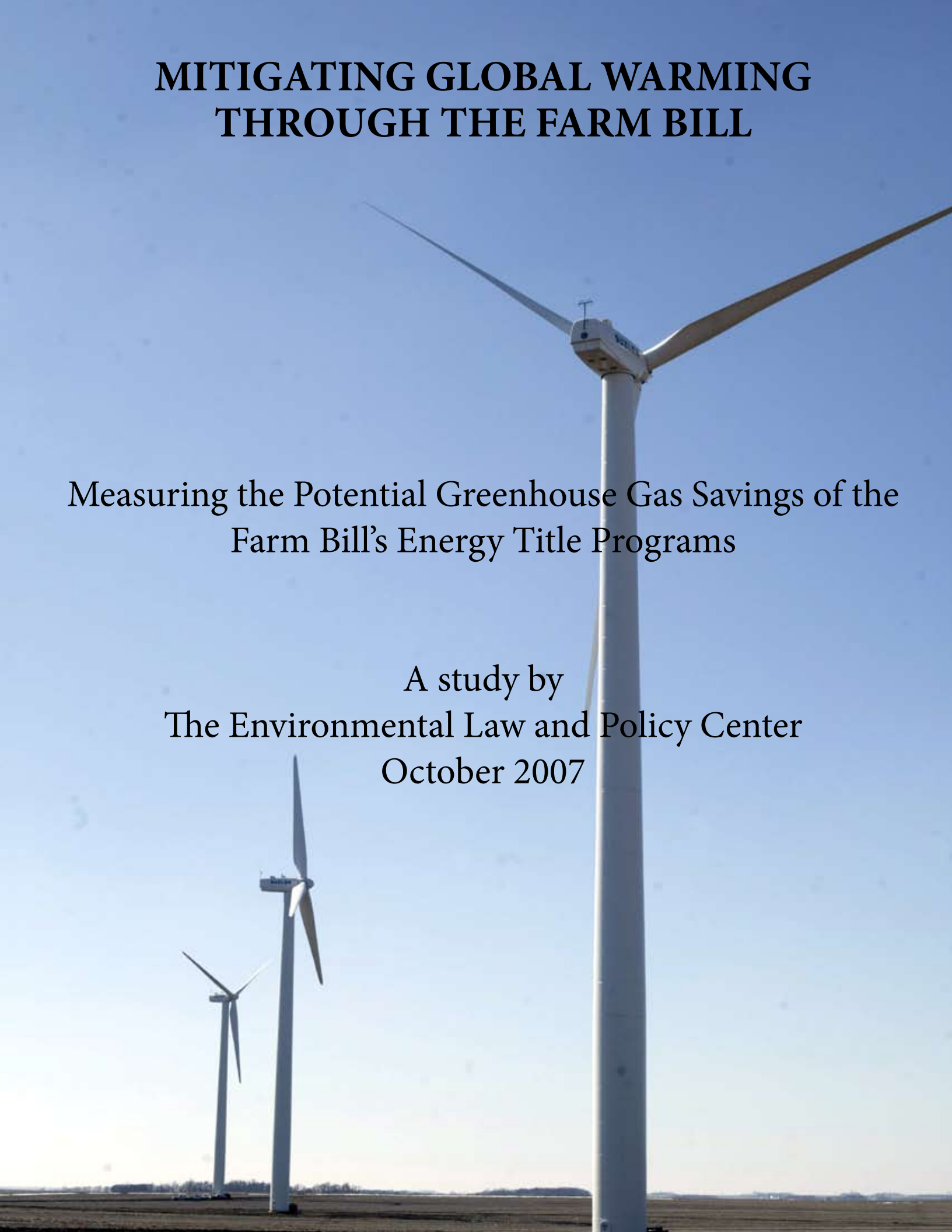
MITIGATING GLOBAL WARMING THROUGH THE FARM BILL



Measuring the Potential Greenhouse Gas Savings of the Farm Bill's Energy Title Programs

A study by
The Environmental Law and Policy Center
October 2007

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Report Summary

IN A TIME OF RISING CONCERN OVER THE CAUSES AND consequences of climate change, farm-based rural renewable energy and energy efficiency programs have the potential to reduce emissions of carbon dioxide (CO_2) and other global warming pollution. This study evaluates the extent to which existing and potential new Energy Title programs in the next five-year Farm Bill could, with an assumed level of funding of approximately one billion dollars a year, further reduce CO_2 and related emissions by encouraging the voluntary production of cleaner power and higher-efficiency farm and rural business operations.

The mix of programs in this report is based primarily on the current Energy Title programs and programs in the House of Representatives' recently passed Farm Bill (H.R. 2419) These programs are principally loan guarantee and grant programs that help to defray the cost and encourage the construction of new renewable power generation and biofuels facilities, and the installation of new energy efficiency improvements.

This study concludes that the next five years of Energy Title programs have the potential to save, or displace, approximately 57 million metric tons per year of CO_2 and other greenhouse gases, assuming that all projects that receive grant and loan guarantee awards are built. That equates, for example, to annual CO_2 emissions from approximately 11.6 million vehicles.

The Farm Bill's Energy Title includes other programs beyond the scope of this analysis, such as funding for the Biomass Research and Development Act, the federal bioproducts procurement program, and the biodiesel fuel education program. Although these and other Energy Title programs also have the potential to reduce carbon emissions, their benefits are either too indirect or long term for the purpose of this analysis.

Technology Overview

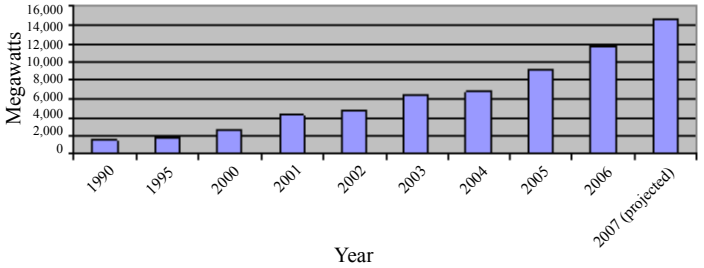
REGARDLESS OF THE PRECISE MIX OF PROGRAMS and funding levels, the Energy Title drives investment primarily in the following technologies, which form the basis of this report's analysis and conclusions:

Wind Power – A single 1 megawatt (MW) wind turbine– which generates no greenhouse gas emissions– can displace approximately 1,600 metric tons of CO_2 each year.[1]

Wind power continues to be the fastest growing energy resource in the U.S. (U.S. DOE – EERE, 2007). Once installed, wind power generates electricity without consuming natural resources or emitting greenhouse gases. Forty-six of the 50 states have wind resources that could be developed to generate electric power. (U.S. DOE - EERE, 2007). To date, approximately 11,600 megawatts of capacity have been installed in 37 states (NREL, 2006). Every megawatt of installed wind capacity can supply enough electricity for approximately 300 homes.(EIS, 2006)and can displace up to 40,000 metric tons of CO_2 over the twenty-five year lifespan of the equipment.

The nation's current commercial wind power facilities

Cumulative U.S. Wind Capacity



could displace more than 18 million metric tons of CO_2 annually based on the average U.S. power plant fuel mix, the equivalent emissions of more than 3 average-sized coal-fired power plants[2] or 3.8 million passenger cars[3].

Anaerobic Digesters - An average anaerobic digester that processes livestock manure waste can capture methane and generate up to 2,900 megawatt-hours of electricity, thereby potentially displacing approximately 4,000 metric tons of CO2 equivalent annually.[4]

Livestock waste currently contributes about 8% of human-related methane emissions in the U.S. (EPA, 2006). In 2005, it was estimated that waste from just the nation's 9 million dairy cattle released approximately 25 million metric tons of CO_2 equivalent. (IDFA, 2007) Anaerobic digesters capture methane emissions from confined animal waste.

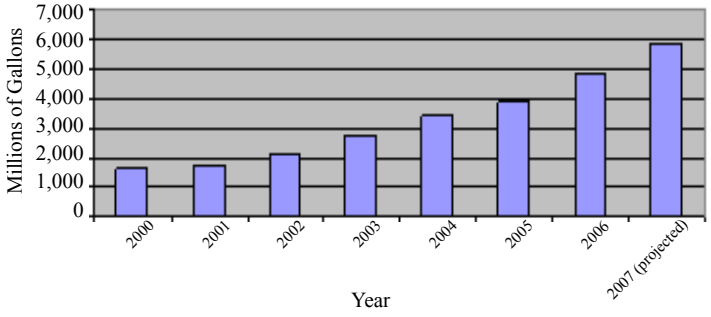
The resulting biogas can be used to produce electricity and heat, thereby displacing greenhouse gas emissions normally produced by fossil-fuel power generation.

Anaerobic digesters installed since passage of the 2002 Farm Bill have reduced CO_2 equivalent emissions by approximately 375,000 metric tons while generating approximately 275,000 megawatt-hours of electricity. (EPA AgStar Program, 2007)

Corn Ethanol– Corn-derived ethanol has the potential to reduce relative greenhouse gas emissions by 18% to 29% compared with gasoline.

Biofuels reduce greenhouse gas emissions relative to petroleum-based fuels because they release a lower net amount of CO_2 over their entire life-cycle. The CO_2 released into the atmosphere from gasoline consumption is not re-captured. When ethanol is subsituted, the CO_2 released into the atmosphere is re-absorbed by the next crop during growth, thereby reducing the overall net greenhouse gas emissions.

U.S. Ethanol Production



In 2006, ethanol use in the U.S. reduced CO_2 equivalent greenhouse gas emissions by approximately 8 million tons, equal to the annual emissions of more than 1.2 million cars. (Wang et al., 2007) Substituting a gallon of corn ethanol for gasoline could reduce greenhouse gas emissions by approximately 18% to 29% depending on the conversion process (wet or dry mill) to ethanol. (Wang, 2005)

Corn-based ethanol production has expanded rapidly from less than 2 billion gallons in 2000 to nearly 5 billion gallons in 2006. (RFA, 2007) That production used 18% of the nation's available corn crop, and represents about 5% of the country's current annual fuel consumption.

Cellulosic Ethanol– Cellulosic ethanol has the potential to displace 85-90% of the total greenhouse gas emissions associated with gasoline.

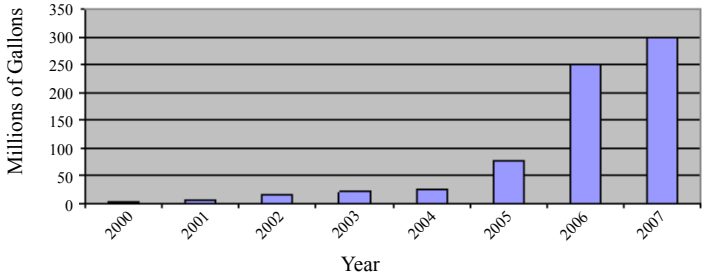
Cellulosic ethanol production uses the plant matter itself as a feedstock rather than the grain, which significantly expands the types and amount of materials available to produce ethanol. Immediate sources of biomass for cellulosic ethanol include agricultural and forestry residues, particularly corn stover. These biomass sources can be supplemented by high-yield "energy crop" feedstocks - perennial grasses and trees that can thrive on marginal lands with minimal fertilizer requirements.

Cellulosic ethanol has the potential to provide greater greenhouse gas benefits than conventional corn ethanol because less fossil fuel is needed to grow feedstocks (for example, natural gas used to produce nitrogen fertilizer, diesel fuel for tractors), and perennial energy crops capture and store carbon in their root systems. The greatest potential greenhouse gas reductions come from using agricultural and forestry residues, although energy crops, such as switchgrass, also yield significant reductions. Substituting cellulosic ethanol for 25% of the nation's gasoline consumption could displace up to 264 million metric tons of CO_2, which represents 4% of the nation's yearly emissions. On a full life-cycle basis , cellulosic ethanol has the potential to lower greenhouse gas emissions by 85-90% compared with gasoline.[5]

Biodiesel– Biodiesel has the potential to reduce CO_2 emissions by approximately 80% compared with petroleum diesel fuel.

Biodiesel production is growing at a faster rate than ethanol, although from a smaller base. Biodiesel production has increased from 2 million gallons in 2000 to 250 million gallons in 2006, and planned construction will more than double the refining capacity in the next two years. (NBB, 2007)

U.S. Biodiesel Production



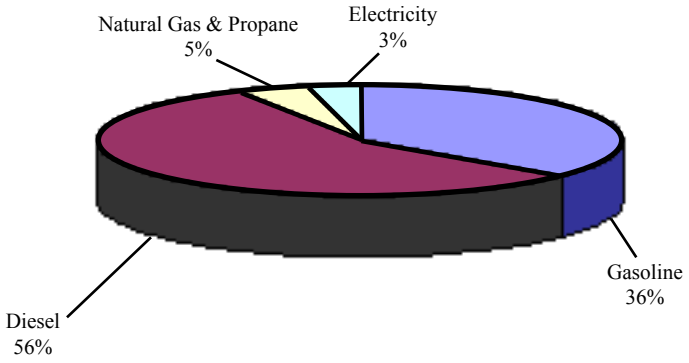
Every gallon of biodiesel can displace approximately 19 pounds of CO_2 emissions.[6] Since biodiesel is typically used in a "B2" blend (2% biodiesel: 98% petroleum diesel), the net impact is 1.5% reduction in carbon dioxide emissions for the blended product. A national B2 blend could displace 1.2 billion gallons of petroleum diesel and 13 million metric tons of CO_2 each year.[7] Depending on the feedstock, life-cycle CO_2 emissions from biodiesel are approximately 78% (soybean oil) to 94% (canola oil) lower than petroleum diesel.

Energy Efficiency– Improving on-farm and rural business energy efficiency can avoid carbon emissions by reducing use of diesel fuel in farm equipment and by reducing electricity, natural gas and propane use.

A recent study by the American Council for an Energy Efficient Economy (Brown, Elliot, 2005) quantified this potential by agricultural end-use and source of energy. Gasoline and diesel energy efficiency improvements are driven primarily by upgrades to new tractors and tillage equipment, as well as better operation of existing equipment. These estimates do not factor in changes in underlying tillage practices (i.e. moving from conventional to no-till farming) which also have carbon emission reduction potential.

Other opportunities for savings include replacement of irrigation equipment, installation of variable speed motors for dairy operations, improved livestock lighting and ventilation and new grain dryers. A table of the energy efficiency potential by energy source and related CO_2 reductions is shown below:

Total Potential Avoided CO_2 (metric tons/year)



Source: ACEEE, ELPC/Duke University Analysis[8]

Solar Energy- Solar technologies generate electric power and thermal energy without emissions.

Two of the primary commercial applications of solar energy are for solar photovoltaic (PV) panels and solar thermal power. Solar PV panels collect solar radiation from sunlight to generate electricity. In rural areas, solar PV is ideally suited to off-grid applications such as irrigation and livestock watering pumps. Under average conditions, each kilowatt of installed solar PV can generate up to 2,000 kilowatt-hours of electricity each year, enough to displace 1.2 metric tons of CO_2 equivalent. (EIA, 2007) Solar PV also can provide maximum CO_2 emission reductions during peak electricity demand on hot summer days

Solar thermal systems collect heat from sunlight to heat air or water, primarily for building use. A typical commercial solar hot water system (10 40-square foot panels) displaces 5 therms of natural gas per day [9] (Leavitt, 2007). On an annual basis, this is equivalent to approximately 10 metric tons of avoided CO_2 emissions compared with natural gas.

Biomass and Geothermal– These systems generate thermal energy for heating and cooling purposes, displacing greenhouse gas emissions primarily from natural-gas fired systems.

Biomass can effectively substitute for natural gas in boiler and heating systems. Substituting one metric ton of dry biomass for the equivalent heating value of natural gas has the potential to displace nearly one metric ton of associated CO_2 emissions.[10] Waste residues, such as sawdust and wood chips, are routinely used in the forest products industry for biomass heat and power. Agricultural by-products have been used in university heating plants. Biomass can displace natural gas in a wide array of rural and agriculture-based applications including lumber kilns, ethanol plants and commercial boilers (also known as ground-source heat pumps).

Geothermal heat pumps take advantage of the constant temperature in the ground (55 degrees year-round) to reduce building heating and cooling requirements. These heat pumps use 25%-50% less electricity than conventional cooling and 50% less gas than forced air heating systems, (U.S. DOE-EERE, 2007). They are ideally suited to rural installations because of the available land area for heat-exchange piping. Agricultural applications include fruit and vegetable dehydration and commercial greenhouses. There are currently an estimated one million geothermal heat pumps already installed in the country. These pumps may reduce emissions by up to 7.4 million metric tons of CO_2 per year by displacing natural gas and electricity use (Geothermal Heat Pump Consortium, 2007).

Estimating the Potential Greenhouse Gas Savings of Farm Bill Energy Title Programs

The current Farm Bill Energy Title provides a reasonable basis from which to estimate some of the potential greenhouse gas savings in the next Farm Bill. Even with relatively modest funding of less than $100 million a year in the last five years, several programs from the 2002 Farm Bill are encouraging farmers and rural businesses to invest in clean energy production and efficiency improvements, which also results in greenhouse gas savings. Through grants and loan guarantees, together with biofuel production incentives, these programs help to fund the construction of wind energy, anaerobic digesters, biofuels, energy efficiency and other projects.

Section 9006 of the Energy Title, the Renewable Energy Systems and Energy Efficiency Investments Program, authorizes USDA to issue grants and loan guarantees to farmers, ranchers and rural small businesses to help construct renewable energy projects and implement energy efficiency improvements. Congress has funded Section 9006 at approximately $23 million per year since 2003, and USDA has issued over 1100 grant and loan guarantee awards for renewable energy and energy efficiency projects worth over $1.5 billion in total investments.

Based on the distribution of awards during the program's first four years, we estimate that the projects funded through Section 9006 may yield, after they are all built, the following potential greenhouse gas savings:

- Wind Energy: Section 9006 has funded 330 megawatts of locally-owned wind power in 17 states. These projects, when fully complete, may displace over **600,000 metric** tons of CO_2 equivalent annually.

- Biofuels: Section 9006 is funding several locally-owned ethanol and biodiesel facilities through grants and loan guarantees. When completed, these projects will have produced a total of 240 million gallons of biofuels, and displace potentially **600,000 metric tons** of CO_2 equivalent annually.

- Anaerobic Digesters: 90 anaerobic digester systems funded since 2003 may displace up to **80,000 metric tons** of CO_2 equivalent annually when complete. These projects represent 75% of the operational digesters in the nation.

- Energy Efficiency: Over 650 energy efficiency projects have received Section 9006 grants. These projects, which range from more efficient irrigation pumps to poultry house upgrades, have the potential to reduce CO_2 equivalent pollution by up to **45,000 metric tons** annually.

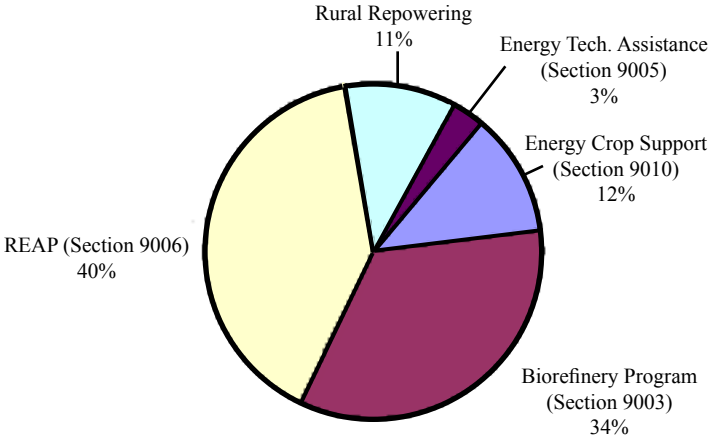
Two other programs in the 2002 Farm Bill also are notable. First, the Bioenergy Program (Section 9010) defrayed the cost of corn and soybean feedstocks for new (and increased production at existing) ethanol and biodiesel production facilities. This program reduces greenhouse gas emissions by encouraging the construction and expansion of biofuels plants.

Another program, the Biomass Research and Development program (Section 9008 of the 2002 Farm Bill), funds advanced biofuels and bioenergy research projects. These grants help to accelerate biomass use and production which ultimately should save millions of metric tons of avoided CO_2 emissions.

Potential Greenhouse Gas Savings From The Next Farm Bill Energy Title

With a comprehensive suite of programs and more funding, the next Farm Bill Energy Title has the potential to significantly reduce greenhouse gas emissions. The following estimates are based on one billion dollars in annual funding distributed over several existing and new programs, and USDA using that funding to issue equivalent levels of grant, loan guarantee and other incentives over the same period. The programs include a synthesis of major Energy Title programs in the 2002 Farm Bill and likely programs in the next Farm Bill (based in part on programs included in the House Farm Bill passed in July 2007).

Potential Greenhouse Gas Savings Major Energy Title Programs



Rural Energy for America Program (Section 9006 of current Farm Bill)

With annual average funding of $250 million per year over five years, Section 9006 likely would significantly increase its carbon reduction potential. With these funding increases and the substantive program changes included in the House Farm Bill passed in July 2007 (H.R. 2419), the program could achieve total CO_2 savings of approximately **21 million metric tons** each year by encouraging new investments in wind energy, biofuel plants, anaerobic digesters, biomass energy, and energy efficiency improvements.[12]

Biorefinery Development Program

This program would provide $250 million in grants and close to $4 billion in loan guarantees to encourage the construction of next-generation cellulosic ethanol facilities. Assuming that up to 51 50-million gallon cellulosic ethanol plants could be built using this funding, the associated CO_2 reductions could be approximately **19 million metric tons** per year.

Bioenergy Support Program

This program - Section 9010 of the current Farm Bill -- would be amended to include feedstock incentives for biofuels facilities using advanced energy crops, agricultural and forestry waste, and other cellulosic feedstocks. The program would also encourage using biomass as a process fuel for heat or combined heat and power (CHP) in these facilities instead of natural gas

or coal. With these changes, this program could displace nearly **6.9 million metric tons** of CO_2 equivalent each year. Excluding potential overlapping support from other programs, this could represent over 800 million gallons of new biofuels production and 44 million mmBtus of reduced natural gas use for this production.

Rural Repowering

This program would encourage owners of the thousands of existing boilers in industrial, institutional, and commercial applications to use biomass as a fuel for space heat, process heat and steam. Biomass can either be gasified to create a substitute for natural gas or combusted directly in boilers. Assuming that this program was fully subscribed, it could fund approximately 67 boilers each year, and could potentially displace about **6.1 million metric tons** of CO_2 equivalent each year, primarily from avoided use of natural gas.

Energy Efficiency/Renewable Energy Technical Assistance

This program was included as Section 9005 of the 2002 Farm Bill but never funded. The program would provide grants to university extension programs, utilities and other agricultural institutions to deliver technical training and assist farmers in identifying energy efficiency and renewable energy opportunities, both in fields and livestock operations. Assuming that these programs could lead to 2% less energy use in agriculture, they could result in an estimated **1.6 million metric tons** in reduced greenhouse gas emissions annually.

Other Biomass Programs

This study does not estimate the greenhouse gas savings potential of a new Biomass Energy Reserve (BER) program or the existing Biomass Research and Development Program. During the next five years the BER could result in up to 50 demonstration projects as outlined in both House and Senate versions of this program. These projects will produce greenhouse gas savings, but the biofuels plants used for the BERs are likely to receive incentive funding under the Biorefinery Development Program for which this report already estimates potential savings. Therefore, this report essentially already includes these savings.

While the basic and applied research funded through the Biomass Research and Development program does not have directly measurable greenhouse gas benefits, continuing to fund this research will accelerate and improve the economics of the commercial applications of advanced biofuels and bioenergy production.

Funding Allocation Assumptions

The program funding estimates are based in part on the mandatory funding levels in the House-passed Farm Bill in July 2007 (H.R. 3121), together with the authors' evaluation of which programs are likeliest to encourage the development of commercial-scale energy projects. Program funding dollars were then allocated between grants and loan guarantees based on the type of program and program history (to the extent that program history exists).

Loan guarantees for the programs were assumed to require 6.5 cents in federal funding for each dollar of loan guarantee. This ratio is the same as the U.S. Department of Agriculture's financing assumptions for its Business and Industry and Section 9006 loan guarantee programs. In other words, every $1 million in program funding leveraged a total of $15 million in loan guarantees.

Project Financial Assumptions

This report assumes that each program will fund a specified number of projects during the program's five year life in the next Farm Bill. The project cost assumptions are based on estimated "typical" capital costs for the types of projects funded by the program. For example, if a 50 million gallon advanced cellulosic ethanol biorefinery costs $100 million, $1 billion in loan guarantee authority (with maximum loan guarantees at 80% of project cost) would represent $1.25 billion in potential projects, or 12.5 projects.

Estimating Potential Greenhouse Gas Savings Benefits

This report's estimates of potential greenhouse gas savings are based on the per unit benefits discussed in this paper. For example, if one megawatt of wind power capacity has the potential to displace approximately 1,600 tons of CO2 annually (from avoided electricity generation), a typical "community scale" wind energy project 3 megawatts in size could displace 4,800 tons of CO2 annually, and 100 projects of this size could displace 480,000 tons of CO2 annually.

Project Timing

Farm Bill legislation typically covers five years; therefore, this report assumes that the next Farm Bill would include five fiscal years (2008-12). However, many of the larger projects might require up to five years for planning, construction, and full-scale operation. Therefore, this report's greenhouse gas potential benefits are based upon a snapshot of conditions in the 2017 reference year. The report assumes that all projects funded through the 2008-12 Farm Bill cycle are fully operational by 2017. The report estimates reasonable potential maximum greenhouse gas emission displacements, and assumes that 100% of the funding is used and that all of the projects are built.[11]

Conclusion

The Farm Bill Energy Title renewable energy and energy efficiency programs have the potential to displace approximately **57 million tons of greenhouse gas emissions each year.** Renewable biofuels can be substituted for a significant portion of total petroleum fuel consumption. Renewable power generation can supplant fossil-fuel fired power plants to provide zero or low-CO_2 emission electricity and heat. Energy efficiency upgrades help to retire older and inefficient equipment with more efficient replacements, reducing the overall consumption of fossil-fuels on the farm and at the power plant.

Minimal funding for the current Farm Bill Energy Title programs has prompted enough energy development to demonstrate that the investments have the potential to deliver significant energy and greenhouse gas savings. Increasing funding levels to at least one billion dollars a year in the 2007 Farm Bill—less than 2% of the total Farm Bill—will allow these energy development programs to evolve from relatively small-scale and locally beneficial to mitigating climate change through lower greenhouse gas emissions across the country.

End Notes

[1] (AWEA, 2006).

[2] Assumes that an average size coal-fired power plant is 667 MW, operating at 85% capacity with an efficiency of 33% will generate 4,966,482 megawatt-hours of electricity annually. Also assumes that every kilowatt-hour of electricity generated produces 2.061 pounds of CO_2 (EIA, 2000), meaning that a 667-megawatt plant will emit 4.65 million metric tons of CO_2 annually.

[3] Assumes that an average passenger car with fuel economy of 21.6 MPG (BTS, 2005; EIA, 2005) and annual vehicle miles traveled (VMT) of 12,000 (EPA, 2005) will emit 11,750 pounds (4.94 metric tons) of CO_2 annually.

[4] This figure assumes the following: An average anaerobic digester processes waste from 1000 animal units (i.e. one thousand 1000-pound cows) each year. In one year, the waste created by each animal unit contains 0.12 metric tons of methane, or 2.75 metric tons of CO_2 equivalent. The anaerobic digester captures this methane and uses the biogas to generate 6 – 8 kilowatt-hours of electricity per animal unit per day. Anaerobic digester use also helps to avoid one additional metric ton of CO_2 equivalent per animal unit per year by displacing power generation from traditional fossil-fuel plants.

[5] These figures assume the following: In 2005, 140 billion gallons of gasoline were consumed by the transportation sector, contributing 34% of the total amount of U.S. CO_2 emissions of 5,955 million metric tons. (EIA, 2005) One gallon of gasoline consumed emits 19.5 pounds of CO_2, therefore 35 billion gallons of gasoline consumed would emit 311 million metric tons of CO_2. Substitution of an equivalent amount of corn ethanol would reduce emissions by at least 56 million metric tons of CO_2 and substitution of and equivalent amount of cellulosic ethanol would reduce emissions by at least 264 million metric tons of CO_2

[6] Assumes that one gallon of petroleum diesel consumed emits 23.9 pounds of CO_2

[7] 2005 U.S. Total Petroleum Diesel Sales = 63 billion gallons (EIA, 2005)

[8]

Energy Source	Energy Savings Potential (MMBtu/Year)	% of Total Potential	Estimated CO_2 per MMBtu (lbs)	Total Potential Avoided CO_2 (metric tons/year)
Gasoline	34,300,000	36.1%	177	2,759,465
Diesel	53,100,000	55.9%	158	3,811,998
Natural Gas	300,000	0.3%	112	15,237
Other (Propane)	4,100,000	4.3%	92	170,316
Electricity	3,200,000	3.2%	210	304,752
Total Ag Sector	95,000,000			7,061,768

[9] Based on typical performance metrics in northern Illinois.

[10] This assumes the following: one pound of dry biomass has a heating value of 8,600 Btu, therefore one metric ton of dry biomass contains 18.9 million Btu. Biomass has a net emission coefficient of zero because any CO_2 emissions will be absorbed in the natural carbon cycle (disregarding fossil fuels used in collecting, transporting and processing biomass). The emission coefficient for natural gas (pipeline) is 117.080 pounds of CO_2 per million Btu of natural gas. (EIA, 2007) Therefore, combustion of 18.9 million Btu of natural gas would have associated emissions of 2,211 pounds (roughly one metric ton) of CO_2.

[11] The following represents the technology-specific assumptions for this study.

Technology	Cost per Project	Project Size	GHG Reductions per Project per year (Metric tons, CO2 equivalent)	Potential # of Projects Funded through Farm Bill
Cellulosic Ethanol	$100 million	50 million gallons	374,773	51
Wind Energy	$4.5 million	3 megawatts	4,800	584
Biomass Heat	$15 million	For 50 million gallon ethanol plant	92,273	67
Anaerobic Digesters	$1 million	750 cow dairy farm	4,000	977
Energy Efficiency	$75,000	various	86	12,500

[12] Projected GHG emission reductions were modeled based on assumptions regarding allocation of federal dollars across programs, distribution between grants and loan guarantees, average project capital cost and size, emissions profile of fossil energy displaced, and lag time between program funding and project completion.

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ENVIRONMENTAL LAW & POLICY CENTER
Protecting the Midwest's Environment and Natural Heritage

The Environmental Law & Policy Center is the Midwest's leading public interest environmental legal advocacy and eco-business innovation organization. We develop and lead successful strategic environmental advocacy campaigns to protect our natural resources and improve environmental quality. We are public interest environmental entrepreneurs who engage in creative business dealmaking with diverse interests to put into practice our belief that environmental progress and economic development can be achieved together. ELPC's multidisciplinary staff of talented and experienced public interest attorneys, environmental business specialists, public policy advocates, and communications specialists brings a strong and effective combination of skills to solve environmental problems.

ELPC's vision embraces both smart, persuasive advocacy and sustainable development principles to win the most important environmental cases and create positive solutions to protect the environment. ELPC's teamwork approach uses legal, economic and public policy analysis, and communications advocacy tools to produce successes. ELPC's strategic advocacy and business dealmaking involves proposing solutions when we oppose threats to the Midwest environment. We say "yes" to better solutions; we don't just say "no."

ELPC was founded in 1993 after a year-long strategic planning process sponsored by seven major foundations. We have achieved a strong track record of success on national and regional clean energy development and pollution reduction, transportation and land use reform, and natural resources protection issues. ELPC brings a new form of creative public advocacy that effectively links environmental progress and economic development and improves the quality of life in our Midwestern communities.

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