BACKGROUND

State Clean Energy-Environment Technical Forum
Call #14: Encouraging Combined Heat and Power with Output-Based Emission Standards
March 9, 2006, 2:00 – 3:30 pm EST

I. Overview

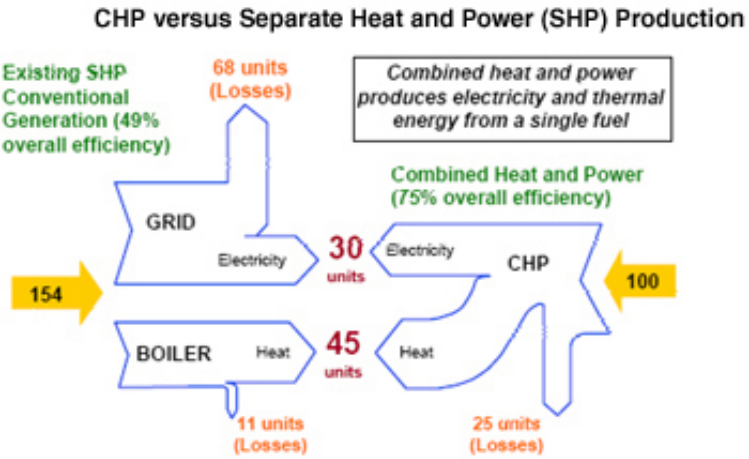
Output-based regulation is a powerful mechanism for rewarding efficiency and encouraging deployment of clean distributed generation and Combined Heat and Power (CHP), as well as other energy efficiency and renewable energy projects. Output-based regulation offers multiple opportunities to reward efficiency and encourage CHP and other clean generation. Since CHP is highly efficient, it reduces traditional air pollutants and carbon dioxide and can lower fuel costs substantially: a CHP system with 75% fuel conversion efficiency can yield a 50% gain in overall efficiency, resulting in a 35% fuel savings. With many states developing regulations for trading under the Clean Air Interstate Rule (CAIR), this is an opportune time to be considering how these mechanisms may be used.

Some issues to consider for this call include:

- What are the primary policy drivers for encouraging CHP and distributed power generation (DG) using output-based regulations in your state?
- What factors should you consider in setting output based emission standards or other policy elements to encourage CHP and output-based regulations?
- How can your state measure CHP and other energy output? Are there specific calculation methods for conversions between fuel input and energy output?
- How can your state quantify the actual or potential benefits of CHP and output-based regulations?
- What challenges might you face and what additional technical assistance would be helpful?

II. Background

A. What are CHP Systems?



Combined heat and power, also known as cogeneration, is an efficient, clean, and reliable approach to generating power and thermal energy from a single fuel source. CHP is not a specific technology but the application of technologies to meet energy users' needs. CHP systems achieve typical effective electric efficiencies of 50% to 70% — a dramatic improvement over the average efficiency of separate heat and power.

Since CHP is highly efficient, it reduces traditional air pollutants and carbon dioxide, the leading greenhouse gas associated with climate change. As seen in the above diagram, a CHP system with 75% fuel conversion efficiency can produce the same electrical and thermal output as separate heat and power systems with 49% efficiency. This is a 50% gain in overall efficiency, resulting in a 35% fuel savings.

B. What are output-based regulations?

Output-based environmental regulations (OBRs) relate emissions to the productive output of a process. The goal of OBR is to encourage the use of fuel conversion efficiency and renewable energy as a pollution prevention measure. While output-based emission limits have been used for years in regulating some industrial processes, they are only recently being used for electricity and steam generation.

Environmental regulations for power generators and boilers have historically established emission limits based on heat input or exhaust concentration: that is, they measure emissions in pounds per million Btu (lb/MMBtu) of heat input or in parts per million (ppm) of pollutant in the exhaust stream. These traditional input-based (or concentration) limits do not account for the pollution prevention benefits of process efficiency in ways that encourage the application of more efficient generation approaches.

To encourage more efficient energy generation, states have begun to design and implement OBR. An output-based emission limit is expressed as emissions per unit of useful energy output (i.e., electricity, thermal energy, or shaft power). Output-based emission limits are particularly important for promoting the significant energy and environmental benefits of CHP, which produces both electrical and thermal output. Because overall efficiency is rewarded, OBR is a powerful mechanism to encourage a range of energy efficiency equipment and process improvements as well as the use of a host of renewable fuels. Output-based limits can be designed to explicitly account for both types of output in the compliance computation. Traditional input-based limits, on the other hand, can present a barrier to selecting CHP technologies because they do not account for the emission reductions achieved through increased generation efficiency.

C. What are the benefits of using OBR for CHP systems?

- A Level Playing Field - Output-based emission limits establish performance criteria that allow energy efficiency and renewable energy to compete on an equal footing with other method of reducing emissions.

- Fuel Savings - Output-based emission approaches encourage energy efficiency improvements through the use of new technology, renewable fuels, opportunity fuels, and energy recovery, resulting in reduced fuel consumption.

- Multi-Pollutant Emissions Reductions – Lower fuel consumption associated with increased fuel conversion efficiency reduces emissions across the board – that is NO_x, SO_x, PM, hazardous air pollutants, and greenhouse gas emissions.

- Transparency - Comparing the emissions impacts of different energy generation facilities is easy and clear when emissions are measured per unit of useful energy output.

III. What are the Mechanisms to Encourage Clean DG and CHP?

A. Emissions Trading

(1) Allowance Allocation

In a cap-and-trade program, an output-based system can mean that efficient systems receive valuable emission allowances based on their relatively high output of useful energy rather than on their fuel input. As noted below, some states already have energy efficiency and renewable energy (EE/RE) allowance set-aside programs under the NO_x SIP Call and other programs. These programs reward EE/RE for producing energy (or reducing energy demand) without the emissions associated with fossil fuel combustion.

Most recently, model rules for the annual and ozone season NO_x trading programs under CAIR use a modified output basis. For new cogeneration units, the thermal output of useable steam is converted to equivalent heat input using conversion factors,. The methodology uses a modified output basis and has specific methods for cogeneration, as seen in the quoted material below.

Modified Output Approach for New Units

"As in the CAIR example allocation approach, the Agency proposes to allocate to new units that have established baselines on a ''modified output'' basis, by multiplying the unit's gross output by a heat rate conversion factor of 7,900 Btu/kWh for coal units and 6,675 Btu/kWh for oil and gas units. A conversion rate for each fuel type will create consistent and level incentives for efficient generation, rather than favoring new units that may have higher heat rates. The conversion factors are based on assumptions in EIA's Annual Energy Outlook (AEO) 2004. (for details see 40 CFR 96.142 and 96.342)

Cogeneration Units

As in the CAIR SIP example methodology, for new cogeneration units, allowances would be calculated by converting the available thermal output (Btu) of useable steam from a boiler to an equivalent heat input by dividing the total thermal output (Btu) by a general boiler/heat exchanger efficiency of 80 percent.

For new combustion turbine cogeneration units, allowances would be calculated by converting the available thermal output of useable steam from a heat recovery steam generator (HRSG) to an equivalent heat input by dividing the total thermal output (Btu) by the same efficiency rate, then adding the electrical generation from the combustion turbine converted to an equivalent heat input by multiplying by the conversion factor of 3,413 Btu/kWh. This sum will yield the total equivalent heat input for the cogeneration unit. This approach focuses on the efficiency of a cogeneration unit in capturing energy in the form of steam or heat from the fuel input." (70 FR 49733)

(2) Emission Reduction Credits

States have instituted trading programs for emission reduction credits (ERCs) as a mechanism for reaching national ambient air quality standards. New major emission sources or major expansions of existing facilities must purchase ERCs as offsets to cover their emissions of specified pollutants such as NO_x, volatile organic compounds, carbon monoxide, or particulate matter. Various mechanisms could be used to reward CHP with credits.

(3) Emission Allowance Set-Asides

Set-asides can add incentives for renewable energy and energy efficiency, including CHP. Several states, including Indiana, Maryland, Massachusetts, New Jersey, New York, and Ohio have EPA-approved EE/RE set-aside programs under the NO_x SIP Call (SIP Call).

For each state affected by the SIP Call, EPA established a NO_x budget (emissions cap) consisting of a specific number of allowances, each representing one ton of NO_x. States generally allocate the budget to major NO_x sources based on a pro rata share of heat input to each source. However, states can allocate on the basis of electrical (and/or process) output. At the end of the control period (May-September), each source must hold allowances to cover its emissions, and sources may trade allowances to achieve compliance. EE/RE set-aside programs in the SIP Call were the topic of the November, 2004 CEET Forum Call; background documents can be accessed at http://www.keystone.org.

B. Regulations

In addition to allowance allocation in cap and trade programs, output-based regulatory concepts can be applied to conventional emissions limits such as those in SIPs for Reasonably Available Control Technology (RACT). EPA has used an output-based approach for new source performance standards (NSPS) for NO_x from utility boilers, NSPS for mercury from coal-fired utility boilers, and National Emission Standards for Hazardous Air Pollutants (NESHAP) for combustion turbines.

Permits may set emission limits for energy generators on the basis of useful energy output along with other elements such as facility size, location, and utilization. As described below, a standard permit for small electrical generators in Texas sets NO_x emissions limits on a lb/MWh basis and calculates energy credit for heat recovery by converting measured steam output (Btu) to equivalent electrical output (MWh). For more information on state regulations to encourage efficiency using OBR you may refer to the State Clean Energy-Environment Guide to Action: http://www.epa.gov/cleanenergy/pdf/gta/guide_action_chap5.pdf

State Output-Based Regulations	
State	Rule Type
California	Small DG Rule*
Connecticut	Allowance Allocation/trading Small DG Rule*
Delaware	Small DG Rule*
Indiana	Allowance Allocation/set-asides
Maine	Small DG Rule
Maryland	Allowance Allocation/set-asides
MA	Allowance Allocation/trading* Small DG Rule Multipollutant Regulation Allowance Allocation/set-asides
New Jersey	Allowance Allocation/trading Allowance Allocation/set-asides
Ohio	Allowance Allocation/set-asides
Texas	Conventional NO_x Limits Small DG Rule*
New Hampshire	Multipollutant Regulation
New York	Small DG Rule Allowance Allocation/set-asides
* Includes recognition of CHP through inclusion of thermal credit.	

IV. What Are States Doing?

Connecticut has promulgated an OBR for NO_x, particulate matter, CO, and CO_2 from small distributed generators (< 15 MW capacity), including CHP. The regulation values the efficiency of CHP based on the emissions that are avoided by not having separate electric and thermal generation. http://dep.state.ct.us/air2/regs/mainregs/sec42.pdf

Indiana has created a set-aside of allowances for energy efficiency and renewable energy in their NO_x trading program. Indiana allocates 1,103 tons of NO_x allowances each year for projects that reduce the consumption of electricity, reduce the consumption of energy other than electricity, or generate electricity using renewable energy. A manual for Indiana's EE/RE set-aside program may be downloaded from their website at:
http://www.in.gov/idem/air/standard/Sip/guide.pdf

Massachusetts has used OBR in several important regulations. The Massachusetts NO_x cap and trade program employs useful output, including the thermal output of CHP, to allocate emission allowances to affected sources (generators > 25 MW). This approach provides a significant economic incentive for CHP within the emissions cap. Massachusetts also has a multi-pollutant emission regulation (NO_x, SO_2, Hg, CO_2) for existing power plants, which uses an output-based format for conventional emission limits. For further information about the output based NBP allowance allocation process for Massachusetts' new unit and public benefit set-asides see: http://www.mass.gov/dep/air/priorities/regsup.doc

Texas has a standard permit with output-based emission limits for small electric generators. The permit sets different NO_x limits (lb/MWh) based on facility size, location, and level of utilization. The compliance calculation accounts for the thermal output of CHP units by converting the measured steam output (Btu) to an equivalent electrical output (MWh). The permit screening process allows CHP units to take credit for the heat recovered from the exhaust of the combustion unit to meet emission standards. Credit is offered at the rate of one MWh for each 3.4 million BTUs of heat recovered. For CHP units that were not sold and certified as an integrated package by the manufacturer, the owner or operator must provide documentation of the heat recovered, electric output, efficiency of the generator alone, efficiency of the generator including CHP, and the use for the non-electric output. The heat recovered must equal at least 20 percent of the total energy output of the CHP unit.
http://www.tceq.state.tx.us/assets/public/permitting/air/NewSourceReview/Combustion/segu_permitonly.pdf

V. Regional and National Programs

A. STAPPA/ALAPCO Alternative NOx Allowance Allocation Language for the Clean Air Interstate Rule

In August 2005, the State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO) prepared suggested language for NO_x allowance allocation under CAIR. Under CAIR, EPA provides flexibility to states in how they allocate NO_x allowances. The STAPPA/ALAPCO document offers states alternative regulatory language, employing allocation flexibility to promote clean technologies through several NO_x allocation options, including:

- Fuel-neutral allocation
- Updating the allocation baseline each time allowances are reallocated
- Reduced allocation lead time to bring new units in more quickly
- Improved treatment of CHP
- Increased new source set-aside
- Energy efficiency/renewable set-aside
- Direct allocation to renewables/energy efficiency
- Output-based allocation
- Reduction of NO_x cap

The full publication including model rule language may be downloaded at: http://www.4cleanair.org/Bluestein-cairallocation-final.pdf Please note, these options have not been reviewed or approved by the EPA.

B. EPA Combined Heat and Power Partnership

EPA's CHP Partnership offers states assistance in identifying and pursuing CHP-specific policies and programs. The Partnership tailors its assistance to each state's specific needs, identifying opportunities for policy options that encourage energy efficiency and CHP applications that are cost-effective and environmentally beneficial.

The Partnership has assisted states with identifying sectors that have the technical and economic potential to install or upgrade CHP projects, including such diverse applications as ethanol production, wastewater treatment plants, and hotels. Possible services include market analyses, education and outreach, targeted workshops and educational materials, direct project assistance, and project recognition, as well as state-to-state networking opportunities and examples of model state policies. The Partnership also offers access to extensive information on:

- Output-based regulations,
- Interconnection Standards,
- Renewable Portfolio Standards (RPS),
- EPA State Implementation Plan (SIP) Guidance,
- Utility Rates, and
- Public Benefit funds (PBFs).

For further information and links to the topics listed above, visit the Partnership homepage: http://www.epa.gov/chp/state_resources.htm.

VI. Resources

(1) The Clean Energy-Environment Guide to Action

The guide provides an overview of clean energy supply technology options, covering output-based regulations and other policies that states have adopted to encourage continued growth of clean energy technologies and energy efficiency. www.epa.gov/cleanenergy

(2) Output-based Regulations: A Handbook for Air Regulators

This handbook documents the benefits of output-based emission limits and the experience of several states in implementing them. It is intended as a resource for air regulators in evaluating opportunities to adopt output-based regulations.
http://www.epa.gov/chp/pdf/output_rpt.pdf

(3) Developing and Updating Output-based NO_x Allowance Allocations

This EPA guidance document was the result of a 1999 stakeholder process to develop approaches to output-based allocation of emission trading allowances, including allocation to CHP facilities. www.epa.gov/airmarkets/fednox/april00/finaloutputguidanc.pdf

(4) Analysis of Output-based Allocation of Emission Trading Allowances

This report for the U.S. Combined Heat and Power Association provides background on emission trading programs and the benefits of output-based allocation, with a particular focus on CHP. http://uschpa.admgt.com/AllocationFinal.pdf

(5) Reducing Greenhouse Gases and Air Pollution: A Menu of Harmonized Options

This October 1999 paper from STAPPA/ALAPCO was prepared to assess strategies that simultaneously reduce conventional air pollution and greenhouse gases. For large stationary sources, like power plants or industrial boilers, the report places special emphasis on systems that boost efficiency, and specifically examines the use of excess heat from primary combustion. The report notes that CHP strategies can increase overall plant efficiency by 40 to 50 percent, reduce fuel use and all associated emissions considerably, and reduce costs.

(6) Regulatory Requirements Database for Small Electric Generators

This DOE/ORNL sponsored database includes a wide range of information on state regulations for distributed generation including CHP.
http://www.eea-inc.com/rrdb/DGRegProject/AirRegs.html

For more information on output-based regulations or incorporating CHP into your air quality plans, please contact Tom Frankiewicz at 202.343.9794 or frankiewicz.thomas@epa.gov.