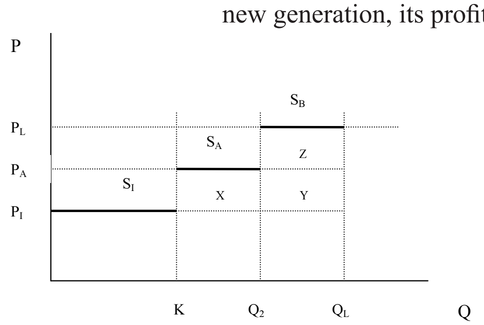

Figure 1
A Simplified Load Pocket Example

However, if it does build the new generator,[31] the load-pocket LMP falls from P_L to P_A, and thus FTR revenue falls from (P_L – P_I)K to (P_A – P_I)K, as illustrated in Figure 2.

This loss in revenue will decrease, and possibly negate, the profit incentive to building new generation in the load pocket. Even worse, the less efficient the old plant, the greater the FTR revenue loss, and the greater the disincentive to replace it. Thus the relevant authority, be it the RTO or the regulator, should disallow any FTR collection in the load pocket beyond the amount (P_A – P_I).[32] In order to align private and social benefit even better, the regulator should instruct the RTO to rebate a certain amount of money back to the VIU, as profit, after the latter builds the new plant. The primary reason for doing so is the social benefit from the improved health of local residents upon replacement of the old plant (providing that new pollution sources are not allowed to move in). The regulator might dictate that any remaining revenue be rebated to the utility's customers outside of the load pocket. This would decrease the amount by which these customers subsidize load-pocket energy consumption.

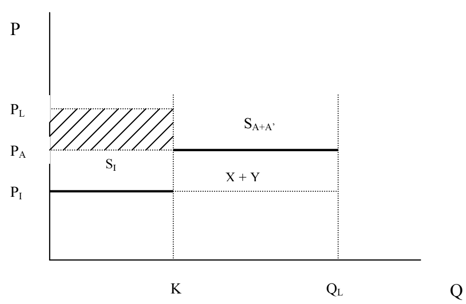

Figure 2
Adding Generation to the Load Pocket Reduces FTR Revenues

Now let us examine the utility's choice between building new generation, as above, or increasing transmission capacity into the load pocket. Increasesd transmission into the load pocket will allow more imports, with marginal cost $P_{I,}$ into the load pocket. The social benefit from the new transmission is, again, the change in redispatch costs, equal to the area X+Z in Figure 1 (plus improved health due to the reduction in pollution). The social cost is equal to the private cost of the new transmission line, any health change due to EMF exposure, and decreased visual aesthetics associated with any overhead portions of the line. In this static example, transmission would be the optimal choice if the difference in redispatch cost savings between new generation and transmission (X) is greater than the difference between the levelized costs of transmission and generation (plus any difference in health effects).

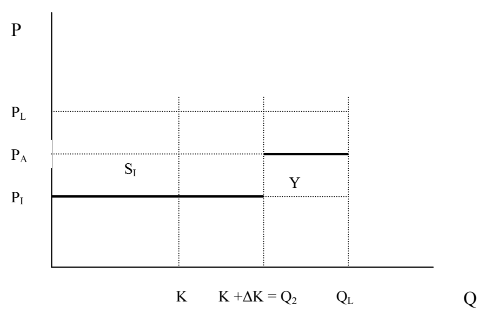

Figure 3
Adding Transmission to the Load Pocket

The good news in this example is that the regulator need no longer worry about the VIU turning down transmission expansion in order to disadvantage rival generation. As long as the utility's load-pocket generation receives marginal cost alone, the utility will be indifferent to how much it runs, ceteris paribus. All else is not constant, however, because in the short run, the utility's retail rates are fixed. This means that the utility will always strive for least-cost operation in the short run. It will thus want its load pocket generation to run whenever doing so is the least- cost (and thus, ignoring pollution) solution. This is why the VIU model, unlike the merchant generation model, gives the socially optimal incentives in the short run.

Turning back to the choice of generation and transmission expansion in the long run, the regulator still needs to be concerned regarding the incentive of the utility to choose the most costly alternative. This is so because the greater the cost, the greater the allowed return on investment. Thus the regulator is still in the business of approving utility resource plans in load pockets. The regulator's work is simplified by the restructured environment, however. Upon receiving the RTO's determination of resource need,[33] the regulator may require the utility to issue a Request-For-Proposals (RFP) for new generation. This RFP could include the utility's self-build option, along with proposals from other parties who would build the generation and then sell it to the utility. The utility would concurrently submit a transmission option. The RTO would then decide on which addition to adopt, severely limiting the ability of the VIU to "gold-plate" its portfolio.

Conclusion

Restructured electricity markets present several problems not present in traditional markets. An important issue glossed over in the restructuring process is whether or not the VIU model is the more appropriate alternative for load-pocket management. This paper has argued that this is the case. In the short run, the incentives of the VIU are better aligned with the goal of attaining power at a just-and-reasonable rate than those of merchant generators, whose incentive is to raise the price of power as high as possible in the face of inelastic demand. As RTOs, such as PJM, or PUCs, such as the CPUC already do resource planning, either model is amenable to long-run decision making regarding the choice of generation or transmission additions to meet load growth and replace old, inefficient plants. With little difference in the long-run mechanics of the two models, the improved short-run incentives of the VIU model argue for its adoption in load pockets.

Footnotes

[1] See, e.g., Keller and Wild (2004). Keller and Wild suggest that in traditional electricity markets, vertically integrated utilities chose transmission and generation to minimize total costs, but the Averch-Johnson effect (Averch and Johnson, 1962) suggests gold-plating by utilities. See, also Brennan, (2006).

[2] 116 FERC ¶ 61,274.

[3] The CAISO designates a transmission constraint as competitive if no three unaffiliated suppliers are jointly pivotal in relieving congestion on that constraint.

[4] These units are paid according to the generator's default energy bid, as explained in MRTU Tariff sections 39.7.1.1 – 39.7.1.4., http://www.caiso.com/17ba/17ba873e19350.html.

[5] See http://www.cpuc.ca.gov/PUC/hottopics/1Energy/R0404003.htm for details.

[6] Generators may choose between a contract that pays a certain percentage of the generator's annual fixed costs while allowing the generator to participate in the energy market, and a contract that pays the unit 100 percent of its fixed costs, but prohibits that unit from participating in market transactions expect under certain circumstances. Bids of RMR units are subject to mitigation (See MRTU Tariff, Section 31.2.2.1). The CAISO has also proposed a scarcity pricing mechanism.

[7] A PJM member that owns or leases local transmission facilities may, as long as it satisfies certain prerequisites, request that the Office of Interconnection dispatch generation in order to maintain local reliability (See Operating Agreement of PJM Interconnection, LLC, (PJM OA) section 6.3). http://www.pjm.com/documents/agreements.html.

[8] See PJM OA, sections 6.4.1. – 6.5.

[9] *i.e.,* load pocket. PJM OA sections 6A – 6A.3 describes PJM's scarcity mechanisms.

[10] See Manual M-18, PJM Capacity Market, at http://www.pjm.com/contributions/pjm-manuals/manuals.html.

[11] See ISO-NE Transmission, Markets & Services Tariff (ISO Tariff), sections III.6.2 and III.A.2.

[12] Id. sections III.9.2.3 and III.12.2. http://www.iso-ne.com/regulatory/tariff/index.html.

[13] See http://www.iso-ne.com/trans/rsp/index.html.

[14] See, e.g., http://www.sfgov.org/site/pppcatf_page.asp?id=18364 www.indiabasin.org/Action_Alert_Potrero.pdf

http://66.35.240.8/cgi-bin/article/article?f=/c/a/2007/10/23/EDVVSU8BI.DTL

http://www.californiachronicle.com/articles/viewArticle.asp?articleID=38469

It is interesting to note that in building the latter project, the City of San Francisco hopes to force the older, dirtier Potrero units out of the market.

[15] Chao et al. (2005) pp. 58-59.

[16] Lave et al. (2004) pp. 17-18.

[17] For a summary of protests, see CPUC Decision 04-08-046, at http://docs.cpuc.ca.gov/published/FINAL_DECISION/39122.htm.

[18] Id., p. 56.

[19] See, e.g., Brennan (2006), Bushnell (1999), Calviou et al. (2004), Joskow and Tirole, (2005), and Leautier (2001).

[20] Chao et al. (2005), p. 52.

[21] Joskow and Tirole (2003), p. 56.

[22] Brennan (2006), p. 43.

[23] Chao et al. (2005), p. 52.

[24] Calviou et al. (2004), p. 9.

[25] Pratt (2003), p. 69.

[26] Calviou et al. (2004) pp. 8-9.

[27] Lave et al. (2004), p. 17.

[28] See, e.g., Blumsack et al. (2006), pp. 18-19.

[29] More generally, the utility will choose between generation and transmission additions to meet peak-load growth in load pockets.

[30] Of course, the utility's building a new generator opens up its rate base to revision. In order not to provide an additional disincentive to building, the regulator should evaluate only the rate change induced by the new plant. .

[31] For sake of simplicity, assume the new generator has the same marginal cost as generator A.

[32] More generally, the RTO would compute FTR revenue in the load pocket based on a hypothetical dispatch assuming generation from A were the marginal load-pocket generation source.

[33] In the case of California, the CPUC has assumed this responsibility.

References

Averch, H. and L. Johnson (1962), "Behavior of the Firm Under Regulatory Constraint," American Economic Review, Volume 52, 1052-69.

Baldick, R. and E. Kahn (1993), "Network Costs and the Regulation of Wholesale Competition in Electric Power," Journal of Regulatory Economics, Volume 5 367-384.

Barmack, M., P. Griffes, E. Kahn, and S. Oren (2003), "Performance Incentives for Transmission," The Electricity Journal, Volume 16, No. 3, 9-22.

Blumsack, S., J. Apt, and L. Lave (2006), "Lessons from the Failure of U.S. Electricity Restructuring," The Electricity Journal, Volume 19, No. 2. 15-32.

Brennan, T. (2006), "Alleged Transmission Inadequacy: Is Restructuring the Cure or the Cause?" The Electricity Journal, Volume 19, No. 4, 42-51.

Bushnell, J. (1999), "Transmission Rights and Market Power," The Electricity Journal, Volume 12, No. 8, 77-85.

Calviou, M., P. Kleindorfer, and M. Paravalos (2004), "Creating Value through Transmission in an Era of RTOs," prepared for the conference, "Electricity Transmission in Deregulated Markets," Carnegie-Mellon University, December 15-16, 2004.

Chao, H., S. Oren, and R. Wilson (2005), "Restructured Electricity Markets: Reevaluation of Vertical Integration and Unbundling," EPRI Technical Paper, July 2005.

Joskow, P. and J. Tirole (2003), "Merchant Transmission Investment," mimeo, MIT and IDEI.

Joskow, P. and J. Tirole (2005), "Merchant Transmission Investment," The Journal of Industrial Economics, Volume 53, No. 2, 233-264.

Keller, K. and J. Wild (2004), "Long-Term Investment in Electricity: A Trade-Off Between Co-ordination and Competition?" Utilities Policy, Volume 12, 243-251.

Lave, L., J. Apt, and S. Blumsack (2004), "Rethinking Electricity Deregulation," The Electricity Journal, Volume 17, No. 8, 11-26.

Leautier, T.O. (2001), "Transmission Constraints and Imperfect Markets for Power," Journal of Regulatory Economics, Volume 19, No. 1, 27-54.

Pratt, C. (2003), "Getting the Transmission Planning Rules Right for Competitive Markets," The Electricity Journal, Volume 16, No. 7, 65-73.