Electricity Markets and Energy Security: Friends or Foes?

Timothy J. Brennan

U.S. energy policy has taken center stage, driven by the growing threat of climate change and rising oil prices. Less prominent perhaps, but also important is the security of our electricity generation capacity. As consumers, we are regularly reminded to conserve energy by turning the thermostat down and buying compact fluorescent light bulbs, but such admonitions sidestep a larger issue.

Since the mid-1990s, the federal government and many of the states have attempted to transform a vertically integrated, top-to-bottom regulated electricity sector into one in which competition among independent energy suppliers determines the prices charged to local utilities and, eventually, commercial, industrial, and residential users.

The path has not been smooth. Its most prominent sinkhole was the implosion of the California electricity market from the fall of 2000 through the spring of 2001. In addition, much of the Northeast suffered a massive blackout in August 2003. At the residential level, customers have generally not taken advantage of opportunities to choose among residential suppliers. More recently, price controls imposed as part of the political bargain for opening markets have expired, and some customers now face rate increases of 50 percent or more.

These developments give rise to the question: to what extent is overall energy security affected by competition in the electricity sector? Letting the markets set prices should improve security, but competition has proven difficult to institute and may exacerbate some concerns, particularly reliability of supply. Opening electricity markets is easier said than done, but here we explore reasons for why this is so.

Different Meanings to Different People.

Even when restricted to electricity, the term "energy security" can take on a number of different dimensions.

THE SHORT TERM

From a short-run perspective—taking as given the productive capacity in place—energy security in electricity has two manifestations. One has to do with sheer availability: Will outages be short, rare, and localized, or long, frequent, and widespread? The other has to do with peaks in the price of electricity, assuming that it is available. Blackouts are harmful, but so are high energy prices, particularly for those with low incomes for whom utility bills constitute a significant fraction of their monthly spending.

Importantly, and unfortunately, mitigating one of these security interests can exacerbate the other. The cost of preventing blackouts is quite high. Because electricity cannot be stored, it must be produced when it is demanded. And energy demand is far from constant; it can hit very high peaks for short

periods of time. The generation capacity needed to meet that demand, then, is in service for only a small fraction of time, perhaps ½₀₀ of a year (a year = 8,760 hours), and maybe less. Recovering the costs of that capacity in such a short time makes that generation very expensive. If prices reflect costs—usually one of the benefits of adopting markets—making the system more reliable will increase insecurity arising from price fluctuations.

THE LONG TERM

In markets with growing demand, the viability of the electricity system depends on expansion of capacity to generate, transmit, and distribute electricity. Numerous political and policy factors come into play. Construction of power plants and transmission lines is often hampered by the NIMBY ("not in my back yard") effect, in that everyone wants electricity generated as long as they do not see it. Some recent controversies include the Cape Wind installation off Cape Cod in Massachusetts and proposals to build new transmission lines through wealthy "horse country" in northern Virginia.

A related problem affecting transmission is that a line needed to improve electricity delivery between generators in one state and customers in another may have to traverse other states in between. States along the path might resist having lines built, figuring that they are bearing costs and reaping none of the benefits. Recent federal legislation has given the secretary of energy the authority to order states to allow transmission construction, specifically to counteract this potential problem.

THE ENVIRONMENT

Environmental security plays a role in electricity for two reasons. First, most electricity in the United States (and much of it elsewhere) is produced by burning fossil fuels—primarily coal and natural gas—that emit carbon dioxide (CO_2) as a by-product. In 2005, fossil fuels burned to generate electricity produced 2,363 million metric tons of CO_2, about 40 percent of the U.S. total. Second, unlike automotive use of gasoline—the other major contributor to greenhouse gas emissions, producing about 32 percent in 2005—there are comparatively few electric power plants.

This makes the math much simpler: with so many fewer "actors" (hundreds of power plants versus millions of cars), it becomes easier to implement efficient and effective policies to control emissions, such as carbon taxes or permit trading, based on the quantities that polluters actually emit. Just as power plants were the initial participants in trading sulfur dioxide emissions permits, they are likely to be leading players in market-based policies to address CO_2 emissions. Increasing the role of markets in electricity overall is likely to improve the effectiveness of taxes or permits in providing incentives to limit emissions.

NATIONAL SECURITY

A final security dimension is threats from external enemies, most prominently terrorist threats to the public—either directly or to its infrastructure. The interstate transmission system is the part of the electricity sector where an attack would probably wreak the most havoc. Because the system is so interconnected, it would remain regulated even if wholesale and retail markets for electricity became open. That continuing regulation suggests that the transmission sector is not affected by opening other markets, and so national security is not directly affected. To the extent that expanding competition among generators increases their propensity to sell to distant users, however, the transmission grid becomes an ever more crucial component of the electricity infrastructure.

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Global Energy and U.S. Electricity

The main global energy security concern involves oil. In the short term, concerns about oil arise from the fact that a large share of the supply comes from parts of the world that are subject to considerable political instability. Moreover, this supply is concentrated in a few countries that, in the past, have been

able to "cartelize" the supply of oil as well as subject world oil markets to shocks from wars and boycotts. More important and certain is global growth in demand, as China and India race toward the developing world in terms of per-capita wealth and, as a result, much greater use of automobiles and other goods and services that rely on petroleum.

The relationship between electricity and global energy security would be more significant if oil were an important part of electricity generation. At least in the United States, though, this effect is likely to be minor. When oil was less expensive, it generated a significant fraction of electricity in the United States, as much as 17 percent as recently as the 1970s. By 2005, however only about 3 percent of U.S. electricity was generated by oil.

A less direct but potentially significant relationship between oil markets and electricity use arises because of substitutions in other markets, particularly involving heating. For example, if the price of oil goes up, more consumers, offices, or factories might switch to electricity for heating and other power uses. This would have a significant effect on the price of electricity because the marginal unit needed to supply electricity, particularly when demand is at its greatest, is generally a plant powered by natural gas.

Markets Generally Boost Security

Electricity is vulnerable to imbalances between supply and demand: too little supply relative to loads can cause outages and too much can cause failures in the grid.

In the short run, markets allow for efficient resource allocation. Absent significant market power or substantial nonmarket effects—both of which are important in electricity—competition among suppliers will result in prices approximating the marginal cost of producing a good. Buyers, as "end users" or "final consumers," decide how much to buy based on whether the price they have to pay is more or less than the item's worth. Ideally, these decentralized decisions lead to allocations where the marginal benefit to consumers of producing more of something is about the same as the marginal cost of that production. There is neither too little—measured by being able to produce benefits greater than those costs—nor too much—as when those marginal benefits are less than those costs.

When it comes to security, markets should help, not hurt. Opening markets to new competitors and, over time, to new entrepreneurs and innovators should result in redundancy. And a region or nation should be less vulnerable to disruptions if it is not depending on the facilities and services of a single monopoly provider. The Internet offers an excellent example: with packet switching and routing available over multiple backbone networks, removing one company's facilities should not bring the entire system down.

More directly, markets can actually help to provide security. Security of service, like any other product feature is one of the attributes that suppliers will offer in an open market, as long as the consumer's willingness to pay exceeds the cost of furnishing it. Security can be viewed in the same way, from the protection against physical invasion of buildings by burglars to the electronic invasion of data by hackers. Not every service will have the same level of reliability. Some cars will have more air bags or engines less likely to need repair than others; some buildings will have more elaborate security systems than others; some data sites will have more elaborate firewalls than others. But to the extent that markets are open to entrepreneurship and innovation, security need not be a matter of public policy.

The Central Security Issue: Reliability

The overarching energy security issue arising in electricity involves reliability of the grid. We all want our cars to start, our furnaces to come on, and our computers to boot up. With that noted, reliability is particularly acute in this context because as a commodity, electricity has three distinct attributes:

First, it is crucial to the economy and to society at large. Virtually every sector on which we depend cannot function without electricity to power lighting, heating, cooling, computing, and communicating,

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along with all types of commercial and industrial equipment.

Second, because it cannot be stored, electricity is vulnerable to imbalances between supply and demand. Too little electricity relative to loads can cause outages; too much relative to loads can cause failures in the grid. Together, these require that supply equal demand virtually minute by minute. They also explain why it is so expensive to to meet extreme demand peaks. Electricity cannot be economically stored to get over a hump; it must be produced in real time.

This vulnerability becomes a general reliability problem only when combined with a third feature of the electricity sector—interconnection. The grid is interconnected to promote efficiency and reliability; more links increase the means by which energy can reach consumers. But unlike other interconnected services, such as telecommunications where routing traffic can be accomplished through switches, the high energy levels in electricity transmission preclude directing energy along particular pathways.

These three factors combine to create a situation in which reliability is, in economic terms, a critical "collective good." Failures of my car, furnace, or computer to start may be serious problems, but they are ones largely between me and the firms I choose to supply and repair those items. If my electricity supplier fails to meet my demand, it is not just my problem; everyone on the grid is blacked out as well.

Numerous factors make it difficult to assess the need for investment and policy to enhance reliability. One such example is deciding how much we should spend to ensure reliability. In the wake of the August 2003 blackout, some called for spending up to $60 billion on new transmission lines. On the other hand, DOE and others estimated the cost of this massive blackout at about $6 billion. If this is an accurate estimate, we might still need to avoid roughly one blackout of this magnitude every year or two to make such an investment worthwhile. Most fundamentally, the cost of a blackout is not unlimited and so does not warrant unlimited expense to eliminate any possibility of a power outage. Careful attention needs to be given to estimating the cost of blackouts because they differ in location, duration, scope, and advance notice, and in the effect of expenditures on reducing the likelihood of blackouts along those various dimensions.

The nature of reliability as a collective good implies some degree of central control. The Energy Policy Act of 2005 authorized the Federal Energy Regulatory Commission to delegate control over reliability to "electricity reliability organizations" that would certify, in this case, the North American Reliability Council.

In considering the effect of electricity markets on security, the key question is the degree to which such centralized control is consistent with the decentralized decision processes essential to entrepreneurial competition. At one extreme, we might need no more central planning than air-traffic controllers exercise in the airline industry. Air space can be policed to avoid collisions without precluding competition among carriers to transport passengers and freight. At the other extreme, a central controller may need to control dispatch of generators in the short run and investment in generation over the long run to ensure reliability as well as efficiency. If so, there may be little left over to make competition worthwhile, particularly if the restructuring necessary to ensure competition is itself costly. Looking through the lens of energy security reveals another perspective on the question of whether "markets have met their match" when it comes to electricity. ■