March 2005 • NREL/TP-710-37721

Technical Report

Comparison of Methods for Estimating the NO_x Emission Impacts of Energy Efficiency and Renewable Energy Projects: Shreveport, Louisiana Case Study

A. Chambers, D.M. Kline, and L. Vimmerstedt
National Renewable Energy Laboratory

A. Diem
U.S. Environmental Protection Agency

D. Dismukes and D. Mesyanzhinov
Louisiana State University

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
303-275-3000 • www.nrel.gov

Operated for the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
by Midwest Research Institute • Battelle

Contract No. DE-AC36-99-GO10337

March 2005 • NREL/TP-710-37721

Comparison of Methods for Estimating the NO_x Emission Impacts of Energy Efficiency and Renewable Energy Projects: Shreveport, Louisiana Case Study

A. Chambers, D.M. Kline, and L. Vimmerstedt
National Renewable Energy Laboratory

A. Diem
U.S. Environmental Protection Agency

D. Dismukes and D. Mesyanzhinov
Louisiana State University

Prepared under Task No. 6020.1060

National Renewable Energy Laboratory
1617 Cole Boulevard, Golden, Colorado 80401-3393
303-275-3000 • www.nrel.gov

Operated for the U.S. Department of Energy
Office of Energy Efficiency and Renewable Energy
by Midwest Research Institute • Battelle

Contract No. DE-AC36-99-GO10337

Available electronically at http://www.osti.gov/bridge

Available for a processing fee to U.S. Department of Energy and its contractors, in paper, from:

U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
phone: 865.576.8401
fax: 865.576.5728
email: mailto:reports@adonis.osti.gov

Available for sale to the public, in paper, from:

U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
phone: 800.553.6847
fax: 703.605.6900
email: orders@ntis.fedworld.gov
online ordering: http://www.ntis.gov/ordering.htm

Printed on paper containing at least 50% wastepaper, including 20% postconsumer waste

TABLE OF CONTENTS

Acknowledgements

This analysis was prepared by the National Renewable Energy Laboratory (NREL) at the request of the State of Louisiana Energy Office, the US Department of Energy (USDOE), and US Environmental Protection Agency (USEPA). USDOE's Technical Assistance Program and USEPA's State and Local Capacity Building Branch provided support for the project. This paper is a revised version of a study done for the Louisiana State Energy Office that was used in Shreveport's Early Action Compact (EAC) submission to USEPA for the 8-Hour Ozone Standard under the National Ambient Air Quality Standards. (That submission is included for reference in Appendices 2 and 3.) NREL developed this analysis in close collaboration with Art Diem in the USEPA State and Local Capacity Building Branch, Louis McArthur at the Louisiana Department of Natural Resources, and David Dismukes and Dmitry Mesyanzhinov from the Louisiana State University Center for Energy Studies (LSUCES), each contributing a separate analysis as described below. This paper also benefited from comments on previous versions provided by David Solomon (USEPA), Michael Morton (USEPA), Shannon Snyder (USEPA), and Jim Orgeron, Louisiana Department of Environmental Quality. We would like to express special thanks to Jerry Kotas of USDOE for the benefit of innumerable useful conversations on this and related topics, and for his strong role in providing resources to underwrite this effort. Any remaining typographical or technical oversights are the responsibility of the authors.

Abstract

Measures to increase the use of energy efficiency and renewable energy (EERE) technologies are among the many tools available to air quality planners for improving local air quality. These technologies can both reduce generation from fossil fuel power plants and reduce their emissions. However, quantifying the emissions reduction caused by given levels of EERE technology use is complicated, since this calculation requires determining which power plants were offset by renewable energy generation or reductions in end-use consumption. Until recently, there had been little discussion of what methods of quantification would be acceptable for the purposes of State Implementation Plan (SIP) submissions to the Environmental Protection Agency (USEPA). This situation began to change when USEPA issued general guidelines for including EERE projects in SIP proceedings (USEPA, 2004). That document endorsed the principle that EERE projects could be included in SIP submissions and laid the groundwork for quantification methods to be proposed. This paper aims to contribute to the ongoing discussion of these issues by comparing three alternative methods that were used in a recent SIP submission for the Early Action Compact for the City of Shreveport, Louisiana. That submission had completed the public comment period and was being incorporated into the Louisiana SIP by USEPA at the time of publication.

This analysis suggests that the energy conservation measures that were submitted for the Shreveport SIP will reduce NO_x emissions on the order of 0.04 tons per day during the ozone season. Comparing three different methods for estimating this impact suggests that a simple approach, which uses an average of the emissions rates for nearby power plants drawn from the eGRID database, is precise and accurate enough to be used for very small projects like this one. The remainder of this paper describes the context for this work, the methods used, and the uncertainty in the resulting estimates.

Introduction

Background

The Shreveport-Bossier City Metropolitan Statistical Area (MSA) in northwest Louisiana is in the process of taking several proactive measures to maintain and improve local ambient air quality. The primary ambient air pollutant of concern is ozone; hence measures are being taken to reduce the ozone precursors of volatile organic compounds (VOCs) and oxides of nitrogen (NO_x). One innovative measure that the MSA has pursued is the indirect reduction of NO_x through installation of energy conservation equipment in 33 city buildings. This paper outlines three different methodologies for calculating the power plant NO_x emissions reduced by implementing these permanent grid-connected energy efficiency projects in the Shreveport-Bossier City region of Louisiana.

The Shreveport-Bossier City MSA is comprised of Bossier, Caddo, and Webster Parishes in northwest Louisiana. The MSA has recorded ambient ozone concentrations that approach the maximum concentration permitted by the Clean Air Act's National Ambient Air Quality Standards for 8-Hour ozone concentrations. In order to ensure that air quality is maintained or even improved, the MSA has committed to implement several candidate control measures through an Early Action Compact (EAC) with USEPA. All EAC areas have voluntarily agreed to proactively reduce ozone precursors, thereby reducing ozone, earlier than required by the Clean Air Act (CAA) for the new 8-hour ozone National Ambient Air Quality Standard (NAAQS). One innovative NO_x reduction measure that the Shreveport-Bossier City MSA selected for inclusion in their EAC is a 20-year contract with Johnson Controls, Inc. for the purposes of installing and maintaining energy conservation equipment in 33 municipal buildings. Large energy efficiency projects such as this one will reduce end-use demand, which may in turn reduce generation at nearby power plants, reducing their emissions.

The remainder of this paper proceeds as follows: The first section describes the results of the analysis, summarizing results from three different methods used to quantify the emissions reductions resulting from Shreveport's contract with Johnson Controls. The discussion then examines each of those methods in turn, and compares their results. The paper concludes with recommendations for the use of quantification methods in the SIP process. Appendix 1 presents a framework that may be useful in comparing different quantification methodologies and in developing better estimates of the uncertainty in their results. Appendix 2 is Shreveport's Early Action Compact Progress Report.

Scope of the Three Methods

This analysis compares three different methods for estimating the impacts of the energy efficiency program, as described in the next section. These methods all estimate the marginal impact of the end-use demand reductions. That is, the reduced generation after the demand reductions is allocated across the power plants supplying the Shreveport area. After that allocation, the emissions reductions are estimated for each plant and summed to yield to total reduction. The crux of the difference between the three approaches is the difference in how they allocate the generation reductions among different power plants.

These approaches do not consider secondary impacts that could occur as the affected generators attempt to make up the loss in sales to Shreveport by selling power elsewhere. They also do not consider the potential impact of the demand reductions on timing or technology of future power plant investments. Finally, none of the approaches considered here assess the phenomenon of additionality—the question of whether some or all of the conservation included in Shreveport's EAC submission would have occurred had the city not engaged Johnson Controls to undertake specific measures. These effects are beyond the scope of the current effort.

Summary of Results

Table 1 compares the results of the different estimates. A calculation method developed by Art Diem at USEPA, which we call the "Power Control Area Dispatch Method," and the calculation method developed by the LSU Center for Energy Studies (LSUCES), the "Economic Dispatch Method," produced estimates of 0.042 and 0.036 tons per day respectively. A third method, the "Plant Average Method," uses average emission rates for different subsets of power plants serving the Shreveport area, and suggests that the impact might range from 0.024 to 0.057 tons per ozone season day.

Table 1: Summary of Estimates

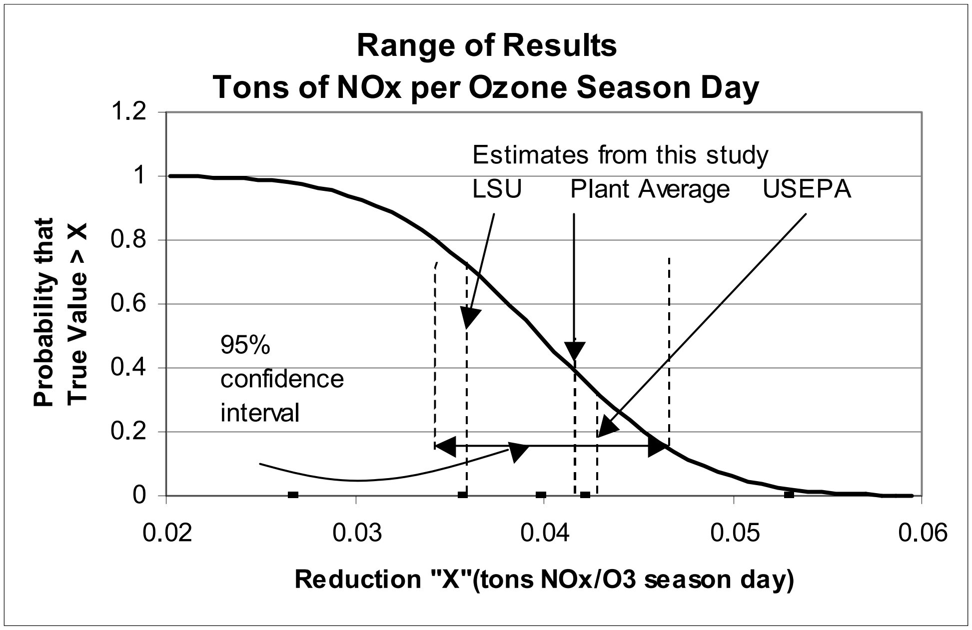
Method	**Result, Tons/O_3 day**
Economic Dispatch	0.036
Power Control Area Dispatch	0.042
Plant Average	0.033 (0.024 to 0.058)[1]

Figure 1: provides an estimate of the probabilities associated with these estimates, in the form of a curve tracing the probability that the true value is greater than the value shown on the x-axis. This estimate suggests that the value will be between .035 and .045 tons per day with a probability of 95 percent.[2]

[1] The range of results from the plant average method is from .024 to .058 pounds per ozone-season day. The average of all the variants of this method, leaving out the US average figure, is .033 pounds per ozone-season day.

[2] The confidence interval mentioned in the discussion of Figure 1 was estimated as follows. First, a single value for the plant average method was calculated as the average of all the estimates except for the U.S. National average. This was done so that the plant average method would have the same weight as the other two methods in the rest of the calculations. That estimate, along with those for the economic dispatch and power control area dispatch methods were then treated as three samples from a population of emissions estimates. Based on those three samples, we calculated the standard error of the mean, which estimates the standard deviation of an average of three samples from the population. Figure 1 uses a normal distribution with the mean equal to the average of the three samples and standard deviation equal to the standard error of the mean. The 95% percent confidence interval is estimated as the mean +/- two standard deviations. As discussed above, the result is a range of estimates from .035 to .045 tons per ozone season day.

Figure 1: Range of Estimates of NOx Reductions



NO_x reductions in the range of the estimates shown in Figure 1 will assist Shreveport in meeting and maintaining compliance with the 8-Hour Ozone Standard. One of the suggestions from the following discussion is that relatively straightforward methods are adequate to characterize the impact of such small projects, while more complex methods may be required to assess the impacts of larger projects. Adopting this viewpoint could significantly lower the staff and technical resources needed by public agencies to quantify the emissions impact of EE and RE measures.

Methodologies Used to Develop Alternative Estimates

As mentioned above, each of the approaches considered here takes a different path in identifying the generating units displaced by the electricity savings. Once the changes in generation in each plant are estimated, the emissions reduction is calculated straightforwardly by multiplying each of those changes by the appropriate NO_x emission factor. All three approaches use the emissions factors in the Environmental Protection Agency's eGRID air emissions database. The differences among them arise from their differing approaches to estimating the generation reduction of each plant.

Ultimately, the decision for which methodology should be adopted into the EAC will be made by the State of Louisiana and USEPA. The intent of this paper is to provide a neutral assessment of different estimation methods and critique the strengths and weaknesses of those methodologies. All methodologies were conducted in parallel and were provided the same amount of raw data. The base year for the analysis was calendar year 2000 and the guaranteed energy savings of the contract is 9,121,335 KWh/yr, according to the energy service contract between Johnson Controls and the City of Shreveport-Bossier.

Economic Dispatch Method

David Dismukes and Dmitry Mesyanzhinov from the LSUCES developed the LSUCES economic dispatch model of the AEP-SWEPCO control area and applied it in this analysis. The model economically dispatches each of the AEP-SWEPCO generating facilities on an hour-to-hour basis. Under an optimal economic dispatch, generators are ranked, or "stacked" based upon their costs, with the lowest cost unit being utilized first, and the highest cost unit being utilized last. The LSUCES model simulated this economic dispatch for each hour of calendar year 2000.

Estimating the emissions reduction associated with energy efficiency measures follows a three-step approach. In the first step, a baseline economic dispatch case for the AEP-SWEPCO control area is developed in order to approximate the normal dispatch of the system. The second step develops a "change case" dispatch. In this instance, the "change case" is the introduction of energy efficiency measures. The third step is to calculate the difference between baseline and "change case," which gives the plant-specific generation displaced by the energy efficiency measures, and calculate the air emission reduction associated with that displacement.

The data used in this analysis came from a variety of sources that included FERC Form 1s, Form EIA-411, RDI International Power Generation Database, Utility Data Institute, information provided by AEP-SWEPCO, and the eGRID database. The economic dispatch, or rank ordering, of facilities was based upon fuel costs as a measure of marginal costs. Per information provided by AEP-SWEPCO, imports to the system were assumed to be 15 percent of total load.

Despite being subject to all the limitations discussed in the previous section, this approach does present a generalized estimate of the opportunities for increased energy efficiency to reduce overall power generation and air emissions. More sophisticated power market modeling approaches could develop more detailed, and arguably more accurate, results. Nevertheless, the basic premise that more energy efficiency can lead to displaced generation, which in turn, can lead to lower air emissions, remains unchanged.

Power Control Area Marginal Dispatch Method

Art Diem from USEPA's State and Local Capacity Building Branch has developed an approximate regional marginal dispatch model that assesses emissions reductions in two stages. First, this method estimates the percentage contribution of each relevant Power Control Area (PCA) to the electricity consumption of the region where the demand reductions occur. These estimates are developed using data on the power flows between all the PCAs in both directions. Second, this method develops estimates for the share of generation from each power plant based on the total power generated in that PCA. Combining the two stages yields a percentage contribution to the target region for each power plant within all contributing PCA's.

Plant Average Method

This calculation approach relied strictly on the eGRID database using simple averages of the emissions coefficients of different sets of power plants from the calendar year 2000 data (Source: eGRID 2002PC). The generation reductions are assumed to be shared equally among all power plants in these different sets of units. The following are the different sets of power plants for which emissions rates were averaged. Data was compiled for NO_x emissions on an annual average and for the ozone season. There may be other methods of dividing the eGRID data but these seemed the most appropriate for calculating emission reductions for Shreveport-Bossier City MSA.

- US National
- NERC Region (SPP)
- NERC Sub-Region (SPP - South)
- State-level (Louisiana)
- State and primary power provider for Shreveport[3](Louisiana and AEP)
- Electric Generating Company (SWEPCO)
- Power Control Area (AEP West SPP/PCA)
- Local Plants in the City of Shreveport and the Caddo Parish
- Local Plants Supplying Shreveport[4]

The emissions rates were calculated directly from the eGRID database and multiplied by the guaranteed annual and monthly load reduction of the 20-year energy efficiency contract. Monthly load demand/reduction estimates are not currently available so the monthly load reduction was calculated by dividing the guaranteed annual reduction by twelve. Johnson Controls, Inc. has agreed to provide monthly load profile data, but the monthly load demand profiles were not available at the time of publication.

---

[3] Per telephone discussions in February 2004 between RJ Robertson of the Southwestern Electric Power Company (SWEPCO) and Adam Chambers of NREL, American Electric Power (SWEPCO's parent company) supplies all of the electricity consumed by the city of Shreveport. This was confirmed through subsequent telephone conversations between David Dismukes of LSUCES, Louis McArthur of Louisiana DEP and Adam Chambers

[4] Relies on LSUCES load distribution data and weighted eGRID emission factors.

Results

Table 1 shows that emissions coefficients range from a low estimate of 1.95 lbs/MWh to a high value of 4.63 lbs/MWh. The lowest emissions impact estimate considers only two natural gas fired plants within the Caddo Parish. The highest calculated values were ozone season estimates obtained from the average of the plants in the State of Louisiana. These extremes serve as upper and lower limits for all of the emission estimation methods in this study.

Using the upper and lower emission estimates mentioned above, we calculated the maximum and minimum emission reductions that could be achieved by the City of Shreveport and Johnson Controls, Inc. energy conservation contract. Relying on the firm contracting obligation of 9,121,335 kWh/yr and the upper and lower bound of 1.95 lbs/MWh and 4.63 lbs/MWh we estimated the lower and upper emission reduction bounds to be **8.89** and **21.12** tons of NO_x/yr respectively. In the units used in SIP planning, these figures are equivalent to **0.024 - 0.058 tons per day**.

More Detailed Comparison Across Methods

Table 2 gives the range of estimates developed for the emissions coefficients used in developing the ozone season impacts summarized in Table 1 of the report. In particular, it shows all the variants of the plant average method, and compares those values to the emissions coefficients of the two other methodologies.

Table 2: Comparison of Different NOx Emission Factors Developed for Assessing EE Projects in Shreveport, Louisiana (Year of Study – 2000)

	Region	Total Tons	Average NOx (Output Rate lbs/MWh)	O3 Season NOx (Output Rate lbs/MWh)[5]
Plant Average Method	National	5644353.87	2.96	
	O3 Season	2431268.00		2.92
	NERC Region - SPP	354187.80	3.79	
	O3 Season	164189.51		3.73
	NERC Sub-Region – SPP South	219962.16	3.42	
	O3 Season	103484.54		3.38
	State – La.	118263.58	2.54	
	O3 Season	55812.95		2.59
	State and Power Provider – Louisiana & AEP	11501.24	4.57	
	O3 Season	5107.37		4.63
	Electric Generating Company – SWEPCO	40310.00	3.45	
	O3 Season	18674.85		3.39
	Power Control Area	73796.33	3.70	
	O3 Season	35478.18		3.67
	Local Plants Supplying Shreveport - Contact AEP		3.72	
	O3 Season			3.79
	Local Plants in Shreveport and Caddo Parish	632.77	1.95	
	O3 Season	488.07		1.95
Power Control Area Method	Marginal Dispatch Modeling		3.47	
	O3 Season			3.37
LSU Modeling Approach	David Dismukes and LSU Methodology	35,169	2.95	
	O3 Season	17,967		2.85
	AVERAGES		3.32	3.30

The average of all emission factors for the ozone season, shown in table 1, is 3.30 lbs/MWh. The average emission factor aligns most closely with the NERC Sub-Region emission factors calculation methodology and the PCA Marginal Dispatch Modeling Approach. Although these two are nearest the average emission value, all of the emissions factors are within the range 3.3 ± 1.35.

Alternative Assumptions

Making the assumption that **ALL** energy conservation will occur during the ozone season (which is not overly ambitious for Shreveport, LA)[6], the emission reduction increases to a range of **0.0486- 0.1154 TPD**. These estimations are further outlined in **Table 3** below.

Table 3: Average, Upper, and Lower NO_x Emission (Estimates)

Emissions Reduction	**Annual Savings**	**O3 Season Month**	**O3 Season Day**
Average (3.30 lbs/MWh)	30100.41	2508.37	82.47
in tons	**15.05**	**1.25**	**0.04**
Conservative Ef (1.95 lbs/MWh) in lbs	17786.60	1482.22	48.73
in tons	**8.89**	**0.74**	**0.02**
Least Conservative Ef (4.63 lbs/MWh) in lbs	42231.78	3519.32	115.70
in tons	**21.12**	**1.76**	**0.06**

The above emission reductions are relatively small in SIP planning terms, so the next question to be answered is "What quantity of energy savings is necessary to realize a 1 TPD reduction in emissions at the upper and lower bounds?" Achieving this emissions reduction would require an energy savings in the range of **432 – 1,026 MWh/day** to reduce 1 ton of NO_x in the Shreveport – Bossier City area, an **annual energy savings of 158 – 374 GWh.** At the project level, this magnitude of energy savings are unlikely but an aggregation of several municipal projects, for example those arising in response to a policy, could achieve such a significant emissions reduction.

Summary and Recommendations on Methods for Use in SIPs

This project represents a first attempt to accurately quantify displaced emissions from grid-connected energy efficiency measures for SIP purposes. We applied three different methods to quantify displaced emissions of NO_x. We identified a lower bound of 0.024 tons per day and an upper bound of 0.058 tons per day, with 95 percent confidence that the value lies between 0.035 and 0.045 tons per day. We also estimated reductions of other pollutants, the ancillary benefits of a NO_x emissions reduction measure.

Based on the experience of this project, we recommend that SIP decision-makers may wish to consider the consistency among different estimation methods, and the size of the project in determining what types of analysis serve as sufficient basis for quantification of displaced emissions. In this project, the relatively narrow 95 percent confidence interval shows that the results are consistent across the different methods. The small project size also contributes to our judgment that this analysis is a sufficient basis for SIP decision-makers to select the quantity of displaced emissions that will be attributed to these energy efficiency measures within the Louisiana SIP.

Assessing the permanence of the emissions reduction is another key issue. In the Shreveport project, there is a high level of certainty that permanent emissions benefits will result from this project due to the longevity and nature of the Performance Contract between Johnson Controls, Inc and the City of Shreveport. The 20-year Performance Contract provides details of the expense, duration, and magnitude of the lighting system upgrades, mechanical system upgrades, control system upgrades, water conservation upgrades, and other miscellaneous upgrades, and guarantees the energy performance of the overall system. A high level of project certainty and permanence is required for SIP planning purposes.

Because this was one of the first projects to quantify EE emissions benefits for use in a SIP, there was some uncertainty as to how the estimation methods would compare. The comparison of the methods discussed above suggests that **plant average** methodology provides an adequate level of detail for calculating the emission benefits of small projects, and we suggest a threshold of **500 MWh/0_3 Season Day**. The plant average approach provides a method that public agencies can use with at a modest cost in staff resources. Above this or another agreed-upon threshold, more accurate (and expensive) modeling approaches such as **Power Control Area Marginal Dispatch Modeling Approach** and the **LSUCES Economic Dispatch Modeling Approach** may be required.

Appendix 1: Unifying Framework for Comparing Methodologies

This section gives a more precise characterization of each method used to develop estimates.

Basic Framework

As mentioned, the three methods described here represent three different ways of estimating the fraction of the conserved electricity to be allocated to different power plants. That is, all three methods can be represented by Equation 1.

Equation 1

$$T = S \bullet \sum_k w_k E_k$$

where
T is the emission reduction
S is the energy savings,
w_k is the weight that gives the fraction of the energy savings allocated to the k-th plant,
E_k is the emission factor of the k-th plant

The summation is then the average emission factor of the plants offset by the electricity conservation measure. In principle, k can be thought of as ranging over all the power plants in the U.S. system, in which case some of the w_k may be zero. In all three methods, the plant emission factors are taken from the EGRID database.

Description of the Three Methods in Terms of this Framework

Power Control Area Marginal Dispatch Modeling Approach

This method proceeds in two stages. It first uses information about the exchanges of power between power control areas (PCAs) to determine the shares of the generation from each PCA in the electricity consumed in each PCA. This first stage of the analysis uses the shares of the generation of all PCA's in the PCA where the conservation occurs, say PCA_1.

Equation 2

$$PCA_1 = \sum_k s_{k1} PCA_k$$

where s_{k1} gives the fraction of the consumption in PCA_1 that comes from the generation in PCA_k.

The second stage combines the shares s_{k1} with estimates of the probability that each plant will be on the margin, and thus be offset by reduced demand. This estimation procedure yields p_j, the probability that plant j is on the margin. The pj and sk1 can then be combined to yield the weights wk in equation 1:

Equation 3

$$w_k = \sum_j s_{j1} \sum_{i \in PCAj} p_i E_i$$

Plant Average Method

The plant average defines the weights w_k as follows

Equation 4

$$w_k = \frac{G_k}{\sum_k G_k}$$

where G_k is the annual energy output of the k-th plant. In this case, the w_k is simply the generation share. The variants on this method allow k to range across different subsets of US power plants.

Economic Dispatch Method

The LSUCES economic dispatch model is based upon the AEP-SWEPCO control area. The model economically dispatches each of the AEP-SWEPCO generating facilities on an hour-to-hour basis. Under an optimal economic dispatch, generators are essentially ranked, or “stacked” based upon their costs, with the lowest cost unit being utilized first, and the highest cost unit being utilized last. The LSUCES model conducted this dispatch for each hour of the year under a 2000 test year. The LSUCES economic dispatch model relies on load contributions (in percentages) from each plant supplying electricity to Shreveport. Load contribution data and the corresponding supply percentages that were consumed by the Shreveport Metropolitan Area were provided by AEP.

Appendix 2: Early Action Compact Progress Report

Shreveport-Bossier City Metropolitan Statistical Area

Shreveport-Bossier City Metropolitan Statistical Area

Early Action Compact Progress Report

December 31, 2003

Prepared for
U.S. Environmental Protection Agency
Region 6
Dallas, Texas

Contents

Attachments

Tables

1. Introduction

The U.S. Environmental Protection Agency (EPA) requires signatories of Early Action Compacts (EAC) to prepare a progress report every six months that describes the progress made to date against the EAC milestones. This progress report is based on the guidance presented in the *Memorandum from Lydia Wegman to EPA Air Directors in Regions III, IV, VI, and VIII, April 4, 2003.* According to this memorandum, the December 2003 progress report, at a minimum, should include the following:

- Document progress in developing the stakeholder process;
- Report progress on evaluating and selecting emission reduction measures for the local control strategy;
- Describe public outreach activities, and
- Provide and update on modeling/technical planning activities.

A brief description explaining the progress to date of each of these processes and activities is described below. A list of current stakeholders is included as Attachment A.

2. Stakeholders Process

In November 2000, an advisory committee, named the Greater Shreveport Clean Air Citizens Advisory Committee (CACAC), was established by the Mayor of Shreveport, consisting of representatives from various local stakeholder groups. The CACAC was tasked with assessing air quality issues in the Shreveport-Bossier City MSA, developing a set of "recommendations for maintaining and improving local air quality, with an emphasis on ozone issues," and reporting its findings to the local city and parish governing bodies. The members of the committee include representatives of the medical profession, academia, industry, utilities, the Greater Shreveport Chamber of Commerce, citizens groups, regional planning bodies, and local governments.

Since June 2003, the CACAC has met monthly from October through December. The purpose of these meetings has been to:

- Review the progress of the photochemical modeling analysis and to discuss the results of base case and 2007 future base case modeling, and
- Review and refine the list of local control measures developed in June 2003 based on the results of the photochemical modeling results.

In addition to CACAC participation, EPA and Department of Environmental Quality (DEQ) have also attended these monthly meetings.

3. Shreveport-Bossier City MSA Background Air Quality

The Shreveport-Bossier City MSA is currently in attainment for all pollutants with established NAAQS. In fact, as of 2002, the MSA has also achieved attainment with the new eight-hour average ozone NAAQS.

Eight-hour average ozone concentrations in the Shreveport-Bossier City MSA have improved over the past three years (2001-2003) as shown in Table 1. The MSA achieved attainment status for the eight-hour average ozone NAAQS in the summer of 2002. The preliminary monitoring data for 2003 shows a continued downward trend in the eight-hour average concentrations at both monitoring locations. The design values for eight-hour average ozone concentrations (defined as the three-year average of the annual 4th highest daily maximum eight-hour average ozone concentration) for the Dixie and Airport sites are 77 parts per billion (ppbv) and 79 ppbv, respectively, for the period ending in 2003.

Table 1. Eight-Hour Average Ozone Maximum Concentrations for 2001-2003

Location	Year	8-Hour Daily Max. Concentrations (ppbv)				Avg. 4th Highest Conc.[1]	No. Days >=85 ppbv
		1ST	2nd	3rd	4th		
Caddo (Dixie)	2001	85	83	78	77	84	1
	2002	80	79	77	75	79	0
	2003	86	82	80	80	77	1
Bossier (Airport)	2001	92	89	85	84	90	3
	2002	80	77	76	76	84	0
	2003	93	82	80	77	79	1

[1]Average 4th highest concentration is the average of the annual fourth highest eight-hour ozone averages over a three-year period. Year given is the ending year of the three-year period for this summary statistic.

Data Source: Louisiana Department of Environmental Quality.

Source: Early Action Compact for the Shreveport-Bossier City Metropolitan Statistical Area Comprising Bossier, Caddo, and Webster Parishes, December 12, 2002 and Shreveport-Bossier City MSA Clean Air Citizens Advisory Committee Meeting, October 1, 2003.

4. Candidate Control Measures Progress

The objective of the EAC is to develop and implement local/regional emissions reduction strategies as may be necessary to ensure the Shreveport-Bossier City MSA will continue to meet the eight-hour average ozone NAAQS in the future. The Shreveport-Bossier City MSA is unique among most EAC participants in that it has been designated by EPA as in attainment for the eight-hour average ozone NAAQS[1]. Therefore, unlike nonattainment areas, there are no defined levels of reductions necessary to achieve attainment. In addition, the photochemical modeling analysis results indicate the EAC MSA will be in attainment of the eight-hour ozone standard in 2007. The 2007 base case future modeling results indicate that eight-hour ozone

[1] Green, R.E., U.S. EPA, Regional Administrator (6RA), Letter to M. Foster, Jr., Governor of Louisiana, Louisiana Eight-hour Ozone NAAQS Attainment Status, December 3, 2003.

design values will be 79 ppb and 84 ppb at the Dixie and Airport monitoring stations, respectively. Both these design values are below the 85 ppb eight-hour ozone standard. Furthermore, the latest three years of eight-hour ozone monitoring data shows that the Shreveport-Bossier City MSA is currently well below the eight-hour ozone standard (See Section 3). [2]

In light of the area's current (as well as modeled future) attainment status, the MSA has had preliminary discussions with both EPA and DEQ regarding the appropriate approach to take in developing our Air Quality Improvements Plan (AQIP). The AQIP would include a list of control measures that the City and private industries will commit to implement by December 31, 2005, as discussed more fully below.

The AQIP would also contain a "contingency" provision, which would further require that the CACAC reconvene in the event that eight-hour ozone design value would reach a "trigger" value, such as 83 ppb, at some point in the future during the term of the EAC. DEQ is receptive to this approach. Should the ozone reduction trend reverse and we see an increase in eight-hour concentrations, 2007 control measures modeling simulations indicate that a 10 percent reduction in nitrogen oxide (NO_x) alone or NO_x and volatile organic compounds (VOCs) combined will reduce the eight-hour ozone design value by 2 ppb (82 ppb). The 2007 modeling results also indicate that NO_x emissions from area and non-road sources and elevated point sources are the largest local source-category contributors to the future ozone concentrations in the four-parish area. The CACAC would use this information as a starting point for developing and implementing new emissions control measures should such be needed. However, rather than commit to particular "contingency" control strategies at the outset of the AQIP, the CACAC believes it would be more prudent to keep all "contingency" control measure options open at this point so that the particular circumstances that trigger a contingency (as well as ongoing/updated emissions inventories and modeling analyses) are properly taken into account in the "contingency" control measure selection process.

In addition to the control measures agreed upon in the Ozone Flex Agreement and those federally mandated (e.g., low sulfur gasoline), the other control measures likely to be contained in the AQIP for implementation by the end of 2005 include:

- Installation of intelligent transportation systems to synchronize and improve traffic signal operations at 27 intersections by the end of 2003, with additional 35 intersections by the end of 2004.
- General Motors plant in Caddo Parish installed new VOC abatement system as part of their new product line in October 2003.

[2] The modeling analysis for 2007 is based upon the 2001 design values for the local monitoring sites, because the 2001 values cover the time period of the particular episodes which were selected for the modeling process. As mentioned, the design values for these sites have since decreased significantly, as shown in Table 1. However, even though the future case modeling analysis is based on the higher 2001 values rather than the more current (and significantly lower) values, the analysis still shows the area to be in attainment in 2007 (79 and 84 ppb at the Dixie and Airport sites, respectively).

- A local utility company has submitted a permit modification to reduce NO_x emissions from Prevention of Significant Deterioration (PSD) levels to below major source levels at a power plant located in the Shreveport-Bossier City area. The reduction of NO_x emissions permit commitments should be in place by the end of 2005.

- Installation of a gas collection system on the City of Shreveport's landfill. The landfill gas is piped to a local General Motors facility for use as boiler fuel. The pipeline began operations in November 2003.

- City of Shreveport plans to enter into a 20-year contract in 2004 with Johnson Controls, Inc. for the purpose of installing energy conservation equipment in 33 city buildings.

Table 2 presents a summary of these control measure commitments, preliminary estimates of their potential emissions reductions, implementation dates and geographic area where these measures will be applied. The City and its consultants will continue to work on quantifying emissions reductions for the recommended control measures commitments. Estimated emissions reductions will be included in the 2007 control measures and 2012 maintenance modeling analyses to be completed by late January 2004.

5. Public Outreach Programs

As reported in the June 30th Progress Report, the area's first "Clean Cities" program stakeholder meeting was held on June 24th, with over 45 representatives from local fleets and fuel providers in attendance. Officials from the U. S. Department of Energy and the Louisiana Department of Natural Resources gave presentations on alternative fuel vehicles and how the program works.

After the meeting, a planning group was formed consisting of nine volunteers from the stakeholder group, to create the structure of the coalition. Since then, three subcommittees have been formed (research & planning; public awareness; and fleets and fuel infrastructure), with the chairman of each, along with Wes Wyche, serving as the Steering Committee for the coalition. The committee has reached an agreement with the LSU-S Center for Business and Economic Research for the development of an inventory of all private and public fleets in the four-parish area (Bossier, Caddo, DeSoto and Webster). The Committee is also coordinating the purchase of a "hybrid" bus by the local bus transit authority (SPORTRAN) through EPA's Supplemental Environmental Project (SEP) program, which will involve a major public awareness campaign to promote the use of alternative, cleaner-burning fuels in the local area.

As discussed earlier, the CACAC has continued to meet on a regular basis throughout the period, and these meetings are always open to the public. The City of Shreveport issued a press release on December 5 to announce the local attainment designation and discuss local planning efforts. Several radio interviews were given to the local news radio station during the period concerning the status of the local ozone program and the EAC.

Table 2
Shreveport-Bossier City MSA Early Action Compact
Proposed Local Control Measures Commitments

Id. No.	Control Measure Category	Proposed Control Measures	Potential Emission Reductions	Implementation Date	Geographic Area
A. Public Awareness Activities					
A-1*	Ozone Awareness Program	This program will build on efforts already undertaken locally, which have included media events, stakeholder meetings, and development of air quality pages included in the City of Shreveport web site. Web site that features information on local air quality, local measures being taken to maintain and improve air quality, the Ozone Action Program, health and welfare effects of ozone pollution, the Air Quality Index, ozone forecasting, and many relevant links that will include EPA, DEQ and DOE Clean Cities web sites.	--	May 2003	Caddo, Bossier and Webster Parishes
A-2*	Ozone Action Program	The Shreveport-Bossier City Ozone Action Program (OAP) is a voluntary ozone reduction and public education program administered on a seasonal basis (May - September) by the City of Shreveport Department of Operational Services through the Clean Air Citizens Advisory Committee (CACAC). The program will consist of two basic facets - a seasonal facet, where participants use measures/actions through the ozone season; and an episodic facet, where participants employ measures or take actions on days predicted to have elevated ozone levels (i.e., Ozone Action Days).	--	May 2003	Caddo, Bossier and Webster Parishes
B. Commute/Transportation Options					
B-1	Traffic signals synchronization	**NOx and VOC:** Synchronizing or improving traffic signal operations reduces vehicle delay and congestion, which reduces air pollution, fuel consumption, and vehicle operating costs, and improving traffic flow through intersections. Since 2000, 27 intersections have been been upgraded with improved traffic signal operations, and another 35 intersections are planned to be upgraded in 2004.	**NOx:** 0.002 tons/day[1]	2002-2004	Caddo and Bossier Parishes
C. Stationary Source Measures					
C-1*	Specific emissions reduction commitments from local commercial/industrial facilities	Contact major industrial sources of emissions in the Shreveport-Bossier City MSA to determine if there are any new emission control measures that any of these sources might formally agree to implement as contingency measures in the event of a violation of the eight-hour average ozone NAAQS. If necessary, establish new emission control measures that will be enforced in the event of a violation of the eight-hour average ozone NAAQS.	--	Contigent upon exceeding 8-hour ozone standard	Caddo, Bossier and Webster Parishes
C-2	General Motors New Product Line Abatement System	**VOCs:** On October 7, 2003, General Motors added a new abatement system as part of their new product line. It is anticipated that VOC emissions should be reduced by 400 to 500 tons per year.	**VOC:** 1.1 - 1.4 tons/day	2003-2005	Caddo Parish
C-3	Local Utility Company Modifications	**NOx**: A permit modification was submitted to reduce emissions from above Prevention of Significant Deterioration (PSD) levels to below major source levels at a power plant located in the Shreveport-Bossier City area.	**NOx:** 2.56 tons/day **VOC:** 0.135 tons/day **CO:** 1.14 tons/day	2005	Caddo and Bossier Parishes
D. Mobile Source Measures					
D-1*	Low Sulfur Gasoline	**NOx:** The Federal Tier 2 program will require low sulfur gasoline (30 ppm) by calendar year 2006, which will reduce NOx.	**NOx:** 5.7-11% reduction[3]	2006	Caddo, Bossier and Webster Parishes

Table 2
Shreveport-Bossier City MSA Early Action Compact
Proposed Local Control Measures Commitments

Id. No.	Control Measure Category	Proposed Control Measures	Potential Emission Reductions	Implementation Date	Geographic Area
D-2	Alternative Fueled Buses	**NOx and VOC:** Fuels other than gasoline or diesel, including compressed or liquified natural gas, methanol, ethanol, propane and electricity. City of Shreveport plans to purchase a hybrid (diesel and electric) bus.	**NOx:** 0.008 tons/day **VOC:** 0.011tons/day[2]	2005	Caddo Parish
D-3*	DOE Clean Cities Program	Shreveport-Bossier City MSA participates Clean Cities Program sponsored by the U.S. Department of Energy (DOE). The Clean Cities program supports public and private partnerships that deploy alternative fuel vehicles (AFVs) and build supporting infrastructure.	**NOx:** 0.00008 tons/day **VOC:** 0.00008 tons/day [2]	2003	Caddo and Bossier Parishes
E. Other Measures					
E-1	Landfill Gas Resource Project	**VOC:** City of Shreveport has installed a gas collection system on the City landfill. The landfill gas is piped to the local General Motors (GM) plant for use as boiler fuel. The pipeline to GM began operations in November 2003.	To be determined[4]	November 2003	Caddo Parish
E-2	Energy conservation programs	**NOx:** City of Shreveport has entered into a 20-year contract in 2003 with Johnson's Controls, Inc., for the purpose of installing energy conservation equipment in 33 city buildings. Energy conservation measures not only decrease NOx emissions, but also can have significant reductions in other pollutants, such as sulfur dioxide, VOCs, air toxics, and carbon dioxide. These various efficiency measures when combined have the potential to add up to significant energy savings and emissions reductions.	To be determined[4]	2004	Caddo Parish

Note: * Denotes those control measures recommended in the Ozone Flex Agreement for the Shreveport-Bossier City MSA.

Sources:

[1]Draft Report Emission Inventories and Potential Emission Control Strategies For Ozone Early Action Compact Areas in Tennessee, The University of Tennessee Department of Civil and Environmental Engineering, April 13, 2003.

[2]CMAQ – Summary Review of Costs and Emission Reductions for 24 CMAQ (Congestion Mitigation and Air Quality) Projects, September 15,1999.

[3]EPA 1999 = U.S. EPA, EPA's Program for Cleaner Vehicles and Cleaner Gasoline, EPA 420-F-99-1, December 1999.

[4] CACAC is currently working with the Lousiana Department of Natural Resources to quantify expected emission reductions from these measures.

6. EAC Milestones Progress

The Shreveport-Bossier City MSA is committed to achieving the milestones and requirements of the EAC. The City of Shreveport hired Camp Dresser & McKee, Inc. (CDM) and SAI/ICF Consulting (SAI) in April 2003 to complete the technical analyses, and help in the preparation of plans, reports and other milestone submittals. Since the June 30th Progress Report, CDM and SAI worked with EPA to obtain approval of the Quality Assurance Project Plan and Photochemical Modeling Protocol (QAPP) that was submitted to U.S. EPA Region VI on May 30, 2003. The approval process took an additional six to eight weeks longer than anticipated; however, the base case and future base case emissions inventory and modeling are complete and initial future control modeling has also been performed. As mentioned, the MSA has been designated as an attainment area for the 8 hour standard, and modeling is demonstrating continued attainment through 2007 with no additional local controls being imposed. Nonetheless, it is anticipated that some additional future control measure modeling will be performed in January, along with the 2012 maintenance modeling, in order to more definitively quantify the effects of any measures that may be listed in the AQIP.

ATTACHMENT A
LIST OF STAKEHOLDERS

City of Shreveport
City of Bossier City
Caddo Parish
Bossier Parish
Webster Parish
CACAC members:
- Dr. Peter Boggs (local allergy/asthma specialist)
- David Burroughs (General Motors)
- Brian Bond (AEP-SWEPCO, local electric utility)
- Laura Guthrie (Centerpoint Energy, local gas utility)
- Dr. Kimberly Jones (LSU School of Medicine, Dept. of Pediatrics)
- Wes Wyche (City of Shreveport)
- Kent Rogers (Northwest Louisiana Council of Governments)
- Bob Molloy (interested citizen)
- Lola May (Queensborough Neighborhood Association)
- Randy Lucky (Caddo Parish Commission)
- Bill Altimus (Bossier Parish Police Jury)
- Lorenz Walker (City of Bossier City)

Ozone Action Plan Participants:
- AEP – SWEPCO
- Barksdale Air Force Base
- BASF Corporation
- Beaird Industries
- Bossier Parish School Board
- Caddo Parish School Board
- Centenary College
- Centerpoint Energy
- City of Bossier City
- City of Shreveport
- Doctors Hospital
- Eagle Distributing
- Frymaster Corp.
- General Electric Co.
- General Motors
- International Paper
- Kansas City Southern Railroad
- La. Department of Environmental Quality (NW Regional Office)
- Libbey Glass
- LSU – Shreveport
- PrintPack, Inc.
- SPORTRAN (Shreveport Transit Management)

References

USEPA, 2004. *Guidance on State Implementation Plan (SIP) Credits for Emissions Reductions from Energy Efficiency and Renewable Energy Measures,* Air Quality Strategies and Standards Division Office of Air Quality Planning and Standards and Global Programs Division, Office of Atmospheric Programs.

Shreveport-Bossier, Louisiana, 2003. Shreveport-Bossier City MSA Early Action Compact Progress Report, December 31. Available on the City of Shreveport Web site at http://www.ci.shreveport.la.us/AirQuality/Shreveport_Appendix%20A_FINAL.pdf

Shreveport-Bossier, 2003b.

REPORT DOCUMENTATION PAGE	*Form Approved* *OMB No. 0704-0188*

1. REPORT DATE *(DD-MM-YYYY)* March 2005	**2. REPORT TYPE** Technical Report	**3. DATES COVERED** *(From - To)*

4. TITLE AND SUBTITLE Comparisons of Methods for Estimating the NOx Emission Impacts of Energy Efficiency and Renewable Energy Projects: Shreveport Louisiana Case Study	**5a. CONTRACT NUMBER** DE-AC36-99-GO10337
	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S) A. Chambers, D.M. Kline, L. Vimmerstedt, A. Diem, D. Dismukes, and D. Mesyanzhinov	**5d. PROJECT NUMBER** NREL/TP-710-37721
	5e. TASK NUMBER 6020.1060
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) National Renewable Energy Laboratory 1617 Cole Blvd. Golden, CO 80401-3393	**8. PERFORMING ORGANIZATION REPORT NUMBER** NREL/TP-710-37721
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	**10. SPONSOR/MONITOR'S ACRONYM(S)** NREL
	11. SPONSORING/MONITORING AGENCY REPORT NUMBER

12. DISTRIBUTION AVAILABILITY STATEMENT
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161

13. SUPPLEMENTARY NOTES

14. ABSTRACT *(Maximum 200 Words)*
This is a case study comparing methods of estimating the NOx emission impacts of energy efficiency and renewable energy projects in Shreveport, Louisiana.

15. SUBJECT TERMS
NOx; emissions; Shreveport; Louisiana; energy efficiency; renewable energy; air quality; State Implementation Plan (SIP);

16. SECURITY CLASSIFICATION OF:			**17. LIMITATION OF ABSTRACT**	**18. NUMBER OF PAGES**	**19a. NAME OF RESPONSIBLE PERSON**
a. REPORT	**b. ABSTRACT**	**c. THIS PAGE**			
Unclassified	Unclassified	Unclassified	UL		**19b. TELEPHONE NUMBER** (*Include area code*)