Kevin Kennedy, Chief
Program Evaluation Branch
Office of Climate Change
Air Resources Board
1001 "I" St. P.O. Box 2815
Sacramento, CA 95812

June 2, 2008

Re: AB 32 Cost-Effectiveness: General Framework

Dear Mr. Kennedy,

We appreciate the efforts of the California Air Resources Board (CARB) to develop economic frameworks and tools for the package of policies necessary to implement California Global Warming Solutions Act of 2006 (AB 32) and meet the requirements of the law. These comments are submitted in anticipation of the June 3, 2008 Economic Analysis Technical Stakeholder Working Group meeting, which will focus on the framework for analysis of cost-effectiveness as it relates to AB 32 implementation.

AB 32 requires CARB to adopt greenhouse gas emission reduction regulations that "achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions."[1] In addition, CARB is required to "consider cost-effectiveness" of the regulations it adopts to meet the law's 2020 emissions limit.[2] The law defines "cost-effective" as "the cost per unit of reduced emissions of greenhouse gases adjusted for its global warming potential."[3] Under AB 32, greenhouse gases include, but are not limited

[1] Health and Safety Code §§ 38560, 38562.
[2] Health and Safety Code § 38562, subd. (b)(5).
[3] Health and Safety Code § 38505, subd. (d).

to, "carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride."[4] The climate change impact of these gases can be expressed in the common unit of "carbon dioxide equivalent" (CO_2e), a universal standard of measuring the global warming potential of greenhouse gases. Thus, AB 32 requires that the cost of regulations be expressed in units of \$/ton CO_2e reduction (or similar units), but it does not set a maximum cost per ton for these regulations.

This letter discusses possible frameworks that CARB could use to determine cost-effectiveness under AB 32. It is important to emphasize at the outset that cost-effectiveness is *only one metric* that CARB must consider when implementing regulations under AB 32. The statute requires that CARB consider numerous factors when implementing regulations, including for example: equity; encouraging early action; not impacting low-income communities disproportionately; compliance with federal and state air quality standards and reductions of toxic air contaminant emissions; overall societal benefits including reductions in other air pollutants, diversification of energy sources and other economic, environmental and public health benefits; administrative burden; and, leakage of emissions outside of California.[5] When CARB ultimately makes its policy determinations regarding which regulations to adopt, cost-effectiveness is just one factor that it must consider.

As we explain below, the cost-effectiveness framework we recommend is the only one that is both consistent with the requirements of AB 32 and economically sensible: it requires defining the least expensive bundle of strategies that is necessary to reach the state's 2020 greenhouse gas emission limit. The bundle will include enough regulations to achieve the necessary emission reductions, with an *approximate* upper threshold of cost per ton above which additional regulations are not required. Because the cost-effectiveness range will continue to evolve over time as further information about the existing and proposed regulations becomes available and is updated, the upper end of the range will continue to shift and should not be considered to be a fixed threshold. The cost-effectiveness range also should not be understood as fixed because, as noted above, CARB must consider numerous other policy factors in addition to cost-effectiveness. Importantly, the cost per ton calculations for regulations must be as comprehensive and accurate as possible, including environmental and other co-benefits in the net costs of the regulations. We are concurrently submitting a separate letter to CARB explaining that, in order to obtain the most comprehensive assessment of a proposed regulation's cost-effectiveness, CARB must account for co-benefits (non-greenhouse gas benefits) in its cost-effectiveness analysis.

[4] Health and Safety Code § 38505, subd. (g).
[5] Health and Safety Code § 38562(b).

I. WHAT IS COST-EFFECTIVENESS?

Cost-effectiveness analysis (CEA) is related to cost-benefit analysis (CBA), but is different in important respects. Very generally, while CBA is often used to assess *whether* a regulation or program should be implemented, CEA is often used to determine *which* regulation(s) or program(s) should be implemented to achieve a particular outcome.

CBA results in a monetization of net social benefits of a proposed regulation or program.

Net social benefits = social benefits – social costs[6]

By monetizing net social benefits, policymakers can determine whether the proposed regulation or program will have a net positive or net negative impact on society. There are many ways in which CBA is used in practice, and many ways in which CBA, when miscalculated, may not accurately represent net social impacts. The general principle, however, is that CBA can help policymakers determine whether a proposed action will have a positive or negative impact on society, and thus whether they should undertake the proposed action.

CEA, by contrast, is comparative rather than absolute. It assumes that a certain desired outcome should be achieved and is used to compare different ways to achieve that outcome.[7] In the case of AB 32, the desired outcome is the reduction of greenhouse gases. CEA results in a ratio of monetized net costs – or "social costs" – of a proposed regulation or program per unit of effectiveness, but does not monetize the total outcome of the program.

Cost-effectiveness = net costs (i.e., gross cost – cost savings) / unit of effectiveness[8]

As this equation indicates, the net costs of the regulation include all monetized costs and savings of the regulation *except* for the desired outcome, which is expressed in the denominator in units of effectiveness. Accordingly, a cost-effectiveness analysis will result in a ratio of dollars per unit of effectiveness, such as $/life saved or $/case of cancer reduced.

The cost-effectiveness (CE) ratio "can be thought of as the average cost per unit of effectiveness. The most cost-effective project has the lowest average cost per unit of effectiveness. . . . Usually, costs are positive, effectiveness is positive, and CE ratios are positive. Sometimes, however, an option is really advantageous—it is both more effective and it costs less than the status quo."[9] For example, energy efficiency policies

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[6] Anthony E. Boardman et al., "Cost-Benefit Analysis: Concepts and Practice," (2nd edition, 2001), p. 2; Office of Management and Budget, "Circular A-4: Regulatory Analysis," (September 17, 2003), p. 10, available at http://www.whitehouse.gov/omb/circulars/a004/a-4.pdf. See also Climate Action Team, "Updated Macroeconomic Analysis of Climate Strategies Presented in the March 2006 Climate Action Team Report: Final Report," (October 15, 2007), p. 21, available at http://www.climatechange.ca.gov/events/2007-09-14_workshop/final_report/2007-10-15_MACROECONOMIC_ANALYSIS.PDF.

[7] Boardman et al., *supra* note 3, at pp. 437-438; Circular A-4, *supra* note 3, at pp. 10-12.

[8] *Ibid*.

[9] Boardman et al., *supra* note 3, at p. 438 (emphasis omitted).

often have a negative cost-effectiveness ratio because they reduce costs relative to business as usual.

In the case of AB 32, the cost-effectiveness of proposed regulatory regulations will be expressed in terms of $/ton CO_2e reduced. Thus, although AB 32 does not define or limit what should be included in the "cost" portion of the cost-effectiveness ratio, the definition of "cost-effectiveness" in AB 32 precludes CARB from monetizing the value of greenhouse gas emission reductions in the cost-effectiveness ratio. It requires a calculation of $/ton CO_2e reduced to be used as a comparative tool for considering which greenhouse gas reduction options are comparatively less costly.

We are concurrently submitting a separate letter to CARB explaining that, in order to obtain the most comprehensive assessment of a proposed regulation's cost-effectiveness, CARB must account for co-benefits (non-greenhouse gas benefits) in its cost-effectiveness analysis.[10] That is, CARB should *monetize* and subtract from a regulation's net costs the value of the co-benefits that will result from the regulation. When data is not available or sufficiently reliable, we recommend that the Board *quantify* or *qualitatively describe* the co-benefits.

II. FRAMEWORK FOR EVALUATING COST-EFFECTIVENESS UNDER AB 32

AB 32 defines cost-effectiveness only by specifying the unit by which the cost of greenhouse gas emission reduction regulations must be expressed and does not establish a specific cost-effectiveness maximum. Because cost-effectiveness is merely a comparative tool, it is impossible to define cost-effectiveness in the abstract. We describe below five points of reference by which cost-effectiveness may be determined: (1) net benefits to society, (2) zero net cost, (3) market price of greenhouse gas emissions, (4) prior or other regulations, or (5) AB 32's 2020 emissions limit.

As we explain below, the first three frameworks are inconsistent with the text of AB 32 and economically problematic. While the fourth framework is not independently sufficient, prior or other regulations that result in greenhouse gas emission reductions can provide additional and useful points of reference. By contrast, the fifth framework – determining which regulations are necessary to meet the 2020 limit – is both contemplated by the statute and rationally based in economic analysis.

1. Net benefits to society: Full cost-benefit analysis

A full cost-benefit analysis would, in principle, show whether each potential regulation would have a net positive or net negative impact on society. One might argue that cost-effectiveness could be defined as meaning those regulations that result in net benefits to society, thereby requiring monetization of the value of reducing greenhouse

[10] In addition to reducing greenhouse gas emissions, many of the proposed AB 32 regulations will result in additional environmental, health, and economic co-benefits. For example, cement regulations can reduce mercury emissions and improve the health of Californians, regulations to mitigate forest land loss can reduce greenhouse gas emissions and improve the health and resiliency of California's forests, energy efficiency regulations can reduce consumer energy bills, and reductions in vehicle-miles traveled can reduce emissions of air pollution and improve public health. Other measures related to the protection, restoration and management of our natural systems can also reduce greenhouse gas emissions while simultaneously enhancing the health and sustainability of fish and wildlife habitat.

gas emissions. Not only are there many complications associated with putting a precise monetary value on greenhouse gas emissions, but also, more importantly, this interpretation is inconsistent with the economic definition of cost-effectiveness, as described above, and the language of AB 32. By enacting AB 32, the legislature has already made the policy decision that the state must reduce its greenhouse gas emissions. The issue now in front of CARB is *which* methods of reducing these emissions are most cost-effective, not whether each regulation that reduces these emissions will have a net positive or net negative impact on society. The definition of cost-effectiveness in the statute requires cost-effectiveness to be represented as "the cost *per* unit of reduced emissions of greenhouse gases adjusted for its global warming potential."[11] Thus, AB 32 removes performing a full cost-benefit analysis as an option, and instead requires that CARB use comparative cost-effectiveness analysis. Pursuant to AB 32, CARB is required to engage in *comparative* cost analysis of the proposed regulations, not *absolute* analysis of whether each regulation will result in net benefits to society.

2. Zero net cost: Regulations with zero or negative costs

An alternative interpretation of cost-effectiveness is to define regulations as relatively less expensive only if they have zero cost or negative costs. This interpretation is not, however, reasonable under the law or the economic definition of cost-effectiveness. AB 32 does not itself require CARB to enact only those regulations that have a zero or negative cost. Moreover, the economic definition of cost-effectiveness does not include any reference to zero or negative costs. The meaning of cost-effectiveness is only that the relative costs of the proposed regulations be considered by CARB. There is no economic requirement that the less expensive alternative have any specific monetary value.

3. Market Price: GHG market price as a proxy

Some might argue that cost-effectiveness could also potentially be defined as any price per ton of greenhouse gas emission reduction that is equal to or less than the market price for purchasing allowances that represent permission to emit a ton of greenhouse gases. For example, CARB could use the market price of greenhouse gas emission allowances in the European Union (EU) emission trading scheme (ETS) as a proxy – or prices in other market systems, such as the Clean Development Mechanism (CDM) offset credit prices, New South Wales (Australia) trading price, etc. AB 32 does not suggest that cost-effectiveness should be defined based on the market price of greenhouse gas emissions, nor would it be economically sound to use such a market price as a proxy.

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[11] Health and Safety Code § 38505(d) (emphasis added). Additionally, sometimes the terms "cost-effectiveness" and "cost benefit" are used interchangeably, without recognition of the difference between the two. For example, the California Public Utilities Commission has identified four primary tests for evaluating demand-side programs and projects. PUC, "California Standard Practice Manual: Economic Analysis of Demand-Side Programs and Projects," (Oct. 2001). Although the PUC uses the term "cost-effectiveness," it is for the most part a misnomer: most tests in fact require cost-benefit analysis. For three of the four tests (Participant, Ratepayer Impact Measure, and Program Administrator Cost), the appropriate means of expressing the results is in dollars, meaning that those tests use CBA's absolute measure of net social benefits. They do not have a denominator expressing unit of effectiveness, so they do not use CE's comparative measure of net costs per unit of effectiveness. *Id* at pp. 9, 18, and 23. The results of the fourth test (Ratepayer Impact Measure) may be expressed either in dollars or in dollars per unit of energy, and thus this test can be used to perform cost-benefit or cost-effectiveness analysis. *Id*. at p. 13.

There are many reasons why using a greenhouse gas emission market price as a proxy for cost-effectiveness would be inaccurate. There is currently no market for greenhouse gas emissions allowances or credits in California, and market prices are determined by many factors, including the level of the cap, and the geographical region and its characteristics (e.g., its economy, historical efforts to reduce emissions, etc.). As an illustration, consider just two of the factors that would make it inappropriate for California to rely on the market price of allowances in the EU ETS:

(1) The ETS is only one policy tool that the EU is using to reduce emissions to meet its Kyoto economy-wide commitment, just as any cap and trade program would only be one tool in the toolbox to meet California's statewide AB 32 limit. Therefore, it is inaccurate to look at the cost-effectiveness of only one policy tool the EU will use to meet its Kyoto commitment to determine the threshold for cost-effectiveness for all policy tools in California.

(2) The stringency of a cap in any cap and trade program is a primary determinant of the market price. It is widely accepted that the EU set the cap for the ETS too high during the first period (as many say, they "over-allocated emissions allowances") thereby leading to low prices.[12]

4. Prior and Other Regulations: Compare AB 32 regulations to other regulations that result in greenhouse gas emission reductions

In other regulatory proceedings, a standard practice by which CARB determines cost-effectiveness is to compare new regulations to prior and similar regulations. In the context of AB 32, because it requires CARB to enact regulations in an area and with a scope not previously addressed, it will be hard, if not impossible, to rely solely on previous regulations to show cost-effectiveness. However, as California's legislature and agencies, including CARB, move quickly forward to address climate change, laws and regulations will evolve. These laws and regulations, including but not limited to AB 32 regulations, will be relevant as points of reference when considering the cost-effectiveness range for AB 32. The early AB 32 regulations may establish preliminary reference points. In addition, laws and regulations enacted pursuant to other authority that result in greenhouse gas emission reductions, which need not satisfy the requirements of AB 32, will provide further information about the cost-effectiveness of reducing greenhouse gas emissions in California.

5. AB 32's 2020 Emissions Limit: Cost range of a bundle of strategies necessary to reach the AB 32 limit

In contrast to the three strategies described above, defining cost-effectiveness as the least expensive bundle of strategies necessary for the state to reduce its greenhouse gas emissions to 1990 levels by 2020 is both based in the text of AB 32 and economically sensible.

AB 32 requires CARB to adopt regulations that will result in reductions of greenhouse gas emissions to 1990 emission levels by 2020, and the cost-effectiveness requirement is imposed in reference to this requirement. CARB must adopt "greenhouse

[12] E.g., Defra "EU Emissions Trading Scheme: UK Results 2006 Report," February 2008, p. 23, available at http://www.defra.gov.uk/environment/climatechange/trading/eu/results/pdf/euets-ukresults-2006.pdf.

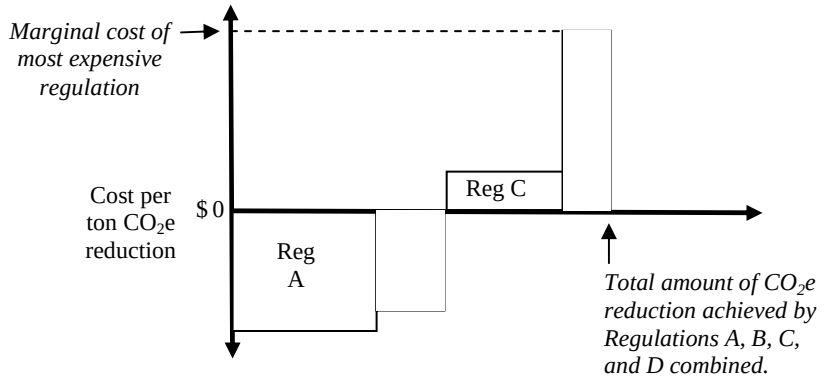
gas emission limits and emission reduction measures by regulation to achieve the maximum technologically feasible and cost-effective reductions in greenhouse gas emissions *in furtherance of achieving the statewide greenhouse gas emissions limit*,"[13] which, as noted above, is "the *maximum* allowable level of statewide greenhouse gas emissions in 2020."[14] Accordingly, it is reasonable to conclude that the legislature intended cost-effectiveness to be determined in reference to this 2020 limit.

Because AB 32 requires considerable reductions in greenhouse gas emissions, CARB must consider, evaluate, and adopt a significant number of regulations. These regulations must be adopted by January 1, 2011.[15] Thus, CARB must determine in a short period of time a relatively large bundle of strategies that will enable the state to reach its 2020 emission reduction limit.

In order to calculate how many and which regulations are required to meet this limit, a marginal abatement cost curve is helpful. This type of cost curve is a graphical depiction of all of the possible and/or necessary regulations, showing the cost of each regulation per ton of greenhouse gas emission reduction and the total number of tons of reduction each will achieve.

In the simple example below, Regulation A has a negative cost and will achieve a relatively substantial amount of greenhouse gas reduction, while Regulation D has a positive cost and will achieve a smaller reduction. Showing all four regulations on the same graph depicts how much total reduction can be achieved by all of the regulations combined (x axis), and the marginal cost of the most expensive regulation (y axis). If a policy aimed to achieve total reductions in the amount reached by Regulations A, B, C, and D added together, the marginal cost of this regulatory system would be the cost of Regulation D. In this example, the marginal cost of Regulation D would represent the approximate upper end of cost-effectiveness for regulations that would be included in a cost-effective bundle of regulations.

Marginal Abatement Cost Curve



A cost curve for AB 32 regulations would show a much larger bundle of regulations – that is, a bundle of regulations sufficient to achieve the GHG emission reductions required by AB 32 (using the most recent data, 173 million metric tonnes

[13] Health and Safety Code § 38562 (emphasis added); see also § 38560.5, subd. (c).
[14] Health and Safety Code § 38505, subd. (n) (emphasis added).
[15] Health and Safety Code § 38562.

CO_2e reduction).[16] The bundle would have an *approximate* upper threshold of cost per ton above which additional regulations are not required, because there are many uncertainties in the metrics that make up the cost curve.

As with any regulatory process, there will be uncertainties associated with predicting how much each regulation will cost and how much greenhouse gas emission reduction it can be expected to achieve. This may be especially true in the context of AB 32, which requires the state to tackle new and challenging regulatory schemes in a relatively short period of time. In addition, there is considerable uncertainty in the emission reductions needed to meet AB 32's 2020 limit. The reduction limit is the difference between the fixed 2020 limit (427 $MMTCO_2e$) and an estimated "business-as-usual" (BAU) baseline that has significant uncertainty. For example, if CARB staff's preliminary estimate of BAU emissions in 2020 of 600 $MMTCO_2e$ is off by +/- 5%, the needed reductions could be as low as 143 $MMTCO_2e$ or as high as 203 MMTCO2e.

Since the cost-effectiveness range will continue to evolve over time as further information about the existing and proposed regulations becomes available and is updated, the upper end of the range will continue to shift and cannot be considered to be a fixed threshold. The cost-effectiveness range also should not be understood as fixed because, as noted above, CARB must consider numerous other policy factors in addition to cost-effectiveness. Accordingly, we urge CARB to emphasize that the cost-effectiveness range that is developed through the scoping plan process represents a *preliminary approximation* of cost-effectiveness.

Finally, the cost curve for any given region will be specific to its particular regional characteristics – including important factors such as the region's economy, its emissions reduction targets, how aggressive the region has been in the past at capturing low-cost savings like energy efficiency, and what the region's business-as-usual assumptions are against which the reductions were calculated. Accordingly, cost curves developed for other regions may be of limited use as additional points of reference,[17] but California cannot rely on these cost curves.

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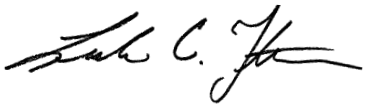
[16] The most recent figures estimated by CARB staff indicate that the state will have to reduce emissions by 173 million metric tones CO_2e ($MMTCO_2e$) – based on the most recent business as usual forecast of 600 $MMTCO_2e$ in 2020 and a target of reducing these emissions to 427 $MMTCO_2e$. CARB, "Staff Report: California 1990 Greenhouse Gas Emissions Level and 2020 Emissions Limit," (November 16, 2007), available at http://www.arb.ca.gov/cc/ccei/inventory/reports/staff_report_1990_level.pdf.

[17] For example, McKinsey has developed a cost curve for the United States economy. McKinsey & Company, "Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?" (December 2007), available at http://www.mckinsey.com/clientservice/ccsi/greenhousegas.asp, pp. 19-20.

III. CONCLUSION

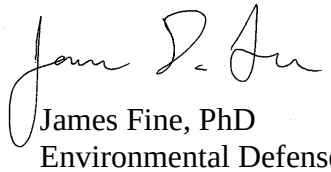
We recommend that CARB establish a cost-effectiveness framework under AB 32 that is based on a bundle of strategies that is necessary to reach the state's 2020 greenhouse gas emission limit. As the state continues to develop greenhouse gas regulations, prior and other regulations may also provide increasingly relevant additional points of reference for this cost-effectiveness framework. When CARB ultimately makes its policy determinations regarding which regulations to adopt, cost-effectiveness is just one of the many factors it must consider.

Sincerely,



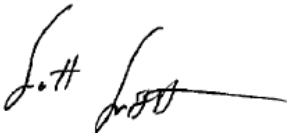
Leah C. Fletcher
Natural Resources Defense Council

Chris Busch, PhD
Union of Concerned Scientists



James Fine, PhD
Environmental Defense Fund

Tim Carmichael
Coalition for Clean Air



Scott Smithline
Californians Against Waste

Rachel McMahon
Center for Energy Efficiency and Renewable Technologies

Nancy Rader
California Wind Energy Association

Michelle Passero
The Nature Conservancy