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Retail Electric Bill Savings and Energy Efficiency Job Growth from the NRDC Carbon Standard: Methodology Description

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1. INTRODUCTION

The Natural Resources Defense Council (NRDC) proposed a carbon pollution 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*.[1] NRDC also conducted an economic impact assessment of the proposal, estimating changes in employment, gross domestic product (GDP), and utility bills.[2] NRDC updated and expanded on the analysis of its carbon pollution standard proposal in March 2014 using the most recent energy projections available from the Energy Information Administration (EIA) at the time the analysis was designed and studying a range of compliance scenarios. In this report we present an updated assessment of projected effects on retail electricity bills and on job growth resulting from the investments in energy efficiency stimulated by the Moderate, Full Efficiency policy scenario described in the March 2014 report. NRDC's proposed carbon pollution standard is intended to address the U.S. Environmental Protection Agency's (EPA) obligations under Section 111(d) of the Clean Air Act.

As with the 2012 analysis, ICF International (ICF) modeled the U.S. power system impacts of NRDC's proposed approach with its Integrated Planning Model (IPM®) and NRDC assumptions.[3] The analysis projected changes in carbon dioxide and other emissions, power plant investment and retirement decisions, and compliance costs. NRDC independently estimated the environmental and public health benefits of reducing emissions using a standard methodology employed in government regulatory impact analyses.

The updated analysis found that under the proposed standard, 470 to 700 million short tons of carbon pollution can be eliminated in 2020 compared to 2012 levels (or 890 to 1,100 million short tons compared to 2005 levels), equivalent to the emissions from 95 to 130 million automobiles. At the same time, the NRDC approach would yield $28 to $63 billion in health and environmental benefits in 2020, far outweighing the costs of putting first-ever limits on carbon pollution. More specifically, the Moderate, Full Efficiency scenario would deliver $30 to $50 billion in health and environmental benefits.

For the current report, NRDC retained ICF International to estimate the impacts on retail electricity bills and jobs resulting from energy efficiency investments in NRDC's Moderate, Full Efficiency case using the IMPLAN® economic model. We estimated impacts in 13 study states and for the United States as a whole, calculating aggregate retail bill savings, and employment effects generated by energy efficiency expenditures and changed spending patterns by energy customers and utilities. The 13 states of focus were chosen by NRDC to represent a diverse range of state circumstances, including power sector carbon intensity, population, and other economic circumstances. NRDC also plans to analyze impacts on employment in other sectors of the economy.

2. OVERVIEW OF METHODOLOGY AND RESULTS

A. ENERGY EFFICIENCY IN NRDC'S MODERATE, FULL EFFICIENCY SCENARIO

For the electric power sector analysis of its Moderate, Full Efficiency Case, NRDC developed an approach for representing demand-side energy efficiency in the model using a simplified supply curve. NRDC derived this curve from the total electricity demand reduction from energy efficiency projected by Synapse Energy Economics[4] in its Transition Scenario presented in the November 2011 report, *Toward a Sustainable Future for the U.S. Power Sector: Beyond Business as Usual 2011*. Synapse assumed that by 2020 all regions achieve savings equivalent to 2 percent of the previous year's electricity sales, consistent with the results of the leading efficiency programs in recent years.

To produce a cost curve for efficiency resources supply, NRDC divided Synapse's total electricity demand reduction from energy efficiency into three equal blocks with different costs. The maximum projected savings from energy efficiency in 2020 was 482 TWh, so each cost block represents 161 TWh of demand reduction. Then, NRDC assigned utility program costs to each block such that the cost of the middle block would be equal to the Synapse's cost estimate. The relative costs assigned to the other two blocks were scaled on the basis of a generic cost curve given in a 2013 LBNL report on the projected costs and savings of utility-funded energy efficiency programs.[5] The first block of energy efficiency savings was available at 2.3 cents/kWh, the second block at 2.6 cents/kWh, and the third block at 3.2 cents/kWh. The costs are uniform throughout the country, while the quantities of energy efficiency available vary by region based on the Synapse assessment. In each region, the model selects how much energy efficiency to deploy based on these levelized program costs relative to other sources available to meet the carbon standard. Efficiency program participants are assumed to contribute 45 percent of the total costs of energy efficiency measures. These participant costs are not part of the selection criteria in the model, but are accounted for in the subsequent economic modeling.

B. NRDC'S MODERATE, FULL EFFICIENCY SCENARIO RESULTS AND RETAIL BILLS

NRDC's March 2014 Moderate, Full Efficiency scenario reduces CO_2 emissions nationwide by 531 million short tons below 2012 (or 945 million short tons below 2005 levels). Incremental net system compliance costs are minimal in 2020, with health and environmental benefits valued at an estimated \$30–\$50 billion. There are a total of 437 TWh of energy efficiency in the generation mix in 2020. The total overnight capital cost of energy efficiency is \$31.6 billion, of which \$17.4 billion is the utility program cost and \$14.2 billion is the customer cost. The calculation of retail bills is based on retail rates in each state. To calculate changes in retail bills, ICF used one of two approaches depending on the regulatory structure in each of the focus states. In states with competitive retail markets, ICF calculated retail electric prices as a function of wholesale price projections from IPM® and transmission and distribution charges, taken from EIA's state-level projections. In states with regulated structures, ICF calculated retail prices as a function of total production costs, net power purchases from neighboring states, averaged over state utility sales, and transmission and distribution charges. Retail bills are estimated based on retail rates and the amount of energy generated. Bill savings are calculated as the difference between retail bills in the reference and policy cases.

C. SUMMARY OF ENERGY EFFICIENCY JOBS METHODOLOGY

ICF used the IMPLAN model to estimate energy efficiency employment impacts in 2020 from the Moderate, Full Efficiency compliance scenario of the NRDC carbon pollution standard proposal modeled in IPM®. IMPLAN is a static input-output model that uses direct investments in economic sectors to model employment impacts, including direct, indirect, and induced employment effects as well as other economic variables. ICF developed the inputs to the IMPLAN model from outputs of IPM®, using incremental changes in spending on energy efficiency. In addition, ICF used projected changes in retail electricity prices and customers' energy bills in order to estimate the effects of changed spending patterns by households and businesses.

Energy efficiency employment estimates are based upon the IMPLAN[6] input-output model, which represents the flows of goods and services among states and economic sectors and industries. In addition to employment effects within a specific energy sector (direct impacts), IMPLAN estimates employment created in upstream industries providing inputs to that sector (indirect impacts), and the re-spending of wages earned from direct and indirect employment (induced impacts). To estimate the employment impacts driven by the changes in spending on energy efficiency throughout the economy, ICF relied upon the cold- and warm-state energy efficiency materials coefficient vectors developed by Synapse Energy Economics, Inc. based on actual and expected energy efficiency program profiles for selected utility energy efficiency programs. This methodology is described in further detail below.

D. SUMMARY OF RESULTS

Energy efficiency investments in the Moderate, Full Efficiency case add a total of 274,000 direct jobs to the U.S. economy in 2020. ICF modeled direct employment changes as activities at the homes and businesses where energy efficiency installations occur, at manufacturing facilities where energy efficient products are made, at retail stores where energy efficient products are sold, and jobs created by redirected spending from net electricity bill savings. Indirect changes in employment occur in industries producing inputs to energy efficiency activities (e.g., transportation, steel, machinery, engineering, financial services). Induced impacts follow overall average patterns of employment across all production and consumption economy wide.

In standard economic jobs modeling terminology, "direct" jobs typically refer to jobs at the establishment making the products being purchased. This definition requires modification in the context of energy efficiency because, in contrast to being tied to any single type of establishment, energy efficiency activities occur across many different sectors of the economy. Energy efficiency displaces activity in the electric utility sector, but is not itself a "sector."

Energy efficiency is also a unique investment activity in that it changes spending patterns by households and businesses, in ways that both decrease and increase purchases of economy-wide goods and services. On the one hand, these entities redirect some of their spending away from economy-wide goods and services toward energy efficiency investments (creating employment in installation, sales and manufacturing). On the other, these investments create bill savings (from reduced energy bills), which can be spent on economy-wide goods and services. This shift in spending creates "direct" jobs across the economy in sectors making these alternative goods and services.

Accordingly, this study considers four spending patterns resulting from investments in energy efficiency: spending to produce "energy efficiency goods and services" (makers, installers, and sellers of more efficient products), reduced revenues to electricity generators, reduced spending on economy-wide goods and services resulting from redirection of some energy efficient products, and increased economy-wide spending by energy customers from their electricity bill savings.

Each of these spending streams is distributed among different economic sectors in IMPLAN and results in changes in direct jobs in each of the sectors where an expenditure change is assigned. The 274,000 "direct" job change represents the sum of all changes (positive and negative) in direct jobs at each of the sectors for each of the four categories of spending.[7] Employment gains resulting from investments in energy efficiency are driven primarily by the fact that construction, manufacturing, and retail sales for energy efficiency activities, as well as economy-wide economic activities, are more labor intensive than conventional electricity generation.

Table 1: U.S. Total increase in efficiency-related employment and electricity bill savings	
Total increase in energy efficiency jobs	
Direct energy efficiency jobs	274,000
Total change in jobs as a percent of 2013 employment	0.16%
Net energy bill savings from efficiency	
Monthly per household bill savings	$8.60
Annual per household bill savings	$103
Total monthly household bill savings	$1,092,000,000
Total annual household bill savings	$13,102,000,000
Total annual commercial savings	$9,358,000,000
Total annual industrial savings	$14,974,000,000
Total energy bill savings (households and businesses)*	$37,434,000,000
Carbon pollution benefits	
Reduced carbon pollution (tons CO_2)	531,211,000
Health and environmental benefits of reduced carbon pollution (in dollars)	$22,842,073,000
*Note: These savings are net of participant investments in more efficient products.	

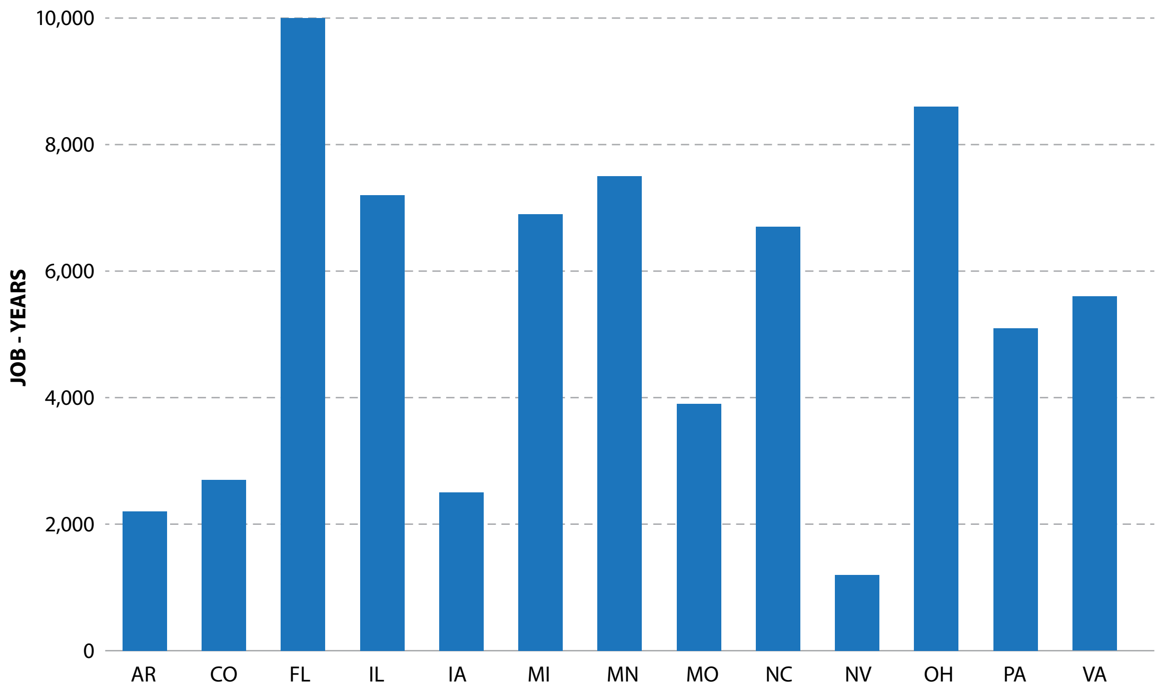
All figures are for the year 2020.

Table 1 above shows that energy efficiency investments drive creation of more than 270,000 direct jobs. Many of these jobs result from the shift in household and business spending from electricity purchases to spending on economy-wide goods and services. There are large net electricity expense savings after "participant" (electricity customer) investments are accounted for: participant energy efficiency investments equal $14.2 billion, while total energy bill savings equal $51.6 billion, leaving a net savings of $37.4 billion. The average household savings is approximately $103 per year[8], totaling $13 billion in 2020; industrial and commercial sectors combined save $24 billion. State-level retail bill savings by customer class are provided in the Appendix.

Table 1 also shows the increase in energy efficiency employment as a percentage of 2013 levels.[9] Relative to the economy as a whole, employment changes are small, consistent with the majority of retrospective analyses of economy-wide effects from pollution controls. Small net gains in employment (due to environmental activities being more labor intensive than conventional electricity generation)[10] occur, with no evidence of harmful effects on the economy.[11] Since the Clean Air Act was passed in 1970, traditional pollution (i.e. non carbon emissions) has dramatically decreased, while the economy has more than tripled in size.[12]

Figure 1 below shows the total increase in energy efficiency employment in 2020 under NRDC's proposed carbon standard relative to the reference case in the 13 states of focus.[13]

Figure 1: 2020 Increase in Energy Efficiency-Related Employment by State



3. DETAILED METHODOLOGY

A. POWER SECTOR ANALYSIS AND ECONOMIC MODELING

The inputs for the economic analysis of energy efficiency investments were based on projected impacts of CO_2 emissions standards on U.S. power markets from the ICF Integrated Planning Model (IPM®).

IPM® is an engineering/economic capacity expansion and production-costing model of the power sector. It is supported by an extensive database of every boiler and generator in the United States and Canada. IPM® endogenously determines capacity expansion plans; unit dispatch and compliance decisions; and power, coal, and allowance price forecasts—all based on power market fundamentals. Those fundamentals include fuel market behavior, power plant costs and performance characteristics, environmental constraints (air, ash and water), and other drivers. Coal and natural gas commodity prices respond to consumption within IPM® so that it captures feedback effects between price and consumption.

IPM® generates power market projections at the unit and regional levels. In determining the most economic manner to meet regional electric demand given constraints (transmission, fuel supply, regulatory, etc.), it determines the optimal unit-level generation and the associated operating, fuel, and capital costs to meet those levels of operation. IPM® projects wholesale market prices, transmission flows, and capacity expansion needs at the regional level. IPM® regions reflect current market structures, such as ISO pricing zones, and known transmission bottlenecks (i.e., sub-regions in which spot prices are expected to diverge significantly). The version of IPM® used for the NRDC analysis includes 117 regions in North America.

ICF used the IMPLAN model to estimate the economic impacts of the energy efficiency investments driven by the proposed carbon pollution standard modeled in IPM®. IMPLAN is a static input-output model that uses direct investments in economic sectors to model direct, indirect, and induced employment effects, and other economic variables. Incremental changes in energy efficiency spending between the policy case and the reference case from IPM® were used for the IMPLAN modeling. Detailed information on the approach used to model energy efficiency in IMPLAN is below.

B. RETAIL RATES, TOTAL ENERGY COSTS, AND AGGREGATE BILL SAVINGS

The economic analysis also relied on projections of total retail expenditures on electricity by state in order to estimate total bill savings for households and businesses from energy efficiency improvements in the policy case. ICF used generation cost projections and energy savings (the amount of generation avoided) as a result of energy efficiency programs along with additional information to develop estimates for retail electric rates. These retail electric rates were also used to calculate the expected aggregate retail bill savings for the purpose of the economic modeling in IMPLAN. In addition, NRDC estimated bill savings for three customer classes based on aggregate retail bill savings and 2012 Energy Information Administration (EIA) data on revenue by customer class.

ICF used one of two approaches to estimate retail electric rates in each state, depending on the regulatory structure of the focus state. In states with competitive retail markets, retail electric prices were calculated as a function of wholesale price projections from IPM, transmission and distribution charges taken from EIA state-level projections, and an assumed gross margin adder of 3 percent, also based on information from the EIA. In states with regulated structures, retail prices were a function of the total costs of producing power in the state, including capital investment, fixed and variable operating costs, energy efficiency program costs, and net power purchases from neighboring states (based on projected transmission flows and wholesale energy prices across IPM® regions), all averaged over state utility sales (net energy for load). Transmission and distribution charges from EIA were added to this average cost to arrive at the retail rate. The regulated rates were based on projected investments and costs in 2020 and did not account for rate adders negotiated for activities prior to 2014.

ICF relied on information from EIA's Annual Energy Outlook 2014 to determine the regulatory structure in each state.[14] The competitive rate calculation described above was used for states that EIA deemed completely competitive and the regulated calculation for regulated states. In states with a mix of regulated and competitive structures, a weighted-average of retail prices was calculated based on the EIA's share of load covered by regulated and competitive markets.

ICF used the retail rates for each state to calculate total electricity expenditures by retail customers by state and total bill savings for the U.S. and each of the 13 focus states. To reflect the varied customer class profiles across the states, NRDC then calculated bill savings across residential, commercial, and industrial sectors using EIA data on each class's share of total electric industry revenue. The simplifying assumptions underlying this calculation are that residential, commercial, and industrial shares of the total electric revenue remain the same in 2020 as in 2012, and that each customer class's savings is a function of its spending and consumption levels.

At both the national and state level, electricity expenditures were calculated as the product of the projected retail rates and net energy for load for each case (the policy case and the reference case). There was lower net load in the policy case due to reduced demand from energy efficiency measures. Bill savings in the policy case are calculated as the difference in total customer electricity expenditures between the reference and policy cases. Net savings are calculated by subtracting the participant portion of energy efficiency investment costs incurred in the policy case.

NRDC allocated ICF's calculation of total bill savings to three customer classes—residential commercial and industrial, according to 2012 EIA data[15] for each of the focus states and the United States. NRDC used these estimates to derive monthly household[16] and annual household retail bill savings.

C. ACCOUNTING FOR THE UTILITY PROGRAM COSTS OF ENERGY EFFICIENCY

In the process of deriving retail rates and retail bill savings, the utility program costs of energy efficiency are accounted for in both competitive retail markets and states with regulated market structures. The optimization process in IPM® compares the levelized utility program costs of energy efficiency (assuming no fuel and no operations and maintenance costs) with the levelized costs of other generation options. As a consequence, both wholesale power prices in competitive market states and total production costs in regulated states reflect the costs of energy efficiency program administration. NRDC's allocation of retail bill savings assumes that all customers across the three customer classes participate in efficiency programs equally, and that the savings are distributed among them in proportion to the amount of electricity each class consumes. In practice, the overall customer participation rate is significantly below 100 percent. This suggests that those customers who participate in efficiency programs would benefit more than those who choose not to participate. Customers who choose not to participate in energy efficiency programs would still benefit from the 6 percent average decline in wholesale power prices under the Moderate, Full Efficiency scenario, but efficiency program participants would benefit to a greater extent.

It is important to note the difference between the total electricity system costs reported in NRDC's March 2014 updated issue brief and the household bill savings calculated here. NRDC's March 2014 study demonstrated that its proposed carbon pollution standard can achieve carbon pollution reductions of 24 percent below 2012 levels at minimal costs to the electric power system, and provide $30–$50 billion in public health benefits. In the Moderate, Full Efficiency case, total electric system costs remain nearly identical to the Reference Case. In addition, we observed downward pressure on wholesale power prices due to lower demand as a result of energy efficiency and because the intensity-based performance standard lowers the net marginal cost of gas generation.

The electric power system costs should not be confused with the estimated customer bill savings presented here. The total electric power system costs count the costs associated with electricity generation and production, while customer bill savings represent the change in costs for electricity customers. This study estimates that U.S. residential bill savings in 2020 will total $13 billion, or $103 monthly for each household. Based on our calculations, residents of Virginia could save more than half a billion dollars in household energy bills, while citizens of Michigan could save $460 million. The starting point to calculate these bill savings was wholesale power prices (or total production costs in regulated states), which are modified with cost adders for transmission and distribution to get the retail rate. Then, to estimate total electricity bills, the retail rate is multiplied by the number of MWh of generation in both the Reference Case and the policy case. The difference between the bill total in the Reference Case and the bill total in the policy case is equal to the bill savings.

Wholesale power prices and system costs account for the net change in generation investments (in this instance the costs of energy efficiency programs and the savings in fuel and other operations and maintenance costs of generating facilities) without accounting for the amount of electricity sold to customers. Bill savings are calculated by multiplying the wholesale power prices by the MWh of electricity sold, increasing the difference between the two cases.

D. MODELING ENERGY EFFICIENCY IN IMPLAN

The energy efficiency model was composed of four primary parts: (1) capital spending on energy efficient equipment, (2) participant and utility costs, (3) utility bill savings for customers, and (4) utility lost revenues.

Capital Spending

Total energy efficiency capital spending nationwide in 2020 equals $31.6 billion in the Moderate, Full Efficiency case. Energy efficiency spending by states varies according to whether a state is classified as a warm or cold state using the approach described below.[17] Expenditures were assigned to IMPLAN sectors producing inputs to the energy efficiency activities.

Energy efficiency (EE) programs vary widely across the country and customer classes. As such, capturing the economic effects of individual EE activities in IMPLAN was outside the scope of this study. Instead, ICF started with the basic assumption that, overall, there would be three major sets of economic sectors contributing to energy efficiency spending: approximately one-third of the spending would occur in construction (for labor to install), one-third in retail (e.g., big box retailers), and the remaining one-third on materials.[18] This approach was adopted to represent the distribution of expenditures and efficiency activities in practice. ICF estimated that 29 percent of spending in warm states would be on construction labor, approximately 36 percent would be spent on the retail sector, and the remaining 35 percent would be spent on materials. In cold weather states, the capital expenditure was split as approximately 33 percent to each of construction, retail, and materials vectors. For the national model, the study averaged the distribution percentages of the warm and cold states and applied 31 percent to construction labor, 34 percent to retail, and 34 percent to materials.

Similar to the approach for the construction vector, the retail sector was assigned to electronics and appliances sector in IMPLAN. Modeling the retail expenditures in this fashion assumes that the money is being spent in the retail sector to buy energy efficient durable goods, including air conditioners, refrigerators, light bulbs, etc.

This study used the warm and cold state classifications developed by Synapse in NRDC's earlier report. Similarly, the current study also used the energy efficiency materials vectors developed by Synapse.

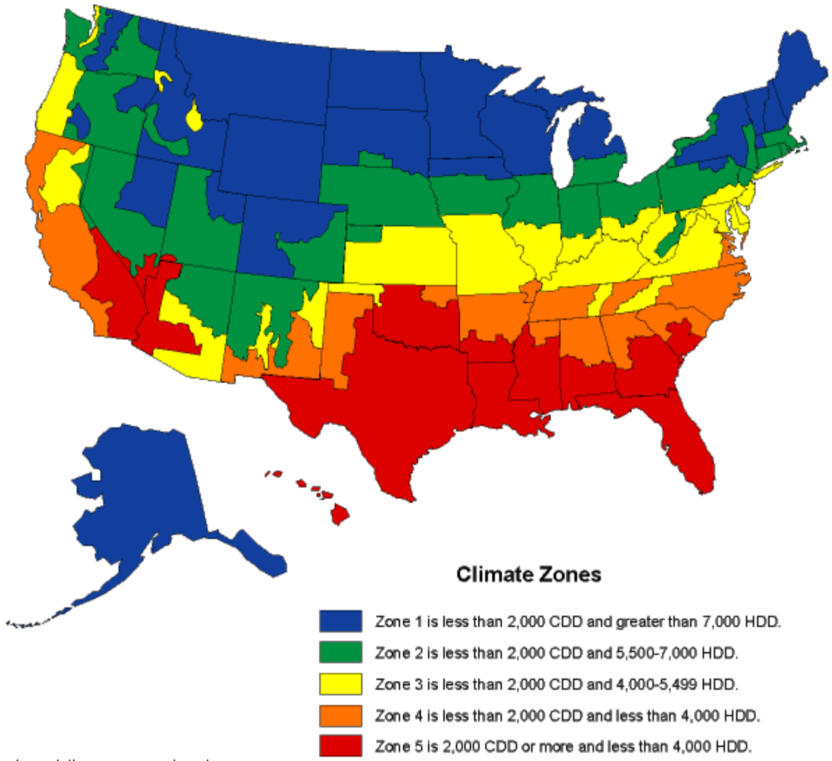
Synapse divided "warm" and "cold" categories based on their number of cooling degree days (CDD) and heating degree days (HDD).

Table 2: 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	Arkansas, Florida, North Carolina,
Cold States	Climate Zones 1, 2 and 3; >=4000 HDD	Colorado, Illinois, Iowa, Michigan, Minnesota, Missouri, Nevada, Ohio, Pennsylvania, Virginia[19]

As shown in Table 2, 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. To calculate the national average breakdown, ICF averaged the percentages between warm and cold states.

Figure 2: U.S. Climate Zones



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

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. The average of the warm and cold state sectoral distributions was used for the national model in the construction, retail, and industry spending on materials.

Table 3: Energy Efficiency Coefficient Vectors for Construction, Retail and Materials

IMPLAN code	IMPLAN code	Warm	Cold	U.S. Average
35	Construction of New Nonresidential Manufacturing Structures	29.0%	33.3%	31.2%
322	Retail Stores – Electronics and Appliances	35.5%	33.3%	34.4%
3104	Wood pulp	1.4%	1.7%	1.6%
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%	12.9%
3234	Electronic computers	0.8%	0.5%	0.7%
3259	Electric lamp bulbs and parts	33.0%	23.4%	28.2%
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%	0.7%
3031	Electricity, and distribution services	4.4%	4.1%	4.3%
3377	Advertising and related services	2.6%	5.3%	4.0%
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%

Participant and Utility Spending

Based on NRDC assumptions,[20] total spending on EE programs was divided into two components – spending by participants (45 percent) and utilities (55 percent).[21] Total participant spending in the national model was $14.2 billion.

To calculate participant spending by customer class, this study used figures from McKinsey[22] that broke down savings potential by sectors—residential, commercial, and industrial – and assumed that participants would save and spend in the same proportions. The McKinsey report estimated 35 percent of the total savings potential could come from the residential sector, 25 percent from the commercial sector, and 40 percent from the industrial sector. National participant spending was weighted according to these estimates.

In conducting the IMPLAN analysis, this study assumed that participant spending on EE investments would result in less spending elsewhere and these expenditure shifts by electricity customers were used as inputs to IMPLAN. Efficiency investments by the commercial sector (25 percent of total spending) was used as a negative input from all commercial sectors in IMPLAN based on energy use for each particular commercial sector. In other words, the reduced spending by commercial sectors on production of their goods and services (to pay for energy efficiency) was assigned to sectors based upon their energy use. For spending coming from the industrial/manufacturing sectors (40 percent of total spending), ICF distributed the spending according to energy use information from the EIA's Manufacturing Energy Consumption Survey (MECS).[23]

Because energy efficiency spending by utilities (55 percent of the total resource cost of energy efficiency) was internalized in the IPM® optimization process and is reflected in wholesale power prices, utility program costs were not included in the inputs to the IMPLAN modeling.

Table 4: Participant Spending in the National Energy Efficiency Model[24]

Spending Category	Expenditure
Residential	$5.0 billion
Commercial	$3.6 billion
Industrial	$5.7 billion

Bill Savings

Total bill savings were calculated as the difference in energy customers' total utility bills between the policy and reference cases for the United States and each focus state. More specifically, total bill savings are equal to the retail price multiplied by the number of MWh of generation in the Reference Case minus the retail price multiplied by the number of MWh of generation in the policy case, or $P_0xQ_0 – P_1xQ_1$, where P is the retail price and Q denotes the number of MWh of generation. As expected, net bill savings was a significant driver of job gains. Nationally, total bill savings amounted to about $51.6 billion, and participant costs to $14.2 billion, for a net savings of $37.4 billion.[25] To identify which sectors would benefit from bill savings, ICF assumed that each sector saves in proportion to the amount they spend—35 percent for the residential sector, 25 percent for the commercial sector, and 40 percent for the industrial sector. Within those sectors, this study attributed money to each IMPLAN sector using the same approach as that used to identify the spending among the sectors. Bill savings in the national model were broken down as follows:

Table 5: Bill Savings in the National Energy Efficiency Model

Savings Category	Moderate Case
Residential	$18.1 billion
Commercial	$12.9 billion
Industrial	$20.7 billion

Utility reduced revenues

Reduced utility revenues were assigned to IMPLAN's electric power generation, transmission and distribution sector, and were estimated to be equal to the $51.6 billion in customer bill savings.

APPENDIX: RESULTS BY STATE

The following table shows the total increase in energy efficiency jobs, retail bill impacts, and economic benefits of reduction carbon pollution for each of the 13 study states.

Table 2. Energy Efficiency Employment and Bill Savings by State

	AR	CO	FL	IL	IA
Energy Efficiency Jobs					
Direct energy efficiency jobs	**2,200**	**2,700**	**10,000**	**7,200**	**2,500**
Total change in jobs as a percent of 2013 employment	0.14%	0.08%	0.10%	0.10%	0.13%
Net energy bill savings from efficiency					
Annual per household bill savings	$43	$12	$3	$70	$76
Monthly per household bill savings	$3.60	$1.00	$0.30	$5.80	$6.30
Monthly Total household bill savings	$5,000,000	$2,000,000	$2,000,000	$30,000,000	$8,000,000
Total annual household bill savings	$57,000,000	$26,000,000	$27,000,000	$355,000,000	$101,000,000
Total commercial savings	$32,000,000	$23,000,000	$19,000,000	$273,000,000	$65,000,000
Total industrial savings	$33,000,000	$13,000,000	$3,000,000	$175,000,000	$69,000,000
Total energy bill savings (households and businesses)*	**$122,000,000**	**$62,000,000**	**$48,000,000**	**$803,000,000**	**$235,000,000**
Carbon pollution benefits					
Reduced carbon pollution (tons CO_2)	1,916,000	13,265,000	11,410,000	33,271,000	9,215,000
Health and environmental benefits of carbon pollution standard (in dollars)	$82,000,000	$570,000,000	$491,000,000	$1,431,000,000	$396,000,000

All figures are for the year 2020.

Table 2. Energy Efficiency Employment and Bill Savings by State

	MI	MN	MO	NC	NV
Energy Efficiency Jobs					
Direct energy efficiency jobs	**6,900**	**7,500**	**3,900**	**6,700**	**1,200**
Total change in jobs as a percent of 2013 employment	0.13%	0.21%	0.11%	0.13%	0.08%
Net energy bill savings from efficiency					
Annual per household bill savings	$109	$105	$67	$86	$2.78
Monthly per household bill savings	$9.10	$8.80	$5.60	$7.20	$0.20
Monthly Total household bill savings	$39,000,000	$20,000,000	$15,000,000	$30,000,000	$250,000
Total annual household bill savings	$462,000,000	$244,000,000	$180,000,000	$363,000,000	$3,000,000
Total commercial savings	$399,000,000	$194,000,000	$129,000,000	$245,000,000	$2,000,000
Total industrial savings	$230,000,000	$149,000,000	$54,000,000	$105,000,000	$2,000,000
Total energy bill savings (households and businesses)*	**$1,091,000,000**	**$586,000,000**	**$363,000,000**	**$713,000,000**	**$7,000,000**
Carbon pollution benefits					
Reduced carbon pollution (tons CO_2)	18,907,000	744,000	20,232,000	4,111,000	4,064,000
Health and environmental benefits of carbon pollution standard (in dollars)	$813,000,000	$32,000,000	$870,000,000	$177,000,000	$175,000,000

All figures are for the year 2020.

Table 2. Energy Efficiency Employment and Bill Savings by State			
	OH	**PA**	**VA**
Energy Efficiency Jobs			
Direct energy efficiency jobs	**8,600**	**5,100**	**5,600**
Total change in jobs as a percent of 2013 employment	0.13%	0.07%	0.12%
Net energy bill savings from efficiency			
Annual per household bill savings	$82	$41	$159
Monthly per household bill savings	$6.80	$3.40	$13.30
Monthly Total household bill savings	$33,000,000	$18,000,000	$43,000,000
Total annual household bill savings	$399,000,000	$214,000,000	$517,000,000
Total commercial savings	$288,000,000	$131,000,000	$406,000,000
Total industrial savings	$216,000,000	$110,000,000	$125,000,000
Total energy bill savings (households and businesses)*	**$903,000,000**	**$456,000,000**	**$1,047,000,000**
Carbon pollution benefits			
Reduced carbon pollution (tons CO_2)	32,042,000	37,249,000	7,881,000
Health and environmental benefits of carbon pollution standard (in dollars)	$1,378,000,000	$1,602,000,000	$339,000,000

*Note: These savings are net of participant investments in more efficient products.

All figures are for the year 2020.

Endnotes

1 Cleaner and Cheaper: Using the Clean Air Act to Sharply Reduce Carbon Pollution from Existing Power Plants, Delivering Health, Environmental, and Economic Benefits http://www.nrdc.org/air/pollution-standards/files/pollution-standards-report.pdf

2 Economic Impacts of the NRDC Carbon Standard, Background Report prepared for the Natural Resources Defense Council. June 20, 2013. Synapse Energy Economics, Inc.

3 These are detailed in Cleaner and Cheaper: Using the Clean Air Act to Sharply Reduce Carbon Pollution from Existing Power Plants, Delivering Health, Environmental, and Economic Benefits. http://www.nrdc.org/air/pollution-standards/files/pollution-standards-report.pdf

4 Toward a Sustainable Future for the U.S. Power Sector: Beyond Business as Usual 2011, November 16, 2011. Prepared for the Civil Society Institute by Synapse Energy Economics, available at: http://www.civilsocietyinstitute.org/media/pdfs/Toward%20a%20Sustainable%20Future%2011-16-11.pdf

5 The Future of Utility Customer-Funded Energy Efficiency Programs in the United States: Projected Spending and Savings Through 2025, Lawrence Berkeley National Laboratories, January 2013, available at: http://emp.lbl.gov/sites/all/files/lbnl-5803e.pdf

6 MIG Inc., http://implan.com

7 This figure does not include any job changes termed, "indirect" or "induced" in the IMPLAN structure. This approach to calculating direct job creation is unconventional but has been used before in the context of energy efficiency. See Garret-Peltier, H. *Employment estimates for energy efficiency retrofits of commercial buildings*, Political Economy Research Institute Issue Brief, June 2011.

8 This is calculated using total 2020 residential bill savings of $13 billion, divided by the number of households using EIA 2012 data.

9 IMPLAN does not project future employment levels, only the *difference* in employment between the policy and reference cases in 2020. Were 2020 employment figures available, the employment shifts we model here would be expected to be smaller as the economy grows over time.

10 Richard D. Morgenstern, William A. Pizer, and Jhih-Shyang Shih, "Jobs Versus the Environment: An Industry-Level Perspective," *Journal of Environmental Economics and Management*, May 2002, Vol. 43, no. 3, at 412-436.

11 This counter-intuitive outcome is because regulations are phased in over time, allowing firms to innovate and adjust, and because compliance obligations are only a fraction of production costs. Annual compliance costs of all (i.e. environmental and other) major Federal regulations from 2001 to 2011 amounted to about 0.5 percent of GDP, derived from data in Table 1-1), 2011 Report to Congress on the Benefits and Costs of Major Federal Regulations and Unfunded Mandates on States, Local, and Tribal Entities, Office of Management and Budget http://www.whitehouse.gov/sites/default/files/omb/inforeg/2011_cb/2011_cba_report.pdf

12 Heather Zichal, *So What Does the Clean Air Act Do?* White House Blog (February 9, 2011), available at: http://www.whitehouse.gov/blog/2011/02/09/sowhat-does-clean-air-act-do

13 In this report, "jobs" refer to changes in the number of jobs in a given year, often called "job years."

14 Energy Information Administration, Annual Energy Outlook 2014 with projections to 2040, available at: http://www.eia.gov/forecasts/aeo/pdf/0383(2014).pdf

15 Energy Information Administration, 2012 Total Electric Industry – Revenue, available at: http://www.eia.gov/electricity/sales_revenue_price/

16 Energy Information Administration, 2012 Number of Consumers, available at: http://www.eia.gov/electricity/sales_revenue_price/

17 Economic Impacts of the NRDC Carbon Standard, Background Report prepared for the Natural Resources Defense Council. June 20, 2013. Synapse Energy Economics, Inc.

18 The previous Synapse analysis did not explicitly represent the retail sector in this manner. Instead, all materials activities were assigned to final demand for materials. ICF modified this approach to better represent materials activities for energy efficiency "production" at homes and businesses. An alternative approach for assessing the spending change in the construction sector was also examined but time and data constraints did not permit a thorough assessment of the alternative. A bounding analysis of the alternative showed that the approach taken in this report likely understates the job increases from efficiency-related construction. Accordingly, the results should be considered a conservative estimate of these job increases.

19 For Virginia, Synapse applied a population-weighted formula to cold and warm states, because some areas are classified as less than 4,000 HDD by EIA, and others greater than or equal to 4,000. For simplicity, ICF classified Virginia as a cold state, following the geographical pattern of Virginia's land mass and EIA's zone 3 classification.

20 See NRDC March 2014 Technical Appendices, available at: http://www.nrdc.org/air/pollution-standards/

21 This assumption is taken from Synapse. Toward a Sustainable Future for the U.S. Power Sector: Beyond Business as Usual 2011, November 16, 2011. Prepared for the Civil Society Institute by Synapse Energy Economics, available at: http://www.civilsocietyinstitute.org/media/pdfs/Toward%20a%20Sustainable%20Future%2011-16-11.pdf

22 McKinsey, Unlocking Energy Efficiency in the U.S. Economy, July, 2009.

23 About the Manufacturing Energy Consumption Survey: http://www.eia.gov/consumption/manufacturing/about.cfm

24 This table provides totals for each of the three categories of participant spending. The commercial and industrial spending figures were further broken down into specific economic sectors. Residential spending was modeled as a change in household income for households at the national median.

25 Charges to rate payers for energy efficiency program costs are not included in the net savings calculations because they are not an additional cost to energy customers. Instead, customers pay for energy delivered by energy efficiency rather than for electricity from displaced generation.

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