



**Ohio's Electricity Usage Reduction Mandate:  
The "Free Lunch" Paid for by Ohio Consumers**

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## EXECUTIVE SUMMARY

Legislation passed in 2008 mandates that Ohio's electric distribution utilities ("EDUs") reduce their customers' electricity usage. Although the mandate is often referred to as an energy efficiency mandate, it is more accurate to describe it as an arbitrary mandate simply to reduce electricity usage. The efficiency of customers' existing electric usage doesn't matter.

The mandate is uniquely applied to EDUs and their customers; it does not apply to Ohio municipal utilities or electric cooperatives, which together supply about ten percent of Ohio's retail electricity demand. Through the end of 2014, Ohio's EDUs will have spent over \$1 billion to comply with this mandate since 2009. Because the legislation requires the EDUs to reduce electricity usage by even larger percentages over time (totaling at least 22% by the year 2025), and because the remaining usage reductions will be more costly to achieve as less "low hanging fruit" remains, the budgets will certainly continue to increase as they have since the mandate's inception. Since 2011, these budgets have grown at an average rate of 12% per year. If that rate of growth continues, by 2020, *Ohio ratepayers will be paying over \$500 million per year as a result of the Ohio mandate.*

Those who favor the electricity usage reduction mandate and oppose any reforms to it assert that Ohio's retail electric consumers will receive a "free lunch" based on their claim that: (1) the mandate suppresses the *wholesale* electric price in a multi-state region; (2) the amount of this suppression flows directly into the *retail* electric prices paid by Ohio's retail electric customers; and (3) the effect of the *retail* price reduction produces a direct Ohio retail consumer benefit in excess of the cost of the mandate tax paid by these same retail consumers. The reform opponents' claims are similar to claims that the costs paid by consumers to subsidize renewable

generating resources spurs economic growth and job creation far in excess of the renewable subsidies' cost, with larger subsidies leading to ever greater economic growth. In other words, government can, at the expense of its citizens, subsidize long-term economic growth and greater employment.

The reform opponents have pointed to several studies to justify these claims, most notably a summary of a study prepared by the Advanced Energy Economy Ohio Institute ("AEEOI") associated with the Center for Resilience at The Ohio State University. A high-level summary of the results of that study was released on September 25, 2013. The summary claims that the electricity usage reduction mandate has reduced Ohio ratepayers' electric bills by "suppressing" wholesale electric prices. The AEEOI study asserts that by mandating reductions in electricity usage Ohio will lower wholesale electric prices which will, in turn, drive retail electric prices lower. Thus, the hundreds of millions of dollars budgeted each year for energy usage reductions are, according to this study, providing Ohio consumer benefits in excess of the significant costs by suppressing wholesale market prices.

Ohio is part of the PJM Interconnection, LLC ("PJM") regional transmission organization, which has a footprint that covers all or parts of 13 states and Washington, DC. In addition to coordinating all of the electric generating plants in the region and ensuring the power system operates safely and reliably, PJM oversees a wholesale energy market in which bids and offers from buyers and sellers set market-based wholesale prices for electricity every hour.

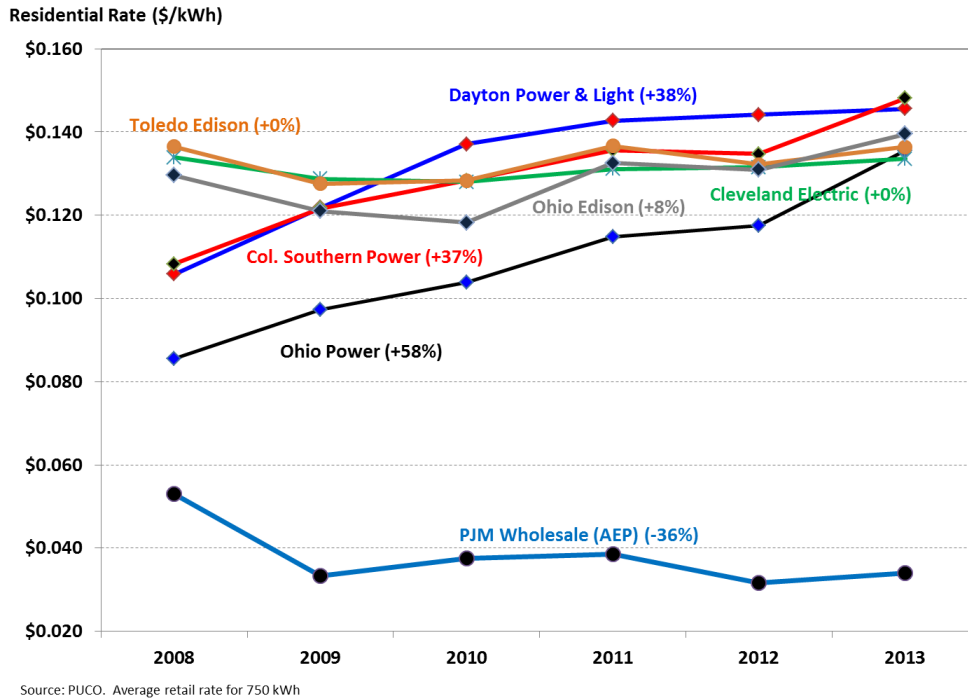
Because the PJM wholesale market is integrated, the effects of the Ohio electricity usage reduction mandate are spread throughout PJM. As a result, 80% of the price suppression "benefits," to the extent they might exist, flow to customers outside Ohio and customers of Ohio municipal utilities and cooperatives, which are exempt from the electricity usage reduction

mandate and the mandate tax. Thus, 80% of the alleged benefits accrue to “free riders” who do not pay for those benefits.

Using data for 2012, my analysis shows that the typical Ohio residential customer using 750 kilowatt-hours (“kWh”) of electricity each month received, *at best*, a 37 cent reduction in their monthly electric bill. I say “*at best*” because, as I describe in more detail in the pages that follow, the simplifying assumptions I made for the purpose of testing the reform opponents’ claims err on the side of maximizing the amount of alleged wholesale price suppression that might be available to retail electric customers of Ohio’s EDUs. *At worst* and, in my opinion, most likely, there is no wholesale price suppression benefit to offset the real, known and measurable cost of the mandate, which is being paid by the retail electric customers of Ohio’s EDUs. ***To obtain the wholesale price suppression benefit theorized by the reform opponents, those same Ohio residential customers pay a monthly mandate tax ranging between \$1.74 and \$3.92, or between five and ten times greater than the theorized price suppression benefit.***

As importantly, the Ohio retail electric bill reduction which the reform opponents have attributed to the mandate are missing in the real world where Ohioans work and Ohio businesses must compete. As shown in Figure EX-1, while PJM wholesale electric prices fell by more than one-third between 2008 and 2013, EDU residential retail electric bills have increased steadily.

**Figure EX-1: Residential Retail Rates and PJM Wholesale Prices, 2008 – 2013**



The increases in retail electric prices in Ohio are not solely due to the electricity usage reduction mandate tax. Retail customers must also pay for costly renewable resources to meet the state’s renewable portfolio standard, as well as pay for the mostly fixed cost of providing transmission and distribution service. Ironically, ratepayers must also pay for some of the EDUs’ lost revenues stemming from these same usage reduction mandates.

The conclusions of my analysis of the reform opponents’ wholesale price suppression benefit theory are as follows:

*If the wholesale price suppression claim is correct, then the biggest winners from the Ohio electricity usage reduction mandate are the consumers and market participants inside and outside Ohio who don’t pay the mandate tax.* To the extent that the Ohio mandate really has “suppressed” PJM wholesale electric prices, the in-state and out-of-state consumers and market participants who do *not* pay the mandate tax are collectively capturing 80% of the

suppression benefit theorized by the reform opponents. These consumers and market participants are classic “free-riders.”

*Ohio businesses are therefore being forced to subsidize some of their out-of-state competitors, including those competitors within the PJM region that are not subject to any mandates or their costs.* Thus, the reform opponents are implicitly urging Ohio’s leaders to leave in place a law that gives out-of-state businesses a competitive advantage while imposing a competitive disadvantage on in-state businesses. Doing this cannot possibly enhance economic growth, job retention and job creation in Ohio.

As this report makes clear, Ohio consumers and businesses are suffering economic harm *because* of the mandate. The reform opponents’ claim that Ohio retail electric consumers will be harmed if the current mandate is reformed is unsupported by the wholesale price suppression theory they advance, and in conflict with the rising Ohio electric bills that Ohio retail electric customers are paying in the real world.

## **I. Introduction**

Legislation passed in 2008 mandates that Ohio’s electric distribution utilities (“EDUs”) reduce their customers’ electricity usage.<sup>1</sup> Although the mandate is often referred to as an energy efficiency mandate, it is more accurate to describe it as an arbitrary mandate simply to reduce electricity usage. The efficiency of customers’ existing electric usage doesn’t matter.

The mandate is uniquely applied to the EDUs and their customers; it does not apply to Ohio municipal utilities or electric cooperatives, which together supply about ten percent of Ohio’s retail electricity demand.

Of course, complying with the electricity usage reduction mandate isn’t free. The 2008 law requires Ohio’s retail consumers of the EDUs to pick up the tab. To do so, these retail customers pay a tax<sup>2</sup> levied on their electric bills. The tax proceeds are used to fund the EDUs’ mandate compliance schemes, which are approved by the Public Utilities Commission of Ohio (“PUCO”). Most of the monies collected by this mandate tax are then transferred to businesses that manufacture, sell, and install goods and services that reduce electricity usage. The remainder is used by the EDUs to pay for administering the usage reduction programs.

The amount of the mandate tax levied varies depending on the type of consumer (i.e., residential, commercial, or industrial). For example, a residential customer of Ohio Power

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<sup>1</sup> R.C. Section 4928.66.

<sup>2</sup> Some may prefer to call this a “fee,” rather than a “tax.” However, like the famed description of taxes as “revenue enhancements,” whether one prefers “tax” or “fee,” the adverse economic impacts on consumers are the same.

Company who consumes 1,000 kilowatt-hours (“kWh”) of power in a month currently pays a tax of about \$2.89 just for the electricity usage reduction mandate.<sup>3</sup>

In 2009, the first year of compliance with the electricity usage reduction mandate, EDUs were required to reduce their customers’ electric usage by 0.3% relative to a baseline level, equal to the average annual consumption for the prior three years.<sup>4</sup> The mandated annual reductions escalate every year and are also cumulative. Thus, under this Ohio government mandate, EDUs were required to reduce their retail customers’ electric consumption by an additional 0.5% in 2010, 0.7% in 2011, and so forth. From 2014 through 2018, the mandate requires additional electricity usage reductions of one percent each year. In total, by the year 2025, the mandate requires consumers’ electricity usage to have been reduced by at least 22% relative to what it would be absent the mandate.

During the course of the Ohio General Assembly’s review of the current mandate, opponents of any reform have asserted that leaving the 2008 law in place has benefitted, and will continue to benefit, Ohio retail electric consumers. More specifically, they have asserted (often inconsistently) that the mandated reductions in electricity usage will “suppress” electricity prices in the multi-state wholesale electric market in which Ohio participates, and that this hypothesized price suppression reduces Ohio retail consumers’ electric prices on a dollar-for-dollar basis.

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<sup>3</sup> There is also a supply-side “alternative energy resource” mandate in this same legislation that imposes an additional tax on the retail electricity consumers of the EDUs. The impacts of the alternative energy resource mandate tax are not addressed in this report.

<sup>4</sup> That baseline is adjusted for the estimated effects of weather. For example, if one of the previous three years’ summers had been unusually hot, electric usage in that year would be “normalized,” i.e., the EDUs would estimate what usage would have been had it been an average Ohio summer. Furthermore, the usage reductions must be based on “normal” weather, so they, too, must be estimated. Thus, determining whether an EDU has met the mandate’s usage reduction requirements is based on estimated usage reductions from an estimated baseline.



While a far more rigorous analysis would be required to determine if the Ohio electricity usage reduction mandate is producing a more *efficient* outcome, the purpose of this paper is to discuss the simplistic and, in my opinion, the fundamentally defective theory of the reform opponents: forcing ever larger electricity usage reductions benefits Ohio's retail electric consumers by reducing the electric bills they pay by even larger amounts.

The fallacy in the reform opponents' theory can be readily seen by simply extending the theory's logic. For example, a straightforward approach to reduce electric bills would be to prohibit Ohioans from using electricity whatsoever. Such a 100% usage reduction mandate would reduce retail electric bills by 100%. Most of us would say such a prohibition is absurd because electricity provides huge benefits for how we live and work today.

Now, consider gasoline, another product that provides huge benefits based on how we live and work today. The State of Ohio does not (nor should it) force oil companies or gas station owners to reduce their customers' gasoline usage by ever larger amounts each subsequent year, and we do not force consumers to pay a gasoline tax to fund such mandates. Although the US government has enacted mandatory fuel efficiency standards for vehicles, consumers can still purchase the vehicles they like and drive those vehicles as many miles as they like each year. Consumers are not forced by the government to purchase only subcompact cars or hybrids with the highest mileage ratings.

The highly capital-intensive nature of the electric utility industry provides another fundamental reason why the reform opponents' claims about lower prices are implausible in the real world. Electric utility capital costs end up being "fixed" by the level of the investment they must make to meet their "obligation to serve." Fixed costs are those that don't vary in the short run. For example, a monthly car loan payment is the same whether you drive one mile or one

thousand miles each month. For any firm to survive in the market, it must eventually cover its fixed costs; that is, it must earn enough revenues to pay for those costs that don't vary with the amount the firm produces. (In the short-term, a firm can survive as long as it recovers its variable costs, but eventually it has to earn enough to pay all costs.)

Their capital-intensiveness means that electric utilities have especially large fixed costs relative to their total costs. The costs of high-voltage transmission lines and distribution systems do not change when electricity usage changes. And a significant percentage of the costs of many generating plants are fixed, too. Because of this high proportion of fixed costs, mandated reductions in electric usage mean those costs must be spread over fewer retail electric sales, which lead to higher average retail prices to cover those fixed costs. Thus, as electricity usage is reduced through the mandate, those fixed costs are spread over fewer and fewer sales, thereby raising the average retail price.

**A. What Does the Electricity Usage Reduction Mandate Cost?**

All of the EDUs are required to file mandate compliance plans with the PUCO. These plans contain compliance cost estimates or budgets and projected savings over time. As shown in Table 1, the EDUs' budgets to meet the mandate have increased steadily. In 2012, the budgeted mandate compliance cost for the electricity usage reduction mandate totaled about \$214 million for the seven EDUs. In 2013, the compliance cost budget increased to over \$233 million and is projected to increase to about \$257 million in 2014. In total, by the end of 2014, the EDUs will have spent, at their customers' expense, over \$1 *billion* on complying with the mandated electricity usage reduction requirements.

**Table 1: Electricity Usage Reduction Mandate Expenditures/Budgets by EDU  
(2009 -2014)**

Year	Utility				Total
	<u>AEP-Ohio</u>	<u>DP&amp;L</u>	<u>Duke</u>	<u>FirstEnergy</u>	
2009	\$36.8	\$7.7	\$24.8	\$9.1	<b>\$78.4</b>
2010	\$53.8	\$12.2	\$30.8	\$23.7	<b>\$120.5</b>
2011	\$71.3	\$14.0	\$37.2	\$59.4	<b>\$181.9</b>
2012	\$85.1	\$15.1	\$33.9	\$79.5	<b>\$213.6</b>
2013	\$91.5	\$18.2	\$51.2	\$72.4	<b>\$233.3</b>
2014	\$97.5	\$21.9	\$53.6	\$83.6	<b>\$256.6</b>
<b>Totals:</b>	<b>\$436.0</b>	<b>\$89.1</b>	<b>\$231.5</b>	<b>\$327.7</b>	<b>\$1,084.3</b>

Source: Individual EDU PUCO filings

Note: AEP-Ohio, includes Columbus Southern Power and Ohio Power. FirstEnergy includes Cleveland Electric, Ohio Edison, and Toledo Edison

There are at least two reasons why the EDUs’ energy usage reduction budgets have increased steadily since 2009, and are likely to continue increasing. First, the mandate compliance requirement escalates each year. In 2014, for example, EDUs must reduce usage by an additional one percent applied to the compliance baseline. Second, the cost of achieving each kWh of usage reduction is also increasing, because the usage reduction programs focus on achieving compliance with the lowest cost measures. As the “low-hanging fruit” is picked to satisfy the mandate, the cost of satisfying each additional kWh of mandated usage reduction increases. As the EDUs’ mandate compliance budgets increase, so does the mandate tax paid by their customers. And, as usage is forced lower by the mandate, the total dollar cost of the mandate is spread over fewer kWh sales, further increasing the charge that is imposed on Ohio retail customers to permit the EDUs to recover the cost of complying with the mandate. Since 2011, these budgets have grown at an average rate of 12% per year. If that rate of growth continues, by 2020, *Ohio ratepayers will be paying over \$500 million per year as a result of the Ohio mandate.*

Moreover, as large as these EDU budgets are, they do *not* include all of the mandate's compliance costs. First, the budgets do not include all of the cost of achieving the usage reduction that is paid directly by retail customers. For example, if a usage reduction program offers a \$2 rebate for a package of compact fluorescent light ("CFL") bulbs that costs \$5, only the \$2 is reflected in the EDU's compliance cost. Second, under "lost revenue" provisions that are part of the compliance plans or otherwise part of retail rate schedules, the EDUs are allowed to recover a portion of the lost revenues stemming from the mandated usage reduction. In other words, because these compliance programs reduce their customers' electric usage, the EDUs are allowed to impose new charges to replace some of the revenue that each would otherwise collect *but for* the mandated usage reduction.

#### **B. The "Free-Lunch" Claim**

An economic "free lunch" means getting something of value at no cost. In the case of Ohio's electricity usage reduction mandate, the reform opponents assert that Ohio's retail electric consumers will receive a "free lunch" based on their claim that: (1) the mandate suppresses the *wholesale* electric price in a multi-state region; (2) the amount of this suppression flows directly into the *retail* electric prices paid by Ohio's retail electric customers; and (3) the effect of the *retail* price reduction produces a direct Ohio retail consumer benefit in excess of the cost of the mandate tax paid by these same retail consumers. The reform opponents' claims are similar to claims that the costs paid by consumers to subsidize renewable generating resources spurs economic growth and job creation far in excess of the renewable subsidies' cost, with larger subsidies leading to ever greater economic growth. In other words, government can, at the expense of its citizens, subsidize long-term economic growth and greater employment.

Although the reform opponents have referenced several “studies” to support their “free lunch” claim, the study that has received the most attention was prepared by the Advanced Energy Economy Ohio Institute (“AEEOI”) associated with the Center for Resilience at The Ohio State University. A high-level summary of the results of that study was released on September 25, 2013. The summary claims that the electricity usage reduction mandate has reduced Ohio ratepayers’ electric bills by “suppressing” wholesale electric prices. The AEEOI study asserts that mandating reductions in electricity usage in Ohio will lower wholesale electric prices which will, in turn, reduce retail electric prices. Thus, the hundreds of millions of dollars budgeted each year for energy usage reductions are, according to this study, providing Ohio consumer benefits in excess of the very significant costs by suppressing wholesale market prices. And, as an added bonus, the AEEOI summary claims that the electricity usage reduction mandate will help the Ohio economy grow, create jobs, and reduce air pollution.

In essence, the claims that reference the AEEOI study assert that Ohio retail electric consumers receive a “free lunch” by leaving the current law in place. In other words, reform opponents implicitly assume that *without the mandate, Ohio consumers and businesses will not invest in measures to reduce their electricity usage even when the benefits they realize from doing so exceed their costs.* The reform opponents also implicitly assume that Ohio consumers and businesses will benefit from reductions in the retail price of electricity that are greater than the cost of the electricity usage reduction mandate tax. Indeed, the summary of the AEEOI study asserts the “free lunch:” the greater the energy usage reduction mandate, the larger the retail consumer price benefit.<sup>5</sup>

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<sup>5</sup> The study also shows that a more stringent renewable portfolio standard will increase economic growth and job creation in the Ohio economy.

The conclusions reached by the reform opponents requires one to accept that Ohio retail consumers who directly “benefit” from the usage reduction mandate either lack the ability to know what’s good for them, or will not otherwise act in their own economic self-interest, even if they do know what’s good for them. Thus, the reform opponents believe that Ohio retail customers, at least customers of EDUs, must be compelled by law to reduce their electric consumption so as to enjoy the promised lower retail prices. I call this the “eat your spinach” approach to government regulation.

Curiously, the same AEEOI study on which the reform opponents have hung their collective hats upon relies on an economic model<sup>6</sup> that assumes the same Ohio consumers (who can’t be trusted to act in their own self-interest when it comes to energy efficiency) do act in their own self-interest and invest in new technology in the face of changing environmental regulations, such as higher carbon taxes. In other words, the AEEOI model results to which the reform opponents point to justify forcing Ohio consumers to “eat their spinach” regarding energy usage reductions assumes these same consumers will happily “eat their spinach” and make investments to improve their overall productivity in the face of changing regulations, so much so that the more stringent the regulations, the more the Ohio economy will grow: same “free lunch” result, but based on completely different consumer behavior.

Ohio’s economy is relatively “energy-intensive.” That means the Ohio economy has a relatively high concentration of manufacturing activity that uses, in the aggregate, *relatively* more energy to produce goods and services than states having relatively little manufacturing activity. A company that manufactures automobile parts, for example, uses more energy per

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<sup>6</sup> In the appendix to this report, I provide an overview of the AEEOI economic model of Ohio, called “DEEPS,” which is based on an economic model developed by the Millennium Institute called “Threshold 21.”

dollar of value added than an insurance company.<sup>7</sup> As a result of this energy-intensiveness, Ohio has relatively high per-capita energy use compared to other states. This means Ohio's economy is more sensitive to increases in the delivered cost of energy regardless of what causes those increases.

All Ohio businesses have an economic incentive to reduce costs and increase profitability. That's just basic economics. The more energy-intensive the industry or business, the more it is affected by the price and availability of energy resources and the greater the economic incentive to identify and implement strategies to reduce energy consumption in ways that lower costs and improve profitability. In other words, energy-intensive firms will tend to focus on energy use and costs in searching for ways to improve productivity and profitability; that's where the money is. Moreover, because Ohio firms compete in global markets, they face immense economic pressure to make those investments *proactively* in order to survive, compete, and grow. In other words, Ohio businesses have a strong and never-ending economic incentive to evaluate new opportunities to reduce their energy-intensiveness. It is basic economic self-interest.

Companies that are traded publicly also have fiduciary responsibilities to their shareholders to protect and grow the value of the equity owners. In other words, these companies' managers are required to act in their shareholders' interests. That such firms must be *forced* to reduce electricity usage by the force of government mandates which, at least according to the reform opponents, provide greater benefits than costs and presumably improve businesses' bottom lines, defies common sense. The reform opponents are effectively claiming that the powerful competitive forces running through our entire economic system are incapable of

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<sup>7</sup> Value added is the difference between the cost of inputs and the market value of output.

causing Ohio businesses to act in their own self-interest. Hence, a government mandate is required to save Ohio businesses from themselves.

Supporters of government intervention to compel consumers to act in their own self-interest attempt to explain away this *apparent* economic irrationality in various ways. The most common explanation is to claim that vague – if not nefarious – “barriers to entry” exist which prevent consumers and businesses from knowing just how good electricity usage reductions are. That explanation is, at best, implausible, given all of the readily available goods and services which have the potential to reduce energy intensity without compromising comfort or productivity.

The theoretical propositions advanced by the reform opponents are not credible. In my opinion, that is reason enough to reject assertions that members of the General Assembly will harm Ohio’s consumers and economy by reducing or eliminating the degree of government intervention that occurs under the current law. However, the reform opponents have also attached dollar amounts to their claims of “stranded” consumer benefits that will occur if the timing and amount of electricity usage reductions are left more to the discretion of Ohioans and less to the arbitrary specifications of a law enacted in 2008 to address fears of scarce electric supplies and “rate shock” that never materialized. I address these claims in the next section of the report.

## **II. Does the Electricity Usage Reduction Mandate Affect Wholesale Electric Prices and, If So, How?**

In this section, I turn to the problems with the numbers which the reform opponents have used to discourage the General Assembly from reforming the current mandate. More specifically, I first evaluate the claim of wholesale price “suppression” and calculate the possible

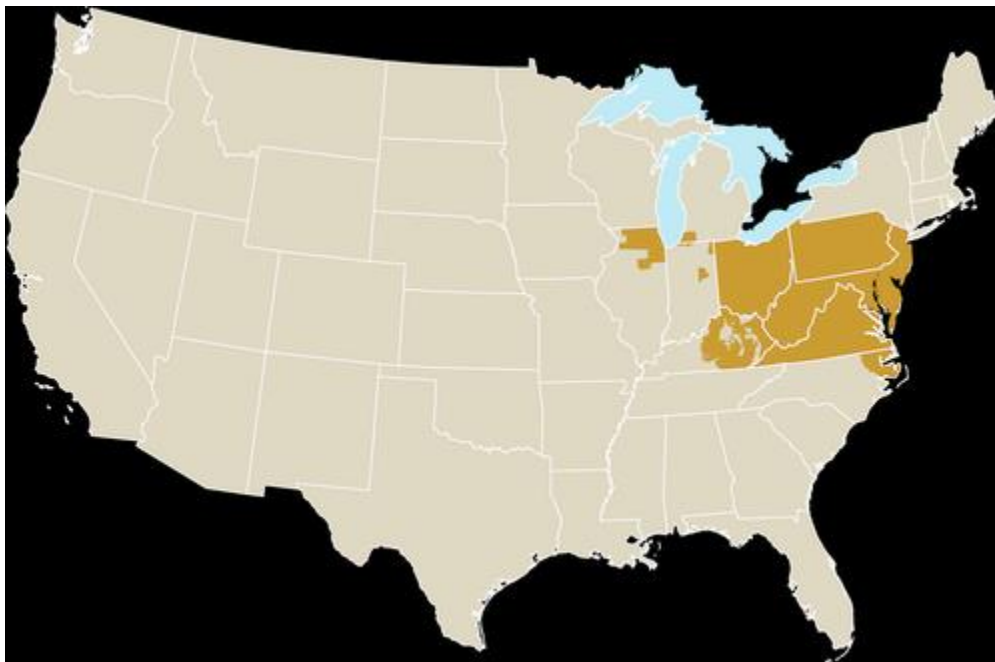


magnitude of that suppression under the conditions and assumptions most favorable to the reform opponents. Next, I compare the benefits accruing to Ohio customers from this potential wholesale price suppression to the tax that EDU consumers pay through their electric bills and then test the reform opponents' claim that reductions in wholesale electric prices flow through to lower retail prices. I conclude by examining who really benefits from the electricity usage reduction mandate and where the proceeds from the mandate tax go.

**A. Estimating the Magnitude of Potential Wholesale Price Suppression**

Ohio is part of the PJM Interconnection, LLC ("PJM") regional transmission organization, which has a footprint that covers all or parts of 13 states and Washington, DC (Figure 1). In addition to coordinating all of the electric generating plants in the region and ensuring the power system operates safely and reliably, PJM oversees a wholesale energy market in which buyers and sellers set market-based wholesale prices for electricity every hour.

**Figure 1: PJM**



Because the PJM wholesale electric market covers the multi-state region illustrated above, the Ohio mandate affects *interstate* commerce because the impacts of the Ohio mandate ripple through the interconnected electric grid system. Therefore, if the Ohio mandate suppresses wholesale electric prices, the impacts are spread throughout PJM and not confined solely to Ohio, or the retail customers paying the mandate tax.

In calendar year 2012, the latest year for which data is available, total retail electric sales in PJM were about 684 million megawatt-hours (“MWh”), as shown in Table 2. Of that amount, retail electric sales in Ohio totaled just over 152 million MWh.

**Table 2: 2012 PJM and Ohio Total Electric Sales**

Region	MWh
Ohio Total (IOU + Muni/Coop)	152,456,864
(less) Ohio-Muni/Coop	<u>16,121,557</u>
<b>Ohio IOU</b>	<b>136,335,307</b>
<u>PJM</u>	
DC+DE+MD+NJ+OH+PA+VA	564,606,218
ComEd	89,977,031
Indiana-Michigan Power	18,403,788
Kentucky Power	<u>6,660,656</u>
Dominion-NC	<u>4,114,548</u>
<b>PJM Total:</b>	<b>683,762,241</b>
<b>Ohio IOU Pct of Ohio Total:</b>	<b>89.4%</b>
<b>Ohio IOU Pct of PJM:</b>	<b>19.9%</b>

Source: EIA Form-861.

The electricity usage reduction mandate does not apply to Ohio’s municipal electric and cooperative utilities. Collectively, these exempted utilities accounted for just over 16 million MWh of Ohio retail electric sales in 2012. In that same year, retail electric sales by Ohio’s EDUs totaled just over 136 million MWh, or 19.9% of total retail electric sales in all of PJM.

The 2008 legislation containing the electricity usage reduction mandate set out specific annual mandate compliance requirements, as shown in Table 3. In 2009, the first year of the mandate, the EDUs were required to reduce electric usage by 0.3%. The law mandated an additional usage reduction of 0.5% in 2010, an additional 0.7% in 2011 and an additional 0.8% in 2012. The annual mandated usage reductions build on each previous year, so that, by the year 2025, the mandated amount of the usage reduction must be at least 22%.<sup>8</sup>

**Table 3: Ohio Mandated Electric Usage Reductions**

Year	Percentage
2009	0.30%
2010	0.50%
2011	0.70%
<u>2012</u>	<u>0.80%</u>
Cumulative Reduction	2.30%

Source: R.C. 4928.66

Because the reductions compound, e.g., the mandated 0.5% reduction in 2010 is based on a baseline consumption that incorporates the 2009 mandated reduction, and so forth, the precise value of the cumulative reduction is just under 2.30%. Specifically, assuming the mandate achieved the annual electric usage reductions set forth in the 2008 legislation, the cumulative reduction in usage over the four-year period, 2009 – 2012, is 2.30%. In other words, by the end of 2012, the electric usage reduction mandate should have resulted in retail electric sales that were lower by 2.30%. Because Ohio’s EDUs accounted for 19.9% of total PJM retail sales in

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<sup>8</sup> The reduction in electric consumption under the electricity usage reduction mandate is based on “normal” weather conditions. Because the weather is never “normal,” this requires developing models that estimate the sensitivity of electricity use to weather and adjusting actual consumption to determine what it would have been had the weather been “normal.” For readers interested in a brief introduction to how such weather normalization is accomplished, see Jonathan Lesser and Leonardo Giacchino, *Fundamentals of Energy Regulation*, 2d ed., (Public Utilities Reports, Inc. 2013), pp. 216-218.

2012, the mandated reduction of 2.30% in Ohio electric usage amounts to 0.45% of the total retail sales in PJM ( $19.9\% \times 2.30\%$ ), or less than one-half of one percent.

The next step of the analysis is to estimate the potential impact of a one-half percent reduction in total PJM retail electric sales on the PJM *wholesale* electric market. Specifically, how much higher would the wholesale price of electricity in PJM have been *without* the Ohio electricity usage reduction mandate?

Answering this question is difficult, because it depends on at least three factors. First, although the electricity usage reduction mandate sets annual reduction targets, the percentage usage reductions achieved in every hour within each year are not the same. For example, a homeowner who installs CFLs is unlikely to use less electricity than the homeowner used previously during the middle of the day or late at night, because the CFLs will most likely be switched off during those hours. Therefore, answering the wholesale price suppression question with the most accuracy would require knowing how the annual amount of mandated electricity usage reduction is spread over each and every hour of the year.

Achieving this level of precision in the case of residential customers is not possible, because few residential electric meters identify usage in each hour and how that usage is affected by, for example, the installation of CFLs. Therefore, all of the models that claim to estimate consumer benefits associated with mandated electricity usage reductions “guess” at how consumers and businesses behave, as well as how long such measures last.

Second, and contrary to the assumption in the AEEOI study summary, the electricity supply consumed by the retail consumers of Ohio’s EDUs is *not* sourced entirely or directly from the PJM wholesale market. Some of this electric supply is provided through long-term bilateral

contracts with prices negotiated by willing buyers and sellers. Some of this supply is also dictated by Ohio's supply-side alternative energy resource mandate.<sup>9</sup>

The distinction is important because, in the short-run, a decrease in the PJM hourly wholesale market price (called the "spot" price) doesn't automatically reduce the wholesale prices that are dictated by long-term contracts or Ohio's alternative energy mandate.

Furthermore, some of the electricity is purchased from suppliers outside of PJM, and will not be affected by lower PJM wholesale prices.<sup>10</sup> Finally some electricity, such as electricity consumed by AEP-Ohio's retail customers, is priced by reference to AEP-Ohio's electric generating plants or priced administratively by the PUCO, rather than by prices established by the PJM wholesale market, or any market for that matter. In other words, any price suppression of wholesale spot prices that might be properly attributed to the Ohio mandate only affects a slice of the overall wholesale electricity pie, a fact completely ignored by the reform opponents.

Third, the wholesale spot price of electricity is affected by many other factors, including the weather, the price of natural gas and coal used to generate power, the amount of wind power being generated, the availability of certain types of technologies, including intermittent resources, to reliably satisfy demand, reliability-related security constraints, scheduled outages, forced outages, economic conditions, the interactions of PJM member state's portfolio mandates

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<sup>9</sup> Ironically, if mandating electricity usage reductions is the "least cost" resource for Ohio retail consumers, the state's mandate requiring that a portion of that same retail electric demand be met with "alternative energy resources" prevents that "least cost" outcome because alternative energy resources, such as wind and solar power, are more expensive than conventional resources. Otherwise, there would be no need for a mandate that EDUs and other retail electric suppliers be required to purchase those resources.

<sup>10</sup> Because electricity is imported into PJM, as well as exported from PJM, changes in the PJM market can have a small impact on wholesale prices in other markets. However, as we discuss below, the electricity usage reduction mandate has such a small impact on the PJM market, that impacts in markets outside of PJM would be too small to measure.

and so forth. A comprehensive analysis of the impacts of the Ohio electricity usage reduction mandate would require a very complex empirical model that separated out all of these other effects so as to isolate and identify the incremental effect, if any, of Ohio's electricity usage reduction mandate in each and every hour.

Despite these analytical complexities and the limitations I briefly describe herein, which may seem like arguments about how many angels dance the polka on the head of a pin, I have nonetheless attempted to estimate the wholesale price impact of the Ohio electricity usage reduction mandate by making some simplifying assumptions. The simplifying assumptions tilt the results of the estimation process in favor of the claims advanced by the reform opponents.

First, I assumed that all electricity used by Ohio retail consumers is sourced directly from the PJM wholesale market. Although that is not a valid assumption for the reasons described previously, doing so gives the reform opponents the "the benefit of the doubt" by maximizing the wholesale price suppressive potential of the Ohio electricity usage reduction mandate.

Second, I assumed that the electricity usage reduction mandate reduced electricity sales by the full 2.30%, such that total PJM retail sales in 2012 were lower by the entire 0.45%.

Third, I assumed that the amount of electricity usage reduction is the same in every hour throughout the year. This simplifying assumption results in underestimating price "suppression" in some hours and overestimating it in other hours.

With these simplifying assumptions, I developed an estimate of the impact of Ohio's mandated reduction in electricity usage on the PJM wholesale market spot price.

According to the PJM Independent Market Monitor, *2012 PJM State of the Market Report* ("2012 SOTM"), the average wholesale price of electricity in PJM was \$33.06/MWh in

2012.<sup>11</sup> Assuming this average price per MWh reflects the full effect of Ohio’s 2.30% mandated reduction in retail electric usage, the reform opponents’ price suppression theory implies that the wholesale market price would have been higher without the Ohio mandate.

Estimating how much higher the average wholesale price might have been also depends on the responsiveness of PJM suppliers to wholesale prices. For example, during the recent “Polar Vortex” cold snap, PJM asked all available generators to produce the most power they possibly could, even to the point of running their plants at above their rated capacities. (An analogy is running your car’s engine in the “red zone” of RPM. You can do so for a very short time, but if you run the engine that hard for too long, the engine will fail.) At that point, there is no more supply to be had. So, even if the market price increases, supply doesn’t change. In other hours, a slight increase in price can lead to huge increases in supply. The physical response of generators in the PJM wholesale market is amplified because the PJM spot market pays all suppliers a “uniform clearing price” established by the price of the last supplier selected by PJM to meet demand. That is how competitive markets work.

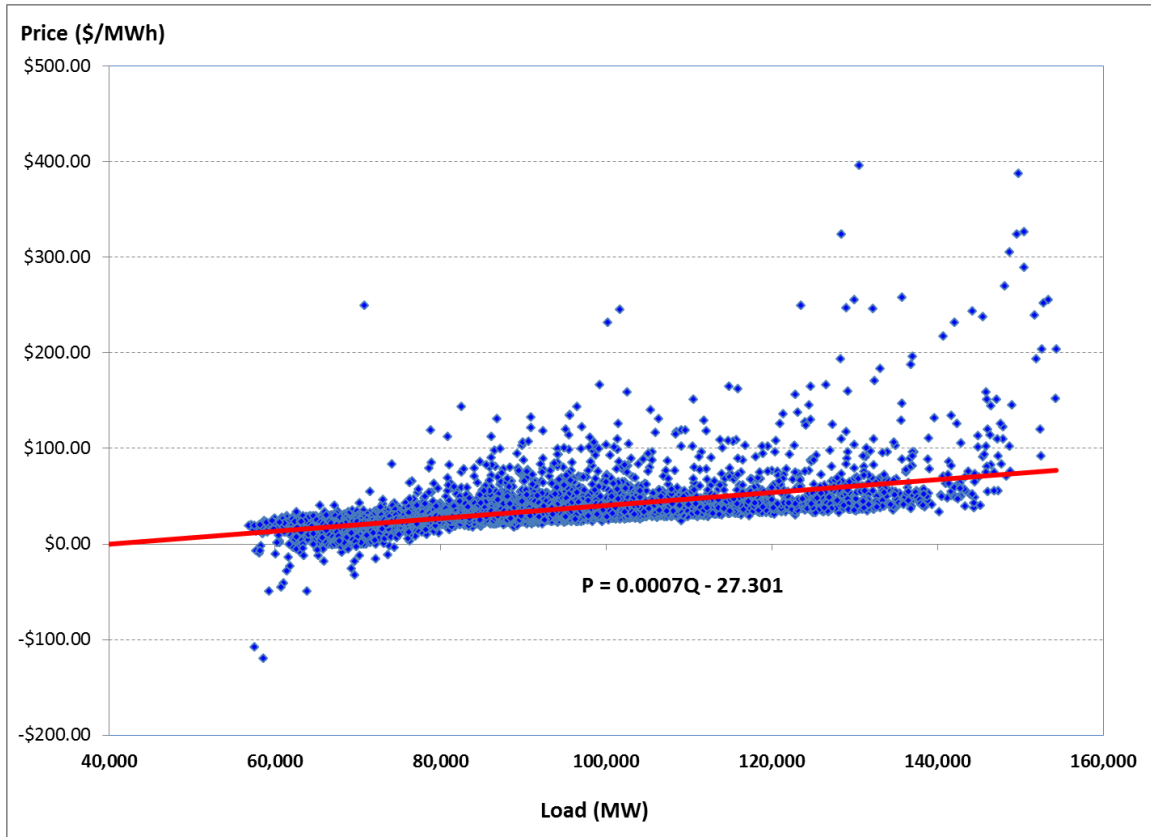
To examine the responsiveness of generation suppliers in PJM, consider Figure 2, which shows the market-clearing price and the amount of electricity supplied in every hour. The figure also includes a regression trend line, which is the statistical result of observations of the relationship between price and supply for the entire year. As we would expect, as prices increase, so does the amount of power supplied in the PJM wholesale market. I use this fitted regression trend line to estimate how much the Ohio electricity usage reduction mandate might have reduced the average PJM wholesale electric price in 2012. As expected, the regression

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<sup>11</sup> Source: PJM Independent Market Monitor, *PJM 2012 State of the Market Report* (2013), p. 51.

shows that the market price increases as demand (and the generation needed to meet that demand) increases.

**Figure 2: PJM 2012 Load and Price**



To estimate the impact of Ohio’s electricity usage reduction mandate, I used this regression trend line to predict what the average wholesale price of electricity would have been *but for* the Ohio electricity usage reduction mandate based on assumptions most favorable to the reform opponents. In other words, I estimated the increase in the published average market price of \$33.06/MWh that might have occurred had average electric demand in PJM been 0.46% greater but for the Ohio mandate. Specifically, using the regression trend line, if retail sales had increased by the estimated 0.45%, then the average PJM wholesale price would have increased by \$0.28/MWh (or \$0.00028/kWh) to \$33.34/MWh. The \$0.28 increase per MWh implies an



overall increase in the resulting cost of wholesale electricity in the multi-state PJM wholesale market of about \$333 million.<sup>12</sup>

Because the usage of Ohio's retail consumers accounted for 19.9% of total retail sales within the PJM region, then the wholesale price suppression benefit share available to Ohio EDU retail consumers would have been 19.9% of the total PJM price suppression of \$333 million, or an Ohio share of just over \$66 million. The remaining \$267 million of the reform opponents' wholesale price suppression benefits would have gone to customers elsewhere within the PJM region at no cost to the recipients. In other words, 80% of the price "suppression" benefits paid for by the consumers of Ohio's EDUs accrued to other PJM wholesale market participants. In effect, all of those other PJM customers enjoy a "free ride" at the expense of the Ohio retail electric consumers served by EDUs.

There is one other, and rather ironic, potential effect of the price suppression claim advanced by the reform opponents, which is an economic consequence of their own price suppression theory. If the Ohio electricity usage reduction mandate really does suppress wholesale prices throughout PJM, it has reduced the incentive for consumers outside Ohio to invest in energy efficiency measures more than they would have *but for* the price suppression benefit they received compliments of Ohio. In other words, mandating electricity usage

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<sup>12</sup> Advocates of the current electricity usage reduction mandate may criticize my analysis for not including the impacts of reductions to peak loads, which are also required under the legislation, and thus not crediting savings in the separate PJM capacity market. I did not do so because capacity market prices are established by PJM in an auction that takes place three years before the corresponding PJM planning year, which runs from June 1 to May 31. Thus, the capacity market prices for the June 2009 – May 2010 PJM planning year were set in 2006, two years before the Ohio legislation was even introduced. The only auction that might have been affected was the one that took place in the spring of 2009 for the 2012 – 2013 planning year. However, because Ohio EDUs had no approved load control programs in place at that time, that planning year's auction price would also not have been affected.

reductions *inside* Ohio has the unintended consequence of increasing electricity usage *outside* Ohio. Thus, in the aggregate, mandated electricity usage reductions in Ohio may reduce electricity sales within the entire PJM footprint less than suspected, if at all. The reform opponents have completely ignored these outside Ohio effects of their price suppression theory.

Despite this unintended consequence, and ignoring the fact that not all of the electricity used by Ohio consumers is supplied from the PJM wholesale spot market, I estimated the impact of wholesale price suppression on a typical Ohio EDU residential customer. Spread out over total Ohio EDU retail sales shown in Table 1, the \$66 million price suppression benefit equates to an annual average retail price reduction of \$0.00049/kWh of electricity sales. The PUCO calculates typical residential customer bills based on average consumption of 750 kWh per month. At that consumption level, the typical Ohio residential customer would have received, according to the reform opponents, a flow-through price suppression benefit of just under \$0.37 per month, or \$4.38 for the entire year. Again, this assumes that the *entire* wholesale price suppression effect flows into retail rates on a dollar-for-dollar basis and ignores any increases in consumption outside of Ohio because of price suppression.

### **III. Comparing the Electricity Usage Reduction Mandate's Costs and Benefits**

As Table 1 shows, through 2012 the EDUs budgeted about \$600 million for the energy reduction mandate. How does this compare with the benefits to their customers? How do the wholesale price reductions estimated in the previous section compare with the mandate taxes levied on Ohio customers to fund the cost of complying with the energy reduction mandate?

First, let's examine the retail price flow-through benefit claim. To do that, I compare the estimated wholesale price savings calculated in the previous section with how much Ohio EDU

customers paid on their electric bills to fund these energy reduction programs. The PUCO website provides access to the EDUs' approved tariffs and rates. For example, AEP-Ohio Columbus Southern zone's published distribution tariff shows that it began charging residential customers 0.289 cents per kWh (\$0.00289) on September 1, 2012 to fund its energy use reduction mandate budget. For a typical residential customer using 750 kWh per month, that is equivalent to a charge of \$2.17 per month to fund the energy reduction mandate. Thus, the mandate tax paid by a typical AEP-Ohio Columbus Southern zone residential customer was *at least* seven times greater than the price suppression benefit theorized by the reform opponents for 2012. In other words, AEP-Ohio Columbus Southern zone residential customers were *forced* to pay *at least* one dollar for every 15 cents of claimed price suppression benefit they received. Similar results hold for residential customers of the other EDUs. Residential customers of Duke Energy fared "best," paying only \$1.75 per month for their 37 cent benefit. Dayton Power & Light residential customers fared worst, forced to pay \$3.90 per month for that 37 cent benefit.

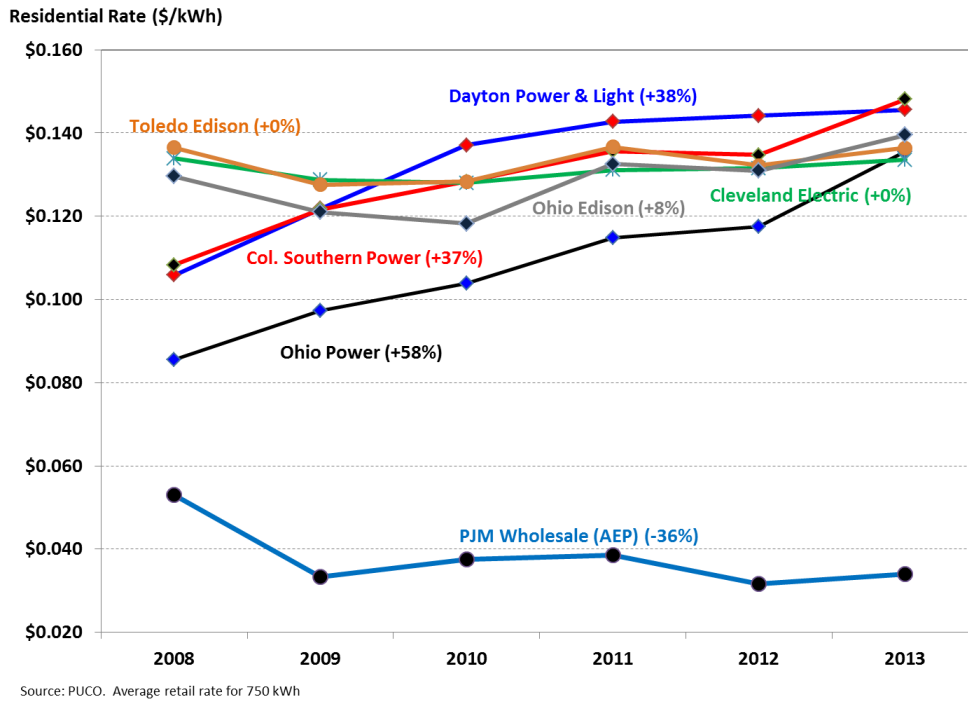
#### **A. Retail Rate Impacts**

In addition, one of the claims made by the reform opponents is that the mandate reduces retail electric prices because the suppressed wholesale prices flow into retail electric prices on a dollar-for-dollar basis. Thus, as the mandate's cumulative energy usage reductions have increased, we would expect to see the rates charged by EDUs reflecting those wholesale price reductions.

However, the mandate tax paid by Ohioans is contributing to the year-over-year increases in Ohio's retail electric bills. As Figure 3 shows, between 2008 and 2013, average retail electric prices have increased significantly for many residential customers, during a period when average wholesale electric prices in the PJM spot market have *decreased* by more than one-third.

Therefore, contrary to the findings of the AEEOI analysis, the electricity usage reduction mandate is *not* reducing retail electric prices on a one-for-one basis to wholesale prices. Ohio’s retail electric bills indicate that what happens in the wholesale market stays in the wholesale market.

**Figure 3: Residential Retail Rates and PJM Wholesale Prices, 2008 – 2013**



It is true, of course, that the increases in retail electric prices in Ohio are not solely due to the electricity usage reduction mandate. Retail customers must also pay for costly renewable resources to meet the state’s renewable portfolio standard, as well as pay for the mostly fixed cost of operating transmission and distribution systems and, as discussed previously, pay for some of the EDUs’ lost revenues stemming from these same usage reduction mandates. Also, Ohio’s retail electric rate schedules are increasingly populated with so-called “reconciliation” riders that are designed to recoup some of the revenue not collected because of a decline in electricity usage. As discussed above, traditional regulation of utilities can cause electricity prices to rise as usage declines to provide an EDU with an opportunity to collect “just and

reasonable” compensation for its fixed costs. In some respects, therefore, the reform opponents are *misleading* consumers into believing their electric bills and electric prices will decrease if Ohio continues to mandate electricity usage reductions.

#### **IV. Winners and Losers**

The dichotomy between the above-illustrated decreasing PJM wholesale market electricity prices and the increasing Ohio retail electricity prices raises two additional, and related, issues: (1) where have the \$1 billion or so in mandate taxes paid by Ohio retail electric consumers gone; and (2) who really benefits from the electricity usage reduction mandate?

*If the wholesale price suppression claim is correct, then the biggest winners from the Ohio electricity usage reduction mandate are the consumers and market participants inside and outside Ohio who don't pay the mandate tax.* To the extent that the Ohio mandate really has “suppressed” PJM wholesale electric prices, the in-state and out-of-state consumers and market participants who do *not* pay the mandate tax are collectively capturing almost 80% of the suppression benefit theorized by the reform opponents. These consumers and market participants are classic “free-riders.”

*Ohio businesses are therefore being forced to subsidize some of their out-of-state competitors, including those competitors within the PJM region that are not subject to any mandates or their costs.* Thus, the reform opponents are implicitly urging Ohio's leaders to leave in place a law that gives out-of-state businesses a competitive advantage while imposing a competitive disadvantage on in-state businesses. *Doing this cannot possibly enhance economic growth, job retention and job creation in Ohio.*

Nevertheless, the reform opponents claim that the Ohio economy benefits from the electricity usage reduction mandate. The Ohio mandate compliance scheme may well allow

some consumers and businesses to extract more benefits than they may pay for through the mandate tax. And it may be true that some Ohio companies that manufacture, sell, and install energy efficiency measures benefit in excess of their share of the mandate tax.

However, it is clear that the majority of Ohio consumers and businesses are *not* benefitting from the electricity usage reduction mandate. Ohio retail electric prices have increased significantly, not declined, since the mandate went into effect. As the electricity usage reduction mandate escalates from year to year in the future, along with the costs of complying with the mandate, Ohio's retail electric prices will continue to increase, even if the wholesale market price "suppression" claim has merit. The Ohio mandate scheme forces the many to subsidize the few and redistributes Ohio consumers' wealth in ways that are incompatible with Ohio's economic well-being and future economic growth.

## **V. Conclusions**

Even using the most favorable assumptions about the impacts of the electricity usage reduction mandate on the PJM wholesale market, the taxes paid by EDU customers on their electric bills to fund the mandate appear to be at least five to thirteen times larger than the possible price suppression "benefits" these same customers are allegedly receiving. Clearly, forcing residential customers to pay between \$1.74 and \$3.92 per month for a 37 cent benefit is no bargain, especially when the vast majority of the benefits accrue to consumers and businesses outside Ohio who "free ride."

The reform opponents implicitly assume that without the mandate, Ohio consumers and businesses will not invest in measures to reduce their electricity usage even when the benefits they realize from doing so exceed their costs. Yet, the DEEPS model, on which the AEEOI study relies for its "free lunch" findings, not only suffers from fatal structural flaws (see the

appendix) that make it useless as a policy instrument, but assumes that consumers and businesses *do* make these same investments whose benefits exceed their costs. This is a fundamental inconsistency in the study that is neither revealed nor explained by the reform opponents.

As my report makes clear, Ohio consumers and businesses are suffering economic harm *because* of the mandate. The mandate places Ohio businesses at a competitive disadvantage relative to out-of-state competitors, which will harm the Ohio economy, leading to less economic growth and lost jobs.

## Appendix: Understanding the AEEOI Model

As discussed in the main body of this report, many opponents of efforts to reform the electricity usage reduction mandate rely on the results published by the AEEOI study, which are based on its “Dynamic Energy-Economic Policy Simulation” (“DEEPS”) model. Although AEEOI has never provided the underlying assumptions of the DEEPS model, a brief description of the model can be found in a report published in 2011, titled, “Assuring Ohio’s Competitiveness in a Carbon-Constrained World.”<sup>13</sup>

The DEEPS model is what economists call a “Computable General Equilibrium” (“CGE”) model.<sup>14</sup> CGE models attempt to model all of the interactions within an entire economy and how they affect one another, building on what economists call “general equilibrium theory.” For example, suppose Ohio imposed a \$50/ton tax on all carbon emissions, including all electric generating plants, manufacturing facilities, commercial entities (e.g., bakeries and dry cleaners), and all fossil fuel consumption. The effects of this tax would ripple through Ohio, affecting the prices of goods and services, economic growth, population, and carbon emissions. A CGE model would attempt to determine what the Ohio economy would look like once the impacts of this tax had been fully absorbed. Another way to think of a CGE

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<sup>13</sup> Chapter 9 of this report, which contains information about the DEEPS model, can be downloaded at: [http://www.ohioenergyresources.com/Docs/AssuringOhiosCompetitiveness\\_OUOSU\\_Ch9.pdf](http://www.ohioenergyresources.com/Docs/AssuringOhiosCompetitiveness_OUOSU_Ch9.pdf)

<sup>14</sup> For a detailed discussion of how CGE models are structured and can be used, see I. Wing, “Computable General Equilibrium Models and Their Use in Economy-Wide Policy Analysis,” MIT Joint Program on the Science and Policy of Global Change,” Technical Note 6, September 2004. Available at: <http://globalchange.mit.edu/research/publications/524>. See also, C. Bohringer, T. Rutherford, and W. Wiegard, “Computable General Equilibrium Analysis: Opening the Black Box,” Centre for European Economic Research, Discussion Paper 03-56, 2003. Available at: <http://ftp.zew.de/pub/zew-docs/dp/dp0356.pdf>.



model is to imagine the Ohio economy (or any economy) as a cue ball sitting on a pool table. The cue ball is in equilibrium because it is not moving. Now we hit the cue ball (the policy change). Eventually, the cue ball comes to rest somewhere else on the pool table, which is the new equilibrium. Only, with a CGE model, that new equilibrium can take years to reach.

As one might expect, simulating the workings of an entire economy and the behavior of millions of individuals and businesses is a daunting task. As a result, CGE models make many simplifying assumptions. Although all models simplify reality, too many simplifying assumptions render a model's results useless. That, in fact, is the problem with the DEEPS model.<sup>15</sup> It is useless.

One of the most critical assumptions in a CGE model is how goods and services are produced, and how easily production can be adjusted in response to changing prices and technology. For example, improved generating technology has reduced the amount of natural gas required to produce one kilowatt-hour of electricity in combined-cycle generating plants. Similarly, electric arc furnaces have made it possible to produce steel using far less energy than old style blast furnaces. And, automobile engineers have improved internal combustion engine technology to reduce gasoline usage while increasing horsepower. Energy efficiency is one manifestation of production, and energy efficiency in Ohio is but one part of what may be happening within the entire PJM region. For example, CFLs produce light using less electricity

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<sup>15</sup> Another type of error that can occur with CGE models stems from the computer programs they are based on. If there are coding errors, the model results can be entirely wrong. The DEEPS model has at least one major coding error that I discovered. For example, it is possible to model a carbon constraint in DEEPS which results in total Ohio carbon emissions that are less than zero, which is impossible, while at the same time creating millions of new Ohio jobs. This is an obvious programming error in the model.

than incandescent lights. Adding insulation to the walls and ceiling of a house lets one produce the same level of “comfort” with less energy.

The ability to substitute inputs is called, unsurprisingly, the *elasticity of substitution*. Moreover, the elasticity of substitution determines how the relative *expenditure* on goods or factor inputs changes as relative prices change. Consider the \$50/ton carbon tax example, except that we only apply it to electricity. The tax would raise the price of electricity, which would lead electricity users to reduce their electricity consumption, for example, by investing in energy efficiency measures. However, the ability to substitute away from electricity can become more difficult and more expensive over time, as the “low-hanging fruit” is consumed.

The ability to change the mix of inputs used to produce goods and services varies over time, in response to changing technology and prices. For example, in response to higher electric prices, suppose a homeowner or business has installed LED lights, which are the most energy efficient lighting technology in existence today. If the price of electricity keeps increasing, the only way the customer or business can respond is by reducing the amount of light used.

In a CGE model, the ease of substitution between inputs depends on assumptions that are made about what are called *production functions*. DEEPS uses a specific form of production function, called a Cobb-Douglas function. Cobb-Douglas production functions are simple to work with, and so make CGE models easier to run.<sup>16</sup>

For a Cobb-Douglas production function, the elasticity of substitution is always equal to one and, as a result, for this type of production function, the relative expenditures on factor inputs never change no matter how much the relative prices of those inputs change. For small

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<sup>16</sup> With two inputs,  $x_1$  and  $x_2$ , used to produce good  $y$ , the Cobb-Douglas production function is:  
$$y = x_1^\alpha x_2^{1-\alpha}.$$

prices changes, that may be a reasonable assumption. But as relative prices change more and more, it is unrealistic to assume that a firm will always spend the same amount on each input.

Another key assumption is the rate of technological change. If technology is assumed to change relatively quickly towards lower-cost production, then a CGE model can result in counterintuitive results. Consider again the Cobb-Douglas production function used by DEEPS. Although the relative expenditures of inputs never change, the total expenditures can. Specifically, the faster is the assumed rate of technological change, the less costly will be production. Similarly, production costs decrease as the assumed labor productivity growth rate increases. In fact, the DEEPS model specifically includes “technology” as an input. As stated in the “Assuring Ohio’s Competitiveness” report, “[e]nergy efficiency is calculated using a reference *exogenous* input, which represents business-as-usual longer-term technology improvements, and the impact of increasing energy prices. Increasing energy efficiency has an impact in turn on energy consumption and expenditure.”<sup>17</sup> Nowhere is the value of that exogenous input identified or documented by the reform opponents; yet, for purposes of energy policy considerations, understanding how this value has been used in the model is crucial to determining the validity and reliability of the model’s output.

Ultimately, as is the case with all CGE models, the input assumptions are crucial. Changing assumptions can make these models produce any results desired, including the counterfactual results the DEEPS model produces. Although it is possible to download the DEEPS model and run it, as I have, the specific parameters assumed in the model are not to be found. Because of the obvious errors the model can produce, such as negative total carbon

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<sup>17</sup> Assuring Ohio’s Competitiveness in a Carbon-Constrained World, Chapter 9, p. 58 (emphasis added).

emissions, and the persistent refusal of the reform opponents to explain precisely how the model was used, Ohio policy makers should not rely on the DEEPS model at all.