TAX INCENTIVES FOR INNOVATIVE ENERGY-EFFICIENT TECHNOLOGIES (UPDATED)

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EXECUTIVE SUMMARY

As part of his National Energy Policy Report (NEP), President Bush has proposed tax credits to stimulate the commercialization and sale of several innovative energy efficiency and renewable energy technologies. Since then, the U.S. House of Representatives passed H.R. 4, a bill establishing tax credits for a somewhat longer list of efficiency technologies.

This report reviews previous experience with tax credits for energy efficiency measures; outlines principles to follow when designing new tax credits; provides comments on the energy efficiency tax credits proposed by the Bush Administration and Congress; and estimates potential energy, economic, and environmental benefits that could result from Administration and Congressional proposals.

Review of Previous Energy Efficiency Tax Incentives

Tax incentives to stimulate adoption of both residential and industrial energy efficiency measures were first enacted during the 1970s. The Energy Tax Act of 1978 included a 15 percent tax credit up to a maximum of $300 for residential conservation and renewable energy measures including insulation, storm windows and doors, weatherstripping, and furnace modifications. From 1978 through 1985, there were about 30 million claims for the residential tax credit, amounting to nearly $5 billion in lost revenue for the U.S. Department of Treasury. Studies indicate that most of the energy efficiency measures probably would have been installed even without incentives, resulting in a high free rider level.

The Energy Tax Act of 1978 also included a 10 percent tax credit for specified energy efficiency measures installed by businesses. The measures covered included heat recovery equipment, waste heat boilers, energy control systems, and economizers. The Act was amended in 1980 to add cogeneration equipment. This credit cost the Treasury approximately $5 billion for the period 1978 through 1982. Due primarily to the small amount of the credit, the legislation had little effect on corporate decision-making. Again, most of the measures probably would have been installed in any case. Both the residential and business tax credits applied to conventional efficiency measures, and therefore did not strongly encourage technological innovation.

Principles for New Energy Efficiency Tax Incentives

Based on the previous experience with tax credits as well as the current policy, market, and technological context, the following principles are suggested for crafting new energy efficiency tax incentives. These principles are meant to yield the greatest return on investment, assuming that the funds available for these tax credits are limited. To be effective, tax incentives should:

- Stimulate commercialization of advanced technologies;
- Establish performance criteria and pay for results;
- Pay substantial incentives;
- Choose technologies where first cost is a major barrier;
- Be flexible in terms of who receives the credit;
- Complement other policy initiatives;

- Select priorities but 'hedge bets"; and
- Allow adequate time before phasing out the incentives.

Review of Administration and Congressional Energy Efficiency Tax Incentive Proposals

The Bush Administration, through the NEP, has proposed tax credits for several technologies, including combined heat and power (CHP) systems and hybrid and fuel cell vehicles. The NEP also encourages "market-based" incentives for additional technologies and programs.

This year, in response to both the Bush Administration plan and energy challenges in California and other states, Congress drafted a significant number of proposed energy bills that include tax incentives. CHP, hybrid vehicles, fuel cell vehicles, alternative fuel supplies and infrastructure, and new energy-efficient homes have received the greatest attention. In the House of Representatives, an omnibus bill, the "SAFE Act of 2001" (H.R. 4) was approved and contains tax incentives for energy-efficient appliances, fuel cell vehicles, hybrid and electric vehicles, and efficient commercial buildings and homes. In the Senate, a number of tax incentive bills have been introduced containing similar measures as those in the House package, but differing on some important points. Tax incentives for energy efficiency may be considered by the Senate later this year, and if not this year, then early next year.

Vehicles

Cars and light trucks are an obvious target for tax credits since innovative, fuel-efficient vehicles are under active development worldwide. Hybrid vehicles combine a small energy storage system, such as a battery, and an internal combustion engine, thereby overcoming the range problem inherent in all-electric vehicles. Tax credits for hybrid vehicles should include minimum fuel economy thresholds reflecting significant efficiency improvements relative to typical vehicles in any size class plus requirements that criteria emissions at least meet the prevailing standards for gasoline-fueled cars in the same model year.

Manufacturers have announced plans to introduce these vehicles but market acceptance is uncertain and first cost could be a barrier. The NEP has recommended the creation of an income tax credit for the purchase of hybrid and fuel cell vehicles. Working from language developed in a collaborative effort involving public-interest organizations (including ACEEE) and the automakers Honda, Toyota, and Ford, Senator Hatch (R-UT) introduced S. 760, the ''Clean Efficient Automobiles Resulting from Advanced Car Technologies (CLEAR) Act of 2001." The CLEAR Act was later introduced in the House of Representatives by Representative Dave Camp (R-MI). These identical bills set tax credits for efficient fuel cell, hybrid, electric, and alternative fuel vehicles, as well as alternative fuel supplies and infrastructure.

An amended version of the CLEAR Act was included in H.R. 4. The new language is seriously flawed due to industry-requested changes that aim to qualify low-efficiency cars and light trucks for sizeable federal incentives and that also eliminate emissions requirements from the qualification criteria. One provision, entitled a "conservation credit," perversely credits the very lowest mileage vehicles. These changes should be rejected, and policy-makers should look towards the original CLEAR Act instead.

Buildings

H.R. 4 includes tax credits for new homes ($2,000 per home) that reduce energy use at least 30 percent relative to a widely used model building code. Most of the other bills that have been introduced in Congress provide less money for homes that save 30 percent, and include a higher tax credit for homes that save at least 50 percent over the model code. The multi-tier approach is preferable because it would encourage and reward higher levels of energy performance. S. 207 (sponsored by Senator Bob Smith [R-NH]), for example, provides a credit of $750 for a 30 percent improvement and $2,000 for a 50 percent improvement relative to the model code. By contrast, the House bill is overly generous—in many cases the $2,000 tax credit for 30 percent savings would exceed the cost of the efficiency upgrades.

Commercial buildings have been recognized for years as a significant source of untapped energy efficiency savings potential. Given the great range in building sizes and energy use, approaches to incentives for commercial building energy efficiency are usually based on energy intensity, or energy use measured on a per square foot basis. Following the per square foot formula, H.R. 4 authorizes a deduction of $2.25 per square foot for commercial buildings certified to achieve at least 50 percent in projected energy savings relative to the most widely used model code. This credit would be a useful inducement for the design and construction of a new generation of high-efficiency buildings.

H.R. 4 also includes a tax credit of up to $2,000 for saving energy in existing homes. The credit would go to homes that reduce energy use at least 20 percent using insulation and window improvements. These "tried and true" efficiency measures are well developed in the market and hence tax credits would primarily serve to promote additional sales of these products, but probably would not contribute to long-term market development. For this reason, an existing homes tax credit, while it would save some energy, is probably not as good an investment of federal funds as many of the other credits discussed in this report.

Building Equipment

Several federal programs and policies currently promote the adoption of energy efficiency measures in residential and commercial buildings, including state and local building codes, appliance and equipment efficiency standards, and labeling and promotion efforts such as the U.S. Environmental Protection Agency/Department of Energy's (EPA/DOE) ENERGY STAR® labeling program. Federal tax credits for building equipment should complement rather than duplicate these important efforts. The credits should be available to both individuals and businesses, and should include central air conditioners and electric heat pumps, furnaces, advanced water heaters, natural gas heat pumps, and building fuel cells. This year, energy efficiency tax incentives were introduced for building equipment in several bills, including S. 596 introduced by Senator Bingaman (D-NM), H.R. 2392 introduced by Representative Inslee (D-WA), and S. 207 introduced by Senator Bob Smith. In H.R. 4, fuel cells for buildings are included, but other promising technologies are not listed. No tax credits for high-efficiency building equipment has been proposed by the Bush Administration.

In the Senate, S. 596 and S. 207 each include tax credits for energy-efficient air conditioners and heat pumps, proposing a 10 percent credit up to $250 for central air conditioners and heat pumps

with a seasonal energy efficiency rating (SEER) of at least 13.5 and a 20 percent credit up to $500 for central air conditioners and heat pumps with a SEER of at least 15.0. The tax credits would help to increase the market share and reduce the first cost premium for high-end units that now have only about a 1 percent market share.

Heat pump water heaters are two to three times more efficient for heating water than conventional electric resistance water heaters. Heat pump water heaters have been produced on a limited basis for many years but have never caught on due to high first cost, limited availability, and technical problems. Several new units are about to enter the market, making this a good time to stimulate production of and demand for this promising technology. Tax credits for heat pump water heaters are included in H.R. 2392.

The average gas water heater sold today has an Energy Factor of approximately 0.56; very few units are sold with an Energy Factor of 0.65 or greater. New efficiency standards recently set by DOE take effect in January 2004 and raise the average Energy Factor for gas water heaters to about 0.58–0.61, varying with storage capacity. A 10 percent credit up to $250 for units with an Energy Factor of at least 0.65 and a 20 percent credit up to $500 for units with an Energy Factor of at least 0.80 could increase availability and sales of these advanced units. In addition, combined water heating/space heating systems should be eligible for the same credit, provided that their water heating efficiency meets the 0.65 or 0.80 levels. Tax credits along these lines are included in the Inslee bill.

Distribution transformers are used to reduce electricity voltage from the high voltage levels used for distribution down to the levels used by consumers. Higher-efficiency transformers are now commercially available that reduce losses by about 30 percent on average. But further efficiency levels are possible through use of improved core materials. Tax credits for very efficient transformers would help spur commercialization and sale of transformers that significantly exceed the performance level of the ENERGY STAR transformer program.

Furnaces and furnace fan motors are significant sources of potential savings due to continuing advances in furnace and blower-motor design. In particular, improvements in motors used to distribute conditioned air are an attractive opportunity for significant homeowner savings. Also, since most furnace fans are also used to distribute air from central air conditioning systems, efficiency improvements would also reduce peak power demand, lessening the stress on utilities. S. 596 and H.R. 2392 include credits for advanced natural gas furnaces that achieve a 90 percent annual fuel utilization efficiency (AFUE) and seasonal electricity use of less than 300 kilowatt-hours (kWh) per year.

Fuel cells are a very promising distributed generation technology offering the potential to cogenerate electricity and useful thermal energy with very low emissions and high electrical conversion efficiencies. All types of fuel cells are still burdened with high capital costs. Phosphoric acid fuel cell systems cost about $3,000 per kilowatt (kW), similar to the expected market entry cost for other types of fuel cells. A 10 percent federal tax credit could be valuable for stimulating initial sales. H.R. 4 includes a 10 percent credit up to a maximum of $1,000/kW for fuel cell cogeneration systems installed in buildings.

Appliances

Among the various household appliances, two types stand out as candidates for tax credits—refrigerators and clothes washers. In both cases, large energy savings are technically feasible and cost-effective on a life-cycle cost basis. In the case of refrigerators, a new federal refrigerator efficiency standard went into effect in July 2001 that brings the average energy use of new refrigerators down to 500 kWh per year. Still, substantial additional efficiency improvements are possible, with some studies estimating that annual energy use could ultimately be reduced to under 300 kWh. We recommend that credits be offered for products that exceed the new federal standard by 10–15 percent (as contained in S. 686 by Senator Lincoln [D-AR] and H.R. 1316 by Congressman Nussle) and that credits also be considered for higher levels of efficiency improvement. Similarly, new clothes washer standards have just been set, with the more stringent standard taking effect in 2007. Tax credits in the Lincoln and Nussle bills would promote these efficiency levels prior to 2007, and also include higher credits for units that exceed these new standards.

Combined Heat and Power Systems

A wide range of advanced CHP technologies are under development for supplying electricity and useful heat in buildings applications. These technologies include engine-based, gas turbine-based, and fuel cell-based systems, operating on natural gas or other clean fuels. Tax credits would assist CHP in overcoming several barriers, including technology cost, bureaucratic and regulatory burdens, and interconnection costs. If these challenges were addressed, CHP has the potential to provide an estimated 50,000 megawatts (MW) of power capacity to U.S. electric grids by 2010.

In the NEP, the Administration proposed either investment tax credits or shorter depreciation periods for qualifying CHP systems. Following the release of the NEP, several bills were introduced in Congress that proposed a 10 percent investment tax credit for qualifying CHP systems. Among these bills are H.R. 1945, the "Combined Heat and Power Act of 2001," and S. 596 and S. 389 by Senators Bingaman and Murkowski (R-AK), respectively. The House-passed bill, H.R. 4, includes a 10 percent investment tax credit for qualifying CHP systems installed by businesses, coupled with a longer 22-year depreciation schedule for systems earning the credit. This longer depreciation period runs counter to efforts to encourage new CHP systems and this provision should be removed. The House bill also limits the tax credit to systems over 50 kW; this provision should be removed since incentives are even more important for small systems than for large systems.

Under all of the bills, a qualifying system would need to produce at least 20 percent of its useful energy as electrical or mechanical power and at least 20 percent as thermal energy, with an overall efficiency of at least 60 percent (up to 70 percent for larger systems).

In lieu of or in addition to tax credits, shorter depreciation periods for CHP assets should be considered. Across the range of applications, depreciation levels vary widely, with many longer than equipment life. Most CHP equipment currently sold has a life of 7 to 10 years before major maintenance must be preformed. For this reason, 7- to 10-year depreciation periods make sense.

Potential Impacts

Over the past several years, members of Congress have drafted a host of bills containing various energy efficiency tax credits and depreciation modifications. In order to be able to judge the merit of these bills, Congress and the Administration have requested estimates of the revenue effects. The Treasury and the Congressional Joint Committee on Taxation (JCT) have provided "scorekeeping" for a variety of measures. There is considerable variation in scorekeeping estimates among the various entities. These inconsistencies reflect differences in assumptions and methods but also the difficulty in long-term forecasting of participation levels and other associated inputs to the estimates. In July 2001, JCT provided Congress with the estimated revenue effects of both the energy efficiency and supply-side provisions of H.R. 4. The total estimated revenue impact of the efficiency-related provisions was estimated to be approximately $5.4 billion, with the advanced vehicles and new homes provisions accounting for three-quarters of the total impact. In September 2001, JCT submitted revenue impact estimates for selected provisions in S. 596, and energy efficiency measures were estimated to have an approximately $4.5 billion impact. However, this estimate does not include vehicles, an item that JCT estimated would cost approximately $2.7 billion.

In 1999, the Treasury estimated that a program of energy efficiency tax credits similar to those described in this report would cost the federal government $8.3 billion during 2000–2009. Over the lifetime of products qualifying for the credits, carbon emissions would decline by 100–150 million metric tons (MMT). The Treasury also estimated that due to the credits, consumers and businesses would realize energy savings worth $22–33 billion. Around the same time, DOE's Energy Information Administration (EIA) estimated that a similar package of energy efficiency tax credits would only cut carbon emissions by 1.6 MMT in 2010. The large difference in savings is attributable to the fact that EIA estimated very small savings from many of the credits, estimates that have earned EIA substantial criticism.

Both the Treasury and EIA analyses considered only the direct effects of the tax credits—impacts from measures actually receiving credits. This is also true for analyses conducted by JCT. But economies of scale, technology learning, and market development are very likely to lead to indirect impacts many times greater than the direct impacts, as the Treasury and DOE acknowledge. While somewhat speculative, estimates of plausible indirect effects are presented below, assuming that the credits discussed above (along with research and development (R&D), and related deployment efforts) are successful in stimulating commercialization and sale of the various advanced energy-efficient technologies.

Energy Savings

ACEEE estimated annual energy savings from 2002 through to 2020. Annual energy savings potential from the listed tax incentives are impressive: 0.6 Quads in 2006; 1.1 Quads in 2010; 2.1 Quads in 2015; and 3.2 Quads in 2020 (the United States used about 100 Quads in 2000). Energy savings continue to increase after expiration of tax credits due to indirect impacts—i.e., sales of the products after the incentives expire. These sales result from increased purchaser knowledge about, and interest in, the efficient products as well as lower product prices engendered by the impact of tax credits on product development and sales. Of the cumulative savings achieved, about 40 percent are achieved by CHP systems, with new commercial buildings accounting for

25 percent and new homes, fuel cell cogeneration, and hybrid vehicles each accounting for 4–9 percent of the savings. Other measures accounting for at least 2 percent of the savings are gas furnaces, heat pump water heaters, energy-efficient appliances, and gas furnaces. These results are summarized in Table ES-1.

Table ES-1. ACEEE Estimates of Direct Costs, Cumulative Energy Savings, and Energy Savings per Dollar of Federal Spending from Selected Tax Credits

Tax Credit	Direct Cost ($million)	Lifetime Energy (Quads)	Energy Per Dollar (mmBtu/$)	Rank
Fuel cell cogeneration	100	4.2	42	1
Combined heat & power	1,000	29	29	2
Commercial buildings	1,400	18	13	3
Heat pump water heaters	250	2.2	8.9	4
Gas heat pumps	120	0.9	7.5	5
New homes	940	6.3	6.8	6
Hybrid vehicles	760	3.1	4.1	7
Transformers	290	0.9	3.1	8
Gas furnaces	750	2.3	3.1	9
Appliances	440	0.8	1.8	10
Central air/heat pumps	1,000	1.5	1.5	11
Electric/fuel cell vehicles	290	0.4	1.3	12
TOTAL	7,300	70	9.6	

Notes: Direct costs are the cost to the Treasury. Energy savings are lifetime savings for measures installed through 2020. A Quad is 10^{15} British thermal units (Btus).

Economic Impacts

ACEEE estimates the total cost to the Treasury, over the lifetime of the tax incentives listed in Table ES-1, will be $7.3 billion. Revenue losses for each of the specific tax credits are also listed in Table ES-1. Overall, our estimate of costs is similar to those of JCT and the Treasury, although estimates for individual measures do differ.

In addition to costs, we estimated the benefits of each of the measures. The energy savings in each year were monetized for measures installed from 2002 through 2020, resulting in total present value energy savings of about $200 billion. Comparing this estimate for the present value of lifetime energy savings with the present value of federal costs yields a benefit-cost ratio of about 30 to 1. Similarly, the present value of total costs associated with the credits (federal costs plus consumer costs) is estimated by ACEEE to be approximately $87 billion through 2020. Comparing the present value of lifetime costs to lifetime benefits yields an overall benefit-cost ratio of about 2.3 to 1. Net benefits (value of energy savings minus costs) are about $190 billion from the federal perspective and $110 billion overall. Table ES-2 lists the benefit-cost ratios for each measure from both the federal and overall perspectives.

Table ES-2. Benefit-Cost Ratios for Tax Credit Measures From Both Federal and Overall Perspectives

Tax Credit	Overall Benefit-Cost Ratio	Federal Benefit-Cost Ratio
Commercial buildings	5.4	30
Transformers	3.9	8
Combined heat & power	3.1	100
Heat pump water heaters	2.5	32
New homes	1.6	15
Gas heat pumps	1.6	26
Central air/heat pumps	1.4	7.1
Gas furnaces	1.4	10
Hybrid vehicles	1.3	23
Appliances	1.2	7.4
Fuel cell cogeneration	1.2	130
Electric/fuel cell vehicles	0.5	7.5
OVERALL	2.3	30

Emissions

Emissions of selected criteria pollutants would also be reduced by tax credits. Emission reductions for sulfur dioxide (SO_2), nitrogen oxides (NOx), and carbon were estimated using factors relating emission rates to fossil fuel energy use. By 2020, the tax incentives would reduce annual NOx emissions by approximately 370,000 metric tons per year and annual SO_2 emissions by approximately 120,000 metric tons per year.

Regarding carbon emissions, we estimate that all equipment directly qualifying for the energy efficiency tax credits would reduce carbon emissions by about 12 MMT in the year 2006. With growing adoption of the advanced technologies following the phaseout of the credits, avoided carbon emissions could reach around 22 MMT per year by 2010 and 60 MMT per year by 2020. The cumulative reduction during 2000–2020 could be over 500 MMT. This is equivalent to about 4 months of U.S. carbon emissions at the current emissions rate.

Tax incentives would help to establish technologies that would have a modest but non-trivial impact on U.S. emissions of carbon and criteria pollutants within a decade. In addition, avoided emissions should continue to increase as market penetration grows, even after the incentives phase out.

Ranking the Credits

In recognition of federal budgetary uncertainties and the possibility that there might not be sufficient money to fund all the tax credits discussed in this report, we ranked the credits on several criteria (summarized in Table ES-3). First, the different tax credits were compared in terms of energy savings per dollar of federal spending. The five measures with the highest savings per federal dollar are fuel cell cogeneration, CHP systems, new commercial buildings, heat pump water heaters, and gas heat pumps. The five measures with the lowest savings per federal dollar are electric and fuel cell vehicles, residential central air conditioners and heat

pumps, appliances, gas furnaces, and transformers. On the other hand, even for the lower-ranked measures, tax credits could lay the groundwork for stronger minimum-efficiency requirements, which would dramatically increase the energy savings achieved (all five of these products are covered by existing or pending federal standards).

Table ES-3. Ranking the Different Tax Credits Based on Three Criteria

Tax Credit	Overall Benefit-Cost Ratio	Rank	Total Savings (Quads)	Rank	Energy per Federal Dollar (mmBtu/$)	Rank	Average Rank	Rank
Combined heat & power	3.1	3	29	1	29	2	2.00	1*
Commercial buildings	5.4	1	18	2	13	3	2.00	1*
New homes	1.6	5	6.3	3	6.8	6	4.67	3
Heat pump water heaters	2.5	4	2.2	7	8.9	4	5.00	4
Fuel cell cogeneration	1.2	11	4	4	42	1	5.33	5
Gas heat pumps	1.6	6	0.9	10	7.5	5	7.00	6*
Transformers	3.9	2	0.9	11	3.1	8	7.00	6*
Hybrid vehicles	1.3	9	3.1	5	4.1	7	7.00	8
Gas furnaces	1.4	8	2.3	6	3.1	9	7.67	9
Central air/heat pumps	1.4	7	1.5	9	1.5	11	9.00	10
Appliances	1.2	10	0.8	8	1.8	10	9.33	11
Electric/fuel cell vehicles	0.5	12	0.4	12	1.3	12	12.00	12
OVERALL	2.3		70		9.6			

* Tied with other credits.

Second, we ranked the different tax credits on the basis of overall benefit-cost ratio. The five measures with the best (highest) benefit-cost ratios are commercial buildings, transformers, CHP systems, heat pump water heaters, and new homes. Measures that rank highly under this criteria overlap heavily with measures that rank highly under the previous criteria, although there are differences. Measures with the lowest benefit-cost ratios are electric and fuel cell vehicles, fuel cell cogeneration, appliances, hybrid vehicles, and gas furnaces. The lower-ranked measures involve either cutting-edge technologies such as fuel cells for which time is needed for costs to decline and sales to increase or technologies such as appliances and furnaces where substantial energy savings have already been achieved and remaining savings are more expensive.

Third, we compared measures on total energy savings, since an objective of a federal energy bill is to reduce national energy use and thus measures with high savings should be favored. By this measure, the highest-ranked measures are CHP systems, commercial buildings, new homes, fuel cell cogeneration, and hybrid vehicles.

Across the three sets of rankings, several measures are consistently high on the list, such as CHP systems and commercial buildings (top 5 on all three measures). Other measures are ranked high on some criteria and low on others. To help show overall trends, in the final column of Table ES-3 we calculate average rank across all three criteria. Using this overall average, the top five

measures are CHP systems, commercial buildings, new homes, heat pump water heaters, and fuel cell cogeneration. Of course there are other ways to rank measures and thus these results should be considered indicative rather than definitive.

Conclusion

Tax incentives, if properly structured, could play a valuable role in stimulating the introduction and initial sales of important energy efficiency technologies such as hybrid and fuel cell vehicles, highly efficient building equipment, and very efficient new homes and commercial buildings.

In this area, the Bush energy plan and the House energy bill offer constructive proposals for tax credits for a variety of energy efficiency technologies. The Congress, with passage of H.R. 4 in the House of Representatives, has adopted selected energy efficiency tax proposals, but has also overburdened them with industry-requested, costly incentives that are not the most efficient uses of federal funds. By refining the House bill to reduce excessively generous credits for cars and new and existing homes, the cost-effectiveness of the credits could be significantly improved.

Since the funds available for tax credits are limited, so will be the direct impact on energy use and related emissions from the adoption of products qualifying for credits. But consideration of direct impacts is not a complete approach to estimating potential impacts. If the credits along with complementary policies and programs are successful, than the sales and market penetration of the advanced technologies would continue to grow after the incentives phase out, leading to indirect energy and economic savings and emissions reductions many times greater than the direct reductions. Put simply, tax credits for innovative energy efficiency technologies would have positive impacts on U.S. businesses, consumers, air quality, and public health, as well as help to reduce greenhouse gas (GHG) emissions and global warming. These credits should be included in any broad-based energy legislation or other appropriate tax bills.