Renewable Energy

The Ozone Transport Commission
Technology and Innovations Committee

September 2000

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Background

The OTC Technology and Innovations Committee has been tasked with exploring options that states can pursue concerning new technologies and innovative policies for reducing air pollution. The Committee took its first step in this process by hosting the Clean Air Technologies 2000 Conference in May of 1999. The resulting list of ideas from the conference was used to help formulate the Committee's work plan for this year.

Part of the Committee's work plan deals with the generation of electricity and its impact on air pollution. One specific topic, Clean Power Generation and Renewable Energy Sources, deals with power generation from "cleaner" sources.

Potential Reductions

The use of renewable energy sources has the potential to significantly reduce air emissions associated with power generation. Additional benefits include waste reduction, wastewater discharge reduction and improved water quality.

The following table summarizes NOx emissions associated with power generation in the Ozone Transport Region, representing emissions that could be reduced if sources of renewable energy were employed instead. These values are from the 2007 Level 0 OTAG inventories, and include the effects of Title IV State Measures, RACT and the NOx MOU:

Generation Source	NOx Emissions (tons per day)	NOx Emissions (tons per year)
Coal	673	245,645
Oil	241	87,965
Gas	155	56,575
Other *	82	29,930

* Includes coke, wood/bark waste, solid waste, liquid waste, kerosene/naptha, landfill gas, CO boiler, and large bore engine.

Source: OTC Supplied Inventory Database

Renewable Definitions

Typically, the term “renewable” energy source is thought to include “clean” power sources such as wind or solar. There is not always agreement, however, as to what power sources can be classified as renewable. Green-e.org defines renewable sources as summarized in the following table:

Green-e.org Definitions of Renewable Power Sources

Solar	Sources that collect solar radiation to produce electricity. A common example would be photovoltaic panels.
Wind	Wind energy is captured by turbines and converted into electricity. Considered by many to be the cheapest, and fastest growing, renewable energy technology.
Biomass	Solar energy that is stored in green plants. Biomass facilities burn wood, agricultural wastes and/or methane gases from landfills to spin a turbine and create electricity.
Geothermal	Geothermal plants use the heat from below the surface of the earth to help power turbines.
Hydroelectric	Electricity is produced from the energy of flowing water. Due to the impact on fish and other water species, green-e.org only certifies plants less than 30 MW in size.

As the electric industry continues to move through the process of deregulation, state legislatures have defined renewable energy in various legislation. In the OTR, these definitions vary somewhat, as evidenced in the following examples:

Summary of Renewable Energy Definitions in Restructuring Legislation

	Solar	Wind	HydroPower	Fuel Cells	Landfill Methane	Bio Mass	Waste-to-Energy	Tidal	Geothermal	Mine-Based Methane
Connecticut Class I Renewables Class II Renewables	√	√	 √	√	√	√ √	 √			
Maine	√	√	√	√		√	√	√	√	
Massachusetts	√	√	√	√	√	√	√	√		
New Jersey Class I Renewables Class II Renewables	√	√	 √	√	√	√	 √	√	√	
New York *	√	√				√				
Pennsylvania	√	√	√		√	√	√		√	√

Source: State Restructuring Legislation

* NYSERDA, the state-wide SBC Fund Administrator, lists these technologies as examples. Other technologies will be considered, as appropriate.

Quantification of Renewables Impact on Air Emissions (Case Study)

It is possible to make a rough estimate of the impact that renewables could have on air emissions. A case study could be developed by examining current policies and technologies related to renewables.

One possible area to start is with the impact of System Benefit Charges (SBCs) and Renewable Portfolio Standards (RPS) resulting from deregulation of the electric industry. (Note: SBCs are further described in another OTC paper. RPS are portfolio standards, mandated by state restructuring legislation, where electrical suppliers must obtain a certain percentage of power from renewable energy sources.)

A June 1999 report sponsored by the National Renewable Energy Laboratory (part of the U. S. Department of Energy), analyzed existing or proposed state policies that have resulted from electric restructuring. (For the OTR, these states included Connecticut, Maine, Massachusetts, New Jersey, New York, Pennsylvania and Rhode Island). The report estimates that the state policies could result in approximately 1250 MW of new renewable energy in the OTR by 2005.

1250 MW of coal-fired generation in the OTR is associated with approximately 8500 tons per year of NOx emissions. *

* Calculated in Attachment A

Renewable Factors

Several factors make it difficult to determine how 1250 MW of new renewable capacity would affect NOx emissions. For the purposes of this study, the following assumptions will be made:

- The 1250 MW capacity of new renewables would replace 1250 MW of coal-fired generation.
- The average increase in power sales/demand of 1.5 % will be ignored.
- Technology cost factors will be ignored.
- It will be assumed that the technology will be readily available.

Several factors affect renewables, including:

- Capacity factors (i.e. percent of nameplate power capacity that actually can be used)
- NOx emission factors (Not all renewable sources are zero-emitting)

Factors for common examples of renewable sources are contained in Appendix B.

Estimate of Impact of Renewables

Given the factors listed in Appendix B, wind and solar are zero-emitting, but could only operate 26 and 34 percent of the time. Appendix C details calculations giving a "best-case" scenario of how 1250 MW of renewable capacity could affect NOx emissions.

A "suite" of renewable energy options could reduce NOx emissions from 8500 tons per year to approximately 425 tons per year.

It should be noted that other "renewable" sources could negatively impact air emissions. For example, if an uncontrolled internal combustion engine is used to generate electricity from landfill gas, NOx emissions are significantly higher than those from a controlled coal-fired source.

Options (Summary)

Because renewable energy sources can positively impact air emissions, the OTC needs to consider a number of options concerning renewable energy sources.

Some suggested options are listed below. The topics are further expanded later in the document.

The majority of items can be classified as "directionally correct" strategies, without the need for regulations. *It is unlikely that these strategies will be useful in addressing near-term shortfalls*.

These items are not traditional control options (e.g. regulations).

Suggested options include:

<u>Short-term, regional options</u>
- Clarification of renewable energy definitions
- Discussion of policies with energy officials

<u>Long-term, regional options</u>
- OTC discussion of renewable energy market forces
- OTC recognition program

<u>Long-term, state options</u>
- SBC Involvement
- Renewable Portfolio Standards Involvement
- Emission reduction credits, SIP credits and Renewables Trading

Options (Expanded)

Clarification of Renewable Energy Definitions

Prior to promoting renewable energy sources, the OTC may want to consider clarifying definitions. The end product would be a list of renewable energy sources that have positive impacts on air quality.

Several starting points exist for this task. The various legislative definitions of renewable power are summarized earlier in this paper. Green-e (www.green-e.org) has published literature that may help the OTC to better define renewable energy for OTC purposes.

Meeting with Energy Officials

It is not clear the extent that energy officials consider the air quality impact of energy policy, and specifically electric deregulation policies.

It may be productive for OTC representatives to meet with energy officials to discuss policy options. The annual NARUC meeting, scheduled for late September or early October, may provide an opportunity. Topics that could be discussed:

- Market Development for Renewable Energy
- Impact of deregulation on air emissions
- System Benefit Charge Programs

OTC Discussion of Market Forces

Entrepreneurs have entered the renewable energy market, as evidenced in Pennsylvania.

Conectiv Energy Example

In the Philadelphia area, Conectiv Energy (with Energy Unlimited, Inc. and Community Energy, Inc.) has been selling electricity to Philadelphia businesses from two 65 kW wind turbines. The company has noted that this project will avoid 800 pounds of NO_x and 1900 pounds of SO_2 per year. Conectiv has sold out the turbines' production capacity by contracting to 25 businesses in center-city Philadelphia.

Demand for energy from this project is driving expansion of the project. Two additional turbines are scheduled to be built this spring.

This project was not funded by SBCs, and Pennsylvania does not have an RPS mandate. Several factors have been attributed to the success of this project, including:

1. Demand for "environmentally-friendly power. As an example, the Sheraton Rittenhouse Square Hotel (now the largest user of windpower in PA) has marketed itself as an environmentally-smart hotel. The Sheraton will purchase 20 kWh per month.

2. Conectiv sells the power in blocks of 400 kWh per month. As with most renewable power, wind-produced electricity is more expensive. The flexible block feature helps companies keep their budgets in place while still purchasing as much wind power as is affordable to them.

3. Pennsylvania's consumer choice program for electricity is working quite well. Of the individuals that switched power suppliers, approximately one-third have chosen "green" power.

Source: Philadelphia Inquirer article, Conectiv Press Release

Other examples also exist. GreenMountain.com is constructing a wind farm in Southwestern Pennsylvania.

One key to the success of making renewable technologies sustainable in the market is to lower the capital cost through economies of scale which requires leveraging of opportunities. The Conectiv billing program brings the total cost of power down by mixing in less-expensive (and probably less clean) power with the wind power. Also, projects such as these help create a stable market, providing more incentives for entrepreneurs.

The OTC could provide some type of forum (e.g. conference call) to provide a "brainstorming session" specifically designed to stimulate thought on ways to promote continued development of this market (e.g. tax incentives, venture capitalists, etc.).

OTC Recognition Program

An OTC Clearinghouse could serve as a vehicle to recognize the need for reduced air pollution and increases in "cleaner" generation. The clearinghouse could also serve as another mechanism to promote renewable accomplishments recognized by individual states. (For examples of state recognition programs, please refer to the OTC paper titled "State Practices"). The Communication Committee may need to interface with the Technology Committee to further expand this topic.

SBC Involvement

Deregulation of the power industry has resulted in funding for renewable energy programs through what are referred to as System Benefit Charges (SBCs). SBC programs are funded through a small monthly charge on a customer's electric bill. Legislation in several OTC states requires that SBC funds be utilized to support renewable energy programs.

These programs provide an opportunity to develop the market for new technologies associated with renewable energy. OTC members could play a role in the design of these programs at the state level, because OTC representatives (commissioners) often have a seat on the boards that govern the expenditure of these funds. The OTC representatives need to continue encouraging the expenditure of these funds for programs that positively impact air emissions.

This is an example of how member states can use the OTC's status as a Commissioner organization to promote clean air strategies in areas outside of the air community.

Renewable Portfolio Standard Involvement

States that have not yet finalized the structure of their RPS could refer to the OTC for information on other state RPS programs. This could be accomplished through the clearinghouse.

Emission reduction credits, SIP credits and Renewables Trading

Individual states in the OTC may want to investigate the possibility of credits for renewable energy sources. Each state would need to evaluate whether their particular situation would allow for this type of idea.

One area of concern for this topic is the need to establish a "user-friendly" tracking system for power sales. If a state could prove that its policies reduced air emissions, it may be able to pursue credit.

Any attempt to gain credits would require that the actions be permanent, quantifiable, enforceable and real.

It should be noted that attempts have been made in the recent past to incorporate incentives for renewable energy into state planning. The Conservation and Renewable Energy Reserve (CRER) was developed in 1990 as part of the Acid Rain Program and trading program. Approximately three percent of the pool was set aside for energy conservation and renewable energy measures. To date, CRER has received few applications for allowances. Suspected reasons include:

- Low prevailing value of SO2 allowances ($100 - $200 per ton in the market)
- Declining price of low-sulfur coal
- Effectiveness of the trading market

Source : Recognizing Efficiency and Renewable Energy under a Cap and Trade Program, Center for Clean Air Policy, July 1999

For the CRER program, it is perceived that simply purchasing credits in the market is less expensive. It is also administratively easier. Both of these thoughts need to be kept in mind if states would like to see a successful set-aside program. To help invigorate the market, could multi-use credits (e.g. NO_x/SO_2) add more value to the program and encourage companies to pursue credits?

As part of the SIP call, EPA has published a document *titled Guidance on Establishing an Energy Efficiency and Renewable Energy (EE/RE) Set-Aside in the NOx Budget Trading Program*. In the document, EPA states that two more guidance documents will be published. The second document will address administration and quantification of awards, the third will outline measurement and verification requirements. If there is interest, the OTC could request that EPA provide formal information on the status of the remaining two documents. The complete set of documents could be used by interested states to develop renewable energy incentives.

Attachment A
Calculation of NOx Emissions

Kilowatt-hours of Electricity Generated:
(Assumes a capacity factor of 1, i.e. 100 % utilization)

$$1250\ \text{MW} \times \frac{365\ \text{days}}{\text{Year}} \times \frac{24\ \text{hr}}{\text{Day}} \times \frac{1000\ \text{kW}}{\text{MW}} = \frac{1.1 \times 10^{10}\ \text{kWh}}{\text{Year}}$$

Calculation of Tons of NOx:

$$\frac{1.1 \times 10^{10}\ \text{kWh}}{\text{Year}} \times \frac{3412\ \text{BTU}}{\text{KWh}} \times \frac{\text{MMBTU}}{10^{6}\ \text{BTU}} \times \frac{1\ \text{Energy In}}{0.33\ \text{Energy Out}} \times$$

$$\frac{0.15\ \text{lbs}}{\text{MMBTU}} \times \frac{\text{Ton}}{2000\ \text{lbs}} = \frac{8530\ \text{Tons}}{\text{Year}}$$

Note: 8530 tons/year would be equivalent to about 3.5 % of the NOx emissions associated with coal in the 2007 inventory.

Conversion Factors

$$\frac{3412\ \text{BTU}}{\text{KWh}}$$

Factor obtained from Energy Information Administration (EIA)

0.33 (or 33%) is a thermal conversion factor for coal-fired plants, the amount of the heat input that is typically converted to electricity.

(Alternative Calculation)

Conversion Factor

$$\frac{10.5 \times 10^{6}\ \text{BTU/hr}}{\text{MW}}$$

Factor obtained AP-42

$$1250\ \text{MW} \times \frac{10.5 \times 10^{6}\ \text{BTU/hr}}{\text{MW}} \times \frac{0.15\ \text{lb}}{\text{MMBTU}} \times \frac{\text{MMBTU}}{10^{6}\ \text{BTU}} = \frac{1968.75\ \text{lb}}{\text{Hr}}$$

$$\frac{1968.75\ \text{lb}}{\text{hr}} \times \frac{24\ \text{hr}}{\text{Day}} \times \frac{365\ \text{days}}{\text{Year}} \times \frac{\text{Ton}}{2000\ \text{lb}} = \frac{8623\ \text{tons}}{\text{Year}}$$

Attachment B

Renewable Energy Source Factors

Typical capacity factors for renewable sources are listed below:

Capacity Factors

Solar	0.26
Wind	0.34
Biomass	0.70
Fuel Cells	0.90
Landfill to Gas	0.90

NOx emission factors can be summarized as following:

NOx Emission Factors (lb/kWh)

Solar	0
Wind	0
Biomass *	0.0017
Fuel Cells	0.000025
Landfill to Gas **	0.006

*

** Worst-case scenario, based on uncontrolled Internal Combustion Engine being used to generate electricity. If a fuel cell would be employed instead, the fuel cell emission factor would apply.

Note: Some information was extracted from a NJ Report.

Attachment C

Given that solar and wind have capacities of 0.26 and 0.34, they could, at best, only contribute 750 MW of production, as follows:

1250 x 0.26 = 325 MW
1250 x 0.34 = 425 MW

1250 – (325 + 425) = 500 MW remaining capacity

Of the renewable technologies listed in Appendix B, fuel cells provide the lowest NOx emissions, but only operate 90 % of the time. The remaining 50 MW of capacity could be replaced by a biomass facility.

A "suite" of renewable power would look like this:

Solar	325 MW
Wind	425 MW
Fuel Cells	450 MW
Biomass	50 MW

NOx emissions from solar and wind sources would be zero. Fuel cell and biomass emissions, calculated with the emission factors from Appendix B, would be:

$$450\ \text{MW} \times \frac{365\ \text{days}}{\text{Year}} \times \frac{24\ \text{hr}}{\text{Day}} \times \frac{1000\ \text{kW}}{\text{MW}} = \frac{3.9 \times 10^{9}\ \text{kWh}}{\text{Year}}$$

50 MW would equate to 4.4×10^{8} kWh/yr

Fuel cells:

$$\frac{3.9 \times 10^{9}\ \text{kWh}}{\text{Year}} \times \frac{0.000025\ \text{lb}}{\text{KWh}} \times \frac{\text{Ton}}{2000\ \text{lb}} = \frac{48.75\ \text{tons}}{\text{Year}}$$

BioMass:

$$\frac{4.4 \times 10^{8}\ \text{kWh}}{\text{Year}} \times \frac{0.0017\ \text{lb}}{\text{KWh}} \times \frac{\text{Ton}}{2000\ \text{lb}} = \frac{374\ \text{tons}}{\text{Year}}$$

A total of approximately 423 tons of NOx would be emitted.