The long-run price elasticity of electricity demand*

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PRELIMINARY AND INCOMPLETE.
NOT FOR GENERAL CIRCULATION.

Abstract

Understanding how consumers respond to electricity prices is vital for predicting the effects and incidence of climate change policy. However, we have little information about the long-run response of electricity usage to changes in price, primarily because existing estimates have relied on price changes that are transient or endogenous. We provide estimates of this elasticity in both the short-run and the long-run by evaluating the effects of a policy change in Illinois that resulted in plausibly exogenous, long-lasting price changes in many communities. Participating communities experienced average price drops of 20-25 percent in the first year of implementation and 14-16 percent in the year after, relative to non-participating communities. Using a flexible matching approach, we estimate that usage increased by 2-6 percent over different points during this time period. The magnitude of the estimated aggregate elasticity increased from 0.13 in the first year of implementation to 0.25 in the second year. Our long-run estimate is larger than many existing estimates, suggesting that accounting for the dynamics of a response to policy change is essential for projecting policy impacts and welfare analysis.

JEL codes: Q41, Q48

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1 Introduction

The threat of climate change has prompted many governments to try to curb their greenhouse gas emissions. The electricity industry is a natural target of these efforts because it accounts for a large share of emissions and has relatively few emitters. Electricity prices in some countries, such as Germany, have already increased substantially as a result of such efforts (Karnitschnig, 2014). Evaluating the impacts and incidence of climate policies depends crucially on the price elasticity of demand. For example, determining the decrease in emissions corresponding to a given carbon tax or evaluating the costs of policy that sets a cap on emissions requires knowledge of this parameter. Critically, it is important to obtain an estimate of the *long-run* price elasticity of demand, because most policies targeting the electricity sector are intended to be long-lasting.

Yet, there is little consensus on the value of the long-run price elasticity of demand for electricity. It is challenging to estimate this parameter: large and lasting changes in prices are rare, and when they do occur it is difficult to find a credible control group. Many price changes, such as a sudden increase in the price due to an unusually hot summer, are likely to be endogenous and are often only temporary. Small price changes, such as those due to short-run changes in fuel costs, are more frequent but may not be salient to consumers. Moreover, a large fraction of electricity consumption comes from durables such as refrigerators and air conditioners, so the long-run response of consumers may differ significantly from the short-run response.

We overcome these challenges by exploiting plausibly exogenous variation in electricity prices attributable to Illinois' Municipal Electric Aggregation (MEA) program. Illinois passed a law in 2009 allowing municipalities to choose an electricity supplier on behalf of their residents. Municipalities interested in participating in MEA were required to first pass a local referendum approving the policy. Individuals could opt out of their city's aggregation if so desired, but the default was to switch all incumbent customers to the chosen supplier. Importantly, because the electricity *distributor* did not change, the switch affected only the price on the electricity bill. The billing format did not change, and consumers did not have to take any action to benefit from aggregation. As of February 23, 2016, 741 of Illinois' 2,800 communities had approved aggregation programs, and the vast majority switched suppliers as a result.[1]

Our analysis employs monthly community-level data from ComEd, one of the two electricity distributors in Illinois. ComEd services 885 of Illinois' communities, including the city of Chicago. We estimate the effect of the adopting MEA using two complementary analyses. The first estimates a difference-in-differences model that compares changes in electricity usage among communities that passed MEA at different points in time. Our identifying assumption is that the timing of MEA passage is exogenous with respect to electricity usage. We show that this is likely to be the case in

[1]Source: https://www.pluginillinois.org/MunicipalAggregationList.aspx

our sample, as these communities do not show substantially different electricity trends prior to the passage of MEA.

The second analysis estimates a difference-in-differences matching estimator based on the work of Abadie and Imbens (2006) and Abadie and Imbens (2011). We match each MEA towns to five "nearest neighbors" on the basis of their electricity usage in 2008 and 2009, which precedes the first implementation of MEA by a year and a half. The matching estimator requires that the outcome conditional on a match is independent of whether or not a town selects into treatment. The advantage of this methodology is that it can reduce both bias and noise by eliminating inappropriate control towns and flexibly predicting counterfactual usage. We present some evidence to mitigate potential endogeneity concerns of this estimator.

Both approaches yield qualitatively similar results. We adopt the the matching estimator as our preferred specification because it significantly reduces the noise in the estimation and best fits pre-referendum usage trends. We find that usage increased by 1.4-5 percent in the two years following the referendum. This specification estimates that the aggregate elasticity was -0.13 in the first year after the referendum and -0.25 in the second.[2] Our short-run and long-run estimates are consistent with earlier estimates, which range from -0.07 or -0.09 (Ito, 2014) to -0.39 (Reiss and White, 2005). We find that consumers are more elastic in the long run than the short run. We expect consumers to adjust more in the long run, through learning, changing consumption habits, and the purchase of energy-efficient appliances. Our results suggest that studies based on short-run changes in electricity prices substantially underestimate the long-run price elasticity of electricity demand.

Theory suggests that the optimal tax on greenhouse gases should equal the marginal damage caused by the externality at the optimal level of emissions. Unless marginal damages are constant, which is unlikely in the case of greenhouse gases, the optimal tax will depend on the optimal level of emissions. This requires knowledge of the marginal abatement cost which, in turn depends on the price elasticity of electricity demand. Needless to say, the optimal level of emissions is extremely difficult to determine, and policymakers frequently set rule-of-thumb goals, like limiting warming to less than 2° C or reducing emissions by a certain percentage relative to a baseline. In this setting, the price elasticity of electricity demand is needed to determine either 1) the relationship between changes in electricity prices and emissions or 2) the costs of meeting a cap-and-trade emissions goal. Because such policies are long-lasting, the relevant price elasticity is one corresponding to long-lasting price changes.

The electricity sector was responsible for 30% of US greenhouse gas emissions in 2014, more than any other sector (U.S. Environmental Protection Agency, 2016), and is thus very likely to be a target of any carbon policy. Indeed, one of the first proposed greenhouse gas regulations

[2] With fewer observations, we estimate that it falls to -0.28 in months 25 through 30.

in the U.S., the EPA's Clean Power Plan Rule, addresses only carbon emissions from electricity generation. The effectiveness and/or social cost of such regulation depend significantly on the price elasticity of demand. All else equal, underestimating the price elasticity of electricity demand will lead to an underestimate of how much a carbon tax would reduce emissions, while overestimating it would do the opposite. Under cap-and-trade or a similar policy, underestimating the price elasticity will make any policy appear more costly than it actually is. Finally, the price elasticity also affects how the benefits and costs of carbon policy are distributed among producers and consumers.

In their analysis of the Clean Power Plan Rule, Bushnell et al. (2015) set the median demand elasticity to -0.05, an extremely low value meant partly to reflect imperfect pass-through in the wholesale electricity market. Because there is little empirical work on the long-run price elasticity of electricity demand, it is *ex ante* difficult to judge whether this assumption is appropriate. However, in their study of the Spanish wholesale of the electricity market, Fabra and Reguant (2014) estimate the pass-through of carbon prices to be nearly full. Combined with this finding, our estimates suggest that the policy-relevant price elasticity should be substantially higher. The findings of Fabra and Reguant (2014) also suggest that the price elasticity of consumers and other energy users is of first-order importance for translating emissions prices into emissions reductions.

There is also a substantial literature on the role of "nudges", social norms/peer comparisons, and information provision in consumer electricity use (e.g., Allcott, 2011b; Ayres et al., 2013; Costa and Kahn, 2013; Jessoe and Rapson, 2014; Gilbert and Graff Zivin, 2014; Allcott and Rogers, ming). Whether such mechanisms are efficient means of reducing electricity usage, however, depends on both how they affect utility and how sensitive consumers are to electricity prices. The latter question has proven difficult to answer. The majority of prior work has relied on small and/or potentially temporary price changes that may not have been anticipated or recognized by the consumer (e.g., Ito, 2014; Jessoe et al., 2014). Jessoe and Rapson (2014) show that informing consumers about price increases is crucial: households that are informed are significantly more responsive to short-run price increases. Our estimates also suggest that information is important for longer-run price changes and that studies relying on month-to-month changes in electricity may be underestimating the responsiveness of consumers to longer-run price changes. Moreover, Allcott (2015) has shown that the benefits of social norms estimated by researchers may be overstated, as early adopters may also be more responsive. Our analysis mitigate this concern by imposing a municipal-level policy on a heterogeneous set of customers. Additionally, the price structure in our data is simple: on top of a monthly fixed fee, customers pay a single rate for each kilowatt-hour of electricity they consume. Given the simplicity of the pricing scheme, consumers are more easily able to respond to the marginal price.

Finally, there is a growing literature on the impact of real-time pricing (e.g., Wolak, 2011; Allcott, 2011a; Jessoe and Rapson, 2014). The elasticity we identify here is fundamentally different from the elasticity estimated in the real-time pricing literature. The latter reflects intra-day substitution patterns as well as any overall reductions in electricity. In our case, we are able to pick up both short- and long-run changes in electricity usage.

The rest of this paper is organized as follows. Section 2 discusses the history of electricity market regulation and Municipal Electric Aggregation in Illinois. Sections 3 and 4 describes our data and empirical approach, respectively. Section 5 presents and discusses the results, and Section 6 concludes.

2 Electricity Market Regulation in Illinois

2.1 Background on the Illinois electricity market

For the majority of the 20th century, the supply of electricity in Illinois was controlled by two regional monopolies: Commonwealth Edison Co. ("ComEd") and Ameren Illinois Utilities ("Ameren").[3] These two utilities both generated electricity and delivered it to everybody in the state. Deregulation was introduced in 1997 with the passage of the Electric Service Customer Choice and Rate Relief Law ("Customer Choice Act"), which separated generation from delivery. ComEd and Ameren remained the sole distributors, but they were prohibited from participating in the generation of electricity and had to sell all assets related to electricity generation.

In August of 1998, the Customer Choice Act reduced the electricity rates of residential and small commercial customers by 15-20 percent and kept them at that level for a period of 5 years. The act was later amended to extend the rate freeze through the end of 2006.

In May of 2002, residential and small commercial customers gained the ability to buy their electricity from competing providers, called alternative retail electric suppliers (ARES).[4] However, because of the rate freeze and other barriers to competition in the residential market, ARES initially served commercial customers only. By October 2005, 22,000 commercial customers were purchasing their electricity from an ARES, but the residential market remained practically nonexistent. The state tried to encourage the ARES to serve the residential market by passing the 2006 Retail Electric Competition Act, which removed some barriers to competition and provided discount programs to customers, but this had little effect. By 2009, only 234 residential customers had switched electricity providers. By contrast, there were 71,000 small commercial, large commercial, and industrial customers who had switched (Spark Energy, 2011).

In response to the perceived failure of deregulation in the residential and small commercial markets, the state decided to hold a procurement auction in order to choose their electricity sup-

[3] Ameren was formerly known as Illinois Power Co.

[4] Large commercial and industrial customers gained this ability at the end of 1999.

pliers and avert a rate hike following the end of the rate subsidies in 2007. However, the auction did not result in low prices and was widely considered a failure. Electricity rates jumped by over 50 percent for most residential and small commercial customers beginning in January of 2007. Following a public outcry, Illinois passed the 2007 Power Agency Act, which provided new rate subsidies for residential and small commercial customers.

2.2 The introduction of Municipal Electric Aggregation

In 2009, the Power Agency Act was amended to allow Municipal Electric Aggregation (MEA), whereby municipalities or counties can vote in a referendum that would allow them to negotiate the purchase of electricity on behalf of their residential and small commercial customers.[5] The amendment was motivated by the observation that few consumers switched away from the incumbent supplier on their own, even when the potential savings were large. In order to ensure that individual consumers retained the ability to choose their provider, municipalities had to allow individuals to easily opt out of aggregation.

In order to implement an opt-out MEA program, municipalities must first educate their communities about MEA using local media and community outreach meetings. After the proposed MEA program has been registered with the state, the municipality must hold a referendum.[6] If the referendum is approved, the municipality must develop a plan, hold public hearings on it, and then have it approved by the local city council. A typical plan consists of soliciting bids from several different suppliers and then selecting the one that submits the most attractive bid. The two main ways in which suppliers differentiate themselves are price and environmental friendliness (i.e., what percent of the generation is from "renewable" sources). Because of the second component, a community will not necessarily select a supplier with the lowest price. Once a supplier is chosen, the price is guaranteed for the length of the contract, typically about 24 months.

Importantly, instead of having to "opt in" to an ARES, customers in a town that passed an MEA referendum are automatically switched to the electricity supplier chosen by their community unless they opt out by filling out and mailing a card, calling, or going online.[7] MEA officially begins at the conclusion of the opt-out process. When MEA starts, the only change to the consumer's electric bill is the electricity supply rate. The bill is still issued by the incumbent distributor, either Ameren or ComEd. The bill includes additional charges for distribution and capacity, which are charged

[5] The amendment went into effect on January 1, 2010. On July 18, 2012, the act was further amended to allow for township governments to pursue aggregation. Two or more communities can also join together to implement a single MEA plan.

[6] The wording of the referendum question is specified in the Act and given in the Appendix.

[7] The few residential customers who had already opted into an ARES or into real-time pricing are not switched over to the chosen supplier.

by the utility.[8] Conveniently, this means that the price effects of MEA will not be confounded by billing confusion. A sample letter notifying households of the MEA program and a sample opt-out card can be found in the Appendix.

It might seem like there is little or no cost to passing Municipal Electric Aggregation, as residents could always opt out. Indeed, Municipal Electric Aggregation has proven very popular in Illinois. As of March 2016, 741 of Illinois' 2,800 communities voted to implement MEA. However, a number of Illinois communities voted on but did not pass MEA. There are several possible reasons for this.[9] If residents do not trust their local government to choose the cheapest supplier and they perceive the costs of opting out as nontrivial, it may be rational for them to vote "no". Some residents may have been concerned about the resulting electricity use increase for environmental reasons. Others may not have understood the opt-out provision (although it is mentioned in the referendum) or thought that choosing an electricity provider for residents was a waste of local resources.

3 Data

We obtain electricity usage data from ComEd, one of the two electricity distributors in Illinois. ComEd serves the vast majority of communities in Northern Illinois, including the city of Chicago. We observe monthly residential usage at the municipality level for 779 ComEd service territories for the time period January 2007 through June 2014.[10] 300 of these communities passed a referendum on MEA in our analysis period (see Table 1) and 289 implemented the program.[11]

We obtain data on ComEd's electricity prices from the ComEd ratebooks, which were obtained from the Illinois Commerce Commission.[12] We obtain data on MEA referenda dates, MEA supply prices, and MEA implementation dates from a variety of sources, including PlugInIllinois, websites of electricity suppliers, and municipal officials. The median length of time between passing the referendum and the MEA contract start date is 4 months; there are 11 communities in our sample where MEA was passed but never implemented. Because the vast majority of contracts last at least twelve months and because our estimation strategy is focused on the effect of MEA in its first two years, our estimates will largely be based on the first MEA contract signed by the community.

[8] A sample bill from ComEd is included in the Appendix.

[9] These are based on authors' attendance of a public hearing in Champaign as well as discussions with ComEd and the Illinois Commerce Commission, which regulates Illinois electricity providers and distributors.

[10] ComEd provides service to 885 communities; the remainder were removed due to missing usage data or usage patterns that suggested a change in how a community's territory is defined.

[11] Though our usage data ends in June 2014, we include 5 towns that passed a referendum in November of 2014.

[12] Prior to June of 2013, customers with electric space heating faced a lower rate than those with non-electric space heating. Because electric space heating is relatively rare and because we do not observe household-level usage, we assume that the incumbent rate is equal to the non-space heating rate, which will be true for the majority of non-MEA customers.

Finally, we obtain data on community characteristics from the 2005-2009 American Community Survey (ACS) Summary File.

A consumer's electricity bill depends on a combination of usage rates and fixed fees.[13] Towns that implement MEA sign a contract with an electricity supplier that specifies a particular supply rate, which is the largest component of the usage rates. Figure 1 displays ComEd's monthly supply rate, and the total of all its other usage rates, during our sample period. The blue line in Figure 1 shows the average monthly supply rate for towns that adopted MEA. This line begins on June, 2011, the date that the first town adopted MEA. The average MEA supply rate is always lower the ComEd supply rate. Illinois does not employ "block pricing", so the marginal price of electricity is constant.

There is heterogeneity in the MEA contract rates, and the difference between these rates and the ComEd supply rate changes over time. Figure 2 illustrates this variation. We plot the mean, the 90th percentile, and the 10th percentile of log changes from the ComEd price as a function of the number of months since the MEA referendum. We use the referendum date as our base period to conservatively capture anticipation effects that might occur prior to the actual price change.[14]

Table 2 summarizes the characteristics of ComEd communities that did and did not pass MEA, as well as communities that both passed *and* implemented MEA. In general, communities that passed and/or implemented MEA are larger, wealthier, younger, and more educated than non-MEA communities. However, their 2010 per capita electricity consumption is not significantly different from communities that did not pass MEA.

4 Empirical strategy

Our empirical strategy is based on a plausibly exogenous shift in electricity rates for towns that implemented the MEA program. We employ two complementary frameworks to estimate the corresponding change in usage. First, we estimate a standard difference-in-differences model. Second, we estimate a matching model that enables us to reduce noise in our estimation by selecting appropriate control towns.

4.1 Difference-in-differences framework

We estimate the following difference-in-differences model:

[13]The average fixed fee for customers residing in ComEd's service territoriers during our sample period is \$12.52. This fee does not differ across towns, so we ignore it in our analysis.

[14]The graph indicates that at least 10 percent of MEA towns implemented the change within three months of the referendum, whereas 10 percent had not implemented a price change six months afterward.

$$Y_{cmy} = \sum_{\tau=-24,\tau\neq-1}^{24} \beta_\tau MEA_{c\tau} + \beta_{25} MEA_{c,25} + \beta_{-25} MEA_{c,-25} + \alpha_{cm} + \alpha_{my} + \varepsilon_{cmy}, \quad (1)$$

where Y_{cmy} is either the natural logarithm of the monthly price or the natural logarithm of total monthly electricity use in community c in calendar month m and year y. $MEA_{c\tau}$ is an indicator variable equal to 1 if, as of month m and year y, community c implemented MEA τ months ago. The month before MEA implementation ($\tau = -1$) is the omitted category. To ensure that our estimated coefficients are relative to this category, we include indicators for MEA having been implemented 25 or more months ago ($MEA_{c,25}$) and for MEA being implemented 25 or more months in the future ($MEA_{c,-25}$). We include a full set of month-by-year (α_{my}) and community-by-month (α_{cm}) fixed effects and cluster standard errors at the community level. We discuss the robustness of our estimates to different sets of fixed effects in Section 5.

We estimate a second specification that assesses the impact by six-month periods and uses the entire two years prior to MEA as the reference period:

$$\begin{aligned} Y_{cmy} = {} & \gamma_1 MEA_{c,0\text{ to }6} + \gamma_2 MEA_{c,7\text{ to }12} + \gamma_3 MEA_{c,13\text{ to }18} + \gamma_4 MEA_{c,19\text{ to }24} \\ & + \beta_{25} MEA_{c,25} + \beta_{-25} MEA_{c,-25} + \alpha_{cm} + \alpha_{my} + \varepsilon_{cmy}. \end{aligned} \quad (2)$$

In this specification, $MEA_{c,0\text{ to }6}$ is an indicator variable equal to 1 if the community implemented MEA in the past 6 months and 0 otherwise. Similarly, $MEA_{c,7\text{ to }12}$ is an indicator equal to 1 if the community implemented MEA between 7 and 12 months ago, and so on. The other variables are defined as in equation (1).

The main identifying assumption is that, conditional on a host of fixed effects, any usage differences in electricity usage between communities that did and did not pass MEA are attributable to MEA. One concern raised by this approach is that towns that did not adopt MEA may not serve as adequate counterfactuals for towns that did adopt MEA. That is, the decision to adopt MEA may be correlated with future energy usage. We therefore also re-estimate equations 1 and 2 limiting our sample to towns that passed MEA. In this specification, our main identifying assumption is merely that the *timing* of MEA adoption is exogenous with respect to electricity use.

Some communities voted on MEA but did not pass it (see Table 1). In principle, this could enable us to estimate a voting regression discontinuity model. However, there are not many communities that failed to pass MEA and the vast majority of those that did had the referendum in the same month (March 2012). More importantly, there are not enough communities that failed to pass MEA by a narrow enough margin to enable us to estimate a true voting RD.

4.2 Difference-in-differences matching framework

Our second empirical approach implements a difference-in-differences matching estimator motivated by the methodology outlined in Abadie and Imbens (2006) and Abadie and Imbens (2011). Specifically, for each of the 289 treatment towns, we find the five nearest neighbors by matching on 2008 and 2009 usage from the pool of 490 control towns available in our sample.

Our setting is an ideal application for this empirical strategy. The large set of communities available in the control group makes it likely that the nearest-neighbor matching approach will successfully find suitable comparison groups. Moreover, the large timespan of our data coverage allows us to validate the accuracy of the match. That is, we have enough data in the pre-period to both match treated units to control units and evaluate the accuracy of that match. As we show below, treated and control towns that are matched based on their 2008-2009 usage also have very similar usage patterns in 2010.[15] The usage patterns diverge only after MEA is implemented.

A key advantage of the nearest-neighbor approach is that it eliminates comparison towns that are not observationally similar to treated towns and whose inclusion would add noise to the estimation. Electricity usage is highly seasonal, and the degree of seasonality varies widely across the different communities in our sample. Filtering out less relevant control towns can therefore greatly increase precision. Figure 3 provides a demonstration of this benefit. Panel (a) displays normalized usage for the MEA towns compared to all control towns. The difference between these two usages, which roughly corresponds to a standard event-study regression plot, is displayed in panel (c). There is a visible increase in the difference beginning in late-2011, which can be attributed to the implementation of MEA, but this difference is quite noisy. The heterogeneity in seasonal patterns poses a challenge for a standard regression that compares treatment towns to all control towns in the sample. Statistically, it is difficult to estimate an effect when the baseline month-to-month divergence in usage is of the same order of magnitude as the effect.

Panels (b) and (d) of Figure 3 show analogous plots for the nearest-neighbor matching estimator that we employ. Panel (d) shows again that the difference in log usage between treatment and control towns increases beginning in late-2011. This difference exhibits far less noise, however, than the difference displayed in panel (c). This allows the matching estimator to generate more precise estimates than the standard difference-in-differences estimator presented in the previous section.

4.2.1 Estimating the Effect on Usage

We estimate elasticities using a two-stage approach. First, we use matched control towns to estimate the effect of the policy change on usage for each MEA town. Second, we use the observed

[15]The first referendum on MEA did not occur until November 2010. The first implementation began in June 2011.

change in price and the estimated change in usage to estimate elasticities.

To select the five nearest neighbors, we match on both levels and seasonal (monthly) patterns from 2008 and 2009. We average annual log usage and monthly log deviations from annual usage to construct 13 match variables. We standardize the variables and use an equal-weight least squares metric to calculate distance, selecting the control towns with replacement.

Let Y_{it} denote log usage for town i in period t after the referendum, N denote the number of towns, and N_1 denote the number of MEA towns in our sample. D_i indicates whether or not the town implemented MEA.

Our estimate of the change in usage is the average treatment effect on the treated, which we calculate for each period t after the referendum was passed:

$$\hat{\tau}_t = \frac{1}{N_1} \sum_{i=1}^{N} D_i \left(Y_{it} - \hat{Y}_{it}(0) \right)$$

For each treatment town i, we select M nearest neighbors. Let $\mathcal{J}_M(i)$ denote the set of control towns for town i. The counterfactual control outcome $\hat{Y}_{it}(0)$ is calculated as

$$\begin{aligned} Y_{it}(0) &= \hat{\mu}_i^m + \frac{1}{M} \sum_{j \in \mathcal{J}_M(i)} \left(Y_{jt}(0) - \hat{\mu}_j^m \right) \\ &= \left(\hat{\mu}_i^m - \frac{1}{M} \sum_{j \in \mathcal{J}_M(i)} \hat{\mu}_j^m \right) + \frac{1}{M} \sum_{j \in \mathcal{J}_M(i)} Y_{jt}(0) \end{aligned}$$

Here, $\hat{\mu}_i^m$ corresponds to the estimated untreated outcome in calendar month m. This is an important bias correction within the matching framework. Thus, the counterfactual $Y_{it}(0)$ is the average usage for the nearest neighbors plus the average (seasonal) difference in usage. We project estimated untreated outcomes with the average log usage in the corresponding month m from 2008 and 2009.

$$\hat{\mu}_i^m = \frac{1}{2} \left(Y_i^m + Y_i^{(m+12)} \right)$$

Here, the superscript on Y indexes calendar months starting January 2008. That is, we account for the average month-by-month usage patterns for each town.

The difference-in-differences matching estimator is

$$\hat{\tau}_t^{DID} = \hat{\tau}_t - \sum_{s \in N_s} \hat{\tau}_{-s} \quad (3)$$

where N_s indicates the number of periods in the year prior to the policy change (e.g. $N_s = 12$ for monthly data). Our difference-in-differences estimate reflects the change over the average difference in the year leading up the the policy change.

4.2.2 Estimating Elasticities

In the previous subsection, we obtained period-specific estimates for the impact of MEA on usage. To construct elasticities, we regress town-specific estimates on town-specific price changes, which we observe. The town-specific measure $\hat{\tau}_{it}^{DID}$ is the single-town analog of Equation (3). We use the following regression:

$$\hat{\tau}_{it}^{DID} = \beta_g \cdot \Delta \ln p_{it} + \eta_{it}$$

This allows us to flexibly construct period-specific estimates for elasticities to show how the response changes over time. In our main results, we run separate regressions with g corresponding to half-year intervals. β_g corresponds to the elasticity within a group g.

4.2.3 Inference

To construct confidence intervals, we employ subsampling, where we subsample $B_1 = R \cdot \sqrt{N_1}$ treatment towns and $B_0 = R \cdot \frac{N_0}{\sqrt{N_1}}$ control towns, where R is a tuning parameter (Politis and Romano, 1994) and N_0 corresponds to the pool of control towns.[16] The matching estimator of the average treatment effect on the treated converges at rate $\sqrt{N_1}$ (Abadie and Imbens, 2006, 2011). The estimated CDF of $\hat{\tau}$ is given by:

$$\hat{F}(\hat{\tau}) = \frac{1}{N_b} \sum_{b=1}^{N_b} \mathbf{1} \left\{ \frac{\sqrt{B_1}}{\sqrt{N_1}} (\hat{\tau}_b - \hat{\tau}) + \hat{\tau} < x \right\}$$

For robustness, we calculate confidence intervals with different levels of R and show that they are stable.[17] The confidence intervals are obtained from $\hat{F}^{-1}(0.025)$ and $\hat{F}^{-1}(0.975)$. Similarly, we calculate elasticity estimates of β_g for each subsample to generate confidence intervals for our elasticities.

[16]This maintains a stable ratio of treatment to control.

[17]The reported results use $R = 3$ ($B_1 = 51$).

5 Results and discussion

5.1 Regression estimates

Figure 4 presents the change in electricity prices following MEA, in logs, as estimated by equation 1. Because it takes the median community four months to switch to a new supplier, the price drop is not immediate. It begins dropping steeply two months after MEA is passed; 6-14 months after voting, the average electricity price is close to 30 percent lower in MEA communities relative to non-MEA communities. There is a large increase in the MEA price fifteen months after implementation. This is due to the fact that electricity prices fell sharply for ComEd customers in June of 2013, the middle of our sample period, making the average MEA contract price look less favorable at that time. However, even with this increase, prices in MEA communities are still about 18-20 percent lower in the second year of MEA.

Figure 5 shows the event study estimates of the effect of implementing MEA on electricity usage. Although there is no clear pre-trend prior to MEA, the fluctuation in coefficients suggests that MEA and non-MEA communities may have different seasonal patterns of electricity use, making it more difficult to obtain precise estimates. Nonetheless, we observe a clear increase in usage following the passage of MEA: electricity usage is 2-4 percent higher in the first eight months after MEA and 5-8 percent higher nine to fourteen months after. In the final ten months of our post-MEA sample period, electricity usage is 2-5 percent higher, although in some months the estimated increase is close to zero. Such large fluctuations are likely due to different seasonal patterns of MEA and non-MEA communities, which makes it difficult to obtain precise results.

Next, we replicate this estimation using only the sample of towns that implemented MEA at some point. Figures 6 and 7 show the electricity price and usage change in these communities, respectively. Both series are similar to the previous results, but much more stable: prices drop by over 30 percent within the first six months following MEA referenda and remain about 30 percent lower for the rest of the post-MEA period. Correspondingly, electricity usage increases gradually over the first nine months following MEA and then stabilizes around 10 percent higher than before.

Table 3 shows the estimated impact of MEA on the log of the electricity price in these communities 0-6, 7-12, 13-18, and 19-24 months after implementation, using the specification in equation (2) with various fixed effects.[18] Overall, the results consistently show large and significant price drops: when community-by-month and month-by-year fixed effects are included, electricity prices are estimated to fall by 10 percent in the first six months following MEA voting and by 31.7 percent in the six months after that. In the next year, prices are 26-29 percent lower. These estimates are very robust to different fixed effects.

[18]Similar tables for the entire sample can be found in the Online Appendix.

Table 4 shows the estimated change in usage as estimated by by equation (2) for the sample of communities that implemented MEA. In our preferred specification, which includes month-by-year and community-by-month fixed effects (Column 4), electricity usage is 4.2 percent higher 0-6 months after MEA and 10.2-10.5 percent higher in the eighteen months after that.

Finally, Table 5 shows the elasticities implied by the two preceding tables. Specifically, we show the ratio of coefficients from Tables 4 and 3, which estimate the MEA-induced change in electricity quantities and prices, respectively. Because the outcomes are in logs, their ratio will be approximately equal to the elasticity. The implied elasticity ranges from -0.33 7-12 months after passage of MEA to -0.45 in the first six months after passage.

5.2 Matching estimates

Our difference-in-differences matching estimates of the change in usage are displayed in Figure 9. Notably, our estimates produces a narrow confidence interval around zero before the policy change, and demonstrate a precisely estimated and long-lasting increase of roughly 5 percent.

Figure 8 displays the average change in log prices for the treatment towns in the sample. Because the matching approach creates separate counterfactuals for each treatment town, the price change is exactly zero in the pre-period. The prices are large and economically significant. After price decreases of around 22 percent from 6 to 14 months after the referenda, MEA prices increased relative to the control towns. This price increase is mirrored by a decrease in usage in month 15 (Figure 9). This zig-zag effect, which shows customers responding to both price decreases and price increases, gives added confidence to our estimation.

The key parameter of interest is the price elasticity of demand. Estimated elasticities are displayed in Figure 10. Consumers appear to be more elastic in the long run than the short run, as the elasticity increases in magnitude from -0.09 to -0.28 over two and a half years.

The results from the difference-in-differences matching approach are summarized in Table 6.

5.3 Robustness of results

Tables 3 and 4, discussed above, demonstrated the robustness of our estimates to various fixed effects. In this section, we discuss two other robustness checks.

First, our regression estimates are almost unchanged when we exclude the city of Chicago (which passed MEA in November of 2012). We have also restricted our sample to communities that have at least 24 pre-MEA and at least 24 post-MEA observations; the estimates are noisier, but nonetheless similar in magnitude and highly significant.

One concern about the accuracy of these results is whether the magnitude of the price change is correlated with the demand elasticity. Suppliers with market power could want to offer lower rates to more inelastic customers, as more elastic customers would demand more at the same price and drive up supply costs. For our matching estimator, we check whether this might be the case. We split our treatment towns into seven groups based on the price change in the first two years after the referendum. We then calculate elasticities separately for each group. Figure 11 plots these estimates. We find no evidence of a relationship between the price change and the estimated elasticity.

6 Conclusion

An accurate estimate of the price elasticity of electricity demand is essential for evaluating the effects of many energy policies, such as a carbon tax. Policies that address climate change can be expected to permanently affect the price of electricity, which in turn will affect emissions. However, few reliable estimates of the price elasticity exist, as price changes in this market are often endogenous, short-lived, small, and/or unnoticed.

We overcome these challenges by exploiting a policy change in Illinois that allowed municipalities to select electricity suppliers on behalf of their residents. We show that towns implementing Municipal Electric Aggregation experienced large and lasting price changes relative to towns that did not implement MEA. These price drops, in turn, led to increased electricity usage. Overall, we estimate that the price elasticity of electricity is twice as large in the long-run as in the short-run.

This finding is important in two ways: First, it challenges researchers to identify settings that can accurately capture long-run elasticities, as short-run data may grossly understate total effects. Second, we find (at least) a two-year window in which consumers adjust to a new policy. This adjustment period may be important to overall welfare and should be analyzed with perhaps a more nuanced analysis than that typically used for the long-run equilibrium.

One downside of the natural experiment created by MEA as far as climate policy is concerned is that it *decreased* electricity prices, whereas price-based climate policies would increase them. That would certainly be a concern if electricity price changes had an income affect that in turn affected the responsiveness of households' electricity demand to prices. While we cannot explicitly estimate the income effect, we do not know of anything that would suggest that it would be large, given that electric bills typically do not represent a large share of household income. It would be fruitful, however, for future research to use household-level data to see if a significant income effect exists.

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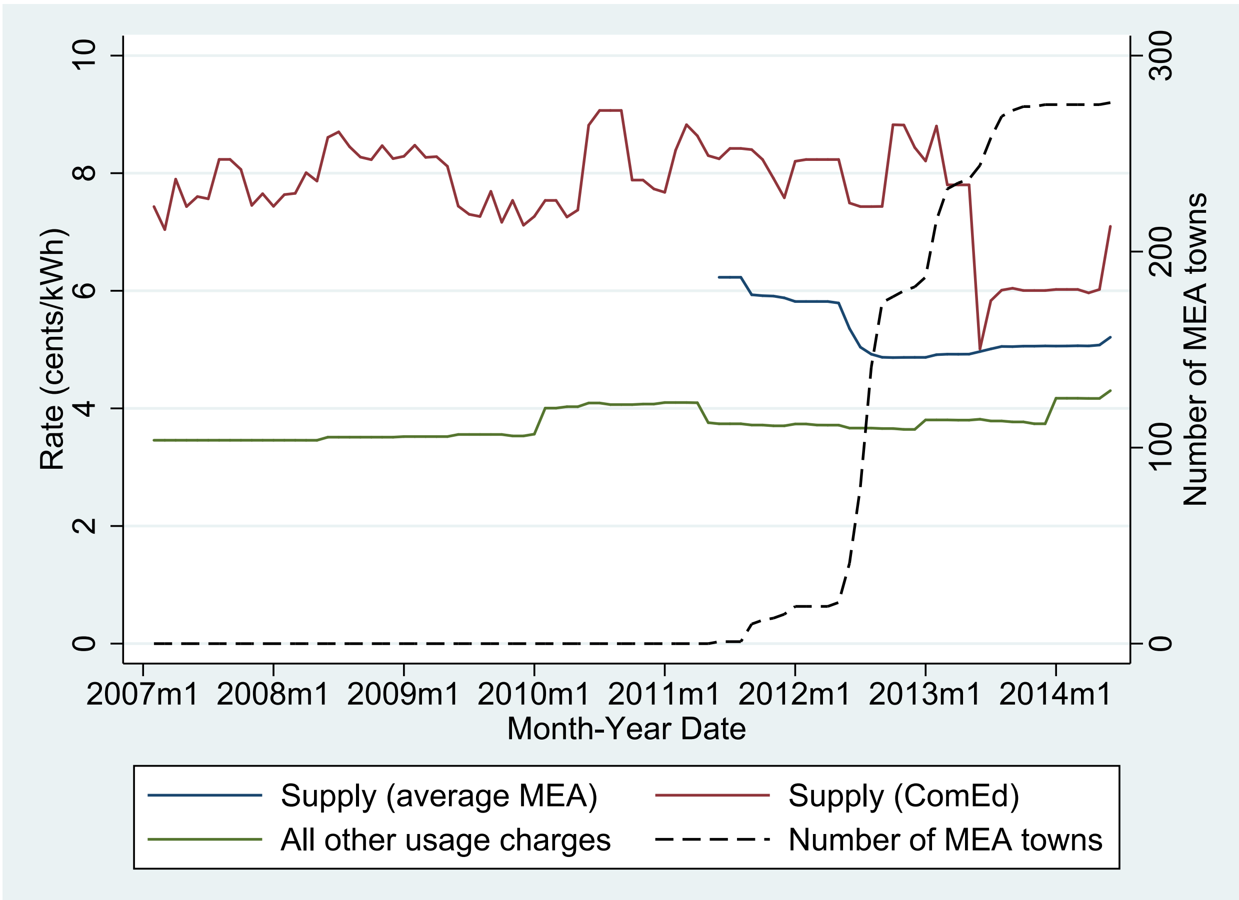
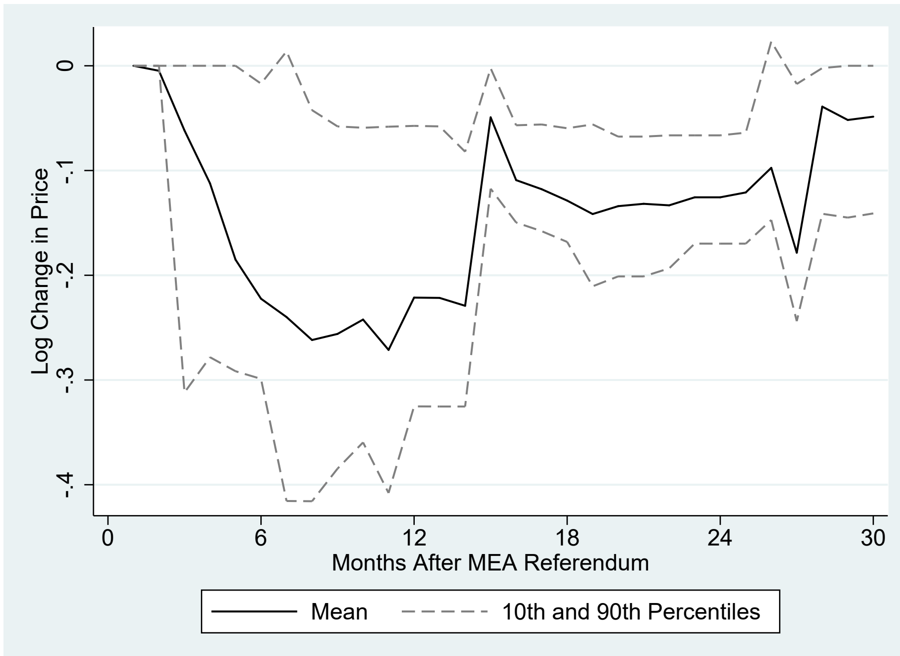
Figures

Figure 1: Electricity rates in Illinois ComEd service territories, 2007-2014



Notes: The blue line displays the average supply rate among all towns that adopted municipal electric aggregation (MEA). The first town adopted MEA in June of 2011. Non-MEA towns pay the supply rate charged by ComEd (red line). The green line displays the total of all other electricity rates on a consumer's residential bill, which do not depend on whether a town has adopted MEA. These displayed rates correspond to those for a single family residence with gas heating.

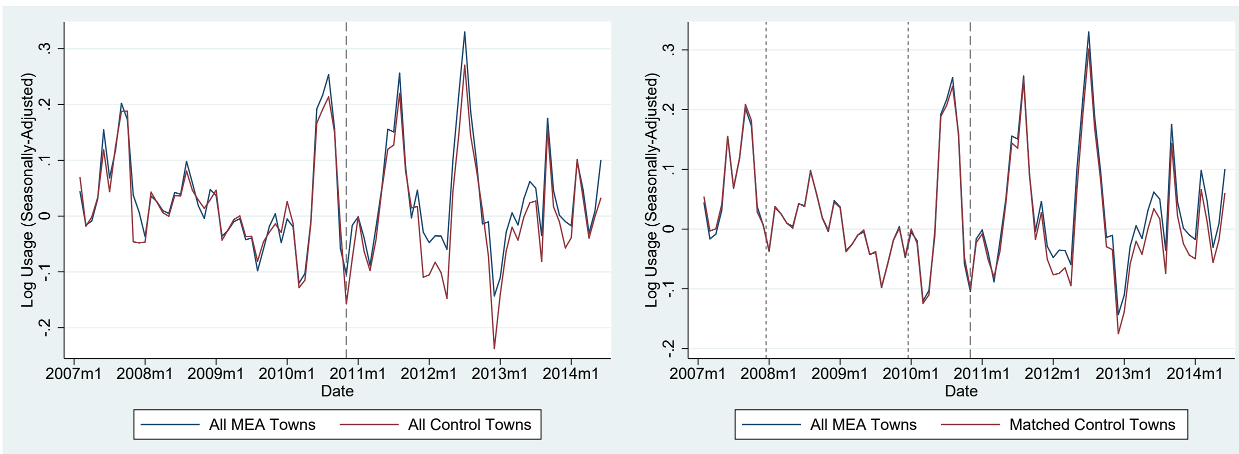
Figure 2: Log Change in Electricity Prices for MEA Towns



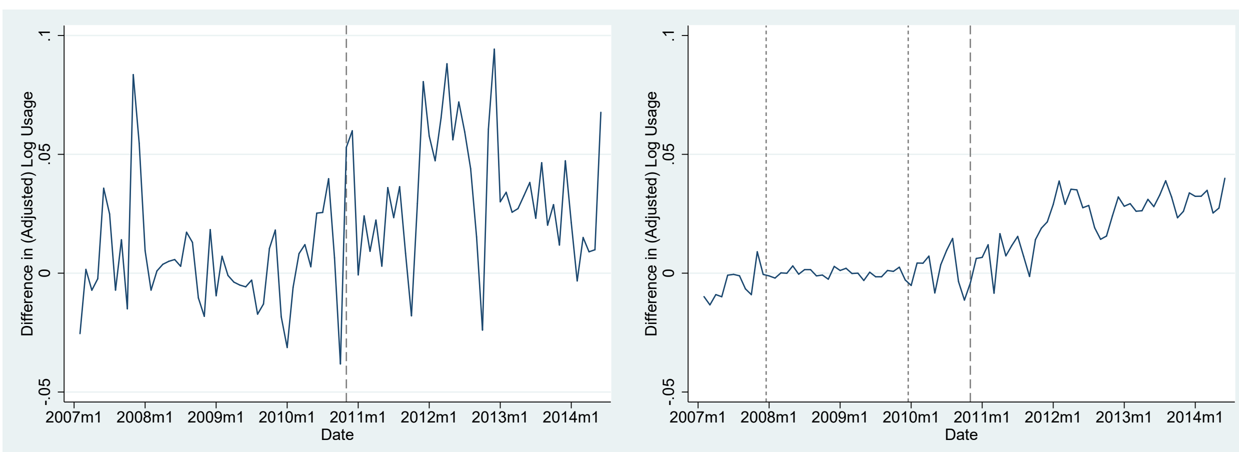
Notes: This figure illustrates the heterogeneity in price changes realized by MEA towns. Three points of the distribution are displayed: the mean, the 90th percentile, and the 10th percentile. The distribution is plotted as a function of the months after the MEA referendum was passed; the mean difference of zero in period one is explained by the fact that all towns took at least one month to implement a price change. A few towns realized supply prices higher than the ComEd rate.

Figure 3: Comparing regression to nearest-neighbor matching

(a) Regression (b) Nearest-neighbor matching

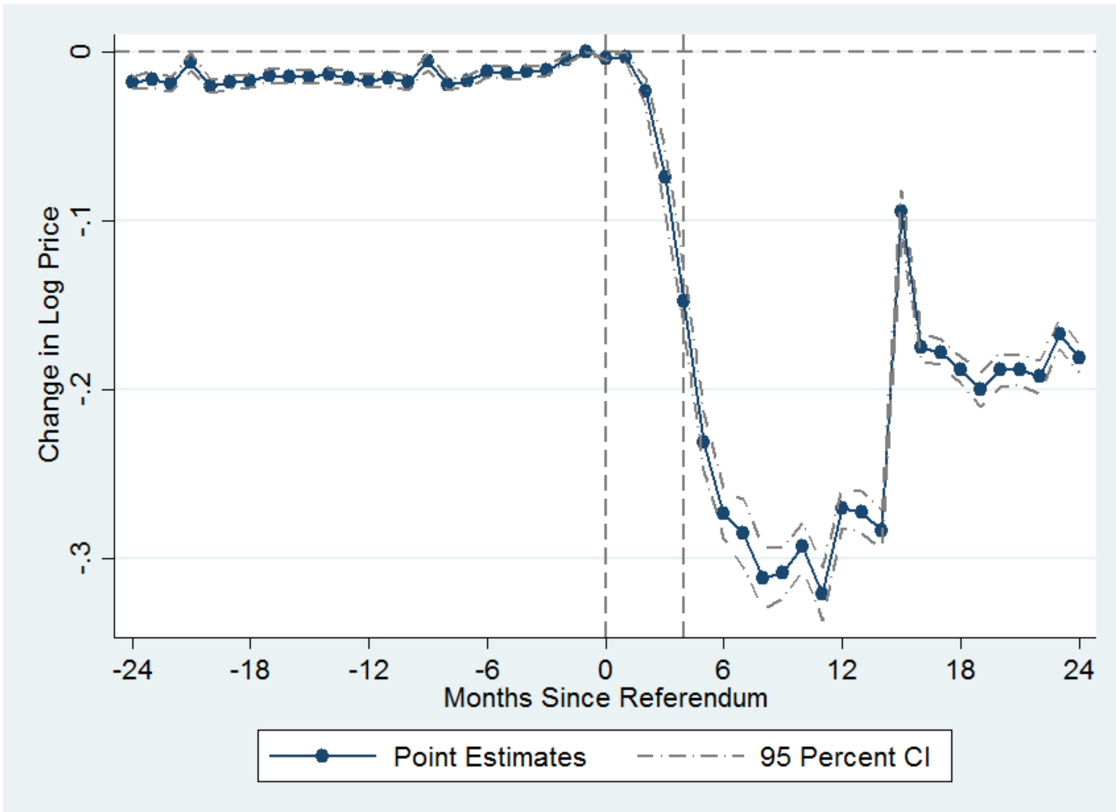


(c) Treatment and All Controls: Difference (d) Treatment and Matched Controls: Difference



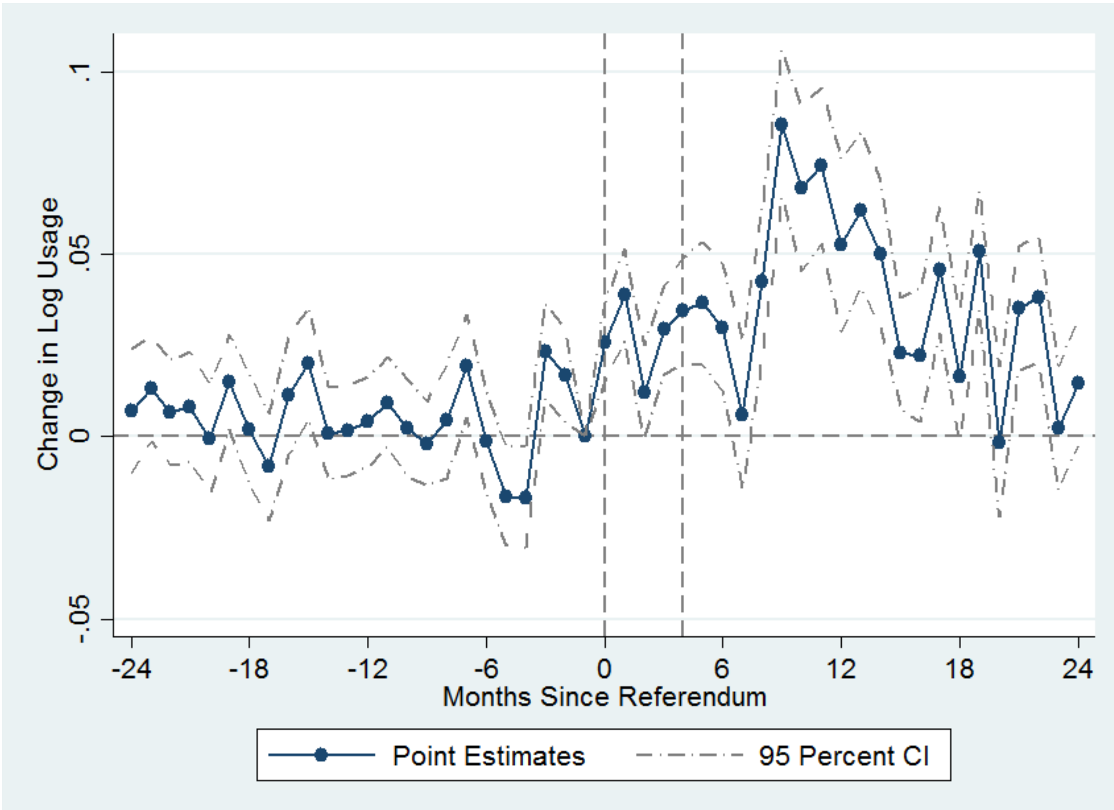
Notes: Panel (a) displays seasonally-adjusted usage for all MEA and non-MEA towns. The red line corresponds to the control group in a typical regression. Panel (b) employs the nearest-neighbor matching procedure, in which five towns are selected for each MEA town, and the control line is weighted by how often each control town is selected. Panels (c) and (d) plot the differences between the treatment and control lines in Panels (a) and (b), respectively. Panel (d) demonstrates that the matching procedure greatly reduces noise compared to a standard regression. The pre-period fit is much better, even for 2010 usage, which was not used in the matching procedure. The vertical dashed lines indicate the first referendum date. The vertical dotted lines in Panels (b) and (d) indicate the window used to match based on usage.

Figure 4: Regression estimates of the effect of MEA on electricity prices, all communities



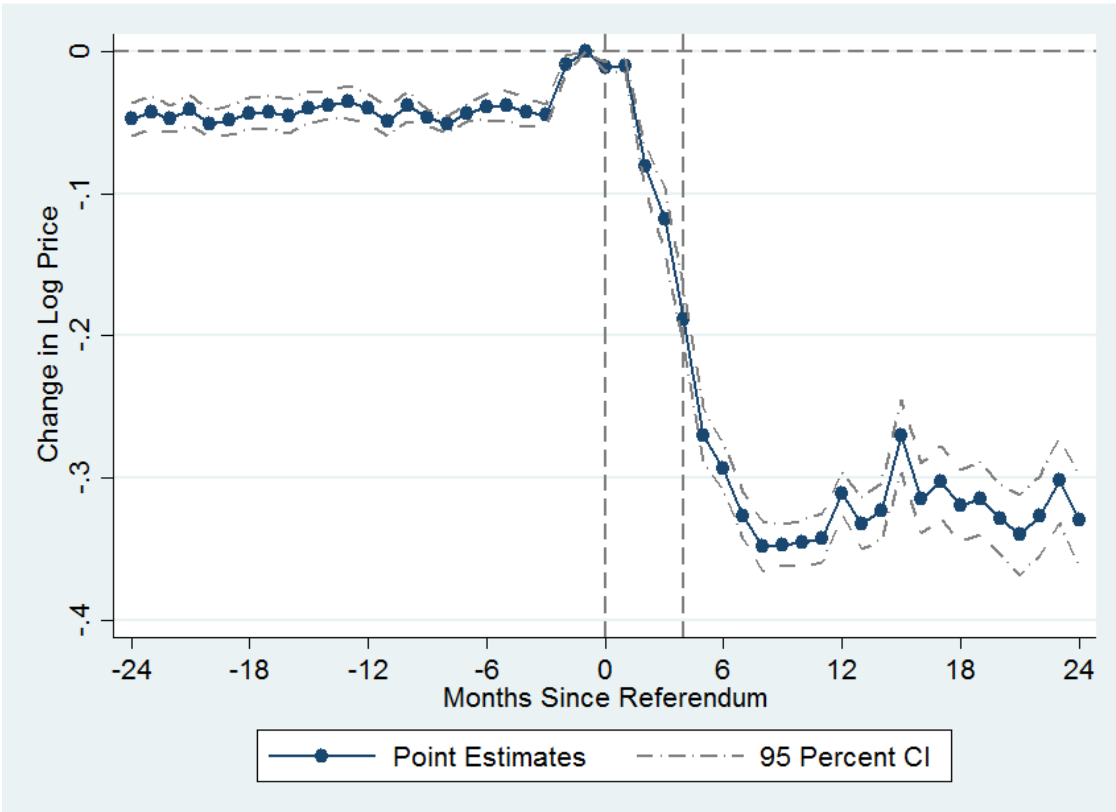
Notes: Outcome is the natural log of the electricity price. The first vertical dashed line indicates the date of the MEA referendum. The second dashed line indicates the date of MEA implementation. Regressions include month-by-year and community-by-month fixed effects. Standard errors are clustered by community.

Figure 5: Regression estimates of the effect of MEA on electricity usage, all communities



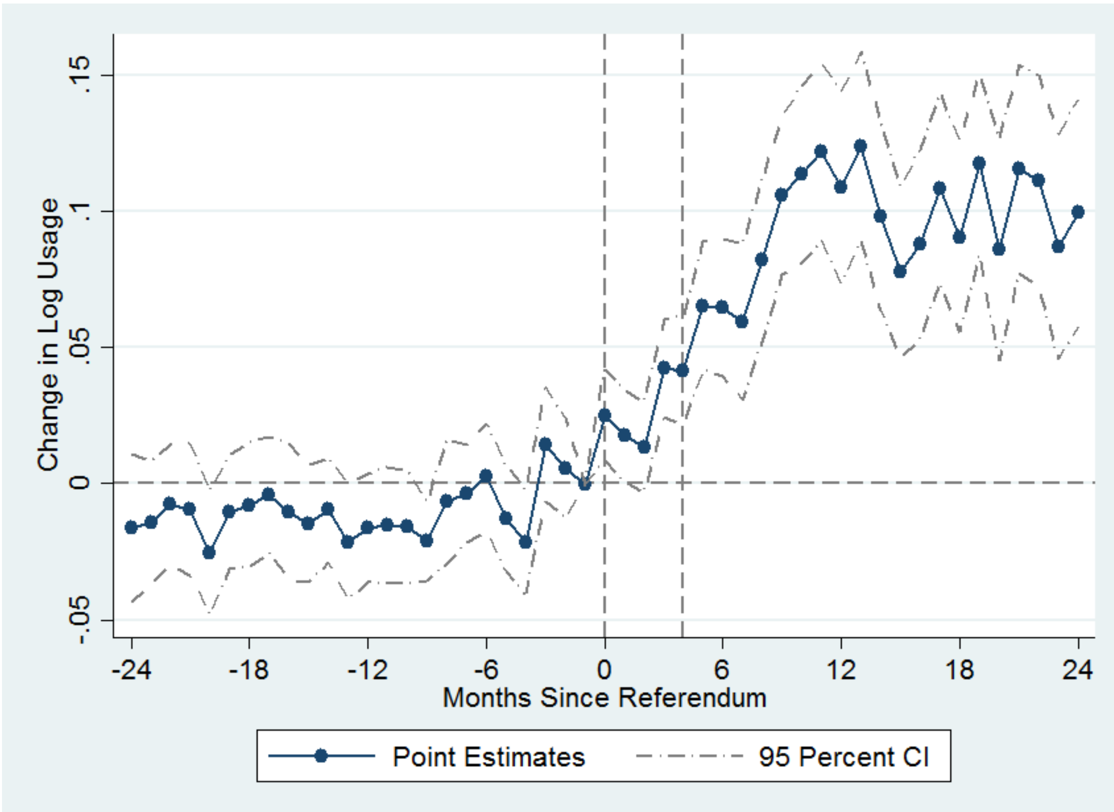
Notes: Outcome is the natural log of total electricity use. The first vertical dashed line indicates the date of the MEA referendum. The second dashed line indicates the date of MEA implementation. Regressions include month-by-year and community-by-month fixed effects. Standard errors are clustered by community.

Figure 6: Regression estimates of the effect of MEA on electricity prices, communities that passed MEA



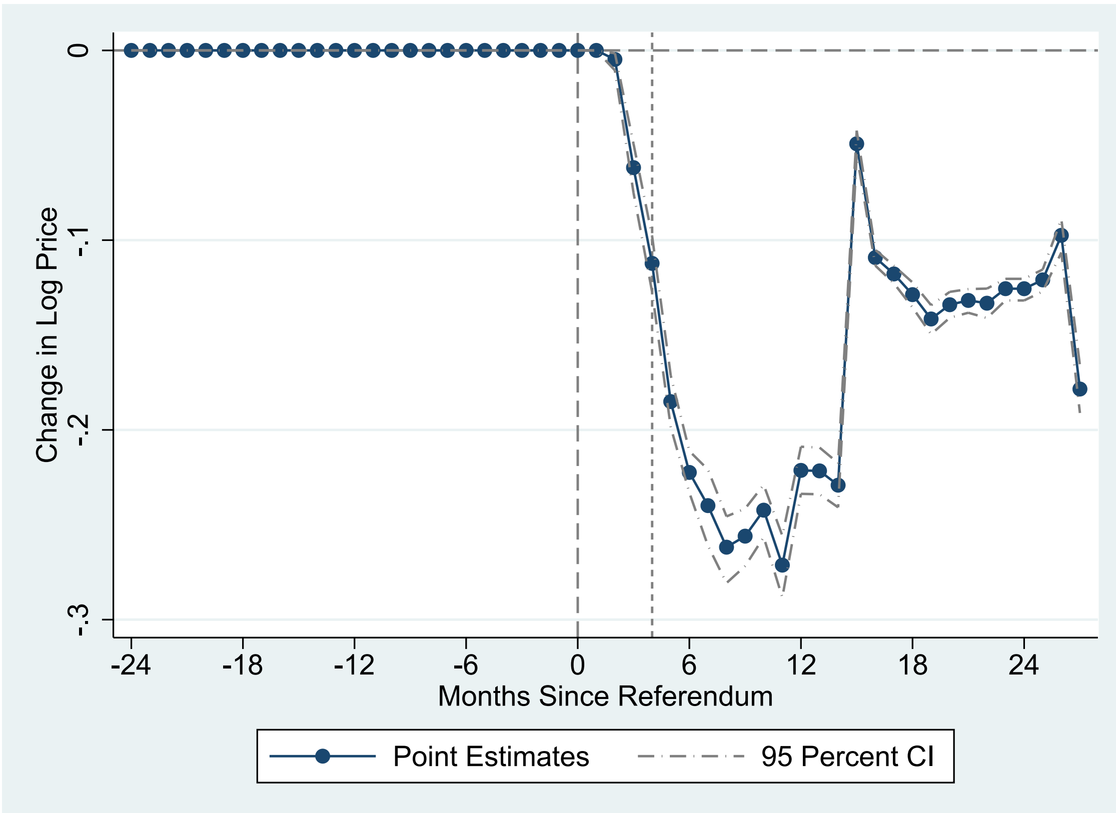
Notes: Outcome is the natural log of the electricity price. The first vertical dashed line indicates the date of the MEA referendum. The second dashed line indicates the date of MEA implementation. Regressions include month-by-year and community-by-month fixed effects. Standard errors are clustered by community. Sample includes only communities that passed MEA at some point during our sample.

Figure 7: Regression estimates of the effect of MEA on electricity usage, communities that passed MEA



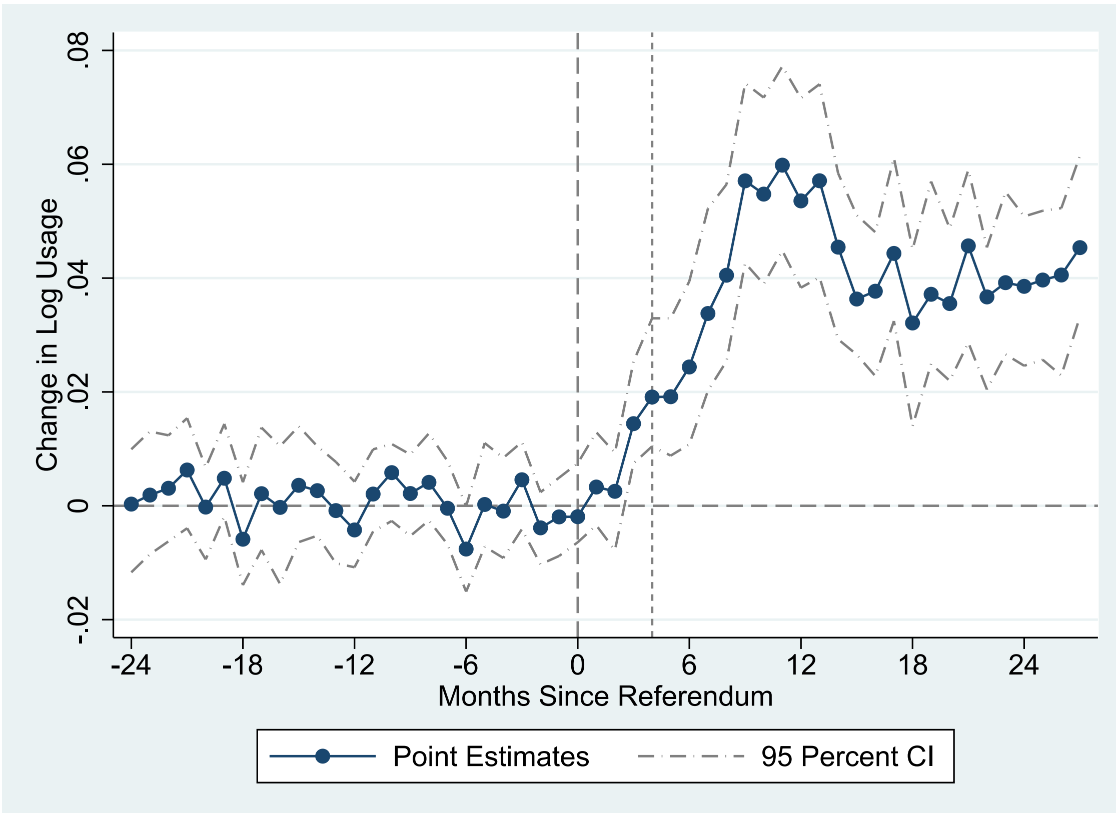
Notes: Outcome is the natural log of total electricity use. The first vertical dashed line indicates the date of the MEA referendum. The second dashed line indicates the date of MEA implementation. Regressions include month-by-year and community-by-month fixed effects. Standard errors are clustered by community. Sample includes only communities that passed MEA at some point during our sample.

Figure 8: Effect of implementing MEA on log prices, relative to matched control group



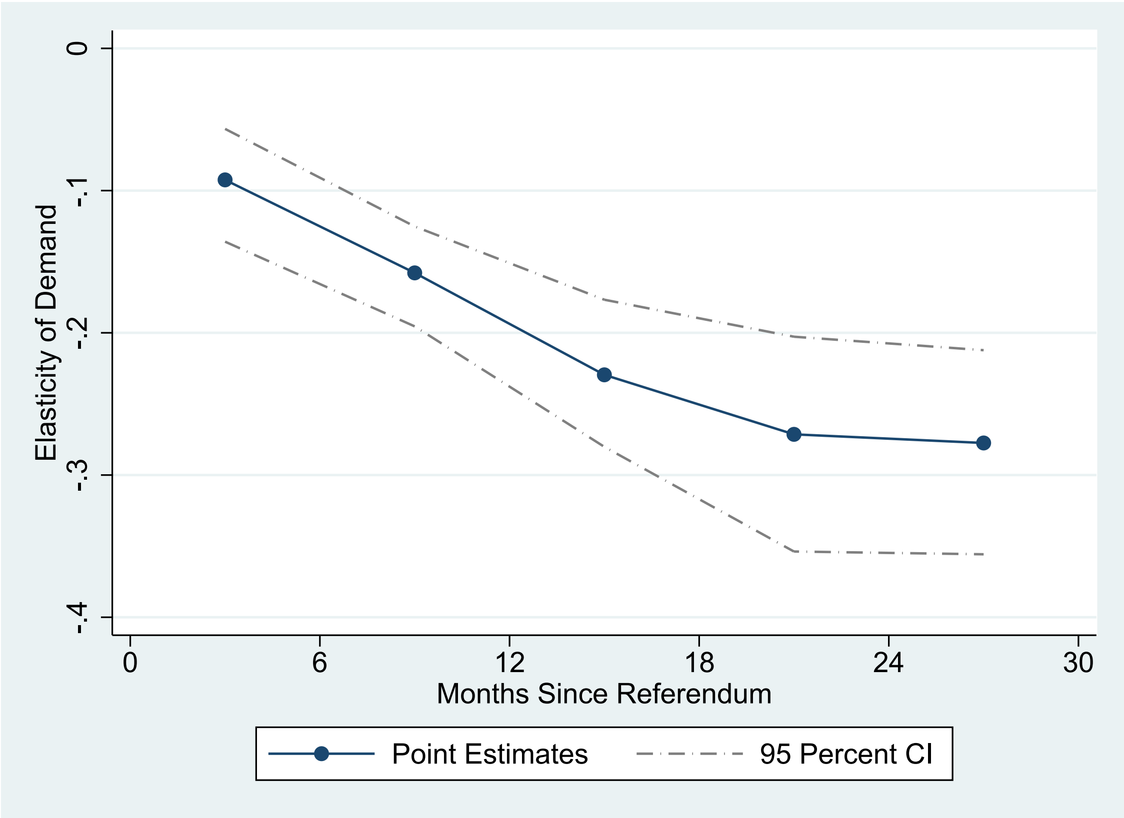
Notes: The figure displays estimates of the mean price effect of implementing MEA in a community relative to that community's five nearest-neighbors, as defined by the matching procedure outlined in the main text. Prices differences are calculated using the natural log of the marginal electricity supply rates. The pre-period difference is exactly zero as matching creates separate controls for each treatment town. The short dashed line indicates the median implementation date relative to when the referendum was passed. Confidence intervals are constructed via subsampling.

Figure 9: Effect of implementing MEA on log usage, relative to matched control group



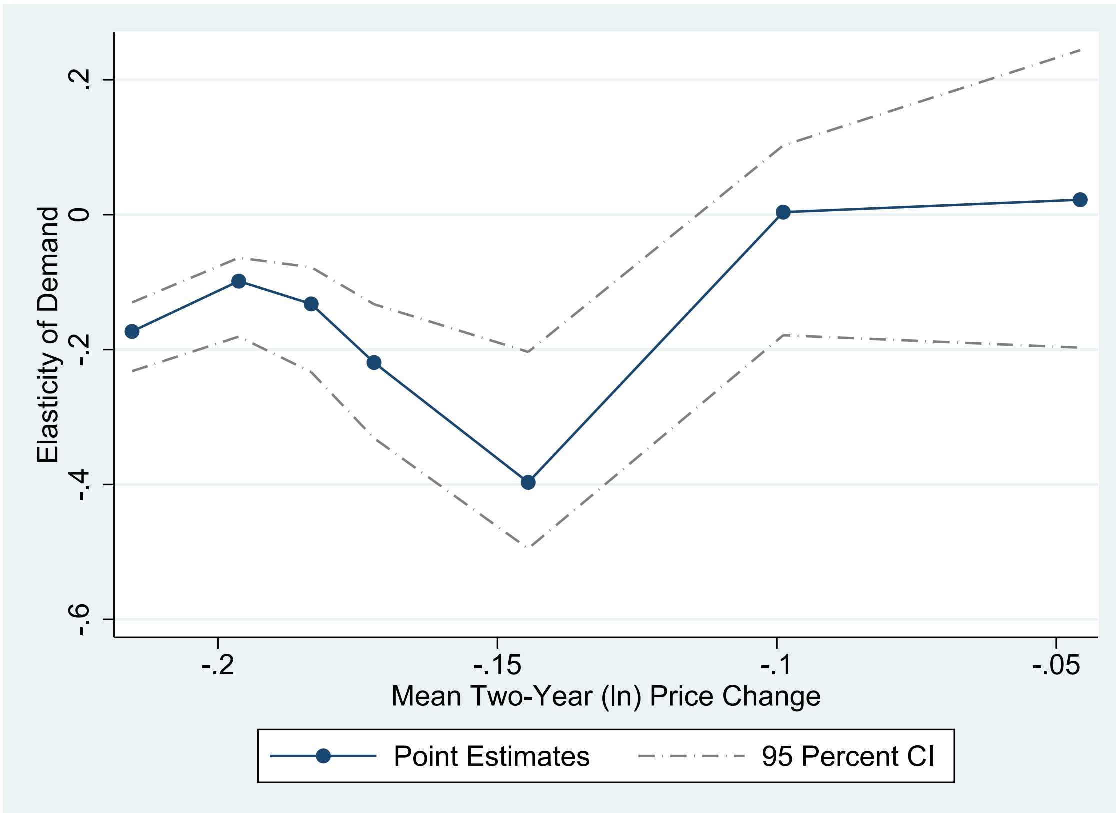
Notes: The figure displays estimates of the mean usage effect of implementing MEA in a community relative to that community's five nearest-neighbors, as defined by the difference-in-differences matching procedure outlined in the main text. The short dashed line indicates the median implementation date relative to when the referendum was passed. Confidence intervals are constructed via subsampling.

Figure 10: Estimated elasticities from the difference-in-differences matching model



Notes: Elasticities are calculated for each six-month period by regressing town-month changes in log usage on the observed change in log price. The corresponding counts of observations for each six-month group are: 1685, 1656, 1504, 1144, and 589. Confidence intervals are constructed via subsampling.

Figure 11: Estimated elasticities versus mean log price change



Notes: Towns are split into seven groups based on the average two-year price change. Elasticities are calculated separately for each group. The graph shows no relationship between the estimated group elasticity and the price change, mitigating some concerns about endogeneity. Confidence intervals are constructed via subsampling.

Tables

Table 1: Count of MEA Towns in Sample

Referendum Date	Implemented	Passed, Not Implemented	Voted, Not Passed
November 2010	1	0	0
April 2011	18	0	0
March 2012	164	0	28
November 2012	57	5	2
April 2013	38	3	6
March 2014	8	1	0
November 2014	3	2	0
Total	289	11	36

Table 2: 2010 characteristics of MEA and non-MEA communities

	(1) Passed MEA	(2) Passed and implemented MEA	(3) non-MEA
Per capita electricity usage in 2010, kWh	4,999	5,074	5,985
Total population	23,529*	23,836*	4,897
Percent black	5.76	4.91	5.33
Percent white	85.38***	86.56**	89.17
Median income	71,212	71,653*	67,719
Median age	38.58***	38.64***	40.95
Total housing units	9,491*	9,646*	1,825
Median year built	1,968***	1,969***	1,965
Median housing value	262,061***	263,715***	216,463
Percent with high school education	29.94***	29.89***	36.22
Percent with some college education	29.74***	29.74***	31.46
Percent with bachelor degree	18.08***	18.26***	14.33
Percent with graduate degree	11.04***	11.17***	7.38
Latitude	41.89***	41.90***	41.55
Longitude	-88.40***	-88.41***	-88.59
Number of communities	300	289	479

Stars denote significant differences from non-MEA mean, based on robust standard errors. Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Electricity usage data come from ComEd. All other characteristics are from the 2005-2009 American Community Survey.

Table 3: Effect of MEA adoption on electricity prices, communities that passed MEA

	(1)	(2)	(3)	(4)
0-6 months post-MEA	-0.114***	-0.095***	-0.117***	-0.094***
	(0.005)	(0.005)	(0.005)	(0.005)
7-12 months post-MEA	-0.304***	-0.310***	-0.308***	-0.317***
	(0.007)	(0.007)	(0.007)	(0.007)
13-18 months post-MEA	-0.294***	-0.262***	-0.298***	-0.261***
	(0.008)	(0.009)	(0.008)	(0.009)
19-24 months post-MEA	-0.284***	-0.287***	-0.285***	-0.289***
	(0.010)	(0.012)	(0.010)	(0.013)
Community fixed effects	X	X		
Month and year fixed effects	X		X	
Month-by-year fixed effects		X		X
Community-by-month fixed effects			X	X
Dep. var. mean	2.207	2.207	2.207	2.207
Observations	26,633	26,633	26,633	26,633
Adjusted R-squared	0.788	0.894	0.797	0.903

Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Standard errors (in parentheses) clustered by community. Outcome variable is the log of the per-kWh electricity price.

Table 4: Effect of MEA adoption on electricity usage, communities that passed MEA

	(1)	(2)	(3)	(4)
0-6 months post-MEA	0.067***	0.053***	0.060***	0.042***
	(0.007)	(0.009)	(0.005)	(0.006)
7-12 months post-MEA	0.050***	0.089***	0.060***	0.105***
	(0.012)	(0.015)	(0.011)	(0.015)
13-18 months post-MEA	0.099***	0.128***	0.081***	0.102***
	(0.014)	(0.018)	(0.013)	(0.016)
19-24 months post-MEA	0.077***	0.066***	0.101***	0.105***
	(0.015)	(0.021)	(0.014)	(0.019)
Community fixed effects	X	X		
Month and year fixed effects	X		X	
Month-by-year fixed effects		X		X
Community-by-month fixed effects			X	X
Dep. var. mean	14.349	14.349	14.349	14.349
Observations	26,633	26,633	26,633	26,633
Adjusted R-squared	0.991	0.993	0.996	0.998

Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Standard errors (in parentheses) clustered by community. Outcome variable is the log of total electricity usage.

Table 5: Estimated price elasticity, communities that passed MEA

	(1)	(2)	(3)	(4)
0-6 months post-MEA	-0.586	-0.562	-0.515	-0.449
7-12 months post-MEA	-0.165	-0.287	-0.194	-0.333
13-18 months post-MEA	-0.337	-0.490	-0.271	-0.391
19-24 months post-MEA	-0.270	-0.231	-0.356	-0.362
Community fixed effects	X	X		
Month and year fixed effects	X		X	
Month-by-year fixed effects		X		X
Community-by-month fixed effects			X	X
Dep. var. mean	14.349	14.349	14.349	14.349
Observations	26,633	26,633	26,633	26,633
Adjusted R-squared	0.991	0.993	0.996	0.998

Table 6: Matching estimates of the effect of MEA on usage and prices

	Log Usage	Log Price	Elasticity	Usage Obs.	Price Obs.
1-6 months post-referendum	0.014***	-0.096***	-0.092***	1692	1685
	(0.003)	(0.004)	(0.019)		
7-12 months post-referendum	0.050***	-0.249***	-0.158***	1668	1656
	(0.007)	(0.008)	(0.019)		
13-18 months post-referendum	0.043***	-0.147***	-0.230***	1516	1504
	(0.005)	(0.002)	(0.026)		
19-24 months post-referendum	0.039***	-0.132***	-0.271***	1155	1144
	(0.005)	(0.003)	(0.041)		
25-30 months post-referendum	0.043***	-0.123***	-0.277***	606	589
	(0.006)	(0.004)	(0.038)		

Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Estimates are constructed by a nearest-neighbor matching approach where each MEA town is matched to the five non-MEA towns with the most similar usage in 2008 and 2009. The number of price observations corresponds to the number of observations for each elasticity estimate, as we always observe usage where we observe a price change. Standard errors are in parentheses. Significance is determined by subsampling to construct confidence intervals.

Appendix

Referendum wording

Excerpt from Sec. 1-92. A[19]

The election authority must submit the question in substantially the following form:

Shall the (municipality, township, or county in which the question is being voted upon) have the authority to arrange for the supply of electricity for its residential and small commercial retail customers who have not opted out of such program?

The election authority must record the votes as “Yes” or “No”.

[19]From 20 ILCS 3855/1-92, Text of Section from P.A. 98-404. Available from `http://www.ilga.gov/legislation/ilcs/fulltext.asp?DocName=002038550K1-92`.

Kane County
C/O Dynegy Energy Services
1500 Eastport Plaza Dr.
Collinsville, IL 62234

John A. Smith
123 Main St
Anytown, IL 65432

Kane County is pleased to announce that Dynegy Energy Services, LLC ("DES") has been selected as the Supplier for its Municipal Aggregation program. This includes a 24-month program with a fixed price of $**0.06533 per kilowatt hour (kWh)** for the first 12 months (August 2015 to August 2016) and steps down to **$0.06065 per kWh** for the last 12 months (August 2016 to August 2017). DES is an independent seller of power and energy service and is certified as an Alternative Retail Electricity Supplier by the Illinois Commerce Commission (ICC Docket No. 14-0336).

As an eligible residential or small business customer located in unincorporated portions of Kane County, you will be automatically enrolled unless you opt out.

HOW TO OPT-OUT
You need do nothing to receive this new fixed rate. However, if you choose not to participate, simply return the enclosed Opt-Out Card **or call DES at 844-351-7691** by **July 10, 2015.** For more information, visit www.DynegyEnergyServices.com or contact DES Customer Care at 866-694-1262 from 8:00am to 7:00pm Mon- Fri or via email at DESCustCare@Dynegy.com.

There is no enrollment fee, no switching fee, and no early termination fee. This is a firm, fixed all-inclusive rate guaranteed until **August 2017**. This program offers automatic enrollment in Traditionally-sourced Power, but you have an option of purchasing Renewable Power at a rate of $**0.06766 per kWh** for the first 12 months (August 2015 to August 2016) which steps down to $**0.06327 per kWh** for the last 12 months (August 2016 to August 2017).

ENROLLMENT PROCESS
Once your account is enrolled, you will receive a confirmation letter from ComEd confirming your switch to DES. A sample ComEd notice is attached. Approximately 30 to 45 days after enrollment you will receive your first bill with your new DES price. Please review the enclosed Terms and Conditions for additional information.

Please be advised you also have the option to purchase electricity supply from a Retail Electric Supplier (RES) or from ComEd pursuant to Section 16-103 of the Public Utilities Act. Information about your options can be found at the Illinois Commerce Commission website: www.pluginilllinois.org and www.ComEd.com. You may request a list of all supply options available to you from the Illinois Power Agency.

See Reverse for Frequently Asked Questions…

Sincerely,

Christopher J. Lauzen
Board Chairman
Kane County

Kurt R. Kojzarek
Development Committee Chairman
Kane County

Electric Aggregation Program
Frequently Asked Questions

Overview of Municipal Aggregation

What is Municipal Aggregation?
Illinois law allows municipalities and counties to negotiate the purchase price of electricity on behalf of residential and small business utility customers living within their borders. While these governmental entities choosing community aggregation would be responsible for negotiating the price of power from a supplier other than the traditional utility, your utility would still be responsible for delivering that power to your home, and billing you for it.

How can I get more information about the municipality or county's aggregation program?
Contact your municipality or county for information related to the referendum and the aggregation program. Additional resources can be found at:
http://www.dynegyenergyservices.com/residential/municipal-aggregation/communities-we-serve.php

Eligibility and Enrollment

Who is eligible to participate?
Residential or small business customers located in the participating governmental entity boundaries may participate. Customers enrolled in real time pricing, Power Smart Pricing, space electric heat rate, or served by an alternative retail supplier may not be eligible.

How do I enroll?
It's simple. It's automatic. Unless you "opt-out" of the program, all eligible ComEd customer accounts within the boundaries will be enrolled in the program. You will receive a "switch" letter from your utility, ComEd, confirming your enrollment.

Do I have to participate in the municipal or county aggregation plan?
All eligible ComEd utility customers within the municipal or county boundaries will receive an opt-out notification letter via U.S. mail. You may "opt-out" by returning the Opt-Out card by the deadline date identified in your notification. If you choose to opt-out, your account remains with ComEd at the current utility rate.

What if I decide to opt-out after the opt-out deadlines have passed?
You may opt out at any time by calling our toll free number or sending us an email.

Rate and Term Information

What are the Rates and Terms for my Municipality or County?
A listing of communities served by DES can be found at www.DynegyEnergyServices.com. Select your municipality or county to find the applicable rates, contract length, and the terms and conditions for your particular governmental entity. You can expect to receive your first bill with the new DES rate in September 2015.

What if ComEd rates decrease?
If at any time during the term of this Agreement ComEd rates fall lower than the DES price, you will have the option to return to the utility without penalty.

Why does the price change in the second and third year?
DES is committed to offering the lowest possible price to participants in municipal aggregation programs. Cost factors in the power market will change during the second & third year. Specifically, the price DES is charged for capacity changes in year two and three and is reflected in the price.

What happens at the end of the Agreement term?
At the end of the Agreement term, as defined in the Terms and Conditions you have the option of staying with a new Municipal Aggregation program, returning to the utility, or signing with a new supplier independent of the Municipal Aggregation program.

Billing and Service Information

Who will bill me for electricity? Will I get two bills?
You will continue to receive one monthly bill from ComEd. The bill will include the charges for electricity supplied by us, as well as the delivery service charges from ComEd.

Can I still have my payment automatically deducted from my checking account?
Yes, how you pay your bill will not change.

Can I stay on budget billing?
Yes, your budget billing will not be affected by your participation in this program.

Who is responsible for the delivery of power to my home or business?
ComEd will continue to deliver your electricity and will be responsible for maintaining the system that delivers power into your home. As your energy delivery company, they will continue to respond around-the-clock to outages, service calls and emergencies regardless of your electric supplier.

Who do I call to report a power outage or problems with my electric service?
You will continue to call ComEd for power outages, problems with your service or questions regarding your monthly bill.

ComEd Residential Customers: 800.334.7661
ComEd Business Customers: 800.334.7661

Who do I call if I have questions regarding the Municipal or County Opt-Out Electricity Aggregation Program?
Questions should be referred to a member of our DES Customer Care team.

DES Customer Care: 844.351.7691
DESCustCare@Dynegy.com

A complete list of Frequently Asked Questions can be found at
http://www.dynegyenergyservices.com/residential/municipal-aggregation/faq-residential-municipal.php
or by calling DES at 844.351.7691

Example of an opt-out card

PLACE

STAMP

MC SQUARED ENERGY SERVICES, LLC
344 South Poplar Street
Hazleton, PA 18201

___ **Opt-Out by returning this form:** I wish to opt-out of the Village of South Barrington electricity aggregation program and remain with my current provider. By returning this signed form, I will be **excluded** from this opportunity to join with other residents in the electricity aggregation program.

You must mail this form by **June 15, 2012**

Name: ____

Service Address: ____

City, State, Zip: ____

Phone: ____

Account Holder's Signature: ____________________________ Date: ______________

Rev 1 – 5/17/12

ComEd
An Exelon Company

Issued **4/12/16** Account # [redacted]

Total Amount Due by 5/4/16 **$50.09**

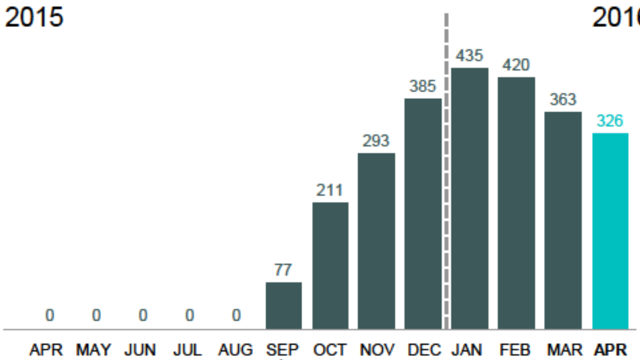
Thank you for your payments totaling **$241.81.**

SERVICE FROM 3/11/16 THROUGH 4/12/16 (32 DAYS)

Residential - Multiple

[redacted]

TOTAL USAGE (kWh)



Current month's reading is **actual.**
*Non-regular Billing Period

AVERAGE DAILY USE (monthly usage/days in period)

Current Month	43° avg. temp
10.2 kWh	

Last Month 35° avg. temp	Last Year
12.1 kWh	**Not Available**

Ten 100W light bulbs for 1 hour = 1 kWh

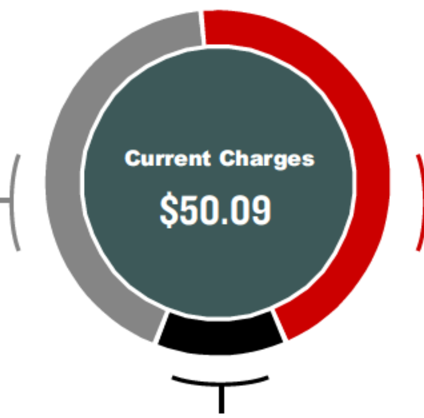
CURRENT CHARGES SUMMARY

See reverse side for details

SUPPLY
$21.34

ComEd provides your energy.

ComEd.com
1.800.334.7661



DELIVERY
$22.70

ComEd delivers electricity to your home.

ComEd.com
1.800.334.7661

TAXES & FEES $6.05

For Electric Supply Choices visit pluginillinois.org

Return only this portion with your check made payable to ComEd. Please write your account number on your check.

ComEd
An Exelon Company

[redacted]

Pay your bill online, by phone or by mail.

See reverse side for more info

Account # [redacted]

Total Amount Due by 5/4/16 **$50.09**

Payment Amount:

[redacted]

Issued **4/12/16** Account # [redacted]

For Questions, Support, and Outages visit ComEd.com

English	**1.800.EDISON1 (1.800.334.7661)**
Español	**1.800.95.LUCES (1.800.955.8237)**
Hearing/Speech Impaired	**1.800.572.5789 (TTY)**
Federal Video Relay Services (VRS)	**Fedvrs.us/session/new**

***Please seek assistance from **ComEd** prior to contacting the
ICC Consumer Services Division
- Inside Illinois **1.800.524.0795**
- Outside Illinois **1.217.782.2024**
- TTY **1.800.858.9277**

Total Amount Due by 5/4/16 $50.09

METER INFORMATION

Read Dates	Meter Number	Load Type	Reading Type	Previous	Present	Difference	Multiplier	Usage
3/11-4/12	[redacted]	General Service	Total kWh	24430 **Actual**	24756 **Actual**	326	x 1	**326**

CHARGE DETAILS

Residential - Multiple 3/11/16 - 4/12/16 **(32 Days)**

SUPPLY **$21.34**

Electricity Supply Charge	326 kWh X 0.05865	$19.12
Transmission Services Charge	326 kWh X 0.01122	$3.66
Purchased Electricity Adjustment		-$1.44

DELIVERY - ComEd **$22.70**

Customer Charge		$7.57
Standard Metering Charge		$4.36
Distribution Facilities Charge	326 kWh X 0.03188	$10.39
IL Electricity Distribution Charge	326 kWh X 0.00116	$0.38

TAXES & FEES **$6.05**

Environmental Cost Recovery Adj	326 kWh X 0.00020	$0.07
Energy Efficiency Programs	326 kWh X 0.00345	$1.12
Franchise Cost		$1.73
State Tax		$1.08
Municipal Tax		$2.05

Service Period Total **$50.09**

Thank you for your payment of $241.81 on April 4, 2016

Total Amount Due **$50.09**

UPDATES

ComEd

- GO PAPERLESS: Enroll in eBill today. Get started by registering your online account at ComEd.com/MyAccount. If you've already set up your My Account, select Paperless Billing in your preferences.
- UNDERSTANDING YOUR BILL: Need help understanding your bill line item definitions? Please visit us at ComEd.com/understandbill
- ENVIRONMENTAL DISCLOSURE STATEMENT: ComEd's Environmental Disclosure Statement can now be found online at ComEd.com/EnvironmentalDisclosure.
- Past due balances are subject to late charges.

OTHER WAYS TO PAY YOUR BILL

Visit ComEd.com/PAY for more information including applicable fees for some transactions.

Online

Set up an automatic payment, enroll in paperless billing, or make a convenience payment at ComEd.com/Pay.

Mobile App

Download the ComEd mobile app on your Apple® or Android™ device to view and pay your bill, or manage your account.

Phone

Call us to make a convenience payment with a credit card, ATM card, or your bank account: 1.800.588.9477. (Fee Applies)

In-Person

Pay your bill in-person at many ComEd authorized agents located throughout the region. Visit ComEd.com/Pay for details.

When you provide a check as payment, you authorize us to use information from your check either to make a one- ime electronic fund transfer from your account or to process the payment as a check transaction.

Appendix Tables

Table 7: Effect of MEA adoption on electricity prices, all communities

	(1)	(2)	(3)	(4)
0-6 months post-MEA	-0.100***	-0.091***	-0.103***	-0.091***
	(0.004)	(0.004)	(0.005)	(0.004)
7-12 months post-MEA	-0.266***	-0.289***	-0.266***	-0.293***
	(0.005)	(0.009)	(0.005)	(0.009)
13-18 months post-MEA	-0.225***	-0.187***	-0.228***	-0.185***
	(0.004)	(0.003)	(0.004)	(0.003)
19-24 months post-MEA	-0.199***	-0.176***	-0.194***	-0.175***
	(0.004)	(0.004)	(0.003)	(0.004)
Community fixed effects	X	X		
Month and year fixed effects	X		X	
Month-by-year fixed effects		X		X
Community-by-month fixed effects			X	X
Dep. var. mean	2.236	2.236	2.236	2.236
Observations	69,264	69,264	69,264	69,264
Adjusted R-squared	0.679	0.893	0.686	0.899

Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Standard errors (in parentheses) clustered by community. Outcome variable is the log of the per-kWh electricity price.

Table 8: Effect of MEA adoption on electricity usage, all communities

	(1)	(2)	(3)	(4)
0-6 months post-MEA	0.064***	0.044***	0.046***	0.023***
	(0.006)	(0.006)	(0.004)	(0.004)
7-12 months post-MEA	-0.001	0.017*	0.029***	0.051***
	(0.009)	(0.010)	(0.008)	(0.009)
13-18 months post-MEA	0.069***	0.072***	0.034***	0.032***
	(0.008)	(0.008)	(0.007)	(0.006)
19-24 months post-MEA	-0.006	-0.040***	0.048***	0.020***
	(0.007)	(0.008)	(0.006)	(0.006)
Community fixed effects	X	X		
Month and year fixed effects	X		X	
Month-by-year fixed effects		X		X
Community-by-month fixed effects			X	X
Dep. var. mean	13.269	13.269	13.269	13.269
Observations	69,264	69,264	69,264	69,264
Adjusted R-squared	0.993	0.994	0.997	0.998

Significance levels: * 10 percent, ** 5 percent, *** 1 percent. Standard errors (in parentheses) clustered by community. Outcome variable is the log of total electricity usage.

Table 9: Estimated price elasticity, all communities

	(1)	(2)	(3)	(4)
0-6 months post-MEA	-0.639	-0.483	-0.451	-0.258
7-12 months post-MEA	0.004	-0.057	-0.110	-0.174
13-18 months post-MEA	-0.305	-0.386	-0.151	-0.175
19-24 months post-MEA	0.028	0.229	-0.248	-0.116
Community fixed effects	X	X		
Month and year fixed effects	X		X	
Month-by-year fixed effects		X		X
Community-by-month fixed effects			X	X
Dep. var. mean	13.269	13.269	13.269	13.269
Observations	69,264	69,264	69,264	69,264
Adjusted R-squared	0.993	0.994	0.997	0.998