



**CALIFORNIA'S CLIMATE POLICY:
THE PRESENT AND FUTURE OF AB 32**

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EXECUTIVE SUMMARY

For the past three years, the California Air Resources Board (CARB) has been performing research and drafting regulations to implement the California Global Warming Solutions Act of 2006 (“the Act”), also known as Assembly Bill (AB) 32. The Act initiated regulatory proceedings to set rules intended to decrease the state’s emissions of greenhouse gases (GHG, largely carbon dioxide and methane) to 1990 levels by 2020. Subsequent Executive Declarations (not yet law) from the Governor’s office contemplate a 2050 goal of only 20 percent of 1990 emissions. Subsequent Executive Declarations (not yet law) from the Governor’s office contemplate a 2050 goal of only 20 percent of 1990 emissions, a drop from 427 million tons of CO₂ equivalent (MMTCO₂E) to 85 MMTCO₂E.

AB 32’s supporters have seen confirmation of California’s environmental leadership in the short run and envision the creation of new employment opportunities long run. Opponents have forecasted increased outmigration of business and reductions in employment—another instance of the over-regulation they believe responsible for the state’s poor economic performance.

CARB, an appointed board with few avenues for appeal of its decisions, has investigated possible reductions of GHG emissions within a range of economic activities, with little more guidance than the Act’s requirement that its choices be “cost-effective.” CARB was also asked to compile an “inventory” of GHG emissions and sources needed to determine its numerical goals. CARB was also to produce a “Scoping Plan” by January 2009 that would set out in detail the necessary regulations, their effects on emissions, and the costs and benefits of implementing each regulation. During 2009, CARB was to conduct investigations and hearings it believed necessary to produce draft regulations. During 2010, it was to conduct formal rulemakings, and all major regulations were to be finalized by Jan. 1, 2011, in preparation for enforcement beginning Jan. 1, 2012.

AB 32 left the details of the Scoping Plan almost entirely in CARB’s hands. The Board’s Scoping Plan proposed two broad regulatory schemes: a “cap-and-trade” system recommended by some economists and a large number of direct controls. Under cap-and-trade, large emitters of GHGs must obtain permits (“allowances”) to emit that they could either apply to their own discharges or sell to others. The important question of how to allocate allowances—whether to give them away or auction them—has not yet been fully resolved, and the same holds for the question of how CARB will dispose of the revenue in the event it chooses an auction. Cap-and-trade dominates policy discussions, but the Scoping Plan proposes that direct controls will create the bulk of GHG reductions. The state must eliminate 174

MMTCO₂E by 2020. Approximately 140 of them will be eliminated by direct controls, and only the residual will be determined in the cap-and-trade market for allowances. The most important direct controls will be mandated motor vehicle redesigns to reduce GHGs, more stringent energy efficiency standards for appliances and buildings, mandated reformulations of motor fuels under a low-carbon fuel standard, and an increased requirement for renewable electricity generation. As a group, they will be responsible for 94.3 MMT of abatement. Each is mandated by laws other than AB 32, and the possible suspension of that law by a November ballot initiative will probably leave them unaffected.

Questions and criticisms of CARB's choices have proliferated. They appear to have been made with minimal public input and instead express the Board's preexisting preferences rather than being the outcomes of a transparent process. Since those choices cannot be altered by further regulatory proceedings or litigation, debate has largely shifted to the costs and benefits of implementation. Estimating the benefits of most pollution control regulations usually entails imputation of a dollar value to saved or extended lives, a conceptually straightforward method often difficult to implement in practice. Since California emits only 2 percent of the world's GHGs, its policies will produce no such health benefits. Instead, CARB chose to measure benefits as the savings to households and businesses expected to result from improvements in energy efficiency that will accompany implementation. Its calculations claim substantial benefits relative to "business as usual," defined as the absence of AB 32. Annualized costs as of 2020 will be \$24.9 billion (in 2007 dollars) and benefits will be \$40.4 billion, yielding a net gain to the state of \$15.5 billion per year. CARB's calculations from an economic model of California further show that its output and employment will continue to increase under AB 32 at approximately the same rates as they would absent the law.

Unfortunately, the estimates of direct efficiency benefits and statewide economic benefits are both highly questionable, on so many grounds that CARB's claims are impossible to take seriously. Moreover, many of the biases in these calculations are on the side of excessive optimism. The estimated efficiency benefits depend on a fundamentally unreasonable assumption—that consumers value only lower energy costs and mandated design changes for energy-using goods mean nothing to them. Improved fuel economy means lighter, less safe, and lower-powered vehicles that many of today's buyers reject, but the Board sees no harm from diminishing the available choices. Likewise, some of CARB's projected cuts in fuel use will be the result of mandated increases in urban density that many homebuyers reject. Even if we follow CARB and disregard such cost, its benefit calculations depend on arbitrary assumptions about fuel prices, ethanol subsidies and other important variables. The Board's estimates are not robust—reasonable and minor changes in just a few numbers easily turn net benefits into net losses.

CARB's statewide results come from a special computer model that estimates how AB 32 will affect output, prices and employment in major economic sectors, the incomes earned by workers employed in them, and the necessary investments to sustain them. These results are entirely dependent on the researchers' assumptions and choices of data. Many of both are doubtful, unfounded, or arbitrary. Nor can the model address concerns about unemployment since its mathematical structure does not allow any unemployment beyond that associated with everyday job switching. It oversimplifies California's relationships with the rest of the world, most particularly by simply assuming that implementing AB 32 will not affect outmigrations of business and labor. The model also simply assumes that "leakages" of economic activity that replace declines in California emissions with increases out-of-state are minimal, and the same holds for any adverse effects of policy uncertainty on business investment. CARB's model cannot even predict the "green jobs" that some believe will be a benefit of AB 32. In reality, California's history of aggressive environmental regulation has yet to produce them—on one definition, the state has fewer green jobs than Michigan.

AB 32 only sets goals for 2020, but CARB is already planning for expected future legislation that imposes more stringent GHG limits. Even if we believe CARB's calculations of small but positive net benefits, they are unlikely to persist if controls are further tightened. As "easy" sources of GHG reduction are exhausted, costs must rise and real benefits become harder to find. CARB is already searching for benefits to rationalize its future choices. While many consumers see mandatory increases in housing density as undesirable CARB intends to disregard their feelings, while counting as benefits the health improvements of increases in walking and public transportation use. CARB has not publicized the fact that meeting its goals will require a 20 percent reduction in passenger vehicles by 2020 to be achieved by taxation or coercion. Looking beyond 2020, CARB sees a 40 percent reduction in them by 2030 (while population increases by 25 percent). Getting to an 80 percent emissions reduction by 2050 will require technologies that have yet to be invented and lifestyle changes that have yet to be imagined. If CARB has its way, the implementation of AB 32 will be only the first step in a long and ever more severe program of self-improvement for California.

CHAPTER 1

AB 32: CALIFORNIA ATTACKS CLIMATE CHANGE

I. Introduction

A. The coming of AB 32

The California Global Warming Solutions Act became law on September 27th, 2006.¹ Also known as AB (Assembly Bill) 32, it made the state's air quality regulators the first in the nation to be charged with designing and enforcing a program to control emissions of carbon dioxide (CO₂) and other "greenhouse gases" (GHG) thought by some experts to be responsible for increasing global temperatures.² AB 32 ordered the California Air Resources Board ("CARB") to oversee a reduction in GHG emissions that would return them to 1990 levels by 2020. The reduction cuts them to approximately 85 percent of today's levels and 70 percent of those forecast for 2020 if there were no climate policy, a situation called "business as usual" or BAU.³ AB 32's 2020 requirements are a way station rather than a goal. CARB's "Scoping Plan" (discussed below) states that "according to climate scientists California and the rest of the developed world will have to cut emissions by 80 percent from today's levels to stabilize the amount of carbon dioxide in the atmosphere and prevent the most severe effects of global climate change."⁴ An earlier non-binding Executive Order from the Governor's Office specified that such a reduction was to be achieved by 2050.⁵ Since the state produces approximately 2 percent of world GHG emissions, however, the program simply cannot significantly impact world GHG levels.⁶ Therefore, its supporters have instead chosen to tout its economic and political benefits. They believe that regulations to implement AB 32 will improve the state's economy by fostering "green" jobs and improve its competitiveness because its research facilities are uniquely suited to produce innovations

¹ AB 32's text as codified into state law can be found at http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf

² Greenhouse gases are so named because the growth in their atmospheric concentrations can create a "greenhouse effect" in which the earth traps increased amounts of solar radiation and becomes warmer, just as would a greenhouse. AB 32 places other GHGs listed in the Kyoto Protocol under state jurisdiction, including methane (natural gas), nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. Because CO₂ is by far the most quantitatively important gas to be controlled, we will sometimes refer to CO₂ as the subject of regulation, when other gases are under similar rules. Some regulations on fertilizer and livestock specifically cover only methane.

³ CARB Final Climate Change Scoping Plan, Dec. 2008, ES-1. (Subsequently referred to as Scoping Plan.) http://climatechange.ca.gov/eaac/documents/state_reports/Adopted_Scoping_Plan.pdf

⁴ Scoping Plan, ES-2.

⁵ California Executive Order S-3-05 (June 1, 2005).

⁶ Scoping Plan, 11.

that will help meet its goals.⁷ In addition, they believe that AB 32 will set an example of enlightened policy to be followed by the federal government and other nations.

AB 32 designated CARB as “the state agency charged with monitoring and regulating sources of emissions of greenhouse gases.”⁸ It has long been responsible for writing and enforcing state pollution standards, and is an agency unique to California.⁹ The only possible appeals from most of its rulings are through the courts. The law set a timeline for CARB to write regulations and begin enforcing them, which it has generally adhered to. Rather than specifying a policy direction, AB 32 allowed the board to choose any method it could justify. Possible tools included command-and-control regulation, a carbon tax, and a “cap-and-trade” program to allocate (or possibly sell) a fixed quantity of emission permits (“allowances”) and operate a market in which they could be bought and sold. AB 32 also gives CARB power to set all fees paid in connection with AB 32. It need only hold a “workshop” prior to approving them, and is not bound by rigorous principles of cost allocation and recovery like those of public utility commissions. By late 2009, it had fee-setting rules in place, but has not yet set any actual fees.¹⁰

B. Hopes and questions

As he signed AB 32 into law Governor Arnold Schwarzenegger modestly called it the start of “a bold new era of environmental protection in California that will change the course of history.”¹¹ He declared that it was “good for business,” particularly “small businesses that will harness their entrepreneurial spirit to help us achieve our climate goals.”¹² Environmentalists at the Natural Resources Defense Council (NRDC) and Environmental Defense (ED, formerly Environmental Defense Fund) cited a study projecting that the law’s implementation would produce 89,000 new jobs and increase gross state product by \$74 billion.¹³ Pacific Gas & Electric (PG&E), supplier of electricity to most of northern

⁷ California Climate Action Team, Biennial Report 2010, 3.18. The Team is a governmental body whose functions are discussed below. <http://www.energy.ca.gov/2010publications/CAT-1000-2010-004/CAT-1000-2010-004.PDF>

⁸ AB 32, §38510. AB 32 was incorporated into the state Health and Safety Code with the section numbering unchanged.

⁹ California is the only state with a regulatory agency that operates like the ARB, which came into being in 1967. The federal Clean Air Act Amendments of 1970 gave the Environmental Protection Agency (EPA) jurisdiction over all atmospheric pollutants. The law allowed CARB to continue its regulatory programs, with a general rule that any controls it chose to institute had to be at least as stringent as EPA’s. For example, CARB has put new vehicles sold in California under emission controls that EPA will not implement for several years to come.

¹⁰ AB 32, §38597. CARB’s order appears at <http://www.arb.ca.gov/regact/2009/feereg09/ab32finalfro.pdf> The board has stated that it will not set fees until the state budget has been finalized. As of this writing (September 2010) the legislature has not set a budget, which was due June 30th and will probably not arrive until after the November election.

¹¹ *San Francisco Chronicle*, Sept. 28, 1996.

¹² *Power Market Today*, Sept. 29, 1996.

¹³ *Power Market Today*, Sept. 28, 2006. This and other studies are discussed in more detail below.

California, supported the bill because “climate change is the most critical environmental challenge of our age, with potentially severe impacts on California.”¹⁴

The reaction was not uniformly enthusiastic. The California Manufacturers’ and Technology Association (CMTA) feared that AB 32 would disadvantage its members, whose costs were already 55 percent above the average for the world’s nine largest manufacturing nations.¹⁵ The California Chamber of Commerce was unequivocal:

AB 32 will drive good companies and good jobs out of California to states or countries that do not have similar restrictions on businesses. It will trigger significant increases in consumer and business costs for things such as electricity and fuel. And it will do next to nothing to affect emissions on a global scale so long as countries such as India and China continue their skyrocketing emissions growth.”¹⁶

Perhaps the best summary came from a respected Sacramento columnist. He called AB 32 “political symbolism with consequences.”¹⁷

Four years after enactment the hopes and concerns persist. The most important regulations will soon be finalized, and enforcement will begin in 2012. They are being formulated during a major recession that has hit California hard, with 12 percent unemployment, heavy middle-class outmigration, a moribund housing market, and a dysfunctional state government. The governor, legislature and CARB uniformly support aggressive implementation of AB 32 as an engine of recovery. Critics see it as a source of policies that will worsen the economic problems, and as a symbol of overregulation that is destroying the state’s promise. Many of the critics support Proposition 23, a November ballot initiative. If passed, it will suspend the implementation of AB 32 until the state’s unemployment rate falls to 5.5 percent for four consecutive quarters.¹⁸ Until then, CARB will not be able to propose or issue new GHG regulations, although it may be able to continue programs of emissions reduction that were mandated by other legislation. The consequences of those programs may be as important as those of AB 32. In the event Proposition 23 does not pass, its opponents hope that the next Governor will take advantage of AB 32’s “safety valve” provision. It allows the Governor to order revision of some or all deadlines “[i]n the event of extraordinary circumstances, catastrophic events, or threat of significant economic harm [not otherwise defined]” for up to 1 year, with further annual extensions as an option.¹⁹ The state’s current

¹⁴ *Foster Electric Report*, Sept. 6, 2006. Southern California Edison more cautiously said that it “supports the goal of AB 32 to address the important issue of climate change, but we remain concerned about the potential costs, particularly for our customers.” (*Ibid.*)

¹⁵ *Business Wire*, Sept. 27, 2006.

¹⁶ *Foster Electric Report*, Sept. 6, 2006.

¹⁷ Dan Walters, *Sacramento Bee*, Aug. 30, 2006.

¹⁸ The unemployment rate was 4.8 percent on the date AB 32 became law.

¹⁹ AB 32, § 38599.

Governor is unwilling to invoke the safety valve, as is one of the two major candidates running for that office in the November 2010 election. The other claims to be opposed to Proposition 23 but intends to turn the safety valve if elected.²⁰

III. Goals, Requirements and Timelines

A. Goals

Like many other environmental laws, AB 32 starts with declarations of endangerment if climate change continues uncontrolled. The legislation states that rising GHG emissions will aggravate the state's air quality problems, reduce the quality and quantity of water from the Sierra snowpack, produce a sea level rise that leaves major residential and commercial concentrations under water or threatened by flood, and increase the incidence of "infectious diseases, asthma, and other human health-related problems."²¹ AB 32 also expressed concerns about economic harm, particularly to agriculture and tourism, as well as the fact that rising temperatures will "increase the strain on electricity supplies necessary to meet the demand for summer air-conditioning in the hottest parts of the state."²²

It was certainly clear to most legislators that reducing California GHG emissions, even to zero, would have virtually no impact on the world's growing total of them. Rather, AB 32 would bring symbolic, persuasive and economic benefits in its wake. As symbolism, it would allow Californians to feel pride in continuing their state's national and international leadership in environmental policy. As persuasion, there were hopes that passage would encourage (or possibly intimidate) other states, the federal government, and other nations to act on the problem, particularly if California showed that climate policy could engender prosperity rather than the depression some feared. The direct benefits to the state's economy further rationalized being a first mover. With a policy in place California could "position its economy, technology centers, financial institutions, and businesses to benefit from national and international efforts to reduce emissions."²³ Employment would grow, pollution would shrink, energy

²⁰ "California's Whitman Says She's Opposed to Proposition 23," *Platts Commodity News*, Sept. 23, 2010.

²¹ AB 32, §38501(a). CARB's Scoping Plan pointed up the immediacy of the problem: "The impacts of global warming are already being felt in California. The Sierra snowpack, an important source of water supply for the state, has shrunk 10 percent in the last 100 years. It is expected to continue to decrease by as much as 25 percent by 2050. World-wide changes are causing sea levels to rise—about 8 inches of increase has been recorded at the Golden Gate Bridge over the past 100 years—threatening low coastal areas with inundation and serious damage from storms." [Scoping Plan at 10]

²² AB 32, §38501(b) A voluminous summary of current research on the economic effects of climate change appears in Climate Action Team, Biennial Report 2010, *Op. Cit.*, Ch. 2.

²³ AB 32, §38501(c) – (e).

efficiency would improve, and prosperity would ensue. Proponents of AB 32 saw it as better than a free lunch. It was a tasty and wholesome meal that Californians would be paid to eat.

B. Requirements

AB 32 gave CARB a simple set of bounds on its future actions. Specifically, it was to “adopt rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions from sources or categories of sources.”²⁴ The law went on to specify tasks for CARB to carry out, aided as necessary by other state agencies, most importantly the California Public Utilities Commission:

- 1 By June 30, 2007, CARB would publish a list of “discrete early action” measures, with the advice of a previously established “Climate Action Team” of state department and agency heads.²⁵ This list came to include measures imposed by other laws, such as a low carbon fuel standard that will require all gasoline and diesel fuel to include approximately 10 percent ethanol or biofuels.²⁶
- 2 By Jan. 1, 2008, the board would adopt a regulation covering mandatory reporting of GHGs by 800 large emitters (defined as over 25,000 tons per year). Beginning in 2010 rigorous third-party verification is required.²⁷
- 3 By Jan. 1, 2008, CARB was to have estimated 1990 GHG emissions, from which it would determine the 2020 goals. Its December 2007 final report specified that the state would produce no more than 427 million metric tons of CO₂ equivalent (“MMTCO₂E”) in 2020.²⁸
- 4 By Jan. 1, 2009, it would produce a “Scoping Plan” to achieve “the maximum technologically feasible and cost-effective reductions ... by 2020.” AB 32 specified virtually nothing about its form or coverage, other than that the plan “shall identify and make recommendations on direct emission reduction measures, alternative compliance mechanisms, market-based compliance

²⁴ AB 32, §38560.

²⁵ AB 32, §§38560.5 and 38562.

²⁶ ARB, “Expanded List of Early Action Measures to Reduce Greenhouse Gas Emissions in California Recommended for Board Consideration,” Oct. 2007. http://www.arb.ca.gov/cc/ceea/meetings/ea_final_report.pdf

²⁷ A summary of reports from individual facilities is at http://www.arb.ca.gov/cc/reporting/ghg-rep/facility_summary.xls A list of approved verifiers is at <http://www.arb.ca.gov/cc/reporting/ghg-ver/ghg-ver.htm>

²⁸ ARB Staff Report, California 1990 Greenhouse Gas Emissions Level and 2020 Emissions Limit, Nov. 16, 2007. “CO₂ Equivalent means that figures for more potent GHGs such as methane are adjusted upward to account for their possible greater per-unit contribution to climate change. http://www.arb.ca.gov/cc/inventory/pubs/reports/staff_report_1990_level.pdf

mechanisms, and potential monetary and nonmonetary incentives for sources and categories of sources.”²⁹

5 CARB has also taken action on three other provisions of AB 32 and a subsequent Governor’s Order:

- [1] It adopted a policy to encourage voluntary early action by emitters, promising that they would receive appropriate credits after the full program takes effect in 2012.³⁰
- [2] It appointed an “Environmental Justice Advisory Committee” whose oversight would “ensure that activities undertaken to comply with [AB 32] do not disproportionately impact low-income communities.”³¹
- [3] It appointed an “Economic and Technology Advancement Advisory Committee (“ETAAC”) to keep abreast of research on economic and scientific aspects of GHG abatement.”³²
- [4] In addition to these, a 2006 Governor’s Executive Order assigned selection of a “Market Advisory Committee” of economic and climate experts to the head of Cal-EPA. The committee was to advise CARB on design of a cap-and-trade system.³³

C. Regulatory Timeline

CARB is moving forward in the process of formulating regulations in proceedings that comply with state administrative law. The basic process and timeline are as follows:

Scoping Plan. The Scoping Plan both provided an overview of the entire regulatory process and specified numerical GHG abatement goals for the state’s economic sectors. After production and peer review of a draft, a final plan was published in December, 2008.

²⁹ AB 32, §§38561(a) and (b). The report’s format is also unspecified, other than for a state that the plan will be “as that term is understood by [CARB].”

³⁰ CARB, Statement on Voluntary Early Actions to Reduce Greenhouse Gas Emissions, approved Feb. 28, 2008. http://www.arb.ca.gov/cc/scopingplan/voluntary/policy/voluntary_policy_final.pdf

³¹ AB 32, §38562 (b)(2). The Committee’s Dec. 10, 2008 report is at <http://www.arb.ca.gov/cc/ejac/proposedplan-ejacommentfinaldec10.pdf>

³² AB 32, §38591(d). The committee’s Feb. 2008 report is at <http://www.arb.ca.gov/cc/etaac/ETAACFinalReport2-11-08.pdf>, with a Dec. 2009 update at <http://www.arb.ca.gov/cc/etaac/meetings/ETAACAdvancedTechnologyFinalAppendices12-14-09.pdf>

³³ Scoping Plan, 8.

Draft Rules. During 2009, CARB staff was to formulate draft rules to implement the Scoping Plan. The process was to include public workshops on the individual measures, including cap-and-trade. Some of the rules are still in process.

Early Action Measures. The Board was to put the Early Action Measures into effect by Jan. 1, 2010. It has done so for most of them.

Formal Rulemakings. During 2010, ARB would conduct formal rulemakings based on the 2009 draft rules, implemented with workshops and public hearings. Probably the most important of them pertain to cap-and-trade and have not yet been finalized.

Completion of Rulemakings. All of the major rules are to be finalized by Jan. 1, 2011, but subsequent revisions and new rules remain possible.³⁴ Some, but not all of the regulations, required by the Scoping Plan will meet this deadline.

Rules Take Effect. By Jan. 1, 2012, all of the rules are to take effect and the cap-and-trade market is to begin operating.³⁵

As has lately become common, California does not currently (September 2010) have a state budget, even after its new fiscal year has begun. CARB's proposed spending (some currently being made under continuing resolutions) for the new fiscal year is \$39 million, an amount likely to survive the legislature. Of that amount, \$33 million will be used to implement the scoping plan. The remainder will be split almost equally between creation of the emissions inventory and policy-related research.³⁶

III. A look ahead

This chapter has discussed AB 32's political and cultural contexts, along with its basic provisions. Those provisions and the consequences will unfold over the next several years. Chapter II supplies background data on the sources of the state's GHG emissions and CARB's most important programs for reducing them. Rather than detail the literally hundreds of rules that the board is in process of producing,

³⁴ AB 32, § 38562 (a).

³⁵ AB 32, § 38562 (c).

³⁶ California Legislative Analyst's Office, Implementation of AB 32 — Global Warming Solutions Act of 2006 (April 14, 2010). http://www.lao.ca.gov/reports/2010/rsr/ab32_implementation/ab32_implementation_041410.aspx

we examine its work on several programs that were designated for early action. The regulations written in connection with these programs range from the prosaic to the ominous to the nearly humorous.

Chapter III discusses the regulatory process and the research that has been performed on possible GHG control programs and their effects. Doing so requires that we examine some general issues in benefit-cost analysis and compare CARB's actual decision-making process with legal and scientific standards. The board's justification for its cap-and-trade policy rests on two foundations: its estimates of costs and benefits and a computer model of their effects on California's economy. To determine whether CARB's claim that the benefits exceed the costs is justified, we will need to discuss the objectives of the modeling, the logic that underlies its model, and the data on which the computations are based.

With these in mind, Chapter IV outlines and analyzes CARB's principal result: the implementation of AB 32 will be costly, but the state's economy will benefit because improvements in energy efficiency will outweigh those costs. Such findings are, however, questionable because their economic logic completely disregards differences in the preferences of individuals. Sensitivity analyses of the model, known as E-DRAM, and work with similar models outside of California have confirmed that cap-and-trade can coexist with strong economic performance under quite different assumptions and in different geographies. The similarities, however, are more likely evidence that models of this type share common and probably irremediable flaws. We go on to enumerate ways in which the gap between these models and reality renders E-DRAM's computational outcomes virtually valueless. Its cost-benefit analyses are also so heavily assumption dependent that plausible changes in a handful of numbers can change their reported net benefits to net losses to California. Chapter V closes the report with a description of CARB's likely future policies and its search for types of benefits that can rationalize those actions. The board will indeed need to find benefits given the costs it intends to impose, which include a 20 percent decrease in the state's passenger vehicle fleet by 2020 and a 40 percent cut by 2030.

CHAPTER II

IMPLEMENTATION AND THE SCOPING PLAN

I. Introduction

Beyond breathing, virtually every human activity and every mechanical process on the planet produces carbon dioxide. It may do so directly, as when an internal combustion engine operates, or indirectly, as when operation of an appliance requires that electricity be generated from fossil fuel. These facts give choices about the cost-efficient control of emissions the same underlying complexity as the economy in which those choices are made. This chapter provides information on the physical and economic dimensions of carbon policy. We begin with what is known about the range of carbon sources and their relative importance, followed by a discussion of CARB's quantitative GHG reduction goals. A large percentage of GHG abatement will utilize programs authorized by laws other than AB 32. We then examine CARB's implementation of nine items that had been set for early action, and follow with a discussion of CARB's attempt to influence sectors that it cannot legally regulate.

II. The Scope of the Program

A. Sources of Emissions

Table 2-1: Sources of GHG Reductions in Scoping Plan	
Reduction Measure	Contribution toward 2020 Target (MMTCO₂E)
Capped Sectors	
Light-Duty Vehicle GHG Standards	31.7
Energy Efficiency	26.3
33 % Renewable Portfolio Standard	21.3
Low Carbon Fuel Standard	15.0
Regional Transport-Related GHG Targets	5.0
Vehicle Efficiency Measures	4.5
Other Transport (truck, rail, ports)	6.1
Solar Roofs Program	2.1
Miscellaneous	0.3
Total: Capped Sectors	146.7

California produces approximately 2 percent of the world’s estimated GHG emissions.

Uncapped Sectors	
Total	27.3
Cap-and-Trade	
Reduced by Cap-and-Trade	34.4
Grand Total	174

Table 2-1 and Figure 2-1 show the

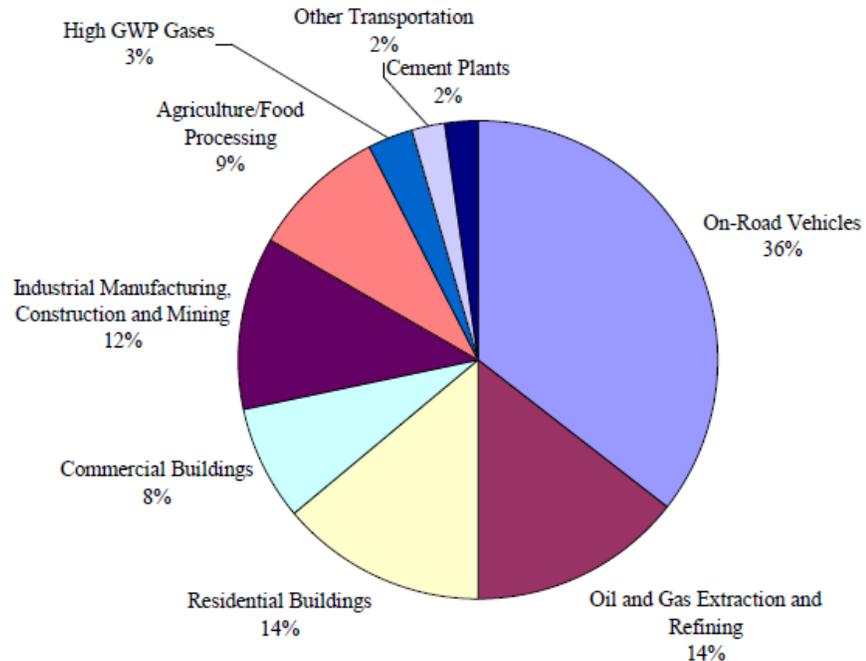
average 2002 – 2004 amounts in millions of metric tons of CO₂ equivalent (MMTCO₂E or MMT) produced by the various sectors of its economy.³⁷ In the absence of GHG policy, CARB expects that 469 MMTCO₂E annually produced then will grow to 596 MMTCO₂E in 2020. If the goals of the Scoping

Source: Scoping Plan, 17, abridged

plan are achieved, 2020 emissions will be 422 MMTCO₂E. This reduction of 174 MMTCO₂E will enable the state to return to estimated 1990 levels.³⁸ Fuels burned in transportation and power generation are the two largest GHG sources, although the latter is somewhat misleading. Roughly half of electricity’s GHG emissions are from coal-burning generators located outside of the state, but AB 32 requires their inclusion in the electric sector totals.³⁹ Unlike transportation and electricity, CARB expects little growth in industrial emissions since the state’s environmental and tax policies drive away fuel-intensive firms. Those that survive are often location-specific, such as refineries and cement producers. “High GWP” is primarily leakage from processes that involve more powerful GHG-producing chemicals than CO₂, most importantly refrigerants. Net emissions from CO₂-absorbing forests are counted as negative.⁴⁰

Figure 2-1: Annual California GHG Emissions 2002-04

Source: Scoping Plan, 11 one footnote omitted



³⁷ The table and diagram are from Plan, App. F.

³⁸ Scoping Plan, 21.

³⁹ AB 32, § 38505(m).

⁴⁰ The reasons for their becoming zero in 2020 are not clear.

B. Sources of Emissions Reductions

Table 2-2, taken from the Scoping Plan, identifies and categorizes CARB’s expectations about emissions abatement by its various programs. The restoration of 1990 levels requires removal of 174 MMTCO₂E per year by 2020. Although we often speak of CARB’s program as cap-and-trade, 139.6 MMT of them will be removed by direct interventions. Cap-and-trade will only remove the remaining 34.4 MMT. The Scoping Plan notes that “Whatever additional reductions are needed to bring emissions within the cap are accomplished through price incentives posed by emissions allowance prices.”⁴¹ CARB distinguishes “capped” sectors subject to the allowance program from “uncapped” ones, which it expects to provide 27.3 MMT of reductions. Those sectors do not lend themselves to customary measurements for CARB’s purposes. They will see actions to diminish leakages of “High Global Warming Potential” gases and increases in GHG abatement from sustainable forestry policies (5.0 MMT). The full tables contain a staggering number of minor measures, ranging from high-speed rail (1.0 MMT abatement in 2020) to solar roofs (2.1 MMT) to a tire pressure check program (0.55 MMT) described below.⁴² Some titles are misleading: “Regional Transportation-Related GHG Targets” are actually interventions into local planning intended to force denser development that will lower vehicle miles traveled and raise shares of public transportation. “Vehicle Efficiency” includes tire inflation and reflective paint regulations, the latter a part of CARB’s recently abandoned “Cool Cars” program described below.

Table 2-2: 2002-2004 Average Emissions and 2020 Projected Emissions (Business as Usual), in MMTCO₂E		
Sector	2002-04 Average Emissions	Projected 2020 Emissions (BAU)
Transportation	179.3	225.4
Electricity	109.0	139.2
Commercial and Residential	41.0	46.7
Industry	95.9	100.5
Recycling and Waste	5.6	7.7
High Global Warming Potential	14.8	46.9
Agriculture	27.7	29.8

⁴¹ Scoping Plan , 15.

⁴² Detailed figures for items like these appear in Scoping Plan Appendices Vol. 2, G-1-6 — G-1-8.

Forest Net Emissions	-4.7	0.0
Emissions Total	469.0	596.0

Source: *Scoping Plan*, 13

Over half of all planned reductions are concentrated in four programs. Their 94.3 MMT total is 2.7 times larger than the 34.4 MMT that are to be eliminated by cap-and-trade. Whatever the fate of cap-and-trade under Proposition 23, these programs were authorized by other legislation and will in all likelihood continue.⁴³ They are:

Light-duty vehicle GHG standards [31.7 MMTCO₂E in 2020]. In 2002 California enacted plans to redesign vehicles in accordance with its own GHG policies, and are popularly known as the “Pavley I” standards. Reversing a 2007 decision that denied a waiver of federal preemption, EPA granted the waiver in January 2009.⁴⁴ ARB is also implementing research on alternative (“low carbon) fuel standards (“Pavley II”) and zero emission (e.g. fuel cell and electric) vehicles.⁴⁵

Energy efficiency policies [26.3 MMTCO₂E]. These reductions are the total of those from a large number of programs, some pre-existing and others new under the California Public Utilities Commission’s “Long-Term Energy Efficiency Strategic Plan.”⁴⁶ Utility-sponsored efficiency programs [whose costs are fully recoverable under regulation], upgraded building codes and appliance standards will reduce emissions by 19.5 MMTCO₂E, and another 6.7 will be saved by increased industrial cogeneration (“combined heat and power”). In the event AB 32 is suspended, most of these programs will continue as ongoing activities of the Public Utilities and Energy Commissions.⁴⁷

⁴³ There are legal questions about the precise GHG amounts to be abated under AB 32, and the degree to which CARB can include reductions made pursuant to other legislation. Most importantly, since three of the four major measures are mandated by previous legislation some believe that CARB should not include them in its plans and instead treat them as business-as-usual. If so, CARB would have to find massively more (and more costly) policy tools to achieve the reductions demanded by AB 32. We do not further consider these issues. See AB 32, § 38562(d)(2).

⁴⁴ As of 2008, these standards had also been adopted by 13 other states.
<http://yosemite.epa.gov/opa/admpress.nsf/bd4379a92ceceac8525735900400c27/5e448236de5fb369852575e500568e1b!OpenDocument>
 The Scoping Plan was written before EPA waivers were granted. It suggested a “Feebate” plan of selective surcharges on high-CO₂-emitting vehicles as an alternative, even if EPA ultimately granted the waiver. See Scoping Plan, 40.

⁴⁵ Unless electricity comes from such costly sources as solar generation it cannot possibly produce zero emissions, a point not considered by ARB

⁴⁶ <http://www.californiaenergyefficiency.com/docs/EEStrategicPlan.pdf>

⁴⁷ Scoping Plan, 42-44. 2.2 MMT will be saved by the state’s solar roof and water heating programs, also the subjects of pre-AB 32 legislation. Scoping Plan Appendices, Vol. I, C-122.

http://www.arb.ca.gov/cc/scopingplan/document/appendices_volume1.pdf

33 percent renewable power requirement [21.3 MMTCO₂E]. In 2002 California enacted a requirement that its regulated (i.e. corporate) utilities were to obtain 20 percent of their power from “renewable” sources such as solar, wind and geothermal by 2010. As a group they currently obtain 15.4 percent of their power from those sources, mostly put in place before the law’s enactment.⁴⁸ Problems in siting of plants and transmission, along with regulatory uncertainty, have resulted in the shortfall. Nevertheless, a 33 percent requirement (that will also apply to municipal utilities that serve 25 percent of the state’s load) will be necessary to meet AB 32’s 2020 deadline.⁴⁹ A bill mandating it passed the legislature in July 2010 but was vetoed by the Governor on grounds that it failed to eliminate important delays in the regulatory process.⁵⁰ On Sept. 26, 2010 CARB unilaterally enacted the 33 percent requirement (also applicable to municipal utilities) by unanimous vote, in the face of adverse reactions by key legislators who believed that such an action was beyond CARB’s power and would be tested in court. If the state is unable to meet the 33 percent requirement by 2020 it is unlikely to attain the Scoping Plan’s goals.⁵¹

Low carbon fuel standard [15.0 MMTCO₂E]. A Jan. 2007 Governor’s Executive Order set a goal of achieving a 10 percent reduction in the carbon content of transportation fuels by 2020.⁵² CARB was ordered to investigate the feasibility of such a low carbon fuel standard (LCFS), determine whether it qualified as a “discrete early action” measure under AB 32, and initiate a regulatory rulemaking if true.⁵³ The Board issued its LCFS rule on Jan. 10, 2010, which ordered a 10 percent reduction in “carbon intensity” to be phased in during 2011 - 2020. The reduction will entail blending low-carbon biofuels into existing motor fuels and otherwise crediting the use of the former. Shortly after the rule was announced, suits were filed claiming that the state’s biofuel standard was preempted by existing federal law and regulation.⁵⁴

⁴⁸ Scoping Plan, 44-46; California Public Utilities Commission, Renewables Portfolio Standard, Quarterly Report, Second Quarter 2010, 2. <http://www.cpuc.ca.gov/NR/rdonlyres/66FBACA7-173F-47FF-A5F4-BE8F9D70DD59/0/Q22010RPSReporttotheLegislature.pdf>

⁴⁹ The Scoping Plan’s 21.3MMT abatement target accounts only for the effects of raising the RPS from 20 to 33 percent. Any additional abatement that will result from reaching the soon-overdue 20 percent requirement will not be included in CARB’s measures of attainment.

⁵⁰ Letter from Governor Arnold Schwarzenegger to CARB Chairman Mary Nichols, July 15, 2010. <http://www.arb.ca.gov/regact/2010/res2010/schwarzenegger.pdf>

⁵¹ “California Delays Key Implementation Decisions While Adopting Tougher RES,” Carbon Control News, Sept. 27, 2010.

⁵² Executive Order S-01-07, Jan. 18, 2007. <http://gov.ca.gov/executive-order/5172/> Its rationale was a White Paper produced by the Governor’s Office. http://www.arb.ca.gov/fuels/lcfs/lcfs_wp.pdf

⁵³ <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm>

⁵⁴ <http://www.arb.ca.gov/regact/2009/lcfs09/finalfro.pdf> The case is *Rocky Mountain Farmers Union et al. v. Goldstene* (E.D.CA. 09-02234).

Beyond these major rulemakings are literally dozens of others pointed at specific activities or specific sectors. As of July 1, 2010, CARB had instituted active implementation plans, some including rulemakings, for 69 distinct measures.⁵⁵ As an alternative, nearly all of the planned measures affect one of ten broadly defined economic sectors, and CARB publishes lists of them with links to the progress of individual regulations.⁵⁶

III. Early Actions under AB 32

A. The Climate Action Team's recommendations

As noted above, an Executive Order from the Governor requested that the Climate Action Team determine "Discrete Early Implementation" areas in which CARB could begin to manage GHG abatement measures prior to the bulk of the rulemakings under AB 32. The Team found 9 areas which were to be operative by Jan. 1, 2010, a deadline that has largely been met. Some, such as the Low Carbon Fuel Standard, are quantitatively important, while others aptly illustrate the micro-levels at which CARB intends to influence households and businesses.

1. Regulations that apply to the Low Carbon Fuel Standard Program (discussed above and in Chapter 4) are nearing their final form.⁵⁷ The program will cover 36 different energy sources.⁵⁸ The Board's "Final Statement of Reason" for the associated regulations (not the regulations themselves) runs to 979 pages.⁵⁹
2. The Landfill Methane Control Program became effective in June 2007. It requires gas collection and control from municipal landfills and specifies performance standards for methane collection equipment.⁶⁰
3. Hydrofluorocarbon emissions from mobile air conditioning are to be further controlled. CARB originally proposed a ban on sale of small containers of refrigerants, but a "grassroots" organization commissioned a study calculating the cost of a ban as \$167 million per year. Instead, there will be additional system inspections, mandated use of lower-emitting fluids, and

⁵⁵ See Scoping Plan Measures Implementation Timeline, July 1, 2010. This document is occasionally revised, but revisions are not scheduled. 7/1/10 ScP implementation timeline for individual rules

http://www.arb.ca.gov/cc/scopingplan/sp_measures_implementation_timeline.pdf

⁵⁶ See CARB's "Economic Sectors Portal," at <http://www.arb.ca.gov/cc/ghgsectors/ghgsectors.htm>

⁵⁷ <http://www.arb.ca.gov/fuels/lcfs/lcfs.htm> Randomly following the links on this page will give the reader a sense of the complexity (and the associated uncertainty) of this rulemaking.

⁵⁸ http://www.arb.ca.gov/fuels/lcfs/121409lcfs_lutables.pdf

⁵⁹ <http://www.arb.ca.gov/regact/2009/lcfs09/lcfsfsor.pdf>

⁶⁰ <http://www.arb.ca.gov/cc/landfills/landfills.htm>

new regulations for abandoned vehicles.⁶¹ A sub-rule covers the control of small refrigerant containers (between two ounces and two pounds), including a mandatory refund program.⁶² A measure to reduce emissions from refrigerated shipping containers is on hold.

4. Special regulations to reduce GHG emissions, including sulfur hexafluoride, in semiconductor manufacturing.⁶³ They appear to be structured in ways that impose disproportionate costs on larger manufacturers.
5. A similar regulation to control sulfur hexafluoride emissions from non-semiconductor and non-electrical manufacturing.⁶⁴
6. Regulations to limit or mandate alternatives to consumer products using chemicals that have high global warming potential (“GWP”).⁶⁵ The many affected products include aerosol cheese and dessert toppings, boat horns, pressurized gas dusters and tire inflators, double phase aerosol air fresheners, multi-purpose solvents and paint thinner.
7. Regulations to require aerodynamic design modifications and tires with low rolling resistance in heavy-duty trucks.⁶⁶ These are to meet EPA “Smart Way” streamlining and energy use standards that do not apply in other states. Smart Way equipment includes a bunk heater (\$1,500), an auxiliary power unit (\$7,000), aluminum wheel sets (\$3,000), trailer aerodynamics (\$2,400), automatic tire inflation (\$900), and oxidation catalyst (\$1,000).⁶⁷ EPA has established loan programs for affected truck owners.⁶⁸
8. Tire inflation regulations, particularly for vehicles built before 2007 (when federal requirements for pressure monitoring systems were imposed). On Aug. 30, 2010 a final regulation requires that

⁶¹ <http://www.arb.ca.gov/cc/hfc-mac/hfc-mac.htm>

⁶² CARB’s description of the rule (the rule itself is far longer) is typical:

In January 2009 the Board approved the mobile air conditioning (MAC) regulation to reduce emissions associated with the use of small containers of automotive refrigerant. Do-it-yourself (DIY) practitioners can purchase HFC-134a refrigerant in small containers holding between 2 ounces and 2 pounds of refrigerant to recharge their MAC system. Typically a traditional container is not fully emptied during the recharging process since the air conditioning system may only require a portion of the container and due to incorrect technique by DIY users. With a traditionally designed container, any unused refrigerant is almost immediately vented to the atmosphere.

This regulation applies to the sale, use, and disposal of small containers of automotive refrigerant with a GWP [global warming potential] greater than 150. The regulation achieves emission reductions through implementation of four requirements: 1) use of a self-sealing valve on the container, 2) improved labeling instructions, 3) a deposit and recycling program for small containers, and 4) an education program that emphasizes best practices for vehicle recharging. This regulation went into effect on January 1, 2010 with a one-year sell-through period for containers manufactured before January 1, 2010. The target recycle rate is initially set at 90%, and rises to 95% beginning January 1, 2012. <http://www.arb.ca.gov/cc/hfc-mac/hfcdiy/hfcdiy.htm>

⁶³ The Statement of Reasons for the regulation appears at <http://www.arb.ca.gov/regact/2009/semi2009/semifisor.pdf>

⁶⁴ <http://www.arb.ca.gov/cc/sf6nonelec/sf6nonelec.htm> A “concept paper” describing processes that emit sulfur hexafluoride is at <http://www.arb.ca.gov/cc/sf6nonelec/sf6-draft-concept-paper.pdf>

⁶⁵ <http://www.arb.ca.gov/consprod/regact/ghgcp/ghgcp.htm>

⁶⁶ <http://www.arb.ca.gov/cc/hdghg/hdghg.htm> Fact sheets for owners are available in English, Spanish, and Punjabi.

http://www.arb.ca.gov/cc/hdghg/documents_hdghg.htm

⁶⁷ <http://www.epa.gov/smartwaylogistics/calculator/loancalc.htm>

⁶⁸ <http://www.epa.gov/smartwaylogistics/transport/what-smartway/financing-clean-diesel-info.htm>

all auto service providers check tire pressures every time they perform a service, using a gauge with total permissible error no greater than 2 pounds per square inch.⁶⁹

9. A “shore power” rule requiring that ship operators turn off auxiliary engines for most of a vessel’s stay in port and connect the vessel to some other source of power, most likely an electric utility; or use alternative control technique(s) that achieve equivalent emission reductions. By 2017 fleet owners will be required to reduce at-berth emissions by 70 percent.⁷⁰

CARB is known to have abandoned at least one GHG regulation. The “Cool Cars” program was to lower interior temperatures of cars parked in the sun, in order to reduce GHG production associated with air conditioning.⁷¹ The board first considered mandating light-colored cars, but changed to a requirement for reflective paint. Its contractors were unable to create reasonable facsimiles for black and brown. The rule also required reflective coating on glass areas, until CARB found out that they inhibited electronic transmissions to and from vehicles. It responded by mandating small non-reflective areas in windshields. The exact cause of abandonment cannot be firmly determined, but it is known that law enforcement agencies expressed concern that people wearing electronic tracking devices might be able to escape surveillance by traveling in cool cars.

B. Regulation in the shadow of AB 32

California’s government is also attempting to influence sectors and initiate activities that were in all likelihood not contemplated under AB 32. Several examples turn up at the coolcalifornia.com web portal, operated by a “partnership” of CARB, the Berkeley Institute of the Environment (operated by the University of California), Lawrence Berkeley National Laboratory, the California Energy Commission, and Next 10, “an independent, nonpartisan organization that educates, engages and empowers Californians to improve the state’s future.”⁷² Alongside such features as carbon-footprint measurement for households, it contains a “Local Government Toolkit” that details possible low-cost and no-cost GHG actions. It also lists sources of loans, grants and rebates that may be available to finance city projects. Coolcalifornia.com also contains instructions on how to prepare a local “Climate Action Plan” of the type encouraged in CARB’s Scoping Plan, along with a set of links to local government GHG “success

⁶⁹ <http://www.arb.ca.gov/cc/tire-pressure/finalreg.pdf> Vehicle service invoices must be kept for at least three years. A customer may decline the inflation check if he affirms that he has checked the pressure in the past 30 days or will do so in the next 7.

⁷⁰ <http://www.arb.ca.gov/ports/shorepower/shorepower.htm>

⁷¹ <http://www.arb.ca.gov/cc/cool-cars/cool-cars.htm>

⁷² Cal EPA and CARB, “Cool California Fact Sheet.” http://www.arb.ca.gov/cc/ccc/cool_california_fact_sheet_english.pdf

stories.”⁷³ There are also GHG education resources and links to resources for elementary and high schools.⁷⁴ Click the tab titled “Youth” and you will find links to the CARB-sponsored “California Climate Champions” program, a statewide network of teenagers who will be celebrated for their efforts to reduce carbon.⁷⁵

IV. Summary

CARB is nearly on schedule in much of its implementation activities. Its December 2008 Scoping Plan sets out the basic numbers and identifies programs that it believes will achieve its 2020 goal of reducing the state’s annual GHG emissions by 174 MMTCO₂E. Perhaps unexpectedly, CARB expects that the cap-and-trade program that dominates most discussions of policy only needs to eliminate 34 MMT of the total. An assortment of direct controls will account for the remainder. The four most important of those programs, expected to remove 94 MMT, are in fact independent of AB 32 and mandated by other legislation and regulation. They consist of light-duty vehicle redesigns and standards (31.7 MMT), energy efficiency policies (26.3 MMT), a low carbon fuel standard (15.0 MMT) and a 33 percent renewable energy requirement for all utilities (21.3 MMT). Other highly diverse direct control programs will be initiated to bring about the remaining reductions. They will affect transportation, city planning, air conditioning, forestry and an assortment of other industries and activities. CARB has written draft regulations for many of the programs. It is currently taking them through its formal rulemaking process, which is scheduled to close at the end of 2010, in preparation for the start of enforcement in 2012.

An assortment of regulations has previously been determined as suitable for early implementation, and most of them are currently in force or nearly so. They provide a good sample of how CARB is likely to draft and implement its other GHG policies. Data are not yet available on enforcement. The programs include some major ones such as the low carbon fuel standard. There are others, less important for total abatement, that are already beginning to impose costs on the economy. These include mandated accessories to be purchased by owners of heavy trucks, some of whom are

⁷³ <http://www.coolcalifornia.org/article/local-gov-toolkit> Also see CARB and Cal-EPA, “Local Government Toolkit,” Presentation Graphics, May 28, 2009. <http://www.arb.ca.gov/board/books/2009/052809/09-5-3pres.pdf>. Cal-EPA is required by law to produce an annual “Report Card” on GHG reduction activities at all state agencies.

⁷⁴ http://www.climatechange.ca.gov/climate_action_team/reports/2010_CalEPA_Report_Card.pdf

⁷⁴ <http://www.coolcalifornia.org/article/school-resources>

⁷⁵ <http://www.coolcalifornia.org/article/champion-the-cause>

abandoning or selling their businesses.⁷⁶ Regulations to mandate tire pressure measurement by garages and specify the details of containers to be used in do-it-yourself air conditioning repairs are almost comical, but an industry organization claims that the added cost of the latter will be \$167 million per year. CARB is also actively originating and participating in programs not explicitly mandated by AB 32, including support for local climate activists and awards to students for anti-GHG efforts.

⁷⁶ There are no available statistics, but individual stories are emerging. See e.g. Gustavo Arellano, "My Parents' Keeper," *Los Angeles Times*, Aug. 29, 2010.

CHAPTER 3

ESTIMATING THE COSTS AND BENEFITS OF AB 32

I. Introduction

The costs of GHG abatement are uncertain, and the benefits are hard to evaluate if one uses orthodox economic techniques. If GHGs nevertheless pose important threats to health or economic activity, determining the economically efficient amount of abatement requires estimation, however imperfectly, of those costs and benefits. This chapter opens with a discussion of conceptual problems in cost-benefit estimation, both in general and as applied to California. In the process it examines alternative measures of AB 32's benefits that will be important in our final reckoning.

We next consider the process by which CARB actually made its choice of policies and, to the extent that it did so, estimated the costs and benefits of those choices. The most immediate difficulty in evaluating CARB's performance is that we know so little about the alternatives it considered. The Board held numerous hearings on sector-specific policies, but in the end, it chose to issue its draft Scoping Plan with little or no public input on its basic findings and policy recommendations. Instead CARB presented a take-it-or-leave-it package of cap-and-trade and direct controls, and the law probably left few choices but for the affected parties to take it. Heavily criticized by normally supportive peer reviewers, the Board provided what most agree were inadequate responses to them and chose to make few important changes between the draft and final Scoping Plans.

CARB chose to evaluate the Scoping Plan's benefits by showing that implementation of AB 32 entailed massive benefits as by-products. Its chosen policies would so improve the efficiency with which Californians used energy that the savings on energy bills would outweigh the program's costs. Reserving that discussion for the Chapter 4, we proceed by examining CARB's chosen computer models of the California economy. A limited number of runs of these models showed that the result of implementing AB 32 would be statewide economic performance no worse than under "business as usual," and possibly a slight improvement. Checking this claim requires delving into the structure of the model. Some technical discussion is necessary because the details of the program are what drive CARB's optimistic forecasts, and a closer examination of the details strongly suggests that there are few reasons to take the forecasts seriously.

II. Benefits and Costs in the Regulatory Process

A. Measuring benefits and costs

Normally, environmental regulations require translation of both costs and benefits to dollar values. A hypothetical EPA regulation that reduces a pollutant known to harm health must be evaluated against possible alternatives, including inaction. Regulators must assign dollar values to saved lives or increased longevity, and account for other benefits (e.g. reduction of other pollutants) and costs of the proposal. They must factor in the costs of its implementation (including those of investments by the public) and discount the expected future costs and benefits in order to compare them with those of other activities. There are many complications, but for localized pollutants with identifiable sources (e.g. power plants) such calculations are feasible and widely used.⁷⁷

There are no precedents in cost-benefit analysis that clearly apply to GHG emissions. Almost all of the factors that facilitate quantification in the case of conventional pollutants are missing for GHGs. Instead of the measurable dose/response relationships that typically exist between conventional pollutants and morbidity, there is such great uncertainty about the consequences (if any) of GHG emissions that it remains easy to selectively justify almost any damage figure one chooses. As of 2008 there were 235 published estimates of the damages from emitting a ton of CO₂.⁷⁸ Some were negative (from researchers who saw higher crop yields) while others exceeded \$1,000 per ton (reflecting expectations of chaotic weather and epidemics due to warming).⁷⁹ One economist ranked 103 estimates of damages from GHGs. The 95th percentile was \$95 per ton, but he found that the most plausible value was \$14 per ton.⁸⁰ There are no available CARB documents that provide any estimates of GHG damage values. The Board has estimated allowance values under alternative assumptions, but these estimates are prices that equate supply and demand for them rather than the savings to society associated with abatement of an extra ton of emissions.⁸¹

⁷⁷ Court decisions have said that EPA is legally bound to consider only the benefits of its actions and not the costs, but as a practical matter it cannot avoid considering these costs when (e.g.) setting an ambient concentration standard for an air pollutant. See *Whitman v. American Trucking Associations et al.*, 531 U.S. 457 (2001).

⁷⁸ Richard S.J. Tol, "The Economic Effects of Climate Change," *Journal of Economic Perspectives* 23 (Spring 2009), 29-51.

⁷⁹ Such expectations have been produced as adjuncts to California's policy by the state's Climate Action Team. Their April 2010 Biennial Report describes numerous research findings to the effect that major climate change is already in progress and is adversely affecting the state's environment and economy. It contains few if any citations to the possible benefits of increased emissions.

⁸⁰ Richard S.J. Tol, "The Marginal Damage Cost of Carbon Dioxide Emissions: An Assessment of the Uncertainties," *Energy Policy*, 33(2005), 2064-74.

⁸¹ Running under 25 alternative assumptions, CARB's model generated allowance prices ranging from \$16 to \$187. See CARB, "Updated Economic Analysis of California's Climate Change Scoping Plan," March 24, 2010. http://www.arb.ca.gov/cc/scopingplan/economics-sp/updated-analysis/updated_sp_analysis.pdf

The benefits and costs depend on details, most importantly the exact forms that regulation takes and assumptions about future technological and market developments. A “command and control” system that imposes strict numerical emissions quotas will probably cost more (in foregone output of other goods and services) than a cap-and-trade system that allows firms to trade emission rights among themselves. We do not know how (and how quickly) technologies and markets will respond to regulations that force the public to pay for the right to emit—whether new production methods and transportation innovations will be forthcoming and allow a relatively easy adjustment to the regulations, or whether the new methods will be harder to find and costlier to initiate. Will consumers be willing and able to adjust quickly to fuel prices that include value of carbon emitted, or will a move to smaller cars, mass transit, and increased density be hard to make and resisted? Finally, the rate at which future costs and benefits are to be discounted is a matter of some controversy. If climate change entails costs borne in the future, inaction by the present generation may inflict substantial harm on future generations. CARB, however, has not publicized any estimates of GHG-related damages, apparently realizing that no figure would be remotely defensible. Without such an estimate, it is impossible to compare the costs CARB plans on imposing against the future environmental costs.

Still another alternative argument is that California already has a de facto carbon tax on electricity, and adding allowance prices to that tax would lead to an inefficiently high premium on avoided GHG emissions. Electric generation produces energy and in the process emits GHGs. Delivering the energy entails fixed costs for the transmission and distribution systems, whose prorated values per kilowatt-hour are added to consumer bills. Currently, the all-in levelized cost for a combined-cycle gas-fired generator (the marginal source in California) is approximately 9.6 cents per kWh. Residential rates start at 11.6 cents and rise to 36 cents for the largest consumers. If carbon is priced at between \$10 and \$40 per ton, the implied surcharge on energy is between 0.5 and 2 cents per kilowatt hour. If fixed charges are loaded into per kWh prices, Californians are already paying a tax on the carbon emitted in the process of electricity production. “Consumers are already receiving an economic signal to eliminate all electricity consumption that is not of particularly high value to them. For the upper rate tiers, the signal is particularly strong.”⁸²

⁸² Carl Danner, “Greenhouse Gas Policy and California Electricity Prices,” *Journal of Regulatory Economics* 37 (2010), 98-106, 94.

C. Valuing Benefits to California

Even if many of the uncertainties could be eliminated or resolved, one major problem remains for AB 32—California produces only about 2 percent of the world’s GHG emissions. If all of its people and emission sources vanished overnight the effects on worldwide CO₂ accumulations would be virtually undetectable. Meaningful long-term reductions in GHGs will only happen if nations like China and India come to burn far less coal, a policy they are understandably reluctant to adopt. If so, California’s carbon policy will yield its residents trivial atmospheric benefits, while they bear the lion’s share of the costs.⁸³ Using conventional regulatory criteria, a consensus value the benefits would effectively be zero, and implementing AB 32 would hardly be in the public interest.

Other common rationales also fail. According to one, AB 32 will turn California into a model and an inspiration for states and nations to initiate their own GHG programs. Other states have enacted climate legislation, but none has instituted a program as comprehensive and aggressive as California’s. There is no obvious reason for others to incur the costs of following California if the only result will be reducing GHG by amounts that will not matter for climate change, regardless of whether or not climate policies are warranted. A related rationale sees implementation of AB 32 as industrial policy. Some expect that a large-scale program will produce massive investments and innovations in GHG-related technologies. The state’s experience will then allow it to become first-mover leader in emerging markets for climate-related goods and services. The inability of governments to “pick winners” is legendary, and there may be even fewer reasons to expect that as politicized a program as AB 32 will bring smart choices. Most claims that investment in renewable power and climate policy will create “green jobs” fail on both logical and factual grounds. Regulations in those areas that force consumers to make additional expenditures will not be available to spend on other goods and services, where workers will encounter fewer desirable opportunities. Relative to other industries the manufacture and operation of most renewables do not offer long-term or highly skilled jobs. Barring special circumstances, state-level environmental policies are unlikely to reduce California’s high (12 percent) unemployment rate and speed up its sluggish economy.

CARB claims it has found those special circumstances. Specifically, it argues that implementing AB 32 will bring massive dollar benefits to Californians that exist independently of any possible

⁸³ Californians might lose while non-Californians might benefit. Its implementation plans include the tracking of carbon produced by coal-burning powerplants elsewhere in the west that sell into California, and adding carbon surcharges to Californians’ power bills. Whatever California’s response, the coal-fired plants will continue to operate. Their power will be bought by other westerners, and probably at lower prices since California’s demand for their power has vanished. This is but one of many manifestations of the generally acknowledged problem of “leakages.”

environmental or climatic effects. As discussed in the next chapter, CARB believes that those benefits will result from increases in the efficiency with which Californians use energy. As noted in Chapter 2, it expects that the largest single source of new efficiencies will be fuel reformulations and new vehicular technologies that lower energy costs per mile driven. CARB also sees efficiency gains coming from innovations in electrical demand management, and changes in building codes and appliance designs that will maintain performance levels with lower energy bills. CARB calculates that these outcomes will actually happen and that if they do the value of saved energy will exceed any increase in costs. Californians will be better off even if GHG reduction is of no direct value to them.⁸⁴ Efficiency is a magic bullet that dodges problems in valuing environmental benefits while offering citizens something for (almost) nothing. Chapter 4 discusses this reasoning quite critically, but until then we will view it as a justification for the cost-effectiveness of CARB's policies.

III. Performing a cost-benefit analysis

A. CARB's internal rules

AB 32 charged CARB with determining and adopting "rules and regulations in an open public process to achieve the maximum technologically feasible and cost-effective greenhouse gas emission reductions from sources or categories of sources."⁸⁵ In the process the board would evaluate "the total potential costs and total potential economic and noneconomic benefits of the plan for reducing greenhouse gases to California's economy, environment, and public health, using the best available economic models, emission estimation techniques, and other scientific methods."⁸⁶

Whether CARB's work met those criteria remains open to question, particularly with regards to cost-effectiveness. There are many tools to control GHG emissions, with different marginal costs and efficacies in abatement. We can only determine the tools that are cost-effective if we know the costs and benefits of all (realistically, most) possible methods. Conceptually, there is a "supply curve" of abatement techniques, arrayed from the lowest to the highest net cost. The cost-effective methods consist of the lowest-cost set that achieves the abatement tonnage goal, and we can only identify that set if we know the entire universe of policies and their costs and benefits. Instead of producing such a listing, CARB chose to present only the choices that it actually decided upon, asserted that these were the cost-

⁸⁴ CARB also calculates that economizing on fuel use in this way will also bring some modest reductions in emissions of conventional pollutants.

⁸⁵ AB 32, § 38560.

⁸⁶ AB 32, § 38561(d).

effective ones, and provided no information on the costs of methods that it had rejected. Some rejected choices were surely cheaper than the 33 percent renewable portfolio standard for electricity, whose net costs per ton of CO₂ abated were a near-astronomical \$133.⁸⁷ Since it failed to enumerate the policies it chose to reject, CARB may be in violation of AB 32's requirement that its choices be cost-effective.⁸⁸

Some have also questioned whether CARB's rulemaking followed the procedures required of its parent Cal-EPA, which are required for all regulations.⁸⁹ The essential steps are to first "analyze, describe, and to the extent possible, quantify the impacts on California businesses and individuals," aided by public input, before the regulation is publicly proposed. Next, a "second element... analyzes the costs of alternatives or combinations of alternatives that may have different environmental protection levels from the regulation under development. The analysis would help decision makers select the most cost-effective alternative." Since many regulations produce valuable reductions in risk, a third step is to "explicitly put the risk reductions and the benefits into perspective by comparing [them], to the extent possible, to other environmental regulatory actions." Finally, after public announcement of a regulation the public may submit alternatives, which will be "subject to a cost evaluation" to determine "whether a less costly alternative to the draft regulation has been proposed."⁹⁰

CARB's adherence to these standards was unclear. There were no junctures in the scoping process at which the board opened itself to alternatives to cap-and-trade that would have the same effects on GHG emissions. Instead, (see below) CARB prepared a package that consisted of a predetermined mix of direct controls (some the results of prior legislation) and a cap-and-trade program. The latter's institutional details remained (and still remain) to be filled in, but its basic logic and primacy were not

⁸⁷ Scoping Plan, App. G, G-1-7. The measure ranked next most costly had net abatement costs of \$55 per ton. Scoping Plan, 84.

⁸⁸ AB 32 stipulates that all "technologically feasible and cost-effective" measures be taken. CARB claims it measures cost-effectiveness as dollars per ton of GHG eliminated, implicitly declaring that its choices are all cost-effective. Two sets of intervenors have filed comments on this practice. One believes that AB 32 is under a rule of reason, i.e. its goals should be reduced or abandoned if they are too costly to meet. Sempra Energy filed such comments and suggested as a standard that CARB compare California abatement costs with allowance prices under the European Trading System. Those prices, however, are set by supply and demand and will only equal the benefits of abatement by coincidence. Environmentalist intervenors see the law's quantitative requirement as indicating the true desires of the public, and that the Board cannot limit implementation on economic grounds. Their claim is that CARB's only responsibility is to determine the cheapest policy mix that meets the law's numerical requirements. Compare Sempra Energy Comments on Cost Effectiveness, June 18, 2008.

http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/060308/SE_comments_on_ce.pdf with Natural Resources Defense Council *et al.*, "AB 32 Cost Effectiveness: General Framework," June 2, 2008.

http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/060308/SE_comments_on_ce.pdf. CARB's positions (and some useful numbers) appear in its June 3, 2008 presentation, White Paper, and Appendix.

http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/060308/ce_presentation.pdf,
http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/060308/ce_white_paper.pdf, and
http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/060308/ce_appendix_a.pdf

⁸⁹ All quotes are from CARB, Economic Analysis Program Framework, <http://www.arb.ca.gov/research/econprog/program.htm>

⁹⁰ Two other elements of the program are of lesser interest. [1] In cases where federal regulations are alternatives, the agency must justify any difference in cost between them and a California alternative, and [2] Examine its impact on lower levels of California government. These standards were finalized in 2003.

publicly evaluated. By CARB's own admission its risk analysis consisted of a small number of runs of extremely complex computer models. Many assumptions of those models remain unquestioned by the board, and they were not made available to the public in forms that would facilitate further research.

B. Problems in policy determination

Whatever climate policy's actual value, AB 32 forced the state to go to work on it. AB 32 was remarkably vague on its face. It stipulated that CARB was to determine the necessary reduction in GHGs and then formulate regulations to reach it, consulting other agencies and the public as necessary. AB 32 posed unique regulatory problems in its combining of scientific knowledge, economic modeling, and policy design, each of which would require the contributions of many specialists if an efficient solution were to ensue. If climate change is real it will arguably be the greatest problem humans have ever faced. It combines immense knowledge requirements, scientific uncertainty, and requirements for what will probably be massive and costly investments. Disregarding international complications, for all practical purposes the global problem is the same, in complexity if not in scale, as the one CARB was told to attack.

The necessary knowledge would be highly dispersed among individuals and organizations that often have substantial differences. Some of the differences are factual but others are about politics and values. Many regulatory problems offer policymakers some latitude, but their typical universe of choices is small relative to the one in which California had to make climate policy. Purely in terms of science, intelligent climate policy formation will require interaction and knowledge-sharing on a very large scale. Adherence to democratic ideals will also require such sharing and cooperation. If CARB wished to form a climate policy with a reasonable chance of being cost-effective as the law required, its necessary starting point would be to set a protocol that would govern the interactions of the various parties, enforce their rights to acquire information and their obligations to disseminate it, and to provide venues in which to explore their differences. Both CARB and the entities it regulates would have the same rights and obligations. If the law offers no choice about whether to have a policy, even opponents will prefer an efficient one.

C. The policy path not chosen

A protocol to specify and formalize the rights and obligations of stakeholders was suggested several months before release of a draft Scoping Plan, and rejected by CARB. In a response to procedural

questions that CARB had issued for comments, Environmental Defense (ED, formerly Environmental Defense Fund) requested at the outset that the board set up a “modeling protocol.”⁹¹

Fluid collaboration between stakeholders, agency staff and consultants will be facilitated by written materials that describe modeling plans, including the interactions of various modeling platforms, important assumptions and how those assumptions will be adjusted in scenario and sensitivity analyses. Detailing modeling output formats and informational content will also be quite helpful to analysts who wish to conduct “add on” studies using the results of ARB modeling as a starting point.

Early input from stakeholders about both what should be in the protocol document and the decisions it should codify is paramount to proceeding collaboratively. Should protocol decisions be made without early input from stakeholders, we risk the chance of the modeling methods, scenarios or sensitivity studies diverging from or missing altogether broad stakeholder interests and, at the end, resistance to findings no matter how rigorously developed and communicated. With the goal of mutual ownership of both research methods and results ... the protocol will be most helpful if made available well in advance of the conduct of modeling to allow for redirection or refocus following stakeholder input and before irreversible analytical decisions are made.⁹²

ED went on to justify its request by appealing to the breadth of institutional alternatives that CARB should consider. It stressed that in the unexplored territory created by AB 32 the only rational way to choose among the alternatives was to conceive different models, run the numbers, and explore the sensitivity of their results. Such a program, however, would require interactions between CARB and the stakeholders that would probably pose threats to its authority. This was particularly true because the board had already made its choice of cap-and-trade.

There is need to study several important and controversial design dimensions for AB32 compliance strategies. One level of policy design pertains to the role of cap-and-trade policy relative to performance or technology standards, taxes or some combination thereof. In modeling cap-and-trade several key features must be represented to accurately depict the mitigation costs and economy-wide impacts ... Two notable design features are banking and borrowing because they offer great promise to significantly reduce compliance costs. Though ARB has indicated that offsets will be modeled eventually, I highlight the need to fully explore offsets since it is another cost-minimizing feature of cap-and-trade. A cap that is inclusive of many sectors of the economy will provide more within-cap options for reductions, thereby lowering overall compliance costs.⁹³

ED went on to stress that sensitivity analyses produced in a competently done rulemaking would allow all parties to identify assumptions that were particularly influential in determining outcomes, and in the

⁹¹ ED, Comments for AB32 Economic Analysis Technical Stakeholder Working Group, April 2, 2008.

http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/031708/edf_comments_economics_final_040208.pdf

⁹² ED Comments, 2.

⁹³ ED Comments, 3.

process suggest areas for research to determine more precisely the numerical values of sensitive variables. Preliminary model runs and analyses had already led ED to concerns about several, which were admittedly hard to estimate. They included such key parameters as energy price trends, rates of technological innovation, vehicle miles traveled, the rates at which future benefits are to be discounted, and offset and allowance banking policies, and the reallocation of proceeds from allowance auctions.⁹⁴ By the time CARB issued its final Scoping Plan (December 2008) most of these critical topics remained virtually unexplored. The policies that would affect the futures of all Californians were instead chosen almost at the outset by unelected individuals who resided in a vacuum of dogma.

D. The Draft Scoping Plan and its reviewers

Essentially, CARB chose to reject the collaborative efforts suggested by ED, and to give minimal attention to factors that ED had early recognized as critical. Following normal procedures, CARB ordered peer reviews of its draft scoping plan. The reviewers were chosen at its request by the University of California, Berkeley Institute for the Environment, whose functions include coordinating and disseminating the results of climate change research.⁹⁵ The five reviewers uniformly found that that CARB had disregarded or rejected important aspects of ED's proposal. In particular, they criticized the lack of sensitivity analyses, the lack of documentation and explanation of policy choices, and the lack of coherent descriptions of the assumptions underlying its models. Most importantly for the Scoping Plan, the choices were made not by a collaborative, but by CARB. Robert Stavins of Harvard University's Kennedy School of Government explained the problem:

Early on in this process, I conveyed to CARB my view that an outside panel of experts, such as the one on which CARB asked me to serve, could be most helpful to the work of CARB if we were to consult with CARB's economic analysis staff at an early stage. This would have allowed outside experts to help the internal staff construct a solid economic analysis, identify any problems as the staff began to carry out the analysis, and then help the staff improve and refine the analysis. Instead, we have been completely uninvolved in the process until we were sent the economic analysis as it became public.

The result is two-fold. First, the analysis is severely flawed, and hence not useful for the purpose for which it was intended, as I explain below. Second, I fear that at this stage of the process, CARB will find itself in a position of being compelled to publicly defend its

⁹⁴ ED Comments, 5.

⁹⁵ Under CARB rules, reviewers have 30 days to submit their comments. This group, however, was given fewer than 22 (the exact number cannot be determined), because they could not receive their invitations prior to passage of a state budget. As usual, passage of the budget was months late.

economic analysis from critiques such as my own, rather than significantly amend it in response to expert commentary. Both of these outcomes are very unfortunate.⁹⁶

Absent other information, CARB simply chose the programs and mix of them without any visible background research of the type specified by ED. Two reviewers from the liberal Pew Center on Global Climate Change described what they saw:

Because the overall results are highly counter-intuitive and contrary to a wide body of theoretical and empirical work, the current analysis should have done more to explain and justify these results. In particular, it appears that the results are being driven by the net cost (in many cases, net savings) calculations of specific regulatory measures that are inputs to the models, as well as the limited set of policy simulations conducted. Furthermore, the report in many places claims that results are conservative but does not provide comparison for this assertion. As such, the analysis gives the appearance of justifying the chosen package of regulatory measures rather than evaluating it.⁹⁷

Instead of a reasoned collaborative choice of policy measures, it appears that CARB chose them without studying the alternatives, and that it did so with little advice from external experts. After CARB made its choices, AB 32 required that the Board model them.

IV. The Models

A. Why model?

There are two fundamental rationales for modeling the statewide effects of AB 32's implementation. A model can help us to identify and distinguish the effects of alternative policies, or it can be used to rationalize the choice of some particular policy by showing that the policy produces an acceptable outcome. By all accounts, CARB put its model to the latter use. It first chose a specific and detailed policy and subsequently attempted to justify the choice by invoking the results of its model. If a model is to be used at all, there is a far stronger rationale for treating it as one of many possible tools for investigating the consequences of alternative policies. The reasons are inherent in the complexities and weaknesses of the model itself.

⁹⁶ Review letter by Robert Stavins , Oct. 20, 2008. http://www.arb.ca.gov/cc/scopingplan/economics-sp/peer-review/peer_review_comments_arb_responses.pdf

⁹⁷ Review letter by Janet Peace and Liwayway Adkins, Oct. 31, 2008. http://www.arb.ca.gov/cc/scopingplan/economics-sp/peer-review/peer_review_comments_arb_responses.pdf

The quality of insights that a computer model can provide depends on both its structure and the data used in its calculations. Structure consists of the underlying mathematical expressions that the computer will manipulate and the choices of which activities (e.g. industries and regions) to analyze and which to omit or dispose of with simplifying assumptions. Reasonable researchers can often differ for good reason about the mathematical details and the choices of included and omitted activities. Seldom do available data correspond exactly to the what is being modeled (even if the names are the same), and many numbers that can substantially affect the model's outcomes are uncertain at best.

These realities strongly suggest that if CARB were to model at all it should have applied a given model structure and data to alternative policies, with an expectation that the outcomes of its calculations would facilitate comparison of their effects on the state's economy. Structural weaknesses and data problems are never fully remediable, but using the same model and data to compare (e.g.) a cap-and-trade regime and a carbon tax can provide at least preliminary insights that can help in choosing between them. In an ultimate sense, any model's results are "wrong," but a less-than perfect model may still allow comparisons that reduce uncertainty about policy choice. Instead CARB ran its model on the assumption that its already-chosen policies were in place, found what it considered to be favorable results, and closed the book on a modeling process that could, if used differently, have provided important guidance for policy.

B. The structure of an economic system

Any model is a simplified version of reality. A researcher (not necessarily an economist) first determines the relevant elements of the situation and their likely interactions. This is typically followed by attempts to test the model's predictions using actual data. Thus, the process entails three steps—a theoretical formulation, a search for data, and a test of the theory's predictions. CARB's modeling of California for the Scoping Plan fell short on all of them. Its model would ideally estimate the effects of AB 32 and its implementation on the state's economy and on its component markets.⁹⁸

Instead of constructing its own model from the ground up (possibly reasonable in light of its time constraints), CARB based its work on the "Environmental Dynamic Revenue Adjustment Model," (E-DRAM). The state Department of Finance had originally constructed it (then known as DRAM) to estimate the effects of certain regulations as required by law. After those laws lapsed the department

⁹⁸ The model also paid particular attention to effects on some groups singled out in AB 32, most importantly small businesses and low income households.

ceased to use and support it, which may raise questions about its usefulness.⁹⁹ CARB hoped to increase E-DRAM's relevance and improve its accuracy by combining it with Energy 2020, a model from consulting firm Systematic Solutions that would produce a more detailed picture of the state's energy production and consumption. They were, however, unable to input data into the latter that would reproduce the conditions that actually prevailed for their base cases.¹⁰⁰ CARB finally integrated E-DRAM and Energy 2020 in its March 2010 updated Scoping Plan Analysis, for which their combined outcomes differed little from those of E-DRAM alone.¹⁰¹ For convenience, from now on we refer to the paired models as E-DRAM.

The logic of CARB's model of the California economy is fundamentally the same but far more complex than that of Figure 3-1, which is found in many textbooks.¹⁰² It portrays the flows of goods, inputs, and money in an economy that has no government and no foreign trade. Households spend their incomes on goods and services that are produced by business firms.¹⁰³ Their incomes come from productive inputs ("factors") that they sell to firms, most importantly their labor. These incomes allow them to purchase the goods and services that have been produced by the inputs they supplied. The oval labeled "goods and services" actually contains an array of markets in which businesses (suppliers) and households (demanders) interact to determine prices. The oval labeled "factors" contains the markets that determine the prices of inputs offered by households (suppliers) and bought by businesses (demanders). At the right are markets for "intermediates," goods and services they buy from other firms necessary for production of goods and services that are valued by households.

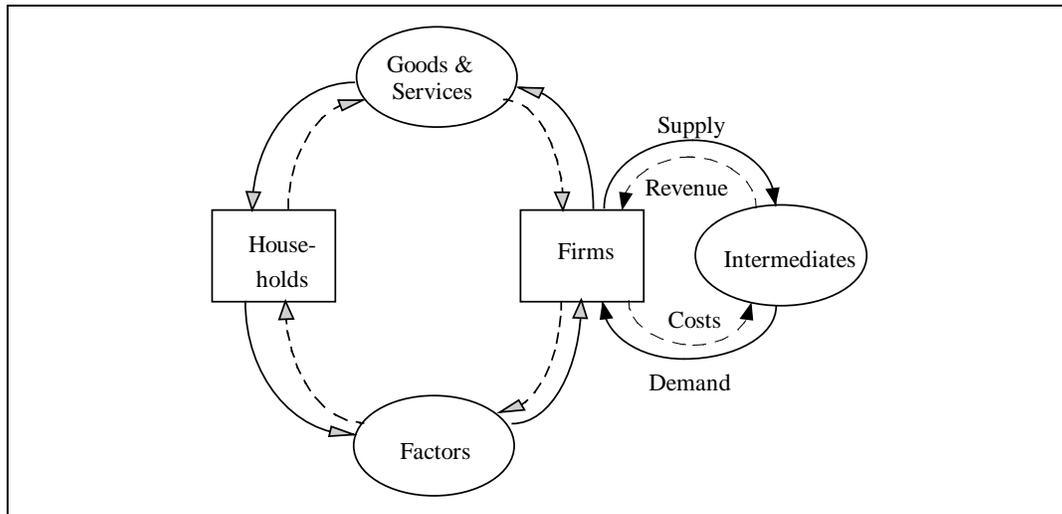
⁹⁹ See California Department of Finance, Reports and Periodicals. http://www.dof.ca.gov/reports_and_periodicals/

¹⁰⁰ This is hardly surprising. The Energy 2020 "Reference Case" requires data from numerous agencies, often independently collected, assembled for other purposes, and definitionally different. To see the basic relationships of the agencies, see slide 16 in ARB's Feb. 29, 2008 presentation http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/022908/feb_29_econ_analysis_presentation.pdf

¹⁰¹ ARB Staff, "Updated Economic Analysis of California's Climate Change Scoping Plan," March 24, 2010. http://www.arb.ca.gov/cc/scopingplan/economics-sp/updated-analysis/updated_sp_analysis.pdf

¹⁰² The figure appears in California Department of Finance, Dynamic Revenue Analysis for California, Ch. 1. http://www.dof.ca.gov/HTML/FS_DATA/DYNA-REV/dram01.doc

¹⁰³ Households also save part of their incomes and businesses invest their savings, a fact that is not of importance for the model's logic.

Figure 3-1: A Circular-Flow Diagram¹⁰⁴

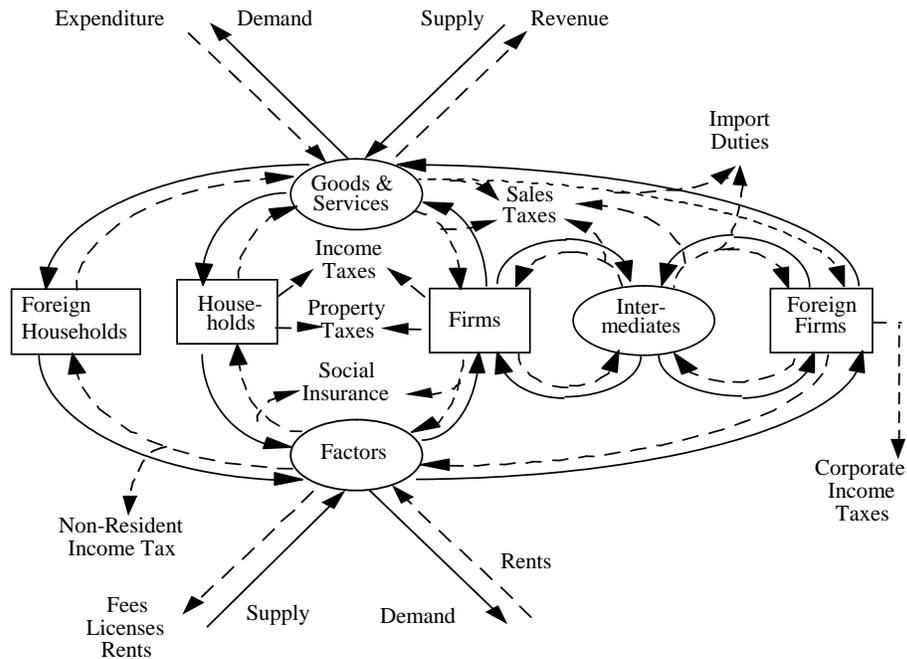
C. Complicating the model

If a model like E-DRAM is to resemble reality, it must be expanded in several directions. First, we must explicitly enumerate the different outputs that are produced and inputs that are used in production, and formulate relationships that determine their prices and quantities. Next, realism requires that we model an economy that moves through time. As it does, businesses invest in new plants and equipment which will be available for production in the future. We must also include governments at various levels that collect taxes, spend them, and issue debt. Doing so requires assumptions about the amounts of various taxes (e.g. income, sales, corporate) that will be paid to the governments, and the amounts they will spend. Finally, because California is not a closed economy the model must account for exports and imports from the rest of the world, whether domestic or foreign. All of these relationships require the formulation and solution of complex systems that contain many equations. The additions make the model more realistic but dauntingly complex, as shown in Figure 3-2, produced by E-DRAM’s creators. As implemented, E-DRAM is known as a “computable general equilibrium” (“CGE”) model. It solves a mass of equations to find the amounts of the different outputs produced, amounts of inputs used, and all of their prices. It also produces numerical values for such important policy variables as governmental revenues from different types of taxes. E-DRAM solution values of the variables are computed for a given year and then moved forward to produce a solution for the next year.

¹⁰⁴ Source: E-DRAM Manual, Ch. 1, 1-4.

Figure 3-2: Structure of the complete E-DRAM model

Source: *E-DRAM Manual, Ch. 1, 1-4.*



E-DRAM is remarkably detailed. Its solution values are determined by over 1,200 equations whose forms and numerical characteristics (“parameters”) have been specified by its creators.¹⁰⁵ These include supply and demand conditions for 186 sectors of the state’s economy, as well as expressions that account for the sectoral interrelationships. 120 of those sectors are industries, some of which are quantitatively important (farming, construction) and others in which AB 32’s possible effects are of concern (oil refining, port activities). E-DRAM’s solution must also account for changes in behavior as prices of inputs and outputs change. Consumers shift in favor of goods that have become relatively less expensive and attempt to economize on costlier ones, and producers similarly substitute among inputs to the extent that technology allows them to. The equations must be formulated to account for substitutions like these, which are related to elasticities of demand and supply. Because AB 32’s drafters were concerned about its effects on those with low incomes, E-DRAM also models the behavior of households at eight different income levels. Originally created for financial analyses, it also contains 45 government sectors that tax and spend.

E-DRAM’s complexity does not extend to markets for labor and business investments, whose treatment is almost surely oversimplified. In labor markets, it assumes that all workers are interchangeable, whether they are executives, scientists, or janitors. It also assumes that the economy

¹⁰⁵ Scoping Plan, Appendix G-2, G-II-23. These are exclusive of many other equations that provide definitions and coding utilities.

utilizes a single capital good in all of its production, i.e. it makes no distinctions between such heterogeneous capital goods as drill presses, tractors, and computers.¹⁰⁶ The simplicity of these formulations means that E-DRAM's version of the California economy will adjust very quickly to "shocks" such as those resulting from implementation of AB 32. Workers are not perfect substitutes for one another. An industry that must rely on workers with a particular skill may not be able to find them if demand for its products rises, and workers laid off as an industry declines may not find local employers who value their particular skills. (Think of construction workers in the current housing decline.) Such common phenomena as unfilled job vacancies, job search by workers, and unemployment are ruled out of E-DRAM by assumption. Ruling them out means that employment and markets for various goods will adjust almost instantly to almost any possible change in economic conditions. E-DRAM also accounts for geography in ways that conceal the likely complexity of labor market adjustments—implicitly it treats a shortage of workers in San Francisco as instantly remediable by migration of workers from Southern California.¹⁰⁷ Oddly, E-DRAM's originators warned users that "CGE models are particularly sensitive to the design of factor markets."¹⁰⁸ CARB's disregard of that warning has probably produced a grossly overoptimistic picture of how California will adjust.¹⁰⁹

D. Sources of the equations and numbers

CGE models produce output that appears to be highly detailed. The price for such detail is that the user must rely on a very large number of assumptions, many of which will be highly arbitrary. If the assumptions are far enough from reality, the seeming precision of its outputs becomes illusory. One important set of assumptions concern "functional forms," the mathematical expressions that express relationships within the model. Their details will determine such key outputs as the mixes of inputs chosen by different sectors, and the abilities of producers to pass on higher costs (e.g. of GHG allowances) to buyers. Even in a model with hundreds of equations, its solution values may be highly

¹⁰⁶ It should be noted that ENERGY 2020 does account for several types of capital, but E-DRAM does not. The associated difficulties are discussed in ARB Staff, "Updated Economic Analysis of California's Climate Change Scoping Plan," March 24, 2010, *Op. Cit.*, 8

¹⁰⁷ For more on how the substitution assumptions of CGE models are likely to bias estimates of adjustment costs and required time downward, see Coalition for Sustainable Cement Manufacturing and Environment, Comments on the Economic Modeling of AB 32, May 14, 2008. http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/042508/ccscme_economic_modeling_letter.pdf

¹⁰⁸ E-DRAM Model Manual, Ch. 1, 1-8. http://www.dof.ca.gov/HTML/FS_DATA/DYNA-REV/dram10.doc

¹⁰⁹ Similar observations apply to the consequences of E-DRAM's assumption of homogeneous capital goods, and the problems are compounded by its model of business investment behavior. Real businesses compete with other businesses to be funded by the capital markets, which lend them to those firms whose plans are expected to yield the greatest profit. E-DRAM instead determines the allocation of funds among non-energy sectors by a formula that does not consider profitability.

sensitive to the user's choice of just a few functional forms. In situations like CARB's, such choices can only be made by the user, and the model's outcomes may be highly dependent on those choices.¹¹⁰

A second critical set of assumptions are those about numerical values that will determine the quantitative significance of relationships in the model, and ultimately the model's solution values. Many of these numbers are associated with changes in behavior as a decision maker's environment changes. Numerical estimates of responsiveness will depend on situational details and the data used in making the estimate. As one example, estimates of the short-run elasticity of demand for gasoline from peer-reviewed journals range from zero to 1.36 and those of the long run elasticity from zero to 2.74.¹¹¹ In the short run, these numbers mean that a ten percent decrease (increase) in the price of gas will lead to a increase (decrease) in gallons consumed that is probably somewhere between zero and 13.6 percent, and in the long run between zero and 27.4 percent. A ten percent change is very small relative to recent U.S. experience, and likely to be very small relative to changes that will come with implementation of AB 32. Further, consumer choices about vehicle fuel economy may be influenced by expectations of future fuel prices. CARB's modeling accounts for such price uncertainty by assuming that it does not exist. They assume a certain price for gas in 2020 and disregard reactions to alternative prices that might prevail.¹¹² Motorists' reactions to them could greatly intensify or attenuate AB 32's effects on actual carbon emissions. Multiply the uncertainties about prices and behavior by the number of fuels analyzed in E-DRAM and the value of sensitivity tests that CARB chose not to make becomes clear.¹¹³

Economic models often assume that decisions of households and businesses are made in situations where information is remarkably abundant and accurate. Further, those models often assume that the consumer or producer knows how to process it to arrive at an optimum. Assumptions like these are implicit in most CGE models, including E-DRAM. They may, however, be poor approximations to behavior in a situation like the implementation of AB 32. That situation will see the beginning of markets that have never before existed in the state and changes in energy prices that will be beyond anyone's experience. The difficulties will be compounded by greater uncertainty about one's future under these unprecedented developments. Choices made under such complete uncertainty are prone to large errors.

¹¹⁰ The difficulty in choosing functional forms and the inherent arbitrariness of whatever choice is made has been used as an argument against the use of CGE models (and for the use of forecast-based models) in many practical situations. See Ross McKittrick, "The Econometric Critique of Computable General Equilibrium Modeling: The Role of Functional Forms," *Economic Modelling* 15 (1998), 543-573.

¹¹¹ These are compiled in Molly Espey, "Gasoline Demand Revisited: A International Meta-Analysis of Elasticities," *Energy Economics* 20 (June 1998), 273-295.

¹¹² CARB's choice for 2020 is \$3.67 per gallon in 2007 dollars. Scoping Plan Appendices, Vol. 1, G-1-4.

¹¹³ This problem was recognized by CARB's peer reviewers. See the reviews of the Draft Scoping Plan by Kahn and Stavins. http://www.arb.ca.gov/cc/scopingplan/economics-sp/peer-review/peer_review_comments_arb_responses.pdf

Important prices will change in unpredictable ways—the “goods movement” provisions of the Scoping Plan will ultimately produce changes in transportation patterns and freight rates that cannot be predicted in advance. E-DRAM simply assumes that decision makers make the right choices effortlessly, but the model’s disregard of uncertainty is likely to conceal important costs that will greatly affect the benefits of implementation.¹¹⁴

A typical E-DRAM run to analyze a policy such as cap-and-trade computes a solution for each year up to 2020. In the process it uses some of last year’s solution values as inputs into this year’s computation. Also used as inputs are econometric forecasts of macroeconomic data such as population supplied by various government agencies.¹¹⁵ Errors in these forecasts will “contaminate” E-DRAM’s forecasts for the year in question, and will also feed errors into the solutions for subsequent years. Perhaps more problematic, our discussion thus far has simply assumed that E-DRAM has a solution that makes mathematical and economic sense.¹¹⁶ Purely as a computational problem, in a model with a thousand equations the solution may show that output of some good is negative, or that an industry’s output exceeds what is producible in its plants. Outcomes like these are the result of assumptions that have been built into its equations, and there is generally no way to determine exactly which assumption is the source of the problem and needs to be modified. When E-DRAM produces nonsensical output or its algorithm fails to converge to a solution, the researcher must depend on *ad hoc* fixes that may poor approximations to the reality that a model purports to analyze.

V. Summary

GHG policy creates novel difficulties for benefit-cost analysis, particularly for a jurisdiction like California, which produces only a minor fraction of the world’s emissions. There are no direct benefits to Californians because unless the rest of the world adopts the same policy there will be no noticeable climate effects. An important dimension of both the costs and the benefits is that their values both depend critically on what is assumed about the public’s reaction to the policy and how quickly it will occur. CARB has chosen to finesse the difficulties by claiming to show that its implementation policies will

¹¹⁴ Oddly, an alleged inability of households and businesses to appreciate the value of improved energy efficiency lies at the heart of many arguments for mandatory demand-limiting measures such as those of the Scoping Plan. Here the economic environment will change in complex and hitherto unknown ways, but CARB assumes that they will make near-perfect and near-instantaneous adjustments.

¹¹⁵ ARB Staff, “Updated Economic Analysis of California’s Climate Change Scoping Plan,” March 24, 2010, *Op. Cit.*, 15.

¹¹⁶ The actual solution is computed iteratively until convergence to final values occurs. This detail is not necessary for understanding the text.

produce improvements in efficiency so great that the savings to the public will substantially outweigh any costs of the program.

The process of policy formation at CARB was hardly conducive to exchanges of information among stakeholders that might have brought consensus. CARB received numerous comments on many aspects of GHG regulation early in the proceeding, but it appears to have made its decision on how to combine cap-and-trade with direct controls with little input from the public. The Draft Scoping Plan embodying that decision was roundly criticized by peer reviewers, but CARB chose to make few changes on the basis of their recommendations.

As part of its benefit-cost calculations, CARB adapted an off-the-shelf CGE computer program to treat energy in somewhat more detail and used it to estimate the effects of its proposed policies on output and employment in various California economic sectors. Its chosen E-DRAM model, like all such models, must selectively simplify a far more complex economy in order to produce results, but those results are critically dependent on details about simplifications and about the numbers used as inputs. With only a single run of E-DRAM to show as evidence, the authors of the Scoping Plan used it to show that implementation of AB 32 would be good for the California economy, or at least no worse than business as usual. In reality, these results were so limited and the model so questionable that any conclusions, whether optimistic or pessimistic, appear unjustifiable.

CHAPTER 4

CARB RUNS THE NUMBERS

I. Introduction

The optimistic conclusions of CARB's cost-benefit study come from its computer models, whose structures we examined in Chapter 3. This chapter describes and evaluates the results of running them. It begins with a summary of EDRAM's most important and controversial finding: contrary to some public concerns, the implementation of AB 32 will in fact benefit Californians relative to business as usual. Perhaps unexpectedly, the findings are similar to (but more optimistic than) those of other CGE models that have been used to analyze other cap-and-trade scenarios at both the state and national levels. Even those sponsored by organizations critical of cap-and-trade often produce economic impacts that are remarkably small. CARB's experts have correctly pointed out that the sole study of implementation that predicts job losses and economic harm is of little or no value. It is, however, possible that the agreement among CGE estimates stems from structural problems that are inherent in those models. If so, their conclusions about cap-and-trade may be worse than useless because they have not captured important costs that are likely to ensue as implementation progresses.

The remainder of this chapter describes inadequacies in implementing the models and problems with their input data. Even if we accept the models as valid pictures of the economy's evolution, their results are dependent on choices of data. CARB has estimated that full implementation of the Scoping Plan's most important provisions will produce over \$15 billion of net benefits to the state on an annualized basis. We show that two minor changes in source data reduce those benefits to nearly zero, an outcome that CARB could have easily found had it performed the sensitivity analyses suggested by peer reviewers. Other plausible data and model assumptions can easily be added to turn the CGE results into net costs for Californians.

Small changes in the numbers can make E-DRAM's results far less optimistic. This sensitivity gives good reason to question its usefulness as justification for cap-and-trade. There are, however, problems at a deeper level. The structure of a CGE model simply cannot capture important aspects of how California will adjust to AB 32, and almost all of the structural issues point to E-DRAM's findings as overstating the benefits of implementation and understating its costs. The various CGE models produce similar results because they have similar structures, but those structures are such poor

approximations to the realities of a dynamic economy that the models' outputs cannot be used for policy analysis. The remainder of this chapter examines and explains some of the inadequacies. These include institutional details that are absent from the models, incomplete and inadequate treatment of labor markets, perfunctory treatment of taxes, poor modeling of both capital and labor mobility, and the effects of increased uncertainty. Finally, CARB fails to examine some transfers of wealth that may be as important as economic losses.

II. The basic results

A. The California economy

Table 4-1 shows the results of incorporating the Scoping Plan's recommendations in an E-DRAM model. Its two right-hand columns compare Business as Usual (BAU) with the outcomes of the Scoping Plan between 2007 and 2020.¹¹⁷ Under BAU, gross state product (in 2007 dollars) grows to 3.6 trillion dollars, at an average 2.8 percent annual rate. Personal Income grows similarly and employment rises from 16.4 to 18.4 million, growing at 0.9 percent. The state performs slightly better under the Scoping Plan, but the numbers are so subject to error that a better guess for the difference is zero. Real GSP in 2020 is 0.9 percent greater than under BAU and employment 0.7 percent higher.¹¹⁸

	2007 Actual	2020 BAU	2020 Scoping	% change from BAU
Gross State Product (\$ Bil)	\$1,811	\$2,586	\$2,593	0.9%
Personal Income	1464	2093	2109	0.8%
Income Per Capita	38600	47600	47760	0.3%
Employment (Millions)	16.41	18.41	18.53	0.7%
Emissions (MMTCO2E)	500	596	421	-29.4%

Source: Scoping Plan, Appendix G, G-III-6

The state growth results under either scenario are the sum of its industries, but with one exception, they move at nearly the same rate. That exception provides some insight into how CGE models operate. Table 4-2 (page after next) first presents price indices calculated by E-DRAM.¹¹⁹ Prices (in 2007 dollars) remain fairly stable in all except the utilities sector, whose output prices (mostly power

¹¹⁷ Scoping Plan, Appendix G, G-III-6.

¹¹⁸ One peer reviewer finds it "almost beyond belief" that CARB claims that these tiny differences are in reality significant See Peer Review Comments of Gary Yohe, Oct. 17, 2008. http://www.arb.ca.gov/cc/scopingplan/economics-sp/peer-review/peer_review_comments_arb_responses.pdf

¹¹⁹ Scoping Plan, Appendix G, G-III-10.

and gas) in 2020 are expected to be 8.8 percent above their 2007 values. Since electricity generation and gas use are among CARB's prime targets, this is unsurprising, particularly since they will need to purchase allowances in order to produce at all. Estimated employment in utilities is expected to drop by nearly 15 percent. E-DRAM calculates this because it assumes a proportional relationship between utility employment and output, and output will drop under AB 32. E-DRAM's assumed relationship misses the realities of California policy. Over the past 20 years, California utility employment has grown faster than output, in part because many utility workers now work in conservation, smart grid, load management and similar activities whose purpose is to reduce consumption. This is but one of many places where unrealistic assumptions produce incorrect results, and those results affect other industries. In E-DRAM, workers who are not working for utilities must be absorbed by other industries.

B. Sensitivity Analysis

External reviewers of the Scoping Plan were uniformly critical of figures like those in Tables 4-1 and 4-2, because they tell us nothing about the robustness of the conclusions. If they are sensitive to minor changes in data or assumptions, CARB would be well-advised to investigate further before committing to some policy. Since the programs are interrelated, problems with one measure may propagate through the system and affect the success of others. CARB attempted to address the model's sensitivity in a March 2010 update report. Table 4-3 (page after next) presents its results for Business as Usual and the Scoping Plan. They differ from those of the original calculations by less than 2 percent.¹²⁰ The updates also test for four potentially important sensitivities, all of which yield only minor differences in estimated 2020 values:

Case 2: (Case 1 is the Scoping Plan as recalculated) Assumes that offsets (i.e. credits for emissions reductions outside of the program) are not allowed. The alternative is the Case 1 assumption of up to 49 percent allowable offsets, whose amount is determined by an assumed "supply curve" at different allowance prices.¹²¹ Expected by some to produce major changes, the new assumptions reduce GSP by under 1 percent of the CASE 1 Scoping Plan calculation.¹²²

¹²⁰ Unlike the Scoping Plan runs, it also included the more detailed findings for various types of energy that resulted from the integration of ENERGY 2020 and E-DRAM, as discussed in Chapter 3.

¹²¹ See Updated Scoping Plan Analysis (Mar. 24, 2010), 28-30.

¹²² Such expectations appear in the Comments of Chevron Corporation, April 4, 2008, and the CRA White Paper for Chevron, April 23, 2008. http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/040408/chevron_arb_workshop_offsets.pdf and http://www.arb.ca.gov/cc/scopingplan/economics-sp/meetings/040408/impacts_of_offsets_final_apr_2008.pdf

TABLE 4-2									
PRICES, OUTPUT AND EMPLOYMENT IN 2020									
INDUSTRY	2020 BAU PRICES (Normalized)	Price Increase with Plan (% of BAU)	2020 BAU OUTPUT (Billion 2007 \$)	2020 BAU Employment (000)	2020 Output with Plan (Billion 2007 \$)	2020 Employment with Plan (000)	Plan Output / BAU Output (%)	Plan Emplmt / BAU Emplmt (%)	
Agriculture, forestry, fishing	1.00	0.00%	109	449	113	464	3.67%	3.3%	
Mining	1.00	0.90%	29	26	31	26	6.90%	0.0%	
Utilities	1.00	8.80%	72	67	60	57	-16.67%	-14.9%	
Construction	1.00	0.10%	164	929	166	934	1.22%	0.5%	
Manufacturing	1.00	0.20%	943	2046	948	2057	0.53%	0.5%	
Wholesale Trade	1.00	-0.60%	171	791	173	793	1.17%	0.3%	
Retail Trade	1.00	-0.30%	296	1901	291	1916	-1.69%	0.8%	
Transport / Warehousing	1.00	-0.50%	109	503	111	510	1.83%	1.4%	
Information	1.00	-0.30%	235	448	238	450	1.28%	0.4%	
Finance, Insurance, Real Estate	1.00	-0.20%	559	1026	572	1046	2.33%	1.9%	
Services	1.00	-0.40%	910	6729	927	6773	1.87%	0.7%	
Government	1.00		N/A	3491	N/A	3502		0.3%	
TOTAL			3597	18406	3630	18528	0.92%	0.7%	

Source: Scoping Plan, Appendix G-III, 10 and 11

TABLE 4-3¹²³: SENSITIVITY ANALYSIS					
(All figures 2007 \$)	Scoping Plan (Case 1)	No Offsets Possible (Case 2)	Reduced Transport Measure Effects (Case 3)	Reduced Electric and Gas Effects (Case 4)	Combined Cases 3 and 4
Gross State Product (billion \$)	\$2,498	\$2,480	\$2,477	\$2,483	\$2,467
Personal Income (Billion \$)	\$2,029	\$2,018	\$2,011	\$2,019	\$2,003
Per Capita Income (Thousand \$)	46.09	46.00	45.84	46.00	45.79
Employment (Millions)	18.42	18.19	18.27	18.22	18.09

Case 3:
Reduced effectiveness of transportation measures. Assumes no change in vehicle miles traveled, and reduced effectiveness of the low carbon

fuel standard and vehicle GHG emissions regulation. These changes again reduce GSP by about 1 percent relative to BAU and Case 1.

Case 4: Reduced effectiveness of electricity and gas measures. Assumes no 33% renewable portfolio standard, along with reduced effectiveness of the electricity, gas and combined heat and power elements of program.¹²⁴ These changes reduce GSP by under 1 percent of both BAU and Case 1.

Case 5: Combining Cases 3 and 4 reduces GSP by under 1.5 percent of both BAU and Case 1.

These calculations appear to carry a single message: implementing CARB's plan will at worst have minor effects on the state's economy. These effects will be indistinguishable from those that result from other small and random economic shocks. Employment (called "Labor Demand" in the table) will continue to grow at about the same rates as without AB 32.

CARB attempts to further support its conclusions of positive benefits (or little harm) by surveying CGE models of cap-and-trade studied by others, some for California and others for the nation. All of the eight models examined produce nearly the same result as E-DRAM's BAU, with lost economic output of nearly zero in all cases.¹²⁵ It remains possible that the similar results reflect their common structural characteristics rather than the robust correspondence of their findings with reality. If the models use

¹²³ Source: CARB, Updated Economic Analysis of California's Climate Change Scoping Plan, Mar. 24, 2010, ES-7 and ES-8.

¹²⁴ The assumed RPS is the 20 percent then in effect.

¹²⁵ Updated Scoping Plan Analysis (Mar. 24, 2010), 94-95.

similar logic (as is common to CGE systems) and incorporate similar data, one would expect some agreement among their results. Agreement, however, tells nothing about their likely accuracy or the realism of their underlying models. The role of E-DRAM is problematic at best. It is a model largely borrowed from another agency that constructed it for a different purpose, and its results have yet to be compared with those of non-CGE models.¹²⁶ There is no available evidence that the creators of E-DRAM have ever attempted to compare its output with reality.

It is easy to find complex economic models (whose structures differ from E-DRAM's but are equally justifiable) that predict a wider range of possible outcomes for large governmental interventions in electricity.¹²⁷ One popular tool is the U.S. Energy Information Administration's (EIA) National Energy Modeling System (NEMS), the source of the agency's Annual Energy Outlook forecasts. Its specification has evolved over the years, and small variations in the researcher's underlying assumptions and data can sometimes produce quite dissimilar forecasts. NEMS analyses of the American Power Act of 2010 (most importantly, its GHG controls) by the U.S. Energy Information Administration and a study of proposed EPA carbon rules by the American Council on Capital Formation have produced similarly pessimistic forecasts.¹²⁸ The liberal Union of Concerned Scientists used a modified NEMS model to broadly conclude that its chosen set of renewable and GHG policies would leave growth unaffected and employment rising by slightly more than under business as usual.¹²⁹

¹²⁶ The one alternative considered by CARB has been the somewhat similar CAL-BEAR model, whose outputs appear similar to those of E-DRAM. See Economic Evaluation Supplement, Climate Change Draft Scoping Plan Pursuant to AB 32, Appendix III, Economic Analysis of California Climate Policy Initiatives using the Berkeley Energy and Resources (BEAR) Model, 2008. http://www.arb.ca.gov/cc/scopingplan/document/economic_appendix3.pdf

¹²⁷ In contrast to CARB, EIA keeps an ongoing record of the accuracy of NEMS forecasts of key energy and macroeconomic variables. It does not appear that the quality of forecasts has improved with the complexity of the model. See EIA, Annual Energy Outlook Retrospective Review: Evaluation of Projections in Past Editions (1982-2009). <http://www.eia.doe.gov/oiaf/analysispaper/retrospective/index.html>. For a listing of additional EIA NEMS-based policy reports, see EIA, *Responses to Congressional and Other Requests*, http://www.eia.doe.gov/oiaf/service_rpts.htm

¹²⁸ "Analysis of the Kerry-Lieberman Bill "The American Power Act of 2010" using the National Energy Modeling System (NEMS/ACCF-SBEC)", A Report by the American Council for Capital Formation and The Small Business and Entrepreneurship Council, 2010. EIA, "Energy Market and Economic Impacts of the American Power Act of 2010", July 2010. Both find losses in GDP between 0.3 and 1.7 percent, and employment losses between 255,000 and 1.9 million, The two models show a wider range of possible decreases in industrial (primarily manufacturing) output, between 2.4 and 7.1 percent by 2030. <http://www.accf.org/publications/138/the-economic-impact-of-regulating-us-greenhouse-gas-emissions-under-the-clean-air-act> <http://www.eia.gov/oiaf/servicerpt/kgf/index.html>

¹²⁹ Union of Concerned Scientists, *Climate 2030: A National Blueprint for a Clean Energy Economy*, May, 2009. It is not clear whether "employment" in this model refers to manufacturing or non-farm work in general. http://www.ucsusa.org/global_warming/solutions/big_picture_solutions/climate-2030-blueprint.html#Download_the_Climate_2030_Blueprint_repo One attempt to estimate AB 32's impact on small businesses and consumers relied on a simpler model (Varshney, 2009). When combined with its authors' use of arbitrary assumptions, the model produced incredibly high estimates of harm that were roundly criticized by virtually all readers, particularly consultants to CARB. James L. Sweeney, "Review of Varshney/Tootelian Report 'Cost of AB32 On California Small Businesses—Summary Report of Findings, Feb. 15, 2010." <http://peec.stanford.edu/library.php> Chris Busch, "Climate Policy and Economic Growth in California," Center for Resource Solutions, Dec. 3, 2009 http://www.resource-solutions.org/pub_pdfs/Climate%20Policy%20and%20Economic%20Growth%20in%20California.pdf

III. Estimating Costs and Benefits

A. The Basic Measures

If correct, CARB's prediction of a strong state economy under AB 32 is encouraging and worthy of further evaluation. Performance, however, takes place under a plan to implement many regulatory programs, each of which will carry its own costs and benefits. The macroeconomic performance may indicate that implementation will do little or no harm in the aggregate, but before drawing any overall conclusions, we must examine the costs and benefits of individual programs. As noted earlier, AB 32 is being promoted as a free lunch that will make Californians richer while their emissions fall.

Beyond the usual measurement problems, any calculation of benefits requires identifying the actual benefits and any costs that are inseparable from them. If, for example, AB 32 requires reformulated gasoline that produces inferior acceleration but allows more miles per gallon, we need to know their combined net value. Some drivers will see sluggishness as the psychological equivalent of a large monetary loss, while others will feel that improved mileage has a sustainability value worth the sacrificed performance. As another example, California intends to reduce vehicle miles traveled by intervening in local land-use proceedings to force higher population densities. Some people will find compact communities preferable to dispersed ones, while others will find them inferior.¹³⁰

With these difficulties in mind, we examine how CARB derived the costs and benefits of AB 32. The Scoping Plan requires a net reduction of 174 MMTCO₂E per year by 2020. 140 of those will be accomplished under the various components of the Scoping Plan, and the remaining 34 MMT will come from other, largely undefined, adjustments under the cap-and-trade program. Table 4-4 lists the plan's major components and the CO₂ reductions expected from each, followed by CARB's estimates of the savings, costs and net benefits. It finds total annualized costs of \$24.9 billion and benefits of \$40.4 billion, which net to \$15.5 billion.

Matthew E. Kahn, "A Review of Cost of AB 32 on California Small Businesses—Summary Report of Findings by Varshney & Associates," Sept. 21, 2009. http://www.arb.ca.gov/cc/scopingplan/economics-sp/matthew_kahn.pdf. California Legislative Analyst's Office, Request to Request by Assembly Member Kevin DeLeon, March 9, 2010. (This office is a nonpartisan state bureau which responds to requests of this type by legislators.) http://www.lao.ca.gov/reports/2010/rsrc/ab32_econ_review/ab32_econ_review_030910.aspx The last is "Daydreams of Disaster," produced for California's Attorney General by Frank Ackerman of the Stockholm Environment Institute's U.S. Center. The office is currently held by Edmund G. "Jerry" Brown, Jr., currently the Democratic candidate for Governor and on record as favoring aggressive implementation of AB 32. http://ag.ca.gov/globalwarming/pdf/Ackerman_review.pdf Sanjay Varshney and Dennis Tootelian, Cost of AB 32 on California Small Businesses—Summary Report of Findings, (June 2009). (subsequently referenced as V&T) http://suspendab32.org/AB_32_Report071309.pdf

¹³⁰ Of course, those who prefer density have choices available, even in California, and in the event they do not competitive homebuilders will have incentives to produce some of the housing those people prefer.

Table 4-4: Major Components of Scoping Plan (2007 \$)					
	2020 MMTCO₂E Reduction	Savings (Million \$ Annualized)	Costs (Million \$ Annualized)	Net Benefits (Million \$ Annualized)	Lower Gasoline Price Assumptions
Pavley I and II light-duty vehicles	31.7	\$13,024	\$1,966	\$11,058	\$6,400
Low carbon fuel standard	15	\$11,000	\$11,000	\$0	(\$6,490)
Heavy-duty vehicle reductions	6.4	\$2,137	\$1,616	\$521	\$521
Building and appliance electricity	15.2	\$5,065	\$3,402	\$1,663	\$1,663
Building and appliance gas	4.3	\$1,433	\$963	\$470	\$470
Renewable portfolio standard	21.3	\$1,889	\$3,672	(\$1,783)	(\$1,783)
Others	46.1	\$5,869	\$2,259	\$3,610	\$3,610
TOTALS	140	\$40,417	\$24,878	\$15,539	\$4,391

B. What kinds of benefits?

The results are highly sensitive to seemingly small differences in the underlying assumptions. That sensitivity is evident in a look at the largest single source of net benefits from the program. 71 percent of them will come from the so-called Pavley rules, written by CARB to satisfy legislation requiring the maximum feasible cost-effective reduction of GHG emissions from new vehicles. The standards, named “Pavley I” (after the legislator who introduced them) go into force in 2011 and reach their maximum stringency in 2016. The technical modifications needed to meet the standards will increase the prices of new vehicles but reduce their fuel costs. CARB has calculated that the net effect on the average consumer will be a saving of \$30 per month. Beginning in 2017, CARB proposes to tighten these restrictions on tailpipe emissions (“Pavley II”). It will accomplish this by working to increase the population of highly efficient vehicles, possibly with “feebates”—payments by buyers of inefficient vehicles used to subsidize buyers of efficient ones. There will be increased use of light materials that reduce vehicle weight, and new measures to reduce emissions associated with air conditioning.¹³¹

The increase in vehicle costs is obvious. Although no more than \$100 in 2011 the Pavley I standards will raise the price of the average car by \$1050 in 2016. The Pavley II standards, not yet codified as regulations, are expected to add \$2100 to that price in 2020.¹³² Because they require downpowering of the average vehicle, the Pavley standards will bring lighter, poorer performing cars that will certainly dissatisfy some fraction of the population. Rather than trying to calculate the net effects on

¹³¹ Scoping Plan Appendices Vol. 1, C-59. Also factored into the calculations are the products of the state’s zero emission vehicle program and other alternative fuel programs, including the “Hydrogen Highway Network.”

¹³² Appendices Vol. 2, I-7.

millions of heterogeneous consumers, CARB simply assumes that what they really want is not cars, but “transport services,” i.e. they are buying something whose only purpose is to move them between places, and the details of the vehicle do not matter as long as it gets them where they are going. Assuming that people want only “transport services” allows regulators to disregard any loss in product value that some motorists perceive. From CARB’s economic consultants we learn:

There is a market failure associated with the fuel-economy offered to consumers and/or consumers’ automobile choices. In the absence of government policies that compel them to do otherwise, consumers fail to purchase more fuel-efficient cars even when the added up-front or capital cost would be more than offset by future fuel costs. In this case, policies that compel consumers to make different choices can make consumers better off. (CARB’s calculations) implicitly assume additional market failures of this sort. They allow for policies that restrict producer or consumer options and yet raise profits or household income.”¹³³

A simple example helps illustrate where this reasoning goes astray. Assume a consumer’s first option is a “conventional” car. It sells for \$20,000 and requires \$20,000 in present-valued fuel expenses. Assume the consumer values it at \$60,000, i.e. he would pay up to that amount for the car/fuel package. If the package is given to him, his benefits are \$60,000. If he pays \$40,000 in total the benefits are \$20,000. Let the second option be a car that CARB says is superior. Technologically more advanced, it sells for \$30,000 but requires only \$5,000 in fuel. Assume that the buyer values the CARB car/fuel package at \$45,000, since it is smaller, slower and riskier than the alternative. His net benefits from buying it are only \$10,000, less than his benefits from the conventional car. There should be no surprise in seeing him pick the conventional car, despite its higher total cost. CARB, however, calls him irrational and proposes to remedy the situation by taking the conventional car off the market.

C. What amount of benefits?

The outcomes of CARB’s cost-benefit calculations are highly sensitive to seemingly minor assumptions, and subsequent research should attempt a fuller dissection of their numbers. Both of the two largest sources of reductions depend heavily on buried assumptions or on facts that CARB neglected to account for. Analyzing the Pavley I vehicle GHG standards, CARB uses a fixed retail gasoline price of \$3.673 per gallon (2007 dollars) in 2020, projected by the California Energy Commission.¹³⁴ CARB estimates that the Pavley I standards will save 3,098 million gallons of gasoline per year by 2020.

¹³³ CARB, Comments on the ARB’s Updated Economic Impacts Analysis by the Economic Impacts Subcommittee of the Economic and Allocation Advisory Committee, Mar. 23, 2010.

http://www.climatechange.ca.gov/eaac/documents/eaac_reports/2010-03-23_EAAC_REPORT_Appendix.pdf

¹³⁴ Scoping Plan Appendices, Vol. 2, I-6. The Energy Commission report is at <http://www.energy.ca.gov/2007publications/CEC-600-2007-009/CEC-600-2007-009-SF.PDF>

Multiplying the two figures yields the \$11.801 billion saving estimated by the scoping plan. If we take a look at the CEC's projections, we learn that \$3.673 is its "high" estimate, a fact CARB did not mention. The "low" estimate is \$2.066 per gallon. Multiplying that price by the reduction in gasoline consumption gives us a saving of \$6.400 billion, half the figure gotten by assuming the high price. Using an equally justifiable fuel price projection reduces the estimated savings of Pavley I by 42 percent, and cuts CARB's estimated net benefits of AB 32 by 30 percent.

The low carbon fuel standard is expected to reduce GHG's by 15.0 MMT. Under the LCFS, ethanol and biofuels will replace 20 percent of gasoline.¹³⁵ Without citation, CARB chose to assume that alternative fuels could be produced at prices at or below the pretax wholesale cost of petroleum fuels on an energy equivalent basis. If so, then the LCFS brings an increase in costs of \$11.0 billion for the new fuels, matched by a saving of \$11.0 billion in gasoline expenses, and CARB concludes that the costs of the LCFS equal its savings. CARB neglected to note that the full cost of biofuels is considerably higher. According to the Government Accountability Office, the \$4 billion of federal spending on ethanol subsidies in 2008 was equivalent to a surcharge of \$1.95 per gallon above the retail price of gasoline.¹³⁶ Dividing \$11.0 billion by the CEC high price of gasoline (\$3.673) yields consumption of 2.995 billion gallons, which require a \$5.84 billion subsidy from taxpayers. Since that subsidy covers part of ethanol's cost to society, it is also a cost of the LCFS. We cannot produce an "exact" figure for the subsidy cost in the event a low gasoline price prevails, since more gallons will be purchased at a high price than a low one. Assume, for example, that the elasticity of demand for gasoline is 0.2, which is in the range of estimates surveyed in Section IV.D. Then a price drop from the CEC's high (\$3.673 per gallon) to its low (\$2.066) value will yield an increase in gasoline consumption to 3.330 billion gallons per year. Assuming a low gasoline price yields an increase in the ethanol subsidy from \$5.84 billion to \$6.49 billion, approximately \$650 billion per year. The LCFS reduces the estimated \$15.5 billion net benefits of AB 32 by 37.6 percent (for a high gas price) or 41.8 percent (for a low one). Add the 30.0 percent reduction in net benefits from Pavley under a low gas price, and we see that two plausible changes in assumptions are sufficient to reduce CARB's estimated net benefits by 71.7 percent. These results appear in the final column of Table 4-4.

¹³⁵ Scoping Plan Appendices, Vol. 2, I-8.

¹³⁶ Cited in Amy Jaffe et al, "Fundamentals of a Sustainable U.S. Biofuels Policy," Rice University, Baker Institute Working Paper, Jan. 2010. <http://www.bakerinstitute.org/programs/energy-forum/publications/energy-studies/the-fundamentals-of-a-sustainable-u.s.-biofuels-policy>

IV. What CARB fails to model

As noted above, an assortment of CGE analyses of cap-and-trade produce quite similar outcomes. While advocates see this convergence as an indication of the models' general correctness, it can also be an indication that all of the models, whose underlying structures are quite similar, have the same weaknesses and are equally inaccurate. In this section, we will consider some of the shortcomings that they have in common and their possible effects on the credibility of CGE-based research.

1. Problems in modeling specific policies. AB 32 specifically states that CARB is to use models that would allow it to compare the virtues of cap-and-trade with those of carbon taxes, command-and-control regulation, and any others that were of interest. As noted in Chapter 3, one plausible interpretation of history is that CARB internally chose its own preferred mix of cap-and-trade and direct regulation without any public comparison of alternatives. CARB defended the exclusion of other models with an assertion that available models did not allow them to compare market-based approaches with more direct control policies, and thus the only work presented is on cap-and-trade.¹³⁷ Peer reviewers pointed out that such was not the case, and that ways did exist to analyze and compare different control regimes, but CARB was either unaware of them or chose not to use them.¹³⁸ Considering that the state may face great risks if cap-and-trade is implemented, it is odd that CARB claims to have chosen that policy on grounds that it did not have a model that would allow it to analyze any others.

2. Labor Markets. CARB's models are grossly inadequate for the analysis of labor markets. The possibilities of widespread unemployment as industries adjust to AB 32 are on many people's minds, but E-DRAM cannot model such phenomena. The math that underlies CGE models forces them to include only markets that adjust quickly and allow businesses to smoothly substitute productive inputs for one another as prices change. E-DRAM assumes a constant level of unemployment regardless of economic conditions, and nothing that might happen can change that level in the model. CARB admits that "this assumption is unlikely to be strictly true, [but] is common to all equilibrium models."¹³⁹ It appears to be saying that unemployment will not be a problem because the model does not allow it, and all of the other CGE models have the same fault. The labor market part of the model also rules out the possibility that CARB's actions will lead to increases in "green jobs" that absorb some workers who would otherwise

¹³⁷ It is odd that CARB would choose to eliminate alternatives that carry billions in costs and/or benefits on the basis that no one had yet written the software that would allow the board to evaluate them. See Economic Analysis Supplement to Draft Scoping Plan, 7. http://www.arb.ca.gov/cc/scopingplan/document/economic_analysis_supplement.pdf

¹³⁸ Janet Peace and Liwayway Adkins, Peer Review of Draft Scoping Plan, Nov. 2008.

http://www.arb.ca.gov/cc/scopingplan/economics-sp/peer-review/peer_review_comments_arb_responses.pdf

¹³⁹ Scoping Plan, Appendices Vol. 2, G-III-23.

remain unemployed. If a green industry grows in E-DRAM, its workers can only come from those that are already employed. The entire rationale for GHG policy is the existence of “market failures” that can only be remedied by a complex mix of interventions. It is particularly paradoxical that CARB bases its support of policies to implement AB 32 on numbers produced by a model that assumes markets function effortlessly and without error. The word “unemployment” never appears in the Scoping Plan.

3. Taxation and government spending. E-DRAM is capable of analyzing over two dozen different taxes. If allowances are auctioned, AB 32 itself institutes a new type of taxation, with many possible ways to redistribute the proceeds. Nowhere in the Scoping Plan do we see any indication of how business decisions will change with allowance prices, or an analysis of what will happen if adjustment to the changes proceeds slowly. As the entire state adjusts to a new economic environment, the amounts of tax revenues will shift, and so will their sources. Because AB 32 requires that CARB examine its impact on low income households, E-DRAM considers personal income taxes, but not in the detail that might better predict the welfare of California’s citizens and businesses. In the entire Scoping Plan, the word “tax” appears only three times.

4. Movement of People. E-DRAM cannot analyze important market dynamics that will surely change as AB 32 is implemented. California has recently become a source of migrants rather than a destination for them, and the dislocations and costs associated with AB 32 may increase the importance of outmigration. Because E-DRAM treats the state as a single unit in its computations, it assumes that workers can move at low cost and little delay from places where their employment opportunities have faded to places where they have improved, and that their information about these opportunities is perfect. E-DRAM is said to have an equation that determines migration into and out of the state, but any results pertaining to that topic are never discussed. The word “migration” never appears in the Scoping Plan, but does turn up in an appendix in the context of animal migrations.

5. Job Creation Supporters of AB 32 expect that it will bring numerous new businesses with green jobs for otherwise unemployed Californians. History already shows that this is unlikely. California has long had stronger and more strictly enforced environmental laws than most states. Since compliance can entail specialized construction, engineering, technologies and job skills, might expect that these tighter regulations have already created more green jobs for Californians. In reality they have not. Using an expansive definition of “green,” the state Employment Development Department estimates that only 3.8 percent of the state’s current employment is in green jobs, just 0.8 percent more than in Rust Belt

Michigan.¹⁴⁰ There are two ways to comply with AB 32—incur the costs of technologies that reduce GHGs or incur the cost of moving to a jurisdiction without such a law.¹⁴¹ AB 32’s supporters concentrate on the former, but as its regulations tighten the latter will become more attractive. Even if AB 32 generates employment opportunities in (e.g.) manufacturing or information, most employers will only locate in California if it on balance it is more attractive than other venues in spite of its unfriendly business climate. In any case, CARB’s many pronouncements about job creation have no numerical foundation. As previously noted, unemployment is a mathematical impossibility in E-DRAM’s model of the labor market. Wages always adjust to fully employ the labor force, save for a fixed small percentage of workers in transition between jobs.

6. “Leakages.” People will leak out of the state as they migrate to better employment opportunities elsewhere, although CARB’s models do not produce publicly available results on their likely numbers. Ironically, as California’s laws become more stringent, industrial activities will do the same. Both GHGs and employment will move beyond the state’s reach, overseas in some cases. Location-specific industries with high emissions, like refining and cement production, will stay, and Californians will pay more for their products. CARB’s expectation appears to be that leakages will be minimal because the state is a participant in the Western Climate Initiative, a consortium of state and provincial governments that expects to begin region-wide trading of GHG emissions allowances in 2012. Several western states have already declared that they do not intend to participate in cap-and-trade, and as of today the only likely participants at the start will be California, New Mexico, and two Canadian provinces. Likewise, it appears quite unlikely that the federal government will institute a nationwide cap-and-trade regime, and quite likely that future Congresses will be able to blunt any regulatory proposals from EPA. Again, E-DRAM is incapable of producing guidance on the migration of businesses. Its models of industrial sectors do not produce projections of either business formations in the state or departures from it.

7. Increasing Uncertainty. Quite possibly no governmental undertaking in history will produce more detailed regulations than CARB’s implementation of AB 32. The board itself recognizes that many of these will need to be fine-tuned as experience accumulates. Further, important new regulations with provisions that cannot be foreseen today will also be put into place as the stringency of emissions

¹⁴⁰ State of California, Employment Development Department, “California’s Green Economy,” April 21, 2010, presentation graphics, 7. <http://www.labormarketinfo.edd.ca.gov/contentpub/GreenDigest/CaliforniaGreenEconomy.pdf> Definitional differences make any comparisons difficult. A 2008 report by the California Department of Labor’s California Economic Strategy Panel used a different definition and found only 43,746 green jobs in the state, 0.3 percent of total employment. See California Economic Strategy Panel, Clean Technology and the Green Economy, Mar. 2008, 16. http://www.labor.ca.gov/panel/pdf/DRAFT_Green_Economy_031708.pdf

¹⁴¹ “Jurisdictions” can include bankruptcy or retirement.

restrictions increases over the years. Businesses of all kinds, including green ones, will face increasing uncertainty that will surely discourage them from investing in new plants and equipment, in addition to the deterrent effect of increased costs due to regulations themselves. In principle, E-DRAM could have been modified to analyze the sensitivity of its results to increasing uncertainty. For unknown reasons, CARB chose not to do so, leaving us with no estimate of the volumes of investment and employment that will be eliminated by the increased uncertainty that CARB itself has caused.

8. Wealth transfers. AB 32 required that CARB estimate its impacts on households at various levels of the income distribution, but its findings were restricted to changes in their incomes and various expenditures. Surely as important as income, however, are the transfers of wealth that AB 32 will produce. Even if we take seriously CARB's finding that on an overall basis the benefits of increased energy efficiency will outweigh those of higher energy prices, the wealth of different subgroups will be differently affected. People in existing houses without advanced (and possibly unaffordable) technologies will face higher costs of climate control than those in new homes with such equipment.¹⁴² Those in coastal locations (typically with higher incomes) where temperatures fluctuate less will be advantaged over inland residents who require both heating and cooling. Part of CARB's campaign to reduce vehicle miles entails intervention in local planning to encourage denser development despite a generally expressed preference for suburban lifestyles in their current forms. If there is an aversion to density, prices will adjust to raise the value of existing homes in less dense areas or on larger lots. The self-interest of many advocates of AB 32 may blend nicely with their environmental concerns, to the detriment of other segments of the population.

V. Summary

According to CARB, AB 32 is desirable, but for reasons quite unlike those usually adduced to justify environmental regulation. There will be few if any health or environmental improvements, but CARB sees net financial benefits to Californians. Energy will become more expensive, but implementing AB 32 will force efficiencies in energy use that create net benefits for the public. This reasoning depends critically on assumptions about individual preferences that cannot easily be justified. As an example, more efficient vehicles will be lighter, smaller, and less safe than those being driven today. CARB invents efficiency benefits by assuming that peoples' preferences over other attributes of their cars are irrelevant. Even if we accept CARB's implied reasoning that efficiency is all that matters, its calculations

¹⁴² Again, all of these amounts are highly uncertain. Varshney and Totellian's figures for increased house prices are outrightly wrong, but this does not mean that the overall effects of AB 32 will be equally distributed and equally beneficial to all Californians.

of the benefits of implementation are dependent on highly questionable numbers and computations with them, many of whose details can only be found by readers willing to pursue their own investigations.

CARB's estimate of AB 32's effects on the state economy comes from a computer model whose underlying assumptions about markets are unlikely to pass the most rudimentary tests for realism. Its underlying structure is one of markets that quickly adjust to any changes in the situations of producers and consumers, but one prime area of concern is AB 32 will impose dislocations that require substantial adjustment costs. These costs will be manifested in higher levels of unemployment and unused capacity in businesses. Instead of producing numbers that might provide guidance, the E-DRAM model simply assumes that all workers are identical, and that they can quickly move in response to changes in market conditions that they invariably perceive accurately. Problems in the composition and financing of business capital investments are likewise assumed away. Instead of modeling the financial and capital goods markets, E-DRAM allocates capital among industries by a mechanical formula and assumes that there is no difference between drill presses and semiconductors.

Other concerns of AB 32's critics are also disregarded. The commonly mentioned threat of leakages—relocations of economic activity and population away from California to jurisdictions without GHG controls—is also assumed away in the model. The model does account for flows of people to and from California, but assumes these flows are fixed rather than responsive to comparative economic conditions between California and other jurisdictions. CARB's E-DRAM model does not even allow for the possibility that workers will come to California and capitalists will allocate their funds to investments that create “green jobs.” Given California's likely business climate as AB 32 is implemented, it may well be that much of the hoped-for manufacturing, financial, and information-related activities will take place in other states and countries. It is important to remember that CARB's only support for its statements about the state's economy are the results of a model which, even if correct as is, cannot produce numbers that address the most basic concerns of the state's citizens. CARB is betting the state on a computer model, and a manifestly inadequate one at that.

CHAPTER 5

CONCLUSIONS: WHAT KIND OF FUTURE?

I. Looking Ahead

A. Costs and benefits

The volume and likely impacts of GHG regulation in California are massive, even at the current level of the program. Many important regulations have yet to be made public, particularly the rules by which allowances will be allocated in the cap-and-trade market, the rules for trading them, and the definitional details of qualifying offsets that can be used for compliance. Important parts of the Pavley and LCFS programs to modify vehicles and fuels will not appear for years, but even CARB claims that the former will ultimately add \$2000 (2007 \$) to the price of a typical car.

All debates about continuing the implementation of AB 32 must be informed by one fact: regulations like these are only the start, and their successors can only be costlier and more intrusive. The difficulty of finding easy GHG reductions becomes obvious by a cursory check of the Scoping Plan. The Tire Pressure Program will provide only 0.55 MMT of the 174 MMT that must be achieved by 2020, and limitation of high global warming potential gases in consumer products will bring another 0.25.¹⁴³ The intrusiveness of the recently abandoned “cool cars” program would have ultimately given Californians only 0.89 MMT of savings. A utopian high-speed rail system between the state’s north and south will be responsible for only 1 MMT per year, at a cost that CARB declines to estimate.¹⁴⁴

As noted earlier, CARB has largely justified its AB 32 program on grounds that it is a free lunch—that the benefits of increased energy efficiency will outweigh the costs of controlling GHG. As regulations proliferate and tighten, CARB will face increased challenges in justifying them. Even if we believe the figures in the Scoping Plan the margin between benefits and costs is thin. As shown in Chapter 4, small changes in assumptions can turn CARB’s net benefits into losses. If the easy opportunities are already exhausted, costs of future regulations can only increase.

¹⁴³ Both of these programs were discussed in Chapter 2.

¹⁴⁴ All of these figures are Scoping Plan Appendices, Vol. 2, Table G-1-2.

B. Searching for Benefits

There remains only one way for CARB to maintain its projected positive balance between benefits and costs: it must find more benefits.¹⁴⁵ There are some potential sources with a degree of legitimacy. For example, reductions in fuel use, reformulations of fuels, and certain mandated emission reduction technologies will have the side effects of reducing ozone and oxides of nitrogen and sulfur. The health improvements from these will have economic value that can legitimately be added to whatever other true benefits may exist.¹⁴⁶ CARB also considers increased diversification of generation fuels (and renewables) as a potential benefit of increased renewable generation in connection with AB 32.¹⁴⁷ Diversity, however, also has costs. Increasing the amounts of intermittent renewables (wind and solar) on the grid can increase total costs and decrease reliability.¹⁴⁸ CARB does not quantify them, and analogies between diversification of electricity generation and diversification of an investor's financial portfolio are at best questionable.¹⁴⁹

To find more benefits we must cross into the world of values, or more accurately CARB's values. One example comes in the board's program innocuously titled "Local Government Actions and Targets (VMT reduction)." This program is expected to reduce GHG emissions by 5 MMT per year by reducing vehicle-miles travelled (VMT), and will generate savings of \$1.554 billion per year. This will be in part accomplished by using new powers granted CARB in SB (Senate Bill) 375 of 2006. That law empowers CARB to work with local planners to set targets for GHG reduction from vehicle miles traveled (VMT) in 2020 and 2035, and methods to reach the targets. The partnership is intended to create "a sustainable vision for the future that accommodates population growth in a carbon efficient way while meeting housing needs and other planning goals."¹⁵⁰

This can only mean state-imposed increases in density, but they are only part of a far larger set of interventions that CARB sees as necessary:

¹⁴⁵ Some readers of the Scoping Plan have adversely compared CARB's assiduous search for additional benefits with its studied disregard of relatively obvious costs. Robert Stavins et al, "Too Good to Be True: An Examination of Three Economic Assessments of California Climate Change Policy," Harvard University, Kennedy School of Government Working Paper RWP-07-16, June 2007.

¹⁴⁶ CARB acknowledges that it has yet to study the reductions of pollutants like these in its GHG programs.

¹⁴⁷ Scoping Plan, 94-95.

¹⁴⁸ See California Independent System Operator, *Integration of Renewable Resources: Operational Requirements and Generation Fleet Capability at 20 % RPS*, Aug. 31, 2010. <http://www.caiso.com/2804/2804d036401f0.pdf>

¹⁴⁹ Philip Hanser and Frank Graves, "Utility Supply Portfolio Diversity Requirements," *Electricity Journal* 20 (June 2007), 22-32.

¹⁵⁰ Scoping Plan, 48.

There are many different ways regions can plan and work toward reducing the growth in vehicle travel. Increasing low-carbon travel choices (public transit, carpooling, walking and biking) combined with land use patterns and infrastructure that support these low-carbon modes of travel, can decrease average vehicle trip lengths by bringing more people closer to more destinations.

[These include] employee transit incentives, telework programs, car sharing, parking policies, public education programs and other strategies that enhance and complement land use and transit strategies. ... Another way to encourage greenhouse gas reductions from vehicle travel is through pay as you drive insurance (PAYD), a structure in which drivers realize a direct financial benefit from driving less. The California Insurance Commissioner recently announced support for PAYD and has proposed regulations to permit PAYD on a voluntary basis.¹⁵¹

There is no discussion of the possible costs of so radically reforming the insurance industry. Perhaps the best part of these new intrusions, according to CARB, is that they will greatly increase the benefits of implementing AB 32. There will be an improved “jobs-housing balance, preservation of open spaces and agricultural fields, and improved water quality due to decreased runoff.”¹⁵² These are only the first of many benefits, which include longer lifespans thanks to CARB’s push for greater density:

More compact communities with improved transit service could increase mobility, allowing residents to easily access work, shopping, childcare, health care and recreational opportunities. Furthermore, if open spaces and desirable locations become more accessible and communities are designed to encourage walkability between neighborhoods and shopping, entertainment, schools and other destinations, residents are likely to increase their levels of physical activity. Research shows that regular physical activity can reduce health risks, including coronary heart disease, diabetes, hypertension, anxiety and depression, and obesity. Measures in the Scoping Plan encourage Californians to use alternatives to personal vehicle travel that could result in increased personal exercise. To complement these changes, future community developments may evolve to include trails and pedestrian access to major centers.¹⁵³

C. How the public participates

To help Californians get these benefits requires “personal action,” including thinking about our carbon footprints and resetting thermostats, as well as planting shade trees.¹⁵⁴ And CARB says the market will respond. As people buy more greenhouse-compliant vehicles, “the auto manufacturers will respond with more innovative models.” As for the people who choose not to buy them, “regulations requiring auto manufacturers to provide these cars will complement the market demand.”¹⁵⁵ There will be other prods, which also have benefits. The state has announced its support for an “EcoDriving” program

¹⁵¹ Scoping Plan, 48-49.

¹⁵² Scoping Plan, 95.

¹⁵³ Scoping Plan, 95.

¹⁵⁴ Scoping Plan, 99.

¹⁵⁵ All previous quotes in paragraph from Scoping Plan, 99.

that encourages “easy-to-use best practices” that save gas. “Furthermore, safety is improved when driving speeds are reduced, a key EcoDriving strategy.”¹⁵⁶ In its description of the vehicular controls CARB neglected to mention that achieving the 2020 goals will require a fleet-wide reduction in passenger vehicles of “almost 20 percent.”¹⁵⁷ This will take place in the face of an expected 12 percent growth in population.

To encourage personal action, the Climate Action Team (described earlier) will “develop a coordinated array of messages and draw upon a wide range of messengers.” The state will also support “highly localized efforts” involving “service club organizations and existing faith-based communities—churches, mosques and synagogues.”¹⁵⁸ CARB notes other laws will require development by 2010 of “climate change education components to the state’s new K-12 model school curriculum.” As described previously, the outreach will also attract educators through the “California Climate Champions” program that provides awards to student activists. The board will also “rely on partners” to develop “options for curricula” at all levels of education, including “programs for four-year colleges.”¹⁵⁹

II. After 2020

AB 32 says nothing about post-2020 policies, but CARB clearly wants to move forward. A 2005 Governor’s Executive Order “calls for” an 80 percent reduction from 1990 GHG emissions by 2050, the number apparently chosen on the basis of what “climate scientists tell us.”¹⁶⁰ Figure 5-1 is a possible trajectory from CARB of a scenario that reduces emissions to that level by 2050. Assuming that the Scoping Plan’s 2020 target is met, population growth will necessitate a decrease in per capita emissions by 5 percent in each year from 2020 to 2030. CARB says this is “possible,” and the necessary measures are “logical expansions of the programs recommended in the Scoping Plan.”¹⁶¹

Perhaps the most alarming expansion is that 2030 goals will require a “40 percent fleet-wide passenger vehicle reduction,” which will occur in the face of a 25 percent growth in population since 2010, i.e. vehicles per capita will be roughly cut in half. In the event you still have a car then, getting to the 2030 goal will continue to require that CARB “[continue] to implement sound land use [i.e. higher densities] and transportation policies” (probably taxes, buses, or rationing). Some new technologies will

¹⁵⁶ Remaining quotes in paragraph from Scoping Plan, 100.

¹⁵⁷ Scoping Plan, 119.

¹⁵⁸ Scoping Plan, 101.

¹⁵⁹ All quotes in paragraph from Scoping Plan, 102.

¹⁶⁰ Scoping Plan, 117.

¹⁶¹ Scoping Plan, 118. This is also the source of Figure 5-1.

have to be invented, including one that cuts the carbon intensity of transportation fuels by 35 percent relative to 2010 (10 percent is required by 2020). There will also be increases in “energy efficiency and green building efforts” so that savings from 2020 to 2030 will be double those accomplished between 2010 and 2020.¹⁶²

By 2030, CARB believes that half of California’s power could come from non-GHG-emitting sources on the assumption that nuclear and hydroelectric generation remain at today’s levels. Statewide passenger vehicle emissions would fall to half their 2020 levels by 2030, a goal which a 40 percent reduction in them would certainly help achieve. There will also be requirements for low-carbon fuels in trucks, ships, rail transport and aviation.¹⁶³ All of these measures must be in place by 2020 if the state is to get to 2030, but the latter year is only a milepost. To get to the 2050 goal will require a 75 percent reduction in per capita emissions below their 2030 levels. Relative to 2010, 2050 will require an 89 percent reduction in per capita emissions. If we extrapolate the 2010 – 2030 percentages, 2050 will also mean an 80 percent reduction in private passenger vehicles.

III. Summing up

A. CARB Chooses Central Planning

CARB’s underlying philosophy of policy formation virtually ensures that its regulations will be unnecessarily costly. The “energy crises” of the 1970s provide an analogy. Any economist could have advised both Democratic and Republican administrations that the surest way to alleviate shortages of energy commodities was to abolish price ceilings that discouraged production and encouraged consumption. Both administrations instead chose to micromanage energy in hopes of achieving a “rational” solution that would coincidentally bring political gains. The consequences included natural gas shortages, thousands of regulations allocating domestic and imported oil, lines of frustrated motorists unable to find gasoline at controlled prices, and temperature regulations for private buildings. All of these ended when the controls were abolished. The nation returned to markets that equilibrated prices, replaced political pressure on producers with competition for customers, and ultimately brought the discovery of near-unlimited quantities of shale gas.

¹⁶² All quotes in paragraph are from Scoping Plan, 119.

¹⁶³ The U.S. Ninth Circuit Court of Appeals recently ruled that CARB could not enforce its rules to control idling by diesel locomotives on grounds that rail transport was exclusively under federal jurisdiction. See *Association of American Railroads et al v. South Coast Air Quality Management District*, (9th Cir, 2010).

This history carries important lessons for CARB, and disregarding its lessons can only aggravate California's climate policy. For now, assume that GHG emissions actually threaten health and economic well-being, and that efforts to control them can actually reduce those harms. (These arguments also hold if GHGs are actually harmless, in which case we still wish to minimize the losses associated with their control.) AB 32 and CARB often mention the benefits of "market-based" compliance, but CARB's actual choices are more akin to central planning. Nevertheless, early in the Scoping Plan CARB recognized the problems of micromanagement:

No chart or graph can fully display how diverse economic sectors fit together. California's economy is a web of activity where seemingly independent sectors and subsectors operate interdependently and often synergistically. ... The measures included in this Scoping Plan are identified discretely, but many impact each other, and changes in one measure can directly overlap and have a ripple effect on the efficacy and success of other measures.¹⁶⁴

After acknowledging the complexity, CARB went on to state (again like the 1970s administrations) that cooperation with other agencies will bring it an understanding of all the relevant details.¹⁶⁵ It is clear that the Board is a long way from that destination. Computer models embody its most important attempts to see the full consequences of its policies, but those models' treatment of sectoral interactions is grossly inadequate.¹⁶⁶ We are left with two possible explanations for CARB's observed decisions: [1] it has no model to guide its detailed policy choices and is making them (almost) randomly, or [2] It has a model that it is not sharing with the public. Neither gives much reason for optimism.

Without explaining how it chose from among the alternatives, CARB simply announced its planned combination of cap-and-trade and direct controls. The mix of the two was hardly consistent with its claim to prefer market-based measures. CARB intends to use direct controls to achieve over 80 percent of its emissions reduction goal. In some cases cap-and-trade is infeasible, but most of its rationales for direct controls are unconvincing. As one example, it claims that the "million solar roofs" initiative is necessary if the costs of solar technology are to come down. If in fact solar roofs are cheap ways to comply, they will be chosen under cap-and-trade. As happens for goods that do not have captive markets, improved technology will bring their prices down. If people choose other methods to limit GHGs, the market is saying that whatever the politics solar power is an economic loser. The rationale for direct intervention in CARB's "goods movement" program is both practically and rhetorically inadequate.

¹⁶⁴ Scoping Plan, 14.

¹⁶⁵ Scoping Plan, 14.

¹⁶⁶ As noted in Chapter 4, The interactions that CARB does notice rely on oversimplifications that pay no attention to actual industrial and government behavior, for example E-DRAM's prediction that employment in electric utilities will fall as a result of implementation.

“[The program] is primarily intended to achieve criteria and toxic air pollutant reductions but will provide important greenhouse gas benefits as well.”¹⁶⁷ Market-based cap-and-trade systems already exist for some of the first two substances. If CARB can institute cap-and-trade for other sources of GHGs, it provides no plausible reason for excluding those from transportation. It seems quite possible that CARB left 20 percent of its goal to cap-and-trade simply because it could not envision any further direct controls that would allow it to reach the full goal.

CARB has chosen direct controls, and once having started on that path it will be hard to reverse course. Its chosen controls will have unforeseeable and unintended consequences. When those consequences show up, its preference will almost surely be to “fine tune” existing regulations rather than to move activities to fend for themselves in the market for emissions allowances. CARB will find itself in the same situation as the federal government during the energy crises, ever more unable to adapt to changes and content to enforce ever-more-complex rules that will impose large and unnecessary costs on the economy. It appears quite possible that the rules that actually emerge from sequential revisions will not allow achievement of AB 32’s quantitative goals, and CARB’s likely response will be still more rules. Whatever the value of GHG control, a market-based system that allows individual households and businesses to adjust as they see fit will minimize the costs of compliance with them. CARB has instead shown a preference for the opposite path, not coincidentally one that will surely increase its powers to intervene in the state’s economy as the years pass.

B. Which way forward?

As quoted in Chapter 1, AB 32 is indeed “political symbolism with consequences.” It will produce a reduction in the world’s GHG output which will be indistinguishable when compared with random variations between the years. California’s dislocations and sacrifices of output and employment will produce leakages that largely negate even its own cuts in emissions, and the continuing growth of emissions in other locations will ensure that the world’s total is unaffected. Political promises that passage of AB 32 would bring California the moral and economic high ground in the battle against carbon are meeting unpleasant realities: a state unemployment rate well above the national average, outmigration of businesses and middle-class households, and failure to set an example that could persuade even its own national government to legislate GHG controls.

¹⁶⁷ Scoping Plan, 20.

AB 32's reach is extending in every direction, from the almost comedic rules requiring the offer of tire pressure checks to the more sobering threats of compulsory increases in urban density and state-supported reformulation of science curricula. Since the actual effects on climate will be nil, CARB has chosen to justify its policies by purporting to show that they will make Californians wealthier. The board's only public evidence for this unexpected conclusion is the output of a computer program. Even a quick examination of that software shows that its model is manifestly inadequate at capturing the likely effects of AB 32 on a real economy. By the state's own estimates, the market for "green" workers is negligible, and California's historically aggressive environmental policies have left it with no greener a job picture than most other states. CARB's calculations of the cost-benefit balance hangs on arbitrary choices of data, selective omissions of costs and selective inflation of benefits. Touch just a few numbers in the scoping plan, and any economic justification for AB 32 evaporates.

Figure 5-1

Trajectory for Reduction in GHG Emissions to 80 Percent of 1990 Value by 2050

Figure 6: Emissions Trajectory Toward 2050

