Federal Tax Credits for Efficient Residential Equipment: Estimating Market, Consumer, and Revenue Impacts by Region

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ABSTRACT

We present results from prospective analysis of two different tax credit scenarios for five types of residential energy efficient equipment: Gas and electric water heaters, gas furnaces, electric heat pumps and central air conditioners. Using a version of the Energy Information Administration's National Energy Modeling System, we find that a ten-year extension of the section 25C tax credit for these equipment types increases sales of efficient equipment by 54%, reduces consumption by 91 TWh of electricity and 0.4 quadrillion btus of natural gas, and achieves NPV energy bill savings of $13 billion. If the incentive for these equipment types is increased to $500 for ten years, projected sales of efficient equipment increase by 278% above the base case, with savings of 320 TWh, 2.1 quadrillion btus of natural gas, and $52 billion in energy bill savings. We also present regional results for certain metrics from the model, including energy bill savings and non-federal investment that occurs due to credit availability.

Introduction and Policy Context

The Energy Policy Act of 2005 introduced three new tax incentives for energy efficient investment, including a credit for homeowners who purchased equipment to improve the efficiency of an existing home. This "nonbusiness energy property" credit, described in section 25C of the internal revenue code, has been modified and extended multiple times since its initial creation, but since 2011 has provided up to $300 for the purchase of a heat pump, central AC system, or gas or electric water heater that met specified efficiency levels (Crandall-Hollick and Sherlock 2016). Most recently, this credit was extended for purchases made in 2017 as part of the Bipartisan Budget Act of 2018 (2018).

Several previous reports have assessed the historical impact of these credits. Borenstein and Davis (2015) consider the 25C credits as part of a broader analysis of the distributional effects of tax credits. Crandall-Hollick and Sherlock (2016) provide details on the legislative history and estimated cost of several residential energy tax credits, and discuss several potential benefits and concerns of interest to Congress. Gold and Nadel (2011) reviewed the impacts of the suite of efficiency tax incentives created in 2005-2011, including the 25C credit. The Energy Information Administration (EIA) has included extension of the 25C credits as part of its Annual Energy Outlook "No Sunset" policy side cases, reporting results from the 2014 Annual Energy Outlook estimate the overall impact on energy consumption, expenditures, and emissions from extension of a suite of expiring clean energy incentives (EIA 2014). However, to our knowledge, there has not been any published analysis that isolates the potential impacts of extending the credit for these five equipment types over a future period.

This analysis included modeling the impact of tax incentives for our five equipment types under two scenarios. In the first, a ten-year extension (from 2017 to 2026) of the existing 25C credit was considered, modeling the impact of every qualifying purchase in the residential replacement market receiving the maximum credit under existing law ($150 for gas furnaces and $300 for the other four equipment types). To assess the incremental impact of a larger incentive, a second scenario provided a $500 credit for all five credit types.

Methodology

The residential module of the National Energy Modeling System (NEMS)[1] was used to analyze the impacts of extending the residential energy efficiency tax credits for another decade. The model projects energy consumption by end use (such as heating, cooling, and lighting) by building type and Census division. For most end uses, energy efficiency evolves over time as existing equipment retires and new equipment is purchased as replacements and in new homes. A set of 3 to 5 technology options with different capital costs and efficiencies is specified for each major equipment type. Market shares among these options are selected using consumer preferences regarding the trade-off of upfront capital expenditures and annual operating costs. A logistic formulation is used that allocates market shares among the technology options, with the most attractive receiving the highest shares. In the reference case, the historic 25C energy efficiency credits are included as capital cost reductions to consumers for the eligible equipment types in the years the credits were available. The costs of some highly efficient technologies to consumers also are assumed to be reduced by utility-provided rebates as part of their efficiency programs (EIA 2015). The levels of these utility rebates were assumed to be unchanged in the tax policy cases.

For the policy analysis, the tax credit is applied to the following eligible equipment shown in Table 1.

Table 1. 25C Tax Credit and Minimum Efficiency Levels

Equipment Type	Min Efficiency Level	Tax Credit
Natural Gas Furnaces	> 95% eff	$150
Central Air Conditioners	> 16 SEER	$300
Electric Heat Pump	> 8.5 HSPF/ > 15 SEER	$300
Natural Gas Water Heater	> .82 energy factor	$300
Electric Water Heater	> 2.0 energy factor	$300

The Annual Energy Outlook Reference case (without the Clean Power Plan) was the starting point. For this analysis the residential model was run without the other sector models of OP-NEMS. This means that energy and electricity prices do not vary between the reference and policy cases.

[1]We refer to NEMS here as OP-NEMS to emphasize that this study was performed independently from EIA and that the views expressed in this paper do not necessarily reflect those of EIA. Documentation of EIA's NEMS Residential Module can be found at https://www.eia.gov/outlooks/aeo/nems/documentation/residential/pdf/m067(2017).pdf

The model's projections include sales of equipment by efficiency level, investments in equipment, energy consumption by end use and fuel type, and energy bill expenditures. Differing the results from the policy cases with the reference case yields the incremental impacts from these credit amounts. In addition to outputs that the OP-NEMS Residential Module produces, we used sales and cost data to provide estimates of two additional metrics that may be of interest to policymakers. First, by multiplying the total number of sales of eligible equipment by the maximum credit that an individual could claim for the purchase ($150 for an efficient gas furnace and $300 for the other four analyzed equipment types), we can provide a maximum total potential of claims from the model's projection of equipment sales. By totaling up the maximum credit value claimed for all sales in the tax credit case, not just those incremental to base case sales, our "potential credit value" estimate includes foregone revenue to the government from credits claimed from purchases that would have been made even without the credit. There are several reasons this estimate from the model would be much higher than the actual tax expenditure. The calculated value based only on modeled sales and maximum credit fails to account for purchasers that are not aware of the credit, or are unable to claim some or all of credit due to lack of tax liability or other claims they have made of the same credit.[2] As shown in Table 2, comparing our "potential credit value" calculation based on model results to historical estimates of credit claims provides a point of calibration - actual IRS line estimates of claims for purchases of these five equipment types (IRS 2017) are well below our average annual "potential credit value" in the model over the 10-year period the tax credits are in effect.

Table 2. Comparison of Modeled 2017-2026 Average Annual "Potential Credit Value" 25C Scenario with 2011-2015 IRS Line Estimates for Same Equipment Types

Year	IRS Line Estimate of Claims for Modeled Equipment Types ($thousands)	% of Average Modeled Annual Credit Value ($644 million)
2011	$399,293	62%
2012	$202,424	31%
2013	$261,707	41%
2014	$214,494	33%
2015	$212,329	33%

Noting the discrepancy between historic estimates of credit claims for this equipment and our calculated "potential credit value" from model sales results, we report "potential credit value" not as an estimate of projected expenditure, but rather an upper bound of the potential claims based on modeled sales.

Model outputs from this work can also be used to estimate the change in "non-federal investment" as a result of the tax credit being available. This may be of interest to policymakers who wish to evaluate the impact of the tax credits based on how much they spur additional private investment in energy efficient products. By comparing the total cost of purchased equipment between the base case and tax credit case, we can observe the increase in total investment in these equipment types in the presence of the tax credit. By subtracting out our previously estimated "potential credit value" as a representation of the federal spending on

[2] The current 25C credit has a lifetime cap of $500, meaning that any previous purchases for which the credit was claimed by an individual would reduce or eliminate the ability to claim credit for a later purchase.

efficient equipment (through the tax credit), we can estimate the increase in "non-federal" investment in the tax credit case and compare it with the total cost of purchases in the base case (where no federal credit is available). Again, because this "potential credit value" calculation makes the simplifying assumption that *all* purchases of efficient equipment result in the maximum tax credit claim, this estimate of non-federal investment should be seen as a lower bound, which would increase for every instance where a unit of efficient equipment was purchased in the base case, but for which a full credit may not be claimed.

Results

Equipment Market Impacts

Figure 1 presents the market share for residential replacement in our Reference Case, our 10-year 25C extension case, and our $500 incentive case in terms of efficient, credit-eligible equipment and less efficient non-credit-eligible equipment. For water heating equipment, it also distinguishes between the two equipment options in the model that were both efficient enough to be eligible for the credit.

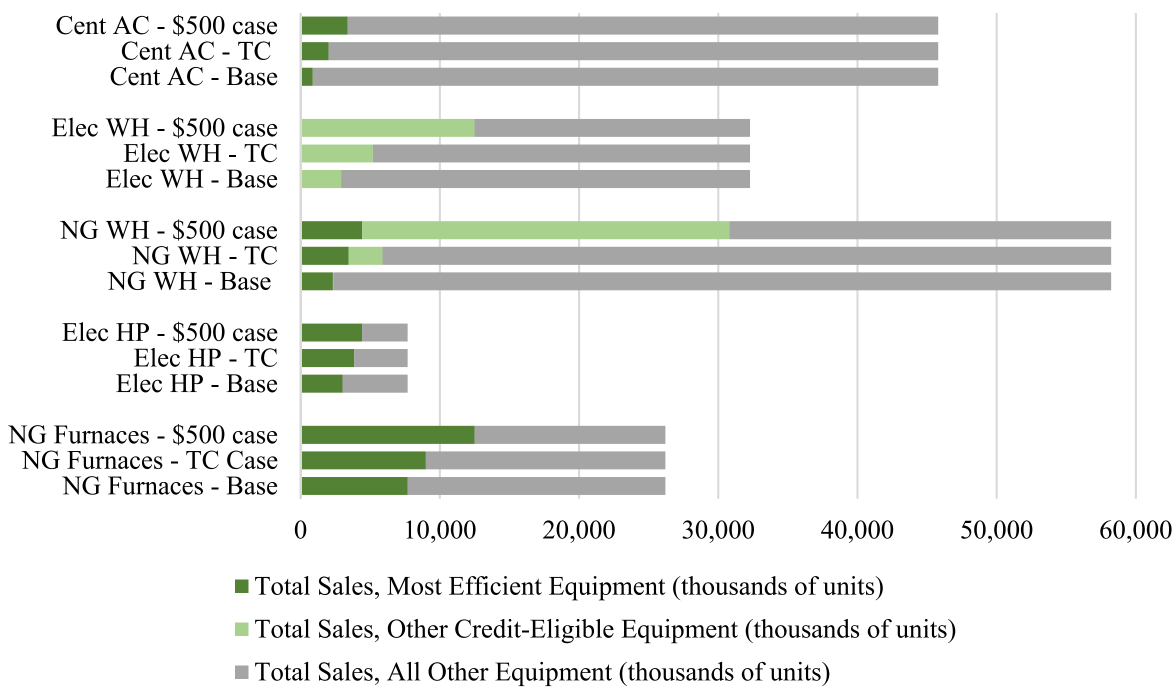

Figure 1: Projected Market Share of 25C-eligible Equipment 2017-2026: Reference, 25C (TC) and $500 Incentive Cases

This figure illustrates multiple dynamics that may be of interest to policymakers about the role these credits play for different equipment types. First, based on the efficiency levels specified in statute and current market conditions, the reference case projected market shares for these five equipment types is wide-ranging, from just 2% of all sales of central AC systems to 39% of all sales of electric heat pumps. If one of the goals of the incentive is to drive greater penetration for innovative technologies that haven't yet carved out significant market share, the current efficiency requirements may need to be reconsidered for some equipment types. Second, by comparing the impact of the 25C-level incentive ($300 or $150) to the impact of the $500 incentive, we can understand how an increase in the incentive can create non-linear impacts and "tip" the market much further toward efficient equipment, which we see in this analysis with both types of water heating equipment. Understanding this potential long-term impact of tax incentives is also of interest because it may address concerns about the distributional equity of federal tax credits. While claims during the period of credit availability could be expected to be made by higher-income households, their impact of driving down prices in the long-term could result in more widespread energy cost savings for families at all income levels who have the option of purchasing less expensive efficient equipment.

Table 3 reports numerically the ten-year sales of tax credit-eligible equipment in each case, and increase for each in comparison with the Reference Case. These results show increases between 17% and 150% in the 25C case, and between 46% and 1210% in the $500 incentive case.

Table 3: Comparison of Reference, 25C and $500 Incentive Case Sales for Efficient Equipment

Equipment Type	Total Sales of Efficient Equipment, Reference Case	Total Sales in 25C case, % Increase from reference		Total Sales in $500 case, % Increase from Reference	
NG Furnaces	7,683,900	9,007,177	17%	12,506,900	63%
Electric Heat Pumps	3,018,836	3,854,207	28%	4,416,400	46%
NG Water Heating	2,351,125	5,887,079	150%	30,808,200	1210%
Electric Water Heating	2,906,473	5,193,464	79%	12,500,100	330%
Central AC	879,330	2,012,263	129%	3,380,000	284%
Total	16,839,664	25,954,190	54%	63,611,578	278%

The rank order of equipment types with the largest sales increases changes between the two incentive cases, with electric water heating and gas furnaces showing a larger increase in the $500 case, and electric heat pumps showing less of an increase with the $500 incentive. The increase of over 100% for Central Air Conditioners in the 25C case and water heating equipment in the $500 cases highlight the significant impact the credit can have on the market for these types of efficient equipment. In contrast, the lower impact of the credit on sales of space heating equipment indicates that the relative cost and performance of eligible technologies in these types may be unlikely to change consumer purchasing decisions in the presence of an incentive on this scale. This is particularly notable for gas furnaces, which under 25C receive a $150 maximum credit, as opposed to the $300 credit for all four other equipment types. Increasing the incentive available from $150 to $500 still does not result in a doubling of sales for credit-eligible gas furnaces.

Bill Savings, Investment and Potential Credit Value Impacts

Table 4 presents national, ten-year and single-year average results for both the 25C case and $500 incentive case. The bill savings, non-federal investment and potential credit value are all presented using a 3% discount rate. When comparing these metrics within a given case and timeframe, two trends hold. First, the bill savings compared to the reference case is larger than the non-federal or maximum potential credit value. Second, the potential credit value that would be claimed if every purchaser took the maximum credit exceeds the net increase in non-federal investment. While the potential credit value, as explained above, is not intended to estimate the likely realized tax expenditure, these two trends illustrate that the impact of the credit from bill savings is likely to have a higher dollar value than increased spending on efficient equipment.

Table 4: National Impacts of 25C and $500 Incentive, 2017-2026

National Metric	25C: 10-Yr. Impact	25C: Avg. Single-year Impact	$500 credit: 10-Year Impact	$500 credit: Single-year Impact
Potential Credit Value	$5.61 billion	$644 million	$27.7 billion	$3.18 billion
Incremental Non-Federal Investment	$4.77 billion	$556 million	$12.76 billion	$1.48 billion
Energy Bill Savings 2050	$13.12 billion	$1.3 billion	$51.6 billion	$5.2 billion

All values calculated using 3% discount rate.

Electricity and natural gas consumption reductions (relative to the reference case) are reported in Table 5. While electricity savings increase by more than three times in the $500 case compared to the 25C case, natural gas savings are even larger, more than five times the 25C case savings.

Table 5: Residential Energy Savings Impacts of 10-year availability of 25C and $500 Incentives

	25C	$500
Total Electricity savings, 2017-2050	90.6 Twh	319.8 TWh
Total Gas savings, 2017-2050	.37 quads btu	2.1 quads Btu

OP-NEMS also produces results by the nine Census Divisions. While not as helpful to policymakers as state or congressional district results, these outputs can help us understand the relative benefits (or absence of benefits) that may influence support or opposition to continuation or reform of residential EE tax incentives.

Table 6 reports the projected bill savings, non-federal investment, and potential credit value by region for the 25C case. Table 7 presents the same results for the $500 case. Because the Census Divisions are not equally divided by population, the most populous ones (South Atlantic and Pacific) are among the largest reported impacts. However, in New England and the

Pacific states (the latter of which has most of its population in California), high energy prices seem to drive the large bill savings numbers, while high utility incentive spending is likely a factor in making these divisions the highest two in incremental non-federal investment.

Table 6 Impacts of 10-year extension of 25C tax credits for five equipment types ($millions)

Census Division (States)	Total Potential Credit Value, 2017-2026	Incremental Non-Federal Investment 2017-2026	Bill Reduction, 2017-2050
New England (CT, ME, MA, NH, RI, VT)	672	2,143	2,942
Mid Atlantic (NJ,NY,PA)	774	279	1,702
East North Central (IL,IN,MI,OH,WI)	599	(13)	737
West North Central (IA,KS,MN,MO,NE,ND,SD)	308	196	603
South Atlantic (DE,FL,GA,MD,NC,SC,VA,DC,WV)	1,228	500	1,955
East South Central (AL,KY,MS,TN)	321	114	416
West South Central (AR,LA,OK,TX)	406	49	657
Mountain (AZ,CO,ID,MT,NV,NM,UT,WY)	458	634	932
Pacific (AK,CA,HI,OR,WA)	841	866	3,172

All values calculated using 3% discount rate.

Based on model outputs, we report that in one census division (East North Central), the incremental non-federal investment is negative. This is based on our calculation of "potential credit value" that assumes *all* purchases of eligible equipment result in the full available credit. Therefore, every energy efficient equipment sale that occurs in the reference case reduces the amount of incremental non-federal investment, because the customer no longer pays the efficient equipment's full price (or even price they would have paid after just a utility incentive). In the East North Central census division, the potential credit value of these purchases that would have happened anyway is larger than the potential credit value from incremental purchases, by $12.8 million over ten years. Paying for "free-riders" in incentive programs is a common concern for many types of energy efficiency programs, as well as for provisions incenting many kinds of individual and corporate behavior in the tax code. The result here reflects the possibility that, at least in one region, the government could forego more in tax revenue than it spurs in additional private investment. However, this alone is an incomplete measure of the tax credit impact for the region, since the amount of bill savings, in this case roughly 50 times larger than the potential loss in non-federal investment, would be available to households to reinvest in the economy. This negative value flips to a positive in the $500 case in Table 7, where incremental non-federal investment is over $1 billion in the same census division.

Table 7: Impacts of 10-year availability of $500 tax credit for five equipment types ($millions)

Census Division (states)	Total Potential Credit Value, 2017-2026	Incremental Non-Federal Investment 2017-2026	Bill Reduction, 2017-2050
New England (CT, ME, MA, NH, RI, VT)	1,911	3,243	5,016
Mid Atlantic (NJ,NY,PA)	4,217	1,048	7,839
East North Central (IL,IN,MI,OH,WI)	4,365	1,003	6,834
West North Central (IA,KS,MN,MO,NE,ND,SD)	2,064	1,000	3,867
South Atlantic (DE,FL,GA,MD,NC,SC,VA,DC,WV)	5,028	2,681	11,853
East South Central (AL,KY,MS,TN)	1,194	310	1,440
West South Central (AR,LA,OK,TX)	2,397	567	3,915
Mountain (AZ,CO,ID,MT,NV,NM,UT,WY)	2,105	1,341	3,059
Pacific (AK,CA,HI,OR,WA)	4,442	1,563	7,736

All values calculated using 3% discount rate.

Because the model reports sales by census division and by equipment type, we can also break out potential credit value by equipment type by region. While population differences again skew some of the highest potential values to the largest census divisions, these results also provide insight into the degree to which certain equipment types provide a large share of the value in different regions. In Tables 8 and 9 below, we present potential credit value for each region and each equipment type in the 25C and $500 cases, respectively. Because potential credit value is based on all sales, not just incremental ones that happen only because of the credit, these results have political economy implications for states where the credit may be beneficial to a high proportion of households, whether their purchase was motivated by the incentive or not. Thus, results showing a plurality of potential credit value coming from different equipment types across regions could help explain the political expediency of extending the credit for all types uniformly. We do see this to some extent in the 25C results, as each of the five equipment types studied is has the largest potential credit value in at least one Census Division. This "parity" of parity value by equipment type is in stark contrast with the $500 case. With the higher incentive for all equipment types, sales of natural gas water heaters grow to represent the largest potential credit value in every region, which may be unsurprising given the more than 1200% increase in purchases of efficient gas water heaters nationally (as reported in Table 3).

Table 8 – Potential Credit Value ($millions) by Census Division & Equipment Type, 25C Case

	New England	Mid Atlantic	E North Central	W North Central	S Atlantic	E South Central	W South Central	Mountain	Pacific
Elec HP	40	77	43	25	**631**	**142**	59	75	64
Gas Furnaces	65	**348**	**267**	95	101	39	120	103	213
HVAC	20	60	13	35	175	42	33	**188**	37
NG WH	**384**	229	245	**107**	220	58	**135**	106	283
Electric WH	269	175	116	91	275	85	117	50	**381**
Total for Census Div.	778	889	683	353	1,402	367	464	522	977

Presented values are not discounted. Highest potential credit value for a census division in bold.

Table 9 – Potential Credit Value ($millions) by Census Division & Equipment Type, $500 Case

	New England	Mid Atlantic	E North Central	W North Central	S Atlantic	E South Central	W South Central	Mountain	Pacific
Elec HP	75	43	78	46	1,210	273	117	144	121
Gas Furnaces	246	1,305	1,355	485	521	203	597	524	1,018
HVAC	57	172	38	101	503	124	98	490	108
NG WH	**1,147**	**2,386**	**2,684**	**1,176**	**1,885**	**616**	**1,499**	**1,163**	**2,847**
Electric WH	658	836	848	563	1,666	145	437	83	1,013
Total for Census Div.	2,183	4,843	5,002	2,372	5,786	1,361	2,748	2,404	5,107

Presented values are not discounted. Highest potential credit value for a census division in bold.

While regional results from this analysis provide some insight into the local differentiated local impacts and political economy of tax credit, the outputs available from this analysis, which focus on customer purchase and energy cost impacts, is only a part of the picture. Our method does not allow us to gain any insight, for example, into the national or regional economic impacts for companies and workers that manufacture, retail, or install these efficient equipment types. Recent studies have provided snapshots of state-by-state employment in these fields (DOE 2017, NASEO 2018), and could be used as a basis for future analysis the impact of policies intended to increase demand for energy efficient equipment.

Conclusions/Future Research

Our analysis produced several important findings, while raising additional questions that could be areas for future research. First, the results help identify how customers may respond differently to the incentive when considering the purchase of different eligible residential equipment types, based in part on the current cost and performance of equipment options on the market. Under our two incentive scenarios, consumer behavior is changed most dramatically in purchases of air conditioning equipment and water heating equipment. This effect is even larger if a $500 credit is assumed for all five modeled equipment types, with the natural gas heating market largest impact by a wide margin. We also found that bill savings from customers who switch to more efficient equipment because of the credits exceed the potential federal expenditure, even if is assumed that all "free-riders" claim the credit. This finding holds true in each individual census division, both when the credit remains at historical levels or is increased to $500 per purchase.

Future research could leverage other analysis tools to consider the full suite of 25C eligible measures, as well as two other efficiency tax incentives that are often extended or expire on the same timetable by Congress (the section 45L credit for new homes, and the section 179d credit for commercial building upgrades. For each of these incentives, another metric of interest not assessed in this analysis is the cost-reducing impact of learning by manufacturers of efficient products. Policymakers may have interest in the extent to which temporary tax credits increase sales for efficient technologies, thereby allowing manufacturers to gain experience producing efficient products at scale and reducing retail prices. A relationship between cumulative sales and rate of decline in cost has been observed for some equipment types (Van Buskirk 2014). Future research to understand how short-term incentives could drive new technologies more rapidly down the cost curve would be valuable to understand the long-term market impact of targeted, short-term federal incentives.

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