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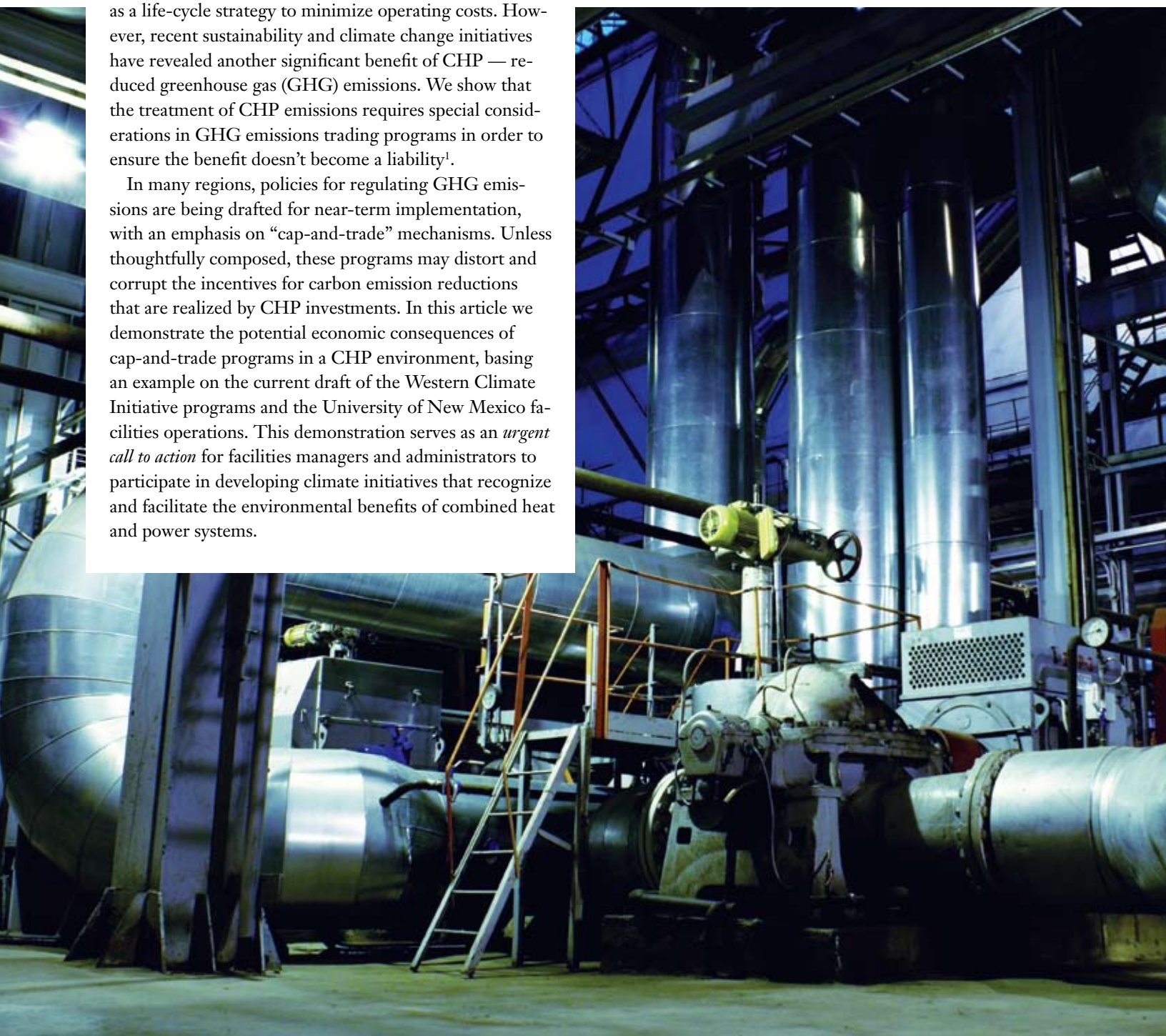
Facility professionals continuously search for projects that reduce energy consumption and operating costs so as to directly benefit their bottom line. Many institutions nationwide have contemplated or made investments in combined heat and power (CHP) projects as a life-cycle strategy to minimize operating costs. However, recent sustainability and climate change initiatives have revealed another significant benefit of CHP — reduced greenhouse gas (GHG) emissions. We show that the treatment of CHP emissions requires special considerations in GHG emissions trading programs in order to ensure the benefit doesn't become a liability[1].

In many regions, policies for regulating GHG emissions are being drafted for near-term implementation, with an emphasis on "cap-and-trade" mechanisms. Unless thoughtfully composed, these programs may distort and corrupt the incentives for carbon emission reductions that are realized by CHP investments. In this article we demonstrate the potential economic consequences of cap-and-trade programs in a CHP environment, basing an example on the current draft of the Western Climate Initiative programs and the University of New Mexico facilities operations. This demonstration serves as an *urgent call to action* for facilities managers and administrators to participate in developing climate initiatives that recognize and facilitate the environmental benefits of combined heat and power systems.



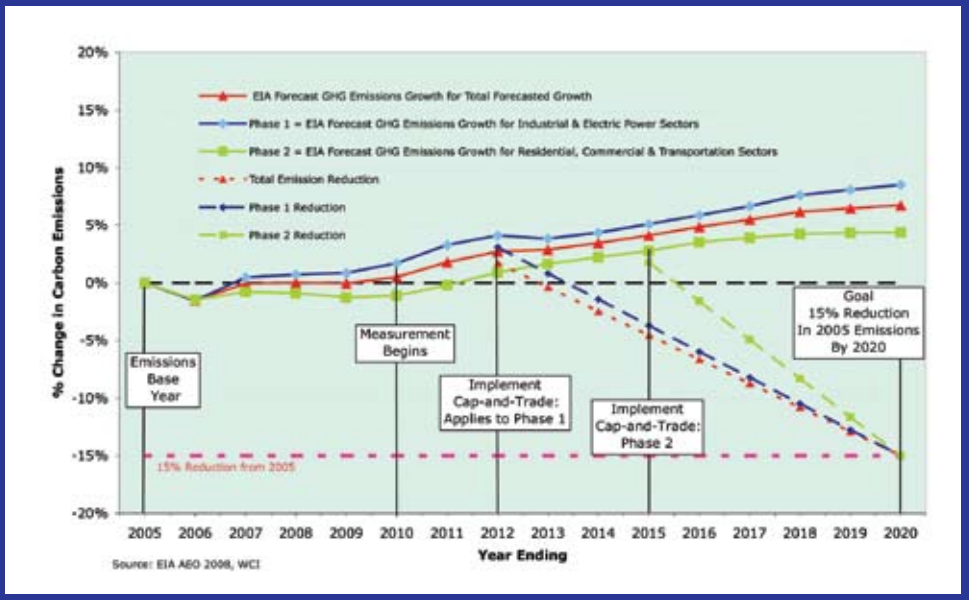
CARBON

EMISSIONS TRADING AND COMBINED HEAT AND POWER STRATEGIES:

UNINTENDED CONSEQUENCES

BY JOHN C. TYSSELING, PH.D., MARY VOSEVICH, BENJAMIN R. BOERSMA, AND JEFFREY A. ZUMWALT

Figure 1



EFFICIENT COMBINED HEAT AND POWER (CHP) SYSTEMS

Facility managers are well aware of the profound improvements in energy efficiency offered by CHP or cogeneration, which generates electricity and utilizes waste steam for heating, cooling, or other processes. Importantly, CHP offers equally profound reductions in greenhouse gas emissions. (See also the U.S. Environmental Protection Agency's website, *www.epa.gov/chp/basic/methods.html*.)

Although utilizing a CHP system approach can achieve a significant reduction in total carbon emissions, the CHP facility will likely face a significant increase in *onsite* emissions it produces, as less electricity is produced at the electric utility company's facility. If the CHP facility incurs financial costs (under pending climate initiatives) for this increase in on-site emissions, the increased cost could act as a significant deterrent or barrier to the implementation or operation of CHP Systems that have proven to be highly efficient and potent sources of emissions reductions. This is the Achilles heel of a CHP emissions profile.

IMPLEMENTING CLIMATE INITIATIVES

Emission trading schemes are at the heart of regional GHG climate initiative market-based programs, specifically: California Air Resources Board (CARB) programs, the Western Climate Initiative (WCI), the Mid-Western Greenhouse Gas Reduction Accord (Accord), and the Regional Greenhouse Gas Initiative (RGGI). The comprehensive GHG emissions provisions of the (draft) WCI "cap-and-trade" program — partnered by seven western U.S. states and four Canadian provinces — serve as the foundation for the balance of this discussion. The cap-and-trade program for the WCI is slated to begin January 1, 2012, with a 2020 emissions reduction target of 15 percent from 2005 emissions levels.

The WCI reporting program starts with measurement of 2010 emissions, to be reported in early 2011. The aggregate regional cap for emissions allowances included in the cap-and-trade program will be the sum of the annual allowance budgets for all of the WCI Partners beginning in 2012 (a "unit" of allowances is measured in metric tons of carbon dioxide equivalent (MTCDE)). Figure 1 illustrates the WCI "trajectory" for emissions reductions, based on the nationwide trend in carbon emissions (by sector) forecasted by the U.S. Energy Information Administration.

CASE STUDY: APPLICATION OF WCI INITIATIVES TO CHP

The University of New Mexico (UNM) relies on a CHP system — commonly identified as a complex District Energy System (DES) — for delivery of its comprehensive utility services to approximately six million square feet of campus facilities. Additionally, the university currently purchases more than half of its electricity requirements from its local utility provider, and has provided "plug-in" expansion capability to double its cogeneration facilities. We present two scenarios that model UNM's facility operations using a cogeneration ("Cogen") facility and without using cogeneration facility operations ("No Cogen").

Table 1 — Greenhouse Gas Emissions – Impact of UNM Cogeneration

UNM Operating Scenario	ONSITE CARBON EMISSIONS Purchased Natural Gas MMBTU	MTCDE / MMBTU	GHG (MTCDE)	OFFSITE CARBON EMISSIONS Purchased Electricity kWh	MTCDE / kWh	GHG (MTCDE)	Total GHG EMissions (MTCDE)
No Cogen	472,197	0,0528	24,932	120,317,822	0,00087	104,677	129,609
Cogeneration	591,944	0,0528	31,255	99,890,822	0,00087	86,905	118,160
Difference	119,747	0,0528	6,323	-20,427,000	0,00087	-17,771	-11,449
Percentage Change in Emissions	Onsite Emissions		25.4%	Offsite Emissions		-17.0%	-8.8%

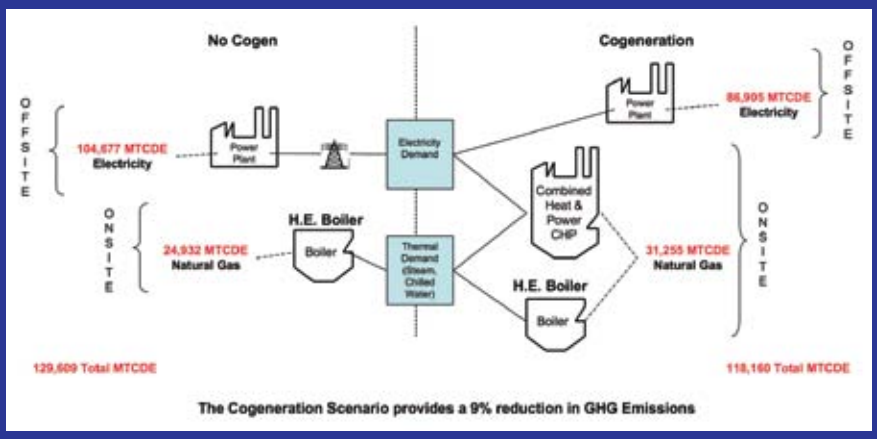
EMISSIONS PROFILES FOR UNM'S ALTERNATIVE OPERATIONS SCENARIOS

In the No Cogen Scenario, UNM's electrical needs are purchased from the local utility, and UNM's boilers

are utilized to meet steam requirements. In the Cogen Scenario, a significant portion of the steam requirements and 17 percent of the purchased electricity are provided by cogeneration, with the balance of energy service requirements provided from the same facilities used in the No Cogen case. Table 1 states the energy use and GHG emissions from the scenarios.

The Cogen case produces 8.8 percent less total GHG emissions than the No Cogen. This net reduction is primarily due to the Cogen Scenario's decreased electricity purchases (by 20.4 million kWh), substituting increased gas use and (corresponding) cogeneration output. While the Cogen Scenario reduces total GHG emissions by nearly 9 percent, it also results in increases in onsite emissions by more than 25 percent. Figure 2 illustrates this — if UNM decides to operate under the Cogen Scenario, it produces 6,323 MTCDE more emissions than under the No Cogen Scenario, but utility company emissions are reduced by 17,771 MTCDE. This is the fundamental issue requiring recognition: shifting emissions from offsite to onsite locations may also *shift the compliance obligations and economic burdens* from one party to another under cap-and-trade programs.

Figure 2



EMISSIONS COSTS AND EMISSION REDUCTIONS INCENTIVES IN A CHP ENVIRONMENT

We conclude our analysis by demonstrating how specific *compliance obligations* and *emission allowance allocations* under WCI can dramatically impact the economic *compliance costs* associated with CHP investments under the WCI program.[2]

Summary of Potential Emissions Compliance Costs Under WCI

Fast-forwarding to 2012, we assume the WCI program is implemented consistent with its current specification. We compare the *onsite emissions compliance costs* under a No Cogen Scenario to two different specifications of UNM's hypothetical *compliance obligation* through 2020 relating to its cogen facilities under the WCI program (draft). We also assume an allowance cost of $10 per MTCDE in 2012, increasing to $25 per MTCDE in 2020.

The emission allowances allocated to UNM under the WCI program decrease annually from 2012 through 2020 — starting in 2012 with a 1 percent reduction in allowed emissions that is further reduced by the additional requirement that 10 percent of its allowed emissions be dedicated to "reallocation" through the WCI auction program. Assuming that UNM energy systems have to satisfy constant annual loads, UNM must purchase emission allowances equal to 10.9 percent of its 2012 actual emissions. By 2020 UNM must reduce its carbon emissions by 15 percent (i.e., its pre-auction "allocated allowances"), and contribute 25 percent of its allocated allowances to the auction. Thus, if UNM continues to have the same energy requirements in 2020, it will be required to *purchase emissions allowances* equal to 36.25 percent of its actual emissions in 2020, based on an assumed straight-line increase from 10 to 25 percent for allowed emissions allocated in the auction.

Figure 3 (on next page) demonstrates this compliance obligation for the No Cogen Scenario. The dashed lines reflect the 2020 WCI combined requirements of a 15 percent emission reduction and a 25 percent allowed emission allowance contribution to the WCI auction. Amounts under the dashed lines represent *allocated allowances* that the WCI program would provide to emitters without cost. The difference between onsite (and offsite) total emissions in 2020 and the allocated allowances in 2020, defines the amount of emission allowances that must be purchased. Implementing WCI programs from 2012 through 2020 under Scenario One: No Cogen, UNM would face total (undiscounted) compliance costs of approximately $1.0 million (for onsite emissions), with costs increasing annually from approximately $27,000 in 2012 to approximately $226,000 in 2020.

The second scenario, Scenario Two: CHP Addition, represents the addition of a CHP facility between 2005 and 2012. This scenario raises a number of issues relating to compliance obligations and costs. Importantly, cogeneration has the additional benefit of lower operating costs — estimated to be nearly $600,000 per year for UNM at currently anticipated natural gas and electricity prices. In Scenario Two, the WCI program again sets UNM's 2020 target based on its actual 2005 emissions, but UNM begins with a now increased 2012 onsite emission profile. Due to UNM's addition of CHP, off-

Figure 3

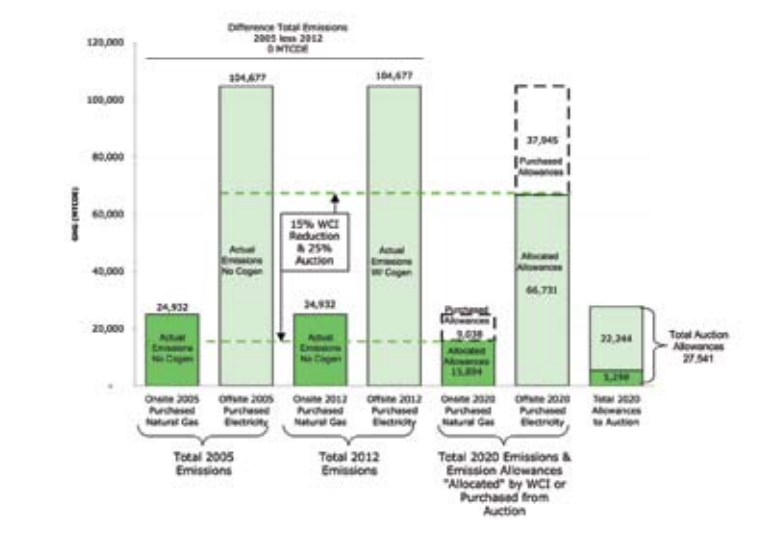


Figure 4

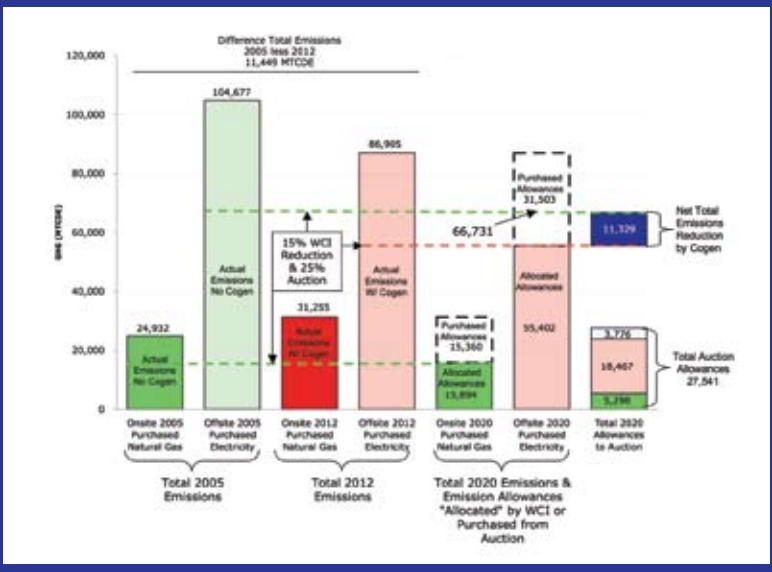
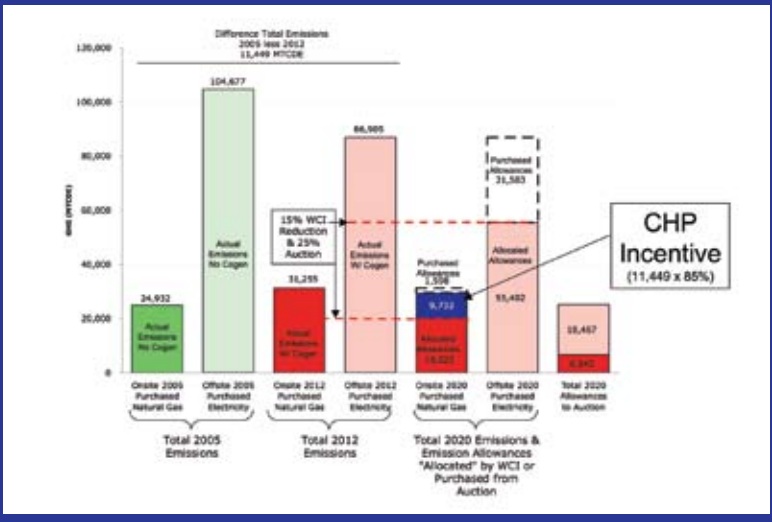


Figure 5



site 2012 emissions are now lower.

In Figure 4, Scenario Two: CHP Addition, the dashed lines again represent *allocated allowances* that the proposed WCI program provides to emitters without cost, and for emissions above the lines emitters must purchase allowances (or physically eliminate). The graph depicts UNM's higher onsite emissions from the addition of CHP after 2005, as well as the higher level of required purchased emission allowances in 2020. Most important, the available allowances in the WCI auction are lower, but there is no recognition of the net social benefit from UNM's reducing total emissions by implementing cogeneration.

In Scenario Two, UNM's compliance costs are substantially increased over the previous scenario as a result of its higher onsite emissions (relating to cogen operations). In fact, UNM's onsite allocated allowances would actually be 32.2 percent lower than its actual 2012 emissions. Total onsite compliance costs (2012 through 2020) soar to more than $2.0 million, with 2012 compliance costs of more than $90,000 increasing to more than $384,000 in 2020. This scenario considers *neither* the social benefit of the UNM cogeneration investment (reducing actual emissions by 11,449 MTCDE when compared to 2005 emissions), nor the "windfall" of offsite emission reductions (17,771 MTCDE) – except to the extent it is implicitly "allocated" to the electric utility.

The final scenario, Scenario Three: CHP Incentive, an "incentive" is provided to UNM by crediting a net social benefit as an addition to its allocated allowances. Figure 5, Scenario Three: CHP Incentive, implements this policy to encourage CHP investment. The incentive (9,732 MTCDE) is assessed by looking at the actual change in emissions in 2012 (11,449 MTCDE) and taking 85 percent of it, to account for the WCI goal of a 15 percent reduction by 2020. The "incentive" allocation of emission allowances increases UNM's allowances by allocating to UNM the net total reduction in emissions associated with its investment in cogeneration technology.

The incentive, when combined with the allocated allowances otherwise granted to UNM by the WCI program, exceeds UNM's actual total emissions for most of the 2012 through 2020 period. It is only at the end of that period that UNM will be forced to purchase allowances to match its total emission levels. In fact, for a portion of the compliance period (2012-2018) UNM will have surplus allowances allocated to it which it can sell in the WCI auction.

Thus, UNM has no additional compliance costs under the WCI program. Indeed, in this specific example it obtains a slight benefit in the form of estimated

income (of $349,400) from selling allowances through the 2012 through 2020 period (nearly $1.4 million in savings and benefit over No Cogen Scenario, ignoring the additional benefit of lower operating costs).

CONCLUSIONS

CHP presents opportunities to both reduce overall emissions in a region and to lower overall operating costs; however, the Achilles heel of CHP is that onsite GHG emissions increase due to burning additional fuel. Greenhouse gas emissions regulations must be written in a manner that adequately addresses the CHP total emission reduction issue. In particular, although WCI has identified CHP as an issue that needs to be addressed,[3] it has proposed no structure or provisions to provide an incentive for CHP implementation. Without special consideration the GHG regulations might encourage institutions like UNM *not to invest* in energy efficient technology like CHP or to choose *not to operate* existing CHP facilities.

In our case study, under the WCI program UNM must reduce overall emissions by 15 percent or purchase an equivalent amount of emission allowances. By implementing CHP, overall actual emissions are already reduced almost 9 percent. Clearly, CHP is a useful tool in achieving some of the reduction that will be required, even given that onsite emissions must increase slightly to achieve overall reductions in GHG emissions.

The UNM case study demonstrates that the current structure of the WCI could impose a significant financial burden on CHP projects if improperly designed. A strong incentive is needed to provide the institutions implementing CHP with the assurance that a decision to implement CHP is indeed the environmentally *and* economically correct one. This incentive should encourage onsite implementation of CHP by correctly identifying the party responsible for the reduction in the region's overall GHG emissions and ensuring allowance credit for their actions is not diverted to other parties.

NOTES

1. Calculated emissions information in this article came from the Lobo Energy Model (LEM), a model jointly developed by E3c, Lobo Energy, Inc. (a UNMowned nonprofit corporation), and UNM's Physical Plant Department to analyze possible strategies for both required capital investment and efficient operations of UNM's DES. The LEM calculates the purchased quantities of natural gas and electricity for defined operational scenarios and provides useful information related to GHG emission issues for UNM's facilities' operations.
2. An interested reader can find this analysis more fully develope in a series of related articles at *http://e3c.com/~/Climate_Initiatives_and_CHP/.*
3. WCI, "Essential Requirements of Mandatory Reporting for the Western Climate Initiative, Second Draft," September 30, 2008, p. 12.

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