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EXECUTIVE SUMMARY

In undertaking this study, EPRI acknowledges the important leadership role being taken by California as it attempts to address the challenge of global warming by limiting emissions of greenhouse gases within the state. These actions have attracted widespread attention and are likely to have significant influence on climate policies in other states and at the federal level. Because such high stakes are involved, it is vital that the cost implications of such climate initiatives be thoroughly understood. In particular, California policymakers have set ambitious emission limits but intentionally provided considerable flexibility about how these goals are to be achieved. The purpose of this study was not to explicitly analyze California's greenhouse gas reduction goals. Rather, the purpose was to examine a range of policy implementation scenarios with a high degree of analytical rigor and estimate potential costs likely to be associated with each. The results of these analyses should be of value to the Climate Action Team and other stakeholders as the implementation of California's climate policies moves forward.

EPRI brings to this task nearly three decades of experience in economic analysis related to climate change and related policy implications, including a leading role in technical support to the Intergovernmental Panel on Climate Change (IPCC). Based on this experience, the present study is designed to move beyond previous analyses of California's climate initiatives in two important ways: It is the first study to use a comprehensive model that links a broad representation of the California economy, in the context of its trade with the rest of the United States, with a detailed model of the U.S. electricity market and power grid. Second, rather than measuring implementation costs only in terms of changes in gross state product (GSP), it focuses on potential gains or losses to the state's economic welfare. Such welfare impacts—defined in terms of changes in future consumption—provide a better measure of how policy implementation decisions will actually affect the average Californian[1]. Figure 3-1 shows the relationship between GSP, investment, and consumption.

[1] The economic welfare measure used in this report is the discounted present value of the consumption of all goods and services plus leisure (economic well being) over the model horizon (2010 to 2050). The welfare cost is the amount of money (in discounted present value terms) that the state of California would need to be as well off as it would be without any climate change policies. Consumption includes the labor versus leisure trade-off. This economic measure places the study in the category of "cost-effectiveness" rather than cost/benefit because it specifically does not include any estimate of the environmental benefits provided by achieving the mitigation targets. The report should in no way be perceived as a cost benefit analysis of California climate policy. The focus is exclusively on the nature and costs of various abatement strategies required to achieve the state's GHG emission targets. No attempt has been made to assess the global or California damages avoided as a result of California climate policies.

The main conclusion of this study is that the proposed emission limits can, indeed, be achieved, but that the costs involved will vary widely depending upon the eventual approaches chosen to implement specific policy goals. EPRI does not advocate any specific approaches, but rather has attempted to present a broad spectrum of potential implementation scenarios and to determine the impact of each on California's economic welfare. EPRI has offered and is providing its analytical capabilities to support State agencies as they develop and implement programs for reducing greenhouse gases.

1.1 Introduction

California's current climate policy is shaped by several important measures that provide the framework in which future policy will develop, but leaves major uncertainties about how the policies will be implemented or modified in response to changing circumstances.

1.1.1 Background

During the last two years, both Governor Schwarzenegger and the California legislature have taken four important climate policy actions. These initiatives were intended not only to reduce the state's greenhouse gas (GHG) emissions but also to spur national and international efforts to counter global climate change as well as to provide a model for doing so. EPRI sponsored this study, conducted by CRA International, in order to ascertain the likely economic costs and emissions reductions of California's climate policy. The four state climate policy steps include:

- In June 2005, Governor Schwarzenegger signed Executive Order S-3-05, which sets targets to limit California's future greenhouse gas emissions.
- The state legislature passed and the Governor signed Assembly Bill No. 32, (AB 32 – the "California Global Warming Solutions Act of 2006"), which calls for enforceable interim emissions limits to be effective starting in 2012 and then gradually reducing emissions to a 2020 target of returning to 1990 emissions levels.
- The Governor's Executive Order S-20-06 directs the California Environmental Protection Agency (Cal/EPA) to develop an emission trading system as part of the implementation of AB 32.
- Senate Bill No. 1368 (SB 1368) established an interim emissions performance standard for greenhouse gas emissions from power plants serving California, whether inside or outside the state.

Taken together these four climate policy actions establish a legal framework in which California's climate policy will evolve, but offer limited guidance as to its future shape.

1.1.2 Uncertainties Related to Implementation of New Climate Policies

Although the new measures specify several norms to guide the regulators' choices, many possible directions for implementation of policies remain open. Among the most critically important uncertainties are:

- Will the policies emphasize market mechanisms, such as cap-and-trade programs, emphasize command-and-control regulations, such as efficiency standards, or will the policy be a mixed one?
- Will there be multiple emission control policies, what will be their details, and how might the policies interact? Or will there be one comprehensive policy?
- Will the legislated targets be implemented rigidly or will regulators temper them through the application of benefit-cost or other economic considerations (e.g., flexibility mechanisms such as safety valves or linkage with other emission trading systems)?
- What will be the post-2020 goals for emission reductions and how soon will the policy process establish them?

How California's government resolves these issues will affect the state's economy, its energy and electricity markets, those of the surrounding states, and the profits or losses that will accrue to the massive investments in power generation and other industries that must be made over the next decade.

1.2 The Analysis

To determine the effect of various policy options on California carbon emissions and on the state's welfare, an economic analysis was conducted on 20 scenarios, using a state-of-the-art model described in Section 3.8.2. These scenarios, we believe, represent a range of possible implementation options for AB 32 and related climate initiatives. Six of these scenarios are briefly described below. The analysis results—which encompass a wide spectrum of policy implications—are presented in Section 1.3. (A more detailed description of all the scenarios is presented in Section 4.1.3.) The six scenarios discussed in this Section include:

- **Pure_Trade –** Comprehensive cap-and-trade program including all sources of emissions to achieve the AB 32 target of reducing emissions below 1990 levels by 2020 and continuing this target to 2050. The Pure_Trade scenario assumes that California will implement AB 32 with market-oriented marginal costs across all sectors of the economy in order to achieve emission reductions in the most cost-effective manner. Standard assumptions about technology development are adopted, except that CA is assumed to neither import nor construct any new nuclear power. (Such construction is currently restricted in California, pending resolution of long-term waste disposal issues.)
- **SV_LCA –** Same as Pure_Trade but with a safety-valve set at the permit prices that result under the scenario with low-cost assumptions (LCA scenario[2]);
- **Trgt40 –** In 2050, achieve 40% emissions reduction below 1990 levels, with the same technology development assumptions and the same comprehensive market approach as in the Pure_Trade scenario.

[2] The low-cost assumptions (LCA) include rapid and effective measures promoting energy efficiency, significantly reduced capital cost and rapid introduction of renewables (especially wind), and penetration of carbon-free transportation four times as great as for the Pure_Trade assumptions. LCA is a very optimistic but plausible scenario. The Safety-Valve could provide insurance against the economic risk that the optimistic assumptions of LCA turn out to be invalid.

- **Trgt80 –** In 2050, achieve 80% emissions reduction below 1990 levels, as set forth in Executive Order S-3-25, with the same technology development assumptions and comprehensive market approach as in the Pure_Trade scenario.
- **Nuclear80 –** Same as Trgt80, but with the assumption that nuclear plants will be built outside of California and that imports of power from these plants will not be restricted.
- **RPS 20 –** Meet California's previous Renewable Portfolio Standard of 20% renewable energy by 2020, but don't impose an overall emissions cap[3]

None of the scenarios assumed banking or borrowing of emission allowances. Sensitivity runs demonstrated that banking made very little difference to the economic impact. Borrowing could have a small but positive effect. Since the effects were small the analysis was conducted without either banking or borrowing in order to simplify the discussion.

The results of the analysis are reported in terms of impacts on California's economic welfare. A comparison of how this measure differs from changes in GSP and investment is illustrated in Figure 3-2, Section 3.1.1. The analysis itself was conducted using an integrated approach that provides a unique and consistent modeling framework described in more detail in Section 4.1.2. During the course of the study, the study design and preliminary results were reviewed by an advisory committee of outside experts listed in the Acknowledgements section of this report.

1.3 Major Findings

The changes in carbon dioxide emissions associated with each of the six policy implementation scenarios just described are shown in Figure 1-1 and compared to a "business as usual" baseline. RPS 20 makes a relatively small contribution to emissions reductions, largely tracking the baseline but at a slightly lower level. SV_LCA initially causes emissions to fall quite rapidly, but does not meet the AB 32 standard and eventually allows emissions to rise again. Selection of the safety valve price affects the degree to which emissions reductions occur. Each of the other four scenarios does achieve the AB 32 requirement, but then they begin to diverge widely in the 2020-2050 timeframe. For Pure_Trade, emissions remain constant after 2020. Both Trgt80 and Nuclear80 achieve the 80% emissions reduction of Executive Order S-3-25 by 2050; the main difference between them is cost, as shown later. Trgt40 illustrates the results of an emissions policy roughly midway between Pure_Trade and Trgt80/Nuclear80.

Costs

Three major conclusions about costs can be drawn from the analysis:

- Policies that combine market-oriented abatement incentives with increased technological innovation are the most cost-effective.

[3] After this research was underway, legislation accelerating the RPS deadline to 2010 (SB 107) was signed into law.

- All else being equal, for an emission control policy based on market-oriented policies, marginal (incremental) abatement costs increase with the stringency of the emission reduction targets.
- Costs increase more rapidly over time than do annual emission reductions.

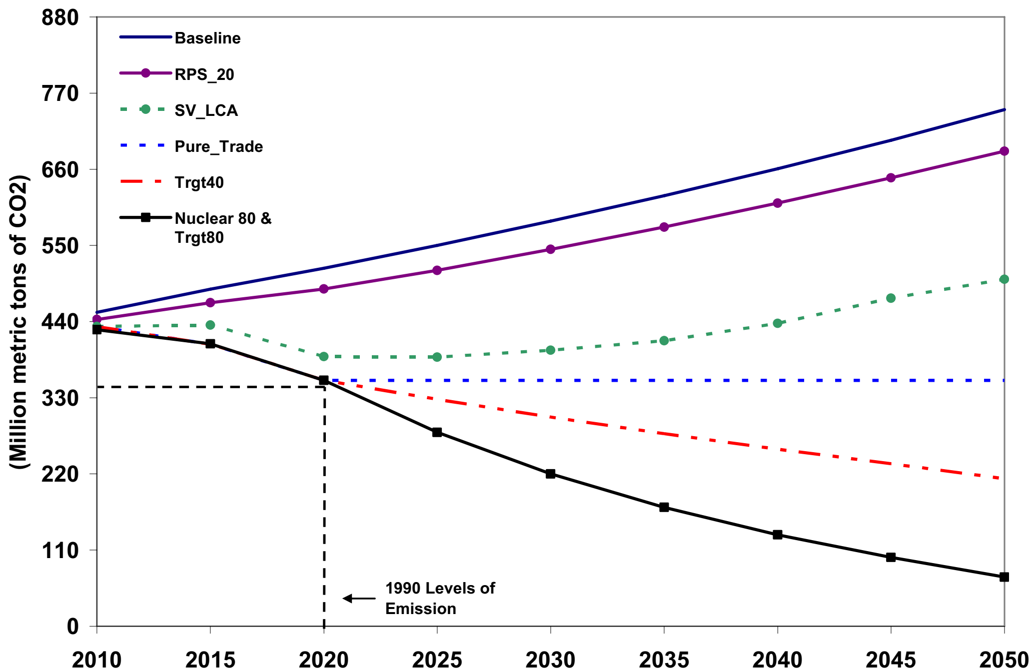

Figure 1-1
California Carbon Dioxide Emissions Under Different Scenarios

Figure 1-2 illustrates these points by comparing the costs of pursuing each policy implementation scenario, compared to business-as-usual, together with the cumulative emissions reductions achieved by each approach. RPS20 makes little difference to overall emissions, but its cost is modest. SV_LCA reduces state welfare by about $134 billion, but does not meet AB 32 emission reductions requirements for 2020. Pure_Trade meets the standard, at a cost of about $229 billion welfare reduction. The bars extending vertically from this point represent a range of costs of the other scenarios discussed more fully in Section 3, Table 3-2. These costs range from about $147 billion to more than $367 billion reduction in state economic welfare. For 2050, both Trgt80 and Nuclear80 meet the very stringent emission reduction requirements of Executive Order S-3-05, but the welfare cost of Trgt80 is about $511 billion, compared to about $444 billion in the Nuclear80 scenario. As expected, Trgt40 lies between Pure_Trade and Trgt80/Nuclear80. An additional scenario, LCA, is included in this graph to allow comparison with previous studies, which use optimistic Low Cost Assumptions and no safety valve. It is important to note that the SV_LCA scenario is a Pure_Trade policy with safety valve carbon prices to guard against economic uncertainty. In other words, if the low cost reduction assumptions fail to deliver the desired emission reductions, then a safety valve carbon price would protect the economy against higher than expected costs. If the safety valve carbon price were reached and exercised, then the state would not achieve the 1990 emission goals.

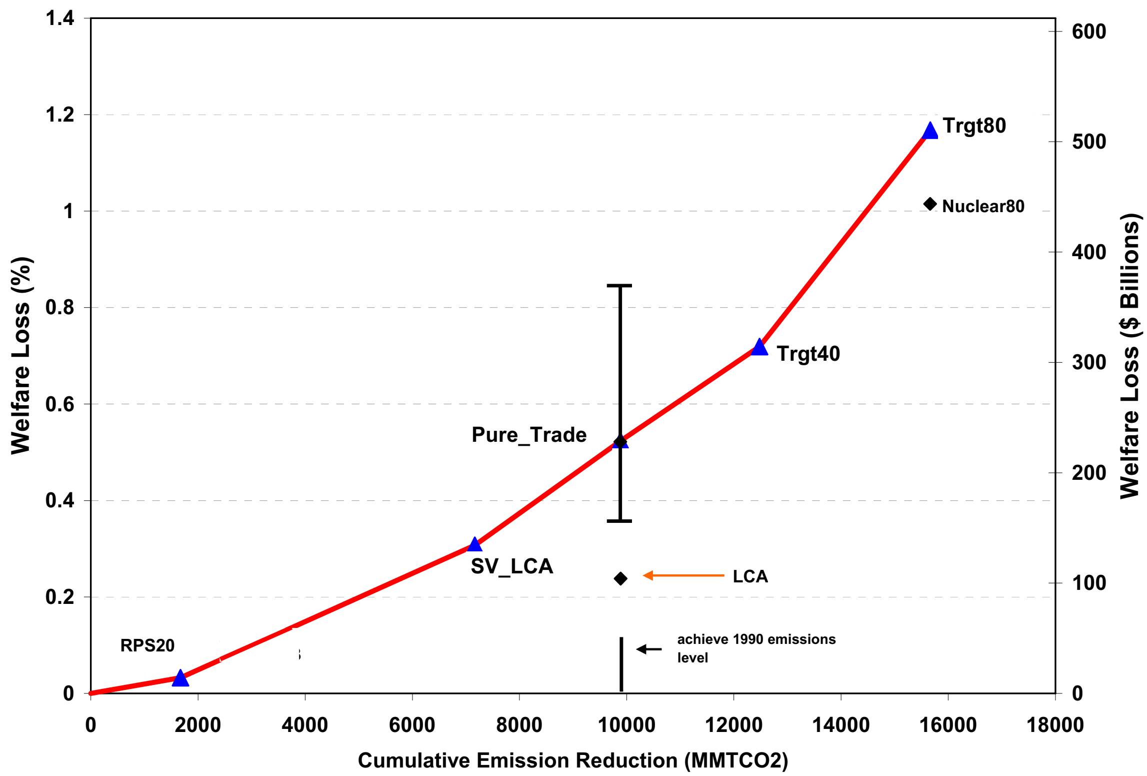

Figure 1-2
Comparison of Cumulative CA Emission Reduction and CA Welfare Change[4]

Implications

Taking into account all the scenarios analyzed (not just the six highlighted above), several key implications for California's emerging climate policy can be identified:

- Although policies differ in the cost per ton of greenhouse gas (GHG) emissions avoided, all policies that significantly reduce GHGs will entail costs to the California economy. These costs will appear as reductions in economic welfare, consumption, and Gross State Product (GSP). The cost of meeting the stated 2020 emission reduction goal could range from $104 billion to $367 billion of reduced consumption (discounted present value through 2050).
- Broad cap-and-trade programs are more cost-effective than are command-and-control regulations because the former can equalize the cost of avoiding an additional ton of emissions (marginal abatement costs) across all available options. In contrast, regulators cannot know the marginal cost of abatement across the array of emission reduction opportunities. Therefore, sector-specific command-and-control regulations will reduce emissions too much in some sectors and too little in others. In addition, attempts to layer command-and-control regulations on top of cap-and-trade programs introduce complexity

[4] Refer to Table 3-2 for an explanation of the Low Cost Assumption (LCA) and other scenarios.

and potential redundancy or could actually degrade cost effectiveness by preventing affected parties from equalizing marginal abatement costs across disparate choices. As an indication of the stakes involved, specific regulatory approaches analyzed could increase costs by over 60% compared to comprehensive market-based approaches that preserve environmental gains and allow flexible choices to reduce costs.

- An allowance price safety valve could enhance a cap-and-trade plan's cost-effectiveness by allowing regulators to sell as many permits as demanded at a pre-specified price. Such an approach could reduce the economic costs by over 40%,if the state's GHG reduction targets should prove to rest on over-optimistic low-cost assumptions about abatement costs. A safety valve price can also dampen the sharp allowance price fluctuations that have proven to be an expensive feature of other cap-and-trade programs, such as the Clean Air Act's Title IV and the European Union's Emission Trading Scheme (ETS). By placing a ceiling on allowance prices, a safety valve also avoids imposing on businesses and consumers the price peaks that can be caused by weather, the business cycle, or shifting energy markets. However, triggering the safety valve price implies that the emission reduction targets will not be reached.
- Regulating emissions associated with electricity imports entails a trade-off between leakage of emissions and higher abatement costs. (In this case emission "leakage" refers to California climate policies that reduce in-state GHG emissions while inadvertently increasing out-of-state emissions.) In addition, the approach currently under development bases emissions calculations on the assumption that California utilities could shift long-term contracts for electricity supply from outside California, although such shifts could potentially result in significant leakage. (Under such contract "shuffling," for example, coal plants in other states could continue to operate at full capacity by selling in other markets, while hydro and other renewable resources are contracted to sell power to California.) Specifically, the analysis shows that, because of contract shuffling, for every ton of emission reduction from the electric sector in California, there could be an increase of 0.85 tons of electric sector emissions from the rest of the western states. Conversely, until full regional emission trading systems are created, regulatory efforts to prevent such contract shuffling could significantly increase costs to California ratepayers. The peak loss in GSP with maximum contract shuffling allowed is 1.0%, but increases to 1.4% if contract shuffling is prevented.
- California's Climate Action Team Report (March 2006) suggests various in-state forestry activities could provide offsets that would augment the cap. EPRI used the CAT estimate and found that these forestry offsets could provide a cost savings of $33 billion through 2050. Expanding the program to out-of-state offsets could provide additional savings while achieving the intended emission targets.
- Current uncertainties about the future course of California's climate policy are likely to affect consumer behavior, business R&D spending, and investments in long lived capital assets. Failure to resolve these issues leaves firms and households uncertain about even relatively near-term investment decisions. Many investors faced with this situation may simply defer investment decisions until future regulatory policy becomes clearer, creating risks for the adequacy of electricity supply in particular.