Synapse
Energy Economics, Inc.

No Need to Wait:

Using Energy Efficiency and Offsets to Meet Early Electric Sector Greenhouse Gas Targets

May 1, 2009

AUTHORS

Chris James, Jeremy Fisher, PhD, Kenji Takahashi and Ben Warfield

22 Pearl Street
Cambridge, MA 02139
www.synapse-energy.com
617.661.3248

Table of Contents

Chapter 1: Executive Summary

The Challenge is Set

President Obama clearly recognizes the problem of global climate change and the urgent need for action. In a November 18, 2008 address to the Bi-Partisan Governors Global Climate Summit, the President-elect stated;

> "Climate change and our dependence on foreign oil, if left unaddressed, will continue to weaken our economy and threaten our national security." And, "My presidency will mark a new chapter in America's leadership on climate change... That [leadership] will start with a federal cap and trade system. We will establish strong annual targets that set us on a course to reduce [greenhouse gas] emissions to their 1990 levels by 2020 and reduce them an additional 80% by 2050."

Some argue that the US should wait until carbon capture and storage (CCS) technology is more fully deployed before establishing emission reduction goals for the electricity sector. But this view ignores three important points:

1. The electricity sector has readily available options and technologies to meet near-term emissions reduction targets as CCS is developed and deployed.
2. Failure to begin emissions reductions now will only require deeper emissions cuts later, increasing total costs.
3. A lack of emissions targets (and the investment signals they generate) will retard the development of CCS technology needed to meet long-term emissions reduction goals.

This report finds that energy efficiency and domestic agriculture and forestry offsets can meet aggressive greenhouse gas targets. There is no need to wait.

Funded by Environmental Defense Fund, this report examines current trends in energy efficiency implementation and domestic agricultural and forestry measures, and analyzes (1) if extending these techniques to a wider participant pool could meet the stated emission reduction targets of the new administration (applied to the electricity sector), and (2) what level of these measures are necessary to meet the targets. Our analysis concludes that the targets can be met through a combination of energy efficiency and improved agricultural and forestry practices.

Meeting the Challenge with Energy Efficiency and Domestic Offsets

Achieving ambitious greenhouse gas (GHG) reductions for the electricity sector is feasible with today's technologies. The required reductions, and more, could be achieved by a combination of energy efficiency, increasing the performance of homes and appliances, businesses and factories, and improved agricultural and forestry practices which reduce waste and hold carbon in plants and soils. Forty years of environmental regulation have shown that American ingenuity can produce technology to meet clear performance standards in a timely and cost-effective manner. This lesson is being reaffirmed today in states that are considered leaders in promoting energy efficiency.

Emissions of carbon dioxide from the electricity sector account for about 40% of combustion-based GHG emissions in the United States in 2006. The EIA estimates that emissions from the sector could reach over three billion tons by 2030, 16% higher than today.

President Obama's pledge to return greenhouse gas emissions to 1990 levels by 2020 and down to 20% of 1990 levels by 2050 is a steep, yet necessary, reductions trajectory. For the electricity sector this trajectory can be achieved by utilizing a wide portfolio of technologies, including cutting-edge renewable energy and carbon sequestration. In the first years, some of the most accessible, economic, and effective technologies for achieving reductions are in energy efficiency. Figure 1.1 shows President Obama's target reductions against a business-as-usual (BAU) emissions trajectory and two options for meeting the goal. The business-as-usual emissions (gray and black line) grow from 1,785 million short tons in 1985 to 2,589 million tons today, and reach 3,008 million tons by 2030. The President's proposed trajectory departs from the BAU line in 2010 (gray dots), moving to a target of 1,471 million tons in 2030. Finally a line traces the expected emissions slope if every state in the nation pursued aggressive energy efficiency goals (purple), and another line traces the additional savings from smart agricultural and forestry management practices (green).

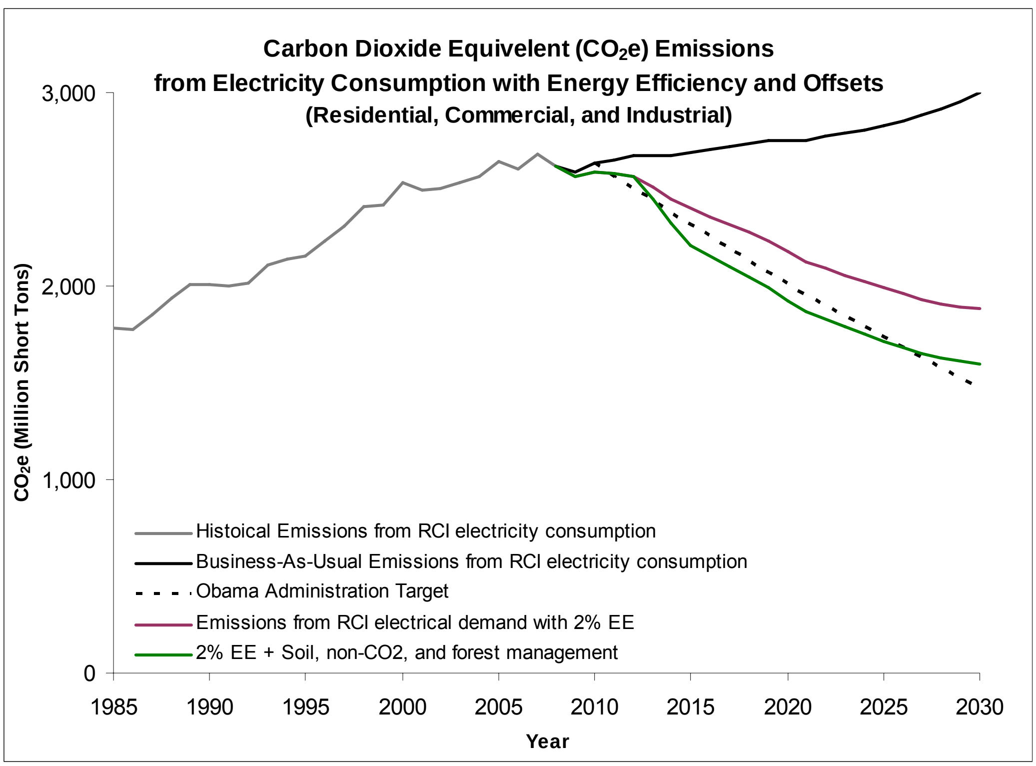


Figure 1.1. Carbon dioxide equivalent (CO_2e) emissions from residential, commercial, and industrial electricity consumption; historical (gray) and business as usual (black), President Obama target to 2030 (dotted), potential emissions reductions from 2% national energy efficiency program (purple), and additional emissions reductions from agricultural and forestry offsets (green). *Note:* Greenhouse gas reductions from energy

efficiency meet over 90% of President Obama's target in 2030. However, because efficiency and offsets go beyond the target from 2014 to 2026, the cumulative reductions from 2010 through 2030 exceed the administration's goal by over 3%.

Energy efficiency will make significant headway towards reducing energy sector emissions, but additional reductions will be required. Reducing agricultural emissions and sequestering carbon through improved agricultural and forestry practices could push GHG emissions below the required target with technology available today. Table 1.1 shows the level of GHG benefits that could be achieved in future years if all 50 states implemented specific energy efficiency programs or improved agricultural and forestry practices.

Table 1.1. GHG Benefits from Energy Efficiency and Improved Agricultural and Forestry Practices

Emissions reduction strategy	2020 Million tons GHG reduced per year	2020 % of Obama Target	2030 Million tons GHG reduced per year	2030 % of Obama Target	Cumulative 2008-2030 Million tons GHG reduced	Cumulative 2008-2030 % of Obama Target
1% annual energy efficiency	350	47%	650	43%	7,300	47%
2% annual energy efficiency	570	77%	1,120	73%	11,900	76%
Soil carbon sequestration	110	15%	180	2%	1,480	9%
Manure and fertilizer management	50	7%	30	5%	910	6%
Forest management	90	12%	70	12%	1,880	12%
Total (2% annual efficiency and offsets)					**16,170**	**103%**

Energy Efficiency is Available and Cost-Effective

Several leading states already have energy efficiency savings of 2% per year. If all 50 states ramped up programs to this level, these savings alone would help to achieve 73% of the President's GHG targets by 2030. Savings programs of 3% per year are anticipated shortly in Massachusetts, Vermont and parts of the Pacific Northwest. A more rigorous efficiency program could provide even deeper cuts towards the GHG targets. These programs cut waste and emissions, save consumers and businesses high energy costs, and promote significant job growth in technology, manufacturing, and skilled trades. Opportunities to improve generator operations, which could reduce GHG emissions and fuel consumption, are not considered in this report.

There is Great Potential for US Agricultural and Forestry Offsets

Improved domestic agricultural and forestry practices could conservatively achieve about a combined 27% of reduction targets. The most promising opportunities in soil carbon sequestration, forest management, and manure and fertilizer management are being implemented now in several areas across the United States. While these practices are not as mature as those that we analyzed for energy efficiency, our analysis evaluated only those practices which have been adopted in the domestic commercial market.

Read the Full Report

Opportunities to reduce waste and improve upon the performance of how energy is used exist in every sector and every part of the United States. Effective energy efficiency programs, already in use in leading states, can make significant headway in reducing greenhouse gas emissions. The programs and potential state savings are explored in detail in the full report. Read the full report at *www.synapse-energy.com.*

Chapter 2: Meeting the Obama Administration Greenhouse Gas Emissions Reduction Targets

INTRODUCTION

Government action to reduce greenhouse gases that contribute to global warming began over twenty years ago. Margaret Thatcher's government in the UK recognized the importance of scientific findings on this issue in the early 1980s, and the US Senate held hearings in the late 1980s.

The United States has lagged behind all developed countries to implement plans to reduce greenhouse gas emissions. But nearly 30 US states and dozens of counties and cities are demonstrating leadership by developing and implementing comprehensive climate change action plans.

What has changed since the 1980s is the level of certainty in our predictions, observations of the first impacts of climate change, and a new understanding that the pace of change is accelerating towards a tipping point. The large number of climate change bills introduced in the 110th Congress reflects this change.

THE TARGET

As noted in Chapter 1, following the 2008 election, President Obama stated a goal of reducing greenhouse gas emissions to 1990 levels by 2020, and an additional 80% reduction by 2050. When the nation follows through on this target, we would anticipate that comprehensive legislation will target multiple emissions sectors, including electricity production, industry, commercial entities, transportation, and agriculture. This report focuses on the electric utility sector, the savings and emission reductions achievable through energy efficiency, and the role agriculture and forestry can play in offsetting and capturing additional electric sector emissions.

Electricity production accounts for over 40% of national emissions or 2,623 million short tons of CO_2 in 2008.[1] If we apply the President's pledge to the energy sector and assume that legislation is enacted and executed by 2010, the targets are to hit approximately 2,007 million tons of annual emissions by 2020 and 401 million tons by 2050. From expected emissions in 2010, these are 24% and 85% reductions, respectively.

Achievable short-term goals are critical for several reasons. First, programs which aim for near-term reductions ensure that elected officials are held accountable for achieving policies enacted under their watch. Second, short-term goals provide an impetus, either legal, financial, or both, to take action now, an increasingly important factor in mitigating the worst effects of climate change. Third, early actions and successes help policies gain traction for long-term successes.

ACHIEVING THE TARGET THROUGH ENERGY EFFICIENCY

The Obama administration goals are ambitious, but necessary. In the long run, 85% reductions will require investments in cleaner energy producing technologies. However, in the short term, we can meet the 2020 target with aggressive and highly cost-effective energy efficiency. Carbon emissions reductions and sequestration activities in the agricultural sector can help achieve even more dramatic reductions, beating the Obama administration's targets while engaging a wide range of American workers.

Energy efficiency and agricultural measures are economic ways to reduce greenhouse gas emissions. The appendices describe economic, energy and environmental co-benefits that complement those realized as a result of reducing GHG emissions. Energy efficiency (EE) reduces GHG by reducing waste in electric appliances, heating and cooling systems, and from entire building envelopes. EE measures reduce energy consumption while maintaining or improving upon the quality of energy services experienced by the building occupants.

EE is promoted primarily through utility or third party energy efficiency programs; updating state and federal building codes; and updating state and federal appliance standards. For example, utility-based energy efficiency programs typically target specific technologies and sectors with directed measures, such as commercial lighting, residential heating or cooling, or appliance upgrades. While these programs do come at a cost, they are often the least expensive way to meet customer demand and can benefit both utility and customers. For a utility, EE programs allow the energy supplier to meet consumer demand without building expensive new generation, while customers benefit from lower (and often less volatile) energy bills. Updating efficiency codes for buildings compels builders and architects to consider energy consumption while building or renovating structures, reducing the costs for all participants and energy costs for consumers. Finally, updating appliance standards compels manufacturers to meet minimum specifications, which ultimately lowers the cost of more efficient technologies for consumers while providing benefit for forward-thinking appliance manufacturers.

Aside from protecting consumers, energy efficiency provides the equivalent of an alternative energy source, reducing or removing the need for costly new generation, easing strain on transmission systems, and providing wider societal benefits. Energy efficiency is highly reliable relative to traditional generators, which are prone to outages. EE lowers the wholesale cost of electricity by reducing the need both for new generators and expensive marginal generators (generators which operate only when energy demand is very high). Finally, unlike new generation, EE does not need to be transmitted over wires, which reduces the strain on transmission systems.

Creative market-based strategies could be instrumental to promote and provide efficiency, for example, to low- or fixed-income residents or large institutional customers. The average cost of electric utility efficiency programs is often around 3 to 4 cents per kWh, while in contrast, electricity prices range from 5 to 20 cents per kWh produced and delivered (the national average is around 9 cents per kWh). The cost of efficiency through building codes and appliance standards are often lower than the cost of savings through utility programs, since fewer financial incentives are needed in order to assure compliance with the codes and standards.

Beating the Target through Agricultural and Forestry Offsets

Offsets are emissions-reducing activities in sectors of the economy which are not regulated under a carbon cap. Projects which either sequester carbon dioxide in soils, plants, or forests, or reduce emissions from agricultural operations can be used to help meet GHG targets. Such projects can include (amongst others) reducing tillage in row crops (which releases carbon dioxide), capturing methane emissions from waste lagoons, or slowing the harvest cycle in managed forests to retain more carbon in trees. In a system using offsets, farmers and foresters would be able to sell carbon credits from carefully vetted projects; these credits could be traded and used to "offset" emissions in the capped sectors. Offset programs help engage a wide pool of participants in a carbon economy: from farmers and foresters, to suppliers and buyers. There are numerous cost-effective activities in the agricultural and forestry sectors which can help reduce or sequester GHG emissions; offsets can be a useful tool in GHG regulation.

Aside from being pursued internationally in such arenas as the Clean Development Mechanism of the Kyoto protocol, offsets programs are being increasingly employed in the US in partnerships between energy utilities and farmers and foresters. Effective offsets have a validated mechanism and are verified and monitored by third-party auditors. There are numerous emissions reductions available from offsets in agriculture and forestry.

Energy Efficiency and Agricultural Offsets Can Surpass the President's Targets, Economically

Extrapolating the Obama administration's targets, we estimate that the US electricity sector would need to achieve approximately 44% GHG emissions reductions by 2030. Figure 2.1 shows that about three-quarters of the reduction targets for residential, commercial, and industrial electricity demand can be met by 2% annual energy efficiency alone.

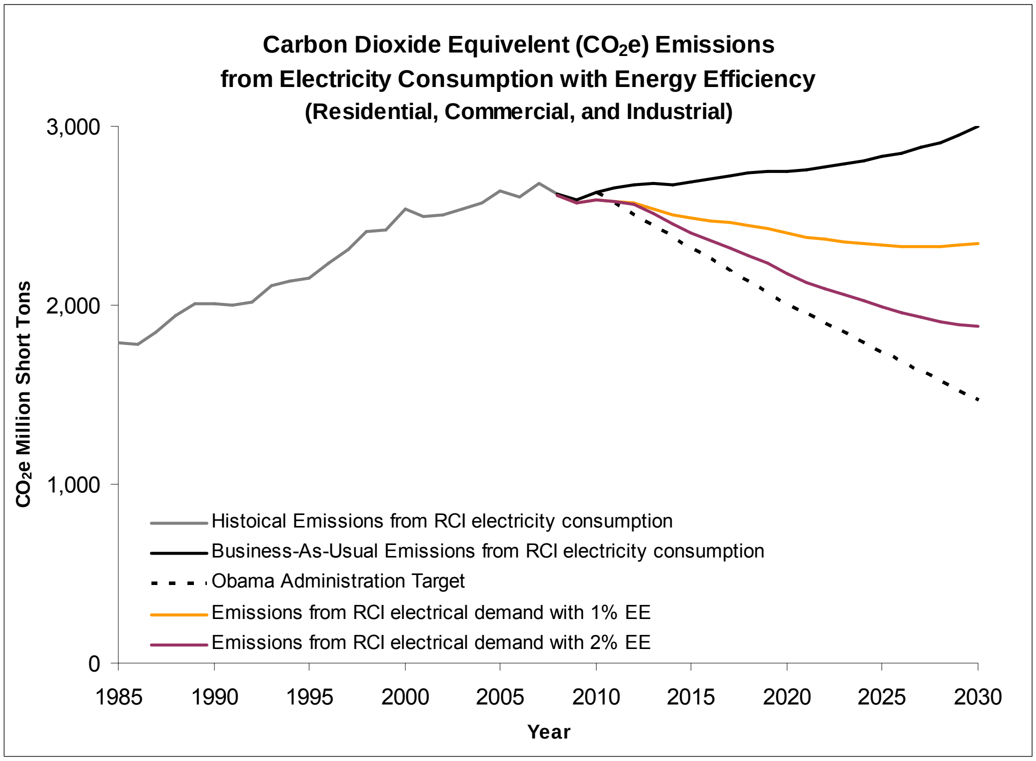


Figure 2.1: Carbon dioxide equivalent (CO_2e) emissions from electricity consumption: historical (gray), business as usual (black), Obama administration target (dotted), and savings from 1% energy efficiency (orange) and 2% EE (purple)..

The figure reflects GHG emission reductions on a national scale. The gray line indicates historical emissions from electricity consumption in the residential, commercial, and industrial (RCI) sectors. The continuing black line at the top reflects business as usual (BAU) according to the latest estimates from the US Department of Energy: an increase in GHG emissions resulting from the continued growth in electricity demand in the residential, commercial and industrial sectors. To mitigate the impacts of climate change, the Obama administration has indicated a required target along the dotted line trajectory. The second to top line in orange reflects the level of GHG emissions that would occur if all 50 states adopted and implemented modest energy efficiency programs equal to most states which have adopted EE programs, at a 1% reduction every year.[2] Some better performing states today are achieving efficiency equivalent to 2% of electric sales on an ongoing, compounded basis. If adopted by all states, the resulting emissions from the RCI sector would be at the purple line. Several states in the Northeast are now implementing programs designed to save 3% of energy sales every year. At this level of efficiency, EE measures are still technically viable and cost effective.

At 2% EE, we anticipate annual emissions savings of 1,120 million tons of CO_2e by 2030 relative to the baseline, or over a 40% reduction below 2010 levels.

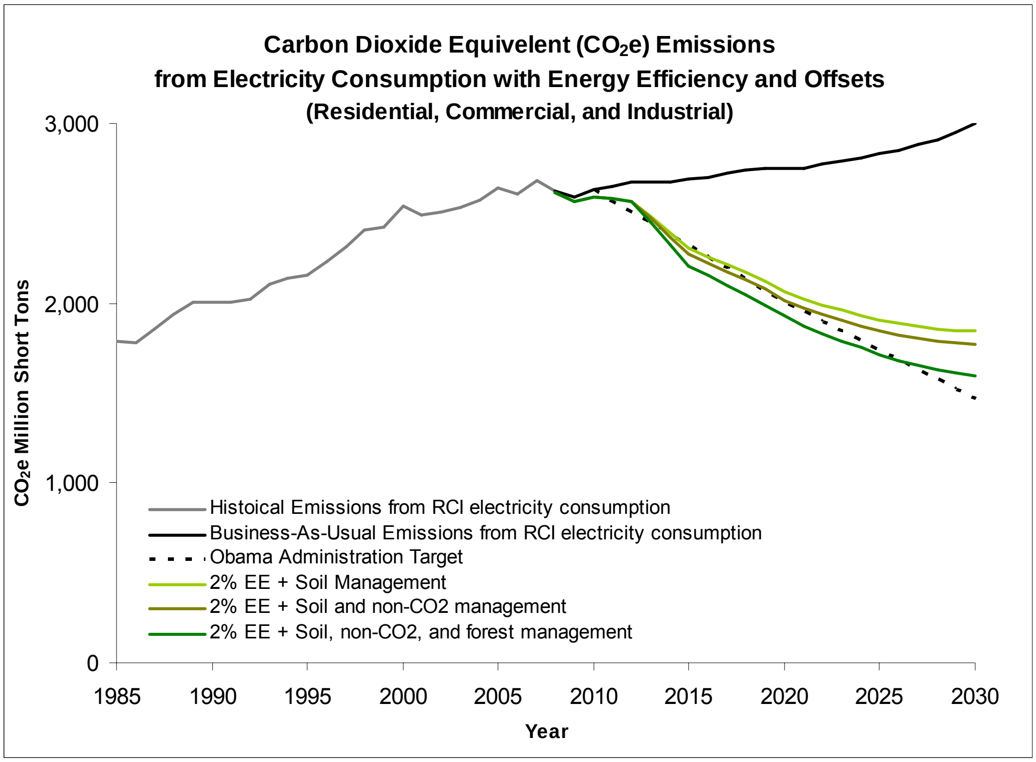


Figure 2.2: Carbon dioxide equivalent (CO_2e) emissions from electricity consumption: historical (gray), business as usual (black), Obama administration target (dotted), and savings from 2% energy efficiency program plus offsets, including soil, agriculture, animal waste, and forestry management techniques (green lines).

The administration's emissions targets can be exceeded by relatively modest agricultural offsets (Figure 2.2). There are a variety of agricultural and forestry emissions reductions and even carbon sequestration techniques which are economic and environmentally sound, including soil management techniques (such as low-till), waste and manure management, and forestry management. In addition to emission reductions achievable through energy efficiency, agricultural and forestry offsets could be used to achieve even greater reductions.

For the agriculture sector, GHG reductions are shown starting below the lines representing reductions from two percent energy efficiency. The three main policy areas evaluated are broken out separately. GHG reductions for soil management are shown by the light green line; adding nitrous oxide (N_2O) and methane (CH_4) management lowers emissions to the gray-green line; finally, adding in forestry management programs brings down net emissions to the lowest line in dark green.

Using only the most economic and minimally invasive techniques, we estimate that offsets could achieve the equivalent of another 290 million tons of CO_2e annually by 2030, or an extra 19% reduction relative to the baseline from 2010. Together with 2% EE, we could anticipate savings of over 1,400 million tons of CO_2e in 2030, or 53% below 2010 emissions.

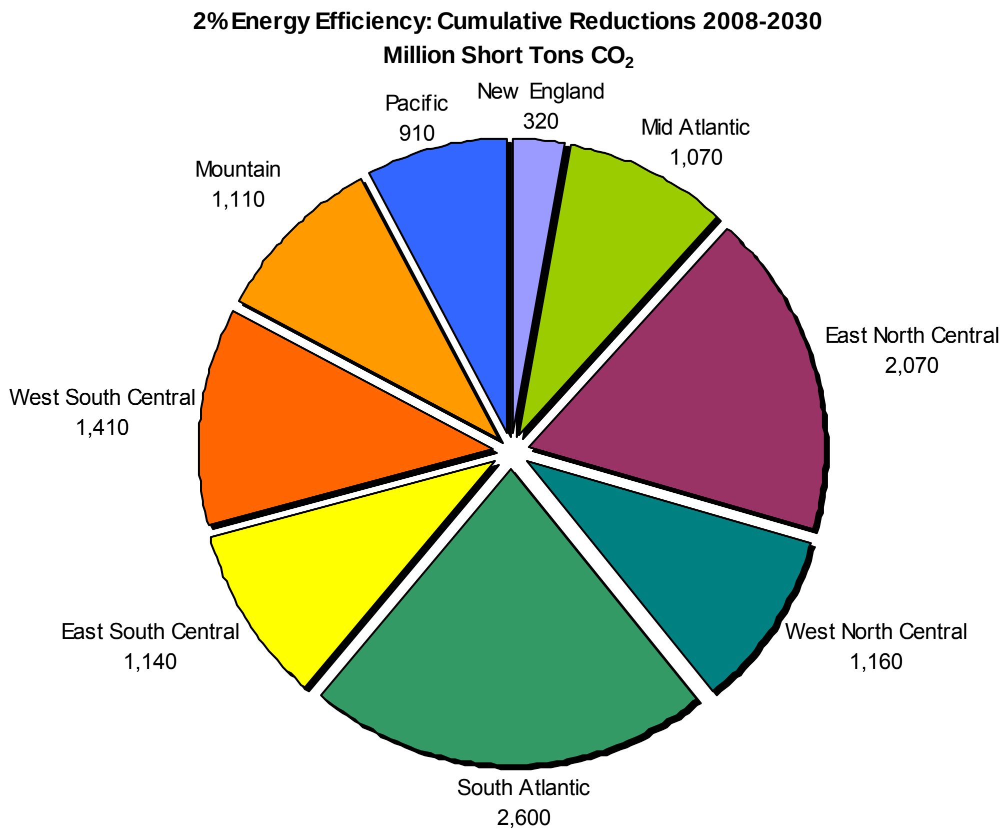


Figure 2.3: Regional carbon dioxide equivalent reduction potential of energy efficiency. Cumulative emissions reductions relative to baseline from 2% energy efficiency between 2008 and 2030.

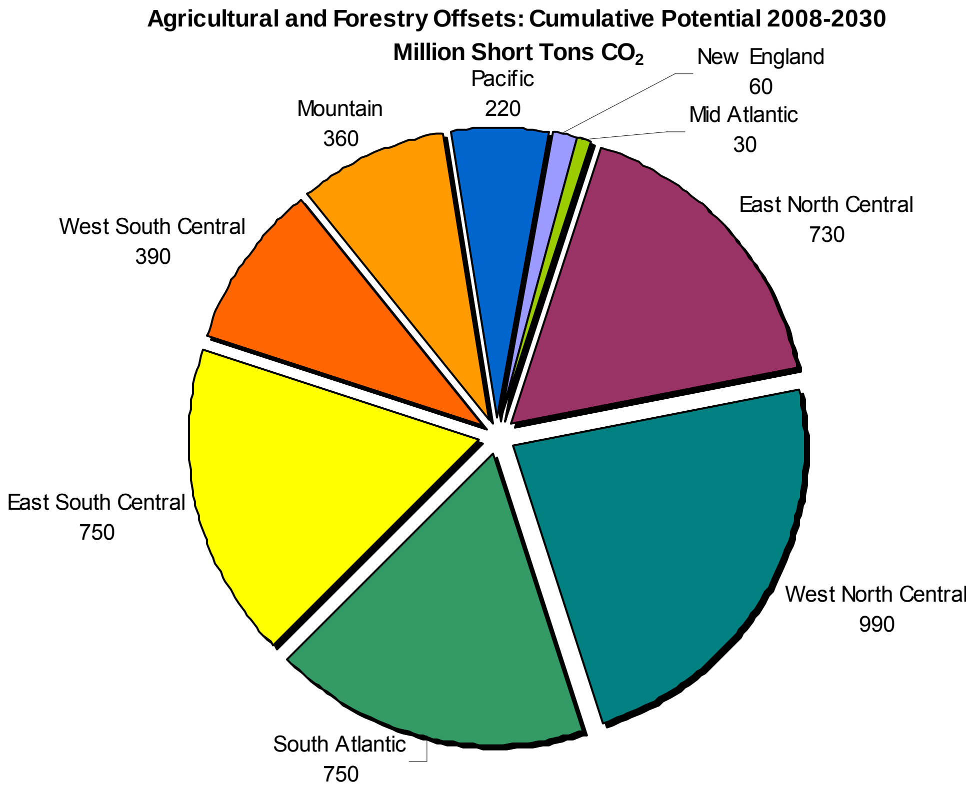


Figure 2.4: Regional carbon dioxide equivalent reduction potential from agricultural and forestry offsets. Cumulative emissions reductions and sequestration between 2008 and 2030. Offsets include soil management, methane and nitrous oxide management, and forestry management.

Figures 2.3 and 2.4 show GHG benefits by geographic region.[3] Each figure reflects cumulative GHG reductions by region by the year 2030. For energy efficiency, the South Atlantic and East North Central regions provide significant reduction opportunities. States in these areas do not have comprehensive energy efficiency programs today. For agricultural offsets, three regions—the South Atlantic, West North Central and East South Central—provide almost 60% of the possible GHG reductions from this sector. This reflects the current agricultural focus of lands in these states, and the opportunities to apply improved agricultural practices on a broader scale.

Energy Efficiency

WHAT IS ENERGY EFFICIENCY?

Energy efficiency reduces the energy required to provide the same (or better) level of service. Energy efficiency refers to techniques, measures and devices that provide equal or better service while using less energy. Consider, for example, a more efficient clothes washer: the clothes still get clean, but the system uses less energy.

Energy efficiency can also mean achieving the same level of service through different means. For example, in a residential building, office, or factory, building occupants require sufficient lighting, cooling and heating to productively perform their duties in comfort. These services can be provided in several different ways, each with varying energy use. Buildings can have long rows of overhead lighting, or they can use skylights to let natural light in. The latter requires less energy to accomplish the same goal. For heating and cooling needs, buildings can install boilers and air conditioners, of varying degrees of efficiency. Buildings can also be constructed or modified to take advantage of sunlight for winter warmth or minimize exposure to the sun for summer cooling. In both examples, the building uses less energy for the same amount of comfort. These buildings can operate with much smaller boilers and air conditioning systems, saving significant energy and money.

There is an important distinction between energy efficiency and conservation. Both terms are sometimes used interchangeably, but they have different meanings and context. Efficiency is when a better tool is used for a given job – a more efficient tool simply wastes less energy. Conservation, on the other hand, is when a conscious decision is made to turn a tool off (regardless of the efficiency of that tool), such as turning off lights or turning down the thermostat. Some efficiency tools use conservation techniques. For example, digital thermostats turn down heating or cooling when it isn't required, and lights on timers or sensors reduce use when light isn't required. Efficiency measures are the broad range of tools which save energy without impacting service.

Energy efficiency and demand-side management programs are implemented either by energy utilities or by third party providers. One common mechanism for implementing efficiency programs is for a state to authorize a Public Benefits Surcharge on utility bills, where collected monies fund efficiency programs (such as appliance and lighting rebates, retrofit inspections, and energy audits). The parties which provide these services are usually required to definitively show how much energy has been saved from an established baseline. Other mechanisms, such as New England's Forward Capacity Market (FCM) provide opportunities for private entities to supply demand reduction and efficiency as if it were a supply resource (i.e. a generator). Performance standards for appliances, buildings and HVAC systems also ensure cost-effective savings for customers and utilities alike.

HOW CAN ENERGY EFFICIENCY BE USED TO MEET GREENHOUSE GAS GOALS?

In a national program to regulate greenhouse gas (GHG) emissions, energy efficiency provides the most cost-effective and reliable means to ensure that emissions reductions occur and accumulate. There are essentially three fundamental ways to mitigate greenhouse gas emissions:

1. Reduce fossil fuel use by replacing fossil generators with renewable energy production (such as wind, solar, and geothermal energy),
2. Capture greenhouse gases before they exit the stack of fossil-burning generators, or

3. Reduce fossil fuel use by reducing energy consumption.

While increasing the availability of renewable energy will almost certainly play a role in meeting GHG targets, energy efficiency is technically achievable today, has a proven track record and is known to be cost-effective. On a relative scale, energy efficiency averages around half the cost of renewable energy, and is far less expensive than yet commercially unproven technologies for capturing greenhouse gases. Opportunities for generator improvements which may reduce GHG emissions are not the focus of this report. For example, marginal GHG reductions can be achieved by improving the heat rate and by operation and maintenance programs such as boiler tune-ups. These techniques should be evaluated by generators, since reduced fuel consumption has economic benefits, but these benefits are not cumulative like those that can be achieved by energy efficiency.

One useful analog for examining a pathway to greenhouse gas reductions is in historical state acid rain and ozone reduction programs. It was found that acid rain-forming sulfur dioxide (SO_2) and ozone-forming nitrous oxide (NO_x) could be cost-effectively reduced by direct controls at the stack, such as scrubbers. There are, however, no commercially-scale versions of the same technologies for carbon dioxide, and it appears that if such technologies do make it to market, they will be expensive and risky.

Energy efficiency reduces electricity demand, which affects the degree and type of electric generation that is required. In the electricity sector, less efficient fossil generators are often more expensive to run because more fuel is required for less energy output. Reducing the total amount of energy required would then likely impact the most expensive and least efficient generators not required to meet daily peak demands. Baseload generation can also be effectively reduced by implementing baseload-type energy efficiency programs (such as refrigeration or industrial processes); rather than displacing gas peaking energy, these programs might displace high emissions baseload coal. The net result is that more efficient generators will continue operations, while less efficient generators will curtail operations.[4]

Energy efficiency measures reduce the need to generate electricity, and can even avoid the need to build new power plants and transmission lines. The avoided emissions will help to ensure that the Obama administration's reduction goals are met, and the avoided new plants and transmission lines will save consumers from paying for unnecessary energy.

WHERE HAS ENERGY EFFICIENCY BEEN SUCCESSFULLY EMPLOYED?

Energy efficiency programs today are being implemented across the United States, providing substantial economic, environmental and energy benefits. Energy efficiency is one of the policy options included in comprehensive climate change action plans completed by thirty states. In the northeast, energy efficiency is now considered a viable energy and capacity resource in electricity markets. For a company selling electricity into the marketplace, the ability to avoid energy use through verified efficiency programs are now valued equally to a traditional generator's ability to create energy.

In the Regional Greenhouse Gas Initiative (RGGI), ten Northeastern and Middle Atlantic States have launched a program that will require GHG emissions from the electric sector to be reduced 10% by 2018. These states have started auctioning GHG allowances to fossil-burning generators and direct the revenue towards programs that reduce electricity demand. States' energy efficiency programs will be ramped up to increase the amount of energy savings achieved, which will lead to GHG reductions. In addition, new state regulations in Massachusetts require all cost-effective energy efficiency to be considered in long-term utility energy procurement plans.

On the West coast, Oregon requires new power plants to offset the GHG emissions from their operation. The Climate Trust of Oregon has developed several energy efficiency projects that have provided the required amount of GHG offsets to allow new power plants to be constructed and operated.

BOX 1: ENERGY EFFICIENCY IN CALIFORNIA

Within the US, California is one of over a dozen states which have invested in energy efficiency to meet demand. Through extensive planning as well as trial and error, the state has developed comprehensive efficiency policies and implementation programs.[5]

The programs have been remarkably effective. From the start of efforts in 1973 through today, California has reduced energy consumption per person dramatically against the backdrop of US consumption (see Figure Box-1).[6] While energy intensity per person has continued to rise steadily throughout the nation, following more trade in electronic goods such as larger televisions, California has achieved a flat rate of consumption. For more information on the California energy efficiency experience see page 38 (California Energy Efficiency)

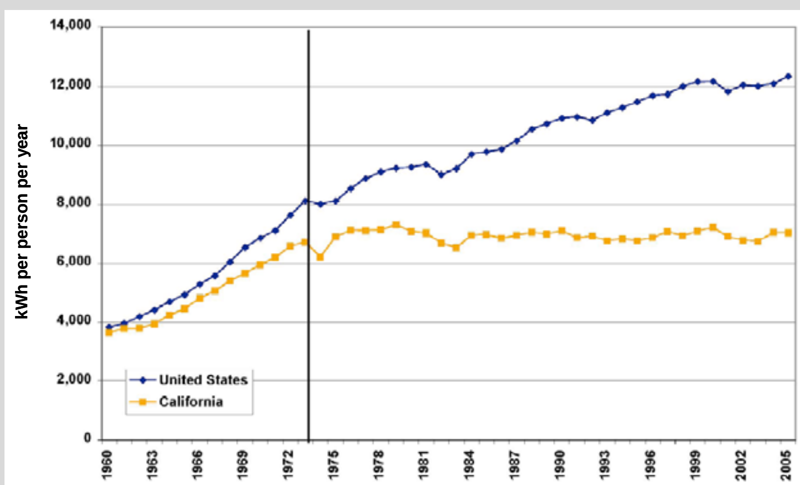


Figure Box-1. California and Total US average annual electricity consumption per person (kWh per capita per year). The black line marks the start of coordinated efficiency programs during the OPEC oil embargo of 1973.

The White Certificate program, enacted in several European nations and recently developed or under development in a few states in the U.S. including Nevada, requires energy suppliers and distributors to obtain tradable certificates which verify that a certain amount of energy has been saved though energy efficiency programs. Parties covered under the White Certificate program can either administer their own efficiency programs or can purchase certificates from other parties running similar programs. The program is designed to ensure that cost-effective energy efficiency is used as a mechanism to both save costs for consumers and meet GHG targets.

IMPORTANT ISSUES IN ENERGY EFFICIENCY

There are four key issues associated with developing and implementing successful energy efficiency programs:

- Valuing energy efficiency as an equal resource to that of generation. Utilities and electric dispatch system operators can recognize the ability of energy efficiency to provide routine, consistent, replicable and predictable performance, equal to that of electricity generation;
- Measuring and verifying performance of energy efficiency measures over time to ensure their sustained performance. Recognized and creditable monitoring and verification protocols have been developed and deployed;
- Designing programs that include long-term goals and short-term objectives that encourage and require revisions that will improve the long-term effectiveness. These programs focus across all sectors—industrial, commercial, residential, government—have dedicated funding, and incentives to reward superior and sustained performance; and
- Removing barriers that preclude or impede energy efficiency from achieving its full technical and cost-effective potential.

Agricultural and Forestry Offsets

WHAT ARE OFFSETS?

Offsets are emissions-reducing activities in sectors which are not regulated under an emissions cap. These activities can be used to generate tradable carbon credits and help reduce the cost and increase the flexibility of meeting GHG targets. Because forestry and agriculture are unlikely to be subject to mandatory emissions limits, offsets include agricultural or forestry activities which sequester or reduce net emissions of carbon dioxide (CO_2) or other greenhouse gases. It is anticipated that in a carbon-constrained economy, farmers and forest managers would be able to sell carbon credits for verified reductions in greenhouse gases and that these credits could be traded and used to “offset” emissions in the capped sectors. There are numerous activities that could qualify as offsets, many of which have environmental co-benefits. Agricultural and forestry offsets can be partitioned into activities which sequester CO_2, or those that reduce the emissions of CO_2, methane (CH_4) and nitrous oxide (N_2O). Both CH_4 and N_2O are potent greenhouse gases, with 12 and 210 times more global warming potential than CO_2.

Crucially, offset activities which are awarded credit for reducing or sequestering GHG emissions must be real, additional, verifiable, and enforceable. Hence, clearly defined criteria based on good science will be needed to define verifiable baseline emissions (i.e. expected emissions in absence of an offset program), and monitoring and verification are essential elements of an effective offset program.

The activities below reduce or sequester greenhouse gases. However, the ability to mitigate global warming does not necessarily always equate to an ecologically sustainable activity, and these types of projects should be pursued carefully to ensure that unintended environmental and economic consequences are anticipated and minimized.

Sequestering CO_2

- Soil management: Intensive tilling releases CO_2 by exposing soil bacteria to oxygen, which then allows the bacteria to process soil carbon into CO_2. Conservation tillage (no-till /low-till) keeps carbon sequestered in the soil and has been estimated to sequester on average 0.7 – 1.2 tons of CO_2 per year for 15-20 years.[7]
- Afforestation: Forests are able to store large amounts of carbon in wood. Planting trees or allowing natural regeneration to occur can result in 2.4 – 10.5 tons of CO_2 per year being sequestered for upwards of 90 years.
- Forest management: Carefully managing forests for maximum carbon storage before harvesting can draw down an extra 1.1 – 8.5 tons of CO_2 per year.

Reduce emissions of CO_2, CH_4, and N_2O

- Fertilizer management: The most important fertilizer is nitrogen in the form of anhydrous ammonia, urea, ammonium sulfate and/or ammonium nitrate. These nitrogen-containing compounds, if not utilized by crops quickly, react in the environment and can be converted into gaseous compounds including a potent GHG N_2O. Increasing nutrient use efficiency, the proportion of the applied fertilizer that gets used by the intended crop, could cut more than half (58%) of all agricultural non-CO_2 GHG emissions utilizing existing best management practices.
- Cattle diet management: Cattle emit CH_4 during enteric fermentation when the bacteria in their gut are unable to effectively process foods in the cattle diet. Nearly one-third (28%) of all agricultural non-CO_2 emissions could be trimmed by optimizing cattle diets to reduce methane emissions.
- Manure management: Manure gathered in lagoons decomposes without oxygen, generating both CH_4 and N_2O (17% of all agricultural non-CO_2 emissions). Capturing and combusting the methane emissions reduces the potency of the emissions source (converting the methane to CO_2), and can be harnessed for on-farm energy production. Manure on open grazing lands decomposes with oxygen present and does not create methane.

HOW CAN AGRICULTURAL OFFSETS BE USED TO MEET GREENHOUSE GAS GOALS?

Offsets are GHG reducing activities from sectors not subject to a regulatory limit on emissions. In an economy where carbon emissions are regulated and traded, credits for reducing greenhouse gases have a commodity price. If an emitter is unable to reduce greenhouse gas emissions below their allowance, they may purchase emissions reduction credits from lower emissions generators. It has been proposed that one way of reducing emissions from a wider range of sectors, as well as achieving more economic reductions is to allow a fraction of these credits to be derived from projects not covered directly by the policy. These verified credits offset the need for a covered emitter to reduce their own emissions. Each offset credit is equal to one ton of carbon dioxide either sequestered or not emitted (relative to a baseline operation).

The United States can effectively reduce greenhouse gas emissions by tapping into offsets in the agricultural sector. Policies allowing the agricultural sector to be involved in the emissions reductions economy could target a wide array of activities and innovative approaches from farmers, dairy and cattle operations, and forest managers. The incentive offered for these complementary activities could be provided in an offset market, where farmers and foresters could choose to participate in the carbon economy by creating real and verifiable emissions reductions through activities identified as sources of net reductions in emissions or increases in sequestration.

In the offset market, for example, a dairy farm could install a manure digestion system and both self-generate power as well as receive credit for the verified methane reductions. The offset market provides both an opportunity for wider participation in the carbon economy and often less expensive ways of reducing GHG emissions. By including offsets in a carbon market, more opportunities are made available, the prevailing price of emissions credits is reduced, and capital is put to productive use at a lower cost. In particular, because agricultural and forestry offsets could be made available quickly with technology and techniques already available, an offset market could help ease the transition into a carbon-constrained world.

Offsets, however, require that regulations dealing with defining beneficial activities, monitoring, verification, and permanence need to be established under a rule making process. They should be considered as complementary activities rather than an exclusive alternative to reducing emissions from fossil fuel combustion.

WHERE HAVE AGRICULTURAL OFFSETS BEEN SUCCESSFULLY EMPLOYED?

A variety of offset projects have been undertaken in recent years. Almost all of these projects have been in the so-called “voluntary” offsets market. These projects are often used to gain experience or substantiate claims to consumers. Under comprehensive climate legislation, rules and regulations governing offset markets will require a higher degree of transparency and verification. Three offset projects are described below. More information on offset programs can be found in Chapter 4.

The Pacific Northwest Direct Seed Association (PNDSA) and Entergy are partnering in a long-term project to quantify soil carbon and greenhouse gas reduction credits resulting from the adoption of direct seed practices by participating growers.[8] PNDSA represents 300 farmers in Washington, Oregon and Idaho who collectively own approximately half a million acres. The direct seed practice includes low- and no-till methods of planting and fertilizing. Direct seeding increases and stores organic soil carbon so that for every ton of carbon sequestered, or stored in the soil, 3.67 tons of carbon dioxide (CO_2) are removed from the atmosphere. The project includes a 10-year lease between PNDSA and Entergy for roughly 30,000 tons of CO_2 sequestered and retained in the soil through direct seeding. Through this leasing arrangement, the CO_2 emissions avoided through direct seed agriculture will be credited to Entergy to offset CO_2 emissions from their energy operations for the term of the lease. The farmers sequestering the carbon gain a new revenue stream, and save money by using less fertilizer and gasoline in the direct seed techniques.

EcoSecurities, an Ireland-based international carbon offset developer, has created the first anaerobic digester project to be registered with the Climate Action Reserve (CAR) and receive Climate Reserve Tons (CRTs). Located at a dairy farm in Wendell, Idaho, the facility processes the manure from approximately 5,400 cows in an anaerobic digester, capturing the methane that is produced. The resulting gas is then transported to a methane enrichment facility where it is scrubbed of impurities, resulting in pipeline quality methane. A small amount of the gas is reserved to fire boilers onsite. Prior to the implementation of the reduction project, the manure was transported to an anaerobic lagoon and all methane was released into the atmosphere. According to the first verification report, for the two-month period of August 2008 to September 2008, the project reduced the emissions associated with the dairy farm's operations by over 9,300 metric tons of CO_2e below baseline levels. The project relies on the methodologies detailed in the California Climate Action Registry's (CCAR's) Livestock Verification Protocol, and First Environment, Inc. verified the emission reductions achieved during the first reporting period. EcoSecurities has been awarded credits for these reductions, which may be sold in the voluntary market.

PG&E, a California-based utility, is relying on forest-based carbon offsets to provide its customers with the option of voluntarily offsetting the GHG emissions associated with their energy use. The Garcia River Project, for example, has established a permanent conservation easement to protect a northern California forest area.[9] In addition to the carbon reduction benefits, the project will preserve habits for a variety of animals, including several endangered species. The project relies on standards provided by the Climate Action Reserve's Forest Protocol. Reductions are verified by an independent auditor.

WHAT ARE IMPORTANT ISSUES TODAY WITH AGRICULTURAL OFFSETS?

There are four key issues which complicate the production and accrediting of agricultural and forestry offset projects.

- Identification of activities: There are many activities that have the potential to either reduce greenhouse emissions, sequester additional carbon or both, but these activities are sensitive to environmental conditions and the net result of specific activities can be either positive or negative depending on location and activity details. It is important to create a science-based framework that identifies the activities that can be used to provide offset credits and the conditions that need to be met to produce positive results

- Verification, validation, and additionally: It is important to verify that agricultural and forestry sequestration projects are successfully holding atmospheric carbon. Auditors need to validate offset assumptions, ensure that appropriate sampling and measurement techniques are used, and check that offset projects enacted for economic reasons other than to reduce GHGs are not double-counted.
- Permanence and monitoring: Agricultural sequestration projects only hold carbon as long as the activity is maintained. Managing the temporally discrete nature of the storage associated with many offset activities needs to be handled through contractual regulations established in advance of these activities. There need to be requirements to monitor storage and emissions in line with contractual obligations.
- Leakage: If a carbon sequestration or reduction program enacted in one location or sector causes another location or sector to increase carbon emissions, this loss of efficacy is called leakage. If, for example, an activity prevents timber in an offset project from reaching the market, buyers may instead import timber from a non-offset area. If this occurs, a forest which would have remained intact elsewhere is instead cut, and the emissions benefit of the project is lost. .Rules and mechanisms for identifying, quantifying, and preventing leakage are important in an offset-based market.

Chapter 3: Background on Energy Efficiency

WHAT IS ENERGY EFFICIENCY?

Energy efficiency reduces pollution and carbon emissions associated with fossil fuel combustion by reducing energy consumption while maintaining the same level of energy service or sometimes improving the quality of energy service. More specifically, efficiency reduces energy consumption by electric appliances, heating and cooling systems, and entire building envelopes at a lower cost per kWh saved than the cost of electricity per kWh (the same applies to heating programs). In addition to economic and environmental benefits, efficiency provides other benefits to society: (a) reducing electricity loss in transmission and distribution lines; (b) avoiding or deferring the need to build new power plants; (c) enhancing reliability of the electric grid; (d) stabilizing and lowering electricity prices in wholesale markets; (e) reducing uncertainty accompanying bulk power generation; and (f) enhancing energy security and boosting local economies.

Energy efficiency fits under the umbrella of demand-side management (DSM), a term used to describe ways in which utilities manage customer demand (as opposed to supply-side management, or generation). DSM can also include demand response (DR), which includes programs which reduce use specifically during peak hours. DR programs reduce peak and capacity requirements, but may have low to negligible emissions benefits.

Traditionally, the United States has had a bias towards supply-side solutions, building more generation to provide electricity, or building more highways to address congestion and growth. We are now learning that these supply side solutions are more expensive to build and maintain, are inflexible and unable to adapt to changing behavior, and have led to many other impacts, such as increased air and water pollution, and land impacts. The table below compares supply-side approaches to those from energy efficiency, reflecting that energy efficiency not only provides GHG benefits, it provides significant economic and energy benefits.

Table 3.1. Comparison of Supply Side Approaches and Energy Efficiency

Supply Side "Build More Generation"	vs.	Energy Efficiency
a) Supply side solutions require construction of new natural gas, nuclear and coal plants with carbon storage and sequestration		a) Demand side reductions are more cost-effective, timely and significant
b) Constructing new power plants requires several years to a decade or more, even if permits are expedited		b) Benefits start to accrue immediately and accumulate over the time and life of installed measures and programs
c) Wall Street is increasingly leery of helping to finance new generation, even if it is heavily subsidized. Growth in peak electricity demand is higher than that of base demand, meaning new large plants have lower operating rates and are less attractive financially to investors		c) Energy Efficiency is immune from and helps to dampen the risk and volatility associated with fossil fuels that are causing existing generating plants to request rate increases due to rapid escalation and uncertainty in the oil, natural gas and coal markets.
d) Natural gas prices are higher than those of coal and oil; in restructured areas, natural gas generating units often set the hourly market clearing price, so increasing reliance could result in additional costs being passed along to ratepayers		d) Energy efficiency lowers peak and base demand, lowers hourly electricity prices. All customers benefit even if they themselves do not participate directly.
e) The cost of new generation is more expensive than demand-side measures and these costs are passed along to all consumers		e) Programs achieve success at costs less than half the cost of new generation (3-4 c/kWh vs. 8-11 c/kWh)[10]
f) Misses opportunities for co-benefits		f) Energy, economic and environmental benefits add further value

HOW CAN EE BE USED TO MEET OUR GHG GOALS?

Numerous market barriers exist that prevent the full implementation of energy efficiency measures. These barriers include split incentives between renters and landlords and between landlords and builders; lack of awareness of and information on energy efficiency options; up-front capital costs; high transaction costs; and electricity prices not reflecting actual and societal costs of energy production. To overcome these barriers, energy efficiency can be and has been promoted mainly through (1) utility- or third party-run energy efficiency programs; (2) state and federal building energy codes; and (3) state and federal appliance standards. Creative market-based strategies by energy service companies could be instrumental to promote efficiency in some cases. Public policies, however, have proven to be most effective to promote efficiency measures in many states.

Energy efficiency programs: Efficiency programs can be funded by ratepayers through a surcharge or in electricity rates. They are usually implemented by utilities, but in some cases they are run by third-party administrators, which could be private, non-profit or state organizations. Examples of third party administrators are Efficiency Vermont, Efficiency Maine, Energy Trust of Oregon, and the New York State Energy Research and Development Authority (NYSERDA). Comprehensive efficiency programs usually cover the retrofit of existing homes and buildings (including upgrades to appliances and HVAC systems), new construction, retailer training, and consumer education. They also cover all types of customers, including low-income, residential, commercial and industrial customers.

Building energy codes: Buildings are significant consumers of energy and other resources, and can contribute to local microclimates. According to EPA (2004), buildings in the United States account for 39% of the total energy use, 12% of the water consumption, 68% of the electricity consumption and 38% of the total carbon dioxide emissions.[11] Building codes (such as the International Energy Conservation Code or IECC and the American Society of Heating, Refrigerating, and Air-Conditioning Engineers Standard or ASHRAE) specify minimum energy efficiency requirements for new buildings or for existing buildings undergoing a major renovation. Given the long lifetime of most buildings, amending state and/or local building codes to include minimum energy efficiency requirements, and periodically updating these codes can provide significant long-term energy and GHG savings.

Appliance standards: Appliance efficiency standards reduce the market cost of energy efficiency improvements by incorporating technological advances into base appliance models, thereby creating economies of scale. There are existing federal standards for 19 residential products and 19 pieces of commercial equipment, as well as 14 lighting standards. Laws require the U.S. Department of Energy (DOE) to set minimum appliance efficiency standards that are technologically feasible and economically justified. However, there are many appliances not covered by federal standards for which state standards can play a role. Appliance efficiency standards can be implemented at the state level for appliances not covered by federal standards, or where higher-than-federal standard efficiency requirements are appropriate.

WHERE HAS ENERGY EFFICIENCY BEEN SUCCESSFULLY EMPLOYED?

A number of leading utilities and states are meeting 1% to 3% of their annual energy requirements through cost-effective energy efficiency measures. On average, these energy efficiency measures are saving 1% or more of annual sales over multiple years.

Examples of highest energy savings experienced per jurisdiction or entity are presented in Figure 3.1 below.

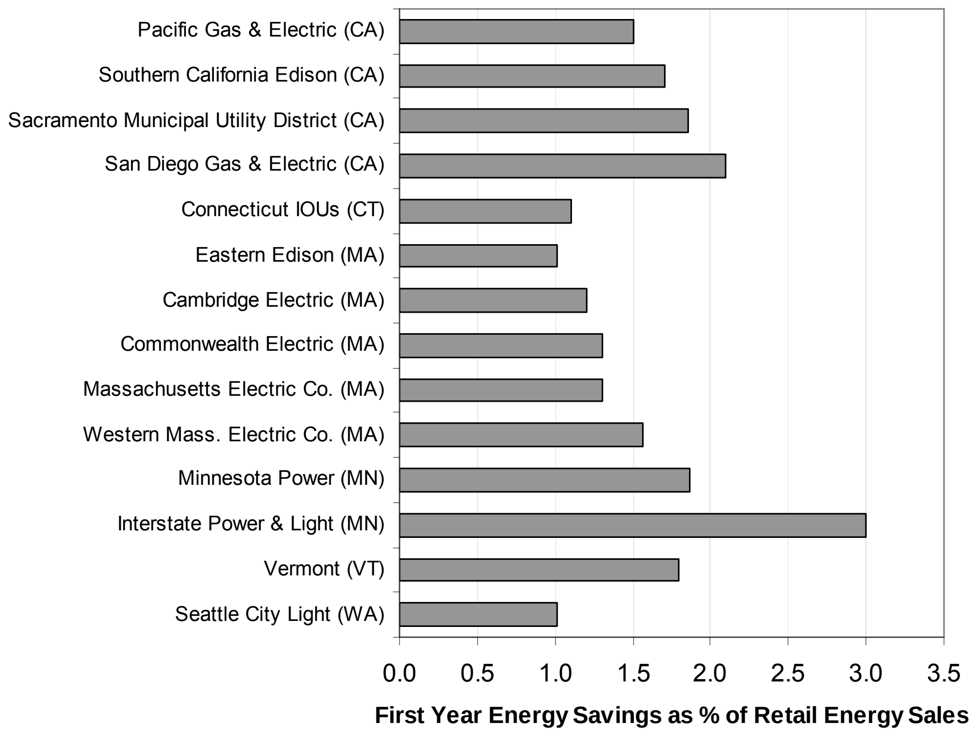


Figure 3.1. First Year Energy Savings as a Percent of Retail Energy Sales by Leading Utilities or Program Administrators[12]

DOMESTIC ENERGY EFFICIENCY PROGRAMS

Three distinct and complementary trends are seen in how states value energy efficiency and integrate it as a resource into their energy policies.

- Reducing electricity consumption in real terms to more than offset the growth in demand. The Empower Maryland Act passed in 2008 requires energy consumption to be reduced 15% by 2015[13]. In New York, NYSERDA is required to develop a plan to reduce energy consumption 15% by 2015[14].
- Specified electric savings goals and targets. California is required to meet a 2013 savings goal of 23,183 GWh (about 7% of the projected sales), 4,885 MW peak.[15] In Texas, legislation passed in 2007 doubled the state's requirement for energy efficiency to 20% to offset growth in demand.[16] Illinois established savings goals that begin at 0.2% of electric sales in 2008, and rise to 2% of sales by 2015 and beyond.[17] Efficiency Vermont is contractually required to meet energy and capacity savings goals. [18] The utility has increased energy savings dramatically each year: 1% in 2006, 1.8% in 2007, and 2.5% in 2008.[19]
- Qualifying energy efficiency as a resource. Connecticut has a separate renewable portfolio standard that includes energy efficiency and the thermal

benefits of combined heat and power (CHP), starting at 1% of electric sales in 2007, and rising to 4% in 2010.[20] Hawaii qualifies energy efficiency as a renewable resource.[21]

Regional cooperation is also occurring. The Energy Security and Climate Stewardship Platform signed by the Midwest Governors Association in November 2007 sets forth a strong energy savings goal that ramps up to 2% of load for all electric and natural gas utilities by 2015. Within this group and others, the key strategy is to maximize economy-wide investment in energy efficiency initiatives that are less expensive than other energy options.[22] In keeping with the high market value of energy efficiency, the energy capacity market of the New England Independent System Operator (ISO-NE) values energy efficiency on equal footing to other resources (such as power plants). Energy efficiency played an important role in a recent auction of capacity resources, resulting in capacity prices that were lower than was expected. Additional energy efficiency resources are anticipated to be submitted in future auctions. These will also help New England to meet its RGGI reduction goals.

THE COST OF ENERGY EFFICIENCY PROGRAMS

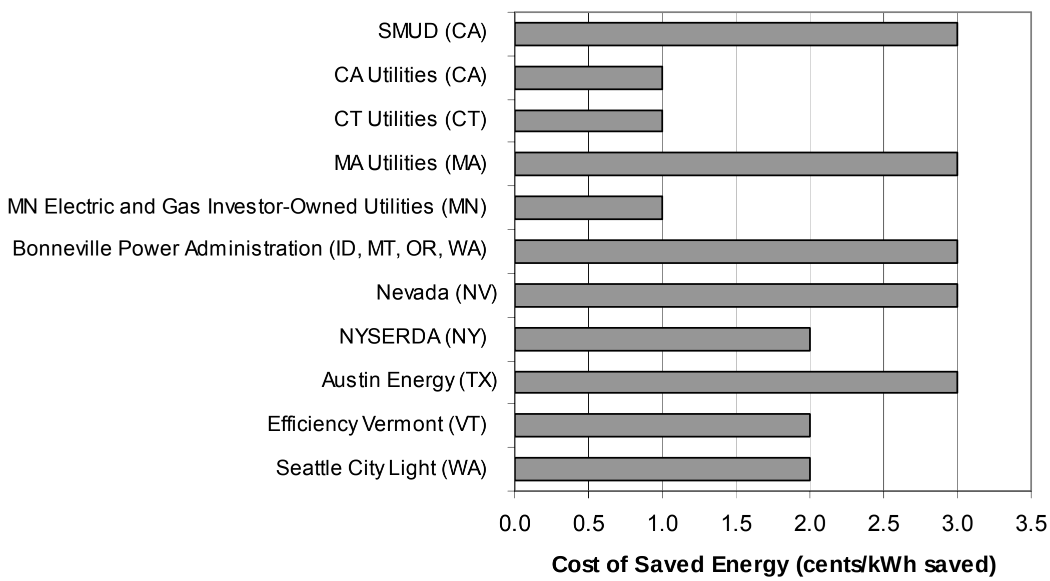


Figure 3.2 Costs of saved energy (CSE), sometimes called the levelized cost of saved energy. These costs are significantly lower than the price of delivered energy.

Data from these programs show the degree to which energy efficiency favorably competes with generation. *The cost of saved energy (CSE), sometimes called the levelized cost of saved energy, is the cost of providing and administering energy efficiency programs per unit of energy savings (e.g., per kWh savings). Depending on the program, CSE by leading utilities ranges as high as 3 cents per kWh saved.*[23] *In contrast, electricity prices range from 5 to 20 cents per kWh produced and delivered, with the national average of slightly above 9 cents per kWh.*[24] This large cost differential between energy efficiency and new generation creates opportunities to pursue even deeper savings (such as for the entire building envelope) that are still more cost-effective than the costs associated with new generation. These data show that even if the program cost effectiveness were twice as high as shown, energy efficiency would still be economically competitive with the costs of new generation.

ISSUES, PROBLEMS, AND SOLUTIONS WITH ENERGY EFFICIENCY

Removing obstacles to energy efficiency measures, such as how they are evaluated and how some programs are implemented, will ensure that the anticipated level of benefits are achieved. Currently, there are disincentives for utilities and distribution companies to aggressively pursue energy efficiency. For example, utility company profits and rate of return are based on the amount of electricity sold in their service territory. By selling less, companies lower their revenues and profits. There are also other barriers to implementing energy efficiency programs:

- Split incentives: This term applies to rental housing and apartment units, where a landlord owns the property and appliances, but does not pay for the electricity. Landlords tend to purchase the least expensive appliances, which consume more energy than slightly more expensive efficient units.
- Cream skimming: Some demand-side management (DSM) programs, especially in their early phases of implementation, have focused on easy, quick-hit types of measures in order to demonstrate significant savings. For example, compact florescent lights (CFLs) provide very real and cost-effective savings, but focusing on such a narrow area misses opportunities to achieve substantial and long lasting savings. If an energy audit simply replaces incandescent lights with CFLs, but does not address other efficiency issues while on-site, there is a significant lost opportunity cost. Having to return to a home or business later to deliver additional services increases administrative costs and decreases overall cost-effectiveness of an efficiency program. Leading programs approach the entire building envelope, appliances and HVAC systems, including boilers and furnaces. Leading programs aim to save fuels in addition to electricity.
- Reliance on certain evaluation tests that exclude consideration of all cost-effective EE. A few states continue to use tests that evaluate potential measures based solely on whether ratepayers who do not participate in the program directly benefit or not, rather than evaluating the costs and benefits for the entire energy system, the state or society.
- Load shapes and customer needs. Post restructuring, many utilities today do not maintain quality data about customer loads, their load shape and demand. This information is typically aggregated by class and then by hour.

However, there are accessible solutions to these barriers. Addressing disincentives to aggressively pursuing energy efficiency can be addressed by either providing performance incentives for utility programs that exceed savings goals, and/or by decoupling electric sales from revenue. Several states, including California and Connecticut, have objective performance incentive criteria that provide utilities up to 8%

additional revenue for substantially exceeding annual savings goals. Other states have passed legislation that would allow sales to be decoupled from revenue in order to remove disincentive to achieve high levels of savings.

Addressing split incentives requires a combination of standard and code setting, and enforcement, along with assuring that state and utility programs include rental and multi-family sector measures. Updating appliance standards and building codes ensures that baseline levels of energy use improve over time. At the building level, programs can work directly with landlords to focus incentives on the differential costs between a basic appliance and an Energy Star one. Both New York and California have had success in working with multi-family rental housing.

Cream skimming is a pitfall of many new programs. The thinking is that “quick-hit” measures, like CFLs buy-down programs will show early and cost-effective success. But, there is a cost associated with each visit to a home or business, and focusing only on quick-hit measures miss opportunities for deeper and more long-lasting savings. The leading efficiency programs now are looking at the entire building envelope. When an audit or visit is conducted, all savings opportunities are evaluated, and the building owner and the efficiency provider work together to develop and implement a plan to install measures that will realize significant savings. These include lighting, motors, boilers and insulation.

States that use EE cost-effectiveness tests which measure only impacts on rates should instead use other evaluative tests which more accurately determine the benefits and impacts of potential measures for the energy system or society.[25] Most states compare long-term costs and benefits of energy efficiency measures from the perspective of the utility, state or society. These tests include the utility cost test, the total resource cost test, and the societal cost test.

Obtaining improved customer data on usage will require consistent and sustained efforts, and the encouragement of public utility commissions. States that have adopted time of use rates or critical peak pricing may be in a better position to improve data quality. Good data are important to effectively target programs to achieve the highest possible savings, and to obtain feedback on their success. The ISO-NE forward capacity market should also help to improve customer data since resources that qualify for capacity payments must follow approved and recognized protocols to measure the amount of savings that is occurring. PJM is completing a similar process during 2009.

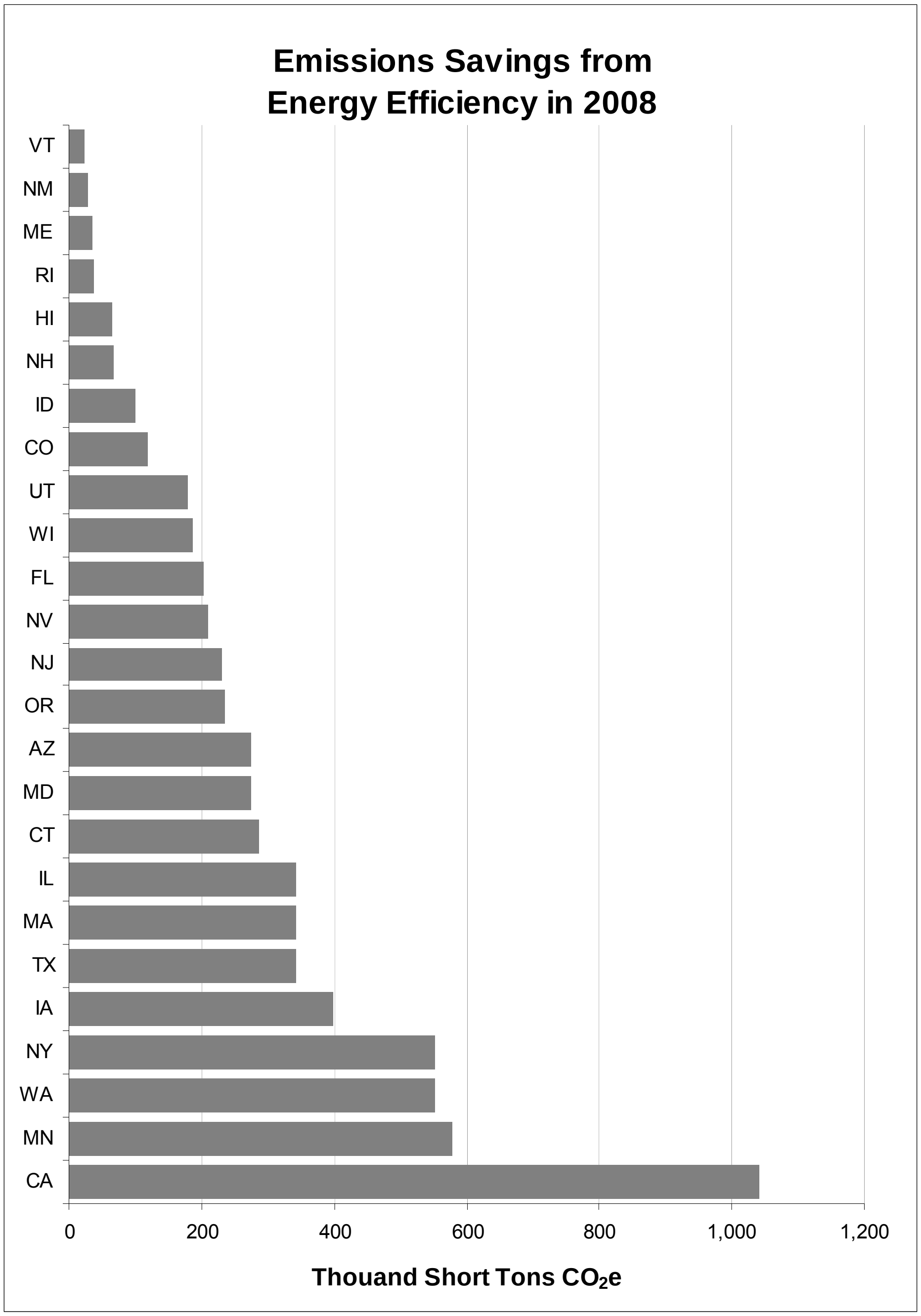


Figure 3.3. New 2008 CO_2 savings from existing state energy efficiency programs. [26]

In Figure 3.3, we calculated GHG emissions reduction for a single year (2008) from the current level of energy efforts in the Unites States to illustrate the degree to which existing programs are achieving new GHG benefits in a single year. These benefits only include emissions reductions attributable to energy efficiency measures that were implemented in a single year; they do not include savings from measures implemented in the past, but which are still operating.[27] Emissions vary by state and region depending upon the fuel used to generate electricity. Only states with available information on operating efficiency programs are listed. This figure shows that programs in the Northeast and Pacific already achieve significant GHG benefits. States in other parts of the United States, such as Iowa and Minnesota, also perform well, and have programs that are avoiding GHG emissions at levels equal to or greater than those on the East and West coasts.

This graph is given as total savings, not relative to a state's consumption. Therefore, larger states with efficiency programs experience larger savings. Even though Vermont, for example, has a rigorous savings program increasing at over 1.6% per year, its energy use and emissions are very small, and thus it shows up as having small savings in this chart.

Note that this estimate is a conservative estimate of total energy savings because there are other program activities that were not included in the analysis such as state-run low-income weatherization programs. The implication of this approach is that our results on emissions savings are conservative in terms of achieving the stated annual efficiency savings goal in each scenario.

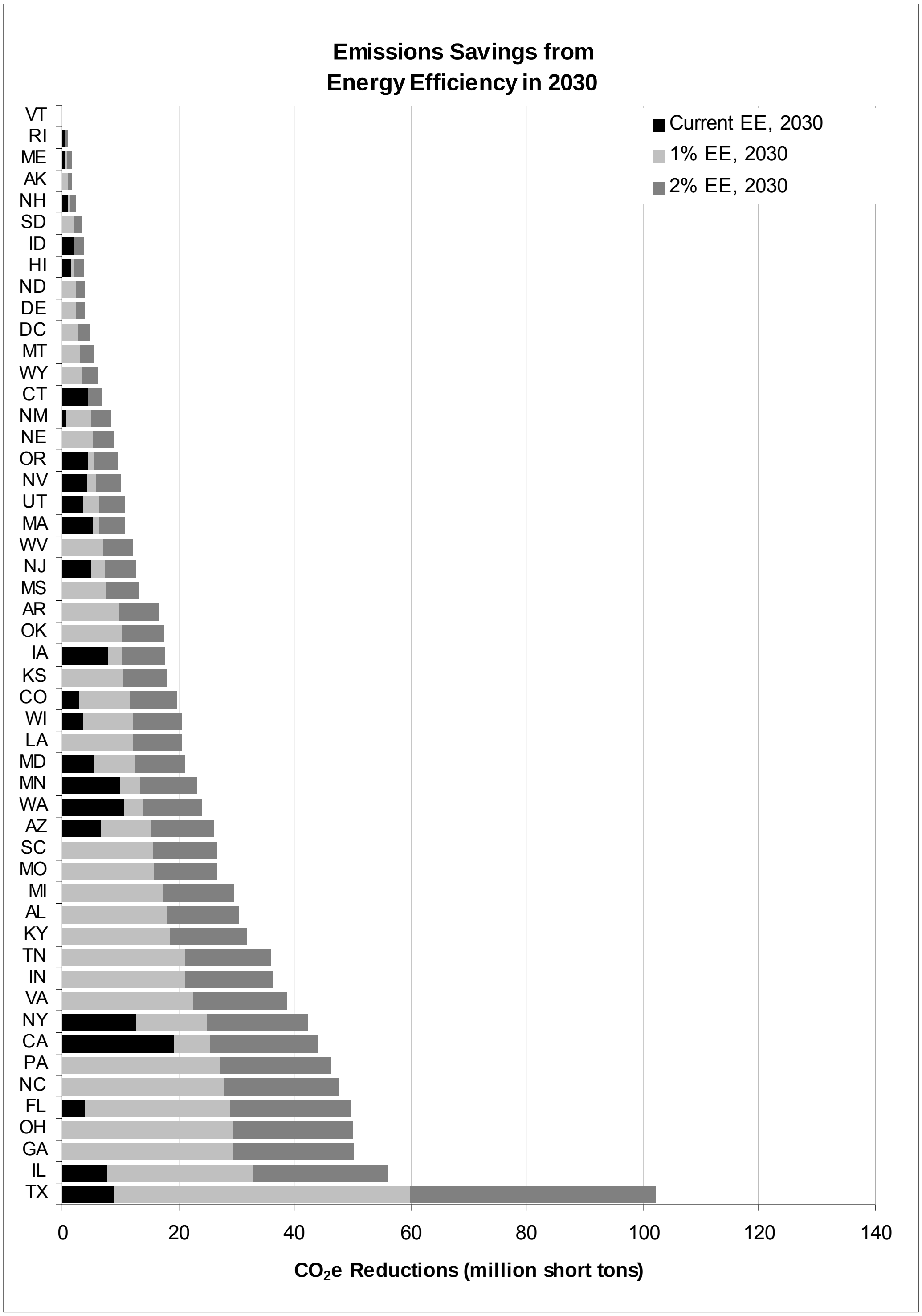


Figure 3.4. CO_2 savings in 2030 from state energy efficiency programs.

In Figure 3.4, we calculated cumulative GHG savings between 2008 and 2030 under three scenarios: (1) efficiency fixed at today's rates from states with active efficiency programs, (2) all states ramping up to 1% annual efficiency over a three-year period, and (3) all states ramping up to 2% efficiency over another four years (please see Appendix A for details on the analysis technique). We calculated this based upon the specific avoided emissions rate for that state or region. The shaded bars represent incremental savings levels from current to 1% and 2% savings per year. The 2% bar represents CO_2e savings which can be achieved by states that implement energy efficiency programs which ramp-up to 2% savings over a seven-year period (average nation-wide).

The states are rank ordered by the cumulative amount of GHG benefits, from least to most. Because this graph is in total GHG savings, large states with high emissions rates show the largest potential savings. Small states or states with low emissions rates have a smaller overall potential. California, for example, has a low emissions rate but a large population, and is already achieving significant savings. Vermont is achieving significant savings already, but has a small population. Texas has a high emissions rate, large population, and does not have a rigorous efficiency program yet. States in the Southeast, which have not previously had comprehensive efficiency programs, are shown to have substantial opportunities to provide for GHG reductions in the future. Data for Georgia and North Carolina, for example, reflect the opportunities there to ramp up from essentially zero to achieving 2%, and their higher avoided emissions due to the predominance of coal generation. Avoiding high coal emissions also helps Ohio, Illinois and Pennsylvania to accumulate substantial GHG benefits over the 22-year period evaluated.

Chapter 4: Agricultural and Forestry Offsets

WHAT ARE OFFSETS?

Offsets are emissions-reducing activities in sectors that are not regulated under an emissions cap which can be used to generate tradable carbon credits. Because forestry and agriculture are unlikely to be subject to mandatory emissions limits, offsets potentially include the suite of agricultural or forestry activities which sequester or reduce emissions of CO_2 or other greenhouse gases. It is anticipated that in a carbon economy, farmers and forest managers would be able to sell carbon credits for activities/practices that achieve verified reductions in greenhouse gases and that these credits could be traded and used to "offset" emissions in the capped sectors. There are numerous activities which could qualify as offsets, many of which have environmental co-benefits. While there are dozens of mechanisms for sequestering and reducing GHG emissions, we choose to focus on three key areas: agricultural sequestration, avoided agricultural emissions, and forest-management. In addition, we have used conservative estimates of feasibility within those areas. All of the programs in this analysis are currently in operation domestically and have identified mechanisms to establish baselines as well as for measurement and verification. We have chosen to exclude biofuels from this analysis as it is likely that liquid fuels and biomass combustion would count towards industrial or electrical allowances rather than function as offsets. Because of data limitations, we also excluded afforestation, avoided deforestation and reduced fossil fuel use on agricultural land although these activities are potentially significant sources of emissions offsets.

Agricultural Sequestration

By adopting no-till or low-till techniques, farmers can potentially store relatively large amounts of carbon in soils, and obtain credit for sequestering CO_2. In contemporary agricultural operations, it is common to intensively till and aerate soils in preparation for planting. Under these conditions, organisms in the soils consume organic materials and respire CO_2, effectively releasing carbon stored in the soil.

By contrast, no-/low-till techniques leave the soil essentially undisturbed. Organisms are not exposed to the air and do not consume organic matter in a way that produces CO_2. Originally conceived to reduce wind and water erosion, no-/low-till techniques leave crop residues on the field between cycles and allow soils to stabilize organic matter.[28] This technique can sequester an estimated 0.7 to 1.2 tons of CO_2 per acre every year, [29] in many soils and agronomic systems.[30] Sequestration rates peak in five to ten years and the system saturates (cannot hold additional carbon) in two to six decades,[31] depending on what types of soils are under what management techniques.[32]

Agricultural Emissions Avoidance and Reduction

Offsets in the agricultural sector can come in the form of sequestration (drawing down CO_2 from the atmosphere) or emissions avoidances and reductions. The EPA estimates that the agricultural sector released the equivalent of over 600 million tons of CO_2e in 2005, over 8% of all US emissions.[33] All of these emissions were released in the form of methane (CH_4) and nitrous oxide (N_2O), potent greenhouse gases which are 21 and 310 times more powerful than CO_2, respectively. Nearly three-fifths of this total was from nitrous oxide emissions from fertilizers on agricultural fields, another third was from methane belched by cattle, and the remainder of the emissions came from manure management practices (see Figure 3.5). Clearly, there are significant opportunities to reduce and avoid emissions in the agricultural sector at a low cost; properly tracking and selling these offset reductions could result in additional income to American farmers.

2005 Agricultural Non-CO_2 Emissions (million tons CO_2e)

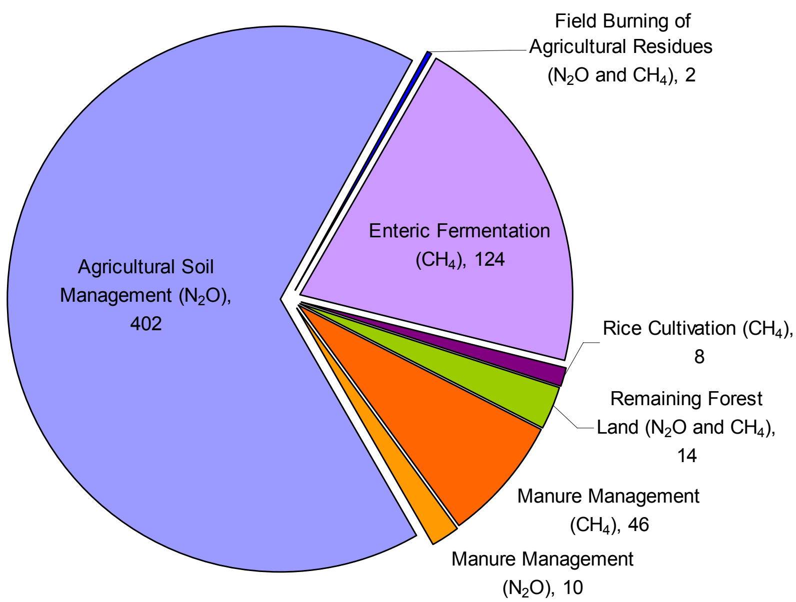


Figure 3.5. 2005 Agricultural Non-CO_2 Emissions, million short tons CO_2e.[34] Source: EPA 2006 Emissions Inventory. [35] This figure does not include emissions from fossil fuels burnt in transportation, farm work, or processing of agricultural products.

The primary emissions from agricultural sources are N_2O from fertilizer applications. These emissions occur when microorganisms in the soil convert the nitrate in fertilizers to nitrogen (N_2). The efficiency of this denitrification process varies with environmental conditions and incomplete conversion results in emissions of N_2O (nitrous oxide). Nitrogen fertilizers are the direct or indirect sources of a large proportion of nitrous oxide emissions [36] (see Figure 3.5). The emissions rate of N_2O can be reduced by using precision agriculture, employing time release fertilizers, and shifting crop types, amongst other techniques.

Methane (CH_4) is released from cattle during enteric fermentation in the ruminant's gut. The rate of fermentation can be managed through diet and supplements to the cattle diet. Methane emissions are significantly lower in foraging animals.[37]

Finally, manure stored in lagoons decomposes without oxygen present [38] and, as a result, produces significant amounts of CH_4 and N_2O. Digesters which cap lagoons and harvest the methane emissions are currently available. These emissions can either be flared, or used to generate on-farm electricity in small combustion turbines; both produce CO_2, which is a much less potent greenhouse gas relative to CH_4. Numerous dairy farms throughout the United States are already utilizing this technology and selling credit from reduced emissions through commercial offset companies.[39]

In a 2005 study, the EPA estimated that the United States could reduce CH_4 and N_2O emissions by 76 million tons of CO_2e every year (with a carbon price) in 2015, increasing to 131 million tons by 2025.[40]

Forest Sequestration and Carbon Retention

Growing forests use CO_2 from the atmosphere to produce wood, leaves, roots, and other plant matter. Over time, some of this carbon dioxide is transferred into the soil. A forest can sequester 2 to 10 tons of carbon dioxide per acre as long as it grows, depending on the location, forest type, and growing conditions.[41] By the time a forest reaches maturity, it can hold over 150 tons of carbon dioxide per acre,[42] but stores very little additional CO_2. At this point, the forest system is "carbon saturated."

If the forest is harvested, some of the carbon dioxide stored in the biomass transfers back into the atmosphere as waste from forestry and lumber operations as it is either burned or decomposes. Therefore, in a carbon economy, one of the most intuitive ways to store carbon in the biosphere is to simply not cut down old, mature forests. Carbon credits or offsets accrued to avoided deforestation can be difficult to track, but can be an effective storage mechanism.[43]

There are subtle, but important, differences among forestry activities as pertains to carbon. Afforestation, the planting of new trees or allowing natural regeneration to occur in previously non-forested areas, is a sequestration activity which draws down CO_2 from the atmosphere into plant material. Forest management and avoided deforestation, although they accomplish sequestration of atmospheric carbon, are carbon management tools, effectively holding CO_2 already fixed in wood rather than sequestering new atmospheric CO_2. Afforestation requires additional land to grow trees (not always an ecologically sound practice), land which is often required to meet other needs including food production. Forest management and avoided deforestation optimizes existing resources.

Establishing new forests or changing the harvesting practices used as part of commercial forestry operations can maximize the carbon stored in forest soils. A forest managed for optimal carbon storage can reduce net CO_2 emissions through increased wood utilization in long-lived wood products and increased conversion efficiency of harvested material to products produced. Some potential mechanisms for increasing carbon storage through forest management include:

- Forests harvested on longer rotations, with more carbon stored in the trees in the forest (this activity has to be balanced with increased harvesting efficiency or a debit for leakage has to be made in the short term).

- Higher tree densities can be established early in a rotation in order to establish higher carbon densities—the resulting added biomass can be harvested for other uses, thus reducing harvesting from other areas.
- Improved harvesting techniques may be used to increase harvesting efficiency and conversion to products—resulting in fewer emissions from decomposition from harvesting and production waste.
- Increased use of high quality wood products that store carbon for long periods in wood products.

Current Domestic Agricultural Offset Programs

The role of agricultural offsets in the domestic and international carbon market is already a reality throughout the United States. State programs to encourage soil and agricultural conservation are rapidly merging to produce economic, profitable, and sustainable income to farmers and foresters through carbon offset programs.[44]

The voluntary Chicago Climate Exchange (CCX) has been actively trading carbon credits since 2003. In 2008, the CCX market traded an average volume of 220,000 tons per day.[45] Amongst its membership CCX lists 67 aggregators of carbon credits, of which at least one-third deal with agricultural and forestry offsets explicitly. It is not clear if projects which sell carbon credits to the CCX today are rigorously monitored and verified, or if these projects will remain intact over the long term.

California, preparing to operate under a cap-and-trade system in AB 32, is rapidly developing GHG reporting standards and baselines to calculate sector-specific emissions reductions. Working groups have already begun creating standards for manure[46] and fertilizer[47] management, and foresting activities[48]. Early studies in the state estimate that at a carbon price of $12.34 per short ton[49] CO_2, California afforestation could sequester up to 19 million tons of CO_2 every year by 2030 and 83 million tons by 2050.[50] Managing forests could retain 8 million tons per year by 2030 in California. In 2001, Wyoming started the carbon sequestration advisory committee to study carbon storage, including in agricultural sequestration.[51] The state is currently considering the effect of 10–25 year contracts for carbon credit in grazing management and conservation tillage, as well as cropland retirement, manure management, and agroforestry.

The Regional Greenhouse Gas Initiative (RGGI), a carbon cap-and-trade system implemented in ten Northeast and Mid-Atlantic States allows a small fraction of emissions allowances to be satisfied through offsets. Generators covered under the cap can offset 3.3% of their compliance obligation through manure management and afforestation within the agricultural and forestry sectors, as well as landfill methane capture, reduced leakage of sulfur hexafluoride (a potent GHG), and energy efficiency of gas and oil use in buildings.[52]

Nebraska and Wyoming enacted legislation at the start of the decade[53],[54] to explore state-wide agricultural offset programs.

ISSUES, PROBLEMS, AND SOLUTIONS WITH AGRICULTURAL AND FORESTRY OFFSETS

Agricultural and forestry offsets serve to sequester CO_2 or directly reduce GHG emissions and thus reduce atmospheric concentrations of greenhouse gases. A national or international program for reducing GHG concentrations can be well served by including the agricultural and forestry community. Agricultural and forestry offsets (a) use a voluntary mechanism to compensate the agricultural and forest sectors for participating in emissions reductions and (b) provide carbon market options by allowing fossil fuel-based emitters (industry and electricity sectors) to find the most economic path towards emissions reductions. However, for both of these significant benefits, agricultural and forest offsets are only effective if the carbon accounting is done rigorously.

There are several issues that need to be addressed in implementing an agricultural and forestry offsets market:

- Verification, validation, and additionally;
- Permanence and monitoring;
- Carbon saturation; and
- Leakage

One of the clearest needs is for uniform verification and validation mechanisms for agricultural and forestry offsets. An offset is always relative to a baseline. If an offset activity is pursued because of the availability of carbon credit, it is a valid offset assuming the activity is verified. However, if a project is pursued for another economic end and would have occurred even without the credit, then the carbon credit is said not to be "additional".[55] There needs to be clear guidance for establishing baselines and ensuring additionality.

Agricultural and forestry sequestration and other activities in uncapped sectors will also require mechanisms to managing "permanence" and monitoring. The goal of reducing GHG emissions is to remove CO_2e from the atmosphere, and keep them out. A tree which sequesters carbon as wood only keeps this carbon out of the atmosphere until the tree (wood) decomposes or is combusted (burned). In a standing forest, new trees replace old trees and carbon builds up in soils, and so the carbon remains sequestered. However, if the forest is harvested and not allowed to regenerate or is not replanted, much of the carbon stored in the forest is no longer sequestered, depending on the fate of the products made from the wood or pulp. By the same token, carbon locked in soils during no-till operations can be released if the soil is intensively tilled. A contractual approach is needed to ensure that the obligations of any emitter which are met through the use of offsets are maintained over time. Leakage occurs when a mitigation or sequestration activity causes an activity outside the reporting area to occur that increases GHG emissions. The IPCC (2000) defines leakage as "the unanticipated decrease or increase in GHG benefits outside of the project's accounting boundary (the boundary defined for the purposes of estimating the project's net GHG impact) as a result of project activities." [56] Conserving forest land may displace farmers or loggers to adjacent lands, which would result in additional deforestation and/or logging. Depending on the region and activity, leakage can vary from non-existent to severe (negating the entire benefit of an activity). In this analysis, we discount the calculated results to simulate the impact of moderate leakage. Details are described in Appendix B.

Finally, the scope for agricultural and forestry offset opportunities varies greatly by region. Figure 3.6 shows state-by-state cumulative offsets which might be obtained from the agriculture and forestry sectors through agricultural soil management, agricultural methane / nitrous oxide abatement, and forestry management. States are ordered by total offset potential. Light gray through dark gray bars indicate the total reductions and sequestration in each of these three sectors, respectively. Negative values indicate states where the sector or activity results in net emissions over the 22-year period. These emissions occur when an activity is abandoned in favor of a more lucrative activity.

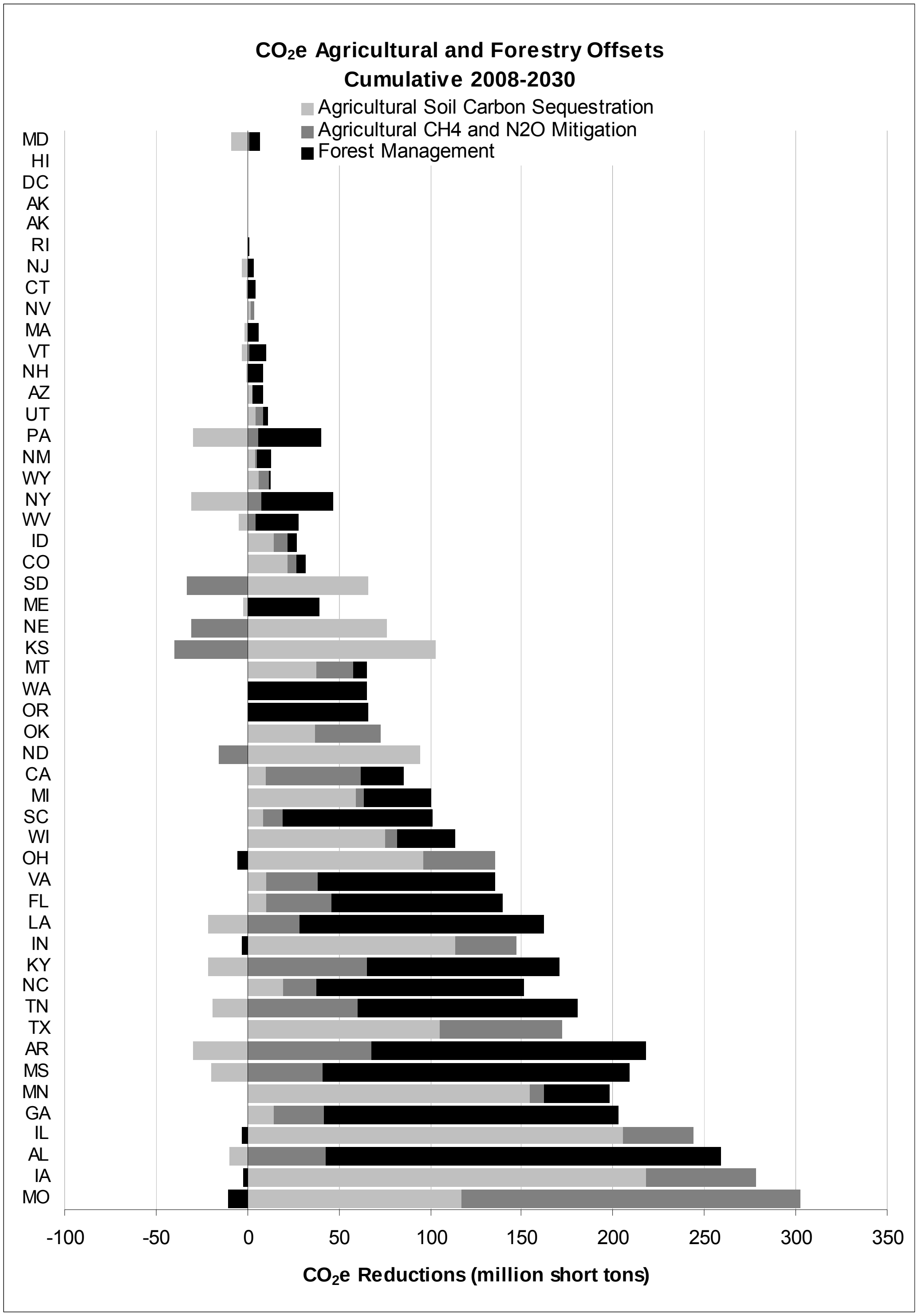


Figure 3.6. CO_2e Agricultural and Forestry Offsets, Cumulative 2008 – 2030. Note: some sectors in some regions experience a net carbon source (i.e. emissions) from offset activities from leakage or from shifting economies (see text). In this graph, these emissions appear as negative reductions, and should be deducted from the total positive reductions.

We calculated agricultural and forestry offsets for each state and year in three categories: CO_2 sequestration from soil management, CH_4 and N_2O reductions from manure, diet, and fertilizer management, and CO_2 sequestration through forestry management (not afforestation) utilizing EPA model results. While these offset activities occurred simultaneously with biofuel production and afforestation efforts, we did not count either of these two categories towards carbon offsets. As the carbon price increases over time, the price point of different offset options shifts. If farmers have perfect foresight, then they will choose offset options which optimize their income in tandem with the price of carbon.[57]

On the whole, however, these simple, inexpensive, and easily achievable offset activities sequester and avoid a significant amount of carbon dioxide emissions, a cumulative 4,270 million tons by 2030. The benefit of these activities are not evenly distributed across the nation: southern states with significant forest cover see a large benefit from extended forest rotations and other forest management practices, while agricultural corn belt states have a great potential for both soil carbon sequestration and, to a lesser extent, N_2O and CH_4 reductions. Northern states do not offer large benefits from these offset activities because of relatively small amounts of agricultural land and/or the existence of already carbon-rich forests. Alaska, Hawaii, and Washington DC were not included in this analysis.

California Energy Efficiency

Within the US, California is one of over a dozen states which have invested in energy efficiency to meet demand. Through extensive planning as well as trial and error, the state has developed comprehensive efficiency policies and implementation programs.[58] Coordinated utility efforts to reduce energy use can be traced back to the energy crisis of 1973, when the OPEC oil embargo led to a spike in energy prices. However, it was not until 1980 when utilities in California moved from conservation programs (i.e. “turn off your lights”) to demand-side management (DSM), a term coined to describe a range of activities which utilities could use to reduce energy or capacity requirements. Spending on energy efficiency, often the least expensive way for regulated utilities to meet demand requirements, rose through the 1980s to $230 million. In the early 1990s, the state began rewarding utilities with performance incentives and allowed the utilities to recoup the costs of efficiency programs. In the late 1990s, California, along with Texas and several Northeast states underwent restructuring, splitting utilities into private generation and transmission companies and regulated distribution utilities. Without clear incentives and regulatory guidelines, utilities shuttered many efficiency programs. Piloting a new mechanism, California utilities were granted the right to collect a Public Goods Charge (known more generally as a System Benefit Charge), monies which were designated specifically for efficiency programs. Today, utilities in California still use this separate pool of capital to fund energy efficiency programs for residential, commercial, and industrial customers. In 2009–2011, the program is expected to be able to fund nearly $1 billion in efficiency each year;[59] utilities are mandated to save 23,183 GWh per year by 2013.[60]

The programs have been remarkably effective. From the start of efforts in 1973 through today, California has reduced energy consumption per person dramatically against the backdrop of US consumption (see Figure Box-1).[61] While energy intensity per person has continued to rise steadily throughout the nation, following more trade in electronic goods such as larger televisions, California has achieved a flat rate of consumption.

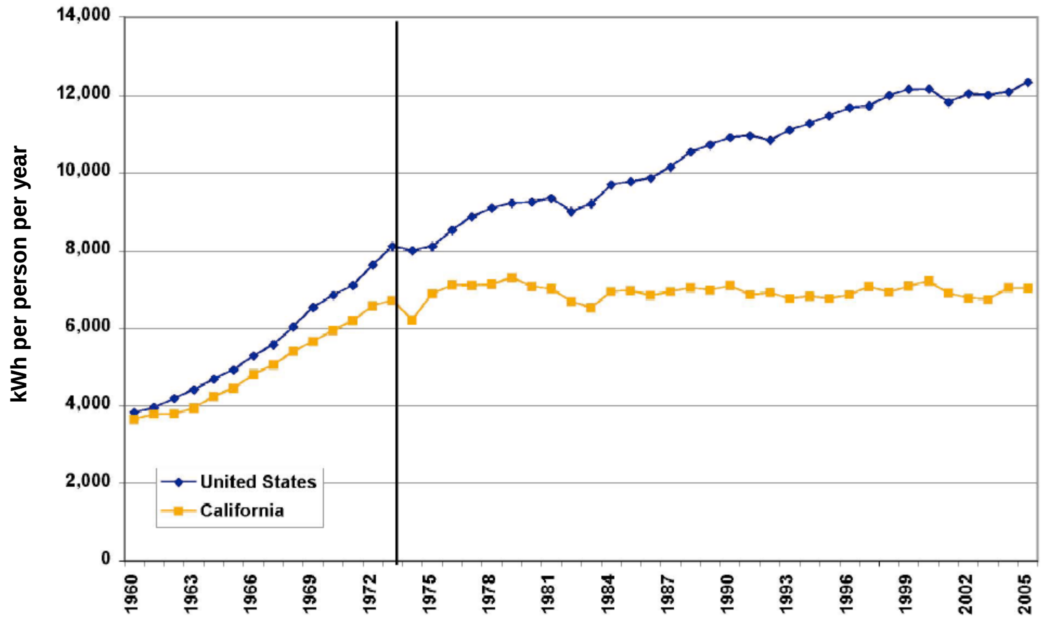


Figure Box-1. California and Total US average annual electricity consumption per person (kWh per capita per year). The black line marks the start of coordinated efficiency programs during the OPEC oil embargo of 1973.

Under California code, utilities must fulfill "unmet resource needs through all available energy efficiency and demand reduction resources that are cost effective, reliable, and feasible."[62] Utility-run energy efficiency in California (and elsewhere) includes a wide suite of programs, including energy audits, rebates for highly efficient appliances, lighting, and windows, weatherization, and recently, heat-island abatement efforts. Utilities in California have mandated reduction goals, which are updated on a three-year cycle by the California Energy Commission (CEC). The utilities administer a variety of programs, as specific as rebates for efficiently rated appliances or working with industrial customers on large-scale retrofits. The funds, as well as monitoring and verification efforts are overseen by the California Public Utilities Commission.

In addition to utility-driven energy efficiency programs, California continues to implement aggressive appliance standards, building codes, and HVAC requirements. These standards and codes set minimum performance standards for energy usages, such as the efficiency of insulation and windows, or furnaces and air conditioners. Performance standards, combined with utility efficiency programs have proven to be highly cost effective. Utilities are now moving at full speed to achieve a high level of savings: in 2008, programs in California's major utilities alone achieved first-year savings of 2.6%. California has set a goal of net zero energy use for residential and commercial new construction by 2020 and 2030, respectively.

Appendix A: Energy Efficiency Analysis and Extended Background

Overview on the analysis

This analysis shows three alternative scenarios of CO_2 emissions from the electric sector between now and 2030 in comparison to President Obama's GHG targets. For the alternative scenarios we assumed all states start or increase their electric energy efficiency activities and reach a certain percentage of energy savings as a percent of annual energy sales over a number of years. Two scenarios are explored: in the first, states seek to increase savings to a load-growth slowing 1% per year; in the second, states look to achieve at the rate of today's leading utilities at 2% per year. In states without in-place efficiency programs, it can take a number of years to implement programs and penetrate the market; therefore we assumed each state would take about 3 to 4 years to increase savings by the amount equal to one percent of sales from current EE levels. We then estimated the total CO_2 emissions from the electric sector under three scenarios based on our projection of emission factors between now and 2030 for each state. Emission factors were developed based on historical and projected emissions data by state or region available from U.S. EPA and EIA.

RESULTS

Projection of Energy Consumption

State specific energy consumptions were required to be projected to 2030 in order to analyze the impact of DSM measures. Data for 2007 state consumption was taken from the EIA's "Current and Historical Monthly Retail Sales, Revenues, and Average Revenue per Kilowatthour by State and by Sector" spreadsheet (Form EIA-826). The 2007 consumptions were then extrapolated out to 2030 using the corresponding annual growth rates that we identified through ISOs load projections and EIA's annual energy outlook. Some regional ISOs provided their estimates for state load growth. Where state specific load growth projection was not available, EIA's regional load growth projections from the AEO 2007 were applied. In the case where an ISO didn't provide state projections to 2030, the AEO 2007 regional growth rate for that state was used from the year where the ISO data left off. The resulting total load forecast for the U.S. is shown below. This estimate includes transmission and distribution line loss. Where line loss data was not available, 8% loss factor was applied.

Table A.1. US Load Forecast

US Load Forecast		
Year	GWh	Growth
2007	3,748,149	
2008	3,824,629	2.0%
2009	3,882,809	1.5%
2010	3,948,702	1.7%
2011	4,013,480	1.6%
2012	4,083,630	1.7%
2013	4,143,829	1.5%
2014	4,206,473	1.5%
2015	4,270,030	1.5%
2016	4,337,552	1.6%
2017	4,391,560	1.2%
2018	4,447,269	1.3%
2019	4,508,888	1.4%
2020	4,576,087	1.5%
2021	4,631,317	1.2%
2022	4,695,771	1.4%
2023	4,758,569	1.3%
2024	4,823,940	1.4%
2025	4,886,380	1.3%
2026	4,953,656	1.4%
2027	5,024,515	1.4%
2028	5,097,808	1.5%
2029	5,159,585	1.2%
2030	5,228,868	1.3%

Projection of CO2 Emissions by State

We used state-specific emissions data available from US EPA's Emissions & Generation Resource Integrated Database (eGRID) for the 2007 state specific total CO_2 rates. The eGRID contains emission totals and rates of, among other gases, CO_2 for all 50 states. The 2007 rates were then extrapolated to 2030 at each states corresponding regional emission growth rates, which were estimated based on the data available in the EIA's AEO 2007. The projected emission rates were then multiplied by the state load forecasts to determine the BAU total CO_2 emissions by state to 2030. The results for total US BAU emissions are shown below.

Table A.2. US Load Forecast

US BAU CO_2 Emissions		
Year	Million Tons CO_2	Growth
2007	2,715	
2008	2,755	1.4%
2009	2,801	1.7%
2010	2,870	2.4%
2011	2,913	1.5%
2012	2,963	1.7%
2013	3,009	1.6%
2014	3,067	1.9%
2015	3,106	1.3%
2016	3,153	1.5%
2017	3,187	1.1%
2018	3,218	1.0%
2019	3,258	1.2%
2020	3,312	1.7%
2021	3,368	1.7%
2022	3,426	1.7%
2023	3,488	1.8%
2024	3,545	1.6%
2025	3,594	1.4%
2026	3,651	1.6%
2027	3,717	1.8%
2028	3,780	1.7%
2029	3,839	1.6%
2030	3,915	2.0%

Separate emission rates were needed to develop an avoided emissions estimate from energy efficiency measures. These rates are different from the BAU rates since the energy saved would displace units operating on the margin, rather than a simple reduction in the overall system-wide fuel mix. Using the eGrid data on state specific non-baseload CO_2 emission rates in 2007, projections could be made to 2030 by applying the same regional growth rates as used in the BAU estimates. These rate forecasts were then multiplied by the avoided energy in each year from efficiency measures to come up with the resulting avoided emissions.

METHODOLOGY

Alternative Energy Efficiency Scenarios

As presented in Table A.3, some electric utilities or third party administrators of energy efficiency programs are satisfying 1 to 2% of the state's electricity needs through energy efficiency measures. Further, Connecticut, Vermont and parts of the Pacific Northwest are aiming toward 3% in their state energy plans. Based off the current experience and state's recent policies for energy efficiency, we developed two scenarios on efficiency savings goals as follows:

(1) all states ramping up to 1% of annual sales per year;

(2) all states ramping up to 2% of annual sales per year; and

Because it is difficult to increase the level of savings quickly, we assumed ramp-up rates to reach a certain level of energy savings. Specifically we assumed states would need 4 years to increase energy savings from 0% to 1% and 3 years again to reach 2% per year. According to this schedule, states that currently do not have sizable energy efficiency programs would reach 2% in 7 years or by 2015. This is consistent with some of existing, aggressive state or regional policies. For example, the Energy Security and Climate Stewardship Platform signed by the Midwest Governors Association in November 2007 sets forth a strong energy savings goal that ramps up to 2% of load for all electric and natural gas utilities by 2015.

A meta-study of energy efficiency potential studies conducted by ACEEE (2004) found that the levels of annual economically achievable energy efficiency potential are slightly above 3% for the first 5 to 10 years with the average of 1.2% for a 20 year period.[63] ACEEE (2004) notes that the drop in savings potential for the average value is primarily "due to the fact that existing technologies can be heavily adopted over the first decade, and that the new technologies and practices that past experience would lead us to anticipate would emerge during the second decade, are not included in most potential studies." In fact, there are also leading utilities or states that already save more than 1.2% of annual energy sales. This is probably a reflection of the study results for the early years of efficiency potentials and states with plans in place to achieve 3% per year or higher.

The current levels of energy savings for numerous states were also investigated with the major focus on investor owned utilities' programs through numerous utility efficiency program filings efficiency annual reports, other reports which analyzed efficiency programs and raw data directly obtained from program administrators. Where any significant activities are not known or if data on efficiency programs are not publicly available we generally assumed a state does not have any sizable efficiency program activities and assigned zero current-day savings. Because we identified energy efficiency expenditures for most of the states in the surveys conducted by ACEEE and CEE (Consortium for Energy Efficiency),[64] we were able to make sure that this approach does not ignore any sizable energy efficiency programs for which budget data were available, but savings data were not available.[65] However, it is important to note that this approach is a conservative estimate of total energy savings because by adding savings from those states mentioned above and savings from public utilities that were not included could have some sizable effects on the current status of energy savings in the U.S. The implication of this approach is that our results on energy savings and thus emissions savings are conservative in terms of achieving the stated annual efficiency savings goal in each scenario.

Table A.3. Current Level of Electricity Savings as a Percent of Annual Sales

State	%	State	%	State	%	State	%
AK	*n.i.*	ID	0.9%	MT	*n.i.*	RI	0.9%
AL	*n.i.*	IL	0.2%	NC	*sm*	SC	*n.i.*
AR	*n.i.*	IN	*sm*	ND	*n.i.*	SD	*n.i.*
AZ	0.4%	KS	*sm*	NE	*n.i.*	TN	0.0%
CA	0.7%	KY	*sm*	NH	0.8%	TX	0.1%
CO	0.2%	LA	*n.i.*	NJ	0.6%	UT	0.6%
CT	1.1%	MA	0.8%	NM	0.1%	VA	*n.i.*
DC	*sm*	MD	0.4%	NV	0.7%	VT	1.7%
DE	0.0%	ME	0.6%	NY	0.5%	WA	0.7%
FL	0.1%	MI	*sm*	OH	*sm*	WI	0.3%
GA	*sm*	MN	0.7%	OK	*n.i.*	WV	*n.i.*
HI	0.6%	MO	*sm*	OR	0.8%	WY	*sm*
IA	0.7%	MS	*n.i.*	PA	0.0%		

Information for the table above was collected from the American Council for an Energy-Efficient Economy (ACEEE), the Council on Energy Efficiency (CEE), as well as state Public Utility Commissions, public filings and information from utilities, and third-party research organizations.[66] The information reflects publically available information. Where information was not available, the table is marked as no information ("*n.i.*"); where a small amount of funding for either energy efficiency programs or research and development is known, the table is marked for small funding ("*sm*"). For both of these categories, it was assumed that at the time data was collected (usually 2007 and after, see sources) the current savings being achieved by these states was zero or near zero. A few of these states have either specific targeted efficiency programs (towards low-income or other groups), or have published plans for future efficiency.

Long-Term Savings by State Energy Efficiency Programs

To be effective as an emissions reduction tool, energy efficiency programs must be sustained over the long term, first flattening demand growth and then pushing it down to meet GHG goals. States and utilities with a history of efficiency practice have demonstrated that it is possible not only to meet one to two percent efficiency targets, but to steadily increase the rate of annual savings each year. Figure A.1 below charts the progress of efficiency programs in four leading utilities (these four are only an example, not necessarily the highest achieving utilities). Over time as both interest and increasingly effective policies and market mechanisms have evolved to encourage energy efficiency, committed programs have steadily increased to offset more demand.

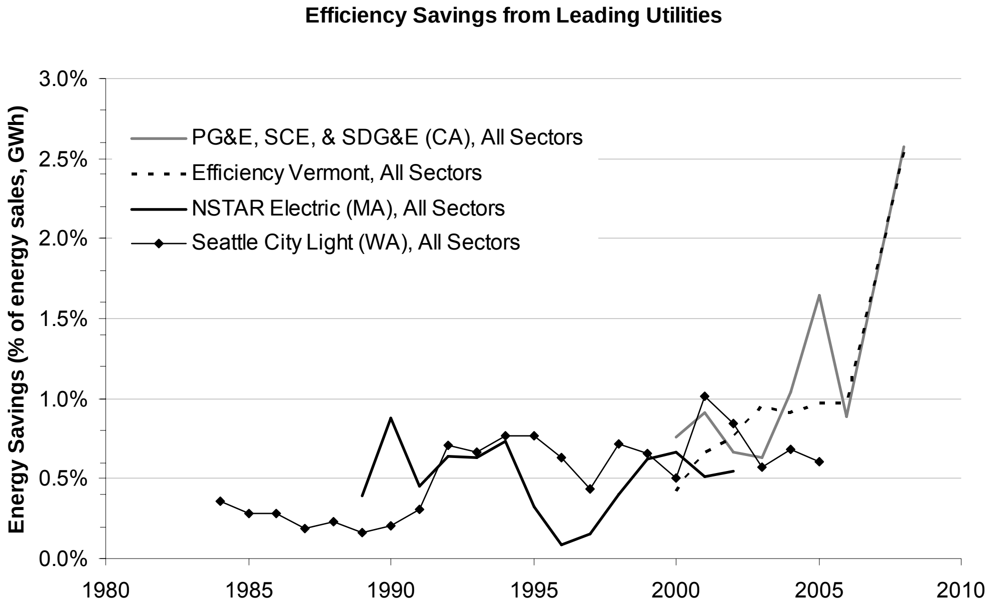


Figure A.1. Energy savings from efficiency programs as a percentage of energy sales for four leading utilities. Time series are first-year savings based on publically available information sources.

Seattle City Light, in Washington, has had a long history of steady improvements in energy efficiency. California utilities have been involved in efficiency programs since the OPEC oil embargo of 1973; the history of California efficiency is described in Box 1. Massachusetts utilities have been operating efficiency programs for decades, which were also impacted significantly by restructuring in the mid-1990s. Both CA and MA utilities are now required by statute to pursue all cost-effective energy efficiency as the preferred resource for new load (demand). Finally, Vermont has established a unique statewide efficiency program (Efficiency Vermont): every three years, a competitive bid awards a third-party provider the designation of a statewide efficiency utility. The utility is charged with providing a targeted level of efficiency relative to a baseline, and is funded based on a surcharge. The provider is awarded a performance incentive for exceeding state targets.

California and the Pacific Northwest have had energy efficiency programs for decades. California has maintained per capita electricity consumption at mid-1970's levels through a combination of utility demand side programs, and new and updated building codes and appliance standards (see *Box 1: Efficiency in California*). The result of this sustained progress is impressive, with about 40,000 GWh of accumulative energy savings since 1975. California is building on this success. By 2013, California is required to achieve an additional 23,000 GWh of savings, or half again on top of what they have achieved since 1975.

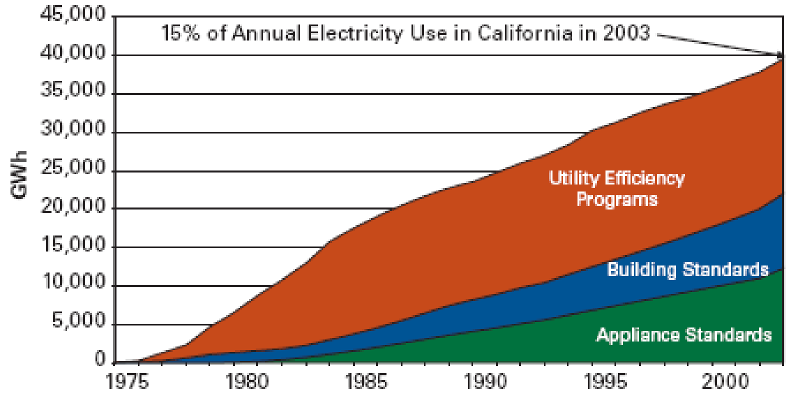


Figure A.2. Cumulative Electricity Savings from California's Energy Efficiency Programs (1975–2003) [67]

Figure A.3 below shows cumulative energy savings that have occurred in the Pacific Northwest since 1978. Like California, these savings have been achieved by a combination of utility DSM programs, and updated codes and standards. Alliance programs refer to programs operated by the Northwest Energy Efficiency Alliance.

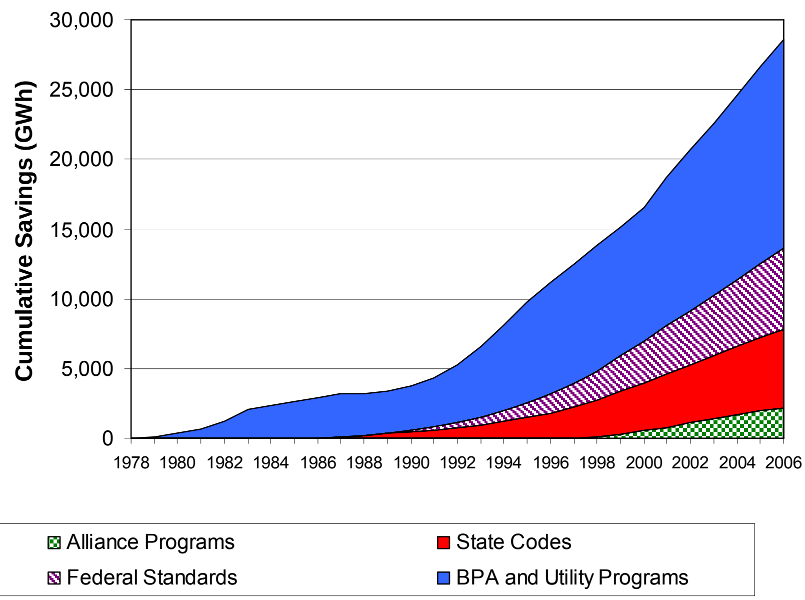


Figure A.3. Cumulative Regional Conservation Savings by Source in Pacific Northwest 1978 – 2006 [68]

Cost of Saved Energy (CSE)

We have undertaken an extensive review of numerous data on the cost of saved energy (CSE) for a number of energy efficiency programs for multiple years since 2000.[69] A total 15 datasets representing utilities or a group of utilities or a state are presented in Figure A.4 below. We found that the CSE range from slightly above 1 cent to close to 7 cents per kWh saved, with the average of 2.5 cents/kWh and the median of 3 cents/kWh saved based on 71 data points. Each data point represents a result of efficiency program activities in one year by one utility or third party administrator or a group of utilities. Another major finding is that each dataset shows a declining trend curve which means that the CSE decreases as energy savings increase relative to annual sales. It is often argued that the CSE would increase if the amount of energy savings increases. However, this effect was not observed in our analysis, but rather the analysis found an opposite trend. While there exists a possibility that the CSE might begin to increase at much higher levels of EE program savings, this evidence suggests that current program savings levels have not yet approached any such point.[70]

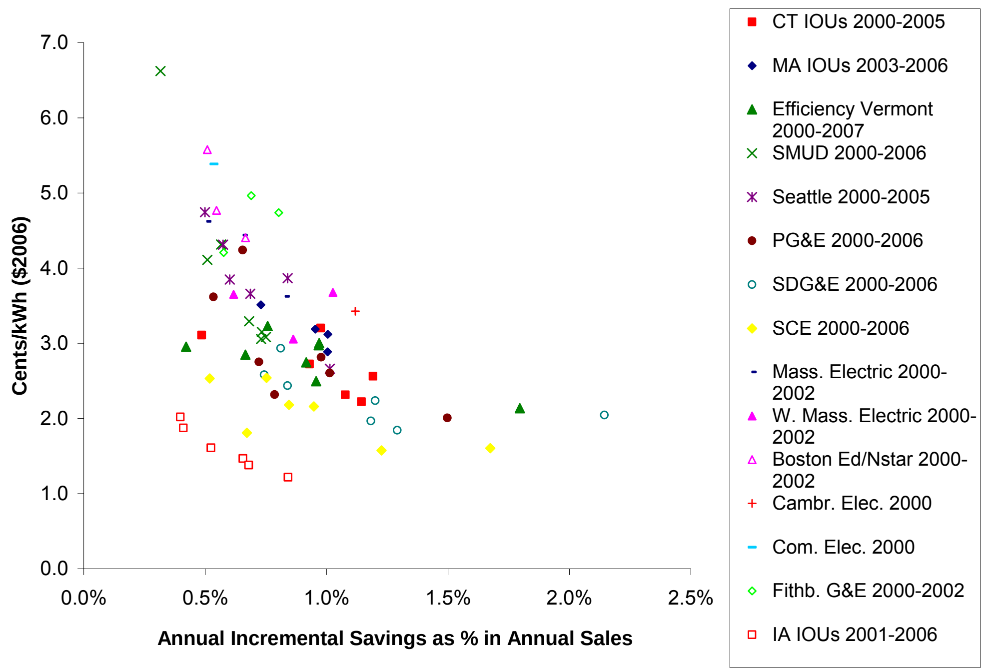


Figure A.4. Utility CSE vs. Annual Savings as a Percent of Annual Sales

The cost of efficiency through building codes and appliance standards are often estimated even lower than the cost of savings through utility programs. For example, an electric efficiency potential study by Optimal Energy Inc. for New England states found out that costs of implementing building energy codes and appliance standards are 2.9 cents and 1 cent per kWh saved respectively while costs of efficiency programs are 3.1 cents per kWh saved.[71]

Relevance of Energy Efficiency to Capacity

While capacity savings are not a focus of this report, efficiency can reduce capacity needs of electric utilities at low costs. One study by Quantec et al. (2008) examined a number of utility programs for capacity reduction relative to peak load and cost per kW saved (Figure A.5 below).[72] The percent of peak reduction in those programs ranges from close to zero to 1.9% with a median savings of around 0.9%. The costs per kW range from slightly above $200/kW to about $1500/kW, with the median of $760/kW. These costs are lower than the installed cost of many power plants or comparable to that of inexpensive combustion gas turbines.

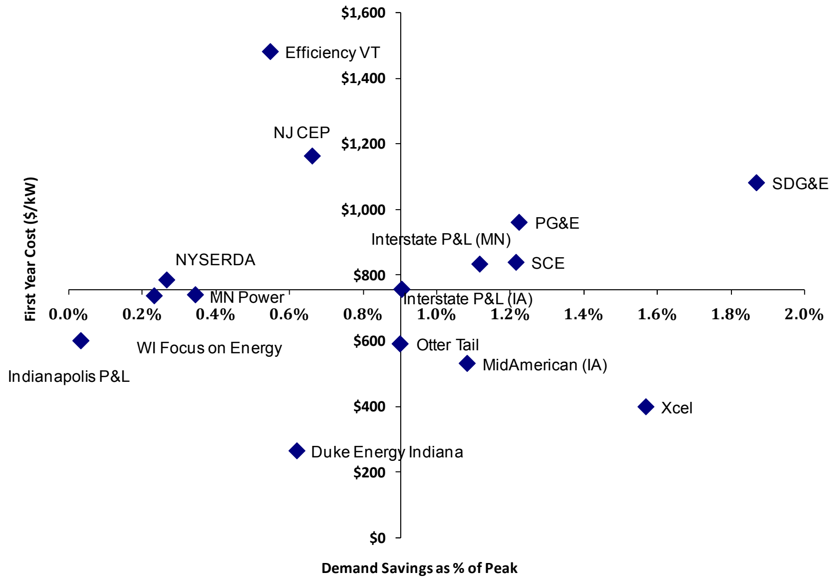


Figure A.5. Scatter Plot of Demand Savings and First Year Costs ($/kW)[73]

BENEFIT-COST RATIO (B/C)

Another indicator for the cost-effectiveness of energy efficiency measures is the benefit-cost (B/C) ratio which provides how much benefits efficiency programs or a portfolio of programs provide over program costs in terms of dollar amounts. ACEEE (2004b) provides the B/C ratios for efficiency programs in a number of states in Table A.4 below. The data here represents the cost-effectiveness of portfolios of energy efficiency measures and programs offered by utilities or other program administrators in each state. The ratio ranges from 1.3 to 7. As an example, the B/C ratio of 2 means that on every $1 spent on efficiency programs, the society receives $2 benefit.[74] As presented in the table, the cost-effectiveness for commercial and industrial programs is often higher than that for residential programs.

Table A.4. Cost-effectiveness of Energy Efficiency Programs[75]

State	Benefit/Cost All programs	B/C Comm/Ind programs	B/C Residential programs	Cost of saved energy ($/kWh)
California	2.0 – 2.4			0.03
Connecticut	NA	2.4 to 2.6	1.5 to 1.7	0.023
Maine	1.3 – 7.0			
Massachusetts	2.1	2.4 to 2.7	1.3 to 2.1	0.04
New Jersey				0.03
New York				0.044
Rhode Island	2.5	3.3	1.5	
Vermont	2.5	2.9	1.8	0.03
Wisconsin	3.0	2.0	4.3	
Median	**2.1 to 2.5**	**2.5 to 2.6**	**1.6 to 1.7**	**0.03**

LIFETIME OF ENERGY EFFICIENCY MEASURES

Electric energy efficiency program involve a large number of measures for residential, commercial and industrial consumers. The measure life of each measure varies significantly from 3 years to 25 years or even 30 years. For example, compact florescent light bulbs could last for 3 years to 6 years depending on number of hours used per year. In contrast, some measures associated with HVAC such as efficient gas boilers, windows, and insulation can last for 20 years or longer. On average, a portfolio of energy efficiency programs and measures tend to have about 10 to 12 year measure life.

While we assume efficiency programs implemented each year have 10 to 12 year life on average, we did not assume any decay of the effect of energy savings after efficiency measures supported by utility programs are replaced in the future with new measures. It is mainly because it is highly likely that consumers replace old measures with new measures with similar or better performance in the future even without utility rebates. Thus it is reasonable to assume that the level of savings continue at the same level.

CO-BENEFITS

Co-benefits matter, and can be categorized by energy, economics and environmental components. GHG reductions will occur and accrue over decades-long commitment. Recognizing and incorporating the many additional benefits from reducing GHG also assists attaining near and medium term goals, such as helping states meet the eight-hour ozone and fine particulate standards, and improving water quality. Important co-benefits include reduction in spending on energy by homeowners and businesses; reduced risk of power shortages, energy price increases, and price volatility; improved public health as a result of reduced pollutant emissions by power plants; reducing dependence on imported fuel sources; and green collar employment expansion and economic development. In addition, several of these policies will have water conservation benefits, not only through reductions in demands from power plants for cooling, but also by reducing water consumption by the end users. One state study also found that conventional utility industry supports 2.4 jobs per $1 million in revenue v. 6.7 jobs per million for energy efficiency[76].

Energy Benefits

Energy efficiency programs and policies can help states achieve their goal of providing a less polluting, reliable, and affordable energy system that addresses multiple challenges, including:

- Lowering energy costs for customers, particularly during periods of peak electricity demand.
- Improving the reliability of the electricity system and averting blackouts.
- Reducing demand for new transmission and distribution capacity.
- Providing targeted load reductions in grid congested areas (e.g., Southwest Connecticut, San Francisco, California).
- Reducing air emissions from power generation and their associated environmental risks.

State PUCs, utilities and their stakeholders (e.g., ratepayer advocates, environmental groups) can quantify the energy system benefits of clean energy to compare traditional grid electricity with demand and supply-side clean energy resources (e.g., energy efficiency, renewable energy, CHP, and clean distributed generation). Although quantifying energy system benefits can be challenging – particularly when analyzing long-term effects in a complex, inter-connected electricity grid – it is crucial to evaluating clean energy resources. Having this information helps inform PUC and utility decisions involving resource planning, future capacity additions, transmission and distribution planning, and ways to address peak demand. In many cases, clean energy may be the least-cost or equally cost-effective option, while also delivering important environmental and economic benefits to the state.

Economic Benefits

Energy efficiency has numerous co-benefits. In particular, energy efficiency measures are more cost-effective than supply side resources. EE programs are designed to fit local and regional needs. Products to meet those programs are manufactured close to the point of use. Skilled labor is required to install and service measures, creating opportunities for states to retrain workers affected by globalization, such as those in the auto industry, textiles and other manufacturing.

- Energy efficiency benefits are cumulative, so the benefits continue long after the measures are installed.

- Current EE programs are avoiding a substantial portion of electric load growth at costs of 3-3.5c/kWh. Compare this to the cost of new generation, which for coal is 9-11 c/kWh and rising.
- Direct economic benefits accrue from the increase in local skilled labor to install and service energy efficiency measures, and from manufacturing facilities that are established to supply the local market. One early national study concluded that investing in energy efficiency "leads to more jobs, higher personal income, and marginally higher GDP throughout the twenty-year period."[77]

ACEEE followed up on this seminal work with several state level assessments of the economic benefits of EE, and recently released a national study that updates and confirms the results of the original 1992 study. A May 2008 report concludes that EE efforts in the US support 1.6 million jobs achieving annual savings equal to the amount of energy that would be provided by 40 coal plants.[78]

At the state level, recommended actions to be implemented in Florida are expected to create over 14,000 new jobs by 2023 and reduce consumer electric bills by $5 billion per year. Such actions would also reduce GHG emissions by 37 million tons by 2023.[79] A similar study completed for Texas concluded that by 2023, over 38,000 new jobs would be created, Texas consumers would save over $5 billion per year through reduced energy bills and GHG emissions would be reduced by 44 million tons.[80] Several additional state level reports, including those for Pennsylvania, Ohio and Virginia, will be completed during 2008.

Environmental Benefits

Several environmental co-benefits will be realized in conjunction with reducing electric sector GHG. Emissions that contribute to acid rain and ground level ozone will also decrease (graph). These reductions will help states achieve EPA's new eight-hour ozone standard and the existing fine particulate standard. Reduced NOx and SOx emissions will also help lakes, streams and forests recover from the effects of acid rain. Improved electric system reliability will also reduce the need to operate inefficient peaking and emergency generators, which have very high NOx emissions per MWh as compared to base loaded units.

Improved agriculture practices also reduce the amount of windblown soil, which has also been documented to be transported long distances and impair the ability of several Western states to attain the fine particulate standard.

Other environmental benefits include: reducing acid deposition to soils, forests and lakes; reducing agriculture runoff into rivers and lakes.

The environmental benefits discussed have substantial economic benefits in terms of reducing and avoiding public health and environmental expenses. Reducing ozone and fine particulate emissions have direct benefits through fewer asthma cases, heart attacks, and days employees have to miss work. These economic benefits are especially evident in urban areas where due to a lack of or insufficient health insurance, many residents use expensive emergency room visits, overloading hospitals and causing financial impact, due to lack of reimbursement for services rendered. Improving water quality and forest health due to lower acid deposition means that less human intervention will be required to restore lakes for fishing and drinking water.

Appendix B: Analysis of Agricultural and Forestry Offsets

CURRENT AGRICULTURAL EMISSIONS

According to the EPA's 2007 report of greenhouse gas emissions from the United States[81], the agricultural sector was responsible for 591 million short tons (563 teragrams) of CO2 equivalent (CO_2e) in 2005, or 7.4% of all US emissions. Almost all of these emissions were released in the form of nitrous oxide (N2O) or methane (CH4), two potent greenhouse gases (310 and 21 times more effective, respectively, at trapping heat in the atmosphere than CO2). These emissions came from a variety of sources, but can primarily be attributed to five major sources (see chart below).

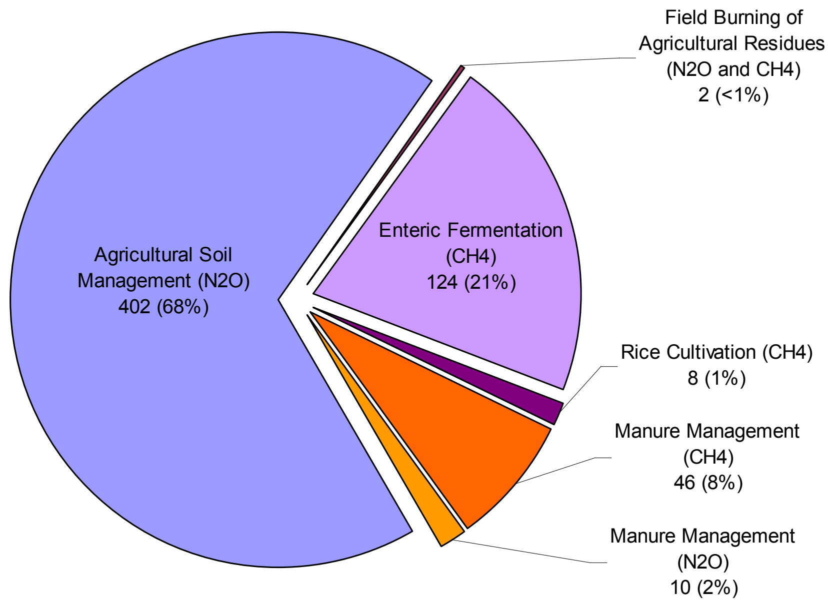


Figure B.1. 2005 Agricultural Non-CO2 Emissions

- Agricultural soil management: An excess of nitrogen-rich fertilizers used on crops accounts for the vast majority of emissions (68%) at 402 million tons (365 Tg) of CO_2e;
- Manure management: Manure from feedlot and dairy operations are stored in anoxic lagoons where bacteria produce and release CH4 and N2O, amounting to 56 million tons (50.8 Tg) of CO_2e;
- Rice cultivation: Rice paddies produce methane when flooded (the equivalent of swamp gas), contributing just under 8 million tons (7 Tg) of CO_2e;
- Enteric fermentation: Bacteria in ruminants' (primarily cattle) stomachs process 'excess' feed into methane at a rate of 124 million tons (112 Tg) CO_2e each year; and

- Field burning of agricultural residues: Just over 1.5 million tons (1.4 Tg) CO_2e of N_2O and CH_4 are released when fields are burned after harvest.

Reducing Agricultural Emissions

Part of the program of agricultural offsets includes reducing and avoiding emissions from agricultural activities. Some of the richest opportunities for reductions lie in carefully controlling and monitoring fertilizer applications to reduce N_2O emissions, capping, capturing, and combusting methane released from manure lagoons, and controlling cattle diets to reduce enteric fermentation. Changing fertilizer use is economic because it entails applying only as much fertilizer as can be utilized by crops. Capping and capturing methane emissions from feedlot and dairy manure lagoons can have a high upfront capital expense (to build an enclosed system), but can pay off quickly if methane is combusted for on-farm energy use. Finally, controlling cattle diets to reduce methane emissions is a more involved operation, but can be accomplished by increasing rumen efficiency in the diet or shifting feed towards grazing and away from corn-based diets.

Agricultural Offsets, General

The universe of potential agricultural offsets includes a wide range of activities, encompassing direct CO_2 sequestration, avoided emissions, and reduced emissions. Among the activities which have been identified in the literature as valid offset options are the following:

Carbon Sequestration

- Conservation tillage: Using low-till and no-till farming techniques, as well as leaving agricultural residue on farmland actively stores carbon in the soil;
- Afforestation: One of the fastest carbon sequestration activities is planting forests or allowing natural regeneration on former croplands which sequesters carbon in woody biomass;
- Forest management: Increasing forest rotation times and changing harvesting methods as well as species mix, stocking densities, and other management practices can increase the amount of carbon stored on the land;
- Riparian buffers: Foresting the land in immediate proximity to waterways both sequesters carbon in the vegetation buffers and retains more carbon in soils that might otherwise erode;
- Convert croplands to grasslands: Grasses are able to sequester carbon into soils, allowing the development of carbon-rich topsoils;
- Effective grazing management: Managing grazing cycles for carbon storage in vegetation and grassland sustainability can lead to increased soil carbon.

Emissions Avoidance

- Avoided deforestation: By choosing not to harvest a mature forest, or by preventing deforestation, carbon is retained in woody biomass rather than released by harvesting, processing, and decomposition;
- Biofuels: Growing and processing biomass for electricity and liquid fuel production from waste that would have otherwise decomposed avoids the combustion of non-recoverable fossil fuels. with little or not net increase in atmospheric carbon dioxide;

Emissions Reductions

- Reduce nitrogen fertilizer inputs (N_2O): Reducing fertilizer use is one of the most effective ways to reduce non-CO2 (N_2O) emissions in the United States (currently over 5% of all US emissions);
- Reduce fossil fuel use in agricultural activities: Using energy efficient farm equipment and optimizing farm activities and product use can significantly reduce emissions from the agricultural sector (this would not create an offset because fossil fuels should be under the emissions cap);
- Manure management (N_2O and CH_4): Capping diary and feedlot lagoons with digesters allows the methane emissions to be captured and combusted for energy, transforming the potent CH4 into less potent CO2 (a reduction of over 95%);
- Enteric fermentation (CH_4): Shifting and controlling cattle diets can reduce, but not entirely avoid, fermentation in the cattle gut, producing CH4;
- Erosion control: Maintaining soils *in situ* means retaining any carbon stored in those soils on site and avoiding the emissions that would occur off site;
- Reduce rice tillage: Rice paddy flooding inevitably produces CH4, so less production of flooded rice cultivars will reduce emissions from this sector.

Issues of Leakage

Leakage occurs where there is an economic advantage conferred by shifting an activity across regions, sectors, or time. If a land manager pursues an emission offset, there is a marginal increase in the cost of business, which increases the cost of any resulting commodity. The offset is only economically advantageous when the price of an emissions allowance exceeds the cost of pursuing an offset (where the cost is either lost revenue or the price of implementing a mitigation program, or both). A competing area or business which is not participating in the offset program may find it economically advantageous to increase production to fill the gap. Subsequently, if production in another area releases as much carbon (or more) than was avoided by the offset activity, the offset has not been productive. A recent draft House bill defines leakage as "…a significant increase in greenhouse gas emissions, or significant decrease in sequestration, which is caused by an offset project and occurs outside the boundaries of the offset project.” [82]

Between regions, leakage occurs when one region pursues an offset and another region changes its activities as a result. Leakage can also occur across sectors, where a change in behavior in one sector leads to an increase in emissions in another sector. For example, a reforestation project may be implemented on agricultural land, causing agriculture to move or intensify elsewhere, with potentially negative consequences. Finally, leakage can occur over time, where a project with supposedly permanent sequestration is dismantled in favor of a more economically advantageous activity.

Leakage can be minimized with carefully written protocols that account for the activities outside the boundaries of the credited activities, and itself mitigated with well scoped sectors covered in a GHG trading regime, carbon insurance (which insures the permanence of a project) or discounting (which reduces the credit given to projects with a high degree of leakage).

The 2005 EPA model which forms the basis for our analysis takes leakage into account. However, we factor into account unknown leakage rates for the three tracked offset activities to account for uncertainty and more severe leakage than anticipated by the model.

Agricultural Offsets, US Analysis with Proxy Lieberman-Warner Carbon Prices

In our analysis, we conservatively tracked only selected offset activities, chosen as techniques which would (a) either currently count as offsets internationally or domestically, (b) would not be a covered activity under a carbon cap (c) are technologically developed enough to be applied today, and (d) have an obtainable price-point even at very low carbon prices. We track the following offsets:

- Agricultural soil management: conservation tillage sequesters a limited amount of carbon for 15-20 years, and can be reversed if the landscape is tilled or converted;
- Agricultural N_2O and CH_4 reductions: Fertilizer management, manure management, and cattle dietary management (enteric fermentation) are all economic and have significant co-benefits.
- Forest management: Existing commercial forestry operations could shift harvesting techniques and cycles, retaining more carbon in the ecosystem, but gains may be reversed or reduced if, for example, the landscape is reverted to agriculture. This category does *not* include afforestation activities, which entail a reduction in agricultural or other types of lands.

We conservatively estimated potential agricultural offsets available for the United States using data presented from a 2005 EPA Model (the Forest and Agriculture Sector Optimization Model with Greenhouse Gases – FASOMGHG).[83] The model tracks agricultural soil management, N_2O and CH_4 reductions, forest management, afforestation, and biofuel production in a competitive forecasting framework. The model is set up such that farmers are able to make economic decisions of what to plant or cultivate over time across ten regions (Pacific Northwest, Pacific Southwest, the Rocky Mountains, the Northern Plains, the Southern Plains, South Central [Gulf Coast], the Corn Belt, Lake States, Northeast, and the Southeast). The model is based on current land-use practices, but allows land uses to change as farmers and foresters compete economically, and produce and manage on farmland and forest land through 2100. Farmers and foresters decide on what activities will take place on their land based on commodity prices and current and future carbon prices. In this way, the model does not guarantee that offsets are permanent or that leakage does not occur. In fact, in numerous circumstances, as carbon prices change, different activities become attractive on the same parcel of land and some sequestration or mitigation activities become net sources rather than sinks.

We use the results of the FASOMGHG model run under the circumstance where carbon prices rise over time. The closest analog for matching President Obama's targets are carbon prices anticipated for the Lieberman-Warner Bill introduced in the 110th Congress (S.2191). A separate analysis for the EPA and Energy Information Administration anticipates that carbon prices will rise from \$29 / tCO_2e in 2015 to \$61 / tCO_2e in 2030. In the FASOMGHG model, carbon prices begin at \$20 and rise by \$1.30 every year. For this analysis, we extrapolated anticipated S.2191 carbon prices in 2015, 2020, 2025, and 2030 and map anticipated activities in FASOMGHG to expected carbon prices in those years.

Results from the FASOMGHG model under a changing carbon price scenario are only available on a national basis. These are parsed down to regional scales using more detailed results from a fixed carbon price model (assuming that the relative proportion of activities throughout the US are relatively fixed; i.e. agricultural activities dominate throughout the Midwest, while forestry dominates throughout the Southeast). State-scale results are obtained are obtained by parsing the regional results by total area in each state of pasture, farm, and forest land. Offsets are calculated by each state from 2012 (no offsets) to 2030.

Carbon prices expected under President Obama's Targets

The EPA ADAGE Model shows that carbon prices under S.2191 will start at approximately \$20 per ton of CO_2 in 2015 and rise to about \$50 (Y2006\$) per ton by 2030 (see figure), reducing the total US emissions from over 9 billion metric tonnes of CO_2 in 2030 down to just under 6 billion tonnes. [84] We extract these prices for CO_2 and compare them to the EPA FASOMGHG model results, shown below.

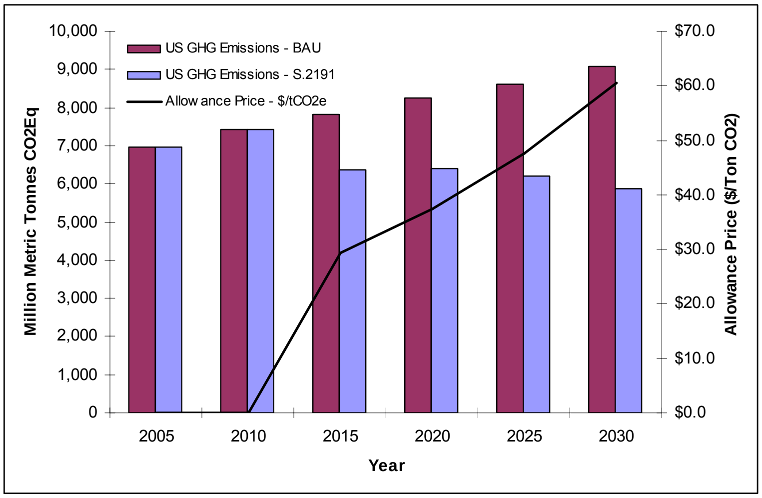


Figure B.2. Carbon prices under proxy S.2191

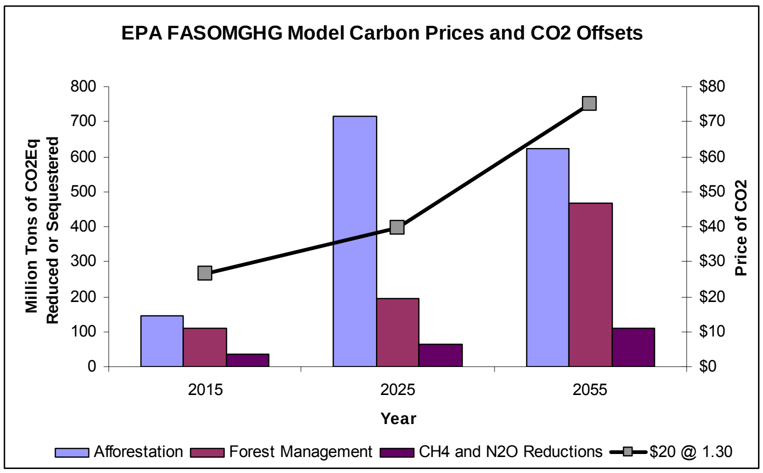


Figure B.3. EPA FASOMGHG Model Carbon Prices and CO_2 Offsets

FASOMGHG Results, Carbon price rises from $20 by $1.30 per year

Using the EPA FASOMGHG offset results, we can determine an approximate offset resulting from President Obama's targets using the analysis of S.2191 as proxy prices. We find total US offsets in the three categories of afforestation, forest management, and CH_4 / N_2O mitigation associated with the S.2191 prices.

Leakage Approximations

The FASOMGHG model does track temporal and cross-sector leakage; however, anticipating that there may be forms of leakage unanticipated in this model, we factor in an additional leakage rate. Thus, our offset potential results are conservative estimates. The following adjustment factors are applied:

- Agricultural soil management: A **20%** additional leakage factor is applied to account for potential cross-project leakage and potential non-permanence where soil carbon is released by plow activity.

- Agricultural N_2O and CH_4 reductions: While there is no evidence to support leakage in N_2O and CH_4 reductions, a leakage factor of **20%** is applied in this sector.
- Forest management: Forestry management projects which extend the rotation period of working forests could cause a shorter supply in the wood and pulp commodity market, causing new lands to be deforested, and other products used to substitute for wood products. Therefore, we apply an additional leakage factor of **50%** in forestry management projects to account for unknown problems in this sector. This factor is well above the calculated leakage rate (18–42%) for afforestation activities,[85] an activity which is prone to leakage.

Parsing FASOMGHG results by region and state

The FASOMGHG model produces regional estimates of offset productivity for fixed carbon price scenarios. We assume that the same regional distribution of offsets applies for the fixed price scenario as the moving carbon price scenario, and parse the U.S. wide offset results by region according to the results of the fixed price scenario in 2015, 2020, 2025, and 203086. Finally, the total offsets available in each region are again subdivided by state according to the relative abundance of forest land, pastureland, and cropland as estimated in the USDA's National Resources Inventory.[87] Offsets, determined by region, were multiplied by the relative fraction of agricultural land (crop, pasture, and forest) in each state relative to the larger region. The amount of agricultural soil carbon sequestration available per state is determined by each state's cropland; the CH_4 and N_2O mitigation options were determined by the relative fraction of pastureland, and the forestry management opportunities were parsed by the state forest land.

Caveats and Exceptions

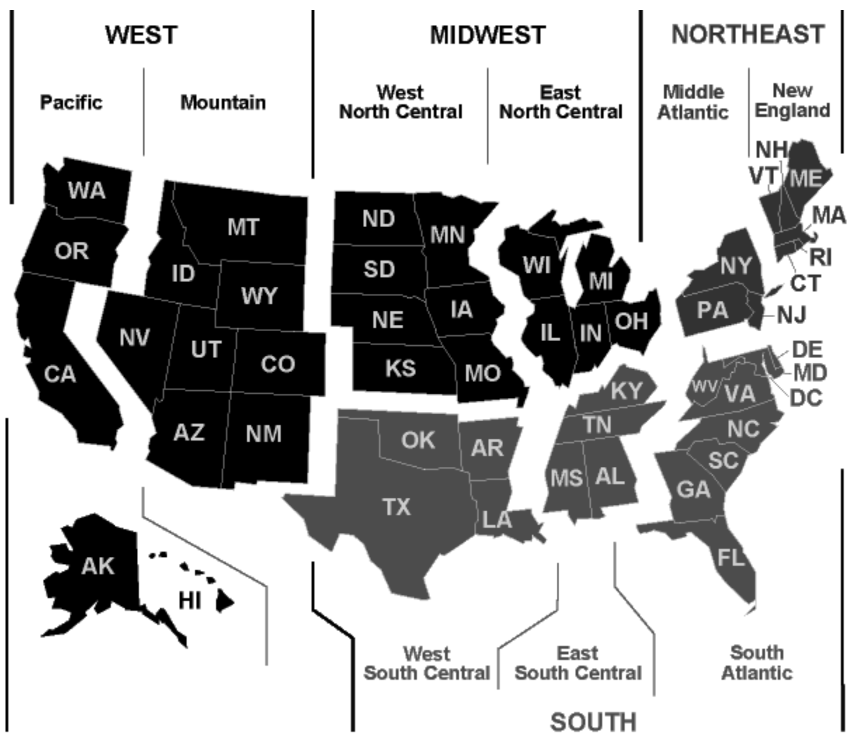
The model described above has been used in good faith, but has not been optimized for handling data specific to proposed legislation. We made significant assumptions about the cross-applicability of a specific EPA model, and parsed the results by state according to a rough analysis. In addition, we chose only a limited range of agricultural and forestry offsets, while the EPA model uses a wider range of offsets (including afforestation and biofuels). In the EPA analysis, the different offset activities compete against each other, and can displace each other. Therefore, a forest managed for carbon could be harvested to create land for biofuels, yielding a net negative offset from the forestry project in a later year. Since we do not include the two largest offset programs (afforestation and biofuels), our analysis is missing key components. We also underestimate the potential for allowable activities because the model assumes that activities have to compete with afforestation and biofuels. If this were not the case, we would anticipate a larger share of forest management and agricultural management practices. The inclusion of biofuels and afforestation would only serve to make offsets look far more attractive. In this case, we have used a rigorously conservative estimate of offsets available. A more rigorous analysis would perform an optimization for the Obama administration's economic proposals on a state-by-state basis and only for the offsets we determine to be valid.

References

[1] US DOE. March 2009. Annual Energy Outlook 2009. Available online: http://www.eia.doe.gov/oiaf/aeo/

[2] Note: Energy efficiency is typically recorded in a percentage savings per year. A single-year one percent (1%) EE program saves 1% of expected sales in that year, and those savings continue for a number of years thereafter (typically 8-12 years before technologies or measures expire or are replaced). An ongoing one percent (1%) EE program saves an *additional* 1% of expected sales every year – compounded savings which build over the life of a program. In this report, we are referring to a typical EE program, with ongoing savings of 1 to 3% every year.

[3] Regions defined by US DOE Energy Information Administration (2009). Annual Energy Outlook. Regions include the following states: New England: CT, RI, MA, VT, NH & ME; Mid Atlantic: NY, NJ & PA; East North Central: IL, IN, MI, OH & WI; West North Central: IA, KS, MN, MO, NE, ND & SD; South Atlantic: DE, DC, FL, GA, MD, NC, SC, VA & WV; East South Central: AL, KY, MS & TN; West South Central: AR, LA, OK & TX; Mountain: AZ, CO, ID, MT, NV, NM, UT & WY; Pacific: AK, CA, HI, OR & WA.



Source: US DOE. Energy Information Administration. Regional Energy Profiles. U.S. Census Regions and Divisions. June 14, 2000. Available online at http://www.eia.doe.gov/emeu/reps/maps/us_census.html

[4] In a carbon constrained economy, inefficient generators may also include high-emissions (and therefore high-cost) power plants, such as coal units.

[5] California Energy Commission. 1999. The Energy Efficiency Public Goods Charge Report: A Proposal for the Millennium. P400-99-020.

[6] California Public Utilities Commission, the California Energy Commission, and the California

Power Authority. 2008. 2008 Update: Energy Action Plan. Available online at: http://www.energy.ca.gov/2008publications/CEC-100-2008-001/CEC-100-2008-001.PDF

[7] US EPA. November, 2005. Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture.

[8] Pacific Northwest Direct Seed Association, 2009. Description available online at http://www.directseed.org/carbontrading.html

[9] PG&E, 2009. Garcia River Forest Project. Other descriptions available at: http://www.conservationfund.org/node/789 and http://www.nature.org/initiatives/climatechange/work/art23798.html

[10] Nuclear Power Joint Fact-Finding Report, the Keystone Center, June 2007 (new nuclear costs 8-11c/kWh low to high range); Efficiency Vermont, 2006 report on program savings, 3.7c/kWh v. 10.4 c/kWh for new supplies (www.efficiencyvermont.org)

[11] U.S. EPA 2004. "Buildings and the Environment: A Statistical Summary," at U.S. Environmental Protection Agency Green Building Workgroup, available at http://www.epa.gov/greenbuilding/pubs/gbstats.pdf., December 20, 2004.

[12] PG&E 2006. Energy Efficiency Programs Annual Summary; SCE 2006, Energy Efficiency Annual Report; Raw data obtained from SMUD; SDG&E 2006, Energy Efficiency Programs Annual Summary; CT Energy Conservation Mgmt. Board, 2006; MA Dept. of Telecommunications & Energy 2003, Electric Utility Energy Efficiency Database; MECo 2006, 2005 Energy Efficiency Annual Report Revisions; Minnesota Department of Commerce 2007. Minnesota's Demand Efficiency Program; IPL DSM Filing 2006, Docket No. 05-581.01; Efficiency Vermont 2008. 2007 Preliminary Results and Savings Estimate Report; and Seattle City Light 2006. Energy Conservation Accomplishments: 1977-2005

[13] Maryland Senate Bill 205

[14] PUC Case 07–M-0548

[15] CPUC 04-09-060, *Interim Opinion: Energy Savings Goals for Program Year 2006 and Beyond.*

[16] Texas Senate Bill 12

[17] Illinois Senate Bill 1592

[18] 30 V.S.A.Sect.209, Docket 5980

[19] Author's calculations: Efficiency Vermont, Year 2008 Preliminary Savings Claim. Available online at: http://www.efficiencyvermont.com/stella/filelib/EVT_2008_Savings_Claim_Final.pdf and US DOE Energy Information Administration, Electric Power Monthly (March, 2009), Table 5.4.B End-Use Sector, by State, Year-to-Date. Available online at: http://www.eia.doe.gov/cneaf/electricity/epm/epm_sum.html

[20] Connecticut Public Act 05-01, June 2005

[21] Hawaii Senate Bill 2474

[22] The Energy Security and Climate Stewardship Platform for the Midwest 2007, available at http://www.midwesterngovernors.org/govenergynov.htm

[23] CSE (or levelized CSE) is often calculated as follows: CSE = Program Costs x Capital Recovery Factor / First year kWh saved where CRF = Capital Recovery Factor, the ratio of a uniform annual (annuity) value and the present value of the annual stream. CRF is determined based on the discount rate and the weighted average of useful measure life.

[24] For the cost of electricity, see EIA 2008. "Current and Historical Monthly Retail Sales, Revenues and Average Revenue per Kilowatthour by State and by Sector (Form EIA-826)" available at http://www.eia.doe.gov/cneaf/electricity/page/sales_revenue.xls

[25] Tests which measure only the impact on electricity *rates* fail to represent several important elements of energy efficiency. First, efficiency measures lower utility *bills* for participants (and often non-participants); secondly, efficiency measures reduce the need to burn expensive fuels and for new generation (i.e. long term capital costs which would keep rates high over time); finally, efficiency measures have numerous co-benefits, such as reducing damages to the environment and health (which are by-products of burning fossil fuels) saving healthcare dollars and lives.

[26] CO_2 savings are calculated by converting energy savings (in GWh) to CO_2 emissions by using an avoided emissions rate (tCO_2/MWh) specific to that state (or region, where state specific data were unavailable). Avoided emissions in future years are calculated relative to today's emissions rates along trajectories from the Energy Information Administration's 2009 Annual Energy Outlook.

[27] Note that the current levels of energy savings for numerous states were largely based on investor owned utilities' programs and some notable public utilities' programs that were found through numerous utility efficiency program filings efficiency annual reports, other reports which analyzed efficiency programs and raw data directly obtained from program administrators. Where any significant activities are not known or if data on efficiency programs are not publicly available we generally assumed a state does not have any sizable efficiency program activities and assigned zero current-day savings (details of these assumptions and data sources are presented in Appendix A).

[28] http://www.notill.org/KnowledgeBase/03_realdirt_Clapperton.pdf

[29] EPA GHG Mitigation, Table 2-1

[30] Baker, JM. TE Ochsner, RT Venterea, TJ Griffis. 2007. Tillage and soil carbon sequestration – What do we really know? *Agriculture Ecosystems and Environment*. 118:1-5.

[31] West and Post, 2002. Soil Organic Carbon Sequestration Rates by Tillage and Crop Rotation: A Global Data Analysis. *Soil Science Society of America*. 66:1930-1946.

[32] Reducing tillage alone can sequester 57 g C m^2 yr^{-1} (0.93 short tons CO_2 $acre^{-1}$ yr^{-1}) for 15 to 20 years, while selectively managing crop rotation complexity can sequester an additional 20 g C m^2 yr^{-1} (0.33 short tons CO_2 $acre^{-1}$ yr^{-1}) and maintain the sequestration potential for up to sixty years; West and Post, 2002.

[33] EPA 2006 Emissions Inventory, Chapter 6: Agriculture.

[34] Offsets are traditionally reported in metric tons of CO_2 equivalents. For consistency within this report, all offsets have been converted to US short tons of CO_2 equivalents. 1 US short ton = 1.102 metric tones.

[35] EPA 2006 Emissions Inventory, Chapter 6: Agriculture.

[36] EPA Emissions Factors, 1996. AP 42, Fifth Edition, Volume 1. Chapter 14: Greenhouse Gas Biogenic Sources. http://www.epa.gov/ttn/chief/ap42/ch14/final/c14s01.pdf

[37] EPA Emissions Factors, 1996. AP 42, Fifth Edition, Volume 1. Chapter 14: Greenhouse Gas Biogenic Sources. http://www.epa.gov/ttn/chief/ap42/ch14/final/c14s04.pdf

[38] EPA 2006 Emissions Inventory, Chapter 6: Agriculture.

[39] http://www.terrapass.com/projects/farm-power.html

[40] EPA, 2005. Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture.

[41] EPA GHG Mitigation, Table 2-1

[42] Birdsey, R.A., 1996. Regional Estimates of Timber Volume and Forest Carbon for Fully Stocked Timberland, Average Management After Final Clearcut Harvest. In: *Forests and Global Change: Vol. 2, Forest Management Opportunities for Mitigating Carbon Emissions*, R.N. Sampson and D. Hair (eds.), pp. 309-334, American Forests, Washington, DC.

[43] Avoided deforestation is only a valid sequestration technique if the emissions from the good which are otherwise produced (in absence of the deforestation) are less than the carbon which would be released if the forest is harvested. The goods which would have been obtained from the intact forest will have a substitute elsewhere; if the emissions from producing the substitute are less than the emissions from deforestation, then the avoided deforestation is an effective mechanism.

[44]Johnson, R. 2007. Climate Change: The Role of the U.S. Agriculture Sector. Congressional Research Service. Code RL33898.

[45] The Chicago Carbon Exchange operates in units of metric tons; 200,000 MT CO_2 were traded on average per day in 2008. http://www.chicagoclimatex.com/docs/publications/CCX_carbonmkt_V5_i4_apr2008.pdf

[46] http://www.arb.ca.gov/ag/manuremgmt/manuremgmt.htm

[47] http://www.arb.ca.gov/ag/fertilizer/presentations/n2o_5_19_08.pdf

[48] http://www.arb.ca.gov/cc/forestry/forestry_protocols/forestry_protocols.htm

[49] California reports emissions reductions in metric tonnes of CO_2 and prices in dollars per metric tonne. This figure is reported in CA as $13.6 / MT CO2e, converted to $12.34 / short ton CO2e.

[50] http://www.arb.ca.gov/cc/forestry/forest_scoping/forest_sector_stakeholders_presentation_feb_22_08.pdf

[51] http://www.wyomingcarbon.org/draftplan.doc

[52] Regional Greenhouse Gas Initiative (RGGI). 2008. Model Rule. Dec 2008. Part XX CO_2 Budget Trading Program. Available online at: http://www.rggi.org/docs/Model%20Rule%20Revised%2012.31.08.pdf

[53] Nebraska Legislative Bill 957, April 10 2000. http://www.pewclimate.org/states.cfm?ID=45

[54] Wyoming Carbon Storage Law, enacted 2001. http://www.wyomingcarbon.org/Brochure12-05_new.pdf

[55] As an example of additionality, take a farmer who finds it profitable to shift to organic operations, and starts to use no-till techniques on her farm. By changing to conservation tillage, she is effectively sequestering carbon, but would have changed operations even if there were no carbon credits. These examples become significantly less clear as carbon credits become a relatively common commodity, because determining which projects are pursued for carbon purposes versus any other purpose becomes blurred.

[56] Intergovernmental Panel on Climate Change. 2000. Section 5.3.3. Leakage. *Special Report on Land Use, Land-Use Change and Forestry*. Available online at: http://www.ipcc.ch/ipccreports/sres/land_use/263.htm

[57] In the model results used here, changing carbon prices drive farmers and foresters to replace existing offset activities with more efficient offset options (such as planting forests in previous conservation-tilled farmland). Therefore, some regions actually show a net emission for some offset activities as stored carbon is released when the landscape changes.

[58] California Energy Commission. 1999. The Energy Efficiency Public Goods Charge Report: A Proposal for the Millennium. P400-99-020.

[59] Fogel, C. California Public Utilities Commission. 2008. CPUC and Energy Efficiency: Utility Programs & Strategic Planning Process (2009-2020). Available online at http://www.energy.ca.gov/ghg_emissions/meetings/2008-05-02_workshop/presentations/3_energyefficiency_cpuc.pdf

[60] The cost savings associated with 23,183 GWh of electricity are not straightforward to calculate. However, for a rough (and conservative) approximation, if we assume a wholesale cost of electricity of 8 cents per kWh, the avoided cost of electricity is over $1.85 billion from under $1 billion of costs. The utility does not need to procure expensive generation, and ratepayers see reduced bills from their own lower energy consumption and lower costs for the utility.

[61] California Public Utilities Commission, the California Energy Commission, and the California

Power Authority. 2008. 2008 Update: Energy Action Plan. Available online at: http://www.energy.ca.gov/2008publications/CEC-100-2008-001/CEC-100-2008-001.PDF

[62] Public Utilities Code Section 454.5(b)(9)(C)

[63] ACEEE 2004. The Technical, Economic and Achievable Potential for Energy-Efficiency in the U.S. – A Meta-Analysis of Recent Studies. In the proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings.

[64] ACEEE 2007. “Summary Table of Public Benefit Programs and Electric Utility Restructuring,” available at http://www.aceee.org/briefs/mktabl.htm; CEE 2008. “Table 3: Estimated 2007 U.S. Energy-Efficiency Budgets for Electric Programs by State and Sector”, available at http://www.cee1.org/ee-pe/2007/budgets-main.php3

[65] More specifically, we identified the budget data for the following states: DC, GA, IN, KS, KS, KY, MO, NC, OH, WY. However, we did not assign any savings value to these states first because energy savings data were not available and secondly because their spending on efficiency programs is very small in both absolute and relative terms, less than or equal to 0.1% of state annual revenue from electricity sales except GA with spending around 0.3% of its electricity sales revenue. We also assigned zero savings value for AK, AL, AR, DE, LA, MS, NE, OK, PA, SC, SD, VA, and WV because national efficiency program surveys by ACEEE (2007) and CEE (2008) did not identify these states.

[66] Sources for current state energy efficiency programs:

- Iowa Utilities Board 2008. The Status of Energy Efficiency Programs in Iowa and The 2007 Iowa Residential Energy Survey Report to the Iowa General Assembly January 1, 2008;
- Northwest Power and Conservation Council 2008. Data on energy efficiency programs by Pacific Northwestern States (raw data obtained from Tom Eckman, May 2008);

- Southwest Energy Efficiency Project (SWEEP) 2008. Update on Utility Energy Efficiency Programs in the Southwest, in the Proceedings of the 2008 ACEEE Summer Study on Energy Efficiency in Buildings;
- Personal Communication with Simon Baker with Colorado Springs Utilities;
- Gerard Ortiz (Public Service of New Mexico) 2007. "PNM Energy Efficiency Program," presentation at the Southwest Regional Energy Efficiency Workshop in November 2007, available at http://www.swenergy.org/workshops/2007/presentations/ortiz.pdf;
- Denise Smith (UniSource Energy/Tucson Electric Power) 2007. "UnitSource Energy Update" presentation at the Southwest Regional Energy Efficiency Workshop in November 2007, available at http://www.swenergy.org/workshops/2007/presentations/smith.pdf;
- Frontier Associates LLC 2007. Energy Efficiency Accomplishments of Texas Investor Owned Utilities Calendar Year 2006;
- Personal communication with Ed Clark with Austin Energy; Garvey, E. 2007. "Minnesota's Demand Efficiency Program." Presentation to the National Action Plan for Energy Efficiency – Midwest Implementation Meeting, Minneapolis, Minn. June 21;
- Wisconsin Department of Administration's Division of Energy 2007. Wisconsin Public Benefits Program ANNUAL REPORT July 1, 2005 – June 30, 2006;
- Personal communication with Alecia Ward with Midwest Energy Efficiency Alliance; Southern California Edison. 2006. 2006 Energy Efficiency Annual Report;
- Pacific Gas & Electric2006. 2006 Annual Earnings Assessment Proceeding Volume III: Energy Efficiency Programs Annual Report for 2005 and Energy Efficiency Programs Annual Report for 2005 Technical Appendix;
- San Diego Gas & Electric 2006. Energy Efficiency Programs Annual Summary and Technical Appendix: 2005 Results;
- Sacramento Municipal Utility District 2007. Data files for energy savings and program expenditures for SMUD. (Unpublished raw data obtained from Jim Parks);
- Massachusetts Division of Energy Resources 2008. "Data File for Energy Savings and Program Expenditures for Massachusetts Utilities for 2003 to 2006 (PARIS database)". (Unpublished raw data obtained from Lawrence Masland in February 2008);
- Connecticut Energy Conservation Management Board 2007. Energy Efficiency Investing in Connecticut's Future: Report of the Energy Conservation Management Board Year 2006 Programs and Operations;
- Efficiency Vermont. 2007a. Year 2006 Annual Report and Annual Energy Savings Claim. Burlington, Vt.: Efficiency Vermont.
- National Grid 2007. The 2006 Electric Demand-Side Management Programs, 2006 Year-End Report, May 1, 2007, submitted to RI Public Utilities Commission in RI PUC Docket No. 3701;

- Granite State Electric Company d/b/a National Grid, et. al. 2008 CORE New Hampshire Energy Efficiency Programs. NHPUC Docket No DE 07-106. Revised February 29, 2008; Efficiency Maine 2006. Efficiency Maine 2006 Annual Report Technical Append;
- Public Service Commission 2008. Annual Report on Activities Pursuant to the Florida Energy Efficiency and Conservation Act. February 2008;
- NYSERDA 2008. 2007 New York Energy $martsm Program Evaluation and Status Report; The Office of Clean Energy 2008. Straw Proposal for Comprehensive Resource Analysis, April 15, 2008;
- ACEEE 2007. Residential Energy Efficiency Program Design Recommendations: Report to BGE from the ACEEE, January 2007;
- Potomac Electric Power Company 2007. Application of Potomac Electric Power Company for Authorization to Establish a Demand Side Management Surcharge and an Advance Metering Infrastructure Surcharge and to Establish a DSM Collaborative and an AMI Advisory Group, filed March 21, 2007;
- Hawaii Electric Company 2007. HECO IRP-3 Report, Docket No. 03-0253; Maui Electric Company 2007. MECO IRP-3, Docket No. 04-0077; Hawaii Electric Light Company 2007. HELCO IRP-3, Docket No. 04-0046

[67] Energy Efficiency: California's Highest Priority Resource, CPUC and CEC, June 2006, www.epa.gov/cleanenergy/pdf/calif_cleanenergy.pdf.

[68] Utility efficiency program data obtained from Tom Eckman with the Northwest Power and Conservation Council in May 2008.

[69] We used a 4% real discount rate to estimate levelized CSE in this analysis.

[70] Details of the analysis are found in Kenji Takahashi, David A. Nichols 2008. The Sustainability and Costs of Increasing Efficiency Impacts: Evidence from Experience to Date, conference paper to be presented at the 2008 Summer ACEEE conference: Synapse Energy Economics, Inc. For references and other information related to this analysis, contact Kenji Takahashi at Synapse Energy Economics (ktakahashi@synapse-energy.com)

[71] Optimal Energy, Inc., 2005. Economically Achievable Energy Efficiency Potential in New England, prepared for Northeast Energy Efficiency Partnerships, Inc.

[72] Quantec et al. 2008. Assessment of Energy and Capacity Savings Potential in Iowa, Appendix I: Benchmarking and Best Practice Results, prepared for the Iowa Utility Association.

[73] Ibid.

[74] Many of these B/C ratios are based on a test called the Total Resource Cost (TRC) test. In the TRC, the costs include all the expenditures by the program administrator, plus all the direct costs incurred by the customer as the program costs and the benefits often include all the avoided utility costs, plus any other cost savings for the customer

such as avoided water costs, avoided oil costs, reduced operations and maintenance costs to the customer.

[75] ACEEE 2004. *Trends in Utility-Related Energy Efficiency Spending in the US*.

[76] The Economic Benefits of an Energy Efficiency and Onsite Renewable Energy Strategy to Meet Growing Electricity Needs in Texas, ACEEE, John "Skip" Laitner, R. Neal Elliott and Maggie Eldridge, September 2007

[77] Energy Efficiency and Job Creation, American Council for an Energy Efficient Economy (ACEEE), Howard Geller, John DeCicco and Skip Laitner,1992

[78] The Size of the U.S. Energy Efficiency Market: Generating a More Complete Picture, ACEEE, Karen Ehrhardt-Martinez and John "Skip" Laitner, May 2008

[79] Potential for Energy Efficiency and Renewable Energy to Meet Florida's Growing Energy Demands, ACEEE, R. Neal Elliott, Maggie Eldridge, Anna M. Shipley, John "Skip" Laitner, and Steven Nadel, ACEEE; Philip Fairey, Robin Vieira, and Jeff Sonne, Florida Solar Energy Center; Alison Silverstein, Independent Consultant; Bruce Hedman and Ken Darrow, Energy and Environmental Analysis, Inc; June 2007.

[80] Texas ACEEE study, September 2007.

[81] USEPA, April 15 2007. Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2005.

[82] U.S. Congress. House. Discussion Draft. 111th Cong., 1st sess., 2009, title VII, Part A, sec. 700, 31

[83] USEPA, November 2005. Greenhouse Gas Mitigation Potential in U.S. Forestry and Agriculture.

[84] USEPA, March 14 2008. EPA Analysis of the Lieberman-Warner Climate Security Act of 2008. (ADAGE - Scenario 2 - S.2191)

[85] Murray, B.C., B.A. McCarl, and H. Lee (2004) "Estimating Leakage from Forest Carbon Sequestration Programs." Land Economics 80(1): 109-124.

[86] Note: The fixed carbon price results in the EPA model are annualized over the 100 year period from 2010 to 2110. We assume that the distribution of these offsets by region is still governed by their relative economic merit and therefore use the same distribution as in the fixed price scenario.

[87] USDA, 2003. National Resources Inventory. http://www.nrcs.usda.gov/technical/NRI/2003/statereports/all.html