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# Model State Implementation Plan (SIP) Documentation for Wind Energy Purchase in State with Renewable Energy Set-Aside

## Execution through November 30, 2004

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*White River Junction, Vermont*

***Subcontract Report***
**NREL/SR-500-38075**
**May 2005**

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Prepared under Subcontract No(s). LEE-4-44827-01

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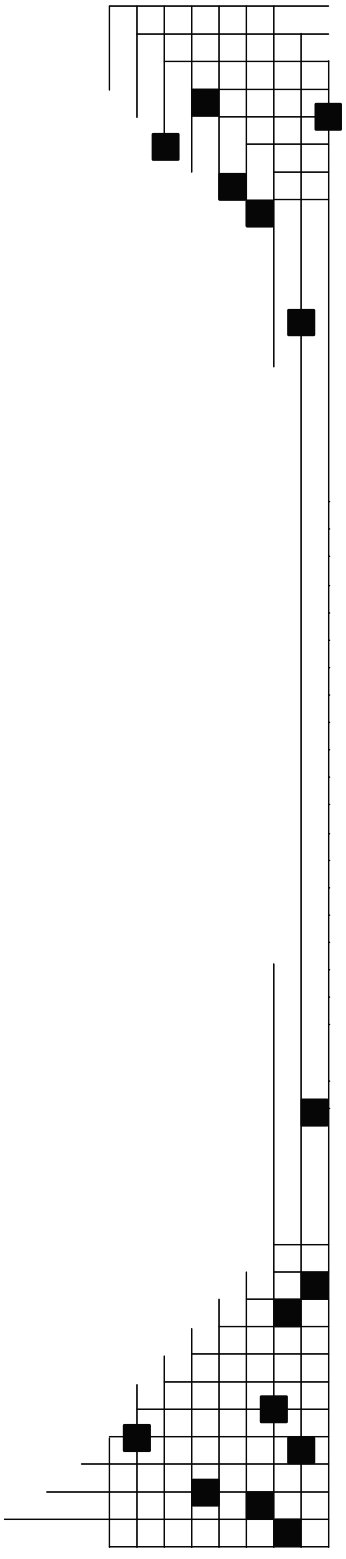

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## PREFACE

This model documentation is designed to assist State and local governments in pursuing wind energy purchases as a control measure under regional air quality plans. It is intended to support efforts to draft State Implementation Plans (SIPs), including wind energy purchases, to assure compliance with the standard for ground-level ozone established under the Clean Air Act.[1]

Electricity generated from zero-emission wind power can help States and municipalities improve air quality and reduce pollution compliance costs. This strategy involves the use of wind energy to displace electric generation from coal-, oil-, and natural-gas-fired plants, thereby reducing conventional air pollutants, such as nitrogen oxides (NOx), as well as greenhouse gas emissions (e.g., carbon dioxide). New wind energy plants can play an important role in reducing air emissions and spurring a transition from fossil-fuel-fired plants to emission-free wind energy.

In addition, wind power often is less expensive than other control measures in achieving equal levels of emission reductions. As a result, wind power often can help a State or municipality reduce the pollution control costs borne by taxpayers in air quality non-attainment areas.

Under guidance issued by the U.S. Environmental Protection Agency (EPA) in August 2004, States and municipalities can receive emission reduction credit in their SIPs for wind power purchases that reduce air emissions and help achieve attainment of the National Ambient Air Quality Standard for ozone.[2] Model SIP documentation is available to assist States in achieving this objective.[3]

In States with NOx emissions "cap and trade" programs, the EPA guidance generally will require the retirement of NOx allowances by the State when the renewable generation comes on line. As a result, the EPA guidance is particularly relevant to States that have adopted renewable energy set-asides as part of their NOx emissions trading programs. These States include Indiana, Maryland, Massachusetts, New Jersey, New York, and Ohio.[4] The renewable set-asides allow the assignment of NOx allowances to wind developers, States, or municipalities, thus providing a pool of NOx allowances that can be retired to achieve SIP credit.

The EPA guidance and NREL documentation is also relevant to States that have not adopted renewable energy set-aside programs but are interested in promoting clean air

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[1] Ground level ozone is formed when volatile organic compounds combine with nitrogen oxides in the presence of sunlight during hot, stagnant, summer days

[2] See www.epa.gov/ttn/oarpg/t1/memoranda/ereseerem_gd.pdf for a copy of the EPA guidance

[3] See www.windpoweringamerica.gov/sips

[4] See www.eandeclearinghouse.com for the regulations implementing the NOx renewable energy set-aside in each of these States

with wind energy purchases. However, many of these States may need to consider changes to their NOx emissions trading regulations to achieve SIP credit. The regulatory changes generally are needed because most of the current regulations in these States only allow the assignment of NOx allowances to fossil fuel generating sources. As a result, these States often do not have a pool of allowances to assign to renewable energy generators.

The air quality improvement strategy embodied in this document is particularly valuable to the States in the Midwest and East that are plagued by interstate transport of NOx emissions from fossil-fuel-fired power plants in upwind areas.[5] New wind energy plants in upwind areas can play an important role in spurring a transition from fossil-fuel-fired electric generation to emission-free wind energy and other renewable energy generation sources.

This model documentation relies heavily on the Regional Wind Purchase portion of the Plan to Improve Air Quality in the Washington, DC-VA-MD Region, dated February 19, 2004.[6] The Metropolitan Washington Air Quality Committee (in cooperation with environmental officials from Maryland, the District of Columbia, and Virginia, and representatives from nine counties and several cities) prepared this SIP to meet the 1-hour ozone standard in the Washington, D.C.-VA-MD non-attainment area. The model documentation refines the February 19, 2004 SIP to reflect guidance issued by the EPA on August 5, 2004: Guidance on SIP Credits for Emission Reductions from Electric-Sector Energy Efficiency and Renewable Energy Measures.[7]

Every effort has been made to conform this model language to the August 5, 2004 EPA guidance document. However, it should be noted that neither the EPA guidance nor this model documentation imposes binding requirements, and EPA Regions retain full discretion to review proposed SIP submissions on a case-by-case basis. As stated in EPA's guidance, "any final decisions by EPA regarding a particular SIP measure will only be made based on the [Clean Air Act] statute and regulations in the context of [an] EPA rulemaking on a submitted SIP revision."[8]

In addition, the model documentation contains excerpts from the Montgomery County, Maryland Request for Energy Proposals (RFP), dated February 2004. This document was prepared by Ann Elsen of the Montgomery County Department of Environmental

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[5] U.S. Environmental Protection Agency, "Proposed Rule to Reduce Interstate Transport of Fine Particulate Matter and Ozone," 69 Fed. Reg. 4603, January 30, 2004

[6] See www.mwcog.org/environment/air Click SIP and pages 7-77-7-80 and Appendix J, pp. 7-71 to 7-76. The authors of this model documentation provided technical analysis and legal and policy support to local and State officials during the development of the draft DC-MD-VA SIP submission. The EPA issued a proposed regulation approving the SIP on December 23, 2004. 69 Fed. Reg. 76889

[7] U.S. Environmental Protection Agency, Memorandum from Brian McLean, Director, Office of Atmospheric Programs, and Steve Page, Director, Office of Air Quality Planning and Standards, to Regional Air Division Directors, August 5, 2004. See www.epa.gov/ttn/oarpg/t1/memoranda/ereseerem_gd.pdf

[8] Id., p. 2

Protection. These excerpts are included because the RFP is a key element of development of an integrated energy and air quality strategy involving the purchase of wind energy.

This model documentation also relies on an analysis conducted by Resources Systems Group and Environmental Resources Trust to quantify emission reductions occurring when additional wind power is placed on the grid. The initial RSG/ERT work in this area was funded by Clipper Windpower.

This model documentation focuses on the use of a wind purchase as a NOx emission control measure creditable in a SIP. However, there are other alternative mechanisms for including wind generation in a SIP. According to EPA's 2004 guidance, one major alternative is to consider wind generation as part of the State's projected baseline in its emissions inventory of NOx emissions from the electric-generating-unit sector.[9] Many of the concepts outlined in this model documentation will be useful in accounting for wind generation in the baseline emissions inventory.

The model documentation contained herein was developed by Alden Hathaway, Director of Clean Energy Programs, Environmental Resources Trust;[10] Dr. Colin High, Vice President, Resource Systems Group;[11] and Debra Jacobson, owner of DJ Consulting LLC. This work was conducted under contract (LEE-4-44827-01) to the National Renewable Energy Laboratory with funding provided by the U.S. Department of Energy's Wind Powering America Program.

[9] Id., p. 13. The SIP baseline consists of the current inventory of emissions in the SIP plus any assumptions regarding growth, or reduction in growth, of an industrial sector and its impact on emissions. If wind generation is considered to reduce emissions in the projected baseline, additional SIP credit should not be granted as a specific control measure (as set forth in this model) because the level of baseline emissions already has been lowered to account for the wind generation

[10] See www.ert.net for a description of Environmental Resources Trust

[11] See www.rsginc.com for a description of Resource Systems Group

## Regional Wind Purchase

Under this measure, **[local, State, Federal]** government agencies in the non-attainment area, including **[county A, city B, State agency C, etc.],** have committed to purchase a specific amount of kilowatt-hours (kWh) of wind energy per ozone season day. The government agencies will purchase the wind energy directly from a supplier or purchase renewable energy certificates (RECs) that assure that such wind energy is placed on the electric grid.[12]

## Source Type Affected

The measure affects certain **[local, State, Federal]** governments within the metropolitan **[insert name]** non-attainment area. The region is implementing this measure to reduce nitrogen oxide (NOx) emissions from coal-, oil-, or natural-gas-fired electric power generation.

## Control Strategy

This measure is envisioned as a **[region-wide]** action encompassing wind power purchases by Federal**,** State, and local governments, **[private industry and non-profit organizations]** within the Metropolitan **[insert name]** non-attainment area. The involved entities have signed long-term commitments with wind power distributors to assure that a fixed quantity of renewable power will be placed on the electric grid. The purchase of wind energy will result in the generation of additional wind energy above baseline amounts within a region that impacts the air quality of the **[insert name]** metropolitan area.

**[Insert name of jurisdiction]** has drafted a Request for Proposal (RFP) to be released in **[month and year]** to purchase **[insert amount]** kWh/yr from wind energy. The RFP will contain:

- A requirement that the wind purchase will result in the generation of additional wind energy above baseline amounts
- A requirement that the NOx emissions displaced by the wind energy purchase will result in a reduction of NOx emissions from fossil-fuel-fired generating units in an area upwind of the **[insert name]** metropolitan area
- A **[number]**-year term
- A reporting requirement indicating the actual amount of wind energy in kWh purchased during the ozone season and per year

[12] Renewable energy certificates (also known as RECs or "green tags") represent the unique and exclusive proof that 1 megawatt-hour of energy was generated from a renewable energy source and placed on the grid

- **[Optional -** The ability for other local and State jurisdictions to "ride" the contract**]**.

The State of **[Y]**'s NOx Reduction and Trading Program includes a provision that sets aside a portion of the State's total NOx allowance budget for renewable energy generation. The State will assign NOx allowances from its renewable energy set-aside to **[insert name]** County in an amount commensurate with the size of **[name]** County's **[insert amount]** kWh/year energy purchase. In addition, the State will require **[name]** County to retire such allowances from future use to assure reductions of ozone season emissions allowed under State **[Y's]** NOx Reduction and Trading Program. Under this specific approach, the wind energy supplier under the contract would not be eligible to receive any set-aside allowances associated with the county's energy purchase.[13]

**Implementation**

**[County, State]**

**[Insert name]** County has drafted an RFP and expects to select an energy supplier or a supplier of renewable energy certificates in the near future. The RFP includes a purchase of power for **[name]** County **[and the following other State, county, and city agencies: …]**

**Monitoring and Enforcement**

The State will provide evidence that it has assured the retirement of the designated amount of allowances from future use under the renewable energy set-aside. In addition, all jurisdictions and agencies participating in the wind power purchase program have committed to maintain copies of signed contracts and energy bills to verify the amount of wind energy purchases. They also will purchase wind energy from a certified supplier who can provide independent verification that the wind energy purchased is placed on the grid. This evidence will serve to validate the emission reduction credit included in the SIP and will be used to provide documentation for the region's **[month and year]** evaluation report to the EPA.[14]

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[13] The State also may structure the retirement of NOx allowances from a renewable energy set-aside in two other ways. The choice of a specific structure for the retirement of NOx allowances will depend on several factors, including the specific legal constraints set forth in the State's NOx trading statute or regulations and the location of the wind farm. Under the first alternative, the State could award the allowances to a wind developer on the condition that the wind developer retire the allowances from future use or transfer the allowances to a municipality for retirement from future use. Under the second alternative, the State could directly retire the NOx allowances from the State's renewable energy set-aside.

[14] The State and local governments may be required to provide some information on emission reductions at the fossil fuel generating plants backed down as a result of the increased wind power generation. The extent of such information required by EPA is likely to depend on a variety of factors, including the percentage of total emission reductions attributed to the wind energy purchase, the extent to which the wind purchase measure is included in a voluntary bundle with other voluntary control measures, and the extent to which the State has discounted its original estimate. For example, EPA is more likely to require a greater amount of emission reduction information if a large percentage of the SIPs total emission reductions are attributed to the wind energy purchase or the wind energy measure is not included as part of a voluntary bundle.

**Projected Reductions**

This program is expected to purchase **[amount]** megawatt-hour (MWh) of power annually, reducing **[amount]** tons per day (tpd) NOx during the ozone season.

**NOx Emissions Calculations**

Quantification of NOx emission reductions resulting from the purchase of wind power and other renewable generation is an evolving area. Several methods have been used to calculate the emission displacement resulting from reduced fossil fuel generation in the power plant dispatch order. The methodology outlined below was developed by Resource Systems Group, Inc. (RSG) under contract with Environmental Resources Trust (ERT). The methodology has been used to estimate the number of NOx allowances that should be retired under the wind power purchase program.

The RSG/ERT methodology is a so-called "power plant dispatch methodology." In developing estimates of emission reductions resulting from the introduction of additional wind energy onto the grid, the analysis employs the following steps based on renewable plant specifications and existing plant dispatch scheduling for the past 12 months:

1. Obtain and analyze an estimated schedule of the wind power production for the summer ozone season (by time of day, week, and month) based on actual wind anemometer measurements and actual meteorological data
2. Obtain a list of the conventional generating units on demand (operating on the margin) from relevant utilities
3. Verify the list of conventional generating units operating at the margin (on demand) by reference to available Continuous Emission Monitoring (CEM) data; information on capacity factors; and actual generating records, on a sample basis
4. Determine the demand schedule priority (back-down order) of the conventional generating units based on information from: (a) the relevant electric utilities or the relevant Regional Transmission Organization (or Independent System Operator); (b) actual power plant dispatch ranking data (specific plants dispatched in order of economic costs); (c) recent past generation and CEM data
5. Obtain and analyze emissions data and generation data for displaced units from CEM for the relevant time periods during the summer ozone season to calculate emissions MWh
6. Determine net reductions in emissions attributable to wind generation by time period during the summer ozone season.

The methodology applied by RSG and ERT in this case is a prospective analysis, based on plant specifications and scheduling in **[name of grid]** over a recent 12-month period. This methodology estimates the NOx emission reductions resulting from the dispatch of a wind generation plant to meet variable load power demand compared to the average **[name of grid]** variable generator (a coal-fired, oil-fired, or natural gas plant). The analysis estimates **[X number]** of pounds (lbs.) of NOx/MWh reduced by dispatching the wind plant. This number is the average lb/MWh generated by **[name of grid]** variable

load plants in the period from **[insert date to insert date].** The annual and seasonal wind generation capacity factors of **[M]** percent and **[N]** percent, respectively, were developed by RSG. In assigning NOx emission reductions to the wind power portion of the voluntary measures bundle,[15] the State air agency has chosen to credit **[Z]**[16] percent of the reductions predicted using the RSG/ERT method. The **[Z]** percent reduction effectively reduces the assumed lb/MWh displaced to **[amount]** tpd.

A summary of the calculation methodology follows.[17] An example report from RSG/ERT is included in Appendix A.

Definitions:

cf = capacity factor
MW=megawatts
Generation reserved = wind turbine power generation capacity that must be available at any given time to meet the power demand under the contract

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[15] The SIP for the Metropolitan Washington Area included the "Regional Wind Purchase" as one of a variety of voluntary control measures, including both stationary and mobile source control measures, under a so-called "voluntary bundle." (See www.mwcog.org/environment/air SIP document, pp. 7-67 to 7-69 and 69 Fed. Reg. 76889, Dec. 23, 2004). This voluntary bundle of control measures was submitted under two EPA policy documents: (1) EPA's stationary source voluntary measures policy, and (2) EPA's mobile source voluntary measures policy.

The Maryland Department of Environment (MDE) developed this creative approach to provide greater flexibility in implementing innovative air pollution control measures. Since some voluntary measures may provide greater air pollution benefits than initially projected and others may provide lower benefits, the "voluntary bundle" allows the municipality to commit to a total overall reduction, even though individual component measures may vary from the initial projections.

EPA is currently refining its stationary-source voluntary control measures policy, so States should assure that they are aware of any updates. See www.epa.gov/ttn/oarpg/t1/memoranda/ereseerem_gd.pdf under Recent Additions for future updates.

[16] The State should consider a variety of factors in determining whether a discount rate should be applied and the amount of this discount factor. Such factors might include: (1) the rigor of the quantification method applied in calculating the prospective estimate of emission reductions, and (2) the extent to which the implementation of existing regulatory controls are expected to reduce NOx emissions below the levels estimated for those fossil fuel units expected to be backed down.

[17] The sample calculation is based on the data in the Maryland SIP and should be adjusted according to local circumstances. In particular, the number of pounds of NOx reduced per MWh of generation and the capacity factors will vary according to the specific facts of the proposed wind purchase, and the actual calculation should be modified to reflect these facts.

In addition, in the Maryland SIP, the local jurisdictions chose to credit half of the emission reductions predicted by the RSG/ERT methodology to assure a conservative estimate in the first application of renewable energy as a control measure. In future cases, each State should consider the appropriateness of any downward adjustment on a case-by-case basis.

$$\text{MW generation reserved} = \frac{\frac{kWh}{year}\ purchased}{37\%\ \text{annual cf} \times 8760\ \frac{hours}{year} \times 1000\ \frac{kWh}{MWh}}$$

$$\frac{tons}{day} = \frac{5.72\ \frac{lb}{Mwh}\ generated \times \text{MWh reserved} \times 20\%\ \text{seasonal cf} \times 24\ \frac{\text{hours}}{\text{day}}}{2000\ \frac{\text{lb}}{\text{ton}}}$$

A copy of the RSG/ERT report and further documentation of the emissions reduction calculations for this program are included in Appendix A.

**APPENDIX A**

# SAMPLE
# PROSPECTIVE ENVIRONMENTAL REPORT
# FOR WIND POWER PURCHASE

# TABLE OF CONTENTS

## INTRODUCTION

The purpose of this report is to provide documentation of the procedures for a wind generator and/or a wind power purchaser to quantify and obtain credit for emissions reductions attributable to the addition of wind power to a regional electric supply grid. These emission reductions typically occur when wind power is dispatched on a "must run" basis to the grid and displaces variably dispatched fossil fuel generating units (coal, oil, or natural gas), which emit much higher levels of air pollution. Wind energy production therefore results in the reduction of a wide range of regulated and non-regulated air emissions.

The focus of this report is on the reduction of nitrogen oxide (NOx) emissions to help achieve attainment of the ozone air quality standard. The authors of this report have assured the consistency of their methodology with the U.S. Environmental Protection Agency's (EPA's) "Guidance on State Implementation Plan (SIP) Credits for Emission Reductions from Electric-Sector Energy Efficiency or Renewable Energy Measures," issued on August 5, 2004.[1]

## GENERAL METHODOLOGY FOR PROSPECTIVE QUANTIFICATION OF $NO_X$ EMISSION REDUCTIONS FROM CANDIDATE WIND PROJECTS

Under this prospective methodology, the projected emission reductions are estimated in advance of a wind power purchase. The first step is to calculate the amount of emission reductions that can be expected to occur if wind generation displaces other power sources in a specific power supply area. Displacement by wind generation occurs because wind power is a "must run" power source.

Wind generators are "must run" units because they have very low operating costs compared with fossil-fuel-fired combustion sources. Therefore, wind power will always be generated and sold to its full practical capacity, when available.

Under all but emergency situations, the wind generators will displace the highest cost variably dispatched electric generating units (EGUs) available on the regional power supply grid. In practice, wind power nearly always displaces fossil fuel generating units (rather than nuclear or hydropower units). However, the mix of fuels displaced varies with location and season. The specific EGUs displaced will depend on their power price at the specific time of day and season. In some cases, transmission constraints on the grid also may be a factor.

The emissions displacement analysis described here follows the "power plant dispatch" methodology used by the Environmental Resources Trust/Resources Systems Group (ERT/RSG) team that prepared the analysis for the Montgomery County, Maryland wind power purchase and is set forth in the February,

[1] U.S. Environmental Protection Agency, Memorandum from Brian McLean, director, Office of Atmospheric Programs, and Steven Page, director, Office of Air Quality Planning and Standards, to Regional Air Division Directors, "EPA Guidance on State Implementation Plan (SIP) Credits for Emission Reductions from Electric-Sector Energy Efficiency or Renewable Energy Measures," August 5, 2004. See http://www.epa.gov/ttn/oarpg/ "Recent Additions."

2004 SIP document prepared by the Metropolitan Washington Council of Governments for the States of Maryland and Virginia and the District of Columbia.[2] The emissions displacement analysis includes two parts: (1) identification of the specific conventional EGUs displaced by wind generators, and (2) quantification of the amount and schedule of emissions reductions at these EGUs.

### Displacement Analysis

The first part of the displacement analysis identifies a price-ordered list of EGUs that will be variably dispatched with changing demand in a particular power supply area. This list sets forth the group of EGUs from which displacement occurs. The information should be obtained for the most recent past year (or two years, if possible). The development of the displacement list can be conducted in one or more of the following ways:

- Request the information from one or more of the local load serving entities (LSEs). These entities are often electric utilities or former utilities. In States with deregulated electricity markets, it may be difficult to obtain this information from LSEs. However, LSEs may be willing to provide a list of variably dispatched plants without price ordering, or they may be willing to provide it under a confidentiality agreement to an independent consultant.
- Request the information from the independent system operator (ISO) or power pool managers. In some cases, this information may be determined from publicly available records.
- Request the information from the State public utility commission (PUC) or related State agency. The information needed also may be available as part of the record in a regulatory proceeding. For example, this information might be derived from extensive modeling undertaken by a PUC in support of the development of a Renewable Portfolio Standard (RPS).
- Compile a list independently by combining data publicly available from data reports filed with the Federal Energy Regulatory Commission (FERC)[3] and databases of the Energy Information Administration (EIA)[4]. This effort typically will involve combining data on heat rate, fuel cost, and emissions control costs. EGUs that are high on the cost stack typically will have high heat rates and high fuel costs and often are old plants. Such plants can be identified in the EIA database because of their low annual capacity factors over several recent years. They almost always will be fossil fuel plants.
- Contract with one of the consultants operating a proprietary EGU dispatch model to obtain a simulation of the market. This option may be more expensive than the other options.

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[2] See www.mwcog.org/environment/air, SIP documents at Appendix J-77 to J-76

[3] Federal Energy Regulatory Commission Form 423 and Form 1 reports available form FERC and at www.eia.doe.gov/cneaf/electricity/page/data.html

[4] Energy Information Administration Databases EIA-860, 861, 423, 906 and 920 are available at www.eia.doe.gov/cneaf/electricity/page/data.html

The second part of the displacement analysis involves matching the generation of the candidate wind generator with the generation schedules of the fossil-fuel-fired EGUs on the displacement list. If the analysis is needed for the entire year and the wind plant is in operation, the wind generator output should be obtained from the generator. If the plant is not operational, the output should be simulated based on the wind developer's on-site wind records.

If the displacement analysis is preliminary and a specific wind plant is not identified, generation records from nearby or comparable wind sites can be used. Alternatively, wind power potential can be obtained from State sources or the state wind resource maps developed by the U.S. Department of Energy's Wind Powering America Program.[5] In some cases, the analysis may be needed for the ozone season only. If so, the plant operator's records or simulations are needed for the summer ozone season.

Generation records for EGUs on the displacement list are available for plants in EIA databases but not always for individual units. Because displacement occurs at the unit level, a record of generation at the unit level is needed. A good approximation of that record can be obtained by using the carbon dioxide continuous emission monitoring (CEM) data required by the EPA for most fossil fueled EGUs.[6] The generation output of a specific EGU is a fairly constant factor of the $CO_2$ output. The reference $CO_2$ factor can be obtained or estimated from the EPA e-GRID database[7].

The hourly generation record of each plant on the displacement list should be compared with the expected or operational generation of the candidate wind generator for the same period in the most recent year. If the most recent year is thought to be atypical, then the calculation should rely on the two most recent years. The comparison should be made using the following approach:

- Compare the hourly generation pattern on one or more sample days in each of four seasons for the annual analysis
- Compare the hourly generation pattern on one or more sample days in at least three months of the ozone season
- Compare the operational availability in all months in the year. The unit should run in the months when the wind generator is running
- Examine each unit's capacity factor in each season. It should have excess capacity in all seasons
- Determine the amount of variable capacity. This amount is the maximum difference between the high and the low capacity experienced in each season
- Determine if the unit is still in operation and expected to be so when the wind power is to be purchased

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[5] U.S. Department of Energy, Wind Powering America State Wind Maps at www.windpoweringamerica/wpa/wind_maps.asp

[6] CEM data for CO2, NOx and SO2 are available in download form at www.epa.gov/airmarkets/emissions/index.html#prelim

[7] The e-GRID database is available at www.epa.gov/cleanenergy/egrid/index.htm

- Determine if any units are transmission-constrained with respect to the market for the wind power and the percentage of time that such transmission constraints occur. This determination may require additional information beyond the generation records.

An active potential displacement list can now be created of plants that meet the following criteria:

- Plants on the variable dispatch list
- Plants expected to be operational when the wind turbine is operational
- Plants that have adequate variable capacity
- Plants that are not significantly transmission-constrained.

Two analyses may be required: one for the annual period and the other for the ozone season.

### Quantification of Emission Reductions

Equipped with an EGU displacement list, the emissions reduction for NOx available at each plant can be determined. The emission rate per megawatt-hour (MWh) for NOx for each unit can be calculated from the EPA CEM database[8] for the most recent 12-month period or for the most recent ozone season. The average potential emission reduction rate for NOx can then be calculated as the generation weighted arithmetic mean of the NOx emission rates of all the units on the active potential displacement list.

## SPECIFIC EXAMPLE OF THE MONTGOMERY COUNTY WIND POWER PURCHASE

In its Request for Proposals, Montgomery County and its partners solicited bids from wind generators in "the region of the Allegheny Mountains and plateau from which emissions from fossil-fuel-fired power plants drift into the Washington Metropolitan Area."[9] The Maryland SIP relied on information obtained by ERT and RSG to identify the displacement of specific fossil-fuel-fired units.

### Displacement Analysis

Based on information provided by load-serving entities in the PJM ISO area, the ERT/ RSG analysis determined that the power displaced by a wind farm located in the Backbone Mountain region of the Allegheny Mountains would be generated in the PJM and PJM Interconnection electric grids. Although

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[8] CEM data for NOx are available in downloadable form at www.epa.gov/airmarkets/emissions/index.html#prelim

[9] Although the ERT/RSG analysis focused on a location on Backbone Mountain in Garrett County, Maryland, the SIP anticipated a competitive process in which the location might vary slightly. The SIP emphasized, "although the analysis contained in Reference 4 [ERT/RSG analysis] focuses on a proposed wind plant located on Backbone Mountain in Garrett County, Maryland, the analysis is relevant to the region's planned wind purchase even if the location varies slightly. The only current wind farm in the region, the Mountaineer Plant, as well as all the proposed new wind farms, are located in the Allegheny Mountains, close to the Backbone Mountain area. Therefore, the emission reduction profile of the Mountaineer plant, as well as the proposed wind plants, is expected to be reasonably similar to the estimate in the analysis prepared with respect to the proposed Garrett County site analyzed in Reference 4. See www.mwcog.org/environment/air at SIP Documents, Chapter 7, pp. 7-79

nuclear power is a significant source of electricity in this area, no nuclear power is displaced because nuclear operating costs are so low that they are operated to the maximum extent possible and are not displaced by any additional sources. Similarly, there are small amounts of hydropower and other renewable sources in the region but none will be displaced by wind power.

Displacement occurs among a set of fossil fuel generating plants that are on a variable dispatch schedule so that the actual generation rises and falls with the demand. Based on information provided by load-serving entities, the generation displaced in PJM is from coal-fired units. Some of the coal plants may have a baseload capacity and a variable dispatch capability as well. In the portion of the PJM region relevant to the project, all of the variable dispatch generation is provided by coal units.

Figure 1 shows the location of plants that are used in the displacement calculations, and the location of the wind plant at "Backbone Mtn" in Table 1 lists the plants with their primary fuels and their "Nameplate Capacity (MW)," which is the maximum amount of power a plant could generate at 100% load. This is the capacity of units in which generation may be displaced and does not necessarily include all units at that location.

***Table 1: Plants with Potential for Displaced Generation***

| State | Plant Name | Plant Code (Orispl) | Primary Fuel | Nameplate Capacity (MW) |
|---|---|---|---|---|
| MD | R Paul Smith Power Station | 1570 | Coal | 110 |
| MD | Aes Warrior Run | 10678 | Coal | 229 |
| MD | Luke Mill | 50282 | Coal | 65 |
| WV | North Branch | 7537 | Coal | 80 |
| WV | Albright | 3942 | Coal | 178 |
| WV | Fort Martin | 3943 | Coal | 1152 |
| WV | Harrison | 3944 | Coal | 2052 |
| WV | Rivesville | 3945 | Coal | 110 |
| WV | Mt Storm | 3954 | Coal | 1681 |
| PA | Hatfield's Ferry | 3179 | Coal | 1728 |

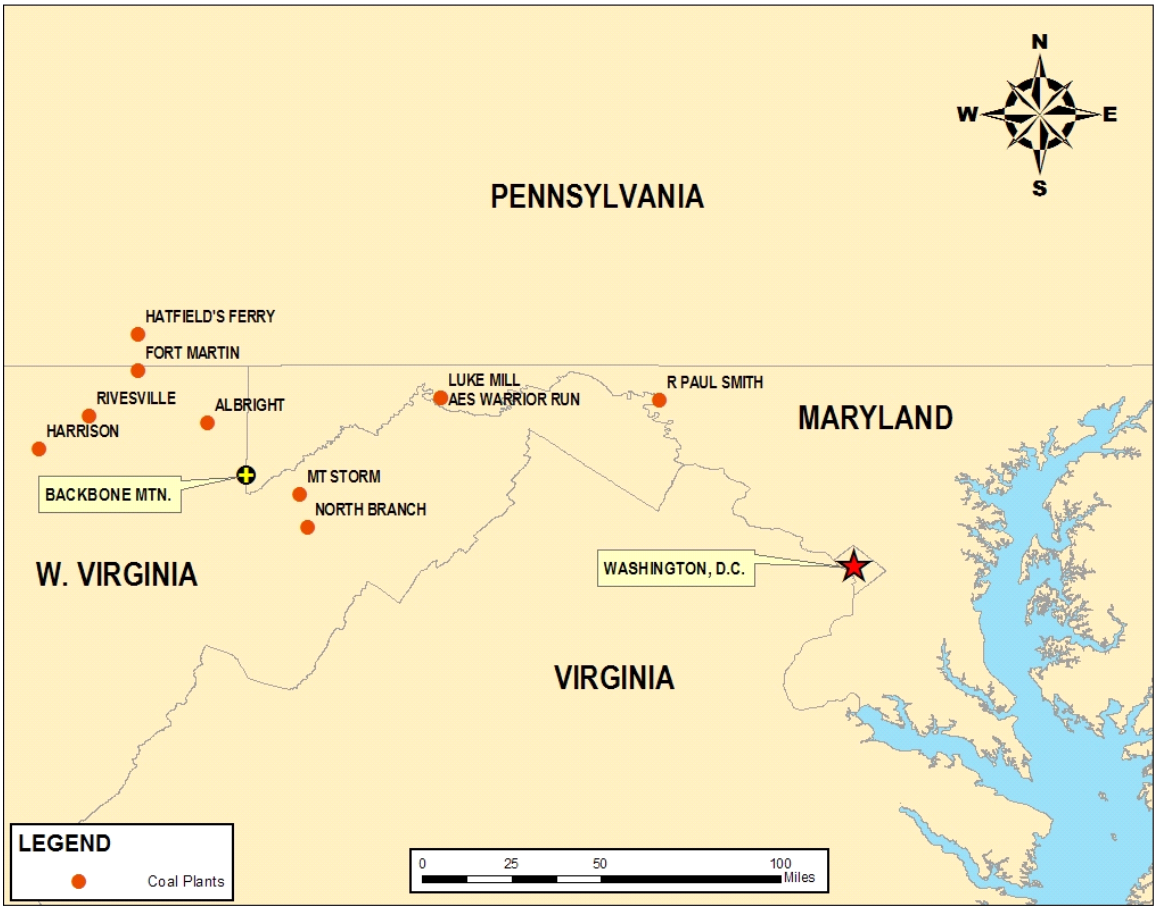


***Figure 1: Location of Plants Included in the Analysis***

In the Maryland example, the analysis relies on the $CO_2$ emissions data to verify the daily and seasonal pattern of generation for selected fossil-fuel-fired units to match the wind generation data, where necessary. The generation record of each plant on the displacement list is compared with the expected or operational generation of the candidate wind generator for the same period in the most recent year.

#### Quantification of Emissions Reduction

For the Maryland example, the displaced emissions for carbon dioxide, nitrogen oxides, and sulfur dioxide from EGUs where generation is displaced are given in Table 2. These are given in lb/MWh. Emissions displacement for the power purchase can be estimated by multiplying by the expected total MWh of the wind power purchase.

***Table 2: Displaced Emissions***

| Pollutant | Average Emissions (lbs/MWh) |
|---|---|
| $CO_2$ | 2113.18 |
| NOx | 5.72 |
| $SO_2$ | 17.66 |

Displaced emissions are based on the CEMs for carbon dioxide, nitrogen oxide, and sulfur dioxide from those plants in the displacement group. The average displaced emissions are calculated from the generation-weighted emission rates of the plants. Generation data are taken from reports to the U.S. Energy Information Administration for the most recent available 12-month period. This is typically through late 2002. Emission rates are taken from the EPA CEM data and are adjusted to the most recent 12-month period, based on generation data by fuel. In cases in which there were obvious errors in the reported emissions, values were calculated with emission rates from a previous year for the facility in question.

Based on information from the LSEs and from analysis of generation and emissions records by Resources Systems Group Inc., it was concluded that the displacement of generation and emissions occurs principally at the variable dispatch plants in the PJM Coal-only group. Therefore the average emissions displacements for that group shown in Table 2 were used.

**Appendix B**

**EXCERPTS FROM**

**REQUEST FOR ELECTRICITY PROPOSALS**
**RFEP #450610014**
**Supply of Electricity and Related Services for**
**Montgomery County and County and Bi-county Agencies and Jurisdictions**
**February 2004**

**2. <u>Threshold Criteria</u>**

For any timely Stage 1 proposals received in response to this RFEP, the Selection Committee will first determine whether the submitting supplier meets the following threshold criteria:

*****

(b) It will supply an amount equal to five percent (5%) of the electricity supply requirements in "clean renewable" fuel sources, as described in this RFEP, on an annual energy (kWh) basis.

*****

**C. STAGE 2 – PROCESS/EVALUATION CRITERIA FOR ELECTRICITY SUPPLY AND CLEAN RENEWABLE POWER**

After the County establishes a list of pre-qualified prospective suppliers (PPSs) in Stage 1, should it choose to proceed to Stage 2, it will then submit to each qualified PPS price quotation forms….The Selection Committee will then evaluate the Stage 2 responses under separate award criteria, one for clean renewable power, and one for conventional electrical supply, in order to award the Contract(s) for each form of energy.

*****

**3. <u>Pricing Evaluation/Award Method for Clean Renewable Power</u>**

Clean renewable power pricing will be evaluated separately. The County requests clean renewable power in the amounts shown for the Participants identified in the accompanying CD-ROM. The amount of clean renewable power being sought by the Participants for the first year of any contract(s) represents an amount equal to 5% of the County's current annual kWh consumption. The Contractor will bill each Participant for one-twelfth (1/12) of the Participant's annual clean renewable power premium each month. A Participant may adjust the amount of clean renewable power required in future years to respond to changes in the Participant's annual kWh consumption. However, the total aggregate amount of clean renewable power that the Participants will consume, collectively, will not be less than 32.7million kWh/yr.

The County may award contract(s) to the lowest responsive and responsible bidder(s), as determined by the following process:

(a) The PPS shall submit pricing for the full clean renewable power requirement

(b) Each PPS must submit one kWh/yr price premium rate, for each term that will be applicable to each Participant.
(c) The PPSs will be ranked by the lowest total cost for the clean renewable power premium per kWh for each of the contract terms.
(d) The lowest bids for each contract term will be evaluated against each other to determine which contract term will offer the lowest total price per kWh to the County.
(e) In the event that more than one PPS submits the same lowest price per kWh, the County will evaluate any financial hedge options offered by the PPSs that are tied for the lowest bid.

*****

**SECTION IV: MANDATORY SUBMISSIONS**
**FAILURE OF A SUPPLIER TO MEET THE THRESHOLD CRITERIA AND TO SUBMIT ALL MANDATORY SUBMISSIONS MAY RENDER THE SUPPLIER'S PROPOSAL UNACCEPTABLE, AS DETERMINED BY THE DIRECTOR.**
**A. STAGE 1**

*****

**4. Certification and References** (Exhibit D)

*****

**c. <u>Clean Renewable Energy Requirements:</u>** The total of "Clean Renewable" fuel sources supplied by the Contractor must equal or exceed 5% on an annual energy (kWh) basis as a Required Minimum Standard under any Contract(s). **[**Suppliers must provide information demonstrating that: (1) the wind purchase will result in the generation of additional wind energy above baseline amounts; and (2) the NOx emissions displaced by the wind energy purchase will result in a reduction of NOx emissions from fossil fuel-fired generating units in an geographic region upwind of the **[insert name]** metropolitan area**.** This geographic region will be defined as limited to the following area: _____ **]**[1] Specific additional requirements for the wind power are set forth in Exhibit B Section 4 below. Suppliers must indicate …whether there will be, and the amount of, NOx allowances, if any, that will transfer to Montgomery County under this contract.

*****

**EXHIBIT A**
**LISTING AND DESCRIPTION OF PARTICIPANTS IN THE PROCUREMENT**
The following is a list of governmental entities that have indicated interest in participating in this procurement. The County reserves the right to supplement the following list before or during Stage 2 of the procurement with governmental entities within or outside Maryland:
Montgomery County, Maryland Chevy Chase Village

[1] In the bracketed area, the model documentation modifies the language of the original Montgomery County RFP to provide a generic approach applicable to other States**.**

Montgomery County Public Schools Chevy Chase Section 5
Montgomery College City of Gaithersburg
Montgomery County Housing Opportunities Commission
City of Rockville
Washington Suburban Sanitary Commission (for clean renewable energy requirements only)
Rockville Housing Enterprises
Maryland-National Capital Park and Planning Commission
City of Takoma Park
Town of Glen Echo
Town of Kensington
Town of Laytonsville
Town of Somerset

*****

**EXHIBIT B**
**SAMPLE PRICING WORKSHEETS AND ACCOUNT DATA**

**4. Clean Renewable Energy Requirements**

The Participants have made a commitment to purchase an amount equal to five percent (5%) of the total electricity supply from a wind energy facility (or facilities). This clean renewable energy must meet the requirements for reduction of nitrogen oxides (NOx) in the Maryland State Implementation Plan (SIP) for compliance with the Clean Air Act. The SIP requirements include a geographic area within which the wind energy must be generated **[**in order to demonstrate that the NOx emissions displaced by the wind energy purchase will result in a reduction of NOx emissions from fossil fuel-fired generating units in an geographic region upwind of the **[insert name]** metropolitan area**.** This geographic region will be defined as limited to the following area: _____ **].**[2] To that end, a required minimum standard has been developed.

**a. Required Minimum Standard**

The Contractor will deliver into the PJM wholesale electric market an annual volume of electricity that is generated using wind energy. This annual volume of wind power will represent not less than five percent (5%) of the Participants' annual electricity use for accounts listed in the accompanying CD-ROM, for the term specified in any resulting Contract(s). ****

**[**Suppliers must provide information demonstrating that: (1) the wind purchase will result in the generation of additional wind energy above baseline amounts; and (2) the NOx emissions displaced by the wind energy purchase will result in a reduction of NOx emissions from fossil fuel-fired generating units in an geographic region upwind of the **[insert name]** metropolitan area**.** This geographic region will be defined as limited to the following area: _____ . This geographic region is limited to the area that includes _____**]**. [3]
****

[2] In the bracketed area, the model documentation modifies the language of the original Montgomery County RFP to provide a generic approach applicable to other States**.**
[3] Ibid.

**b. Additional Volume of Clean Renewable Energy Purchased by Other Parties**

In addition to the Participants, other parties or jurisdictions have been invited to add additional volumes of wind power to this agreement, on an annual kWh basis. These additional parties and their wind energy purchase volumes will be listed on Quotation Sheet #4 on the accompanying CD-ROM, and may be supplemented during Stage 2 of this procurement. The Contractor must, upon request from those parties, enter into separate contracts with those parties for wind power, pursuant to which they will pay a price premium equal to the premium paid per kilowatt-hour by the Participants. All terms, conditions and reporting requirements applicable to the Participants' purchase of wind power must apply to these other parties, unless mutually agreed to by the parties.

**c. Renewable Energy Reporting/Documentation Requirements.**

****

The Contractor will report to the County, on an annual basis, the number of kilowatt hours of wind power that it had delivered to the electricity grid under the provisions of any resulting Contract(s), on an annual basis and during the ozone season, which begins on May 1 of each year and ends on September 15 of each year. Contractors must bill Participants monthly, based on 1/12 of projected annual use (currently projected at 32.7 million kWh for the first year).

****

d. **Clean Renewable Energy Quotation Sheet Form**

**i. Price Premium**

Each agency listed on Quotation Sheet #4 requests Clean Renewable Power in the amounts shown in Column B. The requested amount of Clean Renewable Power represents a minimum of 5% of the agency's current annual kWh consumption. For contracts longer than one (1) year, the amount of Clean Renewable Power required in future years may be adjusted to account for changes in the County's annual kWh consumption, but shall in no instance be less than 32.7 million kWh per year. Supplier must enter the premium that it will charge for the supply of Clean Renewable Power for any or all of the contract terms in Row 19. The price must be entered in dollars/KWH. For example, a price of 1.5¢ per KWH must be entered as 0.01500.

ii. **Financial Hedge on Energy Price Escalation**

The Participants are interested in obtaining a financial hedge that will reduce the price premium paid for wind power if and when the market price for electricity increases substantially. Therefore, the County will give a preference to proposals that provide a price premium for wind power that is stated as a cap, and for which the price premium may be reduced relative to increases in the market price for electricity in the PJM wholesale power pool. PPSs that can provide this financial hedge should indicate on Quotation Sheet #4 the market price levels that will trigger a reduction in the wind power price premium, and the amount by which the price premium will be reduced.

The market price level indicated will be the day-ahead 12:00 noon spot market clearing price for the EDC location in which the clean renewable power source is located. The price premium reduction indicated will continue for the number of days for which the spot market clearing price remains at or above this level. PPSs that can provide a financial hedge should indicate the spot market clearing price levels that will trigger a reduction in the wind power price premium, and the amount by which the price premium will be reduced.

*****

**EXHIBIT E**
**ELECTRICITY PURCHASE TERMS AND CONDITIONS OF CONTRACT BETWEEN THE PARTICIPANT & CONTRACTOR**

The following terms and conditions will be incorporated into all Contracts that may result from a subsequent award under this Request for Electricity Proposals. The term "Participant" as used in these terms and conditions means each County or Bi-county agency and local governmental jurisdiction or other governmental entity entering into a Contract(s) with the successful awardee(s).

*****

7. **Clean Renewable Energy Requirements**

a. Except as expressly set forth in this Contract, the Contractor warrants and covenants that it will supply to the Participant generation from "renewable" and "clean" fuel sources of an amount equal to five (5) percent of the Contractor's total generation supply on an annual energy (kWh) basis under this Contract. The terms "renewable" and "clean" fuel sources mean wind energy for the purposes of this Contract.

b. Upon request by the Participant, the Contractor will provide documentation to the Participant, in a form acceptable to the Participant, demonstrating its compliance with its warranty and covenant stated in this paragraph.

*****

**B. CONTRACT TERM**

*****

3. The term for purchases of Clean Renewable Energy shall be set separately and that term or extension may be for more than 5 years.

*****

# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



**PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.**

| 1. REPORT DATE *(DD-MM-YYYY)* | 2. REPORT TYPE | 3. DATES COVERED *(From - To)* |
|---|---|---|
| May 2005 | Subcontractor Report | Execution through 11/30/2004 |

**4. TITLE AND SUBTITLE**
Model State Implementation Plan (SIP) Documentation for Wind Energy Purchase in State with Renewable Energy Set-Aside

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DE-AC36-99-GO10337

**5b. GRANT NUMBER**

**5c. PROGRAM ELEMENT NUMBER**

**6. AUTHOR(S)**
A. Hathaway, D. Jacobson, C. High

**5d. PROJECT NUMBER**
NREL/SR-500-38075

**5e. TASK NUMBER**
WER5 6103

**5f. WORK UNIT NUMBER**

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
Environmental Resources Trust, Inc.
1612 K. Street NW Suite 1400
Washington, DC 20006

**8. PERFORMING ORGANIZATION REPORT NUMBER**
LEE-4-44827-01

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
National Renewable Energy Laboratory
1617 Cole Blvd.
Golden, CO 80401-3393

**10. SPONSOR/MONITOR'S ACRONYM(S)**
NREL

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5285 Port Royal Road
Springfield, VA 22161

**13. SUPPLEMENTARY NOTES**
NREL Technical Monitor: L. Flowers

**14. ABSTRACT** *(Maximum 200 Words)*
This model documentation is designed to assist State and local governments in pursuing wind energy purchases as a control measure under regional air quality plans. It is intended to support efforts to draft State Implementation Plans (SIPs), including wind energy purchases, to ensure compliance with the standard for ground-level ozone established under the Clean Air Act.

**15. SUBJECT TERMS**
wind energy; state implementation plan; SIP; Clean Air Act; clean air standards; MWCOG; emissions

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