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A Look at GHG Allowance Allocation in the Western Electric Coordinating Council (WECC) Region

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Introduction and Summary

Proposed national cap and trade legislation to control greenhouse (GHG) gases would allocate a majority of each year's emission allowances to emission sources at no direct cost.[1] The remainder would be distributed via periodic public auctions or set aside for special purposes. Under the Lieberman-Warner bill a total of 5,775 million metric tons of carbon dioxide (CO_2) equivalent allowances would be issued to cap nationwide emissions in year 2012.[2] About 21.5 percent of these allowances would be auctioned, and the percentage of auctioned allowances would increase each year until 2030, and then remain level until 2050. As the impacts of climate legislation are examined, auction percentages and methods proposed for free allocations are subject to change. Indeed, under California's AB 32, a legislated state program, and the Western Climate Initiative, a voluntary regional program, the methods for free allowance allocation and the fractions of allowances to be auctioned in each year have yet to be determined.

This paper compares three greenhouse gas (GHG) allowance allocation methods for the electric sector by applying 2004 CO_2 emissions and generation data for power plants located in the Western Electricity Coordinating Council (WECC) region:

- grandfathered historical emissions,
- several values for a single fixed output-based emission rate applied to all coal and natural gas power plants, and

[1] Emission allowances will be measured in CO_2 equivalent (CO_2e) tons, where a carbon dioxide equivalent ton is defined for each GHG as the quantity of that gas that makes the same contribution to global warming as one metric tonne of carbon dioxide, as determined by EPA. Starting in 2012, power plants emitting greenhouse gases (GHG) would have to surrender an emission allowance for each ton emitted. Overall emissions caps, either regional or national, will limit the number of allowances issued. The cap and, hence, the number of allowances issued will be reduced each year. Emitters must acquire sufficient allowances to cover their annual GHG emissions or pay a penalty for each uncovered ton.

[2] "Lieberman-Warner Climate Security Act of 2007" (S.2191) reported from the Senate Committee on Environment and Public Works, December 5, 2007.

- several fuel-differentiated, fixed output-based rates applied separately to coal and natural gas power plants.[3]

Results for each allocation method show that by making the unallocated allowances available for auction, target percentages of the total allowances could be made available for an allowance auction. In future years the base year allocation could be adjusted to change the corresponding auction percentages in response to lower caps. After calculating the no-cost allocations to individual power plants, the costs of purchasing the remaining allowances needed by each plant to cover its annual emissions are estimated here, assuming a cap set at the level of 2004 emissions, 2004 generation levels and CO_2 allowance prices of $10/ton and $40/ton.[4]

For each allocation method the estimated net costs to natural gas and coal power plants are summarized on a total net cost and $ per kW-year basis. These comparisons demonstrate that a wide disparity in allowance acquisition costs could be created by adopting different allocation approaches. Undoubtedly, the substantial differences in potential costs to natural gas and coal-fired power plants will affect the perceived equity of each prospective allowance allocation method.

Not surprisingly, the calculations show that the up-front costs of an auction-only approach (i.e., 100 percent auctioned allowances with no free allocations) would be much more expensive than alternative approaches that auction a smaller percentage of the total allowances. Under some of the allocations, the costs of allowance purchases would fall predominantly on coal-fired generating units, because average CO_2 emission rates for natural gas generating units in the WECC are currently only about 54 percent of emission rates at coal plants.

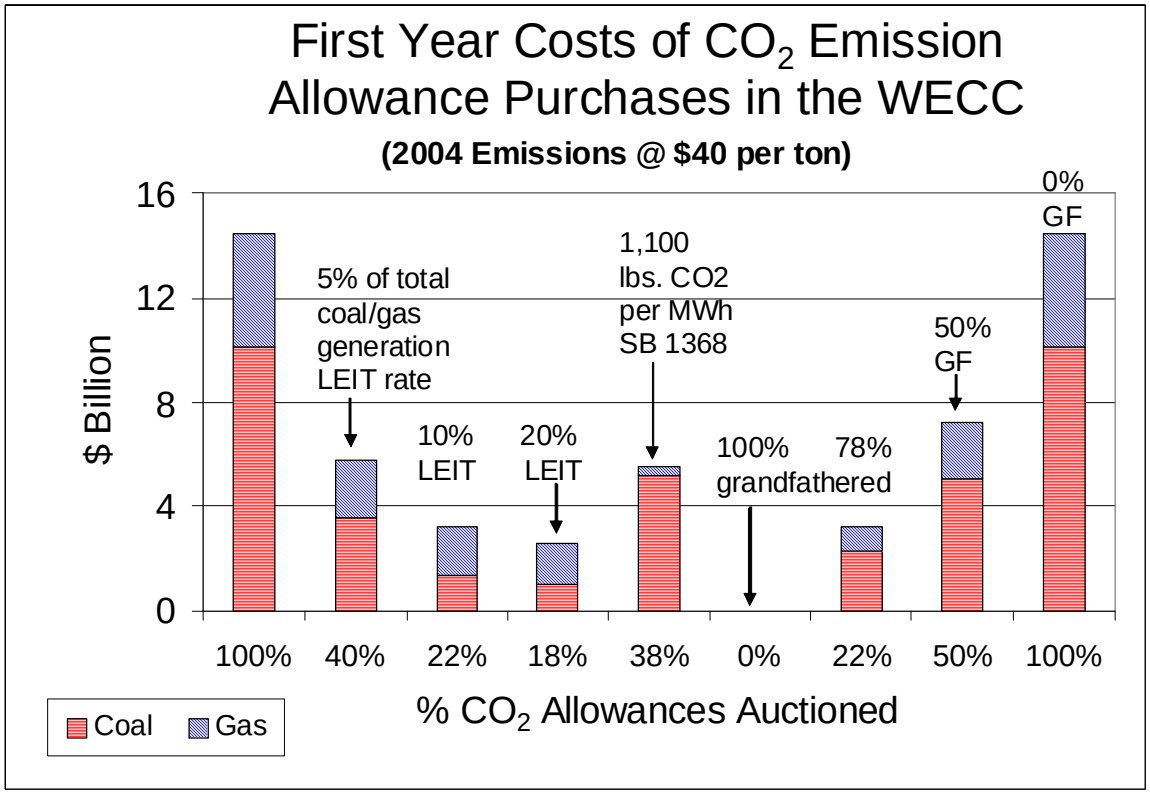
The results of several allocations are illustrated in Figure 1. Table 1 also provides quantitative comparisons for first-year allocations that would leave from 13 to 40 percent of the total allowances unallocated and, thus, available for auction. The net cost calculations assume that high emitting generators would buy allowances from those low emitting generators with a surplus. As expected, the net cost to coal-fired generators is generally much higher than to gas-fired generators.[5]

[3] The specific fuel-differentiated rates were calculated as the average of the lowest emitting plants burning each fuel, subject to the plants' cumulative generation adding up to the same designated fraction of the WECC's total coal and natural gas-fired generation, respectively. This method is referred to as the Lowest Emitting Installed Technologies (LEIT) approach. Another method, not examined here, would apply to categories of plants differentiated by both fuel and combustion technology, similar to the categories for EPA's New Source Performance Standards.

[4] In contrast to an increasing number of studies that should be commended for using metric units throughout, we have relied on U.S. dollars and short tons in this comparison, purely for convenience.

[5] In example variations where the fixed emission rate applied to all gas generators is higher than the average emissions rate for WECC gas-fired generators, gas generators as a whole would have zero net costs.

Figure 1. Comparison of First Year Allowance Costs in the WECC for Three Allocation Methods and Varying Percentages of Auction Purchases



*Compares three allocation methods with varying percentages of auctioned allowances, as indicated.

Different allocation methods for four specific cases are compared in Table 1. Each row compares allocations that would lead to the same total percentage of auctioned allowances. A single output-based allocation rate applied to all coal and natural gas plants (see the middle columns) results in considerably higher costs to coal generators than either the grandfathered historical allocation method (see the columns on the left) or the corresponding fuel-differentiated LEIT allocation method (see the columns on the right). The disparity in costs among the methods is shown by comparing the net $ per kW-year for coal and gas plants in each case. The LEIT method, which creates separate categories for plants burning coal and gas fuels, brings the net costs per kW-year closest together. This is particularly true for allocations that would result in 10 to 25 percent of the allowances being auctioned.

Table 1. Comparison of Three CO_2 Allowance Allocation Methods – First Year Auction Percentages and Costs for Coal and Natural Gas-fired Power Plants in the WECC

Method of Allowance Allocation:	**Grandfathered Tons at Each Individual Coal and Gas Plant**			**One Output-based Emission Rate Applied to All Coal and Gas Plants**			**Lowest Emitting Installed Technologies (LEIT) Output-based Rate for each Fuel Category**			
Based on Year 2004 Data	**Coal**	**Gas**	**Total**	**Coal**	**Gas**	**Total**	**LEIT % MWh**	**Coal**	**Gas**	**Total**
							5%			
% Auctioned	**40%**	**40%**	**40%**	**51%**	**9%**	**38%**		**35%**	**51%**	**40%**
% Allocated	60%	60%	60%	49%	91%	62%		65%	49%	60%
lbs per MWh Applied	N.A.	N.A.	N.A.	1,100	1,100	1,100		1,452	590	1,071
Net $ per kW-year	**117**	**23**	**53**	**150**	**5**	**50**		**104**	**29**	**53**
Total Net Costs, $ Billion	4.0	1.7	5.8	5.2	0.4	5.5		3.6	2.2	5.8
							10%			
% Auctioned	**22%**	**22%**	**22%**	**31%**	**0%**	**22%**		**14%**	**44%**	**22%**
% Allocated	78%	78%	78%	69%	100%	78%		86%	56%	78%
lbs per MWh Applied	N.A.	N.A.	N.A.	1,540	1,540	1,540		1,948	678	1,386
Net $ per kW-year	**65**	**13**	**29**	**92**	**0**	**29**		**39**	**25**	**29**
Total Net Costs, $ Billion	2.2	0.9	3.2	3.2	0	3.2		1.3	1.9	3.2
							20%			
% Auctioned	**18%**	**18%**	**18%**	**26%**	**0%**	**18%**		**10%**	**37%**	**18%**
% Allocated	82%	82%	82%	74%	100%	82%		90%	63%	82%
lbs per MWh Applied	N.A.	N.A.	N.A.	1,670	1,670	1,670		2,022	760	1,464
Net $ per kW-year	**53**	**10**	**24**	**75**	**0**	**24**		**29**	**21**	**24**
Total Net Costs, $ Billion	1.8	0.8	2.6	2.6	0.0	2.6		1.0	1.6	2.6
							50%			
% Auctioned	**13%**	**13%**	**13%**	**18%**	**0%**	**13%**		**6%**	**30%**	**13%**
% Allocated	87%	87%	87%	82%	100%	87%		94%	70%	87%
lbs per MWh Applied	N.A.	N.A.	N.A.	1,840	1,840	1,840		2,121	847	1,557
Net $ per kW-year	**38**	**7**	**17**	**53**	**0**	**17**		**16**	**17**	**17**
Total Net Costs, $ Billion	1.3	0.6	1.9	1.9	0	1.9		0.6	1.3	1.9

Over time, the costs to consumers and other impacts of GHG reduction will depend significantly on the emissions cap and its rate of decline, on changes to the annual allowance allocations, the use of auction revenues, and rates of technology advancement and deployment. The price of electricity will depend on how the opportunity costs of allowances influence existing electricity contracts, on changes to WECC-wide electric system dispatch and each utility's portfolio of plants and purchases. Companies that will bear significant costs to reduce GHG emissions are quite reasonably concerned about the magnitude of the capital they will need to obtain, in order to purchase allowances in an auction. These up-front auction purchase costs might commit funds that could otherwise be used to modify and replace high emitting facilities with improved technologies.

Depending on the adopted allocation method, existing high GHG emitters would also provide additional revenues and profits for low GHG emitters. A transfer of wealth that impairs the ability of the owners of high emitting plants to finance, develop and implement improved technologies would not be efficient for society as a whole. Thus, the choice of allocation method should recognize existing fuel and technological differences, in order to minimize unproductive transfers of funds and to bring about an orderly transition to lower emitting technologies as the GHG cap declines.[6]

Given the known differences in existing electric generation resources now utilized by individual utilities, the California Public Utilities Commission and the California Energy Commission acknowledged their own concerns regarding allowance allocation in their joint Interim Opinion of March 13, 2008:

> [I]t is not our intent to treat any market participants unfairly based on their past investments or decisions made prior to the passage of AB 32…
>
> The method by which GHG emission allowances are distributed will affect liquidity in the emission allowance market; incentives to invest in low-GHG technologies and fuels, including energy efficiency; the potential for windfall profits; and costs to various groups of stakeholders.
>
> With these impacts in mind, we recommend that some portion of the emission allowances available to the electricity sector should be auctioned. Among the options under consideration would be to phase in auctioning beginning with a small percentage in the first year and transitioning to greater percentages over time as the State and market participants gain experience with auctions.[7]

[6] Before reaching policy decisions, careful year-by-year regional assessments should be made of the critical market design parameters that will govern this transition.

[7] California Public Utilities Commission, Interim Decision On Basic Greenhouse Gas Regulatory Framework For Electricity And Natural Gas Sectors. Rulemaking 06-04-009, Decision D.08-03-018 (http://docs.cpuc.ca.gov/PUBLISHED/FINAL_DECISION/80150.htm) adopted March 13, 2008, and Energy Commission Interim Decision CEC-100-2008-002-F (http://www.energy.ca.gov/2008publications/CEC-100-2008-002/CEC-100-2008-002-F.PDF) adopted March 12, 2008. p 8.

Because of their potential *efficiency, equity and simplicity* compared to other approaches, the fuel-differentiated output-based allowance allocation method (LEIT) and its associated allocation parameters might well satisfy the Commissions' objectives better than other approaches. Therefore, we recommend that these allocation approaches be evaluated, as part of the separate Western Climate Initiative, California PUC and CARB-sponsored analyses now in progress.

WECC Regional CO_2 Emissions and Emission Rates in 2004

Table 2 provides annual summary data for 2004 for coal and natural gas-fired power plants located in the WECC, calculated from EPA's national EGRID database for power plants. In the west, natural gas generation capacity exceeds that of coal, but because coal plants operate at higher capacity factors and coal contains a higher carbon content, coal plants produce more generation and emissions. Overall, CO_2 emission rates for natural gas-fueled power plants in 2004 were about 54 percent of those for coal-fired plants.

Table 2. 2004 Generation and Emissions from Coal and Natural Gas-fired Power Plants in the WECC

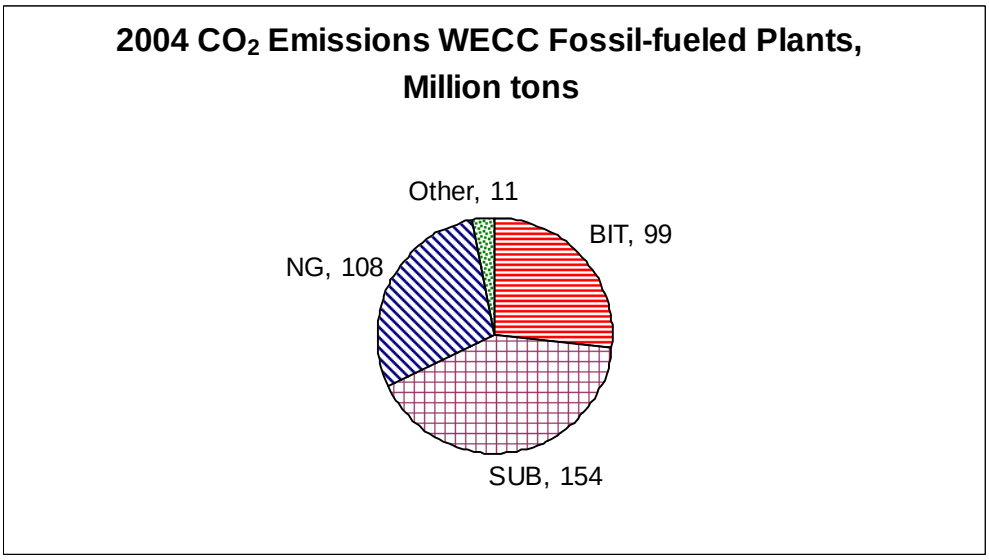
2004 eGRID Data				
Power Plant Fuel	**MW**	**MWh**	**CO_2 tons emitted per year** [8]	**CO_2 emissions rate, lbs per MWh**
Sub-bituminous coal	21,302	135,845,862	153,724,787	2,263
Bituminous coal	13,184	89,534,010	99,170,190	2,215
Natural gas	75,242	178,621,238	107,651,550	1,205
Totals	109,728	404,001,110	360,546,527	1,785

Figure 2 shows that the predominant CO_2 emissions from power plants in the WECC in 2004 were from coal-fired plants (253 million tons, 68 percent of total power plant emissions) and from natural gas-fired plants (108 million tons, 29 percent). Only about 3 percent of WECC power plant CO_2 emissions came from other fossil fuels, such as oil.[9]

[8] Emissions data in eGRID are reported in short tons, i.e., 2,000 lbs. per ton.

[9] Emissions from certain other fossil fuels, such as oil, as well as one plant fueled by lignite and two plants fueled by waste coal, are not included in Table 2, but are shown as "Other" in Figure 2. Carbon dioxide emissions in 2004 from power plants not other than fossil were 4 million tons or just over 1 percent of the total emissions. The data are adjusted for biomass and combined heat and power. See "The Emissions & Generating Resource Integrated Database for 2006 (eGRID2006) Technical Support Document," Pechan Rpt. No. 07.04.002/9216.027, April 2007, which is the technical support document for year 2004 data, for information on the methodology for these adjustments.

Figure 2. 2004 CO_2 Emissions at WECC Power Plants Fueled by Bituminous Coal, Sub-bituminous Coal, Natural Gas and Other Fuels.



Figures 3a, 3b and 3c illustrate the CO_2 emission rates in 2004 for individual natural gas, bituminous coal and sub-bituminous coal-fired power plants in the WECC. The emission rates vary significantly for the different fuels, and they also vary due to differences in individual plant heat rates, i.e., the fuel Btu consumed per kWh produced.[10]

[10] A few power plants with outlying values were excluded from our tabulation.

Figure 3a. CO_2 emission rates from individual natural gas-fired power plants in the WECC in 2004.

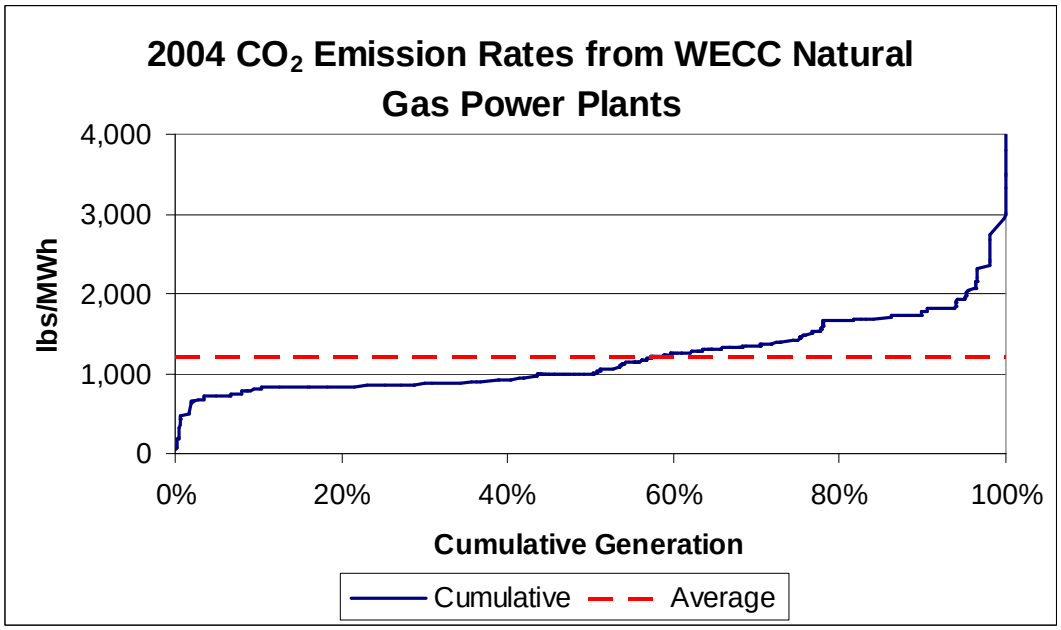


Figure 3b. CO_2 emission rates from individual bituminous coal-fired power plants in the WECC in 2004.

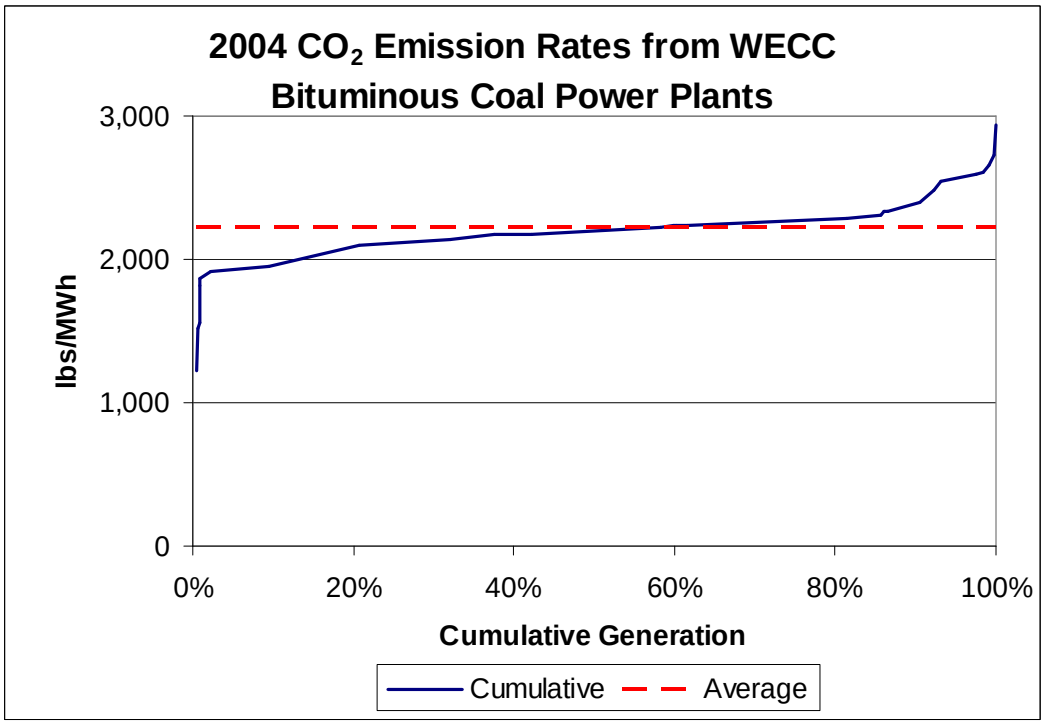
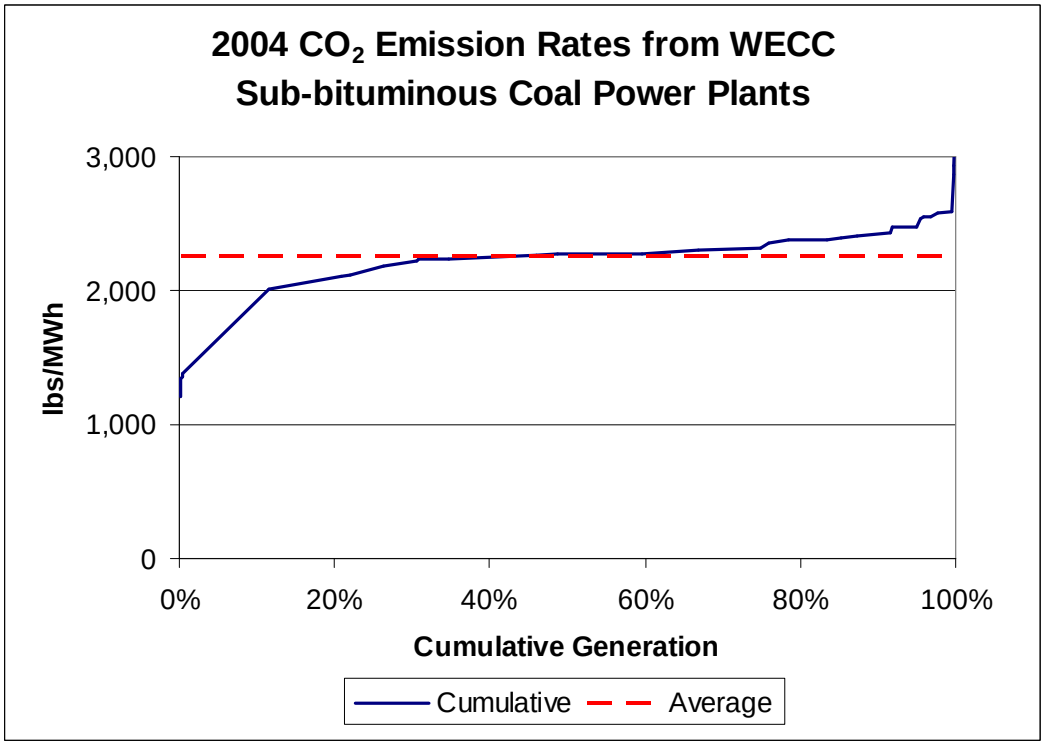


Figure 3c. CO_2 emission rates from individual sub-bituminous coal-fired power plants in the WECC in 2004.



First Year Costs of Different GHG Allowance Allocations and Auction Percentages

The allowance allocation methods described below have been applied to estimate the approximate tons of CO_2 emission allowances that might be issued to the owners/operators of power plants operating under cap and trade regulations. Costs were then calculated for allocations reduced by the percentage of allowances to be auctioned, assuming that plant owners with deficiencies must acquire additional allowances at prevailing market prices by purchases from companies with surplus allowances or by auction purchases.

Although these calculations are only for one year, they illustrate the relative one year costs of different CO_2 allowance allocation methods with different overall percentages withheld from the allocations to be sold at auction. By using year 2004 emissions as a proxy to represent emissions in the first year of a cap and trade program, such as 2012, we ignore the effects of generation growth, plant additions and retirements, and changes in dispatch.

The allocation methods compared in this paper are:

- Grandfathered historical annual emissions. Allocations are made corresponding to each power plant's (or, in practice, an individual generating unit's) historical annual emissions. The highest tonnage that occurred during a representative set of years could be selected, considering hydro conditions and other factors. For this comparison, year 2004 CO_2 emissions are used.
- Output-based, administratively-specified allocations. These allocations are calculated by multiplying an administratively determined, fixed output-based emissions rate in lbs. CO_2 per MWh by each plant's historical generation in a selected year. In this method, administrative emission rates are determined for groups of existing power plants with similar fuel and combustion technology characteristics. The specified rate is then multiplied by each power plant's (or by each generating unit's) highest historical annual generation during a representative set of years to obtain the base allocation. The base allocation is then reduced by the percentage of allowances to be auctioned in that year. In future years the administratively determined fixed rate applied in the first year would be reduced pro rata with the declining emissions cap to achieve a declining base allocation.

  Two specific methods are evaluated here:

  a. Output-based allocation based on California's SB 1368 emission rate. This allocation is calculated by applying a fixed carbon dioxide (CO_2) emissions rate of 1,100 lbs. per MWh to each fossil-fired plant's 2004 generation. This fixed emission rate is based on measured rates from natural gas combined cycle generating units and was adopted in California as an interim emissions performance standard for future baseload power contracts to comply with California's Senate Bill 1368.

  b. Output-based, fuel-differentiated allocation based on the Lowest Emitting Installed Technologies (LEIT) in the WECC. Separate fixed emission rates are calculated for the lowest emitting natural gas and coal plants operating in the WECC in 2004 and are applied to coal and natural gas power plants, respectively. These rates are the average rate calculated from those coal and gas power plants with the lowest observed CO_2 emission rates that comprise the same designated percentage of total coal or natural gas generation in the WECC in 2004.[11] As can be seen in

[11] To determine category emission rates by the Lowest Emitting Installed Technologies (LEIT) method, coal and natural gas plants were separately ranked in order of their 2004 annual emission rates. Average emission rates in lbs. per MWh corresponding to the lowest emitting plants that generated a minimum of 5, 10, 20, 30, 50 and 100 percent of cumulative total WECC generation by that type of plant were calculated separately for coal and natural gas plants. (A more detailed breakdown of plants by fuel and combustion technology could have been used to derive the LEIT rates, in order to better reflect both technology and fuel differences. For example, allocation categories could be defined analogous to those used by the U.S. EPA in setting New Source Performance Standards.) Appendix A provides an example LEIT calculation for 10 power plants.

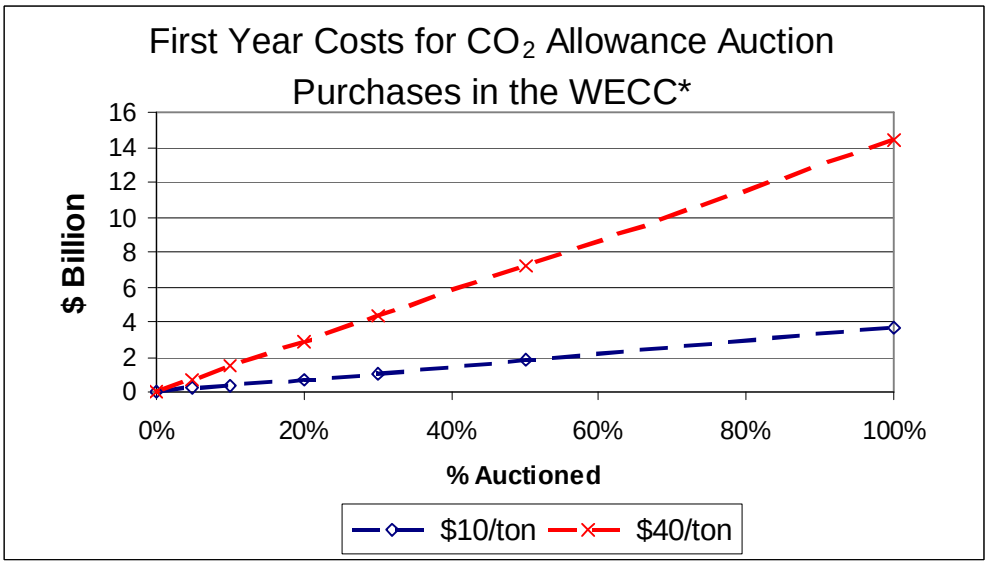
Figure 3, these fixed rates increase as more plants are included in the calculation.

To obtain these results, CO_2 allowances that are not allocated at zero cost are assumed to be auctioned and then purchased by those plants that need allowances, i.e., those plants allocated insufficient no-cost allowances to cover their 2004 emissions. Two market prices are assumed for the first year of the program, either $10 per ton or $40 per ton.

Figure 4 illustrates the estimated net costs of purchasing CO_2 allowances for this single year, assuming 2004 emission levels and different percentages of auctioned allowances. If 100 percent of the GHG emission allowances were to be purchased at a price of $40 per ton CO_2, the one year allowance cost for the entire WECC would amount to about $14.4 billion.[12] Even at $10 per ton, the single year cost of 100 percent allowance auction purchases would be about $3.6 billion.

It should be noted that the costs of allowance auction purchases shown here would be in addition to expenditures to reduce future emissions, as the overall GHG emissions cap and the allocations decline to meet 2020 target levels.

Figure 4. First Year Costs of Purchasing CO_2 Emission Allowances in the WECC for Various Percentages of Auctioned Allowances.



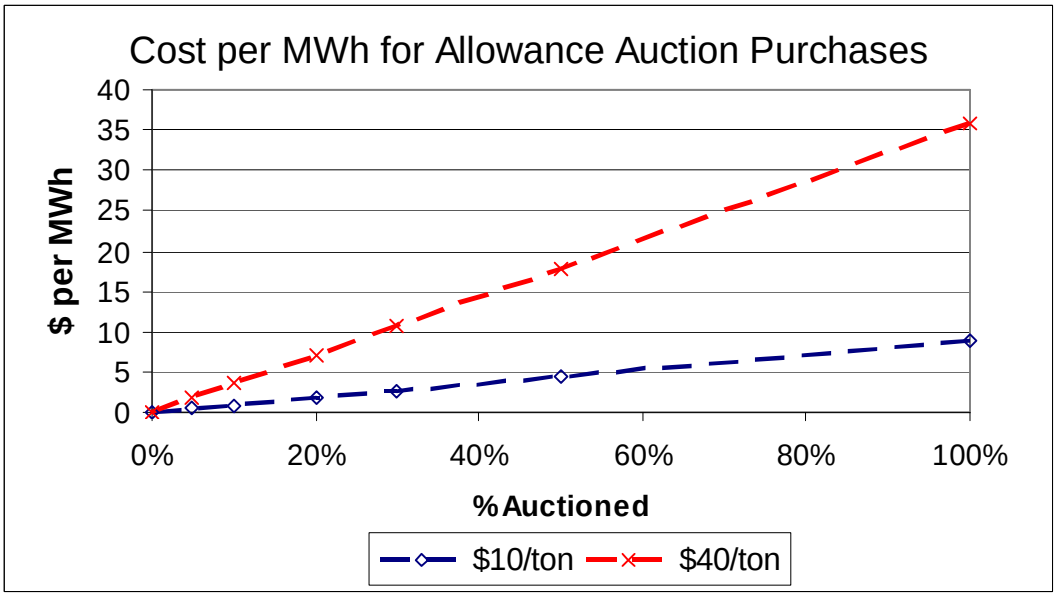
*Assumes 2004 emission levels and two potential allowance purchase prices.

Prices for wholesale electric power from fossil-fueled generating units will increase to account for the costs of allowance purchases, as well as for the costs of achieving emission reductions. The general magnitudes of the increased costs per MWh to make allowance auction purchases are shown in Figure 5. If 100 percent of the allowances

[12] While projections for 2012 suggest various potential prices for GHG allowances, recent prices of EUA GHG allowances in the European Union Emission Trading Scheme are about $35 per metric tonne. These prices are expected to rise by 2012.

were purchased at $10 per ton the cost of allowances would amount to about $9/MWh across all fossil MWh, while at $40 per ton, the cost to coal and gas generators would be about $36/MWh. If 20 percent of the allowances were auctioned, the allowance costs would amount to about $2/MWh at $10/ton and about $7/MWh at $40 per ton. At the margin, these costs can be roughly compared to $48.94/MWh, the California Independent System Operator's (CAISO's) average estimated cost of wholesale energy delivered to load in 2007.

Figure 5. Added Cost per MWh for First Year Allowance Auction Purchases



*Assumes 2004 emission levels and two potential allowance purchase prices.

The costs of long run GHG emission reductions will be largely dependent on the availability, costs and timing of lower emitting technologies. Improved technologies will be needed to replace or augment technologies now used by fossil-fired power plants. Because carbon capture and sequestration technologies will not be widely available for at least a decade, the owners of existing coal-fired power plants will bear a larger cost burden to comply than owners of natural gas-fired power plants

Because of the potential disparity in the costs that would be borne by coal plants relative to natural gas or renewable-fueled power plants, the efficiency and equity of potential allowance allocation methods will have important consequences. Allowance allocations over time must be evaluated in conjunction with the rate of decline of the GHG emissions cap, the entry of new power plants, retirement of old plants, generation growth, the cost and availability of new and innovative technologies, the percentage of allowances to be retained for auctions, and the allocation of auction revenues. There are many moving parts to this puzzle that must be understood and carefully considered, in order to design and implement a workable cap and trade system.

As shown in the first section, Figure 1 compares the basic allocation methods described above. First year costs for allowance purchases are estimated as a function of the percentage of allowances auctioned, assuming a $40/ton allowance price. Figure 1 also shows the distribution of the costs of purchased allowances between coal-fired and natural gas-fired power plants under the indicated allocation method. Not surprisingly, both the method of allocation and the percentage of allowances auctioned will significantly affect the magnitude and distribution of allowance costs.

In Figure 1 the four left-most stacked bars illustrate the LEIT allocation and the corresponding unallocated allowances that would be available for auction. The cases shown apply the average emissions rates of the lowest emitting coal or gas plants that make up 0, 5, 10 and 20 percent of the total WECC coal and gas generation, respectively.[13] If 100% of the allowances were to be auctioned, as shown on the left and right bars, coal-fired power plants would pay $10.1 billion, and natural gas-fired plants would pay $4.3 billion. At $40 per ton these amounts are equivalent to an annual expense of about $290 per kW-yr averaged across all WECC coal capacity and $55 per kW-yr for natural gas plants.[14]

If the LEIT emissions rate is determined from the lowest emitting plants that make up 5 percent of total WECC coal and natural gas generation for each fuel, respectively, the allocation of free allowances leaves about 40 percent of the total allowances available for auction. Correspondingly, the inclusion of the lowest emitting generators making up 10 percent of the respective total WECC coal and natural gas generation levels would make available about 22 percent of the allowances for auction.[15]

It is instructive to compare the estimated allowance purchase costs for the LEIT allocation for coal and natural gas that would leave about 13 percent of the allowances available for auction (as shown in the bottom rows of Table 1) with the allocation method that applies a single fixed 1,840 lbs CO_2/MWh rate to allocate allowances. Although both allocation methods leave 13 percentage of total allowances available for auction, the distribution of costs is much different. Under the fixed 1,840 lbs.CO_2/MWh output-based allocation and an allowance cost of $40 per ton of CO_2, coal generators would need to pay about $1.9 billion or $53/kW-yr to purchase 18 percent of their required allowances, while natural gas generators would not need to purchase any allowances. Under the corresponding fuel-differentiated LEIT there would be a different distribution of costs: coal generators would pay $0.6 billion or $16/kW-year, while natural gas generators would pay $1.3 billion, also about $16/kW-year. The grandfathered approach would have both coal and natural gas plants purchasing 13 percent of their allowances at a cost of about $1.3 billion or $38/kW-year for coal plants and $0.6 billion for natural gas plants or about $7/kW-year.

[13] See Appendix A for an example calculation.
[14] If all allowances were to be purchased at $10 per ton of CO_2, these amounts would be equivalent to an annual expense of about $73 per kW-yr for WECC coal plants and $14 per kW-yr for natural gas plants.
[15] The Western Climate Initiative Allocations Subcommittee's "Draft Allocations Design Recommendations" promulgated on April 2, 2008, suggests that a minimum of 25 to 75 percent of the allowances should be auctioned.

Conclusions

In order to achieve the GHG emission reductions sought under potential cap and trade legislation, it is desirable to devise and apply allowance allocation methods that can be successfully adopted throughout the West and the U.S. The preferred approach should be relatively simple and straightforward, based on verifiable data, and lead to efficient and equitable outcomes.

Any of the three allocation methods analyzed here can be adjusted to enable higher percentages of allowances to be auctioned. In general, the allowance auction percentages compared in this paper are consistent with the auction percentage in the Lieberman-Warner bill and with auction ranges recommended in the Western Climate Initiative. However, as shown in Table 1, under the single fixed output-based rate method, almost all the costs of purchasing allowances would be borne by coal plants and the ratepayers of those electric utilities that rely most heavily on coal-fired generation. These impacts may adversely affect the ability of some affected companies to invest in new technologies, at the same time as they must purchase sufficient allowances to satisfy their immediate allowance requirements.

Overall, the fuel-differentiated output-based rates examined here could satisfy the objectives of efficiency, equity and simplicity. The grandfathered historical approach could also be considered to be equitable and simple to administer. However, the single fixed output-based rate allocation approach does not account for existing differences in fuels and technologies. As a result, almost no gas-fired plants would need to purchase allowances in a first-year allowance auction, and its distribution of allowance purchase costs does not appear to be equitable.

Based on the foregoing comparisons, we recommend that the three allocation approaches described in this paper be further examined, alongside other approaches that are now being evaluated.

Appendix A Description of the LEIT Approach for GHG Emissions Allowance Allocation

The Lowest Emitting Installed Technologies (LEIT) method for the allocation of GHG emissions allowances is an output-based approach (tonnes GHG emitted per MWh) for allocating emissions allowances to generating units in the electric sector.[16] It accounts for differences in GHG emission rates between coal and natural gas fuels by defining two or more fuel-differentiated GHG emissions categories: e.g., coal-fired and natural gas-fired generators.[17] It also provides a simple means for making a transition between the initial free allocation of a portion of the allowances and the increased auctioning of allowances over time. If need be, LEIT emission rates could be updated after a period of years as lower emitting technologies are implemented.

An output-based approach is intended to encourage operating efficiency. However, the technological differences between coal and natural gas-fired power plants and their differing locations across the U.S. pose severe equity issues that could be debated for years. The free allocation of a major portion of the total annual allowances using the method outlined here for the electric sector would provide some efficiency incentives for the existing fleet of fossil-fired generators and will reduce the up-front costs to existing plant owners and ratepayers[18] of acquiring allowances upfront in auctions, which could be phased in gradually over time in conjunction with a declining emissions cap.

Ideally, an output-based allocation to each existing fossil generating unit would encourage efficiency improvements, while allowing time for the acquisition and deployment of capital to develop and implement lower-emitting technologies. As proposed here, the initial GHG allowance allocation would be based on the "lowest emitting installed technologies" ("LEIT") in each generator category, i.e., the existing lower emitting fossil-fired generating units. The lowest emitters in each category would receive sufficient allowances to cover all or most of their GHG emissions in the early years of the program, while all other, higher-emitting units in each category will need to purchase some allowances in an auction, depending on how their GHG emission rates compare to the LEIT category rate and their own future MWh generation compared to historical generation.

[16] VHC's comments on the WCI Workplan were submitted in November 2007, and address other market design issues.
[17] For a national analysis it would be desirable to consider more categories defined like the fuel-differentiated categories used for EPA's New Source Performance Standards ("NSPS"). For this analysis we have used bituminous, sub-bituminous and natural gas-fired power plant categories.
[18] At the present time most coal-fired power plants are owned by regulated electric utilities.

A Fuel-differentiated Output-based Allowance Allocation Method Derived from the Lowest Emitting Installed Technologies (LEIT) in Each Fuel/Generator Category

In its February 2008, report the California Air Resources Board's ("CARB's") Economic and Technology Advancement Advisory Committee ("ETAAC") recommended an output-based approach (GHG tonnes emitted/MWh), rather than an input-based approach (GHG tonnes emitted/MMBtu heat input), if free allowance allocations were selected by the CARB. On page 9-4 of its final report, ETAAC states:

> "All ETAAC members agreed that if a free allocation method is to be used, output-based free allocation methods are preferable to grandfathering. Any free allocation method should be designed in such a way that the setting of baseline emissions levels does not discourage early reductions…
>
> Some amount of auctioning is necessary for establishing a clear and early price signal." [19]

For the illustrative analysis presented here, electric generators in the WECC have been divided into two basic categories (i.e., coal-fired and natural gas-fired power plants). Data from EPA's Emissions & Generation Resource Integrated Database (eGRID) on a plant basis for year 2004 has been used to make the comparisons shown above.

Attributes of the LEIT Allowance Allocation Method

The above LEIT allocation approach can be evaluated across several important attributes. These attributes include:

- **Efficiency** – The output-based approach encourages low emitting generators in each generator category, while requiring generating units with rates higher than the LEIT rate to purchase some of their allowances. Thus, high heat rate generating units will need to buy more allowances, depending on how they compare to the lowest emitting plants in their category.

  As the percentage of allocated free allowances decreases over time, even the lowest emitting plants will need to buy an increasing number of allowances in the market or at auction. The approach will encourage generators to make investments to reduce emissions, if the projected costs for allowances exceed the costs of investments to reduce emissions. Importantly, the free allocation of allowances to each generator will reduce the up front costs of compliance to all

[19] "Recommendations of the Economic and Technology Advancement Advisory Committee (ETAAC): Final Report, Technologies and Policies to Consider for Reducing Greenhouse Gases in California." California Air Resources Board, February 11, 2008. p 9-4.

generator categories, as well as to electric ratepayers, while benefiting those with the lowest emission rates the most.

- **Equity** – Owners of lower emitting technologies will have to purchase fewer allowances than will owners of higher emitting technologies. Yet, coal-fired generating units will receive free allocations commensurate with the lowest emitting coal plants, giving them time to improve operations and adapt to a market where the number of free allowances diminishes over time.
- **Ease of allocation and administration** – It will be straightforward to calculate the number of free allowances to be allocated. Once the specific sector cap is determined for each year, the remaining unallocated allowances would be auctioned or set aside.

  If all U.S. power plants were included in the calculation of the LEIT rate, the method would be directly transferable to a similar nationwide allocation approach.[20]

In its recommendations, California's ETAAC discussed the potential effects of each market design element on Early Action, Innovation and Clear Price Signals.[21] The LEIT method proposed here comports with each of ETAAC's criteria, as follows:

- **Early Action** – As pointed out by ETAAC on page 9-3, "output-based allocations do not discourage early actions." Early actions to improve the operations of individual power plants to move them closer to the lowest emitting plants in their categories will reduce the number of allowances that need to be purchased. Because the LEIT category rates will be set by the more efficient plants, those that took early action will benefit more than those that did not.
- **Innovation** – On page 9-3, ETAAC points out that:

  > "Allowance auctions provide the strongest financial incentives for innovation within capped sectors. With auctioning, permits are allocated efficiently and all parties have an incentive to innovate so as to reduce the number of permits they must purchase. Auctions are also an easy way to permit the entry of innovative new firms into the market. The revenue from auctions can be used to encourage innovation. However, it was mentioned by some ETAAC members that firms have limited available capital. Money expended for purchasing permits may reduce their ability to invest in new technology."

[20] Publicly available data for the electric sector will enable the effects of the LEIT allocation approach to be examined over time in upcoming studies, using appropriate models of electricity market investment and operating decisions and emissions.

[21] "Recommendations of the Economic and Technology Advancement Advisory Committee (ETAAC): Final Report, Technologies and Policies to Consider for Reducing Greenhouse Gases in California." California Air Resources Board, February 11, 2008. Chapter 9.

The suggested LEIT allocation method would lessen upfront compliance costs, and free up capital for technology development and innovation that would otherwise be needed to purchase allowances.

- **Clear Price Signals** – Since auctions would be conducted during each year of the program for some portion of the total allowances, a public price signal would be available to complement price signals from bilateral transactions and published industry indices. In addition, because owners of almost all affected generators will need to acquire some allowances every year under the LEIT allocation approach, participation in the GHG allowance market will be broad-based from the beginning.

Example of the LEIT CO_2 Allowance Allocation Calculation

When the cumulative total annual emissions in a category of generators is divided by the cumulative total annual generation in a category of generators, the LEIT rate corresponds to an annual average emissions rate per MWh across the category. For the foregoing analysis, the two generator categories are simply coal-fired and natural gas-fired power plants. When generators in a category are sorted in ascending order of emission rates and a cumulative percentage of the total generation in that category is applied to designate the lower emitting generators, the LEIT rate is the average for those selected generators. Generators with emission rates below the LEIT average will have a potential surplus of allocated allowances, while all others will have some degree of a deficit that will require emission reductions or allowance purchases. Alternatively, the allocation could be the lower of the LEIT calculated allocation and historical annual emissions for each plant, which would make more allowances available for auction than presented in the above graphs.

The tables below illustrate base year calculations for a small group of natural gas-fired plants, using 2004 EGRID plant data. Similar calculations can be performed on a WECC-wide or national basis.

TABLE A-1
2004 Generation and Carbon Dioxide Emissions Data for Ten Selected Gas-fired Plants

Plant name	Plant annual net generation (MWh)	Plant annual CO_2 emissions (tons)	CO_2 Emissions (lbs per MWh sorted lowest to highest in each category)	Cumulative Plant annual net generation in this Plant category (MWh)	Cumulative % generation in this Plant Category	Cumulative Plant annual CO_2 emissions (tons)	Cumulative % Annual CO_2 emissions by Plant Category	LEIT CO_2 Rate (pick one): Cumulative CO_2 Emissions, lbs per MWh
Morro Bay Power Plant	332,149	197,938	1,192	332,149	2%	197,938	1%	1,192
Haynes	2,046,335	1,241,340	1,213	2,378,484	12%	1,439,278	9%	1,210
Ormond Beach	2,248,643	1,425,847	1,268	4,627,127	23%	2,865,124	19%	1,238
AES Redondo Beach LLC	1,290,308	830,005	1,287	5,917,435	30%	3,695,129	24%	1,249
Pittsburg Power	1,800,604	1,186,086	1,317	7,718,039	39%	4,881,215	32%	1,265
AES Alamitos LLC	2,954,395	2,082,825	1,410	10,672,434	53%	6,964,041	45%	1,305
Etiwanda Generating Station	212,791	161,568	1,519	10,885,225	54%	7,125,608	46%	1,309
Valley	1,975,076	1,704,736	1,726	12,860,301	64%	8,830,344	57%	1,373
La Paloma Generating LLC	5,630,210	5,108,398	1,815	18,490,511	93%	13,938,743	91%	1,508
AES Huntington Beach LLC	1,486,025	1,442,354	1,941	19,976,536	100%	15,381,097	100%	1,540
TOTAL	19,976,536	15,381,097	1,540					

TABLE A-2
2012 Allocation and Auction Amounts -- Based on 2004 Example LEIT Allocations in Table I

Target (closest) LEIT rate, % cumulative generation included in LEIT rate	N. A.		Target cumulative generation 25%, Result (23%) LEIT rate: 1238 lbs/MWh		Target cumulative generation 50%, Result (53%) LEIT rate: 1305 lbs/MWh		Target cumulative generation 75%, Result (64%) LEIT rate: 1373 lbs/MWh		Target cumulative generation 100%, Result (100%) LEIT rate: 1540 lbs/MWh	
Plant name	**Allowances Allocated by Generator, tons**	**Required Reductions or Auction Purchases, tons**	**LEIT Allocation by Generator, tons**	**LEIT Required Reductions or Auction Purchases, tons**	**LEIT Allocation, tons**	**LEIT Required Reductions or Auction Purchases, tons**	**LEIT Allocation, tons**	**LEIT Required Reductions or Auction Purchases, tons**	**LEIT Allocation, tons**	**LEIT Required Reductions or Auction Purchases, tons**
Morro Bay Power Plant	0	197,938	205,667	(7,729)	216,736	(18,798)	228,065	(30,128)	255,741	(57,803)
Haynes	0	1,241,340	1,267,094	(25,754)	1,335,287	(93,947)	1,405,087	(163,747)	1,575,592	(334,252)
Ormond Beach	0	1,425,847	1,392,363	33,483	1,467,298	(41,451)	1,543,999	(118,152)	1,731,361	(305,514)
AES Redondo Beach LLC	0	830,005	798,961	31,044	841,960	(11,955)	885,972	(55,967)	993,483	(163,478)
Pittsburg Power	0	1,186,086	1,114,937	71,149	1,174,941	11,145	1,236,359	(50,273)	1,386,390	(200,303)
AES Alamitos LLC	0	2,082,825	1,829,366	253,459	1,927,820	155,006	2,028,594	54,232	2,274,761	(191,935)
Etiwanda Generating Station	0	161,568	131,761	29,807	138,852	22,716	146,110	15,458	163,840	(2,272)
Valley	0	1,704,736	1,222,970	481,766	1,288,788	415,948	1,356,158	348,578	1,520,726	184,010
La Paloma Generating LLC	0	5,108,398	3,486,235	1,622,164	3,673,858	1,434,540	3,865,904	1,242,494	4,335,026	773,372
AES Huntington Beach LLC	0	1,442,354	920,149	522,205	969,670	472,684	1,020,358	421,996	1,144,177	298,177
TOTAL	0	15,381,097	12,369,502	3,011,595	13,035,209	2,345,888	13,716,607	1,664,490	15,381,097	0
Percent Auctioned		100%		20%		15%		11%		0%
Percent Allocated		0%		80%		85%		89%		100%