Output-Based Environmental Regulations

An Effective Policy to Support Clean Energy Supply

How Do Output-Based Environmental Regulations Encourage Clean Energy?

Output-based environmental regulations (OBR) can be an important tool for promoting an array of innovative energy technologies that can help achieve national environmental and energy goals by reducing fuel use. OBR encourage energy efficiency and clean energy supply such as combined heat and power (CHP) by relating emissions to the productive output of the energy-consuming process. The goal of OBR is to encourage the use of fuel conversion efficiency as an air pollution control measure. While OBR have been used for years in regulating some industrial processes, they have only recently begun to be applied to electricity and steam generation.

Most environmental regulations for power generators and boilers have established emissions limits based on heat input or exhaust concentration: that is, they measure emissions in pounds per million British thermal units (lb/MMBtu) of heat input or in parts per million (ppm) of pollutants in the exhaust stream. These traditional input-based limits do not account for the pollution prevention benefits of process efficiency in ways that encourage reduced energy use. For example, installation of energy-efficient technologies reduces emissions because less fuel is burned for the same energy

What Are the Benefits of Using More Energy Efficient Technologies?

- ***Reduced Fossil Fuel Use***. Encouraging energy efficiency will reduce the demand for fossil fuels.
- ***Multipollutant Emissions Reductions.*** The use of efficiency as a pollution control measure results in multipollutant emissions reductions. For example, a source that chooses to comply with NOx limits by increasing fuel conversion efficiency will also reduce emissions of all other pollutants as well.
- ***Multimedia Environmental Reductions***. By encouraging reduced fuel use, OBR reduce air, water, and solid waste impacts that result from the production, processing, transportation, and combustion of fossil fuels.
- ***Technology Innovation.*** Encouraging more efficient energy generation can advance the use of innovative technologies, such as CHP.
- ***Reduced Compliance Costs.*** Allowing the use of energy efficiency as part of an emissions control strategy provides regulated sources with additional compliance options. This flexibility enables the plant operator to determine the most cost-effective way to reduce emissions, while providing an incentive to use less fuel.

output. But with input-based emissions limits, the reduced emissions from improved energy efficiency are not counted toward compliance. By not accounting for these emissions reductions, input-based emissions limits do not properly incentivize energy efficiency improvements.

To encourage more energy-efficiency measures, states can design and implement OBR. OBR are expressed as emissions per unit of energy output (i.e., electricity, thermal energy, or shaft power). The units of measure can vary depending on the type of energy output. For electricity generation, the unit of measure is mass of emissions per megawatt-hour (lb/MWh).

How Do Output-Based Environmental Regulations Recognize the Unique Benefits of CHP?

OBR do not favor any particular technology and do not increase emissions. OBR simply level the playing field by establishing performance criteria and allowing energy efficiency to be considered on an equal basis along with other methods of reducing emissions (e.g., combustion controls and add-on controls).

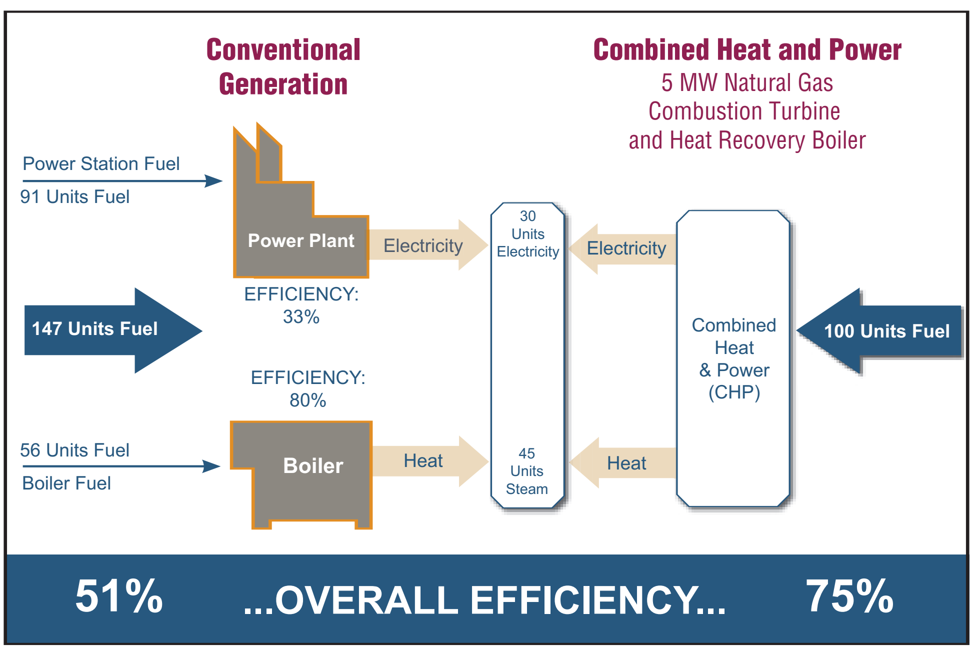
OBR are particularly important for recognizing the significant energy and environmental benefits of CHP (see Figure 1). CHP units produce both electrical and thermal output. OBR can be designed to explicitly account for both types of output in the compliance computation (accounting for thermal output is particularly important because CHP achieves its superior energy-efficiency by producing both electricity and thermal energy from a single fuel source).

What are the Benefits of an Output-Based Approach?

Emissions standards that account for the emissions reduction benefits of energy efficiency, and specifically of CHP, will make it more attractive for facilities to obtain permits for, and install, CHP. Output-based approaches also can be designed into cap and trade programs to encourage end-use energy efficiency and renewable energy projects.

OBR can reduce compliance costs because they give the plant operator additional flexibility in reducing emissions. Facility operators can comply by installing emissions control equipment, using a more energy-efficient process, or using a combination of the two. Regulating the emissions produced per unit of output has value for equipment designers and operators because it gives them additional opportunities to reduce emissions through more efficient fuel combustion, more efficient cooling towers, more efficient generators, and other process improvements that can increase plant efficiency.

Figure 1. CHP System Efficiency



Source: EPA, 2011

Example of Cost Flexibility Allowed by Output-Based Environmental Regulations

Consider a planned new or repowered coal-fired utility plant with an estimated uncontrolled nitrogen oxide (NOx) emissions rate of 0.35 lb/MMBtu heat input. To comply with an input-based emissions limit of 0.13 lb/MMBtu heat input, the plant operator would have to install emissions control technology to reduce NOx emissions by more than 60 percent. On the other hand, if the plant were subject to an equivalent output-based emissions limit of 1.3 lb/MWh, then the plant operator would have the option of considering alternative control strategies by varying both the operating efficiency of the plant and the efficiency of the emissions control system (Table 1). This output-based format allows the plant operator to determine the most cost-effective way to reduce NOx emissions and provides an incentive to reduce fuel consumption. The total annual emissions are the same in either case.

Table 1: Design Flexibility Offered by an Output-Based Emissions Limit

Plant Efficiency (%)	Emissions Limit (lb/MWh)	Required Control Device Efficiency (%)
34	1.3	60
40	1.3	55
44	1.3	48

In What Ways Can Output-Based Approaches Be Incorporated Into Air Pollution Regulations?

Output-based regulatory concepts can be applied to a variety of air pollution regulations, including:

- *Conventional emissions limits*, such as emissions limits in State Implementation Plans for Reasonably Available Control Technology.[i]
- *Emissions limits for small distributed generation (DG) and CHP.* Most states that have recently promulgated emissions limits for DG are using OBR.
- *Allowance allocation in emissions trading programs.* Emissions allowances are most commonly allocated based on either heat input or energy output. Allocation based on heat input gives more allowances to less-efficient units. Allocation based on energy output gives more allowances to more-efficient units. If based on energy output, an updating allocation system (where allowances are reallocated periodically) provides an ongoing incentive for improving energy efficiency.
- *Allowance allocation set-asides for energy efficiency and renewable energy.* In addition to allocating allowances to regulated sources, a cap and trade program can "set aside" a portion of its allowances for allocation to energy efficiency, renewable energy, and CHP projects that meet an output-based emissions limit and that are not regulated under the cap and trade program. These unregulated units can sell the allowances to regulated units to generate additional revenue.
- *CO_2 emissions performance standards (EPS).* Several states have used OBR to implement CO_2 emissions performance standards by placing limits for power plants.

Which States Have Established Output-Based Environmental Regulations?

In the early to mid-2000's, most OBR took the form of output-based emissions limits established as part of state Small Distributed Generation (DG) rules, or output-based set-asides and allowance distributions established as part of the NOx SIP Call or the Clean Air Interstate Rule (CAIR).[ii] Subsequently, several states established output-based CO_2 emissions performance standards or developed output-based set-asides as part of the Regional Greenhouse Gas Initiative (RGGI).[iii]

At the federal level, EPA has established a number of output-based New Source Performance Standards (NSPS) since 2006.[iv] The federal NSPS for NOx from electric utility boilers and the proposed NSPS for combustion turbines are structured as OBR. Each rule also contains compliance provisions for CHP. These regulations provide excellent examples of output-based rule language and technical documentation (*http://www.epa.gov/ttn/oarpg/t3pfpr.html*).

Additionally, a number of climate change bills have contained output-based performance standards for new power plants (e.g., Boxer-Lieberman-Warner Climate Security Act (S. 3036)). EPA also issued air toxics standards for boilers (often referred to as the "boiler MACT") in February 2011 that included an output-based emissions standard as an option (the standards are being reconsidered as of June 2011 while EPA seeks and reviews additional public input on new standards).[v,vi]

Several states have adopted OBR and developed rules that account for the efficiency benefits of CHP. Table 2 presents a summary of state OBR programs. The state examples described below were chosen because they account for both the electrical and thermal output of CHP or exemplify a variety of regulatory options for adopting output-based standards (allowance allocations, set-asides, small DG regulation, etc.):

Conventional Emissions Limits—California. California has set output-based emissions limits (NOx, CO, VOCs, and PM) for DG units in the state. The standards include a separate limit for DG units. The DG limit applies to CHP and accounts for both electrical and thermal output. For information on the DG certification program see, *http://www.arb.ca.gov/regact/dg06/finalfro.pdf.*

Emissions Limits for Small Distributed Generation (DG) and CHP—Connecticut. Connecticut has promulgated an OBR for NOx, particulate matter, CO, and CO_2 from small DG (< 15 MW capacity), including CHP. Connecticut's regulation recognizes the efficiency of CHP by accounting for both the electrical and thermal output of the systems. For information on Connecticut's DG rule see, *http://www.ct.gov/dep/lib/dep/air/regulations/mainregs/sec42.pdf*.

Allowance Allocation in Emissions Trading Programs—Massachusetts. The Massachusetts NOx cap and trade program (under CAIR[vii]), 310 CMR 7.32 accounts for the thermal output of CHP when allocating emissions allowances to affected sources (generators > 25 MW). For more information on the state's CAIR regulations visit *http://www.mass.gov/dep/air/laws/cairfnl.pdf*.

Allowance Allocation Set-Asides for Energy Efficiency and Renewable Energy—Indiana. Indiana's NOx trading program as part of the Clean Air Interstate Rule (CAIR[viii]) includes a set-aside of allowance allocations for energy efficiency and renewable energy. Indiana allocates 999 tons of NOx 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. Eligible technologies include combined cycle systems, CHP, microturbines, and fuel cells. For more information, visit *http://www.in.gov/legislative/iac/T03260/A00240.PDF*.

Emissions Performance Standards (EPS)—California, Oregon, and Washington. These states apply output-based standards to control CO_2 emissions from power plants. The standard for all three states is 1,100 lbs of CO_2/MWh. Also, Massachusetts under its earlier multi-pollutant regulations for power plants set an output-based standard of 1,800 lbs of CO_2/MWh. For information on the CO_2 emissions performance standard, please see, *http://www.energy.ca.gov/emission_standards/index.html*.

Elements of a Successful Policy

Based on the experiences of state environmental agencies that have developed OBR, a number of best practices have emerged for designing and implementing effective OBR:

- ***Conduct internal education*** to ensure that state air regulators understand the benefits, principles, and mechanisms of OBR and CHP.
- ***Evaluate the state's overall air pollution regulatory program.*** Regulatory programs are routinely reviewed and revised, and occasionally new programs are mandated by state or federal legislation. States can take advantage of those opportunities to evaluate their regulatory programs to determine whether their regulations are structured to encourage energy efficiency, as well as pollution prevention and renewable resources.

Table 2: State Output-Based Environmental Regulations

State	Conventional Emissions Limit	Small DG Rule	Allowance Trading	Allowance Set-Asides	Emissions Performance Standard (EPS)
Arkansas			X*		
California	X*	X*			X
Connecticut		X*	X*	X*	X
Delaware	X*				
Illinois			X*	X*	
Indiana			X	X	
Maine	X				
Massachusetts	X	X	X*	X	X*
Missouri			X*	X*	
New Hampshire	X				
New Jersey			X*	X*	
New York		X (proposed)			
Ohio			X*		
Oregon					X
Pennsylvania			X*		
Rhode Island	X*				
Texas		X*			
Washington					X
Wisconsin			X*		

*Includes recognition of CHP by accounting for thermal output.

- ***Coordinate with other state agencies that can lend support.*** State energy offices, energy research and development offices, and economic development offices can be important supporters in promoting OBR, efficiency, and CHP. Their perspective on the importance of energy efficiency and pollution prevention can be very valuable when formulating OBR policies.
- ***Determine what types of DG and CHP technologies and applications might be affected*** and whether there are any specific technology issues that regulations need to address. Consult with the Public Service Commission, Independent System Operator, and owners or operators of DG and CHP units to inform regulatory determinations.
- ***Gather/review available output-based emissions data for regulated sources.*** Alternatively, convert available data to output-based format. Obtain information from equipment providers on technologies and emissions profiles, and capitalize on experience and work already conducted by other states.
- ***Ensure that OBR account for thermal output.*** In order for OBR to fully recognize the benefits of CHP, the value of the thermal energy output must be included in the output computation.
- ***Train permit writers*** on implementation of the new rules, once adopted.

EPA Assistance Available

The EPA CHP Partnership is a voluntary program that seeks to reduce the environmental impact of power generation by promoting the use of cost-effective CHP. The Partnership assists state policy makers and air regulators to evaluate opportunities to encourage CHP through the implementation of policies and programs. See *www.epa.gov/chp*.

Additional Resources

EPA has developed *Output-based Regulations: A Handbook for Air Regulators*, which explains the benefits of OBR, how to develop OBR, and the experience of several states in implementing OBR. This handbook is intended as a resource for air regulators in evaluating opportunities to adopt OBR and writing regulations. The handbook is available at *http://www.epa.gov/chp/documents/obr_final_9105.pdf*.

EPA has created *The Clean Energy-Environment Guide to Action.* The Guide provides an overview of clean energy supply technology options and, in addition to OBR, presents a range of policies that states have adopted to encourage continued growth of clean energy technologies and energy efficiency. The Guide is available at *http://www.epa.gov/statelocalclimate/resources/action-guide.html*.

Developing and Updating Output-Based NOx Allowance Allocations. This EPA guidance document was the result of a 1999 stakeholder process to develop approaches to output-based allocation of emissions trading allowances, including allocation to CHP facilities. See *http://www.epa.gov/airmarkt/progsregs/nox/docs/finaloutputguidanc.pdf*.

End Notes

i EPA has used an output-based approach with recognition of CHP for the new source performance standards (NSPS) for NOx from utility boilers, NSPS for mercury from coal-fired utility boilers, and National Emission Standards for Hazardous Air Pollutants for combustion turbines.

ii Beginning in 2009 NOx and SO_2 emissions were regulated by the Clean Air Interstate Rule (CAIR). In July 2011 pursuant to a court order CAIR was replaced and strengthened by the Cross-State Air Pollution Rule which takes effect beginning in 2012. More information on the Cross-State Air Pollution Rule can be found at: *http://www.epa.gov/crossstaterule/basic.html*.

iii The Regional Greenhouse Gas initiative (RGGI) applies to ten Northeastern and Mid-Atlantic states. The program imposes CO_2 caps on electric power generators larger than 25 MW in participating states and functions as a multi-state cap-and-trade program with a market-based emissions trading system. As of June 2011, ten states are participating in RGGI: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island and Vermont. New Jersey announced its withdrawal from the program in June 2011 (the state will continue its participation until the start of 2012). The cap began in 2009 at 2009 emissions levels and will be reduced by 10% between 2016 and 2019.

iv The following NSPS regulations developed over the past five years are output based – 1) utility and industrial boiler NSPS, 2) stationary combustion turbine NSPS, and 3) the reciprocating internal combustion engine NSPS (for both compression ignition and spark ignited engines). An overview of recent output-based regulations can be accessed at: *http://www.epa.gov/chp/documents/wbnr012909_fellner.pdf*.

v Emissions Standards for Boilers and Process Heaters and Commercial/Industrial Solid Waste Incinerators. *http://www.epa.gov/airquality/combustion/*.

vi EPA announced that new standards will be proposed by the end of October 2011 and final regulations will be released by the end of April 2012. See, *http://www.epa.gov/airquality/combustion/actions.html#jun11*.

vii See endnote ii.

viii See endnote ii.

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