Emissions Allowance Market Opportunities for Small Combined Heat and Power Projects in New York State

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New York State
Energy Research and
Development Authority

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Emissions Allowance Market Opportunities for Small Combined Heat and Power Projects in New York State

Final Report

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NOTICE

PREFACE

The New York State Energy Research and Development Authority is pleased to publish "Emissions Allowance Market Opportunities for Small Combined Heat and Power Projects in New York State," prepared by Andrew Greene of Navigant Consulting, and Thomas Bourgeois and Daniel Rosenblum of the PACE Energy Project.

Combined heat and power (CHP) is typically more efficient than the separate generation of electricity in a central power plant and production of heat in an on-site boiler. This improved efficiency can result in a reduction of air pollutant emissions. The subject of this report is how existing NYS Department of Environmental Conservation allowance-based regulations can be interpreted and implemented with regard to small CHP projects to transform the general intent of the rules into a practical and effective mechanism to incentivize CHP projects.

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ABSTRACT

Although small-scale combined heat and power (CHP) projects offer many environmental and economic benefits to the facility owner, the grid, and the public in New York State, some of these benefits are only partially captured in the market economics, hindering the development of such projects. This report explores how CHP facilities below 15 MW can be included in the energy efficiency and renewable energy (EE/RE) allowance set-aside provisions of "cap and trade" emissions rules for nitrogen oxides (NO_x) and sulfur dioxide (SO_2). An emission allowance provides a regulated source with a tradable right to emit one ton of a particular pollutant; surplus allowances can be sold in established markets and an allowance deficit can be "covered" by purchasing them in such markets. Because small CHP projects are not regulated sources, any allowances they are given as an economic incentive can be sold and turned into cash. The formula for calculating the number of allowances would take into account (1) the relative efficiency of the CHP unit as an electricity generator (after subtracting fuel associated with the useful (i.e. delivered to a purposeful application and <u>not</u> wasted) thermal output); (2) the avoided energy losses (and resultant emissions benefits) associated with onsite generation compared with central station plants; and (3) the unit's emissions. The illustrated set-aside treatment—similar to that anticipated for large CHPs—could significantly boost the economic viability of small CHP projects by reducing installed costs by as much as 10% and thus provide a meaningful economic incentive that would promote such projects in New York State.

Key Words: CHP, Allowances, NOx, SO_2, Set-Aside, Efficiency

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SUMMARY

Despite the significant potential in New York State for thousands of commercial and institutional facilities to build small (below 15 MW) combined heat and power (CHP) projects, the financial benefits for owner/operators of such projects have not been sufficiently compelling to date, and a very small percentage of economically viable projects has been developed. CHP projects offer many environmental and economic benefits to the facility owner, the grid, and the public, yet some of these benefits are not currently captured in the market economics and therefore have little, if any, effect in moving projects forward. The New York State Department of Environmental Conservation (NYSDEC) and the New York State Energy Research and Development Authority (NYSERDA) recognize these benefits and have worked to help internalize benefits (such as through the award of emissions allowances) or other helpful policies and programs. The subject of this report is how the existing (and possibly future) NYSDEC allowance-based regulations can be interpreted and implemented with regard to small CHP projects to transform the general intent of the rules into a practical and effective mechanism to incentivize CHP projects.

This report illustrates how small CHP facilities could be included in the energy efficiency and renewable energy (EE/RE) allowance set-aside provisions of the existing NYSDEC "cap and trade" emissions rules for nitrogen oxides (NO_x) and sulfur dioxide (SO_2) and in potential rules that may be developed for carbon dioxide (CO_2) or particulates. An emission allowance provides a regulated source with a tradable permit to emit one ton of a particular pollutant; surplus allowances can be sold in established markets and an allowance deficit can be "covered" by purchasing them. Because small CHP projects are not regulated sources, any allowances they are given as an economic incentive are surplus, and can therefore be sold and turned into cash. Inclusion of small CHP in the EE/RE set-aside, although not articulated explicitly in the NYSDEC cap-and-trade regulations, is clearly consistent with the intent of the program to encourage more efficient, less polluting forms of energy generation.

Further, this report illustrates the benefits of small CHP projects receiving such allowances for up to five years (following the year in which the installation is completed), which is a sufficient duration to provide a meaningful incentive, but not so long that the pool of set-aside allowance would become oversubscribed and diminish the benefit available for new entrants in future years. The formula for calculating the number of allowances would take into account (1) the relative efficiency of the CHP unit as an electricity generator (net of useful thermal output) compared with the average grid-connected fossil generation unit in New York State; (2) the avoided energy losses (and resultant emissions benefits) associated with onsite generation compared with central station plants; and (3) the emissions from the CHP facility. In many respects, the illustrated approach is equivalent to the anticipated treatment of large (over 15 MW) CHP units and other energy-efficient generators under the NYSDEC set-aside provisions. For purposes of determining the electrical efficiency of the CHP unit, this report demonstrates apportioning fuel use

between electrical production and useful thermal production in proportion to their respective British Thermal Units (BTUs) heat content.

The set-aside treatment illustrated in this report could significantly boost the economic viability of small CHP projects by reducing installed costs by as much as 10%—and potentially more, if CO_2 cap-and-trade rules with EE/RE set-asides are adopted. This proposal would provide a meaningful economic incentive that would help bring more of these projects to fruition in New York State.

INTRODUCTION

The New York State Department of Environmental Conservation (NYSDEC) currently has three "cap and trade" emissions allowance rules that are designed to reduce the overall level of emissions from large industrial sources and electricity plants that generate more than 15 MW: (1) 6 NYCRR Part 204, covering emissions of nitrogen oxides (NO_x) during the ozone season (May–September); (2) 6 NYCRR Part 237, covering non-ozone-season NO_x emissions; and (3) 6 NYCRR Part 238, covering year-round emissions of sulfur dioxide (SO_2). Each of these rules includes an identical "set-aside" provision that reserves 3% of the total allowance cap for economic incentives awarded to qualifying energy efficiency and renewable energy (EE/RE) projects.[1] Qualifying EE/RE projects can sell the set-aside allowances in established emissions markets and thereby capture additional value. Because small CHP projects are not regulated sources under the NYSDEC cap and trade program, any allowances they receive are not required for regulatory purposes and can therefore be sold. The intent of the set-aside program is to provide economic incentives that can help increase market penetration of EE/RE technologies, which provide a host of societal benefits that are not fully compensated in existing markets.

The purpose of this study is to investigate specific ways in which small (below 15 MW) combined heat and power (CHP) units, with support from the New York State Energy and Research Development Authority (NYSERDA), can participate in the NYSDEC cap-and-trade emissions programs. Although small CHP units are not regulated sources under these rules, they stand to benefit through voluntary participation if they earn emissions allowances that can be sold. This report suggests addressing small CHP units in the allowance programs through the (EE/RE) set-aside mechanism.

CHP applications have the potential to produce emissions reduction benefits relative to separate heat and power (SHP) approaches, in which an on-site boiler serves an end-user's thermal needs and the utility grid serves all its electrical needs. The air emissions benefits of CHP depend on three factors: (1) the emissions of the CHP unit; (2) the avoided emissions of the retired or derated on-site boiler (or a typical boiler, if the CHP is being installed in a new facility); and (3) the avoided power plant emissions that are displaced by

[1] The distinction between an emission allowance and an emission reduction credit is an important one in this report and the companion report, *Guidebook for Small Combined Heat and Power Systems Seeking to Obtain Emissions Reduction Credits in New York State*. An emission allowance provides a regulated source with a tradable permit to emit one ton of a particular pollutant, such as NOx or SO2. An emission reduction credit (ERC) is used only in the context of permitting major new or modified emission sources under the New Source Review (NSR) program. Under NSR, a new/modified source's maximum permitted yearly emissions of non-attainment pollutants (such as NOx, volatile organic compounds, or carbon monoxide) must be offset by the permanent reduction (e.g. through facility closure or irreversible process changes) of these same pollutants at other facilities. A large new facility (such as a power plant) is required to obtain ERCs as part of the NSR process, and, once operational, it will also need to possess enough allowances each year to cover its actual emissions of "cap and trade" pollutants, such as NOx and SO2.

the output of the CHP unit. In some situations, particularly where high-emitting diesel engines are the power generating technology in the CHP application, CHP may actually produce more emissions than SHP. In its pending rulemaking on distributed generation (DG) emissions standards, NYSDEC is taking steps to ensure that new and existing DG installations—including diesel engines—are relatively clean.

The increased use of clean, highly efficient CHP technologies could further numerous policy objectives, including energy efficiency, reductions in air pollution and greenhouse gases, grid reliability and power quality, more competitive wholesale electricity markets, and lower energy costs for end-users. Continuing technological development promises to augment the benefits from CHP and help expand the presence of small CHP units in the marketplace.

CHP is already well established in New York State. Such units are installed at 210 sites and account for approximately 5,000 MW. Approximately 78% of CHP capacity is located at industrial facilities, with a small number of large CHP units making up the bulk of the capacity. A recent study conducted for NYSERDA found that of the 8,500 MW of technical potential for new CHP at 26,000 sites in New York State, 74% of this capacity is for systems below 5 MW that would be sited primarily at commercial and institutional facilities. Despite this significant potential, market penetration of small CHP has been minimal to date. This unexploited segment of the CHP market is the focus of our study.

Although voluntary participation in cap-and-trade programs will assist small CHP market penetration, significant market barriers to greater use of small CHP persist and require appropriate solutions. For example, burdensome interconnection requirements, cumbersome or punitive tariffs for standby power, or unclear permitting requirements can deter otherwise-sound small CHP projects. Although this study evaluates the use of emissions cap-and-trade programs as an incentive mechanism, CHP project developers often perceive environmental regulation as a threat rather than an opportunity. The policies that follow from this study (and other such initiatives) are intended to alter this perception.

Section 1

CHP AND AIR EMISSIONS REGULATION: A NEED FOR APPROPRIATE ELECTRICAL AND THERMAL METRICS

OVERVIEW OF THE PROBLEM

A critical issue affecting CHP units in cap-and-trade programs (and other areas of environmental regulation) is how the thermal output of CHP is taken into account by regulators in setting and measuring environmental performance. Although air pollution regulation in New York State (and elsewhere) has achieved significant air quality benefits over the past few decades, CHP advocates see three critical shortcomings. First, air emissions rules typically set and measure emissions requirements as a function of fuel input (e.g., lb/MMBtu) or stack emissions concentrations (e.g., parts per million) rather than as a function of useful energy output.[2] Second, even when output based, air regulations sometimes ignore the thermal output of CHP systems and treat all fuel use and emissions as stemming exclusively from CHP's electricity production. Third, environmental regulations typically do not recognize that CHP units have negligible transmission and distribution losses compared with the U.S. average of almost 8% T&D losses for central station power plants, thereby resulting in a lower effective emissions rate, whether input- or output-based. CHP proponents contend that because of these emissions measurement practices, CHP is viewed (and sometimes regulated) as having higher emissions rates than is actually warranted.

Regulating CHP solely as an electricity generator overlooks the useful thermal output produced. CHP can be designed to function primarily as a thermal source (essentially replicating the work performed by a boiler) or primarily as an electricity generator (providing enough electricity to displace all or a substantial portion of on-site load requirements) or any combination in between. The relationship between electrical and thermal production is described by the "power–to-heat" ratio, which can vary significantly.[3] In an extreme case, a CHP unit that is primarily designed and operated like a boiler for its thermal output (e.g., with a power-to-heat ratio of 0.15)[4] might nevertheless be regulated as if it were an electricity generator. Figure 1 shows how this might look.

[2] It is interesting to note that, in contrast to stationary source standards, auto emission standards have always been output-based, expressed in terms of grams of pollutant per vehicle mile traveled. Output-based standards make even more sense for electric generators than for vehicles, since electrical output (e.g., 1 kWh) is a uniform and consistent output measure. A vehicle mile traveled, on the other hand, is not a uniform measure of energy output, since vehicle weights and other mileage-related factors vary considerably.

[3] In its Emission Standards for Smaller-Scale Generation, the Regulatory Assistance Project recommends that an acceptable range of power-to-heat production can vary from 15% to 400%.

[4] A power-to-heat ratio of 0.15 means that the electric output is 15% of the useful thermal output.

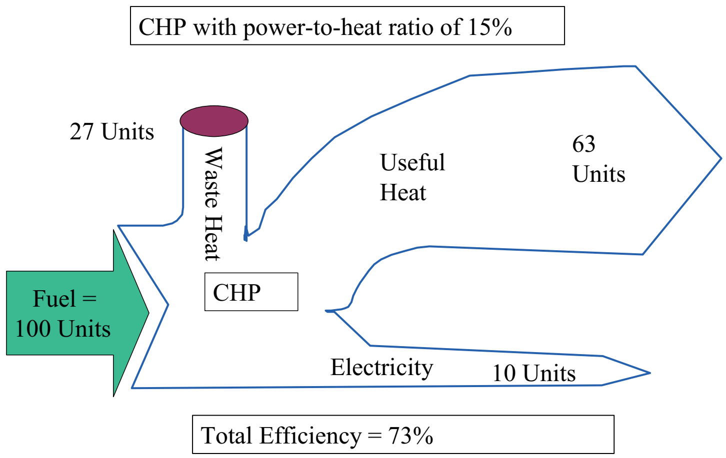

Figure 1. CHP That Closely Resembles a Boiler.

Regulations for electricity generators and industrial and commercial boilers can vary significantly. With few exceptions, regulations pertaining to CHP units overlook the dual functions of CHP and treat them as if they were electricity generators only. This potential regulatory bias increases as the proportion of useful thermal output grows relative to electrical output.

The following example illustrates the bias that can occur for CHP under existing regulations. NYSDEC's NO_x Budget Trading Program (6 NYCRR Part 204) uses a basic allocation factor of 0.15 lb/MMBtu of heat input for electricity-generating units (EGUs) and a 0.17 lb/MMBtu allocation factor for non-EGUs. In New York State, large CHP units (over 15 MWs) are treated solely as EGUs, thus receiving allowances at a rate of 0.15 lb/MMBtu rather than the 0.17 lb/MMBtu rate applicable to industrial boilers, even though those boilers serve the same function as the thermal side of CHP units. A more equitable approach for CHP would use both allocation factors, weighted by the relative amounts of electrical and useful thermal output.

Another instance where the regulatory treatment of CHP's thermal side raises concerns is the proposed emissions standards for distributed generation. Although the DG standards are output based, the proposal does not include useful heat recovery as "output"; only the electricity produced is so treated. Thus, all emissions from the CHP unit are viewed as a function of the MWhs produced—even if the useful thermal output dominates the electrical production.[5] Many similar examples can be found in other states.

[5] NYSDEC is aware of this concern but does not view the proposed rule as problematic, since the overwhelming majority of actual CHP systems on the market today should be able to meet the proposed standard. (Personal conversation with John Barnes, NYSDEC.)

A POTENTIAL SOLUTION

Given the longstanding disparities between regulatory provisions for EGUs and industrial boilers, coupled with the significant variability in CHP power-to-heat production, a more appropriate way to regulate CHP emissions is as both an EGU and a thermal source. This can be accomplished by "unbundling" fuel use, emissions, and heat rates between the thermal and electrical functions of CHP—that is, by treating CHP as two separate pieces of equipment. With separately delineated electrical and thermal profiles, EGU and non-EGU regulations can be applied to the relevant portions of a unit without bias or disregard for CHP's thermal functions.[6]

To unbundle the CHP unit's thermal and electrical characteristics, three pieces of data are needed: (1) fuel use; (2) electrical production; and (3) useful heat recovered. Each of these can be measured with a high degree of accuracy. Fuel flow meters and electric meters are commonly used for measurement purposes in environmental regulation. Although measuring useful heat recovery is not as well established or straightforward, there exist steam-flow meters, water-flow meters, and other measurement devices that are used in performance contracting arrangements to account for heat recovery.

Despite the simplicity of the concept, at least six different approaches to unbundling have been taken in practice in various regulatory programs, each yielding different results (Table 1).

Table 1. Existing Methods for Allocation of Fuel Input and Emissions in CHP Systems.

Allocation method (and proponent)	*Thermal-side fuel input allocation*	*Thermal-side emissions allocation*	*Electrical-side fuel input allocation*	*Electrical-side emissions allocation*
Pure EGU method (NYSDEC proposed DG emissions rule)	None	None	All	All
PURPA method (Federal Energy Regulatory Commission)	50% of useful heat recovery	Thermal-side fuel input as percentage of total fuel input times total emissions	Total fuel input less thermal-side fuel input	Total emissions less thermal-side emissions

[6] One potential concern with this approach may be that if CHP is treated as two separate units for air regulatory purposes, the unit may somehow evade permitting thresholds that become applicable as potential emissions increase (e.g., the progression from exempt/trivial emitter, to minor facility registration, to State facilities permit, to Title V permits for major sources). However, these permit thresholds are based on facility-wide emissions potential, with no advantage for defining more numerous but smaller emission units at a facility.

Allocation method (and proponent)	*Thermal-side fuel input allocation*	*Thermal-side emissions allocation*	*Electrical-side fuel input allocation*	*Electrical-side emissions allocation*
Thermal output deduction	Equal to useful heat recovery	Thermal-side fuel input as percentage of total fuel input times total emissions	Total fuel input less thermal-side fuel input	Total emissions less thermal-side emissions.
Proportional responsibility (Texas DG rule, Massachusetts NO_x SIP Call rule)	Useful heat recovered as percentage of total useful heat and power output times total fuel input	Thermal-side fuel input as percentage of total fuel input times total emissions	Total fuel input less thermal-side fuel input	Total emissions less thermal-side emissions
Thermal credit with proxy boiler (Environmental Protection Agency CHP partnership)	Fuel use required in 80%-efficient boiler to produce useful heat recovered	Thermal-side fuel input as percentage of total fuel use times total emissions	Total fuel input less thermal-side fuel input	Total emissions less thermal-side emissions
Emissions credit with proxy boiler Regulatory Assistance Project model rule)	Fuel use required in 80%-efficient boiler to produce useful heat recovered	Thermal-side fuel input at applicable emissions standard for proxy boiler	Total fuel input less thermal-side fuel input	Total emissions less thermal-side emissions

Attachment 1 (a–f) shows the application of the above allocation methods for an illustrative 5-MW combustion turbine–based CHP system. The allocation methods make a considerable difference in how the CHP unit's electrical and thermal performance would be measured.

The NYSDEC NO_x Budget Trading Program rule (and the Acid Deposition Reduction Program rules as well) gives some consideration to the question of how to unbundle large CHP sources (i.e., "cogeneration" facilities) for measuring the effective heat rate of the unit. The following definition of *average annual heat rate* is specified for purposes of awarding EE/RE set-aside allowances to fossil fuel–fired EGUs that have a lower net heat rate than the annual average heat rate for all fossil fuel–fired electricity generated in New York State:

> **Annual average heat rate** A measure of an electricity generating unit's thermal efficiency, expressed in Btu's per net kilowatt-hour, computed by dividing the heat input (based on total

higher heating value BTU content of the fuel burned) for electricity generation by the resulting net kilowatt-hour generation during a calendar year. *For co-generation facilities, the heat input for electricity generation is calculated by the sum of the heat input for combustion turbines, steam boilers (excluding backup boilers) and supplemental firing minus the net heat input of useful thermal energy provided for purposes other than electricity generation.* (emphasis added)

The NYSDEC rule, which does not offer a specific numerical example or equation, could be interpreted in two ways. The term *net heat input of useful thermal energy* could mean that the actual heat recovered is subtracted from the fuel input to determine the net electrical heat rate. This approach is described as the "thermal output deduction" method in Table 1.

Annual average heat rate (using the thermal output deduction method)

$$= \frac{(FuelInput_{CalendarYear}) - (\text{Useful Thermal Energy}_{\text{Calendar Year}})}{NetKWh_{CalendarYear}}$$

Alternatively, *net heat input* may suggest that useful thermal energy refers to the amount of fuel that must be burned to produce the useful thermal energy, not just the useful thermal energy itself. The difference between the useful thermal energy recovered and the related fuel input stems from conversion losses (boilers are typically 80% efficient). To convert thermal energy recovered to fuel input energy, energy recovery is divided by a thermal efficiency factor. This approach, which appears in Table 1 as the "thermal credit with proxy boiler" method, results in a lower heat rate than the thermal output deduction approach.

Annual average heat rate (using the thermal credit with proxy boiler method)

$$= \frac{(FuelInput_{CalendarYear}) - (\text{Useful Thermal Energy}_{\text{Calendar Year}}/\text{Thermal Efficiency Rate})}{NetKWh_{CalendarYear}}$$

As noted in Table 1, there are still other alternatives to unbundling thermal and electrical fuel use and emissions. In its DG emissions standards rule, Texas uses the "proportional responsibility" method. This approach treats a kWh of electricity the same as a kWh of useful thermal output (i.e., 3,412 Btus). There is also precedent for use of the proportional responsibility method for CHP in the output-based emissions allowance allocation rules for the NO_x State Implementation Plan (SIP) Call rule of the Massachusetts Department of Environmental Protection. Under the Massachusetts allocation formula, 1 kWh of electricity and 3,412 Btus of useful thermal energy (1 kWh of useful thermal energy) each receive the same basic allocation of allowances (0.0015 lbs).

As discussed in Section 5 below, the choice of a fuel-emissions unbundling formula will also affect the treatment of small CHP units in the EE/RE set-aside stemming from the "efficient generator" provisions. As shown for the illustrative cases in Attachment 2, the proportional responsibility approach leads to the greatest amount of surplus allowances for CHP units, followed by the thermal credit with proxy boiler approach, and then the thermal output deduction approach. Using the proportional responsibility method gives equal weight to the thermal and electrical production of CHP units.

Section 2
HOW CHP RELATES TO CAP-AND-TRADE PROGRAMS

OVERVIEW OF CAP-AND-TRADE

Cap-and-trade programs are a relatively recent addition to the tools used by state and federal environmental regulators to achieve improvements in air quality. The essence of the cap-and-trade approach is that an aggregate amount of emissions of a particular pollutant, in a specified time period, is established as the "cap" and achieved through a prescribed number of emissions allowances. Regulated sources are required to surrender allowances equal to the tonnage of capped pollutants they emit. Emissions allowances are tradable in secondary markets, enabling sources to buy or sell them as needed. The cap-and-trade approach provides flexibility and decision-making authority to individual sources, enabling them to make their own choices as to the best, most advantageous compliance strategy.

One important aspect of cap-and-trade policy design is how emissions allowances are distributed to eligible sources. To date, most state and federal cap-and-trade programs have allocated emissions allowances (at no cost) based on the amount of fuel the source consumed during a baseline period. Although the federal Acid Rain Program of the U.S. Environmental Protection Agency (EPA) established fixed allocations, state programs typically revise the number of allocated allowances on a periodic basis. For example, NYSDEC updates the allocations to affected sources annually; Pennsylvania updates the allocations to sources every five years.

State cap-and-trade programs typically apply to large electricity generators (over 15 MW), large industrial sources (whose maximum fuel input exceeds 250 MMBtu per hour), and cement kilns. Large CHP units (over 15 MW) are also affected sources and are typically regulated like electricity generators. For example, in the NYSDEC NO_x Budget Trading Program, CHP units are allocated allowances based on the 0.15 lb/MMBtu EGU formula rather than the 0.17 lb/MMBtu formula (applicable to industrial boilers) for the thermal portion of their fuel consumption. In contrast, the Massachusetts NO_x SIP Call rule makes no distinction between industrial boilers and EGUs: each is allocated allowances on an identical, output-based formula (in which a kWh is equal to 3,412 Btus of useful heat output).

Another general feature of cap-and-trade rules is the ability of small sources to participate in the program voluntarily. The "opt-in" source agrees to be treated as if it were a regulated source: it receives an allocation of allowances and must surrender enough allowances to cover its emissions. Emissions monitoring procedures are also required of opt-in sources, just as with large sources. Under state and federal Part 75 emissions monitoring and reporting requirements, large sources (over 50 tons of NO_x per ozone season) must have continuous emissions monitoring (CEM) equipment. Sources below this level can choose between alternative monitoring approaches that rely on fuel use data and emissions factors (through stack testing, or default values from AP-42). Under the NO_x SIP Call, if a source opts-in to a state's program, EPA provides additional allowances that increase the state's emissions cap.

Opt-in source allocations are typically set at the lesser of the permitted baseline emissions rate limit or the actual baseline emissions rate times baseline heat input. In theory, opt-ins could be beneficial for small sources that make significant improvements in emissions performance (e.g., through fuel switching). In practice, however, opt-in provisions are seldom used because of the difficulty of obtaining enough allowances in excess of emissions to warrant the added costs of meeting emissions monitoring requirements and other administrative costs.

ENERGY EFFICIENCY AND RENEWABLES SET-ASIDES

As part of its guidance to states affected by the NO_x SIP Call, EPA suggested that state rules include a pool of energy efficiency and renewable energy (EE/RE) set-aside allowances of 5% to 15% of the state NO_x budget. Thus far, approximately six states (including New York) have adopted EPA's suggestion and implemented a set-aside for EE/RE.[7] To date, none of the states has implemented an EE/RE set-aside greater than 5% of its NO_x budget.

By awarding tradable allowances, EE/RE set-aside programs provide an additional source of market value to qualifying projects and make them more feasible to develop. In Massachusetts and Indiana, eligible renewable sources are limited strictly to non-emitting technologies (thus excluding biomass), whereas in New York, biomass facilities can qualify for the renewable set-aside. It is not yet clear whether the NYSDEC approach for awarding set-aside allowances to emitting renewable resources will be affected by the source's emissions. This issue could have some bearing on the treatment of CHP (also an emitting resource) in the EE/RE context.

EPA guidance and state-specific set-aside proposals have resulted in a variety of new activities that count toward the EE/RE set-aside mechanisms:

- utility-scale, grid-connected renewable generation projects;
- behind-the-meter renewable generation projects (e.g., photovoltaic installations);
- end-user energy efficiency measures;
- efficiency improvements in transmission and distribution (T&D);
- highly efficient fossil generation (or generation efficiency upgrades);
- combined heat and power (CHP); and
- nuclear capacity expansion (New Hampshire).

[7] EPA guidance documents, such as those addressing the EE/RE set-aside area, are not regulations and do not have the effect of regulations; they are merely suggestions.

As the list suggests, states have rather broad discretion in deciding which types of activities to encourage through the EE/RE mechanism. Although EPA has established guidelines for development of such programs, they are not mandates that states are obligated to follow. And although it frequently comments on the development of set-aside provisions, EPA has not taken issue with any EE/RE proposals submitted as part of the NO_x SIP Call rule implementation process.

Despite EPA guidance that attempts to dissuade states from providing EE/RE set-aside allowances for efficiency improvements at *existing* regulated sources (which will directly benefit from increasing their generation efficiency), several states, including New York, have nevertheless incorporated such provisions. EPA guidance nevertheless explicitly supports the inclusion of end-use CHP systems in the set-aside program. EPA advised that the set-aside for CHP units should be based on the amount of electricity produced and thereby displaced from other types of generation, accounting for NO_x emissions produced on-site by the CHP unit. As described in Attachment 3 and Section 5 below, New York, Massachusetts and Indiana appear to be the only three states that have created set-aside mechanisms with explicit provisions pertaining to CHP.

SMALL CHP UNITS AND EMISSIONS CAPS

An important factor to consider in addressing the role of small CHP units in electricity sector emissions caps is the potential danger of "emissions migration" and a resultant breach of the emissions cap intended for the electricity sector. Small CHP is not covered by the emissions caps that NYSDEC has placed on large electricity generators (as well as large industrial boilers). The non-participation of small CHP units (and other distributed generators) in the emissions cap can pose a risk to the ability of cap and trade programs to actually limit emissions for the electricity sector in its entirety.

To illustrate this risk, imagine that new installations of small CHP units realize their full technical potential of 8,500 incremental MWs (which represents about 20% of the generating capacity of the New York Independent System Operator, NYISO), operate in a baseload manner, and remain exempt from the cap-and-trade program. In this scenario, it is likely that a significant amount of existing central station generation output in the NYISO region and adjacent markets will be displaced, resulting in lower electricity production and lower total emissions from central station plants than would have otherwise occurred. The substantial amount of generation (and emissions) that migrates to small CHP units is exempt from the emissions cap. The wave of CHP-induced central generation plant displacement would create downward pressure on emissions allowance market prices as generators find themselves with surplus allowances precipitated by growing CHP activity.

Falling prices in allowance markets could have both short-term and long-term effects. In the short term, the lower allowance prices will encourage some generators to buy allowances rather than reducing plant emissions through more costly changes, such as fuel switching. Some generators may even turn off existing emissions controls if the allowances are less expensive per ton than variable control costs per ton removed. In the long term, lower, sustained allowance prices will discourage some plants from undertaking emissions control projects that would have otherwise been economic. Thus, the emissions "avoided" by CHP are likely to eventually reenter the atmosphere once economic equilibrium returns to the allowance market. Meanwhile, the CHP units would still be emitting pollution, free from the constraints of cap-and-trade rules. In this scenario, migration of generation to CHP could actually increase the aggregate level of emissions that were supposed to be capped.

The obvious solution to a potentially "leaky" emissions cap is to broaden the application of the cap to include small generation sources that effectively compete in the grid-connected market. This issue is largely confined to the electrical side of CHP, given that on-site thermal generation is generally not a substitute for other capped emissions sources (such as large industrial boilers).

Section 3
IS CHP CLEAN ENOUGH TO WARRANT REGULATORY INCENTIVES?

By definition**,** CHP applications produce simultaneous heat and power (which can include electricity or mechanical energy or both) and thus differ from traditional power plants and end-use boilers (and other thermal equipment), which produce only electrical power and only useful heat output, respectively. Many small CHP applications can achieve significant emissions reduction benefits relative to the typical separate heat and power (SHP) configuration, in which an on-site (often older) boiler serves an end-user's thermal needs, and central station power plants serve its electrical needs. The net air emissions benefits of CHP depend on three factors: (1) the emissions of the retired or derated on-site boiler; (2) the emissions of the CHP unit; and (3) the power plant emissions that are displaced by the CHP unit. The total energy efficiency of the CHP system (the combined electrical and useful thermal output as a percentage of fuel input) is often significantly higher than the typical SHP setup, usually ranging from 60% to 85%, depending on the type of CHP equipment and thermal application. This compares favorably with SHP's overall efficiency of around 45% to 60% (about 30% to 35% for the electrical side and 75% to 80% on the thermal side). Figures 2, 3, and 4 illustrate hypothetical examples.

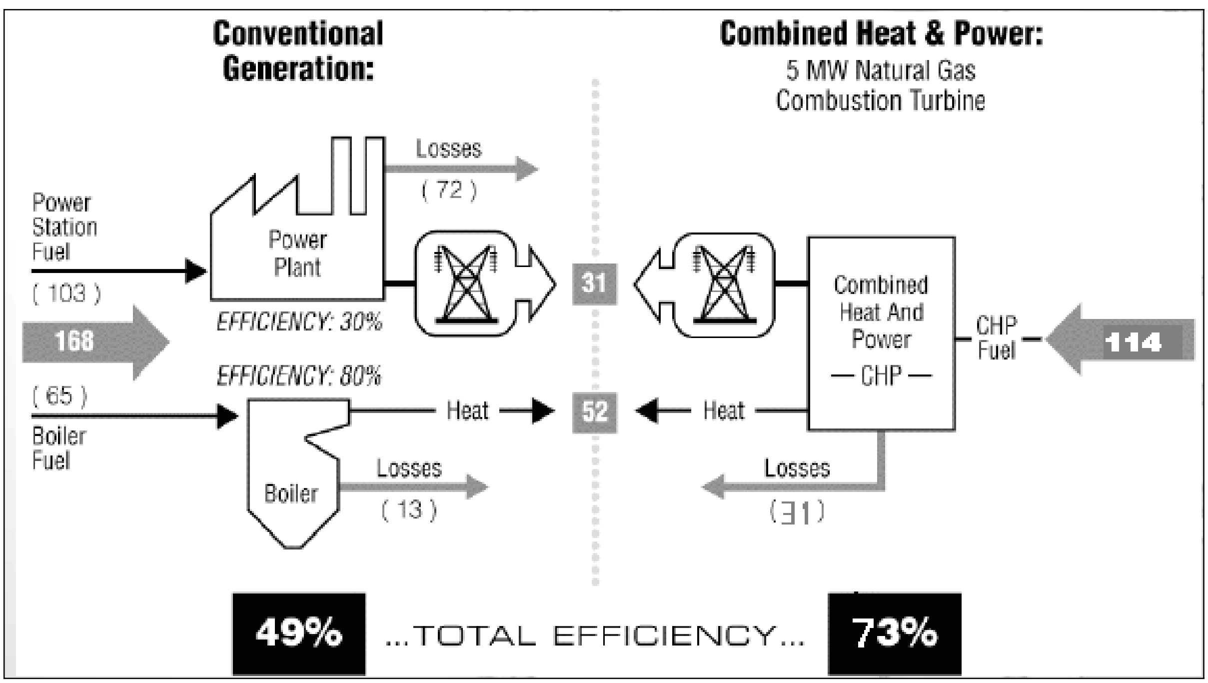

Figure 2. Total Efficiency of Separate versus Combined Heat and Power.

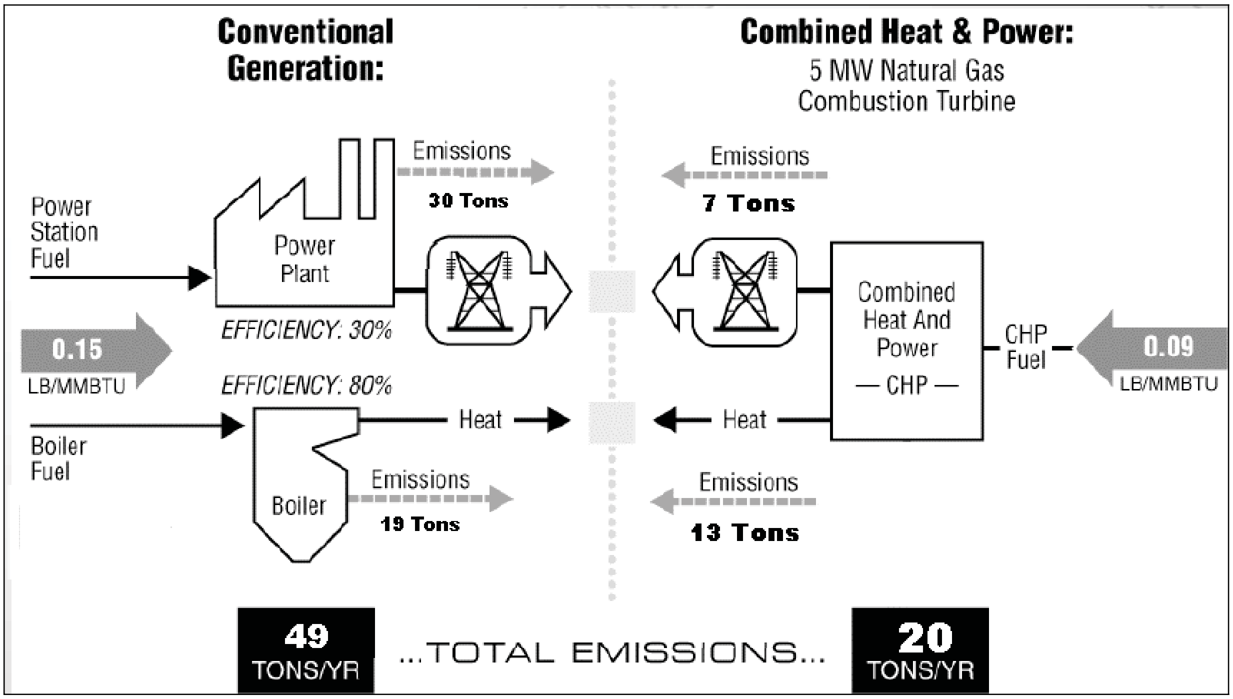

Figure 3. Emissions of Separate versus Combined Heat and Power with #2 Fuel Oil.

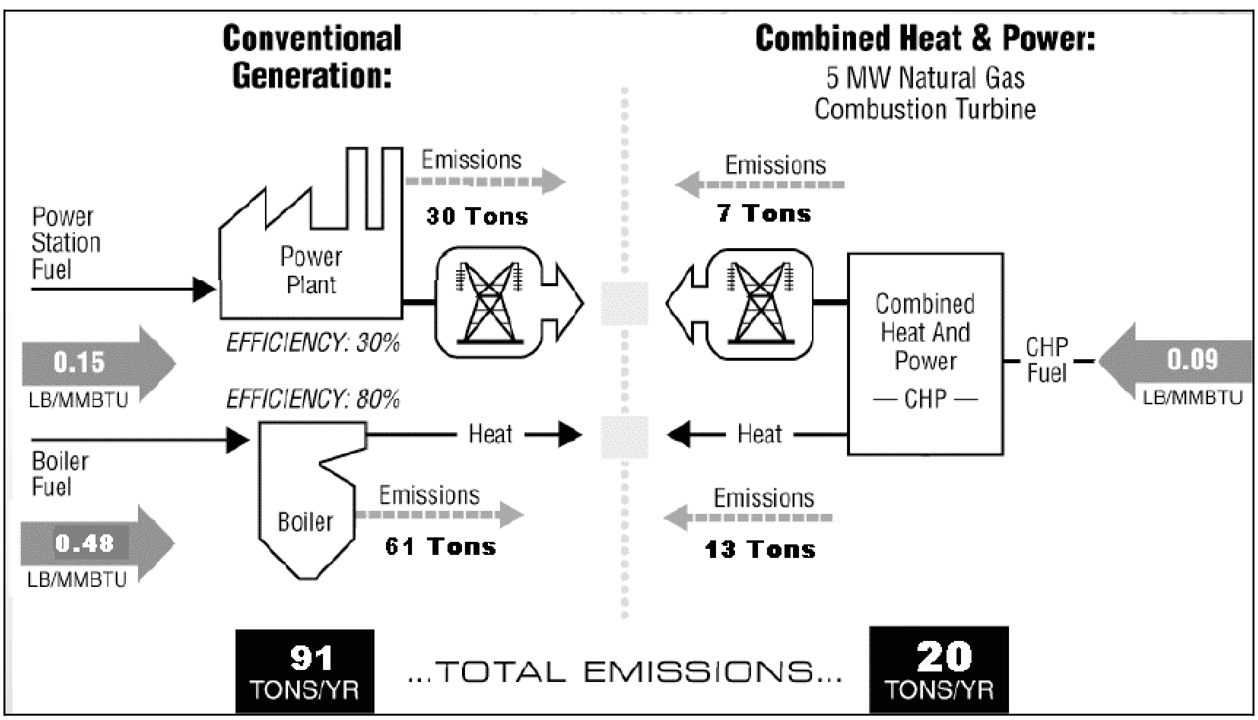

Figure 4. Emissions of Separate versus Combined Heat and Power with #6 Fuel Oil.

Source: EPA CHP Partnership/Energy & Environmental Analysis, Inc., with NCI modifications

Attachment 4 compares representative emissions rates (in lbs/MWh) for various DG and central station generating technologies. In a CHP configuration, the emissions rates of the DG technologies shown would be lower because of the unbundling of emissions between the electrical and thermal sides of the CHP operation. Assuming a typical range of power-to-heat ratios of 0.5 to 2, the emissions per MWh would be reduced by as much as 66%. Even with this adjustment, very few DG technologies can match the low emissions rates offered by combined-cycle gas turbine (CCGT) plants. If small CHP units replace combined-cycle gas plants, there will be few if any emissions benefits. However, there still may be considerable benefits associated with retiring or derating old, high-emitting boilers in favor of the CHP unit.

Regulatory determinations about the nature of avoided emissions vary considerably. In Vermont, the Public Service Board has accepted a “distributed utility planning” settlement that is based on the presumption that all forms of DG displace new, CCGT units, thus tending to create “emissions adders” for various forms of DG technology. Other regulators contend that even though combined-cycle plants are the likely candidates added to the grid, at any given time, marginal units (those last dispatched to meet load requirements) tend to be a mix of fuel and technology types, with emissions rates that are significantly higher than a combined-cycle unit.

Whether or not the electrical side of CHP has higher or lower emissions rates than the central station generators it displaces, the critical issue affecting environmental quality is the emissions cap. If the CHP units are subject to an emissions cap, the entire fleet of electricity generators will have to live within the cap, with minimal “leakage” from exempt sources.

If CHP sources are outside the cap, there are two potentially negative repercussions that should give pause to policy makers. First, if CHP units are higher-emitting than the units they displace, electricity sector emissions of the pollutant will be greater than would otherwise have been the case. Second, the effect may be magnified by downward pressure on allowance prices (because of the displacement of capped sources by uncapped sources), and as a result, emissions levels may increase further. However, there may be substantial emissions reductions on the CHP’s thermal side (relative to the retired or derated old boiler) that could exceed the electricity sector effects.

Section 4
OPERATION OF THE SET-ASIDE PROGRAM IN NEW YORK STATE

New York State adopted the NO_x Budget Trading Program, codified as 6 NYCRR Part 204, in February 2000 as the component of the federal NO_x Budget Trading Program. The federal NO_x emissions cap-and-trade program is designed to reduce regional emissions of NOx in the Eastern U.S. and reduce interstate ozone (and it precursor, NOx) transport in a cost-effective manner while providing compliance flexibility.

In New York State there are three classes of units that must participate in the trading program:

- *Electricity-generating units.* Any unit that at any time on or after January 1, 1995, serves a generator with a nameplate capacity of 15 MW or greater.
- *Portland cement kilns.* Any unit that is a Portland cement kiln having a maximum design heat input capacity greater than or equal to 250 MMBtus per hour.
- *Non-electricity-generating units.* Any unit other than an electricity-generating unit or a Portland cement kiln that has a maximum design heat input capacity greater than or equal to 250 MMBtus per hour.

These "applicable units" were required to file a NO_x budget permit application with a request for NO_x allowances by May 1, 2002.

The federal NO_x budget for New York State was set at 41,350 tons for the 2003 control period, the first year of program operation, and for each subsequent control period from 2003 through 2008 (§204-5.1). The control period is defined as the period beginning on May 1 of a year and ending on September 30 of the same year, inclusive. Of the total amount, 30,405 tons is allocated to electricity-generating units, 8,085 tons is allocated to Portland cement kilns, and 2,860 tons is allocated to non-electricity-generating units. Each affected unit must surrender NO_x emissions allowances equal to the amount of NO_x emissions from that unit during the control period. A NO_x allowance is an authorization by NYSDEC to emit up to 1 ton of nitrogen oxides during the control period of the specified year or any year thereafter. Unused allowances, limited to 10% of the yearly state budget, may be carried over to future time periods.

NYSDEC has elected to create an energy efficiency and renewable energy (EE/RE) set-aside, which is defined in §204.5.3(f). Of the total budget of 41,315 tons, 3% (1,240 tons) has been reserved for the EE/RE set-aside.

In each control period NYSDEC opens an EE/RE set-aside general account. Project owners of the following types of projects (located in New York State) are eligible:

- end-use energy efficiency projects;
- renewable energy projects (wind, solar thermal, photovoltaics, and landfill or digester methane);
- in-plant energy efficiency projects; and
- fossil fuel–fired electricity-generating units that produce electricity more efficiently than the annual average heat rate attributable to all fossil-fired electricity generated in New York State and non-electricity-generating units that exceed a thermal efficiency of 80%.

The authorized account representative of a project sponsor submits a written request to NYSDEC to reserve a number of NO_x allowances in the EE/RE set-aside allocation general account. The request must be made by July 1 after the control period for which the request is being made, and the control period (or portion thereof) must be within five years of the project's implementation.

Sponsors of end-use energy efficiency projects, renewable energy projects, or in-plant energy efficiency projects may request the reservation of NO_x allowances for any control period that is within five years of project implementation. End-use energy efficiency projects implemented on or after the 2002 control period that achieve creditable NO_x emissions reductions will obtain allowances for a five-year period. NYSDEC distributes NO_x allowances from the EE/RE set-aside allocation general account to the general account of a project sponsor within two years from the start of the control period for which the request was made.

NYSDEC has established a hierarchy of claims on NO_x allowances in the general account. First priority is given to end-use energy efficiency projects and renewable energy projects. Project sponsors of in-plant energy efficiency projects or fossil fuel–fired projects that meet the above criteria are considered for allowance reservation requests only after the department has satisfied all allowance reservation requests related to end-use energy efficiency or renewable energy projects.

If the number of NO_x allowances requested and approved exceeds the number of allowances in the EE/RE set-aside general account, NYSDEC distributes the allowances in the order in which project sponsors submitted approvable reservation requests. Reservation requests are assumed to have occurred simultaneously if they are made in the same calendar quarter. Should the number of approvable requests submitted in the same calendar quarter exceed the number of NO_x allowances in the general account, they are distributed in a manner proportional to the number of approved requests by each sponsor.

With the adoption of the Acid Deposition Reduction Trading Programs for NO_x (6 NYCRR Part 237) and SO_2 (6 NYCRR Part 238), NYSDEC has extended the application of allowance set-aside programs in an identical manner to the NO_x Budget Trading Program in 6 NYCRR Part 204. However, the new NO_x program addresses the non-ozone season (October–April), whereas the new SO_2 program addresses SO_2 on a year-round basis. Both of the new rules keep the earlier EE/RE set-aside percentage at 3% of the respective budget total.

Section 5

OPTIONS FOR ADDRESSING SMALL CHP IN NYSDEC CAP-AND-TRADE PROGRAMS

CRITERIA FOR PROGRAM DESIGN

There are several options for incorporating small CHP projects in the NYSDEC cap-and-trade programs in ways that encourage energy efficiency and emissions reductions. Suggested criteria for evaluating the options include the following:

- Does the program provide meaningful incentives that can stimulate market activity?
- Does it differentiate between clean, efficient CHP projects and those that are not?
- Is it consistent with NYSDEC precedents and the treatment of large CHP units that offer comparable benefits?
- Is administration of the program feasible for NYSDEC?
- Does it promote participation by eligible sources?

SUMMARY

The EE/RE set-aside in the cap-and-trade rules can be used to reward clean and efficient small CHP units. The suggested set-aside allowance allocation process for small CHP units would have three components:

- a surrogate allocation, which provides allowances as if the small generator were a regulated source for the duration of the set-aside eligibility;
- an efficiency multiplier, which scales the surrogate allowances based on the relative efficiency of the CHP unit compared with the average fossil fuel–fired unit in New York State; and
- an avoided line-loss allocation, which recognizes the savings in MWhs of CHP production due to avoided transmission and distribution line losses (assumed to be 9% on average in New York State).

The actual control period emissions from the CHP unit are then subtracted to yield a net award of allowances for the CHP unit. As noted in the NYSDEC cap-and-trade rules, the set-aside would be limited to a five-year period following the control period in which the unit goes into operation.

$$\text{Net emission allowances allocated to CHP unit} = (\text{surrogate allocation} \times \text{efficiency multiplier}) + \text{avoided line loss allocation} - \text{control period emissions}$$

APPLICABILITY OF THE EE/RE SET-ASIDE PROGRAM TO SMALL CHP

Description

As noted in Section 5, the NYSDEC EE/RE set-aside program is applicable to (1) end-use efficiency projects; (2) renewable energy projects; (3) in-plant energy efficiency projects; and (4) fossil fuel-fired electricity-generating units that produce electricity more efficiently than the annual average heat rate attributable to all fossil fuel-fired electricity generated in New York State and non-electricity-generating units whose thermal efficiency exceeds 80%. Although large CHP units (which are affected sources under the NO_x Budget Trading Program) are clearly eligible under provisions (3) and (4) to seek EE/RE allowances, there are no specific provisions for small CHP units.

Analysis

Although small CHP projects could conceivably qualify for EE/RE set-aside allowances under any of the four eligibility provisions described above, some definitional issues may require clarification from NYSDEC.

(1) *End-use efficiency project* is defined in the NYSDEC cap-and-trade rules as follows:

> A measure implemented at the customer level that uses a reduced amount of electricity, measured in kilowatt-hours to maintain or increase the level of energy service, including product output and comfort level. Examples of such a measure include, without limitation, installing new equipment or systems, modifying existing equipment or systems, or improving operation and maintenance procedures.

Does small CHP meet this definition? Generally speaking, CHP does not reduce the amount of electricity used by the end-user, even though the electricity may be generated in a more efficient manner. It can be argued, however, that because CHP is on-site and not subject to T&D system losses, fewer MWs need to be generated to meet the end-user's requirements. This is clearly a form of energy efficiency, but it does not result from the end user's *using* electricity more efficiently; rather, it is more accurately characterized as a T&D system efficiency benefit.

The end-use efficiency provision might pertain to small CHP because CHP is highly efficient and often exceeds the overall efficiency of the separate heat and power that it displaces. If the thermal side of the CHP system is more efficient than the existing stand-alone boiler, its installation would clearly be an end-user efficiency measure. However, NYSDEC rule defines "end-use efficiency projects" to those measures that reduce consumption of electricity. Unless the thermal side of the CHP unit displaces the existing use of electricity (by, for example, reducing the use of electric water heating), it would not necessarily meet the NYSDEC definition.

(2) *Renewable energy project* includes fuel and technology types that could encompass CHP. For example, a CHP system that burned sustainably managed biomass would appear to meet this provision. It should be noted that this provision is not limited to projects of any particular size.

(3) *In-plant energy efficiency project* is defined as "a measure undertaken at a NO_x (or SO_2) Budget source that increases the overall energy efficiency of the facility." Although small CHP units could satisfy the substantive aspect of this definition, they are not affected sources (because they are small) and therefore do not fit the definition. If a small CHP source were to opt-in to the cap-and-trade rule, it would become an affected source, but as noted below, we do not believe that opt-in will be appealing to many (if any) small CHP sources.

(4) *Efficient electricity-generating unit and efficient non-electricity-generating unit* is the most logical category for small CHP because of the often-greater overall efficiency of CHP compared with SHP. The difficulty, however, is that this provision is applicable to only a large electricity-generating unit, whose definition in the cap-and-trade rules reads,

> Any unit that, any time on or after January 1, 1995, serves a generator with a nameplate capacity equal to or greater than 15 MW and sells any amount of electricity.

Small CHP units, by definition, produce less than 15 MW, and furthermore, they do not generally sell electricity to other parties. The electricity produced by small CHP is generally consumed on-site and not sold to third parties beyond the point of interconnection with the distribution utility. However, if the CHP unit is owned by an entity other than the end-user, the electricity and thermal output may, in fact, be sold to the end-user.

Non-electricity-generating unit is also a defined term in the NYSDEC rules: it pertains to sources that have a maximum design heat input equal to or greater than 250 MMBtu/hr. Again, small CHP systems do not reach this level.

Although the defined terms in this provision could preclude small CHP from participating in the EE/RE set-aside program, it is doubtful that this was the intended effect of the cap-and-trade rule. This area is ripe for clarification from NYSDEC about how small CHP can participate in the EE/RE program.

EFFICIENCY MULTIPLIER AND SURROGATE ALLOCATION

The NYSDEC cap-and-trade rules include set-aside provisions to reward efficient electricity generators and thermal sources with additional allowances. However, the rules do not specifically define how the set-aside awards are to be calculated. For electricity generators, the rules call for a comparison between the heat rate of the efficient unit and the average heat rate for fossil units in New York State, but it does not specify what happens next to translate the relative heat rates into an allowance award. Thermal units that are more than 80% efficient are also eligible for additional allowances, but again, the rules do not specify a method for calculating the amount of the allowance award.

Electrical Side Implementation

Efficiency Multiplier. CHP units produce electrical and thermal output but are nevertheless treated as electricity-generating units in the NYSDEC cap-and-trade rules. A specific provision in the rules takes account of useful heat recovered in CHP for purposes of determining the unit's net heat rate. If small CHP units are treated in a similar manner, they, too, would be viewed as electricity generators, with the same consideration for the amount of useful heat recovered.

One way to translate the intent of the NYSDEC EE/RE set-aside rule to a practical allocation formula for both regulated and non-regulated sources is to compare the relative heat rates of the average New York State fossil fuel–fired unit and the CHP unit to compute an efficient generation multiplier (EGM), as follows:

$$\text{Efficient generation multiplier (or EGM)} = \left[\frac{\text{Heat Rate}_{\text{Avg.NYFossil}}}{\text{Heat Rate}_{\text{CHP}}} \right]$$

The EGM can be used to scale up the standard allocation of allowances to reflect the relative efficiency gain from CHP compared with the average New York fossil unit. For example, assume that the average fossil heat rate in New York State is 10,000 Btu/kWh, and that the electrical-side heat rate of a CHP unit is 7,000 Btu/kWh. This would result in an EGM of 10,000/7,000, or 1.43. In effect, the EGM rewards the efficient source of generation for the percentage increase in kWhs that can be produced from a given quantity of fuel, relative to the average fossil unit in New York State. Once calculated, the EGM can then be used to scale up the standard allocation (e.g. 0.15 lb NOx per MMBtu) of allowances for regulated sources. For example, if the standard allocation of allowances resulted in 100 tons (allowances), then the efficient generation multiplier would increase this to 143 tons in total.

$$\text{Standard allowance allocation} \times \text{EGM} = \text{scaled allowance allocation}_{\text{electric}}$$

Surrogate Allocation. The obvious limitation of the EGM approach for small CHP (and other non-affected applicants) is that they have no standard allocation of allowances that can be multiplied by the EGM. This can be addressed by creating a surrogate for a standard allocation, as if these sources were in the cap-and-trade program. For electricity, the surrogate allocation could be based on an allocation factor of 0.15

lb/MMBtu of heat input, similar to the approach for power plants and large CHP units. To keep the surrogate allocation approach simple and timely, the heat input could be based on the fuel used during the control period for which the set-aside allowances are being sought, rather than an earlier baseline period. The surrogate allocation would be used in the same manner as the "standard allocation" in the example above, yielding a similar scaled allowance allocation.

The opt-in provision of the cap-and-trade rule is another way that non-regulated units might be able to receive an allocation of emissions allowances that can be scaled up with the EGM. The opt-in mechanism allows non-regulated emissions sources to voluntarily participate in the cap-and-trade program as if they were regulated under the cap. Because of the burdensome procedures associated with this program, however, only one source in New York State has elected to opt-in thus far. Therefore, the opt-in mechanism is not viable as the sole basis of providing a surrogate allocation for use with the EGM.

Thermal-Side Implementation

Although large CHP units are treated strictly as electricity generators in the NYSDEC cap-and-trade rules, small CHP units could be treated in a different manner that reflects the unbundling of the thermal and electrical functions of CHP; that is, each side would be treated separately for purposes of the efficiency set-aside. On the electrical side, the set-aside would operate as described above, although only the amount of fuel related to electricity production would be used to develop a surrogate allocation. This report illustrates the proportional responsibility method for making the apportionment between the thermal and electrical sides of CHP.

On the thermal side, a slightly different approach is required. As noted in the NYSDEC cap-and-trade rules, efficient thermal generators are compared with a benchmark thermal unit that is 80% efficient. To receive efficiency allowances, a thermal unit must be more than 80% efficient. This benchmark can be used to construct a thermal generation multiplier (TGM), which is similar to the EGM, as follows:

$$\text{Thermal generation multiplier (or TGM)} = \left[\frac{(\text{Useful Heat Recovered/Heat Input}_{\text{therma}})}{.80}\right]$$

The surrogate allocation on the thermal side for small CHP units would use the allowance allocation factors established for large thermal sources in the NYSDEC rules. In the case of NO_x, the basic allocation factor is 0.17 lb/MMBtu for thermal sources. Opt-in provisions can also be used for thermal sources, yielding an allowance allocation similar to the process described above for electricity generators.

$$\text{Standard allowance allocation x TGM = scaled allowance allocation}_{\text{thermal}}$$

Analysis

NYSDEC's cap-and-trade rules, like most of those implemented to date in other states, allocate emissions allowances to affected sources using a fuel *input*-based methodology. *Output*-based allocation systems (such as those now used in Massachusetts and New Hampshire) inherently reward units that efficiently convert fuel into useful output, whether electrical, thermal, or mechanical, or some combination thereof. In output-based cap-and-trade programs, there is no need to establish additional incentives for efficient units: they are built into the workings of the system.

The use of an efficient generation multiplier essentially transforms an input-based allocation system, such as NYSDEC's, into an output-based system—but only for those units eligible to participate. For example, under the efficient generation multiplier approach described above, a generator that produces twice as many kWhs per Btu as the "average fossil unit" will receive twice as many emissions allowances (all else being equal).[8] Because the EGM approach is constrained by the size of the EE/RE set-aside account (3% of the cap) and does not apply to inefficient generators (which would be penalized under an output-based allocation regime), significant differences will remain between the NYSDEC allowance allocation system (even with the efficiency set-asides) and those in output-based jurisdictions. An additional difference is that Massachusetts and New Hampshire, both output-based states, do not impose a control period potential to emit (CPPTE) limitation.

In Section 1, we noted problems with regulating CHP as if it were only an electricity-generating source. The logical extension of this perspective is to deal with the EE/RE set-aside mechanism by treating CHP as a generator of both heat and electricity and calculating separate efficiency set-asides. The problem, however, is that such an approach is complicated and would diverge from the way in which NYSDEC rules treat large CHP, thus introducing a bias that was merely a function of the size of the unit (i.e., whether it is an affected unit). In addition, an unbundling approach would very likely award fewer EE/RE set-aside allowances than an electricity-only approach, since few CHP systems will exceed the 80% thermal efficiency benchmark no matter how fuel use is apportioned between the thermal and electrical sides. Therefore, an electricity-only EE/RE set-aside calculation that essentially parallels the methods already delineated for larger CHP units is an approach to consider.

AVOIDED T&D LOSSES

Description

Although CHP is very efficient overall, it does not meet the definition of *end-use energy efficiency project,* as the term is used in the NYSDEC allowance rules: "a measure implemented at the customer level that

[8] The NYSDEC cap-and-trade rules limit the total of allocated allowances to the lesser of the allowances allocated through the standard application of the rule (including EE/RE allowances) or the unit's control period potential to emit (CPPTE), the maximum quantity of emissions permissible pursuant to permit or other regulatory provisions. The CPPTE limit may significantly alter the outcome of the allocation process.

uses a reduced amount of electricity, measured in kilowatt-hours, to maintain or increase the level of energy service, including product output and comfort level." CHP does not alter the amount of electricity used at the customer's premises. However, by generating electricity on-site, CHP avoids the transmission and distribution system losses that occur when central station electricity is delivered to end-users. Such losses in New York State are generally around 9% of the electricity supplied from central station plants, although they vary by location. For purposes of simplicity, this report suggests that the average New York State transmission and distribution loss factor be used in determining small CHP emission benefits for purposes of the EE/RE set-aside rather than location-specific loss factors.

A formula that can be used to quantify the emissions benefit of the T&D losses avoided by CHP is shown below. In this approach, we assume that, as in standard end-use efficiency projects, electricity saved through avoided T&D line losses is assigned an emissions value of 0.0015 lb/kWh:

$$\text{Avoided emissions} = (\text{avoided T\&D losses}) * (0.0015\ \text{lb/kWh})$$

where

$$\text{Avoided T\&D losses} = \left[\frac{kWh_{CHP}}{(1 - T\,\&\,D_{lossfactor})}\right] - kWh_{CHP}$$

and

$$kWh_{CHP} = \text{kWh generated by the CHP unit}$$

Analysis

Avoided T&D losses due to on-site CHP are a significant benefit that is often overlooked in environmental regulations, yet it meets the intent (if not the actual language) of the EE/RE set-aside program. The formula above can be used in addition to the efficient generation multiplier to yield the gross award of allowances for CHP projects. The assumed emissions value of 0.0015 lb/kWh is not specified in the NYSDEC cap-and-trade NO_x rules but is anticipated to the factor at which end-use efficiency projects are awarded allowances. This benchmark is also used in many other states with EE/RE set-aside programs.

MWh PRODUCTION @ 1.5 lb/MWh

Description

An alternative and much simpler way to award allowances to CHP units is to treat them in roughly the same manner as renewables and end-use energy efficiency projects, which are expected to receive 1.5 lbs of NO_x allowances per MWh generated or saved. The award of allowances could be reduced by the emissions released by the CHP unit during the control period. Such allowance awards would continue for the same five-year period as other EE/RE projects. Potentially, this approach could be expanded to award allowances for the MWh-equivalent amounts of useful thermal energy recovered.

Analysis

Using the same allocation formula for CHP as for EE/RE measures is very simple and straightforward and would establish a consistent method across the EE/RE set-aside program. However, it also would create a totally different basis for allowance allocations to small CHP units than the one established for large CHP units in the existing cap-and-trade rules. The use of a simple per MWh allocation factor also seems inconsistent with the underlying rationale for including CHP in the EE/RE program—namely, energy efficiency. This allocation method does not distinguish between CHP applicants as a function of either their efficiency or their emissions. An example can illustrate this concern.

Assume that two comparably sized CHP units are placed in service. One unit has a power-to-heat ratio of 4 but very low overall energy efficiency; the other unit has a power-to-heat ratio of .25 but is much more energy efficient. Using a simple 1.5 lb/MWh allocation formula will result in allocating the less-efficient CHP unit a relatively larger number of emissions allowances—and turning the logic of the EE/RE program on its head.

Although the simplicity of this approach is tempting, its inconsistency with the rationale of the EE/RE program (i.e., promoting efficiency) is a clear problem. In addition, it presents a discrepancy in the treatment of large and small CHP systems that serves no particular purpose.

CHP ALLOWANCE TREATMENT AND EMISSIONS REDUCTION CREDITS

Although the eligibility of CHP projects for emissions reduction credits (ERCs) is not the intended focus of this report, a few observations are nevertheless important. We have noted that older, high-emitting boilers are often the ones displaced by small CHP units, which thereby produce significant potential emissions benefits. In the optimal approach for awarding emissions allowances, however, these presumed emissions reductions are not the basis of the allocation. The allocation is governed by other factors, such as comparable treatment with large CHP units, the relative efficiency of the CHP unit compared with other fossil-fired electricity generations, and the benefits of avoided T&D losses.

Eligibility of small CHP units for both set-aside allowances and ERCs is clearly beneficial in increasing the potential value of CHP installations to project owners. The allowance allocation method leaves open the question of whether the new CHP installations should also be eligible to receive ERCs. While it may seem that awarding set-aside allowances and ERCs is a form of double-counting, this is not the case for two reasons. First, as noted earlier, allowances and ERCs are distinctly different, and are used in completely separate regulatory programs (cap and trade programs vs. New Source Review) and both programs can and do apply to some facilities. There is a logical consistency that if a source can be regulated by both programs, then another facility that reduces emissions -- and meets EE/RE allowance set-aside and ERC certification criteria -- should similarly be able to participate in both programs. Second, the set-aside allowance mechanism focuses on the emission reduction benefits associated with the CHP's electrical production while the ERC program focuses on the CHP unit's emissions compared to baseline emissions of an existing on-site boiler, used for thermal purposes.

OPTIMAL APPROACH

The use of the efficient generation multiplier in conjunction with a surrogate allocation of allowances to small CHP units is an optimal approach. In addition, because CHP avoids T&D line losses, additional allowances could be awarded to CHP for this benefit, using the current average New York State T&D loss factor (9%), regardless of the project's location on the grid. The final step is to deduct the relevant emissions (NO_x or SO_2) emitted during the control period for which the allowances are sought. Regulatory programs can offer reasonable emission measurement alternatives for small CHP sources such as calculations based on fuel use records, manufacturers' (or regulatory agency) emission rate certification of the CHP equipment, or other simplified approaches that strike a balance between accuracy and feasibility for CHP applicants seeking set-aside allowances.

The NYSDEC cap-and-trade rules explicitly provide that the award of EE/RE allowances cannot exceed five years following the control period in which an eligible EE/RE measure goes into operation. Although CHP units have considerably longer lifespans (20 years or more), the limited quantity of EE/RE set-aside allowances supports the shorter duration of awards and the desire to encourage new EE/RE projects through incentives. Even with the five-year duration, the EE/RE allowances for small CHP units can still provide significant added value to these projects, as shown in Attachment 2.

$$\text{Net emissions allowances allocated to the CHP unit} = (\text{surrogate allocation} \times \text{efficiency multiplier}) + \text{avoided line loss allocation} - \text{control period emissions}$$

Table 2. Example of Efficient Generation Multiplier Approach.

CHP Total Efficiency	73%
Heat rate (w/o allocation of fuel to thermal side)	12,366 Btu/kWh
Heat rate (w/ allocation of fuel to thermal side based on power-to-heat ratio)	4,670 Btu/kWh
Ozone Season fuel use	181,632 MMBtu
"Surrogate EA Allocation"	181,632 x 0.15 lb = 13.6 tons
Efficient Generation ("EGM") Multiplier	$\frac{9{,}889}{4{,}670}$ = 2.12
Scaled Surrogate Allocation	13.6 tons x 2.12 = 28.8 tons
T&D loss = Factor @9%	[14688/0.91] – 14688 = 1,453 MWh x 1.5 lb = 2,179 lb = 1.09 tons NOx
Total NOx EA Allocations	28.8 + 1.09 = 29.9 Tons
NOx Emissions	8.4 tons (@0.09 lb/MMBtu)
Net Allocation of Allowances	**29.9 – 8.4 = 21.5 Tons**

Note that under the proposed NYSDEC emissions limit of 2.2 lb/MWh, the control period potential to emit is 20.2 tons; allocations may be limited to the control period potential to emit rather than to the calculated value.

Section 6
MARKET IMPACT AND ENVIRONMENTAL BENEFITS

CHP MARKET PENETRATION

A major policy objective in making small CHP units eligible for the EE/RE set-aside allowance is to promote their market penetration. As a source of cash flow, allowances can improve the financial viability of CHP projects that otherwise might not be sufficiently profitable.

Several market characteristics of emissions allowances market could affect the value of any allowances awarded to small CHP sources. First, there are transaction costs associated with preparing and submitting applications to NYSDEC, plus potential system design and installation costs necessary to meet NYSDEC requirements. These costs could involve emissions monitoring equipment (if required) or data systems to record fuel use, useful thermal output, or other surrogates for emissions data. It is anticipated that NYSDEC (with technical assistance from NYSERDA) will adopt relatively efficient procedures that do not place undue burden on the applicants for small CHP projects. Further efforts to educate the CHP community on the process for filing such applications (in the form of guidebooks or training workshops) are contemplated by NYSDEC and NYSERDA.

Once allowances are awarded, CHP sources face additional costs in selling them through established emissions markets. A majority of transactions in these markets are facilitated by emissions brokers (or other trading companies), which charge fees for their services. For small transactions, the fees may represent a proportionately higher percentage of the net proceeds from the sale of emission allowances. Typically, such fees are less than 5% of net proceeds, although they can go higher for smaller transactions.

Hypothetical cases showing the value of the proposed EE/RE set-aside allocation for ozone-season NO_x are shown in Attachment 2. Taking the present value of these amounts (over the five-year period that allowances would be awarded with a 10% discount rate) yields the net present values and percentages of installation cost shown in Tables 3 and 4.

Table 3. Net Present Value and Percentage of CHP Installation Cost for Ozone-Season NO_x Allowances with CPPTE Cap (NOx allowances at $3,000 per ton).

Thermal allocation method	*5 MW combustion turbine @ $1,100/kW*	*800 kW gas engine @ $1,000/kW*	*300 kW microturbine @ $1,200/kW*
Proportional responsibility	$134,660 2.2%	$18,377 2.3%	$5,955 1.7%
Proxy boiler	$134,660 2.2%	$12,237 1.5%	$5,955 1.7%
Thermal output deduction	$134,660 2.2%	$6,001 0.8%	$5,955 1.7%

Table 4. Net Present Value and Percentage of CHP Installation Cost for Ozone-Season NO_x Allowances without CPPTE Cap (NOx allowances at $3,000 per ton).

Thermal allocation method	*5 MW combustion turbine @ $1,100/kW*	*800 kW gas engine @ $1,000/kW*	*300 kW microturbine @ $1,200/kW*
Proportional responsibility	$239,597 4.4%	$18,377 2.3%	$15,743 4.4%
Proxy boiler	$198,546 3.6%	$12,237 1.5%	$11,125 3.1%
Thermal output deduction	$138,739 2.5%	$6,001 0.8%	$9,466 2.6%

As the figures demonstrate, the control period potential to emit (CPPTE) cap can substantially reduce the potential award of emissions allowances. In the case of the 5 MW combustion turbine unit (with the proportional responsibility method), the CPPTE cap cuts the allocation in half. With the CPPTE cap, the ozone-season NO_x allowances (over the five-year period) have a net present value of 2.2% of the first cost of the CHP installation. Without the CPPTE cap, the figure rises to 4.4% for the combustion turbine CHP unit.

There are other sources of allowance and ERC value that could improve the economics for the illustrative CHP units. First, with the adoption of the Acid Deposition Reduction regulations, NYSDEC has begun new allowance programs that include SO_2 (year-round) and non-ozone-season NO_x. It is certainly possible that each of these programs could add value for CHP that is comparable to the ozone-season NO_x program, shown in Tables 2 and 3. Second, CO_2 credits or allowances could potentially be offered to CHP sources under the evolving Regional Greenhouse Gas Initiative (RGGI), in which New York State and other northeastern states are participating. Under the EPA's recent Clean Air Interstate Rule (CAIR), New York State is required to achieve additional SO_2 and NOx emission reductions in future years, and NYSDEC's implementation plans may involve additional (or substitute) cap and trade programs to those that now exist, which could also include set-aside provisions applicable to small CHP units. Under the CAIR Model Rule, which NYSDEC will consider in a future rulemaking, there are specific provisions about the allocation of NOx allowances to regulated (over 25 MW capacity) CHP sources, as well as set-aside programs[9].

Finally, to the extent that the CHP unit results in the displacement or retirement of older, higher-emitting on-site boilers and similar equipment, its installation would also be eligible for ERCs that cover avoided NO_x and potentially carbon monoxide and particulates as well. If the fuel associated with the retired or derated boilers is number 6 oil (a high-emissions fuel), the value of the ERCs could be comparable to the ozone-season NO_x allowances value in Table 3. Cumulatively, the net present value for clean, efficient CHP units of all available allowance programs and ERCs could rise to 10% or more of the cost of the installation.

The ultimate market effect of the allowance values is difficult to assess, given the uncertainties as to where the new allowance program values will fall and the potential additional benefits from ERCs. Nevertheless, an estimate of the incremental penetration of CHP attributable to the opportunity to participate in the EE/RE set-aside can be made in a qualitative manner.

The CHP Market Assessment prepared for NYSERDA in October 2002 developed two scenarios with penetration rates ranging from 764 MWs under a business-as-usual base case to 2,169 MWs given a set of assumptions labeled the accelerated case. The differences between these cases occurred primarily with divergent assumptions regarding future technology costs and performance and with regulatory changes that would make interconnection and standby tariffs less costly for distributed generation.

The accelerated case scenario was constructed in a manner in which several variables were changed at one time, making it impossible to separate the effects of price reductions (which could result from set-aside allowances and ERCs) from other changes. Our conversations with the individuals who did the modeling for this analysis reinforced the conclusion that a precise “supply elasticity” due to price changes cannot be calculated.

The improvement in market climate assumed for the accelerated case results in an additional 1,400 MW of CHP market penetration over the forecast period. Although it is difficult to determine the impact of the

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[9] Several analysts and regulators have expressed concerns about the CAIR model rule relating to CHP allowance allocation because it does not give sufficient weight to the useful thermal output of CHP, and allocates fewer allowances for CHP electrical output that similarly situated conventional electric generators. A discussion of these concerns is presented in *Alternative NOx Allowance Allocation Language for the Clean Air Interstate Rule*, State and Territorial Air Pollution Program Administrators (STAPPA) and the Association of Local Air Pollution Control Officials (ALAPCO) August 2005 (http://www.4cleanair.org/Bluestein-cairallocation-final.pdf)

various assumptions that make up the accelerated case because of interaction among them, we have estimated that the reduction in standby charges between the two cases can explain about 35% of the increase in market penetration.

It is possible to make some assumptions about the relative impact that the changes in exogenous variables had on the resulting change in market penetration. As the Tables below indicate, we do have data points from the study for assumed changes in price and the resulting changes in the CHP penetration rates statewide. This information gives us some sense of the responsiveness of market penetration to a decrease in total CHP system costs.

Table 5 shows that in the accelerated case, CHP power costs decline 10% to 20%, and market penetration of systems larger than 500 kW grows about 350%. The study's authors attribute about one-third of the increased market penetration to revisions in standby charges, and the remainder to factors that reduce the cost of power from the CHP unit. Assuming that the combined effect of allowance and ERC programs could reduce CHP installation costs by 10%, and that CHP capital costs are roughly one-third of the net cost of CHP power, the emissions-related value of CHP could increase its market penetration by 50% to 75% or more from the base case.

Table 5. CHP Market Penetration in New York State [2002 - 2012].

System size (MWs)	*Base case market penetration (MWs)*	*Accelerated case market penetration (MWs)*
.05–.5	0.0	61.4
.5–1	91.6	331.1
1–5	204.1	699.1
5–20	208.0	703.4

Source: NYSERDA, *Combined Heat and Power Market Potential for New York State*, October 2002

Table 6. Decrease in CHP Power Costs and Change in Market Penetration.

System size (MWs)	*Percentage decrease in CHP power costs*	*Percentage increase in market penetration*
0.05–0.5	19.6%	n.c.
0.5–1	14.5%	361%
1–5	12.7%	343%
5–20	10.7%	338%

POTENTIAL ENVIRONMENTAL BENEFITS

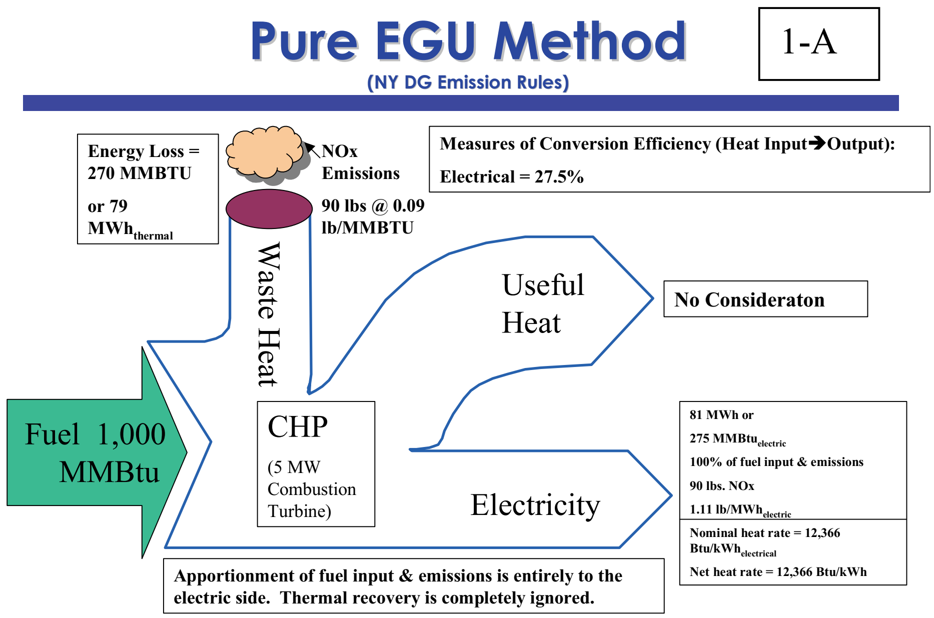
As shown in Figure 2, CHP has the potential to result in lower total emissions than SHP systems. The net air emissions benefits of CHP depend on three factors: (1) the emissions of the retired or derated on-site boiler; (2) the emissions of the CHP unit; and (3) the power plant emissions that are displaced by the CHP unit. In some situations, particularly where high-emitting, uncontrolled diesel engines are the power generating technology in the CHP application, CHP may actually produce greater emissions than SHP. In its pending rulemaking on distributed generation emissions standards, NYSDEC is taking steps to ensure that new DG and CHP installations—including diesel engines—are relatively clean.

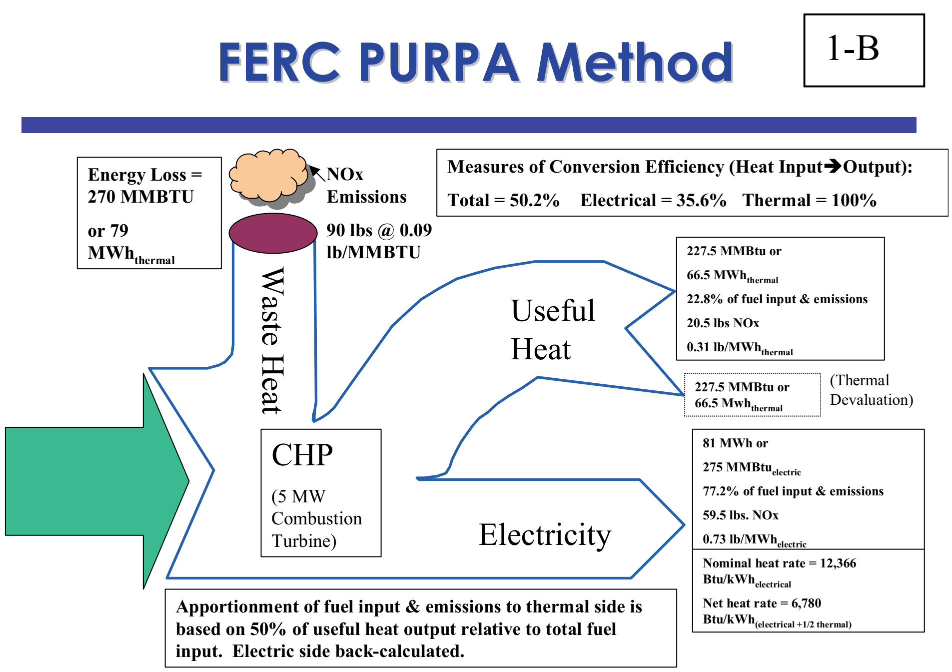
As noted above, the nature of emissions caps is another factor that must be considered in drawing conclusion about the environmental benefits of CHP. Under NYSDEC rules, electricity generators larger than 15 MW will soon operate under a year-round cap for SO_2 and NO_x; small CHP units (and other smaller DG technologies) are not affected sources. Displacement of power (and emissions) from capped central station units to distributed generation facilities could eventually result in increased emissions, even if the CHP unit has lower emissions rates than the power it replaces. On the boiler side, most CHP is likely to achieve emissions reductions, especially if CHP results in switching from high-emitting fuels (such as number 6 oil) to natural gas.

Over time, various policy developments could provide greater certainty that CHP will yield net air quality benefits. Including small CHP units in cap-and-trade programs (with reasonable emissions monitoring provisions) would preclude the possibility of "emissions migration" from capped to uncapped sources. Even if CHP units are mandated to participate in the cap-and-trade program, their success in the market may lead to more stringent caps in the future.

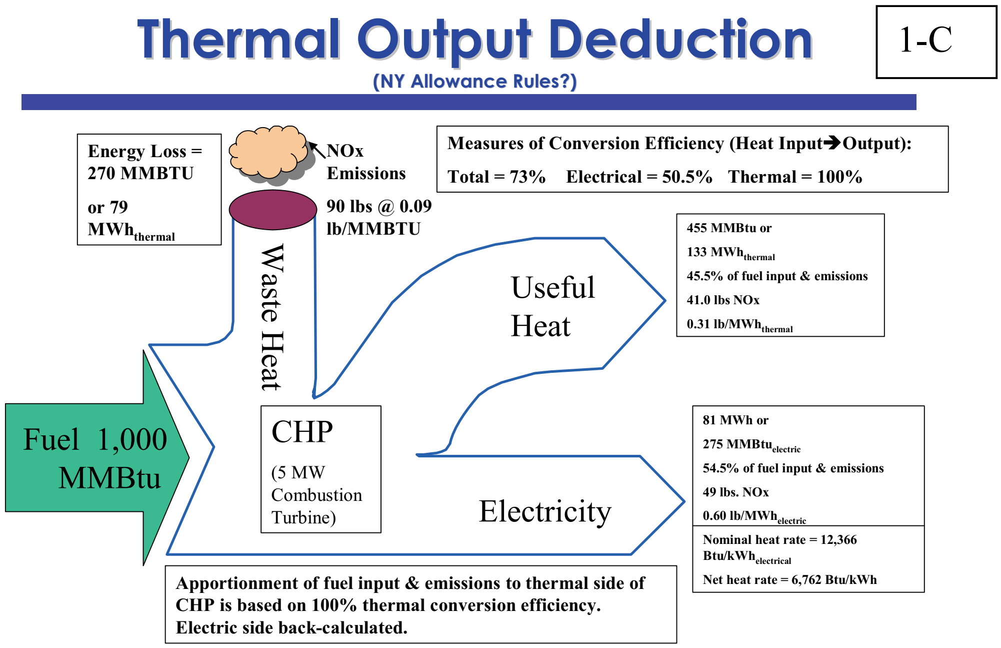
APPENDIX A

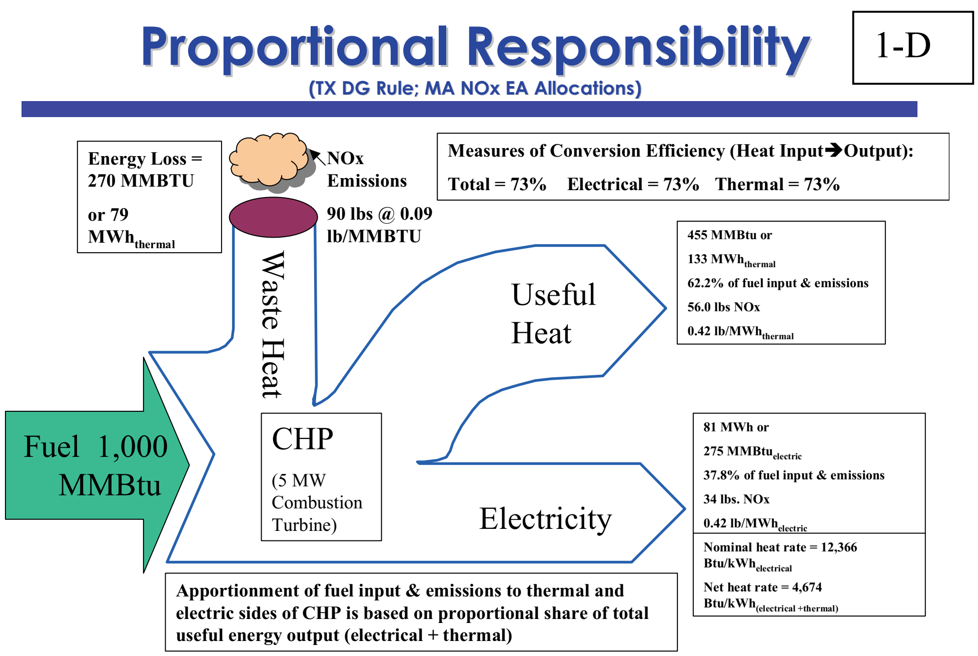
Attachment 1 (A–B)





Attachment 1 (C–D)



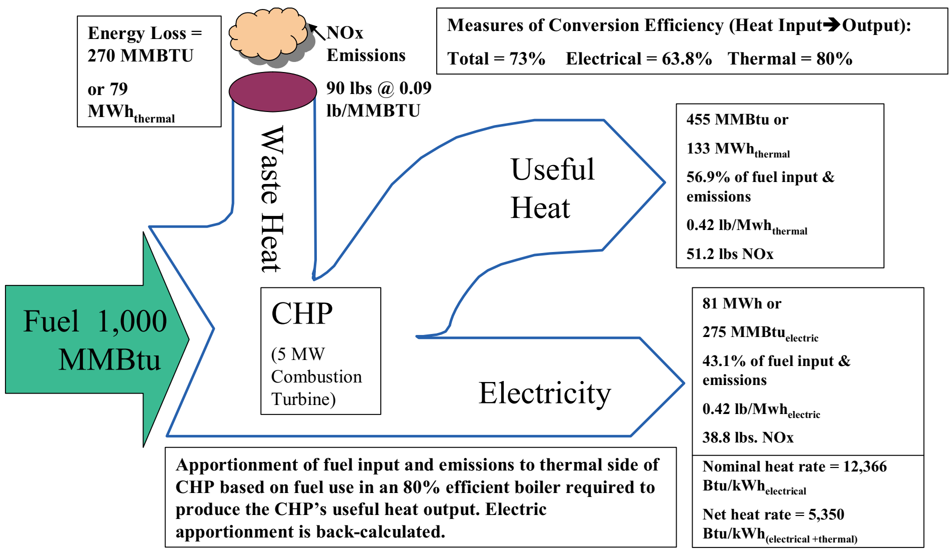


Attachment 1 (E–F)

Thermal Credit w/Proxy Boiler

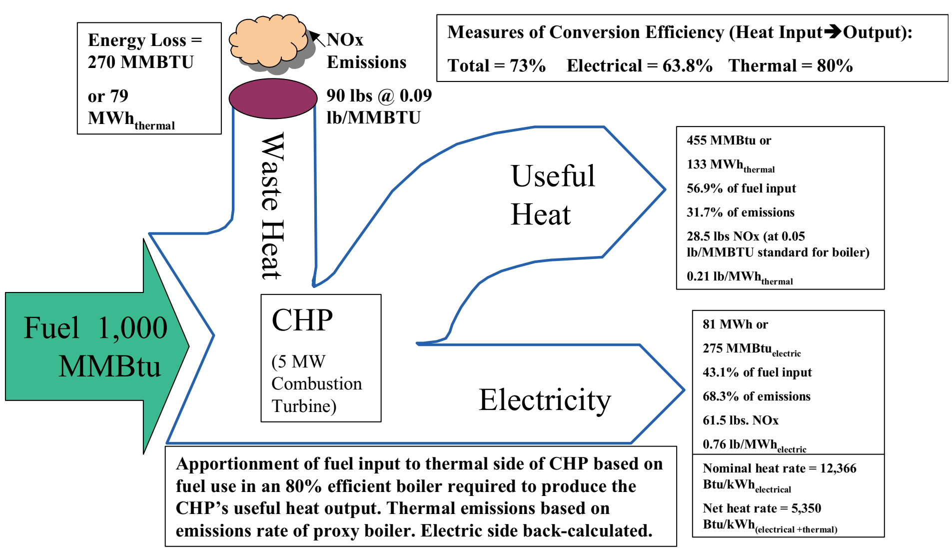
1-E

(EPA CHP Partnership)



Emission Credit w/Proxy Boiler (RAP Model Rule)

1-F



Attachment 2. Proportional Responsibility Method of Unbundling

5 MW Combustion Turbine

Unit Capacity (MW)	5
Capacity Factor	80%
Total Efficiency	73%
BTU/kWh_e	12366
$BTU_{recovered}/kWh$	5622
$BTU/kWh_{(e\&t)}$	4670
Total MWh_e	14688
Total MWh_t	24202
Total MMBTu	181632
NOx lb/MWh_e	1.14
NOx $lb/MWh_{(e\&t)}$	0.43
NOx lb/MMBTu	0.09
Total NOx (lbs)	16710
Total Tons emitted	8.4
Allowance Price	$3,000
NY Avg. Fossil HR	9,889
Permit Limit (lb/MWh)	2.2
CPPTE (lbs)	40,392
CPPTE (tons)	20.20
Avoided Losses %	9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		22032
Allowances (tons)		11.0
Value @	$3,000	$33,048
Avoided Loss Tons		1.09
With Avoided Losses		$36,316
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		15721
Allowances (tons)		7.9
Value @	$3,000	$23,581
Avoided Loss Tons		1.09
With Avoided Losses		$26,850
Annual $/MWh of Benefit		$1.83
Annual $/MW of Benefit		$5,370

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		27245	27245
Surrogate Allocation (tons)		13.6	13.6
Efficient Gen. Multiplier		2.1	2.1
Scaled Allocation		28.8	28.8
Avoided T&D Loss Tons		1.09	1.09
Gross Allocation		29.9	29.9
Allocation w/CPPTE Cap		20.2	N/A
Control Period Emissions		8.4	8.4
Net EE/RE Allocation		11.8	21.6
Value @	$3,000	$35,523	$64,734
Annual $/MWh of Benefit		$2.42	$4.41
Annual $/MW of Benefit		$7,105	$12,947

800 kW Gas Engine

Unit Capacity (MW)	0.8
Capacity Factor	80%
Total Efficiency	70%
BTU/kWh_e	11050
$BTU_{recovered}/kWh$	4323
$BTU/kWh_{(e\&t)}$	4874
Total MWh_e	2350.08
Total MWh_t	2978
Total MMBTu	25968
NOx lb/MWh_e	2.07
NOx $lb/MWh_{(e\&t)}$	0.91
NOx lb/MMBTu	0.19
Total NOx (lbs)	4856
Total Tons emitted	2.4
Allowance Price	$3,000
NY Avg. Fossil HR	9,889
Permit Limit (lb/MWh)	4.4
CPPTE (lbs)	12,925
CPPTE (tons)	6.46
Avoided Losses %	9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		3525.12
Allowances (tons)		1.8
Value @	$3,000	$5,288
Avoided Loss Tons		0.17
With Avoided Losses		$5,811
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		1383
Allowances (tons)		0.7
Value @	$3,000	$2,075
Avoided Loss Tons		0.17
With Avoided Losses		$2,598
Annual $/MWh of Benefit		$1.11
Annual $/MW of Benefit		$3,247

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		3895	3895
Surrogate Allocation (tons)		1.9	1.9
Efficient Gen. Multiplier		2.0	2.0
Scaled Allocation		4.0	4.0
Avoided T&D Loss Tons		0.17	0.17
Gross Allocation		4.1	4.1
Allocation w/CPPTE Cap		4.1	N/A
Control Period Emissions		2.4	2.4
Net EE/RE Allocation		1.7	1.7
Value @	$3,000	$5,093	$5,093
Annual $/MWh of Benefit		$2.17	$2.17
Annual $/MW of Benefit		$6,366	$6,366

300 kW MicroTurbine

Unit Capacity (MW)	0.3
Capacity Factor	80%
Total Efficiency	59%
BTU/kWh_e	13652
$BTU_{recovered}/kWh$	4638
$BTU/kWh_{(e\&t)}$	5786
Total MWh_e	881.28
Total MWh_t	1198
Total MMBTu	12031
NOx lb/MWh_e	0.44
NOx $lb/MWh_{(e\&t)}$	0.19
NOx lb/MMBTu	0.03
Total NOx (lbs)	385
Total Tons emitted	0.2
Allowance Price	$3,000
NY Avg. Fossil HR	9,889
Permit Limit (lb/MWh)	1.3
CPPTE (lbs)	1,432
CPPTE (tons)	0.72
Avoided Losses %	9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		1321.92
Allowances (tons)		0.7
Value @	$3,000	$1,983
Avoided Loss Tons		0.07
With Avoided Losses		$2,179
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		1159
Allowances (tons)		0.6
Value @	$3,000	$1,738
Avoided Loss Tons		0.07
With Avoided Losses		$1,934
Annual $/MWh of Benefit		$2.19
Annual $/MW of Benefit		$6,447

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		1805	1,805
Surrogate Allocation (tons)		0.9	0.9
Efficient Gen. Multiplier		1.7	1.7
Scaled Allocation		1.5	1.5
Avoided T&D Loss Tons		0.07	0.07
Gross Allocation		1.6	1.6
Allocation w/CPPTE Cap		0.7	N/A
Control Period Emissions		0.2	0.2
Net EE/RE Allocation		0.5	1.4
Value @	$3,000	$1,571	$4,245
Annual $/MWh of Benefit		$1.78	$4.82
Annual $/MW of Benefit		$5,235	$14,150

Attachment 2. Proxy Boiler Thermal Credit Method of Unbundling

5 MW Combustion Turbine

Unit Capacity (MW)		5
Capacity Factor		80%
Total Efficiency		73%
BTU/kWh$_{e}$		12366
BTU$_{recovered}$/kWh		5622
Thermal Conversion Fact.		80%
BTU/kWh$_{e\ Proxy\ Credit}$		5339
BTU/kWh$_{t\ Proxy\ Credit}$		7028
Total MWh$_{e}$		14688
Total MWh$_{t}$		24202
Total MMBTu		181632
NOx lb/MWh$_{e}$		1.14
NOx lb/MWh$_{Proxy\ Credit}$		0.49
NOx lb/MMBTu		0.09
Total NOx (lbs)		16710
Total Tons emitted		8.4
Allowance Price		$3,000
NY Avg. Fossil HR		9,889
Permit Limit (lb/MWh)		2.2
CPPTE (lbs)		40,392
CPPTE (tons)		20.20
Avoided Losses %		9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		22032
Allowances (tons)		11.0
Value @	$3,000	$33,048
Avoided Loss Tons		1.09
With Avoided Losses		$36,316
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		14818
Allowances (tons)		7.4
Value @	$3,000	$22,227
Avoided Loss Tons		1.09
With Avoided Losses		$25,496
Annual $/MWh of Benefit		$1.74
Annual $/MW of Benefit		$5,099

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		27245	27245
Surrogate Allocation (tons)		13.6	13.6
Efficient Gen. Multiplier		1.9	1.9
Scaled Allocation		25.2	25.2
Avoided T&D Loss Tons		1.1	1.1
Gross Allocation		26.3	26.3
Allocation w/CPPTE Cap		20.2	N/A
Control Period Emissions		8.4	8.4
Net EE/RE Allocation		11.8	18.0
Value @	3000	$35,523	$53,905
Annual $/MWh of Benefit		$2.42	$3.67
Annual $/MW of Benefit		$7,105	$10,781

800 kW Gas Engine

Unit Capacity (MW)		0.8
Capacity Factor		80%
Total Efficiency		70%
BTU/kWh$_{e}$		11050
BTU$_{recovered}$/kWh		4323
Thermal Conversion Fact.		80%
BTU/kWh$_{proxy\ Credit}$		5646
BTU/kWht Proxy Credit		5404
Total MWh$_{e}$		2350.08
Total MWh$_{t}$		2978
Total MMBTu		25968
NOx lb/MWh$_{e}$		2.07
NOx lb/MWhproxy credit		1.06
NOx lb/MMBTu		0.19
Total NOx (lbs)		4856
Total Tons emitted		2.4
Allowance Price		$3,000
NY Avg. Fossil HR		9,889
Permit Limit (lb/MWh)		4.4
CPPTE (lbs)		12,925
CPPTE (tons)		6.46
Avoided Losses %		9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		3525.12
Allowances (tons)		1.8
Value @	$3,000	$5,288
Avoided Loss Tons		0.17
With Avoided Losses		$5,811
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		1044
Allowances (tons)		0.5
Value @	$3,000	$1,566
Avoided Loss Tons		0.17
With Avoided Losses		$2,089
Annual $/MWh of Benefit		$0.89
Annual $/MW of Benefit		$2,611

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		3895	3895
Surrogate Allocation (tons)		1.9	1.9
Efficient Gen. Multiplier		1.8	1.8
Scaled Allocation		3.4	3.4
Avoided T&D Loss Tons		0.2	0.2
Gross Allocation		3.6	3.6
Allocation w/CPPTE Cap		3.6	N/A
Control Period Emissions		2.4	2.4
Net EE/RE Allocation		1.16	1.16
Value @	3000	$3,472	$3,472
Annual $/MWh of Benefit		$1.48	$1.48
Annual $/MW of Benefit		$4,340	$4,340

300 kW MicroTurbine

Unit Capacity (MW)		0.3
Capacity Factor		80%
Total Efficiency		59%
BTU/kWh$_{e}$		13652
BTU$_{recovered}$/kWh		4638
Thermal Conversion Fact.		80%
BTU/kWh$_{proxy\ credit}$		7855
BTU/kWht Proxy Credit		5798
Total MWh$_{e}$		881.28
Total MWh$_{t}$		1198
Total MMBTu		12031
NOx lb/MWh$_{e}$		0.44
NOx lb/MWh$_{(e\&t)}$		0.25
NOx lb/MMBTu		0.03
Total NOx (lbs)		385
Total Tons emitted		0.2
Allowance Price		$3,000
NY Avg. Fossil HR		9,889
Permit Limit (lb/MWh)		1.3
CPPTE (lbs)		1,432
CPPTE (tons)		0.72
Avoided Losses %		9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		1321.92
Allowances (tons)		0.7
Value @	$3,000	$1,983
Avoided Loss Tons		0.07
With Avoided Losses		$2,179
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		1100
Allowances (tons)		0.6
Value @	$3,000	$1,651
Avoided Loss Tons		0.07
With Avoided Losses		$1,847
Annual $/MWh of Benefit		$2.10
Annual $/MW of Benefit		$6,156

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		1805	1805
Surrogate Allocation (tons)		0.9	0.9
Efficient Gen. Multiplier		1.3	1.3
Scaled Allocation		1.14	1.14
Avoided T&D Loss Tons		0.1	0.1
Gross Allocation		1.2	1.2
Allocation w/CPPTE Cap		0.7	N/A
Control Period Emissions		0.2	0.2
Net EE/RE Allocation		0.5	1.0
Value @	3000	$1,571	$3,027
Annual $/MWh of Benefit		$1.78	$3.43
Annual $/MW of Benefit		$5,235	$10,089

Attachment 2. Thermal Output Deduction Method of Unbundling

5 MW Combustion Turbine

Unit Capacity (MW)		5
Capacity Factor		80%
Total Efficiency		73%
BTU/kWh$_e$		12366
BTU$_{recovered}$/kWh		5622
Thermal Conversion Fact.		80%
BTU/kWh$_{e\ Output\ Deduction}$		6744
BTU/kWh$_{t\ Output\ Deduction}$		5622
Total MWh$_e$		14688
Total MWh$_t$		24202
Total MMBTu		181632
NOx lb/MWh$_e$		1.14
NOx lb/MWh$_{Output\ Deduction}$		0.62
NOx lb/MMBTu		0.09
Total NOx (lbs)		16710
Total Tons emitted		8.4
Allowance Price		$3,000
NY Avg. Fossil HR		9,889
Permit Limit (lb/MWh)		2.2
CPPTE (lbs)		40,392
CPPTE (tons)		20.20
Avoided Losses %		9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		22032
Allowances (tons)		11.0
Value @	$3,000	$33,048
Avoided Loss Tons		1.09
With Avoided Losses		$36,316
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		12919
Allowances (tons)		6.5
Value @	$3,000	$19,378
Avoided Loss Tons		1.09
With Avoided Losses		$22,647
Annual $/MWh of Benefit		$1.54
Annual $/MW of Benefit		$4,529

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		27245	27245
Surrogate Allocation (tons)		13.6	13.6
Efficient Gen. Multiplier		1.5	1.5
Scaled Allocation		20.0	20.0
Avoided T&D Loss Tons		1.1	1.1
Gross Allocation		21.1	21.1
Allocation w/CPPTE Cap		20.2	N/A
Control Period Emissions		8.4	8.4
Net EE/RE Allocation		11.8	12.7
Value @	3000	$35,523	$38,128
Annual $/MWh of Benefit		$2.42	$2.60
Annual $/MW of Benefit		$7,105	$7,626

800 kW Gas Engine

Unit Capacity (MW)		0.8
Capacity Factor		80%
Total Efficiency		70%
BTU/kWh$_e$		11050
BTU$_{recovered}$/kWh		4323
Thermal Conversion Fact.		80%
BTU/kWh$_{Output\ Deduction}$		6727
BTU/kWht $_{Output\ Deduction}$		4323
Total MWh$_e$		2350.08
Total MWh$_t$		2978
Total MMBTu		25968
NOx lb/MWh$_e$		2.07
NOx lb/MWh$_{Output\ Deduction}$		1.26
NOx lb/MMBTu		0.19
Total NOx (lbs)		4856
Total Tons emitted		2.4
Allowance Price		$3,000
NY Avg. Fossil HR		9,889
Permit Limit (lb/MWh)		4.4
CPPTE (lbs)		12,925
CPPTE (tons)		6.46
Avoided Losses %		9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		3525.12
Allowances (tons)		1.8
Value @	$3,000	$5,288
Avoided Loss Tons		0.17
With Avoided Losses		$5,811
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		569
Allowances (tons)		0.3
Value @	$3,000	$853
Avoided Loss Tons		0.17
With Avoided Losses		$1,376
Annual $/MWh of Benefit		$0.59
Annual $/MW of Benefit		$1,720

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		3895	3895
Surrogate Allocation (tons)		1.9	1.9
Efficient Gen. Multiplier		1.5	1.5
Scaled Allocation		2.9	2.9
Avoided T&D Loss Tons		0.2	0.2
Gross Allocation		3.0	3.0
Allocation w/CPPTE Cap		3.04	N/A
Control Period Emissions		2.4	2.4
Net EE/RE Allocation		0.6	0.6
Value @	3000	$1,828	$1,828
Annual $/MWh of Benefit		$0.78	$0.78
Annual $/MW of Benefit		$2,285	$2,285

300 kW MicroTurbine

Unit Capacity (MW)		0.3
Capacity Factor		80%
Total Efficiency		59%
BTU/kWh$_e$		13652
BTU$_{recovered}$/kWh		4638
Thermal Conversion Fact.		80%
BTU/kWh$_{Output\ Deduction}$		9014
BTU/kWht $_{Output\ Deduction}$		4638
Total MWh$_e$		881.28
Total MWh$_t$		1198
Total MMBTu		12031
NOx lb/MWh$_e$		0.44
NOx lb/MWh$_{Output\ Deduction}$		0.19
NOx lb/MMBTu		0.03
Total NOx (lbs)		385
Total Tons emitted		0.2
Allowance Price		$3,000
NY Avg. Fossil HR		9,889
Permit Limit (lb/MWh)		1.3
CPPTE (lbs)		1,432
CPPTE (tons)		0.72
Avoided Losses %		9.00%

1.5 lb/MWh Approach (Gross)

Allowances (lbs)		1321.92
Allowances (tons)		0.7
Value @	$3,000	$1,983
Avoided Loss Tons		0.07
With Avoided Losses		$2,179
Annual $/MWh of Benefit		$2.47
Annual $/MW of Benefit		$7,263

1.5 lb/MWh Approach (Net)

Allowances (lbs)		1159
Allowances (tons)		0.6
Value @	$3,000	$1,738
Avoided Loss Tons		0.07
With Avoided Losses		$1,934
Annual $/MWh of Benefit		$2.19
Annual $/MW of Benefit		$6,447

Large CHP Approach

			w/o CPPTE Cap
Surrogate Allocation (lb)		1805	1805
Surrogate Allocation (tons)		0.9	0.9
Efficient Gen. Multiplier		1.1	1.1
Scaled Allocation		0.99	0.99
Avoided T&D Loss Tons		0.1	0.1
Gross Allocation		$1	$1
Allocation w/CPPTE Cap		0.72	N/A
Control Period Emissions		0.2	0.2
Net EE/RE Allocation		0.5	0.9
Value @	3000	$1,571	$2,588
Annual $/MWh of Benefit		$1.78	$2.94
Annual $/MW of Benefit		$5,235	$8,628

Attachment 3. Case Studies and Analysis of Existing NO_x Set-Asides

Indiana

The Indiana Department of Environmental Management (IDEM) includes a 2% EE/RE set-aside account in its NO_x SIP Call rule. In its final rules and procedures and forms for the administration of the EE/RE program, IDEM has given extensive consideration to the inclusion of CHP measures and provides explicit provision for how they are treated in the EE/RE program. Like the NYDEC allowance rule, IDEM includes both end-user efficiency measures and highly efficient large generating plants. Also like the New York approach, IDEM has a hierarchy in which allowances are awarded to end-use efficiency measures and eligible renewable projects before being provided to EGUs that already receive allowances.

Eligible units must be at least 60% energy efficient. All Btu input (multiplied by a net electrical efficiency rate) is translated into kWh and given allowances at the assumed avoided emissions rate (0.0015 lb/kWh) less the CHP emissions rate per kWh (with kWh including both electrical and thermal equivalent). This approach is clearly a candidate model for how NYSDEC addresses CHP in the allowance rules.

Maryland

The Maryland Department of the Environment has established a set-aside pool for each control period consisting of 5% of the total NO_x budget for regulated sources. Of the total budget, 3% is set aside for clean air projects and another 2% is set aside for new or modified trading sources. The set-aside for clean air projects can be used for energy efficiency, renewable projects, and new trading sources with state-of-the-art controls. Unused allowances in the pool remain in the pool for uses as determined by the department. Allowances in the set-aside pool "may be distributed for projected actual, permitted or increased emissions occurring during any control period" (COMAR 26.11.29.09).

The department is currently developing an amendment to the regulations that will provide more details. According to department staff, clean air projects are those with "state-of-the-art controls" and presumably would include some combined heat and power units. CHP should be able to take advantage of both subsets of the set-aside pool.

Massachusetts

Massachusetts has a 5% EE/RE set-aside program in its NO_x SIP Call rule for projects that were implemented after the 1998 control period. Eligible projects can receive allowances for up to five years following implementation. Any undistributed allowances in the EE/RE account are redistributed to existing sources in the Budget Trading Program.

As part of the final NOx Trading Program rules (310 CMR 7.28) the Massachusetts Department of Environmental Protection (MADEP) established a set-aside provision specifically designed for CHP units that exceed 60% overall energy efficiency (including the production of both electricity and heat). The MADEP set-aside for CHP is based on the amount by which the CHP system's total emissions are less than a generator/boiler assumed match the CHP energy output and to emit NOx at 0.15 lbs/MMBtu of fuel input. The assumed efficiency of the conventional generator is 34%, and the thermal output (boiler) is assumed to be 80% efficient. Under this rule, the CHP unit will receive allowances to the extent that it has a lower emission rate than 0.15 lb/MMBtu, and/or is more efficient than the performance characteristics assumed for a conventional generator/boiler.

New Hampshire

New Hampshire is not a NO_x SIP Call state, but it has adopted a cap-and-trade system for ozone-season NO_x as part of its participation in the Ozone Transport Commission. In addition, a multi-pollutant cap-and-trade rule affecting year-round NO_x emissions, SO_2, mercury, and CO_2 has also been adopted; it includes EE/RE set-aside provisions as well as other non-emitting sources, such as nuclear power uprates.

New Jersey

New Jersey has established two set-aside reserves of the 8,200 allowances available for allocation. Of that total, 820 allowances (10%) are allocated to a new source and growth reserve and will be available for distribution after the control period to new NO_x Budget Trading Program sources. In addition, allowances from this reserve will be provided to budget sources that have low NO_x emissions rates if they emit more tons of NO_x than the number of allowances allocated for the sources for the particular control period.

Another 410 allowances (5%) are allocated to an incentive reserve and will be available for distribution after the control period; they will be based on saving or generating electricity through the implementation of certain environmentally beneficial techniques pursuant to N.J.A.C. 7:27-31.8. The state Department of Environmental Protection must receive claims for incentive allowances by October 30 of the year in which the electricity savings or generation occurred during the control period. Eligibility is limited to (1) energy efficiency measures that do "not result in the construction, installation, or operation of a new emission source or increase the emissions of any existing emission source at the facility"; or (2) environmentally beneficial techniques limited to landfill or digester gas, generation by fuel cell, generation using solar energy or wind power, and the owner or operator of equipment that generates electricity by "another environmentally beneficial technique" approved by the department.

Whether a new CHP unit might qualify for the new source and growth reserve depends on its size and emissions characteristics. The department's interpretation of "another environmentally beneficial technique" might also qualify CHP for allowances from the incentive reserve.

New Jersey provides that if one reserve is exhausted in a control year and the other is not, allowances roll over to the exhausted reserve, and allowances not needed in either reserve are allocated to budget sources to the extent they are under allocated. Finally, any allowances still unused remain in the reserves for allocation in the next year.

Ohio

The EE/RE project set-aside has been allocated NO_x allowances equal to 1% of the tons of NO_x emissions in the state Budget Trading Program. Any project that reduces end-use demand for electricity during the control period can be considered for implementation. This includes demand-side management practices, as well as the displacement of electrical energy through the use of wind power, solar power, and biomass or landfill methane generation.

Innovative technology projects have also been allocated 1% of the tons of NO_x emissions in the state budget. These can be any projects utilizing technology that has not been adequately demonstrated in practice but would have a substantial likelihood of reducing NO_x emissions compared with current practices. An innovative technology project could include technology to decrease electrical energy or fuel use in either stationary or mobile sources.

Proposals are reviewed and, if warranted, approved based on criteria determined by the director of the Ohio Environmental Protection Agency. The Ohio Department of Development determines the methodology for monitoring and verification.

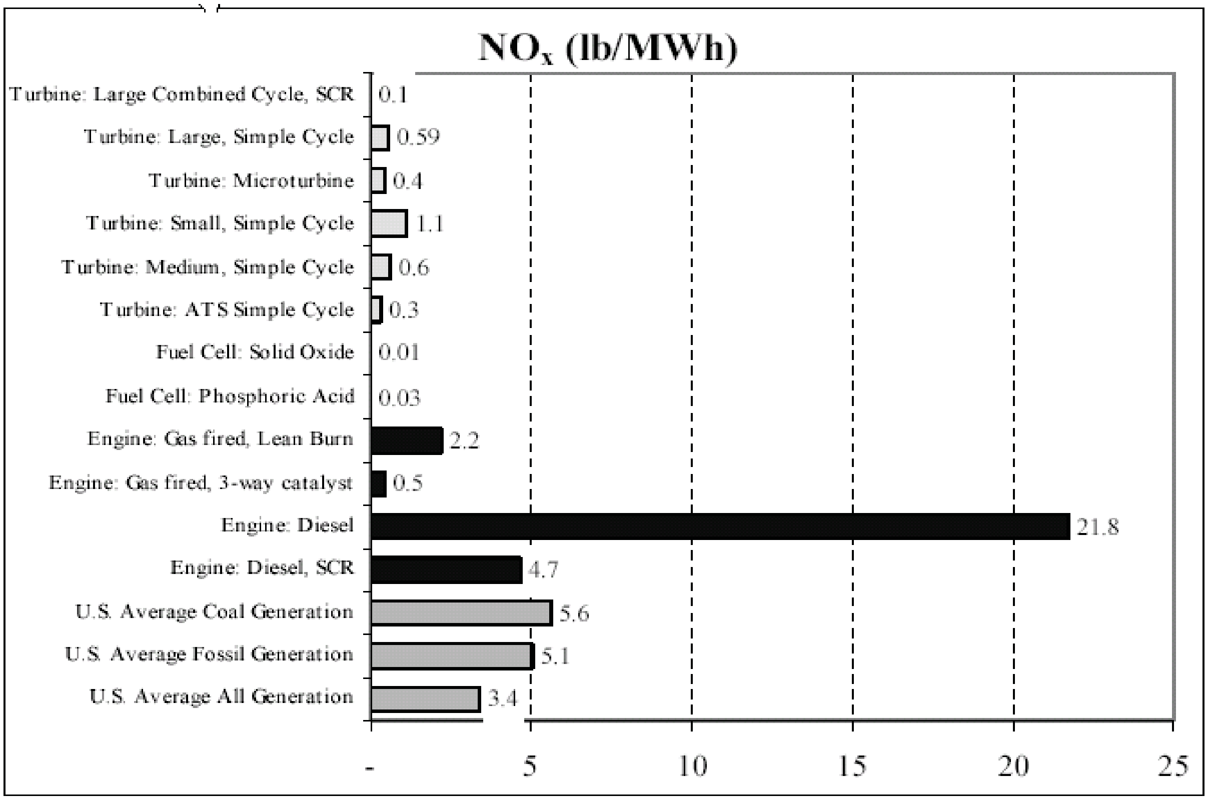
Ontario, Canada

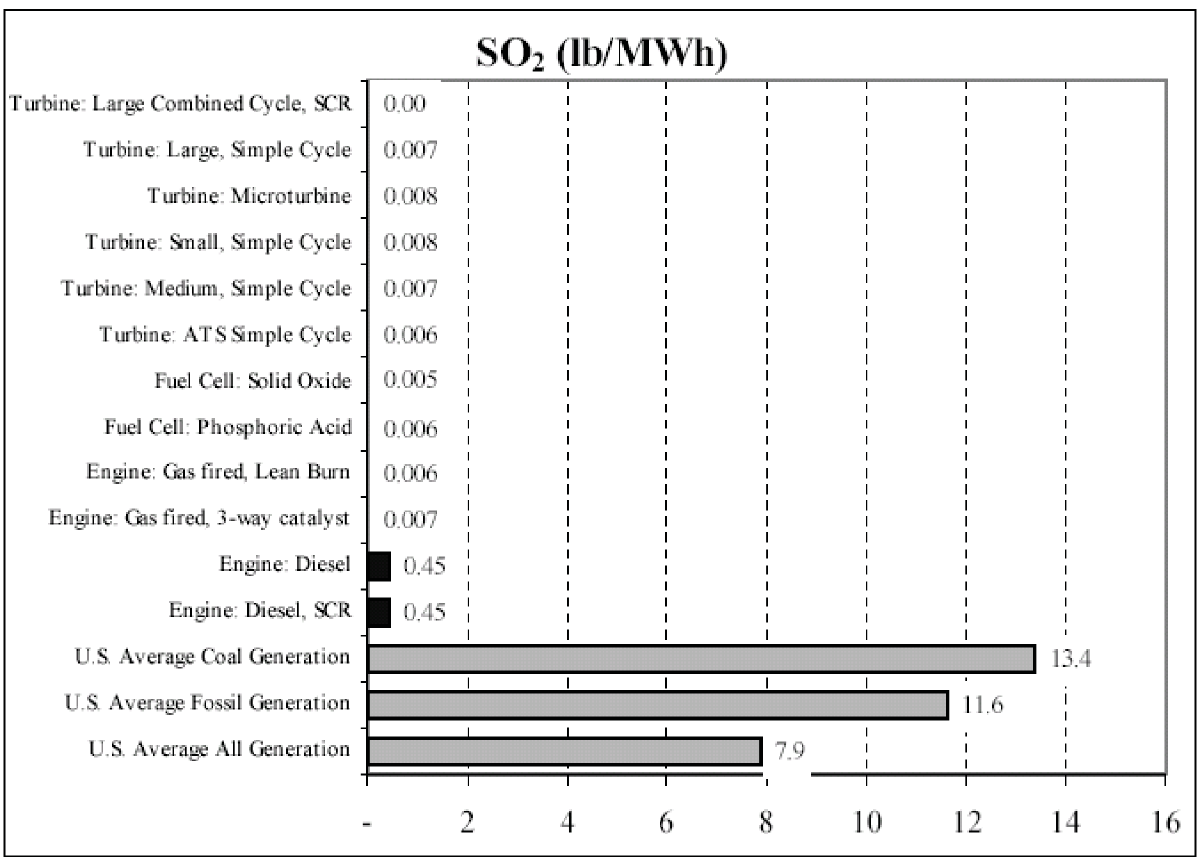
Ontario has set aside 1 kilotonne per year (kt/yr) of NO_x and 4 kt/yr of SO_2 from overall allocations beginning at 36 kt/yr of NO_x and 157.5 kt/yr of SO_2 through 2006 and decreasing to 28 kt/yr of NO_x and 131 kt/yr of SO_2 for 2007 through 2010. The set-aside is available to new "conservation" and renewable energy projects that displace electricity produced from coal- or oil-fired plants, and unused kilotonnes are returned to Ontario Power Generation through the end of 2007 and to the common allowance pool thereafter. A protocol, emissions reduction report, verification report, and other supporting documents relating to the emissions reductions must be submitted to the Ontario Emissions Trading Registry. The documents must meet the same recording, public review, and comment requirements as documents submitted in application for ERCs, but emissions reductions from renewable energy projects and conservation projects do not qualify for creation of ERCs. They stay in the registry until they are used in an application for set-aside allowances.

Renewable energy projects are limited to photovoltaics, wind turbines, run-of-river hydropower, and new hydro from existing dams (with no increase in reservoir size). Conservation projects are defined as those that “[r]educe the use of electricity purchased or received from the IO controlled grid through the implementation of energy efficiency measures that reduce the consumption of electricity received from the IMO controlled grid” (Ontario Emissions Trading Code, Section 9.2). Electricity savings must be determined in accordance with Section 3.4.2 (Option B) and Section 3.4.3 (Option C) of the 2001 version of the International Performance Measurement and Verification Protocol (IPMVP), Volume 1. The savings will be eligible for an award of allowances from the allowance set-aside for seven years after the project is completed.

CHP units do not appear to be eligible for emissions allowances. They are included in the list of renewable energy projects, and the description of conservation and energy efficiency measures appears to envision traditional demand-side measures (such as the IPMVP and the seven-year eligibility period).

Attachment 4. Comparative Emissions Rates of DG vs. Central Technologies





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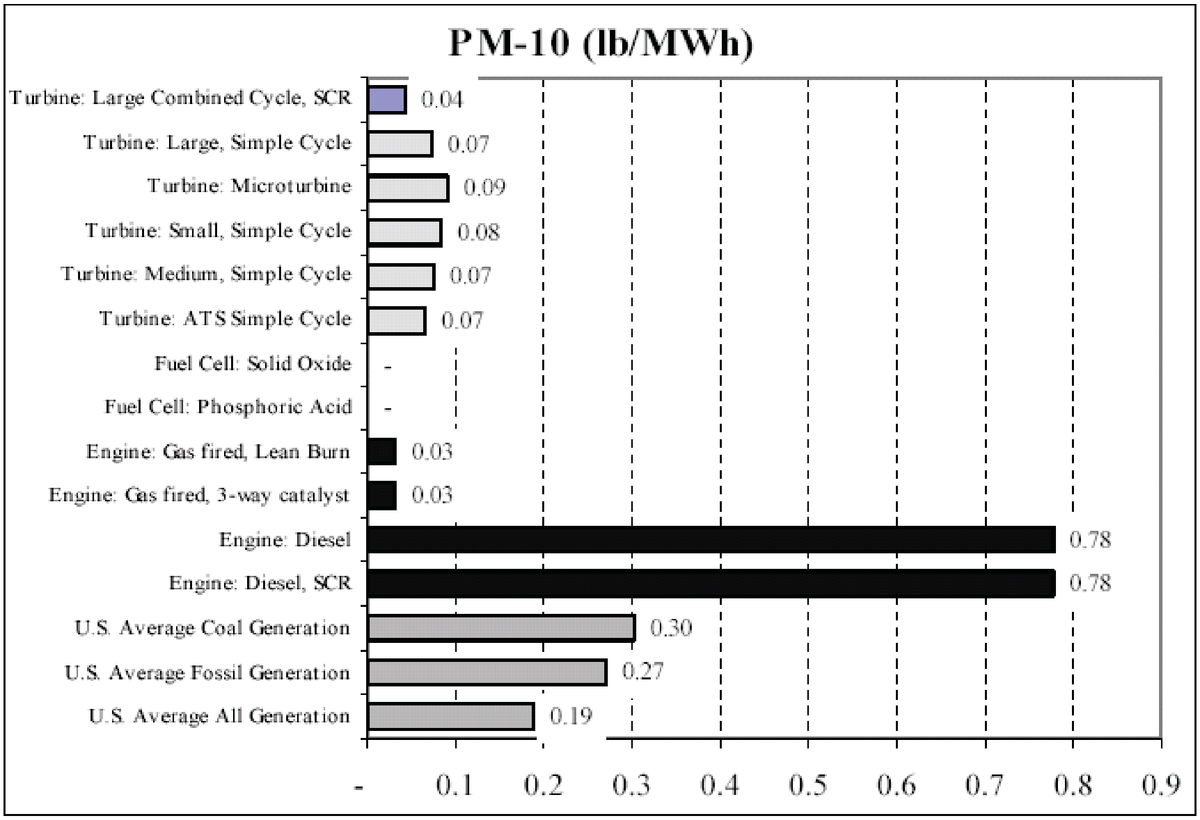

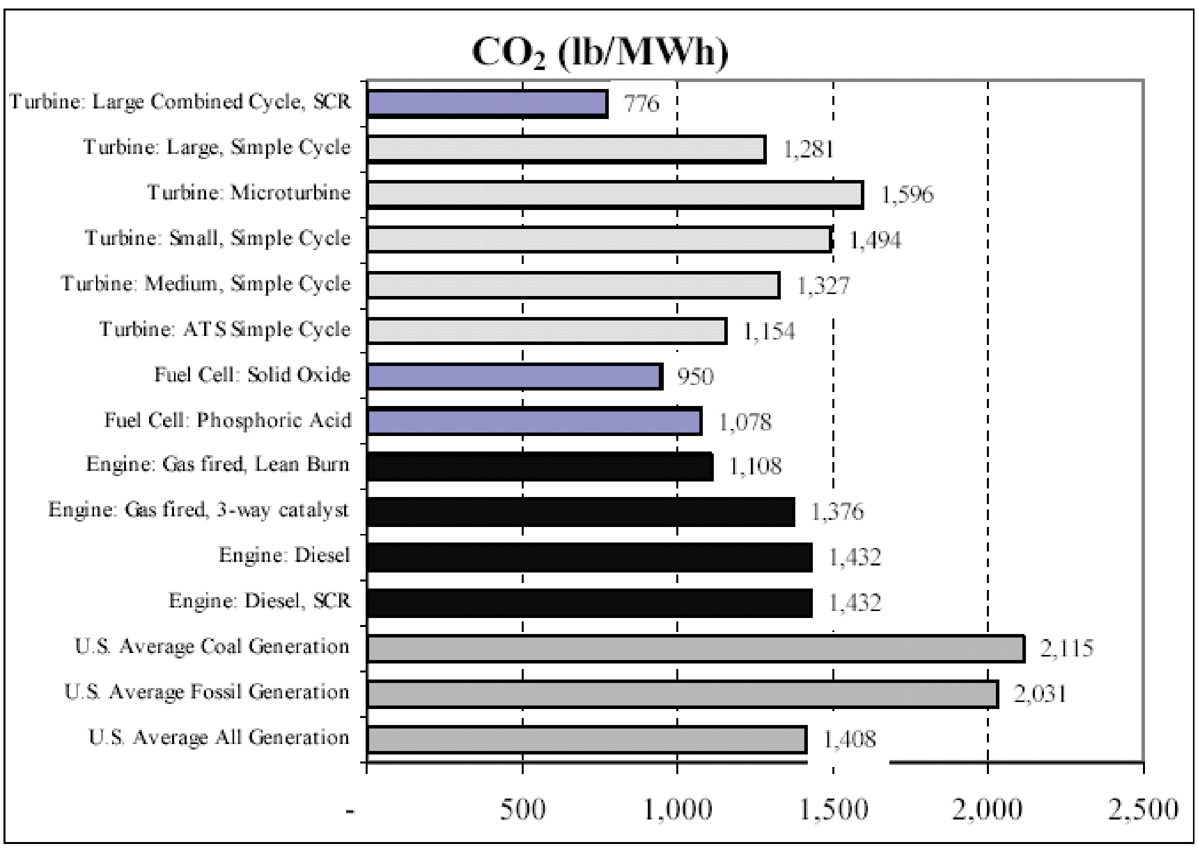

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