Electricity Burden and the Distribution of Rate Increases from Fuel Cost Adjustments with a Decreasing Block Rate Pricing Structure

by

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Abstract

A decreasing block rate pricing structure is a common tariff used by electric utilities that provide residential services. Under this pricing structure, consumers that use less electricity per billing cycle pay a higher per unit price on average compared to consumers that use more electricity. The correlation between Midwestern households' electricity consumption and their annual income level suggests that households with a lower median income level consume less electricity than households with a higher median income level. This means, under a decreasing block rate pricing structure, households with lower income bear a higher electricity burden. Fluctuation of the fossil fuel energy market also has a ripple effect on households' electricity burden when fuel cost increases are passed on to households. This research studies the electricity burdens for households under a decreasing block rate pricing structure and explores the impact of fuel cost adjustment on household electricity burdens. Three potential ways of distributing cost increases are proposed and explored. A profile is built using income level data from the U.S. Census and an electricity consumption projecting parameter generated from data published by the U.S. Energy Information Administration. An economic model is built to study the cost increase absorption for a household under a decreasing block rate pricing structure and for households that have individual electricity storage. Spreadsheets and a python script are created to simulate the proposed distribution approaches. The result shows that the current cost absorption method used by electric utilities results in a bigger energy burden increase on low-income households. The proposed distribution approaches can either alleviate or exacerbate the electricity burden on households with low income while keeping the same level of profit for the company.

Contents

Introduction

The electricity utility industry commonly uses a block rate pricing structure to charge their customers. A block rate pricing structure charges the same price per unit of electricity before consumers reach a certain threshold of usage. Afterwards, a different price per unit will be charged until customers reach another threshold. Most electricity utilities have one to two thresholds for their block rate pricing structures, where there is no upper limit of usage for its second or third rate. When the price of each block increases as the quantity of consumption increases, such pricing structure is called an increasing block rate structure; when the price of each block decreases as the quantity of consumption increases, it is called a decreasing block rate structure. A 2020 study that surveyed all of U.S. electricity utilities' residential services found that 246 of the utilities employ an increasing block rate pricing structure, while 255 of them employ a decreasing block rate pricing structure (Levinson & Silva, 2020). Figures 1 and 2 below show simple examples of an increasing and a decreasing block rate pricing structure.

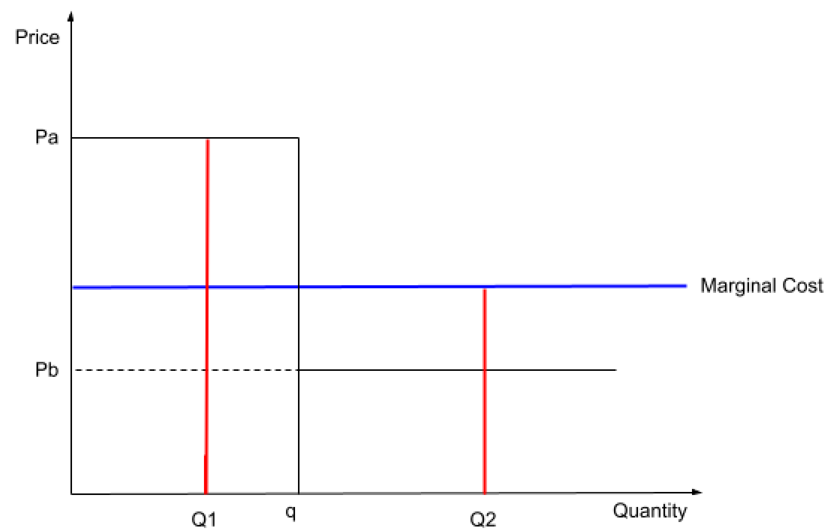


Figure 1 Decreasing block price structure

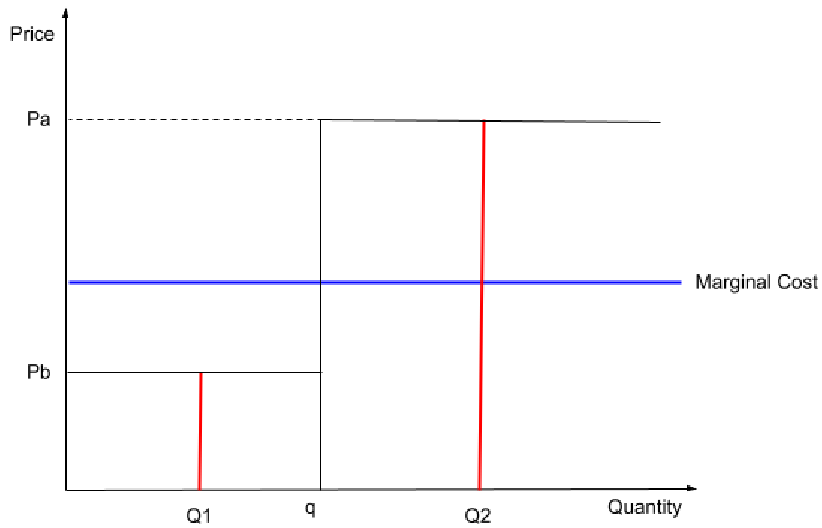


Figure 2 Increasing block rate structure

In both block rate pricing structures, the profit gained from consumption at the higher tier price cross-subsidizes for the lower price tier consumption. Consumers have the incentive to limit their electricity consumption when an increasing block rate structure is in place. Such incentive is absent with a decreasing block rate structure. When using a large amount of electricity that surpasses threshold q, consumers pay less for each unit of electricity on average than paid by lower-using consumers.

Residential electricity consumption by households is correlated with household income level. The 2020 Residential Energy Consumption Survey (RECS) conducted by the U.S. Energy Information Administration surveyed 27.04 million household units in the Midwest, collecting their basic household information along with their household energy consumption data. A simple regression analysis between these basic household characteristics and electricity consumption data found correlation between electricity consumption and household income. Figure 3 below illustrates the relationship between household income level and household electricity consumption for the Midwestern region in 2020.

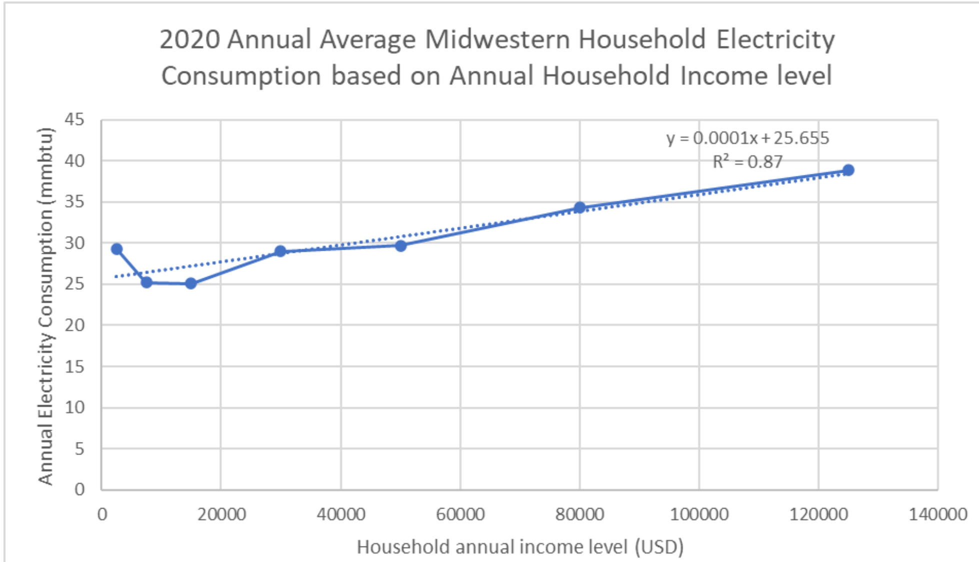


Figure 3 Linear regression of 2020 annual average Midwestern household electricity consumption and annual household income level

The Residential Energy Consumption Survey published in 2020 collected 27.04 million households' data. An average level of household electricity consumption was calculated for households of each annual income level, ranging from below $5,000 to more than $150,000. These data points are plotted in figure 3. The regression analysis yields a positive linear relationship between household electricity consumption and household income level, with an 87% goodness of fit. The sample size of the survey and goodness of fit suggest that the regression result to be significant. As shown in the figure, a household with a lower income level in the Midwestern region is likely to use less electricity. When residential electricity bills are determined by a decreasing block rate pricing structure, households with lower income levels might be facing a bigger financial burden, where the percentage of income these households spend on electricity consumption is higher than households with higher income levels have. Since using a decreasing block rate structure for residential services is still a prevalent practice in the US, it is worth studying how the deployment of a decreasing block rate structure affects low-income households.

Due to research data availability and research team size, this study is not able to conduct nation-wide research. Instead, this study focuses on one investor-owned electricity utility company in the state of Indiana. This selection is based on the fact that said utility, Duke Energy Indiana LLC, is a single company that self generates, transmits, and delivers its residential electricity services, covers 75% of the counties in Indiana, and has a relatively high level of data availability at the Indiana Utility Regulatory Commission. Indiana's residential electricity services are provided by five investor-owned electricity utility companies. (Indiana Office of Energy Development, 2022) Duke Energy uses a decreasing block rate pricing structure with three tiers, as shown by Table 1. Appendix A shows a summary of the five utilities' current pricing structures for the residential services and Appendix B shows a service map of Duke Energy in the Midwestern region.

Residential electric service (in effect since September 22nd, 2022)	
Connection charge	$10.54
First 300 kwh	$0.148799 per kWh
Next 700 kwh	$0.108297 per kWh
Over 1,000 kwh	$0.098147 per kWh

Table 1 Most recent residential electric service rate structure at Duke Energy Indiana

Methods

Household income and electricity consumption

Median household income data was collected from the American Community Survey published in 2020 by the U.S. Census. The average annual household income data of each census tract covered by Duke Energy Indiana was selected from the survey data set, totaling 832 data points. An estimated annual electricity consumption for each data point was then generated using the income level data and the parameter obtained using the RECS data as indicated in figure 3. The annual electricity consumption was averaged into monthly electricity consumption. A list of electricity bills was then calculated using the monthly electricity consumption level and Duke Energy rate structure. Each bill represents the amount of money spent on electricity by a household of average income level with averaged projected electricity consumption in each census tract.

Electricity burden and fuel cost adjustment

Electricity burden describes the percentage of income spent on household electricity consumption each month, calculated by dividing the monthly electricity bill of each household by monthly household income. The monthly electricity burden of each data point was calculated. In order to reflect the degree to which a decreasing block rate pricing structure has on electricity burdens, another series of electricity bills electricity burden data were generated with the same method for counties serviced by Indianapolis Power & Light, which has a flat rate pricing structure for its residential consumers.

Additionally, it is useful to study how fuel cost fluctuation impacts residential electric bills. The electricity market constantly fluctuates. The wholesale price of electricity changes every second. For residential services provided by the retail market, per unit price is more stable. However, when the cost of producing electricity increases considerably, electricity utility companies submit fuel cost adjustment petitions to their utility regulatory commissions. In the case of Duke Energy Indiana, fuel cost adjustment petitions are submitted around every 3 months. To quantify the impact of fuel cost adjustment on residential consumers, this study collects data from the four approved fuel cost adjustment petitions submitted by Duke Energy to the Indiana utility regulatory commissions from March 2022 to December 2022, generates sets of estimated monthly electricity bills for the data points, and studies the subsequent change in distribution of energy burden across income levels because of rate increases.

Modeling four approaches to changing rates in reaction to a fuel cost increase

In the face of fossil fuel cost increase, electricity utility companies that own and operate electricity generators, such as Duke Energy, face a higher marginal cost of producing electricity. According to the approved fuel cost adjustment petitions submitted by Duke Energy, the company has chosen to compensate for the cost increase by adding a certain price increase to the unit price of residential services. This increase in electricity rate is uniform to all consumers. Such distribution of rate increase allows companies like Duke Energy to keep its original level of profit. However, this is not the only way electric companies that utilize decreasing block rate pricing structures can avoid loss of profit. This study proposes three more potential ways of rate increase distribution that absorb the marginal cost increase. These four ways of rate increase distributions are explored as follows:

The flat increase

Using the household electricity consumption profiles developed in this study, the aggregated rate increase percentage level approved for Duke Energy from 2021 to 2022. The following three distribution approaches will aim to achieve the same total revenue increase resulting from this distribution. This study also discusses the significance of a flat increase in Appendix C via econometric analysis.

Adjusting the lower price tier

This distribution approach tries to achieve the target level of revenue increase by only adjusting the rate of the lower price tier in the decreasing block rate structure. The calculation is completed using features of an Excel spreadsheet.

Adjusting the higher price tier

This distribution approach tries to achieve the target level of revenue increase by only adjusting the rate of the higher price tier. The calculation is also completed using features of an Excel spreadsheet.

Adjusting the price tier threshold

This distribution approach does not change the electricity rate at all, and only changes the threshold level between price tier 1 and price tier 2. A python script is written to calculate how the ideal level threshold q should be adjusted to achieve this increase in revenue. When the level of revenue increase cannot be achieved by adjusting the threshold quantity level, the program returns the highest level of revenue it can be adjusted to base on the household consumption profiles. A link to the script is included in the reference.

Results

Monthly household electricity burden

Figures 4 and 5 below show the estimated monthly household electricity burden of households of different average income levels serviced by Duke and by Indiana Michigan Electric Co. (I&M). While Duke Energy has a decreasing block rate pricing structure and I&M has a flat rate pricing structure, both figures show a higher electricity burden on households with lower income levels. This suggests that the effect of households with lower electricity consumption levels bearing more electricity burden is not unique to the decreasing block rate pricing structure.

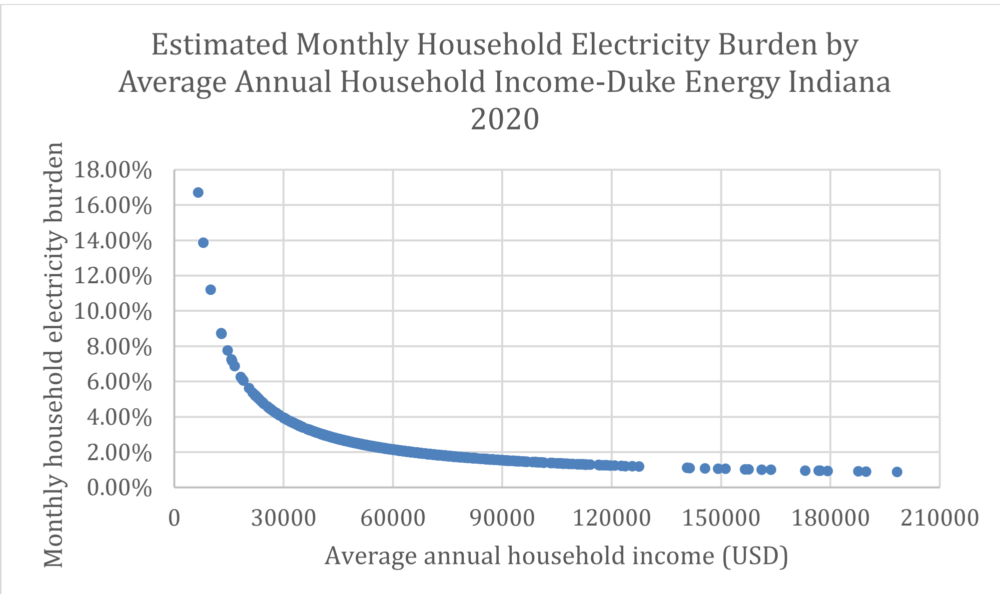


Figure 4 Estimated monthly household electricity burden of residential consumers serviced by Duke Energy Indiana 2020 distributed by levels of average annual household income[1]

[1] Due to data limitation, the electricity consumption level was generated using a parameter instead of being actual electricity bills collected from households. This explains the near perfect shape of the data trend. Researchers with data on actual residential electricity bills are encouraged to conduct this analysis again using the same method.

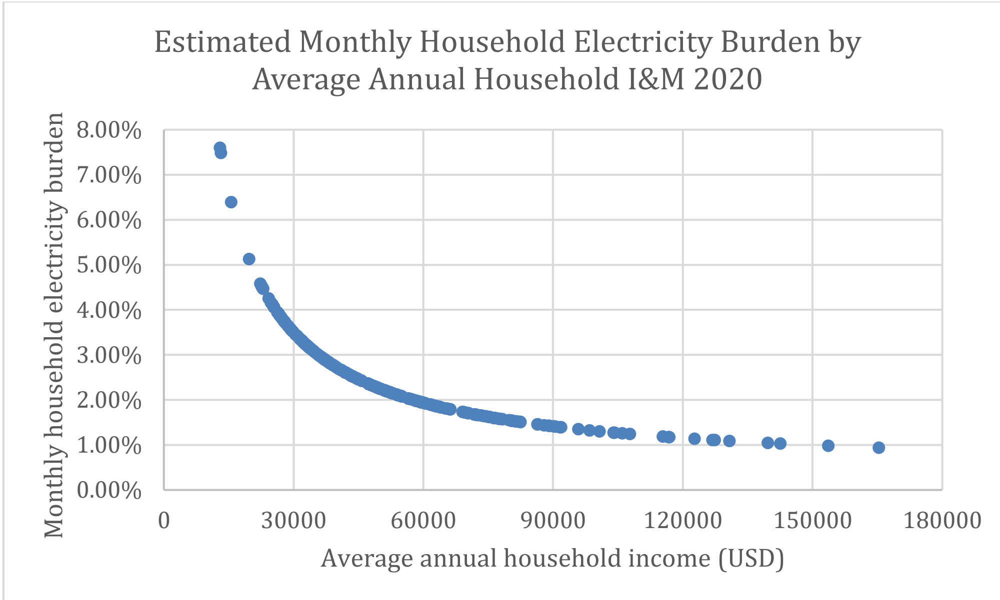


Figure 5 Estimated monthly household electricity burden of residential consumers serviced by Indiana Michigan Power Co. 2020 distributed by levels of average annual household income[2]

Between the two electric utility companies, monthly household electricity burden decreases as average annual household income increases. Figure 6 below combines the monthly electricity burden data and annual household income data from the two electric companies. The figure shows that low-income consumers of both companies have a higher electricity burden. When consumers' annual income level is below $30,000, household electricity burden climbs at a much higher rate as income level decreases compared to consumers with higher annual income levels. Additionally, consumers of Duke Energy experience an overall higher electricity burden than I&M consumers. The difference in electricity burden level is the highest for consumers with the lowest income level, decreases as income level increases, and reaches near zero once income level is higher than $150,000. According to the U.S. Census Bureau, the median annual household income in Indiana is $61,944 in 2021 dollars. For households with income levels lower than the state's median in Indiana, they are likely to have a higher electricity burden level if under a decreasing block rate pricing structure than under a flat rate pricing structure.

[2] This footnote repeats the same data limitation as the last footnote.

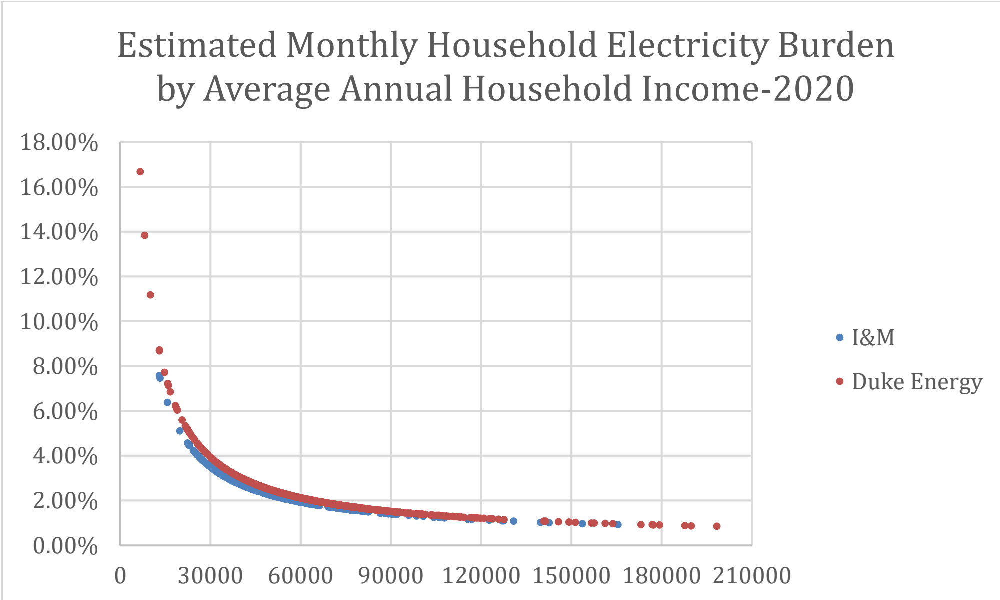


Figure 6 Estimated monthly household electricity burden of residential consumers of two electric companies in Indiana 2020 distributed by levels of average annual household income

Electricity rate increase and impact on energy burden

Figure 7 illustrates a summary of approved fuel cost adjustment petitions submitted by Duke Energy from 2021 to 2022. The figure shows a sharp increase in electricity rate from June to December 2022. Duke Energy claimed in their petitions that this surge in electricity rate is caused by the increasing cost of coal and natural gas, which are the top two fuels used by Duke's generating fleet. (Duke Energy Indiana, 2021) This sudden increase in coal and gas prices is not a unique case for Duke. According to the EIA, the cost of fossil fuels delivered to the US has increased by 34% from 2021 to 2022. (EIA, 2023)

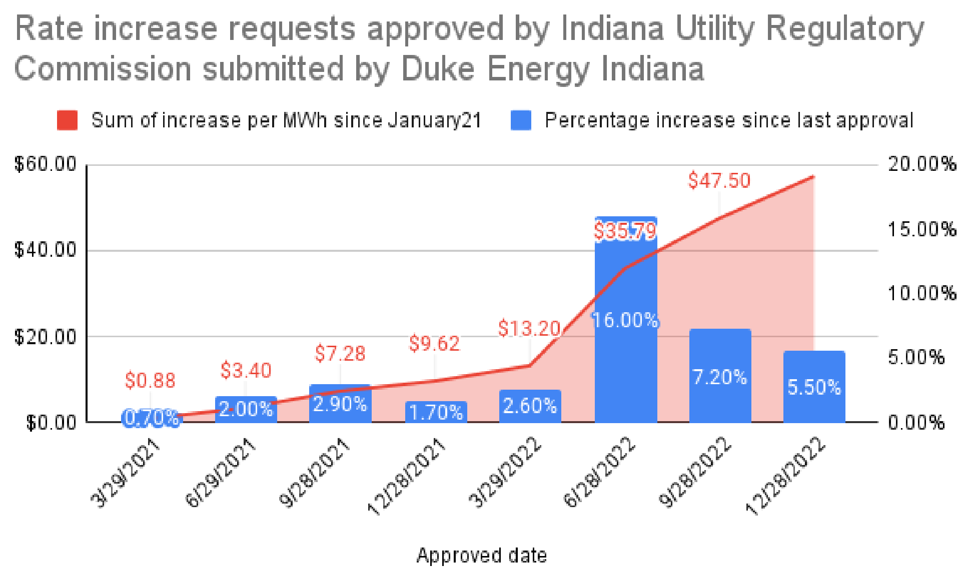


Figure 7 Summary of rate changes resulting from fuel cost adjustment petitions submitted by Duke Energy LLC and approved by Indiana Utility Regulatory Commission 2021-2022

Reaction to fuel cost increase

There has been a 38.6% increase in aggregated residential rate at Duke Energy approved by the IURC throughout 2021. This percentage increase was applied to the 832 household electricity consumption profiles built in this study. A total revenue increase of $30,941.10 was generated from this adjustment. Table 2 specifies the amount of change of the rate structure for each proposed type of distribution style to achieve the same level of revenue increase.

Distribution	Tier 1	Q1(kwh)	Tier 2	Q2(kwh)	Tier 3	Status
Flat	$0.206235	300	$0.150100	700	$0.136032	Achieved
Adjusting Tier 1	$0.272762	300	$0.108297	700	$0.098147	Achieved
Adjusting Tier 2	$0.148799	300	$0.1863544	700	$0.098147	Achieved
Adjusting Tier 3	$0.148799	300	$0.108297	700	$53.21224	Achieved
Adjusting q1	$0.148799	1174[3]	$0.108297	700	$0.098147	Can't be achieved

Table 2 Adjusted rate structure of Duke Energy that results in a 38.6% increase in total revenue in an estimated consumer profile

The first three achievable distribution styles are plotted for their impact on electricity burdens on the consumer profiles. Adjusting the price of tier 1 has the most impact on households with lower income levels and adjusting tier 2

[3] This is the maximum to which the threshold can extend to while still causing an increase in revenue based on the consumption profiles used in this study.

has the least impact on households with lower income levels. Adjusting the third price tier led to a very drastic change since there are very few households in the profile that use more than 1,000 kwh per month to suffice such change.

Annual Income Level (USD)	Flat increase		Adjust Tier 1		Adjust Tier 2		Adjust Tier 3	
	Increase in bill	Increase in burden	Increase in bill	Increase in burden	Increase in bill	Increase in burden	Increase in bill	Increase in burden
Less than 25,000	$32.80	2.33%	$37.19	2.66%	$29.08	2.05%	$0	0%
25,000 to 49,999	$35.02	1.06%	$37.19	1.13%	$33.23	1.00%	$0	0%
50,000 to 74,999	$37.19	0.729%	$37.19	0.731%	$37.27	0.730%	$0	0%
75,000 to 99,999	$39.47	0.565%	$37.19	0.533%	$41.53	0.594%	$0	0%
100,000 to 125,000	$42.15	0.459%	$37.19	0.405%	$46.54	0.507%	$0	0%
More than 125,000	$45.98	0.347%	$37.19	0.281%	$53.69	0.405%	$1719	11.3%

Table 3 Summary of monthly electricity bill increase and electricity burden increase over four different rate increase distribution approaches

The four different approaches to rate increase distribution result in different increases in electricity bill and electricity burden for consumers. Figure 8 shows that for households with annual income level below $50,000, adjusting tier 1 of the pricing structure results in the biggest increase in electricity burden, while adjusting tier 2 of the pricing structure results in the second least increase in electricity burden. Adjusting tier 3 results in an 11.3% increase in electricity burden for consumers with annual income level more than $125,000, as shown in table 3. This significant increase in electricity burden is because very few census tracts in this study that have a significantly high level of income. This causes the dataset to have only a few consumer profiles with a high monthly electricity consumption level, since this study uses a linear regression parameter to project monthly electricity consumption based on annual income level.

Combining the different level of electricity burden increase from the four approaches and the statistical makeup of the consumer profiles, this study suggests the rate increase distribution approach that adjusts the price tier with the highest quantity threshold while there are an adequate number of consumers paying for electricity in that price tier should add the least to the financial burden of low-income households. When considering whether there is an adequate amount of consumption in the price tier with the highest threshold, regulators should look at the percentage increase in electricity burden from adjusting this price tier and compare it with the average electricity burden level in the state.

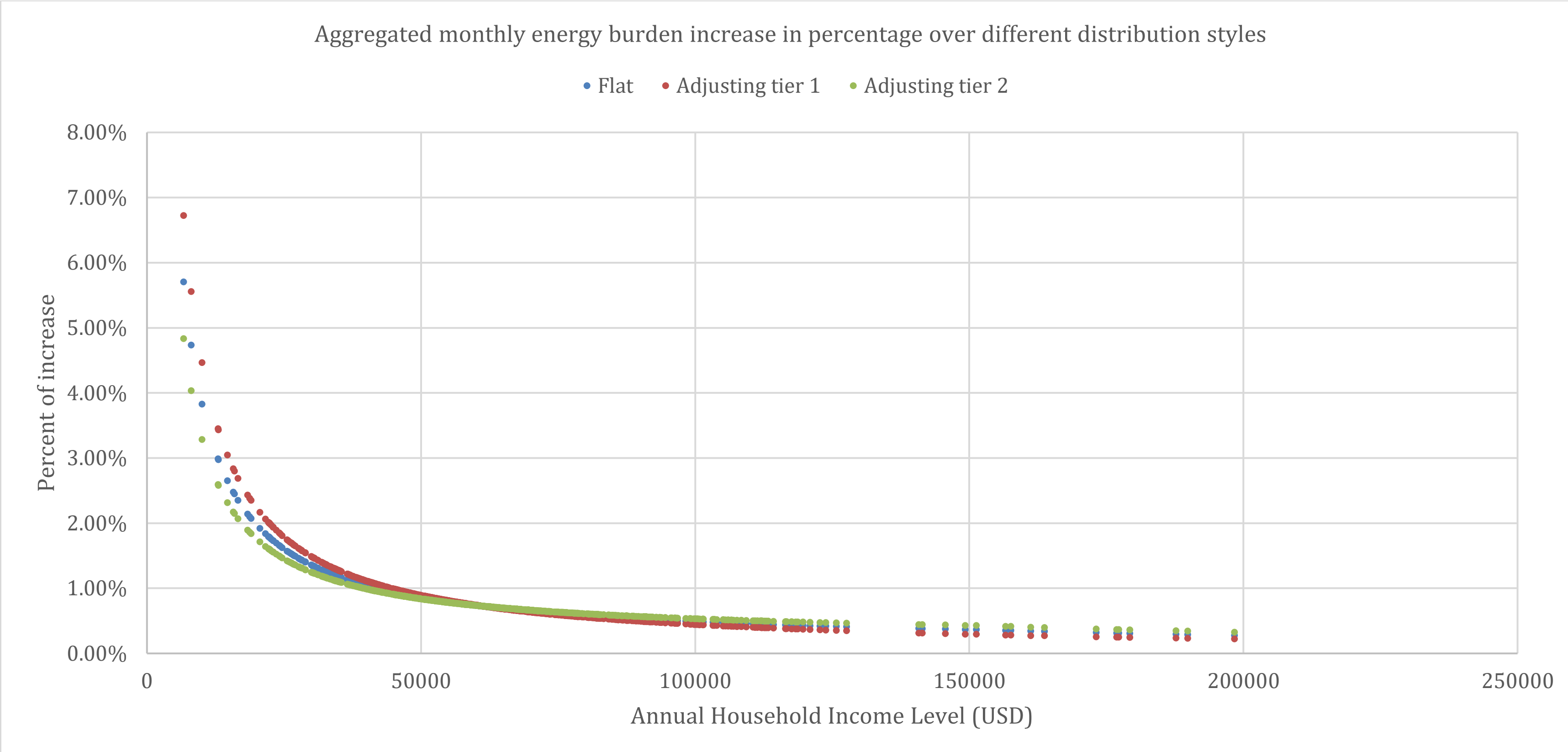


Figure 8 Comparison to monthly electricity burden increase over three different rate increase distribution approaches[4]

[4] Adjusting tier 3 is not included such that the scale of difference between the three other distribution styles can be seen clearly.

Discussion

The way electric companies absorb fuel cost increase is determined by both utility companies' strategies and the states' regulation. This study explored different ways in which electric companies with a decreasing block rate structure can absorb cost increases while maintaining the same level of profit. While the common practice is to increase price the same amount for each unit of electricity consumed, it is worth noting that electric companies can choose to absorb cost increase in a way that unevenly increases the electricity burden on lower-income households without losing profit. A more thorough study should be conducted regarding states' regulation on this matter. It would be beneficial if another study could be done using the same method with real-life electricity bills, along with income levels of the same households.

Appendix A

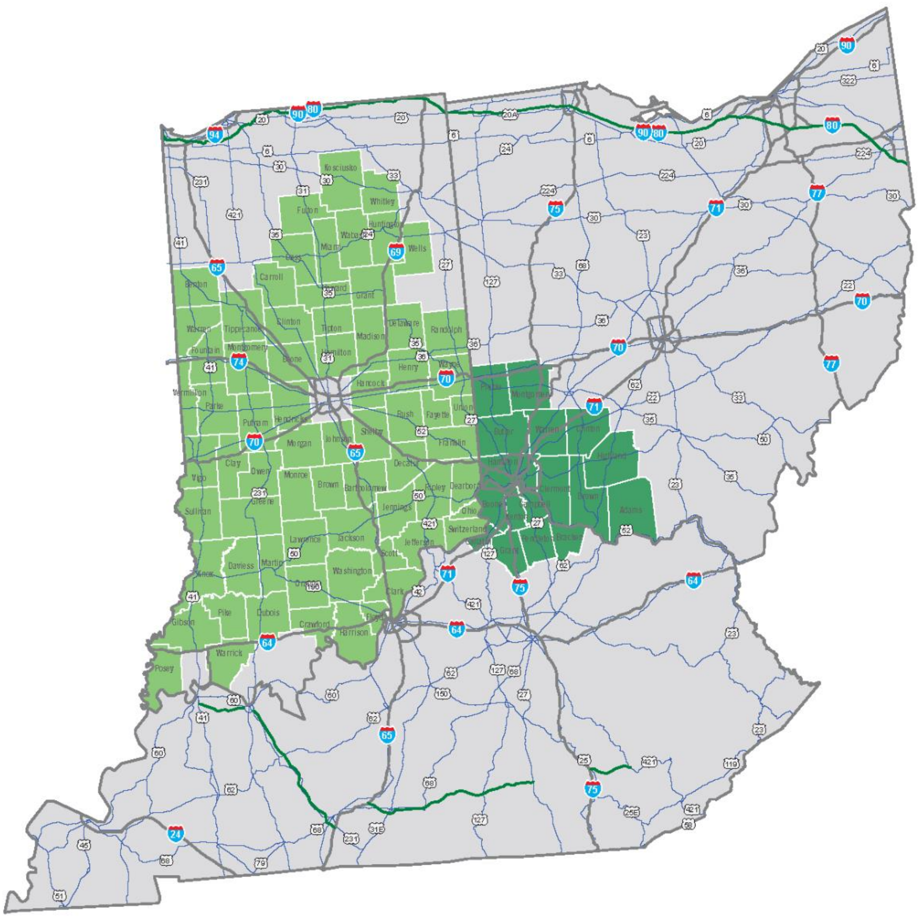
Summary of residential service tariffs at investor-owned electricity utility companies in Indiana[5]

Rate Structures				
Utility	Effective date	Consumer type	Tier	Structure
Duke Energy	09/22/2022	Residential	3	Decreasing
NIPSCO[6]	05/31/2022	Residential	1	Flat
AES[7]	01/01/2023	Residents–0 to 325 kWh per month	2	Decreasing
AES	01/01/2023	Residents–over 325 kWh per month	2	Decreasing
Vectren[8]	05/01/2019	Residential, Standard	1	Flat
Vectren	05/01/2019	Residential, Transitional	2	Decreasing
I&M[9]	07/01/2022	Residential, Experimental-TOD[10]	1	Flat
I&M	07/01/2022	Residential-TOD	1	Flat
I&M	07/01/2022	Residential	2	Decreasing

5 Information gathered from the United States utility rate database at OpenEI
6 Northern Indiana Public Service Company
7 AES Indiana, formerly known as Indianapolis Power & Light Company
8 Also called CenterPoint Energy
9 Indiana Michigan Power Co.
10 Short for time of day

Appendix B

Midwest Service Territory



Service Territory
Counties Served*

- Duke Energy Indiana
- Duke Energy Ohio and Kentucky

**Portions may be served by other utilities.*

DUKE ENERGY.

Appendix C

The economic model in this appendix analyzes how the per unit electricity rates for a two-tiered decreasing block rate pricing structure should be set for an electricity utility company to break even while providing a level utility to consumers with a budget constraint. Additionally, this model analyzes whether individual electricity storage owned by consumers would interfere with the rate setting process.

Decreasing block price with two price tiers

Problem Setup

In a simple scenario where a utility company charges its customers with a two-tier decreasing block price structure, let access fee be zero, let fixed cost F be zero, let q be the threshold quantity that divides the first and second tier of rating.

Let there be n_L low-using households that only pay for the first-tier rate p_H due to their lower usage of electricity; let there be n_H high-using households that pay for the first and second tier rates p_H and p_L due to their higher usage of electricity.

Constraints and objective function

Two budget constraints can be developed for the two types of households:

- Low-using: $x^i + p_H e^i = w^i$
- High-using: $x^i + p_L(e^i - q) + p_H q = w^i$

(where x is a numeraire good, and w is the income of each household).

We adjust income levels to $\widetilde{w}_L^i$, and $\widetilde{w}_H^i$, where:

- $\widetilde{w}_L^i = w^i$
- $\widetilde{w}_H^i = w^i + (p_L - p_H)q$

such that the amount of electricity used by both types of households can be expressed as a dependent variable of adjusted income and electricity rate.

An indirect utility function can then be devised and used as the objective function:

$$\sum_{i\in L} v^i\left(p_H, \widetilde{w}_L^i\right) + \sum_{i\in H} v^i\left(p_L, \widetilde{w}_H^i\right)$$

A constraint equation can be devised as:

$$(p_H - c)\sum_{i\in L} e^i(p_H, \widetilde{w}_L) + (p_H - c)n_H q + (p_L - c)\sum_{i\in H} e^i(p_L, \widetilde{w}_H) = F$$

where c is the cost of producing each unit of electricity.

Letting λ be the multiplier of the constraint function, using Roy's identity to rewrite v_p^i, or $\frac{\partial v^i}{\partial p}$, as $-\mathrm{e}^{\mathrm{i}}\mathrm{v}_{\widetilde{\mathrm{w}}}^{\mathrm{i}}$, the three first-order conditions would be:

$$-\sum_{i\in H}\left(e^i - q\right)v_{\widetilde{w}}^i + \lambda\left[\sum_{i\in H} e^i + (p_L - c)\left(e_p^i - e_{\widetilde{w}}^i\, q\right)\right] = 0$$

in regard to p_L

$$-\sum_{\mathrm{i}\in\mathrm{L}} \mathrm{e}^{\mathrm{i}}\,\mathrm{v}_{\widetilde{\mathrm{w}}}^{\mathrm{i}} + \lambda[\sum_{\mathrm{i}\in\mathrm{L}} \mathrm{e}^{\mathrm{i}} + \mathrm{n_H q} + \sum_{\mathrm{i}\in\mathrm{H}}(\mathrm{e}^{\mathrm{i}} + (\mathrm{p_L} - \mathrm{c})(\mathrm{e}_{\mathrm{p}}^{\mathrm{i}} + \mathrm{e}_{\widetilde{\mathrm{w}}}^{\mathrm{i}}(\mathrm{e}^{\mathrm{i}} - \mathrm{q}))] = 0$$

in regard to p_H

$$(p_L - p_H)\sum_{i\in H} v_{\widetilde{w}}^i + \lambda[n_H\,(p_H - c) + (p_L - c)(p_L - p_H)\sum_{i\in H} e_{\widetilde{w}}^i] = 0$$

in regard to q

In the third equation, since $p_L - p_H$ is negative, either $p_H - c$ is positive or $(p_L - c)(p_L - p_H) > 0$. It can be deduced that $p_L < c < p_H$. This shows that when using a decreasing block price structure, the utility must set the lower-tier price to be less than the cost of production and the higher-tier price to be more than the cost of production to meet demand and break even. This conclusion is intuitive, for if marginal cost is lower or higher than both price tiers, the electricity utility would either lose money or make a profit, instead of breaking even.

Decreasing block price for consumers with energy storage

Addition to previous set up

For consumers with individual energy storage devices installed at their own home, such as roof top solar panels with batteries, there would be a "free" amount of electricity said consumers own. To build upon previous setup, let $\tilde{e}^i$ be the amount of free electricity each consumer has, which is included in $\tilde{e}^i$, the total amount used by each consumer.

Depending on level of storage and consumer's choice, a high-using household has two ways to utilize their stored energy:

1. Consumers start using stored energy before the amount of electricity used reaches threshold q and continue to use stored energy until the end of their billing cycle. This lets stored energy cover the cost of using utility-generated energy under both price tiers.
2. Consumers start using stored energy after the amount of electricity used has reached threshold q and continue to use energy storage until the end of their billing cycle. In this scenario, energy storage would cover the cost of utility-generated energy charged in the second, lower price tier.

The first scenario yields the same adjusted budget constraint as explored in the last section. Therefore, this analysis will only consider the second scenario for high-using households.

Constraints and objective function

The new budget constraints would be:

- Low-using: $x^i + p_H(e^i - \tilde{e}^i) = w^i$
- High-using: $x^i + p_L(e^i - \tilde{e}^i - q) + p_H q = w^i$

We adjust income levels to $\widetilde{w}_L^i$,and $\widetilde{w}_H^i$, where:

- $\widetilde{w}_L^i = w^i + p_H \tilde{e}^i = x^i + p_H e^i$
- $\widetilde{w}_H^i = w^i + (p_L - p_H)q + p_L \tilde{e}^i = x^i + p_L e^i$

An indirect utility function can then be devised as:

$$\sum_{i \in L} v^i(p_H, \widetilde{w}_L^i) + \sum_{i \in H} v^i(p_L, \widetilde{w}_H^i)$$

A constraint equation can be devised as:

$$(p_H - c)[n_H q + \sum_{i \in L} e^i(p_H, \widetilde{w}_L)\,] + (p_L - c)\sum_{i \in H} e^i(p_L, \widetilde{w}_H) = F$$

Letting λ be the multiplier of the constraint function, using Roy's identity to rewrite v_p^i, or $\frac{\partial v^i}{\partial p}$, as $-\mathrm{e^i v^i_{\widetilde{w}}}$, the three first-order conditions would be:

$$-\sum_{i \in H}(e^i - \tilde{e}^i - q)\, v^i_{\widetilde{w}} + \lambda[\sum_{i \in H}(e^i + (p_L - c)(e^i_p + e^i_{\widetilde{w}}(\tilde{e}^i - q))] = 0$$

in regard to p_L

$$-\sum_{i \in L}\left(e^i - \tilde{e}^i\right) v^i_{\widetilde{w}} + \lambda\begin{bmatrix} n_H q + \sum_{i \in L}((e^i + (p_H - c)(e^i_p + \tilde{e}^i e^i_{\widetilde{w}})) \\ +(p_L - c)\sum_{i \in H}\left(e^i_p - e^i_{\widetilde{w}} q\right) \end{bmatrix} = 0$$

in regard to p_H

$$(p_L - p_H)\sum_{i \in H} v^i_{\widetilde{w}} + \lambda[n_H\,(p_H - c) + (p_L - c)(p_L - p_H)\sum_{i \in H} e^i_{\widetilde{w}}] = 0$$

in regard to q

In the third equation regarding q, since $p_L - p_H$ is negative, either $p_H - c$ is positive or $(p_L - c)(p_L - p_H) > 0$. It can then be deduced that $p_L < c < p_H$. This shows that when using a decreasing block price structure, the utility must set the lower-tier price to be less than the cost of production and the higher-tier price to be more than the cost of production to meet demand and make zero or more profit. The addition of electricity storage yields the same conclusion as of the previous section. This conclusion makes sense intuitively, since the addition of storage does not change the fact that the revenue gained from the higher price tier is still subsidizing the revenue gained from the lower price tier. To break even and hold the level of utility provided, the relationship between electricity rates and marginal cost should also hold.

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