The Clean Power Plan's Economic Impact

by Income Group and Local Area

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CONTENTS

Executive Summary

Energy poverty, a term once reserved for developing nations, now threatens far too many families in the United States. According to a 2011 survey, 52 percent of respondents said that their energy bills were more difficult to afford compared to the previous year. Supporting these claims, the number of households receiving energy assistance from the federal government remained 40 percent higher as of 2014, compared to the average number of households requiring assistance prior to the Great Recession.

The Obama Administration's intention to implement the Clean Power Plan (CPP) is particularly troubling in light of these affordability problems. Implementation of the CPP is currently stayed by the U.S. Supreme Court because several states are claiming that the Environmental Protection Agency (EPA) exceeded its authority by trying to promulgate these regulations. If implemented, the CPP will reduce overall U.S. economic growth, increase average electricity expenditures, and worsen the problem of energy affordability for many U.S. households.

Implementation of the CPP will require radical changes to the current electricity infrastructure. Fossil fuels (coal, natural gas, and petroleum) account for approximately two-thirds of total electricity generation. Coal is currently the main power source in 22 states (West Virginia, Kentucky, and Wyoming being the states most reliant on coal). Natural gas is the main power source in 15 states including all of the states along the Gulf of Mexico, California, Georgia, Massachusetts, Nevada, New York, and Virginia.

Nuclear power, a low GHG energy source, currently generates around 20 percent of the country's electricity, but is the major power source in only five states – Connecticut, Illinois, New Hampshire, Pennsylvania, and South Carolina. Twenty states have no nuclear electricity generation at all. While nuclear power is a low GHG energy source, according to the Energy Information Administration, the last newly built reactor to become operational was in 1996.

The other low GHG energy sources come from alternative energy sources (hydroelectric, wind, and solar). Alternative energy sources accounted for 13 percent of total electricity generated in 2015 – the largest share (6 percent) coming from the 1,436 hydroelectric plants. Idaho, Oregon, and Washington generated the most power from hydroelectric plants, and hydroelectric plants provided 48 percent or more of the power in five states. Hydroelectric plants provided less than 10 percent of the electricity in 40 states.

The 843 wind-powered electric plants in the U.S. generated 5 percent of the country's electricity in 2015. Wind power's largest share of electricity generation was in Iowa and South Dakota (accounting for 33 percent of the states' electricity) followed by Kansas (accounting for 25 percent of the state's electricity).

The 772 solar-powered electric plants in the U.S. generated only 1 percent of the nation's electricity. Solar power is predominantly used in the Southwest where the sun shines reliably and 38 of the 48 continental states have no solar generating plants at all.

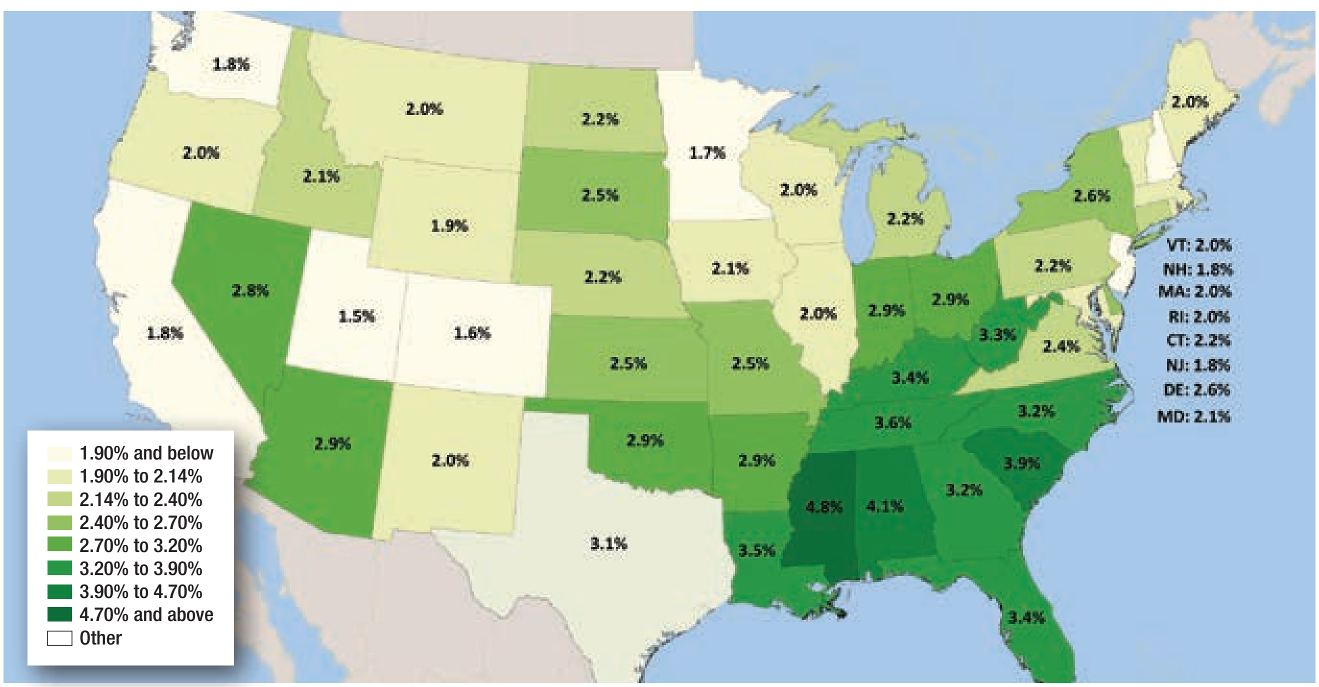
> The median household incomes in the states with the higher electricity burdens are less than the median household incomes in the states with the lower electricity burdens – current electricity costs impose a regressive burden.

If the CPP's CO_2 reduction goals are to be met, then fossil fuel energy sources, particularly the coal power plants, would need to be retired and replaced with some combination of the low GHG energy sources. By forcibly revising the current energy infrastructure, the CPP will raise the costs of electricity and impose large costs on the economy. But, these costs will not be borne equally. Just as the power sources vary by state, the costs from the CPP will vary by state. They will also vary by income group. Before reviewing these differential costs from the CPP, it is beneficial to review the current burden from electricity expenditures by state and income group.

Based on EIA price and consumption data for 2014, the average U.S. electricity customer spent $1,465 per year, which was 2.7 percent of 2014 median household income. On a dollar expenditure basis, the highest average annual expenditures per customer in the Continental U.S. occurred in South Carolina ($1,774) and the lowest was in New Mexico ($935). Relative to income, however, the largest burden from current electricity expenditures was in Mississippi (4.8 percent) and the smallest burden was in Utah (1.5 percent). Map ES1 presents the current average burden for the 48 continental states.

MAP ES1

Current Average Annual Electricity Expenditures Relative to Median Household Income Continental U.S.



Source: Author calculations based on data from the EIA

As Map ES1 illustrates, the largest current burdens are in the Southeastern states, while the Mountain region and Pacific Coast region have the lowest current burdens. Generally speaking, the median household incomes in the states with the higher electricity burdens are less than the median household incomes in the states with the lower electricity burdens – current electricity costs impose a regressive burden.

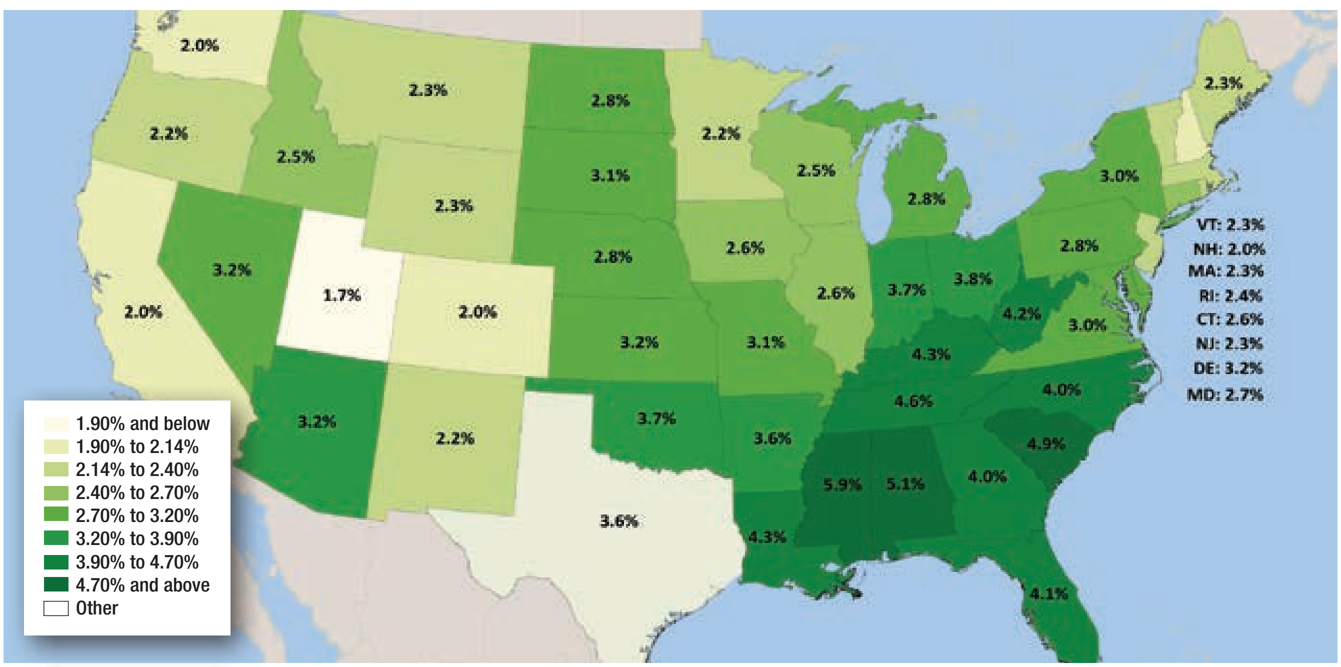
A study by NERA (2014) estimated that the net present value of the additional consumer energy expenditures due to the CPP between 2017 and 2031 range between $366 billion and $479 billion. Similarly, a study performed by Energy Ventures Analysis (EVA), estimated that by 2030 the CPP will increase wholesale electricity expenditures by $214 billion compared to what households would have paid without the CPP regulation. Except for California and New Mexico, the percentage increase in wholesale electricity prices will be larger than 10 percent.

Assuming that retail electricity prices increase by the same percentage as the estimated increases in wholesale prices that EVA estimated, the price increases associated with the CPP will worsen the expenditure burden on all households in all states; however, the impact will not be uniform across the states. Some states, such as California (+9.4 percent), would experience smaller price increases while other states, such as Ohio (+31.2 percent), would experience much larger price increases. Overall, the states in the upper mid-west will experience the largest price increases due to the CPP and the states in the west will experience the smallest price increases.

The extent to which the price increases lead to overall expenditure increases depends upon how consumers respond to the higher electricity prices. If consumers do not change their electricity consumption at all following the electricity price increases, then consumers will bear the highest increase in the expenditure burden following the CPP's price increases. This behavioral assumption, also known as a static analysis, provides a logical maximum impact from the CPP regulations. Total electricity expenditures under this scenario, referred to as the static impact scenario, increase by the same percentage as the increase in electricity prices. The resulting increase in the electricity expenditure burden relative to 2014 median household incomes is illustrated in Map ES2.

MAP ES2

Average Annual Electricity Expenditures Relative to Median Household Income
Static Impact Scenario — Continental U.S.



Source: Author calculations based on data from the EIA

Two trends are apparent when comparing Maps ES1 and ES2. First, the average expenditure burden increases across all of the states – if the CPP is implemented, the average household will be devoting a larger percentage of its income toward electricity expenditures than without the CPP based on a static analysis. Second, the regional gap between the Southeast region and the Mountain and Pacific regions expands – the Southeast will be facing an even larger relative burden compared to the Mountain and Pacific regions. Therefore, the CPP is relatively more burdensome on households in the Southeast region compared to households in any other region.

It is likely that consumers will make behavioral adjustments in response to rising electricity prices. Economic theory predicts that as electricity prices rise the quantity of electricity demanded will fall, holding all else constant. In economics this is known as the "Law of Demand." How sensitive changes in the quantity of electricity demanded are to changes in electricity prices is an empirical question. Empirical analyses measuring this sensitivity (referred to as the price elasticity of demand) are centering on a range of estimates. The elasticity estimates from NERA Economic Consulting exemplify the converging consensus. The study examined 72 electricity distribution companies in the United States from the period 1972-2009 finding that the price elasticity of demand for residential, commercial, and industrial consumers was between -0.38 and -0.61.

Accounting for two additional considerations can provide greater context regarding how households will change their behavior in response to the CPP's price increases.

First, previous estimates of the price elasticity of demand for electricity suggests that the longer a price change has been in effect, the more behavioral changes consumers of electricity are able to implement. Reciprocally, there are fewer options available to consumers to change their behavior in response to changes in the price of energy within a shorter timeframe. Therefore, consumers should be more responsive to changes in price the longer the time period they have to adjust to the higher prices. According to a 2006 study by the Rand Corporation, the short-run price elasticity for residential electricity demand was -0.2, while the estimated long-run price elasticity for residential electricity demand was -0.32.

Consumers should be more responsive to changes in price the longer the time period they have to adjust to higher prices.

Second, regional differences in price sensitivity should be expected. For instance, the electricity needs of a household living in the relatively mild climate of San Francisco, California should differ from a household living in Fargo, North Dakota or Miami, Florida. The 2006 study by the Rand Corporation also examined the elasticity of electricity demand by region and by state. The Rand analysis found that there are, in fact, regional and state differences in the price-demand relationship for electricity particularly for residential electricity use. The analysis also found that there is consistency in residential electricity use among states within a region. Table ES1 summarizes the regional estimates from the Rand analysis. The short-run regional elasticities range from -0.054 in the East North Central region to -0.318 in the South Atlantic region. For the long-run, elasticities ranged from -0.058 in the East North Central to -0.618 in the East South Central.

TABLE ES1

Short-Run and Long-Run Price Elasticity for Residential Electricity by Region

REGION	SHORT-RUN PRICE ELASTICITY	LONG-RUN PRICE ELASTICITY
Pacific Coast	-0.188	-0.254
Mid Atlantic	-0.232	-0.247
New England	-0.192	-0.325
Mountain	-0.211	-0.267
South Atlantic	-0.318	-0.352
East North Central	-0.054	-0.058
East South Central	-0.266	-0.618
West North Central	-0.163	-0.244
West South Central	-0.127	-0.174

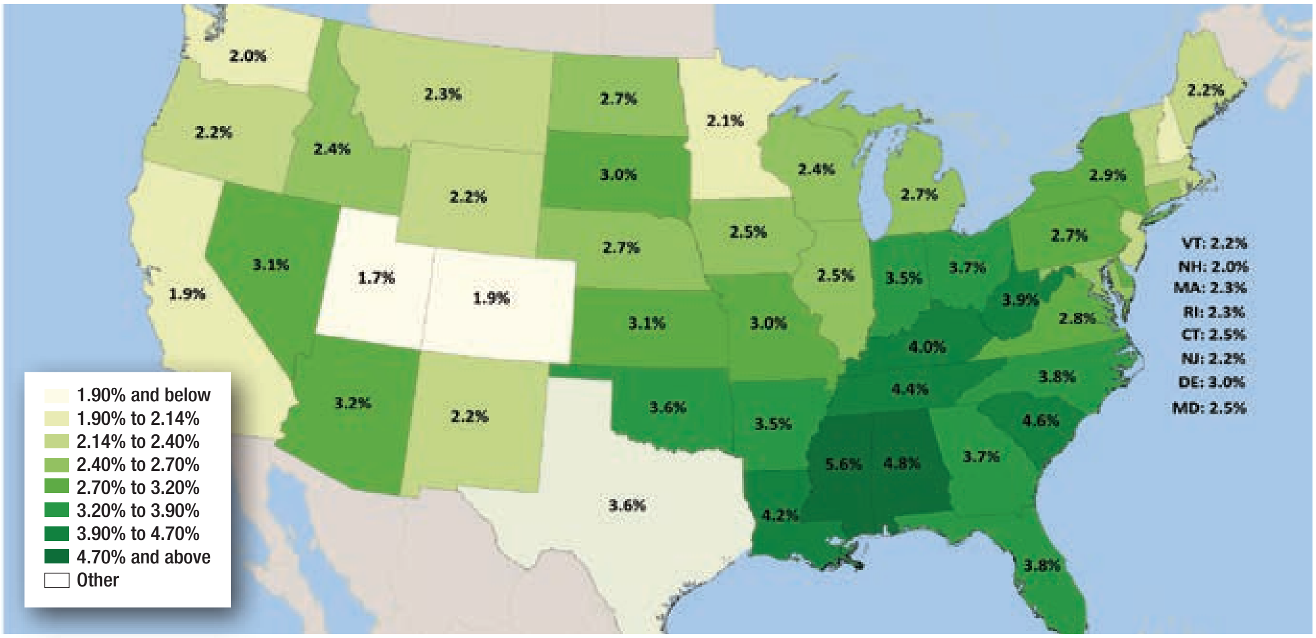
Source: Bernstein, M.A and J. Griffin (2006) "Regional Differences in the Price-Elasticity of Demand for Energy," RAND Corporation, NREL/SR-620-39512, February.

As illustrated in Table ES1, households in the South Atlantic and East South Central regions change their electricity consumption the most in the short-run in response to changes in electricity prices. On the other hand, households in the East North Central region change their consumption habits the least in response to changes in electricity prices. The long-run price elasticity estimates confirm that, across all of the regions, when households have more time to adjust, they are able to make larger changes to their electricity consumption.

Relying on these regional elasticity estimates, we evaluate two different CPP impact scenarios that account for the likely changes in households' behavior in response to the now higher electricity prices. We refer to these scenarios as the dynamic short-term scenario and the dynamic long-term scenario. The dynamic short-term scenario evaluates the impact from the higher electricity prices on energy expenditures by households based on the short-run estimated sensitivity, see Map ES3. The dynamic long-run scenario evaluates the impact from the higher electricity prices on energy expenditures by households based on the long-term estimated sensitivity, see Map ES4.

MAP ES3

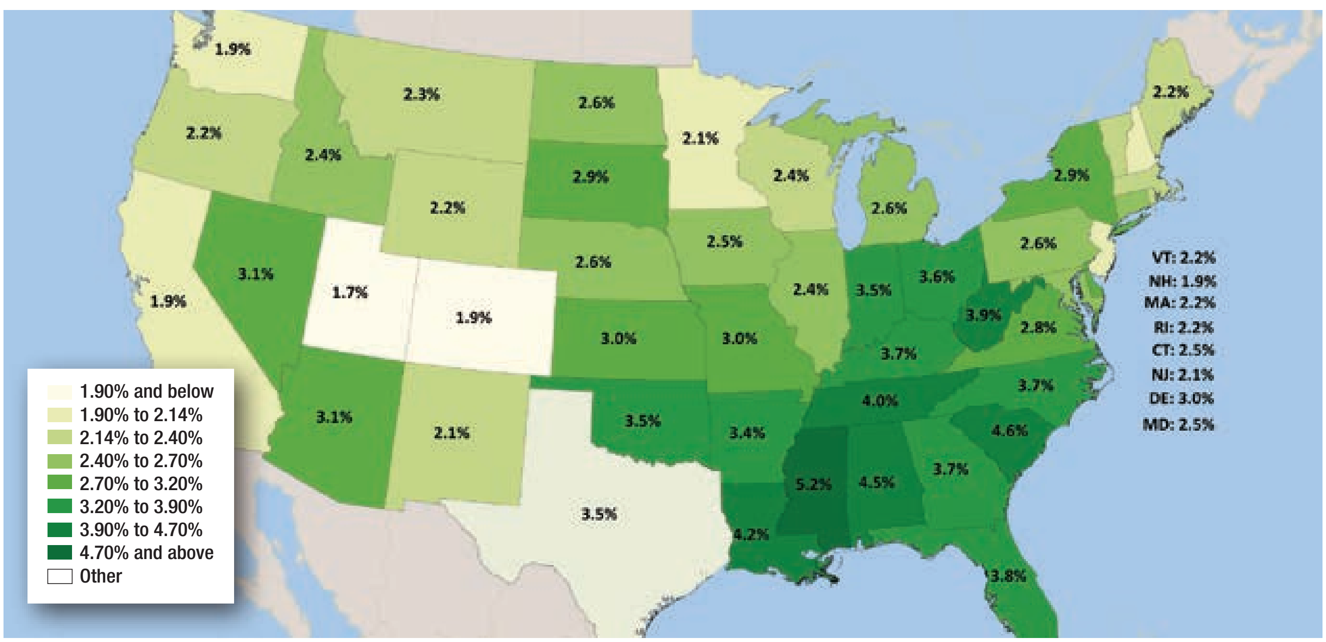
Average Annual Electricity Expenditures Relative to Median Household Income Dynamic Impact Scenario/Short-term — Continental U.S.



Source: Author calculations based on data from the EIA

MAP ES4

Average Annual Electricity Expenditures Relative to Median Household Income Dynamic Impact Scenario/Long-term — Continental U.S.



Source: Author calculations based on data from the EIA

Maps ES3 and ES4 show the same pattern as Map ES2 – if implemented, the CPP will increase the average electricity expenditure burden across all states, with the Southeast bearing a larger burden from the CPP than the Mountain and Pacific regions.

The increase in the average electricity expenditure burden across the three scenarios – static, dynamic short-term, and dynamic long-term – is summarized in Table ES2. On average, the CPP will increase the average household's electricity expenditures between 0.4 percent and 0.5 percent of its income – depending upon the behavioral response. Based on the short-term dynamic scenario, the largest impact (0.8 percent of income) occurs in Mississippi, and the smallest impact occurs in California (0.1 percent of income).

TABLE ES2

Increased Average Electricity Expenditure Burden Relative to Median Household Income Due to the Implementation of the CPP

	CHANGE IN AVERAGE EXPENDITURES RELATIVE TO MEDIAN HOUSEHOLD INCOME		
	STATIC SCENARIO	DYNAMIC SHORT-TERM SCENARIO	DYNAMIC LONG-TERM SCENARIO
Alabama	1.0%	0.7%	0.4%
Arizona	0.3%	0.3%	0.2%
Arkansas	0.7%	0.6%	0.6%
California	0.2%	0.1%	0.1%
Colorado	0.3%	0.2%	0.2%
Connecticut	0.4%	0.3%	0.2%
Delaware	0.6%	0.4%	0.4%
Florida	0.7%	0.5%	0.4%
Georgia	0.7%	0.5%	0.5%
Idaho	0.4%	0.3%	0.3%
Illinois	0.5%	0.5%	0.4%
Indiana	0.8%	0.7%	0.6%
Iowa	0.5%	0.4%	0.4%
Kansas	0.6%	0.5%	0.5%
Kentucky	0.9%	0.7%	0.4%
Louisiana	0.8%	0.7%	0.7%
Maine	0.2%	0.2%	0.2%
Maryland	0.6%	0.4%	0.4%
Massachusetts	0.3%	0.3%	0.2%
Michigan	0.6%	0.5%	0.5%
Minnesota	0.4%	0.4%	0.3%
Mississippi	1.1%	0.8%	0.4%
Missouri	0.6%	0.5%	0.5%
Montana	0.3%	0.2%	0.2%
Nebraska	0.5%	0.4%	0.4%
Nevada	0.4%	0.3%	0.3%
New Hampshire	0.3%	0.2%	0.2%
New Jersey	0.4%	0.4%	0.3%
New Mexico	0.2%	0.2%	0.1%
New York	0.5%	0.4%	0.3%
North Carolina	0.8%	0.5%	0.5%
North Dakota	0.5%	0.4%	0.4%
Ohio	0.9%	0.8%	0.7%
Oklahoma	0.7%	0.6%	0.6%
Oregon	0.3%	0.2%	0.2%
Pennsylvania	0.6%	0.5%	0.4%
Rhode Island	0.3%	0.3%	0.2%

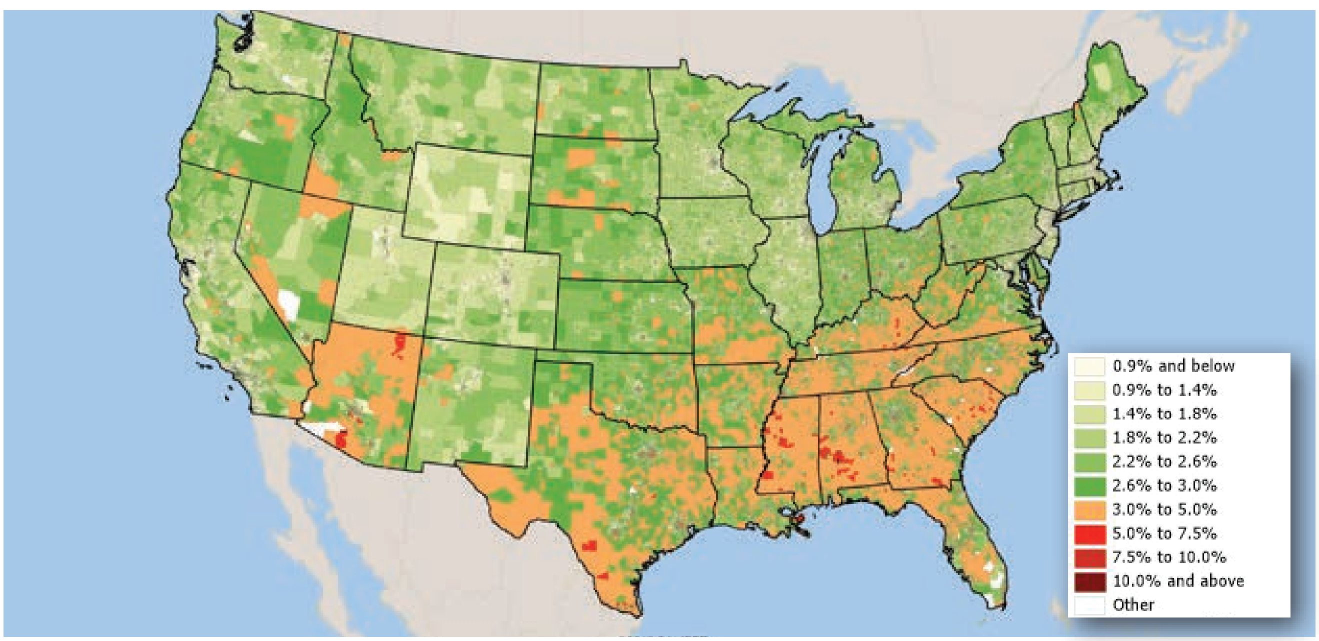
	CHANGE IN AVERAGE EXPENDITURES RELATIVE TO MEDIAN HOUSEHOLD INCOME		
	STATIC SCENARIO	DYNAMIC SHORT-TERM SCENARIO	DYNAMIC LONG-TERM SCENARIO
South Carolina	0.9%	0.6%	0.6%
South Dakota	0.6%	0.5%	0.4%
Tennessee	1.0%	0.7%	0.4%
Texas	0.6%	0.5%	0.5%
Utah	0.2%	0.1%	0.1%
Vermont	0.3%	0.2%	0.2%
Virginia	0.7%	0.5%	0.4%
Washington	0.2%	0.2%	0.2%
West Virginia	1.0%	0.7%	0.6%
Wisconsin	0.5%	0.4%	0.4%
Wyoming	0.4%	0.3%	0.3%

Author calculations

These average burden increases gloss over the important distributional impacts from the CPP within each state. It is, therefore, instructive to evaluate how the CPP will impact households in different income groups within each state. Map ES5 through Map ES8 illustrates the electricity expenditure burden by neighborhoods (officially census tracts) for the current average electricity expenditure burden; the estimated electricity burden under the static scenario; the estimated electricity burden under the dynamic short-term scenario; and, the estimated electricity burden under the dynamic long-term scenario.

MAP ES5

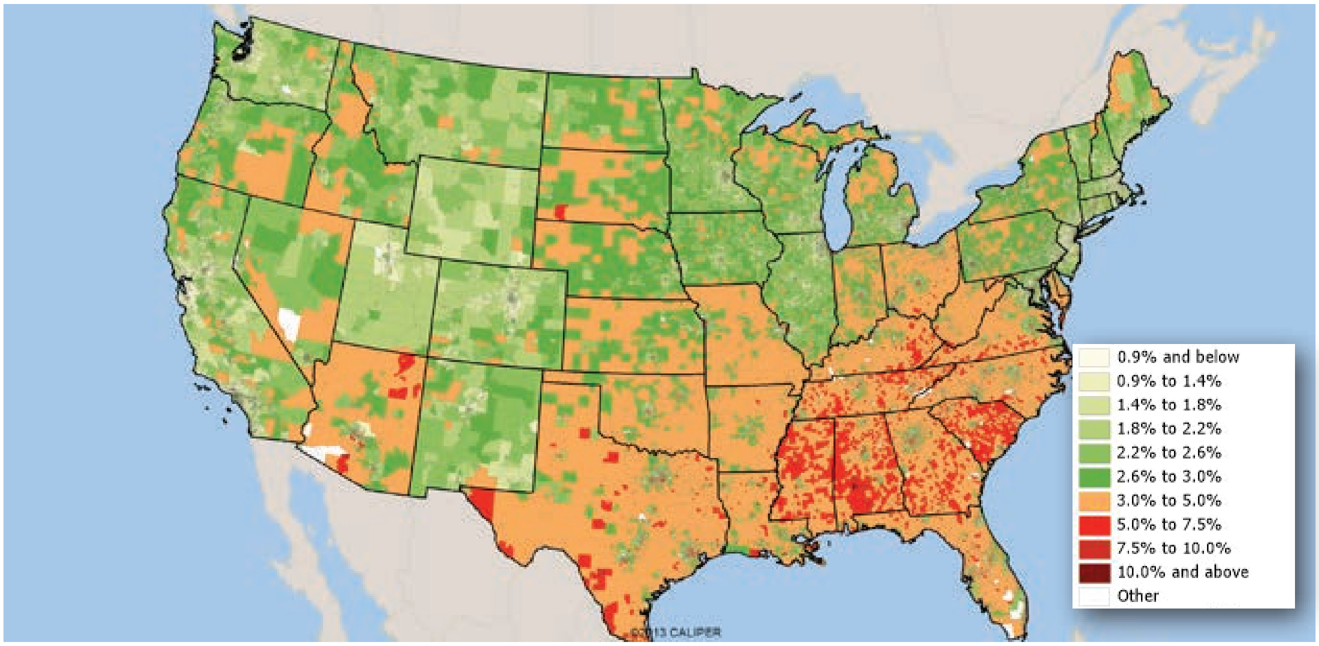
Current Average Annual Electricity Expenditures Relative to Median Household Income Continental U.S. By U.S. Census Tract



Source: Author calculations based on data from the EIA

MAP ES6

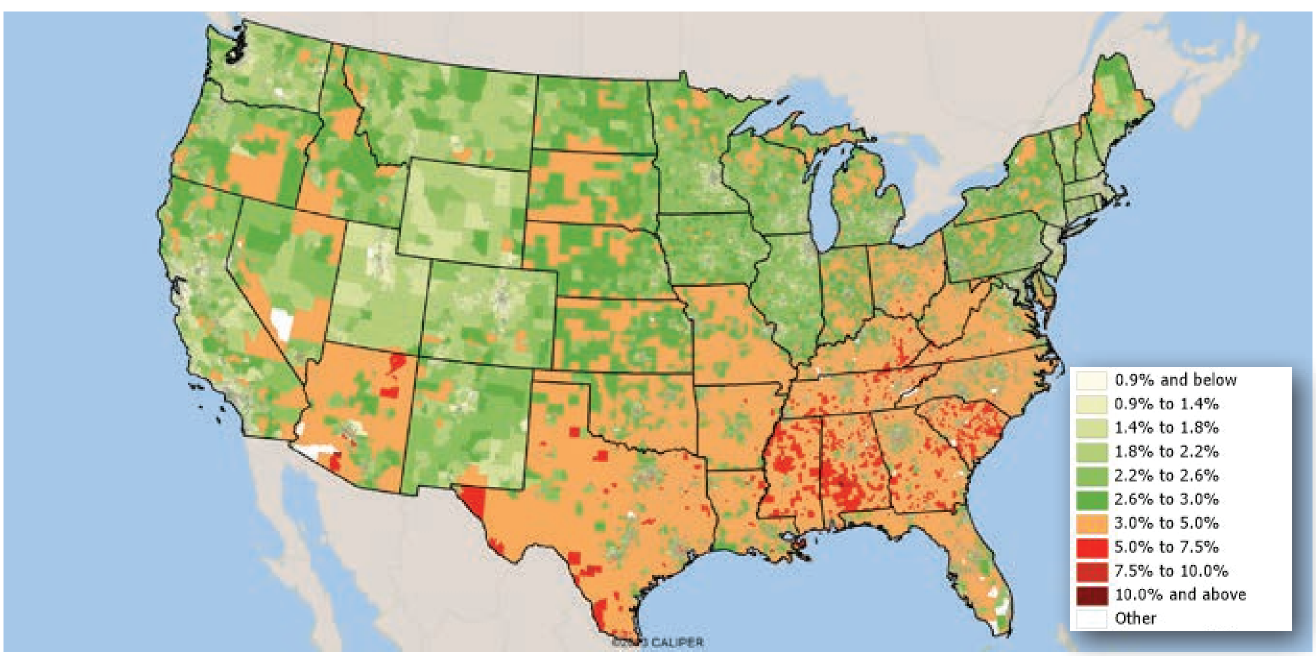
Average Annual Electricity Expenditures Relative to Median Household Income
Static Impact Scenario — Continental U.S. By U.S. Census Tract



Source: Author calculations based on data from the EIA

MAP ES7

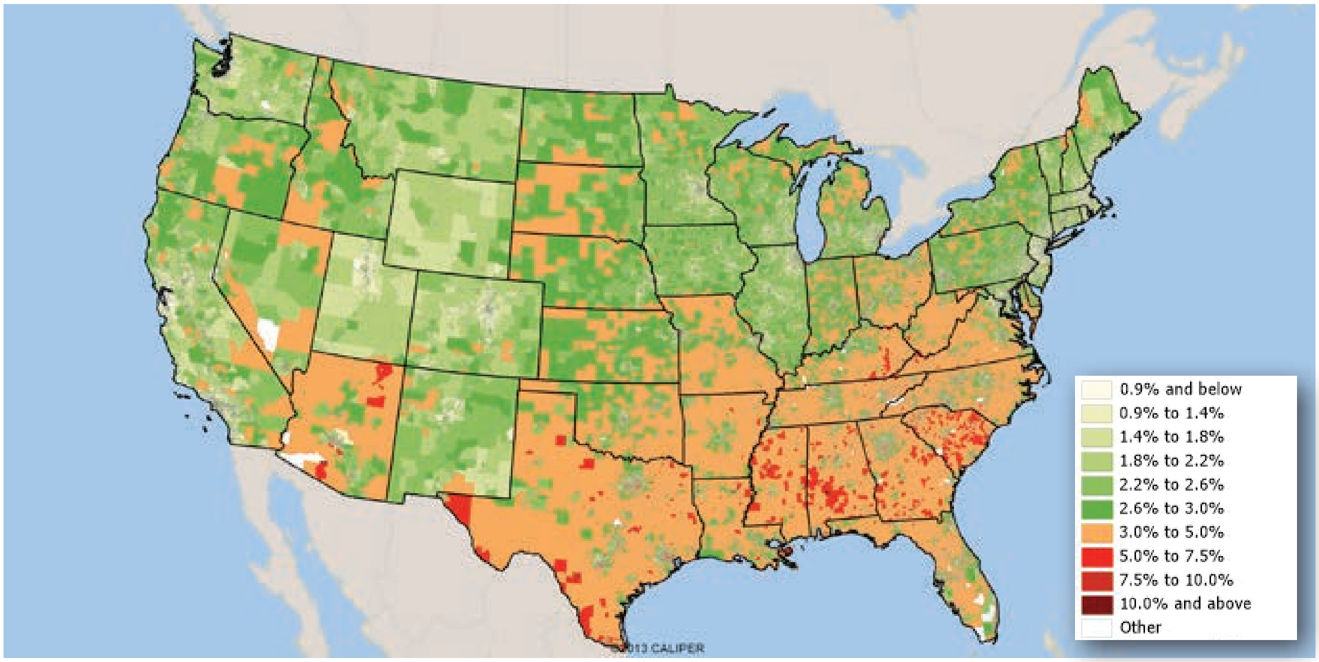
Average Annual Electricity Expenditures Relative to Median Household Income
Dynamic Impact Scenario – Short-term
Continental U.S. By U.S. Census Tract



Source: Author calculations based on data from the EIA

MAP ES8

Average Annual Electricity Expenditures Relative to Median Household Income
Dynamic Impact Scenario – Long-term
Continental U.S. By U.S. Census Tract



Source: Author calculations based on data from the EIA

Several important trends emerge from reviewing the patterns illustrated in Maps ES5 through ES8:

- First, the current burden from average electricity expenditures is magnitudes higher on the households in the lowest-income neighborhoods compared to the households in the highest-income neighborhoods and the households in the median income neighborhoods;
- Second, the burden from the average electricity expenditures relative to neighborhood income increases for everyone under all three impact scenarios;
- Third, the increased burden is much larger for the lowest-income neighborhoods relative to the highest-income neighborhoods and the median income neighborhoods – the regressivity from electricity expenditures worsens due to the CPP; and,
- Fourth, the CPP worsens the problem of energy poverty.

Beyond the macroeconomic costs that implementing the EPA's Clean Power Plan will inflict, the CPP will disproportionately burden low-income and middle-income households across the country. Additionally, due to the untenable share of the lower-income household's budget that unsubsidized electricity expenditures would require, the CPP will worsen the poverty trap facing too many households (the poverty trap being defined as a disincentive to work due to the value of lost income support benefits). When coupled with the stagnating inflation adjusted incomes since 2000, it becomes clear that middle-income and low-income households can ill-afford the costs that the CPP will inflict on the economy.

Introduction

On August 3, 2015, President Obama announced his intention to implement the Environmental Protection Agency's (EPA) Clean Power Plan (CPP). The CPP furthers the Obama Administration's goal of federally mandating reductions in greenhouse gas (GHG) emissions from power plants, particularly carbon dioxide (CO_2) emissions. More than two dozen states have sued the Obama Administration, claiming that by promulgating these regulations, the EPA has exceeded the authority granted to it by the U.S. Congress.[1] Due to the lawsuit, the U.S. Supreme Court has stayed the CPP regulations while the merits of this court case are being adjudicated.

The pause in the CPP's implementation creates a valuable opportunity to reconsider the large economic costs that are associated with any rule that mandates reductions in CO_2 and other GHGs. The EPA estimates that the CPP regulations will impose small costs on the economy; however, several studies have illustrated that these estimates are flawed and, consequently, the EPA significantly underestimates the economic costs from the proposal. An estimated large economic impact from the CPP is also consistent with previous studies that have examined the consequences from mandated reductions in CO_2 and other GHGs.

Mandated reductions in GHGs impose large economic costs due to the impact of these mandates on electricity prices – the stricter the mandate, the higher the resulting electricity price increases will be. Mandating reductions in GHGs also requires expensive investments in new technology and the scrapping of economically viable equipment, both of which also represent large economic costs.

Mandated reductions in GHGs impose large economic costs due to the impact of these mandates on electricity prices – the stricter the mandate, the higher the resulting electricity price increases will be.

Many studies have documented these economic costs in the aggregate; however, the distribution of the economic impacts is also important. As cited in the *Los Angeles Times,* California Lt. Governor Gavin Newsom noted that "'there is a regressive nature to some of these things,'… more than 1 million state households spend more than 10 percent of their income on energy. 'We have to be sensitive to issues relating to energy costs.'"[2]

Due to the reality that electricity expenditures comprise a larger share of lower-income households' budgets relative to higher-income households' budgets, larger economic costs from mandating reductions in GHGs will be imposed on lower-income households relative to higher-income households – the regulations have regressive impacts. In a December 2014 study, PRI documented the regressive impacts from policies that mandate reductions in power plant GHG emissions for Ohio (Winegarden, 2014).[3] This study updates the methodology used in the December 2014 study by examining the impact across different income groups due to the CPP, and expands the analysis to examine all states excluding Alaska and Hawaii.

Before examining the impact by income group, it is beneficial to review some background information, starting with a quick overview of the studies that have examined the economic impact from policies that mandate reductions in GHGs. Next the CPP, its goals, and its technical details are reviewed; which is then followed by an overview of the studies that have examined the economic impact from the CPP. These studies illustrate that it is reasonable to expect large and significant energy price increases if the CPP is implemented.

In the next section the trends in household income growth for the U.S. are discussed. Adjusted for inflation, household income has declined over the past 15 years for the median household, and for the poorest households. The declines in real household income accentuates the CPP's negative consequences as lower and middle-income households are now financially less able to afford the higher energy prices that will result than in the past.

These studies illustrate that it is reasonable to expect large and significant energy price increases if the CPP is implemented.

Next, the methodology used to estimate the energy price increases relative across the 48 states is described, and the expected cost increases to median household income by neighborhood (more precisely, census tract) are evaluated. These impacts are summarized in four national maps that illustrate the regressive economic burden the CPP regulations will impose. The national maps enable the additional cost burden from the CPP to be visualized by comparing the expenditure burdens in lower-income neighborhoods to the expenditure burdens in higher-income neighborhoods, both within the same state and across the states. These regressive impacts are particularly troubling once the problem of stagnating median incomes for middle- and lower-income households, are taken into account. An Addendum to this report presents a series of four maps for each state, excluding Alaska and Hawaii, which enables a more detailed examination of the regressive impacts within each state.

The study's findings provide further evidence that the CPP will have negative consequences for the U.S. economy and impose a large burden on lower-income households who can least afford these additional costs.

Past Studies Illustrate That Mandating GHG Reductions Reduce Economic Vibrancy

The goals of the CPP can only be achieved if states (separately, or in coordination) implement taxes on GHGs (particularly CO_2), subsidize alternative energy production, or implement cap-and-trade regulations.[4] Therefore, before we review the CPP, it is instructive to provide an overview of some of the previous literature dealing with climate change policy and its effects on the U.S. economy as a whole and households in particular.

Cap-and-trade regulations are the oft-used regulatory proposal for reducing GHGs because many U.S. policymakers believe that cap-and-trade represents an economically superior approach to climate policy when compared to tax schemes designed to address the emissions issue. However, cap-and-trade regulations are quantity constraints that lead to significant price volatility and impose large economic burdens on households just as a carbon tax plan would. Due to the relative popularity of the cap-and-trade approach to reducing GHG emissions, the literature review focuses on the economic impacts from cap-and-trade regulations.

While our review focuses on cap-and-trade regulations, a tax on CO_2 would also negatively impact the economy. For instance, according to the Congressional Budget Office (CBO),

> Without accounting for how the revenues from a carbon tax would be used, such a tax would have a negative effect on the economy. The higher prices it caused would diminish the purchasing power of people's earnings, effectively reducing their real (inflation-adjusted) wages. Lower real wages would have the net effect of reducing the amount that people worked, thus decreasing the overall supply of labor. Investment would also decline, further reducing the economy's total output.
>
> The costs of a carbon tax would not be evenly distributed among U.S. households. For example, the additional costs from higher prices would consume a greater share of income for low-income households than for higher-income households, because low-income households generally spend a larger percentage of their income on emission-intensive goods. Similarly, workers and investors in emission-intensive industries, who would see the largest decrease in demand for their products, would be likely to bear relatively large burdens as the economy adjusted to the tax. Finally, areas of the country where electricity is produced from coal—the most emission intensive fossil fuel per unit of energy generated—would tend to experience larger increases in electricity prices than other areas would.[5]

The CBO claims some uses for the carbon tax revenues, such as reducing the deficit or cutting marginal tax rates, could offset some of the negative economic costs; however, other uses, such as using the revenues to offset the negative impacts on certain groups, would not. Consequently, similar to cap-and-trade regulations, the net effect from the imposition of the carbon tax is also negative.

Table 1 summarizes the results from several studies that have examined the national economic consequences from cap-and-trade regulations. Studies that evaluated the CPP are discussed later in the paper. These analyses all found that mandated reductions in GHG emissions impose negative costs on the economy.

TABLE 1

Estimated Economic Impacts from Cap-and-trade Regulations
Various Studies

AUTHORS & YEAR	CLIMATE PROPOSAL EVALUATED	GHG REDUCTION TARGET AS OF 2030	ESTIMATED IMPACT BY 2030			
			GDP IMPACT	INDUSTRIAL PRODUCTION	EMPLOYMENT IMPACT	ELECTRICITY PRICE IMPACT
SAIC[6]	Waxman-Markey Bill of 2009	% below 2005 emissions levels: 2012: 3% 2020: 17% 2030: 42% 2050: 83%	-1.8% to -2.4%	-5.3% to -6.5%	-1.8 million to -2.4 million	+31% to +50%
EIA[7]	Greenhouse Gas Emission Trading System proposed by the National Commission on Energy Policy (NCEP)	2.6% per year decline from 2012 – 2021; 3% per year 2022 onward	-0.26% to -0.41% lower than in the reference case in 2030	N/A	N/A	+11% to +13%
Tax Foundation[8]	N/A	15% of 2006 levels	-$136 billion	N/A	-964,900	+$144.8 billion
CBO (2007)[9]		15% reduction coupled with tax cut offsets	-0.13% to -0.34%	N/A	N/A	Annual Cost Increase as a Percentage of Income by Quintile (ascending): Lowest: 3.3% Next: 2.9% Middle: 2.8% Upper: 2.7% Highest: 1.7%
PJM[10]	Scenarios based on: Lieberman/McCain Bill (S.280) Bingaman/Specter Bill (S.1766) Lieberman/Warner Bill (S.2191)	Based on various prices of CO_2 emissions	N/A	N/A	N/A	CO_2 emissions price per ton / Electricity price increase: $10 / +15.5% $25 / +39.0% $40 / +61.9% $60 / +95.4% $100 / +167.4%
Anspacher et al. (2011)[11]	N/A	17% reduction in CO_2 emissions	-0.30% to -0.47%	N/A	N/A	+ 16% to +25%

The Waxman-Markey Bill of 2009 (Waxman-Markey), which was approved by House of Representatives but was never brought to the Senate floor, sought to implement a cap-and-trade system where the government would set a nationwide greenhouse gas emissions limit with companies then allowed to trade permits to emit these greenhouse gases. In 2009, Science Applications International Corporation (SAIC) conducted a study for The American Council for Capital Formation (ACCF) and the National Association of Manufacturers (NAM) in order to examine the potential costs imposed on the U.S. economy from the enactment of the Waxman-Markey Bill, formally titled "The American Clean Energy and Security Act of 2009" (H.R. 2454).[12] The SAIC report found that U.S. economic growth was expected to significantly slow due to the Waxman-Markey Bill.

Compared to the baseline scenario without the bill, the SAIC analysis illustrated that the cap-and-trade system would have raised energy prices, reduced GDP growth, lowered federal and state tax revenues, lowered industrial production growth, and reduced total employment. As of 2030, relative to the baseline, SAIC estimated:

- **Inflation adjusted GDP** would decline between 1.8 percent ($419 billion) and 2.4 percent ($571 billion);
- **Annual household income** would decline between $730 and $1,248, with the states located in the Midwest experiencing significantly larger declines;
- **Industrial production** would decline between 5.3 percent and 6.5 percent, with the impacts concentrated in the manufacturing, mining, and electric utility industries;
- **Employment,** even after accounting for "green" jobs, would decline between 1.79 million and 2.44 million jobs, with the impacts concentrated in the manufacturing sector;
- **State and federal tax receipts** would decline by up to $170 billion;
- **Energy prices** would rise significantly, including electricity prices for residential consumers rising between 31 percent and 50 percent and gasoline prices rising between 20 percent and 26 percent;
- **Gross energy expenditures** would rise between 19 percent and 27 percent; and,
- **Retiring or retrofitting coal-based generation would be required** for about one-half of the coal-based generation plants. Large investments in expensive and unproven technologies to capture CO_2 emissions and higher cost generation technologies, like wind, in place of historically cheaper coal generation would have been required.

Compared to the baseline scenario without the bill, the SAIC analysis illustrated that the cap-and-trade system would have raised energy prices, reduced GDP growth, lowered federal and state tax revenues, lowered industrial production growth, and reduced total employment.

The Energy Information Administration (EIA), the independent analytical agency within the Department of Energy, studied the impacts on energy prices, energy expenditures, and economic growth from a cap-and-trade proposal that reduces GHG emissions intensity (GHG emissions per dollar of GDP) by 2.6 percent per year between 2012 and 2021, and then by 3.0 percent per year beginning in 2022.[13] Summarizing the

EIA's findings as of 2030 relative to the baseline:[14] electricity prices would be 13 percent higher; annual household energy expenditures would be 8.1 percent higher; and overall economic growth would be 0.41 percent smaller compared to the baseline.

The EIA notes that in response to higher delivered fossil fuel and electricity prices, consumers and businesses would be forced to spend more money purchasing fewer overall energy services. Spending more money on less energy consumption negatively impacts people's standard of living – for example, households may keep their houses cooler in the winter and warmer in the summer than they otherwise would if energy prices were lower.

A 2009 Tax Foundation study modeled the impact of a cap-and-trade system designed to cut U.S. carbon emissions by 15 percent compared to emissions levels in 2006.[15] The Tax Foundation found that households would face an annual burden of roughly $144.8 billion per year as a result of the required cap-and-trade regulations. Depending on the particular cap-and-trade system implemented, the annual costs to the economy would be large including: 965,000 fewer jobs being created, $37.8 billion in lost household earnings, and $136 billion in lost economic output (or about $1,145 per household).

Unlike most studies of climate policy the Tax Foundation study analyzed how the energy cost burdens from cap-and-trade regulations would be borne by different income groups, age groups, and by the state. Starting with income groups, the Tax Foundation study found that while the dollar burden is greater for high-income households, it is lower as a share of these households' incomes when compared to lower-income households, see Figure 1.

FIGURE 1

The Tax Foundation's Estimated Annual Increase in Households' Costs from a 15 Percent Cut in CO_2 Emissions

LOWEST	6.2%
SECOND	3.2%
MIDDLE	2.4%
FOURTH	2.0%
HIGHEST	1.4%

Source: Chamberlain, Andrew (2009) "Who Pays for Climate Policy?" Tax Foundation, March.

Different age groups also bear different cost burdens due to the typical income and consumption patterns of people at different stages of life. Typically, income starts low, rises throughout the working years, and then declines in retirement; consumption as a percentage of household income tends to be highest in youth and old age, and lowest during the prime earning years of the household. Similar to this typical pattern, the Tax Foundation found that relative to income, the cost burden from cap and trade regulations is the heaviest for young and old households.

Households over the age of 75 bear the heaviest burden at 2.8 percent of income. The second heaviest burden is experienced by households aged 65-75 at 2.5 percent of income. The youngest households under age 25 have cap-and-trade burdens at 2.4 percent of income. Cap-and-trade burdens represent just 1.8 percent of income for higher-earning households in the 35-44 age group. For the 45-54 age group, burdens represent 1.9 percent of income. Consequently, the economic costs from cap-and-trade would be disproportionately borne by households over the age of 65 and under age 25.

The Tax Foundation also examined how the burdens varied across states. Residents in the Western part of the United States bear the largest annual cap-and-trade burden of $1,318 per household per year. Households in the Midwest and South have the smallest average dollar burden at $1,156 and $1,157 per year, respectively. However, the burdens as a percentage income are highest for residents in the South, representing 2.06 percent of income. This result further shows the regressive impact of cap-and-trade regulations with Southern households earning the lowest average incomes in the country. The lowest burdens as a percentage of income are faced by households in the West, which represents the nation's highest-income residents.

A 2007 report from the Congressional Budget Office (CBO) also substantiates the Tax Foundation's regressive findings when evaluating a cap-and-trade program designed to cut CO_2 emissions by 15 percent,

> Researchers conclude that much or all of the allowance cost would be passed on to consumers in the form of higher prices. Those price increases would disproportionately affect people at the bottom of the income scale. For example, the Congressional Budget Office (CBO) estimated that the price rises resulting from a 15 percent cut in CO_2 emissions would cost the average household in the lowest one-fifth (quintile) of the income distribution about 3.3 percent of its average income. By comparison, a household in the top quintile would pay about 1.7 percent of its average income…. That regressivity occurs because lower-income households tend to spend a larger fraction of their income than wealthier households do and because energy products account for a bigger share of their spending. The price increases resulting from a cap on CO_2 emissions would persist as long as the cap remained in place, affecting both current and future consumers.[16]

Figure 2, reproduced from the CBO study, presents these results.

FIGURE 2

CBO's Estimated Annual Increase in Households' Costs from a 15 Percent Cut in CO_2 Emissions

LOWEST	3.3%
SECOND	2.9%
MIDDLE	2.8%
FOURTH	2.7%
HIGHEST	1.7%

Source: CBO "Trade-Offs in Allocating Allowances for CO_2 Emissions" April 25, 2007

The CBO report also examined the potential impact on the U.S. economy from cap-and-trade regulations that reduce CO_2 emissions by 15 percent.[17] Regardless of whether the government gives away the rights to emit carbon emissions (emission allowances) or auctions the emission allowances to the private sector, the CBO documents that consumers will face higher electricity prices. These higher prices will negatively impact the U.S. economy. According to the CBO's estimates, the net economic impact depends upon what the government does with the revenues raised from auctioning emission allowances to industries that emit CO_2.

In order to reduce the economic costs imposed from the higher electricity prices, the CBO evaluated combining the revenues raised by auctioning emission allowances with a corporate or payroll tax cut.[18] This policy combination causes a 0.13 percent decline in annual GDP from the current baseline according to the CBO. If the revenues are used to provide an equal lump-sum rebate back to households (to reduce the impact from higher prices on household's budgets), then the CBO expects GDP to decline 0.34 percent relative to the baseline. The CBO documents that economic growth from a 15 percent reduction in CO_2 emissions is negative for the overall U.S. economy.

PJM is a regional transmission organization that operates the largest U.S. electric grid, which services parts of the Mid-Atlantic and Great Lakes regions.[19] In 2009, PJM evaluated the price impacts for its consumers from policies to reduce CO_2 and other GHG emissions.[20] The study evaluated the electricity price impacts for various prices for CO_2 emissions. As documented in Winegarden (2014), the CO_2 emissions price of $60 per short ton is consistent with most emission reduction proposals.[21] This implies that electricity customers in the PJM region could see price increases of 95.4 percent should such emission reduction plans be implemented.

Finally, Anspacher, Osborne, and Richards (2011) evaluated "the effects on the U.S. electricity producing sector, by 2020, of a 17 percent reduction in U.S. CO_2 emissions…."[22] The study evaluated two scenarios: one in which nuclear power was able to expand unrestricted, and a second scenario where nuclear power's growth was restricted. Restrictions on the growth in the nuclear power industry, by forcing consumers to purchase electricity from higher-cost producers, led to larger increases in electricity prices and, consequently, greater economic impacts. Based on their assessment, the economic costs relative to the baseline from reducing CO_2 emissions by 17 percent include:

- A reduction in real GDP between -0.30 percent (nuclear growth scenario) and -0.47 percent (nuclear restricted scenario);
- An increase in electricity prices between +15.94 percent (nuclear growth scenario) and +24.85 percent (nuclear restricted scenario); and,
- A reduction in real household consumption of -0.20 percent (nuclear growth scenario) and -0.37 percent (nuclear restricted scenario).

In contrast to the above analyses, some studies conclude that mandating reductions in GHG emissions does not harm economic growth, which is particularly relevant due to the EPA's findings that the CPP will not harm economic growth. Typically, the studies that find no negative economic impact rely upon unrealistic or inaccurate assumptions, and when more realistic assumptions are incorporated, the conclusions that emissions reductions policies do not harm economic growth are no longer supported.

For instance, the often cited *Stern Review: The Economics of Climate Change* (2006) concluded that policies aimed at reducing GHG emissions will impose minimal economic harm;[23] but the report's conclusions are driven by the author's time discount rate assumptions.

The time discount rate assumption is important because $100 received tomorrow is not as valuable as $100 received today – having $100 today creates additional options, such as the ability to invest the money and earn interest that is not available if the $100 is received tomorrow. Specifically, a person who received $100 today could save that money in the bank and earn interest (say 5 percent a year). After one year, the original $100 would be worth $105 – the original $100 plus $5 in interest. In this simplified example, receiving $105 next year would, therefore, be equivalent to receiving $100 this year; or from a time discounting perspective, the current value of $105 next year is $100 today. Time discounting techniques enable the value of something received, or paid for, in the future to be accurately compared to something received, or paid for, in the present.

In the case of environmental policies, the issue is how to compare the economic costs imposed today with the environmental benefits gained tomorrow. In the extreme, policies that imposed $1 trillion in costs today, but provided no environmental benefits tomorrow should be avoided; but policies that imposed no cost today, but provide large environmental benefits tomorrow, should be pursued. The discount rate chosen is important because the value of the environmental benefits received tomorrow can vary widely depending upon the discount rate chosen. Historically, market-based discount rates will depend upon risks and the types of asset classes, but generally range between 4.0 percent and 10.0 percent.[24]

In his reply to the *Stern Review on the Economics of Climate Change*, Nordhaus (2006) estimates that the discount rate used in the *Stern Review* was only 0.1 percent. Due to Stern's assumption that the discount rate is close to zero, which violates accepted discounting practices, the benefits from the GHG emissions reduction policy are grossly overstated and the net economic costs are grossly understated. Nordhaus further illustrates that Stern's minimal economic impact conclusions, which widely differs from the majority of economic studies on this topic, is mainly due to Stern's unrealistic assumptions about time discounting.[25]

In the extreme, policies that imposed $1 trillion in costs today, but provided no environmental benefits tomorrow should be avoided; but policies that imposed no cost today, but provide large environmental benefits tomorrow, should be pursued.

Percoco and Nijkamp (2007) confirm Nordhaus' conclusions by listing 13 estimates of the social discount rate for a variety of countries ending up with an average value of 4.6 percent – magnitudes higher than the discount rate estimates used by Stern.[26] The discount rate assumption made by Stern, consequently, incorrectly supports significant reductions in emissions. Once a more realistic discount rate is incorporated in Stern's analysis his recommendations no longer hold.

The EPA's analysis of the economic impacts from the Clean Power Plan similarly makes unrealistic assumptions that greatly impact its results. Before reviewing these results, however, it is beneficial to review the CPP.

What is the Clean Power Plan?

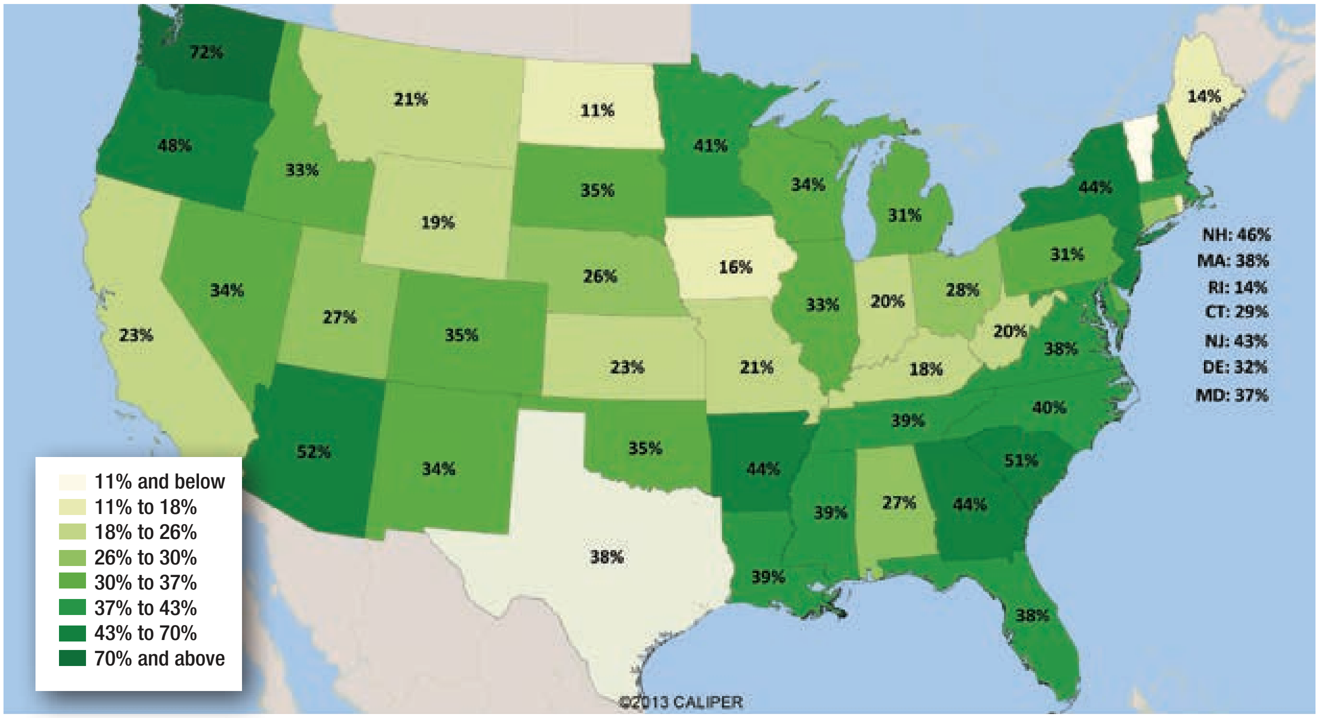
The Clean Power Plan (CPP) is a controversial EPA regulation that seeks to transform the nation's electricity system under the Clean Air Act without first receiving congressional consent. The EPA first proposed the CPP in June 2014 with the stated goal of reducing CO_2 emissions. The final version of the CPP regulations was released on August 3, 2015.[27]

The stated purpose of the CPP is to accelerate the decline in U.S. carbon dioxide emissions by mandating a 32 percent reduction in power sector emissions below 2005 levels by the time the regulation is completely implemented in 2030.

The Clean Power Plan is the first regulation in U.S. history that sets a nationwide limit on carbon emissions produced by power generators. The stated purpose of the CPP is to accelerate the decline in U.S. carbon dioxide emissions by mandating a 32 percent reduction in power sector emissions below 2005 levels by the time the regulation is completely implemented in 2030.[28] The actual emission reduction goals vary by state. In order to determine each state's goal, the EPA divided the country into three regions, which were chosen based on the connected regional electricity grids.[29] These regions were then used to determine a particular state's emissions target, with the mandatory reductions beginning in 2022. The CPP mandated emission reduction targets for each state are illustrated in Map 1.

MAP 1

CO_2 Emission Rate Reduction Target for 2030 Relative to 2012 Rate



Sources: Environmental Protection Agency, Clean Power Plan and NERA "Potential Energy Impacts of the EPA Proposed Clean Power Plan"

Meeting the CPP regulatory goal requires a combination of: heat rate improvements at coal units, increased utilization of existing natural gas combined cycle units, increases in renewables and nuclear energy, and increases in end-use energy efficiency.[30] These four changes are called building blocks in the CPP regulations.[31] The CPP's CO_2 emission rate targets are calculated based upon the emission rates that the EPA predicts could be achieved in each state through the use of these building blocks.

Each state is required to design and implement its own specific combination of the building blocks to meet its emission reduction requirements, and these plans must be submitted to the EPA for approval by September 2016, or by September 2018 if an extension is granted.[32] The EPA has announced that individual states would be allowed flexibility to meet the required CPP state targets. As a result, as long as the EPA's overall target emission rate is met, each state could choose their preferred combination of the four building blocks listed above. Any state that has not submitted an emissions reduction plan within the EPA specified timeframe loses the ability to develop its own plan. Under such a scenario, the EPA assumes the authority to impose its own emissions plan on such states.

The EPA does not measure how the new rules will affect the climate since these reductions in carbon dioxide emissions will not meaningfully lower global emissions. Additionally, rather than setting an emissions standard based upon best available technology that could be used at individual power plants, the EPA constructed an assumed electric grid that would result in the level of carbon dioxide emission reductions that the EPA seeks.[33] This regulatory approach means that the standards set by the EPA cannot be met by any existing plant in the coal power generation fleet. It is important to note that coal generation has historically been the largest source of the nation's electricity supply.

Ten days after the final version of the CPP was announced, more than two dozen states petitioned the United States Court of Appeals for the District of Columbia Circuit for an emergency stay.[34] On February 9, 2016, the Supreme Court ordered the EPA to halt enforcement of the Clean Power Plan until a ruling is issued by a lower court.[35]

Challengers of the Clean Power Plan argue that the EPA overstepped its legal authority in issuing the CPP, and that the scope of the "building blocks" for action go beyond the Clean Air Act standards applied to specific electric generating units.[36] The Clean Power Plan will likely remain stayed until after the next presidential election.

The EPA has compiled a list of benefits that implementing the Clean Power Plan are supposed to achieve.[37] With respect to the economic impact, the EPA claims that the CPP will work to accelerate the move to energy efficiency and reduce growth in demand for electricity – according to the EPA, by 2030 when the plan is fully in place, electricity bills nationwide would be expected to be roughly 8 percent lower than they would have been without the regulation. As a result, the average household electricity bill will fall by about $8 on an average versus the baseline scenario without the CPP. Due to the assumption that electricity expenditures will not increase, the EPA finds that the implementation of the CPP will not negatively impact the economy.

In order to arrive at these conclusions, however, the EPA's analysis makes unreasonable assumptions regarding the adoption of energy efficiency programs.[38] The approach taken by the EPA does not allow the analysis to indicate whether any of the potential energy efficiency programs would be cost-effective in the absence of the CPP.[39] The EPA simply made arbitrary assumptions regarding when energy efficiency programs would be adopted. Specifically, the EPA made the unrealistic assumption that no energy efficiency programs will be adopted in any year without the CPP, and that 100 percent of the identified energy efficiency programs would be adopted in the case where the CPP was implemented. These assumptions are what drives the EPA's conclusions that the CPP *will not have* a negative economic impact. Therefore, the EPA is not *estimating* that the CPP has no negative economic consequences, it is *assuming* it has none.

In contrast to the EPA's study, NERA Economic Consulting derived a model that uses the alternative cost of adopting energy efficiency programs compared to the cost of electricity to determine when and how much of the assumed energy efficiency supply will be adopted. The NERA study, in contrast to the EPA's analysis, uses a consistent framework across both scenarios to determine whether (and when) energy efficiency programs are adopted. We review the specific results of the NERA study later in the paper.

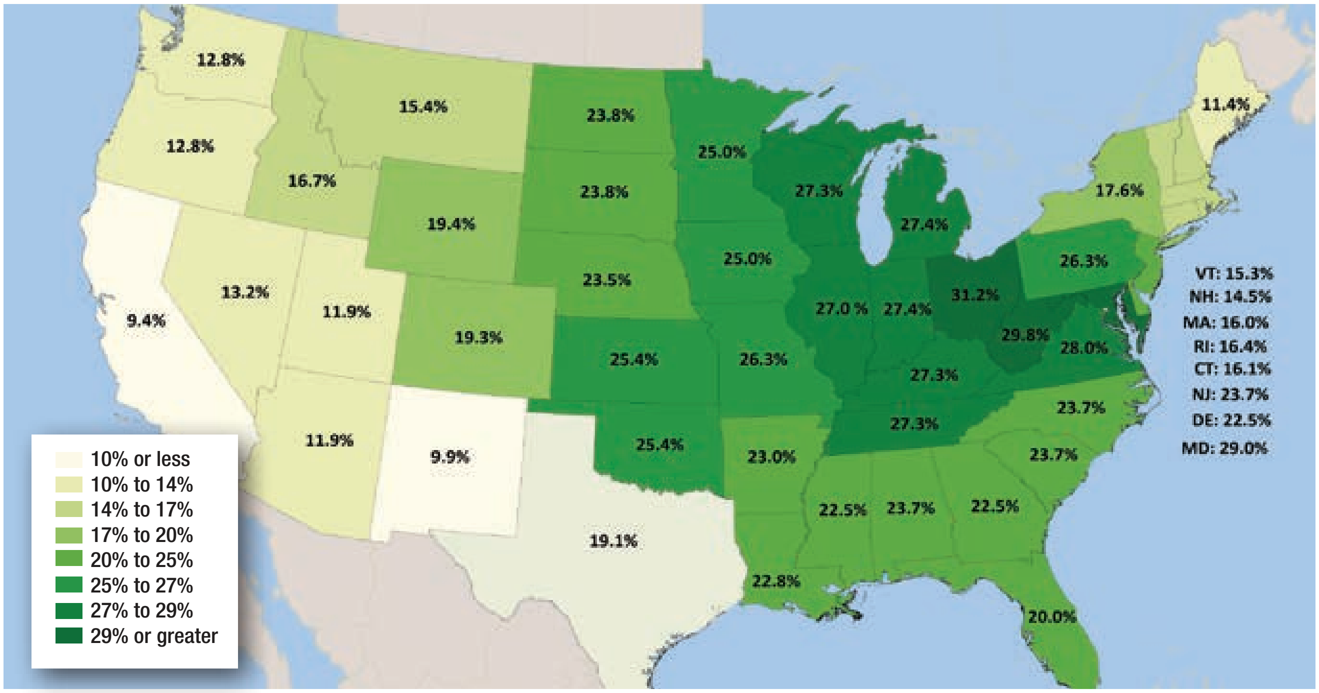
The EPA's analysis of the CPP also fails to correctly account for the investment and depreciation process that naturally replaces the country's asset base.[40] This error compounds the bias introduced by the EPA's assumptions regarding energy efficiency, and therefore overestimates the impact of GHG policies on encouraging energy efficiency.

Studies Find the CPP Will Raise Electricity Costs

A study sponsored by the National Mining Association (NMA) and performed by Energy Ventures Analysis (EVA), summarizes the cost implications of the CPP for American households.[41] Except for California and New Mexico, the EVA study estimates that the percentage increase in wholesale electricity prices will be larger than 10 percent. Map 2, reproduced from the EVA study, illustrates the predicted state wholesale electricity price increases as of 2030 due to the CPP. In 16 states, mostly located in the Mid-Atlantic and upper Mid-West region that are the darker shades of green on Map 2, wholesale electricity prices are projected to increase by 25 percent, or more.

MAP 2

Wholesale Electricity Price Increases by 2030



Source: Energy Ventures Analysis, "EPA's Clean Power Plan"

The EVA study estimates that, in 2030, based on average annual wholesale power price projections, electricity customers will see a 21 percent increase in their power bill compared to what they would have paid without the CPP regulations. This means that consumers nationwide will end up paying approximately $214 billion more for electricity when compared to the non-CPP base case.

In addition, the analysis also examines the costs of replacing lower-cost power generation prematurely retired due to the CPP regulation – a large economic cost that is often overlooked. The EVA study estimates that it will cost $64 billion to replace an estimated 41 gigawatts (GW) of power plant capacity serving 24 million homes around the nation, which the CPP regulations will end up closing prematurely. This wholesale cost will also eventually be passed on to electricity customers. The replacement costs mandated by the new EPA regulations will vary dramatically across the states. Generally, those states that currently generate more of their electricity from coal power plants will experience higher replacement costs from the EPA regulations than those states that generate less electricity from coal.

NERA (2014) similarly found that implementing the CPP will impose large economic costs.[42] According to NERA, the "principal objective [of the study] is to evaluate the potential energy market impacts and energy costs of the CPP, focusing on results over the period from 2017 through 2031. (2017 marks the beginning of the ramp up of EPA's assumed end-use energy efficiency and renewable generation, and 2031 represents the most stringent rates that are achieved by 2029)."

Assuming states follow a "least-cost" approach to implementing the regulations, NERA models two scenarios: (1) the states' strategies include improving coal units, increasing natural gas units, increasing use of renewable and nuclear energy, and increasing energy efficiencies; and, (2) the states' strategies only include improving coal units and increasing natural gas units. NERA evaluates these two scenarios because "some legal analysts have questioned whether EPA has the statutory authority to…account for emissions other than those from the specific existing electricity generation units…." The two scenarios provide insights regarding the impact on costs should some strategies for demonstrating compliance with the emission targets be called into question.

The economic costs are estimated using the NERA proprietary energy-economic model. Based on its model, NERA estimates that the net present value of additional consumer energy costs due to the CPP between 2017 and 2031 range between $366 billion and $479 billion.

NERA also estimates the price impacts of the EPA's carbon proposal by state. The NERA results for the 48 targeted states illustrates a similar dynamic. Depending upon the assumptions and state, NERA estimates that electricity prices could increase between 9 percent and 54 percent.[43]

Rising Energy Prices in the Context of Stagnating Household Income

The adverse economic consequences estimated by EVA and NERA arise due to the CPP's impact on energy prices. When sharp increases in energy prices negatively impact economic growth, they also negatively impact a household's financial security. Due to the precarious financial position of many U.S. households, particularly low- and middle-income households, the CPP's timing is particularly troubling, and threatens to worsen the already financially difficult situation many families are facing.

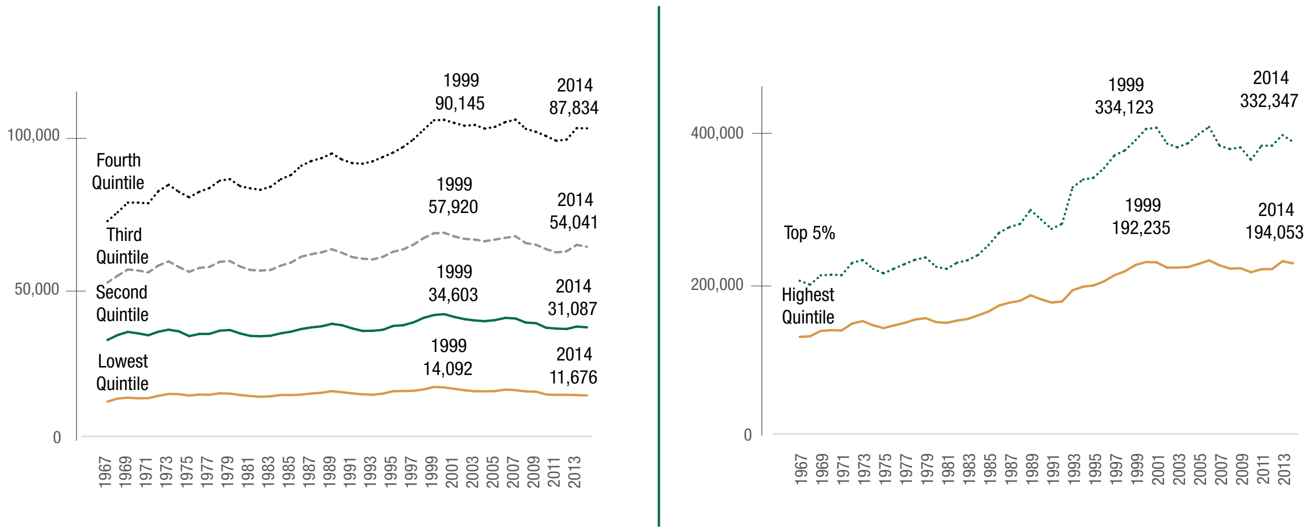
Even without the energy price increases the CPP will cause, energy prices are an exceptionally large percentage of middle- and lower-income families' budgets. According to Trisko (2015),

> Rising electricity prices and declining family incomes are straining the budgets of America's lower- and middle-income families. U.S. households with pre-tax annual incomes below $50,000, representing 48 percent of the nation's households, spend an estimated average of 17 percent of their after-tax income on residential and transportation energy. Energy costs for the 29 percent of households earning less than $30,000 before taxes represent 23 percent of their after-tax family incomes, before accounting for any energy assistance programs. Minorities and senior citizens are among the most vulnerable to energy price increases due to their relatively low household incomes.[44]

Making matters worse, based on U.S. Census Bureau data, the inflation adjusted average incomes of American households have declined or stagnated across all five income quintiles since 1999, see Figure 3.

FIGURE 3

Average Inflation Adjusted Income by Income Quintile, and Top 5 Percent of Income Earners 1967 – 2014



Source: U.S. Census

It is important to note that the largest percentage losses of income since 1999 are in the two lowest-income quintiles (-1.2 percent per year for the lowest quintile and -0.7 percent per year for the second lowest quintile).[45] These trends contrast starkly against the pre-1999 trend. Between 1967 and 1999 the average inflation adjusted income for the lowest-income quintile grew 1.1 percent per year, and the average inflation adjusted income for the second lowest-income quintile grew 0.7 percent per year.[46]

The decline in real incomes increases the vulnerability of lower-income households to the CPP's energy price increases. Lower-income families are more vulnerable to higher energy costs than higher-income families because energy represents a larger portion of a low-income household budget. As a consequence, high or rising energy costs cause low-income households to sacrifice other important priorities.

For instance,

> A 2011 survey of low-income households for the National Energy Assistance Directors Association reveals some of the adverse health and welfare impacts of high energy costs. Low-income households reported these responses to high energy bills:
>
> · 24 percent went without food for at least one day.
>
> · 37 percent went without medical or dental care.
>
> · 34 percent did not fill a prescription or took less than the full dose.
>
> · 19 percent had someone become sick because their home was too cold.[47]

It is, consequently, important to translate the adverse macroeconomic impacts from the CPP into the impacts on households – particularly low- and middle-income households.

The Projected Impact of the CPP on Household Electricity Expenditures

The impact from the CPP on households will vary depending upon each state's electricity generation sources – those states where coal is the dominant power source will likely be impacted more than those states where coal has traditionally been less important. The percentages of state electricity generation by power source for the continental U.S. are shown in Table 2.

TABLE 2

2015 Electricity Generation by Power Source for the 48 States in the Continental U.S.[48]

STATE	COAL	NATURAL GAS	NUCLEAR	HYDRO	WIND	SOLAR	OIL	OTHER
Alabama	26%	36%	28%	8%	< 1%	< 1%	< 1%	2%
Arizona	36%	18%	35%	7%	< 1%	4%	< 1%	< 1%
Arkansas	37%	29%	25%	5%	< 1%	< 1%	< 1%	3%
California	< 1%	54%	12%	7%	7%	8%	< 1%	13%
Colorado	63%	18%	-	3%	16%	1%	< 1%	< 1%
Connecticut	4%	41%	48%	1%	< 1%	< 1%	3%	4%
Delaware	13%	80%	-	< 1%	< 1%	1%	4%	3%
Florida	18%	65%	13%	< 1%	< 1%	< 1%	< 1%	4%
Georgia	31%	36%	27%	3%	< 1%	< 1%	< 1%	4%
Idaho	< 1%	15%	-	64%	17%	< 1%	< 1%	4%
Illinois	39%	5%	49%	< 1%	6%	< 1%	< 1%	1%
Indiana	75%	17%	-	< 1%	5%	< 1%	< 1%	3%

Iowa	54%	3%	9%	1%	33%	< 1%	< 1%	< 1%
Kansas	58%	3%	14%	< 1%	25%	< 1%	< 1%	< 1%
Kentucky	89%	5%	-	4%	< 1%	< 1%	< 1%	2%
Louisiana	15%	58%	16%	1%	< 1%	< 1%	< 1%	10%
Maine	1%	23%	-	27%	11%	< 1%	9%	29%
Maryland	44%	9%	38%	5%	1%	< 1%	1%	2%
Massachusetts	13%	54%	14%	3%	1%	2%	6%	7%
Michigan	45%	15%	29%	1%	5%	< 1%	< 1%	5%
Minnesota	47%	11%	19%	1%	19%	< 1%	< 1%	4%
Mississippi	11%	69%	18%	< 1%	< 1%	< 1%	< 1%	2%
Missouri	80%	4%	13%	1%	1%	< 1%	< 1%	< 1%
Montana	50%	2%	-	38%	7%	< 1%	< 1%	3%
Nebraska	60%	1%	26%	4%	9%	< 1%	< 1%	< 1%
Nevada	5%	71%	-	8%	1%	5%	< 1%	10%
New Hampshire	9%	25%	48%	6%	2%	< 1%	2%	7%
New Jersey	4%	45%	47%	< 1%	< 1%	1%	1%	2%
New Mexico	63%	28%	-	< 1%	7%	2%	< 1%	< 1%
New York	2%	38%	32%	19%	4%	< 1%	3%	2%
North Carolina	33%	28%	32%	4%	< 1%	1%	< 1%	2%
North Dakota	74%	< 1%	-	6%	20%	< 1%	< 1%	< 1%
Ohio	62%	22%	12%	< 1%	1%	< 1%	< 1%	2%
Oklahoma	34%	44%	-	3%	19%	< 1%	< 1%	< 1%
Oregon	< 1%	20%	-	69%	10%	< 1%	< 1%	2%
Pennsylvania	35%	24%	36%	1%	2%	< 1%	< 1%	2%
Rhode Island	< 1%	91%	-	< 1%	< 1%	< 1%	4%	4%
South Carolina	24%	13%	57%	3%	< 1%	< 1%	< 1%	2%
South Dakota	13%	6%	-	48%	33%	< 1%	< 1%	< 1%
Tennessee	41%	11%	33%	13%	< 1%	< 1%	< 1%	1%
Texas	26%	53%	10%	< 1%	10%	< 1%	< 1%	1%
Utah	79%	17%	-	2%	1%	< 1%	< 1%	2%
Vermont	< 1%	< 1%	-	57%	18%	3%	< 1%	22%
Virginia	20%	36%	35%	2%	< 1%	< 1%	2%	5%
Washington	2%	6%	7%	78%	5%	< 1%	< 1%	2%
West Virginia	95%	1%	-	2%	2%	< 1%	< 1%	< 1%
Wisconsin	55%	20%	16%	4%	3%	< 1%	< 1%	1%
Wyoming	88%	1%	-	2%	9%	< 1%	< 1%	3%

Summarizing these trends, coal has historically been the leading fuel source for electricity generation in the United States, generating around 33 percent of total U.S. electricity in 2015.[49] Coal is the main source of electricity generation in 22 states (West Virginia, Kentucky, and Wyoming being the states most reliant on coal). Overall, there were 511 coal-powered electric plants in 2015.

Natural gas also accounted for 33 percent of total electricity generation in 2015, and is the main power source in 15 states including all of the states along the Gulf of Mexico, California, Georgia, Massachusetts, Nevada, New York, and Virginia. In 2015, there were a total 1,740 natural gas-powered electric plants in the U.S.

Nuclear is the third-largest source of electrical power in the U.S., generating 20 percent of the country's electricity. However, only five states – Connecticut, Illinois, New Hampshire, Pennsylvania, and South Carolina – derive more of their power from nuclear than any other type of energy source, and there are twenty states with no nuclear electricity generation whatsoever. In 2015, there were a total of 63 nuclear electric plants in the U.S.

Alternative energy sources (hydroelectric, wind, and solar) accounted for 13 percent of total electricity generated in 2015 – the largest source being hydropower (6 percent) from the 1,436 hydroelectric plants. Idaho, Oregon, and Washington generated the most power from hydroelectric plants, and hydroelectric plants provided 48 percent or more of the power in five states. Hydroelectric plants provided less than 10 percent of the electricity in the 43 remaining continental states.

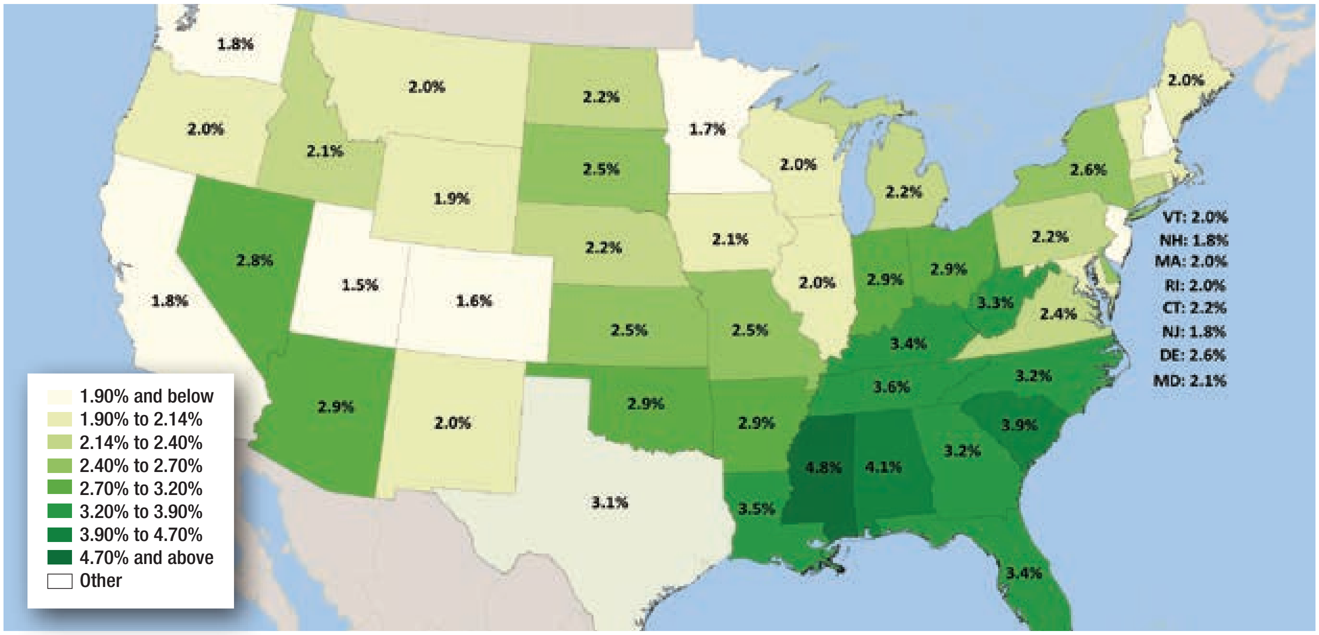
The 843 wind-powered electric plants in the U.S. generated 5 percent of the country's electricity in 2015. Wind power's largest share of electricity generation was in Iowa and South Dakota (33 percent of the states' electricity was generated from wind) followed by Kansas (25 percent of the state's electricity was generated from wind). The 772 solar-powered electric plants in the U.S. generated only 1 percent of the nation's electricity. Solar power is predominantly used in the Southwest where the sun shines reliably while 38 of the 48 continental states have no solar generating plants at all. California derives 8 percent of its electricity from solar power followed by Nevada at 5 percent, and then by Vermont and Arizona each with 4 percent.

Nuclear is the third largest source of electrical power in the U.S., generating 20 percent of the country's electricity.

Just as the power sources vary by state, current average electricity expenditures vary by state as well. Based on EIA price and consumption data for 2014, the average U.S. electricity customer spent $1,465 per year, which was 2.7 percent of 2014 median household income.[50] On a dollar expenditure basis, the highest average annual expenditures per customer in the Continental U.S. occurred in South Carolina ($1,774) and the lowest was in New Mexico ($935). Relative to income, however, the largest burden from current electricity expenditures was in Mississippi (4.8 percent) and the smallest burden was in Utah (1.5 percent). Map 3 presents the current average burden for the 48 continental states.

MAP 3

Current Average Annual Electricity Expenditures Relative to Median Household Income Continental U.S.



Source: Author calculations based on data from the EIA

As Map 3 illustrates, the largest current burdens are in the Southeastern states, while the Mountain region and Pacific Coast region have the lowest current burdens. Generally speaking, the median household incomes in the states with the higher electricity burdens are less than the median household incomes in the states with the lower electricity burdens – currently electricity costs impose a regressive burden. By raising the costs of electricity, the CPP will increase these state burdens and worsen the regressivity problem.

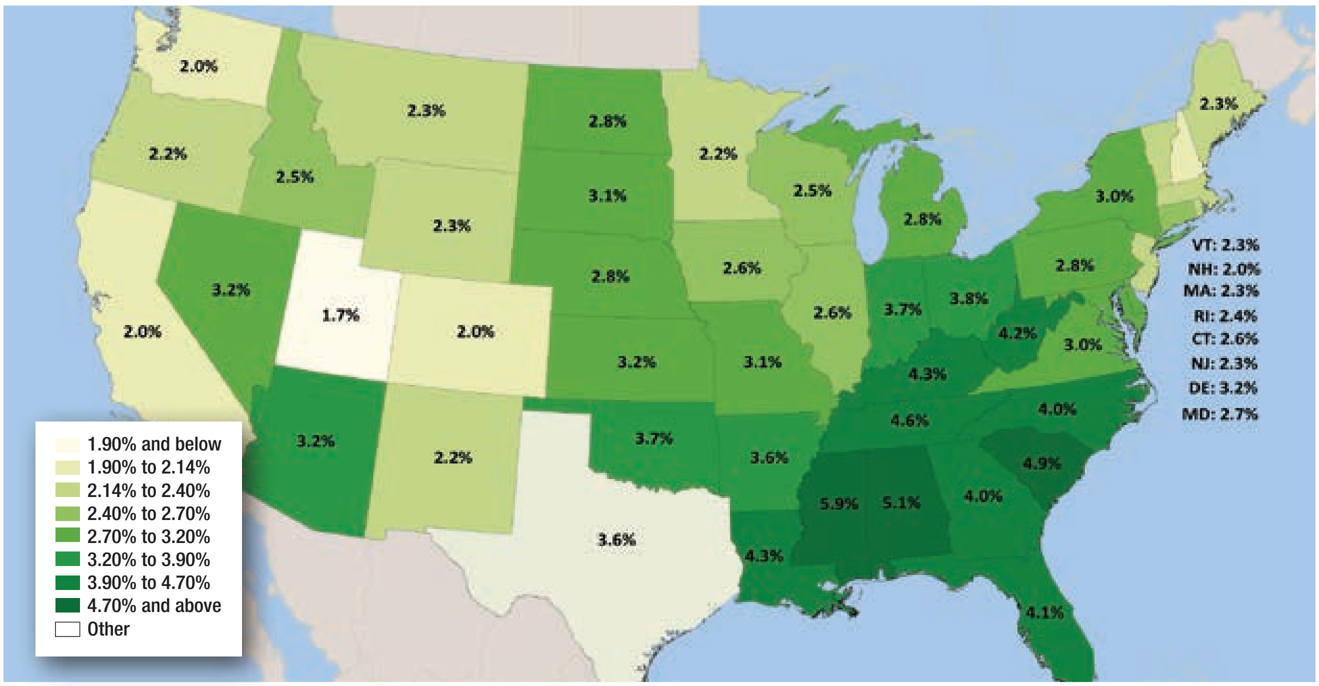
The state-by-state addendum to this report provides a deeper view of the regressive nature from the current electricity expenditure burden for each state. The first map for each state compares the average household electricity expenditures for that state, adjusted for income, to the median household income for each census tract (or neighborhood).[51] As these maps illustrate, the current burden from electricity expenditures ranges widely. Across all 48 states, in neighborhoods with incomes in excess of $250,000 a year, the average state electricity expenditures are around one percent of the average household's income. In other neighborhoods, where residents would likely receive energy assistance and other income supplements, the average expenditures can equal as much as 43.5 percent of the average household's income. The state specific maps illustrate that within each state, electricity expenditures burden households in lower-income areas to a much larger extent than households in wealthier areas.

As the EVA analysis illustrated, the CPP will significantly increase wholesale electricity prices across the country. Assuming that retail electricity prices increase by the same percentage as the estimated increases in wholesale prices that EVA estimated, these price increases will worsen the expenditure burden on all households in all states; however, the price increases will not be uniform. Some states, such as California (+9.4 percent), would experience smaller price increases while other states, such as Ohio (+31.2 percent), would experience much larger price increases. Overall, the states in the upper mid-west will experience the largest price increases due to the CPP and the states in the west will experience the smallest price increases.

The extent to which the price increases lead to overall expenditure increases depends upon how consumers respond to the higher electricity prices. If consumers do not change their electricity consumption at all following the electricity price increases, then consumers will bear the highest increase in the expenditure burden following the CPP's price increases. This behavioral assumption, also known as a static analysis, provides a logical maximum impact from the policies. Total electricity expenditures under this scenario, referred to as the static impact scenario, increase by the same percentage as the increase in electricity prices. The resulting increase in the electricity expenditure burden relative to 2014 median household incomes is illustrated in Map 4.

MAP 4

Average Annual Electricity Expenditures Relative to Median Household Income
Static Impact Scenario
Continental U.S.



Source: Author calculations based on data from the EIA and Energy Ventures Analysis, "EPA's Clean Power Plan"

Two trends are apparent when comparing Map 3 and Map 4. First, the expenditure burden increases across all of the states – if the CPP is implemented, the average household will be devoting a larger percentage of its income toward electricity expenditures than without the CPP based on a static analysis. Second, the regional gap between the Southeast region and the Mountain and Pacific regions expands – the Southeast will be facing an even larger relative burden compared to the Mountain and Pacific regions. Therefore, the CPP is relatively more burdensome on the Southeast than on any other region.

The second map in the state-by-state addendum presents the static impact from the CPP by neighborhood across the 48 states. Comparing the first and second maps for each state illustrates a similar pattern – the CPP raises the expenditure burden on all households, but the burden increases more for households in the lower-income areas of each state than the households in the higher-income areas. Thus, under a static analysis, the regressivity of electricity expenditures significantly worsens due to the CPP.

It is likely, however, that consumers will make behavioral adjustments in response to rising electricity prices. Economic theory predicts that as electricity prices rise the quantity of electricity demanded will fall, holding all else constant. In economics this is known as the "Law of Demand." How sensitive changes in the quantity of electricity demanded are to changes in electricity prices is an empirical question. Empirical analyses measuring this sensitivity (referred to as the price elasticity of demand) are centering on a set range of estimates.[52] The elasticity estimates from NERA Economic Consulting exemplify the converging consensus.[53] The study examined 72 electricity distribution companies in the United States from the period 1972-2009 finding that the price elasticity of demand for residential, commercial, and industrial consumers was between -0.38 and -0.61.

Using the lower-end value from the NERA study, the -0.38 elasticity estimate indicates that the quantity of electricity demanded will decline 3.8 percent for every 10 percent increase in electricity prices. Table 3 illustrates the implications for the quantity of electricity consumed and the total expenditures on electricity in a simplified example.

TABLE 3

Simplified Example of the Elasticity of Demand for Electricity

	PRICE PER KWH	MONTHLY ELECTRICITY SALES (IN KWH)	TOTAL MONTHLY EXPENDITURES
Starting price	$0.12	1,000	$120.00
100% price increase	$0.24	620	$148.80
% Change	+100%	-38%	+24%

Source: Author calculations

Assume that the initial price of electricity per kilowatt hour (kWh) is $0.12. At that price, consumers purchase 1,000 kWh of electricity per month spending $120 per month on electricity (Row 1 of Table 3). If the price of electricity increased by 100 percent (Row 2 of Table 3), then based on the elasticity estimate of -0.38, total monthly sales would decline 38 percent to 620 kWh of electricity per month. This decline reflects changes in behavior such as purchasing more energy efficient appliances or keeping the house cooler in the winter and warmer in the summer. Notice that even though less overall electricity is being purchased, the total expenditure on electricity is still higher (+24 percent in Table 3). As the simplified example in Table 3 illustrates, the elasticity measures provide an empirical estimate of the behavioral changes households will make in response to the higher electricity prices the CPP will cause.

Accounting for two additional considerations can provide greater context regarding how households will change their behavior in response to the CPP's price increases. First, previous estimates of the price elasticity of demand for electricity suggests that the longer a price change has been in effect, the more behavioral changes consumers of electricity are able to implement.[54] Reciprocally, there are fewer options available to consumers to change their behavior in response to changes in the price of energy within a shorter timeframe. Therefore, consumers should be more responsive to changes in price the longer the time period they have to adjust to the higher prices. And, this is what a 2006 Rand study found.[55] At the national level, the Rand study estimated the short-run price elasticity for residential electricity demand was -0.2, while the estimated long-run price elasticity for residential electricity demand was -0.32.[56] These two estimates are consistent with the results from the studies of residential electricity elasticity.

Second, regional differences in price sensitivity should be expected. For instance, the electricity needs of a household living in the relatively mild climate of San Francisco, California should differ from a household living in Fargo, North Dakota or Miami, Florida. The 2006 study by the Rand Corporation also examined the elasticity of electricity demand nationally, by region and by state.[57] The Rand analysis found that there are, in fact, regional and state differences in the price-demand relationship for electricity particularly for residential electricity use. The analysis also found that there is consistency in residential electricity use among states within a region.

Specifically, the Rand study estimated the short-run and long-run price elasticities for residential electricity for nine census divisions that the DOE Energy Information Agency uses in energy modeling. These nine census divisions are New England, Mid-Atlantic, South Atlantic, East North Central, East South Central, West North Central, West South Central, Mountain, and Pacific, which are shown in Table 3 below.[58] Regional estimates of short-run elasticities range from -0.054 in the East North Central region to -0.318 in the South Atlantic region. For the long-run, elasticities ranged from -0.058 in the East North Central to -0.618 in the East South Central.

TABLE 4

Short-Run and Long-Run Price Elasticity for Residential Electricity by Region

REGION	SHORT-RUN PRICE ELASTICITY	LONG-RUN PRICE ELASTICITY
Pacific Coast	-0.188	-0.254
Mid Atlantic	-0.232	-0.247
New England	-0.192	-0.325
Mountain	-0.211	-0.267
South Atlantic	-0.318	-0.352
East North Central	-0.054	-0.058
East South Central	-0.266	-0.618
West North Central	-0.163	-0.244
West South Central	-0.127	-0.174

Source: Bernstein, M.A and J. Griffin (2006) "Regional Differences in the Price-Elasticity of Demand for Energy" RAND Corporation, NREL/SR-620-39512, February.

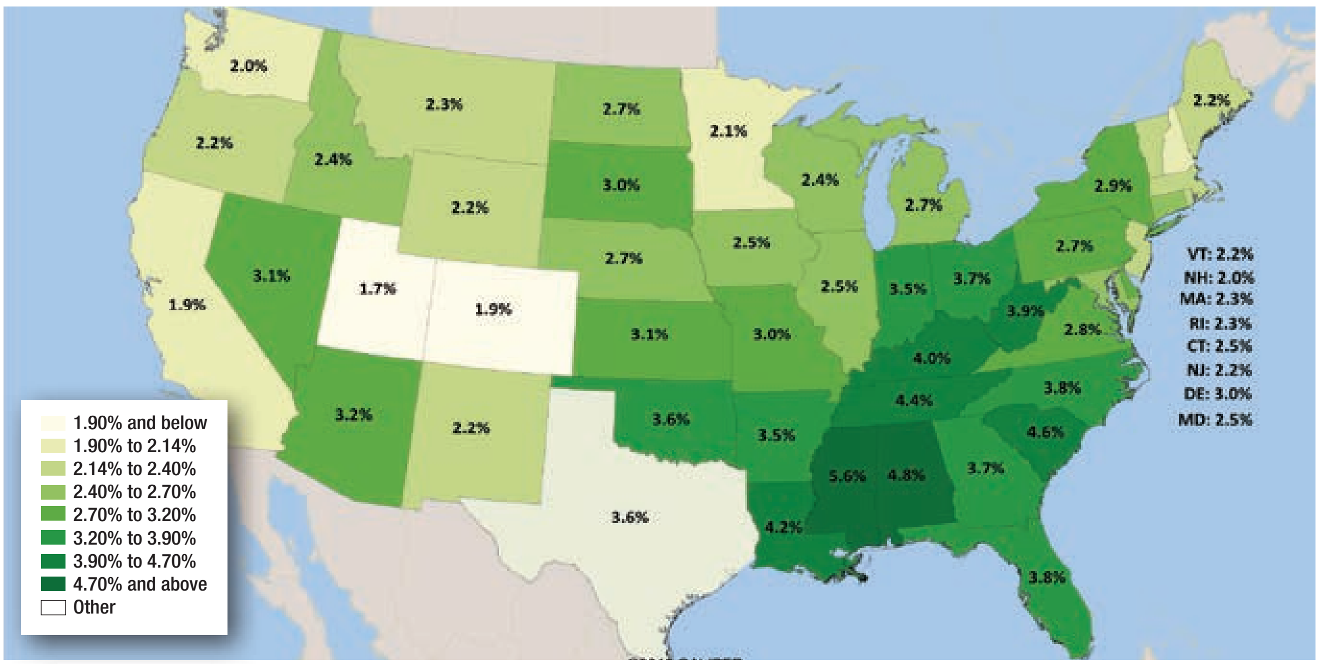
As illustrated in Table 4, households in the South Atlantic and East South Central regions change their electricity consumption the most in the short-run in response to changes in electricity prices. On the other hand, households in the East North Central region change their consumption habits the least in response to changes in electricity prices. All regional estimates are negative, as would be expected, and except for the East North Central, are also statistically significant. The elasticity estimates confirm that households in different regions will change their consumption in response to electricity price increases differently.

The long-run price elasticity estimates confirm that, across all of the regions, when households have more time to adjust, they are able to make larger changes to their electricity consumption. The regional pattern of long-run price elasticity results is similar to the short-run elasticity results. For example, households in the East South Central and South Atlantic regions change their demand the most in response to price changes, while households in the East North Central region will change their demand the least in response to price changes. As with short-run elasticities, all of the long-run estimates had the expected sign and all were statistically significant except for the East North Central regional estimates.

Relying on these regional elasticity estimates, we evaluate two different CPP impact scenarios that account for the likely changes in households' behavior in response to the now higher electricity prices.[59] We refer to these scenarios as the dynamic short-term scenario and the dynamic long-term scenario. The dynamic short-term scenario evaluates the impact from the higher electricity prices on energy expenditures by households based on the short-run estimated sensitivity. The dynamic long-run scenario evaluates the impact from the higher electricity prices on energy expenditures by households based on the long-term estimated sensitivity.

MAP 5

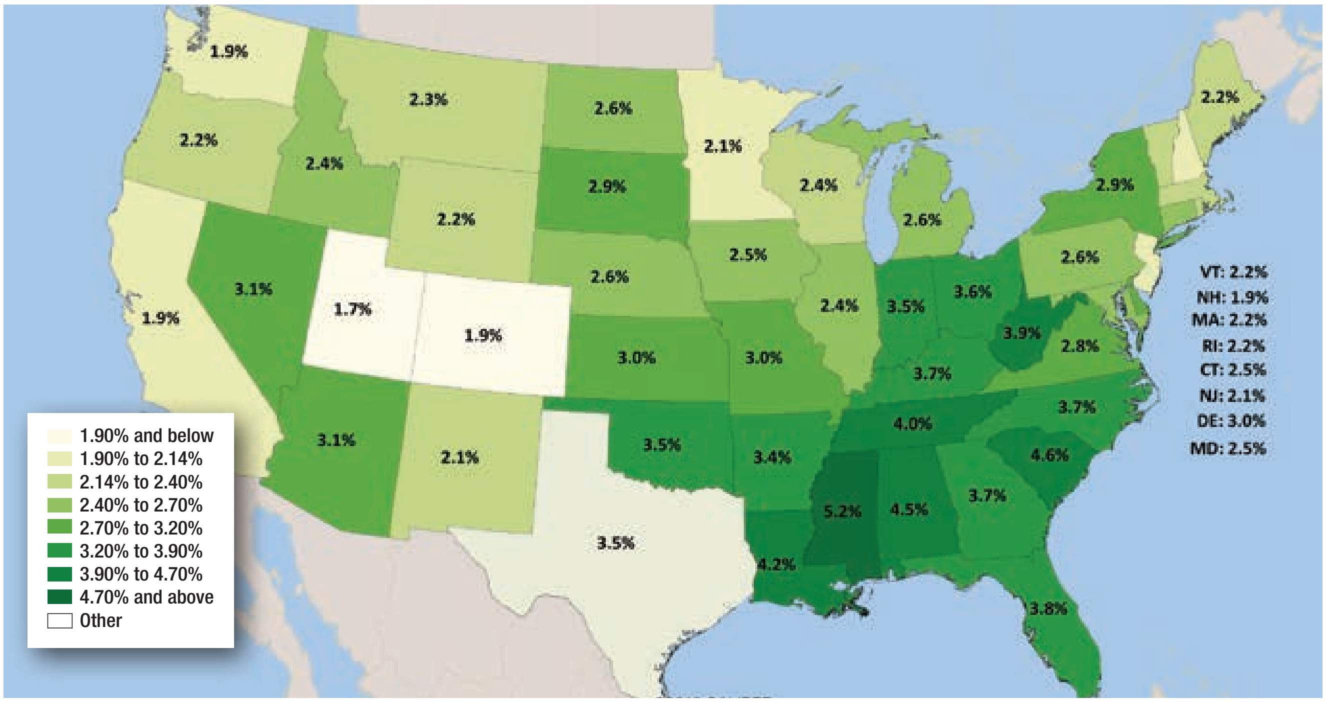
Average Annual Electricity Expenditures Relative to Median Household Income
Dynamic Impact Scenario – Short-term
Continental U.S.



Source: Author calculations based on data from the EIA and Energy Ventures Analysis, "EPA's Clean Power Plan"

MAP 6

Average Annual Electricity Expenditures Relative to Median Household Income
Dynamic Impact Scenario – Long-term
Continental U.S.



Source: Author calculations based on data from the EIA and Energy Ventures Analysis, "EPA's Clean Power Plan"

The expenditure impacts from the dynamic short-term and dynamic long-term scenarios are summarized in Maps 5 and 6. Maps 5 and 6 show the same pattern as Map 4 – if implemented, the CPP will increase the average electricity expenditure burden across all states, with the Southeast bearing a larger burden from the CPP than the Mountain and Pacific regions. The increase in the average electricity expenditure burden across all the three scenarios – static, dynamic short-term, and dynamic long-term – is summarized in Table 5. On average, the CPP will increase the average household's electricity expenditures between 0.4 percent and 0.5 percent of its income – depending upon the behavioral response. Based on the short-term dynamic scenario, the largest impact (0.8 percent of income) occurs in Mississippi, and the smallest impact occurs in California (0.1 percent of income).

TABLE 5

Increased Average Electricity Expenditure Burden Relative to Median Household Income Due to the Implementation of the CPP

	CHANGE IN AVERAGE EXPENDITURES RELATIVE TO MEDIAN HOUSEHOLD INCOME		
	STATIC SCENARIO	DYNAMIC SHORT-TERM SCENARIO	DYNAMIC LONG-TERM SCENARIO
Alabama	1.0%	0.7%	0.4%
Arizona	0.3%	0.3%	0.2%
Arkansas	0.7%	0.6%	0.6%
California	0.2%	0.1%	0.1%
Colorado	0.3%	0.2%	0.2%
Connecticut	0.4%	0.3%	0.2%
Delaware	0.6%	0.4%	0.4%
Florida	0.7%	0.5%	0.4%
Georgia	0.7%	0.5%	0.5%
Idaho	0.4%	0.3%	0.3%
Illinois	0.5%	0.5%	0.4%
Indiana	0.8%	0.7%	0.6%
Iowa	0.5%	0.4%	0.4%
Kansas	0.6%	0.5%	0.5%
Kentucky	0.9%	0.7%	0.4%
Louisiana	0.8%	0.7%	0.7%
Maine	0.2%	0.2%	0.2%
Maryland	0.6%	0.4%	0.4%
Massachusetts	0.3%	0.3%	0.2%
Michigan	0.6%	0.5%	0.5%
Minnesota	0.4%	0.4%	0.3%
Mississippi	1.1%	0.8%	0.4%
Missouri	0.6%	0.5%	0.5%
Montana	0.3%	0.2%	0.2%

Nebraska	0.5%	0.4%	0.4%
Nevada	0.4%	0.3%	0.3%
New Hampshire	0.3%	0.2%	0.2%
New Jersey	0.4%	0.4%	0.3%
New Mexico	0.2%	0.2%	0.1%
New York	0.5%	0.4%	0.3%
North Carolina	0.8%	0.5%	0.5%
North Dakota	0.5%	0.4%	0.4%
Ohio	0.9%	0.8%	0.7%
Oklahoma	0.7%	0.6%	0.6%
Oregon	0.3%	0.2%	0.2%
Pennsylvania	0.6%	0.5%	0.4%
Rhode Island	0.3%	0.3%	0.2%
South Carolina	0.9%	0.6%	0.6%
South Dakota	0.6%	0.5%	0.4%
Tennessee	1.0%	0.7%	0.4%
Texas	0.6%	0.5%	0.5%
Utah	0.2%	0.1%	0.1%
Vermont	0.3%	0.2%	0.2%
Virginia	0.7%	0.5%	0.4%
Washington	0.2%	0.2%	0.2%
West Virginia	1.0%	0.7%	0.6%
Wisconsin	0.5%	0.4%	0.4%
Wyoming	0.4%	0.3%	0.3%

Source: Author calculations

State-by-State Electricity Expenditure Burden

The average burden data gloss over the important distributional impacts of the CPP within state. The expenditure increases that the CPP inflicts on households will be much more burdensome on lower-income households compared to higher-income households. Table 6 summarizes these results by presenting the electricity expenditure burden for the highest-income neighborhoods (officially census tracts) and the lowest-income neighborhoods for each state in the country (excluding Alaska and Hawaii), adjusting for the differences in electricity expenditures across households with different incomes. Also included is the impact on the median household for comparison.

TABLE 6

Average Electricity Expenditure Burden Relative to Median Household Income Due to the Implementation of the CPP Highest-income Neighborhoods Compared to Lowest-income Neighborhoods

STATE	NEIGHBORHOOD INCOME	CURRENT EXPENDITURES % MEDIAN INCOME	STATIC EXPENDITURE % MEDIAN HHI	DYNAMIC SHORT-TERM EXPENDITURE % MEDIAN HHI	DYNAMIC LONG-TERM EXPENDITURE % MEDIAN HHI
Alabama	Highest	1.43%	1.77%	1.68%	1.56%
	Median	4.13%	5.11%	4.85%	4.50%
	Lowest	13.73%	16.99%	16.12%	14.98%
Arizona	Highest	0.89%	0.99%	0.97%	0.96%
	Median	2.90%	3.23%	3.16%	3.14%
	Lowest	10.15%	11.32%	11.07%	11.01%
Arkansas	Highest	0.92%	1.13%	1.11%	1.10%
	Median	2.90%	3.56%	3.48%	3.45%
	Lowest	6.32%	7.78%	7.59%	7.53%
California	Highest	0.59%	0.64%	0.63%	0.63%
	Median	1.79%	1.96%	1.93%	1.92%
	Lowest	15.87%	17.36%	17.08%	16.98%
Colorado	Highest	0.54%	0.65%	0.62%	0.62%
	Median	1.64%	1.95%	1.89%	1.87%
	Lowest	7.19%	8.58%	8.29%	8.21%
Connecticut	Highest	0.85%	0.99%	0.96%	0.95%
	Median	2.24%	2.60%	2.53%	2.48%
	Lowest	9.43%	10.94%	10.65%	10.45%
Delaware	Highest	1.06%	1.30%	1.22%	1.21%
	Median	2.60%	3.18%	2.99%	2.97%
	Lowest	8.47%	10.37%	9.77%	9.70%
Florida	Highest	0.85%	1.02%	0.96%	0.96%
	Median	3.38%	4.05%	3.84%	3.82%
	Lowest	28.31%	33.97%	32.17%	31.98%
Georgia	Highest	1.01%	1.24%	1.17%	1.16%
	Median	3.25%	3.98%	3.75%	3.72%
	Lowest	43.49%	53.28%	50.16%	49.83%

Idaho	Highest	1.04%	1.21%	1.17%	1.16%
	Median	2.15%	2.50%	2.43%	2.41%
	Lowest	5.20%	6.07%	5.88%	5.83%
Illinois	Highest	0.60%	0.76%	0.74%	0.72%
	Median	2.02%	2.56%	2.47%	2.43%
	Lowest	18.03%	22.90%	22.11%	21.71%
Indiana	Highest	0.95%	1.21%	1.17%	1.15%
	Median	2.89%	3.68%	3.55%	3.48%
	Lowest	29.08%	37.05%	35.75%	35.11%
Iowa	Highest	0.97%	1.21%	1.17%	1.15%
	Median	2.07%	2.59%	2.50%	2.46%
	Lowest	5.93%	7.41%	7.17%	7.05%
Kansas	Highest	0.78%	0.98%	0.95%	0.93%
	Median	2.54%	3.19%	3.08%	3.03%
	Lowest	9.73%	12.20%	11.79%	11.59%
Kentucky	Highest	1.08%	1.38%	1.30%	1.19%
	Median	3.36%	4.28%	4.03%	3.71%
	Lowest	10.78%	13.72%	12.94%	11.90%
Louisiana	Highest	1.11%	1.36%	1.33%	1.32%
	Median	3.50%	4.30%	4.20%	4.16%
	Lowest	11.53%	14.16%	13.83%	13.70%
Maine	Highest	1.12%	1.25%	1.22%	1.21%
	Median	2.04%	2.27%	2.23%	2.20%
	Lowest	5.45%	6.07%	5.95%	5.87%
Maryland	Highest	0.87%	1.12%	1.04%	1.04%
	Median	2.11%	2.72%	2.53%	2.51%
	Lowest	14.46%	18.66%	17.32%	17.18%
Massachusetts	Highest	0.75%	0.87%	0.85%	0.83%
	Median	1.99%	2.31%	2.25%	2.21%
	Lowest	14.56%	16.89%	16.45%	16.14%
Michigan	Highest	0.70%	0.89%	0.86%	0.84%
	Median	2.19%	2.78%	2.69%	2.64%
	Lowest	8.93%	11.37%	10.97%	10.78%
Minnesota	Highest	0.73%	0.91%	0.88%	0.87%
	Median	1.74%	2.18%	2.10%	2.07%
	Lowest	6.45%	8.06%	7.80%	7.66%
Mississippi	Highest	1.51%	1.85%	1.76%	1.64%
	Median	4.78%	5.85%	5.57%	5.19%
	Lowest	9.84%	12.06%	11.47%	10.69%
Missouri	Highest	0.82%	1.04%	1.00%	0.99%
	Median	2.47%	3.12%	3.01%	2.96%
	Lowest	14.12%	17.84%	17.23%	16.93%
Montana	Highest	1.00%	1.15%	1.12%	1.11%
	Median	2.03%	2.34%	2.28%	2.26%
	Lowest	5.14%	5.93%	5.76%	5.72%
Nebraska	Highest	0.74%	0.92%	0.89%	0.87%
	Median	2.25%	2.78%	2.69%	2.65%
	Lowest	12.94%	15.99%	15.49%	15.24%

Nevada	Highest	1.00%	1.14%	1.11%	1.10%
	Median	2.79%	3.15%	3.08%	3.06%
	Lowest	6.47%	7.33%	7.15%	7.10%
New Hampshire	Highest	0.86%	0.99%	0.96%	0.95%
	Median	1.77%	2.02%	1.97%	1.94%
	Lowest	4.11%	4.71%	4.60%	4.52%
New Jersey	Highest	0.65%	0.81%	0.78%	0.76%
	Median	1.84%	2.28%	2.19%	2.14%
	Lowest	7.00%	8.65%	8.33%	8.11%
New Mexico	Highest	0.71%	0.78%	0.77%	0.77%
	Median	2.00%	2.20%	2.16%	2.15%
	Lowest	5.30%	5.83%	5.72%	5.69%
New York	Highest	0.75%	0.89%	0.86%	0.84%
	Median	2.56%	3.01%	2.92%	2.86%
	Lowest	10.23%	12.03%	11.68%	11.44%
North Carolina	Highest	0.91%	1.12%	1.06%	1.05%
	Median	3.23%	4.00%	3.76%	3.73%
	Lowest	40.85%	50.53%	47.45%	47.12%
North Dakota	Highest	1.16%	1.44%	1.39%	1.37%
	Median	2.23%	2.76%	2.67%	2.63%
	Lowest	6.69%	8.28%	8.02%	7.89%
Ohio	Highest	0.88%	1.16%	1.11%	1.09%
	Median	2.91%	3.82%	3.67%	3.60%
	Lowest	27.85%	36.54%	35.13%	34.42%
Oklahoma	Highest	1.00%	1.25%	1.22%	1.21%
	Median	2.91%	3.65%	3.56%	3.52%
	Lowest	14.85%	18.62%	18.14%	17.96%
Oregon	Highest	0.77%	0.87%	0.86%	0.85%
	Median	1.98%	2.23%	2.18%	2.16%
	Lowest	9.54%	10.76%	10.53%	10.45%
Pennsylvania	Highest	0.74%	0.94%	0.90%	0.88%
	Median	2.25%	2.84%	2.73%	2.65%
	Lowest	17.44%	22.03%	21.15%	20.54%
Rhode Island	Highest	0.93%	1.08%	1.05%	1.03%
	Median	2.02%	2.35%	2.29%	2.25%
	Lowest	6.96%	8.10%	7.88%	7.73%
South Carolina	Highest	1.43%	1.76%	1.66%	1.65%
	Median	3.95%	4.89%	4.59%	4.56%
	Lowest	26.14%	32.33%	30.36%	30.15%
South Dakota	Highest	1.29%	1.59%	1.54%	1.52%
	Median	2.47%	3.06%	2.96%	2.92%
	Lowest	4.26%	5.27%	5.11%	5.03%
Tennessee	Highest	0.94%	1.19%	1.12%	1.03%
	Median	3.64%	4.64%	4.37%	4.02%
	Lowest	22.73%	28.93%	27.28%	25.10%
Texas	Highest	0.90%	1.07%	1.04%	1.04%
	Median	3.06%	3.65%	3.57%	3.55%
	Lowest	21.44%	25.53%	25.01%	24.82%

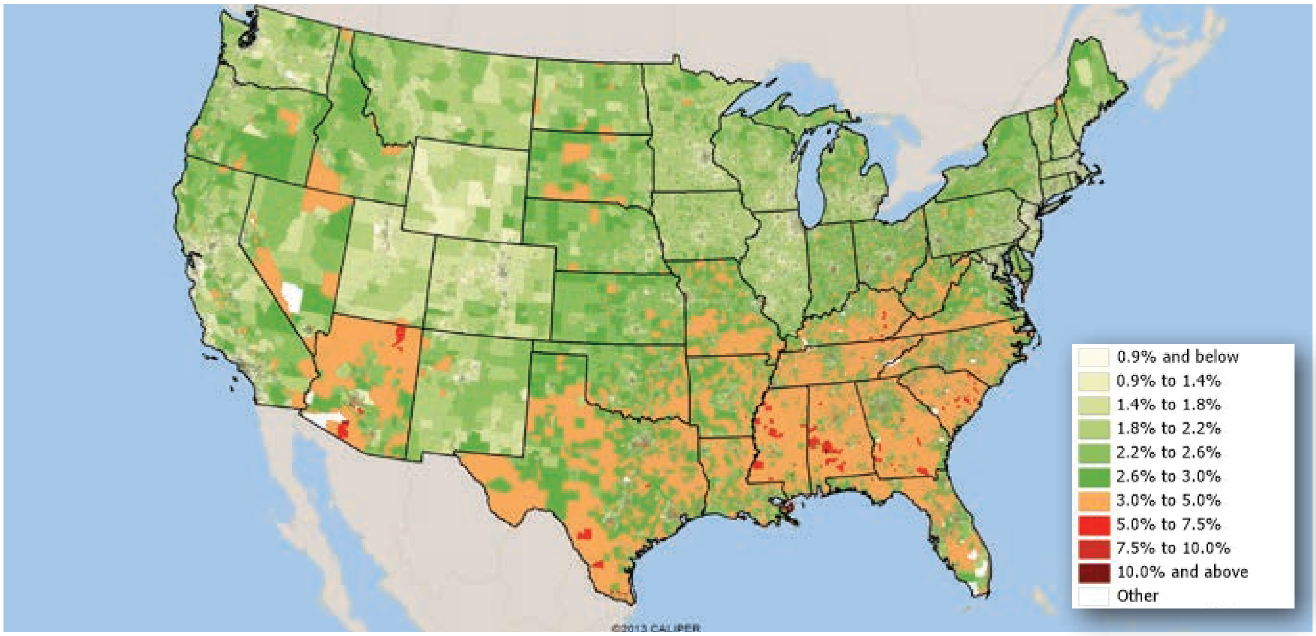
Utah	Highest	0.66%	0.74%	0.72%	0.72%
	Median	1.52%	1.70%	1.66%	1.65%
	Lowest	4.30%	4.81%	4.71%	4.68%
Vermont	Highest	1.05%	1.21%	1.18%	1.16%
	Median	1.96%	2.26%	2.20%	2.16%
	Lowest	3.44%	3.97%	3.86%	3.79%
Virginia	Highest	0.85%	1.08%	1.01%	1.00%
	Median	2.36%	3.02%	2.81%	2.79%
	Lowest	42.14%	53.94%	50.19%	49.79%
Washington	Highest	0.62%	0.69%	0.68%	0.67%
	Median	1.77%	2.00%	1.95%	1.94%
	Lowest	11.88%	13.40%	13.11%	13.01%
West Virginia	Highest	1.33%	1.72%	1.60%	1.58%
	Median	3.27%	4.25%	3.94%	3.90%
	Lowest	10.92%	14.17%	13.14%	13.03%
Wisconsin	Highest	0.70%	0.90%	0.87%	0.85%
	Median	1.96%	2.50%	2.41%	2.37%
	Lowest	8.96%	11.40%	11.00%	10.81%
Wyoming	Highest	1.16%	1.39%	1.34%	1.33%
	Median	1.95%	2.32%	2.24%	2.22%
	Lowest	4.63%	5.53%	5.34%	5.29%

Source: Author calculations

Providing greater details, Maps 7 through 10 illustrate the electricity expenditure burden by neighborhoods: currently; under the static scenario; under the dynamic short-term scenario; and, under the dynamic long-term scenario.

MAP 7

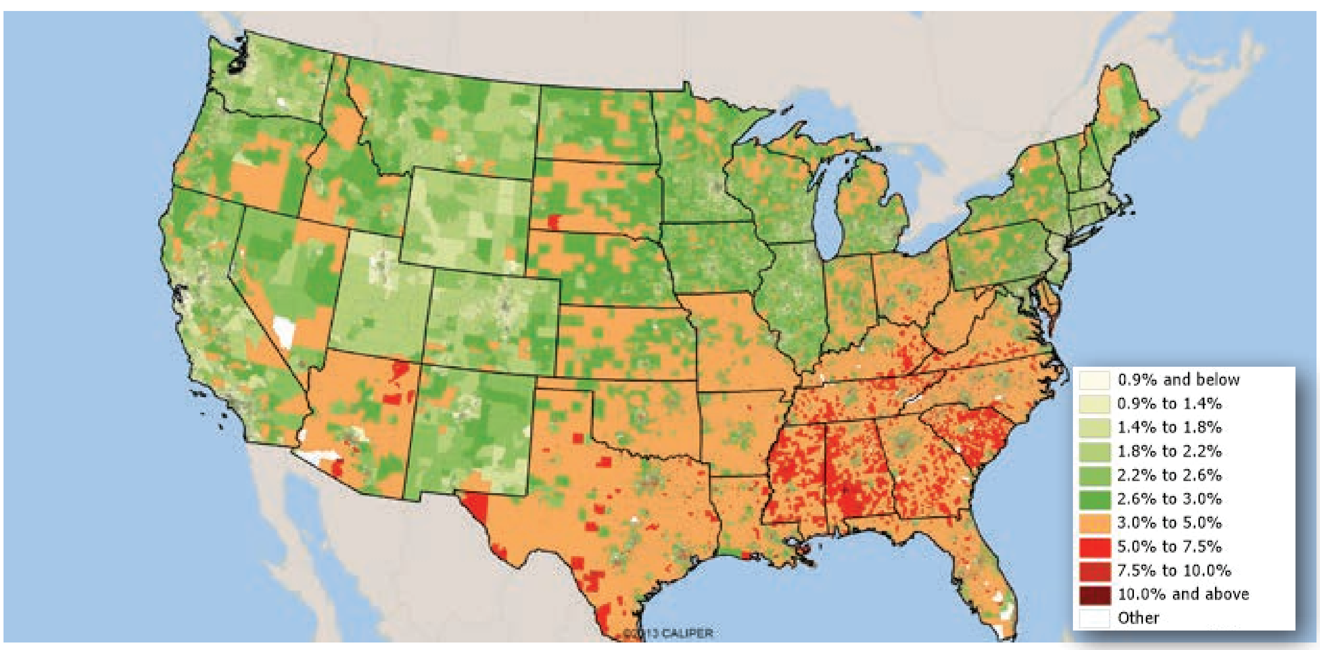
Current Average Annual Electricity Expenditures Relative to Median Household Income Continental U.S. By U.S. Census Tract



Source: Author calculations based on data from the EIA and Energy Ventures Analysis, "EPA's Clean Power Plan"

MAP 8

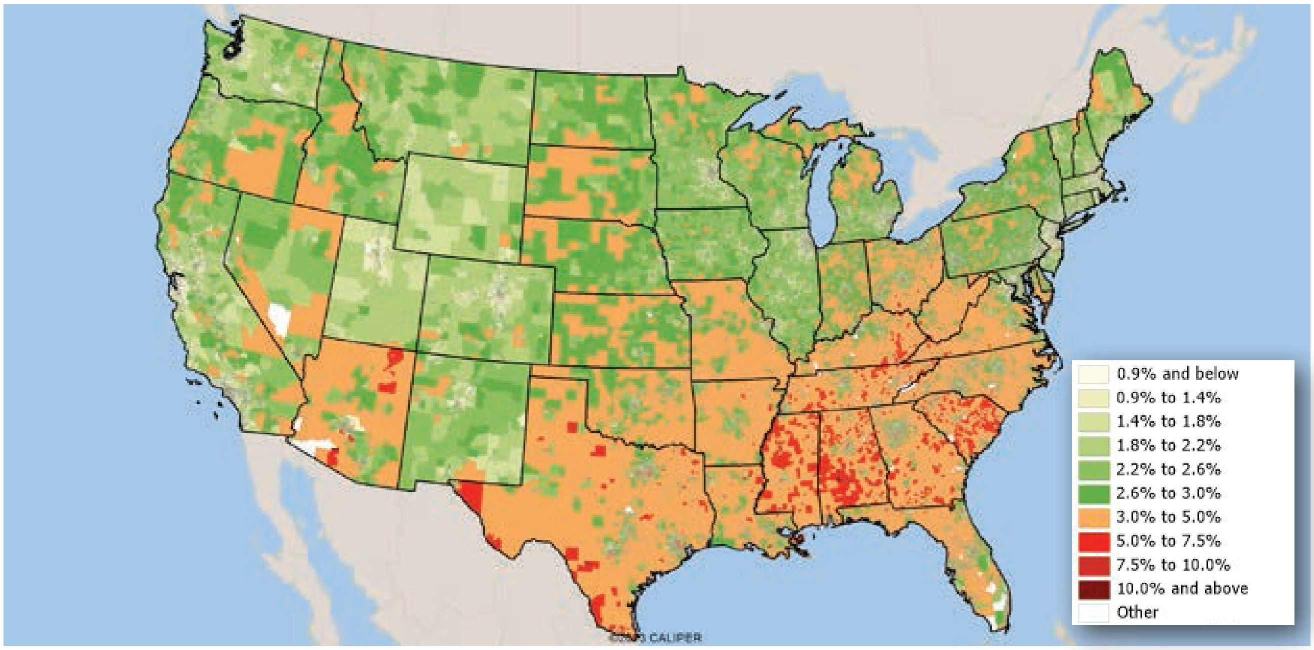
Average Annual Electricity Expenditures Relative to Median Household Income Static Impact Scenario Continental U.S. By U.S. Census Tract



Source: Author calculations based on data from the EIA and Energy Ventures Analysis, "EPA's Clean Power Plan"

MAP 9

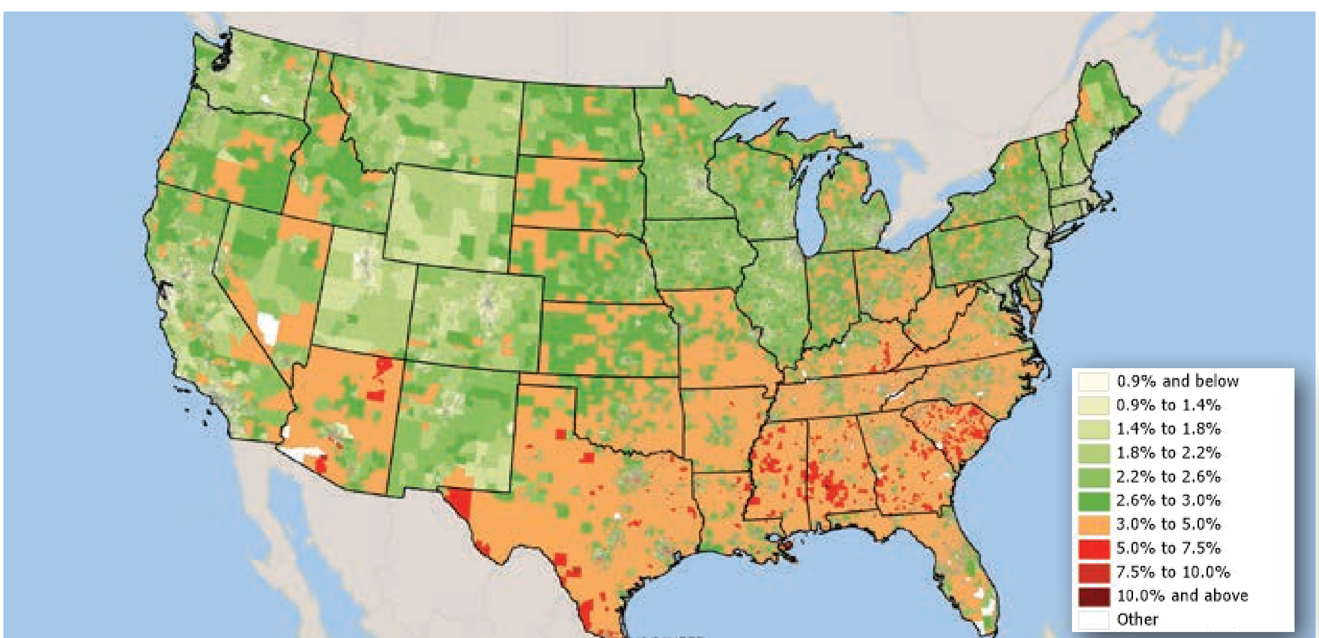
Average Annual Electricity Expenditures Relative to Median Household Income
Dynamic Impact Scenario – Short-term
Continental U.S. By U.S. Census Tract



Source: Author calculations based on data from the EIA and Energy Ventures Analysis, "EPA's Clean Power Plan"

MAP 10

Average Annual Electricity Expenditures Relative to Median Household Income
Dynamic Impact Scenario – Long-term
Continental U.S. By U.S. Census Tract



Source: Author calculations based on data from the EIA and Energy Ventures Analysis, "EPA's Clean Power Plan"

The data presented in Table 6, and Maps 7 through 10, clearly illustrate the regressive impacts from the CPP. Lower-income households will experience both a larger increase in electricity costs, and will also devote a larger share of their household incomes toward electricity expenditures, than wealthier-households and middle-income households. Such impacts are worsened due to the problem of stagnating household incomes that is most acutely felt by the lowest-income quintiles.

In the state-by-state addendum to this report, the electricity expenditure burden by neighborhood for each state (excluding Alaska and Hawaii) are visualized. The series of maps displays the current household burden from electricity expenditures, as well as the estimated burden from the three impact scenarios. By focusing on each state, the addendum enables a deeper comparison and confirms the conclusions from the national perspective – while the CPP imposes a noticeable impact on the average household's budget, the impacts on the poorest households are not only the largest, they are clearly unaffordable.

Conclusion

Policies that mandate reductions in CO_2 and other GHGs, such as the proposed Clean Power Plan, will lead to higher energy prices and less overall economic activity. Upon reviewing the expenditures by neighborhood in the previous section, several trends are apparent.

- First, the current burden from average electricity expenditures is magnitudes higher on the households in the lowest-income neighborhoods compared to the households in the highest-income neighborhoods. The burden on lower-income households is also significantly higher than the burden on median-income neighborhoods.

- Second, under all three impact scenarios, the average cost increases associated with the CPP increases the average electricity expenditures for everyone.

- Third, the CPP induced cost increases relative to household income is much higher for households in lower-income areas compared to households in wealthier areas. All necessities, including energy, are a much smaller share of the budget for wealthier households, and a much larger share of the budget for lower-income households. Therefore, increasing electricity costs will appreciably harm the financial well-being of lower-income families significantly more than higher-income households.

- Fourth, the higher electricity expenditures that the CPP will cause worsens the problem of energy poverty.

The conclusion from reviewing the national maps is that the economic costs created by the CPP will burden lower-income families to a much greater extent than wealthier families. This distributional impact is an important consideration that is only worsened by the problem of stagnating household incomes, particularly the incomes for the middle- and lower-income households.

Due to the untenable share of the a lower-income household's budget that unsubsidized electricity expenditures would require, the CPP will worsen the poverty trap facing too many households (the poverty trap being defined as a disincentive to work due to the value of lost income support benefits). When coupled with the stagnating inflation adjusted incomes since 2000, it becomes clear that middle-income and low-income households can ill-afford the costs that the CPP will inflict on the economy. These large economic costs argue against implementing the CPP, and, as a consequence, the current pause in the implementation of the CPP should be made permanent.

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- 67.5 percent of the overall average for the lowest-income quintile;
- 87.0 percent of the overall average for the next lowest-income quintile;
- 98.9 percent of the overall average for the middle income quintile;
- 110.8 percent of the overall average for the upper income quintile; and,
- 135.7 percent of the overall average for the highest-income quintile.

The average statewide household electricity expenditures for each neighborhood are adjusted based on the above percentages to estimate the expenditure burden for each neighborhood. The average income threshold for each quintile was based on the average income data by quintile from the U.S. Census (www2.census.gov/programs-surveys/demo/tables/p60/252/table4.pdf).

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58 The states included in each region were:

- Pacific Coast: Washington, Oregon, and California
- Mid Atlantic: New York, Pennsylvania, and New Jersey
- New England: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, and Connecticut
- Mountain: Montana, Idaho, Wyoming, Nevada, Utah, Colorado, Arizona, and New Mexico
- South Atlantic: Delaware, Maryland, West Virginia, Virginia, North Carolina, South Carolina, Georgia, and Florida
- East North Central: Wisconsin, Michigan, Illinois, Indiana, and Ohio
- East South Central: Kentucky, Tennessee, Mississippi, and Alabama
- West North Central: North Dakota, South Dakota, Minnesota, Nebraska, Iowa, Kansas, and Missouri
- West South Central: Oklahoma, Arkansas, Texas, and Louisiana

59 The Rand study also estimated short-run and long-run residential electricity price elasticities by state. However, a significant number of the state estimated elasticities were positive, indicating a possible omitted variable bias. For example, Colorado experienced both rising prices and a sharp growth in electricity demand in the early 1980s. The state also experienced faster than average population growth, which could be obscuring the results. The Rand study also found a positive relationship between rural states and a positive elasticity, confirmed by Houthakker et al. (1974), which was not included in the analysis but could be skewing the state results. Additionally, most of the positive elasticity estimates are near zero with confidence intervals including the negative range of elasticity. Consequently, we elected to use regional elasticity estimates instead of state-specific ones. This results in a more conservative analysis than would be provided if the below state-specific estimates were used.

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