Assessment of a Low-Income Weatherization Program as a Carbon-Reduction Program

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ABSTRACT

As weatherization becomes an important tactic in the current national strategy to develop "green jobs" to spur economic recovery *and* energy efficiency, it is useful to look at these long-standing low-income programs in a new light. Is low-income weatherization an effective greenhouse gas (GHG) reduction tool? Do new economic tools like "green tags" and "emissions offsets" markets have a place in low-income programs? If that potential exists, how can low-income program designers and implementers maximize their effectiveness in these new pollution reduction arenas? Are there simple means to evaluate and report GHG reductions resulting from low-income weatherization?

This analysis concludes that a weatherization program as implemented in Wisconsin has real potential as a GHG reduction program. Further, it identifies a relatively simple means to assess carbon emissions impact, to project long-term emissions reductions and to "true-up" electricity emissions reductions as the electricity generation fuel mix changes.

Weatherization work on a typical Wisconsin home reduces energy use by 164 therms and 915 kWh, realizing an occupant savings of $284 per year, and reducing emissions of CO_2, NO_x .and SO_x. At present, these pollution reductions have a value of $27 per home per year. In a carbon-capped market, this pollution reduction could be valued at $75 per home per year. Wisconsin's Weatherization program at its present volume could produce a carbon credit income stream of $3 million annually after 10 years aggregated production, which would level out after 15 years at close to $6 million per year. This amount of added "revenue" could fund treatment of an additional 1,000 homes per year. In a carbon-capped economy, where CO_2 emissions would generate more revenue, these figures roughly double.

The weatherization program model as implemented in Wisconsin is well suited for participation in emissions markets. The energy savings and emissions reductions from weatherization work are substantial, and achieved in an economic strata where the savings are unlikely to occur absent the program. The impacts of weatherization have concrete results that are readily quantified within an existing data and budget reporting system. Although the credit registration process could be complex; the program already has in place tools that can be adapted to accomplish that task, should the opportunity arise.

Introduction

As weatherization becomes an important tactic in the current national strategy to develop "green jobs" to spur economic recovery *and* energy efficiency, it is useful to look at these long-standing low-income programs in a new light. Is low-income weatherization an effective greenhouse gas (GHG) reduction tool? Do new economic tools like "green tags" and "emissions offsets" markets have a place in low-income programs? If that potential exists, how can low-income program designers and implementers maximize their effectiveness in these new pollution reduction arenas? Are there simple means to evaluate and report GHG reductions resulting from low-income weatherization?

This analysis concludes that a weatherization program as implemented in Wisconsin has real potential as a GHG reduction program. Further, it identifies a relatively simple means to assess carbon emissions impact, to project long-term emissions reductions and to "true-up" electricity emissions reductions as the electricity generation fuel mix changes.

Weatherization work on a typical (2002) Wisconsin home reduced energy use by 164 therms and 915 kWh, realizing an occupant savings of $284 per year. This energy efficiency improvement translates to a reduction in CO_2 production of roughly 26 tons over 15 years, at a cost of approximately $6,000 per home. The same program work produces marketable reductions in NO_x (4 pounds/year @ $1.73/pound) and SO_x (4.4 pounds/year @ $1.20/pound) emissions as well.

In the current voluntary U.S market for emissions credits, these pollution reductions have a value of $27 per home per year. In a future carbon-capped market that allows energy efficiency credits (assuming a price of $30/ton CO_2), this pollution reduction could be valued at $75 per home per year.

Since weatherization measures are long-lived, carbon credits accrue over years. The overall financial impact of carbon savings increases the longer the program markets its credits. Weatherization work performed has an average "measure life" of 15 years. An ongoing Wx program selling emissions credits would see an ongoing growth in "carbon revenue" until emissions credit production levels off at approximately 15 years. In likely near-term U.S. markets ($3.00/ton CO_2), Wisconsin's Weatherization program at its present volume would produce an annual income stream that reaches approximately $3 million annually after 10 years aggregated production, and would level out after 15 years at close to $6 million per year (constant 2007 dollars). This amount of added "revenue" could fund treatment of an additional 1,000 homes per year. In a carbon-capped economy, where CO_2 emissions would generate more revenue, these figures roughly double.

The weatherization program model as implemented in Wisconsin is well suited for participation in emissions markets. The energy savings and emissions reductions from weatherization work are substantial, and achieved in an economic strata where the savings are unlikely to occur absent the program. The impacts of weatherization have concrete results that are readily quantified within an existing data and budget reporting system. Although the credit registration process could be complex, the program already has in place tools that can be adapted to accomplish that task, should the opportunity arise.

Low-income Weatherization and Greenhouse Gas Reduction

The low-income weatherization program as implemented in Wisconsin already delivers substantial benefits to the state. Accounting for and marketing the GHG emission reductions it already produces would provide effective evaluation of a previously-unrecognized social benefit. To understand the GHG reduction provided, it is useful to review the origins of the program, the needs it meets, and the process by which weatherization works to provide energy cost savings and GHG reductions.
The term "weatherization" is typically used to describe comprehensive work performed to reduce energy

use in homes. Weatherization (which is abbreviated here, as in the field, as Wx) is most often implemented specifically as "low-income weatherization," structured government or utility programs intended specifically to mitigate the social costs of high energy use and high energy cost burdens in households that have difficulty affording space heating energy costs in cold climates.

Wisconsin launched one of the first low-income Wx programs in the country, in the mid-70s, as a response to the first oil price shocks. When fuel oil costs doubled virtually overnight, the need for some assistance was obvious. Congress created low-income fuel subsidy programs immediately. After that, the Wx program was an obvious longer-term intervention, to reduce the energy demand and energy use of low-income households. In the state of Wisconsin, Wx efforts have developed in a manner consistent with the state's early adopter status and cold climate. Program efforts have also been heavily influenced by the state's political tradition of aggressively regulating public utilities.

The Need for Weatherization In Wisconsin

To understand the Wx program, it is important to recognize that energy costs are a disproportionate burden on low-income households. The entry point into Wisconsin's Wx program is the "Wisconsin Heating Energy Assistance Program (WHEAP)", which provide annual grants to households having trouble paying utility bills. The program is means-tested, so applicants are required to report their income and their typical utility costs. From this data, it is possible to measure the hardship utility bills create.

Energy analysts working in the field start first by assessing the "energy burden" of target households, the proportion of household income required to pay energy bills. In Wisconsin, an average-income household has an energy burden of approximately five percent. By contrast, low-income households typically pay approximately 20 percent of their income in energy bills, and some pay a far higher proportion of their income to keep essential utilities turned on.

Table 1 -- 2003 Mean Energy Burden of Wisconsin Applicants for Energy Assistance

Energy Burden	Frequency	Percent	Valid Percent	Cumulative Percent
1 to 10 %	57,252	42.4	47.4	47.4
10 to 20%	43,607	32.3	35.9	83.1
20 to 30%	10,772	8.0	8.9	92.0
30 to 40%	3,292	2.4	2.7	94.7
40 to 50%	1,414	1.0	1.2	95.9
50 to 60%	746	0.6	.06	96.5
60 to 70%	456	0.3	0.4	96.9
70 to 80%	367	0.3	0.3	97.2
80 to 90%	259	0.2	0.2	97.4
90 to 100%	1,730	1.3	1.4	98.8
Over 100%	1,443	1.1	1.2	100
Missing/Insufficient Info	13,745	10.2		
Total	135,082			

Source: Department of Administration, Energy Services Division. WHEAP database, FFY 2003 through August 11, 2003

The lowest and largest bin (1 to 10%) is heavily biased to the high end. The mean energy burden of households qualified for WHEAP grants and Wx services is 19.8 percent.

However, this heavy energy burden is not a simple mathematical artifact of lower income. *Ceteris paribus*, utility bills often *increase* as household income falls. Low-income families generally live in older, lower-quality, less energy-efficient housing. A low-income family in Wisconsin is twice as likely as average to live in a home built before 1930, and space heating use/waste is closely correlated to the age of the structure. The per-square-foot energy intensity is 10 percent higher, as low-income homes are $2^{1}/_{2}$ times more likely than the average home to have excessive infiltration, and twice as likely to be inadequately insulated (Pigg and Nevius). Low-income families are more likely to have older appliances and equipment in their homes.

One-to-four unit rental housing, especially, is likely to impose greater-than-average energy costs, since they are subject to a form of "principal-agent" market failure known as the "split incentive." These small buildings are almost always metered to the tenant, but the owner decides how to maintain the building, and what energy-consuming appliances will be furnished. The landlord's "split incentive" motivates installing the lowest-cost (and lowest-efficiency) HVAC systems and electric appliances. While a Wisconsin homeowner, paying their own utility bills, virtually always chooses an efficient furnace, an absentee owner is more motivated to save a few hundred dollars on the less efficient furnace, and take the chance that a prospective renter will not reject his unit solely because of the furnace. It has been observed that a rented home is far more likely than an owner-occupied home to have an induced-draft (80 percent efficient) furnace instead of a condensing (90+ percent efficient) one. (Definitive data has not been found. This observation is from reports by Wx workers to the author at Weatherization Tech Fairs in Wisconsin, in October 2006 and September 2008, and personal observation.) The same split incentive affects all other owner-provided features and appliances; insulation, refrigerators and water heaters.

Willy Sutton robbed banks because "that's where the money is." Residential efficiency programs do well to target low income housing, because that's where the savings are.

What is Weatherization, and How Does it Create Carbon Reductions?

Weatherization is the organized and comprehensive retrofit of a building to reduce its energy use. In the Wx program, a residential energy expert (an "auditor") makes an assessment of the building's condition, energy-using features, and (often) its present energy consumption. He/she then identifies the energy conservation measures (ECMs) to be applied to the building that will reduce energy use and (especially) energy waste. In the early days of formal Wx programs, workers weather stripped doors, installed storm windows or window plastic, and caulked around building openings, intending to prevent wind intrusion and heat loss. The effects on energy use were relatively small, as demonstrated by the first nationwide evaluation of the program.

Today, Wx work is far more comprehensive. Wx work almost always involves insulating deficient areas of the building shell and replacing or completing deferred maintenance on energy-using hardware such as furnaces or water heaters. In heating-dominant climate zones, hot water is usually the second largest energy use after space heat. Reducing hot water use by replacing conventional showerheads and faucet aerators with low-flow models is very cost-effective. (While water heater replacement reduces energy use, demonstrations of cost-effectiveness are far less certain. Water heater replacement is usually not undertaken as an ECM.) In cooling-dominated climates, Wx work may involve upgrading air conditioning systems, especially in areas where security concerns deprive residents of free cooling because they are forced to keep windows closed.

One unusual ECM that all Wx workers must master is that of "air sealing" a residence. One thing Wx workers didn't know when the program was first created is that air leakage in cold-climate homes is an important energy waster, usually the largest single driver of space heating (or cooling) energy use.

However, the air leakage that actually matters is almost everywhere in a typical home except where most people first look for it, at the windows and doors. Wx workers get up in the attic and seal the gap that is always left between the ceiling and chimneys, electrical boxes, sewer vent pipes, and attic hatches. They go down in the basement and seal between the concrete wall and the wood frame that sits on it, between the underside of the floor and the beam wrapped around the wall, and around all the pipes, tubes and wires coming into the basement. Where the walls are generally leaky, Wx workers have perfected a technique where cellulose fibers, blown into wall cavities under pressure, flow into the gaps and cracks hidden under the house siding. Besides the added insulation, this "dense-pack" system reduces infiltration significantly. A calibrated fan system ("blower door") measures the air leakage of the building shell, and helps Wx workers find and fix the holes that leak conditioned air and waste energy.

Wx program protocols also involve some non-energy measures. They require repair or replacement of minor building elements to assure that installed energy measures will be protected, such as minor roof repairs, electrical repairs to installed devices, and repairs to areas accessed while installing ECMs. The program also provides for measures to reduce health and safety risks, such as installation of smoke alarms and repair of gas leaks. One last group of required measures is oriented toward assuring that the newly air-sealed home does not develop high humidity and moisture/mold problems. This can require the repair of water leaks or installation of active ventilation in bathrooms or kitchens.

Historically, Wx programs have been oriented entirely towards space heating energy savings. After all, the original goal was to keep people from freezing in their homes and suffering utility disconnects. In the minority of Wisconsin homes still heated with oil, the GHG reductions from space heating conservation are substantial. Most weatherized homes, however, are heated with natural gas, which is significantly less carbon-intensive. If this were the entire Wx effort in Wisconsin, GHG emissions reductions would be a small part of the program benefit. And, since GHG emissions from natural gas are a known quantity (11.76 pounds CO_2/therm) the assessment of GHG reductions would be very straightforward.

Wisconsin's program is very different from most states, making it a uniquely useful look at all the energy use in homes, at potential ECMs for homes, and especially at GHG reductions. In 1999, the Wisconsin legislature introduced sweeping changes in funding for the program, especially with a surcharge on electric bills. This encouraged implementation of new measures oriented toward electricity savings. As a result, GHG reductions from the program are dramatically higher, but far less predictable. Wisconsin electricity generation is carbon-intensive, with 75 percent coal (EIA, 2003), but the fuel mix is in constant flux. This makes evaluation of GHG reductions from the program far more complex.

Electrical measures employed are typical. Since refrigerator efficiency has improved so dramatically in the last 20 years, refrigerator replacement is an important measure. Wisconsin Wx analysts have gone to some lengths to define simple, effective protocols for energy auditors to use in selecting inefficient refrigerators for cost-effective replacement.

Other electrical measures include replacing incandescent light bulbs and halogen torchiere lamps with energy efficient CFL lights, switching electric water heaters to natural gas, replacing inefficient freezers and encouraging the removal of second refrigerators and freezers.

Note that the efficiency industry has long been involved in intensive discussion of lighting use and lighting savings in homes; with aggressive efforts to replace every incandescent bulb that is not exposed/ornamental, the average Wx home takes 24 CFLs.

Greenhouse Gas Reductions from Weatherization – The "Electricity Problem"

The total Wx production for 2006 involved 3,902 single family units, 2,167 units in 2-4 unit buildings, and 776 mobile homes. Over the entire 6,845 units, the average cost for direct work on units was $5,255 per unit. The distribution of the most important measures in 2006 was as follows:

Table 2 -- Measure distribution in Wisconsin Wx Program (1 to 4 Unit buildings, CY 2006 data):

Measure	Proportion of Units
Attic Insulation	99+ %
Wall Insulation	40%
Air Sealing	94%
Heating System (furnace or boiler) Replacement	42%
Heating System clean & tune	30%
Refrigerator Replacement	39%
Incandescent/CFL Light Bulb Switch	98+%
Window Replacement (as repair, not cost-effective as ECM)	7%
Hot Water Heater Blanket	18%
Hot Water Pipe Insulation	76%
Showerhead Replacement	28%

All of this work creates energy savings, of both natural gas and electricity. Because every unit is addressed individually, but actual savings calculations are not performed for every unit, assessing the energy savings of the program as a whole is not straightforward. The program administrators conduct general program evaluations on a regular basis, selecting units at random and investigating actual utility consumption. They regularly verify that the program succeeds at selecting homes with space heating energy consumption well above average for a Wisconsin household, and reducing that energy use to below-average levels. This is true even as the typical low-income Wx home and the average Wisconsin (non-low-income) home have both become more energy efficient over the last three decades.

Evaluating the effects of Wx work is a complex undertaking. Measures interact in a wide variety of ways that are not always predicable. The most direct and accurate (and most complex!) evaluation technique involves direct comparison of before-and-after utility bills from weatherized units. Wisconsin undertook such a program evaluation in 2004, examining the utility bills of Wx recipients over the period from July 2001 to June 2004. The evaluation team assembled, cleaned, aggregated and analyzed three years worth of data from more than 11,000 electric accounts and over 8,000 natural gas accounts. According to this evaluation, the average energy saving per unit, over all housing types, was 833 kWh per year and 156 therms per year. This represented a reduction of 11 percent compared to pre-participation electricity use, and a 15 percent reduction in natural gas use. This hard data provides a baseline from which to understand the emissions savings created by Wx efforts.

Table 3 -- Energy Savings Per Unit -- Utility Bill Analysis Pre- and Post-Wx

Building Type	Electricity			Natural Gas		
	Annual kWh saved per participant	Number of Participants	Total Annual Savings (thousand kWh)	Annual therms Saved per participant	Number of Participants	Total Annual Savings (thousand therms
Single Family	924	7,033	6,497	169	4,519	764
Mobile Home	1,167	1,642	1916	59	1,039	61
2-4 Units	783	2,525	1,976	185	2,311	427
Multifamily (5+ units)	46	1,352	62	94	383	36

Average	**833**	12,552	10,452	**156**	8,252	1,288

Translating these energy savings into emissions savings involves an understanding of the fuel mix used to provide the energy. Natural gas savings are straightforward to calculate. Natural gas produces 11.76 pounds of CO_2 per therm burned. Natural gas also contains very small amounts of sulfur, yielding minute amounts of SO_x, and small-scale combustion creates small amounts of NO_x, but the production of each is generally considered to be negligible.

Analyzing emissions caused by electricity generation is a good deal more complex, since Wisconsin's grid is primarily (75%) coal-based generation, with some (17%) nuclear, three percent hydro, and the rest a mix of natural gas peaking plants, biomass/coal co-firing, petroleum, and imported power (Wisconsin DOA, 2007). All these plants are used at varying times, and at varying rates. Thus, the emissions mix shifts from hour to hour, from season to season, and from year to year. The short-run fuel mix changes not only in response to demand, but also as fuel availability and prices change. Emissions also vary in the long run, since the state's generation mix changes as Wisconsin utilities build new capacity.

Generator use and the resulting emissions can be calculated in great detail, thanks to data collected and managed by the Environmental Protection Administration. All large emission sources (electric generators, industrial boilers, foundries and kilns, etc.) are required to monitor their exhaust streams. They measure and report emissions to the Environmental Protection Agency's Office of Air and Radiation. The data is published as "Acid Rain Hourly Emissions Data (EPA, multiple years). From this data, the overall emissions from electrical generation can be calculated. This painstaking and precise hour-by-hour process, applied to CY 2000 generation data, was used to develop the emissions factors used in the 2004 low-income evaluation.

The disadvantage of this hourly approach for the present purpose is that it is essentially too specific and too variable. In the years used in the above analysis, much of the mid-load (500 to 2,000 hours/year) electrical generation added had been from imports and cleaner-burning natural gas-fired generators. These NG generators were mostly simple-cycle turbines built originally as peaking units (<500 hours/year.) Heavier use of these "clean" generators (typical heat rate of 9,750 Btu/kWh and 1,150 pounds CO_2/MWH) (EIA-860, multiple years) or combined cycle units (typical heat rate of 7,340 Btu/kWh and 822 pounds CO_2/MWh at full output) meant that Wisconsin's generation mix had gotten significantly less carbon-intensive over the years from 1998 to 2006.

This fact is certain to change. By 2012, state utilities plan the addition of 2,700 MW (nameplate rating) of new electrical generation; two thirds of the planned new capacity is three new coal-fired baseload plants that are already under construction (EIA 860). The new coal units incorporate the best available control technologies, and so will increase average SO_x and NO_x emissions in the state only slightly. These new supercritical coal plants will be more efficient than current coal units (heat rate of 8,550 to 9,760 Btu/kWh (Wisconsin Public Service Commission, 2003), as compared to an average of 11,233 Btu/kWh (CIER, 2001) at four existing coal baseload units), but will still emit approximately 1,820 pounds of CO_2/MWh (assuming that the primary fuel is Powder River sub-bituminous coal). That is, even with their substantially improved efficiency compared to existing generators, they still emit CO_2 at a rate 50 percent higher than the NG-fired turbines they replace. Thus, their addition will boost average carbon emissions per MWh significantly, since they will "crowd out" significant amounts of NG-fired simple-cycle turbine generation, moving these units from mid-load use back in the class of strictly peak load generation.

A Simplified Electric Emissions Model

Estimating emissions from electric generation with all these changes is unwieldy and costly. A constant tension in evaluation protocols is that between data quality and data cost. In this case of the GHG impacts of Wx, a simpler emissions modeling protocol would be useful, if it could be sufficiently accurate. The ideal protocol for an ongoing program would be more global and less detailed, which h would especially facilitate regular updates to accommodate the effects of long-lived carbon reductions.

In the case of Wx work, energy efficiency measures impact energy use for years. This would imply that more accurate sale of carbon credits would necessitate regular re-assessment of the carbon emissions avoided in the state from measures applied in already Wx'ed homes. In a program where homes across an entire state are treated, and the treatments will apply across all seasons and all grid load conditions, the energy impacts are diffused across the grid. It is difficult to see that extremely precise GHG data is better or more accurate, than a simpler and more aggregated data analysis system.

In this searching for a simpler GHG analysis system, a useful framework was built on data reported to the Federal Energy Regulatory Commission and aggregated by the Energy Information Administration. All utilities have been required, on a monthly basis, to complete form FERC 423, reporting all generation and fuel consumption. (Starting in 2009, FERC discontinued collection of FERC 423 data, but utilities will be required to report similar data to the Energy Information Administration, as form EIA 923.) The FERC 423 fuel data has a level of specificity that is useful for carbon analysis, especially as it differentiates between anthracite, bituminous and sub-bituminous coal. The emissions factors for these fuels are different, but are known from readily available data.

From FERC 423 data, relatively simple analysis allows a very accurate carbon emissions calculation for the previous year (or even a given month of that year). It also allows quite accurate projection for one or two years into the future, even if sizable generation changes are planned. Most importantly, this simple and accurate emissions analysis allows an annual GHG re-evaluation of measures performed several years in the past.

Table 4 -- Emissions Factors for Wisconsin Electric Generation

Pollutant	Lbs/MWh (2000 Hourly Data) (DOA 2004.)	2006 Lbs/MWh (Simplified Model)	2012 Lbs/MWh (Simplified Model)
NO_x	5.7	2.1	2.5
SO_x	12.2	4.6	5.0
Mercury (per GWh)	0.0489	0.0179	0.02
CO_2	2,216	1,649	1,900

With this information in hand, the assessment of emissions reduction from the energy savings rate per unit of Wx'ed housing in 2002-3 (from Table 2 above) is straightforward:

Table 5 -- Year 2006 Annual Per-Unit Emissions Avoided as a Result of Wx

Pollutant	Lbs/MWh 2012	Emissions Reduction (833 kWh savings)	Emission Reduction (156 Therms savings)	**Total Annual Reduction**
NO_x	5.7	4.75	--	**4.75**
SO_x	12.2	4.16	--	**10.16**
Mercury (per GWh)	0.0489	0.000041	--	**0.00041**
CO_2	2,216	1,583	--	**3,418**
CO_2 from Natural Gas			1,835	

Considered on its own, the cost per unit of annual reduction is considerable. In the 2007-08 program year, the average expenditure was $6,000 per weatherized home, with a projected measure life of 15 years. At that rate, the CO_2 reduction attained costs $243 per ton, or $0.122 per pound. Of course, in this case, the attained emissions reductions could be said to have zero cost, since they are a by-product of efficiency efforts that are already cost-effective.

With this data, the state-wide impact of the Wx program on emissions releases can be calculated:

Table 6 -- Aggregated Annual Emissions Reduction from Statewide Wx Program

Pollutant	Lbs/Unit Wx'ed 2012 Model	Annual Reduction from 6,845 Units (CY 2006)	**Annual Reduction from 10,000 Units (FY 2008-9)**
NO_x	1.75	11,979 Lbs.	**17,500 Lbs.**
SO_x	3.83	26,126 Lbs.	**38,300 Lbs.**
Mercury (per GWh)	0.0179	123 Lbs.	**0.41 Lbs.**
CO_2	1,583 Electric 1,835 NG	23,396,219 Lbs. (11,698 tons)	**34,180,000 Lbs. (17,090 Tons)**

Funding for Wisconsin Wx Programs

Multiple funding sources have been tapped over the years, to sustain what has always been a mainstay of the state's poverty programs. The state has always been an outsized recipient of federal Wx funds, given its proven capacity to implement a strong program and the state's cold climate. Federal Wx funding averaged about $10 million/year in the early 90s.

Regulated public utilities in the state have also been substantial funders (and sometimes direct implementers.) In 1975, Wisconsin legislated a wholesale reorganization of public utility regulation, instituting a long-term planning model, demand-side management programs, and mandatory support for low-income programming. One outcome is that, in the early 90s, utilities were contributing some $18 million annually in additional funding.

In the mid-90s, as Wisconsin electric utilities positioned themselves for an anticipated de-regulation of their markets, state utility contributions for Wx programs began to fall. Federal support had been waning for years, as well. By 1996, funding for low-income Wx had declined by more than 40 percent, to about $8 million from each major funding source.

This system was substantially revised in 1999, with a new utility regulatory regime. In the re-structuring, energy advocates succeeded in creating a "public benefits" fund to support low-income programs and a new energy efficiency program (now known as "Focus on Energy.") This new and far more robust financing structure essentially quadrupled the support for low-income programs. The new funding mechanism established a monthly low-income support fee to be paid by all public utility ratepayers, intended to create permanent state support of at least $40 million annually.

The new funding, coming as it does from natural gas and electric ratepayers, has opened entirely new possibilities to address electric use issues. Since average electric use has been climbing even as natural gas use falls, this added program focus has been very beneficial to low-income households. For a program seeking to claim carbon credits, however, the new funding structure makes it unclear who actually owns carbon savings that could be claimed from low-income Wx work. Program implementers argue any credit revenue belongs to the public, since utilities are not funding the program with corporate funds, but only serving as a pass-through to collect a fee from the general public. If pressure regarding GHG emissions continues to build, utility operators can be expected to seek any (cost-free) existing carbon savings they can claim. If, as this paper suggests, the revenue from carbon credits could approach $12 million, considerable controversy can be expected over the ownership of carbon savings from the

Wx program.

Pollution Reduction and Emissions Markets

In the present political environment, emissions credits and pollution markets are generally presumed to be the tools of choice to control GHG emissions in the most cost-effective manner. It is not clear that this is necessarily true; traditional taxation and prescriptive regulation (command-and-control) programs have operated effectively in the U.S. for more than a century, and in pollution-reduction regulations for the last 35 years. These prescriptive regulation programs have restored to health hundreds of bodies of water and dozens of nearly-extinct animal populations, reduced pollution impacts from tens of thousands of landfills, mines, and industrial plants, and generally made the U.S a far less polluted country than it was in 1970.

Regardless of the short history of market programs in contrast to the long use of prescriptive regulation, GHG emissions markets are being aggressively developed around the world. They were the primary GHG reduction tools envisioned in the 1997 Kyoto Accords. The 2001 Marrakech Accords established an international framework for implementing carbon emissions caps, with economic incentive programs to match.

It is not clear that GHG program models being considered presently are structured in a manner that allows the Wx program (or any domestic efficiency program) to claim offset credits. It appears that the plan before the U.S. Senate issues credit directly to states to auction to emitters, and they are to use the auction revenues to reduce energy cost impacts for low-income residents. But this present plan would not issue offset credits to directly to energy efficiency programs unless they were operated by electric utilities. The European Union Emissions Trading Scheme allows offsets for efficiency projects, but (apparently) only if they are operated in less-developed countries.

At present, the only emissions credit system in Wisconsin is the Department of Natural Resources' "Voluntary Emission Reduction Registry" (Wisconsin DNR, n. d.) In this system, entities that reduce greenhouse gas emissions, produce renewable energy or initiate energy savings programs can register their efforts. The Registry has two purposes. First, firms that reduce green house gas emissions before the institution of emissions caps can register their efforts. This is intended to create a record of the efforts, with the hope that the reduction will be recognized when caps are created. A company that voluntarily reduced emissions could argue that their GHG credit allocation ought to be based on their emissions before this voluntary reduction, not afterward. This could shield that company from suffering deeper reductions when caps are imposed. Second, firms that want to be awarded "green tags" under a future emissions system for renewable energy production or energy efficiency efforts use the Registry to create a public record of their efforts. There is at least a possibility that such efforts could be recognized in any emissions trading system.

At present, the only operating United States emissions credit market is the Chicago Climate Exchange. Since there is no mandatory GHG program in the U.S., the CCX is a purely voluntary system. Like the Wisconsin Emissions Registry, the CCX establishes a public record of GHG emissions reductions. The credits are identified, awarded and tracked in accordance with the system operated by the European Climate Exchange. It also goes a good deal further, making a liquid market in GHG credits, and operating a futures market.

A few early adopters are already purchasing "carbon offset" credits or futures from the CCX. In the last year, groups of various sorts have sought to take concrete action to support GHG reductions. Event planners, entertainers and others have purchased credits recognized by the CCX, "Carbon Financial Instrument®" contracts. Each CFI represents a commitment to reduce emissions or remove carbon from the atmosphere, in standard units of 100 (metric) tonnes per unit. This assures that the GHG emissions from their event will be offset by legally binding contracts to reduce GHG emissions elsewhere that are represented by CCX "Carbon Financial Instrument®" contracts. Since many GHG reduction projects continue for many years, the CCX also writes and monitors a futures contract system. This operates just as any other futures market; a 2010 vintage CFI represents a commitment to prevent/remove 100 tonnes of GHGs from the environment during the year 2010. This creates a system wherein a project that will reduce GHGs some year in the future can sell a futures contract for present-day revenue to start or manage the project.

In 2008, the CCX traded seven billion tonnes of emissions credits (Chicago Climate Exchange, n. d.). In the last two years, CFI prices (for 2008 vintage contracts) have ranged generally between $1.50 and $3.5 per tonne, with an average of $2. In general, it appears that U.S. credits price out at a tenth of the value of those in Europe's mandatory market.

There is one major obstacle to be addressed if the Wx program is to participate in carbon markets. It appears that most GHG program models proposed at this time are not structured in a manner that allows the Wx program (or any efficiency program) to claim offset credits. The European Union Emissions Trading Scheme allows offsets for efficiency projects, but (apparently) only if they are operated in less-developed countries. A "first-generation" GHG bill in the U. S., S. 280 (the "Climate Stewardship and Innovation Act of 2007") might offer a window for GHG credit awards based on Wx program results. It allows any "entity," including a government that is a substantial energy consumer, to acquire "domestic offsets" registered by other actors. This bill was introduced in January 2007, but has seen no action since then. A follow-on bill, S2191, has seen significant action, including several committee hearings. It has provisions that issue some credits directly to states, which they are to take to auction. The auction revenue is directed specifically for states to operate programs to reduce energy cost impacts for low-income residents. But it would not issue offset credits to energy efficiency programs unless they were operated by electric utilities.

This provision in particular may add to the likely ownership controversy that would arise if Wisconsin's Wx program were to attempt to market GHG credits. Electric utilities in general understand very well that they are the primary targets of any GHG reduction scheme; electric generation is the source of fully 40 percent of all GHG emissions in the U.S (EIA 2003). Since regulated utilities in the state provide the mechanism for collecting the state funds supporting the Wx program (through a surcharge on utility bills), they will undoubtedly have great interest in claiming for their own any carbon credits allocated through Wx work. State staffers report that utilities in the state have already suggested strongly that they ought to be the owners of any GHG credits coming out of the state's "Focus on Energy" (non-means-tested) efficiency programs. It is likely that similar pressures would come into play if the low-income programs sought to register and claim GHG offset credits from Wx work.

If these obstacles can be overcome, the new economic tools being developed to create incentives for GHG mitigation can be used in Wx program design to promote new innovation and strengthen low-income programs, by placing real economic value on heretofore neglected, but very real, program outcomes.

Conclusions

This analysis concludes that a weatherization program as implemented in Wisconsin has real potential as a GHG reduction program. Further, it identifies a relatively simple means to assess carbon emissions impact, and to project long-term emissions reductions. This analysis shows that a typical home weatherized in Wisconsin will reduce carbon dioxide emissions by 50,000 pounds over 15 years.

Making conservative assumptions about carbon markets, Wisconsin's Weatherization program at its present volume would produce an annual income stream after 15 years close to $6 million per year on carbon markets (constant 2007 dollars). This amount of added "revenue" could fund treatment of an additional 1,000 homes per year. In a carbon-capped economy, where CO_2 emissions would generate more revenue, revenues would be approximately three times as great.

The weatherization program model is well suited for participation in emissions markets. There is great potential for additional energy savings in the low income sector, the savings are real, unlikely to be captured without the weatherization program, and easily tracked and verified for carbon trading markets. One barrier to turning these savings into revenues to expand the program will be negotiating with the electric utilities and the state about who owns the credits.

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