

Appendix:

Comments on the ARB's Updated Economic Impacts Analysis by the Economic Impacts Subcommittee of the Economic and Allocation Advisory Committee

1 Introduction

As indicated in the introduction to main text of this report, in June 2009 the California Environmental Protection Agency Secretary Linda Adams and ARB Chair Mary Nichols appointed the 16-member Economic and Allocation Advisory Committee (EAAC). The EAAC was assigned two roles. One was to provide advice to the ARB relating to the method of allocation of emissions allowances under the cap-and-trade component of AB 32. The other was to assist the ARB in its analysis of the economic impacts of the AB 32 Scoping Plan. For the latter role the EAAC formed an Economic Impacts Subcommittee, whose members are listed below:

James Bushnell, Subcommittee Chair

Associate Professor, Cargill Chair in Energy Economics, Iowa State University

Lawrence Goulder, EAAC Chair

Shuzo Nishihara Professor in Environmental and Resource Economics and Director, Stanford Environmental and Energy Policy Analysis Center, Stanford University

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Chief Economist, Kyser Center for Economic Research, Los Angeles County Economic Development Corporation

James L. Sweeney

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Since its inception, the Subcommittee has worked closely with the ARB, offering suggestions about data and modeling, as well as about interpretation and presentation of model results. In the Subcommittee's opinion, it developed a good working relationship with ARB staff. We appreciated the staff's accessibility and its sustained good-faith efforts to incorporate our suggestions in its analyses. Many of the Subcommittee's suggestions are reflected in the main text of this report.

The Subcommittee also wished to offer brief comments on the ARB's completed report. This appendix provides such comments.

2 Main Results and Their Interpretation

We begin with some general comments relating to the main results from the ARB's analysis and their interpretation.

First, considerable uncertainties surround any projection of future economic costs (or benefits). The ARB has done a commendable job recognizing these uncertainties by assessing the economic costs of AB 32 under a range of scenarios. The analysis carried out by ARB staff evaluates the impacts of five cases differing according to the policy components included and according to the assumed effectiveness of some of the components. However, we would have liked the analysis to include attention to a wider range of assumptions about fuel prices and various parameters that determine behavioral responses.

Second, while the analysis considered a range of scenarios, a general result emerging from the ARB's analysis is that the impact of AB 32 on the California economy will be modest relative to the overall California economy. We believe that the ARB's modeling work provides a good foundation for the view that AB 32's impact on California income (gross state product) will be in the range of about zero to about -1½ percent in the year 2020. It should be kept in mind that this impact does not account for the climate-related and other environmental benefits from AB 32. As indicated in the main report, the ARB's general result is similar in magnitude to results from other studies such as the analysis of CRA International. This overall picture is rather consistent across studies despite important differences in modeling approaches and input assumptions. At the same time, as indicated in Section 3 below, some specific impacts of AB 32 are highly sensitive to input and modeling assumptions.

Third, as the report indicates, the impacts on individual sectors can differ significantly. Some sectors likely will experience increases in economic activity levels, while others might experience declines in economic activity relative to the reference case.

Fourth, we appreciate the report's serious attempt to make use of available data and the detail with which it considers various energy technologies. We believe the report deserves praise for its careful consideration of various recent policy measures in California and at the federal level that are outside of AB 32 (and yet would affect the impact of AB 32) and its incorporation of these measures in the reference case. We also commend the report for the detail it offers in disclosing its results, its acknowledgment of the analysis' potential weaknesses (as well as strengths), and its sustained attempts to interpret the results fairly.

Fifth, we would point out some general limitations in the ARB's analysis.

- The ARB’s analysis does not capture some important elements related to the overall impact of AB 32. As acknowledged in the report, the analysis does not consider policy-induced innovation (“technological change” in economic lingo) and the cost-savings associated with it. The report also acknowledges that it does not measure the potential health, environmental and competitiveness benefits of reducing air pollution through the impact of AB 32 on reducing co-pollutants associated with GHG emission reduction. While these omissions are understandable given the scope of the staff analysis, they are important. Both of these omissions would tend to bias upward the cost assessment. On the other hand, the report introduces the opposite bias in assuming that the vehicle miles traveled reductions called for as part of AB 32 do not come at a cost to consumers. Prior empirical work suggests that imposing these reductions would involve costs.
- The ARB report (as well as some similar analyses) focuses on the economic impacts of AB 32 within California. It does not address the important question of the environmental and economic impacts *outside* of California. In particular, the question of how California policies may increase emissions outside of the state is largely not addressed. When the out-of-state impacts on emissions are accounted for, the overall emissions impacts of the California effort is likely to be more modest than what the report might suggest.
- The ARB study of economic impacts focuses on the year 2020. This is therefore not necessarily reflective of the impacts for 2015, let alone 2012. Since much of the public discussion is focused on the immediate impacts of AB 32 it is important to understand these distinctions. Future analysis that can focus on interim years, such as 2015 will help inform the ongoing public discussion.
- The ARB’s modeling does not consider alternative ways of allocating emissions allowances or the potential implications of alternative ways to return allowance value. As indicated in the EAAC’s March 2010 Allocation Report, the choices about these aspects of allowance allocation can have very significant impacts on the overall cost of AB 32 as well as the distribution of this cost across various households and businesses.

Our overall assessment is that the ARB has offered a careful and competent analysis, one that makes a very important and well-founded contribution to our understanding of the potential economic impacts of AB 32. At the same time, we were disappointed when we observed how few staff members and how little resources were available for this important effort. These restrictions imposed some significant limits on what the ARB could do. Each of the models employed by the ARB was only partly suited to addressing the economic impacts of AB 32. A full integration of the two models could have provided a stronger assessment, but the ARB had neither the time nor the staff necessary to accomplish such an integration. Nor did the ARB have the time or resources to undertake various useful enhancements to the individual models or to perform a significant analysis of some key uncertainties. While acknowledging California’s severe budget strains, we feel that a commitment to hire additional staff with economics training, and to bring in additional modeling tools, is justified. This would enable the ARB to continue to

improve its modeling capabilities and provide state-of-the art analyses in the necessary time-frame.

3 Comments on Modeling Assumptions and Applications

Our comments here cannot do justice to the full complexity and detail of the ARB's modeling efforts. Our comments are selective, focusing on what we consider to be among the most important aspects of the models and their application by ARB. These comments are intended both to help with the interpretation of the ARB's results and to suggest areas of focus for future modeling efforts.

Because of our close and ongoing interactions with the ARB's economic impacts analysts, our comments concentrate on the ARB study. However, many of these comments apply to other studies as well.

3.1 Accounting for Uncertainties

The ARB analysis does a good job considering a range of policy scenarios. In particular, it considered scenarios differing in terms of the effectiveness of the "complementary measures" that are part of AB 32 and in terms of the availability of offsets. However, there are other important areas of uncertainty that are not included in this study. These include uncertainties relating to the supply costs of alternative fuels and the costs of energy-efficiency improvements. These should be considered in future work.

Another uncertainty relates to behavioral responses to energy price changes. The report indicates that in Energy 2020 these responses depend on a number of factors and change through time. Apparently, prior statistical work underlies the specification of the timing and magnitude of responses to given price changes in given sectors. This aspect of the modeling might be a particularly strong element. Unfortunately, however, the nature of this specification is left obscure. Future work should expose the empirical basis of this specification and the relevant formulas. In addition, alternative specifications should be performed to reveal the sensitivity of overall results to the assumptions involved.

3.2 Reference Case Assumptions

The ARB's reference case is the scenario without cap and trade or the complementary policies. This case, described on page 7 of the ARB report, is based on a set of economic, demographic and energy price and usage assumptions that came from the 2009 California Energy Commission Integrated Energy Policy Report (IEPR) and related background reports (citation).

Reference case assumptions are very important because they directly affect the estimated economic impacts of climate policy. In particular, higher economic growth and emissions in the reference case would imply that the emissions reductions under climate policy must be larger in order to reach the specified emissions target for the year 2020. Higher economic growth in the reference case therefore implies higher policy costs.

We believe that the ARB's choice of the 2009 CEC forecasts of state growth and energy use was a reasonable choice for most of the growth forecast variables at the time it was made. However, we recommend aspects of these forecasts be reconsidered in future work. Some of the most important aspects include:

- *Updating the forecast to reflect recent economic trends and forecasts.* Economic and related forecasts do change over time and their use needs to be monitored to insure that the most up-to-date forecasts are used in future analyses. The CEC and ARB staffs lowered prior economic growth forecasts to take account of the recession. Real (i.e., inflation adjusted) Gross state product was forecast to increase by 2.4% annually from 2007 through 2020. The economy has performed more poorly than anticipated in early 2009 when the CEC inputs were developed. Job losses have been worse than anticipated and the timing of economic recovery to pre-recession levels is now further in the future. In addition, the California Department of Finance released 2009 population estimates and revised short-term state population projections in December 2009 and January 2010. The new population projection for 2015 and 2020 is lower than the one used in the ARB analysis. Even if the 2020 growth forecast targets in the reference case are reached, it is highly likely that job and output levels (and related emission levels) will be lower than anticipated in the ARB reference case alternative for most of the earlier years before 2020.
- *Re-examining the transportation demand forecasts.* The CEC transportation demand forecasts used a different and higher personal income growth forecast from the one (2.4% annual growth) used in the main IEPR report. The transportation demand forecast was based on a real increase in personal income of 2.9% per year to 2030, which is higher than other current long-term projections examined by EAAC. Since transportation demand (VMT, air travel and trucking) is highly dependent on income growth, there is the likelihood that reference case transportation demands and associated emissions will be lower than in the IEPR transportation forecast. In addition there have been recent declines in air travel and port traffic that have occurred since the CEC transportation forecast was produced. The VMT, aviation and freight growth forecasts should be reexamined in light of recent declines in activity related to the recession and in light of the discrepancy between the 2.4% and 2.9% income growth forecasts apparently used in different parts of the CEC IEPR analyses.
- *Integrating expected age structure changes into the forecast methodologies.* California's population growth rates differ widely by age group. The California

Department of Finance projections used in the reference case show that most of the population growth between 2008 and 2020 will occur in the 55+ age groups. After a decade in which the state's population aged 35-54 grew by 2 million, there will be almost no growth. Energy use for homes and transportation varies by age as well as income. The rapid growth in older age groups will reduce VMT per capita for both work (many older workers will retire by 2020) and non-work travel. In addition the rapid growth in older households combined with no growth in prime family age households should affect both the size and energy usage in homes over the decade to 2020. We were unable to determine how much CEC and ARB models are able to incorporate relationships between energy usage and the age structure of the population. Given the dramatic changes in the age structure of future population growth, it is important going forward to take account of the relationship between age and energy use.

3.3 Technology Cost Curves

A large share of the greenhouse gas reductions under AB 32 will come from changes in the products or services offered to consumers. Automobiles will have greater fuel economy, and low-carbon fuels will make up a larger share of automobile fuels. Large reductions will also come from retrofitting existing buildings with more energy efficient appliances and insulation and from improvements in how new buildings are constructed. Calculating the cost of these behavioral changes requires assumptions about "technology cost curves" – the curves indicating how rapidly product costs increase as efficiency increases.

Greenhouse gas reductions can be achieved two ways. One is by improving the efficiency of a particular product (e.g., increasing the fuel-economy of a car with a given engine horsepower). The other is by changing the product attribute (e.g., reducing the power of the engine).

Holding product attributes constant, the cost of greenhouse gas reductions depends on the cost of improving efficiency as specified by the assumed technology cost curves. The steeper are the technology cost curves, the larger the social costs.

This makes assumptions regarding the technology cost curves important for estimating the social costs of AB 32. For this reason, the Subcommittee recommends being as transparent as possible with the assumed technology cost curves. The ARB, given the constraints of their contract with ICF, have done their best to provide the Subcommittee with the cost curves used in Energy 2020. However, additional analysis involving alternative cost curves is warranted. Such sensitivity analysis would give a much better picture of the potential range of impacts of AB 32.

The difficulty with generating the cost curves is that many of the technologies that would be adopted under AB 32 are either yet to be developed or currently prohibitively expensive. Therefore, the ARB is required to project the

costs of these technologies. For example, projected compliance with the Low Carbon Fuel Standard includes using second and third generation biofuels. The cost of these fuels is projected to fall considerably over the next 10 years. The cost of complying with AB 32 could be higher or lower than projected, depending on whether the costs of these fuels fall more slowly or more quickly than assumed. Similarly, meeting fuel efficiency standards relies on the use of many technologies that are not currently economical, such as plug-in hybrids and camless valve technologies.

3.4 Assessment of Complementary Measures and Cap and Trade

Costs of Complementary Measures

The ARB study finds that complementary measures lower overall compliance costs. Excluding these measures, and relying exclusively on cap and trade to achieve emissions reductions, is considerably more costly. This contrasts with studies, such as the one by CRA International (CRAI), which find that including the complementary policies raises the costs of meeting the AB 32 goals.

The difference stems from contrasting assumptions about pre-existing market failures. The CRAI study assumes that the only market failure in the economy is that associated with the external costs of greenhouse gas emissions. Otherwise, markets operate efficiently. Under these assumptions, policies that compel producers to alter their products (e.g., achieve greater fuel-economy or lower-greenhouse gases per mile) are costly to producers, consumers, or both.

In contrast, the Energy 2020 and E-DRAM models assume additional market failures beyond the one associated with the climate-change externality. For example, 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. The Energy 2020 and E-DRAM models 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.

These differences are reflected in the models' contrasting assessments of the costs of including complementary measures as part of AB 32. In Energy 2020, many efficiency investments forced by the complementary measures in fact *reduce* costs and that these beneficial investments would not be made *except for* the imposition of the complementary measures. The CRA study, by contrast, assumes any cost-reducing investments would be made if market prices implied they would indeed reduce costs. Thus, in the CRA model higher carbon prices spur energy efficiency

investments that would not arise in Energy 2020 without additional complementary measures.

Need for Updated Assessments of the Complementary Policies

For a modeler, these are very murky waters to explore. There is a wealth of evidence that individuals and even firms do not undertake energy efficiency investments that would appear to an outside analyst to reduce their costs. However, it is extremely difficult to quantify the extent of this phenomenon across the many sectors modeled here. The uncertainty about complementary measures can vary greatly across these measures. Technologies for many forms of renewable electricity generation are widespread and fairly advanced. Many of the technical costs of energy efficiency are well documented, although less is understood about the costs and effectiveness of particular incentive programs to promote their adoption.

In contrast, other measures have little or no specific policies or costs actually modeled. Here the goals for achieving reductions in vehicle miles traveled stand out as particularly speculative. The current VMT forecast is for 2.2% average growth per year to 2020. In addition the VMT reduction alternative assumes a 4% reduction in VMT associated with SB 375 policy implementation. Both of these assumptions merit continued monitoring. The relationship between SB 375 and vehicle use should be updated as regional planning agencies produce their SB 375 GHG emission reduction plans and the next round of their regional transportation and land use plans. The ARB forecasts of reduced expenditures on vehicles as a result of the 4% VMT reduction associated with SB 375 should be tested by further work on the relationship between VMT reduction and auto ownership. It may be that the types of VMT reduction associated with aging and changes in land use may result in less travel but not less auto ownership by 2020. In addition VMT reductions may not result in substantial reductions in car ownership, depending on how VMT is reduced and regional GHG emission reduction plans may require additional transportation system investments.

Connection with Cap and Trade

Cap and trade deals with the externality associated with greenhouse gas emissions by putting a price on such emissions. If this were the only significant market failure, there would be no need for complementary policies. Such policies would be redundant: putting a price on greenhouse gas emissions would efficiently trigger the various responses needed to reduce emissions, including many of the response required by the complementary measures.

On the other hand, to the extent that the other market failures exist and are important, additional measures would be needed to bring about the additional market adjustments. A price signal would not be sufficient.

We support the ARB's attention to the costs of complementary measures (while calling for further sensitivity analysis). However, we would recommend

allowing for a wider set of interactions between cap and trade and the complementary measures. Many of the complementary measures involve intensity requirements (e.g., restrictions on the ratio of high- to low-carbon fuels under the low-carbon fuel standard). They put limits on ratios rather than on the absolute use of fuels. A higher carbon price will tend to induce firms to achieve given ratios with lower absolute uses of fuels. In the Energy 2020 model, a higher price of emissions allowances influences only a subset of the capital-equipment or fuel-input decisions for facilities subject to the complementary measures. Future work should allow cap-and-trade to influence a wider range of decisions.

3.5 Leakage and Reshuffling

One important aspect to consider about climate policy is the potential for local actions to lead to increases in emissions in other jurisdictions. This problem, which can be described as *leakage* or *reshuffling* depending upon the form it takes, is of particular concern when the regulations are applied at the state level rather than on a broader (regional or national) level.

Analysts often focus on the *indirect* leakage that can occur if economic activity migrates away from regions applying environmental regulations. Most often these are the industries that are both energy-intensive and trade-exposed.

However, in the AB 32 context there is great potential for *direct* leakage: a switching or reshuffling of the sources of energy production. For example, the Low Carbon Fuel Standard in California would require the consumption, in California, of fuels that the national Renewable Fuels Standard will itself require be consumed *somewhere* in the U.S. If both regulations remain in place, it is very plausible that the effect of the California regulation will be to divert some low-carbon fuel to California that otherwise would be consumed in other parts of the U.S. The implication of this diversionary effect (often referred to as *reshuffling*) is that a regulation that reduces local emissions achieves much smaller reductions at a broader level.

As the example above illustrates, these effects are not limited to those created by cap and trade. Complementary measures such as the LCFS and the Pavley II vehicle standards can create a circumstance in which to California standards make the compliance with Federal standards less stringent in other regions of the U.S.

Another important source of potential leakage and reshuffling falls in the electricity sector, where the *first deliverer* policy is intended to be the main deterrent to leakage. Under this policy, importers of electricity into California would be required to surrender allowances equivalent to the carbon content of their imported power. This gives firms an incentive to import power from low-carbon sources, but does not necessarily lead to the high-carbon sources reducing their emissions. If purchasers of power outside of CA are willing to take the output of

these high carbon sources, the impact of California's policy on aggregate emissions is reduced.

The ARB study did not attempt to measure leakage. The models utilized are not equipped to capture how California policies might cause firms to alter behavior in ways that lead to leakage or reshuffling. For example, the Energy 2020 model treats certain coal plants currently under contract to California utilities as effectively located within California for purposes of modeling AB 32 regulations. In scenarios where allowance prices are high, many of these plants essentially shut down by 2020 in the face of higher CO₂ prices. However, there is no *California* regulatory mechanism currently under consideration that could compel that result. In the absence of a regional climate policy, a plausible alternative outcome would be that these coal plants continue to operate but sell power to customers outside of California.

Because it is not a focus of the present analysis, it is difficult to estimate exactly how significant these impacts might be. However there is reason to believe they might be quite substantial. Many of the measures and sectors from which large GHG reductions are drawn in the study are also the ones most vulnerable to leakage and/or reshuffling. This is an important area of focus for future analysis.

3.6 Sector-Specific Modeling

As a consequence of the broad scope of the models, many important sector specific details are lost to aggregation. Among the detail that is lost is the geographic and demographic diversity in energy prices. Electricity, natural gas, and gasoline prices are aggregated to state levels. This masks important differences in the prices faced by individual consumers in specific locations. The breakdown of impacts by income category, in particular, can be misleading because many lower income customers are insulated by utility pricing structures and programs. In contrast, higher-income residential customers, and commercial and industrial customers as well, may face higher utility costs than those implied by this study.

Wholesale energy and product markets within the western U.S. are also more diverse than most aggregate models allow for. One area in which this regional diversity can overstate the price impacts of AB 32 is in the pricing of gasoline. While Energy 2020 considers a western gasoline market that is fully integrated, the California market is in fact differentiated from those in other regions by blending requirements motivated by air-quality considerations.

We recommend that future work consider additional sector detail. This would yield better information about energy prices and products, as well as important information as to how costs are distributed across various household groups and industries.

Greater sectoral detail would also allow for a richer characterization of costs. For example, while the Energy 2020 model captures the costs of investment in new technologies, such as renewable electricity generation, and the costs of producing alternative fuels, such as cellulosic ethanol, some infrastructure costs are not reflected in the study. These include the costs of electricity transmission facilities likely necessary to comply with a 33% RPS and any changes to the fuel transportation infrastructure necessary to comply with the LCFS. These costs could be on the order of several billion dollars and their absence causes the study to likely understate the costs of AB 32 and the relative costs of specific complementary programs.

4 Conclusions

The ARB's analysis provides valuable information on the impacts of AB 32 on fuel prices, allowance prices, employment, and overall economic cost. The results reflect a serious attempt to make use of available data as well as competent numerical modeling work. The report is careful to interpret the results fairly and openly.

As with all studies, this one has its limitations. The analysis would benefit from greater attention to uncertainties, technological change, out-of-state impacts, allowance allocation design, and assumptions underlying the reference case and the modeling of cap and trade. The two main models could be more fully integrated. On the other hand, the ARB's work has some attractions not enjoyed by other studies. It offers, for example, a far more detailed treatment of energy supply technologies than other California assessments with which we are familiar.

The report primarily focuses on one set of economic impacts: on output and income, employment, and prices. It is important to recognize that some potential benefits of AB 32 are not considered. Of particular importance are the benefits to health and well-being associated with the environmental improvements stemming from AB 32. In addition, to the extent that AB 32 offers insights into how climate policy might take shape, it could have value in helping stimulate climate policies in other states or at the national level.

The ARB's assessment contributes constructively and importantly to the discussion of AB 32. Although particular omissions or assumptions in the work introduce bias (as discussed above), there is no obvious *overall* bias to the ARB's assessment and thus, given the sophistication of the work, we believe that the assessment succeeds in refining our expectations about the likely impacts of AB 32 on households and businesses. We expect that future work will lead to further improvements in what is already a solid assessment.