CAP AND TRADE PROGRAM DESIGN OPTIONS

REPORT OF THE CAP AND TRADE SUBGROUP OF THE CLIMATE ACTION TEAM

FINAL REPORT

PREPARED BY:

CAP AND TRADE SUBGROUP

CLIMATE ACTION TEAM

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Acknowledgements

The Cap and Trade Subgroup was created under the Climate Action Team to identify and evaluate cap-and-trade program design options. The Subgroup was comprised of representatives from the agencies included on the Climate Action Team, as well as representation from the Department of Finance.

The Subgroup reviewed and relied on a wide range of materials and input, including comments from stakeholders and the public. The Subgroup held two public meetings during which the Subgroup's activities were presented and public input was solicited. Comments were solicited on a discussion paper that was made available on October 20, 2005. The Subgroup also reviewed and relied on information from the docket supporting the California Energy Commission's Integrated Energy Policy Report (IEPR), including input from the Energy Commission's Climate Change Advisory Committee.

The Cap and Trade Subgroup included the following members: Susan Brown, California Energy Commission; Lainie Motamedi, California Public Utilities Commission; Reza Nevai, California Department of Transportation; Robert Schladale, Department of Finance; Chuck Shulock, California Air Resources Board; Eileen Tutt, California Environmental Protection Agency; Patrick Wright, California Resources Agency; and Michael Gibbs, ICF Consulting and Subgroup Chair. Nancy Sutley, City of Los Angeles, provided direction during the initial stages of the Subgroup process.

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"Cap and trade" is a market-based program that can be integral to California's strategy for reducing greenhouse gas (GHG) emissions. The program sets an emissions cap that can be phased down over time. Regulated sources have flexibility to comply with the cap using methods of their own choosing. *The primary benefits of a cap-and-trade program are its ability to establish a firm GHG emission limit for entities covered by the cap and to reduce emissions at the least cost.*

Because greenhouse gases (GHGs) are emitted from diverse sources and are long-lived gases in the atmosphere, setting an emission cap and allowing emission trading is recognized as a particularly effective strategy for reducing emissions. The European Union (EU) adopted this approach to reduce GHG emissions from four energy-intensive sectors.

Based on our assessment of cap-and-trade program options, we offer the following:

- A cap-and-trade program can be implemented as part of a comprehensive emission reduction effort that includes complementary programs and initiatives. The declining emission cap can be the primary mechanism for motivating innovation and infrastructure investments that are consistent with declining carbon intensity in the long term.
- A national approach to capping GHG emissions within an international framework would be most effective. In the absence of national action, or even regional action, California can lead by example by developing a cap-and-trade program as a model for national action. The added impacts and benefits on the state of taking *unilateral* action must be assessed.
- There is no single, best solution for designing an effective cap-and-trade program. Trade-offs are required to create a program that promotes low-cost emission reductions, in a framework that is equitable and administratively feasible. Divergent interests must be balanced in designing the program scope, emission allowance distribution, and other program elements.
- There are several alternatives for defining the scope of a cap-and-trade program.
  - A *carbon cap on all fossil fuels* provides the broadest opportunity to reduce GHG emissions, covering about 75% of state GHG emissions, including both stationary and mobile fossil fuel combustion.
  - An *emission cap focused on five industrial sectors* would cover about 30% of state emissions, including primarily stationary sources of fossil fuel combustion. Mobile source emissions, accounting for about 42% of state emissions, are not easily incorporated into a sector-based emission cap. However, alternative emission reduction strategies can focus on mobile sources.

  There are strengths and weaknesses of these, and other, options for defining the facilities and emission sources covered by a cap-and-trade program.
- The impact of a cap-and-trade program on GHG emissions, the state economy, and individual businesses and organizations, depends on the details of how the program is designed and implemented. Impact analyses are required to assess the relative costs and benefits of detailed program design alternatives.
- New legislative authority is required to implement a comprehensive cap-and-trade program to reduce GHG emissions.

The next step in considering a cap-and-trade program is to develop data and perform analyses that would provide the foundation for assessing: (1) whether to implement a cap-and-trade program; and (2) how best to implement it to contribute to achieving the state's GHG emissions targets. If the decision is made to continue consideration of cap-and-trade program options, the following would be the next steps.

- ***Facility-Level Emission Reporting:*** Facility-level emission reporting is needed to support the detailed consideration of a cap-and-trade program, and to better understand current emissions and options for reducing emissions. The following steps are recommended for adopting facility-level emission reporting requirements:
  - A lead agency for implementing an emission reporting requirement must be designated.
  - The legislative authority required to develop and implement mandatory reporting must be identified and developed.
  - Reporting protocols are needed to support the mandatory reporting. Multiple stakeholders expressed support for the California Climate Action Registry's protocols and data management processes, which should be the used as the basis for providing this capability.
- ***Cap-and-Trade Program Alternatives:*** Several complete cap-and-trade programs should be defined in detail, representing a range of program design options including a sector-based approach and an upstream fuels-based approach. Stakeholder participation in the development of these alternatives should be sought, including representatives of affected industries, the Legislature, interest groups, and the general public. The program alternatives should be presented publicly to get stakeholder feedback and public comment.
- ***Analyses of Cap-and-Trade Options:*** Each of the program alternatives should be evaluated to assess the program's impacts on: GHG emissions; emission reduction costs; state competitiveness, businesses, local governments, and jobs; and communities with environmental justice concerns.
- ***Legislative Authority:*** An analysis of the new authorities required from the California Legislature is recommended, along with an assessment of any federal legal issues that may arise.
- ***Comparison with Non-Cap-and-Trade Options:*** The costs and impacts of the cap-and-trade program alternatives should be compared to options for achieving the state's GHG emission targets that do not include a cap-and-trade program.
- ***Electric Utilities as Load Serving Entities:*** Several cap-and-trade program options will consider covering electric utilities as LSEs. Options for developing the detailed emission tracking capability required to support this approach need to be defined.
- ***Administrative Assessment:*** Administrative options for implementing each of the program alternatives should be developed. The budget requirements to support the administration of each program option should be assessed.

To ensure timely and continued progress toward meeting the state's GHG emission targets, the following timeframe can be implemented.

- An emission reporting program can be developed in 2006 so that it can take effect in January 2007. Authority to proceed is required from the California Legislature.
- Detailed cap-and-trade program alternatives can be developed and analyzed in 2006 and 2007.

- Assessments of whether and how to proceed with further consideration of cap-and-trade program options can be conducted in 2007 with a recommendation to the Governor and the Legislature at that time.

1. Introduction

1.1 Purpose of this Report

This report assesses options for designing a "cap-and-trade" program to reduce greenhouse gas (GHG) emissions in California. This report was prepared as one of the activities undertaken to implement Governor Schwarzenegger's Executive Order S-3-05. Signed on June 1, 2005, the Executive Order established the following GHG emission reduction targets for California:

- by 2010, reduce GHG emissions to 2000 levels;
- by 2020, reduce GHG emissions to 1990 levels; and
- by 2050, reduce GHG emissions to 80 percent below 1990 levels

The Governor directed the Secretary of the California Environmental Protection Agency to coordinate efforts to meet the targets and report to the Governor and the State Legislature by January 2006 (and biannually thereafter) on progress made toward meeting the emission targets. The Executive Order also directs the Secretary to report on the impacts to California of global warming, and on mitigation and adaptation plans to combat the impacts.

The Secretary assembled the *Climate Action Team* to address the requirements of Executive Order S-3-05. The Climate Action Team includes representation from: the Business, Transportation and Housing Agency, the Department of Food and Agriculture, the Resources Agency, the Air Resources Board, the Energy Commission, the Public Utilities Commission, and the Integrated Waste Management Board. The Climate Action Team is examining a broad set of strategies for reducing emissions to meet the Governor's targets.

Among the options being examined is a cap on GHG emissions from various sectors or sources. The Cap and Trade Subgroup was created under the Climate Action Team to identify and evaluate cap-and-trade program design options. The Subgroup was comprised of representatives from the agencies included on the Climate Action Team, as well as representation from the Department of Finance.

To prepare this report, the Subgroup reviewed and relied on a wide range of materials and input, including comments from stakeholders and the public. The Subgroup held two public meetings during which the Subgroup's activities were presented and public input was solicited. Comments were solicited on a discussion paper on cap-and-trade program options that was made available on October 20, 2005. The Subgroup also reviewed and relied on information from the docket supporting the California Energy Commission's Integrated Energy Policy Report (IEPR), including input from the Energy Commission's Climate Change Advisory Committee. This report presents the Subgroup's results.

1.2 Organization of this Report

This report is organized as follows:

- Section 2 presents a brief overview of cap and trade as an emission reduction policy. This chapter describes how a cap-and-trade program works, and provides brief descriptions of previous cap-and-trade emission reduction programs.
- Section 3 presents design options for a cap-and-trade program. Each of the major design elements is defined, and options are provided with a discussion of the pros and cons for each.
- Section 4 summarizes environmental justice concerns associated with a cap-and-trade program.

- Section 5 provides a brief summary of other policy options that may be considered as complements or alternatives to a cap-and-trade program.
- Section 6 lists next steps for considering a cap-and-trade program.

2. Cap and Trade as an Emissions Reduction Policy

This chapter provides a brief overview of cap and trade as an emissions reduction policy. First, the basic concept of a cap-and-trade program is defined. Next, the role of emission reduction credits or "offsets" in a cap-and-trade program is described. Brief overviews of previous implementations of cap-and-trade programs then follow. Finally, we address the question of whether cap and trade is an appropriate policy to consider for reducing greenhouse gases (GHGs) in California.

2.1 What is Cap and Trade?

"Cap and trade" is a market-based policy tool that can be used to limit pollutant emissions for environmental protection. The **"cap"** in cap and trade refers to a total emission limit (or cap) that is imposed on all the sources included in the program. To ensure that total emissions from all the sources included in a cap-and-trade program remain below the cap, the following process is used: [1]

- The emission cap for the pollutant of interest is set. The cap is expressed in units of mass per time, such as tons per year.
- The agency implementing the program creates a regulatory instrument that allows the holder of the instrument to emit a specified amount of the pollutant. The instrument is generally referred to as an "emission allowance." For example, one emission allowance may allow for one ton of the pollutant to be emitted in a year. The sum of the emissions in all the emission allowances equals the emission cap.
- The sources that must comply with the emission limit are identified—these sources are "covered by the emission cap." The legal entities responsible for the sources (e.g., businesses and other organizations) are notified that their facilities must comply with the cap.
- The emission allowances are distributed by the agency to the entities responsible for complying with the cap. The process for distributing allowances can take various forms, including giving the emission allowances to the appropriate entities or selling them.
- To comply with the emission cap in a given year, each entity must:
  - report the actual emissions from its facilities covered by the cap; and
  - surrender enough emission allowances to the regulatory agency to cover the actual emissions from its facilities.
- The agency implementing the program tracks compliance by ensuring that actual emissions are reported accurately and that each entity surrendered sufficient emission allowances to cover its emissions. In the event that an entity's emissions exceeded its emission allowances, enforcement actions would be taken.

Through this process, total emissions each year can be kept at or below the emission cap. To comply, each entity must ensure that its annual emissions are less than or equal to the number of emission allowances it holds for the year.

The **"trade"** portion of cap and trade refers to the ability of entities to trade emission allowances. If one entity needs more emission allowances to cover its emissions in a year, it can purchase additional allowances from entities that have more allowances than they need. This ability to trade emission allowances is what makes the policy "market based."

The concept of a cap-and-trade program was first articulated in the 1960s.[2] The two primary benefits of using this approach to limit emission are that: (1) emissions can be capped reliably; and (2) the cost of reducing emissions is minimized. In order for the cap to be effective, the program must be able to enforce its requirements. Effective enforcement requires the following.

- The agency implementing the program must be able to verify that all relevant facilities are participating in the program and that the emissions reported by the facilities required to comply with the cap are true and accurate. If false reports are not identified, cheating can go undetected.
- The agency implementing the program must have the ability to impose penalties for non-compliance that are sufficiently severe so that it is less costly to comply than to exceed the cap. To keep emissions below the cap, the penalty can include a requirement that the facility acquire emission allowances to cover its excess emissions.

These enforcement capabilities are no more onerous than what would be anticipated in any regulatory program. The relatively simple requirement to surrender enough allowances to cover actual emissions helps to simplify compliance tracking, and consequently makes enforcement a straightforward exercise.

The cost of reducing emissions is minimized under a cap-and-trade program by allowing emission allowances to be traded. Each entity that must comply with the cap has flexibility to devise its own compliance strategy. Entities that can reduce emissions cheaply can reduce emissions a lot and sell their excess emission allowances to others. Entities that find it costly to reduce emissions may decide to purchase emission allowances rather than invest in emission reduction technologies. Through this trading, the least-cost options for reducing emissions are implemented across all the entities covered by the cap.

The value of using allowance trading to reduce compliance costs depends on the diversity of compliance opportunities available to entities that fall under the cap. If all the entities under the cap face the same (or very similar) costs for reducing emissions, then there is little or no benefit to providing a trading mechanism. However, if some entities face high costs while others face low costs, the benefits of allowing trading can be substantial.

While relatively straightforward in concept, there are several practical considerations that must be addressed in designing and implementing a cap-and-trade program to reduce pollutant emissions.

- ***Setting the Cap:*** Although a cap-and-trade program can reduce emissions at least cost, there is no guarantee that the cost will be low. If the emission cap is stringent, the cost of keeping emissions below the cap could be significant. Phasing in the emission reduction can help reduce costs by providing a transition period during which emission reduction actions can be undertaken. The eventual cost of reducing emissions will be driven by the level of the cap, the cost of emission reduction technologies, and decisions made by emission sources and consumers.
- ***Allowance Allocation:*** A mechanism is required for allocating the emission allowances to the entities that must comply with the cap. The mechanism must be viewed as fair and equitable, balancing diverse interests among the entities required to comply with the cap, as well as the needs of society at large.
- ***Effective Trading Market:*** An effective market for trading emission allowances is required in order to reduce emissions at least cost. An effective market requires enough participants to facilitate liquidity and price discovery. Consequently, multiple and diverse emissions sources must be in the program. In a market with too few participants, prices can be

volatile, complicating decisions regarding whether to purchase allowances or to reduce emissions.

- ***Leakage:*** An effective cap-and-trade program must encompass all relevant emission sources to prevent "emission leakage." Emission leakage occurs when some facilities are allowed to operate outside the cap. Under this circumstance, activities that emit GHGs could shift from facilities that fall under the cap to those that do not fall under the cap. The emissions "leak out" from under the cap by shifting to facilities outside the cap.

  For example, leakage can occur when the cap applies to facilities in one jurisdiction, but not to facilities in a neighboring jurisdiction. In this case, activities that emit GHGs could shift to the neighboring jurisdiction to avoid the cap. The end result is that emissions are low at the facilities under the cap, but emissions increase at facilities outside the cap.

- ***Local Environmental Impacts:*** When pollutants have local environmental impacts, it may not be possible to allow complete compliance flexibility and unlimited emission allowance trading because individual facilities could increase local emissions by purchasing emission allowances. In this circumstance, specific emission restrictions may be needed to protect against increased local impacts. Section 4 discusses environmental justice concerns associated with using a cap-and-trade approach to reducing GHG emissions.

Through practical program design and implementation, these issues can be mitigated. Experience with cap-and-trade programs has demonstrated that this approach can be effective in reducing emissions at significantly reduced costs. Examples of emissions reduction programs are discussed below in Section 2.4.

2.2 What Sources are Appropriate to Include in a Cap-and-Trade Program?

A cap-and-trade program is not necessarily the best approach for reducing emissions from all types of sources. To be most effective, sources and the emissions being controlled in a cap-and-trade program should have the following characteristics:

- ***Able to Measure or Calculate Emissions:*** Facilities included in a cap-and-trade program must be able to measure or calculate their emissions reliably. As described above, facilities must report their emissions and the appropriate regulatory agency must be able to verify the accuracy of the emission reports. To support emission allowance trading among facilities, emission reports must be prepared with similar precision across facilities.

- ***Compliance Flexibility is Appropriate:*** Cap and trade provides substantial compliance flexibility to facilities covered by the cap. By purchasing emission allowances, some facilities may be able to increase emissions. If a facility's increased emissions causes adverse local environmental impacts, for example from toxic emissions, then a cap-and-trade framework would not be appropriate without steps taken to safeguard against the creation of emission hotspots.

- ***Administrative Feasibility:*** The sources included in a cap-and-trade program must not be so small that they make administration of the program cost prohibitive. If sources are too small, reporting and compliance tracking costs for both the complying entities and the program administrators will be out of proportion to the emission reduction benefit achieved.

- ***Adequate Number of Sources:*** To create a vibrant market for trading emission allowances, a sufficient number of sources must be included in the program, ideally with diverse costs and opportunities for reducing emissions.

Applying these criteria to GHG emission sources in California, we find that some sources fit well, and others are less appropriate for inclusion in a cap-and-trade framework. Facilities with

large stationary sources, particularly those emitting carbon dioxide (CO_2) from fossil fuel combustion, are the best fit for a cap-and-trade program: emissions can be measured or calculated reliably, GHG emissions do not cause local environmental impacts, and the size and number of facilities are appropriate.

The situation for process emissions is mixed. CO_2 emissions from clinker production during cement manufacturing can be calculated reliably. Alternatively, some types of process emissions, such a fugitive emissions, are less amenable to measurement or calculation at the facility level. Consequently, many fugitive emissions sources may not work will under a cap-and-trade program.

Emissions from biological processes can also be difficult to quantify, and may not work well under a cap-and-trade program. Examples of biological sources include enteric fermentation from livestock, manure management, soil cultivation and fertilizer application. Emissions and sinks in forests also rely on biological processes. While emission inventories for forested areas have been developed, they may not be suitable for use in a program that allows trading among sources because the forestry emission/sink estimates are much more uncertain than the emission reports for other sources.

Finally, some sources are too small to be included in a cap-and-trade program as individual facilities. For example, each residence with a gas furnace or a gas cook top/oven is a source of CO_2 emissions. Similarly, each gasoline-fueled passenger car emits several GHGs. It is not practical, and it is unlikely to be effective, to cap emissions at each home or each car. As discussed below, capping emissions from these small sources requires focusing upstream, such as on total fuel use.

Exhibit 1 applies these criteria to the California emission inventory. Sources that are highly suitable for including in a cap-and-trade program include electricity generation, many industrial sources, and cement production. Sources that are somewhat suitable include methane emissions from landfills and petroleum and natural gas supply and some sources of emissions of high global warming potential (GWP) GHGs. As a group, these sources account for about 35% to 40% of statewide GHG emissions.

Not included in this group are emissions from transportation, which account for more than 40% of statewide GHG emissions. Given the importance of this sector in the state's GHG emissions, alternative strategies for reducing emissions are warranted, such as an upstream cap-and-trade approach (discusses in Section 3.2.3) or other policy options (discussed in Section 3.2.1.3 and Section 5). Residential and commercial fossil fuel combustion account for another 8.5% of emissions. An upstream approach would also be appropriate for capping emissions from these sources, which are too diffuse to include individually.

Alternative regulatory approaches may be needed to reduce emissions from those sources that are not suitable for including in a cap-and-trade program. The next section discusses tradable emission reduction credits, and how the concept can be used to motivate emission reductions from sources outside the emission cap. Section 5 discusses how other regulatory approaches can complement a cap-and-trade program.

2.3 Do Tradable Emissions Reduction Credits Play a Role in Cap and Trade?

Tradable emission reduction credits (ERCs) are another form of market-based policy for reducing emissions. Although a tradable ERC program is not the same as a cap-and-trade program, the ERC concept can be included in a cap-and-trade program as *emission offsets*.

Exhibit 1: Suitability of California GHG Emission Sources to a Cap-and-Trade Framework

Emissions Source	2002 Emissions (MMT CO_2-eq)	% of State Inventory	Suitability for Cap and Trade
Carbon Dioxide Emissions	***391.5***	***82.6%***	
Fossil Fuel Combustion			
Transportation	189.9	40.1%	Individual sources too diffuse. Address upstream.
Electricity Generation – In-state	43.5	9.2%	Highly suitable.
Electricity Generation – out-of-state	51.7	10.9%	Highly suitable.
Industrial	74.6	15.7%	Many sources highly suitable.
Residential and Commercial	40.3	8.5%	Individual sources too diffuse. Address upstream.
Other	0.7	0.1%	
Cement Production	6.2	1.3%	Highly suitable.
Land Use Change and Forestry Emissions	4.3	0.9%	Not well suited to cap and trade.
Other Carbon Dioxide Emissions	0.7	0.1%	
Land Use Change and Forestry Sinks	-20.3	-4.3%	Not well suited to cap and trade.
Methane Emissions	***31.3***	***6.6%***	
Enteric Fermentation, Manure Management, Rice Fields	14.5	3.1%	Not well suited to cap and trade.
Landfills	10.1	2.1%	Somewhat suitable.
Petroleum and Natural Gas Supply	2.8	0.6%	Somewhat suitable.
Wastewater Treatment	1.9	0.4%	Not well suited to cap and trade.
Fossil Fuel Combustion (Stationary and Mobile Sources)	1.8	0.4%	Stationary sources highly suitable.
Burning of Agriculture Residues	0.1	0.0%	Not well suited to cap and trade.
Nitrous Oxide Emissions	***33.6***	***7.1%***	
Agricultural Soils	18.6	3.9%	Not well suited to cap and trade.
Fossil Fuel Combustion (Stationary and Mobile Sources)	12.9	2.7%	Stationary sources highly suitable.
Other Nitrous Oxide Sources	2.1	0.4%	
High Global Warming Potential (GWP) Gases	***17.3***	***3.7%***	
Substitution of Ozone Depleting Substances	15.5	3.3%	Individual sources too diffuse.
SF_6 from Electricity Transmission and Distribution	1.2	0.3%	Somewhat suitable.
Semiconductor Manufacture	0.5	0.1%	Somewhat suitable.
Total California Emissions	***473.8***	***100.0%***	

Excludes international bunker fuel carbon dioxide emissions of 31.8 MMT. Values may not add to totals due to rounding.

Source: Bemis, Gerry and Jennifer Allen, *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2002 Update*, California Energy Commission Staff Paper, Sacramento, California, Report CEC 600 2005 025, June 2005, Table 1, p. 21.

An ERC can be created by a facility that reduces its emissions below some pre-existing regulatory baseline level of emissions. Once the emission reduction is verified, a tradable instrument, an ERC, is issued by the regulator to the entity that achieved the emission reduction. The ERC can be sold to a second entity that is required to reduce its emissions. The emissions reduction represented by the ERC is used by the second entity to comply with its emission limit.

Under an ERC-based program, trading ERCs provides a facility with flexibility on how to achieve its regulatory baseline. The facility may reduce emissions or purchase ERCs from another facility with excess emission reductions. As part of a cap-and-trade program, tradable ERCs can be used to motivate emission reductions from entities that are ***outside*** the cap. As discussed in the previous section, a cap-and-trade program may exclude certain types of emission sources. Tradable ERCs can be used to motivate and capture emission reductions from entities outside the cap using the following process:

- An entity would undertake a project that reduced emissions from sources that are outside the emission cap. Once the emission reduction is verified, a tradable instrument would be issued by the regulator that represents the emission reduction.
- An entity that is covered by the cap can purchase the instrument that represents the verified emission reduction and use it as an emission allowance.

Using this process, entities ***inside*** the cap can pay for verified emission reductions achieved by sources ***outside*** the cap. In the discussion in Chapter 3, we refer to these verified emission reductions as ***emission offsets***. Offsets can be a valuable component of a cap-and-trade program by increasing the diversity of emission reduction opportunities that are available to help achieve the cap.

2.4 Recent Experience with Cap and Trade as a Market-Based Emissions Reduction Policy

In the United States three cap-and-trade programs have been used to reduce air emissions: The Acid Rain Trading Program; the Northeast NOx Budget Program; and the Regional Clean Air Incentives Market (RECLAIM) Program. A full description of these programs is beyond the scope of this paper. Several summaries are available for review, including: *Emissions Trading in the U.S.* (Ellerman, Joskow, and Harrison); "How Environmental Laws Work: An Analysis of the Utility Sector's Response to Regulation of Nitrogen Oxides and Sulfur Dioxide Under the Clean Air Act" (Swift); *US Experience with Emissions Trading* (Clean Air Action Corporation); and *An Evaluation of the South Coast Air Quality Management District's Regional Clean Air Incentive Market – Lessons in Environmental Markets and Innovation* (USEPA).[3] The following are brief overviews of the three U.S. programs, followed by a brief summary of the newly developed European Union Emission Trading program.

Acid Rain Trading Program

Title IV of the Clean Air Act Amendments (CAAA) of 1990 set a goal of reducing annual sulfur dioxide (SO_2) emissions by 10 million tons below 1980 levels. To achieve these reductions, the CAAA established an emissions trading system to reduce SO_2 emissions from fossil-fuel burning power plants in the continental 48 states. The program consisted of two phases:

- Phase I, from 1995 to 1999, covered 263 electric generating units larger than 100 MW with an annual average emission rate in 1985 greater than 3.4 kilograms of SO_2 per kJ of heat input. Emissions caps for these Phase I units were provided in the Act.

- In Phase II, beginning in 2000, additional plants having generating units larger than 25 MW were added to the program. Phase II limited emissions to an annual cap of 8.12 million tons, equivalent to an average emission rate of 0.98 kg/kJ, when divided by the mid-1980s level of heat input at fossil-fuel burning power plants. This cap level is about half of the total electric utility SO_2 emissions in the early 1980s.

Phase II generating units had the option of opting-in to the program in Phase I, and industrial units emitting SO_2 had the option of participating in the program, starting either in Phase I or Phase II.

Caps on emissions were implemented by issuing tradable allowances that in total equaled the annual cap. To comply, sources were required to surrender one allowance for each ton of emissions. A source that had more allowances than it needed could sell its excess allowances, and sources that required additional allowances to cover emissions could purchase allowances. Allowances not used in the year they were issued could be banked for future use.

Most of the allowances were issued to sources on the basis of each unit's average annual heat input during the three-year baseline period, 1985 to 1987, multiplied by their specified emissions rate, which in turn depended on the plant category. In all, each of 35 different types of plants received allowances based on a different formula. A small share (2.8 percent) of allowances was sold through an annual auction conducted to ensure the availability of allowances for new generating units. The revenues from these sales were returned to the owners of the existing units on a *pro rata* basis.

The trading program relied on emissions monitoring equipment and tracking provisions. All participating units were required to use continuous emissions monitoring systems (CEMS) or an approved alternative measurement method. The data are made available publicly to ensure program transparency. At the end of the year, compliance is demonstrated by comparing each unit's allowances to the unit's total annual SO_2 emissions. Units with too few allowances are subject to two penalties: (1) a fine; and (2) a requirement to offset the excess emissions with an equivalent number of allowances.

Following implementation of the program, an allowance market emerged and a significant amount of trading took place. As explained by Ellerman, Joskow and Harrison, the allowance trading market has been active and efficient, with reliable price discovery and liquidity.[4] Swift confirms the effectiveness of the trading market, highlighting the transparency and consistency of price quotes.[5] However, Swift also points out that a relatively small portion of the trading activity has been inter-firm trades performed for emission compliance purposes.

The Acid Rain Program has experienced a near-perfect record of compliance. Because all participating units must have working CEMs, there is no question as to the number of allowances that are needed for compliance. The fine for non-compliance is significant (roughly ten times greater than the cost of allowances) and automatic. The ability to "bank" unused emission allowances from one period into subsequent periods is credited with producing significant levels of early emission reductions.

The overall view of the program is that it has successfully reduced SO_2 emissions in a manner that cost less than what would have likely been the case with command-and-control style requirements. Ellerman, Joskow and Harrison estimate that during the first 13 years of the program, compliance costs were reduced by 57% as a result of the ability to trade emission allowances across affected units.[6]

Northeast NOx Budget Program

Section 176 of the Clean Air Act permits the creation of commissions to deal with regional air pollution issues, and Section 184 of the Act specifically created the first such commission, the Ozone Transport Commission (OTC). The OTC was created to coordinate actions among the Northeastern and Mid-Atlantic States and the District of Columbia to address persistent air quality problems along the Northeastern Corridor. In 1994, these jurisdictions signed a Memorandum of Understanding that established the "NOx Budget Program" to control NOx emissions from electric utility and large industrial boilers.

NOx is a criteria pollutant regulated under the Clean Air Act, and contributes to various environmental problems including the formation of ozone or "smog." After initially controlling NOx through technology standards, the OTC implemented a cap-and-trade program to limit emissions in the entire region during the May to September ozone season. The states developed a model emissions trading rule that all could adopt. Each state retained control over how to allocate emission allowances within their state. Electric generators with capacities of 15 MW or greater, and comparably sized industrial boilers were included in the program.

The initial phase of the program, running from 1999 through 2002, included 11 states and the District of Columbia. The program covered more than 900 electric generating units and more than 100 industrial sources.[7] During this phase, the cap was set at a reduction of about 60% from pre-control 1990 levels. Starting in 2003, the program was revised to incorporate 19 states and the District of Columbia, and is referred to as the NOx SIP Call program. The cap was reduced to set a 75% reduction, starting in 2003.

While similar to the acid rain trading system, a key feature of the NOx program is that it restricts the use of banked emission allowances. The restrictions were instituted to prevent significant increases in emissions over the emissions cap. If the total amount of banked emission allowances used in a year exceeds 10% of the cap, a portion of the banked allowances are "discounted" by 50%. The portion of banked allowances discounted increases as the number of banked allowances exercised increases.

Reportedly, the NOx trading market got off to a slow start, but subsequently has developed into an active market.[8] Significant price volatility was observed in the first year of the program, which subsequently leveled out.[9] As with the acid rain program, the opportunity to trade emission allowances has been credited with significantly reducing the cost of achieving the emission targets.

Overall, through a combination of emissions standards and the cap-and-trade program, the OTC region achieved a 59% reduction in NOx emissions between 1990 and 2002. All participating states except for Maryland and the District of Columbia had emissions below their NOx budget levels in 2002, and both average and peak daily emissions have declined overall. Emission reductions have continued to be achieved under the NOx SIP Call implementation of the program. In 2004, ozone season power industry NOx emissions were reduced by about 30% from 2003 levels and by about 50% from 2000 levels (before the NOx SIP Call was implemented).[10]

One of the significant innovations of the OTC cap-and-trade program is that it was implemented using a coordinated multi-jurisdictional approach. The participating states developed complementary rules and facilitated the creation of a regional emission trading market.

RECLAIM

The Regional Clean Air Incentives Market (RECLAIM) is a cap-and-trade program developed and implemented by the California South Coast Air Quality Management District (SCAQMD).

The objective of the program is to improve air quality by reducing NOx and SOx emissions in the South Coast air basin. Adopted in October 1993, the program includes more than 350 participants in its NOx market and about 40 participants in its SOx market.[11]

As a market-based program, RECLAIM provides flexibility regarding how to reduce emissions and comply with the emission cap. NOx and/or SOx emission allocations were issued based on historical activity levels and applicable emission controls. Facilities have the option of reducing emissions to the level of their emission allowance allocation or purchasing RECLAIM Trading Credits (RTCs) from other facilities.

The RECLAIM emission goal was to reduce NOx and SOx emissions from the affected facilities by about 50% by 2003 from early-1990 levels.[12] The mechanism for allocating emission allowances was reportedly contentious, with numerous competing formulas considered.[13] The program incorporated unique features, including geographic limits on trading of emission allowances. Facilities in the coastal zone were permitted to purchase emission allowances only from facilities located in the coastal zone. Facilities in the inland zone could purchase emission allowances from facilities in either the coastal or the inland zone. This trading limitation was used to prevent coastal emissions from increasing and adversely affecting the inland area (which is generally downwind of the coastal area).[14] The program also limited emission banking in order to prevent emissions from increasing in future years.

During its initial years of implementation, a RECLAIM trading market developed. Actual emissions were below the cap in the early years, so that trades were primarily for allowances that applied to later years. Because emissions were below the cap, allowance prices were modest and new emission control equipment was not required. In 2000, the RECLAIM trading market for NOx experienced significant price spikes that subsequently had a serious adverse impact on the program. The factors that contributed to the problems were examined by the U.S. EPA in 2002. Among the factors cited are:[15]

- During 1999 and 2000 the emission cap became binding for the first time. The actual emissions from the participating facilities approached and exceeded the emission cap. Program participants were unaware that the emission cap would become binding during this period.
- Installing emission controls had not been a priority prior to the 1999/2000 period. Aggregate emissions were below the cap and RTCs were available at reasonable prices.
- When the emission cap become binding, there was a shortage of RTCs. Facilities were unable to comply by reducing emissions quickly because of lead times to install equipment. Prices for RTCs increased from previous levels of on the order of $4,000 per ton in 1999 to more than $45,000 per ton.[16] Some participants reduced output to reduce emissions, while others purchased RTCs at high prices.
- During this period, adverse impacts from the deregulation of the electric power sector in California were also being felt. Opinions vary regarding the contribution of the power sector deregulation problems to the price spikes in the RECLAIM trading market.[17]

As a result of these events, NOx emissions exceeded its cap in 2000, although the majority of facilities were able to remain in compliance. The program was changed to exclude electric generators, who were returned to a command and control regulatory regime. The electric generators were allowed to pay an emission mitigation fee of $15,000 per ton when they exceeded their caps, with revenues used to pay for emission reductions elsewhere.[18]

This experience with RECLAIM demonstrates how unacceptably volatile market swings can adversely affect a cap-and-trade program. Whether the price spikes would have occurred in the

absence of the electric power industry deregulation problems is not known. Because the emission caps had not been binding for the initial years of the program, program participants may have become complacent, and as a result they may have under-invested in emission control equipment. The lack of emission banking has also been cited as a factor that limited the flexibility of facilities to comply by moving emissions among time periods.

European Union Emission Trading Program

The European Union has adopted a cap-and-trade program to control emissions of greenhouse gases. This program, being initiated in 2005, will be the largest cap-and-trade program in the world, involving 25 countries and more than 12,000 installations. The program is designed to cap emissions by allocating emission allowances to facilities that fall under the cap. The emission allowances may be traded among participating facilities. Kruger and Pizer summarize the program features, including the following:[19]

- The EU emission limit was allocated to each of the member countries. Each country is responsible for complying with its national limit.
- The emission trading program covers four sectors:
  - Energy: electric power, oil refineries, and coke ovens;
  - Metal ore, iron and steel production;
  - Minerals: cement, lime, glass, and ceramics; and
  - Pulp and paper.
- (CO_2) emissions are covered in the initial implementation, with the possibility of additional gases being added later.
- Each member state must develop and submit a plan for how it will distribute emission allowances to the affected facilities. Up to 5% of emissions allowances may be auctioned during the first compliance period (2005-2007) and up to 10% may be auctioned during the second compliance period (2008-2012). All remaining allowances must be distributed to participating installations.
- Installations are required to prepare and report installation-specific emission inventories. Installations must hold sufficient emission allowances to cover their total emissions during the compliance period.
- Emission offsets from outside the EU can be used by member countries to meet their national emission limits.
- Banking of emissions is permitted between compliance periods. Each member state may develop its own rules for banking.
- Emissions in excess of allowances will result in a penalty of €40 per ton of CO_2 during the first compliance period and €100 per ton during the second compliance period.

Because this is a new program, it is too early to draw conclusions regarding its effectiveness. The program is designed to have very broad coverage across sources, and focuses on the GHG (CO_2) for which emissions estimates are most reliable. The fixed non-compliance penalties provide an upper bound on the compliance costs for the program.

2.5 Is Cap and Trade Appropriate for Reducing Greenhouse Gas Emissions in California?

It is appropriate to ask whether a cap-and-trade strategy is an appropriate policy tool to consider for reducing GHG emissions in California. In particular, do the sources of GHG emissions in the state have the characteristics needed to enable a cap-and-trade program to operate successfully? We find that many of the necessary elements exist to support the use of a cap-and-trade program.

- ***Multiple Diverse Sources:*** GHGs are emitted by a large and diverse set of sources in the state. Depending on how many sources the program is designed to cover, there appear to be enough sources to support an emission allowance trading market.
- ***Diverse Emission Reduction Opportunities:*** The diverse set of GHG emission sources has a wide variety of emission reduction opportunities. Therefore, significant benefits may be derived from allowing trading of emission allowances. The allowance market will provide value by enabling the least-cost emission reduction options to be implemented first.
- ***Most Emissions Can be Estimated with Confidence:*** CO_2 emissions, particularly from fossil fuel combustion, can be estimated with enough precision to enable facility-level emission reports to be prepared and verified. The facility-level reports can be used to track emissions and compliance. Most of the non-CO_2 emissions are more difficult to estimate, and it will be more difficult to ensure the quality of non-CO_2 emission reports. Consequently, the non-CO_2 emissions may not be as suitable for inclusion in a cap-and-trade program at this time.
- ***Compliance Flexibility:*** Unlike criteria pollutants and toxics that affect local air quality, GHGs have no direct local air quality impacts. Consequently, emission trading is not expected to produce adverse local environmental impacts due to concentrations of GHG emissions. Additionally, GHGs have long atmospheric lifetimes, so that emission banking over several years can also be used to provide compliance flexibility without adversely affecting total GHG abundance in the atmosphere. However, potential impacts may arise from spatially concentrated emissions of pollutants that are produced jointly with GHGs in some processes. Potential environmental justice concerns in this regard are discussed in Section 4.

While these points support the applicability of a cap-and-trade program, as discussed above in Section 2.2, not all sources are conducive to being included in a cap-and-trade program. Sources highly or somewhat suitable for including in a cap-and-trade program account for only about 35% of statewide GHG emissions (see Exhibit 1 above). Most notably, the largest source of GHG emissions in the state, the transportation sector, is not easily included in a cap-and-trade program, unless an upstream approach is used.

There are several issues that need to be addressed in order for a cap-and-trade program to work properly in California. Although the state has various regulatory agencies and authorities, an organization responsible for the program must be defined, and additional regulatory authority is likely to be required. Also, the state GHG emission inventory does not currently include facility-level emissions data. A comprehensive facility-level emission inventory is needed to provide the foundation for developing a cap-and-trade program, including defining the facilities that would fall under the cap and estimating the portion of total state emissions that we be included. Some form of mandatory reporting of facility-level GHG emissions would be needed to establish an effective and workable program.

The primary weakness associated with implementing a cap-and-trade program only in California is that it will be vulnerable to emission leakage. If the state implements the program without

other western states, there will be an incentive for activities that emit GHGs to shift to neighboring states to avoid the emission cap. If this occurs, emissions may decline in the state, only to increase in neighboring states. A coordinated national approach to capping GHG emissions within an international framework would be the best approach for addressing this leakage problem. In the absence of national action, or even regional action, the leakage issues may only be partially mitigated. If the state implements a cap-and-trade program without regional or national coordination, data should be collected to track leakage over time so its impact can be assessed on the state economy and on the effectiveness of the emissions cap.

3. Cap-and-Trade Program Design Options for Reducing Greenhouse Gas Emissions in California

3.1 Program Design Options

This chapter presents the design options for a cap-and-trade program. The chapter is divided into the following sections:

- ***Scope:*** The scope of the cap-and-trade program defines the sectors, sources, or activities that are included under the cap. Based on the scope, the entities or facilities required to participate in the program can be identified. Entities and facilities that fall outside the scope of the program are not required to participate.
- ***Greenhouse gases covered:*** The greenhouse gases (GHGs) included in the cap-and-trade program must be defined.
- ***Allowance distribution:*** The method by which emission allowances are distributed to entities and facilities included in the program must be defined.
- ***Allowance trading:*** The program must define whether and how to allow trading of allowances.
- ***Allowance banking and borrowing:*** The manner in which allowances can be banked for future use or borrowed against future limits must be defined.
- ***Emission offsets:*** Offsets are verified emission reductions achieved by entities and facilities that do not fall under the cap-and-trade program. Whether to allow entities under the program to comply with the cap by acquiring emission offsets must be determined.
- ***Compliance and enforcement:*** The manner in which compliance and enforcement will be performed must be defined.

In each section below, the design element is defined, and options are provided with a discussion of the pros and cons for each.

Prior to examining each of these program design elements, it is useful to emphasize two overarching principles regarding cap-and-trade programs. As discussed above in Chapter 2, a primary benefit of using a cap-and-trade program to reduce GHG emissions is its ability to reduce emissions at the least possible cost. Taking maximum advantage of this fundamental aspect of a cap-and-trade program implies the following design considerations:

- ***Broad Coverage is Preferred:*** Broad coverage has multiple benefits for a cap-and-trade program. First, it helps to ensure that emissions will be reduced at the lowest possible cost. By covering a broad range of emission sources, the program can capture the least-cost emission reduction opportunities. Second, broad coverage enlarges the set of emissions sources with an incentive to innovate to find ways to reduce emissions. Spurring innovation is an important mechanism by which a cap-and-trade program helps to lower the cost of reducing emissions. Third, broad coverage enables the cap-and-trade program to have a direct impact on a large portion of total GHG emissions. Broad program coverage generally argues in favor of a broad scope, including as many sources as possible and including all GHGs. Broad coverage also implies that offsets should be incorporated into the program to capture emission reduction opportunities that fall outside the cap.
- ***Flexibility is Preferred:*** Flexibility is critical to lowering the cost of reducing GHG emissions. Cap-and-trade programs provide those that fall under the cap with the flexibility

to meet their obligation under the cap using methods of their own choosing. Some entities may choose to reduce emissions, while others may prefer to purchase emission allowances. The opportunity to trade emission allowances is the fundamental mechanism that enables the low-cost emission reduction options to be undertaken. Flexibility argues in favor of: unrestricted trading of emission allowances; the incorporation of emission offsets into the program; and the ability to bank and borrow emission allowances across time periods.

The desire for broad coverage and maximum flexibility must be tempered by administrative realities and industry-specific considerations. As discussed above in Section 2.2, not all sources are appropriate for including in a cap-and-trade program. Consequently, there is no one best answer for how to design a cap-and-trade program to reduce GHG emissions. Rather, trade-offs are required to create a program that promotes low-cost emission reductions in a framework that is equitable and administratively feasible.

3.2 Program Scope

The scope of the cap-and-trade program defines the industries, sectors, emission sources, or activities that are included under the cap. Based on the scope, the entities or facilities required to participate in the program can be identified. Entities and facilities that fall outside the scope of the program are not required to participate.

We examine three ways in which the scope of the program could be defined:

- ***Sectors:*** Scope can be defined by the industry sectors included in the program.
- ***Stationary Combustion Sources:*** The scope can be defined to encompass all major fossil fuel stationary combustion sources. Under this option, sources would be included without reference to their industry sector.
- ***Comprehensive Fuels:*** The scope can be defined by the fossil fuels covered by the cap.

Each of these three approaches can be implemented at varying degrees of comprehensiveness of coverage. Each is discussed in turn.

3.2.1 Scope Defined by Sectors

The scope of the cap-and-trade program can be defined in terms of ***sectors*** that are required to participate in the program and comply with the emissions cap. A “sector” can be considered to be a set of facilities that conduct similar activities to produce a similar set of goods or services. To define the scope in terms of sectors, a list of facilities that fall into each sector would be required. Developing this list of facilities would be a critical first step in creating a cap-and-trade program organized by sectors.

In the United States, the North American Industry Classification System (NAICS) is used to describe economic activity by industry sector.[a] The NAICS groups “like processes” that are used to produce goods or services to provide a "production-oriented" classification system. Therefore, NAICS codes could be used to define the sectors included in the program. One advantage of relying on NAICS codes is that these codes are recognized throughout the U.S., enabling a California-based program to be harmonized with a regional or national cap-and-trade program. Additionally, NAICS is used in Canada and Mexico, providing the potential to facilitate coordination with GHG programs in those countries.

[a] In 1997 the NAICS replaced the Standard Industrial Classification (SIC) Code system in the U.S. A description of NAICS is available from the U.S. Bureau of the Census at: http://www.census.gov/epcd/www/naics.html.

Ideally, as many sectors as possible should be included in order to have the broadest scope possible. Exhibit 2 presents a summary of the number of entities and the portion of total state GHG emissions accounted for by each of the sectors discussed here. Our discussion of sectors is divided into the three parts shown in the exhibit.

- ***Electric Power Sector:*** Depending on how the electric power sector is defined, as much as 20% of the state GHG inventory could be covered by this sector, making it the second-largest source in the state. Section 3.2.1.1 discusses several alternatives for defining the electric power sector.
- ***Other Industrial Sectors:*** The other industries that could reasonably be included in the program account for about 10% of total GHG emissions in the state. Section 3.2.1.2 discusses these other sectors.
- ***Mobile Sources:*** The mobile source sector accounts for about 42% of total state emissions, making it the largest source in the state. As discussed in Section 3.2.1.3, there are challenges to including mobile sources in a cap-and-trade program that is defined in terms of sectors.

Exhibit 2: Summary of Sectors for Defining Program Scope

Sector	# Entities	Portion of State GHG Emissions
Electric Power Sector:		
Generation Based: In-state generators (≥25 MW)	≈313 facilities	≈10%
Load Serving Entity Based:		
Investor Owned Utilities Only	3 IOUs	≈14% (approx)[a]
All Load Serving Entities	≈47 LSEs	≈20%[a]
Other Sectors:		
Oil Refining	21 refineries	≈3%
Oil and Gas Extraction	429 facilities	≈3%
Landfills	≈300 landfills	≈2%
Cement Production	11 cement plants	≈1.5%
Others	(various)	<1%
Mobile Sources:		
Motor Gasoline (light duty vehicles, on and off road)	(see text)	≈28%
Diesel – on road		≈7%
Domestic Aviation		≈6%
Other		<2%

a. Includes emissions from electricity imports.

Sources: Number of entities from various state databases, see text. GHG emissions estimates from Bemis, Gerry and Jennifer Allen, *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2002 Update*, California Energy Commission Staff Paper, Sacramento, California, Report CEC-600-2005-025, June 2005.

We have not included several sectors in our discussion of a sector-based approach to defining the scope of the program. Residential and commercial fossil fuel combustion (almost exclusively natural gas) is not easily included in a sector-based cap-and-trade program due to the very large number of sources involved. We excluded agriculture sources from consideration, including emissions from livestock, manure management, and soils, because emissions from these biogenic processes are difficult to quantify precisely at the facility level.

Finally, input from stakeholders and others suggests strongly that forest-management emissions are better addressed as part of an offset approach, rather than under the cap (see Section 3.7).

3.2.1.1 Electric Power Sector

The electricity sector is the second largest source of GHG emissions in California, following the mobile source sector, which is the single largest source of GHG emissions in the state. The electricity sector accounts for nearly 20% of total statewide emissions of greenhouse gases, if emissions from imported power are included in the total.

- In-state electricity generation represents approximately 80% of electricity consumed in California and 10% of total state emissions of greenhouse gases.
- Imported power accounts for about 20% of electricity consumed in California, and 10% of the total state emissions.

Compared to in-state generation, imported power has higher GHG emissions per unit of electricity because 50% of imported power is produced from coal, while virtually no in-state power is supplied from coal.

We examined two main options for including the electric power sector in the scope of a cap-and-trade program.

1. California Power Plants of 25 MW or Larger. Under this option, in-state electric power plants of 25 MW or larger would be required to comply with an emissions cap. Each electric power plant would be required to hold emission allowances that covered its emissions. The California Energy Commission (CEC) reports that there are approximately 313 fossil fuel-burning generating facilities that operate in the state that meet this criterion, including 98 facilities that are identified as co-generation facilities. These facilities account for about 90% of the electricity generated from fossil fuel in the state, and about 55% of total power generation in the state. The overwhelming majority of this electricity is produced from natural gas. The primary limitation of this option is that out of state imported power would not be included in the cap. As described above, imported power is a significant contributor to California's GHG footprint.
2. Load Serving Entities (LSEs). Under this option, the electric power industry is defined in terms of LSEs rather than power plants. A LSE is an organization responsible for procuring and delivering electric power to customers. In California there are three investor owned utilities (IOUs) that are LSEs: Pacific Gas and Electric; Southern California Edison; and San Diego Gas and Electric. Municipal utilities, irrigation districts, the Department of Water Resources, and private electric service providers are also LSEs.

   Each LSE would be required to hold emission allowances that cover the emissions associated with the power they deliver to their customers. To comply with its emission limit, each LSE would be required to track or calculate the emissions associated with all the electricity it delivered, regardless of whether it was produced in California or generated and imported from out of state sources. To implement this option, the power sector must track emissions associated with all power generation through the market to its eventual delivery. No such tracking system exists today. Options for creating this tracking include: relying on average emissions rates by region, season and time of day; requiring power contracts to include emissions data for electricity delivered; requiring tracking of emissions characteristics for all power (with the possible exception of power sold on the spot market); and other methods. Methodologies have been developed that provide a good starting point to implement these options.

This LSE approach differs fundamentally from the option of focusing on generators. Under the LSE approach, LSEs are required to hold the allowances – not the generators. Each LSE would have the responsibility to obtain power from the set of generators that enables it to comply with its emission cap. LSEs could trade emission allowances: those with extra allowances could sell to those who need additional allowances, given their procurement decisions.

The California Public Utilities Commission (CPUC) currently has regulatory authority over the investor-owned utilities (IOUs). With its existing authority, the CPUC could require the three main IOUs (PG&E, SCE, and SDG&E) to limit their total GHG emissions associated with the power they deliver to their customers. These three utilities account for about 70% of the electric power delivered statewide.

With new regulatory authority provided by the California Legislature, all the LSEs statewide could be included in the cap. In addition to the three main IOUs, there are two large municipal utilities: Los Angeles Department of Water and Power (LADWP) accounts for about 9% of the power delivered in the state; and Sacramento Municipal Utility District (SMUD) accounts for about 4%. Other LSEs include: the California Department of Water Resources (DWR) with 3% of state load; and municipal utilities, irrigation districts, private electric service providers, and potentially community choice aggregators with 10% of state load. About 4% of power is self generated. There are 47 LSEs overall that would be included in the program.

There are pros and cons for each of these options. The generator-based option (including only California power plants), would likely be simpler to implement than a LSE-based cap. All the facilities that would fall under the generator-based cap are well identified. There is also a solid basis of emissions data for these facilities because carbon dioxide (CO_2) emissions data from individual power plants of 25 MW or greater are currently available via U.S. EPA's Continuous Emissions Monitoring System (CEMS) program, California Air Resources Board (CARB) reporting requirements, and other generator reporting requirements. The generator-based approach is also consistent with existing regulatory programs that limit emissions from stationary sources.

However, there are two significant drawbacks to the generator-based approach:

- Leakage: A key drawback of the generator-based approach is that it excludes emissions from imported electricity. A cap on emissions from in-state electric power plants would provide an incentive to build new power plants in other states, and to import the power in order to avoid the in-state emissions limit. This result is called "leakage" in that emissions "leak out" from under the cap, in this case into neighboring states. With this leakage, the cap on in-state emissions does not necessarily produce any real emission reduction, as electric power generation increases outside the state.
- Comprehensiveness: In-state generators account for about one-half of the emissions associated with state electricity consumption. Therefore, the generator-based approach would exclude half the emissions from this sector.

The potential for significant leakage over time makes the generator-based option particularly unattractive for a California-only program. Unfortunately, requiring out-of-state generation facilities to submit to California's GHG emission cap cannot solve this leakage problem because California does not have authority over out-of-state facilities. The leakage problem for California could be solved if all the states and provinces in the Western Interconnect were included in the cap-and-trade program, at least for the electric power sector. Such a regional approach may be

preferred for a variety of reasons, including the ability to address this leakage problem. However, it is beyond the capability of California to implement on its own.

A significant advantage of the LSE-based approach is that it solves the problem of providing an incentive to locate new electricity production outside of California. In-state and out-of-state generation are treated equally under the LSE-based option, and the cap applies to total emissions associated with all electricity consumed in the state.

However, the LSE-approach requires LSEs and their suppliers to have an emissions-tracking capability that does not currently exist. In addition, some form of mandatory reporting would need to be established. Most LSEs procure power from various sources under a variety of purchase agreements. Some procurement agreements specify the specific sources of the power being provided. The emissions associated with these energy purchases from specific sources can be known today. Alternatively, some procurement agreements do not specify the source of the power being provided. The provider has flexibility to secure power from various sources, which may vary from day to day. The emissions associated with these energy purchases cannot be precisely determined today. Additionally, some power is purchased on the spot market. The generation source of the spot market power is not typically known.

In order to implement the LSE approach, a system is required that enables LSEs to know the emissions characteristics of all (or nearly all) the power they procure. Developing such a tracking capability presents significant challenges.[20] Based on input from industry experts, we believe that there are several workable approaches for solving this problem. We recognize that significant effort would be required, but suggest that initiating an effort to develop a tracking capability that enables a LSE-based approach to be used is worthwhile.

There is a second type of leakage that must be addressed under the LSE-based option. To help LSEs comply with their emission limits, suppliers with multiple generation units could selectively assign output from low-emitting units to California's LSEs, while continuing to serve non-California load with the units that have higher emissions. This action is referred to as "contract shuffling." The immediate short-term impact of contract shuffling would be that low-emitting units are "assigned" to serve California load. As a result, it would "appear" that California had reduced its electric power sector emissions, when in fact no actual emission reduction had been achieved.

The potential impact of contract shuffling would need to be addressed to prevent this leakage. For example, the level of the emission cap could be set with the expectation that a certain amount of contract shuffling will take place. In this way, it would not be possible to use contract shuffling *alone* to meet the emission cap, and real emission reductions would need to be achieved. Also of note is that contract shuffling does not appear to be a viable *long term* strategy for complying with a declining emissions cap. The assignment of existing low-emitting units to California LSEs would be a one-time event: once all the existing low-emitting units are spoken for, additional emission reduction would need to be achieved through other means. Therefore, over the long term, contract shuffling may have little adverse impact on the effectiveness of the cap-and-trade program to reduce emissions from the electric power sector.

In terms of coverage, we see that the options defined here have varying levels of comprehensiveness. As discussed above, a broader, more comprehensive program is desired to cover a large portion of emissions and to capture a rich and diverse set of emission reduction opportunities. Focusing only on in-state power plants would limit the portion of emissions covered. Additionally, in-state generators have a fairly limited set of technical options for reducing emissions.

The LSE-based approach is more comprehensive, providing more emissions coverage and a more diverse set of options for reducing emissions. Of course, the all-LSE approach would be more comprehensive than the IOU-only approach. Additionally, an IOU-only approach would create an inequity between the IOUs and the other LSEs. While this inequity may not significantly disadvantage the IOUs themselves, it could increase electricity rate differences between the IOU and non-IOU service territories. It is also worth noting that some of the non-IOUs have not committed to the Renewable Portfolio Standard (RPS) and energy efficiency goals beyond current statutory requirements. Consequently, some have suggested that some non-IOUs are the entities most in need of being included under a GHG emissions cap.

The LSE-based cap also motivates emission reduction opportunities that are not motivated by a generator-based system. To comply with its emission cap, a LSE could promote energy efficiency among its customers as a means of reducing the load itself. Under CPUC direction, the IOUs have established aggressive energy-efficiency goals, with energy efficiency being identified as the "…first in the "loading order" of resources used by utilities to meet their customers' energy service needs."[21] LSEs can also procure renewable-based power or shift to fossil-generated power sources with lower emissions. A LSE by its nature has a broader set of opportunities for achieving its emissions cap, as compared with an individual power plant owner/operator.

Prior to implementing a GHG emissions cap for the electric power sector, the impacts of a cap on system reliability and electric rates need to be assessed. The cost impacts on various classes of customers, including low-income customers need to be examined. Because the IOUs are regulated, the CPUC will determine how costs are shared among ratepayers, shareholders, and other stakeholders. The non-IOUs, primarily municipal utilities and irrigation districts, are structured to set rates based on cost recovery. These LSEs would be expected to pass compliance costs through to their customers.

Finally, any new program to limit GHG emissions from the electric power sector needs to be harmonized with other requirements and programs. For example, care is needed to ensure that the GHG emissions cap, the RPS, and ratepayer-funded energy-efficiency programs do not work at cross purposes. Similarly, a level playing field is needed to ensure that existing and potential new cogeneration opportunities are treated equitably under either the generator-based approach or the LSE-based approach.

3.2.1.2 Other Industry Sectors

The state GHG emissions inventory estimates that other than the mobile source and electric power sectors, no individual industrial sector accounts for more than 5% of total state GHG emissions.[a] Nevertheless, in order to cover a larger portion of state GHG emissions, as well as to encompass a diverse set of emission reduction opportunities, it is appropriate to consider the sectors with the largest GHG emissions.

As shown above in Exhibit 2, we have identified four industry sectors for consideration as part of a sector-based cap-and-trade program. These sectors account for about 10% of the state GHG emission inventory. Each of these sectors is described, followed by a brief listing of additional sectors, with lower emissions, that could also be considered.

[a] Total residential GHG emissions from fossil fuel combustion (almost exclusively natural gas) are estimated to be approximately 5% of state GHG emissions. However, it is not practical to include individual residential sources in a cap-and-trade program due to the number of sources involved. The Comprehensive Fuel approach to defining scope, presented in Section 3.2.3, is one way to include this sector in a cap-and-trade program.

Oil Refining. Oil refining accounts for about three percent of state greenhouse gas emissions. The U.S. Bureau of the Census reports that in 2002 there were 25 establishments in California that met the definition of "primarily engaged in refining crude petroleum into refined petroleum,"[22] within the category of NAICS Code 324, Petroleum and Coal Products Manufacturing.[23] The California Energy Commission lists 21 refineries operating in California, with the capacity to refine about 2 million barrels of oil per day.[24] A recent report by Lawrence Berkeley National Laboratories (LBNL) groups these facilities into 14 operating refineries.[25]

The fact that the refining sector is comprised of relatively few facilities with relatively large GHG emissions at each facility makes it attractive to include in a sector-based cap-and-trade program. Refineries are also reportedly the largest energy using industry in California,[26] with multiple energy-efficiency opportunities. However, there are several drawbacks, including the following:

- ***Lack of Emission Inventory Data:*** California's refineries have not published detailed GHG emission inventory data. One company (BP) has joined the California Climate Action Registry, and as of this writing, BP is in the process of voluntarily reporting its emission inventories for the period 2002 through 2004 to the Registry.
- ***Complex Emission Sources:*** Refineries are complex facilities with numerous combustion and fugitive GHG emission sources. Given the complexity of the source, a protocol is required to ensure consistent and accurate emission reporting and verification. An emission inventory reporting protocol for refineries is being developed but has not yet been adopted by the California Climate Action Registry.
- ***Leakage:*** The emissions from the refining sector may be subject to leakage. Insofar as a cap on emissions makes refining in California more costly, in-state demand for refined products could be met through increases in refined-product imports. In this case, emissions associated with the imported refined products would occur in other states or outside the United States. Some forecasts include increases in imports of refined products to the U.S., which would be a continuation of recent trends.[27] To address this leakage issue, options for requiring emission allowances for imported refined products could be explored to keep in-state and imported refined products on an even playing field in terms of GHG emissions.

An analysis of the GHG emission reduction opportunities in the refining sector is warranted to assess opportunities for reducing emissions in this sector. Additionally, the impacts of a GHG emissions cap on the availability of fuels in the state should be examined.

Oil and Gas Extraction. Oil and gas extraction accounts for about three percent of state greenhouse gas emissions. The U.S. Bureau of the Census reports that in 2002 there were 330 establishments in California that were part of the oil and gas extraction industry, and the support industry to oil and gas extraction, including the relevant portions of NAICS Code 211, Oil and Gas Extraction and NAICS Code 213, Support Activities for Mining.[28] The California Air Resources Board identifies about 429 facilities in SIC Code 13, which includes "producing crude petroleum and natural gas; extracting oil from oil sands and oil shale; producing natural gasoline and cycle condensate; and producing gas and hydrocarbon liquids from coal at the mine site."[29]

GHG emissions in the oil and gas extraction sector are associated with fuel combustion, flaring, and fugitive emissions of methane. As with the refining sector, detailed GHG emission inventories have yet to be reported, and a reporting protocol has not yet been adopted by the California Climate Action Registry. With on the order of 400 facilities in the sector, the average emission rate per facility is expected to be lower than the rate for refineries. Additionally, the emissions are likely to be associated with a large number of small emitting sources dispersed spatially, as contrasted with sources concentrated at a central facility.

Emissions from oil and gas extraction are less likely to be susceptible to leakage. By its nature, oil and gas extraction is tied to its locations in the state, so that the operations cannot move to other states. However, the amount of in-state oil and gas extraction activity could be reduced in the state. The potential for an emissions cap to affect in-state production should be assessed to estimate the impact of the emission cap on the state's dependence on imported energy.

Landfills. Landfill methane emissions are estimated to account for about two percent of state greenhouse gas emissions. Methane produced in landfills migrates to the surface and is emitted to the atmosphere. The California Integrated Waste Management Board's Solid Waste Information System (SWIS) database lists more than 2,500 solid waste facilities in the state, of which about 300 are identified as landfills. Of these landfills, 162 are listed as active, with the remainder being closed or otherwise inactive. Approximately 85 landfills account for 90% of the amount of waste estimated to have been disposed in the approximately 300 landfills, and more than 90% of the waste currently being disposed in landfills in California. These facilities would likely be the primary sources of methane emissions from this sector.

The emissions estimate for this source is more uncertain than the estimates for emissions from fossil fuel combustion in other sectors. The emissions are typically diffuse and are not easily measured. Also, the rate of emissions varies over time. The fact that there are relatively few major landfills (probably fewer than 100), and that methane capture and combustion can be used to reduce emissions, makes this sector attractive to include in a cap-and-trade program. There are several issues that would need to be addressed, however, to include landfill emissions in a cap-and-trade program.

- ***Carbon Sequestration:*** Landfills not only emit methane, they can also sequester carbon for long periods of time. Whether and how to consider carbon sequestration in the landfill emission inventory would need to be addressed.
- ***Useful Energy:*** Combusting landfill gas eliminates methane emissions. If the gas is used for a beneficial purpose, such as to generate electricity or to produce a liquid fuel, the landfill gas could displace fossil-fuel derived energy. Whether and how to account for the emissions benefits associated with these uses of landfill gas within the landfill emission inventory would need to be addressed.
- ***Facility Operational Boundaries:*** Some landfills may be operated in conjunction with fleets of trucks for hauling waste. Whether to include the mobile source emissions from the truck fleets in the operational boundary of the landfill emission inventory would need to be addressed.

Cement Production. Cement production accounts for on the order of one to two percent of state greenhouse gas emissions, and there are 11 cement plants located in California. The U.S. Bureau of the Census reports that in 2002 there were 25 establishments in California that were part of the cement production industry under NAICS Code 327310.[30] The California Air Resources Board has identified approximately 124 facilities with air pollution emissions in SIC Code 32,[31] which incorporates more types of facilities, including "manufacturing flat glass and other glass products, cement, structural clay products, pottery, concrete and gypsum products, cut stone, abrasive and asbestos products, and other products from materials taken principally from the earth in the form of stone, clay, and sand." The 11 cement plants account for the overwhelming majority of the greenhouse gas emissions from this sector.

The cement industry in California has initiated activities to reduce GHG emissions associated with their energy consumption as well as the process emissions associated with clinker production (an integral part of cement production). These early voluntary actions on the part of

the industry should be appropriately considered if this sector is included in a cap-and-trade program.

Other Sectors. The remaining sectors that could be included in the cap-and-trade program account for smaller portions of the state GHG emission inventory: less than one percent each. These sectors may include: pulp and paper production; semiconductor manufacturing; natural gas transmission and distribution; and others. Including these sectors in a cap-and-trade program requires balancing the benefits of increasing the scope with the administrative and program costs of adding numerous smaller emission sources. To evaluate these tradeoffs, these sectors need to be examined in greater detail.

3.2.1.3 Mobile Source Sector

The mobile source sector is the largest individual source of GHG emissions in California, accounting for about 42% of the state inventory. Light duty vehicles account for about 65% of the emissions from this sector, followed by on-road diesel vehicles (about 15%) and domestic aviation (less than 15%). Other miscellaneous categories, including off-road vehicles, account for the remainder. The California Air Resources Board has adopted motor vehicle regulations which limit the greenhouse gas emissions from light-duty passenger vehicles, which take effect in 2009. Similar regulations could be adopted for medium or heavy-duty vehicles, while domestic aviation remains within the purview of the federal government.

While we recognize the importance of reducing emissions from this sector, the analysis required to identify the most appropriate mechanisms for reducing emissions was beyond the scope of this report. The following is an initial discussion of options for this sector.

The factors that drive the level of emissions from mobile sources are complex and interrelated. For example, emissions from passenger travel are affected by:

- the demand for mobility – i.e., the desire and need for people to move around;
- the cost, availability, and convenience of travel options, including private vehicles and mass transportation; and
- the emissions per passenger mile of the transportation mode used, which is driven by the technology employed and the fuel used.

A range of policies can be used to address these factors that influence GHG emissions. Land use planning can affect the demand for mobility: co-locating housing, shopping, and employment can reduce the demand for mobility. Improved availability and convenience of transportation options (such as mass transit and bike paths) can shift the mix of travel modes used toward modes with lower emissions. Selecting and improving technologies and fuels to reduce the GHG emissions intensity of transportation vehicles can also contribute to reductions in overall GHG emissions from the mobile sector.

The most comprehensive approach to reducing GHG emissions from this sector through a cap-and-trade program would be to cap the fossil carbon included in all transportation fuels consumed in the state. This option is discussed below in Section 3.2.3 as the Comprehensive Fuels approach. As discussed in that section, limiting the availability of fossil carbon-based transportation fuels could influence the full range of decisions affecting mobile source emissions, including land use planning, choice of transit options, the emission intensity of vehicles, and the carbon intensity of transportation fuels. A sector-based cap, however, is unlikely to be able to capture and motivate the full set of decisions that affect mobile source emissions.

Recognizing that a sector-based cap is necessarily a partial solution to mobile source emissions, there are several options that could be considered.[32] For example, imposing an emission cap on individual vehicles or on retail fuel outlets is conceptually feasible. However, such caps are impractical because of the large number of sources involved. The main alternative that could be implemented would be to make vehicle manufacturers the point of regulation. An emission cap could be imposed on the sale of new vehicles in California for each automobile manufacturer. Based on the emission intensity of each vehicle (emissions per mile) and the expected annual miles driven by each vehicle type, the emissions "embedded" in new vehicle sales could be calculated. The manufacturers could be provided with an emissions cap for their total new vehicle sales each year. Manufacturers would be able to meet their caps by reducing the emission intensity of their vehicles or by shifting the mix of vehicles sold toward those with lower emission intensity.

Over time, the emissions intensity of the vehicle fleet would improve as older vehicles were retired and new vehicles were incorporated into the fleet. If the emission cap caused the price of some new vehicles to increase (e.g., those with relatively higher emissions intensity), the rate of turnover of a portion of the fleet could be slowed as consumers use their existing vehicles longer prior to replacing them with new vehicles. This potential impact on the rate of turnover of the fleet would need to be considered in the design of the cap.

This vehicle manufacturer-based cap is similar to the California Air Resources Board's recently promulgated motor vehicle regulations that limit the average emission intensity of new passenger vehicle sales. The emission intensity rule does not cap total emissions – emissions can increase if new vehicle sales increase. By putting a cap on total emissions, the manufacturer based emission cap would constrain emissions even if new vehicle sales increase. While the two regulatory policies do not necessarily conflict, it would be critical to coordinate the two policies if they were to be enacted simultaneously.

3.2.1.4 Conclusions Regarding Defining Scope in Terms of Sectors

Defining scope in terms of sectors can capture a significant portion of state GHG emissions:

- 20% of the inventory can be covered by defining the electric power sector as all load serving entities (LSEs).
- 10% of the inventory can be covered by including four sectors: oil refining; oil and gas extraction; landfills; and cement production.
- Additional sectors should be examined in more detail to assess the opportunity to include them in a sector-based design. Additional sectors could cover several percent of state GHG emissions.

Mobile sources, the largest emissions source, cannot be covered fully in a sector-based approach to defining the scope of the program. Due to the importance of this sector, other options should be considered (such as the upstream fuels approach discussed below in Section 3.2.3). A manufacturer-based vehicle emissions cap could be imposed as a companion to the recently promulgated rule that limits vehicle emission intensity. Such a cap may not be needed immediately, while the emission intensity requirements come into force for the first time. Emissions associated with the mobile sector should be monitored over time to assess whether a cap of the type described here, or an alternative approach, is needed.

Facility-level emission inventories are lacking in several key sectors, including refineries, oil and gas extraction facilities, and landfills. Emission reporting protocols would be required for these sectors to ensure consistent and accurate reporting. Full reporting of emissions from all

facilities in the sectors should be conducted first to provide a basis for developing and implementing a cap-and-trade program.

Finally, it is important to highlight the implications of the investor-owned utilities operating under a regulated framework. The CPUC determines how costs are shared among ratepayers, shareholders, and other stakeholders. Municipal utilities, operating under a cost recovery framework, would likely pass compliance costs through to their customers. All, or nearly all, of the facilities in the other sectors operate in the private sector, and are consequently constrained in their ability to pass along costs by market forces. This fundamental difference in the market conditions faced by LSEs may affect the manner in which they participate in the market for emission allowances, due to both their size and their ability to pass certain allowable costs through to their customers. The need to monitor the market for emission allowances to ensure it is operating effectively is discussed below in Section 3.5.

3.2.2 Stationary Source Combustion-Based Approach

The scope of the cap-and-trade program can be defined to include all major sources of fossil fuel stationary combustion in the state. This approach would encompass all major stationary sources of carbon dioxide (CO_2) emissions, without reference to specific sectors as being either in or out of the cap. This scope would not capture mobile source emissions.

Because the California Air Resources Board's current emission inventory for stationary sources does not include CO_2 emissions, we are currently unable to estimate precisely the emissions covered by this approach. Based on the state emissions inventory, major stationary source combustion of fossil fuel accounts for about 15% to 20% of total state GHG emissions, including the electric power sector's in-state generation emissions (but excluding emissions associated with imported electricity).

To assess the number of facilities that would be covered under this definition of the scope of the cap-and-trade program, we examined sources of nitrogen oxide (NOx) and carbon monoxide (CO) emissions as the set of facilities likely to have CO_2 emissions from fossil fuel combustion. The California Air Resources Board identifies approximately 5,200 facilities statewide with NOx or CO emissions.[33] Using the NOx and CO emissions as a rough proxy for the relative level of CO_2 emissions among stationary sources, we can assess how emissions are likely to be concentrated among a portion of the 5,200 facilities.

Based on NOx and CO emissions, the concentration of emissions among large sources is shown in Exhibit 3. The 50 largest sources are estimated to account for nearly 60% of total stationary source NOx and CO emissions. The largest 750 sources account for about 95% of these emissions. We can also examine the emissions data by Standard Industrial Classification (SIC) Code.[34] Exhibit 4 shows data for facilities in the 10 SIC Codes that account for the largest portion of emissions among the top 750 facilities. These 10 SIC Codes account for 593 of the top 750 facilities, and 90% of total stationary source NOx and CO emissions.[a]

We believe that CO_2 emissions are likely to be concentrated in a similar manner, so that more than 90% of CO_2 emissions from stationary fossil fuel combustion can be covered in a program that reaches about 750 facilities statewide. The impact of the program would be focused primarily in 10 SIC Codes, addressing about 90% of these emissions.

[a] Exhibit 4 shows that SIC Code 24, Lumber and Wood Products, is one of the industries with significant NOx and CO emissions. To the extent that facilities in this SIC Code are combusting wood waste and other biomass products, the CO_2 emissions from these facilities may be much less than would be implied by their NOx and CO emissions. Additional analysis is required to estimate more precisely the contribution of facilities in SIC Code 24 to CO_2 emissions.

Exhibit 3: Concentration of NOx and CO Emissions among Stationary Sources

Facility Group by Emissions Rank	Portion of Total NOx and CO Emissions	Cumulative NOx and CO Emissions
1-50	59%	59%
51-100	13%	72%
101-250	10%	82%
251-500	10%	92%
501-750	3%	95%
751-1,000	2%	97%
1,001-5,216	3%	100%

Source: Analysis of data from: 2002 California Emission Inventory Development and Reporting System (CEIDARS), California Air Resources Board, September 2005.

Exhibit 4: Concentration of NOx and CO Emissions by SIC Code (Stationary Sources Only)

Standard Industrial Classification Code	Number of Facilities		% of NOx and CO Emissions	
	By SIC Code	Cumulative	By SIC Code	Cumulative
49 Electric, Gas, Sanitary Services	249	249	31.8%	32%
32 Stone, Clay, and Glass Products	44	293	22.8%	55%
29 Petroleum & Coal Products	53	346	14.9%	70%
24 Lumber and Wood Products	23	369	7.8%	77%
13 Oil And Gas Extraction	104	473	6.8%	84%
14 Nonmetallic Minerals, Excluding Fuels	35	508	1.8%	86%
28 Chemicals and Allied Products	16	524	1.6%	88%
20 Food and Kindred Products	45	569	1.3%	89%
26 Paper and Allied Products	12	581	0.9%	90%
33 Primary Metal Industries	12	593	0.8%	91%
Other SIC Codes (31 total)	157	750	4.0%	95%

Note: Data for facilities in the top 750 facilities in terms of NOx and CO emissions.

SIC 49 includes electric power generation and landfills.

SIC 32 includes cement production.

SIC 29 includes refineries.

Source: Analysis of data from: 2002 California Emission Inventory Development and Reporting System (CEIDARS), California Air Resources Board, September 2005.

Currently, the reporting of CO_2 emissions is not uniformly required for stationary sources in California. As discussed above, CO_2 emissions are measured and reported by electricity generators of 25 MW and greater. Most of the other facilities that would be covered under this definition of the scope of a cap-and-trade program do not currently estimate and report CO_2 emissions. Nevertheless, we believe that these facilities should be able to develop and submit reliable estimates of CO_2 emissions from fossil fuel combustion. The existing reporting

requirements for these facilities (required by the air districts) typically include throughput data, such as fuel use, boiler size and hours of operation. Because CO_2 emissions are almost entirely a function of fuel use and carbon content in the fuel, emissions estimates sufficiently precise for purposes of a cap-and-trade program focusing on CO_2 emissions can be developed for each of the facilities from readily available data. Thus, it appears that there are no major barriers from a data collection standpoint to defining the scope of the cap-and-trade program in terms of stationary combustion of fossil fuels.

One of the weaknesses of this approach to defining the scope of the cap-and-trade program is that it omits non-combustion sources, including process-related emissions. Some of these sources are significant, such as CO_2 emissions from clinker production (in cement manufacture), methane emissions from landfills, and fugitive emissions of high GWP gases (e.g., sulfur hexafluoride (SF_6) emissions from electric power distribution systems). To cover these emissions, the scope of the program could be expanded to include specific sources and processes on an as-needed basis.

This combustion-based approach to defining the scope of a cap-and-trade program is susceptible to leakage. As discussed above, the electricity sector is particularly vulnerable to leakage due to a significant portion of electricity demand in California being served by out-of-state generation. This electric-sector leakage could be addressed by adopting a LSE-based approach to the electric sector (as discussed in Section 3.2.1.1). The resulting program would then be a hybrid approach: the electric sector would be defined to include all LSEs, and all remaining major stationary combustion sources (not including in-state generation) would be included under the stationary source definition.

Other sectors are also vulnerable to leakage to varying extents, as discussed above in the section that examines a sector-based approach:

- imports of refined petroleum products could increase in response to a cap on refinery emissions;
- oil and gas extraction activities could be reduced, increasing the state's reliance on energy imports; and
- imports of cement could increase in response to a cap on cement manufacturing emissions.

It is also appropriate to point out that this approach can create inequity within an industry sector. For example, there are 44 facilities in SIC Code 32 (Stone, Clay, and Glass Products), that fall within the top 750 sources in terms of NOx and CO emissions statewide. There are an additional 80 facilities with lower emissions in this SIC Code that do not fall within the top 750 sources. By covering only "major" sources of emissions, some facilities in the industry would be covered by the cap, while other facilities would not be covered by the cap.

New regulatory authority would be required to implement a cap on greenhouse gas emissions from all major stationary combustion sources in the state. The new authority could be developed within the existing framework of authority to regulate criteria and toxic pollutant emissions from stationary sources. The approach could also be coordinated regionally and/or nationally. Each state would be required to develop reliable data on CO_2 emissions from its stationary sources, and to cap emissions from relevant facilities. Ideally, the requirements for capping and reducing emissions would be coordinated nationally so that leakage can be avoided.

Finally, by definition this scope does not include mobile source emissions, the largest emission source in the state. A cap-and-trade program that focused on major stationary fossil fuel

combustion sources would need to be paired with a mobile sector initiative in order to cover the majority of state GHG emissions.

3.2.3 Comprehensive Fuels

The scope of the cap-and-trade program could be defined to include all fossil fuels. This approach would implement a limit on GHG emissions by placing a cap on the total carbon content of oil, gas, and coal consumed in the state. The primary advantage of taking this approach to defining the scope of the program is that it encompasses all sectors that use fossil fuels. Consequently, all options for reducing fossil fuel combustion across all sectors can contribute to achieving the emissions cap. Additionally, all sectors are put on an equal footing as it relates to their use of fossil fuels.

To achieve GHG emissions reductions via this cap, "carbon allowances" would be defined. These allowances would be required to be held by entities at specific points in the distribution or use of fossil fuels in the state. The points at which allowances are required should be selected to minimize administrative burden and maximize coverage and effectiveness. For fuel markets, these considerations would favor an "upstream" approach to regulating the total carbon content of fossil fuel combustion: meaning that fuel producers and importers would be required to hold carbon allowances for the fuels they produce in the state or import into the state.[35]

To focus the carbon cap on fossil fuel combustion, an upstream-based cap could be implemented with the following features:

- carbon allowances would be required to introduce fossil fuels into commerce in the state;
- carbon credits could be earned by exporting fossil fuels from the state (because the fuel would not be combusted in the state);
- carbon credits could be earned by sequestering the carbon from fossil fuel (e.g., the carbon sequestered in asphalt and plastics would not be combusted in the state); and
- carbon credits could be earned by capturing and sequestering carbon from fuel combustion as an emission control strategy (because, by sequestering the carbon, the CO_2 emissions are prevented).

For oil consumption, one appropriate point to require that carbon allowances be held is where liquid fuels enter into commerce at refineries, marine terminals, and storage facilities. This distribution point is called the "terminal rack." There are approximately 100 terminal rack locations in the state. The flow of liquid fuels is currently tracked at these locations for federal excise tax purposes. Those responsible to pay federal excise taxes on these fuels could also be required to hold carbon credits in an amount that matches the carbon content of the fuel they deliver.

An alternative to tracking the carbon content of liquid fuels (i.e., refined products) is to track the carbon content of the crude oil inputs to refineries. This crude oil carbon tracking may be simpler than tracking the carbon content of multiple products. Additionally, it has the advantage of incorporating in the cap the carbon emissions from refinery operations. As discussed above, the California Energy Commissions lists 21 operating refineries in the state. Each refinery would be required to hold carbon allowances to cover the carbon content of the crude oil and other inputs (such as natural gas liquids) used in their refining processes. To ensure that the cap accurately covered fuel consumption, carbon allowances would also be required to import refined products, and carbon credits could be earned by exporting refined products.

The upstream point for tracking natural gas flows would be at major pipeline transfer points and the natural gas utilities. There are fewer than 10 locations statewide where these flows would

need to be tracked. The three natural gas utilities would be required to hold carbon allowances for the carbon content of the gas delivered to their core customers. Carbon allowances would also need to be held by non-utility Gas Service Providers that supply gas to non-core customers. Settlement quality gas flow data from pipelines should provide a sufficient basis for calculating the quantity of carbon allowances required by the regulated entities.

For coal, there does not appear to be a convenient upstream point in the market for tracking carbon consumption. Because relatively small amounts of coal are used in the state, it may be easiest to track coal combustion in major boilers. Each major coal combustion facility would be required to hold carbon allowances that cover the coal combusted each year.

By designing the cap-and-trade program to limit total fossil fuel combustion in the state, about 75% of the state GHG emission inventory is covered, including mobile sources. This approach has the following benefits:

- The program scope is very broad, encompassing all sectors that combust fossil fuels. All sectors that combust fossil fuels are treated equally, and all facilities within a sector are also treated equally.
- Upstream implementation limits the number of compliance points that must be tracked.
- Limits on fossil fuel supply provide incentives for both: (1) improving the efficiency with which fossil fuels are used; and (2) developing non-fossil energy sources.
- Improvements in the mobile sector are motivated by this comprehensive fuel approach. Reduced availability of fossil-based transportation fuels provides incentives for shifting modes of transportation, improving vehicle efficiency, and adopting non-fossil based fuels.
- Over the long term, the California economy could realize a competitive *advantage* through less reliance on fossil fuels and improved access to a more diverse fuel supply that is both less susceptible to price shocks and supply disruptions and more sustainable economically and environmentally.

This comprehensive fuel approach has several drawbacks.

- non-fuel related emissions are excluded;
- the impacts of an absolute limit on the availability of fossil fuels in the state may be significant;
- price signals are the sole mechanism for motivating emission reduction; and
- like other approaches, leakage may occur.

Non-fuel related emissions are, by definition, excluded from the scope of the program. Some of these sources are significant, such as CO_2 emissions from clinker production (in cement manufacture), methane emissions from landfills, and fugitive emissions of high global warming potential (GWP) gases (e.g., sulfur hexafluoride (SF_6) emissions from electric power distribution systems). To cover these emissions in a cap-and-trade framework, a separate program component would be needed with an emission cap for the specific sources and processes. Alternatively, emission reductions from these sources could motivated by making them eligible to produce emission offsets.

Perhaps most significantly, the comprehensive cap on fossil fuel carbon essentially creates an absolute limit on the availability of fossil fuels in the state. The supply constraint would lead to increases in the prices for fuels, which would be the primary motivation for improving fuel use efficiency and for developing alternative fuels. The size of the price increase will depend on the level of the carbon cap and the cost and availability of alternative fuels. During a transition

period, prior to the widespread availability of alternative fuels, prices increases could be substantial if the fossil fuel carbon cap is set too low.

The impacts of increased fuel prices would probably need to be addressed in order to make this approach viable. Increases in transportation fuel prices would affect the cost of moving goods and people. If fuel costs were persistently higher in California than in neighboring states, fuel-intensive businesses would have an incentive to move out of California. Impacts on low income groups may need to be ameliorated. However, if the impacts of increased fuel prices could be managed, the California economy could realize a competitive *advantage* through access to a more diverse fuel supply that is both less susceptible to price shocks and supply disruptions and more sustainable economically and environmentally. The key to realizing this outcome is to adopt a gradual phase-down of fossil-carbon based fuels that allows improved efficiency and alternative fuels to constrain the rate of price increases.

Managing this phase-down process would require balancing the need for higher prices to motivate action and the desire to maintain reasonable prices to limit adverse impacts. As part of this balancing, the state can also use tax policies to reduce the impacts of the cap on fossil fuels. As discussed below in Section 3.4, the state can capture as revenue most of the increases in fossil fuel prices by auctioning the carbon allowances. Alternatively, if an auction is not used, taxes could be used to capture revenue from price increases that are caused by the carbon cap. This revenue can be used to reduce the impact of the fossil fuel phase-down by subsidizing energy efficiency or non-fossil energy development, or reducing other taxes on the people and business most affected by increased fuel prices. The larger the increase in fuel prices, the more funding would be generated to offset the impacts of the higher prices.

Another criticism of the comprehensive fuel cap is its sole reliance on price signals to motivate action. The approach does not focus attention on technologies or investments for reducing GHG emissions. Given that the carbon cap would exist only as a state policy, some consumers may expect that the cap would be lifted if fuel prices rose too high or too fast. For these consumers, the cap may lack sufficient credibility to motivate action to reduce emissions. If many consumers hold this belief, prices may rise so rapidly that the cap must be lifted. In this circumstance, the belief that the cap will be lifted in the future could lead to circumstances under which it is difficult to maintain the cap in the face of high fuel prices.

One way to prevent unacceptably high fuel price increases is to put a maximum value on the carbon allowances, and to make additional carbon allowances available at that maximum value. This “safety valve” for the market sets an upper bound on the impact of the carbon constraint on fuel prices. However, it also effectively removes the cap when the maximum value is reached. Nevertheless, a safety valve of this type may be needed to help ensure that unacceptable price increases are avoided during transition periods.

The implementation of this comprehensive fuel approach would need to address several other issues. As discussed above, the electricity sector is particularly vulnerable to leakage due to a significant portion of electricity demand in California being served by out-of-state generation. The cap on fossil-carbon based fuels would not limit electricity imports, so that there would be an incentive to locate new power generation out of state to avoid the cap. This electric-sector leakage could be addressed by adopting a load serving entity (LSE) based approach to the electric sector (as discussed in Section 3.2.1.1).

The resulting program would then become a hybrid approach. An emissions cap would be placed on the electric sector, defined to include all LSEs. The cap on fossil-carbon based fuels would also be in place. Any fuels used to produce electricity delivered by the LSEs would not count against the fuel cap. For example, the gas used by an in-state electricity generator to produce electricity that was sold to California customers through one of the LSEs under the LSE

cap would not require a carbon allowance under the carbon-fuel cap. Similarly, the emissions associated with the fuels used for power generation would count toward the LSE's cap, and would not count against the fuel sector cap. The two caps, one on LSE emissions and one on carbon in fuels, could be traded to allow emissions to flow to their most highly valued uses.

This hybrid approach requires the tracking of fossil-carbon fuels used in-state to produce electricity consumed in-state. An alternative to this approach would be to require that electricity importers hold carbon allowances in amounts that equal the embedded carbon content of the imported electricity. In this case, the carbon content of imported electricity would be treated like the carbon content of all other fuels consumed in the state. The point of regulation would be electricity importers, which again would be the LSEs. However, the LSEs would only need to hold emission allowances for their imported electricity, not for all of the electricity delivered to their customers. A system for tracking the emissions characteristics of imported power would need to be developed in order to implement this approach.

Ideally, to prevent leakage, carbon allowances should be held by importers of all products with significant "embedded carbon" content, not just electricity. However, it is unlikely to be practical to require carbon allowances for products with diverse distribution channels in the state. Consequently, some amount of leakage may be expected as products are produced outside the state and imported.

It should also be noted that capping the delivery of natural gas to customers is technically impractical. Natural gas pipelines are operated to ensure that pipeline pressures are maintained within an acceptable operating range. As customers consume gas, pipeline operators must maintain pressures by adding gas to the pipeline. Operationally, pipeline operators and natural gas utilities have little ability to force reduced consumption in order to stay under a cap. Although a natural gas utility could promote improved efficiency and reduced consumption among its customers, it may not be possible for the utility to guarantee that natural gas consumption will stay below the carbon allowances held by the utility. In this case, the utility may be required to obtain additional allowances after the fact to cover the actual natural gas consumption by its customers the previous year.

Finally, if California is the only state in the western U.S. to implement this comprehensive fuel approach, a "black market" for fuels may develop, particularly for liquid transportation fuels. Although marine terminals, storage facilities, and refineries could be tracked, gasoline is easily transported long distances in tanker trucks. Fuel from neighboring states could be trucked into California without the proper carbon allowances. Policing this activity could be difficult, and if significant fuel volumes move through a black market, the effectiveness of the cap will be eroded.

3.2.4 Conclusions Regarding Scope

We can make several observations regarding the three approaches for defining the scope of a cap-and-trade program for reducing GHG emissions in California. The Comprehensive Fuels approach is the most comprehensive approach, covering about 75% of the state emission inventory. As such, it encompasses the greatest diversity of emission reduction opportunities and has the potential to motivate action across the broadest set of emission sources.

One of the concerns with the Comprehensive Fuel approach is that it works exclusively through price signals. While prices can be successful in motivating action, unacceptably high fuel prices cannot be ruled out, unless a "safety valve" is incorporated into the program design. Additionally, a black market for liquid fuels could develop, eroding the effectiveness of the cap and reducing confidence in the whole regulatory approach.

The sector-based approach to defining the program scope would focus attention on the specific industries that contribute most to state GHG emissions. Stationary sources in the largest sectors cover about 30% of the state emission inventory. To significantly increase coverage beyond 30%, mobile sources, with about 42% of the emission inventory, would need to be included in the cap. However, mobile sources are not conducive to a sector-based approach. A manufacturer-based cap on "embedded" emissions associated with new vehicle sales could be included in the cap. However, this approach is not recommended at this time. Rather, mobile sector emissions should be monitored to assess the effectiveness of the vehicle emissions intensity standards that are coming into force for the first time.

The Stationary Source definition of program scope encompasses all major stationary sources of CO_2 emissions from fossil fuel combustion, without reference to specific sectors as being either in or out of the cap. Approximately 750 facilities could be included in the program to cover the overwhelming majority of emissions from these sources. This scope does not capture mobile source emissions, and consequently is limited to about 15% to 20% of the state inventory. An additional 10% of emissions can be covered if emissions associated with imported electricity is captured using a hybrid approach that includes a comprehensive definition of the electricity sector.

All three methods for defining the scope of a cap-and-trade program are vulnerable to emissions leakage. A coordinated national approach to capping GHG emissions within an international framework would be the best approach for addressing this leakage problem. In the absence of national action, or even regional action, the leakage issues can only be partially addressed. Data should be collected to track leakage over time so its impact can be assessed on businesses and on the effectiveness of the emissions cap.

All three methods appear to be administratively workable. The upstream implementation of the Comprehensive Fuel approach would have a manageable number of points at which compliance would need to be tracked. Additionally, it does not require facility-level emission inventories to either design the program or track compliance. Both the Sector approach and the Stationary Source approach would cover many hundreds of facilities. Each facility would require detailed emissions calculations, and would be a compliance point for the program.

It may be preferred to cap emissions from the electric power sector under all three scope definitions using the LSE-based approach. To implement the LSE-based approach, a tracking system is required to track the emission attributes of all electricity that serves California loads. This tracking system does not currently exist, and developing such a tracking capability presents significant challenges. We believe that there are several workable approaches for solving this problem, and that the effort is worthwhile to enable an LSE-based approach to be used.

Finally, all three approaches to defining the program scope could be leveraged into a regional or national GHG program. An assessment of the relative likelihood of any of the three approaches being adopted nationally is beyond the scope of this assessment. However, it can be observed that the Sector and Stationary Source approaches are more similar to past national regulatory programs than the Comprehensive Fuel approach.

3.3 Greenhouse Gases Covered

The cap-and-trade program can be defined to include all greenhouse gases, or a subset, such as carbon dioxide (CO_2) only. To capture as many emission reduction opportunities as possible under the cap, the broadest definition would be preferred in which all gases were included. However, consideration should be given to limiting the coverage of the program, particularly

during its initial implementation, to those gases and sources for which facility-level emissions can be measured or calculated reliably.

CO_2 emissions from fossil fuel combustion account for nearly three-quarters of the emissions in the state, and a larger percentage if emissions associated with imported electricity are included. Non-CO_2 emissions most often come from processes or biological sources that are more difficult to quantify than CO_2 emissions from fossil fuel combustion. Exhibit 5 shows how CO_2 emissions from fossil fuel combustion dominate the statewide emissions inventory.

Exhibit 5: Summary of California GHG Emissions Inventory by Gas and Source

Emissions Source	2002 Emissions (MMT CO_2-eq)	% of State Inventory
Carbon Dioxide Emissions	***391.5***	***82.6%***
Fossil Fuel Combustion	348.9	73.6%
Emissions From Imported Electricity	51.7	10.9%
Cement Production	6.2	1.3%
Land Use Change and Forestry Emissions	4.3	0.9%
Other Carbon Dioxide Emissions	0.7	0.1%
Land Use Change and Forestry Sinks	-20.3	-4.3%
Methane Emissions	***31.3***	***6.6%***
Enteric Fermentation, Manure Management, Rice Fields	14.5	3.1%
Landfills	10.1	2.1%
Petroleum and Natural Gas Supply	2.8	0.6%
Wastewater Treatment	1.9	0.4%
Fossil Fuel Combustion (Stationary and Mobile Sources)	1.8	0.4%
Burning of Agriculture Residues	0.1	0.0%
Nitrous Oxide Emissions	***33.6***	***7.1%***
Agricultural Soils	18.6	3.9%
Fossil Fuel Combustion (Stationary and Mobile Sources)	12.9	2.7%
Other Nitrous Oxide Sources	2.1	0.4%
High GWP Gases	***17.3***	***3.7%***
Substitution of Ozone Depleting Substances	15.5	3.3%
SF_6 from Electricity Transmission and Distribution	1.2	0.3%
Semiconductor Manufacture	0.5	0.1%
Total California Emissions	***473.8***	***100.0%***

Excludes international bunker fuel carbon dioxide emissions of 31.8 MMT.

Values may not add to totals due to rounding.

Source: Bemis, Gerry and Jennifer Allen, *Inventory of California Greenhouse Gas Emissions and Sinks: 1990 to 2002 Update*, California Energy Commission Staff Paper, Sacramento, California, Report CEC 600 2005 025, June 2005, Table 1, p. 21.

As shown in the exhibit, emissions that are not from fossil fuel combustion include:

- Process emissions and fugitive emissions:
  - cement production CO_2 emissions
  - oil and natural gas system methane emissions

- nitrous oxide (N_2O) emissions from nitric acid production (included in Other N_2O Sources)
- high GWP gas emissions

- Biological emissions:
  - enteric fermentation, manure management, and rice field methane emissions
  - landfill methane emissions
  - wastewater treatment methane emissions
  - land use change and forestry CO_2 emissions
  - agricultural soils N_2O emissions

Several of these sources can be accurately quantified at the facility level, including CO_2 emissions from cement production; N_2O emissions from nitric acid production; and SF_6 fugitive emissions in electricity transmission and distribution (included in the category of high GWP gases). The facility-level emissions data for these sources are sufficient to enable them to be included in a cap-and-trade program.

Facility-level emissions inventory methods and data for the other sources are of varying quality. Landfill methane emissions can be quantified, although as discussed above, the emissions are typically diffuse and emission rates vary over time. A detailed reporting protocol for CO_2 emissions from forestry activities has been adopted by the California Climate Action Registry. This protocol provides a basis for developing emissions inventories from this source. For the other sources, particularly those driven by biological processes, the facility-level inventory data and methods need to be improved prior to including them in a program.

3.4 Allowance Distribution

A cap-and-trade program, by its design, requires facilities that fall under the cap to hold sufficient "allowances" to cover the facility's activities.

- If the program is capping emissions, then the facility must hold sufficient emission allowances (measured in tons) to cover its emissions (also measured in tons).
- If the program is capping the carbon content of fossil fuels, then the facility must hold enough carbon allowances (measured in tons) to cover the carbon content of the fuels it enters into commerce in the state (also measured in tons).
- If the program is capping emissions associated with the generation of electricity delivered by a load serving entity (LSE), then the LSE must hold enough emission allowances (measured in tons) to cover the emissions associated with the electricity that it delivered to its customers (also measured in tons).

In all cases, the regulated entity that falls under the cap holds some type of allowance to comply with the cap-and-trade program. The allowances are denominated in tons of emissions, for example tons of CO_2-equvalent emissions.

In order for regulated facilities to hold emission allowances, the allowances must be obtained by them through some mechanism. There are three main options for distributing allowances:

- ***Distribution:*** Allowances may be distributed by the program to the regulated facilities that fall under the cap. With this method, the allowances are given to the regulated facilities, which can use the allowances to cover their own emissions, or sell the allowances to others

who fall under the cap. The primary issue associated with distributing allowances in this way is the process for deciding how many allowances go to each regulated facility.

- ***Auction:*** Allowances may be auctioned by the program to the regulated facilities that fall under the cap. With this method, the program holds an auction, and regulated facilities bid to acquire allowances. Successful bidders receive allowances, which they can then use or sell to others. Bidders who were not successful in acquiring allowances in the auction could purchase allowances from successful bidders if they needed allowances to cover their emissions.
- ***Hybrid:*** A hybrid approach can be used in which some allowances are distributed for free to regulated facilities, and a portion of allowances are auctioned.

Much has been written regarding the pros and cons of distributing allowances versus auctioning allowances.[36] When allowances are distributed to entities covered by the cap, those entities receive something of value: the emission allowances. When the allowances are auctioned, the government collects a portion of the value of the allowances in the amounts paid for the allowances during the auction. Both approaches can result in essentially the same cost of controlling emissions, and both approaches are expected to have the same impact on consumer prices in most cases.

Exhibit 6 summarizes the main issues surrounding auctioning versus distributing allowances for free. While there is a growing literature on how to design and run auctions of emission allowances, cap-and-trade programs have primarily distributed allowances. The Acid Rain program that limits sulfur dioxide emissions distributed emission allowances to individual facilities for free. The European Union's new emissions trading program requires that at least 95% of emission allowances be distributed to regulated facilities for the initial compliance phase, and 90% in the second phase, limiting auctions to at most 5% and 10% of the allowances in each period.[37] Consequently, there is little experience using auctions as the primary mechanism for allocating emission allowances under an environmental program.

If an auction is not used, the allowances must be distributed to the relevant entities using an agreed-upon process. Typically, the distribution algorithm would take into account facility-specific factors in order to promote equity among the regulated facilities. Therefore, data describing the relevant facility-specific factors would need to be reported by each entity that falls under the cap. Although there are a variety of facility-specific factors that can be considered, two primary factors are commonly discussed as bases for distributing emission allowances:

- Baseline Emissions. Emission allowances can be distributed on the basis of recent emissions as defined in a baseline for each facility. With this approach, total baseline emissions across all facilities would be computed, and each facility would account for a share of the total baseline emissions. The emission allowances can then be distributed on the basis of each facility's share of total baseline emissions. This method has the potential to distribute fewer allowances to those entities that reduced their emissions prior to the baseline period, thereby penalizing them for taking early action.
- Baseline Output. Emission allowances can be distributed using an average emission intensity for each industry and baselines of recent facility output. The average emission intensity for an industry would be equal to the total emission cap for the industry divided by the total baseline industry output. Each facility's allocation would be the product of the relevant industry average emission intensity and the individual facility's baseline output. By using this approach, past actions by a facility that reduced its emission intensity are rewarded. To implement this approach, suitable measures of output would be required for

all entities across diverse sectors in the program.[38] In addition, consideration should be given to selection of the baseline year (or years) given that output fluctuates year to year.

Neither method of distributing emissions automatically accommodates new emissions sources on an equal basis with previously existing sources. Insofar as emission allowances are distributed on the basis of past emissions or output, new sources would not receive a share of the distribution of allowances. Thus, such sources would be at a competitive disadvantage as compared to existing sources. To address this issue, a portion of the emission cap can be set aside for new sources, so that they can be allocated a share of the cap. Alternatively, a share of the cap could be set aside to be auctioned off, so that all sources, new and existing, could bid for additional emission allowances over and above the allowances they receive through a distribution.

To distribute emission allowances, data would be required from all facilities that fall under the cap in order to make the distribution.

- Each facility that falls under the cap would need to be identified. The eligibility of each facility to receive an allocation would need to be verified.
- Each verified facility would be required to report data that would be used to make the allowance distribution. The data would likely include an emission estimate for recent years as well as relevant output data. Reporting protocols would be required to ensure that the information was produced in a consistent manner across facilities. The data would need to be verified.

The choice of allocation algorithm can have a significant impact on the amount of allowances received by individual facilities that fall under the cap. Facilities that have relatively high emissions will favor distributing allowances on the basis of recent emissions, because under this approach they will receive more allowances. Facilities that have taken early action to reduce their emissions will want to ensure that these early actions are considered so that their allowance allocation is not adversely affected. Facilities that have relatively lower emission intensities will favor distributing allowances on the basis of an industry average emission intensity. Facilities with growing levels of emissions or output would want to ensure that the method allows flexibility in the selection of the baseline year, so that recent periods of high emissions or output could be considered.

The specification of a distribution algorithm requires that these divergent interests be balanced against each other. One way to satisfy competing interests in this situation is to be overly-generous in the initial allocation of emission allowances. In doing so, all parties can receive a share of the emission cap that meets their current needs. In this case, care must be taken to reduce the cap over time, and to ensure that the extra allowances are not banked indefinitely in a manner that reduces the effectiveness of the emission cap over the long term.

Auctioning allowances avoids this problem of balancing competing interests by but putting all facilities on an equal footing. The auction option also avoids the step of developing facility-specific emission and output data to support the allowance allocation. However, detailed facility-specific data will be required in order to ensure compliance with the cap, regardless of which method is used to allocate emission allowances. Therefore, reporting protocols, facility reporting, and data verification are required in all cases.

Exhibit 6: Summary Auction versus Distribution Issues

Issue	Allowances are Auctioned	Allowances are Distributed (Given Away)
Who gets the value of the allowances?	The value of allowances is captured by the government in the auction revenue. The revenue can be used by the government to direct the value of the allowances to various parties. For example, revenue can be used to subsidize consumers or workers impacted by the emission cap program.	The businesses receiving the allowances get their value: the allowances may be considered a capital asset.
How does the allocation method affect the cost of reducing emissions?	The method of allocating emission allowances does not affect the cost of reducing emissions by an individual business, nor by the economy as a whole. Some have argued that an auction produces an initial allocation of allowances that better reflects the relative value of emission allowances among regulated facilities. Consequently, less emission trading may be necessary to re-distribute allowances to their most highly-valued uses under an auction approach. As a result, an auction approach may have lower transaction costs due to reduced allowance trading.	
How would new sources get emission allowances?	New sources and existing sources would be on an equal footing under an auction approach.	New sources would be required to purchase emission allowances from existing sources that received their allowances through the distribution.
Does the allocation method affect investment in emission reductions?	An auction reduces businesses' financial resources. Consequently, less capital may be available for investing in emission reduction technologies.	By receiving allowances for free, businesses' financial resources are enhanced by the value of the allowances. The distribution of allowances does not adversely affect businesses' financial ability to invest in emission reductions.
Does the allocation method affect consumer prices?	Under typical circumstances, the method of allocating allowances does not affect consumer prices. However, in the electric power industry in California, the rates of the investor owned utilities (IOUs) are regulated by the CPUC. Additionally, the municipal utilities' rates are generally developed under a cost recovery structure. Consequently, an auction would likely increase electric rates more than distributing the allowances for free because a portion, or all, of the auction payment would be a cost passed through to ratepayers.	
Does the allocation method affect profits?	Limiting emissions through a cap-and-trade program will benefit some firms and disadvantage others. To the extent that some facilities have the potential to increase their profits due to the emission cap, the auction can capture a portion of the increased profits through competitive auction bids. When allowances are distributed, opportunities to increase profits are captured by the businesses. The electric power sector may be an exception to this general conclusion. The CPUC could regulate the rates of the IOUs to ensure that they do not realize increased profits. Also, municipal utilities do not operate to maximize profits.	
What is revenue recycling?	Revenue collected from an auction of emission allowances can be used, in whole or in part, to reduce taxes or fees on labor or investment. By reducing these taxes or fees, the economy can become more efficient overall, improving overall economic growth and offsetting a portion of the cost of reducing GHG emissions.	Revenue recycling is not realized when emission allowances are distributed for free.
How does the allocation method affect the State of California?	Through an auction, the state captures the value of the emission allowances in the form of auction revenue. This revenue can be used within the state to offset impacts of the cap-and-trade program, to invest in GHG emission reduction projects, or other uses.	The value of the emission allowances goes to the owners of the businesses that receive the allowances. To the extent that the business owners are outside the state (e.g., as shareholders of publicly held companies), the value of the allowances will accrue outside the state. The electric power sector may be an exception to this general conclusion. The CPUC could regulate the rates of the IOUs to ensure that the value of the allowances is passed through to their customers.

In addition to defining how to allocate emission allowances, the program must also determine how frequently to allocate allowances. Allowances can be allocated one time, so that the allowances are permanent. In this case, the original recipients (whether by distribution or auction), own the emission allowances in perpetuity unless they sell them. To reduce the cap over time, the annual emissions represented by each allowance can be decremented according to a set schedule. (If emission allowances are allocated one time so that the owner has perpetual rights to emit, the emissions allowance would typically be expressed in emissions allowed per year.)

As an alternative, the emission allowances can be allocated periodically, such as annually or every five years. In this case, the emission allowances would confer the right to produce a specific amount of emissions during the relevant period, such as a total of five tons of emissions over a specific period of five years. Some have argued that a periodic auction of emission allowances, such as annually, helps to create a liquid market for allowances and helps produce price signals regarding the marginal cost of reducing emissions.

Recognizing that a cap-and-trade program would likely be phased in over time, periodic allocations of emission allowances may be preferred. For example, a Phase 1 cap-and-trade program could be implemented that covered an initial set of facilities, with a five-year compliance period such as 2010 through 2014. Emission allowances would be allocated to the relevant facilities to enforce the Phase 1 emission cap. Based on the results of the Phase 1 program, adjustments could be made in a Phase 2 implementation, such as expanding the coverage of the program to more sectors, sources types, or gases. The Phase 2 compliance period would presumably immediately follow the Phase 1 period, such as 2015 through 2019. Phase 2 of implementation would require a second round of emission allowance allocations.

Although a phased implementation with periodic distributions of emission allowances provides opportunities to adjust the program design, care must be taken to avoid adding uncertainty to the process. Many of the facilities, that would likely fall under the cap, use equipment with very long lifetimes. As such, the facilities must make equipment investment decisions that are sensible within the context of the expected long-term emission reduction requirements of the cap-and-trade program. Uncertainty regarding the future direction of the program will make it more difficult for facilities to make these long-term investment decisions. Therefore, if a phased approach is adopted, the fundamental objectives and purpose of the overall program should be maintained as stable as possible.

Of note is that if future distributions of allowances depend, in part, on future levels of facility output, facilities will have an incentive to increase output in order to capture a larger share of the future allowance distribution. Because total emissions are capped, this increase in output must be accompanied by a reduction in emission intensity per unit of output. Although this behavior increases total societal costs of the program, it has the benefit of providing an added incentive for reducing emission intensity.

Several analyses can be performed to assess the implications of these alternative allowance allocation methods. An analysis of the expected value of emission allowances would provide insight into the amount of revenue that could be collected through an auction. Such an analysis would need to be conducted for the range of scope and emission cap levels under consideration for the program. The implications of the alternative methods for distributing the emission allowances can be examined by assessing how alternative distribution algorithms would affect various entities. Because facility-specific data are required to conduct this assessment, facility-level reporting of emissions and output is an important first step to understanding better the impacts of alternative allocation methods on various entities.

3.5 Allowance Trading

A fundamental aspect of a cap-and-trade program is the ability for entities covered by the cap to trade emission allowances. The opportunity to trade helps to ensure that emissions are reduced at the lowest cost possible. Entities that can reduce emissions at low cost will sell their emission allowances to entities that face higher costs.

The primary program design question regarding trading is whether to impose some limits on how allowances are traded. Program options include:

- ***No Trading:*** Under this approach, no trading would be allowed. This approach severely limits the ability of the market based mechanism to reduce compliance costs. It would lock in entities to their emissions allowance (although they could potentially purchase offsets if they are allowed). This approach undercuts the basic premise of using a cap-and-trade program to reduce emissions.
- ***Limit Trading:*** This approach would limit trading in some manner, for example by only allowing trading within sectors or source categories. Trading limits reduce the ability for the market to shift allowances to where they are most highly valued. On the other hand, such limits can be used to ensure that trades take place between emissions sources that have comparable data quality. For example, the program could allow trading among all fossil fuel combustion sources, but limit trading of process emissions to like emissions within a sector. This approach could help ensure that trading results in actual emission reductions.
- ***Unlimited Trading:*** Under this approach there would be no restrictions placed on trading of emission allowances. This approach maximizes the opportunity for the market to shift allowances to where they are most highly valued.

Because trading is fundamental to the cap-and-trade program as a market-based strategy, the general principle should be to allow unlimited trading. Concerns about the varying quality of emission data should not be significant among facilities included under the cap because all participating facilities will be required to prepare and report detailed emission inventory data that will be verified as part of the program. Consequently, the emissions data from the facilities and sources included in the cap will be sufficiently precise to allow for credible trading of emission allowances.

Concerns about the potential concentration of emissions in impacted communities must also be considered. Unlimited trading may allow a facility to increase emissions by obtaining additional emission allowances. Although total emissions across all facilities will remain under the overall cap, the community near the facility may be negatively impacted by the local increase in emissions. Trading restrictions could be used to address this issue, for example, by prohibiting individual facilities from obtain emission allowances that would exceed its baseline emissions. These types of trading restrictions are not recommended, however, for the following reasons:

- The cap-and-trade program focuses on greenhouse gas emissions. These gases do not have a direct impact on local air quality. Consequently, concentrating emissions of these gases in a single location does not pose health or environmental risks.
- The emissions of concern to impacted communities, including criteria pollutants and toxics, are better addressed through appropriate air emissions permits. The ability to trade GHG emissions does not alter the need to protect impacted communities from these emissions.
- Trading restrictions could increase the cost of reducing GHG emissions overall without solving the problem of concentrations of criteria pollutant and toxic emissions in impacted communities.

The issue of impacts on specific communities is discussed more fully in Section 4.

Although unlimited trading is preferred as a general principle, the market for trading emission allowances should be monitored closely to ensure that it is operating fairly and freely. Ideally, a vibrant trading market can evolve that provides for accurate price discovery and market liquidity. Under these conditions, unlimited trading among all parties can be encouraged.

However, if the market is not liquid, and if there is poor price discovery, the market may become susceptible to market power being exercised by a small number of large emitters. For example, under a program scope that includes the electric power sector as load serving entities (LSEs), the individual investor owned utilities (IOUs) and the large municipal utilities would individually hold the largest share of emission allowances by far. This large position, combined with the ability of the IOUs and municipal utilities to pass through the costs of purchasing emission allowances to their customers, may enable the LSEs to dominate the trading market. Under these circumstances, facilities with lower levels of emissions may not be served well by the market.

Mechanisms may be needed to ensure that the emission allowance trading market remains liquid and that prices are not manipulated to the detriment of market participants. In all cases, allowance trades must be recorded with the appropriate regulatory authority so that the ownership of allowances is not in doubt. Also, the list of the ownership of all allowances should be publicly available so that all market participants have complete information on the status of ownership.

3.6 Allowance Banking and Borrowing

Banking and borrowing provide compliance flexibility by enabling facilities covered by the cap to shift emissions among time periods. Banking allows unused emission allowances to be carried into future years, and is reasonable for greenhouse gas emissions given the long atmospheric lifetimes of the relevant gases. Banking provides an incentive for facilities to reduce current emissions below the level of their currently held emission allowances because the unused allowances can be carried into a future year, when the emission cap may be tightened. This banking opportunity is credited for motivating power plants to reduce SO_2 emissions faster than required under the Acid Rain program. The banked SO_2 emissions provided flexibility in later years when the emission cap was reduced. Banking can also enhance the liquidity of the allowance market and can be an important cost-reducing compliance strategy when the emission cap is scheduled to decline in the future.

One significant issue associated with banking would occur if the allowance allocation is overly generous in early years. In this case, large amounts of allowances may be carried forward, thereby allowing more emissions in the future than would otherwise be desired. If this issue arises, the program could “devalue” the banked allowances over time, e.g., at a set rate such as 5% per year. This devaluation reduces the attractiveness of accumulating unused allowances in the early years, while providing flexibility across years.

Borrowing allows a facility to borrow allowances from future allocations in order to comply with current emission limits. This option only applies if allowances are distributed; if allowances are auctioned then there are no future allocations from which to borrow. Although borrowing provides an additional compliance option for entities that have too few allowances in a compliance period, care must be taken to ensure that the opportunity to borrow is not abused.

Overall, banking and borrowing are consistent with the use of a market-based program to achieve emission reductions at the lowest possible cost. The added flexibility afforded, particularly by banking, can help reduce compliance costs.

3.7 Emissions Offsets

Emission offsets refer to verified emission reductions achieved by entities that are outside the cap-and-trade program. The primary benefit of emission offsets is that they help lower the cost of reducing emissions in the state. With the availability of emission offsets, entities covered by the cap could purchase low-cost emission reductions from outside the cap as a means of complying with their emission limit.

To ensure that offsets do not compromise the emission reduction goal of the program, they should only be included if they are real or additional, quantifiable, excess to any regulatory requirement, permanent and enforceable.

- ***Real or Additional:*** Real or additional emission reductions are those that have actually occurred, not emissions that could have been emitted but were not or are avoided emissions. This means that the emission reductions result from actions taken that are beyond the course of normal activity such that the emission reductions are not considered "business as usual." For example, activities that are cost effective even the absence of getting paid for emission reductions would not be considered “additional.”
- ***Quantifiable:*** Quantifiable means that the amount of the emission reductions can be measured with reasonable certainty. Quantification requires that: a baseline set of conditions can be defined; the emissions associated with the baseline conditions can be measured; the alternative set of conditions that will exist due to the project can be defined; and the emissions associated with the alternative set of conditions can be measured. The emission reduction is the change in emissions from the baseline to the new conditions caused by the emission reduction project.
- ***Regulatory Surplus:*** Emissions reductions must be surplus of any requirements by local, state or federal regulations or measures contained in a regional air quality plan or government commitment or agreement.
- ***Enforceable:*** Enforceable means that the reductions can be independently verified and are legally binding. Offset projects thus must be accessible to inspection by appropriately authorized California staff. Penalties for noncompliance or nonperformance need to be determined and assessed.
- ***Permanent:*** Permanent means that the life of the emission reductions is reasonably established and commensurate with the proposed use of the offsets. Projects should be “irreversible”; that is, the reductions achieved should not be subject to backsliding or vulnerable to changes in external conditions.

The emission offset process would include the following:

- ***Verification Process:*** A process must be established by which emission offsets will be verified. This process must define the characteristics that emission reduction projects must have to be eligible to create emission offsets, as well as the data and analyses required to support the emission reduction claim.
- ***Emissions Reduction Projects:*** Emissions reduction projects are undertaken at facilities that fall outside the cap. Documentation of the project is submitted for verification.
- ***Verified Emission Offsets:*** Once an emission reduction project has successfully completed the verification process, an emission offset instrument (such as a certificate) is issued that specifies the emission offset in tons of emissions.
- ***Emission Offset Purchase:*** The emission offset instrument can be purchased by a facility that falls under the cap.

- ***Emission Offset Use:*** The facility that owns the emission offset instrument can use the emission offset (in tons) to comply with its emission limit. For example, the facility may have 10 tons of emissions during the compliance period. The facility must have 10 tons of emission allowances and emission offsets in order to be in compliance. In this case, the facility may have received 8 tons of emission allowances in its distribution, and it may decide to purchase 2 tons of emission offsets. In this example, the facility is in compliance because it is able to surrender emission allowances and emission offsets that are sufficient to cover its actual emissions during the compliance period.

Through this process of using offsets, entities outside the cap have a financial incentive to develop low-cost emission reduction projects. As discussed above in Section 2.2, some sources are not well suited for being covered by a cap and trade program. Insofar as such sources are able to undertake emission reduction projects that conform to the necessary requirements, they can create and sell emission offsets. The forestry sector, for example, may not fit well under a cap and trade program, but may produce emission offsets through the implementation of forestry projects. Therefore, offsets have the potential to broaden the set of emission reduction opportunities that are motivated to be undertaken by the cap-and-trade program.

Critical to the credibility of offsets is the process for verifying emissions reductions and enforcing emission reduction commitments. Ideally, the process will not only be transparent and predictable, it will be relatively low cost as well. If the verification process is too time intensive and costly, low-cost offsets will be difficult or impossible to generate. The cap-and-trade program can build on previous work regarding emission reduction verification:

- For the forest sector, the California Climate Action Registry has developed and adopted the Forest Project Protocol (FPP) as the Registry's guide for the design, implementation and registration of forest projects that reduce GHG emissions. It complements the Registry's Forest Sector Protocol (FSP), which governs the reporting of total GHG emissions from forests. Only those forest projects that comply with the FPP may be reported to and certified by the Registry.
- The Climate Trust has developed its own process for defining and verifying emissions offsets.[39] The Climate Trust can customize its approach to produce emission offsets with characteristics specified by those purchasing the offsets.
- The Clean Development Mechanism (CDM) has been developed under the Kyoto Protocol as the process for documenting and registering emission offset projects. The European Union is using the CDM process in its emission trading program.
- The GHG Protocol Initiative is developing a Project GHG Reporting and Accounting Standard. This work is focusing on land use change and grid-connected electricity projects.[40]

From this previous work, we conclude that protocols will be required for each of a variety of "prototype" emission reduction projects that are deemed eligible for producing emissions offsets under the state's cap-and-trade program. Each protocol would address the verification requirements specific to its prototype project. With this view, the Registry's FPP is one example from a set of protocols that would be needed. Project-specific protocols have also been developed under CDM.

As part of the development of protocols for prototype projects, several issues common to all offsets would need to be addressed:

- ***Location:*** The location of the emission reduction could be restricted to California, for example to capture the economic development and other benefits of investments in offset projects. Additionally, projects outside the state may be more difficult to verify and/or enforce. Alternatively, any appropriately documented emission offset could be allowed regardless of location in the U.S., or internationally.
- ***Baseline:*** The emission offset must demonstrate emission reduction relative to a baseline. The baseline would reflect existing regulatory requirements, so that the verified emission reduction is surplus to existing requirements. If offsets generated outside of California are eligible, it may be appropriate to define the baseline as *California regulatory requirements*, as opposed to the regulatory requirements in the location where the offset is generated. In this manner, the offset project must first achieve a California-equivalent baseline that reflects the California requirements for the source (if there are any), and then demonstrate emission reductions that are surplus to that California-equivalent baseline.
- ***Changing Regulatory Requirements:*** A complicating factor in the development and use of emission offsets is that regulatory requirements change over time. An emission reduction project that is surplus to existing regulatory requirements when initiated, may become required when new regulations come into effect. The manner in which changing regulatory requirements affect emission offset projects needs to be defined as part of implementing an offset program.

A final issue to address regarding offsets is whether the cap-and-trade program should rely solely on the market to generate emission offsets, or whether an entity dedicated to producing offsets should be created. A dedicated organization could develop expertise and procedures that enable it to identify and execute emission reduction projects efficiently. The organization could specialize in projects that are particularly relevant to California and qualify under the California program. Following initial funding for start up, the organization could have the goal of becoming financially self-sustaining.

The primary benefit of creating an organization dedicated to creating offsets is that it can expand the availability of low-cost emission reductions. Initial experience under the CDM process indicates that offset projects may be slow to materialize. The Climate Trust is an example of an organization that was created to create emission offsets.

3.8 Emission Tracking, Compliance Tracking and Enforcement

Under all formulations of a cap-and-trade program, emissions and compliance must be tracked for all the entities covered by the cap, and appropriate action must be taken if entities fail to comply. The regulatory agency (or agencies) implementing the cap-and-trade program must have the authority to require that:

- Emissions reports are prepared according to an accepted method and submitted appropriately in a timely manner.
- Ownership of emission allowances is tracked and disclosed.
- Ownership of emission offsets is tracked and disclosed.
- Delivery of emission reductions from offsets projects are tracked, disclosed, and enforced.
- Emission allowances and emission offsets are held by each entity in sufficient quantity to cover the verified emissions for that entity.
- Documentation of the emissions and allowance ownership is maintained.

3.8.1 Emission Reports

Facilities that fall under the cap must be required to file timely and accurate emission reports that include all the facility emissions subject to the cap. Reporting procedures will be required to ensure that facilities produce consistent and reliable emissions estimates.

Continuous emissions monitors (CEMs) are used in RECLAIM and the Acid Rain program to provide timely and accurate emissions tracking at the facility level. For power plants, these CEMs measure CO_2 emissions. CEMs may be appropriate for some facilities included in a cap-and-trade program. However, requiring CEMs at all facilities is unlikely to be a cost-effective under a broad, multi-sector program.

In the absence of CEMs, operational data can be used to calculate GHG emissions with adequate precision in most cases. The California Climate Action Registry has used this approach to develop and adopt emission reporting protocols for GHGs. Two types of protocols are used by the Registry:

- ***General Reporting Protocol (GRP):*** A GRP is used to report GHG emissions that can be reasonably estimated from data that is expected to be available. The GRP is used by a wide variety of entities.
- ***Industry-Specific Reporting Protocol:*** Industry-specific protocols are used to address data, measurement, calculation, or other issues that are specific to certain industries. To date the Registry has developed protocols specific to the forest sector and the power/utility sector. Work is also well along in the development of a protocol for the cement production industry. Additional industry-specific protocols will likely be required if a multi-sector program is adopted. As discussed above, emission reporting protocols would be required for: oil refining; oil and gas extraction; and landfills.

We believe that the general approach taken by the Registry can produce emission reports that are sufficiently precise to be used by the emissions sources likely to be included in a cap-and-trade program. Multiple stakeholders expressed support for the Registry protocols and the process that was used to develop both the GRP and the industry-specific reporting protocols. As an enhancement to the existing protocols, it has been recommended that the operational data currently reported by facilities to the air districts under their air permits be used to cross-check the GHG emission report estimates for consistency. Adding this feature to the GHG emissions reporting process will help ensure that the facility-specific GHG emission reports are consistent with the facility-specific criteria air pollutant emission reports submitted to the air districts.

The Registry protocols are designed to produce entity-wide emission inventories. The protocols would need to be revised to provide instruction for reporting the specific emissions sources that would be defined to fall under the emission cap. This adjustment should be easy to accomplish, as the existing reporting protocols include facility-level emission calculations.

Mandatory reporting of facility-level emissions is recommended as an initial step to create the basis for designing a cap-and-trade program. The Registry, in its current form or a restructured form, could be the organization designated to receive the emissions reports. The Registry has created the infrastructure needed to receive and manage emission data that conform with its reporting protocols. The Registry could work jointly with the air districts to ensure that all facilities required to report are identified and made aware of the new reporting requirements.

The Registry process currently requires that emission reports be verified by qualified third-party certifiers. The cost of certification is borne by the reporting entities. Under a mandatory reporting program, the existing verification process could be continued. Alternatively, the organization receiving the emission reports (e.g., the Registry) could take on the responsibility

of verifying the emission reports. Both approaches can ensure consistency and maintain quality control of the emission reports. However, centralizing responsibility for verification of the emission reports in the entity that receives the reports may enable efficiencies to be realized.

Some stakeholders have suggested that entity-wide reporting should be required for all entities that have facilities that fall under the cap. In this case, two reports would be prepared. The facility report would calculate the facility emissions that are subject to the cap. This facility-specific emissions estimate would be used for tracking compliance under the cap-and-trade program. The second report would cover entity-wide emissions, as defined by the Registry. The entity-wide report would be used for information purposes only, and would not be subject to the emission cap. The added reporting burden of an entity-wide emission report should be examined to assess whether it should be mandated.

3.8.2 Compliance Tracking

Closely related to emissions tracking is compliance tracking. Compliance is tracked by comparing the emission reports to the official record of emission allowances and emission offsets. A system for tracking ownership is needed, including "expiring" the allowances and offsets when they are used to cover emissions in a compliance period. The compliance tracking needs to be done in a timely manner, so that compliance can be evaluated shortly after the end of the compliance period.

It is anticipated that emission allowances and offsets would be owned by entities, such as corporations and other organizations. These entities own the facilities that have emission sources that fall under cap. To comply with the cap, the entities would be required to hold enough allowances and offsets to cover the emissions at the facilities that they own. To assess compliance, the capability must exist to:

1. identify all the entities that own facilities that fall under the cap;
2. track the ownership of the emission allowances and offsets owned by each entity;
3. track the emissions reported at facilities owned by each entity; and
4. compare the total emission allowances and offsets owned by each entity with the total emissions reported for each entity.

Some facilities (e.g., power plants) have joint ownership among multiple parties. To assess compliance at the entity level, the emissions from facilities with multiple owners must be allocated among the facility owners using an agreed-upon method. The Registry has adopted methods to perform this allocation as part of their reporting protocols. This emission allocation among owners would need to be reported and cross-checked during the compliance tracking process.

3.8.3 Enforcement

Enforcement provides consequences in the event that an entity cannot surrender emission allowances in sufficient quantity to cover its actual emissions. The design and implementation of the enforcement requirements will determine the strength of the incentives that entities have to comply. Additionally, the enforcement scheme can have a significant impact on whether the desired emission reductions are achieved. Enforcement options for non-compliance include:

- Require the entity to acquire emission allowances or offsets to make up its shortfall. Including this requirement will ensure that the emissions are reduced to the emission cap.
- Require the entity to pay a fee per ton for which they did not have sufficient allowances: Including this requirement would provide a financial incentive to comply.

- Require that the entity implement controls to reduce emissions. This requirement would reduce compliance flexibility.

If the sole enforcement method is a fee per ton of excess emissions, this would provide a "safety valve" on compliance costs. The fee would become the upper bound for the price of emission allowances. The risk of this approach is that if the fee were set too low, the emission cap may become ineffective, as entities choose to pay the fee rather than reduce emissions.

To ensure that the emission cap remains effective, the non-complying entity may be required to acquire emission allowances or offsets to make up its shortfall. The risk of maintaining the cap in this way is that the cost of the additional allowances may become very high, particularly during a period of non-compliance by many entities. Significant volatility in the cost of complying can adversely affect the program, and as discussed in Section 3.2.3, could lead to the cap being relaxed in response to unsustainably high compliance costs. This situation is not hypothetical, as these conditions were observed in the RECLAIM Program in 2000.[41]

Specifying the enforcement penalties requires balancing these competing benefits and risks. Analyses can forecast likely compliance costs and allowance prices. Because there is no track record for a GHG emission cap-and-trade program in the United States, the forecasts will necessarily be uncertain.

4. Environmental Justice

A changing climate will affect all communities. Higher temperatures are expected to worsen local air quality by enhancing smog formation, and risks of heat-related illness will rise. Our water systems will be under increased stress, and coastal and low-lying areas will be at increased risk for flooding and erosion. The Climate Action Team, through its Scenario Analysis Subgroup, is examining the broader impacts of climate change in California.

Our most vulnerable populations will be particularly impacted by climate change. Low-income communities have fewer resources to overcome climate change impacts. Limited financial resources make it difficult for them to adapt to a changing climate. These communities have less access to health care and lack the means to move. Therefore, these communities are acutely aware of the need to address the fundamental causes of climate change decisively and effectively.

We must acknowledge that low-income and minority communities have historically been impacted by land use and facility siting decisions, which have burdened them with disproportionate exposure to poor air quality, contaminated land, and toxic waste. Low-income communities often live near transportation corridors, ports, factories, waste recycling plants and power generation stations. As a result, these communities tend to have higher rates of illness and asthma while having less access to health care.

Many of the facilities that emit greenhouse gases (GHGs) are the same facilities that emit criteria pollutants and toxics that cause local environmental and health impacts. Carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx), and particulate matter (PM) may all be produced as byproducts of fossil fuel combustion. These same combustion processes emit CO_2, the primary GHG emitted in the state, and often emit other GHGs as well. Because GHG emissions and criteria pollutant emissions are linked through common sources, we must understand how efforts to limit GHGs could affect criteria pollutant emissions, and the communities.

The primary question to ask is how a cap-and-trade program may affect environmental conditions in communities that are already heavily impacted. The principal concern is not with the GHG emissions themselves because the GHGs do not directly cause smog or other local air quality problems. Rather, the concern is with the emissions of other pollutants (CO, NOx, SOx, PM, toxics) which may be affected by efforts to reduce GHG emissions. Two types of impacts may be of particular concern:

- Options that reduce GHG emissions could increase emissions of pollutants that cause smog and other local air quality problems. For example, if a facility switches from a fossil fuel to a biomass fuel, emissions of non-GHG pollutants could increase--unless appropriate emission control technologies are installed as part of the switch.
- Efforts to reduce GHG emissions may result in facilities with lower GHG emissions per unit of output being operated more than would otherwise have been the case. Under these conditions, emissions of criteria air pollutants may increase near the facility that increases it operations.

In both of these cases, a local community could be impacted by increased emissions, even though GHG emissions decline overall. Because a cap-and-trade program provides substantial flexibility for facilities to select their preferred methods for achieving the GHG emission cap, the design of the program does not automatically mitigate this concern. Other regulatory programs, in particular the air programs implemented through the air quality management districts, may be

the appropriate venue for ensuring that the trading of GHG emissions under a cap and trade program does not adversely affect impacted communities. Under certain circumstances, the existing air programs may be sufficient to ensure that emissions do not increase in impacted communities.

The following steps are recommended to address environmental justice issues associated with the development of a cap and trade program for GHGs.

- Procedure Equity: Any plan to reduce GHG emissions, including the use of a cap-and-trade program, must provide for early and continuous public involvement. Environmental justice concerns must be incorporated into the decision-making process, and take into account the necessary and tailored outreach required to inform, engage, and involve diverse communities.
- Building Relationships: This public outreach must acknowledge that many affected communities are wary of programs that include trade offs of pollutants. Thus, it must involve community-based and environmental organizations to be credible and productive. This outreach effort must proactively go into communities for evening and early morning meetings, as many community members do not have the means to travel or leave their jobs. As needed, bilingual interpreters should be used to engage the state's diverse communities on this important topic.
- Analysis: Potential impacts on communities, from the perspective of environmental justice and equity, must be explicitly recognized in any planning and discussions, and must include analysis of the potential impacts of a cap and trade program on local communities. In particular, the analyses must examine:
  - *The impacts of emission trading among facilities*. Might cross-sectoral emission trading lead to increases in criteria air pollutants because non-GHG emissions rates vary across sectors? Might trading increase toxic emissions in some areas?
  - *The accuracy with which emissions are measured or calculated*. Might inconsistent emission reporting across facilities lead to emission increases despite reports of emission reductions?
  - *Options for preventing increases in criteria air pollutant emissions*. If a cap-and-trade program provides compliance flexibility, what other environmental policies are required to ensure that criteria air pollutant emissions do not increase? How might these policies be linked to the cap-and-trade program?
  - *The distribution of environmental benefits among all communities*. How will the local air quality impacts and benefits be distributed as the result of a cap-and-trade program that limits GHG emissions?
- Program Design: If analyses show that a cap-and-trade program would likely produce adverse environmental justice impacts, the program design must include reliable measures and strategies to prevent or mitigate the impacts. As needed, opportunities to link related environmental programs, such as air emission programs, to compliance with the cap-and-trade program should be examined to assess how best to ensure that local impacts do not increase, but are in fact reduced.

Finally, we need to recognize that communities heavily impacted by environmental conditions are often also impacted by economic concerns. The economic impacts of GHG emission reduction initiatives, whether under a cap-and-trade program or other strategies, must not fall disproportionately on those communities with the fewest financial resources. If efforts to reduce GHG emissions cause price increases, particularly of necessities such as food, energy, and

transportation, low-income communities may be especially affected. Similarly, the potential for impacts on jobs to be unevenly distributed needs to be assessed.

Consequently, the value of capturing and channeling revenue from auctioning emission allowances back into affected communities must not be overlooked. These resources could be used to mitigate the economic impacts on low-income communities of GHG emission reductions. The resources could also be used to mitigate existing adverse environmental conditions in these communities. The opportunity to achieve these goals should be considered.

5. Other Policy Approaches

Cap and trade is one of a variety of policy approaches that can be used to reduce GHG emissions, whether in California or nationally. Cap and trade has been considered a preferred approach for limiting GHG emissions for several reasons:

- the emission cap provides an absolute emission limit;
- emission trading provides flexibility and helps to reduce the cost of reducing emissions; and
- regulatory programs can be coordinated and linked among multiple jurisdictions (for example, across countries).

Other regulatory approaches can be used to reduce GHG emissions, either as a complement to a cap-and-trade program or in place of a cap-and-trade program. The following is a brief summary of the main alternative policy approaches.

- ***Mandated Technologies or Practices:*** Specific technologies or practices can be mandated to be used. This approach is often referred to as a "command and control" regulatory policy, in which facilities are required to install emission control equipment that has been demonstrated to be effective. The requirement can be implemented with some flexibility, allowing facilities to use alternative emission control strategies if they can demonstrate that their alternative approach is at least as effective as the mandated technology. Technology requirements can be implemented as a complement to a cap-and-trade program. Examples of technology requirements include: electrification of truck stops to eliminate idling; electrification of ports to eliminate the use of diesel generators on ships while in port; installation of solar panels on new homes; and collection and flaring of landfill gas.

  To help reduce compliance costs, command and control programs can incorporate the trading of emission reduction credits (ERCs). As described above in Section 2.3, ERCs are created by a facility that reduces its emissions below some pre-existing regulatory baseline level of emissions. Once the emission reduction is verified, a tradable instrument, an ERC, is issued to the entity that achieved the emission reduction. The ERC can be sold to a second entity that is required to reduce its emissions. The emissions reduction represented by the ERC is used by the second entity to comply with its emission limit.

- ***Intensity or Performance Standards:*** Emission limits can be expressed as intensity standards that define the maximum allowable emission rate per unit of activity or output. An intensity standard can provide broad flexibility regarding how the standard is achieved. The entity required to comply with the standard can devise its own strategy for ensuring that emissions remain under the standard. Unlike an emissions cap, an intensity standard does not limit total emissions. Total emissions can increase or decrease if the underlying activity grows or declines. The emission impact of an intensity standard varies depending on how aggressively the standard is set, and how the level of the underlying activity changes over time. Several examples of intensity standards are as follows.

  - Motor Vehicle Climate Change Emission Standard: The California Air Resources Board has adopted an emission intensity standard for new passenger car and light duty truck sales in California. Each manufacturer is required to achieve a fleet average emission standard, expressed in CO_2-equivalent emissions in grams per mile.
  - Energy-Efficiency Building Codes and Product Standards: Energy-efficiency building codes and product standards mandate maximum levels of energy consumption. For

new buildings, Title 24 defines the maximum energy consumption allowable. Product standards similarly define the maximum energy consumption, for example for appliances and air conditioners. These types of efficiency standards can be implemented as a complement to a cap-and-trade program.

- Renewable Portfolio Standard: The renewable portfolio standard requires that qualifying renewable energy be used to provide a minimum portion of the total load delivered by electric utilities in California. The RPS defines the minimum intensity of renewable energy sources within each utility's resource portfolio. RPS-type requirements can be implemented as a complement to a cap-and-trade program.

To provide compliance flexibility, intensity standard programs can allow trading and banking of emissions. For example, an entity may find that it is able to reduce emission to a level below what is required by the intensity standard. The program may be designed to create an emission reduction credit (ERC) equal to the extra emission reduction. This ERC could be sold to another entity in the intensity standard program, or could be banked for use in a subsequent year. Allowing this trading helps to reduce compliance costs.

Analyses have shown that complicating issues arise if a cap-and-trade program is linked to an intensity standard program to allowing trading of ERCs and emission allowances.[42] In particular, emissions will typically increase if participants in the two programs are allowed to exchange ERCs and emission allowances with each other. Although such exchanges may help reduce overall costs, the two programs may be considered to be somewhat incompatible due to the impact of the inter-program trading on total emissions.

- ***Direct Program Implementation:*** Programs can be undertaken in which actions are taken that reduce emissions directly. For example, the CPUC has directed the investor-owned utilities to meet aggressive energy efficiency goals. Using ratepayer funds, the utilities are making cost effective energy-efficiency investments that save energy, both kilowatt hours (kWh) of electricity and Therms of natural gas. By reducing kWh and Therms, the utilities reduce electric power generation and natural gas combustion, and hence also reduce emissions. Programs can be developed in other sectors with similar results. For example, land use and transportation planning can be used to reduce the demand for travel. Improved transportation infrastructure can motivate shifts to mass transportation options and/or reduce the emission intensity of transportation activities. Direct implementation activities such as these can be implemented as a complement to a cap-and-trade program.
- ***Financial Incentives:*** Financial incentives can be used motivate action. Emission fees have been discussed as a mechanism for reducing GHG emissions. A fee would be imposed on each ton of CO_2-equivalent emissions. Emission sources would be motivated to reduce their emissions in order to reduce the fees owed. Alternatively, a broad-based fee on the fossil carbon content of fuels could be imposed. The fee would increase the price of fossil carbon based fuels, providing an incentive for consumers to use less fuel and/or to switch to alternative fuels. The revenue from fees can be used for various purposes, including to: provide rebates for emission reduction activities; and promote improved economic efficiency and growth by reducing other distorting taxes or fees in the economy.

  Under a fee-based approach, compliance costs are defined by the level of the fee. Consequently, businesses and consumers will know what their costs will be, and can make plans accordingly. However, the level of emission reduction achieved is not known. The emission reduction may be less than or greater than expected.

  Broad-based emission fees and fuel-carbon fees are considered substitutes for a cap-and-trade program. Such fees would not typically be levied on a sector that is also required to

comply with an emission cap. However, targeted financial incentives can be implemented as a complement to a cap-and-trade program. For example, a road pricing program implemented to alleviate congestion, promote a shift to mass transit, and reduce travel could be a complement to a cap-and-trade program.

6. Next Steps

The Cap and Trade Subgroup finds that a cap-and-trade program should be considered further as an approach for reducing GHG emissions in California. The next step in considering a cap-and-trade program is to develop data and perform analyses that would provide the foundation for assessing: (1) whether to implement a cap-and-trade program; and (2) how best to implement it to contribute to achieving the state's GHG emissions targets. If the decision is made to continue consideration of cap-and-trade program options, the following would be the next steps.

- ***Facility-Level Emission Reporting:*** Facility-level emission reporting is needed to support the detailed consideration of a cap-and-trade program, and to better understand current emissions and options for reducing emissions. The following steps are recommended for adopting facility-level emission reporting requirements:
  - A lead agency for implementing an emission reporting requirement must be designated. Whether and how the California Climate Action Registry retains responsibility for GHG emission inventory reporting under a mandatory reporting process must be determined.
  - Legislative authority is required to develop and implement mandatory reporting. At a minimum, the legislative authority should require emission reports from facilities in the industry sectors with significant emissions, including: the electric power sector (defined as load serving entities, LSEs); oil refining; oil and gas extraction; landfills; and cement production. Reporting from facilities in any sector with GHG emissions above a minimum threshold should also be included (the threshold remains to be defined).
  - Reporting protocols, including industry-specific protocols, are needed to support the mandatory reporting. Multiple stakeholders expressed support for the California Climate Action Registry's protocols and data management processes. The protocols must be reviewed and revised as needed to focus on facility-level reporting requirements. Additionally, as an enhancement to the existing protocols, operational data currently reported by facilities to the air districts under their air permits should be used to cross-check the GHG emission report estimates for consistency.
- ***Cap-and-Trade Program Alternatives:*** Several complete cap-and-trade programs should be defined in detail, representing the range of program design options including a sector-based approach and an upstream fuels-based approach. At a minimum, the program alternatives should each include:
  - the sources and GHGs that would be under the cap;
  - the level (or range of levels) of the cap and the rationale for setting the level(s);
  - an estimate of the number of facilities or entities that would likely be required to participate in the program;
  - other program design choices, including: the method and algorithm for distributing emission allowances; the role of emission offsets; rules for borrowing and banking; and trading restrictions (if any); and
  - options for mitigating potential environmental justice concerns and local community impacts.

  Stakeholder participation in the development of these alternatives should be sought, including representatives of affected industries, the Legislature, interest groups, and the

general public. The program alternatives should be presented publicly to get stakeholder feedback and public comment.

- ***Analyses of Cap-and-Trade Options:*** Each of the program alternatives should be evaluated to assess the program's:
  - contribution to meeting the statewide GHG emission targets, taking into consideration emission leakage;
  - impact on the cost of reducing emissions from sources under the cap, as well as the cost of reducing emissions across all sources statewide;
  - impact on state competitiveness, businesses, local governments, and jobs;
  - impact on communities with environmental justice concerns, including the potential for adverse local environmental impacts; and
  - capability to be leveraged into a regional or national initiative.

  Additionally, an analysis of the new authorities required from the California Legislature is appropriate, along with an assessment of any federal legal issues that may arise.
- ***Comparison with Non-Cap-and-Trade Options:*** The costs and impacts of the cap-and-trade program alternatives should be compared to options for achieving the state's GHG emission targets that do not include a cap-and-trade program.
- ***Electric Utilities as Load Serving Entities:*** Several cap-and-trade program options will consider covering electric utilities as LSEs. Options for developing the detailed emission tracking capability required to support this approach need to be defined. The options should examine: the data to be tracked and reported; the entities required to track and report; the likely reliability and precision of the data; legal issues associated with tracking and reporting; confidentiality issues; the cost of creating and maintaining the tracking capability; and alternatives for funding the development and implementation of the tracking capability.
- ***Administrative Assessment:*** Administrative options for implementing each of the program alternatives should be developed. The budget requirements to support the administration of each program option should be assessed.

To ensure timely and continued progress toward meeting the state's GHG emission targets, the following timeframe can be implemented.

- An emission reporting program can be developed in 2006 so that it can take effect in 2007. Authority to proceed is required from the California Legislature.
- Detailed cap-and-trade program alternatives can be developed and analyzed in 2006 and 2007.
- Assessments of whether and how to proceed with further consideration of cap-and-trade program options can be conducted in 2007 with a recommendation to the Governor and the Legislature at that time.

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8. End Notes

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[38] An issue specific to LSEs are differences in past investments in energy efficiency. Under oversight from the CPUC, the IOUs have procured cost-effective energy efficiency resources. Some municipal LSEs have not invested as extensively in energy efficiency. By reducing customer demand, these past actions have reduced GHG emissions and have reduced the IOUs' output (in kWh) below what it would otherwise have been. If emission allowances are allocated on the basis of past output, these previous investments will have the effect of penalizing the IOUs by reducing the IOUs' emission allowance allocations. Stakeholders and others have recommended that adjustments be incorporated into the allocation method to avoid penalizing the IOUs for these beneficial past actions.

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