
Showing the World How It's Done

**Limiting Offsets in California and the West to Promote Cleaner Air and
Advance Clean Tech and Green Jobs Development**

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Union of Concerned Scientists

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Chris Busch is an economist in the Union of Concerned Scientists (UCS) Climate Program.

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EXECUTIVE SUMMARY (updated 12/08)

Chris Busch, Ph.D.
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California is poised to enter its third year of implementing Assembly Bill 32 (AB 32)—the country's first economy-wide cap on global warming emissions— which requires global warming emissions in California to be reduced to 1990 levels by 2020, about a 29-percent reduction from “business as usual.”

As part of the effort to meet that requirement, the California Air Resources Board (CARB) released its proposed Scoping Plan on October 15, 2008. It includes a set of strong sectoral policies designed to achieve 80 percent of the emissions reductions called for under AB 32 and it calls for a California cap-and-trade program to be developed and linked with the Western Climate Initiative (WCI), which brings together seven western states and four Canadian provinces.¹

The WCI has established a regional emissions-reduction target of 15 percent below 2005 levels by 2020, a strong economy-wide target. The WCI released guidelines for a regional cap and trade program on September 23, 2008.

Offsets Recommendation from California's Proposed Scoping Plan

The proposed Scoping Plan suggests allowing compliance offsets to comprise up to 49 percent of the total emission reductions below the 2012 limit on capped sectors during each three-year compliance period through 2020. This means that the vast majority of the reductions that cap-and-trade seeks to achieve in California could be obtained through offsets—many, if not all of which could be based on projects happening in other states or countries.

The Scoping Plan suggests a role for compliance offsets that is too large. Offsets should be limited to a small fraction of the reductions in a cap-and-trade program so that that the program results in emissions reductions occurring within the capped sectors themselves. Such a policy will encourage investment in clean technology, creation of green jobs, and attainment of clean air in California.

¹ Under a cap-and-trade system, regulated entities are required either to reduce their emissions or to procure allowances (also called tradable permits) for any emissions they cannot reduce. In addition, they may have the option of satisfying a portion of their compliance obligation by holding “compliance offsets,” which essentially are credits for emissions reductions made outside of the capped sectors.

Designing Effective Limits on Compliance Offsets

California and the WCI states and provinces must carefully design their compliance offsets policies so as to place significant limits, both quantitative and geographic, on these offsets. Such policies should ensure:

- ***The prioritization of clean air and public health benefits*** from investments in global warming solutions
- ***The realization of benefits*** from clean-tech investments and innovation in key (capped) sectors
- ***Meaningful reductions*** in high-emitting capped sectors and avoidance of costly lock-in of long-lived fossil-fuel technology
- ***The preservation of the option of linkage*** to other cap-and-trade programs that have chosen to limit offsets.

Prioritize clean air and public health benefits for residents of California and the West.

While reducing global warming pollution offers valuable climatic benefits in its own right, it will also provide many other important environmental benefits. When electricity providers, oil and gas companies, and other industrial sources reduce the amounts of global warming pollution that they produce, Californians will be exposed to lower levels of conventional smog-forming and toxic air pollutants as well. This improved air quality will in turn lead to better public health, lower health care costs, and higher levels of worker productivity and student performance. On the other hand, if offsets are allowed from anywhere in the world, which would be equivalent to the outsourcing of emissions reduction projects, then the valuable health benefits will be lost.

At present, Californians are quite literally dying from dirty air. The state has three of the five most polluted air basins in the country and the Los Angeles air basin has the worst year-round small-particulate pollution and the worst ozone levels in the country. CARB estimates that the policies cited in its Scoping Plan would reduce nitrous oxide and small particle emissions enough to result in 400 premature deaths avoided and a range of other public health benefits. The Natural Resources Defense Council, which recently released its own assessment, concludes that the improvement in air quality and reduction in health care costs would be even larger, preventing more than 700 premature deaths and saving \$3.2–\$5 billion in 2020.

Spur clean-tech investment, green-job development, and innovation.

A 2004 survey of venture capitalists found that one of the main reasons why they are motivated to invest in California's clean-technology industry is the state's strong climate policies. As a result, that sector is surging. In 2007, California garnered 45 percent of North America's venture capital investment in clean-energy technologies, or \$1.8 billion, up from \$1 billion in 2006. California last year attracted more venture capital in clean tech than did all of Europe combined. Carefully designed offset limits will help maintain this momentum, thereby preserving the rates of investment and innovation in California's clean-tech industries that will be the foundation of the future's low-carbon economy.

By contrast, overly permissive offset policies would shift emissions reductions from capped sectors to other sectors or to other geographic areas. Investor expectations on the

future profitability of technological advances in the capped sectors would be reduced, thereby depressing investment.

Moreover, the learning-by-doing and economies of scale that come with increased utilization would be lost. California's competitive advantage in the rapidly growing clean-tech global market should not be squandered; it makes much more sense to prioritize investment and innovation in clean tech—within the state, as opposed to essentially outsourcing—to take advantage of present opportunities. Other ancillary benefits that result from investing in a clean energy future is reduced reliance on imported fossil fuels, greater insulating from volatile oil and gas markets, and improved energy security.

Ensure meaningful reductions and avoid lock-in to higher-emitting capital. The broad reach of the cap-and-trade program proposed in the Scoping Plan means that almost all fossil-fuel combustion (in transportation, electricity generation, and other industrial activities) will be capped. Carefully designed offset limits promote technological changes in capped sectors by forcing emissions reductions within those sectors instead of diverting the reductions to other sectors of the economy or to other geographic areas.

By allowing nearly half of the emission reductions expected from the cap and trade program to be achieved through the use of offsets, opportunities for promoting investment in clean technology could be lost, resulting in costly lock-in to high-emitting capital that would make the eventual task of curtailing emissions far more expensive in the short timeframe we have left to avoid dangerous climate change.

Offsets Not Necessary for Cost Containment in AB 32 Implementation

Most economic-modeling results suggest that the direct costs of AB 32 will be modest, close to zero, or possibly even positive. Moreover, these models of cost do not account for the many ancillary economic and environmental benefits of reducing global warming emissions. CARB's proposed Scoping Plan expresses a similar view: "The economic analysis of this plan indicates that implementation of the recommended strategies to address global warming will create jobs and save individual households money" as well as increasing overall state gross product by \$7 billion in 2020 compared to business-as-usual. Under these circumstances, compliance offsets would not be needed in California as a cost-containment approach.

Offsets: One of many Ways to Reduce Global Warming Pollution

Compliance offsets offer just one way to achieve reductions outside the direct reach of a cap-and-trade program. Other means for producing reductions in noncapped sectors include incentive programs as well as other policy instruments covering a broad spectrum from mandates to informational campaigns about best practices. Offsets have the advantage of being funded by polluters regulated under cap-and-trade, but they also create an incentive for the sectors providing offsets to resist future mandatory measures (such as direct inclusion in cap-and-trade program), as this could mean loss of the offset-project revenue stream. And offsets offer particular challenges in the area of benefit

estimation because the product of an offset project is intangible and can only be estimated indirectly.

Conclusion

While carefully designed limits on compliance offsets are an important aspect of cap-and-trade systems, the recommendation in CARB's Scoping Plan allows for too large a role for compliance offsets. The suggested limit fails to guarantee that cap-and-trade will produce significant reductions in the capped sectors that should be the primary targets of the program. Less permissive limits, however, would promote the capture of ancillary benefits for the residents of California and WCI jurisdictions, would avoid lock-in to long-lived fossil fuel combustion technologies, and would ensure that meaningful reductions in the short and mid-term would put us on the path to our long-term goal of much deeper reductions.

California has the chance to demonstrate that the transition to a clean-energy future—especially one that offers a wide range of environmental and economic benefits—is possible. Given the state's visionary climate policies and its comparative advantage in innovation, California is uniquely positioned to attract clean-tech investment funding. In fact, the world is increasingly looking to California for solutions to the global warming challenge. CARB should help seize this opportunity by reconsidering its suggested offset policy, which is overly permissive and downright counterproductive.

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1. Introduction

California is poised to enter its third year of implementing Assembly Bill 32—the country’s first economy-wide cap on global warming emissions. AB 32 requires such emissions in the state to be reduced to their 1990 levels by 2020, about a 29-percent reduction from business as usual.

By January 1, 2009, the California Air Resources Board must adopt a “scoping plan” that contains a policy framework for fulfilling the 2020 mandate. On June 26, 2008, CARB released its draft scoping plan, which calls for large menu of policies across many sectors of the economy. The bulk of the reductions, about 80 percent, come from policies such as performance standards, best-available control-technology standards, fees, incentives, and measures to encourage voluntary action. The draft calls for a modest portion of the AB 32 reductions, about 20 percent, to come from a regional cap-and-trade system (defined just below) under the aegis of the Western Climate Initiative (WCI), which includes seven western states and four Canadian provinces. WCI has established a regional emissions-reduction target of 15 percent below 2005 levels by 2020, a target roughly equivalent to AB 32’s mandate for California but actually more aggressive, in terms of reductions over business as usual, for the other jurisdictions covered in the regional pact. This paper was written with the California context in mind and is intended as an input to the debate regarding AB 32’s implementation, but its findings, arguments, and conclusions also extend to the WCI.

UCS concludes that to avoid dangerous climate change, the United States must achieve reductions of 15-20 percent below the country’s 2000 levels of global warming pollution by 2020 in order to be on target to reach at least an 80 percent reduction below 2000 levels by 2050 (Luers et al. 2007). This goal provides the foundation for our argument that it is critical for California to become a model of effective climate action and demonstrate that the challenge ahead, though significant, is surmountable. As part of these pursuits, California must continue its leadership within the WCI to ensure a strong regional outcome. The state is already illuminating the path to a clean energy economy, and it has shown time and again that we can grow the economy and clean up the air.

The importance of a package of policies. Throughout the implementation of AB 32 we have stressed the importance of complementary policies. The Cal EPA Market Advisory Committee, in its recent report, agrees: “By itself, a cap-and-trade program alone will not deliver the most efficient mitigation outcomes for the state. There is a strong economic and public policy basis for other policies that can accompany an emission trading system,” (MAC 2007, p.19). An important insight that California can pass along to others is that cap-and-trade is not a silver bullet. The draft scoping plan presented on June 26, 2008, embodies this principle.

Definition of a well-designed cap-and-trade program. Under a cap-and-trade system, regulated entities are required to either reduce their emissions or procure allowances (also called tradable permits) for any emissions they cannot reduce. In addition, they may have the option of satisfying a portion of their required reductions through “compliance offsets” which essentially are credits for emissions reductions made outside of the capped

sectors. Though cap-and-trade allows for flexibility, it also imposes a regulatory requirement that a permit be held. Called “allowances” in the parlance of cap-and-trade, these tradable permits provide the instrument for regulators to impose reductions. By reducing the number of allowances made available, which effectively lowers the cap imposed by cap-and-trade, such a program can force declining emissions in covered sectors over time.

Thus we have also stressed, during the AB 32 implementation process, the need for certain elements in a well-designed cap-and-trade program. The core must be a tight cap that yields significant reductions in capped sectors. Strong enforcement measures and—to provide transparency—the public availability of emissions and trading data, are important as well. In addition to carefully designed limits on compliance offsets, we have advocated the auctioning of 100 percent of allowances and the inclusion of transportation fuels in the scope of the cap-and-trade program.

Free allocation—the giving away of allowances—would not be warranted; it could lead to overcompensation of regulated entities (“windfall profits”) from pass-through of the cost of an allowance. Past cap-and-trade programs have shown that polluters can pass through much of the price of an allowance even if allowances are received for free, and that the price is independent of whether or not they are auctioned or given away. Auctioning 100 percent of allowances, on the other hand, would ensure that windfall profits did not accrue to polluters but rather that auction revenue could be used to further the public interest—in particular, consumer protection. Auctioning is the simplest and most transparent approach to distributing allowances.

We also argue that the scope of cap-and-auction should be as broad as possible, including electricity generation, natural gas, and transportation fuels, in order to directly cap key fossil-fuel-combusting sectors. Such direct coverage to the greatest extent practical is preferred.

Overview of the paper. This paper proceeds as follows. In Section 2 we provide a definition of an offset and elaborate on what we call foundational issues, aspects of offsets policy other than the importance of carefully designed limits. In Section 3, we introduce the argument at the core of this paper:

Carefully designed limits on compliance offsets are a critical design feature of any climate policy. Effective limits will promote investment in clean technology and clean air in California.

Section 4 explains the reasoning that underlies our position. Section 5 briefly reviews the academic literature relevant to this research; it considers the range of approaches that have been taken in climate-policy analysis, with particular emphasis on how offsets have been modeled, and also takes the ancillary benefits of climate policy into account. Section 6 considers how offsets could result in the loss co-benefits; and in Section 7 we provide an overview of these co-benefits, including air quality, energy savings, and investment. Section 8 documents our quantitative work on these benefits and introduces a set of renewable-energy and efficiency measures. Section 9 surveys the planet’s rapidly growing clean-tech industries, California’s recent spectacular growth in this area, and its

decades-long history of steady development of environmental businesses. Section 10 provides a brief treatment of the importance of developing a reliable voluntary market, and of encouraging renewable energy development, in cap-and-trade design. Finally, Section 11 offers concluding comments and a technical appendix provides details on quantification methodology.

2. Offset definition and foundational issues

The simplest definition of an offset is an emissions-reduction project in an uncapped sector that would not have taken place without the added incentive provided by an offset program. This is the basis for the terminology that offsets must be *additional*—they must be above and beyond the actions that are required by regulation and that would be expected as common practice. By definition, if an offset project would have occurred anyway—i.e., without the offset incentive—then it is not additional. Under a cap-and-trade program, compliance offsets create an exception to the rule that regulated entities are required to hold an allowance. If offsets are allowed, businesses regulated under cap-and-trade can cover their emissions through a combination of allowances and compliance offsets.

An example of an offset project might involve the waste-product methane, a potent heat-trapping gas, that results from livestock operations. While this methane is typically not managed, being released uncontrolled into the atmosphere instead, technologies are available that could destroy the gas, reduce its global warming effect, or capture the gas for use generating electricity. Because global warming pollution benefits can be estimated in any of these cases, offsets could be a way to provide incentives for technological changes in livestock operations.

But offsets are not the only mechanism for generating reductions, and in fact we see a limited role for them, as incentives, standards, and technological mandates can achieve precisely the same objective. Thus we urge that offsets be conceptualized as a funding mechanism. In the climate bill that the U.S. Senate is currently considering, auction revenue is set aside specifically for the purpose of funding reductions from international tropical deforestation but not as compliance offsets, as the reductions in emissions due to tropical deforestation would not substitute for reductions that would otherwise be achieved under a cap-and-trade program.

It is necessary to distinguish between compliance offsets and voluntary offsets. Compliance offsets are those used as a mechanism for meeting the requirements of regulations. Voluntary offsets can be purchased by entities that wish to go beyond the minimum required by the law. This report is focused on compliance offsets, though we discuss the voluntary market in Section 10.

A difficulty with offset projects in general is that the global warming benefit they produce is intangible—an emission does not take place that would have taken place in the absence of the project. Therefore while the outcomes of offset projects are often measured in terms of known technological improvements or improved management practices, *environmental* benefit can be estimated but never be known with certainty.

We do not focus here on the types of projects most likely to be successful as offset projects or the necessary institutions and protocols, but these issues are clearly important if offsets are to play a constructive role in serving as an effective means of ameliorating climate change. The requirements of AB 32 are also of obvious importance to the implementation of the law, both the requirement that all reductions be “real, permanent, quantifiable, verifiable, and enforceable by the state board,” and its “no backsliding” provision that requires that all reductions be surplus, verifiable, permanent, and enforceable by CARB. Conditions have also been added that require that market-based compliance mechanisms, such as offsets, be designed to prevent any increase in the

emissions of toxic air contaminants, criteria air pollutants, or any other negative localized environmental quality impacts.

Offsets in Other Programs

The European Union's Emission Trading Scheme (EU ETS).

The EU ETS, aimed at reducing heat-trapping emissions, is the first and multisector cap-and-trade program for that purpose that has been implemented. The EU ETS is currently in its second phase, which runs through 2012 and is part of the EU's effort to reduce its economy-wide emissions as required under the international climate treaty called the Kyoto Protocol. Current EU ETS rules place limits on the use of international offsets in order to ensure that the majority of each country's overall emissions reductions occur domestically. This "supplementarity condition" reflects the thinking that international offsets should supplement, not outweigh, domestic actions.

The precise limit in each country is subject to approval by the European Commission (EC) as part of each member state's National Action Plan (analogous to California's Scoping Plan). The approved limits vary, given that the division of effort between cap-and-trade and other policies varies across member states, but they are always defined as the maximum amount that any particular regulated entity (such as a firm that must surrender allowances and offsets to account for its emissions) can rely on. EC documentation provides a breakdown of offset limits, which are translated into the percentage of emissions that can be covered by offsets. In the current Phase 2 of the EU ETS, the allowable percentage of emissions that can be covered by offsets ranges from zero to 20 percent, with 10 percent being the most commonly allowed percentage (applying to 11 countries).

The EC's proposed guidance for Phase 3 of the EU ETS, which is expected to run from 2013 to 2020, sharply cuts back on the amount of offsets that will be allowed.² The guidance implies that an overly permissive offset policy delays the necessary transition to a clean energy future. It states that offsets beyond what was generated under the Clean Development Mechanism (described below) and beyond those allowed during Phase 2 would not be allowed during Phase 3 in achieving Europe's target of 20 percent below 1990 levels. If Europe makes a deeper emissions-reduction commitment in the context of an international agreement beyond Kyoto, as it has stated it is willing to do, then offsets generated through the Clean Development Mechanism could play a limited role. The proposed guidance suggests that up to 50 percent of the additional reductions needed for the EU to go from 20 percent to 30 percent below 1990 levels could be achieved through international offsets.

The Clean Development Mechanism

The primary international offsets-generating process under the Kyoto Protocol is the Clean Development Mechanism (CDM), so called because it is intended not only to achieve reductions in heat-trapping emissions but also to promote development in

² The Commission of the European Communities' Proposal for a Directive of the European Parliament and of the Council amends Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance-trading system of the Community. Brussels, 23 January 2008.

developing countries. In the most comprehensive assessment to date, Schneider (2007) reviews a random sample of 97 CDM projects and finds that up to 40 percent of them are questionable. Victor and Wara (2008) also look broadly at CDM projects and conclude that there are serious problems with the emissions reductions being claimed by project developers. Citing a separate analysis, David Victor, Director of the Program on Energy and Sustainability at Stanford University, has estimated that between one-third and two-thirds of emissions-reductions claims under the CDM do not represent real reductions (Obey 2008). In addition to these broad studies, numerous case studies have also raised doubt about the validity of CDM claims.

The Regional Greenhouse Gas Initiative (RGGI)

RGGI was developed with a different mission and in a different context from those of the EU ETS and the proposed cap-and-trade system for California and the West, which are economy-wide reduction efforts. Whereas cap-and-trade is but one policy instrument in those systems, cap-and-trade is the core of RGGI and its primary target is a single sector—electricity generation.

It is also important to point out that the RGGI's compliance-offsets limit was set at a different time, when the risks posed by global warming were less well understood. RGGI's default limit allows a regulated entity to satisfy up to 3.3 percent of emissions with offsets, chosen to represent approximately half of reductions over business-as-usual emissions trends.³ Five offset project types are allowed: (1) landfill methane capture and destruction, (2) avoided methane emissions from livestock manure management, (3) reductions in sulfur hexafluoride, (4) afforestation, and (5) end-use efficiency that reduces emissions from combustion of natural gas, propane, or oil (i.e., outside of the electricity sector).

Offsets can be sourced from anywhere in the United States as long as states outside of those included in RGGI enter into a memorandum of understanding on verification and monitoring to ensure environmental integrity. The quantity limit increases to 5 percent of emissions if the allowance prices exceed \$7/ton on average for 12 months. If the price of an allowance exceeds \$10/ton on average for 12 months, then the limit increases to 10 percent of emissions and offsets generated under the CDM are allowed.

³ For more about the analytical work that set the 3.3-percent-of-emissions limit, see: "Analysis Supporting Offset Limit Recommendation," available at http://www.rggi.org/docs/offsets_limit_5_1_06.pdf (accessed June 11, 2008).

3. Designing Effective Limits on Compliance Offsets

Compliance offsets for AB 32 implementation and in the WCI should be limited to a small fraction of the reductions that a cap-and-trade program seeks to achieve. We emphasize that in defining our favored quantitative limit, this small fraction of reductions translates into an even smaller fraction of emissions. As discussed above, in order to render operational the quantitative offset limits in the cap-and-trade systems in Europe and the Northeast—the EU Emission Trading System and the Regional Greenhouse Gas Initiative, respectively—overall limits are translated into the percentage of emissions that any particular regulated entity can cover by offsets.

Offsets Recommendation for California’s Scoping Plan

The draft Scoping Plan suggests that “a limit on offsets, such as 10 percent of the compliance obligation for an individual firm, would allow [C]ARB and WCI to test the viability of the offsets system while limiting the risk that unconstrained offsets could weaken the stringency of the overall cap-and-trade program” (p.19). The term “compliance obligation” could be interpreted in different ways; the draft plan defines it as a percentage of allowances. Because the preliminary 2020 cap level within the cap-and-trade program is 365 MMT of CO₂e (million metric tons of carbon dioxide equivalent) and this figure determines the quantity of allowances that the program would create, CARB’s suggested limit implies that up to 36.5 MMT of reductions could be achieved through compliance offsets in 2020. Yet the cap-and-trade program is only tasked with achieving 35.2 MMT of reductions in the overall plan. Therefore, potentially all of the reductions that cap-and-trade seeks to achieve could be done through offsets, and no emission reductions whatsoever would necessarily occur in capped sectors. This would satisfy the letter but not the spirit of quantitative limits on offsets, which should ensure that the cap-and-trade program yields *meaningful* reductions in capped sectors.

In other words, the draft Scoping Plan suggests a role for compliance offsets that is too large. They should be limited to a small fraction of the reductions in cap-and-trade so that that emissions reduction will actually occur, and to a significant degree, within the capped sectors themselves. Such a policy will encourage investment in clean technology, creation of green jobs, and attainment of clean air in California.

Compliance Offsets and the Western Climate Initiative

Because California cannot solve the climate challenge alone, we urge the state’s policymakers to show leadership within the WCI. California and the world are better off if a strong western regional climate-policy framework emerges. A broader regional approach will not only expand markets for California’s green technologies but also create a level playing field across the West, protecting against the possibility that businesses will try to avoid adherence to climate policy by moving to neighboring areas.

Still, there is a danger that the WCI could devolve toward a least common denominator outcome (i.e., weak policy) that could have a negative impact on the effectiveness of a future federal program. By stressing that the California cap-and-trade program will be an entity unto itself, CARB has demonstrated that it will not be dependent on a successful outcome of the WCI process and that it recognizes the need to observe AB 32 provisions that go beyond the WCI charter.

This paper is being written as the WCI's preliminary recommendations are being refined, and the definition of its offset policy to date is only skeletal. While WCI has so far indicated that quantitative limits on offsets should ensure meaningful reductions in capped sectors, it has not made a recommendation with respect to the locations of offset projects. The WCI has suggested that mechanisms to prioritize offset projects within the states and provinces included in the WCI should be considered, but at the same time it is also considering that offset projects throughout North America, as well as those generated through the CDM, be allowed. We believe that offsets should be located only within the jurisdictions that constitute the WCI.

4. The Rationale for Limited Offsets

In this document we advocate for two types of compliance offset limits, quantitative and geographic, and in this section we discuss the separate but overlapping reasons why. The underlying rationale is that climate action is an opportunity for California—that the state has a unique capacity for innovation and that the most important leadership role it can take is to focus on emissions reductions. In that way, California can be a model for effective climate action while also generating advances in global warming solutions that the world will need to rapidly and successfully transition to a low-carbon economy.

The Goals of Effective Offset Limits

California and the WCI states and provinces should carefully design their compliance offset policies so as to place significant limits, both quantitative and geographic, on these offsets. Such policies should ensure:

- *The prioritization of clean-air and public-health benefits* from investments in global warming solutions
- *The realization of benefits from clean-tech investments and innovation in key (capped) sectors*
- *Meaningful reductions* in high-emitting capped sectors and avoidance of costly lock-in of long-lived fossil-fuel technology
- *The preservation of the option of linkage* to other cap-and-trade programs that have chosen to limit offsets.

Prioritize clean-air and public-health benefits for residents of California and the West.

While reducing global warming pollution offers valuable climatic benefits in its own right, it will also provide many other important environmental benefits. When electricity providers, oil and gas companies, and other industrial sources in the state reduce the amounts of global warming pollution they produce, Californians will be exposed to lower levels of conventional smog-forming and toxic air pollutants as well. This improved air quality will in turn lead to better public health, lower health-care costs, and higher levels of worker productivity and student performance. If offsets are allowed from anywhere else in the world, which would be equivalent to the outsourcing of emissions-reductions projects, valuable local health benefits will be compromised.

At present, Californians are quite literally dying from dirty air. The state has three of the five most polluted air basins in the country (Nichols 2008) and the Los Angeles air basin has the worst year-round small-particulate pollution and the worst ozone levels in the country (American Lung Association of California 2008). CARB estimates that the policies cited in its draft Scoping Plan would reduce nitrous oxides emissions by 50 tons per day and the most dangerous kind of particulate matter (the smallest particles) by 10 tons per day. These reductions, according to CARB estimates, would result in 340 premature deaths avoided and a range of other public-health benefits, with a combined economic value of \$1.5–\$2.4 billion in 2020. The Natural Resources Defense Council, which recently released its own assessment, concludes that the improvement in air quality and reduction in health-care costs would be even larger, preventing more than 700

premature deaths and saving \$3.2–\$5 billion in 2020 (Natural Resources Defense Council 2008).

Spur clean-tech investment, green-job development, and innovation. A 2004 survey of venture capitalists found that one of the main reasons why they are motivated to invest in California's clean-technology industry is the state's strong climate policies. As a result, that sector is surging. In 2007, California garnered 45 percent of North America's venture-capital investment in clean-energy technologies, or \$1.8 billion, up from \$1 billion in 2006 (Baker 2008). California last year attracted more venture capital in clean tech than did all of Europe combined. Carefully designed offset limits will help maintain this momentum, thereby preserving the rates of investment and innovation in California's clean-tech industries that will be the foundation of the future's low-carbon economy.

By contrast, overly permissive offset policies would shift emissions reductions from capped sectors to other sectors or to other geographic areas. Investor expectations on the future profitability of technological advances in the capped sectors would be reduced, thereby depressing investment. Moreover, the learning-by-doing and economies of scale that come with increased utilization would be lost. California's competitive advantage in the rapidly growing clean-tech global market should not be squandered; it makes much more sense to prioritize investment and innovation in clean tech—within the state, as opposed to essentially outsourcing—to take advantage of present opportunities. An ancillary benefit that will result from progress toward a clean-energy future is reduced reliance on imported fossil fuels, greater insulating from volatile oil and gas markets, and improved energy security.

Ensure meaningful reductions and avoid lock-in to higher-emitting capital. The broad reach of the cap-and-trade program proposed in the draft Scoping Plan means that almost all fossil-fuel combustion (in transportation, electricity generation, and other industrial activities) will be capped. Carefully designed offset limits promote technological changes in capped sectors by forcing emissions reductions within those sectors instead of diverting the reductions to other sectors of the economy or to other geographic areas. The draft plan recognizes this important objective, stating “[C]ARB is considering limiting the use of offsets... to help ensure a significant portion of required reductions come from within the state and within the regulated sectors” (p. 44).

However, CARB's suggested quantitative limit does not square with this objective, as it implies that all of the reductions produced by capped sectors could come through offsets. The draft plan's suggested allowable quantity of offsets (36.5 MMT) is actually greater than the reductions that the program is designed to achieve (35.2 MMT). With such an offset policy, opportunities for promoting investment in clean technology could be lost, resulting in costly lock-in to high-emitting capital that would make the eventual task of curtailing emissions far more expensive in the short timeframe we have left to avoid dangerous climate change.

To further understand our view on quantity limits, it is important to consider capped sectors, which are projected to account for about 85 percent of California's emissions in 2020. If we are to meaningfully reduce these emissions, it is crucial that clean-energy and energy-efficiency technologies be developed—especially through prioritized reductions and policies, such as limitations on offsets, for fostering innovation

in capped sectors. At the same time, the most cost-effective climate policy will draw on all sectors of the economy because global warming pollution is an economy-wide challenge. Agriculture and forestry are generally accepted as unsuitable for inclusion in cap-and-trade programs because of analytical challenges (i.e., challenges in measuring and monitoring global warming pollution emissions). Offsets are one way to extend the reach of a cap-and-trade program to sectors that are not directly capped such as agriculture and forestry, as the analytical challenges are more manageable at the level of a bounded project as opposed to an entire sector. It is worth noting, however, that offsets are not the only—or always the best—way to produce reductions in non-capped sectors. They are politically attractive in that they do not draw on public resources but rather are paid for directly by offset purchasers, emitters covered by cap-and-trade. At the same time, offsets also present special analytical and institutional challenges compared with other policy options.

The Market Advisory Committee report (MAC 2007) emphasized investment in research to promote innovation; its emphasis was on the supply side. University of California Professor Margaret Taylor’s research, which we discuss in some detail in our exploration of the literature on technological innovation, suggests that innovation is maximized when policy pays attention to the demand side of the market as well. To the extent that offsets spread out the mitigation effort, they reduce the stringency of the program and weaken the price signals to entrepreneurs regarding the returns to be expected from their investments in inventive aspirations. As we discuss below, such outcomes would have innovation-dampening effects on the capped sectors. Technological innovation in capped sectors is necessary not only to meet the 2020 cap under AB 32 but, more importantly, to meet the essential long-term goal of 80-percent reduction by 2050. Widespread use of offsets by regulated entities could delay technology advancements in capped sectors for decades—advancements that we are going to need eventually anyway to meet our 2050 goals.

Preserve the option of linkage to other cap-and-trade programs that have chosen to limit offsets quantitatively. But linkage is unlikely in the absence of harmonization with those programs’ offset policies. The EU ETS in particular has signaled its intention to sharply curtail offsets in order to ensure that cap-and-trade provides the necessary impetus for a transition to a clean-energy future.

Offsets Are Not Necessary for Cost Containment in AB 32 Implementation

Most economic-modeling results suggest that the direct costs of AB 32 will be modest, close to zero, or possibly even negative (i.e., profitable). Moreover, these models of cost do not account for the many ancillary economic and environmental benefits of reducing global warming emissions within local capped sectors. CARB’s draft Scoping Plan expresses a similar view: “[T]he projected effect of the recommendation on the state economy...is likely to be overall positive” (p.49). Under these circumstances, compliance offsets would not be needed in California as a cost-containment approach.

We discuss these models further below in our review of some of the relevant literature. A key insight is that none of them consider the benefits of climate action, with the important exception of the monetary value of reduced energy consumption. Beyond

accounting for lower energy bills, the models only seek to account for costs. Nonetheless, despite this limitation in accounting for the upside of climate action, the results from these economic studies suggest that costs will be moderate.

There have been three major economic studies of AB 32's impact:

1. CARB's work with the EDRAM model (CAT 2007A)
2. Work at the University of California, Berkeley, with BEAR (CAT 2007A)
3. The Electric Power Research Institute (EPRI) and Charles River Associates' (CRA) efforts with their MRN-NEEM model (EPRI/CRA 2007).

The results of these three initiatives to model costs are clustered around zero. They range from slightly negative (i.e., energy savings and related macroeconomic effects alone outweigh costs) in CARB's estimation, to close to zero in the modeling work of UC Berkeley's David Roland-Holst, to slightly positive (modest costs) in the work of EPRI and CRA.⁴ As we will emphasize in this document, these models do not account for the value of co-benefits and are limited in their ability to capture the potential for innovation, though Roland-Holst has demonstrated creativity in pushing the modeling frontier in this regard.⁵ What's more, as researchers at Resources for the Future show in an award-winning paper, the costs of environmental policies usually turn out smaller than they were predicted to be before a program was implemented (Harrington, Morgenstern, and Nelson 2000). In technical policy terms, ex-post costs—costs as they are realized in the real world—are usually smaller than ex-ante estimates suggest.

Offsets Are Just One Way to Produce Reductions in Non-Capped Sectors

Compliance offsets offer just one way to achieve reductions outside the direct reach of a cap-and-trade program. Other means for producing reductions in non-capped sectors include incentive programs as well as other policy instruments covering a broad spectrum from mandates to informational campaigns about best practices. Offsets have the advantage of being funded by polluters regulated under cap-and-trade, but they also create an incentive for the sectors providing offsets to resist future mandatory measures (such as direct inclusion in cap-and-trade program), as this could mean loss of the offset-project revenue stream. And offsets offer particular challenges in the area of benefit

⁴ To be more specific, CARB's modeling suggests that real state output will increase by 0.2 percent (CAT 2007A, p. 40) as a result of AB 32 implementation; UC Berkeley's work suggests a slight decline of 0.1 percent in real state output (CAT 2007A, p. 40); and even under the more pessimistic assumptions used in the EPRI/CRA modeling, the cost is fairly moderate—a decrease in state income of about 1 percent, which translates into a cost of \$32 billion in a \$2.35-trillion economy (EPRI/CRA 2007, p.7-1). It is important to point out that even under this most expensive scenario, the California economy continues to grow substantially. The output of the EPRI/CRA model shows the economy growing at 2.81 percent over 2010-2020 with AB 32 implementation instead of 2.95 percent in the no-climate-action scenario.

⁵ Brian Murray and Martin Ross, who run the ADAGE model—one of two economic models used by the EPA to assess climate models—describe the limited capability of economic models to account for innovation and how this limitation affects projections of future costs: “The actual realized cost of the policy will depend significantly on the development and deployment of low carbon technologies that are not widely in use today... It is difficult to predict and model how these developments will occur... Capturing these factors in the long-term economic assessment of climate policy remains the focus of the economic modeling community's continued efforts” (Murray and Ross 2007, p. 7).

estimation because the product of an offset project is intangible and can only be estimated indirectly.

The Clean Development Mechanism and Climate Action in California and the West

Over the long term, the world needs an effective international mechanism to channel investment and technology to developing countries, both for efficiency and equity reasons. We hope that the Kyoto Protocol's Clean Development Mechanism can evolve into such an institution or that some alternative will soon develop. That said, California does not need international offsets to achieve its AB 32 reductions; indeed, such offsets would threaten to export valuable environmental and economic co-benefits.

California can provide leadership by demonstrating that a reasonable transition to a low-carbon economy needn't create an economic burden, by being a model for climate action, and by concentrating our emissions reductions in-state in order to fully leverage the interest, excitement, and, more concretely, the large amount of investment in clean-energy and efficiency technologies occurring in the state. Moreover, because California does not have a direct means to influence the CDM, by not accepting credits generated under the CDM we can send it a very clear and possibly reform-inducing signal—that the CDM's performance, in particular the indication of significant problems with additionality, is not acceptable. A decision to disallow CDM offsets could be revisited later, should environmental integrity improve to an acceptable level in the context of deeper emissions reductions beyond 2020.

Perhaps California can contribute to the development of an arsenal of effective policy instruments for addressing global warming pollution by pioneering a modest offset program that is effective both in cost and environmental-integrity dimensions. The same is true for the WCI. CDM credits are not needed to achieve emissions reductions called for under the WCI, and perhaps the most constructive role for the WCI is in developing and refining reliable offset methodologies, procedures, and institutions within its own borders.

5. Literature review for context

Since the early 1990s, researchers have struggled to adequately account for the ancillary benefits of investments in global warming solution, constrained by the fact that the theoretical ideal of a completely monetized net-benefit evaluation (societal cost-benefit analysis) has rarely been carried out, whether in academic studies or as a direct input to environmental decision making. The environmental and socioeconomic impacts of global warming policy are simply too wide-ranging and difficult to comprehensively quantify, much less amenable to being assigned a dollar value. Nonetheless, there have been occasional efforts toward that end, including Boyd et al. (1995), which joined a computable general equilibrium (CGE) model with a separate valuation of seven pollutants to find that ancillary benefits of global warming solutions were valuable. This study concluded that CO₂ reductions of between of 8–64 percent over business as usual were available at no social cost.

Two major net-social-impact studies of climate action are attributable to Nicholas Stern (2007) and Bill Nordhaus, who has been using his global model to evaluation climate policy since the mid-1990s—a recent application of the model can be found in Nordhaus and Boyer (2007). However, both of these research efforts focused on direct costs and benefits (i.e., avoided climate damage), and they did not push the frontier on the question of the ancillary impacts. Most recent climate-policy analysis has focused only on the cost of climate action, both in California and at the national level. Studies of the costs of inaction are multiplying, but these are typically done in isolation from economic studies of the impacts of policy options.

A separate body of work has sought to better characterize the related impacts of global warming solutions. Efforts such as Krupnick, Burtraw, and Markandya (2000) broadly considered and defined, in a qualitative way, the many indirect effects of global warming solution investments. Two major symposia have targeted the issue of multiple benefits due to climate action, one under the aegis of the OECD and one convened by the U.S. EPA.⁶

The bulk of the efforts to quantify and monetize ancillary impacts have focused on the other air-pollution reductions that accompany avoided fossil-fuel combustion. This approach reflects the view that local air-quality improvements will be valuable co-benefits of climate action. They will enhance public health and quality of life, reduce health care costs, and increase worker productivity and student performance, among other positive effects. Such outcomes were noted by Pearce (2000), who reviewed 15 studies that estimated the economic value of improved local and regional air quality. The most frequently considered co-pollutants in these studies were NO_x, SO₂, and particulate matter.

⁶ For more information on the OECD effort, see “Workshop on Assessing the Ancillary Benefits and Costs of Greenhouse Gas Mitigation Strategies,” http://www.oecd.org/document/59/0,3343,en_2649_34361_1914811_1_1_1_1,00.html. Accessed June 6, 2008.

For more information on the U.S. EPA effort, see “Symposium on Cost-Effectiveness Analysis for Multiple Benefits,” <http://yosemite.epa.gov/ee/epa/eed.nsf/webpages/CEAforMB.html>. Accessed June 6, 2008.

The quantification efforts we make here do not take the additional step of putting a dollar value on avoided emissions, and so we do not review these valuation studies in detail. Further, we leave our treatment of the induced-innovation literature for our qualitative co-benefit evaluation section (Section 9).

Approaches to incorporating offsets in modeling frameworks. Questions about offsets add another layer of complexity to the challenge of developing an analytical basis for global warming policy. Offsets operate at multiple scales, potentially encompassing the entire globe. So, for example, offsets in California could be a policy instrument for capturing some reductions in land-based sectors, such as agriculture and forestry, that are not good candidates for direct capping because they are difficult to measure. Offsets could also conceivably be sourced from other parts of the United States or even from developing countries. In places without economy-wide reduction efforts, every sector of the economy can potentially be a source of offsets, which further increases the analytical complexity.

The policy literature includes two approaches to incorporating offsets in a model to evaluate climate policy:

1. Scenario analysis, in particular the testing of a range of offset prices
2. Supply and demand analysis, which seeks to model supply and demand over time.

Scenario analysis (California Climate Action Team). The scenario approach was undertaken, as described in CAT 2007A, both by the CARB team and David Roland-Holst at UC, Berkeley. The two efforts modeled the effects of offsets by developing three price scenarios: \$10, \$30, and \$50 per metric ton for offsets from outside of California. They assumed generic offsets—no particular mitigation options were ascribed to them—and an unlimited supply. A quantitative limit of 17.4 million metric tons was imposed, representing 10 percent of the total reductions that AB 32 seeks to achieve (as opposed to reductions from cap-and-trade alone). Because the two models, CARB’s EDRAM and Roland-Holst’s BEAR, yielded allowance prices lower than \$30 per ton (\$21 and \$22 respectively), only the \$10 scenario affected implementation of AB 32. At \$30 and \$50 per ton, there was no demand for offsets from outside California in the two models.

In the \$10-per-ton scenario, offsets had a slightly negative economic effect (lowered state income and employment levels) in the BEAR model and a slightly positive effect in EDRAM. Both were CGE models, but whereas BEAR included energy as a variable input, energy per unit of production was fixed in EDRAM, which was originally constructed for the California Department of Finance and not for the analysis of climate policy. (Note, however, that energy per unit of production could be changed exogenously—i.e., by the analyst from outside the structure of the model.) BEAR’s negative impact stemmed from energy-efficiency investments foregone, which increased the outflow of money from the state to cover the costs of energy (on top of the cost of the offsets itself). Professor Roland-Holst is in the process of writing a policy brief to elaborate on these results and his view of evidence thus far on how offsets could affect prospects for innovation in California.

Supply and demand modeling of offsets (U.S. EPA). An alternative to the scenario approach to incorporating offsets in a modeling framework involves estimating the supply of and the demand for offsets in order to forecast their price over time. A supply curve is sketched out for each sector, based on the technical potential and costs; and demand for offsets is generated, based on projections of business-as-usual trends and potential reduction targets.

The EPA has taken this approach in an effort to explore how different offsets policies might interact with climate bills, recently considered in Congress, that have cap-and-trade as their primary policy mechanism (Murray and Ross 2007). But while the EPA has made a good-faith effort on a gargantuan task, which requires global coverage and stretches for decades, there is reason to believe that the agency's modeling of the impact of international offsets on U.S. climate action is not realistic.

Here is why: The EPA's modeling predicts that the price of international offsets will be \$9 per ton in 2015, and it is on the basis of this unrealistically low price that dramatic allowance-price effects are predicted. Such a price is difficult to accept as reasonable when the current price for international offsets (technically, Certified Emission Reductions generated under the Kyoto Protocol's Clean Development Mechanism) is about \$25—and over \$30 when potentially invalid reduction claims on the order of 20 percent are factored in (according to Schneider [2007], invalid offset claims mean that the dollars going to offsets are spread over a smaller denominator, which produces a higher “real” price). The actual price was \$24.78 during the first week of April 2008,⁷ and this value increases to \$30.97 if 20 percent of the offset credits are not valid, as Schneider suggests may be the case.⁸

What are some of the limitations of the EPA approach? For one thing, it makes overly optimistic assumptions about supply—i.e., that every economically rational offset project takes place, despite the fact that a perfect response to a voluntary program is unrealistic. Second, it ignores the transaction costs of offsets. Despite their adding another layer of complication to an already difficult analytical issue, transaction costs deserve some attention. Here is what the Cal EPA Market Advisory Committee said in its report on cap-and-trade design for California: “[T]he number of staff needed to implement an effective offset-monitoring program could conceivably be larger than the staff needed to run the cap-and-trade program itself” (MAC 2007, p.74).

The issue here is what economists would call an “incentive compatibility problem.” In the absence of a serious effort to evaluate the work of third-party verifiers, all actors in an offset program have incentives to inflate claimed reductions (indeed, the cheapest “reductions” will be investments that would have been made anyway). Sellers want more “product” to sell. Buyers benefit from the price being depressed by greater supply. And third-party verifiers are interested in developing a reputation for giving favorable reviews, so that they will get more business. Schneider (2007, pp. 19-24) discusses the poor performance by third-party verifiers in the CDM experience thus far and attributes it to such incentive compatibility problems.

⁷ For Dec 08 CERs on the U.S. secondary market, according to <http://www.carbonpositive.net/viewarticle.aspx?articleID=1044>

⁸ Earlier we mentioned Schneider's finding that up to 40 percent of offset projects were not additional. However, because these were more likely to be smaller projects, the figure translates to the smaller 20 percent of credits that we use here.

While it may well be reasonable to expect that allowing more offsets will lower allowance price, those inclined to believe the EPA's modeling results have the burden of explaining why they are realistic, given the difficulties the international offset market has experienced thus far.⁹ While there are efficiency as well as equity reasons to support effective flows of funds to clean development in the international context, we should resist flawed modeling and simplistic reasoning. Further, the importance of offsets can be overstated by ignoring other policy instruments that exist for achieving these same reductions.

⁹ Alan Noguee, UCS Clean Energy Program Director, offers empirical evidence that suggests some caution in accepting the result, implied from economic theory, that offsets can only lower allowance prices: "In theory they should, but consider the real-world RES (Renewable Energy Standard) experience where companies have chosen to pay very high alternative compliance payments (\$50+/Mwh) when long-term contracts for renewables were available for much less (\$25-40/Mwh). Where market or cultural barriers make companies risk-averse to long-term investments, or where such investments run counter to their business plans, they will sometimes choose higher-price spot market purchases. If a robust offset spot market were to develop, it could possibly lead to higher long-term compliance."

6. Illuminating the Mechanics of Lost Co-Benefits: Analytical Approach

Global warming solutions have a wide range of indirect impacts, mostly positive, that are often called co-benefits.¹⁰ We also refer to these co-benefits, which are both economic and environmental in character, as ancillary impacts, reflecting the fact that they are not the primary goal of climate action. Still, because these co-benefits can be very valuable, CARB should take them into account as it finalizes its offset policy.¹¹

While seeking to illuminate the inherent tradeoffs involved when offsets are allowed as an alternative compliance mechanism, this report does not attempt a predictive analysis of exactly how offsets would interact with AB 32 implementation. Rather, we consider in more detail the co-benefits offered by global warming solution investments. In this section we consider the question: How would the loss of co-benefits come about under policies that allow for compliance offsets? Or, put differently, how do offset limits contribute to appropriate prioritization of projects with the most valuable co-benefits?

While most global warming solution investments have co-benefits, those associated with reduced fossil-fuel consumption—in particular, reduced emissions of “conventional” air pollutants and improved air quality—are likely to be the most valuable. The dominance of these particular co-benefits in the research literature is consistent with this view—that is to say, researchers have focused on quantifying ancillary air-quality impacts because they have the greatest payoffs.

Thus by directly covering as much fossil-fuel combustion as possible and retaining most reductions in capped sectors, California can not only advance innovation in the key sectors but also ensure investment in global warming solutions that have the most valuable co-benefits. Diverting reductions from capped sectors to non-capped sectors—agriculture and forestry—would result in less innovation in capped sectors and fewer air-quality benefits. This is not to say that offsets have no role in helping to capture reductions in non-capped sectors; compliance offsets may be useful in combination with other policy instruments. The point, however, is that an effective offset limit will protect against excessive shifting of reductions to sources outside capped sectors.

The mechanism by which offsets from outside California (or outside the WCI, in that context) could lead to lost co-benefits is fairly obvious. Such offsets, by diverting investment to projects located elsewhere, would cause an outflow of capital from California and—in the context of AB 32 and the potential positive economic benefits it offers—lost opportunities for the state.

While the general view is that offsets will be allowance-price moderating (note Alan Noguee’s alternate view, as described in Footnote 4 of Section 5), this effect is achieved by a diversion of resources from the regulated entity to the offset provider, which is possibly out of state. Is a lower price always preferable? The growing consensus is that a price of zero is not the preferred price for carbon emissions, and we would

¹⁰ In some instances there may be negative impacts associated with mitigation projects. For example, on-site combustion of methane captured from livestock operations produces NO_x. Post-combustion controls for smaller distributed generating units are not well developed, and so they are more polluting per unit of electricity produced than are larger plants.

¹¹ “Accounting for Co-Benefits in AB 32’s Cost-effectiveness Framework,” comment letter submitted to Kevin Kennedy, May 30, 2008.

further assert that unacceptably low allowance prices—which could result from a flood of offsets into the market—could delay clean investment today and slow the flow of future investment dollars that fuel the processes of research, development, and deployment of low-carbon technologies. While it is desirable to avoid prices so high as to be disruptive to the economy, very low prices could also be problematic; they would weaken incentives for a badly needed transition to a *clean* economy.

Additionally, there is the concern that offsets payments for out-of-state projects do not contribute to moving California toward our long-term emissions reduction goals. CARB has consistently said that an important criterion for shaping the scoping plan to achieve our required 2020 reductions will be putting the state on a pathway to realizing our more ambitious target of 80 percent below 1990 levels by 2050.

The particular set of policies that we address in our quantitative work all fall within the electricity sector. These are not necessarily emissions reductions that are likely to result from cap-and-trade or that might not occur because of an overly permissive offset policy. It is difficult to know in advance what particular reductions will occur because of the program's flexibility. Moreover, we now know that a 33 percent RPS, expanded energy-efficiency measures, and water-sector measures have been included in the draft Scoping Plan. Still, we think that quantifying the co-benefits of these measures is instructive in the sense that they are indicative of the co-benefits of other global warming solution investments that could come from a well-designed cap-and-trade program.

7. Overview of co-benefit analysis, quantitative and qualitative

Before going into detail regarding what we've done on the co-benefits of global warming solutions, we offer some examples in order to make the notion more concrete. Urban forestry, which sequesters carbon in trees, counters the urban heat island effect (which in turn reduces electricity demand for air-conditioning) and helps to control flooding. Measures to shift transportation from private to public modes—an element of “smart growth” strategies—reduce traffic congestion and associated time lost, which decrease associated losses in economic productivity. Renewable energy provides a hedge against gas and coal price increases, and indeed it reduces demand on these commodities and associated upward price pressure. It also offers clean-air benefits—a focus of this paper.

We look as well at California's surging clean-tech industries and investigate the innovation co-benefits that could result from concentrating on key sectors. And we survey some statistics from the research literature to explore findings on innovation and public policy.

In our quantitative analyses of co-benefits we focus on reduced emissions of two important air pollutants, nitrogen oxides (NO_x) and particulate matter (PM). Sulfur-dioxide emissions, not as large a problem in California as they are in other parts of the country, are mostly due to coal combustion, and most of the coal we consume is in the form of electricity imported from outside the state.

In addition to co-pollutant reductions, we estimate energy savings attributable to efficiency measures and the avoided costs of achieving co-pollutant reductions through other mitigation measures. We describe in more detail below our quantitative approach to estimating clean-air benefits, energy savings, and avoided costs.

The large impacts on health and their particularly unjust distribution across the population make air quality a particularly compelling element of the co-benefit issue. In fact, there seems to be rather broad agreement that air-quality-related co-benefits are among the most important. Air pollution has multiple deleterious impacts, including damage to public health, concomitant costs of treatment, reduced worker productivity because of illness (and related decreases in economic growth, both because of lower productivity and the diversion of resources to health care from other productive uses), and reduced student performance because of illness (together with related future damage to productivity and economic growth).

We don't try to directly estimate these related effects of worsened air pollution, though we hope in the future to continue advancing the knowledge frontier in this regard. Meanwhile, others who have looked at the problem of air pollution have found the costs to be huge. We mention, for example, CARB's estimate of \$71 billion in annual health costs linked to air pollution, and this was before its recent and dire finding on the health effects of exposure to particulate matter (CARB 2007A). In a column posted on Forbes.com in March 2008, CARB Chair Mary Nichols suggests that the public health benefits of pollution controls could exceed their cost by a four-to-one ratio.

“Industry has fought us,” she wrote, “on most all of our major regulations, decrying that the economic impacts of our rules outweigh the project benefits to public health. Over the long haul, however, we have consistently found that claim to be false. A 2004 report to Congress found the benefits of air pollution control between 1993 and 2003 exceeded its costs by two to six times, or by an average of four times. Assuming

that the same ratio applies to California, the benefits of pollution control in the last 40 years would be approximately \$340 billion, or 4 times the cost of \$85 billion... We have also found that our regulations spur companies to invest in more research and development, and in many cases result in new pollution-control patents and products.” (The report that Chair Nichols cites is “Progress in Regulatory Reform: 2004 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities” by the U.S. Office of Management and Budget.)

8. Quantitative Analysis of Co-Benefits: Improved Air Quality

This section documents our efforts to quantify the co-benefits of three types of global warming solution investments: increased use of renewable energy; increased water efficiency; and electricity-sector efficiency measures. For each of these measures, we provide a table below that summarizes the ancillary benefits and a more detailed description of our methodology in the Appendix. All monetary values are reported in 2007 dollars unless otherwise noted. In many cases, substantial uncertainty exists with respect to these quantified estimates. To avoid the illusion of precision, we limit ourselves to two significant figures.

In addition to avoided emissions of NO_x and PM, we also estimate the value of energy savings (for efficiency measures) and the “avoided cost of alternative controls.” The value of energy savings is fairly straightforward to see as a co-benefit; less energy consumed, after all, means that less energy must be purchased. The co-benefit category of “avoided cost of alternative controls” refers to monetary savings that can be inferred from not having to install other mitigation measures to improve air quality. The Appendix further defines these terms and describes the methods used to approximate their future value.

The first global warming solution investment we consider is an increased reliance on renewable energy. We rely on work from the Center for Resource Solutions (CRS) on implementation of a 33-percent Renewable Portfolio Standard (RPS), together with California Energy Commission load forecasts, to develop our quantification of the ancillary benefits. We present the co-benefits implied by this increased utilization of clean energy in Table 1.

Table 1: Increased Use of Renewable Energy (equivalent to 33-percent RPS)

Estimates for year 2020 alone			
GHG benefit	13 MMTCO ₂ e		
Cost	Uncertain		
Value of energy savings	N/A		
Co-benefit type	Range of emission factors		
	CAT***	E3 low	E3 high
Metric tons of NO _x	530	3700	730
Metric tons of PM ₁₀	160	400	210
Avoided cost of alternative controls**	\$22M	\$100M	\$30M
Estimates of cumulative co-benefits, 2012-2020			
GHG benefit*	52–69 MMTCO ₂ e		
Cost	Uncertain		
Value of energy savings	N/A		
Co-benefit type	Range of emission factors		
	CAT	E3 low	E3 high
Metric tons of NO _x	2,100	15,200	3,000
Metric tons of PM ₁₀	2,100	5,400	2,900

Sources: CRS (2005), CAT (2007A), BLS (2008), and UCS calculations, as explained in the Appendix.

*This range reflects uncertainty as to when the 20-percent RPS will be met. The smaller estimate assumes 2013 while the larger assumes 2010. All other values in this table are based on the 20-percent RPS being met in 2013.

** Climate Action Team estimates of avoided cost (CAT 2007A)

*** CAT = Climate Action Team; E3 = Energy and Environmental Economics, Inc.

In the Appendix, we discuss estimates from Energy and Environmental Economics, Inc. (E3), CRS, and the Climate Action Team (CAT) of the incremental cost of achieving the above additional renewable energy-generation capacity. Substantial uncertainty exists regarding the values that have been put forth thus far.

To reduce the potential for overstating criteria-pollutant-emissions reductions, we have eliminated the NO_x and PM₁₀ emissions reductions and the avoided costs of alternative controls associated with biomass- and biogas-fired renewables. Biomass- and biogas-generating units emit NO_x and PM₁₀, and the extent to which they are part of a 33-percent renewable system will have important criteria-pollutant effects. On-site biogas-generating units, such as those located next to methane-digester facilities to utilize the captured gas, emit relatively more NO_x than a centralized generating unit. A different option for utilizing such gas involves aggregating it for combustion at larger, more efficient, and cleaner-burning units.

Using E3's "Greenhouse Gas Calculator" (its heat-trapping emissions modeling program) developed for the California Public Utilities Commission and made available for public use, approximately 26 percent of the global warming emissions reductions associated with a 33-percent RPS come from biomass and biogas. We chose to reduce our NO_x and PM₁₀ emission reductions and avoided costs of alternative controls by 26 percent in an effort to take these emissions into account. Actual criteria-pollutant

reductions may be larger or smaller, depending on which types of biomass and biogas facilities are constructed.

Next, in Table 2, we summarize our estimated co-benefits of increased investment in water efficiency. Roughly 20 percent of the state’s electricity consumption and 30 percent of its natural gas consumption are attributable to the water system (CEC 2005, p. 8);¹² energy is used to transport, treat, distribute, and heat water. We built our estimates on Department of Water Resources analyses, as explained in greater detail in the Appendix. Note that the values presented in the table are order-of-magnitude estimates at best—there is significant uncertainty regarding the energy-intensity-of-water value used in this analysis and by the CAT update. We discuss this uncertainty further in the Appendix.

Table 2: Increased Water-Efficiency Strategy

Estimates for year 2020 alone			
GHG benefit	3.3 MMTCO ₂ e		
Cost*	\$310 million (M)		
Value of energy savings	\$1,200 M		
Co-benefit type	Range of emission factors		
	CAT	E3 low	E3 high
Metric tons of NO _x	190	1,300	260
Metric tons of PM ₁₀	190	480	260
Avoided cost of alternative controls**	\$8.2 M	\$39 M	\$11 M
Estimates of cumulative co-benefits, 2012-2020			
GHG benefit	23 MMTCO ₂ e		
Cost*	\$2,200 M		
Value of energy savings	\$8,100 M		
Co-benefit type	Range of emission factors		
	CAT	E3 low	E3 high
Metric tons of NO _x	1,300	9,300	1,800
Metric tons of PM ₁₀	1,300	3,300	1,800

Sources: CAT (2007A), BLS (2008), DWR (2005), and UCS calculations, as explained in the Appendix.

* Costs of water-efficiency measures include direct investments by the local water agency, investments by CALFED agencies through grants, and additional investments by local water agencies leveraged by grants from CALFED agencies.

** Climate Action Team estimates of avoided cost (CAT 2007A)

Finally, we generated energy-efficiency savings estimates for the electricity sector using version 2b of the E3 Greenhouse Gas Calculator (E3 2008). The model was run under the aggressive policy scenario—what E3 calls the “33-percent RPS/High Goals Energy Efficiency” scenario—that includes investor-owned utility programs, the California Public Utility Commission’s Big Bold Energy Efficiency Strategies, the Huffman Bill for energy-efficient lighting (AB 1103), state building standards, and

¹² This is a gross measure of electricity use that does not reflect the electricity generated by water flowing downhill in California’s water-distribution system.

federal efficiency standards (for clothes dryers, dishwashers, and heating and cooling units). Table 3 presents our findings regarding the co-benefits implied by the E3 work.

Table 3. E3 Evaluation of Electricity-Sector Efficiency Measures

Estimates for year 2020 alone			
GHG benefit	10.2 MMTCO ₂ e		
Cost*	\$1.6 billion		
Value of energy savings	\$1,500 million (M)		
Co-benefit type	Range of emission factors		
	CAT	E3 low	E3 high
Metric tons of NO _x	370	2,600	500
Metric tons of PM ₁₀	370	920	490
Avoided cost of alternative controls***	15	72	20
Estimates for cumulative co-benefits 2012-2020			
GHG benefit	Not calculated		
Cost*	\$9,400 M **		
Value of energy savings	\$8,700 M		
Co-benefit type	Range of emission factors		
	CAT	E3 low	E3 high
Metric tons of NO _x	2,200	15,000	3,000
Metric tons of PM _{10t}	2,200	5,500	2,900

* Utility energy-efficiency costs include administrative costs to run the program, utility program costs, and capital costs to customers. They do not include incentive payments to customers, as these are transfer payments and do not increase the economy-wide cost of energy efficiency.

** Because the E3 model provides forecasts for years 2012 through 2020, the cumulative values in this table apply just to that period. The E3 model reports customer costs, however, for 2020 only. Customer costs for years 2012 through 2019 were estimated by assuming that the ratio of utility costs to customer costs remains constant over time.

*** Climate Action Team estimates of avoided cost (CAT 2007A)

9. Innovation Co-Benefits from Limited Offsets

To address the climate crisis in a way that improves quality of life and maintains broad political support for reductions in global warming pollution, innovation will be critical. And enlightened policies in general, including challenging regulation (such as cap-and-trade regulation) in particular, can contribute to innovation. They play an important role in forcing creative industrial problem-solving and the transformation of markets.

California is uniquely positioned to be a leader in clean technologies, lower their future costs, and gain a competitive advantage in a booming global market. California attracted \$1.8 billion in clean-energy venture capital last year—more than all of Europe combined. The interest is intense enough that it has been sustained even in the face of the current economic slowdown.¹³

Limiting compliance offsets maintains the innovation-forcing capacity of cap-and-trade within capped sectors. That is because unrestricted offsets have the effect of reducing the emission reductions required; they spread out the mitigation effort, either to other sectors or to other geographic areas. In other words, offsets weaken the effect of cap-and-trade on capped sectors. At the extreme, unlimited offsets and weak complementary policies could even allow emissions to *rise* in capped sectors. But sufficient offset limits ensure that investment will flow to clean technology and that costly lock-in to polluting technology will be avoided. We note that our position is based in part on the achievability and affordability of the AB 32 reductions in California, as well as on the state's comparative advantage in clean tech.

We need look no further than clean-tech entrepreneurs and venture capitalists (VCs) for evidence in support of limited offsets as a spur to innovation. Fifteen clean-tech firms, including most of the state's major solar-power companies, have endorsed a statement of support for limited compliance offsets and submitted it to CARB. The statement (included in Appendix B of this report) reflects the view that limiting compliance offsets can spur investment and help to realize lower long-run costs. The group Environmental Entrepreneurs supports limits on compliance offsets as well.

And venture capitalists themselves strongly support the idea that the incentives created by challenging policies are important to clean-tech development. A survey of leading VCs found that:

- The second most important reason why VCs are motivated to invest in California's clean-tech industry is the state's regulatory climate. (The primary reason is entrepreneurial culture and management talent.)
- Among the VCs surveyed, 79 percent say that California's current regulatory climate is a factor in their clean-tech investment decisions.
- According to 91 percent of the VCs, advancing California's environmental public policies would be a driver for new investment in the state's clean-tech industry.¹⁴

¹³ Gronewold, N. 2008. "Renewable energy: Venture capital keeps industry humming in credit crisis." *Greenwire* (April 4)

¹⁴ Environmental Entrepreneurs. 2004. "Creating the California Cleantech Cluster: How Innovation and Investment Can Promote Job Growth and a Healthy Environment" (September).

California's unprecedented portfolio of clean-energy venture-capital investments can surely be traced in part to the passage of AB 32. But expectations about the future shape of the market also play a crucial role. If policies and regulations under the law are not sufficiently challenging to redirect our economy, we might lose this opportunity to capitalize on the state's clean-tech potential.

In essence, we are suggesting that limits on offsets will support the continuance of clean-tech investment trends in California. There are three mechanisms in particular by which limited offsets can produce innovation co-benefits for the state: (1) lower future costs because of the learning-by-doing and economies of scale that are driven by higher investment; (2) improvement in California's competitive advantage in the clean-tech market; and (3) avoiding further capital investment in and lock-in to high-emitting technologies that would prove costly to replace in the long run. We discuss these mechanisms in turn below.

What Can We Learn from Research on the Role of Policy for Demand Pull?

The research of University of California Professor Margaret Taylor and, more broadly, the innovation and public policy literature, underscore the dual importance of encouraging "technology-push" (research and development) and "demand-pull" (market incentives) through effective policy making. "A relatively high degree of regulatory stringency appears to be a necessary condition for inducing higher degrees of innovation," says Taylor. And "a combination of policy instruments—both 'technology push' and 'demand pull'—will offer the greatest chance of successfully inducing the innovation to meet [California's] 2050 GHG emission target" (Taylor 2006, pp. 3-27).

Demand-pull, which occurs when policy changes the economic position of a new technology in the marketplace, can take a variety of forms: incentive payments, performance standards (for appliances, lighting, buildings, and transportation fuels, for example), and portfolio standards (such as California's renewable electricity standard). Energy-efficiency standards for refrigerators, and consequent advances in that technology over time, provide an example of demand-pull in action. Dr. Jim McMahon (2007)¹⁵ illustrates the dynamic effect of six different levels of California and federal standards, each in turn ratcheting down the appliance's average energy use for new models sold. Pointing to an annualized five-percent growth in energy efficiency over 27 years, McMahon shows that significant gains in efficiency coincided with increases in size and decreases in cost for the average model. Such improvements belie the conventional economic wisdom, offered by Stavins et al. (2006) and some other economists,¹⁶ that regulatory interventions will have serious hidden costs associated with consumer dissatisfaction.

The energy-efficiency standards group at Lawrence Berkeley National Laboratory offers numerous instances of demand pull in action. Busch et al. (2000), for example, explore the role of rebates in the market shift toward a more efficient technology part

¹⁵ This is from a presentation at the 2007 Berkeley Energy Symposium, <http://berc.berkeley.edu/symposium2007/presentations/6-%20Innovation%20Sessions%20II/Carbon%20Regulation/2007-0321-McMahon-DRAFT.ppt>, accessed April 25, 2007.

¹⁶ The CGE model from Charles River Associates implicitly rejects the possibility that regulatory policies can produce positive economic net benefits.

from the previous conventional technology (e.g., electronic ballasts over magnetic ballasts in fluorescent lights).

No one has done more to investigate how cap-and-trade programs have performed in driving innovation than Prof. Taylor, though she has found that they have a mixed record in this regard. “Cap-and-trade programs in the past have not proven as effective in inducing innovation as proponents might have wished,” she says (Taylor et al. 2006, pp. 3-28). Taylor’s work suggests that lower-than-expected allowance prices, indicative of a lack of environmental stringency—i.e., not very ambitious emissions reductions in light of existing technological potential—is likely to slow the rate of innovation. In contrast, challenging policies that demand a fundamental departure from business as usual and foster creative problem solving can contribute to the transformation of markets. This is the path to the low-carbon future. Cap-and-trade is potentially such a policy, and its demand-pull mechanism can help to create effective price signals and produce the required emissions reductions. Offsets, by contrast, weaken the demand-pull that cap-and-trade produces on capped sectors. They lower the emissions reductions demanded of these sectors and they lower the price signal, thereby diminishing the advantage to clean tech.

The primary challenges of the climate crisis are fossil-fuel combustion and the transition to a sustainable energy infrastructure. Because investment flows respond both to present market conditions and expectations about the future, current policy should prioritize renewable energies and efficiency, as energy infrastructure is long-lived. For example, recent research from Lawrence Berkeley National Laboratory (Barbose et al. 2008) finds that relatively low expectations about future carbon prices are inhibiting clean-energy investment across the western United States.

Meanwhile, increased installation and use (market penetration) of existing clean technologies offer technological co-benefits through productivity gains, cost improvements from learning by doing, and possibly economies of scale as production is ramped up. In one study of such effects, the International Energy Agency IEA (2000) found cost improvements of 3-35 percent after a doubling of installed capacity of new electricity-generation technologies such as wind, solar, and biomass (though these figures did not account for selection biases that could occur from ignoring technologies that fail).

Learning by doing and scale economies can be lost if we divert investment from renewables and efficiencies, especially if the investment goes to out-of-state reductions. Therefore limited offsets can yield innovation co-benefits by retaining such improvements.

Efficiency as a Renewable Resource; Competitiveness and the Porter Hypothesis

California has led the nation on energy efficiency since the 1970s, and it presently boasts clean-energy activity from north to south. Moreover, efficiency should continue to play an important role in the state, not only in its management of heat-trapping but also in its economy. The notion that the progress made in past years indicates that we cannot continue to innovate is proved wrong by McMahon’s finding that the succession of standards and practices over time can yield consistent performance improvement.

CARB has identified many measures with net benefits that should play a role in AB 32-mandated reductions. Above we analyzed some of these measures, including their co-pollutant benefits and the costs of alternative air-pollution controls foregone. At the

national level, efficiency-based no-regrets measures (actions that yield more monetary savings than imposed costs due to investment in improved capital) account for about 40 percent of reductions, according to McKinsey and Company's analysis of its middle-of-the-road emissions-reduction scenario for the nation (McKinsey and Company 2007). Recent commodity-price increases further raise the value of energy savings generated by improved technologies.

At a more micro scale, the firm level, numerous studies of businesses implementing global warming emissions-reduction strategies show that the realized energy efficiencies result in rapid payback periods and gains in profitability. California-based Cisco Systems is saving \$5.75 million annually from its investments in efficiency.¹⁷ Bentley Prince Street, California's largest carpet manufacturer, saved some \$3.8 million in 2005 thanks to the company's efforts to reduce global warming emissions.¹⁸ Says its Director of Sustainability Judy Pike: "Being leaders in solving global warming has also made our company more competitive and better able to withstand rising energy costs. Reducing waste has saved us so much money, it has enabled us to invest in new and innovative projects."¹⁹

Next 10's *Green Innovation Index* (2008), which has traced the macro effects of efficiency policies for California, shows that the state has joined robust economic growth with declining per-capita energy use and emissions. According to University of California researchers: "From 1970 to 2004, California decreased its annual residential energy consumption by 35 percent while other states increased. Alternative explanations, including weather, income, prices, and economic structure, account for at most 15 percent" (Chong and Hanemann 2007). Because our currently energy system relies substantially on imported resources, when we shift our spending away from energy we purchase a higher proportion of goods and services produced in the state. And this yields a boost to the California economy. Energy is only a means to an end, and when we devote less money to it we have more left over to put toward other productive uses.

Next 10 shows how California has reduced its energy use in comparison to other parts of the United States. Though the state's electricity prices are somewhat higher, it actually spends less on energy. The average residential electricity bill in Texas, for example, is twice that of California. On a statewide basis, Texas' electricity bill amounts to 3.24 percent of state income, compared to 1.79 percent in California. This difference of 1.45 percent amounts to \$24.7 billion in direct savings, not counting the boost from greater economic activity that follows from spending the money in-state, as opposed to exporting it to energy suppliers (e.g., for natural gas). A study by the RAND Corporation (Bernstein et al. 2000) found that California's per-capita income in 1995 was between \$875 and \$1300 higher (in 1998 dollars) because of energy-efficiency programs implemented by the state from 1977 onward. Put differently, the study found that in the absence of its efficiency programs, the California economy would have been three percent smaller in 1995.

¹⁷ The Climate Group. 2006. "California: Low Carbon Leader: Business and Job Growth Opportunities" (April).

¹⁸ Madsen, T. and B. del Chiaro. 2006. "Greening the Bottom Line: California Companies Save Money by Reducing Global Warming Pollution." Environment California Policy and Research Center (August).

¹⁹ Ibid.

Such results support the thinking of Michael E. Porter, university professor at the Harvard Business School. According to the Porter Hypothesis, stringent environmental policies can motivate firms to evaluate their operations, become more efficient and innovative, and thus increase their competitiveness relative to unregulated firms. His view is that pollution is indicative of “inefficient or incomplete utilization of resources or [of] resources not used to generate their highest value.”²⁰ From this perspective, pollution is not only harmful to public health and our quality of life, it is also bad for business. Pollution represents waste. By limiting offsets and consequently advancing efficiency, California can improve the competitiveness of enterprises throughout its private sector.

Building on Historical Success, Nurturing Emerging Clusters

California has vibrant clean-tech clusters from north to south. In fact, the *Green Innovation Index* published by Next 10 shows green establishments in almost every county of the state (Next 10 2008, p.49). Next 10’s study of innovation found that California accounted for 44 percent of all solar patents and 37 percent of all wind patents in the United States in 2007; since 1990, the roster of green business establishments in the state has grown by 84 percent while doubling the number of workers employed (Next 10 2008). There has been growth in markets for green vehicles, lighting, and buildings, but perhaps most impressive has been the explosion of interest in clean energy sources—solar, wind, and biofuels.²¹ The global market for clean energy increased from \$55 billion in 2006 to \$77 billion in 2007 (including project finance and research and development, the growth was from \$93 to \$148 billion). Moreover, these figures are an extension of trends from recent years that show signs of continuing.

The trends are likely to continue because clusters drive economic development (Krugman 1999); they enjoy the increasing returns that result from information sharing and spillovers. One might posit that modern information technology has made location increasingly irrelevant, but there is substantial evidence to the contrary. Recall the clusters that emerged, with Silicon Valley at the heart, in the course of the Internet revolution. Even at Google, physical proximity outweighs electronic connectedness, according to a study of information flows at the firm: “Even at an Internet company, information travels fastest on the ground” (Cohen 2008).

Notably, any one cluster may further subdivide itself into specialized nodes. According to the *New York Times*: “Silicon Valley, the wellspring of the digital technologies fueling globalization, is itself a collection of remarkably local clusters based on industry niches, skills, school ties, traffic patterns, ethnic groups, and even weekend sports teams” (Lohr 2007). The phenomenon by which clusters support economic growth

²⁰ Esty, D.C. and M.E. Porter. 1998. “Industrial Ecology and Competitiveness: Strategic Implications for the Firm,” *Journal of Industrial Ecology* 2:35-43

Esty, D.C. and M.E. Porter. 2001. “Ranking National Environmental Regulation and Performance: A Leading Indicator of Future Competitiveness?” Chapter 2.1. in *The Global Competitiveness Report 2001-2002*: New York: Oxford University Press.

Porter, M.E. and C. van der Linde. 1995. “Toward a New Conception of the Environment-Competitiveness Relationship.” *Journal of Economic Perspectives* 9:97-118.

²¹ Only certain biofuels would fall into a clean-energy category; they are not necessarily low in heat-trapping emissions or other damaging environmental impacts (e.g., deforestation, degraded water quality from agrochemical runoff).

is not limited to clean tech or to California. Consider the fashion industry in New York, Paris, and Milan, for example, or China, where factory towns have sprung up around particular products such as ties, underwear, sweaters, kids' clothing, wedding dresses, jeans, and socks (Barboza 2004).

The fastest growing clean-energy source is solar energy, which has been doubling its worldwide output every two years; in 2007 alone, 2.3 GW of PV were installed (Gardiner and Madhok 2008). New Energy Finance finds that there was \$28.6 billion in solar installation in 2007 and that annual growth since 2004 has been 254 percent.

The greatest excitement actually surrounds PV's counterpart, thermal solar power, whose growth was heralded in a recent *New York Times* story headlined "A Green Energy Industry Takes Root in California."²² The state's thermal solar industry has added thousands of jobs; for example, Foster City's SolarCity, an installer of solar rooftop units, has grown to 215 employees and \$29 million in sales since being founded in 2006. Also consider the company's announcement that it plans to build one of the world's largest solar thermal projects on warehouse rooftops in Los Angeles. When completed in 2010, it should generate enough electricity to power 162,000 homes.

Many leaders of the Internet revolution in Silicon Valley have turned to the challenge of clean energy. Vinod Khosla, cofounder of Sun Microsystems, is part of a consortium that recently invested \$50 million in ethanol startup Altra, based in Los Angeles. In July 2006, Carpinteria-based Clipper Windpower signed a \$30-million wind turbine supply contract (with an option for a second \$30-million installment) with BP Alternative Energy. Upon completion of the deal, shares of Clipper Windpower increased in value by 33 percent.²³

An example from the air-pollution-control industry—another segment of the broad clean-tech sector—is Catalytic Solutions, Inc., of Oxnard, California. CSI designs and manufactures advanced catalysts that lower the cost and extend the life of catalytic converters for vehicles and stationary motors. The firm employed 140 people as of 2004. Tim Truex, CSI's vice president for new business development, explains his firm's locational decision: "California leads the nation in emissions regulations, and new regulation accelerates technological development. Here in California, we are right in the middle of it."²⁴

One need not rely only on current activity or projected future gains to understand the potential for clean technology. There is historical evidence that environmental initiatives have been good business for California. For example, the state's air-pollution-control industry generated \$6.2 billion in revenues in 2001, employed 32,000 Californians, and experienced an annualized growth rate of nine percent over the period 1972–2001 (Killion 2004). The California renewable energy sector employs more than 170,000 people and 175 California companies export goods and services related to the generation of renewable energy.²⁵

²² Richtel, M. and J Markoff. 2008, *New York Times* (February 1).

²³ Clipper Windpower Website: http://www.clipperwind.com/pr_073008.html.

Reuters. 2006. "BP buys U.S. wind firm Greenlight Energy" (August 15).

²⁴ Environmental Business International. 2004. "The Economic Contribution of the California Air Pollution Control Industry" (October).

²⁵ Ibid.

An overly permissive offset policy, however, would unduly weaken the innovation-promoting potential of climate policy and thereby fail to maximize the emergence of clean-tech clusters.

Summing Up on Innovation Co-Benefits

Burtraw warns that in assessing induced innovation, it is important to consider the diversion of resources involved—the anticipated gains from one use weighed against the opportunity cost (the benefit foregone) from not directing the resources to an alternative use. In other words, he suggests that we ask: What else would the investment money have gone to? This question is more compelling in a global sense, as opposed to a narrower California perspective. After all, is it reasonable to expect that much of the of the \$1.8 billion that California gained in venture capital in 2007 would have been invested in other parts of the state if it had not gone to clean-energy ventures? Probably not. It seems more reasonable to suppose that this is investment that California would not have otherwise received.

By limiting offsets, we can gain innovation co-benefits, maintenance of sufficient demand-pull that encourages continued investment, and gains from learning by doing and economies of scale. By giving innovation a high priority, we can exploit this moment in time when the world is looking to California for clean-energy solutions.

10. Encouraging the Voluntary Market

This report has focused on compliance offsets, which involve legally mandated actions. But some “good actors,” whether individuals or businesses, want to go further than what may be possible within their own household or commercial operations, and this is where *voluntary* offsets have a role to play. We support the development of a robust and reliable voluntary market so that those that wish to go beyond what the law requires are able to do so with credible and verified offsets.

A first step in going beyond legally required minimum standards should involve an internal assessment, followed by steps to reduce waste and enhance efficiency. But while such modifications to directly reduce emissions are effective, they can only go so far. The term “carbon neutral” refers to people or firms that purchase voluntary offsets to counter the emissions they are unable to avoid through behavioral change.

Nationwide, voluntary purchases have been an important impetus for growth in clean energy. Therefore we support designing cap-and-trade in such a way that it will bolster the voluntary renewable energy market. For instance, allowances should be retired and taken out of circulation on behalf of reported voluntary sales in order to recognize the carbon-reduction value of this renewable energy. Prior to the allocation of any allowances, projected voluntary demand for RECs, renewable electricity, or the output from on-site distributed renewable generation should be reported and megawatt-hours converted to tons of avoided carbon. That quantity of allowances should then be removed from the entire pool of allowances available. This procedure has come to be known as an “off the top” approach to providing incentives for voluntary clean-energy purchases within cap-and-trade programs.

11. Conclusion

No one has yet produced an analytical basis for identifying the optimal limits on compliance offsets, partly because of the difficulty of taking the co-benefits of global warming solutions into account. In this paper we have sought to provide insights into these valuable co-benefits and in the process shed some light on the tradeoffs that offsets present—in particular for the AB 32 implementation process.

Focusing in our quantitative work on a small set of clean-energy and energy-efficiency measures, we have seen that they offer significant reductions in the most damaging air-pollutant emissions—some of the nation’s highest levels—that are taking place in California. We are thus encouraged by CARB’s stated interest in taking a comprehensive approach to addressing this pollution—which causes global, regional, and local air-quality problems—by addressing it at the source.

We have also explored innovation co-benefits. Though this was a more qualitative look, we did discuss some quantitative aspects of the state’s surging clean-tech industries. As noted, the progress to date and the potential suggested by current trajectories are nothing short of astounding. California captures more venture-capital investment than virtually any other area of the world, and the amount is steadily increasing from year to year. As a result, there are high rates of job creation in the state, and it has the entrepreneurial culture that can produce the innovations needed.

The continuation of these trends would be aided by carefully designed limits on compliance offsets for cap-and-trade systems, but the recommendation in CARB’s draft Scoping Plan allows for too large a role for such offsets. The suggested limit fails to ensure that cap-and-trade will produce *any* reductions in the capped sectors, which should be the primary targets. Less permissive limits, on the other hand, would promote the capture of ancillary benefits for the residents of California and WCI jurisdictions, avoid lock-in to long-lived fossil fuel combustion technologies, and ensure that meaningful reductions in the short- and mid-terms would put us on the path to much deeper reductions over the long term.

Given its reputation, track record, and potential for the future, the world is looking to California not only to advance clean technologies but in the process help catalyze international cooperation in managing global warming—the greatest environmental challenge of our time. Will we rise to the challenge or will we shirk it, thereby squandering a great opportunity? Our future prosperity, and indeed our capacity to respond to the global warming problem, hang in the balance. California has led in the area of environmental progress before by pushing the boundaries of policy and technology, and the state has benefited from it, both economically and in the form of a cleaner environment. Now is the time to demonstrate such leadership once again.

California can show this country and the world that the transition to a clean-energy future—especially one that offers a wide range of environmental and economic benefits—is possible. CARB should help seize this opportunity by reconsidering its suggested offset policy, which is overly permissive and downright counterproductive.

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Appendix: Summary of Calculation Methodologies and Sources

In this appendix, we describe in greater detail our approach to co-benefit quantification. We discuss our approach to estimating co-pollutant reductions; the monetary value of electricity savings; the monetary value of avoided alternative methods for pollution control; pollutant reductions from, and costs of, increased use of renewable energy; and the effects of increased efficiency regarding both water and energy.

A.1. Co-Pollutant Emission Factors

The question of what emission factors to use is complicated because electricity-generation technologies are highly heterogeneous in their criteria-pollutant emissions, much more so than in their carbon-dioxide emissions. Generating units are of different vintages and have had different post-combustion controls installed. Such post-combustion technologies do not exist at this time for carbon dioxide.

The heterogeneity of generating units means that actual emissions reductions associated with a particular efficiency measure will be highly dependent on which unit is being shut off. This in turn will be a function of time of day, weather, load (the amount of electricity being produced at any particular moment), what units may be out for maintenance, and the reality of the human factor in dispatch decision making.

Another complication in estimating co-pollutant reductions from efficiency measures is the RECLAIM program in California's South Coast Air Management District. It is reasonable to expect that reductions of NO_x emissions from electricity-generation facilities regulated under RECLAIM would free up NO_x emissions allowances that could allow increases at other point sources.

Given the technological mix and regulatory environment in California, it is widely assumed that the electricity-generating unit on the margin—the one that will be turned on or shut off to match fluctuating demand (load)—is a natural gas unit. We use four different emission values in our quantitative co-benefit estimation, as detailed in Table A-1 below. Emission factors from the CAT Macroeconomic Update (CAT 2007A) assume that the avoided emissions are due to a new modern natural gas plant—in particular a natural gas-fired combined-cycle turbine meeting Best Available Control Technology standards—not being built or being run less.

Energy and Environmental Economics, Inc. (E3) is a consulting firm responsible for modeling global warming emissions policy analysis for the California Commission. E3's work on criteria-pollutant emission factors is based on its survey of 15 natural gas combined-cycle units in California, which it categorizes into two groups: the dirtiest (low-efficiency) and cleanest (high-efficiency) plants (E3 2006). We use the emission factors E3 has developed for low- and high-efficiency plants so that we may demonstrate potential co-pollutant reductions. The low-efficiency unit emits substantially more criteria pollutants than do today's best technologies.

While a major assumption of the CAT report—that avoided emissions due to avoided electricity generation will take place at cleaner plants that meet the most stringent standards—is a plausible scenario, it could also be that emissions reductions will take place to some extent through reducing generation at existing facilities that have higher levels of criteria-pollutant emissions. The extent to which reductions take place

through new generation facilities that do not have to be built, as opposed to reductions at existing facilities, will largely be decided by future policy decisions.

Today we do not know the extent to which emissions in the electricity sector will be further reduced below current levels and how this would be achieved—i.e., with what mix of measures and technologies. If the electricity-generating sector is required to make substantial reductions by 2020, it is reasonable to expect that some of them would be achieved by reducing emissions at existing dirtier plants.

Table A-1: Criteria-Pollutant Emission Factors (kg/MWh)

	NO_x	PM₁₀
CAT Macroeconomic Update (CAT 2007A, p. 14)	0.018	0.018
E3 Low-Efficiency NGCC Plant (E3 2006)	0.125	0.045
E3 High-Efficiency NGCC Plant (E3 2006)	0.025	0.024

A.2. Valuing Energy Savings

In estimating energy savings due to efficiency measures, the value of avoided electricity generation can be computed as a combination of the quantity of electricity saved and the assumed future price.²⁶

Dollar savings associated with avoided energy use (both natural gas and electricity) were based on values presented in the CAT update, which in turn were calculated with the current California Public Utilities Commission (CPUC) avoided-cost model (E3 2006).²⁷ The avoided-cost model assumptions used in the CAT Update (CAT 2007A, p.16) were:

- Natural gas combined-cycle generating unit with a heat rate of 7,000 Btu/kWh
- Natural gas price forecast from the California Energy Commission’s 2005 Integrated Energy Policy Report (IEPR)
- No inflation (all of the analysis was done in real 2006 dollars)
- No externality costs (considered elsewhere in CAT’s analysis).

Avoided costs were generated for the three Investor Owned Utilities (IOUs) that provide electricity, and “the individual IOU results were weighted by sales volume for each of the 8,760 hours to produce three standardized sets of statewide prices” (CAT 2007A, p.16). Table A-2 presents the avoided-cost values for energy efficiency used both in this analysis and in the October 2007 CAT Update.

²⁶ Such an approach leaves aside the question of the extent to which efficiency can also lead to savings in not just the marginal cost (i.e., the value of avoiding having to produce an extra unit of electricity from a given electricity-generation system) but also in fixed costs. Efficiency, after all, can reduce the need to build new power plants (which represent fixed costs). Not considering such costs in the effects of efficiency is a cautious way to estimate the value of electricity savings—it will tend to bias the estimated value of savings downward.

²⁷ The avoided-cost model estimates a long-run marginal cost for power generation, together with externalities costs (criteria pollutant and GHG emissions), transmission and distribution costs, and reliability costs.

Table A-2: Avoided Costs for Electricity and Natural Gas (CAT 2007A, p. 17)

Year	Electricity (2006\$/MWh)	Natural Gas (2006\$/MMBtu)
2007	\$110.88	\$8.17
2008	\$99.85	\$6.55
2009	\$98.90	\$6.45
2010	\$87.14	\$5.25
2011	\$100.07	\$6.56
2012	\$95.49	\$6.09
2013	\$106.10	\$7.15
2014	\$99.01	\$6.42
2015	\$106.69	\$7.20
2016	\$106.12	\$7.13
2017	\$105.25	\$7.03
2018	\$108.55	\$7.36
2019	\$111.85	\$7.69
2020	\$111.82	\$7.69

Using the avoided costs in Table A-2 above leads to conservative estimates of the savings due to energy-efficiency measures. The values are based on an IEPR natural gas price forecast, which was adopted by the CAT for use in the update. The recent history of such forecasts is one of consistent underestimation (Bolinger and Wiser 2008). The same holds true for avoided cost of electricity generation and retail power price forecasts. In fact, the 2007 IEPR omitted an updated forecast because:

“Most retail price forecasts are simply current rate structures projected out over time and applied to forecasted changes in operating costs. The process of developing the 2007 IEPR retail price projection experienced the same oversimplification that plagued the 2003 and 2005 IEPR cycles. Although virtually all utility submittals to the Energy Commission call for real retail prices to fall, these forecasts do not consider the cost of infrastructure improvements and are based on extremely optimistic assumptions about the price of natural gas” (CEC 2007B, p.81).

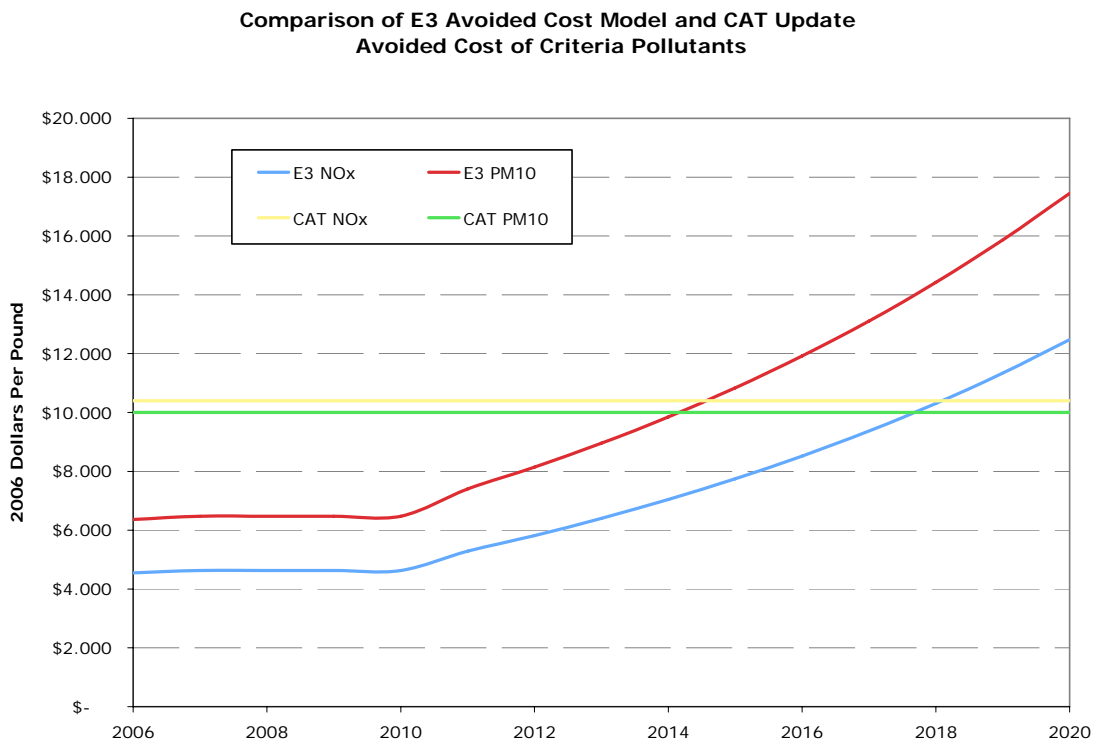
Therefore we feel confident that these estimates are conservative and do not overestimate the value of energy savings. Future savings due to energy-efficiency investments associated with this strategy are likely to be larger than the savings reported in this document.

A.3. Avoided Cost of Alternative Mitigation Approaches for NO_x and PM

To estimate the value of avoided alternative approaches to controlling NO_x and PM, we used data from the Climate Action Team that suggested a cost savings of \$20,800 per short ton of NO_x reduced and \$20,000 per short ton of PM₁₀ reduced (CAT 2007A, p.22). These values were then converted from 2006 dollars to 2007 dollars, using a GDP-based inflator index for 2007 over 2006 that was equal to 1.0266 (BLS 2008).

The E3 and CAT approaches to avoided cost of alternative controls are highly divergent. The CAT takes numbers from CARB's 2007 statewide air-quality plan, which looks at the costs of emissions reductions outside the electricity sector because these areas—such as more rigorous smog checks, old-vehicle retirement programs, and evaporative standards for off-road vehicles—correspond to CARB's expertise (CARB 2007B, Appendix E, p.56). E3 considers the cost of technological measures within the electricity-generation process itself—again, reflecting the organization's particular expertise. The E3 avoided costs for NO_x and PM₁₀ emissions are based on a survey of marginal emissions-abatement technology costs for natural gas-fired power plants and market prices for NO_x and PM₁₀. Another difference stems from the fact that CARB's is a point estimate—a single estimate for a specific time—whereas E3 explores costs as they rise *over time*. Figure A-1 compares the CARB and E3 figures year by year.

Figure A-1. Comparing E3 and CAT avoided costs



We would hope that information from the two divergent approaches might ultimately be combined to produce a richer and more comprehensive perspective on

mitigation options and costs. As a short-term expedient, we decided against complicating the tables for each measure with additional information on the E3 cost; we already had a range of four emission factors embedded in our tables. We report the CAT avoided costs as a marker in order to remind the reader of their existence—the CAT avoided cost number is the lower of the two for 2020. Though E3’s avoided cost estimates start out lower than the CAT estimates—reflecting lower mitigation costs in the electricity sector than elsewhere—by 2020 the E3 estimates are higher than the CAT’s static (i.e., not changing over time) result. Though we choose to report an avoided cost figure in our quantitative result, we also emphasize that these are very rough estimates, with much work remaining to be done.

A.4. Increased Use of Renewable Energy (33-Percent Renewables by 2020)

Our emissions-reduction estimates for a 33-percent RPS for all load-serving entities (LSEs) are substantially greater than the corresponding figures in the CAT Update. In part this is because it appears that the CAT Update considered only the impact on Investor Owned Utilities (IOUs), while we consider both IOUs and municipally owned LSEs. However, our estimates of emissions reductions are still somewhat larger when we limit our calculations to a 33-percent RPS for IOUs only. For the sake of comparison, we also evaluated the global warming emissions reductions in 2020 due to a 33-percent RPS for all LSEs using the E3 model. The results were remarkably similar to our estimates, which we arrived at independently, using a different approach. The E3 model attributed 12.8 million metric tons of global warming emissions reductions to renewables while we estimated 13 million metric tons (both exclude the California Solar Initiative).

Although California’s 20-percent RPS by 2010 is the law of the land, some uncertainty remains about whether the legally mandated increases in renewable energy generation will be achieved. Below we explore two scenarios: (1) the mandated 20-percent RPS by 2010 is accomplished on time; and (2) achievement of the 20-percent RPS is delayed until 2013.

A.4.1. Estimates of Emissions Reductions if 20-Percent RPS by 2010 Is Achieved on Time

The estimated emissions reductions due to a 33-percent RPS given in the CAT Update are based on values presented in a 2005 Center for Resource Solutions (CRS) report (CRS 2005, p. 38), which provided estimates of incremental renewable energy procurement by year to meet a 33-percent RPS by 2020. These estimates were added to the previous year’s installed capacity to create cumulative renewable generation figures for each year.²⁸ The CRS report also estimated statewide energy sales for each year (CRS 2005, p. 37). Renewable energy production as a percentage of total consumption for each year was calculated using the renewable energy generation estimates and the California energy sales estimates presented in the report. These values are presented in Table A-3.

²⁸ Note that the CRS report assumed that the 20-percent RPS is met by 2020. In creating estimates of cumulative renewable energy generation due to a 33-percent RPS, the 2010 value was set at 0. If in the next year 1 GWh of additional renewable energy was procured, the total renewable energy generated in that year was calculated as 0+1=1.

Table A-3: Renewable Energy Production Due to 33-Percent RPS

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PG&E PA	20%	21%	23%	24%	25%	26%	28%	29%	30%	32%	33%
SCE PA	20%	21%	23%	24%	25%	26%	28%	29%	30%	32%	33%
LADWP	20%	21%	22%	24%	25%	26%	28%	29%	30%	32%	33%
SMUD PA	20%	21%	23%	24%	25%	26%	27%	28%	29%	31%	32%
SDG&E	20%	21%	23%	24%	25%	27%	28%	29%	31%	32%	33%
BGP PA	20%	23%	25%	28%	29%	32%	34%	36%	38%	40%	42%
Total	20%	21%	23%	24%	25%	26%	28%	29%	30%	32%	33%

Notes: Abbreviations in the tables A-3 through A-5 are as follows- Pacific Gas and Electric (PG&E), Southern California Edison (SCE), Los Angeles Department of Water and Power (LADWP), Sacramento Municipal Utility District (SMUD), San Diego Gas and Electric (SDG&E), Burbank Glendale and Pasadena (BGP), Planning Area (PA), and Investor Owned Utility (IOU).

The percentage of renewable energy procured due to a 33-percent RPS above and beyond a 20-percent RPS was calculated by removing 20 percent from the estimates shown in Table A-3. These values are presented in Table A-4.

Table A-4: Additional Renewable Energy Production Due to 33-Percent RPS

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PG&E PA	0%	1%	3%	4%	5%	6%	8%	9%	10%	12%	13%
SCE PA	0%	1%	3%	4%	5%	6%	8%	9%	10%	12%	13%
LADWP	0%	1%	2%	4%	5%	6%	8%	9%	10%	12%	13%
SMUD PA	0%	1%	3%	4%	5%	6%	7%	8%	9%	11%	12%
SDG&E	0%	1%	3%	4%	5%	7%	8%	9%	11%	12%	13%
BGP PA	0%	3%	5%	8%	9%	12%	14%	16%	18%	20%	22%
Total	0%	1%	3%	4%	5%	6%	8%	9%	10%	12%	13%

Because the CRS report relied upon a now-outdated California Energy Commission (CEC) load forecast, the “Total” percentage values in Table A-4 were applied to the most recent CEC load forecast to generate new renewable energy procurement estimates (CEC 2007A, p. 38).²⁹ The new estimates of additional renewable energy procured due to a 33-percent RPS are presented in Table A-5.

Table A-5: Renewable Energy Production Due to a 33-Percent RPS Beyond 20-Percent RPS (GWh)

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
PG&E	-	1,053	2,191	3,312	4,532	5,734	6,935	8,213	9,488	10,845	12,177
SCE	-	1,088	2,237	3,405	4,623	5,871	7,221	8,587	9,972	11,360	12,761
SDG&E	-	271	521	789	1,035	1,300	1,541	1,861	2,177	2,485	2,789
IOUs Only	-	2,412	4,949	7,506	10,190	12,905	15,698	18,660	21,636	24,689	27,726
All Other	-	1,136	2,299	3,492	4,682	5,898	7,137	8,389	9,661	10,998	12,366
Total	-	3,583	7,286	11,117	14,969	18,939	23,016	27,159	31,399	35,745	40,193

²⁹ Estimates for 2019 and 2020 were generated by applying a 1.2-percent growth rate, consistent with the growth rates used in the CEC load forecast.

A.4.2. Estimates of Emissions Reductions if Achievement of 20-Percent Standard Is Delayed Until 2013

It is possible that several power utilities will not meet the 20-percent RPS by 2010, as required. To evaluate the impact that this contingency would have on ancillary benefit estimates, we developed a case in which only SMUD and LADWP meet the 20-percent RPS by 2010 while the other utilities meet the target by 2013. This alternative scenario is based on the judgment of our Clean Energy Program regarding how such a delayed scenario would be likely to unfold. By developing this scenario we in no way endorse it. To the contrary, we urge in the strongest terms that every effort be made to ensure that the 20-percent RPS is achieved on its legally mandated schedule (i.e., by 2010), which we believe is possible.

The pessimistic scenario does not change our estimates for 2020 of the global warming emissions reductions because we still assume that the renewable energy represented by a 33-percent RPS is brought on line by 2020. Table A-6 below details the renewable generation assumptions for this scenario.

Table A-6: Renewable Energy Production as a Percent of Total Consumption (Delayed 20-Percent RPS)

2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
15%	17%	19%	21%	22%	24%	26%	28%	29%	31%	33%

The methodology described above was applied to these values. The effect of not meeting the 20-percent RPS by 2010 can be seen in Table A-7 below. The criteria pollutant values in the table are calculated using the CAT Update emission factors.

Table A-7: Comparison of Achieving a 20-Percent RPS in 2013 vs. 2010

<i>Benefits of a 33-Percent RPS, Assuming that a 20-Percent RPS Is Met by 2010</i>			
	2015	2020	Cumulative
CO ₂ Reductions (MMTCO ₂ e)	6	13	69
NO _x Reductions (Metric Tons)	340	720	3,800
PM ₁₀ Reductions (Metric Tons)	340	720	3,800
Cost (Million 2007\$)	64	64	1,283
Avoided Pollution Control Savings (Million 2007\$)	14	30	160
Avoided Healthcare Costs (Million 2007\$)	56	120	640
<i>Benefits of a 33-Percent RPS, Assuming that a 20 Percent RPS Is Met by 2013</i>			
	2015	2020	Cumulative
CO ₂ Reductions (MMTCO ₂ e)	4	13	52
NO _x Reductions (Metric Tons)	220	720	2,900
PM ₁₀ Reductions (Metric Tons)	220	720	2,900
Cost (Million 2007\$)	64	64	1,283
Avoided Pollution Control Savings (Million 2007\$)	9	30	120
Avoided Healthcare Costs (Million 2007\$)	36	120	480

Our criteria-pollutant estimates are based on the assumption that the 20-percent RPS is not met till 2013.

A.4.3. Assessment of Potential for Steps to Avoid Double Counting

We took steps, as follows, to assess and avoid potential double counting that could occur from interactions between renewable energy and energy-efficiency policies. An avoided CO₂ emission factor of 390 kg/MWh was applied to the estimates in Table A-5 of renewable energy production beyond a 20-percent RPS, consistent with the factor used in the CAT Update's methodology for calculating reductions due to renewable energy generation (CAT 2007A, p. 12). CO₂ emissions reductions in 2020 were then adjusted for possible double counting; 2.87 MMTCO₂e was subtracted.

We estimated the double-counting potential by developing an emissions reduction factor for energy efficiency, assuming that a 33-percent RPS by 2020 is in place. All calculations were performed in a manner consistent with the methodology for the CAT Update energy-efficiency emissions reduction factor. Table A-8 presents the calculations and assumptions from the CAT Update that led to a 313 kg per MWh emissions reduction factor for energy efficiency. This factor reflects the assumption that natural gas combined-cycle (NGCC) plants and renewable energy serve as the marginal supply resource in California. Large hydro and nuclear provide base-load capacity and are therefore not marginal.

Table A-8: Emissions Reduction Factor Calculations Based on a 20-Percent RPS (CAT 2007, p. 13)

<i>Assumptions</i>	
815	pounds of CO ₂ /MWh for natural gas combined-cycle turbine
80%	portion of additional energy that will be generated from NGCC
20%	RPS (portion of additional energy that will be generated from renewable power)
33%	portion of renewable resource that comes from geothermal
50	pounds of CO ₂ /MWh for geothermal
0	pounds of CO ₂ /MWh for non-geothermal renewable
20%	portion of additional capacity from out-of-state generation
80%	portion of additional capacity from in-state generation
7.5%	transmission losses associated with out-of-state generation
4.5%	transmission losses associated with in-state generation
2.2046	pounds per kg
<i>Calculations</i>	
881	pounds of CO ₂ /MWh for out-of-state NGCC generation, considering transmission losses (815/(1-0.075))
17.6	pounds of CO ₂ /MWh for out-of-state renewable generation, considering transmission losses (0.33)(50/(1-0.075))
708	pounds of CO ₂ /MWh for out-of-state generation, considering NGCC/renewable mix and transmission losses 881(0.80)+17.6(0.20)
853	pounds of CO ₂ /MWh for in-state NGCC generation, considering transmission losses (815/(1-0.045))
17.3	pounds of CO ₂ /MWh for in-state renewable generation, considering transmission losses ((0.33)(50/(1-0.045))
686	pounds of CO ₂ /MWh for in-state generation, considering NGCC /renewable mix and transmission losses 853(0.80)+17.3(0.20)
691	pounds of CO ₂ /Mwh on average for generation, considering NGCC/renewable mix, transmission losses, and in/out-of-state mix (708(0.20)+686(0.80))
313	kg of CO ₂ /MWh avoided due to energy efficiency (considers renewable/NGCC mix) (691/2.2046)
390	kg of CO ₂ /MWh avoided due to renewable energy (considers NGCC displacement only) (0.20(881)+0.80(853))

Table A-9 presents the energy-efficiency emissions reduction factor calculations based on a 33-percent RPS.

Table A-9: Emissions Reduction Factor Calculations Based on a 33 Percent RPS (CAT 2007, p. 13)

<i>Assumptions</i>	
815	pounds of CO ₂ /MWh for natural gas combined-cycle turbine
67%	portion of additional energy that will be generated from NGCC
33%	RPS (portion of additional energy that will be generated from renewable)
33%	portion of renewable resource that comes from geothermal
50	pounds of CO ₂ /MWh for geothermal
0	pounds of CO ₂ /MWh for non-geothermal renewable
20%	portion of additional capacity from out-of-state generation
80%	portion of additional capacity from in-state generation
7.5%	transmission losses associated with out-of-state generation
4.5%	transmission losses associated with in-state generation
2.2046	pounds per kg
<i>Calculations</i>	
881	pounds of CO ₂ /MWh for out-of-state NGCC, considering transmission losses (815/(1-0.075))
17.6	pounds of CO ₂ /MWh for out-of-state renewable generation, considering transmission losses (0.33)(50/(1-0.075))
596	pounds of CO ₂ /MWh for out-of-state generation considering NGCC/renewable mix and transmission losses 881(0.67)+17.6(0.33)
853	pounds of CO ₂ /MWh for in-state NGCC generation, considering transmission losses (815/(1-0.045))
17.3	pounds of CO ₂ /MWh for in-state renewable generation, considering transmission losses ((0.33)(50/(1-0.045))
577	pounds of CO ₂ /MWh for in-state generation considering NGCC/renewable mix and transmission losses 853(0.67)+17.3(0.33)
581	pounds of CO ₂ /Mwh on average for generation considering NGCC/renewable mix, transmission losses, and in/out-of-state mix (596(0.20)+577(0.80))
264	kg of CO ₂ /MWh avoided due to energy efficiency (considers renewable/NGCC mix) (581/2.2046)
390	kg of CO ₂ /MWh avoided due to renewable energy (considers NGCC displacement only) (0.20(881)+0.80(853))

The difference between the 33-percent RPS energy-efficiency emissions reduction factor of 264 kg CO₂e per MWh and the 20-percent RPS energy-efficiency emissions reduction factor of 313 is 49. This difference was then multiplied by the 2020 energy-efficiency savings from multiple strategies, as reported by the CAT macro update presented in Table A-10. This resulted in a 2.87 MMTCO₂e double-counting potential. Our double-counting estimate for a 33-percent RPS is slightly larger than the value presented in the CAT Update.

Table A-10: Energy-Efficiency Savings in 2020

Strategy	MWh
T-24	5,219,688
T-20	12,635,358
IOU EE	24,589,639
Muni EE	16,200,000
Total	58,644,685

Double-counting potential from the generation of renewable energy through strategies such as forest-fuel management are not included in the 33-percent-RPS double-counting potential value that we developed. The CAT macroeconomic update explores such interactions and the potential double counting they may create (e.g., the renewable energy generated through a forest-fuels management strategy is noted as a double-counting potential). However, we do not separately address forest-fuels management or other measures beyond those we have discussed; so we limit our assessment of double counting to the approach described above.

NO_x and PM₁₀ emissions reductions and associated benefits were estimated using the methodology described above. As with global warming emissions reductions and savings were adjusted for the 33-percent RPS strategy to address possible double counting. Values associated with these criteria pollutants were multiplied by a ratio equal to the 2020 CO₂ emissions reductions with double counting accounted for, divided by the 2020 CO₂ emissions reductions, before taking into account potential double counting. Equation A-1 explicitly defines this ratio.

Equation A-1. Avoiding Double Counting

$$Ratio = \frac{Reductions_{2020} - Potential_{Double\ Counting}}{Reductions_{2020}}$$

A.4.4. Comparison of 33-Percent RPS Results to E3 CPUC Greenhouse Gas Modeling Work

For comparison purposes, we ran a 33-percent RPS case using version 2b of the E3 global warming emissions calculator (E3 2008). We assumed high energy-efficiency goals, implementation of the California Solar Initiative, and 4,378 MW of combined heat and power. These values define what has been referred to as the aggressive policy case in the E3-model discussion forms. Table A-11 below details our assumptions regarding new installed capacity of renewable resources in 2020 (Mahone 2008) that leads to the achievement of a 33-percent RPS in California (excluding Department of Water Resources power).

Table A-11: Assumed Build-Out of Renewables in 2020

Location(* Indicates zones based in California)	MW Build-Out
Alberta	-
Arizona-Southern Nevada	-
Bay Delta*	-
British Columbia	-
CA – Distributed*	900
CFE	1,500
Colorado	-
Geysers/Lake*	500
Imperial*	4,500
Mono/Inyo*	-
Montana	-
NE NV	-
New Mexico	-
Northeast CA*	-
Northwest	-
Reno Area/Dixie Valley	-
Riverside*	-
San Bernardino*	-
San Diego*	750
Santa Barbara*	-
South Central Nevada	-
Tehachapi*	4,394
Utah-Southern Idaho	-
Wyoming	-

A.4.5. Concerns about Existing Estimates of Cost

We chose not to report the cost estimates for a 33-percent RPS that are currently in the public domain, given the lack of sufficient confidence in these figures because of unclear documentation. Nonetheless, here we explain three cost estimates that have been put forward.

The approach in the CAT report involves amortizing an estimated total cost of \$1,283 million (2007\$) over 20 years. This exercise yields an average cost of \$64 million (2007\$) per year.³⁰ The CRS report concludes that the renewable energy production implied by a 33-percent RPS can be had at a net gain. It estimates a net present value savings of \$175 million (2011\$, 9 percent) to California ratepayers over the 2011-2030 time period (CRS 2005, p. 2).

³⁰ Note that the CAT Update reports 2020 costs for a 33-percent RPS as being \$100 million per year (2006\$). It states that this figure was generated by levelizing the \$1,250 million (2006\$) total cost figure over 20 years using a 5-percent discount rate. However, applying a discount rate to a net present value cost figure in an amortization calculation generates a uniform cost stream in current dollars, not constant dollars. Hence the \$100 million cost figure in the CAT must be in 2020\$. A simple test of multiplying \$100 million by 20 years reveals a total cost of \$2 billion, not \$1.25 billion.

The E3 model estimates \$3.5 billion (2008\$) in increased costs and \$1.8 billion (2008\$) in savings in 2020 due to a 33-percent RPS. However, our view is that E3’s modeling *overestimates* cost, and we cite the following reasons:

- The model paints an unrealistically static picture of renewable technology development.
- The model fails to account for the natural gas-price suppression effect of increased levels of clean energy.
- The model does not assess the risks to consumers of different scenarios.
- The costs of transmission investments to access renewable resources are not fairly allocated among generators.
- The assumed capacity values understate the true contribution of renewable energy generators.
- The model should assume that the California Solar Initiative goal is accomplished in the reference case, but it does not do so.
- The modeling results should emphasize changes in total resource costs instead of changes in rates.

For a more detailed discussion of these issues, see our comments to the California Public Utilities Commission, “Comments of the Natural Resources Defense Council and Union of Concerned Scientists on Allowance Allocation, Flexible Compliance, CHP, Emission Reduction Measures, and Modeling Issues,” filed June 2, 2008 under rulemaking 08-06-009.

A.5. Increased Water Efficiency

Emissions reductions through improved water efficiency in California in 2030, as developed in the 2005 California Water Plan, are based on the technical potentials both in the urban and agricultural domains. Table A-12 below summarizes these potentials.

Table A-12: 2005 CA Water Plan Water Efficiency Technical Potentials (DWR 2005, p. 22.6)

	2030 Water Efficiency Potential (1,000 acre-feet per year)	Annual Investment (Million 2004\$)
Urban	3,096	352 ³¹
Agricultural–On Farm	2,352	75
Agricultural–Water Supplier	471	75
TOTAL	5,919	502

Agricultural on-farm improvements in the Plan are based on the natural replacement over time of lower-performing irrigation systems with higher-performing ones and on the impact of increased state funding levels for demand- and supply-side management efforts. Agricultural water-supplier improvements are based on the implementation of efficient water-management practices and increased state funding

³¹ Annual investment in urban water efficiency in 2030 was estimated by applying the same ratio of \$/ac-ft that was used for the level of water-efficiency achievement immediately below technical potential (2,075 thousand ac-ft), as reported in the 2005 California Water Plan. It is important to note that this cost is illustrative only. It is unlikely that cost and water efficiency savings are linearly correlated as technical potential is approached.

levels that provide incentives for turnover of the capital stock. Thus water efficiency includes measures aimed both at demand and supply.

Note that the agricultural technical potentials used in this analysis reflect reductions in recoverable flows (e.g., water that flows back into an aquifer) as well as irrecoverable flows (e.g., water that evaporates). Therefore the agricultural water-efficiency potential values presented in Table A-12 are considerably larger than what would likely be presented in a typical water-efficiency context. Water savings categorized as affecting recoverable flow may not be as effective in conserving water resources, but they are equally as important and effective as savings in irrecoverable flows in an energy and emissions sense. Even if water is “recoverable,” energy and emissions must still be used to move it to the farm.

The estimates in Table A-12 were developed by assuming that the full technical water-efficiency potential is achieved by 2030. Water-efficiency values for years 2008 through 2029 were estimated by using simple linear interpolation, assuming that no technical potential had been realized in 2007.

Annual investment costs were estimated by assuming that costs were directly proportional to water-efficiency savings. These costs were converted from 2004 dollars to 2007 dollars by applying GDP-based inflator ratios of 1.0649 (from 2004 to 2006) and 1.0266 (from 2006 to 2007) (BEA 2008).

The urban water-efficiency potential estimated in the 2005 California Water Plan is based on an evaluation of urban water-savings potential from appliance-water efficiency, local water-agency implementation of urban conservation Best Management Practices (BMPs), other locally cost-effective efficiency measures, and additional urban-conservation measures cofunded through CALFED Agency grant programs. Table A-13 outlines existing BMPs for California water conservation and efficiency.

Table A-13: California Urban Water BMPs (CUWCC 2007)

BMP 1	Residential Survey Programs
BMP 2	Residential Plumbing Retrofit
BMP 3	System Water Audits
BMP 4	Metering with Commodity Rates
BMP 5	Large Landscape Conservation
BMP 6	High-Efficiency Clothes Washers
BMP 7	Public Information Programs
BMP 8	School Education Programs
BMP 9	Commercial Industrial Institutional
BMP 10	Wholesaler Agency Assistance Programs
BMP 11	Conservation Pricing
BMP 12	Conservation Coordinator
BMP 13	Water-Waste Prohibitions
BMP 14	Residential Ultra-Low-Flush Toilet Replacement Programs

Estimates of water-efficiency potential were converted into emissions-reduction potentials by assuming that one million metric tons of CO₂ emissions are reduced for every million acre-feet of water saved (CAT 2006, p. 50).³² Because this is an average

³² The California Energy Commission estimates that an average of 44 million metric tons of CO₂e are emitted annually to provide 44 million acre-feet of water used statewide.

emission factor for statewide water use, it is likely to underestimate the savings from some water-efficiency measures and overestimate the savings from others. And there are significant concerns with using a statewide average value for water's heat-trapping intensity, given that the energy embodied in water is extremely location- and use-dependent. For instance, hot water saved at the top of a tall building in Los Angeles will have significantly more energy and emissions reductions associated with it than irrigation water saved on a farm in Sacramento.

There are other potential problems with using the emission factor of one million metric tons of CO₂ per million acre-feet. For instance, the Navigant report (CEC 2006) that informed the emission factor includes energy used for clothes dryers and space cooling in its water energy-intensity values.³³ The factor nevertheless provides an illustrative example of potential global warming emissions reductions associated with water efficiency.

It is also important to note that the values presented in this document may not be true upper limits on emissions-reduction potential through water efficiency. It is possible that the BMPs on which values are based are no longer true BMPs. Significant additional efficiency potential is likely, given technological advances.

Estimates of energy savings due to water savings were calculated by applying the CAT Update energy-efficiency emissions-reduction factor of 313 kg/MWh to the estimated global warming emissions reductions. As with other strategies, the monetary value of natural gas and electrical energy savings, NO_x and PM₁₀ emissions reductions, and associated benefits were estimated using the methodology described above.

Table A-14 presents alternative emissions-reduction factors for water conservation, segmented into northern and southern California and indoor and outdoor use. These values are for comparison purposes and were not used to estimate reductions in this document. The values do highlight the issues associated with using a statewide average emission factor.

Table A-14: Water Emissions Intensity, MMTCO₂e/Million Acre-Foot (CEC 2006, p. 2)³⁴

	Indoor Use		Outdoor Use	
	Northern CA	Southern CA	Northern CA	Southern CA
Water Supply and Conveyance	0.216	0.992	0.216	0.992
Water Treatment	0.011	0.011	0.011	0.011
Water Distribution	0.130	0.130	0.130	0.130
Wastewater Treatment	0.195	0.195	0.000	0.000
Regional Total	0.552	1.328	0.357	1.133

Water saved in urban and residential environments in southern California likely has a greater emissions-reduction factor than 1.0 MMTCO₂e per million acre-feet. Nearly 60 percent of people in the state live in Southern California, and population there is expected to grow by 28 percent in the 2000-2020 time period (CDF 2007). Because this

³³ Gary Klein, personal communication, June 5, 2008.

³⁴Estimates presented in the Navigant report for the CEC were given in units of kWh per acre-foot. These estimates were converted to MMTCO₂e per acre-feet using an emission reduction factor of 313 kg per MWh, consistent with the CAT Update emission reduction factor for energy efficiency.

population growth will significantly increase the water-efficiency technical potential in the region, an emissions-reduction factor of 1.3 MMTCO₂e per million-acre feet may better reflect the impact of these savings.

We chose to develop our own water efficiency-based emissions-reduction estimates, as noted earlier, rather than use the estimates given in the Climate Action Team October 2007 Update (CAT Update), which presented increased water efficiency as a strategy for reducing the state's global warming emissions. The Department of Water Resources (DWR) developed this strategy.

The CAT Update estimated that 1.1 million acre-feet of water savings can be achieved by 2030, with 0.63 Million acre-feet of savings potential by 2020 (CAT 2007B, p. 263). The energy savings attributed to these water-efficiency savings are estimated to be 2,028 GWh in 2020 and 3,588 GWh in 2030 (CAT 2007B, p. 264). Applying the CAT emissions-reduction factor for energy efficiency of 313 kg of CO₂e per MWh to these estimates results in an emissions reduction of 0.6 MMTCO₂e in 2020 (CAT 2007A, p. 12). This value is a lower bound of the global warming emissions reductions that are possible in California because of water efficiency.

The 1.1 million acre-feet value represents a lower-bound estimate for several reasons:

1. This value, used by DWR, is less than the 1.2 million acre-feet estimate for water-efficiency potential for 2030 given in the California Water Plan *assuming that historic implementation rates continue*. In effect, the DWR estimate is lower than the previous status quo estimate. In addition, the Plan estimates a best-case-scenario urban technical potential of 3.1 million acre-feet by 2030 (DWR 2005, p. 22.3).
2. The estimate only evaluates urban water-efficiency potential, even though there is significant potential for water-efficiency improvements in the agricultural sector. The 2005 California Water Plan estimates an agricultural water-efficiency technical potential, under best-case conditions, of 2.8 million acre-feet in 2030 (DWR 2005, p. 3.6).
3. In general, the water-efficiency potentials that serve as the basis for the DWR estimates utilize Best Management Practices that have long been in place and may no longer be true BMPs, as noted earlier. Water-efficiency potential is likely to be significantly greater if state-of-the-art technologies and water-management practices are included. Given the huge potential, and the overlap in this instance between climate-change mitigation and adaptation objectives, it seems reasonable to assume that there will be significant technical progress in water efficiency.

A.6. Energy-Efficiency Measures Derived from the E3 Modeling Effort

Energy and Environmental Economics, Inc., has developed and is continuing to refine a global warming emissions-reduction model for the electricity sector (both investor-owned and municipal utilities) for the California Public Utilities Commission (E3 2008). The model estimates global warming emissions reductions and cost impacts of various emissions-reduction strategies, including a 33-percent RPS, investor-owned-utility energy-efficiency programs, Title-24 standards, federal energy-efficiency standards for

appliances and HVAC equipment, the Huffman lighting-efficiency standard bill, the California Solar Initiative (CSI), Combined Heat and Power (CHP) programs, and demand response (DR) programs.

Table A-15 outlines the E3 model inputs that we chose to use.

Table A-15: E3 Model Assumptions

Energy Efficiency:	High Electric and High Natural Gas EE
RPS:	33-percent by 2020
CSI:	3000 MW by 2020
CHP <5MW Capacity in 2020:	1,574 MW
CHP >5MW Capacity in 2020:	2,804 MW
Administrative Cost Percentage:	0 percent (to avoid double counting; see below)

We chose, for example, to run the model with 0 percent energy-efficiency-program administrative costs because the current E3 model double counts these costs.³⁵ In discussing the model with E3, Eric Wanless discovered that administrative costs were included in the original cost estimates from Itron, Inc. CAT monetary values were converted to 2008 dollars for comparison with E3 model outputs using a 1.0266 GDP-based inflator from 2006 to 2007 and the E3 model inflation rate of 2 percent from 2007 to 2008.

³⁵ Amber Mahone, E3, personal communication, June 2, 2008