Electricity Competition at Work

The Link Between Competitive Electricity Markets, Job Creation, and Economic Growth

Report prepared for: COMPETE Coalition

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EXECUTIVE SUMMARY

Today, electricity is almost as basic a necessity as food and shelter. Electricity has fundamentally altered business and industry. The electric industry began over a century ago through competition between Thomas Edison and George Westinghouse. By the 1920s, the rapid consolidation of electric companies spurred by scale economies and decreasing costs led to an industry structure that replaced pure competition with government regulation designed to simulate the forces of competitive markets on participants.

Economic regulation of the electric utility industry changed little from the 1930s through the 1970s. Electric utilities continued to use scale economies, building ever-larger generating plants that produced power at ever-lower cost. But the energy market turmoil of the 1970s, beginning with the 1973 OPEC oil embargo, as well as the need to reduce air and water pollution, including from large coal-fired power plants, set in motion market forces that continue to influence the electric industry today.

The Energy Policy Act of 1992 laid the foundation for the competitive wholesale and retail electric markets that benefit consumers and businesses today. A number of states restructured their electric industries, establishing retail competition for generation, while distribution remained a monopoly service.

But electric industry restructuring slowed after the California energy crisis of 2000-01, which led to the bankruptcy of one of the largest electric utilities in the nation, and the near-bankruptcy of a second utility. Although multiple factors contributed to the California crisis, many politicians and state regulators used California as an excuse to halt electric restructuring in their own states. Yet, other states, such as Texas, Pennsylvania, Illinois, and Ohio, continued to embrace electric competition. That perseverance has paid off.

The Natural Gas Industry Shows the Way

The natural gas industry is perhaps the best example of the benefits of vibrant energy market competition. In the late 1960s, the conventional wisdom was that natural gas supplies would soon be exhausted. Wellhead natural gas prices were regulated and capped. Supplies began to diminish as production from existing wells declined. Growth in the natural gas industry came to a standstill because there was little economic incentive to undertake new, more costly exploration. Then, in 1978, Congress began to remove these price controls so as to establish a truly competitive market for natural gas. The impacts were amazing. Coupled with severing the connection between production, pipeline transportation, and local distribution, by the early 1990s the natural gas market was vibrant; the predicted shortages had turned into a gas "bubble."

More recently, the rapid development of shale gas over the last decade, made possible through technological innovations, has fundamentally altered the U.S. natural gas market. Shale gas production has boomed, creating thousands of new jobs and significantly lowering natural gas prices. The positive impacts of this abundant, domestic energy supply will be evident for many years to come. With ample supplies of low-cost shale gas, new, high-efficiency natural gas generating plants will be able to displace older, less-efficient coal-fired power plants, lowering electric prices, increasing reliability and reducing pollution.

The success of competition in the natural gas industry provides a blueprint for the electric industry. Wholesale and retail electric competition will provide industry and consumers with the lowest possible cost electricity, and help grow the economy because, when it comes to one of the most important and ubiquitous commodities in our economy, price matters.

Yet, despite the success of market competition in the natural gas industry, and in states that have embraced electric competition, other states (e.g., Michigan)—and some electric utilities—have continued to squelch competitive markets through policy mandates and improper subsidies, as well the adoption of onerous and disruptive tariff and business practices. However, whether it is claims of "energy security" that require in-state electric generation, bureaucratic pronouncements of technological "winners" and "losers," or attempts to manipulate competitive wholesale markets, these attempted "end-runs" around private sector investment decisions effectively short-circuit competitive electric markets and thereby inflict long-term economic harm. By artificially driving down market prices, states drive out legitimate competitive generators. As a result, any price reductions are temporary. Worse still is the long-term damage to markets as such policies increase financial risk—after all, investors don't know if the plant they finance will be forced out of business in the future by some other state policy action.

When policymakers tout the job-creating benefits of subsidized electric generation or policies that foreclose market competition, they either ignore or dismiss the job-killing impacts of higher electricity costs, or dismiss those higher costs. But regardless of the incremental impacts on a single customer, the cumulative impacts are real and significant, costing thousands of jobs.

Promoting Lower Prices and Market Innovation

Because competitive electric markets are the best way to keep prices as low as possible, such markets will also provide the greatest opportunity for economic growth and job creation. Five general policies can help.

1. <u>Actively promote wholesale and retail electric competition</u>. States that belong to transmission organizations like PJM can access competitively priced wholesale electricity, and benefit from improved system reliability. Competitive wholesale markets for energy and capacity provide clear market signals, and promote innovation and greater efficiency. Moreover, competitive markets also provide the best platform for other state policies, such as promoting clean energy sources and retail customer choice. Interconnecting clean energy sources can be more easily accommodated on larger, integrated power systems than at the local level. Allowing all customers unfettered access to competitive retail electric suppliers, and ensuring that local distribution utilities' "provider of last resort" roles are met using competitive procurement mechanisms, will provide all retail customers with the lowest possible rates and greatest variety of choices.

2. Create an environment that lets the market work and reduces investment uncertainty. All investors abhor uncertainty, because it increases their costs. For capital-intensive, long-lived investments like electric generating plants, providing a stable market environment in which the rules are clear is crucial. State policies that create artificial subsidies for a few generators or mandate uneconomic investments to upend competitive markets send flashing "Do Not Invest" signals to developers, by driving out real competitors and increasing uncertainty. Ultimately, such policies lead to higher long-term electric prices, thus harming the very customers the subsidies are supposed to benefit.

3. Do not allow monopoly electric utilities to thwart competitive markets. Monopolies are notoriously inefficient, because they have no incentive to improve productivity and reduce costs. Allowing monopoly utilities to thwart competition, whether by imposing unreasonable costs on customers who wish to shop from competitive electric suppliers or negotiate bilateral agreements with favored suppliers, needlessly increases costs for customers.

4. Avoid using artificial subsidies as an economic stimulus. Just as we don't build schools as a way of providing jobs for school bus drivers, electric generating plants should be built in response to market conditions, not political ones. Policies that mandate in-state development of subsidized generation on the promise of job creation will cause more jobs to be lost, as customers not only bear the cost of the subsidies themselves, but also pay more for their electricity in the long-run. Moreover, state subsidies are no guarantee of "permanent" new jobs, as Massachusetts discovered after providing Evergreen Solar with $43 million worth of subsidies, only to see that company move its operations to China one year later.

5. Combine policies that promote electric competition with broader economic policies that promote economic growth. By itself, electric competition cannot rescue a moribund economy. But combined with other policies, electric competition can be a catalyst for economic growth. The State of Texas not only offers the most advanced competitive electric market in the U.S., it offers an environment that encourages investment and job creation. That may explain why, according to the Federal Reserve Bank of Dallas, Texas created 37% of net new jobs in the U.S. between June 2009 and May 2011. Pennsylvania, another state with a vibrant competitive electric market, also ranked high in terms of job creation, was third, with 93,000 new jobs, in part to development of the Marcellus Shale natural gas reserves.

Like electrons, investment and economic growth follow the path of least resistance. And, although there may not be any economic "silver bullets" to create jobs overnight, competitive electric markets, and their ability to provide the lowest available cost over time for businesses and households, will be increasingly important to our economic future.

I. Introduction: Electricity's Importance to the U.S. Economy

In 1879, the City of San Francisco built and operated the first electric generating station, which was used to power the city's arc lamps.[1] In that same year, Thomas Edison developed the incandescent light bulb and invented a commercially viable lighting system. In 1882, Edison opened the first complete incandescent lighting system on Pearl Street in New York City, complete with a 560 kilowatt (kW) central generating station and distribution circuits that powered 400 lamps.

Although Edison was the first to develop the forerunner of today's electric system, it was George Westinghouse's development of an alternating current (AC) system in 1886 that allowed electricity to become such an important element in our lives, and a fundamental driver of today's economy. Because AC power could be transmitted economically much greater distances than Edison's direct current system, the cost of electricity decreased and its use by industry and households expanded. The "electrification" of the U.S. economy had begun, providing an early example of how competition, with investors, not customers, bearing the risks, led to innovation and benefited consumers.

Today, electricity has become almost as basic a necessity as food and shelter, something unimaginable a century ago. Electricity has also fundamentally transformed business and industry. Blast furnaces for making steel have been replaced by far more efficient electric arc furnaces. Refrigeration is the single most important contributor to the safety of the food we eat, and has made it possible to enjoy everything from apples in Alaska to cod in California. Automobiles are manufactured with robotic technology. Computers and the internet have revolutionized commerce, from banking and finance, to the goods and services we can buy with the click of a button. None of these innovations would have been possible without electricity.

A. Legacy of the Past and Promise for the Future

In the 1920s, the rapid consolidation of electric companies spurred by scale economies and decreasing costs replaced pure competition with government regulation designed to simulate the forces of competitive markets on participants.

The system of economic regulation of the electric utility industry changed little from the 1930s through the 1970s. Electric utilities continued to use scale economies, building ever-larger generating plants that produced power at ever-lower cost. But the energy market turmoil of the 1970s, beginning with the 1973 OPEC oil embargo, as well as the need to reduce air and water pollution, including from large coal-fired power plants, set in motion market forces that continue to influence the electric industry today.

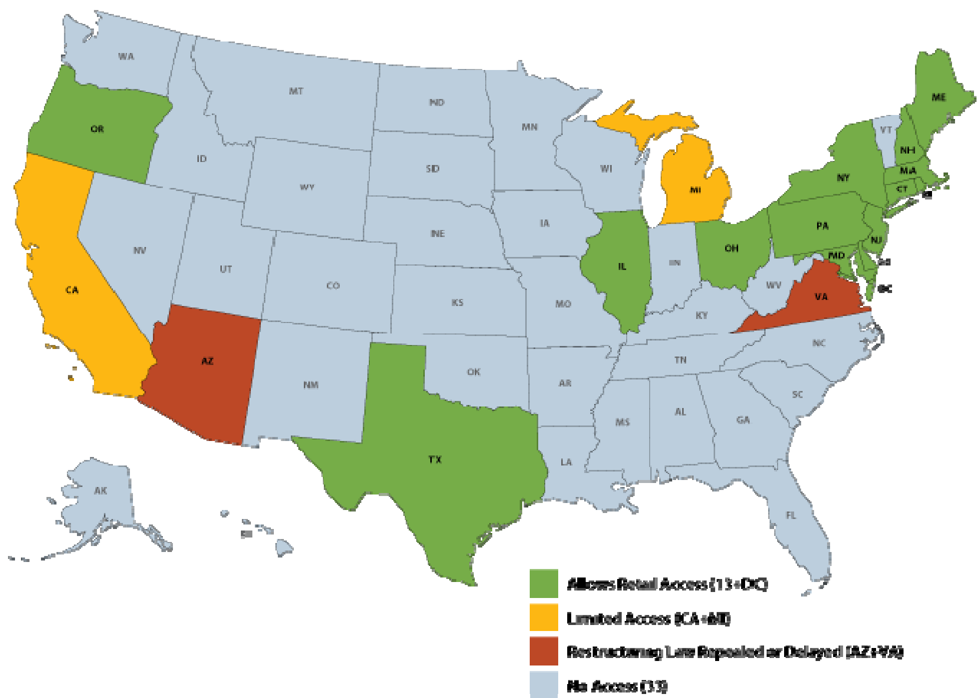
Although Congress passed a series of energy legislation in 1978, including the Public Utilities Regulatory Policy Act (PURPA), which introduced independently-owned generating companies called Qualifying Facilities, it was the Energy Policy Act of 1992 that laid the foundation for the

[1] For a detailed history of the electric utility industry, see Charles F. Phillips, *The Regulation of Public Utilities*, 3d ed., Public Utilities Reports, Inc., (1993), pp. 623-689.

competitive wholesale and retail electric markets that benefit consumers and businesses today.[2] A number of states restructured their electric industries establishing competition for generation, while maintaining monopoly service for distribution.

Electric industry restructuring, however, slowed after the California energy "crisis" of 2000-01, which led to the bankruptcy of one of the largest electric utilities in the nation, and the near-bankruptcy of a second utility.[3] Although multiple factors contributed to the California "crisis," many politicians and state regulators used California as an excuse to halt electric restructuring in their own states. Nonetheless, numerous states in New England and the Mid-Atlantic, as well as several states in the Midwest and Texas chose to restructure (**Figure1**).

Figure 1: Status of Electric Restructuring



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2 For a brief history of events that shaped the electric industry from the 1990s, *see* Jonathan A. Lesser and Leonardo R. Giacchino, *Fundamentals of Energy Regulation*, Public Utilities Reports, Inc., (2007), pp. 10-12.

3 For a detailed discussion of the economic and regulatory factors that led to the crisis, *see* Paul L. Joskow, "California's Electricity Crisis," *Oxford Review of Economic Policy* 17 (2001), pp. 365-88. Available at: http://www.puc.state.pa.us/electric/pdf/PPT-NEM_Presentation101910-Cawley.pdf.

Opposition to electric competition continues. As a consequence, a patchwork of state laws and policies implemented to "protect" consumers has distorted market competition, which will ultimately harm the very consumers these laws and policies are supposed to protect. In Ohio, for example, AEP Ohio has proposed a host of nonbypassable charges to subsidize its own generating facilities and reduce the economic incentives of consumers to purchase electricity from competitive electric suppliers. In Connecticut and New Jersey, both of which have active competitive markets, distribution utilities are required to subsidize construction of generating plants in order to artificially reduce wholesale market prices. In a few states, there are government-run "power authorities" that can act as brokers, buyers, and in some cases, generation developers. And, some states have rules or proposals mandating that local utilities and competitive suppliers buy power from in-state generators, or build generation in state.

Yet, while some states have adopted policies to thwart competitive electric markets, others have fully embraced competition. Texas, which has a vibrant economy that has created far more jobs than any other state over the last two years, has a fully competitive retail electric market, in which competitive electric suppliers now offer more than 250 different products to residential consumers.[4] Pennsylvania has also embraced retail electric competition and almost 1,200,000 customers have switched to competitive electric suppliers.[5] Illinois is another success story, with competitive electric suppliers providing 75% of the electricity purchased by commercial and industrial customers. According to data published by the Public Utilities Commission of Ohio (PUCO), as of March 31, 2011, over 1.4 million customers of Cleveland Illuminating, Ohio Edison, and Toledo Edison, which are subsidiaries of FirstEnergy, had switched to competitive electric suppliers, including over 70% of residential customers.[6] Similarly, over 200,000 Duke Energy Ohio customers had switched to competitive suppliers by March 31, 2011.[7] The combination of highly competitive wholesale electric markets and retail competition, promises to provide consumers with the most efficient, cleanest, and lowest available cost electricity. For an economy that relies on electricity, therefore, electric market competition is key.

Perhaps the best known physical law of electricity is that it flows along the path of least resistance. Well, so does the capital needed for new investment and economic growth. States that embrace electric competition are likely to benefit in the long run because competition encourages the most efficient generation and new investment, leading to the lowest possible electric prices. Those lower prices, in turn, can ripple through individual states' and the U.S economy, creating hundreds of thousands of new jobs each year.

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4 *See* http://www.powertochoose.org/_content/_compare/compare.aspx.

5 *See* Pennsylvania Office of Consumer Advocate, Pennsylvania Electric Shopping Statistics, July 2011. Available at: http://www.oca.state.pa.us/Industry/Electric/elecstats/Stats0711.pdf.

6 Source: PUCO, "Summary of Switch Rates from EDUs to CRES Providers in Terms of Customers," March 31, 2011. Avaialble at: http://www.puco.ohio.gov/emplibrary/files/util/MktMonitoringElecCustSwitchRates%5CSWITCH%20RATES%20CUSTOMER%5C2011%5C1Q2011.pdf.

7 *Id*.

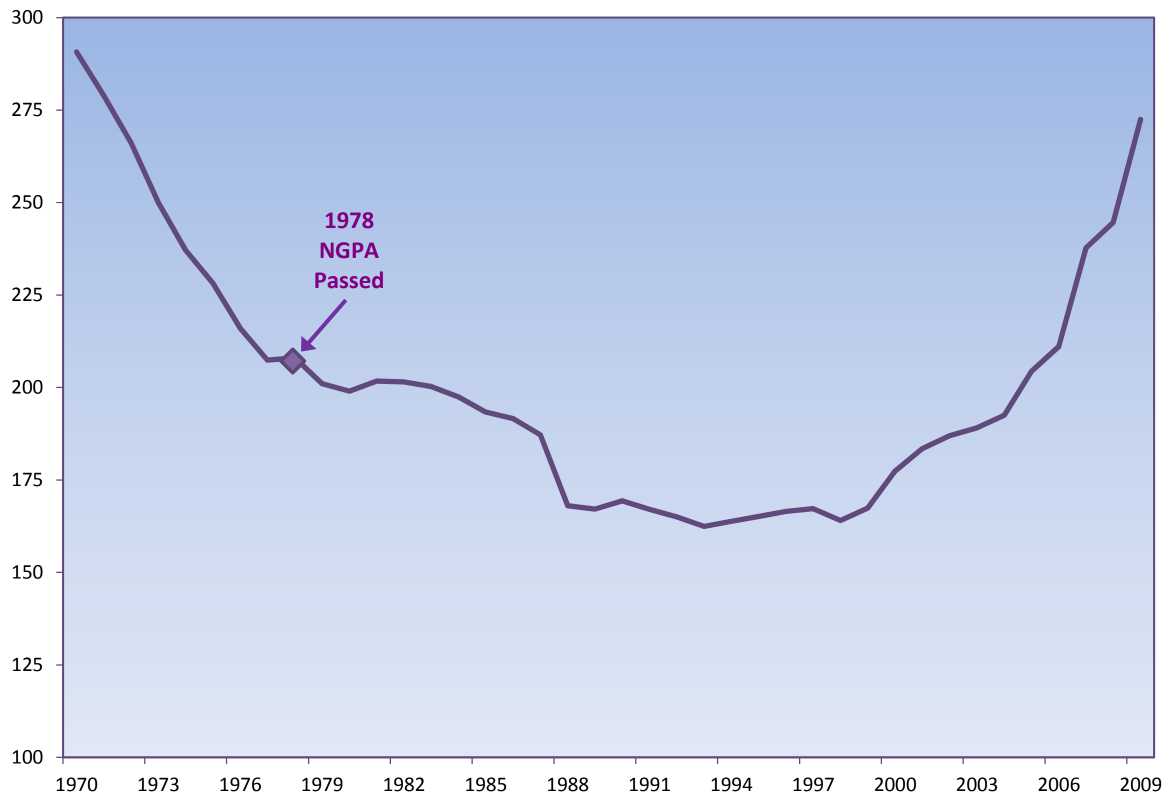
In contrast, state policies that mandate energy investments that are subsidized by consumers, or that shield local electric utilities from market competition, do not encourage investment, either in the electric industry or elsewhere. Rather, they promise short-term benefits, whether artificially low prices, "protection" from volatile energy prices, or local jobs. In fact, such subsidies are hidden taxes that attempt to use energy policy as an economic stimulus mechanism paid for by all electricity customers. Ultimately, however, the long-term costs are far higher than any short-run benefits because, by distorting electric markets, these policies themselves increase economic "resistance" to new investment, greater uncertainty, and higher prices that ultimately destroy jobs. As when Westinghouse prevailed over Edison, and as has been proven repeatedly to be the best policy for sustained growth, investors, not customers, should bear the risks for investment.

II. The Natural Gas Industry: A Competitive Success Story

In the late 1960s, the conventional wisdom was that natural gas supplies would soon be exhausted. Wellhead natural gas prices were regulated and capped. Supplies began to diminish as production from existing wells declined. Growth in the natural gas industry came to a standstill because there was little economic incentive to undertake new, more costly exploration. By 1967, estimated reserves had peaked and production began to fall steadily. Shortages began to develop, natural gas service was curtailed for industrial customers, and predictions that "the spigot would run dry" within a decade became prevalent.

Then, in 1978, Congress passed the Natural Gas Policy Act (NGPA), which addressed the real problem: price controls that had eliminated incentives to explore for new supplies. The NGPA set a timeline for deregulating wellhead natural gas prices. Not surprisingly, removing price controls and establishing a truly competitive market for natural gas worked wonders. Coupled with severing the connection between production, pipeline transportation, and local distribution, by the early 1990s the natural gas market was vibrant; the predicted shortages had turned into a gas "bubble." The decline in proven reserves slowed and then, amazingly, reserves began to increase rapidly, and by 2009, proven reserves were almost the same as they had been in 1970, four decades earlier (**Figure 2**).

Figure 2: U.S. Natural Gas Reserves (Trillion Cubic Feet)

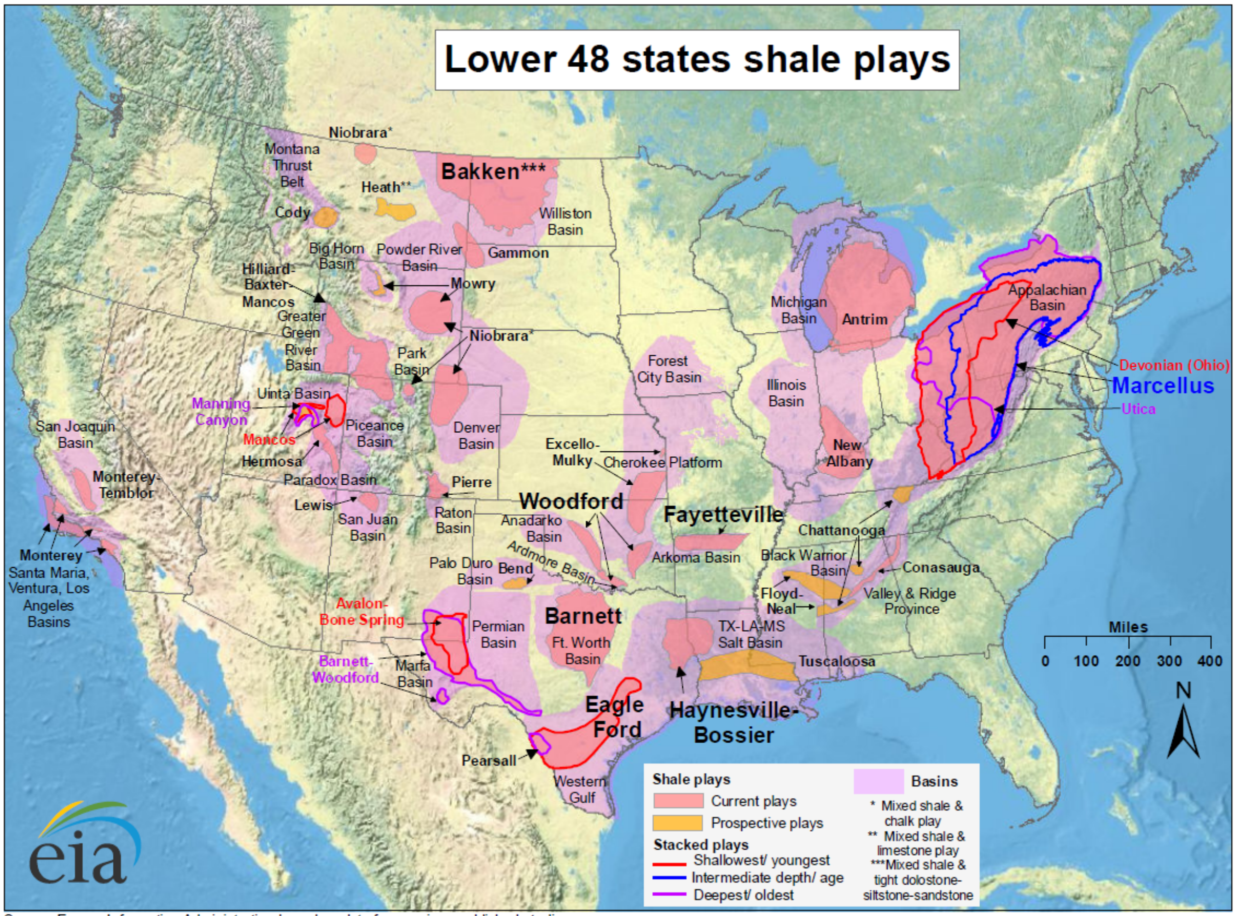


Source: U.S. Energy Information Administration

A. The Shale Gas Revolution

Although market competition led to additional discoveries and increased production of conventional natural gas, the rapid development of shale gas over the last decade has fundamentally altered the U.S. natural gas market. Shale gas production has been made possible by several factors. The first was increasing natural gas demand, especially for generating electricity, which took advantage of significant advances in the design and efficiency of natural-gas fired generators. New gas-fired generators were modular and offered the lowest emissions profile of any fossil-fuel generating resource. As more gas-fired generation was developed, especially by competitive generating companies, the gas “bubble” of the 1990s evaporated and market prices increased. Higher market prices, in turn, helped accelerate technological advances in horizontal drilling and hydraulic fracturing. Those advances in drilling technology have allowed shale gas production to skyrocket. Numerous shale gas fields have been discovered throughout the U.S. (**Figure 3**), so that we have become the “Saudi Arabia” of natural gas.

Figure 3: U.S. Shale Gas Plays



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

The U.S. Energy Information Administration notes that shale gas production has increased 1,400 percent over the last 10 years and that proven reserves of shale gas increased by 76% between 2008 and 2009 alone.[8] As a result, wellhead natural gas prices decreased by about half between 2008 and 2010, falling from an average of about $8 per 1000 cubic feet (Mcf) to just over $4/Mcf. The positive impacts of this abundant, domestic energy supply will be evident for many years to come. With ample supplies of domestic low-cost shale gas, new, high-efficiency natural gas generating plants will be able to displace older, less-efficient coal-fired power plants. This will benefit consumers in electricity markets that allow all energy sources to compete and, as discussed in a recent study prepared by the Massachusetts Institute of Technology (MIT), will reduce carbon emissions and criteria air pollutants.[9]

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[8] Source: U.S. EIA, Natural Gas Annual 2009. Available at: http://www.eia.gov/oil_gas/natural_gas/data_publications/natural_gas_annual/nga.html.

[9] *The Future of Natural Gas: An Interdisciplinary Study*, MIT, June 2011, Chapter 4. Available at: http://web.mit.edu/mitei/research/studies/natural-gas-2011.shtml

B. The Natural Gas Industry Offers a Blueprint for Electric Competition

Were it not for vibrant market competition in the domestic natural gas market, the shale gas revolution, with the huge Marcellus Shale would never have occurred, and the resulting economic growth and new jobs that shale gas development has spurred in numerous states would not exist. The Pennsylvania Department of Labor and Industry estimates that, Pennsylvania employed 200,000 people in jobs related to Marcellus Shale production at the end of 2010.[10] Similarly, a study prepared for the Fort Worth Chamber of Commerce estimated that over 100,000 people were employed in jobs related to the Barnett Shale in central Texas in 2008.[11]

The rapid increase in shale gas production, not only promotes economic growth in states like Pennsylvania and Texas, but also has provided economic benefits throughout the country. Lower natural gas prices benefit industry and consumers. As the electric industry increasingly relies on natural gas-fired generation to meet growing demand, lower natural gas prices have, in turn, reduced wholesale and retail electric prices, again benefitting industry and consumers. For example, a recent study by the author of this report found that, for every $100 million dollar reduction in electric costs, the state of Ohio would create over 1,200 new jobs. Moreover, competition places investment risks where they belong—whether it is natural gas developers or electric generators, rather than customers.

The success of competition in the natural gas industry provides a blueprint for the electric industry. Robust wholesale and retail electric competition will provide industry and consumers with the lowest possible cost electricity, and help grow the economy because price matters.

III. Needlessly Increasing Electricity Costs Destroys Jobs

In 2010, retail customers spent $370 billion on electricity.[12] Of that total, commercial and industrial customers spent more than $200 billion. Because prices matter, states that impose policies undercutting competition and needlessly increase the cost of electricity, risk losing jobs to lower-cost states, and other countries.

For example, in rejecting a proposed power purchase contract between Deepwater Wind (a small offshore wind development) and National Grid in April 2010, one of the reasons cited by the Rhode Island Public Utilities Commission was the job-killing effects of higher electric prices.

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10 Pennsylvania Dept. of Labor and Industry, *Marcellus Shale Fast Facts*, June 2011. Available at: http://www.paworkstats.state.pa.us/admin/gsipub/htmlarea/uploads/Marcellus_Shale_Fast_Facts_Viewing.pdf.

11 The Perryman Group, "An Enduring Resource: A Perspective on the Past, Present, and Future Contribution of the Barnett Shale to the Economy of Fort Worth and the Surrounding Area," March 2009. Available at: www.barnettshaleexpo.com/docs/2009_eco_report.pdf .

12 Source: U.S. Energy Information Administration, *Electric Power Monthly*, May 2011.

> *It is basic economics to know that the more money a business spends on energy, whether it is renewable or fossil based, the less Rhode Island businesses can spend or invest, and the more likely existing jobs will be lost to pay for these higher costs.*[13]

The Rhode Island PUC was not rejecting wind generation per se; it was rejecting a specific project that was far more expensive than other wind generation alternatives. Subsidized fossil-fuel generating projects can raise the same job-destroying concerns. In Illinois, the proposed 716 MW Taylorville coal-gasification project was rejected by the Illinois Senate in January 2011, only to be resurrected by the Illinois House in May. A September 2010 report issued by the Illinois Commerce Commission found that the cost of electricity produced by the project would be "substantially higher than that which is associated with other types of generation facilities" and "features high costs to ratepayers with uncertain future benefits, and uncertainties that potentially add to already-significant costs,"[14] The report estimated the project would increase electric bills by almost $300 million per year.[15]

A. Market Competition Can Best Identify "Winners" and "Losers"

Not all resource decisions made by regulators recognize the adverse economic consequences of higher electric prices. In approving a negotiated contract between National Grid and Cape Wind with a levelized cost of over $250/MWh, the Massachusetts Dept. of Public Utilities (DPU) rejected wind generation alternatives that had been bid in a competitive solicitation and were available at half the cost of Cape Wind.[16] In contrast, NStar, another Massachusetts electric distribution utility, used a competitive solicitation to select wind generation from bidders throughout New England. One of the winning bids, which was submitted by Blue Sky East, LLC, cost below NStar's forecast of wholesale market prices of energy and capacity.[17]

The Rhode Island PUC clearly understood that higher electric rates have adverse economic impacts that will ripple through an entire economy. Moreover, there is a long history of government attempting to choose "winners" and "losers," and invariably making the wrong choices. Following on the second OPEC oil embargo in 1979, for example, the Carter Administration launched U.S. Synfuels Corporation in early 1980. The goal was to produce cheap synthetic crude oil and reduce

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[13] *In Re: Review of New Shoreham Project Pursuant to R.I. Gen Laws § 39-26.1-7*, Docket No. 4111, Report and Order, April 2, 2010, p. 82. Subsequent to rejecting the proposed contract, the Rhode Island legislature passed a law that, in essence, mandated the Rhode Island PUC to approve the contract.

[14] Illinois Commerce Commission, Report to the Illinois General Assembly, Analysis of The Taylorville Energy Center Facility Cost Report, September 1, 2010, at 2.

[15] *Id*. at 29.

[16] *Petition of Massachusetts Electric Company and Nantucket Electric Company each d/b/a National Grid For Approval of Proposed Long-Term Contracts for Renewable Energy With Cape Wind Associates, LLC Pursuant to G.L. c. 169, §83*, D.P.U. 10-54, Direct testimony of Jonathan Lesser, July 30, 2010.

[17] *NSTAR Electric Company, Blue Sky East, LLC - Power Purchase Agreement*, D.P.U. 11-07, Direct Testimony of James Daly, February 18, 2011.

the country's dependence on OPEC. The company was shut down in 1984, having spent $25 billion in taxpayer money and producing far less synthetic crude oil than was promised.

The problem with such bureaucratic fiats is not bad intent. Rather, it is simply that competitive markets are far more efficient in winnowing out the most efficient alternatives. For example, in a letter to the Federal Energy Regulatory Commission (FERC) regarding artificial subsidies to build generating plants to suppress wholesale market prices, Safeway Vice President of Operations George Waidelich succinctly identified the benefits of fully competitive markets:

> *In our experience, restructured competitive markets provide transparent power prices, increased risk management options, new product opportunities and better service at both the wholesale and retail level. This also flows down into secondary offerings such as demand response, renewable power and energy efficiency which add additional value to customer energy portfolios. … Safeway strongly believes in competitive markets for all commodities because they are the proven, most effective way to produce the most reasonable long-term prices and to encourage efficiency and innovation.*[18]

Regional transmission organizations (RTOs) like the PJM Interconnection, which spans all or parts of the 13 Mid-Atlantic and Midwest states, plus the District of Columbia, also enhance market competition by providing robust competitive wholesale markets, access to more generation alternatives, and greater reliability. A recent study of clean energy jobs, prepared by the Brookings Institute recognized the benefits of such markets for developing renewable generation, stating:

> *[E]lectricity market reform represents a significant [clean energy] market-making opportunity for states. … states should consider moving to the more transparent, competitive, and flexible model in which independent system operators (ISOs) or FERC-approved regional transmission organizations (RTOs) administer the planning of new infrastructure and the pricing of wholesale electricity. In addition to its role in lowering prices, the ISO/RTO model is more conducive to clean energy because the market shares generation and transmission over a larger geographic area and harbors fewer conflicts of interest in expanding capacity to accommodate new renewable generators or in allocating costs to market participants.*[19]

Similarly, in testimony before the U.S. House of Representatives, Committee on Energy and Commerce, FERC Chairman Jon Wellinghoff strongly supported letting markets determine "winners" and "losers," stating:

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[18] Comments on Revisions to the PJM Interconnection, L.L.C.'s Minimum Price Offer Rule Docket Number ELll-20-000, February 14, 2011. Available at: www.ferc.gov.

[19] M. Muro, *et al.*, "Sizing the Green Economy," The Brookings Institution, July 2011, at 26. Available at: http://www.brookings.edu/reports/2011/0713_clean_economy.aspx.

> The policies that we implement aren't directed to specific technologies but rather directed to the integration of all technologies into competitive marketplace. We believe and I think my colleague, Commissioner Moeller, I think would agree. We believe the competition means good for consumers and so, to the extent that we can maximize competition we can increase the types of resources that are available in the market whether they'd be coal, nuclear, natural gas, solar, geothermal, hydroelectric or any of these resources and also to the extent that we can do things like incorporating in demand response and energy efficiency which usually the lowest cost resources. The whole mix of those resources in a competitive environment allowed to compete fairly in that competitive environment will in fact produce the lowest cost for consumers.[20]

FERC Commissioner Philip Moeller, added that competitive wholesale markets "are what benefit consumers the most."[21]

Market competition is also the best solution for meeting policy goals at the lowest possible cost, such as state renewable generation requirements, and thus benefits consumers. For example, California uses an innovative auction approach to obtain solar photovoltaic generation to meet that state's renewable energy portfolio requirements. That approach[22] replaces government-determined "feed-in tariffs," such as those used in European countries like Spain and Germany, with a market-based approach that rewards the most efficient and least costly solar developers. The result is that the best solar facilities—producing the most electricity at the lowest cost—are built. In contrast, solar photovoltaic feed-in tariffs that have been set administratively, such as in Germany and Spain, caused electric rates to skyrocket, and imposed tremendous economic costs.[23]

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20 House Energy and Commerce Committee, hearing on "The Views of the Independent Agencies on Regulatory Reform," July 7, 2011. Available at: http://energycommerce.house.gov/hearings/hearingdetail.aspx?NewsID=8763.

21 *Id*.

22 *See* J. Lesser and X. Su, "Design of an Economically Efficient Feed-in Tariff Structure for Renewable Energy Development." *Energy Policy* 36 (March 2008), pp. 981–990.

23 *See, e.g*., G. Calzada et al., "Study of the Effects on Unemployment of Public Aid to Renewable Energy Sources," Universidad Rey Juan Carlos, March 2009, published at: PROCESOS DE MERCADO. Volumen VII, Número 1, Primavera 2010. Available at: http://www.juandemariana.org/pdf/090327-employment-public-aid-renewable.pdf; M. Frondel, N. Ritter and C. Vance, "Economic Impacts from the Promotion of Renewable Energies: The German Experience, Final Report," Rheinisch-Westfälisches Institut für Wirtschaft sforschung, October 2009. Available at: http://www.instituteforenergyresearch.org/germany/Germany_Study_-_FINAL.pdf; P. Voosen, "Spain's Solar Market Crash Offers a Cautionary Tale About Feed-In Tariffs," New York Times, August 18, 2009, Available at: http://www.nytimes.com/gwire/2009/08/18/18greenwire-spains-solar-market-crash-offers-a-cautionary-88308.html?pagewanted=all.

B. Electric Competition: A long-term Focus

One of the arguments often made against competitive electric markets, and competition in general, is that competitors focus solely on the short-run, rather than considering what's best for consumers in the long run. This view was expressed by AEP Ohio President and Chief Operating Officer Joseph Hamrock in a January letter to the Ohio Public Utilities Commission, as part of that company's filing of its "Electric Security Plan," a non-market alternative for AEP Ohio's distribution customers. Mr. Hamrock stated, "A framework biased toward current short-term market mechanisms will likely lead to retirement of critical assets, an irreversible course that will leave the State exposed to tighter supplies and the associated increases in market prices."[24]

However, Mr. Hamrock's statement belies a misunderstanding of competition and competitive markets. Competitive markets will lead to the retirement of uneconomic resources and the continued use and development of the most economic resources when the long run leads to lower market prices for all consumers. As Safeway's Mr. Waidelich stated, the benefits from competition are <u>not</u> focused on the short-term. Rather, competition produces the lowest possible long-term prices and encourages long-run economic efficiency and innovation.

Critics also point to bankruptcies of competitive generation developers as evidence that competition has somehow "failed." It is true that a number of competitive generation developers misjudged markets and were forced out of business. In some cases, new plants were built based on faulty expectations of future electric demand and market prices. In other cases, developers did not anticipate that state regulators and politicians would attempt to restrict market competition, such as through mandated price caps. But generator bankruptcies, rather than demonstrating the failure of competition, illustrate another <u>benefit</u> of competition: the risk of failed investments is borne by developers, not customers. Indeed, one of the driving forces of market competition in the electric industry was a legacy of construction cost-overruns at generating plants built by regulated electric utilities, cost overruns that were imposed on captive ratepayers. In competitive generation markets, however, developers, not customers bear the financial risks because it is the developers who can best manage those risks. As Steve Elsea, Director of Energy Services at Leggett & Platt, a diversified company with 100 manufacturing facilities nationwide, stated:

> *We believe that competitive markets eliminate subsidization and thereby create the price transparency that produces market efficiency. By transferring the risk of building new generation facilities from investors to consumers, the Act skews the balance of supply and demand that sets the true market price. When New Jersey manipulates the market by legislative fiat, it may end up devaluing the assets of existing, unsubsidized*

[24] *In the Matter of the Application of AEP Ohio, Case No. 11-346-EL-SSO and Case No. 11-348-EL-SSO*, Letter of Joseph Hamrock, January 27, 2011 ("Hamrock Letter"), p. 1.

> *generators and creating a disincentive for future investment. At the end of the day, this will result in higher prices for New Jersey consumers.*[25]

Because electric competition will result in the lowest long-term prices, it will also provide the greatest long-term economic benefits, leading to higher economic growth and more jobs. Yet, ironically, it is that quest for jobs that is causing some states to promote artificial subsidies for their "favorite" types of generation or adopt various measures under the rubric of "electricity security." However, the economic damage such policies cause in the long-run will far exceed any benefits in the short-run.

IV. Artificial Subsidies: Short-term "Gain"; Much Greater Long-term Pain

Despite the documented benefits of electric competition, a number of states—and some electric utilities—continue to attempt various "end-runs" around competitive markets. These include (1) "energy security" requirements, in which states mandate that generation be built within state boundaries, including specific technologies to meet renewable portfolio standards and thereby create entire new industries; (2) mandates for local utilities and their customers to subsidize new generation investment to undercut competitive wholesale markets; and (3) state-sanctioned "power authorities," some of whom would be vested with the ability to finance construction of new generating plants whose output would be sold to select customers and also undercut competitive wholesale markets.[26]

Some argue that only governments can finance new generating plants, because energy markets are too "volatile," and point to the relative lack of new generation investment by private sector develops in the last few years. Others argue that competitive markets are "unfair," and reward existing generation plant owners with "windfall" profits, thus requiring government intervention to protect ratepayers. Still others argue that government can build lower-cost power than private competitors because of its ability to issue lower-cost debt. Finally, there are those that argue subsidies are necessary to overcome "market barriers" that prevent private investment in innovative energy technologies. None of these arguments is valid.[27]

Regardless of the justification, "end-runs" around private sector investment decisions effectively short-circuit competitive electric markets and thereby inflict long-term economic harm. It's true, of course, that building and operating generating plants within a state's borders will create new jobs

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25 *In the Matter of the Long-Term Capacity Agreement Pilot Program*, BPU Docket No. EO11010026, Comments of S. Elsea on behalf of Leggett and Platt, Inc., February 23, 2011.

26 For a discussion of different types of power authorities envisioned, see. A. Kleit, "The Debate over Power Authorities: A View from Pennsylvania," November 2010. Available at: http://www.electricitymarkets.psu.edu/reports/power_authority_outline1.pdf.

27 For a more detailed discussion of why these arguments are invalid, see J. Lesser, "Gresham's Law of Green Energy," *Regulation*, Winter 2010-2011, pp. 12-18 ("Lesser 2011"). (Gresham's Law is named after named after Sir Thomas Gresham (1519–1579), and is commonly stated as: "Bad money drives out good.")

for construction workers, as well as jobs for the people needed to operate and maintain the plant. But such a view considers only part of the economic ledger.

A. How Artificial Subsidies Destroy Jobs and Harm Consumers

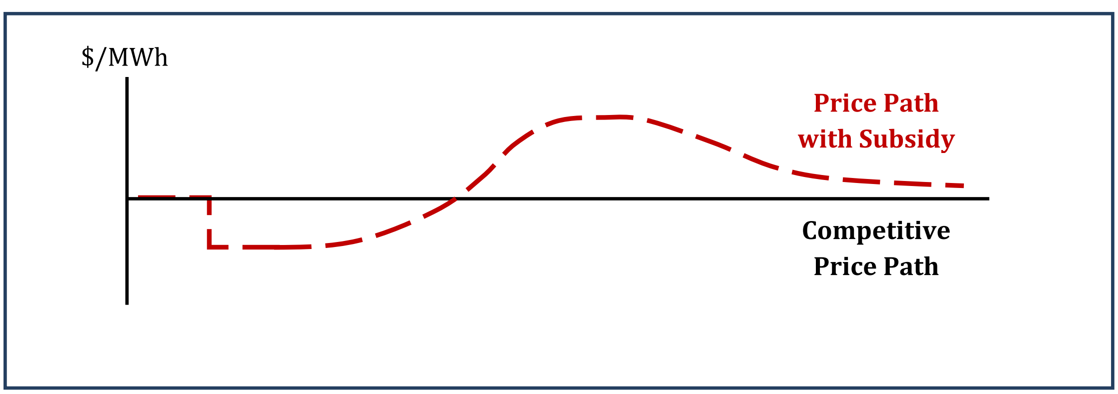
Economists continue to note that there is no such thing as a "free lunch". Some politicians nonetheless ignore economists and continue to promote the myth that subsidizing electric generation lowers prices and creates jobs, the ultimate free lunch.

Consider, for example, a state that mandates construction of generating plants for the express purpose of reducing wholesale market costs. The generating plant is not economic, so local distribution customers are required to subsidize the plant. Proponents of this strategy will argue that, once the plant is built and its energy and capacity are bid into the respective wholesale markets, the increase in supply will decrease market-clearing prices by more than the cost of the plant. Supposedly, everybody wins, except for competitive generators who invested their capital.

These "free-lunch" arguments are wrong, for many reasons.[28] First, such state policies wrongly and illegally manipulate the market to drive down prices artificially. Just as regulators do not allow generators to artificially withhold supplies to force market prices upwards, neither can subsidized generation artificially flood the market to drive down prices. Yet, that is precisely what such subsidized generating plants do.

Second, by artificially driving down market prices, states drive out legitimate competitive generators. Thus, any price reductions are temporary. Worse still is the long-term damage to markets. By driving out legitimate competitors, these policies increase financial risk, as investors don't know if the plant they finance will be forced out of business in the future by some other state policy action. Finally, subsidies reduce the incentive to innovate and lower costs. Thus, in the long-run, because competitive generators will be more hesitant to invest and because investors will demand higher returns to compensate for the additional financial risk, market prices will actually increase even more (**Figure 4**).

Figure 4: Price Path with Subsidized Generation



[28] *Id.*

In Figure 4, the artificial subsidy initially reduces market prices below the competitive price path, providing a temporary illusory "benefit" to consumers. However, because the artificial subsidy drives out competitive generators, prices ultimately increase. The increased market uncertainty causes prices to rise above the competitive price path, and then gradually fall to that path in the long-run. Thus, the same customers who are supposed to benefit from the subsidized generation will, in fact, pay more for their electricity in the long run. Moreover, those higher electric prices will damage the entire state economy and, as the Rhode Island PUC understood, reduce jobs. In fact, far more jobs will be lost than the subsidized generating plant will create. And, because most electric markets are regional, the impacts of individual state subsidies may cross state lines, causing long-term harm and lost jobs to other states' economies.

For example, in a July 13, 2011 letter to members of the Pennsylvania Congressional delegation, the Pennsylvania Public Utility Commission (PPUC) stated, "[t]he ability to bid in new capacity at potentially artificially low prices can skew the capacity market leading to less investment in new and existing capacity, including in Pennsylvania. Without such investment, the end result from the consumer's perspective, ultimately, could be higher rates in Pennsylvania than without this state-mandated subsidy."

These impacts were also noted by the PJM Independent Market Monitor, in a report of the impacts of NJ Assembly Bill 3442, which would require New Jersey to procure 1,000 MW of new capacity that was not needed for reliability, require that capacity to clear in the PJM capacity market auction through an offer price below its costs, and subsidize that capacity. As the report concluded:

> The result of such a subsidy by New Jersey ratepayers would be to artificially depress the Reliability Pricing Model (RPM) auction prices below the competitive level, with the result that the revenues to generators both inside and outside of New Jersey would be reduced as would the incentives to customers to manage load and to invest in cost effective demand side management technologies.[29]

The "electric security" canard is another argument raised as justification for artificial subsidies (See **Box**). Again, however, this argument is flawed. Market signals, not mandates, are the most efficient way of eliciting new supply when it is needed. Building new generating plants when the market cannot support those investments wastes scarce resources. It is the electric equivalent of the infamous Alaska "Bridge to Nowhere." Moreover, because almost all electric markets are regional,

[29] *See* Monitoring Analytics, "Impact of New Jersey Assembly Bill 3442 on the PJM Capacity Market," January 6, 2011. Available at: http://www.monitoringanalytics.com/reports/Reports/2011/NJ_Assembly_3442_Impact_on_PJM_Capacity_Market.pdf.

and deliberately so because such multi-state markets lower costs and improve reliability, in-state generation development mandates needlessly raise costs.

By mandating that new generation be built within a state and artificially manipulating competitive electric markets, policy makers increase the financial risks to competitive generators and deter competitive build. States that create such uncertain economic environments in which the rules frequently change raise economic "red flags" among investors.

The Electric "Security" Canard or Why They Don't Grow Oranges in Ohio

In its January 2011 filing of its non-market Electric Security Plan to provide power to its distribution customers, AEP Ohio CEO Joseph Hamrock also raised the risk that the current regulatory environment could not "sustain needed investment in any generating assets," which could create "a distinct risk Ohio could become an importer of electricity." A similar "electric security" issue was raised in Maryland in 2007. Known as the Maryland Energy Independence Act, the legislation would have required that the state's local distribution utilities to provide 100% of all standard offer service to customers (the power provided to customers who cannot or will not purchase from a competitive retail electric provider) from in-state generating plants, declaring that "a self-sufficient means of electricity generation within the state will benefit consumers as well as electric companies and electricity suppliers."

Mr. Hamrock's warning against Ohio becoming a net importer of electricity from other surrounding states, and his conclusion that this would adversely affect Ohio's "electric security," is inconsistent with basic economics and the entire purpose of PJM. Mr. Hamrock's argument is that only electricity supplies produced within the boundaries of the state can provide "electricity security," as if surrounding states could somehow "embargo" electricity deliveries similar to the OPEC oil embargoes of the 1970s. The entire purpose of a multi-state power pool like PJM, which is the largest integrated power pool in the country, is to enhance reliability and security of electric supplies. And, because PJM operates highly competitive wholesale energy and capacity markets, generators are efficient and customers receive the lowest possible prices for their electricity.

Because of the fundamental economic benefits provided by unfettered trade, A state's lawmakers would not, for example, mandate creating a state orange-growing authority with the authority to build huge greenhouses to grow oranges to meet citizens' demand for orange juice, and create jobs for construction workers and orange growers. The reason is that, thanks to market competition, it is far cheaper to purchase orange juice from oranges grown in Florida. Other states benefit from lower-cost orange juice and Floridians benefit by selling orange juice nationwide. The same is true of electricity. Allowing generation investment where and when it is needed benefits everyone by providing the lowest available prices, thus enhancing economic growth and creating jobs.

B. The Job-Killing Impacts of Needlessly Raising Electricity Prices

When policymakers tout the job-creating benefits of subsidized electric generation or policies that foreclose market competition, they either ignore or dismiss the job-killing impacts of higher electricity costs. For example, advocates of Cape Wind argued that residential customers' electric bills would increase less than two dollars per month,[30] while AEP Ohio's Mr. Hamrock touted the benefits of allowing his company to impose various nonbypassable rate riders.

Regardless of the incremental impacts on a single customer, however, the cumulative impacts on a state's economy are real and significant. Cape Wind's proponents admitted that, in the aggregate, the project would increase electric costs for National Grid customers by between $564 million and $715 million (in present value terms) over the 15-year contract life. That represents a loss of hundreds of jobs each year as those higher electric costs rippled through the Massachusetts economy.[31] As for AEP Ohio, it would force customers who wished to purchase electricity from competitive retail electric suppliers to pay twice for environmental controls, renewable generation, and AEP Ohio's economic development efforts, thus undermining their ability to shop for lower-cost electricity.

A recent study evaluated the economic impacts of the AEP Ohio plan. It showed that each million dollar increase in electricity costs in Ohio directly causes the loss of almost 13 jobs cumulatively when compared to competitive alternatives AEP Ohio's proposal could increase the cost of power paid by all AEP Ohio customers by as much as $2 billion dollars each year, resulting in the loss of thousands of jobs.[32]

Because competitive electric markets are the best way to keep prices as low as possible, such markets will also provide the greatest opportunity for economic growth and job creation. A group of major commercial customers expressed that sentiment clearly in a June 13, 2011, letter to the Governor of Maryland urging the Governor to maintain Maryland's competitive electric market.

> *Competitive electricity markets are providing documented benefits to consumers. They keep prices as low as possible, drive innovation, and produce other benefits for consumers, while ensuring a reliable supply of electricity. Vibrant electricity markets are important to Maryland's economic and job growth. A stable framework within*

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30 D.P.U. 10-54, Supplemental Testimony of Jeanne Lloyd on behalf of National Grid U.S.A., August 9, 2010, p. 1.

31 For a more detailed discussion, *see* Lesser 2011.

32 *See In the Matter of the Application of AEP Ohio, Case No. 11-346-EL-SSO and Case No. 11-348-EL-SSO*, Direct testimony of Jonathan Lesser on behalf of FirstEnergy Solutions Corporation, July 25, 2011. Available at: http://dis.puc.state.oh.us/DocumentRecord.aspx?DocID=710a2c81-cf95-4664-8f4e-5d7a61fef2a4, and Direct testimony of Michael Schnitzer on behalf of FirstEnergy Solutions Corporation, July 25, 2011. Available at: http://dis.puc.state.oh.us/ViewImage.aspx?CMID=A1001001A11G26A80700B55314.

which competitive suppliers can operate will increase competition and benefit consumers.[33]

V. Policy Recommendations

Because electricity is such a critical part of today's economy, promoting the lowest available prices and increasing innovative choices are critical to future economic growth. Five general policies can help.

1. Actively promote wholesale and retail electric competition. States that belong to transmission organizations like PJM can access competitively priced wholesale electricity, and benefit from improved system reliability. Competitive wholesale markets for energy and capacity provide clear market signals, and promote innovation and greater efficiency. Moreover, competitive markets also provide the best platform for other state policies, such as promoting clean energy sources and retail customer choice. Interconnecting clean energy sources can be more easily accommodated on larger, integrated power systems than at the local level. Allowing all customers unfettered access to competitive retail electric suppliers, and ensuring that local distribution utilities' "provider of last resort" roles are met using competitive procurement mechanisms, will provide all retail customers with the lowest possible rates and greatest variety of choices. .[34]
2. Create an environment that lets the market work and reduces investment uncertainty. All investors abhor uncertainty, because it increases their costs. For capital-intensive, long-lived investments like electric generating plants, providing a stable market environment in which the rules are clear is crucial. State policies that create artificial subsidies for a few generators or mandate uneconomic investments to upend competitive markets, send flashing "Do Not Invest" signals to developers, by driving out real competitors and increasing uncertainty. Ultimately, such policies lead to higher long-term electric prices, thus harming the very customers the subsidies are supposed to benefit.
3. Do not allow monopoly electric utilities to thwart competitive markets. Monopolies are notoriously inefficient, because they have no incentive to improve productivity and reduce costs. Allowing monopoly utilities to thwart competition, whether by imposing unreasonable costs on customers who wish to purchase electricity from competitive electric suppliers or negotiating bilateral agreements with favored suppliers, needlessly increases costs for customers.
4. Avoid policies that use artificial subsidies as an economic stimulus. Just as we don't build schools as a way of providing jobs for school bus drivers, electric generating plants should be

[33] Letter to Governor Martin O'Malley, June 13, 2011, p. 1. Available at: http://www.competecoalition.com/files/Maryland%20letter.pdf.

[34] *See* COMPETE-AWEA, "Joint Statement Supporting Competitive Wholesale Electricity Markets," October 27, 2010. Available at: http://www.competecoalition.com/files/AWEA_COMPETE_Wind_Joint_Statement.pdf.

built in response to market conditions, not political ones. Policies that mandate in-state development of subsidized generation on the promise of job creation will cause more jobs to be lost, as customers not only bear the cost of the subsidies themselves, but also pay more for their electricity in the long-run.[35]

5. Combine policies that promote electric competition with broader economic policies that promote economic growth. By itself, electric competition cannot rescue a moribund economy. But combined with other policies, electric competition can be a catalyst for economic growth. The State of Texas not only offers the most advanced competitive electric market in the U.S., it offers an environment that encourages investment and job creation. That may explain why, according to the Federal Reserve Bank of Dallas, Texas created 37% of net new jobs in the U.S. between June 2009 and May 2011.[36] Pennsylvania, another state with a vibrant competitive electric market, also ranked high in terms of job creation, was third, with 93,000 new jobs, in part to development of the Marcellus Shale natural gas reserves.

Like electrons, investment and economic growth follow the path of least resistance. And, although there may not be any economic "silver bullets" to create jobs overnight, competitive electric markets, and their ability to provide the lowest possible electric prices for businesses and households, will be increasingly important to our economic future.

[35] Moreover, state (and federal) subsidies are no guarantee of "permanent" new jobs, as Massachusetts discovered after providing Evergreen Solar with $43 million worth of subsidies, and the U.S. DOE discovered after providing California solar panel manufacturer Solyndra with $535 million in loan guarantees.

[36] Federal Reserve Bank of Dallas, "Texas Job Growth—Special Data Report," July 12, 2011. Available at: http://www.dallasfed.org/research/update-reg/2011/1105.cfm. *See also*, "The Lone Star Jobs Surge," *The Wall Street Journal*, June 10, 2011.

Appendix: Estimating the Economic Impacts of Increased Electric Costs

1. Mathematics of the Input-Output Framework[1]

An input-output framework begins with observed transaction data for a particular region. For example, the IMPLAN model is constructed from data at the national, state, and county levels. The transactions are typically converted into dollar amounts, as that makes tracing economic flows much easier, since dollars are a uniform measure.

We assume that the economy is made of up of numerous sectors, e.g., manufacturing, mining, agriculture, services, government, and foreign trade. To construct an input-output table, we record how the output produced (supplied) by a given sector, such as steel, is purchased by (demanded) the other industry sectors (who then use those purchased inputs to manufacture other goods), plus external sales to government and consumers. Thus, if there the economy consists of N industries, the total output produced by an individual industry, X_k, will be purchased by the other N–1 industries, used by itself, and sold to final consumers. Thus,

$$X_k = z_{k,1} + z_{k,2} + z_{k,3} + ... + z_{k,N} + Y_k \tag{1}$$

where the $z_{i,n}$ are sales to each industry *n*, and Y_k equals sales for final demand (i.e., to consumers, the government, and for export). Since we have N industries, we can write the entire set of flows as

$$\begin{bmatrix} X_1 = z_{1,1} + z_{1,2} + ... + z_{1,k} + ... + z_{1,N} + Y_1 \\ X_2 = z_{2,1} + z_{2,2} + ... + z_{2,k} + ... + z_{2,N} + Y_2 \\ \vdots \\ X_k = z_{k,1} + z_{k,2} + ... + z_{k,k} + ... + z_{k,N} + Y_k \\ \vdots \\ X_N = z_{N,1} + z_{N,2} + ... + z_{N,k} + ... + z_{N,N} + Y_N \\ \end{bmatrix} \tag{2}$$

Each column of coefficients on the right-hand side of equation (2), *i.e.*,

[1] For a far more detailed discussion, see Leontief, *op. cit*. See also, R. Miller and P. Blair, *Input-Output Analysis: Foundations and Extensions*, (Englewood Cliffs, NJ: Prentice-Hall 1985), Chp. 2.

$$\begin{bmatrix} z_{1,k} \\ z_{2,k} \\ \vdots \\ z_{k,k} \\ \vdots \\ z_{N,k} \\ \\ \end{bmatrix}$$

represents the purchases from industry sector k to the N–1 other industry sectors, and to itself ($z_{k,k}$). In other words, industry k purchases inputs from all of the other industries to produce output X_k. When all of the N different columns are combined, they create an *input-output table*, with each selling sector a different row, and each purchasing sector a different column, as shown in Table 1.

Table 1: An Input-Output Table

		Purchasing industry sector					
		1	**2**	**…**	**K**	**…**	**N**
	1	$Z_{1,1}$	$Z_{1,2}$	…	$Z_{1,k}$		$Z_{1,N}$
Selling	**2**	$Z_{2,1}$	$Z_{2,2}$	…	$Z_{2,k}$		$Z_{2,N}$
Industry	⋮	⋮	⋮		⋮		⋮
Sector	**k**	$Z_{k,1}$	$Z_{2,k}$	…	$Z_{k,k}$		$Z_{N,k}$
	⋮	⋮	⋮		⋮		⋮
	N	$Z_{N,1}$	$Z_{N,2}$	…	$Z_{N,k}$		$Z_{N,N}$

Although the input-output table above incorporates all of the inter-industry sales and purchases, it does not account for the remainder of the economy. For example, final demand includes sales to consumers, state, local, and the federal government, investment, and exports. Moreover, in addition to buying outputs from other industries, each industry pays wages to its employees (W), pays for government services (in the form of taxes), pays for capital (in the form of interest payments, I), and profits. Together, these components are called *value-added*. On top of that, each sector imports goods and services from outside the economy. For example, if building a new high-voltage transmission line requires buying substation equipment from Germany, then the input-output model for the U.S. would consider that an import.

The input-output framework assumes that production coefficients are fixed. This means that there are specific quantities of inputs required to produce a given output. Thus, building a car—any car—is assumed to take (say) 2000 pounds of steel, 100 pounds of rubber, 200 pounds of glass, and so forth. Obviously, this assumption of fixed production coefficients does not hold true entirely—the amount of materials needed to build a large pick-up truck is greater than that needed to built a subcompact car—but for estimating short-run impacts, the overall assumption is reasonable: building more cars and trucks will clearly require more steel, producing more steel will require more iron ore, and so forth.

Because the input-output framework assumes fixed production coefficients (called a "Leontief production function"), the necessary inputs needed to produce a unit of output are all constant. If we divide the purchases made by industry k from every industry, *i.e.*, the $z_{i,k}$, to produce output X_k, we derive the *technical coefficients, $a_{i,k}$*, for industry k. In other words,

$$a_{i,k} = \frac{Z_{i,k}}{X_k} \tag{3}$$

If we substitute equation (3) into equation (2), we obain:

$$\begin{bmatrix} X_1 = a_{1,1}X_1 + a_{1,2}X_2 + \dots + a_{1,k}X_k + \dots + a_{1,N}X_N + Y_1 \\ X_2 = a_{2,1}X_1 + a_{2,2}X_2 + \dots + a_{2,k}X_k + \dots + a_{2,N}X_N + Y_2 \\ \vdots \\ X_k = a_{k,1}X_1 + a_{k,2}X_2 + \dots + a_{k,k}X_k + \dots + a_{k,N}X_N + Y_n \\ \vdots \\ X_N = a_{N,1}X_1 + a_{N,2} + \dots + a_{N,k}X_k + \dots + a_{N,N}X_N + Y_N \end{bmatrix} \tag{4}$$

What equation (4) tells us is that some of the output produced by an industry is sold to all other industries and used in fixed quantities to produce those industries' outputs, and the remainder is sold as final demand to consumers, government, and as exports. As a final step, we isolate the final demands for the output from each industry, Y_k. Thus,

$$\begin{bmatrix} X_1 - a_{1,1}X_1 + a_{1,2}X_2 + \dots + a_{1,k}X_k + \dots + a_{1,N}X_N = Y_1 \\ X_2 - a_{2,1}X_1 + a_{2,2}X_2 + \dots + a_{2,k}X_k + \dots + a_{2,N}X_N = Y_2 \\ \vdots \\ X_k - a_{k,1}X_1 + a_{k,2}X_2 + \dots + a_{k,k}X_k + \dots + a_{k,N}X_N = Y_n \\ \vdots \\ X_N - a_{N,1}X_1 + a_{N,2} + \dots + a_{N,k}X_k + \dots + a_{N,N}X_N = Y_N \end{bmatrix} \tag{5}$$

Equation (5) lies at the heart of the economic impact analysis, because it allows us to answer the question, "If the demand for the output of industry k changes, by how much would the output of all of the other industries change?" For example, building a new high-voltage transmission line would increase the demand for concrete, steel, and so forth. How will these changes in demand ripple through a state's economy and what will be the final changes in output levels in all other industries, as well as the change in total labor (i.e., jobs) and income?

To answer this sort of question, we solve equation (5) for each of the X_i. This requires a bit of matrix algebra. It turns out that the solution can be written as

$$\mathbf{X} = (\mathbf{I} - \mathbf{A})^{-1}\mathbf{Y} \tag{6}$$

where

$$\mathbf{A} = \begin{bmatrix} a_{1,1} \cdots a_{1,N} \\ a_{2,1} \cdots a_{2,N} \\ \vdots \\ a_{k,1} \cdots a_{k,N} \\ \vdots \\ a_{N,1} \cdots a_{N,N} \end{bmatrix}, \qquad \mathbf{X} = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_k \\ \vdots \\ X_N \end{bmatrix}, \qquad \mathbf{Y} = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_k \\ \vdots \\ Y_N \end{bmatrix}$$

The matrix $(\mathbf{I} - \mathbf{A})^{-1}$ is called the *Leontief inverse*. By changing the level of final demand in the output vector **Y** and knowing the technical coefficients $a_{i,k}$, we can determine the flows through the economy.

There are three types of economic impacts typically evaluated in an input-output study: *direct*, *indirect*, and *induced*. Direct effects are those that are a direct result of an increase in demand for good k. For example, building a new high-voltage transmission line will require concrete for the tower foundations. Thus, the demand for concrete will increase. That is a *direct* impact. Increasing the demand for concrete, however, will require concrete manufacturers to increased their purchases of all of the inputs used to manufacture concrete, including sand, gravel, electricity, and so forth, thus increasing the demand for all of those inputs. Thus, the *direct* increase in the demand for concrete *indirectly* increases the demand for all of these other products. Finally, all of these manufacturers pay wages to employees. Those employees, in turn spend a portion of their wages on food, electricity, new cars, and so forth. As a result, we say the resulting consumer spending from households *induces* further increases in demand, and thus additional economic impacts.

Because of the interconnections among industries and between industries and households, an increased demand for just one good or service is said to cause *ripple effects* throughout the economy. These ripple effects lead to additional jobs and increases disposable income as workers are hired, equipment and supplies are purchased from other local businesses, wages are paid to employees, and taxes are paid to government entities. These impacts are called *multiplier effects* or *multipliers*. For example, if the demand for concrete increases by $1 million and the overall impact on a state's economy is $2 million, then the output multiplier equals $2million/$1 million = 2.0. We can also calculate jobs and income multipliers. For example, if 100 workers are hired to construct a transmission line, and the overall ripple effects lead to 50 new jobs created as a result, the employment multiplier will equal 150/100 = 1.5.

2. Estimating economic impacts

Ripple effects act like waves bouncing off walls. Eventually, each subsequent round of impacts decreases in magnitude, just like a wave bouncing off walls eventually subsides. The speed at which these ripple effects diminish, and the overall magnitude of multipliers, depends on what are called *leakages* out of an economy. For example, not all of the materials needed to build the transmission line will be purchased from in-state companies. Moreover, some of the workers hired to construct the project may be from outside the state. Furthermore, in-state workers who are hired will not spend all of their wages within the state, but will instead buy goods and services from neighboring states, too. As we discuss in the sections that follow, assumptions about *leakage rates*, i.e., what fraction of spending occurs outside the state, are crucial in estimating the overall economic impacts to the state.

a. Calculating multipliers[2]

Multipliers are calculated from the Leontief inverse matrix defined previously. For example, suppose we have an economy with just two industries, industry **X** and industry **Y**, with the following technical coefficients matrix.

$$\mathbf{A} = \begin{bmatrix} 0.15 & 0.25 \\ 0.20 & 0.05 \end{bmatrix} \tag{7}$$

What this means is that to produce $1 of additional output, industry **X** purchases $0.15 from itself and $0.20 from industry **Y**. The remaining $0.65 is accounted for through valued added – wages and salaries paid to employees, taxes paid to federal, state, and local governments, and profits. Similarly, to produce $1 of additional output, industry **Y** purchases $0.25 from industry **X**, $0.05 from itself, and the remaining $0.70 is value added. It turns out the Leontief inverse matrix (ignoring the value added impacts) is

$$(\mathbf{I} - \mathbf{A})^{-1} = \begin{bmatrix} 1.254 & 0.33 \\ 0.264 & 1.122 \end{bmatrix} \tag{8}$$

The values in the Leontief inverse provide the output multipliers, by adding up each column. Specifically, if there is a $1 increase in final demand for the output of industry **X**, then the total

2 For a much more detailed discussion, see Miller and Blair, fn. 1, from which these examples are drawn.

increase in demand for output of industry **X** is \$1.254 - \$1 for the increase in final demand, and \$0.254 for inter-industry and intra-industry use. There is also an *indirect* increase in demand of \$0.264 of industry **Y** for inter-industry and intra-industry use. Thus, if we sum down the first column, a \$1 increase in demand for industry **X** leads to a total increase in output of \$1.254 + \$0.264 = \$1.518. The output multiplier for industry **X** is thus \$1.518/\$1 = 1.518. Because we are not considering households in this example, this output multiplier is called a *Type I* multiplier.

Next, we consider household impacts, such as from wages paid to households. Suppose that industry 1 **X** pays \$0.30 in wages per dollar of output and that industry 2 pays \$0.25 in wages per dollar of output. By incorporating these payments into the technical coefficients matrix, we can determine the direct, indirect, and *induced* impacts from increased output. So, we rewrite the technical coefficients matrix as follows:

$$\mathbf{A} = \begin{bmatrix} 0.15 & 0.25 & 0.05 \\ 0.20 & 0.05 & 0.40 \\ 0.30 & 0.25 & 0.05 \end{bmatrix} \qquad (\mathbf{I}-\mathbf{A})^{-1} = \begin{bmatrix} 1.365 & 0.425 & 0.251 \\ 0.527 & 1.348 & 0.595 \\ 0.570 & 0.489 & 1.289 \end{bmatrix} \tag{9}$$

The new technical coefficients matrix **A** now contains 3 rows and 3 columns. The 2x2 matrix of values in the top left hand corner is the original matrix shown in equation (7). The third column represents households. So, in the example, households spend \$0.05 per dollar buying items from industry **X**, \$0.40 per dollar buying items from industry **Y**, and \$0.05 buying items from within the household sector. (The remainder is spent paying taxes and for investment.). The third row shows that industry **X** spends \$0.30 per dollar on wages, while industry **Y** spends \$0.25 per dollar on wages.

When we calculate the new Leontief inverse $(\mathbf{I}-\mathbf{A})^{-1}$, the first thing to notice is that the previous coefficients (the top-left 2x2 matrix) are all larger than they were in equation (8). This is because we are now including household demand impacts. Now, the output multiplier for industry **X** is the sum of the first column [1.365, 0.527, 0.570], or 2.462. Thus, for every \$1 increase in demand in industry **X**, total output in the local economy increases by \$2.462. The output multiplier for industry **X** is therefore 2.4262. In matrix notation, the output multiplier for industry *i* in our N-industry economy is:

$$M_{output,i} = \mathbf{i}_i \bullet (\mathbf{I}-\mathbf{A})^{-1} \bullet \mathbf{i}_i', \tag{10}$$

where $\mathbf{i}_i = \begin{bmatrix} 0 & \cdots & 1_j & \cdots & 0 \end{bmatrix}$.[3]

In our 2-industry example, we can calculate the household income multiplier for industry **X** in several ways. The first is to treat household spending as outside our model and estimate impacts

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[3] In other words, $\mathbf{i}_j$ is a 1*x*N unit vector having value 1 for industry j. The term $\mathbf{i}_j'$is called the *transpose* of $\mathbf{i}_i$, and is a N*x*1 column vector.

using the Type 1 multipliers. To do that, we go back to the initial Leontief inverse in equation (8) and multiply the household income coefficients in **A** for our two industries (the third row) by the first column in the Leontief inverse, and add the results, i.e.,

$$H_X = (0.30)(1.254) + (0.25)(0.264) = 0.442$$

What this means is that, for every $1 increase in demand for the output of industry **X**, total household income increase by $0.442 because of the direct and indirect economic impacts on output. Thus, the *Type 1 multiplier* is $0.442/$0.30 = 1.47.

If we include the economic impact caused by households also spending money in the economy, the result is called a *Type II multiplier*. To do this, we use the new **A** and $(\mathbf{I}-\mathbf{A})^{-1}$ matrices shown above. For industry **X**, we calculate the total household income change, including the within-household sector impacts and divide by $0.30 that industry 1 pays directly to households in the form of wages. Thus, we have

$$H'_X = (0.30)(1.365) + (0.25)(0.527) + (0.05)(0.57) = 0.570$$

and the multiplier is H'_X /0.30 = $0.57/$0.30 = 1.9. Note also that the overall household impact, $0.57 is just the value in the last row of the Leontief inverse matrix for industry **X**.

Finally, we estimate *employment multipliers*, following the same approaches previously outlined. Only this time, the multipliers do not reflect dollar changes, but changes in employment. To do this, one determines the number of employees (in full-time equivalents) per dollar of output in each industry. For example, suppose for each million dollars of output produced in industry **X**, 300 employees are required, and that in industry 2, 400 employees are used per million dollars of output. This translates to values of 0.003 and 0.004 employees per dollar in industries **X** and **Y**, respectively. Similarly, assume the household sector requires 100 employees per million dollars of output, or 0.001 employees per dollar. Then, using the Leontief inverse matrix in equation (9), we calculate the total employment impact for industry **X** as

$$E'_X = (0.003)(1.365) + (0.004)(0.527) + (0.001)(0.570) = 0.000572$$

Then, using the same approach as for calculating the Type II income multipliers, we can calculate the Type II employment multiplier for industry 1 as E'_X /0.0003 = 1.907. Thus, for every job added in industry **X**, a total of 1.907 jobs are added in the entire economy.

3. The IMPLAN Model

IMPLAN was first developed in the 1970s by the U.S. Forest service to analyze the economic impacts of different forestry policies. The current version of IMPLAN is maintained by the University of Minnesota IMPLAN group. IMPLAN provides a detailed breakdown of the U.S. economy, with over 500 separate economic sectors. IMPLAN is widely used by numerous government agencies, including at the federal and state levels.

The IMPLAN model begins with the most current national transactions matrix developed by the current National Bureau of Economic Analysis Benchmark Input-Output Model. Next, the model creates state and county-level values by adjusting the national level data, such as removing industries that are not present in a particular state or economy. The model also estimates imports using what are called *regional purchase coefficients* (RPCs). RPCs measure the proportion of the total supply of a good or service required to meet a particular industry's intermediate demands and final demands that are produced locally. The larger the RPC value, the greater the percentage of total regional demand that is met through local supplies.

In addition to calculating standard Type I and Type II multipliers, IMPLAN can also calculate what are called "SAM multipliers." SAM stands for "Social Accounts Matrix," and is a more detailed breakdown of transactions within an economy. Specifically, whereas the typical input-output framework captures production and consumption, it leaves out some income transactions, such as taxes, savings, and transfer payments. IMPLAN allows users to capture these components as well, and thus derive what are called SAM multipliers.[4] SAM multipliers are a form of Type II multiplier. Thus, SAM multipliers incorporate direct, indirect, and induced impacts, while accounting for the effects of savings, taxes, and transfer payments.

4. Estimating the economic impacts of higher electric prices

To estimate the overall economic impacts of the higher wholesale electric prices and higher capacity market costs, we assumed a short-run elasticity of zero. That is, we assumed consumers would not, initially, reduce their electric consumption in response to the slightly higher electric prices they faced. Since consumer income is assumed to be fixed in the short run, this implies consumers must reduce their expenditures on all other goods and services (including savings and investment) by an equivalent amount.

Similarly, we assumed that in-state businesses would react to the increased price of electricity by reducing their total output such that their aggregate production expenses remained unchanged. This assumption is consistent with the assumption of fixed production coefficients in the Leontief model. It also assumes that businesses would not be able to pass on the increased production costs to consumers.

b. Estimating the total impacts on individual state output

With these assumptions, we estimate the overall change in output as follows. First, we calculate a weighted-average *regional purchase coefficient* for output in a state's economy, excluding electric power. A regional purchase coefficient (RPC) equals the fraction of local demand for a good or service that is satisfied from local production. For example, in Ohio, about 47% of all ready-mix

[4] For complete discussion of how SAM multipliers are derived, see G. Alward, "Deriving SAM multipliers using IMPLAN," paper presented at the 1996 National IMPLAN Users Conference, Minneapolis, MN, August 15–17, 1996, 1996. Available at: http://implan.com/v3/index.php?option=com_docman&task=doc_download&Itemid=138&gid=127.

concrete was purchased from in-state manufacturers, based on 2008 data. Thus, the weighted RPC, RPC_W, equals the sales-weighted average of the individual sector RPCs, excluding the electric generation sector (assumed to be sector k). Thus,

$$RPC_W = \frac{\sum_{i=1, i \neq k}^{N} Q_i \cdot RPC_i}{\sum_{i=1, i \neq k}^{N} Q_i} \tag{11}$$

Similarly, we calculate the weighted-average state SAM output multiplier, $\bar{M}_{State}^{output}$, using the output from each industry as the individual industry weights. Thus, using equation (10) for the output multiplier for industry i, we have

$$\bar{M}_{State}^{output} = \sum_{i=1, j \neq k}^{N} Q_i \cdot \{\mathbf{i_i} \bullet (\mathbf{I} - \mathbf{A})^{-1} \bullet \mathbf{i_i}'\} / \Delta Q_{State}^{TOT} = \sum_{i=1, j \neq k}^{N} Q_i \cdot M_{output,i} / \Delta Q_{State}^{TOT}, \tag{12}$$

The total impact on output in the state, ΔQ_{State}^{TOT}, will equal the weighted RPC times the weighted output multiplier, times the estimated increase in total electric expenditures. Thus, if the total change in electric expenditures is ΔQ_{ELEC}, we have:

$$\Delta Q_{State}^{TOT} = \Delta Q_{ELEC} \cdot RPC_{State} \cdot \bar{M}_{State}^{output} \tag{13}$$

c. Estimating the total impact on state employment

We can follow a similar procedure to estimate the total impacts on state employment arising from the higher electric expenditures, with the additional step of estimating the weighted average employment per million dollars of output, using the employment multipliers calculated by IMPLAN. Thus, the weighted jobs per million dollars of output can be written as:

$$\bar{J}_{State} = \sum_{i=1, i \neq k}^{N} Q_i \cdot J_i / \Delta Q_{State}^{TOT}, \tag{14}$$

where J_i is jobs per million dollars of output in industry i. Therefore, the overall weighted jobs multiplier is:[5]

$$\bar{M}_{State}^{jobs} = \sum_{i=1, i \neq k}^{N} Q_i \cdot J_i \{\mathbf{i_i} \bullet (\mathbf{I} - \mathbf{A})^{-1} \bullet \mathbf{i_i}'\}, \tag{15}$$

[5] The jobs multiplier is just the output multiplier weighted by jobs per million dollars of output.

And so, the total impact on jobs in the state from the increased expenditures on electricity will equal:

$$\Delta J_{State}^{TOT} = (\Delta Q_{ELEC} \cdot RPC_{State}) \cdot (\bar{J}_{State} \cdot \bar{M}_{State}^{jobs}) \qquad (16)$$