

STATE OF OHIO

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Solicitation Title: **2005 STATE ENERGY PROGRAM (SEP)
SPECIAL PROJECTS**

Program Category: **Air Quality Integration**

Proposal Title: **Quantifying Emission Reductions From Energy
Efficiency/Renewable Energy SEP Projects in
the State of Ohio**

State Agency: **Ohio Department of Development – Ohio Energy
Office**

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Executive Summary

According to United States Environmental Protection Agency (EPA), electric generation is the single largest contributor to sulfur dioxide (SO₂) emissions from stationary and mobile sources in the State of Ohio¹, and the 2nd largest contributor to nitrous oxides (NO_x) emissions behind on-and off-road vehicles². According to the World Resources electric generation is single largest contributor to carbon dioxide (CO₂) emissions in the State of Ohio³. These pollutants contribute significantly to the level of particulate matter in the air, which aggravates heart and lung diseases⁴. NO_x emissions contribute toward the formation of ground level ozone, which can irritate the respiratory system, reduce lung function, and increase susceptibility to respiratory infection⁵.

This report: 1) Examines how energy efficiency and renewable energy (EE/RE) projects are incorporated into Ohio's plan to reduce emissions. 2) Estimates the level of emission reduction impacts (and future potential impact) from a number of EE/RE projects that have been implemented in Ohio. 3) Evaluates the health and economic impacts from implementation of these EE/RE projects.

Background

The U.S. Clean Air Act requires the U.S. EPA to regulate pollution that negatively impacts human health. The EPA has established standards that set the allowable level of pollution (Particulate Matter, Ozone, Sulfur Dioxide, Nitrogen Dioxide, Carbon Monoxide, and Lead) in the U.S. Areas are designated to be in "non-attainment" when air quality monitoring shows a violation of EPA's standard.

In Ohio there are currently 32 counties and 3 partial counties in non-attainment for one pollutant or for multiple pollutants⁶. This means that 8.4 million Ohio citizens (74.8%) live in one of the counties that have pollution levels that are considered unsafe⁷.

In addition to the human health impacts from pollution in these counties, there are also potential negative economic impacts as well. New industrial facilities that want to locate or expand in "non-attainment" areas are subject to more stringent emission regulations and must show that their increased emissions will not delay progress towards cleaner air. Failure to reduce pollution levels below the national standard by the designated deadline can result in a loss of federal highway funds and even more stringent emission requirements for new industries to locate/expand in "non-attainment" areas. By law the Ohio EPA is required to produce a plan, known as the State Implementation Plan that details how sufficient emission reductions will occur in these Ohio counties to bring them into attainment.

¹ EPA's National Emission Inventory Database, 2001

² EPA's National Emission Inventory Database, 2001

³ World Resources Institute, CAIT, 2001

⁴ American Lung Association,

<http://www.lungusa.org/site/apps/s/content.asp?c=dvLUK9O0E&b=34706&ct=67879>

⁵ World Health Organization, "Effects of Air Pollution on Children's Health and Development," 2005

⁶ Ohio EPA, <http://epa.gov/air/data/nonat.html?st~OH~Ohio>

⁷ 2000 U.S. Census, U.S. Census Bureau

Virtually all (94.2%) of Ohio's electricity is generated in 35 non-attainment counties, with 99% of the electricity generated in these counties from the burning of coal⁸. The State of Ohio has committed to the deployment of clean coal technologies, and utilities have started to install emission control technologies i.e. scrubbers. An additional option to reduce the need for electric generating facilities located in non-attainment counties is through the deployment of non-emitting renewable energy generation technologies and through implementation of energy efficiency projects and practices.

Project Methodology and Results

This report evaluated the emission reduction impacts from 53,553 energy-efficiency (EE) projects and 253 renewable energy (RE) projects that were installed in Ohio during 2006. These projects came from various sources, including EE measures installed at 43 Ohio schools, state-funded residential and utility-scale RE projects located across the state, EE upgrades at 122 State of Ohio facilities, home weatherization activities in 6,411 low-income Ohio residences, and others.

Following are steps used to determine impacts from the evaluated EE/RE projects:

Step 1 – Measure or estimate of the number of kilowatt-hours (kWh) generated annually and during the ozone season (May 1st-September 30th) from each clean renewable energy project.

Step 2- Measure or estimate of the number of kWh of electricity saved and the number of thousand cubic feet (mcf) of natural gas saved from each energy efficiency project annually and during the ozone season.

Step 3 – Determine an emission factor for each pollutant (NOx, SO₂, and CO₂) for each unit of kWh of electricity saved/generated cleanly and for each unit mcf of natural gas saved.

Step 4- Multiply the number of kWh saved and mcf saved annually and during the ozone season by the appropriate emission factor to calculate the annual and ozone season emission impacts.

The evaluated EE/RE projects were determined to save 115,959,145 kWh of electricity annually, and save 176,495 mcf of natural gas in 2006. The emission reductions impacts on NOx, CO₂, and SO₂ emissions from these energy savings are outlined in the following table:

⁸ EPA's Emissions & Generation Resource Integrated Database, 2004

	CO2	SO2	NOx
Emission reductions from electricity savings/clean generation	107,320 tons	201.37 tons	67.6 tons
Emission reduction from natural gas savings	10,560 tons	0.05 tons	13.14 tons
Total Emission Reductions	117,880 tons	201.42 tons	80.74 tons

The Ohio EPA currently only allows NOx emission reductions from EE/RE projects that occur during the ozone season to get credit and be incorporated into its plan to bring Ohio counties into attainment. This limitation required quantification of emission reductions that occurred during ozone season from these EE/RE projects. Of the projects evaluated, 16,254,750 kilowatt-hours of electricity were either generated cleanly or saved through energy-efficiency during the ozone season. This translates into NOx emission reductions of 12.19 tons that would potentially qualify under Ohio EPA's current plan to reduce emissions.

In addition to reducing emissions, energy efficiency and customer-sited renewable energy also reduces the need to purchase energy from utilities, thereby saving Ohio companies, institutions, and residents money. The estimated dollar savings from examined energy efficiency and renewable energy projects totaled \$18,080,946 in 2006.

Conclusions

Energy efficiency and renewable energy are a quickly deployable and quantifiable tool available to policy makers, regulators, and electric utilities to help reduce emissions and health impacts, bring Ohio counties into attainment, and keep more dollars in the hands of Ohio consumers. Numerous states have incorporated energy efficiency and renewable energy into their state's plan to reduce emissions. Texas has included the energy savings from increased building code standards into their plan. Minnesota, Illinois, Wisconsin, Indiana, and Virginia have all included EE/RE projects in their plan to reduce **annual** NOx emissions, in addition to ozone season emissions.

Moving forward, Ohio, through regulations and policies should continue to reduce barriers to and support the additional deployment of energy efficiency and renewable energy projects as a viable option to help improve Ohio's air quality. This includes the expansion of the Ohio EPA NOx program to recognize and incorporate the emission reductions from EE/RE projects, not just during the ozone season, but annually as well. The State of Ohio should also encourage the existing cap and trade program for SO2, and any future federal cap and trade emission program that regulates CO2, to include the ability to recognize EE/RE project impacts in those systems.

Section 1 Background Information

Section 1.1 Objectives

The objective of this research effort was to determine the emission reduction impacts for multiple pollutants from a wide range of energy efficiency and renewable energy (EE/RE) projects across the State of Ohio. Emission reduction impacts were calculated both annually and during the ozone season (May 1st- September 30th).

Emission factors for each pollutant in Ohio (NO_x, CO₂, and SO₂) had to be determined. Electricity generation/savings of evaluated projects had to be either estimated or measured. Electricity generation/savings annually and during the ozone season were then applied to each emission factor to calculate annual and ozone season emission impacts. Projects impacts that are part of this research could eventually apply for allowances under cap and trade emission programs that have renewable energy/energy efficiency (RE/EE) set-asides (NO_x State Implementation Plan, Clean Air Interstate Rule). Definitive methodologies for measuring and verifying energy efficiency savings that would qualify for SIP credit are not fully developed on a national scale. This evaluation will hopefully add to the discussion on potential ways to quantify and measure impacts.

Ohio faces high non-attainment status (35 out of 88 counties are in non-attainment), and large emission rates. Quantifying emission reductions from EE/RE projects with the aim of future integration into a State Implementation Plan (SIP) and future emission regulations could become a very necessary/useful tool for the State of Ohio, and was one of the motivations of this research.

There are currently no cap and trade programs or any other regulations for CO₂ in the State of Ohio, or federally for the U.S. SO₂ has a cap and trade program, but does not have set-aside for RE/EE projects. The energy generation/saving data and estimated emission impacts could provide a starting point to estimate impacts if such programs emerged or developed RE/EE set-asides. In absence of set-asides in federal cap and trade programs (SO₂), or federal regulation of emissions (CO₂), the impacts from the measured RE/EE projects provide an estimation of co-benefits (CO₂ reduction), and the level at which RE/EE projects in Ohio displace load to make it easier for electric utilities to meet federal caps (SO₂).

Attempts were made to determine the economic and health benefits from the emission reductions that were the result of the energy efficiency and renewable energy projects.

Included in the list of examined projects were photovoltaic (PV) units, small and large-scale wind projects, and energy efficiency savings from State of Ohio administered or supported programs.

Section 1.2 Specific Projects Examined

The Ohio Energy Office (OEO) examined a number of different energy saving/generating projects that were funded from different sources at different points in time.

Table 1. Name of Project, Number of Projects by Project Type, Project Implementation Year, and Type of Energy Generation/Savings Data Available to Estimate Impacts

Project Examined	EE projects	Wind Projects	PV projects	Year of Project/s	Type of energy generated/savings data
Ohio School Facility Commission	43			2003-2005	Annual pre and post energy consumption
Office of Energy Services	122			1998-2005	ESCO guaranteed annual dollar savings
Rebuild America	7			2001-2002	Partner reported annual energy savings
Metered Distributed Energy Resources		4	15	2003-2004	Grantee monthly/annual energy meter readings
Change a Light	36,783			2005	Estimated energy savings
Home Weatherization Assistance Program	6,411			2003	Monthly weather adjusted pre and post energy consumption
Electric Partnership Program	10,184			2004	Weather adjusted pre and post energy consumption
Envinta Phase 3	3			2006	Estimated energy savings
Other Statewide SEP/OEO and non-OEO Projects		44	189	1998-2006	Estimated monthly generation
Utility-Scale Wind		1		2004	Metered monthly generation
TOTAL	53,553	49	204		

Energy saving projects at 43 different K-12 schools were included as part of this study. These projects were the result of the 2002 Energy Conservation Management Program implemented by the Ohio School Facilities Commission at 10 different school districts through the state.

The Office of Energy Services, in the Department of Administrative Services, included energy upgrades projects at 122 State of Ohio facilities conducted between 1998 and 2006. These impacts were included in OEO's analysis.

The energy savings from 7 Rebuild America partners' projects were examined as part of this study.

15 photovoltaics (PV) installations, and 4 residential wind, these projects were all funded as part of either the 2003 or 2004 OEO distributed energy resource (DER) grant programs. These projects have a total capacity of 54 kW for PV and 50 kW for wind.

The OEO included the results of the 2004 Energy Star Change a Light, Change the World program in which 36,783 compact fluorescent light bulbs (CFL) were purchased.

The OEO included the impacts from the Home Weatherization Assistance Program (HWAP) program, which weatherized 6,411 homes during 2003.

10,184 home energy improvements that were the result of the Electric Partnership Program (EPP), between 2004 and 2005 were included.

70 EnVinta One-2-Five diagnostics have been completed on manufacturing facilities in Ohio. 3 projects have taken the next step to implement the recommended energy saving measures.

An additional 189 solar photovoltaics (PV) installations were included as part of this evaluation. These installations were installed in Ohio starting in 1998, and total a rated capacity of 866 kW. 44 wind projects with a rated capacity of 307 kW were also evaluated as part of this study. These projects have been supported by DOE SEP funding and from OEO project financing and grant support, but did not have direct meter data available.

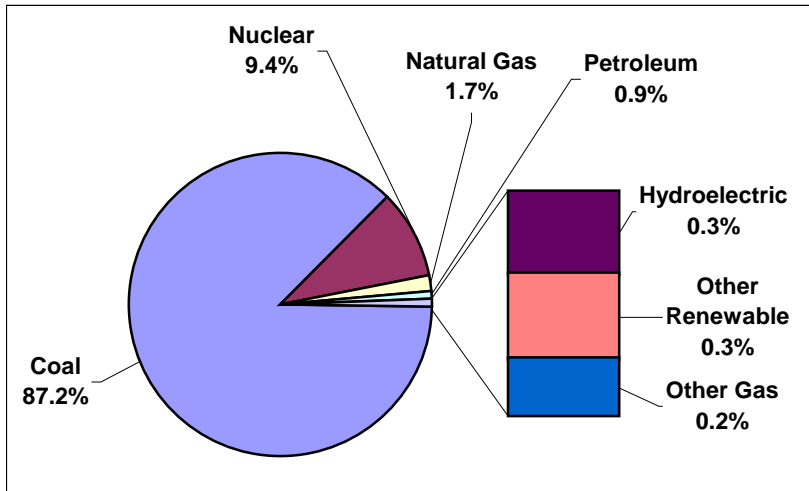
1 utility-scale wind farm with a capacity of 7200 kW was included as part of this study and included direct meter readings.

A 250 kw fuel cell, that was part of the City of Westerville's generation mix, was proposed to be included, unfortunately the fuel cell shut down operation shortly after OEO's study began and was not included in OEO's study.

Section 1.3 Energy Usage and Emissions

Ohio's fuel mix according to the latest Energy Information Administration (EIA-906) 2005 data consists of 87.2% Coal, 9.4 % nuclear, 1.7 % natural gas, 0.9% petroleum, 0.3% hydroelectric, 0.3% other renewable, and 0.2% other gas. 156,976,323 MWh were generated in Ohio in 2005 (EIA-906).

Figure 1. Percentage of Ohio Electric Generation by Fuel Type



In 2005, the total electric power industry in Ohio emitted 131,831,144 metric tons of CO₂, 1,056,640 metric tons of SO₂, and 238,298 metric tons of NO_x.

In 2005, the entire total U.S. electric power industry emitted 2,513,609,417 metric tons of CO₂, 10,339,530 metric tons of SO₂, and 3,961,135 metric tons of NO_x. 4,054,688,027 MWh were generated in the U.S. in 2005. This information was used to calculate level of emissions per unit of electricity generated in Ohio and in the U.S.⁹

Table 2. 2005 NO_x, SO₂, and CO₂ Electricity Emission Ratios per unit of Generation

	NO _x (lbs/MWh)	SO ₂ (lbs/MWh)	CO ₂ (lbs/MWh)
Ohio	3.347	14.84	1,851
U.S.	2.153	5.621	1,366

Natural gas reductions from 3 programs were included in this study and included the following projects: Ohio School Facility Commission, Envinta Phase 3, and the Home Weatherization Assistance Program. All natural gas savings were converted to thousand cubic feet (mcf). Natural gas reductions were converted directly into reduced emissions based upon the type of measure and the applicable pollution emission factor.

The pollution emission factors from the combustion of natural gas for residential furnaces and uncontrolled boilers was taken from "Compilation of Air Pollutant Emission Factors, AP-42, Fifth Edition, Volume I: Stationary Point and Area Sources," U.S. Environmental Protection Agency, 2003.

⁹ Emission amounts were taken from "U.S. Electric Power Industry Estimated Emissions by State (EIA-767 and EIA-906)." Generation information was taken from "Net Generation by State by Type of Producer by Energy Source (EIA-906)"

Table 3. CO2 Emissions from Natural Gas Combustion

	NOx (lbs/Mcf)	SO2 (lbs/Mcf)	CO2 (lbs/Mcf)
Residential Furnace	0.094	0.0006	120.0
Uncontrolled Boiler	0.22	0.0006	120.0

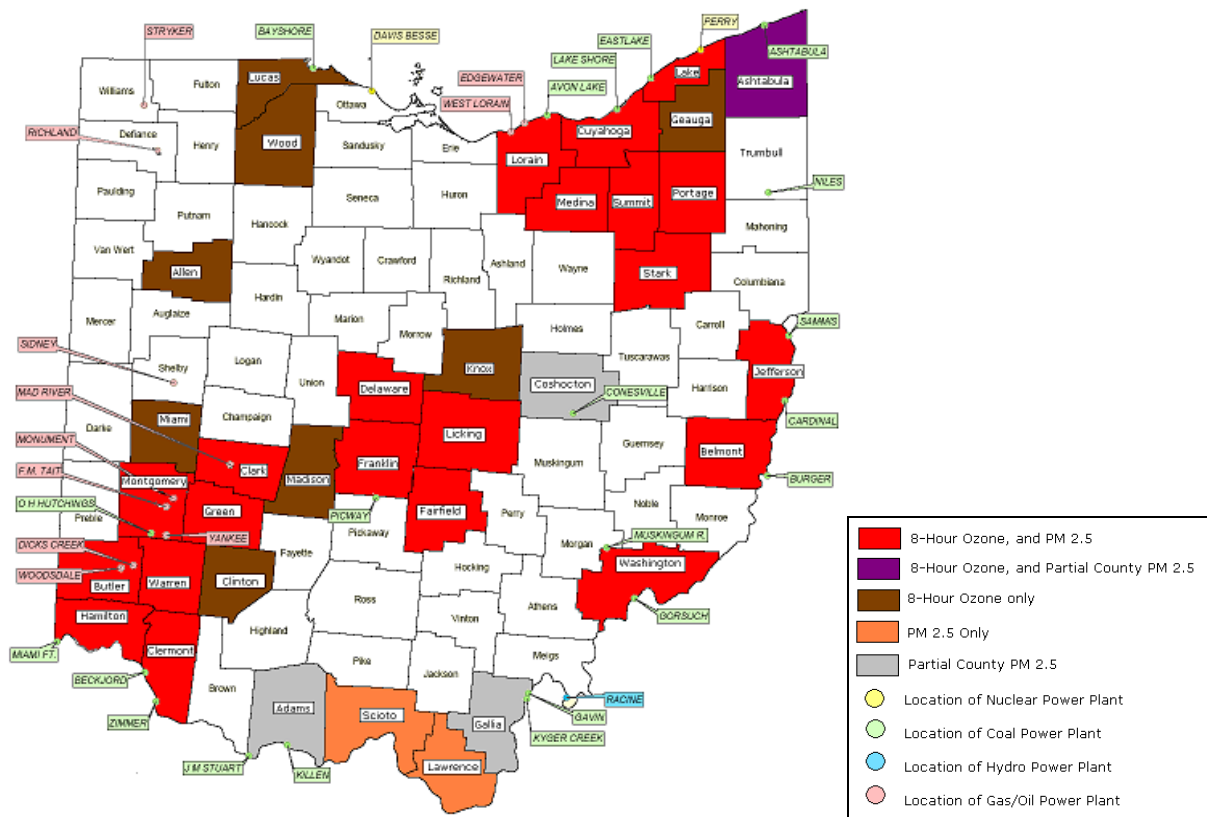
For example, if annual residential furnace efficiency measures save 1,000 Mcf, and each Mcf of natural gas would have produced 120 lbs of CO2 emissions, these EE measures would save;

- 120 lbs/Mcf x 1,000 Mcf, = 120,000 lbs, or 60 tons of NOx per year

Section 1.4 Non-Attainment Status

Ohio currently has 30 counties in non-attainment for 8-hour ozone, 23 counties in non-attainment for PM 2.5, and 4 partial counties in non-attainment for PM 2.5.

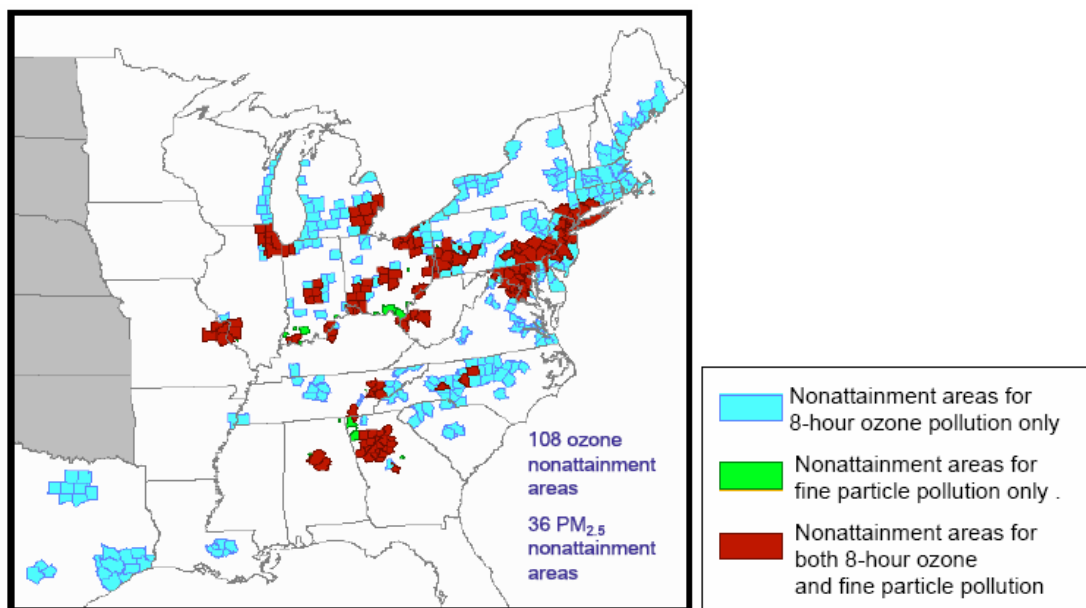
Figure 2. Map of Ohio Counties in Non-Attainment for 8-Hour Ozone, Particulate Matter (PM 2.5), and County Location of Major Electric Generating Units



This translates into 32 counties, and 3 partial counties out of 88 in the state being in non-attainment for one pollutant or another. Of the 99 electric generating plants in the state

(33,703 MW total rated capacity), 62 of these plants (32,452 MW rated capacity) are located in counties that are in non-attainment for one pollutant or another. The 37 plants that are located outside of non-attainment counties only account for 1.9% of annual CO₂ emissions for the state. The 62 generating plants located in non-attainment counties account for 94.2% of all MWh produced in 2004. 74.9% of Ohio's population lives in one the 35 non-attainment counties.¹⁰ Many of Ohio's downwind neighboring states (West Virginia, Pennsylvania, New York) are also in a similar status of non-attainment. The study proposed to include all energy efficiency and renewable energy activity in this project due to the fact that virtually all electric generation emissions (98% of CO₂) are emitted in non-attainment counties.

Figure 3. Ozone and Fine Particle Non-attainment Areas (April 2005)



Section 1.5 Integration with Ohio NO_x SIP and Ohio CAIR

The Ohio Environmental Protection Agency (OEPA) is currently implementing the NO_x SIP set-aside program for renewable energy / energy efficiency (RE/EE) projects during the ozone season. 1% of NO_x allocations were set-aside for RE/EE (454 tons) and 1% of the NO_x allocations of Ohio's cap for existing Electric Generating Units (EGU) were set aside for Innovative technologies (454 tons) for the 2006 ozone season. Innovative technologies includes: fuel cells, other innovative technologies, and mobile source emission reduction technologies including fuel additives.

The NO_x SIP currently caps the number of emissions allocated to Ohio EGUs during the ozone season. At the end of the Ozone season, Ohio EGUs must hold the amount of allowances equal to their actual emissions, or be heavily fined and future allocations will be even more so reduced. EGUs may either reduce emissions to a level equal to their

¹⁰ US Census Bureau, 2000 Census

initial allocation, or purchase allowances on the open market. If they have allocations in excess of their actual emissions, they may sell them on the open market.

Current US EPA guidance for the NO_x SIP suggests using an emissions allocation rate for RE/EE projects of 0.0015 for pounds per kilowatt-hour. An equation to determine the number of allowances allocated currently is:

Allowances = (kWhs x 0.0015) / 2000, where:

kWhs = the number of kilowatt hours of electricity saved / generated during the compliance period by the project, and

0.0015 is the default emissions rate in pounds of NO_x per kilowatt hour.

2000 is the conversion factor for converting pounds into tons.

For projects to qualify, they must reduce NO_x emissions during the Ozone season (May 1st- September 30th) by the minimum of 1 ton (roughly 1.3 million kWh saved by EE or produced by RE). Under the SIP call set-aside program, for the 2006 ozone season, four projects applied and received allocations for 76 allowances. These projects included 1 large CHP project, 1 large wind turbine and 2 hydroelectric projects. No energy efficiency or innovative technology projects applied for the set aside program for the 2006 ozone season. One of the main reasons for this is the large electricity reductions (1,333,333 kWh) required to reach the 1-ton of NO_x emission reductions. The 2006 ozone season was also the first year the set-aside was available.

The OEO has begun exploring legal options to aggregate and apply for set-asides for any unclaimed energy savings / RE generation realized from projects funded by the Ohio Energy Office. The OEO would either retire/or sell allocated allowances to finance additional renewable energy production or energy saving projects.

The SIP call will remain in place until the proposed Clean Air Interstate Rule (CAIR) is implemented in 2009. The CAIR is a regional cap and trade program that Ohio will participate in. The currently proposed Ohio NO_x CAIR rule for 2009 and 2015 has a 1% RE/EE set-aside and a 1% innovative technology (IT) set-aside for the ozone season. Implementing an annual NO_x set-aside is up to the discretion of the Ohio EPA. The Ohio EPA is currently evaluating comments that were received about the proposed NO_x CAIR.

The OEO recommended that the final NO_x CAIR rules include an annual set-aside for RE/EE and IT of 2% in addition to the set-aside that was proposed during the ozone season. The OEO also suggested that the 5-year limit on re-applications from EE/RE and IT projects be extended for RE projects for as long as they are operational and that the 5-year limit for EE projects be closer examined for extension. These comments were collected in August 2006 and final rules are not expected until 2007.

A 2% set-aside applied to the yearly allowance NOx trading program for Ohio would amount to a potential allowance set-aside or reduction of emission of 1,860 tons in 2010, and 1,660 tons in 2015, if this program was fully subscribed.

The Ohio EPA also proposed rules for the SO2 CAIR. The SO2 CAIR is a federally determined program and RE/EE set-asides are not currently prescribed or allowed under this regional cap and trade program.

Section 2 Project Design

Ohio proposed to follow the August 2004 U.S. EPA “Guidance on State Implementation Plan (SIP) Credits for Emission Reductions From Electric-Sector Energy Efficiency and Renewable Energy Measure.” The Guidance was established to guide states on how to include set-asides for RE/EE projects that would qualify for allocations that would have otherwise gone to emitting sources of electricity generation. This document was chosen due to the fact that one of the major drivers for this project was to be able to quantify and verify emission benefits that could eventually apply for credit under the NOx SIP Call.

The four steps for quantifying SIP credit identified included:

Step 1 – Estimate the energy savings that an energy efficiency measure will produce, or, for a renewable energy project, the amount of energy generation that will occur.

Step 2 - Convert the energy impact in Step 1 into an estimated emission reduction.

Step 3 – Determine the impact from the estimated emission reduction on air quality in the non-attainment area.

Step 4- Provide a mechanism to validate or evaluate the effectiveness of the project or initiative.

Section 2.1 Data Caveats

The OEO has not attempted to collect energy saving/generation data from all of the various programs that it either supports or administers from an impact assessment perspective at the same time. However, regularly the OEO has contracted for third party impact evaluations of programs of significant dollar value and statewide impact. The cost of doing this type of evaluation is prohibitive for smaller projects, unless the projects can be easily aggregated. The OEO has typically funded and supported a series of customized energy savings programs and a number of renewable energy installments. The OEO has also analyzed and included in this study other such customized energy saving activities in both State of Ohio facilities and K-12 schools. The verification of all of these programs has relied on measurements through either direct bill analysis or meter data collection for renewable generation sources.

The size and type of measures typically supported by the OEO has not lent itself to using broad averages for the type of measurement installed due to the customized nature of program support. When averages were used to estimate energy savings / RE generation, this was noted.

Section 2.2 Degradation Factors

For renewable projects that had been installed previous to 2006, or that had metered data that was collected before 2006, a degradation factor of 5% per year was applied. For example, projects that were measured in 2005 with actual metered data, these savings were degraded to 95% of their savings so they were comparable to 2006 savings. This degradation factor can help account for equipment removal, equipment deterioration, and system failures.

Application of degradation factors for energy efficiency measures was based upon whether the Technical Degradation Factor (TDF) was non-existent or positive, and if the installation occurred within the Effective Useful Life (EUL) of the measure. Effective Useful Life (EUL) (See Appendix Table A-1 and Table A-2) and Technical Degradation Factor (TDF) (See Appendix Table A-3 and Table A-4) determinations were taken from the “California Energy Efficiency Evaluation Protocols: Technical, Methodological and Reporting Requirements for Evaluation Professionals,” California Public Utilities Commission, April 2006.

The EUL is the estimate of the median number of years that the measures installed under the program are still in place and operable. The TDF is the difference over time, between the energy usage of the efficient equipment/behavior and the standard equipment/behavior it replaced and is defined as “A scalar to account for time and use related change in the energy savings of a high efficiency measure or practice relative to a standard efficiency measure of practice.”¹¹

Use of degradation factors was not typically applied since measures were installed within their EUL and TDF was non-existent or positive.

Section 3 Project Results

Section 3.1 Step One- Estimate Annual Energy Savings

This step included compiling data from multiple reports that were available and collecting impact data from projects that had not previously had full reports conducted. OEO attempted to collect metered electricity data where available to estimate savings. When metered data was not available, estimates were used based upon well-established tools and identified accordingly.

¹¹ Summary Report of Persistence Studies: Assessments of Technical Degradation Factors, Final Report, CADMAC Persistence Subcommittee, February 23, 1999

Table 4. Annual Energy Savings from Examined Energy Efficiency and Renewable Energy Programs

Program	Annual Electricity Savings (kWh)	Annual Natural Gas Savings (Mcf)
Ohio School Facility Commission	4,090,893	33,516
Office of Energy Services	53,208,294	
Rebuild America	24,040,735	
Metered Distributed Energy Resources	70,322	
Change a Light	1,879,611	
Home Weatherization Assistance Program	2,604,765	99,624
Electric Partnership Program	15,000,706	
Envinta Phase 3	550,879	43,355
Other Statewide SEP/OEO Projects	1,245,009	
Utility-Scale Wind	13,267,931	
TOTAL	115,959,145	176,495

Section 3.1.a Ohio School Facility Commission

The OEO evaluated projects implemented in 43 building in 10 Ohio school districts during 2002 as part of the Ohio School Facilities Commission, Energy Conservation Management Program. All of the projects included energy efficiency upgrades that included electricity. Project electricity and natural gas savings are based on pre and post project measured electricity consumption data. Post project energy consumption data was collected in 2003, 2004 and 2005 depending on the district. Energy upgrades were implemented through energy service companies at each school facility.

Electricity savings in 2006 are estimated to be:

- 4,090,893 kWh

Natural Gas savings in 2006 are estimated to be

- 33,516 thousand cubic feet (Mcf)

Section 3.1.b Office of Energy Services

The OEO evaluated Department of Administrative Services energy upgrades at 122 different state facilities. Ohio relied on the Office of Energy Services (OES) data for energy savings. The OES receives applications from state facilities and oversees and evaluates applications as well as Energy Service Company's (ESCO) guaranteed energy

savings through project implementation and evaluation. Projects were implemented going back to 1998 and up till 2006.

The project savings were based upon guaranteed dollars saved per year from ESCOs. For example, projects implemented in 2005 were guaranteed to save \$30,000 per year starting in 2005. Applying the appropriate electricity rate depending on the year the saving are expected can approximate the number of kWh saved. In 2005 electricity cost \$0.076/kWh, with a guaranteed savings of \$30,000 per year, this would equal 378,310 kWh saved. In 2006 (\$0.085/kwh), savings of \$30,000 per year would equal 352,941 kWh saved. Since electricity rates change over time (typically upward), the expected electricity reductions are reduced over time.

All projects evaluated were under 10 year contracts for the amount of dollars that would be saved and all projects evaluated had been implemented well within the past 10 years.

Electricity savings in 2006 are estimated to be:

- 53,208,294 kWh

Section 3.1.c Rebuild America

The Rebuild America energy savings data was provided by Rebuild America partners that submitted annual kWh savings. 7 different partners reported first year electricity savings to the Rebuild America Program, including lighting upgrades in City of Cuyahoga Falls facilities and building shell and HVAC upgrades completed by the Lucas Metropolitan Housing Authority. Depending upon the year the project was implemented, the projects' savings were degraded annually to estimate 2006 kWh savings.

Electricity savings in 2006 are estimated to be:

- 24,040,735 kWh

Section 3.1.d Metered Distributed Energy Resources

For "Metered Distributed Energy Resources," Ohio collected electricity generation in 2006 from projects that were implemented between 2003 and 2004. These projects included wind, and Solar PV projects.

For PV projects, Ohio collected information that was preferably directly metered. In the absence of metered information Ohio collected pre and post energy consumption information for PV projects that were tied to the grid taking into consideration significant load changes in the customers' home or business. This information was ascertained directly from the customer through a series of phone and e-mail correspondence.

The total number of PV projects included fifteen projects totaling 54kw that were found to annually generate

- 49,149 kWh

The Four wind projects were found in 2006 to generate

- 21,173 kWh

The total number of measured kWh generated in 2006 for “Metered Distributed Energy Resources:

- 70,322 kWh.

Section 3.1.e Change a Light

The Change a Light program distributed 36,783 energy star rated compact florescent bulbs in 2005¹². Each CFL is estimated to save 51.1 kWh/year. Total savings were estimated to be:

- 1,879,611 kWh

Section 3.1.f HWAP

Ohio's Home Weatherization Assistance Program (HWAP) targets low-income households' energy use. Services include attic, wall and basement insulation; blower-door-guided air leakage reduction; heating system repairs or replacements; and health and safety testing and inspections. All measures are provided based on an on-site energy audit and on cost-effective guidelines.

The HWAP energy savings were taken from the Ohio “Home Weatherization Assistance Program Impact Evaluation” that was completed in July 2006. This was a third-party assessment of the 2003 program year. There were 6,411 homes weatherized that year. Savings as a result of these efforts were based on utility provided data:

- 2,604,765 kWh
- 99,624 Mcf

Section 3.1.g EPP

The Electric Partnership Program (EPP) energy savings were taken from “Ohio Electric Partnership Program Impact Evaluation, Results for April 2004 – March 2005” which was completed in June of 2006. The EPP replaces old refrigerators with more efficient ones and provides efficient light bulbs CFLs, provides energy education and additional energy saving technologies to qualifying low-income Ohio residents.

This evaluation included collecting usage data histories for program participants, detailed program tracking system data, and weather data. Net program savings were calculated as the average weather-adjusted energy savings for participants minus the average change in a matched comparison group that was made up of customers who participated in the EPP after March 2005.

¹²“Change A Light, Change The World 2005 Campaign Summary Report, Results and Lessons Learned,” Midwest Energy Efficiency Alliance, April 10, 2006

This third-party evaluation determined that at the 10,168 homes, which participated in this program between April 2004 and March 2005, electricity savings per year was:

- 15,000,706 kWh

Section 3.1.h Envinta Phase 3 Implementation

The Envinta Phase 3 Implementation program projects' energy savings are based on estimated annual energy savings from applications for funding from three industrial energy users. These companies have gone through the process of the initial Envinta assessment which determined the energy saving potential at each location as well as a 2nd step evaluation that worked with each company to determine the impacts from options that they would consider implementing. The 3rd step of this process is the implementation phase. The three companies that have applied for and have been awarded OEO funding to implement their proposed energy saving upgrades were evaluated. Only one of the three companies has proposed to implement electricity savings measurements that will reduce consumption by:

- 550,879 kWh in the first year of project implementation (2006).

All three projects have proposed to implement natural gas savings that will reduce consumption by:

- 43,355 Mcf

Section 3.1.i Other Statewide SEP/OEO and non-OEO Projects

For projects that did not have one full year of information or were not part of OEO funded projects, which Ohio did not have direct access or the ability to collect data from, Ohio used the "Clean Power Estimator" tool and the Solar PV Watts tool to estimate electricity generation from renewable sources.

For wind, this tool provides statewide monthly production estimates based on the size of the system (1,421 kWh/kw). 44 wind projects totaling 307 kw were evaluated. These projects were installed between 1995 and 2006. For wind projects that were older than 1 year, the degradation factor of 5% per year was applied

Electricity generation in 2006 from the 44 wind projects is estimated to be:

- 366,476 kWh

For PV, the Solar PV Watts tool provides regional monthly estimates for electricity production. There are 7 different PV zones located in Ohio. 189 PV projects totaling 866kw were included.

The location, rated capacity, and installation date were used to calculate 2006 electricity generation from these PV systems and totaled:

- 878,533 kWh

The total number of estimated kWh generated in 2006 for “Other Statewide SEP/OEO and non-OEO Projects” was:

- 1,245,009 kWh

Section 3.1.j Utility-Scale Wind

Ohio’s only utility scale wind turbine generated 13,267,931 kWh in its first year of full operation, based on metered information from this project.

Section 3.2 Step One – Estimate Ozone Season Energy Savings

The Ozone Season is defined by the U.S. EPA as the period between May 1st and September 30th for NOx SIP Call compliance. Only savings that occur during this period are able to qualify as emission reduction. The OEO calculated ozone season energy savings to satisfy this requirement.

Monthly generation and monthly electricity savings data, either metered, or estimated was collected to satisfy this requirement. When only annual generation or annual electricity savings data was available, ozone season allocation factors were applied based upon the type of measure installed. The summer ozone season load factors were derived from the “Emission Reduction workbook¹³” when available (see Appendix Table A-5 for details). All savings/generation data was calculated based on 2006 estimates. A degradation factor for renewable energy projects of 5% per year were applied for non-metered or estimated projects that were implemented or measured prior to 2006.

Table 5. Ozone Season Energy Savings from Examined Energy Efficiency and Renewable Energy Programs

Program	Ozone Season Energy Savings (kWh)
Ohio School Facility Commission	N/A
Office of Energy Services	2,422,501
Rebuild America	2,648,197
Metered Distributed Energy Resources	34,308
Change a Light	695,456
Home Weatherization Assistance Program	936,133
Electric Partnership Program	5,643,722
Envinta Phase 3	215,783
Other Statewide SEP/OEO Projects	529,650
Utility-Scale Wind	3,129,000
TOTAL	16,254,750

¹³ “The OTC Emission Reduction Workbook 2.1,” Synapse Energy Economics, 2001

Section 3.2.a Ohio School Facility Commission

43 projects in 10 Ohio school districts generated electricity annual savings estimates in 2006 to be: 4,090,893 kWh. Monthly savings were not available to calculate ozone season savings. Application of load shapes was not available since individual measures from the OTC Emissions Reduction Workbook did not apply to measures installed at schools.

Section 3.2.b Office of Energy Services

The 122 Department of Administrative Services projects had an estimated annual 2006 electricity savings of: 53,208,294 kWh. Monthly savings estimates were not available. OEO applied summer season allocation factors based on the type of energy upgrade reported to determine ozone season savings. Most projects had an array of efficiency measures installed and savings were not attributed to each measure, so application of the proper summer ozone load factor was not possible. This resulted in only 10.8% of annual project savings being included.

The 2006 ozone season electricity savings for Office of Energy Services Projects totaled:

- 2,422,501 kWh

Section 3.2.c Rebuild America

The Rebuild America energy savings data provided of 7 Rebuild America partners' projects saw electricity savings in 2006 estimated to be 18,924,277 kWh. Monthly reported savings were not available. OEO applied summer season allocation factors based on the type of energy upgrade reported, to determine ozone season savings using the New Jersey Clean Energy Protocols, and the OTC Emission Reduction Workbook 2.1. Rebuild America projects also had an array of efficiency measures installed and savings that were not attributed to each measure, so application of the proper summer ozone load factor was not possible in all instances. This resulted in only 28% of annual project savings being included.

The 2006 ozone season electricity savings for Rebuild America projects totaled:

- 2,648,197 kWh

Section 3.2.d Metered Distributed Energy Resources

For "Metered Distributed Energy Resources," Ohio collected monthly May through September electricity generation in 2006 from fifteen PV projects totaling 29,121 kWh, and from four wind projects totaling 5,187 kWh.

The 2006 ozone season electricity generation for metered distributed energy resource projects totaled:

- 34,308 kWh

Section 3.2.e Change a Light

The Change a Light program distributed 36,783 bulbs in 2005, saving an estimated 1,879,611 kWh in 2006 savings. Applying the summer season allocation factors from the OTC Emission Reduction Workbook 2.1 for efficient lighting of 0.37, the 2006 ozone season electricity savings for the Change a Light project totaled:

- 695,456 kWh

Section 3.2.f HWAP

The Home Weatherization Assistance Program saved an estimated 2,604,765 kWh in 2006. Monthly savings data was not available to estimate summer season savings. The HWAP evaluator suggested applying the number of days occurring during the ozone season (153) divided by the total number days in the year (365). Using this simplified method, the 2006 ozone season electricity generation for HWAP projects totaled:

- 936,133 kWh.

Section 3.2.g EPP

The OEO estimated that annual 2006 savings from the Electric Partnership Program (EPP) equaled, 15,000,706 kWh. Converting the annual total to ozone season savings involved applying ozone season load factors from the OTC Emission Reduction Workbook 2.1 for known measures. For the Targeted Energy Efficiency program, a load factor was not available from the OTC workbook for the different measures identified in the EPP impact analysis. Electric Heating Annual savings were not included in the OTC workbook, but a summer ozone season factor of zero was applied since these measures included upgrades to heating systems and impact during summer would be minimal if existent.

Table 6. EPP Annual and Ozone Season kWh Savings by Measure

	Annaul kWh Savings	Ozone Load Factor	Ozone kWh savings
Light bulb savings	6,201,065	0.37	2,294,394
Refrigerator savings	6,110,514	0.43	2,627,521
Continuous savings	1,804,518	0.40	721,807
Electric Heating	884,609	0.00	0
TOTAL	15,000,706		5,643,722

2006 ozone season electricity savings from the EPP program totaled:

- 5,643,722 kWh

Section 3.2.h Envinta Phase 3 Implementation

The Envnta Phase 3 project that was included estimated 2006 electricity savings of 550,879 kWh. Monthly savings estimates were not available. OEO applied summer season allocation factors based on the type of energy upgrade reported to determine

ozone season savings. The summer ozone season allocation factors were either derived from “New Jersey Clean Energy Program Protocols to Measure Resource Savings” and from project specific ozone season factors based on individual project estimates.

Table 7. Envinta Annual and Ozone Season kWh Savings by Measure

	Annual Savings	Load Factor	Ozone Season Savings
VFD	185,096	0.32	59,231
Compressed Air	32,003	0.416	13,332
Scheduling	28,272	0.419	11,852
Lighting	305,508	0.43	131,368
TOTAL	550,879		215,783

The 2006 ozone season electricity savings for the Envinta Phase 3 project totaled:

- 215,783 kWh

Section 3.2.i Other Statewide SEP/OEO and non-OEO Projects

Annual renewable energy generation from the other statewide RE programs was: 1,245,009 kWh. To estimate summer ozone season savings, data from the 44 wind projects used the “Clean Power Estimator” summer season allocation factor of 0.22 to estimate electricity generation during the 2006 ozone season to be: 80,625 kWh

For PV, the Solar PV Watts tool provided regional monthly estimates for electricity production based on location in the state. The 189 PV generated an estimated 449,025 kWh during the ozone season

The total number of estimated kWh generated during the 2006 ozone season for “Other Statewide SEP/OEO and non-OEO Projects” was:

- 529,650 kWh.

Section 3.2.j Utility-Scale Wind

Monthly 2006 electricity generation data from May through September for this project totaled:

- 3,129,000 kWh

Table 8. Annual and Ozone Season Energy Savings from Examined Energy Efficiency and Renewable Energy Programs

Program	Annual Energy Savings (kWh)	Ozone Season Energy Savings (kWh)
Ohio School Facility Commission	4,090,893	N/A
Office of Energy Services	53,208,294	2,422,501
Rebuild America	24,040,735	2,648,197
Metered Distributed Energy Resources	70,322	34,308
Change a Light	1,879,611	695,456
Home Weatherization Assistance Program	2,604,765	936,133
Electric Partnership Program	15,000,706	5,643,722
Envinta Phase 3	550,879	215,783
Other Statewide SEP/OEO Projects	1,245,009	529,650
Utility-Scale Wind	13,267,931	3,129,000
TOTAL	115,959,145	16,254,750

Section 3.3 Step Two – Emission Reductions

For all of OEO’s projects Ohio determined emission reductions rates for CO₂, NO_x, and SO_x.

To convert energy savings into emission reductions, Ohio considered the “Toolkit for States: Using Supplemental Environmental Projects (SEP) to Promote Energy Efficiency (EE) and Renewable Energy (RE)” report prepared for the U.S. EPA, which states:

The first and simplest way to estimate the emission reductions is to apply an emission factor to the energy generation or energy savings. The emission factor can be an average emission rate for a specific set of electric generators within a given region or a marginal emission rate.

The OEO considered numerous approaches to establish an emission factor for Ohio. Ohio considered applying the most recent emission ratios on an annual basis for each electric generator taken from the EPA Clean Markets Database and tying each back to where electricity savings/ renewable energy generation occurred based on real-time dispatch modeling to determine emission reductions. Ohio also considered using the plant average method based on a statewide emission ratio for the latest year available.

The OEO came to the conclusion that for emission reduction to be real in the face of cap and trade pollutants (NO_x and SO₂), the only way to ensure emission reduction from EE and RE projects would be to use emission ratio that are established for application for EE and RE set-aside 1-ton allocations that directly remove allocations that would have otherwise gone to electric generating units. This is due to the severity of emission reductions required under future emission reduction requirements under the Clean Air

Interstate Rule (CAIR), and because of the ability of EGUs to incorporate the savings from RE/EE projects into their new baselines if these RE/EE projects are not allocated set-aside allocations.

Section 3.3.a NOx Emission Reductions

Currently for NOx, under the Ohio NOx SIP, there are only set-asides for emission reductions that occur during the Ozone season. The emission ratio to determine the amount of set-aside allocations is set at 0.0015 lbs/kWh. The OEO could potentially apply for allowances under this program.

Table 9. NOx Ozone Season Energy Emission Reductions from Electric RE/EE Projects

Program	2006 Ozone Season Energy Savings (kWh)	lbs/kWh NOx reduction Ratio	lbs reduced	Tons Reduced
Ohio School Facility Commission	N/A	0.0015	N/A	N/A
Office of Energy Services	2,422,501	0.0015	3,633.75	1.82
Rebuild America	2,648,197	0.0015	3,972.29	1.99
Metered Distributed Energy Resources	34,308	0.0015	51.46	0.03
Change a Light	695,456	0.0015	1,043.18	0.52
Home Weatherization Assistance Program	936,133	0.0015	1,404.20	0.70
Electric Partnership Program	5,643,722	0.0015	8,465.58	4.23
Envinta Phase 3	215,783	0.0015	323.67	0.16
Other Statewide SEP/OEO Projects	529,650	0.0015	794.47	0.40
Utility-Scale Wind	3,129,000	0.0015	4,693.50	2.35
TOTAL	16,254,750	0.0015	24,382.13	12.19

The OEPA has proposed to have an ozone season set-aside provision for EE and RE under NOx CAIR, but has not proposed to have an annual set-aside.

OEO’s analysis of annual set-aside impacts are based on CAIR allocation ratios for 2009 and 2015 for RE and EE measured projects. The OEO currently has the legal authority, to apply for NOx SIP set-aside allocations, for any unclaimed EE and RE projects that are implemented with OEO assistance.

The 2009 NOx CAIR ratio is 0.001166 lbs/kWh. Applying 2009 set-aside allocation ratios for RE and EE projects that would potentially qualify from OEO evaluated projects, the following ton reductions could be expected annually.

Table 10. Annual NOx Ton Reductions from Examined Electric Energy Efficiency and Renewable Energy Programs Under 2009 NOx CAIR

Program	Annual Energy Savings (kWh)	2009 NOx lbs/kWh reduction ratio	lbs reduced	Tons Reduced
Ohio School Facility Commission	4,090,893	0.001166	4,770	2.38
Office of Energy Services	53,208,294	0.001166	62,041	31.02
Rebuild America	24,040,735	0.001166	28,031	14.02
Metered Distributed Energy Resources	70,322	0.001166	82	0.04
Change a Light	1,879,611	0.001166	2,192	1.10
Home Weatherization Assistance Program	2,604,765	0.001166	3,037	1.52
Electric Partnership Program	15,000,706	0.001166	17,491	8.75
Envinta Phase 3	550,879	0.001166	642	0.32
Other Statewide SEP/OEO Projects	1,245,009	0.001166	1,452	0.73
Utility-Scale Wind	13,267,931	0.001166	15,470	7.74
TOTAL	115,959,145	0.001166	135,208	67.60

The same estimates were conducted for 2015 emission reductions using the same energy savings and generation data, but applying it to the 2015 RE and EE allocation set-aside ratio of 0.0010117 lbs/kWh.

Table 11. NOx Ton Reductions from Examined Electric Energy Efficiency and Renewable Energy Programs Under 2015 NOx CAIR

Program	Annual Energy Savings (kWh)	2015 NOx lbs/kWh reduction ratio	lbs reduced	Tons Reduced
Ohio School Facility Commission	4,090,893	0.0010117	4,139	2.07
Office of Energy Services	53,208,294	0.0010117	53,831	26.92
Rebuild America	24,040,735	0.0010117	24,322	12.16
Metered Distributed Energy Resources	70,322	0.0010117	71	0.04
Change a Light	1,879,611	0.0010117	1,902	0.95
Home Weatherization Assistance Program	2,604,765	0.0010117	2,635	1.32
Electric Partnership Program	15,000,706	0.0010117	15,176	7.59
Envinta Phase 3	550,879	0.0010117	557	0.28
Other Statewide SEP/OEO Projects	1,245,009	0.0010117	1,260	0.63
Utility-Scale Wind	13,267,931	0.0010117	13,423	6.71
TOTAL	115,959,145	0.0010117	117,317	58.66

The total number of tons reduced was lower in 2015 than 2009 due to the fact that allocation ratios for 2015 are lower than 2009 since the total cap is reduced in 2015 compared to 2009.

Three OEO programs had annual natural gas savings. Including natural gas savings in annual impacts for NOx found the following NOx reductions.

Table 12. NOx Ton Reductions from Natural Gas Savings of Examined Energy Efficiency Programs

Measure	Annual Mcf Savings year 2006	NOx (lbs/Mcf)	Pounds	tons
Residential Furnace	99,624	0.094	9,365	4.68
Uncontrolled Boiler	76,871.0	0.22	16,912	8.46
TOTAL			26,276	13.14

Ozone season NOx reductions as the result of OEO evaluated programs would total:

- **12.19 Tons.**

Expected 2009 annual NOx reductions as the result of OEO evaluated programs would total electric reductions of 67.6 tons, plus natural gas reductions of 13.14 tons, for a total annual NOx reductions of:

- **80.74Tons**

Expected 2012 annual NOx reductions as the result of OEO evaluated programs would total electric reductions of 58.66 tons, plus natural gas reductions of 13.14 tons, for a total annual NOx reductions of:

- **71.8 Tons**

Section 3.3.b SO2 Emission Reductions

There are currently no set-aside provision for RE or EE under the current SO2 cap and trade program nor proposed in the replacement program, the SO2 Clean Air Interstate Rule. SO2 emission reductions expected under SO2 CAIR are significant for Ohio. Although it is a market-based approach and Ohio will not be forced to reduce SO2 emission levels to the SO2 CAIR allocation levels, it can be expected that Ohio emissions levels will approach this level. In 2005 Ohio electric generating units emitted 1,085,475 tons of SO2. Under SO2 CAIR, allocation amounts will total 298,000 tons in 2010 and 208,000 tons for 2015.

If set-aside provisions for RE and EE projects are not in place they reduce the number of kWh that are need to be generated at an EGUs, thereby reducing the regionally capped amount that may be emitted by reducing the needed electric generation at that facility. Any reductions in the needed energy generation at EGUs that result from additional RE projects operating or EE projects being implemented will translate into EGUs either not having to operate control technologies for as long, or installing less stringent control

technologies. These impacts have value to EGUs, but are not accounted for if RE and EE projects are not given allocations, since EGUs are required to meet their SO₂ allocation targets under SO₂ CAIR from a regionally capped emission total. In absence of regulation, any amount of kWh reduction or clean energy generation would be expected to reduce emissions at a rate comparable to the rate of emission (lbs/kWh) that would have otherwise been generated.

The OEO did analyze the hypothetical emission reductions if SO₂ set-asides for RE and EE were in place. OEO used 2010 SO₂ CAIR emission ratios that would be dispersed to Ohio electric generating units at a rate of 0.00368 lbs/kWh.

Table 13. Hypothetical SO₂ Ton Reductions from Examined Energy Efficiency and Renewable Energy Programs under SO₂ CAIR 2010

Program	Annual Energy Savings (kWh)	2010 SO₂ NO_x lbs/kWh reduction ratio	lbs reduced	Tons Reduced
Ohio School Facility Commission	4,090,893	0.0036805	14,304	7.15
Office of Energy Services	53,208,294	0.0036805	195,833	97.92
Rebuild America	24,040,735	0.0036805	69,651	34.83
Metered Distributed Energy Resources	70,322	0.0036805	259	0.13
Change a Light	1,879,611	0.0036805	6,572	3.29
Home Weatherization Assistance Program	2,604,765	0.0036805	8,220	4.11
Electric Partnership Program	15,000,706	0.0036805	52,450	26.22
Envinta Phase 3	550,879	0.0036805	2,028	1.01
Other Statewide SEP/OEO Projects	1,245,009	0.0036805	4,582	2.29
Utility-Scale Wind	13,267,931	0.0036805	48,833	24.42
TOTAL	115,959,145	0.0036805	402,732	201.37

Similar hypothetical SO₂ emission reductions were calculated for 2015 using 2015 SO₂ CAIR compliance ratio of 0.002534 lbs/kWh

Table 14. Hypothetical SO2 Ton Reductions from Examined Energy Efficiency and Renewable Energy Programs under SO2 CAIR 2015

Program	Annual Energy Savings (kWh)	2015 SO2 lbs/kWh reduction ratio	lbs reduced	Tons Reduced
Ohio School Facility Commission	4,090,893	0.0025354	10,372.0	5.19
Office of Energy Services	53,208,294	0.0025354	134,903.2	67.45
Rebuild America	24,040,735	0.0025354	60,952.4	30.48
Metered Distributed Energy Resources	70,322	0.0025354	178.3	0.09
Change a Light	1,879,611	0.0025354	4,765.5	2.38
Home Weatherization Assistance Program	2,604,765	0.0025354	6,604.1	3.30
Electric Partnership Program	15,000,706	0.0025354	38,032.5	19.02
Envinta Phase 3	550,879	0.0025354	1,396.7	0.70
Other Statewide SEP/OEO Projects	1,245,009	0.0025354	3,156.6	1.58
Utility-Scale Wind	13,267,931	0.0025354	33,639.2	16.82
TOTAL	115,959,145	0.0025354	294,000.5	147.00

Three OEO programs had annual natural gas savings. Including natural gas savings in annual impacts for SO2 found the following SO2 reductions.

Table 15. SO2 Ton Reductions from Natural Gas Savings of Examined Energy Efficiency Programs

Program	Annual MCF Savings year 2006	SO2 (lbs/MCF)	lbs	tons
HWAP	99,624	0.0006	60	0.03
Envinta Phase 3	43,355	0.0006	26	0.01
H.B. 264	33,516.3	0.0006	20	0.01
TOTAL	176,495		106	0.05

Expected 2010 annual SO2 reductions as the result of OEO evaluated programs would total electric reductions of **201.37** tons, plus natural gas reductions of 0.05 tons, for a total annual SO2 reductions of:

- **201.42 Tons**

Expected 2015 annual SO2 reductions as the result of OEO evaluated programs would total electric reductions of 147.0 tons, plus natural gas reductions of 0.05 tons, for a total annual SO2 reductions of:

- **147.05 Tons**

Section 3.3.c CO2 Emission Reductions

Based on 2005 “U.S. Electric Power Industry Estimated Emissions by State (EIA-767 and EIA-906),” the emission ratio for CO2 for Ohio was 1,851 lbs/MWh. In absence of a

cap on CO2 emissions, it can be expected that the statewide ratio for Ohio electric generators can be applied to energy generation and energy savings realized from OEO evaluated programs to determine emission reductions.

Table 16. Estimated CO2 Ton Reductions from Examined Electricity Energy Efficiency and Renewable Programs

Program	Annual Energy Savings (kWh)	CO2 lbs/kWh reduction ratio	lbs reduced	Tons Reduced
Ohio School Facility Commission	4,090,893	1.851	7,572,243	3,786
Office of Energy Services	53,208,294	1.851	98,488,552	49,244
Rebuild America	24,040,735	1.851	44,499,400	22,250
Metered Distributed Energy Resources	70,322	1.851	130,166	65
Change a Light	1,879,611	1.851	3,479,160	1,740
Home Weatherization Assistance Program	2,604,765	1.851	4,821,420	2,411
Electric Partnership Program	15,000,706	1.851	27,766,307	13,883
Envinta Phase 3	550,879	1.851	1,019,677	510
Other Statewide SEP/OEO Projects	1,245,009	1.851	2,304,512	1,152
Utility-Scale Wind	13,267,931	1.851	24,558,940	12,279
TOTAL	115,959,145	1.851	214,640,377	107,320

These totals can be calculated this way and do not require set-aside provisions in a cap and trade system to be realized due to the fact that there is no regulation of CO2. There is no incentive for electric generators to incorporate these reductions by not having to install CO2 emission control technologies, so these reductions can be simply based on the amount of MWh that are reduced from program implementation. The ratio will change over time, but cannot be expected to be lowered over time simply because the ratios for SO2 and NOx will be lowered as CAIR is implemented.

Table 17. CO2 Ton Reductions from Natural Gas Savings of Examined Energy Efficiency Programs

Program	Annual MCF Savings year 2006	CO2 (lbs/MCF)	Pounds	Tons
HWAP	99,624	120	11,954,880	5,977
Envinta Phase 3	43,355	120	5,202,600	2,601
H.B. 264	33,516	120	4,021,956	2,011
TOTAL	176,495		21,179,436	10,590

Estimated annual CO2 reductions as the result of OEO evaluated programs would total electric reductions of 107,320 tons, plus natural gas reductions of 10,560 tons, for a total annual CO2 reductions of:

- **117,880 Tons**

Section 3.4 Step Three - Determine Impact on Air Quality

Since more than 98% of CO2 emissions from electric generating units are emitted in non-attainment counties, the OEO is confident EE/RE projects located in the state will directly impact air quality in non-attainment areas of the state. Any and all emission reductions that are given standing in the form of renewable energy and energy efficiency set-asides under the Clean Air Rule and the pre-cursor the Ohio NOx State Implementation Plan, would have a direct impact on air quality. All of these reductions are quantifiable, surplus, enforceable, and permanent for the year of which they are allocated allowances. In the absence of set-aside provisions for cap and trade pollutants (NOx and SO2), which remove allocations otherwise given to electric generating units, these emission reductions from EE/RE cannot be determined to have an impact. For CO2 which is not subject to regulation, impacts on air quality can be estimated based on statewide emission ratios for the most recent year.

Please see section 4, “Emission Control Interaction” for further discussion on this topic.

Section 3.5 Step Four - Verification

Measurement of energy savings is based on directly measured or metered energy savings/generation. Direct verification is less necessary for programs that include direct measurement of energy production and savings as was the case in many of the OEO programs and programs included in this evaluation. All projects that used estimated data relied on the best available estimation tools that are widely used across the nation, for instance the Clean Power estimator. Other programs that would potentially require additional verification would be Envinta Phase 3 Implementation projects. These projects used estimated electricity savings based on proposed energy efficient upgrades.

The “Change a Light” program was the only other program that utilized estimated energy savings in place of directly measured savings. The Change a Light program only included compact florescent bulb replacement, a very common and much studied technology whose impacts on a per bulb basis are fairly well established.

Because of all of these factors, verification was not explored beyond ensuring that measured impacts were properly calculated and that estimation tools that were used were the best available.

Section 3.6 Replicability

Having OEO’s methodology be replicable and easily applied in other states and to other projects in the State of Ohio was one of the driving factors of this special project. Ohio

used the latest and most widely available data and commonly used models and tools. Programs like the Rebuild America and Home Weatherization are in operation in most states across the country. Seven states, including Ohio have RE and EE set-asides as part of their NO_x SIP and many have set-asides proposed for NO_x CAIR implementation. Ohio also included a broad range of measures using a number of different energy saving calculation methodologies that Ohio hopes will be of assistance to other states attempting to aggregate energy saving projects for set-aside application allocations.

Section 4 Health Impacts

The health impacts of the energy savings / renewable energy generated were attempted to be quantified through the Co-Benefits Risk Assessment Tool (COBRA). Unfortunately, the COBRA Analysis did not produce any measurable impacts. This was because the ton reductions (102.61 NO_x tons and 311.9 SO₂ tons in 2010) were not large enough to register on the model. Ohio ran multiple models to see at what level tonnage reduction would register and roughly 10 times the current reductions for NO_x and SO₂ would be needed to register on the COBRA model. This assumes that SO₂ set-asides would be established for RE/EE projects.

COBRA analysis was conducted on a theoretical basis for a 2% reduction achieved through a 2% set-aside for RE/EE for both NO_x and SO₂ under CAIR for year 2010 and measurable impacts were recorded.

To get the tonnage reduction 2% of the Ohio’s CAIR SO₂ and NO_x allocation was used. 2% of 298,000 is 5,960 tons for SO₂, and 2% of 93,000 is 1,860 tons for NO_x.

The COBRA model assumes that in 2010, SO₂ tons will total 327,178 and 96,677 tons of NO_x will emitted from Ohio electric utilities. These numbers assume that Ohio will not meet CAIR compliance without having to purchase allocations on the open market. COBRA model assumes 9% more SO₂ emissions and 4% more NO_x emissions than CAIR allocates. 4% is very close for NO_x when looking at 2005 ozone season emissions, which were 4.5% higher than the initial allocation. Assuming the COBRA model percentage of CAIR allocation to actual emissions, the following health impacts and work lost day impacts register.

Table 18. 2010 COBRA Model Impacts from a 2% Ton Reduction

Year	SO ₂ Ton Reduced	NO _x Ton Reduced	Work Loss Day \$	Total Health Savings (\$)
2010	5,960	1,860	(\$788,651,888)	\$4,518,139

If you do not assume COBRA baseline tonnage estimates and replace them with CAIR allocations, so as to have a new baseline of estimated tonnage emissions during 2010, new amounts for health impacts are seen. The model was run again with the impacts that would be seen with an additional 2% emission reduction for NO_x (1,860 tons) and SO₂ (5,960 tons).

These two model impacts were then subtracted from each other to determine the additional impacts that would be seen if the 2% above CAIR for electric utilities was accomplished.

Table 19. 2010 COBRA Model Impacts from a 2% Ton Reduction above CAIR

2010	SO2	NOx	Work Loss Days \$	Total Health Savings (\$)
With just CAIR	29,178	3,677	(\$86,131,481,475)	\$117,804,930
With 2% above CAIR	35,138	5,537	(\$104,554,041,042)	\$142,886,543
Difference	5,960	1,860	(\$18,422,559,567)	\$25,081,613

The impacts of the same amount of reductions, occurring using different baselines had a significant impact on the severity of health savings. This may have to do with the fact that when not attempting to correct for CAIR, the size of the estimated emission reductions (5,960 SO2 and 1,860 NOx) was just at the threshold of registering on the COBRA model compared to the more significant reductions that could be expected if CAIR was strictly adhered to. These interactions may warrant further analysis, but was not conducted as part of this evaluation.

Section 5 Economic Impacts

Ohio proposed to evaluate the economic impacts of the energy savings as well as the impacts from emission reductions using the REMI model. The REMI model requires a monetary value be entered to determine the regional or statewide impact. Ohio had planned to enter health impacts based on COBRA analysis, but since OEO's tonnage reductions were too low to register on COBRA, non-monetary values could be estimated based on health impacts to feed into REMI. Ohio did collect and analyze the value of energy saved from OEO's energy efficiency and renewable energy projects that Ohio included in this study. We did not include GSP, job impacts, or income impacts in the attempted REMI analysis.

Table 20. Annual Dollar Savings from Examined Energy Efficiency and Renewable Energy Programs

Program	Annual Energy Dollar Savings (\$)
Ohio School Facility Commission	\$791,154.94
Office of Energy Services	\$4,487,391.00
Rebuild America	\$3,326,342.00
OEO Funded RE/DG Projects	\$5,118,846.46
Change a Light	\$203,154.75
HWAP	\$696,093.83
EPP	\$1,452,210.37
Envinta Phase 3 Implementation	\$453,669.00
Other Statewide RE Projects	\$1,552,084.43
Total Combined	\$18,080,946.78

These totals included guaranteed dollar savings from energy service companies from projects by the Office of Energy Services. Dollar savings from Ohio School Facility Commission program projects were based on actual bill comparisons of pre and post energy upgrade and included savings from natural gas reductions. Rebuild America actual dollars savings were based on reported savings from Rebuild partners. OEO funded RE/DG project \$ savings were based on average electric utility rates of \$0.108/kWh for residential and \$0.0775/kWh for commercial. A price of 11.77/Mcf was used for natural gas for commercial customers. Change a Light dollar savings was based on estimated energy savings and applying the statewide residential electricity rate to determine dollar impacts. HWAP dollar savings included program impacts on natural gas, electricity, propane, and fuel oil expenditures by weatherized homes. EPP dollar savings was based on measured electricity reductions from program implementation applied to the service territory \$ rate charged by that utility for electricity. Envinta Phase 3 Implementation program dollar savings are based on estimated energy savings from project implementation. Other Statewide RE projects dollar savings are based on the estimated and measured energy production applied to the average residential electricity rate. The cost of the system installed or measures installed were not included in this evaluation.

The Ohio Department of Development (ODOD), which houses the Ohio Energy Office has a licensed version of REMI and Staff that have used the model before. The OEO worked with ODOD staff to run the REMI model. Unfortunately, it was determined that current data sets are not robust enough for the REMI model to establish noticeable economic impacts from a statewide perspective.

Section 6 Discussion

Section 6.1 Cap and Trade

According to “NOx Budget Trading Program, 2005 Program Compliance and Environmental Results,” by the US EPA, Office of Air and Radiation, EPA430-R-013, September 2006:

Cap and trade programs deliver results with a mandatory cap on emissions while providing sources flexibility in how they comply. Cap and trade programs have proven highly effective in reducing emissions from multiple sources on a regional or larger scale. The mandatory cap on emissions is critical to protect public health and the environment and to sustain that protection into the future. Under cap and trade programs, affected sources are allocated authorizations to emit in the form of emission allowances, but the total number of allowances cannot exceed the cap. The cap also serves to provide stability and predictability to the allowance trading market.

The Clean Air Interstate Rule (CAIR) program allocates emission allowances to generating units based on an established rate lbs/MWh that will reduce emissions to the targeted cap amount. All participants at the end of the year must hold as many allowances as they emitted either through reducing emissions directly or through purchasing allowances on the open market. 1 allowance equals 1 ton of emissions. This potentially makes it more economically attractive for electric generating units to install emission reduction technology (scrubbers) compared to buying allowances on the open market for EGUs that emit at a ratio higher than their initial allocation.

Total emissions for any given state are not capped, only the amount of total emissions for the region, but allocations are given to each state based on baseline generation for each state. What drives the economics of the trading market and in turn the amount of emission reductions one tries to attain is the number of allowances initially allocated. Also, “the key feature of emissions trading is that allowing regulated facilities to transfer emission allowances should lead to a distribution of emission reductions that equates the marginal cost of emission reductions among facilities and therefore minimizes the total costs of emission controls.”¹⁴

Allocations are based on heat input and are not a direct output based allocation process. To determine the number of tons allocated to Electric Generating Units for the 2005 NOx SIP, the rate for allocation was 0.15 lb/mmBtu multiplied by the average of the two highest heat input amounts during the ozone seasons occurring in 1995 through 1998 divided by 2000 lb/ton. Ohio’s EGU total allocation equaled 45,432 tons. 5% of these were set-aside for new units and for RE/EE projects, or 2,272 tons. This left 43,160 allowances to be allocated to EGUs. In 2005, the full 2,272 tons were returned to EGUs on a pro-rated basis because no new units were brought online.

¹⁴ “Economics of Pollution Trading for SO₂ and NO_x, Dallas Burtaw et al, March 2005, Resources For the Future, <http://www.rff.org/Documents/RFF-DP-05-05.pdf>

Before the NOx SIP call was in place during the 2000 ozone season, Ohio power plants emitted 155,601 tons of NOx using the average emission rate for 2000 for Ohio electric generating units of 0.005486 lbs/kWh. If Ohio power plants continued to emit at the same rate in 2005 as they did in 2000, they would have had to secure over 110,169 allowances on the open market to equal the 45,432 tons of allowances that were allocated. Companies consider this because if it is not deemed cost effective to install emission reduction technology, companies can simply buy allowances on the open market. The decision to buy allowances or install technology is driven by the current price of the allowance, the age of the generating unit (if a plant were going to be decommissioned soon, you would not want to install emission reduction technology), and the amount of kWh you plan on generating.

In 2005, allowances averaged \$3,000 per allowance. That means had NOx emissions held at 2000 levels in Ohio, utilities would have spent \$330,507,000 per year to purchase allowances on the open market. However, utilities significantly reduced emissions for 2005 in the face of such potential costs. 51,815 tons of NOx were emitted during the 2005 ozone season in Ohio. This is a reduction of over 66.7% compared to 2000 levels.

2005 total NOx emissions for the year in Ohio was 254,904 tons, compared to 382,102 tons in 2000, a reduction of 33.3%. During 2005 142,328,593 MWh were produced. During the Ozone season in 2005, 60,672,650 MWh of electricity were produced in Ohio. Electricity generated during the 2005 ozone season (May 1st-September 30th) accounted for 42.6% of electricity generated that year, but only 20.3% of NOx emissions. This shows that Ohio electric generating units are able to ramp up and down NOx controls depending on whether it is the ozone season or not.

Under the proposed NOx CAIR, yearly NOx emission allocations will be reduced from 254,904 in 2005 to 93,000 tons in 2009, and 83,000 tons in 2015. The actual cost of NOx CAIR allowances is currently not established since compliance doesn't begin until 2009, but estimates have ranged from \$1,000-2,000 per ton. According to PUCO forecasted additional Ohio consumption needs and assuming that Ohio's in-state generation percentage remains the same, it would be expected that 164,078,253 MWh would be generated in 2015. Using the current (2005) rate of emissions/kWh (3.5819 lbs/MWh) for NOx, it would be expected that, 288,687 tons would be emitted in Ohio if emission ratios continued the same. Under NOx CAIR, by 2015 utilities will be expected to reduce emissions to 83,000 tons. A reduction of 205,687 tons. Potentially costing \$205,687,000 - \$411,374,000 each year, using the estimated allowance price of \$1,000 - \$2,000, if no action was taken by EGUs in Ohio to comply with NOx CAIR.

SO2 CAIR would potentially reduce SO2 emissions, according to EPA estimates, from 1,373,000 tons down to 298,000 tons in 2010. By 2015, SO2 CAIR would reduce SO2 in Ohio from 1,064,000 tons down to 208,000 tons.

Section 6.2 Cap and Trade and Renewable Energy and Energy Efficiency

One way to reduce lbs emitted at power plants in Ohio is to lower the number of kWh a plant generated during its base year generation used for initial allocation of emission

credits under cap and trade programs. This is a more direct route that off-sets emissions by the amount of allowances allocated to energy efficiency projects since they are removed from the pool of eligible allowances for the State of Ohio.

This is all driven by the fact that power plants will typically emit emissions at the level for which they are allocated. For NO_x this is 0.0015lbs/kWh during the ozone season. Also, since power plants can control the level of their emissions by ramping up their controls, if they install controls to comply with more restrictive summer NO_x standards, this does not mean that they will be activated during the winter. And most likely they will not, since operating these emission control technologies incurs a cost. This can be seen since emission rates during the ozone season in 2005 were 0.001708 lbs/kWh compared to 0.00358 lbs/kWh annually.

SO₂ emissions are similarly capped, but there are no set-asides under this program. There may be some interaction between the controls that are placed on units for NO_x with SO₂, allowing more reductions of SO₂ emissions to occur.

There is currently no cap or regulation for CO₂ in Ohio.

The effectiveness of the cap and trade program model for Ohio has clearly been established under the NO_x SIP during the ozone season. Ozone season emissions during 2000 were 155,601 tons. In 2005, under the NO_x SIP, Ohio was allocated 49,460 tons. Actual emission in 2005 was 51,815 tons, which was 4.5% more than allocated, but 68.2% less than 2000. This suggests that a similar outcome would occur under NO_x CAIR, of significantly reducing emissions and matching or coming close to the initial emission allocations.

The OEO further suggests that RE and EE projects only reduce pollution in a cap and trade system to the amount that they are allocated, which would optimally be based upon the rate that all electric generators receive. Under the NO_x SIP for NO_x during the ozone that rate was 0.015 lbs/kWh.

The retirement of allowances from any RE/EE project is not as important as the fact that it off-sets Ohio generated electricity and that it is given allowances for the electricity it produces or reduces. If Ohio allowed renewable sources to retire their allowances from the regional program it would have the affect of raising the price of allowances on the open market, since allowances would be more-scarce. This would lower the allowable tonnage emissions for the region, but not necessarily in Ohio since retirement of Ohio based renewable allowances would not stop Ohio utilities from going outside of the state to purchase needed allowances on the open market.

Regardless of whether allowances are retired, when Ohio renewable and energy efficiency projects receive allowances this reduces the number of allowances that would have otherwise been returned at no cost to utilities. This therefore reduces the amount of allocations allocated to traditional sources of electricity generation and increases potentially the number of allowances they have to purchase on the open market. This also would potentially affect their decision to implement NO_x controls on their plant since they would now have to

purchase the allowances that had been allocated to renewable/energy efficiency projects, that they had gotten for free in the past. When allowances have to be purchased on the open market at a price instead of given at no cost to traditional EGUs, this motivates reductions.

The retirement of Ohio renewable energy and energy efficiency allowances does not reduce emissions specifically in Ohio. If Ohio traditional EGUs were only allowed to purchase allowances from Ohio, the retirement of Ohio RE/EE allowances would reduce Ohio emissions. This is not the case though since Ohio is part of a regional trading system, and Ohio traditional EGUs are still able to purchase allowances from the region regardless of Ohio RE/EE allowance retirement. The retirement of Ohio RE/EE allowances does reduce emissions nationwide by the amount retired. This in turn drives the price of allowance up since they are now more scarce. This would proportionately affect Ohio traditional EGUs because it would potentially change their internal decision making process to decrease NO_x emissions vs. the decision to purchase (now higher priced) allowances on the open market.

Increased presence of renewable energy and energy efficiency projects also displaces the amount of electricity needed to be produced from traditional NO_x emitting sources since they are generated with new clean renewable sources, or reduced through efficiency.

SO₂ is also capped and allowances are given out to electric generating units, so there are savings here as well on the potential cost of compliance. The major difference between the SO₂ and the NO_x program under CAIR is that the State of Ohio does not have the authority to provide set-asides for renewable energy under the SO₂ cap and trade program like it does with the NO_x implementation.

Section 6.3 Deregulation Interactions

Ohio's electricity generation and distribution is currently deregulated and is going through the process of market rate stabilization. As part of this process investor owned utilities (IOU) are no longer required to administer demand-side management (DSM) programming to reduce electricity consumption and reduce energy demand. As part of the deregulation process, an energy efficiency revolving loan fund, administered by the OEO, was established to act as a replacement to many of the traditional DSM programs.

Utilities located in nearby states that continue to be regulated, that have DSM programs, and that will be subject to CAIR, will be expected to incorporate the energy reductions realized from their DSM programs into their internal CAIR compliance plans, as these programs reduce the need for the production of electricity, which reduces an EGU's yearly emissions.

Set-asides for renewable energy and energy efficiency in cap and trade programs allow for efforts that are conducted by non-utility programs to be given standing to ensure that they are not incorporated into utilities internal CAIR compliance plans. Allowances given to non-utility entities are typically sold or retired. These allowances that are allocated to RE and EE projects have a monetary value that would have to be purchased by an EGU if they are in non-compliance with their initial allocation. Since allowances allocated to EGU are given at

no charge this is different than RE/EE set-asides that are returned to the market that have a monetary value.

Under the Ohio NOx SIP, AMP-Ohio, a municipal electric company qualified for 63 allowance set-asides from their two hydro and one wind project. These allocations can either be internalized by AMP-Ohio and counted towards their SIP compliance if they are in need of additional credits, or potentially be factored into how stringent controls are either installed or the length that they are needed to operate. Both of these options provides a potential benefit to AMP-Ohio. They may, on the other hand, sell their set-aside allocations on the open market, but would lose the before mentioned benefits. This assumes that Ohio EGU must ramp up or install controls to meet NOx SIP caps.

Power generated in Ohio can also be transmitted and sold to another state under a deregulated system. When power requirements of traditional EGUs are reduced from Ohio customers through energy efficiency and renewable energy that does not necessarily mean that less electricity is generated in Ohio.

Section 7 Further Study / Information Collection Needs

The OEO is currently evaluating and implementing new data collection protocols for funded projects. This research project has brought to light many additional requirement needs that were not previously established. Data collection needs to occur not just for annual electricity reductions, but for monthly electricity savings, if aggregation is to occur for NOx SIP or future ozone season CAIR applications for set-asides as a result of State implemented and funded projects. The OEO has the authority to aggregate and apply for any unclaimed emission reduction credits from projects that are the result of OEO funding.

Section 8 Policy Implications/Recommendations

Policy Implication #1: The existence of set-asides/direct allocations of emission allowances to renewable energy and energy efficiency projects (RE/EE) is the only currently available method that ensures the emission reduction impacts of these projects are recognized and realized when they are part of a cap and trade program.

Recommendations:

- A. The Ohio Environmental Protection Agency's (EPA) should establish annual as well as ozone season set-asides/direct allocations for RE/EE projects in the NOx Clean Air Interstate Rule (CAIR) cap and trade program and annual set-asides/direct allocations in the Clean Air Mercury Rule (CAMR) cap and trade program.
- B. The Ohio Energy Office (OEO) should work with the Ohio EPA to encourage the U.S. EPA to develop set-asides/direct allocations for the SO2 trading program.
- C. When/if a future CO2 cap and trade program is established, OEO should support the inclusion of RE/EE set-asides/direct allocations, regardless of whether it is implemented at the State or Federal level.

Policy Implication #2: The design and parameters of RE/EE set-asides/direct allocations is critical.

Recommendations:

- A. The current limit of 5 years RE/EE projects are allowed to reapply for set-asides under the NOx CAIR should be removed. RE/EE projects should instead be allowed to reapply for set-asides for as long as they continue to offset emissions. This should apply for any future set-asides that are created as well.
- B. Set-asides/direct allocations should be sized adequately and distributed proportionately to the number of emissions that they offset.¹⁵

Policy Implication #3: Government support for RE/EE projects can have a direct impact on reducing emissions of capped pollutants when they apply for set-asides/receive direct allocations.

Recommendations:

- A. All State Energy Plan (SEP) and OEO supported RE/EE projects that are eligible should apply for emission set-asides/direct allocations.
- B. Coordination with other Ohio agencies that support RE/EE eligible projects should occur. OEO should work with these agencies to ensure that they apply for set-asides, or the State Energy Office should apply for set-asides on their behalf.

Policy Implication #4: Set-asides/direct allocations for RE/EE projects provide financial benefits to existing and future RE/EE projects and improve the financial viability of that project's existence.

Recommendation:

- A. OEO should adequately promote RE/EE set-asides/direct allocations to existing and future private RE/EE projects so they become aware of and apply for eligible emission set-aside allowances.

Policy Implication #5: Set-asides/direct allocations for RE/EE typically require 1-ton reductions to qualify.

Recommendation:

- A. Aggregation of eligible RE/EE projects both state-funded and/or privately-funded that are too small to qualify individually should be encouraged and/or coordinated by OEO.

¹⁵ The number of allowances set-aside for RE/EE projects is currently capped at 1% of the Ohio NOx CAIR. The Ohio EPA has written into its NOx CAIR rules that the number of set-asides will be re-evaluated starting in 2009 and every three years if demand for RE/EE set-aside allocations reaches 570 tons between 2009 and 2012 tons, or 499 tons in 2015 and beyond. If this happens they will "adjust set-asides upwards as necessary for the following year's control period but up to a maximum of five per cent for the energy efficiency/renewable energy set-aside or the innovative technology project set aside."

Policy Implication #6: Proper data collection showing energy production/reduced electricity consumption is essential to determine emission reductions and to receive either annual or season RE/EE set-asides/direct allocations.

Recommendations:

- A. Direct measured monthly savings/generation data should be required/collected from state-funded projects.
- B. Standardized estimation tools for seasonal and annual savings should be applied, and if not available, developed, when directly measured data is not available.

Appendix

Table A-1 Updated DEER Measure Lifetimes (and Comparison to Protocols EULs)¹⁶

Identification / Information				Years**	Years	Years
A. New Row Num	B. End Use	C. Measure Name from EUL Study	D. Sector	E. DEER Newly Adopted EUL (2005)	F. Interim / previous DEER EUL	G. A Priori Protocols EULs
1	AC	A/C Central, <65 kBTU/HR, Sokut-SYS/SNGL PKG	C	15	15	15
2	AC	Air Conditioners with SEER >= 11.0	R	18	15	18
3	AC	Central Air Conditioners	R	18	15	18
4	AC	Evaporative Coolers	R	15	15	15
5	C	Cooking measures , Assorted	C	12	n/a	12
6	C	Gas Cooktops	R	20	n/a	20
7	CW	Gas Dryer Stub	R	18	18	18
8	EMS	Install HVAC EMS	C	14	15	14
9	HVAC	All Energy-Efficient Furnaces Installed Through Energy Advantage Home Program	R	18	20	18
10	HVAC	Duct Testing	RNC	18	15	25
11	HVAC	Heat Pumps	R	15	15	
12	HVAC	High Efficiency Furnace	RNC	18	20	18
13	HVAC	High Energy Efficiency Ducts	R	18	15	25
14	L	CFL Bulbs -- see second sheet using results from logger study	CIA	Table 3.3	varies	5.8
15	L	CFL Fixture: no add'l description	C	12	16	12
16	L	CFL Fixture: no add'l description	R	16	16	n/a
17	L	Electronic Ballast	C	11	16	10
18	L	Electronic Ballast	CIA	11	16	10
19	L	Electronic Ballast	I	11	16	10
20	L	Electronic Ballast	NRNC	11	16	10
21	L	T8 Fixtures	C	11	16	11
22	L	T8 Fixtures	CIA	11	16	11
23	L	T8 Fixtures	I	11	16	11
24	L	T8 Fixtures ; lamp or ballast	I	11	16	11
25	L	T8 Fixtures or ballast	R	15	16	11
26	L	T8 Lamps	C	5	n/a	5
27	L	T8 Lamps	CIA	5	n/a	5
28	L	T8 Lamps	I	5	n/a	5
29	LL	Delamp/reflectors	CI	11	n/a	n/a
30	LL	Optical Reflectors- new construction	I, NRNC	12	n/a	n/a
31	LL	Optical Reflectors- retrofit	I, NR	10	n/a	n/a
31	LL	HID fixture: Interior, >= 176 Watts lamp	I	16	16	16

¹⁶Revised/Updated EULs Based on Retention and Persistence Studies Results, Skumatz Economic Research Associates, July 8, 2005

Identification / Information				Years**	Years	Years
A. New Row Num	B. End Use	C. Measure Name from EUL Study	D. Sector	E. DEER Newly Adopted EUL (2005)	F. Interim / previous DEER EUL	G. A Priori Protocols EULs
32	LL	HID fixture: Interior, 251-400 Watt lamp	C	16	16	16
33	M	Adjustable speed drive, application unknown	A	10	n/a	10
34	M	Adjustable speed drive, application unknown	C	10	n/a	10
35	M	Adjustable Speed Drive: HVAC fan, 50 HP Max	C	16	n/a	16
36	M	Pump repair	A	11	n/a	9
37	P	Injection molding machines	I	15	n/a	15
38	P	Plastic extrusion equipment	I	15	n/a	15
39	P	Process cooling	I	15	n/a	15
40	P	Process equipment insulation	I	15	n/a	15
41	R	Refrigerator Recycling	R	10	6	n/a
42	R	Refrigerator - Energy Efficient; 20% more efficient	R	18	18	20
43	R	Refrigerators	R	18	18	20

Table A-2. CFL Measure Lifetimes Based on Operating Hours from Logger Study¹⁷

Building Code	Market Sector	Annual Operating Hours	EUL (in years)
EPR	Education - Primary School	1,440	5.56
ESE	Education - Secondary School	2,305	3.47
ECC	Education - Community College	3,792	2.11
EUN	Education - University	3,073	2.60
GRO	Grocery	5,824	1.37
HSP	Health/Medical - Hospital	8,736	0.92
NRS	Health/Medical - Nursing Home	8,736	0.92
HTL	Lodging - Hotel	8,736	0.92
MTL	Lodging - Motel	8,736	0.92
GST	Lodging - Guest Rooms	1,145	6.99
MLI	Manufacturing - Light Industrial	2,860	2.80
OFL	Office - Large	2,739	2.92
OFS	Office - Small	2,492	3.21
RSD	Restaurant - Sit-Down	3,444	2.32
RFF	Restaurant - Fast-Food	6,188	1.29
RT3	Retail - 3-Story Large	4,259	1.88
RTL	Retail - Single-Story Large	4,368	1.83
RTS	Retail - Small	3,724	2.15
SCN	Storage - Conditioned	2,860	2.80
SUN	Storage - Unconditioned	2,860	2.80
WRF	Warehouse - Refrigerated	2,600	3.08
Residential		Avg Daily Operating Hrs	EUL (in Years)
(based on 8,000 hour manufacturer rated bulb life)			
		2.34	9.4
		3.1	7.1

¹⁷CFL_EUL.xls from Gary Cullen, Itron, 5/12/05

Table A-3 Technical Degradation Factor Descriptions¹⁸

Measure #	High Efficiency Measure	Baseline Technology
M01	Residential Central A/C - high efficiency.	Standard SEER A/C
M02	Commercial A/C - Package DX	Standard efficiency unit
M03	Oversized evaporative cooled condenser	Air cooled condenser
M04	Refrigerator 10-30% better than std.	Standard efficiency refrigerator
M05	Electronic Ballast	Efficient magnetic ballast
M06	T8 with electronic ballast	T12 w/efficient magnetic ballast.
M07	Optical Reflector, delamp	Standard fixture
M08	HID interior Metal Halide 250-400W	Mercury vapor 400-1000W
M09	Occupancy Sensor	On/off switch
M10	Motor - high efficiency	Standard efficiency motors
M11	Adjustable Speed Drive for HVAC Fan	Variable inlet vanes or damper
M12	Infra-red Gas Fryer	Standard atmospheric fryer
M13	Residential ceiling insulation	Standard levels attic insulation
M14	LED exit signs	Incandescent exit signs
M15	Process adjustable speed drives — waste water pumps	Inlet vane throttling on waste water pumps
M16	Process adjustable speed drives — injection molding machines	Standard injection molding machines
M17	Fiberglass batt R-15 wall and R-19 floor insulation	R-13 fiberglass batt wall and floor insulation
M18	Switched or stepped daylighting controls	Standard manual lighting controls
M19	Dimmable daylighting controls	Standard manual lighting controls
M20	Agricultural pump repair or replacement	Existing agricultural pump
M21	Variable air volume HVAC distribution system	Constant air volume HVAC distribution system
M22	Energy management systems	Manual operation
M23	New air compressors	Existing air compressors
M24	High efficiency compressed air distribution system	Standard efficiency compressed air distribution system
M25	13 watt hard-wired compact fluorescent downlights	Incandescent downlights

¹⁸ Summary Report of Persistence Studies: Assessments of Technical Degradation Factors, Final Report, California DSM Measurement Advisory Committee, February 23, 1999

Table A-4 Technical Degradation Factors¹⁹

M#	M01	M02	M03	M04	M05	M06	M07	M08
YEAR	Resid DX AC	Comm DX AC	Oversized Evap Condens	Resid Refrig	Electronc Ballasts	Elect T8 lamps	Optical Reflectrs	HID fixtures
1	1	1	1	1	1	1	1	1
2	1	1	0.98	1.04	1	1	1	0.96
3	1.01	1	0.96	1.06	1	1	1	0.96
4	1.01	1.01	0.93	1.07	1	1	1	0.96
5	1.02	1.01	0.91	1.08	1	1	1	0.96
6	1.02	1.01	0.89	1.08	1	1	1	0.96
7	1.03	1.01	0.87	1.09	1	1	1	0.96
8	1.03	1.01	0.84	1.09	1	1	1	0.96
9	1.04	1.01	0.82	1.09	1	1	1	0.96
10	1.04	1.02	0.8	1.09	1	1	1	0.96
11	1.05	1.02	0.8	1.1	1	1	1	0.96
12	1.05	1.02	0.8	1.1	1	1	1	0.96
13	1.06	1.02	0.8	1.1	1	1	1	0.96
14	1.07	1.02	0.8	1.1	1	1	1	0.96
15	1.07	1.02	0.8	1.1	1	1	1	0.96
16	1.08	1.02	0.8	1.1	1	1	1	0.96
17	1.09	1.02	0.8	1.1	1	1	1	0.96
18	1.09	1.02	0.8	1.1	1	1	1	0.96
19	1.1	1.06	0.8	1.1	1	1	1	0.96
20	1.1	1.08	0.8	1.1	1	1	1	0.96

¹⁹ Summary Report of Persistence Studies: Assessments of Technical Degradation Factors, Final Report, California DSM Measurement Advisory Committee, February 23, 1999

Table A-4 Technical Degradation Factors (continued)

M#	M09	M10	M11	M12	M13	M14	M15	M16	M17
YEAR	Occupancy Sensors	High Effic Motors	ASD HVAC Fan	Infrared Gas Fryer	Resid Ceiling Insulation	LED exit	ASD Pump	ASD IMM	Wall&Flr Insul
1	1	1	1	1	1	1	1	1	1
2	1	1	1	1	1	1	1	0.98	1
3	1	1	1	1	1	1	1	0.91	1
4	1	1	1	1	1	1	1	0.74	1
5	1	1	1	1	1	1	1	0.57	1
6	1	1	1	1	1	1	1	0.5	1
7	1	1	1	1	1	1	1	0.48	1
8	1	1	1	1	1	1	1	0.47	1
9	1	1	1	1	1	1	1	0.47	1
10	1	1	1	1	1	1	1	0.47	1
11	1	1	1	1	1	1	1	0.47	1
12	1	1	1	1	1	1	1	0.47	1
13	1	1	1	1	1	1	1	0.47	1
14	1	1	1	1	1	1	1	0.47	1
15	1	1	1	1	1	1	1	0.47	1
16	1	1	1	1	1	1	1	0.47	1
17	1	1	1	1	1	1	1	0.47	1
18	1	1	1	1	1	1	1	0.47	1
19	1	1	1	1	1	1	1	0.47	1
20	1	1	1	1	1	1	1	0.47	1

Table A-4 Technical Degradation Factors (continued)

M#	M18	M19	M20	M21	M22	M23	M24	M25
YEAR	Stepped Dlighting	Dimmable Dlighting	Ag Pump	VAV	EMS	Cmpr	Cmpr Air Dist Sys	CFL Downlite
1	1	1	1	1	1	1	1	1
2	1	0.73	1	1	1	1	1	1
3	1	0.61	1	1	1	1	1	1
4	1	0.54	1	1	1	1	1	1
5	1	0.48	1	1	1	1	1	1
6	1	0.43	1.01	1	1	1	1	1
7	1	0.39	1.01	1	1	1	1	1
8	1	0.36	1.01	1	1	1	1	1
9	1	0.33	1.01	1	1	1	1	1
10	1	0.31	1.01	1	1	1	1	1
11	1	0.29	1.01	1	1	1	1	1
12	1	0.27	1.01	1	1	1	1	1
13	1	0.26	1.01	1	1	1	1	1
14	1	0.24	1.02	1	1	1	1	1
15	1	0.23	1.02	1	1	1	1	1
16	1	0.23	1.02	1	1	1	1	1
17	1	0.22	1.02	1	1	1	1	1
18	1	0.21	1.02	1	1	1	1	1
19	1	0.21	1.02	1	1	1	1	1
20	1	0.2	1.02	1	1	1	1	1

Table A-5 Default Load Shapes for Energy Efficiency²⁰

Measure	Ozone Season	Non-Ozone Season
Residential Appliances		
Energy Star Refrigerator	43	57
Energy Star Dishwasher	41.5	58.5
Energy Star Clotheswasher	37	63
Energy Star Residential Air Conditioner	100	0
Continuous Running Equip.	40.5	59.5
Residential Lighting		
Compact Fluorescents	37	63
RC Fluorescent Fixture	37	63
Torchiere	37	63
Fixtures Other	37	63
Commercial		
Commercial Lighting — New	42	58
Commercial Chillers — New and Retrofit	84	16
Commercial Large Motors — New and Retrofit	41	59
Commercial VSDs — New and Retrofit	32	68
Commercial Comprehensive New Construction Design	43	57
Industrial		
Industrial Lighting — New and Retrofit	42	58
Industrial Unitary HVAC	84	16
Industrial Chillers — New and Retrofit	84	16
Industrial Motors — New and Retrofit	39	61
Industrial VSDs — New and Retrofit	39	61
C&I Gas Absorption Chiller — New or Replacement	84	16

²⁰“OTC Emission Reduction Workbook: 2.1,” Synapse Energy Economics, 2001

