Synapse
Energy Economics, Inc.

Economic Impacts of the NRDC Carbon Standard

Background Report prepared for the Natural Resources Defense Council

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1. Introduction

The Natural Resources Defense Council (NRDC) proposed a carbon emissions standard for existing power plants in its December 2012 report, Closing the Power Plant Carbon Pollution Loophole: Smart Ways the Clean Air Act Can Clean Up America's Biggest Climate Polluters NRDC Report[1]). This standard is intended to address the U.S. Environmental Protection Agency's (EPA) obligations under Section 111(d) of the Clean Air Act, following on EPA's April 2012 proposed Carbon Pollution Standard for new power plants under Section 111(b).[2]

As detailed in the NRDC report, ICF International modeled the NRDC proposal's application and impact on the U.S. power system using ICF's Integrated Planning Model (IPM®) and a number of NRDC assumptions. The analysis projected changes in air emissions, power plant investment and retirement decisions, compliance costs, and environmental and public-health benefits. The NRDC report concludes that under the proposed standard,

> …in 2020 the societal, public health, and economic benefits of reducing emissions of SO_2 will be \$11 billion to \$27 billion, while the benefits of reducing CO_2 will be \$14 to \$33 billion. The range in total benefits is \$25 billion to \$60 billion, or roughly 6 to 15 times the costs of compliance. The benefits accounted for in the valuation of avoided SO_2 emissions include avoided mortality, heart attacks, asthma attacks, hospital visits, respiratory symptoms, and lost workdays. *(NRDC Report, p.5)*

NRDC subsequently retained Synapse Energy Economics, Inc. (Synapse) to examine the broad economic impacts of NRDC's proposal. In order to conduct the analysis, NRDC first worked with ICF to disaggregate the national and regional results from its original analysis into 14 specific states, along with a residual region representing the remainder of the United States. Based on this disaggregation, Synapse used the IMPLAN economic model to calculate changes in employment, gross domestic product (GDP), and consumer utility bills in each state and for the United States as a whole.

2. Overview of Methodology and Results

A. Summary of Economic Impact Methodology

We modeled the economic effects of NRDC's estimated changes in spending between the carbon standard and a reference or "business-as-usual" scenario, which included the following:

- Changes in capital spending for construction of generation facilities.
- Changes in spending on energy efficiency installations.
- Changes in operations and maintenance spending at generation facilities.

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[1] http://www.nrdc.org/air/pollution-standards/files/pollution-standards-report.pdf
[2] http://www.epa.gov/carbonpollutionstandards/

- Changes in customers’ electricity bills.

The specific costs for implementing NRDC’s proposal, including construction costs and operations and maintenance costs (including fuel), were provided by NRDC, based on the requirements to build and operate the fleet of power plants identified by ICF to meet the proposed standard. Direct compliance costs that utilities might have to pay, such as the cost of carbon credits, were not included in this analysis because they represent a transfer from one entity to another and are not a net cost in themselves.

Our analysis relies on the IMPLAN[3] input-output model, which represents the flows of goods and services among states and economic sectors and industries. In addition to the direct expenditures provided by NRDC, IMPLAN estimates upstream suppliers’ spending required for each type of economic activity (indirect impacts) and the re-spending of wages and energy savings in the state’s economy (induced impacts).

The impacts shown here are the economic activity the carbon standard is projected to generate in each study area (i.e. each of the 14 states and the United States as a whole). IMPLAN has built-in, sector-specific assumptions regarding the portion of each industry’s supplies that are produced in-state, as well as the portion of household spending that remains in-state. IMPLAN provides representations of the economic interrelationships among 410 industries; all types of electricity generation, however, are represented as a single industry in the standard IMPLAN dataset. We have extended these standard assumptions for the electric sector by developing technology-specific details for each energy resource technology. Our coefficient vectors for energy efficiency—refined for cold and warm states for this study—and eleven generation technologies provide a more detailed representation of the materials needed for construction, and operation and maintenance of each type of energy resource.

B. Summary of Results

Figure 1 shows the net difference in employment in 2016 and 2020 under NRDC’s proposed carbon standard, relative to the reference case, for each of the states highlighted in this study. In the United States as a whole, we find that NRDC’s proposed carbon standard would result in 76,000 more jobs in 2016 and 210,000 more jobs in 2020 than would the reference case.[4] Changes in employment include direct, indirect, and induced jobs.

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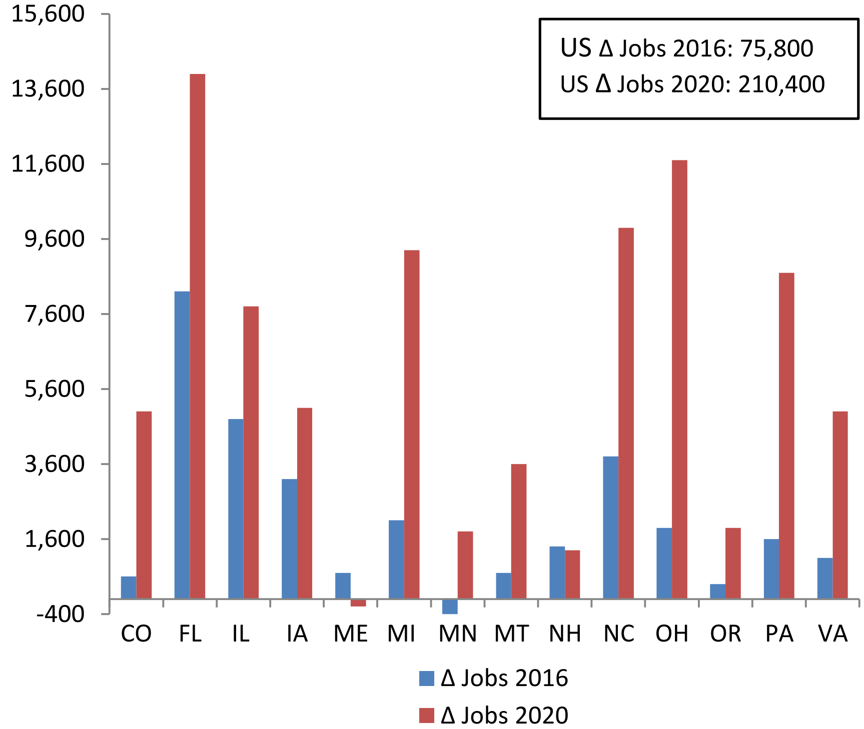
[3] MIG Inc., http://implan.com

[4] In this report, “jobs” refer to changes in the number of jobs in a given year, often called “job years.”

Figure 1: Net job years added by state in 2016 and 2020 from proposed carbon standard (direct, indirect, and induced)



Any change in the electricity generation mix will result in job losses in some areas, such as the closure of existing coal plants, and gains in other areas, such as new renewable energy resources and energy efficiency investments. Figure 1 shows that the gains far outweigh the losses nationally relative to the reference case, as they do in almost every state we studied. For 2016, the addition of 76,000 jobs nationally is consistent with the additional jobs created in 13 of the 14 states with the only net loss (relative to the reference case) being 400 jobs in Minnesota. In 2020, net gains of 210,000 jobs nationally results, again, in job growth in 13 of the 14 states, including Montana. The only net loss in 2020 relative to the reference case predicted by our model was about 100 fewer jobs created in Maine.

Table 1 breaks out various components of these projected employment changes at the national level. Detailed state-level results are presented in Section 4. In each of these tables, the difference in direct (on-site) employment is shown for each resource type, separated into construction- and operations-related jobs. Negative numbers in these tables represent *fewer jobs added* in the policy case versus the reference case. They do not represent a net loss of jobs relative to present-day employment levels. For example, total employment at coal and natural-gas fired plants is projected to increase in 2016 and 2020 relative to 2012 levels in the policy case, but it is reported as negative in 2016 for coal and 2020 for gas in Table 1 because more jobs are added at these plants in the reference case than in the policy case.

Table 1: Changes in employment and average utility bills: Policy Case vs. Reference Case

US Total	*2016*	*2020*
Total difference in employment	**75,800**	**210,400**
Direct jobs	136,700	253,800
Indirect + induced jobs	38,800	35,500
Expenditure shift jobs*	-99,700	-78,900
Difference in average monthly utility bill (2012 USD)	**$0.69**	**-$0.90**
Difference in direct jobs by energy source		
Energy efficiency	**155,300**	**236,300**
Construction (direct jobs)	155,300	236,300
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-21,900**	**20,000**
Construction (direct jobs)	-14,400	34,300
Operations and maintenance (direct jobs)	-7,500	-14,300
Gas-fired power plants	**2,000**	**-1,900**
Construction (direct jobs)	1,400	-1,700
Operations and maintenance (direct jobs)	600	-200
Nuclear power plants	**-300**	**-700**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	-300	-700
Wind	**1,600**	**100**
Construction (direct jobs)	1,400	-100
Operations and maintenance (direct jobs)	200	200
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

Note: Negative numbers in Table 1 represent *fewer jobs added* in the policy case relative to the reference case. They do not represent a net loss of jobs relative to the present. For example, total employment at coal and natural-gas fired plants is projected to increase in 2016 and 2020 relative to 2012 levels in the policy case, but appear as negative in 2016 for coal and 2020 for gas because more jobs are added at these plants in the reference case than in the policy case in those years.

**Expenditure shift jobs represent the net change in employment resulting from shifts in household spending on energy versus other goods and services. Changes in household spending are changes to utility bills resulting from the policy, and energy-efficiency participant costs (out-of-pocket costs that households and businesses incur to pay for energy-efficiency measures).To the extent that energy efficiency and cleaner power generation cost more or less than the more carbon-intensive fossil fuel generation they displace, other, non-energy household spending must make up the difference.*

Employment changes resulting from generating energy (this includes energy "generated" from energy efficiency investments) are comprised of direct, indirect, and induced impacts. Direct jobs are those that occur at power plants, or at the homes and businesses where energy efficiency installations occur. Indirect changes in employment occur in industries producing inputs to energy production (e.g., boilers, fuel, energy efficient appliances) while induced changes occur in all industries supported by economy-wide spending of wages earned via direct and indirect employment.

A fourth employment effect is referred to here as "expenditure shift" jobs. These represent the net change in employment resulting from shifts in household spending on energy versus other goods and services. Expenditure shifts are derived from both positive and negative changes in utility bills, (reflecting energy efficiency utility program expenditures and changes in spending on different sources of power generation) and direct spending by households and businesses on efficient equipment and appliances.[5]

The vast majority of 2016 employment gains, relative to the reference case, result from increases in investments in the end-use energy efficiency in homes and businesses. These relative job gains are partly offset by reductions to employment at new and existing coal-fired power power plants resulting, for example, from coal retirements. In 2020, there is both a gain in employment in coal-fired power plant construction due to an additional 5 GW of coal capacity outfitted with carbon capture and storage, and a loss in operation and maintenance jobs at retiring conventional coal plants as compared to the reference case.

For natural gas generation, the NRDC carbon standard has two counteracting effects. On the one hand, energy providers replace coal generation with natural gas, through both new construction and fuel switching. On the other hand, energy efficiency reduces the need for new generation overall. The net effect of these two factors on natural gas power plant employment is 2,000 more jobs in the policy case than in the reference case in 2016, and 1,900 fewer jobs in 2020. Both the policy case and the reference case show *net* increases in natural gas employment relative to 2012 levels—the policy case adds more natural gas jobs than the reference case in 2016, but the reverse is found for 2020.

Overall, the effect of the NRDC carbon standard on residential utility bills is modest. Our analysis shows that nationwide, average monthly utility bills would be about 69 cents higher under the policy case than under the reference case in 2016. By 2020, the policy case bills would be about 90 cents lower per month, in 2012 dollars.

The model also calculates the impact on GDP, showing slightly lower GDP (~$200 million) in the policy case compared to the reference case in 2016, and slightly higher GDP (~$2.4 billion) in the policy case in 2020. In the context of the U.S. economy, these changes in GDP are small relative to overall economic growth.[6]

The impacts shown in Table 1 and in the detailed state-level tables in Section 4 are conservative in the sense that we did not consider the impact of the NRDC's carbon standard on wholesale electricity prices. The introduction of additional low or zero running-cost resources such as energy efficiency and renewables is likely to lower the clearing price for wholesale electricity and capacity, leading to greater savings for and re-spending by consumers. The price impacts of the policy case

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[5] Jobs supported by economy-wide household spending increase as utility bills decline, and decrease when utility bills rise. That is, increased savings (lower electric bills) shifts spending to economy-wide goods and services, while higher electric bills have the opposite effect. Similarly, household purchases of energy efficient equipment reduce spending on economy-wide goods and services.

[6] The US GDP in 2011 was approximately $15 trillion; the changes shown here represent about 0.001% of US GDP in 2016 and 0.016% in 2020.

relative to the reference cases were not provided to Synapse and thus could not be included in this analysis.

3. Detailed Methodology

A. Economic Impacts

Economic impacts are a measure of an investment or policy's stimulus of a local economy. These impacts are composed of:

1. Direct economic effects (e.g. spending on goods and services at a construction site or the purchase of a piece of new equipment), and
2. Multiplier effects, which include:
    a. Spending on supporting goods and services by the firms providing that direct activity ("indirect" impacts), and
    b. Re-spending of wages earned by employess of firms providing direct and indirect activity ("induced" impacts).

Direct spending on labor accrues to the related contractors and workers during the construction period, or to those that operate and maintain facilities. In order to capture these impacts, Synapse estimated the shares of spending on labor versus materials for each resource. Indirect spending on supplies and services to support construction, and operations and maintenance is modeled for the relevant industries (e.g. wind farms purchase turbines from turbine manufacturers). Induced spending occurs when workers re-spend the wages classified as direct spending and from changes to electricity bills and energy-efficiency participant costs, further affecting the local economy.

The type of materials required and the extent to which they are produced locally is a key determinant of the magnitude of economic impacts in each state. This is accounted for at the industry level (e.g. the portion of wind turbines that are manufactured in Ohio.) Synapse's analysis relies on the IMPLAN[7] model's default estimates for the portion of each industry's demand that is met by in-state suppliers; one of the key benefits of the IMPLAN model is that it has been calibrated to each state's specific industry and household spending patterns. To supplement IMPLAN's industry-specific data—which does not provide detail for key energy sector sub-industries—Synapse created custom coefficients, or "sector-specific materials coefficient vectors," to capture spending patterns that represent construction, and operations and maintenance, for each energy technology (including energy efficiency) considered in this study.

B. Cost Input Data

ICF's modeling results were provided to NRDC on a regional basis. NRDC then disaggregated ICF's regional results into values for the 14 states considered here, as well as a "U.S. residual" region, based on shares of electricity generation and accounting for

[7] MIG Inc., http://implan.com

expected future retirements. Synapse's analysis was based on this disaggregated forecast of expenditure differences between the policy and reference cases, as provided by NRDC.

Specifically, Synapse used the difference between the policy and reference scenarios' overnight capital costs, based on NRDC's disaggregation of ICF's model results, as a measure of the change in direct spending on construction under the NRDC carbon standard relative to the reference case. Table 2 and Table 3 show this projected difference in spending on new construction by resource in 2016 and 2020, respectively for each of the 14 states, as provided by NRDC.

NRDC provided results for new facility construction by resource and state for every second year from 2012 through 2020. In order to capture the economic activity in the year in which it occurs, we assumed that construction would be completed during the year reported from IPM, but that economic activity would be spread out so that for most resources, only half of the construction spending would occur in that year.[8] (The exceptions were solar and EE, for which we assumed that all of the construction spending would take place in the indicated year.) Synapse developed costs of energy efficiency based on our own methodology, as described below.

Table 2: ICF Overnight Capital Cost Difference in 2016 (Policy minus Reference scenario), $2010 million

State	Coal (CCS & IGCC)	Coal (Conventional/ Retrofits)	Combined Cycle (Gas)	Combustion Turbine (Gas)	Nuclear	Oil/Gas Steam	Solar	Wind	EE (Synapse estimate)	TOTAL
FL	$0	-$9	$0	$0	$0	$0	$0	$0	$920	**$911**
NH	$0	-$2	$0	$0	$0	$0	$0	$0	$148	**$146**
ME	$0	-$1	$0	$0	$0	$0	$0	$0	$61	**$61**
VA	$0	-$77	$7	$0	$0	$0	$0	$0	$260	**$190**
PA	$0	-$175	$93	$0	$0	$0	$0	-$30	$777	**$666**
NC	$0	-$76	$2	$0	$0	$0	$1	$0	$524	**$450**
MI	$0	-$103	$174	-$100	$0	$0	$0	$6	$497	**$474**
OH	$0	-$205	$136	-$22	$0	$0	$0	$0	$645	**$554**
IL	$0	-$47	$150	$0	$0	$0	$0	$94	$989	**$1,186**
IA	$0	-$54	$79	-$46	$0	$0	$0	$132	$604	**$715**
MN	$0	-$43	$174	-$100	$0	$0	$0	$63	$535	**$628**
MT	$0	$15	-$24	$10	$0	$0	$0	$48	$123	**$171**
CO	$0	-$18	-$5	$26	$0	$0	$0	$175	$255	**$433**
OR	$0	-$5	-$83	$8	$0	$0	$0	$97	$159	**$174**
US total	**$0**	**-$2,166**	**$973**	**-$305**	**$0**	**-$20**	**-$682**	**$1,062**	**$20,342**	**$19,205**

[8] Nuclear plants typically take much longer than two years to build, however, no new nuclear plants were included in either the policy or reference scenario.

Table 3: ICF Overnight Capital Cost Difference in 2020 (Policy minus Reference scenario), $2010 million

State	Coal (CCS & IGCC)	Coal (Conventional/ Retrofits)	Combined Cycle (Gas)	Combustion Turbine (Gas)	Nuclear	Oil/Gas Steam	Solar	Wind	EE (Synapse estimate)	TOTAL
FL	$0	$0	$0	$0	$0	-$12	$0	$0	$1,568	**$1,556**
NH	$0	$0	$0	$0	$0	$0	$0	-$46	$147	**$101**
ME	$0	$0	$0	$0	$0	$0	$0	-$456	$78	**-$378**
VA	$32	$0	$0	$0	$0	-$2	$0	$207	$468	**$706**
PA	$302	$0	$0	$0	$0	$0	$0	$0	$1,338	**$1,640**
NC	$9	-$1	-$5	$0	$0	$0	$0	$0	$902	**$905**
MI	$131	$0	$313	-$86	$0	-$3	$0	$0	$859	**$1,213**
OH	$355	$0	$71	-$20	$0	-$1	$0	$0	$1,090	**$1,495**
IL	$108	$0	$0	$0	$0	$0	$0	$0	$1,490	**$1,598**
IA	$69	$0	$142	-$39	$0	-$1	$0	$0	$624	**$795**
MN	$55	$0	$313	-$86	$0	-$3	$0	$0	$622	**$901**
MT	$212	$0	-$8	$0	$0	$0	$0	$0	$168	**$372**
CO	$364	$0	$0	$0	$0	$0	$0	$0	$361	**$726**
OR	$70	$0	-$29	$1	$0	$0	$0	$0	$166	**$209**
US total	**$5,158**	**-$4**	**-$331**	**-$384**	**$0**	**-$54**	**-$669**	**-$51**	**$30,959**	**$34,625**

Synapse used the difference in the annual other operation and maintenance costs (including fuel) between the policy and reference scenarios as a measure of the change in direct spending on operating costs. Table 4 and Table 5 report fuel, and operation and maintenance costs by state and technology for 2016 and 2020 as provided by NRDC.

Table 4: ICF Fuel, and Operation and Maintenance Cost Difference in 2016 (Policy minus Reference scenario), $2010 million

State	Coal (CCS & IGCC)	Coal (Conventional/	Combined Cycle (Gas)	Combustion Turbine (Gas)	Nuclear	Oil/Gas Steam	Solar	Wind	TOTAL
FL	$0	-$34	-$388	-$75	$0	$6	$0	$0	**-$492**
NH	$0	-$48	-$42	-$11	$0	$0	$0	$0	**-$100**
ME	$0	-$11	-$35	-$9	$0	$0	$0	$0	**-$55**
VA	$0	-$239	-$51	-$13	$0	$0	$0	$0	**-$302**
PA	$0	-$384	$129	$11	-$38	$0	$0	-$3	**-$285**
NC	$0	-$204	$32	-$6	$0	$4	$0	$0	**-$174**
MI	-$32	-$676	$335	$214	-$85	$2	$0	$0	**-$240**
OH	$0	-$580	$230	$69	-$17	$1	$0	$0	**-$296**
IL	$0	-$889	$161	$129	-$80	$9	$0	$6	**-$665**
IA	$1	-$356	$152	$97	-$20	$1	$0	$5	**-$120**
MN	$0	-$285	$335	$214	-$60	$2	$0	$2	**$209**
MT	$0	-$123	$73	$10	$0	$3	$0	$2	**-$34**
CO	$0	-$192	$238	$23	$0	$10	$0	$9	**$87**
OR	$0	-$62	$12	$11	$0	$0	$0	$10	**-$27**
US total	**$5**	**-$11,280**	**$1,670**	**$1,496**	**-$403**	**-$111**	**$0**	**$59**	**-$8,564**

Table 5: ICF Fuel, and Operation and Maintenance Costs in 2020 (Policy minus Reference scenario), $2010 millions

State	Coal (CCS & IGCC)	Coal (Conventional/	Combined Cycle (Gas)	Combustion Turbine (Gas)	Nuclear	Oil/Gas Steam	Solar	Wind	TOTAL
FL	-$1	-$101	-$552	-$40	$0	-$204	$0	$0	**-$897**
NH	$0	-$69	-$64	-$15	$0	$0	$0	-$1	**-$148**
ME	$0	-$16	-$53	-$12	$0	$0	$0	-$9	**-$91**
VA	$0	-$466	-$200	-$3	$0	-$7	$0	$4	**-$672**
PA	$96	-$960	$73	$28	-$37	-$2	$0	-$3	**-$806**
NC	$3	-$834	$45	$34	$0	-$1	$0	$0	**-$753**
MI	-$35	-$1,174	$428	$182	-$83	$8	$0	$0	**-$674**
OH	$109	-$1,307	$243	$78	-$16	$2	$0	$0	**-$892**
IL	$34	-$1,752	$152	$133	-$78	$38	$0	$6	**-$1,467**
IA	$16	-$618	$194	$83	-$20	$3	$0	$5	**-$336**
MN	$13	-$494	$428	$182	-$59	$8	$0	$2	**$79**
MT	$51	-$218	$0	$1	$0	-$5	$0	$2	**-$168**
CO	$87	-$347	$80	$1	$0	-$7	$0	$9	**-$178**
OR	$17	-$105	-$82	$4	$0	-$10	$0	$10	**-$164**
US total	**$1,455**	**-$22,971**	**-$1,743**	**$1,387**	**-$828**	**-$553**	**$0**	**$59**	**- $23,194**

C. Sector-Specific Materials Coefficient Vectors

Synapse supplemented IMPLAN data with sector-level materials coefficient vectors for specific generating technologies. These vectors are developed and maintained internally at Synapse and have been used for multiple analyses. For this project, Synapse updated its energy efficiency materials coefficient vectors using the methods and data described in the next sub-section. Data sources and brief methodologies for all other generating technologies are reviewed in the subsequent sub-section.

Energy Efficiency Vectors

Cold- and warm-state energy efficiency materials coefficient vectors are based on actual and expected energy efficiency program profiles for selected utility energy efficiency programs as follows:

Step 1

States were divided into “warm” and “cold” categories based on their number of cooling degree days (CDD) and heating degree days (HDD) (Table 6 and Figure 2).

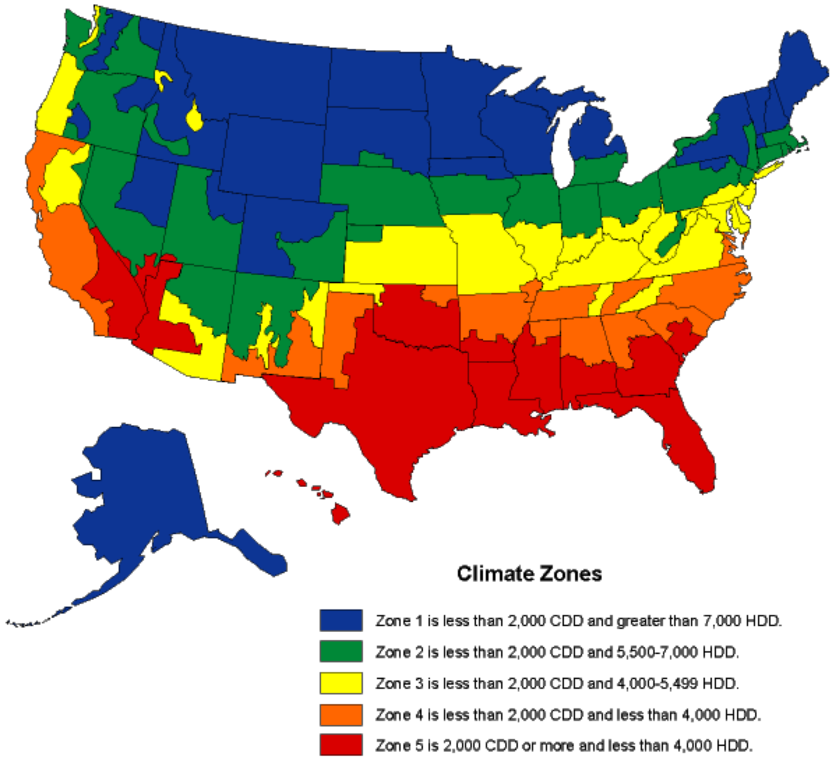
Table 6: States in NRDC's Analysis in the Warm-State and Cold-State Categories

Category	Definition	States
Warm States	Climate Zones 4 and 5; <4,000 HDD	Florida, North Carolina,
Cold States	Climate Zones 1, 2 and 3; >=4000 HDD	Colorado, Illinois, Iowa, Maine, Michigan, Minnesota, Montana, New Hampshire, Ohio, Oregon, Pennsylvania,
U.S. Average		Virginia

As shown in Table 6, states predominantly in EIA's Climate Zones 4 and 5 were assigned to the "warm-state" category, and states predominantly in Climate Zones 1, 2, and 3 were assigned to the "cold-state" category. This choice of Climate Zone for each state took into account the geographic distribution of state populations; Virginia's population was so evenly distributed by warm and cold Climate Zones that it was assigned the U.S. electricity-consumption-weighted average energy efficiency materials coefficient vector for modeling.[9]

[9] EIA. 2012. T2: Sales to Bundled and Unbundled Consumers by Sector, Census Division, and State. http://www.eia.gov/electricity/sales_revenue_price/

Figure 2: U.S. Climate Zones *(Source: EIA)*



Source: http://www.eia.gov/emeu/recs/climate_zone.html

Step 2

Representative states were selected for analysis based on their large energy savings and high energy efficiency program budgets: California for the warm-state category; and Minnesota and Massachusetts for the cold-state category. In these selected states, the utility or utilities with the largest energy savings were chosen for detailed analysis. For the selected utilities, energy efficiency investments both by utilities and customers were identified at the program or end-use levels.

California was selected to represent the warm-state category because it has the largest utility energy efficiency programs among the warm states, and because end-use energy efficiency program data are readily available for investor-owned utilities. While no publicly available data provide measure-level expenditures, the California Public Utilities Commission's (CPUC) staff generously provided us with data for the 2010 to 2012 program cycle through their CPUC Energy Efficiency Program Quarterly Claim Tracking Database.[10] The Claim Tracking Database provides measure-level incentives and measure incremental costs; these data were combined with measure-evaluation measurement and verification, and non-rebate incentive and direct implementation costs to capture the entirety of the energy efficiency investment.[11] Among California's three investor-owned utilities, we selected Southern California Edison ("Edison")

[10] Personal communication, February 2013, Amy Reardon, CPUC Energy Division.
[11] Utility efficiency program quarterly reports, http://eega.cpuc.ca.gov/Documents.aspx

because its electric savings related data are more readily available than that of the other two utilities, and because it is located in an area of the state that is more representative of the warm-state category.

Minnesota and Massachusetts were selected to represent the cold-state category because of their high savings and spending on energy efficiency programs based on the ACEEE's 2012 State Energy Efficiency Scorecard.[12] Xcel Energy Minnesota and NSTAR Electric were then selected to for use in developing energy efficiency materials coefficient vectors for these states, respectively, because of these utilities' dominant share of electric energy efficiency programs in each state, and the availability of their measure-level data.[13]

Step 3

For both warm- and cold-state job-vector profiles, the total efficiency measure cost per end-use type or measure was allocated to labor and materials based on Edison-specific measure database, our past experience with efficiency program job analysis,[14] and several other data sources.[15] The resulting aggregated labor and material ratios for the warm and cold state categories are presented Table 7.

Table 7. Shares of Aggregated Labor versus Materials Spending for Warm and Cold States

Share of Spending	Warm States	Cold States
Labor	29%	33%
Materials	71%	67%

The non-labor costs were then allocated to the appropriate IMPLAN sectors based on detailed utility program data on measure types.

Step 4

Finally, warm- and cold-state energy efficiency materials coefficients for each relevant IMPLAN sector were calculated as that sector's share of total energy efficiency investment. Program expenditures for administration, program and measure evaluation and verification, and non-rebate incentives and direct implementation were assigned to IMPLAN's "electricity and distribution services" sector, and program expenditures for marketing were assigned to IMPLAN's "advertising and related services" sector.

[12] ACEEE, 2012 State Energy Efficiency Scorecard, October 2012, http://aceee.org/sector/state-policy/scorecard

[13] Xcel Energy. Status Report & Associated Compliance Filings Minnesota Electric and Natural Gas Conservation Improvement Program Docket No. E. G002/CIP-09-198, http://www.xcelenergy.com/staticfiles/xe/Regulatory/Regulatory%20PDFs/MN-DSM-CIP-2011-Status-Report.pdf; and NSTAR Electric Company, 2013-2015 Three-Year Energy Efficiency Plan, D.P.U. 12-110, Exh. 5, November 2012.

[14] Energy efficiency program job impact profile for Vermont prepared by Optimal Energy Inc. and Synapse Energy Economics. 2011. *Economic Impacts of Energy Efficiency Investments in Vermont.* Prepared for Vermont Department of Public Service.

[15] U.S Department of Energy. June 2011. Technical Support Document: Energy Efficiency Program for Consumer Products: Residential Central Air Conditioners, Heat Pumps, and Furnaces. http://www.regulations.gov/#!documentDetail;D=EERE-2011-BT-STD-0011-0012; RSMeans. 2011. Mechanical Cost Data. Norwell, MA: RSMeans; and Tim Merrigan. n.d.. Solar Thermal Systems Analysis. National Renewable Energy Laboratory. https://www1.eere.energy.gov/solar/pdfs/solar_tim_merrigan.pdf.

Table 8: Energy Efficiency Materials Coefficient Vectors

IMPLAN code	IMPLAN code	Warm	Cold	U.S. Average
3104	Wood pulp	1.4%	1.7%	1.5%
3215	Heating equipment (except warm air furnaces)	0.0%	0.0%	0.0%
3216	Air conditioning, refrigeration, and warm air heating equipment	13.6%	12.1%	13.0%
3234	Electronic computers	0.8%	0.5%	0.7%
3259	Electric lamp bulbs and parts	33.0%	23.4%	28.6%
3261	Small electrical appliances	0.2%	0.1%	0.2%
3263	Household refrigerators and home freezers	1.2%	0.3%	0.8%
3265	Other major household appliances	0.8%	0.5%	0.6%
3031	Electricity, and distribution services	4.4%	4.1%	4.3%
3377	Advertising and related services	2.6%	5.3%	3.9%
3416	Electronic and precision equipment repairs and maintenance	0.0%	2.4%	1.2%
3417	Commercial and industrial machinery and equipment repairs and maintenance	2.5%	3.8%	3.2%
3230	Other general purpose machinery	9.8%	12.6%	11.2%
	Labor (Non materials) share:	*31.1%*	*34.9%*	*32.3%*

Generation Vectors

The following list identifies sector-specific materials coefficient vectors developed by Synapse and used in our economic impact modeling of the NRDC carbon standard, and the basis for each vector. Vectors are listed in alphabetical order. Full citations for the referenced data sources are provided at the end of this sub-section.

- **Coal Construction:** Construction spending based on: 1) power plant construction data from IMPLAN I-O Direct Requirements Matrix; and 2) costs for each resource from NREL JEDI Model.
- **Coal Operation and Maintenance:** Operation and maintenance based on electricity generation sector requirements in the IMPLAN I-O Direct Requirements Matrix, adjusted for each resource type using data from NREL JEDI Model.
- **Gas Construction:** Construction spending based on: 1) power plant construction data from IMPLAN I-O Direct Requirements Matrix; and 2) costs for each resource from NREL JEDI Model version.
- **Gas Operation and Maintenance:** Operation and maintenance based on electricity generation sector requirements in the IMPLAN I-O Direct Requirements Matrix, adjusted for each resource type using data from NREL JEDI Model version.
- **Nuclear O&M:** O&M based on electricity generation sector requirements in the IMPLAN I-O Direct Requirements Matrix, adjusted for each resource type using data from NREL JEDI Model version.

- **Solar PV Construction:** Construction spending based on: 1) power plant construction data from IMPLAN I-O Direct Requirements Matrix; and 2) costs for each resource from NREL JEDI Model version.
- **Solar PV Operation and Maintenance:** Operation and maintenance based on electricity generation sector requirements in the IMPLAN I-O Direct Requirements Matrix, adjusted for each resource type using data from NREL JEDI Model version.
- **Wind Construction:** Construction spending based on: 1) power plant construction data from IMPLAN I-O Direct Requirements Matrix; and 2) costs for each resource from NREL JEDI Model version 01D_Wind_Model_rel._W1.10.03.
- **Wind Operation and Maintenance:** Operation and maintenance based on electricity generation sector requirements in the IMPLAN I-O Direct Requirements Matrix, adjusted for each resource type using data from NREL JEDI Model version 01D_Wind_Model_rel._W1.10.03.

Additional Assumptions

- **Construction Labor/Non-Labor Shares:** Based on data source(s) listed for each vector (by resource).
- **Operation and Maintenance Income per Worker:** Based on data source(s) listed for each vector (by resource), with one exception: Operation and maintenance income per worker for the Nuclear was based on the mean income for "Nuclear Power Reactor Operators" in the Bureau of Labor Statistics (BLS) Occupational Employment Statistics.
- **Operation and Maintenance Labor/Non-Labor Shares:** Based on data source(s) listed for each vector (by resource).
- **Household Spending:** IMPLAN vector for household spending.

Data Sources

Bureau of Labor Statistics, Occupational Employment Statistics. http://www.bls.gov/oes/

IMPLAN, MIG Inc. http://implan.com/V4/Index.php

National Renewable Energy Laboratory (NREL). Jobs and Economic Development Impact Model (JEDI). http://www.nrel.gov/analysis/jedi/

D. Energy Efficiency Cost Estimates

Energy efficiency programs generate economic impacts in the year in which measures are installed due to the required labor for installation and equipment manufacture. They may also change energy spending in other years depending on their funding mechanisms. Program participants and ratepayers' incur costs to fund the efficiency programs and participants save on energy spending over time. The portion of funding that comes from utility programs is typically built into ratepayers' bills as a separate surcharge—often called a System (or Societal) Benefits Charge—in a way designed to recover the entire annual program expenditure in one year, although some utilities may recover energy efficiency program investment over multiple years.

In order to estimate annual investments in years 2016 and 2020, we first estimated annual incremental savings for each state based on the level of savings for each state for 2012 and the energy savings ramp-up rates assumed in Synapse *Beyond Business As Usual* report for the Civil Society Institute.[16] We then estimated each state's annual investments by applying annual investment factors (i.e., costs per first year kWh savings) to the annual incremental savings. Annual investment factors were derived from the levelized cost of energy efficiency programs assumed by NRDC for its carbon standard analysis.

Based on the *Beyond Business As Usual* report, NRDC adopted Synapse's assumption of 4.7 cents/kWh ($2010) for the total cost of energy efficiency programs and policies, including out-of-pocket investments by participants, in analyzing the proposal.[17] This cost consists of 2.6 cents/kWh for program expenditures and 2.1 cents/kWh for participants' out-of-pocket expenditures. We converted these levelized costs of energy efficiency to annual investment dollars spent per first year kWh savings based on a 5-percent real discount rate and a 12-year amortization period, corresponding to a typical average energy efficiency program life.

Participants' out-of-pocket spending was assumed to be paid 50 percent upfront (i.e. in the installation year) and 50 percent financed through a ten-year loan at a 2.5-percent real interest rate, representing an average rate of various loan offerings for consumers participating in efficiency programs (e.g., zero or low interest loans, home mortgage, or equity loan). The annual energy spending associated with energy efficiency is equal to the sum of the annual ratepayer and program participant costs. For instance, in 2016, we are capturing the economic impacts of installation of 2016 measures but also the spending impacts of measures installed in that year and previous years (to the extent that participants are paying back loans).

E. Energy Expenditure Shift

The difference in annual generation spending (i.e. power plant production) between the scenarios is based on the change in the levelized costs of capital and operation and maintenance spending by year from IPM modeling results. Synapse added the annual energy efficiency program spending to the policy case. Together, the difference in generation and energy efficiency spending between scenarios is the change in total energy spending. It should be noted that the change in total energy spending is only partly due to efficiency spending, since the generation mix is different for the two scenarios. For example, the NRDC carbon standard case assumes that more clean energy resources will be built, including expensive integrated gasification combined cycle plants. There are also changes in generation patterns across states, as well as changes in interstate electricity imports and exports, in the IPM model results, and these also contribute to energy spending changes between the reference and policy scenarios.

For energy efficiency spending, only efficiency program spending is included in calculating impacts on average monthly electricity bills, since these costs would be passed on to ratepayers.

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[16] Keith et al. 2011. Toward a Sustainable Future for the U.S. Power Sector: *Beyond Business As Usual 2011*. Synapse Energy Economics. This study projected savings by region. To estimate the economic impacts of NRDC's Carbon Standard, we followed the same methods to project state-specific savings.

[17] This estimate was used for a study period between 2011 and 2020. Synapse *Beyond Business As Usual* report assumes higher energy efficiency costs in later study periods (e.g., 7 cents per kWh in the 2040-50).

Participant costs are paid out-of-pocket (i.e., do not appear on electric bills) so these are included in the energy spending impacts but not on the monthly bill impacts.

The aggregate impacts from energy spending are allocated to residential, commercial and industrial sectors based on the percentage of each sector's energy usage by state as reported to the Energy Information Administration EIA in 2012.[18] The energy spending changes affecting residential customers were allocated to IMPLAN's household spending vector. The energy spending changes affecting commercial and industrial customers were allocated 50 percent to household spending and 50 percent to these sectors' profits; this assumes that some of the effects of changes in energy costs would be absorbed by businesses and some would be passed on to consumers.

4. State level results

The following tables show the detailed differences in employment and average residential electricity bills between the policy and reference cases for each of the 14 states investigated in this report, for each of the study years. As with the national summary table (Table 1), direct jobs are those that occur at power plants or the homes and businesses where energy efficiency installations occur.

As with Table 1, the values shown in these tables represent the differences between the policy and reference cases, and not overall changes in employment or utility bills from current levels. For example, negative values for employment at natural gas plants generally represent increases from current levels that are smaller in the policy case than in the reference case.

[18] EIA 861 - Annual Electric Power Industry Report, found here: http://www.eia.gov/electricity/data/eia861/index.html

COLORADO	*2016*	*2020*
Total change in jobs	**600**	**5,000**
Direct jobs	1,900	4,700
Indirect + induced jobs	1,200	2,300
Expenditure shift jobs	-2,500	-2,000
Difference in average monthly utility bill (2012 USD)	**$3.60**	**$1.82**
Changes in direct jobs by energy source		
Energy efficiency	**1,800**	**2,500**
Construction (direct jobs)	1,800	2,500
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-200**	**2,200**
Construction (direct jobs)	-100	2,400
Operations and maintenance (direct jobs)	-100	-200
Gas-fired power plants	**100**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	100	0
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**200**	**0**
Construction (direct jobs)	200	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

FLORIDA	*2016*	*2020*
Total change in jobs	**8,200**	**14,000**
Direct jobs	8,700	14,800
Indirect + induced jobs	2,300	3,800
Expenditure shift jobs	-2,800	-4,600
Difference in average monthly utility bill (2012 USD)	**$0.07**	**-$0.31**
Changes in direct jobs by energy source	*2016*	*2020*
Energy efficiency	**8,900**	**15,100**
Construction (direct jobs)	8,900	15,100
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-100**	**-100**
Construction (direct jobs)	-100	0
Operations and maintenance (direct jobs)	0	-100
Gas-fired power plants	**-100**	**-200**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	-100	-200
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

ILLINOIS	*2016*	*2020*
Total change in jobs	**4,800**	**7,800**
Direct jobs	5,500	8,500
Indirect + induced jobs	600	-1,600
Expenditure shift jobs	-1,300	900
Difference in average monthly utility bill (2012 USD)	**-$0.40**	**-$2.47**
Changes in direct jobs by energy source		
Energy efficiency	**5,900**	**8,900**
Construction (direct jobs)	5,900	8,900
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-800**	**-400**
Construction (direct jobs)	-300	600
Operations and maintenance (direct jobs)	-500	-1,000
Gas-fired power plants	**400**	**100**
Construction (direct jobs)	300	0
Operations and maintenance (direct jobs)	100	100
Nuclear power plants	**-100**	**-100**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	-100	-100
Wind	**100**	**0**
Construction (direct jobs)	100	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

IOWA	*2016*	*2020*
Total change in jobs	**3,200**	**5,100**
Direct jobs	4,300	5,000
Indirect + induced jobs	1,700	2,100
Expenditure shift jobs	-2,800	-2,000
Difference in average monthly utility bill (2012 USD)	**$5.02**	**$1.06**
Changes in direct jobs by energy source		
Energy efficiency	**4,600**	**4,700**
Construction (direct jobs)	4,600	4,700
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-700**	**0**
Construction (direct jobs)	-400	500
Operations and maintenance (direct jobs)	-300	-500
Gas-fired power plants	**200**	**300**
Construction (direct jobs)	100	200
Operations and maintenance (direct jobs)	100	100
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**200**	**0**
Construction (direct jobs)	200	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

MAINE	*2016*	*2020*
Total change in jobs	**700**	**-200**
Direct jobs	600	-100
Indirect + induced jobs	100	-900
Expenditure shift jobs	0	800
Difference in average monthly utility bill (2012 USD)	**-$0.53**	**-$3.19**
Changes in direct jobs by energy source		
Energy efficiency	**600**	**800**
Construction (direct jobs)	600	800
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Gas-fired power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**0**	**-900**
Construction (direct jobs)	0	-900
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

MICHIGAN	*2016*	*2020*
Total change in jobs	**2,100**	**9,300**
Direct jobs	2,700	7,100
Indirect + induced jobs	1,000	3,400
Expenditure shift jobs	-1,600	-1,200
Difference in average monthly utility bill (2012 USD)	**$0.44**	**-$0.84**
Changes in direct jobs by energy source		
Energy efficiency	**3,800**	**6,500**
Construction (direct jobs)	3,800	6,500
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-1,300**	**100**
Construction (direct jobs)	-800	1,000
Operations and maintenance (direct jobs)	-500	-900
Gas-fired power plants	**300**	**600**
Construction (direct jobs)	200	500
Operations and maintenance (direct jobs)	100	100
Nuclear power plants	**-100**	**-100**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	-100	-100
Wind	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

MINNESOTA	*2016*	*2020*
Total change in jobs	**-400**	**1,800**
Direct jobs	3,500	5,000
Indirect + induced jobs	1,600	2,500
Expenditure shift jobs	-5,500	-5,700
Difference in average monthly utility bill (2012 USD)	**$6.97**	**$6.02**
Changes in direct jobs by energy source		
Energy efficiency	**3,700**	**4,300**
Construction (direct jobs)	3,700	4,300
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-500**	**100**
Construction (direct jobs)	-300	400
Operations and maintenance (direct jobs)	-200	-300
Gas-fired power plants	**300**	**600**
Construction (direct jobs)	200	500
Operations and maintenance (direct jobs)	100	100
Nuclear power plants	**-100**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	-100	0
Wind	**100**	**0**
Construction (direct jobs)	100	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

MONTANA	*2016*	*2020*
Total change in jobs	**700**	**3,600**
Direct jobs	1,200	3,100
Indirect + induced jobs	0	800
Expenditure shift jobs	-500	-300
Difference in average monthly utility bill (2012 USD)	**$2.00**	**-$1.25**
Changes in direct jobs by energy source		
Energy efficiency	**1,100**	**1,400**
Construction (direct jobs)	1,100	1,400
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**0**	**1,700**
Construction (direct jobs)	100	1,800
Operations and maintenance (direct jobs)	-100	-100
Gas-fired power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**100**	**0**
Construction (direct jobs)	100	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

NEW HAMPSHIRE	*2016*	*2020*
Total change in jobs	**1,400**	**1,300**
Direct jobs	1,100	900
Indirect + induced jobs	400	300
Expenditure shift jobs	-100	100
Difference in average monthly utility bill (2012 USD)	**-$1.20**	**-$3.61**
Changes in direct jobs by energy source		
Energy efficiency	**1,100**	**1,100**
Construction (direct jobs)	1,100	1,100
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**0**	**-100**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	-100
Gas-fired power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**0**	**-100**
Construction (direct jobs)	0	-100
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

NORTH CAROLINA	*2016*	*2020*
Total change in jobs	**3,800**	**9,900**
Direct jobs	4,600	8,600
Indirect + induced jobs	1,100	1,300
Expenditure shift jobs	-1,900	0
Difference in average monthly utility bill (2012 USD)	**$0.80**	**-$2.73**
Changes in direct jobs by energy source		
Energy efficiency	**5,400**	**9,200**
Construction (direct jobs)	5,400	9,200
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-800**	**-600**
Construction (direct jobs)	-600	100
Operations and maintenance (direct jobs)	-200	-700
Gas-fired power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

OHIO	*2016*	*2020*
Total change in jobs	**1,900**	**11,700**
Direct jobs	3,200	9,800
Indirect + induced jobs	400	2,900
Expenditure shift jobs	-1,700	-1,000
Difference in average monthly utility bill (2012 USD)	**$0.16**	**-$1.03**
Changes in direct jobs by energy source		
Energy efficiency	**4,700**	**8,000**
Construction (direct jobs)	4,700	8,000
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-1,900**	**1,600**
Construction (direct jobs)	-1,500	2,500
Operations and maintenance (direct jobs)	-400	-900
Gas-fired power plants	**400**	**200**
Construction (direct jobs)	300	100
Operations and maintenance (direct jobs)	100	100
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

OREGON	*2016*	*2020*
Total change in jobs	**400**	**1,900**
Direct jobs	1,000	1,400
Indirect + induced jobs	400	800
Expenditure shift jobs	-1,000	-300
Difference in average monthly utility bill (2012 USD)	**$1.80**	**-$0.65**
Changes in direct jobs by energy source		
Energy efficiency	**1,100**	**1,100**
Construction (direct jobs)	1,100	1,100
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**0**	**400**
Construction (direct jobs)	0	500
Operations and maintenance (direct jobs)	0	-100
Gas-fired power plants	**-200**	**-100**
Construction (direct jobs)	-200	-100
Operations and maintenance (direct jobs)	0	0
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**100**	**0**
Construction (direct jobs)	100	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

PENNSYLVANIA	*2016*	*2020*
Total change in jobs	**1,600**	**8,700**
Direct jobs	3,700	9,600
Indirect + induced jobs	100	1,800
Expenditure shift jobs	-2,200	-2,700
Difference in average monthly utility bill (2012 USD)	**$0.36**	**-$0.29**
Changes in direct jobs by energy source		
Energy efficiency	**4,800**	**8,300**
Construction (direct jobs)	4,800	8,300
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-1,300**	**1,300**
Construction (direct jobs)	-1,100	1,800
Operations and maintenance (direct jobs)	-200	-500
Gas-fired power plants	**200**	**0**
Construction (direct jobs)	200	0
Operations and maintenance (direct jobs)	0	0
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0

VIRGINIA	*2016*	*2020*
Total change in jobs	**1,100**	**5,000**
Direct jobs	1,300	3,900
Indirect + induced jobs	-800	-500
Expenditure shift jobs	600	1,600
Difference in average monthly utility bill (2012 USD)	**-$1.93**	**-$4.35**
Changes in direct jobs by energy source		
Energy efficiency	**2,000**	**3,700**
Construction (direct jobs)	2,000	3,700
Operations and maintenance (direct jobs)	0	0
Coal-fired power plants	**-700**	**-100**
Construction (direct jobs)	-500	200
Operations and maintenance (direct jobs)	-200	-300
Gas-fired power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Nuclear power plants	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0
Wind	**0**	**300**
Construction (direct jobs)	0	300
Operations and maintenance (direct jobs)	0	0
PV	**0**	**0**
Construction (direct jobs)	0	0
Operations and maintenance (direct jobs)	0	0