A CHEAP AND EFFECTIVE CO_2 CAP & TRADE FOR ELECTRICITY

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By Steven Michel [1]

Now that debate has shifted from regional toward federal cap-and-trade policy, it's time to reintroduce the idea of using reduction credits rather than allowances to drive emission reductions. A credit system appears to work well to reduce CO_2 emissions with minimal compliance cost – and without windfall, wealth transfer, or market power concerns. It also provides a strong incentive for renewable energy and energy efficiency, and a ready means to harmonize a federal cap-and-trade with state and federal renewable energy portfolio requirements.

1.0 Introduction

Policymakers today are faced with a difficult challenge. A worldwide recession has provided an opportunity for opponents of greenhouse gas regulation to argue that, given current economic conditions, it is too expensive to implement. This paper demonstrates that CO_2 cap & trade regulation in the electricity sector can be accomplished in an economic and consumer-friendly manner, without compromising the aggressive targets needed to avoid catastrophic climate change.

A free allocation of allowances to polluters can result in lower compliance costs[2] and lower consumer prices for carbon-regulated products, if the allocation is based on production output rather than historic baselines. Due to its unique nature, however, an output-based cap & trade does not work well in the electricity sector. This paper describes an alternative approach for electricity that can, by using CO_2 reduction credits rather than allowances, dramatically reduce compliance costs of greenhouse gas regulation. Important advantages of this approach are the positive nature of the mechanism, and its robust encouragement of energy efficiency and renewable energy. When coupled with a compliance requirement for electricity distribution companies, this credit system works quite well in economically reducing greenhouse gas emissions.

2.0 The Allowance Allocation Debate

One of the most contentious debates surrounding greenhouse gas regulation is whether, how, and to what extent allowances issued to reduce CO_2 should be distributed freely or auctioned to polluters. The answer can greatly affect the economic impacts of carbon regulation.

An allowance auction has been advocated for several reasons. First is that it provides a mechanism to allocate CO_2 reduction responsibility while at the same time sending a price signal to consumers to reduce their consumption of carbon-intense products. In addition, an auction can prevent windfall profits to merchant generators that would accrue if they received free allowances. The concern with windfall profits stems from economic theory suggesting that the marginal cost of a product will also be the market clearing price. In other words, if allowances are freely distributed based on historic emissions, as is typically suggested, then new entrants, which must purchase allowances to cover their entire CO_2 footprint, will set the marginal cost of that product. And recipients of free allowances will be able to charge that market clearing price, and capture the value of their free allowances as a windfall profit.[3] Auction advocates argue that, rather than permitting windfalls to polluters, an auction would transfer the value of those allowances to government – which can then use those proceeds to the benefit of its citizenry.

Allowance auction opponents contend that auctions will dramatically, and unnecessarily, increase the compliance cost of greenhouse gas regulation. [4] In addition, opponents argue that auction design is difficult, international markets with unregulated participants will preclude windfalls, and deciding how to use auction proceeds will be contentious. Auctions are complex, with transactions involving billions of dollars. Financial interests will exploit middleman opportunities for gain, and Enron-type players will dissect the auction design to identify deficiencies which would allow additional profit. Market oversight will be critical, and if history is a lesson, perhaps ineffective.

In the electricity sector, allowance allocation is complicated by a diversity of production techniques, which can unevenly distribute the impacts of carbon regulation among utilities and regions. Those reliant on coal, oil and natural gas would be much more severely impacted by an auction than hydro and nuclear-based utilities. A free allowance allocation in the electricity sector is also problematic, however, because a lack of price regulation over merchant generators could allow those producers to capture windfall profits and drive up the price of electricity even if there is no auction. In sum, the dilemma in the electricity sector is that an auction may not work equitably, but neither does a free allocation of allowances that can trigger windfall profits.

3.0 Output-based Allowance Allocation

One method often considered to provide free allowances without triggering windfall profits is an output-based allocation, i.e. one that distributes allowances per unit of production. Unlike a free allocation based on historic emissions, an output-based allocation restricts windfalls because it does not create a compliance cost difference between existing suppliers and new suppliers.[5] Unfortunately, an output-based allocation works poorly in the electricity sector. The reason, again, is because of the diversity of production types in this sector. If allowances to electricity producers are based upon output, then hydro and nuclear plants receive the same number of allowances per megawatt-hour as coal and gas generators – even though the emissions of that first group is zero. The result is that fossil generators would have to purchase substantial allowances from zero-emission generators – creating a substantial wealth transfer from coal, oil and gas-fired generation and its consumers, to hydropower in the Northwest and nuclear.[6]

4.0 Alternative Allocations for the Electricity Sector

Despite the difficulties described above, there are two allocation approaches that could work in the electric industry to accomplish reductions without windfalls or wealth redistribution, and without extraordinary compliance costs. One is to provide allowances directly to electric utility local distribution companies (LDCs) rather than to generators. Another, that appears to work better, accomplishes emission reductions using *credits*, rather than allowances.

4.1 Allowances to LDCs

A proposal that has recently gained traction in the electric industry and among policymakers is to provide free allowances to electricity LDCs, which are often price-regulated, rather than to generators. This approach, endorsed by the National Association of Regulatory Utility Commissioners (NARUC)[7] and the Edison Electric Institute, would presumably mean that each LDC receives allowances based, at least in part, upon the historic emissions of its generation sources.

This proposal limits windfall opportunities by providing allowances to price-regulated entities – whose profits can be controlled. Under this proposal, generators would have to obtain sufficient allowances for their operations from the LDCs. The value of those allowances would therefore accrue to LDCs, and State commissions, cooperative boards, and city councils could assure that proceeds from allowance sales accrued to the benefit of the electricity consumers facing higher prices.

Unfortunately, this method has several drawbacks. One is that, to work, every allowance must be transacted from an LDC to a generator – meaning billions of dollars of transactions that will likely attract the same financial speculation and gaming that is of concern with an auction. Second, placing all these allowances in the hands of LDCs enhances market power and the ability to limit electricity imports from independent power producers. Finally, allowances provided to an LDC must generally match the allowances required by the generators serving that LDC. Any mismatch means some wealth transfer from under-allocated LDCs to over-allocated LDCs.

4.2 Using Credits Rather than Allowances

The second approach, using reduction credits rather than allowances to drive emission reductions, was introduced in *The Electricity Journal* in May 2008[8] as an effective means to accommodate a regional cap-and-trade with incomplete market participation. Now, with the debate shifting toward a federal cap-and-trade with full market participation, this same approach can address a variety of issues facing federal policymakers. In particular, this method appears to work well to reduce CO_2 emissions in the electricity sector with minimal compliance cost – and without windfall, wealth transfer or market power concerns. At the same time, this method provides a strong and direct incentive for renewable energy and energy efficiency, and a ready means to harmonize a federal cap-and-trade program with state and federal renewable energy portfolio requirements.

Rather than issuing allowances that authorize pollution, this approach would provide credits for emission reductions. Credits would be awarded based upon both output and emission performance, and compliance would work in a similar manner to how State renewable energy requirements are met with tradable renewable energy certificates or "RECs". This approach, which relies upon CO_2 reduction credits or "*CO_2RC*s" (pronounced "corks"), will be described in some detail because it is conceptually different from a traditional cap & trade. The discussion of this method begins with a description of how it works, followed by implementation requirements, its likely impact on energy efficiency and renewables, its resistance to windfalls and recognition of early action, and its easy linkage with allowance-based regulation.

4.2.1 How a Credit System Would Work

The highest CO_2-emitting generators today are older, subcritical, pulverized coal plants, which typically emit 1000 tonnes CO_2 per GWh[9]. Under a credit approach, for every GWh produced, a generator would be assigned one *CO_2RC* for each tonne less than 1000 that it emits. Viewed as an equation, for each GWh that a generator produces:

$$CO_2RCs + \text{Emissions (tonnes)} = 1000.$$

This means that a combined-cycle combustion turbine, which emits 400 tonnes CO_2 per GWh, would receive 600 *CO_2RC*s for every GWh generated. A wind generator would receive 1000 *CO_2RC*s for every GWh. An older pulverized coal plant would receive zero *CO_2RC*s. The equation is important because it shows that as *CO_2RC*s increase, emissions reduce, and *vice versa*. So, by requiring the surrender of an increasing number of *CO_2RC*s, regulators can reduce emissions, and this provides an alternative to *allowances* for regulating emissions. A starting rate of 1000 is used to assure the full spectrum of emission outcomes is included, and to also assure there is always an incentive for generators to reduce emissions and earn more *CO_2RC*s.

In conjunction with assigning *CO_2RC*s to generators, the regulation would require LDCs to procure and surrender enough *CO_2RC*s to meet emission reduction targets. As the requirement for LDCs to procure and retire *CO_2RC*s increases, power plant CO_2 emissions are necessarily reduced. It is important to keep in mind that this approach allows LDCs to procure their electricity from one source, and their credits from another. Because *CO_2RC*s, unlike allowances, have the emission attribute embedded in them at their creation, there is no need for the power and credits to be bundled and transmitted together, and no need for LDCs to track their electricity sources for emission attributes, as other load-based mechanisms require[10].This allows electricity markets to continue to operate efficiently.

One might ask how the *CO_2RC* method would curtail dirtier generation if that power is typically inexpensive, and can be sold independent of *CO_2RC*s. It is important to keep in mind that *CO_2RC*s are *only* produced when actual GWhs are generated and delivered. Consider an example where every LDC bought only unsequestered coal-fired power. In that example, there would be a great scarcity of *CO_2RC*s in the market, and the price of *CO_2RC*s would rise dramatically. The high *CO_2RC* price would enable cleaner generators to charge lower prices for their electricity and compete with dirtier coal. The clean generators would have to do this because, if they did not sell any electricity, they would not receive valuable *CO_2RC*s. As the *CO_2RC* requirements increase over time, this drives dirtier generation out of the market. When a utility retires an older coal plant and replaces the output with renewable energy, it receives 1000 *CO_2RC*s per GWh replaced.

4.2.2 Implementation

Implementing and administering the *CO_2RC* method is relatively simple. Generating facilities have emission rates driven by their fuel type, model, location and vintage. In addition, the Clean Air Act requires most generators to report their CO_2 emissions, so a database of emissions is readily available. To establish eligibility for *CO_2RC*s in a compliance year, a generator would provide the regulating agency with its CO_2 emission rate and its energy output. Once the crediting mechanism was in place, emission reduction goals would be implemented by adjusting the LDC's *CO_2RC* requirements. This adjustment would take the form of a percentage reduction of emissions from a "base" period.[11]

An algebraic formula is all that is required to establish an LDC's annual *CO_2RC* compliance requirement, and the only inputs needed for the formula are base period emissions assigned to the LDC, compliance year energy served, and the percent reduction policymakers will require from the base period.

$$CO_2RCs = (1000 \times GWh_C) - (CO_{2B} \times (1-R))$$

GWh_C = compliance year energy served[12]
CO_{2B} = base year CO_2 emissions
R = required % CO_2 reduction from base year (expressed as a decimal)

An easy way to think about this formula is that all consumption must be accompanied by 1000 *CO_2RC*s per GWh (carbon neutrality), less the authorized emissions – which are the baseline amounts reduced by the required percentage. This formula assures that load growth does not undermine the CO_2 reduction target.

An example can help demonstrate how this approach works. Assume a market with three electric utilities (A, B & C), and merchant generation. The loads and resources for each utility in a base year are as shown in the following table. These utilities own or have contract-dedicated coal, gas, and renewables, and make unspecified power purchases. In the example, coal generation emits 1000 tonnes per GWh, gas emits 500 tonnes per GWh, renewables emit 0 tonnes per GWh, and power purchases emit an average 500 tonnes per GWh. With these profiles, base year emissions for each utility are determined as shown: 1.5 million tonnes for A and C, and 750,000 tonnes for B.

BASE YEAR	UTILITY A	UTILITY B	UTILITY C
Load	3000 GWh	2000 GWh	2000 GWh
Coal (1000 tonnes/GWh)	1000 GWh	0 GWh	1000 GWh
Gas (500 tonnes/GWh)	1000 GWh	1000 GWh	0 GWh
Renewables (0 tonnes/GWh)	1000 GWh	500 GWh	0 GWh
Purchases (500 tonnes/GWh)	0 GWh	500 GWh	1000 GWh
Emissions (tonnes)	1.5 million	0.75 million	1.5 million
Total base yr emissions	*3.75 million*	- - - - -	- - - - -

Now, in the compliance year, we assume policy-makers want to decrease emissions for each utility by 2%. Also, between the base year and compliance year, growth has increased utility A and C loads by 5%. Utility B experienced no growth due to energy efficiency. Using the formula identified above, the number of *CO_2RC*s each utility must surrender is calculated: 1.68 million for A, 1.265 million for B and 630,000 for C. To the extent a utility would have insufficient *CO_2RC*s for compliance, it must adjust its generation profile or buy additional *CO_2RC*s to make up the deficiency. Recalling that, for every GWh produced, *CO_2RC*s plus emissions will always equal 1000, one sees that emissions for each utility, and all three utilities, are reduced by 2 % from the base year – with A's and C's emissions dropping to 1.47 million tonnes, and B's dropping to 735,000 tonnes.

COMPLIANCE YEAR	UTILITY A	UTILITY B	UTILITY C
Load – 5% growth for A & C	3150 GWh	2000 GWh	2100 GWh
*CO_2RC*s required[13]	1.68 million	1.265 million	0.63 million
Emissions (tonnes)	1.47 million	0.735 million	1.47 million
Total compliance yr emissions	*3.675 million*	- - - - -	- - - - -
Total reduction in emissions	*0.075 million*	- - - - -	- - - - -

A description of the specific steps to deploy the *CO_2RC* method is provided as an Addendum to this Paper.

Finally, although no auction revenues are associated with this method, policymakers can sell rather than give away *CO_2RC*s to authorized recipients. Selling *CO_2RC*s would provide revenues to fund the program or for other purposes. A charge of $1.00 per credit would produce hundreds of millions of dollars each year. The advantage of the *CO_2RC* method is that policymakers can establish a charge that produces the revenues needed or desired[14], rather than have those revenues subject to the uncertainties of an auction. Also, unlike auction revenues for allowances, *CO_2RC* proceeds would grow over time rather than diminish – because *CO_2RC* issuances increase as regulation tightens, whereas allowances disappear over time.

4.2.3 Energy efficiency and renewable energy

One advantage of the *CO_2RC* method is the strong and direct incentive it provides for energy efficiency and renewable energy development. Energy efficiency is considered one of the best, lowest-cost resources available for electric utilities to reduce CO_2 emissions. [15] Regulation which places the obligation to reduce CO_2 on the load-serving entity is often considered a more effective vehicle than generator-based regulation to spur energy efficiency. This is because the regulated entity is also the entity that can provide energy efficiency. In other words, the incentive for efficiency is more direct in a load-based approach to CO_2 regulation.

In addition, unlike other cap & trade mechanisms that may not provide appropriate incentives for end-use efficiency, the CO_2RC method provides a strong and consistent incentive. It does so by reducing an LDC's CO_2RC requirement by 1000 for every GWh saved.[16] Using the formula discussed earlier, one sees mathematically how, as an LDC's served energy (GWh_C) is reduced, the LDC's CO_2RC requirement is likewise reduced by 1000 per GWh: CO_2RCs required = (<u>1000</u> x GWh_C) – (CO_{2B} x (1-R)).

Similarly, the CO_2RC method provides a substantial and immediate incentive for renewable energy development. Zero emission renewable energy resources receive 1000 credits for every GWh produced. The owners of these resources would thus receive a valuable commodity that can be sold, traded or banked. This compares with an allowance-based system, in which a renewable developer must rely upon the higher price of carbon-intensive resources to make their renewable resource competitive. What this means for both efficiency and renewables is that, if carbon is trading at $40 per tonne, renewables and efficiency will receive a $0.04 per KWh advantage over coal-fired generation.

Finally, the CO_2RC method can help resolve another issue that has been vexing policymakers: how to harmonize state renewable energy requirements with cap and trade regulation. The problem arises because renewable energy is typically represented by renewable energy certificates or RECs, which often include all environmental attributes, including emission reduction benefits. So, if a REC is retired in compliance with a renewable portfolio standard (RPS), then those low emission attributes are presumably not available to generators for cap & trade compliance. This also means that renewable energy without its associated RECs, i.e. "null power," must be assigned a carbon footprint, and it is not clear what that footprint should be.

The method described here, however, provides a solution. RECs derived from zero emission renewables would be exchanged one-for-one with CO_2RCs. This solution works because a REC is produced for every MWh of renewable energy that is generated, providing it the same carbon reduction value (1 tonne) as a CO_2RC. The null power would be treated just like all other electricity in the market – as pure electricity without a carbon emission attribute. Of course, the non-carbon environmental attributes of a REC would still have to be accounted for in some manner.

<u>4.2.4 Windfalls and early action</u>

Another difficult issue confronting policymakers has to do with rewarding early action for decisions made by generators in advance of CO_2 regulation, while at the same time avoiding windfall payments to generators as a result of mere circumstance. In other words, policymakers might want to reward a relatively new solar generator installed because of its environmental benefits, but not reward an older hydro-electric plant built simply because it provided cheap electricity. Giving CO_2RCs to merchant generators – for example older hydro-electric or nuclear facilities – and then requiring LDCs to purchase CO_2RCs from these generators, could trigger unjustified windfalls at the expense of consumers.

Adjusting the CO_2RC mechanism to provide CO_2RCs associated with older generators to LDCs, rather than to generators,[17] resolves this issue. As an example, if policymakers decide that facilities built after the year 2005 should receive early action credit, then CO_2RCs would be awarded to generators for all generation, or generator emission improvements, going into service after the year 2005. The CO_2RCs that would otherwise be assigned to older generators would instead be distributed to LDCs, and then collected and retired for compliance.[18] Providing these CO_2RCs to price-regulated LDCs rather than generators avoids windfalls to merchant generators. Unlike providing allowances to LDCs, however, because the point of regulation in the *CO_2RC* method is on the LDC there is no need for *CO_2RC*s to be transferred from LDCs to generators – avoiding market power concerns and huge transaction expenses and associated risk. This adjustment provides an economic incentive and benefit for actions taken after the year 2005, but does not reward, and compensate generators for, actions taken before that date, i.e. a time before "early action" credit could be anticipated.

4.2.5 Linkage

A common currency - tonnes CO_2 - of both an allowance-based cap & trade and the *CO_2RC* method allows the *CO_2RC* method to link seamlessly with other CO_2 reduction systems in the United States and beyond. This is true even though an allowance authorizes one tonne of CO_2 emissions, and a *CO_2RC* is a one tonne CO_2 reduction. Linkage works because the only *CO_2RC*s available to trade into an allowance system are those in excess of the LDCs' compliance obligation. As such, these *CO_2RC*s can be thought of as genuine offsets. And for the same reason, allowances or offsets from another sector can be substituted for *CO_2RC*s in the electricity sector. In other words, an allowance-based cap & trade in an industrial sector can use *CO_2RC*s interchangeably with its allowances. And a *CO_2RC*-based system can exchange allowances for *CO_2RC*s one-for-one. In either case, the total emission reductions will be the same after the exchange as before.

The example in the following Table illustrates this interchangeability, and assumes two different CO_2 reduction systems. System A uses *CO_2RCs* and emits 1000 tonnes of CO_2 per year. System B uses allowances and emits 2000 tonnes per year. Both systems target 2% CO_2 reductions in year 2. As such, System A requires that 20 *CO_2RC*s be presented and retired in year 2, and system B reduces its available allowances in year 2 from 2000 to 1960. This reduces CO_2 emissions on the two systems a total of 60 tonnes.

Year & Target	System A (*CO_2RC*) 1000 tonnes CO_2	System B (Allowance) 2000 tonnes CO_2
1 – zero reduction	0 *CO_2RC*s	2000 CO_2 allowances
2 – 2% reduction	20 *CO_2RC*s	1960 CO_2 allowances

Now let us say that CO_2 reductions are cheaper on System A than System B. So, B buys 40 *CO_2RC*s from A, and adds those *CO_2RC*s to its allowances. This gives B 2000 allowances in Year 2, and eliminates B's reduction requirement. However, to meet System A's requirements, A must provide 20 *CO_2RC*s for compliance, plus an additional 40 *CO_2RC*s to sell to B. So, the total reduction across the two systems is still 60 tonnes CO_2.

The same result works in reverse, i.e. if reductions are cheaper on System B. In that case, A buys 20 allowances from B, and uses those allowances to meet its *CO_2RC* requirements. A, therefore, does not reduce CO_2 at all. B, however, has only 1940 CO_2 allowances remaining (because it sold 20 to A), so it must reduce its CO_2 emissions by 60 tonnes (2000 – 1940), again accomplishing the 2% reduction across the two systems.

5.0 Conclusions

This Paper has described two CO_2 cap & trade approaches for the electricity sector that would reduce the compliance cost of greenhouse gas regulation. The first would freely distribute allowances to LDCs. The second would use emission reduction credits rather than allowances to accomplish CO_2 reductions. While both approaches can avoid windfall profit and wealth redistribution concerns, this paper concludes that using credits is the better of the two. A credit-based mechanism directly rewards the behavior sought - CO_2 emission reduction – and does so in a manner that strongly encourages energy efficiency and renewable energy development. In addition, a credit approach does not involve the worrisome financial transactions and market power concerns of the allowance-to-LDC approach. Finally, a credit system for the electric industry would provide a relatively simple way to regulate greenhouse gas emissions without compromising *at all* the dramatic emission reductions needed to avoid catastrophic climate change.

ADDENDUM: Steps to implement a CO_2RC-based cap & trade:

1. Establish a base period annual emission level for each LDC, i.e. determine the average annual emissions for each generator during a base period (e.g. 2003-2006), and assign those emissions to LDCs as follows:

    a. all emissions from generators dedicated to LDCs (through ownership or bilateral contract) go to those respective LDCs
    b. all remaining emissions go to LDCs pro rata based upon each LDC's average annual base period load

2. Establish annual CO_2 emission reduction requirements for each LDC (e.g. 2% per yr)

3. In January thru March after each compliance year, award CO_2RCs based upon the following criteria (with one CO_2RC created for each tonne less than 1000 that the responsible generator emits per GWh):

    a. For all, e.g. post-2005, generators, and emission improvements to generators, the CO_2RCs are awarded directly to the generator
    b. For all pre-2006 generators, LDCs are awarded the CO_2RCs associated with the generation assigned to them for base period emissions

4. In the January thru June after each compliance year, LDCs must retire CO_2RCs according to the formula: $CO_2RCs = (1000 \times GWh_C) - (CO_{2B} \times (1-R))$.[19]

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[2] Throughout this paper references to the "compliance cost" of a cap & trade approach refer to the price consumers will pay for carbon-regulated products. When allowances are auctioned or sold, in addition to the cost of reduction, producers must also pay for each tonne of their emissions – which adds to the price of carbon-regulated products to consumers.

[3] To illustrate this concern, assume there are 10 electric generators, each emitting 1000 tonnes. Also assume each produces one GWh costing $50,000. If policymakers want to reduce CO_2 by 10%, they will issue each generator 900 allowances, or 9,000 allowances total. If a new generator, with the same operating characteristics, enters the market, that generator must purchase all its allowances, i.e. 1000, and if an allowance costs $40, then that new generator will pay $40,000 for allowances. Existing generators would only need to purchase an additional 100 allowances, adding only $4,000 to their cost. But because the new generator's marginal cost is $90,000 per unit – this marginal cost will set the market-clearing price for all generators, and existing generators will capture $36,000 in windfall profits while the electricity price will escalate to the same level as if allowances were auctioned.

[4] As an example, assume a coal-fired electricity generator emits 1 tonne per MWh, and charges $50 for each MWh. During the course of a year, the generator produces 1000 MWhs, charges $50,000 for that power, and emits 1000 tonnes of CO_2. Now let's say regulators require a 5% reduction in emissions, and CO_2 allowances trade at $40 per tonne[4] – which is also the cost that generator would incur to reduce its CO_2 by one tonne. If free allowances are provided, the generator would receive

950 allowances, and would have to either purchase an additional 50 allowances to cover its remaining emissions, or reduce its emissions by 50 tonnes. In either case, the additional cost would be $2000, increasing the cost of the power by 4%.

If, however, an auction is instituted, with the same clearing price and reduction cost of $40 per tonne, the generator must purchase 950 allowances at auction, plus reduce its emission by 50 tonnes. The total compliance cost would then be $40,000, increasing the cost of power by 80 percent, a twenty-fold increase over the compliance cost of a free-allowance system, without a single tonne more CO_2 reduction.

[5] In the footnote 1 example, if instead of an allocation based upon historic emissions, an output-based allocation were implemented, then each of the eleven generators would receive 818 allowances, and would need to purchase 182 allowances. The marginal cost for each generator would be the same, at $50,000 plus (182 x $40), or $57,280. With this type of allocation, there is no windfall profit, and the market clearing price is substantially less than $90,000, reflecting only the cost of reducing emissions, without additional profit.

[6] Another alternative that has been considered for electricity is to distinguish an output-based allocation by generation type. This, however, would be cumbersome and could create perverse incentives and outcomes. For example, assume we have three categories of generation, and assign 80% of the allowances to existing coal-fired generators at 900 per GWh, 20% to existing gas- and oil-fired plants and new generation at 450 per GWh, and zero allowances to existing renewable resources and nuclear plants. Then, allowances are distributed by output for each of those categories. Such a scheme could incentivize a gas plant to re-dispatch to an existing coal plant - because the allowance penalty would be minimal. Instead of 450 allowances for 500 tonnes of emissions, it would receive 900 allowances for 1000 tonnes of emissions – a penalty of only 50 allowances. In addition, as new technologies emerge, categorizing them could be problematic and litigious. A solar thermal or geothermal modification to an existing coal plant could be characterized as an efficiency improvement to the existing plant (entitling it to 900 allowances per GWh), or a new facility (entitling it to only 450 allowances per GWh). An overhaul of an existing coal plant could likewise be viewed as a new plant, with a 450 allowance allocation, or as an existing plant, with a 900 allowance per GWh allocation. Future possibilities are unknown and unlimited, and creating a regulatory scheme to accommodate them would be very difficult.

[7] Letter to Peter Orszag, Director, Office of Management and Budget, from NARUC, March 17, 2009.

[8] "Popping the CO_2RC: An Alternative Load-Based CO_2 Cap-and-Trade Instrument for the Electricity Sector" *The Electricity Journal*, Volume 21, Issue 4, May 2008, pages 31-42, Steven Michel and John Nielsen.

[9] "Carbon Dioxide Emissions from the Generation of Electric Power in the United States," Department of Energy, Environmental Protection Agency, July 2000: http://www.eia.doe.gov/cneaf/electricity/page/co2_report/co2emiss.pdf

[10] Tracking electricity to determine the emissions of an LDC's supply portfolio is required in other load-based cap & trade proposals, See Cowart, "Power System Carbon Caps: The Load-Side Option" NREL Energy Analysis Forum, November 27, 2007; and adds significant complexity to those proposals, see Keeler, "State Commission Electricity Regulation under a Federal Greenhouse Gas Cap-and-Trade Policy," NRRI, November 2008 at 53.

[11] The "base" year or period refers to the historic period from which emissions reductions are measured. For example, if the base period was 2003-2005, the average annual CO_2 emissions during that period would be the starting point from which to measure reductions.

[12] Including line losses.

[13] (1000 x GWh_C) – (CO_{2B} x (1-R)), so A's *CO_2RC*s = (1000 x 3150) – (1.5 mil x 0.98) = 1.68 mil

[14] To assure the *CO_2RCs* are sold, the sale price would need to be less than the anticipated market price.

[15] "Reducing Greenhouse Gas Emissions: How much at What Cost?" U.S. Greenhouse Gas Abatement Mapping Initiative, Executive Report, December 2007, McKinsey & Company - http://www.mckinsey.com/clientservice/ccsi/pdf/US_ghg_final_report.pdf

[16] This has a similar result as assuming the saved loads were served with zero-emission resources.

[17] An issue in distributing *CO_2RCs* to LDCs may arise if the generator controls unit dispatch. Providing *CO_2RC*s to LDCs in this instance could diminish incentives to re-dispatch generation as a means of *CO_2* reduction.

[18] While it may seem unnecessary, it is important that these *CO_2RC*s are both issued and retired in order to keep track of CO_2 emission levels in the market. Under the *CO_2RC* method, emissions plus *CO_2RC*s will always equal 1000 per GWh. This feature allows the method to regulate emissions by regulating *CO_2RC*s . However, for that same reason, to make this system work, every *CO_2RC* in the market must be accounted for.

In assigning older generator *CO_2RC*s to LDCs, there would have to be a consistency between the specific generators used to determine an LDC's baseline emissions, and the generator *CO_2RC*s assigned to that LDC in compliance years. In other words, it would be unfair to assign an LDC low base year emissions from which to reduce, but not provide it the *CO_2RC*s associated with the generators that made up that low base year emission profile.

[19] GWh_C = Compliance year energy served (including losses)
CO_{2B} = Base year CO_2 emissions

R = % CO_2 reduction from base year (expressed as a decimal)