

MW Gamble: The Missing Market for Capacity

Timely investment in economically warranted capacity is as necessary for long-run efficiency as marginal-cost allocation of existing capacity is for short-run efficiency, yet little attention is being given to capacity planning. If an efficient energy market gives rise to an inefficient capacity market, utilities may become the investors of last resort.

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Whatever their other differences may be, advocates of bilateral contracts and mandatory pools have invariably favored the expansion of short-term energy exchanges, disagreeing mainly on whether they should arrive by regulatory order or by evolution. The market will equilibrate, they say, at a "transparent" price that allocates production efficiently, presents consumers with meaningful signals of scarcity, and facilitates the formation of financial contracts to assign risk.¹ Both sides also agree that high energy prices will induce investors to build new plants when it is effi-

cient to do so, as happens in any well-functioning market.

... [B]ecause of the visible spot market, the value of availability becomes explicit—it is the spot price of electricity less the short-run operating cost of the plant. Managers can make decisions about how much it is worth investing to make the plant available, and many decisions can be decentralized. A bid price pool ... induces economic dispatch of the entire system. It also offers the right marginal incentives to build, to maintain, to run, and to close plant.²

Expanded energy markets will "commodify" electric energy, but in important ways it will continue

to be a unique commodity. Energy is a service that is inseparable from the capacity that produces it. Efficiently constructed supplies of firm, full-requirements power contain energy and capacity contracts (including ownership of generators) of various lengths. If users can resource themselves with transparently priced energy from a power exchange, capacity becomes a "common pool" resource that will be inefficiently used and insufficiently built.³ The exchange will allocate existing production efficiently, while misallocating investments in new generation by attenuating capacity markets. Economists will get their wish for an energy market purged of short-term inefficiencies, but they (and consumers) will pay for it with long-term inefficiencies in capacity investment.

Competitors in any market succeed by assessing future opportunities and acting on them now. In electricity, however, competitors have oddly asymmetric expectations. Literally hundreds of marketers are actively soliciting consumers, hoping to profit both from the growth of consumer choice and the growth of the entire market as power prices fall. On the production side, market growth (coupled with nuclear problems in some areas) is eliminating the generation glut of the past two decades, at least for peaking capacity. Marketers already transact a substantial fraction of wholesale power trades and have eagerly begun accumulating retail commitments before markets legally open.⁴ By contrast, as of June 1997, generation entrepreneurs had *proposed* only

10,000 MW of "merchant plants" to sell into these markets.⁵ Few such plants have been built, and many have yet to obtain financing. In the unlikely event that all are completed over the next several years, these efficient plants will produce slightly over 1 percent of national peak demand. Wary investors in merchant plants may be waiting to see how mar-

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kets unfold, but marketers are making substantial commitments under the same uncertainty. In any case, the uncertainty is probably over details. Almost everyone anticipates that in most regions energy exchanges will determine prices for a commodity that already trades on a smaller scale, and that markets for energy derivatives will expand as they have in gas.

The reluctance to commit to generation in anticipation of markets may instead indicate that we have not adequately thought through the consequences of the institutions we are putting in place. If

there are no payments for capacity, users will treat it as a free good and investors will view it as an unprofitable one.

It has long been known that efficiently designed interruptible rates contain only energy charges. Expanded energy exchanges do not alter the fundamental economics of the industry, but their coming has somehow engendered a belief that efficient rates for firm power now have the same design. California's coming Power Exchange will determine only unbundled energy prices, with capital and related costs folded into regulated retail rates almost as before.⁶ Retail wheeling customers will be able to resource themselves entirely with exchange energy (or through bilateral contracts), leaving open the question of how nonutilities will amortize their capacity. The traditional regulated utility was a far from perfect institution, but it was one that in principle could build new plants in the right amounts and at the right times.

I. Transparency and Short-Run Efficiency

A perfectly competitive market in short-run equilibrium generates the economically efficient extent of exchange and the efficient assignment of production. The efficiency stems from the unique market-clearing price that prevails when information flows quickly, a homogeneous commodity is traded, and transactions are otherwise costless. A transparent equilibrium price attracts bids from all producers who can earn short-run profits by selling at it, and thereby ensures that the mar-

ket quantity will be produced at the lowest possible avoided cost. Likewise, each buyer that values the good at or above the equilibrium price will obtain the quantity it desires. If uncertainty exists, a transparent price facilitates the construction of hedge instruments to reallocate risks efficiently. The sheer perfection of this equilibrium has one easy consequence: any deviation entails inefficiency. In neoclassical economics, deviant markets have "imperfections," to be excised by corrective government policy or by the design of exchange mechanisms that can attain more perfect equilibria.

Two generic imperfections dominate economic thought on short-term energy markets. First, a producer (or a colluding group) may be able to profit by withholding output that would have been sold in a more perfectly competitive market. There is some evidence that producers in the British energy pool are successful at this activity, but its relevance for proposed energy exchanges and utility mergers in the U.S. is not clear.⁷ Concerns about inefficiency have some theoretical validity, but the cost to economic welfare of inefficient energy exchanges remains unestimated.⁸ Second, if a market does not price transparently individuals can use non-public information to manipulate transactions and prices in ways that destroy efficiency.⁹ Advocates of mandatory pooling believe that bilateral contract markets will contain "inefficiencies and unnecessary complexities that diversified, sophisticated players will be able to exploit at the expense of competitors and consumers gener-

ally."¹⁰ There are also no available estimates of these efficiency losses. The benefits of an energy exchange are clear: more price information is surely better than less, a kWh of energy is a transparently defined commodity, and an exchange lessens the likelihood of monopolistic behavior or informational manipulation. The potential losses from relying on an exchange seldom get equal time.



II. Inefficiency, Missing Markets, and Empty Cores

An energy exchange produces a time-varying market-clearing price that leaves no frustrated sellers unable to find buyers, and vice versa. Because there are no shortages or surpluses (and system operators are responsible for reliability), users can dependably resource themselves with firm power on the exchange. Producers only sell those kWh whose variable costs are below the market price, while depending on the margin between them for recoupment of their capital (plant) costs over the years. Consumers get energy and firmness at the marginal

cost of energy alone. Energy-based "contracts for differences" and related derivatives can hedge only energy prices; only incidentally do they make up for shortfalls in capital recovery.

Investors will only finance a new plant if expected revenue over its life span, discounted for risk and the cost of funds, will cover both operating and capital expenses. Plants in existence prior to the exchange will operate as long as price exceeds their avoidable costs because the expense sunk in building them is unrecoverable. Because firm energy is always available at the exchange price, a user and an investor in a new plant will only negotiate for capacity payments if they expect high energy prices to persist for a long time. The industry's pattern of investment will be inefficient because, if users can always fully resource themselves with exchange energy, there is a "missing market" for capacity.¹¹ Exchange prices will efficiently produce and allocate energy from plants in existence, but only by accident will efficient amounts of new capacity be built at times when it is efficient to do so.¹²

On the supply side, assume that generation technology is unchanging. Even if investors are good forecasters and demand is seasonally invariant, exchange prices will fluctuate. Price can only be constant for the long term if each generator can recover operating cost, a levelized part of its fixed cost, and some profit if it is a more efficient producer. Since this price probably exceeds short-run marginal cost of at least some generators, each could increase its

profits if it alone produced more power. If all (or enough) of these generators increase output, however, market price will drop below breakeven. This market has an "empty core" and is unable to sustain a long-run constant-price competitive equilibrium.¹³ (The core is non-empty if no subset of producers can profit by changing its output after the market has attained equilibrium.)

As plants depreciate, investors come to understand the market's instability. They delay new projects until high prices reassure them that they are likely to recover a competitive return on their funds over the near future. The dynamics will vary with the details, but the market will display unstable prices and chaotic investment patterns even if in the long run investors in generation earn competitive returns on average. Because the exchange dispatches efficiently, at any moment its energy price will still equal short-run marginal cost. The risks of an empty core market stem from uncertainty about competitor responses rather than more easily insurable phenomena such as fuel prices, and will be reflected in a higher cost of capital to the industry.

In the energy-only regime, capacity becomes the equivalent of a "common property" resource. Standard examples of common property are facilities (highways, parks) that become overutilized because there is no charge for access to the "services" (transportation, recreation) they facilitate.¹⁴ End-users who can avoid paying for capacity can resource themselves firmly for the marginal cost

of producing energy in what plants are available. An investor in capacity creates value by raising the amount of energy potentially available to the market, but receives only the uncertain margin between energy price and marginal cost. A transparent market for energy aggravates the effects of a missing market for capacity.¹⁵

A subset of users that contracts with one or more suppliers for



dedicated plants can benefit from the transaction, but some of the benefits of their commitments will be captured by non-parties to the contract.¹⁶

Users who contract for capacity (and the associated energy) can cap their rates at the cost of energy from their plants plus levelized capacity charges that they have no choice about paying. If these plants have unused capacity when exchange prices are high, they can sell the unneeded energy on it, benefiting because they can credit the margins they make on the exchange against their capacity obligations. The subset's capacity investment,

however, also benefits buyers on the exchange who have not committed to pay for it because the addition to supply lowers the energy price they must pay. The existence of the exchange ensures that capacity will be underbuilt because the value it creates is captured by both those who pay it off and those who do not. In principle, the entire buyer population (including those who have yet to arrive or be born) could arrange an enforceable contract to pay off beneficial capacity, but the benefits of extortion by holdouts would render the negotiation intolerably costly.¹⁷

Government and regulation reduce transactions costs by coercion. If for some reason an energy exchange must exist, taxes earmarked for capacity additions could in principle bring the efficient amount of new plant on line, like gasoline taxes ease the common pool problem of highways. Cost-of-service regulators implemented an analogous scheme to induce utilities to resource themselves for reliable energy deliveries. Regulation lowered investment risk by binding ratepayers to a single server and giving them no choice but to pay off both plant and operating costs, even in transitory situations of excess capacity. Rates (sometimes explicitly in two parts) fluctuated with operating costs, but had predictable terms for capital recovery. In effect, the utility was obligated to sell ratepayers a stream of call options whose strike price was its long-run cost of service. The options were contingent claims on an efficient mix of energy and capacity, regulated to be priced as if

it were in a competitive market. The near-absence of spot markets (plus regulatory oversight of prudence) forced the utility to cover the options by holding real assets. Its ability to invest efficiently depended on its ability to refuse customers the alternative of taking only energy, save for interruptible service that made no marginal claims on capacity. However imperfect regulation was, the problems it had to cope with will not vanish with the coming of markets.

III. What's Different about Electricity?

To determine the economic importance of a missing market for capacity, begin with a hypothetical unique good whose sole purchaser deals with a single producer. Assume the producer must invest heavily in a one-of-a-kind technology that has a salvage value of zero and cannot produce anything else. With no market for either the output or the plant, a transaction that benefits buyer and seller only occurs if the buyer commits to cover both the production and plant costs. If their contract is not clear and enforceable, the buyer (particularly if this is not a repeated transaction) can gain by acting opportunistically, staging a "holdup" and refusing to pay off the plant while offering the seller a small margin over production cost for the good.¹⁸ The buyer is now also dependent on the seller, who might insist on more than the contract price because the buyer has no other supplier and needs the good today. The richer the alternatives available to the parties in the market,

the smaller the possibilities for a holdup.¹⁹

Next assume that production of the unique good requires that the seller modify a commonly available machine in an inexpensive and reversible way. The buyer can no longer hold up the seller for the full cost of the machine because the seller can unmodify it cheaply and subsequently produce goods desired by other buyers. Because the capital is not as transaction-specific as in the prior example, a seller who faces com-

To learn the importance of a missing capacity market, begin with a hypothetical good with one buyer and one seller.

petition will be unable to extract a commitment from the buyer to pay off the full value of the machine at the outset.²⁰ The seller will also be unable to hold up the buyer for much after production begins because other producers can modify their machines like the first one did. A thicker market lowers both the cost of transacting (finding a trading partner, writing a contract, etc.) and the expected loss from misfortune, e.g. if the buyer goes bankrupt before the job is completed.

Now introduce competition among suppliers serving an or-

ganized market. They build plants to produce a standardized good, each unit of which sells for equilibrium price in a competitive market. If plants can be cheaply refurbished to produce other goods or relocated to serve other markets (the costs may include those of finding a buyer), the irretrievable losses ("sunk costs") of a decision to enter this business are minimal. The industry's plant, while durable, is a variable input that will quickly find a new use if its returns fall by enough to cover the small cost of redeploying it. Because worst-case costs of exit are low, investors in such plants require only a small risk premium.²¹ Investments that carry cheaply reversible commitments are more responsive to forces in the financial markets and in the markets for their outputs than investments in industries that require idiosyncratic capital. In addition to the capital value of income from a plant, there is option value in delaying investment until some uncertainties are resolved.²²

The effects of sunk cost vary little with the structure of the market for a plant's output. Whether there are few sellers or many, sunk costs of a given investment pose the same risk problem for each of them. If oligopoly and entry barriers lead to higher energy exchange prices, most sellers will probably earn higher average profits than they would in a more competitive market. More reliable profitability might increase an oligopolist's incentive to build new plants, but this only happens because the market fails to achieve short-run competitive efficiency.²³

Even collusion will not necessarily produce efficient patterns of new investment.²⁴ If the economic size of an industry's plants falls, the problem still does not go away. Plants of any size with substantial sunk cost proportions will require the same risk premiums. If technological change reduces scale economies in generation, more structurally competitive markets for energy become possible. More perfect competition in the market for output, however, need not imply a more efficient pattern of industry investment.

Although no estimates of the sunk components of generation and transmission are available, redeploying them is probably not easy.²⁵ Both are: (1) useless for producing any other goods, (2) long-lived, (3) costly to alter (repowering or fuel switching), and (4) costly to salvage and relocate. In today's industry, a given generator must operate in a regional market whose boundaries are largely set by constraints on system operation and transmission capacity. Manufacturing is a common but weak analogy to electricity. Many types of manufacturing capital are so cheap to redeploy (relative to their value) that they trade in large markets, as power plants and transmission do not. Buildings are fixed in place but so reusable that any city contains numerous brokers who facilitate their reallocation by sale and lease. New and used tools, computers, furniture, and vehicles are widely sold and leased.²⁶ Some industry-specific equipment such as restaurant supplies can be cheaply relocated within its market. Other standardized ex-

change-traded commodities are also questionable analogies. Most farmers can produce many different crops on their land, need not commit to grow a given product for over a year, and can easily increase or decrease the amount of land they use.²⁷ Organized markets can and do support hedges for resources that are flexible over short horizons. Whether markets can sustain the contractual depth to hedge electricity generation investments remains uncertain.

If investment is going to take care of itself in the future, the paucity of merchant plants gives pause for thought.

IV. Merchant Plants and the Missing Market

Many expect that generation investment will soon be dominated by merchant plants that will sell energy into exchanges and recover their capital as the difference between energy price and operating cost. Today, short-term energy markets are expanding, law and regulation having eased independent producers' access to them, and within months retail wheeling will be a reality on both coasts. Nevertheless, at most fewer than five small merchant plants are in operation.

If merchanting is the future, some owners of existing plants ought to be renegotiating contracts that commit buyers to pay off capacity in order to try their luck at market-rate energy sales. In this industry as elsewhere, press releases tell little about reality. Cambridge Economic Research Associates' June 1997 list of "potential" merchant plants itemized 30 projects with approximately 12,000 MW total capacity. Of these, seven plants that accounted for 586 MW were operating, five of them with 100 percent of their output under contract.²⁸ (Why these are called merchant plants is unclear.) Every non-operating plant on the list is "planned" or "proposed."²⁹

If investment is going to take care of itself in the future, the paucity of merchant plants gives pause for thought. A market worth tens of billions is opening and growing, and merchant plant builders have access to technologies that are competitive with all but a fraction of the industry's existing plant.³⁰ The reluctance to invest is understandable if further quantum improvements in technology are near. In all likelihood, however, it will be several years before the newer plants become marginal in most regions, and over those years the geographic opportunities to sell their power will expand. Gas-fired plants can be built so quickly that they are reasonable bets in regions with shortages, and half of CERA's potential megawattage is in New England, which is prematurely losing much of its nuclear capacity.³¹ In a further anomaly, the Midwest and Southeast have the

lowest regional capacity margins, but the 24 states in those areas contain only two of CERA's potential merchant plants.³² However efficient the new technology, it is still embodied in durable, site-specific plants that can only be used in this industry.

The designers of the United Kingdom's pool foresaw the potential shortfall of new investment if capital recovery depended on marginal cost energy prices alone. They specified an energy price adder, to be triggered when available capacity bumped against regulator-defined constraints. In practice the adder operates sporadically and does not create a large or dependable enough margin to induce merchant investments. Almost all new plants in the U.K. are built with purchase commitments that increase the likelihood of capital recovery.³³ In practice, the adder encourages strategic withholding of capacity in order to qualify for it.³⁴

At first glance, an adder unobtrusively encourages the construction of new plants whose details are determined in the market, and its low impact on actual investment might be improved by larger and more stable payments. The U.K. adder is set by the value of lost load, a hard-to-estimate figure which varies with the system's capacity margin. Dependable payments for investment, however, must be independent of that margin's current size. If regulators instead base the amount on the cost of new plants, the industry returns to the same world it was trying to leave, albeit one with a few extra sellers and time-

varying energy prices. Worse yet, since this cost varies with fuel type, plant location, and forecasts, the industry could regress to integrated resource planning. Lighter-handed regulation is also not without drawbacks. In Chile, mandatory payments are set at the marginal cost of new peaking capacity, adjusted for actual margins.³⁵ Such a rule might encourage investment in inefficiently small plants that carry a higher



probability of recoupment, but any alternative to this regulation can probably also be gamed.

V. Conclusions

Alfred Kahn has noted that incumbent producers facing deregulation invariably assert that markets will create perverse investment incentives, but they disagree to extremes on the nature of the perversity. Some believe deregulation will so increase risk that investment in their industry will cease, while others expect newcomers to self-destructively build plants in such numbers that everyone takes losses.³⁶ Electricity

experts both inside and outside of the industry, by contrast, usually dismiss capital investment as a de-regulatory issue, citing their casual observations of manufacturing examples. Suppliers of many other goods survive on product sales, they say, and build plants at reasonable times without capacity commitments by buyers. Electricity, however, differs from manufacturing in enough important ways that a second glance is probably in order.

Timely investment in economically warranted capacity is as necessary for long-run efficiency as the marginal-cost allocation of existing capacity is for short-run efficiency. The division of professional labor in restructuring, however, is wildly at odds with this symmetry. Numerous specialists are laboring to squeeze every possible inefficiency out of short-term energy exchanges before they begin to operate, but hardly anyone is thinking about future investment in the capital that will produce and move this energy. The allocation of skills is doubly paradoxical. If plants are in place and financial and operating responsibilities have been determined, we can probably count on market actors to construct workable short-term energy exchanges on their own. Regulators allowed interutility exchanges of bulk power to grow into today's market with attention that was small in comparison to their oversight of capacity investments.

It is not enough to note that scale economies in generation are vanishing and then conclude that, because efficient plants are

smaller, investment in them will take care of itself. Scale economies are but distantly related to efficient patterns of investment in new plants. If the sunk costs of a plant of any size (as distinguished from its fixed costs) are high enough, investments will be inefficiently timed unless there is a market for capacity commitments.

Numerous utilities are vocal advocates of energy exchanges, but with the market so close at hand many of them are also seeking new and durable capacity commitments. In 1996, capacity solicitations by utilities increased substantially over those of prior years. They also chose to buy power under longer contracts rather than waiting for exchanges to open and resourcing themselves with short-term energy.³⁷ Instead of counting on energy from merchant plants, utilities are giving themselves new long-term obligations, presumably with regulatory approval in most cases. The utilities' choices may be both prudent and strategic. If an efficient energy market gives rise to an inefficient capacity market, utilities may become the investors of last resort, almost as good as being the suppliers of last resort that they were before all this began. ■

Endnotes:

1. For example, as outlined in Don Garber, William W. Hogan, and Larry Ruff, *An Efficient Electricity Market: Using a Pool to Support Real Competition*, ELEC. J., Sept. 1994, at 48.
2. SALLY HUNT AND GRAHAM SHUTTLEWORTH, *COMPETITION AND CHOICE IN ELECTRICITY* 70 (Wiley 1996).
3. The reliability consequences of an analogous externality are discussed in Adam Jaffe and Frank Felder, *Should*

Electricity Markets Have a Capacity Requirement? If So, How Should It Be Priced? ELEC. J., Dec. 1996, at 52. This article supplements their work with an investigation of long-term investment. It also responds to Shuttleworth's criticism of their work in *Getting Markets to Clear*, ELEC. J., April 1997 (Letters to the Editor), at 2.

4. It is difficult to characterize the size of marketer commitments, which are also more liquid than investments in fixed, durable plants. In the first quarter of 1997, marketers transacted 167.7 gigawatt-hours of wholesale energy, while total retail sales were 995.5



gWh. The former figure can mislead because it includes both sales to utilities and resales between marketers.

Top 20 Power Marketer Transactions by Sales, First Quarter, 1997, ELEC. WORLD, July 1997, at 8; ENERGY INFO. ADMIN., ELEC. POWER MONTHLY, July 1997.

5. Cambridge Energy Research Associates (CERA), *North American Electric Power Watch*, Sum. 1997, at 15.

6. Fed. Energy Reg. Comm'n, *Order Conditionally Authorizing Establishment of an Independent System Operator and Power Exchange*, 77 FERC ¶ 61,204 (Nov. 26, 1996) (Docket Nos. EC96-19-000 and ER96-1663-000).

7. See, e.g. Richard J. Green and David M. Newbery, *Competition in the British Electricity Spot Market*, 100 J. POLIT. ECON. 929 (1992); and Robert J. Michaels, *Market Power in Electric Util-*

ity Mergers: Access, Energy, and the Guidelines, 17 ENERGY LAW J. 401 (1996).

8. Estimates of lost efficiency due to unregulated monopoly in the American economy seldom exceed one percent of Gross Domestic Product. The literature begins with Arnold C. Harberger, *Monopoly and Resource Allocation*, AM. ECON. REV., May 1954, at 77.

9. The efficient degree of transparency is also not theoretically clear, but if there are competing exchange institutions the market may determine that degree. See J. Harold Mulherin, *Market Transparency: Pros, Cons, and Property Rights*, 5 J. APPLIED CORP. FIN. 94 (Win. 1993).

10. Larry E. Ruff, *An Efficient, Competitive Electric Industry: Can the Vision Become Reality?*, ELEC. J., Jan./Feb. 1997, at 8, 9.

11. David M. Newbery, *Missing Markets: Consequences and Remedies*, in THE ECONOMICS OF MISSING MARKETS, INFORMATION, AND GAMES 211 (Frank Hahn, ed., Clarendon Press at Oxford, 1989).

12. The timing of investment matters, even if on average total capacity is constant, because energy is not storable. If my demand curve does not vary seasonally, I prefer facing a constant price and consuming at a constant rate. Even if fluctuating prices average out to the same constant, the pleasure of keeping the lights on all day when price is low does not compensate for the unpleasantness of darkness or frostbite when it is high.

13. LESTER G. TELSER, *ECONOMIC THEORY AND THE CORE* (Univ. of Chicago Press, 1978); George Bittlingmayer, *Decreasing Average Cost and Competition: A New Look at the Addyston Pipe Case*, 25 J. LAW AND ECON. 201 (1982).

14. See, e.g. STEVEN LANDSBURG, *PRICE THEORY AND APPLICATIONS*, ch. 14 (3rd ed., Dryden Press, 1994).

15. Besides the timing of investment, the uncertainty of recovery may also lead investors to build capacity that is less durable than economically warranted.

16. In the lyrical language of economics, the contracting parties create a

beneficial externality that they cannot internalize.

17. This is not the "regulatory compact" of the stranded investment debate. What drives the holdout problem is the existence of an overhang of capacity that benefits payers and nonpayers alike. If the industry is brand new, both entrepreneurs and customers can gain (relative to no power at all) from contracts that cover both capacity and energy.

18. Vertical integration of the supplier and buyer under a common management is a commonly encountered solution to holdup problems. See Benjamin Klein, Robert Crawford, and Armen Alchian, *Vertical Integration, Appropriable Rents, and the Competitive Contracting Process*, 21 J. LAW AND ECON. 297 (1978).

19. OLIVER WILLIAMSON, *ECONOMIC ORGANIZATION* chs. 6 and 7 (New York Univ. Press, 1986).

20. Contract terms vary with the specificity of capital. See, e.g. Victor Goldberg and John Erickson, *Quantity and Price Adjustment in Long-Term Contracts: The Case of Petroleum Coke*, 30 J. LAW AND ECON. 369 (Oct. 1987), and Paul L. Joskow, *The Performance of Long-Term Contracts: Further Evidence from Coal Markets*, 21 RAND J. ECON. 251 (Sum. 1990).

21. The text presupposes that investors will diversify to minimize the risk associated with the expected returns on their holdings.

22. AVINASH K. DIXIT AND ROBERT S. PINDYCK, *INVESTMENT UNDER UNCERTAINTY* (Princeton Univ. Press, 1994).

23. Interdependence among sellers produces additional complications. Assume that there are three potential builders of a new plant in a market that can only accommodate one. In addition to any other risk, seller A now faces the risk that seller B will also build a plant and both will be ruined. If potential entrants increase, the probability that at least one will actually enter can sometimes decrease. Increases in the apparent competitiveness of the capacity market can yield less efficient patterns of actual investment. See Lionel Kalish, Henry J. Cas-

sidy, and Jerry Hartzog, *Potential Competition: The Probability of Entry with Mutually Aware Potential Entrants*, 44 SO. ECON. J. 542 (1978).

24. Where a large fraction of a firm's capital is highly specific, collusion can be economically efficient under limited circumstances. See Bittlingmayer, *supra*, note 13, and LESTER G. TELSER, *A THEORY OF EFFICIENT COOPERATION AND COMPETITION* ch. 2 (Cambridge Univ. Press, 1987).

25. Competition will encourage the development of plants with smaller sunk components that can more quickly en-



ter profitable markets and exit unprofitable ones. Suppliers of generators to nations with reputations for insolvency and debt repudiation have mounted them on barges for easy delivery and departure.

26. See, e.g., Stephen D. Oliner, *New Evidence on the Retirement and Depreciation of Machine Tools*, 34 ECON. INQUIRY 57 (1996).

27. Where land must be made specific for a certain crop, e.g. rice or cranberries, farmers are more likely to sell their outputs under long-term contract.

28. CERA, *supra* note 5, at 14-16. One of the two uncommitted operating plants is a 276 MW West Virginia coal-fired facility purchased by Allegheny Power subsidiary AYP Energy from Duquesne Light in October 1996. At

the time of purchase, AYP did not mention selling the plant's power into the PJM Pool. Instead the company announced that it had negotiated and continued to seek long-term and short-term sales contracts. *AYP Energy Acquires 276 MW*, www.aypenergy.com/Pages/pr01.htm.

29. CERA calls Calpine's 240 MW cogenerator in Pasadena, Texas "planned for 1997," and the builder claims operation will begin in July 1998. Forty-six percent of this plant's output is under contract. *Id.* at 15; *Calpine Sees Second Texas Merchant Plant*, ELEC. DAILY, Aug. 26, 1997, at 1.

30. *New Coal and Gas Plants Cost Down 20-40 Percent in Past 5 Years*, ELEC. UTIL. WEEK, June 3, 1996, at 5.

31. *Conn. to Get New Power Plant by Next Summer*, RESTRUCTURING TODAY, June 27, 1997, at 3; *Duke, UI and Siemens Join in Merchant Venture in N.E.*, ELEC. DAILY, June 30, 1997, at 3; *U.S. Generating Planning a 400 MW Merchant Plant in Massachusetts*, ELEC. UTIL. WEEK, June 24, 1996; CERA, *supra* note 5, at 15.

32. CERA, *supra* note 5, at 14.

33. Robert J. Michaels, *Wholesale Pooling: The Monopolist's New Clothes*, ELEC. J., Dec. 1994, at 70.

34. Larry E. Ruff, *Competitive Electricity Markets: The Theory and Its Application*, in FROM REGULATION TO COMPETITION: NEW FRONTIERS IN ELECTRICITY MARKETS 11 (Michael Einhorn, ed., Kluwer, 1994).

35. R. Peter Lalor and Hernan Garcia, *Reshaping Power Markets: Lessons from South America*, ELEC. J., March 1996, at 67. Prior to this, Lalor argued against this view of capacity commitment (as expressed in my articles) by stating that "[t]he absence of full capacity payment commitments in [an energy pool] is the shield of the ratepayer against uneconomic utility investments." R. Peter Lalor, *Poolco, for Real Competition*, ELEC. J., June 1995, at 82 (Letters to the Editor).

36. Alfred Kahn, remarks before Energy Daily Conference on Stranded Investment, Washington, D.C., June 4, 1997.

37. CERA, *supra* note 5, at 14.