Review 2011 IEPR Transportation Energy Forecasts
CEC Docket 11-IEP-1L

prepared by:

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In late August 2011, the California Energy Commission (CEC) released a draft staff report (Draft Report) entitled "Transportation Energy Forecasts and Analysis for the 2011 Integrated Energy Policy Report."[1] The stated purpose of this report is to provide:

> …*long-term forecasts of state transportation energy demand and prices as well as analyses of supply and projected ranges of transportation fuel and crude oil requirements. These forecasts support analysis of petroleum reduction and efficiency measures, introduction and commercialization of alternative fuels, transportation fuel infrastructure requirements and energy diversity and security.*

However, as described in detail below, while the Draft Report does present a wealth of data related to topics cited in the above quote, it fails to provide the comprehensive analysis and conclusions needed to accurately assess California's transportation energy demand between now and the end of the forecast period in 2030. In addition, there are a number of areas where the data and analyses that are presented in the Draft Report need to be modified to reflect more robust data and more appropriate assumptions.

The biggest weaknesses identified with the Draft Report are:

1. Failure to provide complete forecasts of the availability, California supply, and price of all fuels expected to participate in the California transportation fuel market;

2. Failure to provide complete forecasts of the costs associated with alternative fuel vehicles and alternative fuel refueling infrastructure; and

3. Failure to provide detailed analyses and conclusions regarding the likelihood of success of the RFS2 and LCFS programs in California and the associated incremental costs of compliance relative to the baseline forecasts.

[1] CEC-600-2011-007-SD, August 2011.

Overall Approach to Forecasting of California Transportation Energy Demand

CEC has been preparing forecasts of California's transportation energy demand for a number of years. In past, this was a relatively straightforward process for the CEC, which, as late as 2002-2003,[2] forecast transportation energy demand using a methodology requiring the agency to develop forecasts only for:

> *…the number of aircraft passenger, vehicle miles travelled, and the number and characteristics of cars, trucks, buses and light-rail transit vehicles.*

While this basic methodology remains sound for forecasting transportation energy demand, its application has become substantially more complicated because of technology-forcing federal (RFS2) and California (LCFS and ZEV) regulatory programs intended to dramatically increase demand for alternatives to gasoline and Diesel fuel, as well as related regulatory programs requiring dramatic improvements in vehicle fuel efficiency and reductions in greenhouse gas emissions (CAFE, Pavley). As a result, in order to accurately forecast California transportation energy demand, the CEC must now do the following:

1. Estimate the existing number of vehicles in California that operate or can operate on gasoline, Diesel, E85, natural gas, propane, electricity, and/or hydrogen, as well as the amount of each fuel that is consumed by vehicles operating in California;

2. Forecast changes in the populations and fuel consumption rates of all of these types of vehicles in light of federal and California regulations that mandate future production of what are currently non-commercial vehicle technologies but do not, in general, mandate vehicle purchase or the development of refueling infrastructure to support alternatively fueled vehicles;

3. Estimate the supply, availability, and price of alternative fuels such as ethanol, biodiesel, and renewable gasoline and Diesel in California, not only in general but also by specific production facilities or geographic locations;

4. Estimate and account for the cost and availability of new refueling infrastructure required to support alternative fuels such as E85 and electricity on both fuel prices as well as consumer vehicle purchase decisions;

[2] CEC 100-0-016SR, October 2003.

5. Estimate the market response to the forecast of available choices of vehicles and fuels to calculate the resulting demand for each fuel in light of vehicle and fuel supplies, prices, and availability of refueling infrastructure; and

6. Reconcile the results of the market response analysis with federal and California regulatory requirements in order to assess whether those requirements will be satisfied given the CEC forecasts.

Unfortunately, while CEC has attempted to modify its transportation energy demand forecasting methodology to address some of the complexities introduced by the current regulatory structure, many additional changes are necessary before the forecasts can be deemed to be reasonable.

These changes need to be made before finalization of the Transportation Energy Forecasts and Analysis for the 2011 Integrated Energy Policy Report and the results need to be thoroughly analyzed. Furthermore, the report should contain a forecast of the availability, California supply, fuel price, and total cost, including refueling infrastructure and incremental vehicle costs, associated with each potential transportation fuel that CEC or existing federal and state regulatory programs envision being used in California.

Accounting for RFS2

The Draft Report assumes that the impact of the federal RFS2 regulatory program in California will be to dramatically increase the amount of E85 available and sold in California relative to what the California market would otherwise demand. This can be seen in Figures 4-4 and 4-5 of the Draft Report (page 94). As shown in these figures, absent the RFS2 regulation CEC is forecasting virtually no California demand for E85.

The increase in the amount of E85 forecast to be used in California in the Draft Report is based on the CEC's estimates of California's proportional share of the RFS2 mandated ethanol volumes shown in Tables 4-2 and 4-3 of the Draft Report (pages 91 and 92) minus the amount of ethanol CEC forecasts will be used in California gasoline at the E10 level. As a result, the CEC forecast for E85 is based on the wholly unsupported assumption that a dramatic increase in E85 use will occur in California simply because the RFS2 regulation is in place. Furthermore, in the Draft Report CEC is forced to make several other unsupported assumptions, as discussed below.

The first of these is that the price of E85 will be the same as E10 on a gasoline gallon equivalent basis. This assumption is stated on page B-7 of the Draft Report and necessitated by the fact that CEC acknowledges that consumers will not purchase E85 unless its price is the same or lower than that of E10 on an energy-equivalent basis. However, CEC shows in Figure 4-15 of the Draft Report that this is not currently the case in California. This figure shows that the price of E85 sold in California during the period from August 2008 to June 2011 has been higher than that of gasoline on an energy-equivalent basis.

Further evidence of the lack of support for the CEC's assumption regarding E85 price is that the proportional share volumes under RFS2 shown in Tables 4-2 and 4-3 include significant volumes of "advanced biofuels," which are likely to be more expensive than starched-based ethanol and are likely to increase the price differential between E10 and E85 in the future. For example, CEC has assumed that the incremental price of Brazilian ethanol, an advanced biofuel, will be $1.75 per gallon relative to corn-based ethanol.

Similarly, with respect to cellulosic ethanol, the Draft Report states on page 87:

> *Progress of cellulosic ethanol production capacity has fallen significantly short of government and various expert projections. Production costs far in excess of corn-based ethanol are the likely cause for the shortfall compared to expectations. As consequence of this lack of progress, the U.S. EPA has repeatedly down-sized the cellulosic biofuels requirement for the years 2010 through 2013. Instead of the original mandated quantity of 600 million gallons of cellulosic biofuels between 2010 and 2012, the U.S. EPA has been compelled to dramatically reduce this requirement to between 16.6 million and 25.7 million gallons.*

Furthermore, with respect to Brazilian ethanol supply, CEC presents data in Figure 5-12 of the Draft Report showing that Brazilian forecasts for total exports of ethanol to the U.S. in 2020 amount to only about 0.5 billion gallons—a reduction from the estimated value in the 2009 IEPR (Figure 3.26) of 0.7 billion gallons for 2017.

Despite the above, CEC assumes, as indicated on page 102 of the Draft Report, that vehicles capable of operation on E85 will refuel with that fuel at least 50% or 75% of the time—presumably on either Brazilian or cellulosic ethanol, as substantial quantities of those fuels will be required to satisfy the RFS2 requirements.

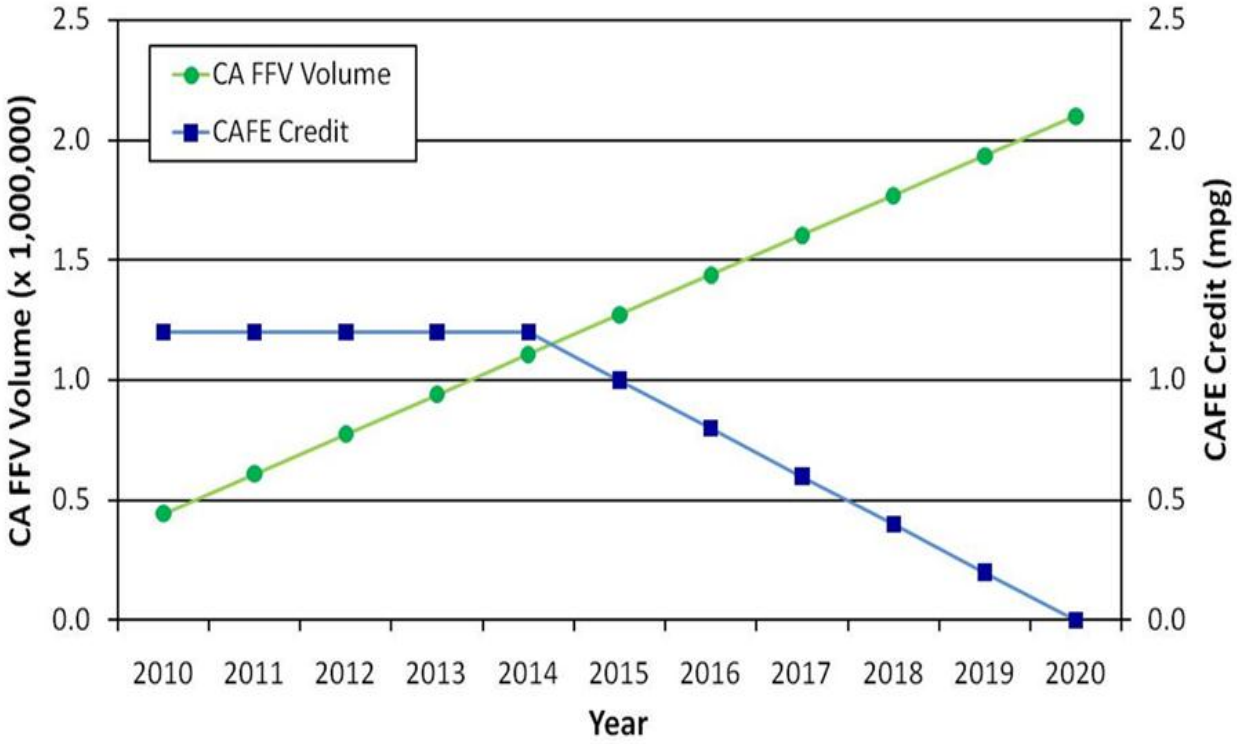
The second of CEC's unsupported assumptions is that a California E85 refueling infrastructure will be installed at a cost that CEC estimates would be between $3.1 and $101.8 billion over the period from 2010 through 2030 (page 99), and that this cost can be recovered without increasing the cost of E85 above that of E10 on an energy-equivalent basis. Although CEC goes on to also admit that this assumption is unreasonable (pages 100-101), the Draft Report still relies on it as one of the bases for the California transportation energy forecast.

The third unsupported assumption is related to the CEC's forecast for increases in the number of flexible-fuel vehicles operating in California that are capable of operation on E85. As noted by CEC in Figure 14-4 and on pages 102 and 103 of the Draft Report, CEC currently estimates that there were 455,188 FFVs operating in California in 2010 and forecasts that this population will increase to 2.1 million vehicles by 2020 and 5.0 million vehicles by 2030. The assumed forecasts require addition of about 166,000 FFVs per year from 2010 to 2020, and by about 290,000 FFVs per year from 2020 to 2030. Actual growth in the California FFV population has occurred at far lower rates, with total California FFV populations of 200,000 vehicles reported in the 2003 IEPR,

250,000 vehicles reported in the 2005 IEPR, 382,000 in the 2009 IEPR and the aforementioned value of 455,188 FFVs in the 2011 IEPR. Furthermore, there is nothing to suggest that FFVs will be added to the California vehicle fleet at increasing rates in the future. The primary driving force behind FFV production has been the availability of federal CAFE credits for those vehicles. As shown in Figure 1, however, those credits will be eliminated at the same time CEC forecasts massive increases in California's FFV population.

A final observation regarding the CEC's analysis of E85 is that CEC assumes, as noted on page 81 of the Draft Report, that the average ethanol content of E85 sold in California will be 79.2% by volume; however, that value does not comport with changes made to ASTM D5798-11 that allow E85 to contain as little as 51% ethanol by volume in order to avoid the necessity of producing specific gasoline blend stocks for use in producing E85. As a result, CEC has likely overstated the ethanol content of E85 and understated the actual number of gallons required to comply with the RFS2 proportional share value used as the basis for the CEC forecast. An increase in the actual required volume of E85 would likely require both additional E85 dispensers as well as additional FFVs to be included in the CEC forecast.

Figure 1
Comparison of CEC FFV Population Forecast and CAFE Credits Available to FFVs



In summary, the CEC ethanol forecast under the RFS2 relies on a number of unsupported assumptions that overstate the amount of E85 that is likely to be used in California while understating the cost of that E85, ignore the need for recovery of E85 infrastructure costs, and overestimate the number of FFVs likely to be available to use E85.

Another potentially important factor with respect to the CEC's treatment of the federal RFS2 regulation is the CEC's failure to include any forecast of the supply, availability, and price of so-called "drop-in" biofuels, which are sometimes also referred to as "renewable" gasoline and Diesel fuel. Furthermore, the Draft Report contains seemingly contradictory qualitative statements regarding the availability of drop-in fuels. Specifically, page 13 of the Draft Report includes the following statement:

> *Renewable diesel, renewable jet fuel, and renewable gasoline are appealing because they are renewable fuels identical to the petroleum-based products they would replace. Although none of these are currently produced in California in commercial volumes, today there are commercial plants with sufficient capacity to enable California to comply with the Low Carbon Fuel Standard.*

On pages179-180, however, the following statement is made:

> *Renewable diesel, renewable jet fuel, and renewable gasoline are appealing because they are renewable fuels identical to the petroleum-based products they would replace. Consequently, they are sometimes also referred to as "drop-in" fuels. Only renewable diesel is currently produced in commercial quantities and might be available in the volumes needed for compliance with the LCFS.*

And the only statement with respect to cost is that "*Renewable Diesel is more costly than petroleum-based Diesel,"* which is also found on page 180 of the Draft Report.

These contradictory statements in the Draft Report highlight the need for CEC to prepare a quantitative forecast of the supply, availability, and price of renewable gasoline and Diesel in California. Furthermore, this forecast should be compared and contrasted to that of EIA, which, in its 2011 AEO, forecasts relatively small nationwide volumes of renewable gasoline and Diesel fuel that total only about 0.8 billion gallons a year as late as 2020.

Finally, although the Draft Report concludes, on page 11 among other places, that there should be sufficient biodiesel availability to provide California with a supply at least equal to its RFS2 "proportional share," there is no quantitative forecast for biodiesel supply in California for the 2010 to 2030 period. In addition, the assumption stated on page B-7 of the Draft Report that B5 will have the same price as Diesel is contradicted by an assumed incremental cost of $3.00 per gallon for Biodiesel used in another recent

CEC analysis[3] and the fact that even the Draft Report indicates (on page 11) that at least $25 to $50 million in biodiesel storage infrastructure is needed in California.

Accounting for the ZEV Program

The Draft Report states on page 72 that full electric vehicles *"never gain appreciable market share,"* and on page 73 that demand estimates for plug-in hybrid electric vehicles (PHEVs) *"have been adjusted to comply with expected upcoming ZEV program requirements."* It is further stated that *"it is assumed that the needed minimum number of fuel cell vehicles will enter the market to comply with the updated ZEV program."* The Draft Report also presents forecasts of PHEVs that indicate their population will increase from about zero vehicles in 2011 to more than 5 million vehicles by 2030. Using CARB's most recent long-term incremental cost estimate of $7,000 per vehicle for PHEVs, the total cost of these 5 million vehicles will be $35 billion.

CEC's assumed growth rate for PHEVs is far higher than the forecast for FFVS which as noted above is itself far higher than the actual growth rate observed for FFVS. Similar issues can be seen in CEC's forecasts for hybrid vehicles where the 2007 IEPR forecast one million hybrids by 2010 as compared to the actual 2010 values of roughly half that volume shown in Figures 3-6 and 3-7 of the Draft Report.

In addition, to what appear to be unrealistic vehicle population growth rates, it appears that there are a number of issues associated with the CEC's forecast of PHEVs, full electric vehicles, and fuel cell vehicles. First, the CEC's forecast is fundamentally at odds with the most recent CARB forecasts, which are presented below in Figure 2. As that figure shows, CARB projects far more demand for full electric and fuel cell vehicles than does CEC. This discrepancy is significant because full electric and fuel cell vehicles are expected to have far higher incremental costs than PHEVs (on page 189, CEC puts the cost of fuel cell vehicles at $100,000), and will have fundamentally different needs with respect to refueling infrastructure.

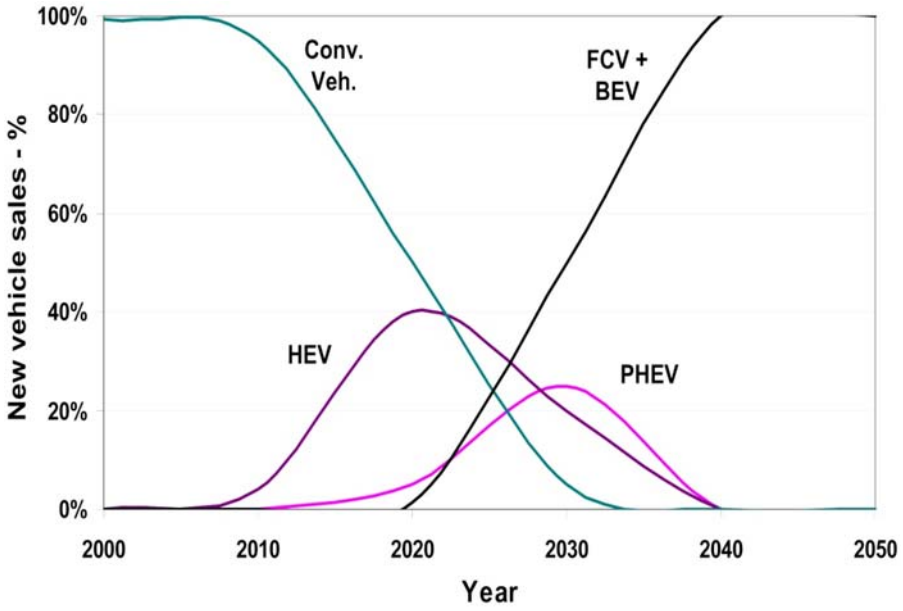
Obviously, large numbers of fuel cell vehicles will require an extensive hydrogen distribution system, which CEC estimates in the Draft Report (page 189) will cost between $1 million and $2.5 million per station. Again, CEC provides no forecast for hydrogen demand in the transportation sector and the prices provided in Appendix B are based on production from natural gas. Furthermore, these prices for hydrogen do not reflect production from biomethane, which is discussed in detail on page 191 of the Draft Report.

Similarly, recharging infrastructure needs for full electric vehicles—which cannot travel on other fuels, as can PHEVs—will demand more higher-level recharging stations and much greater development of public recharging stations. This in turn will increase infrastructure costs and also have potential impacts on California's electrical system.

[3] "Low Carbon Fuel Standard Analysis," Gordon Schremp, CEC, September 9, 2011.

Figure 2

CARB Forecasts for Vehicle Sales Under the ZEV Mandate[4]



Accounting for LCFS

The analysis of the LCFS in the Draft Report fails to take into account the impact of the LCFS on California's transportation energy demand. Instead, the requirements of the LCFS are investigated using four scenarios that involve different assumptions regarding the availability, California supply, and price of various alternative fuels, as well as their "carbon intensity" (CI) values. However, these assumptions have no relationship to the forecasts presented elsewhere in the Draft Report, and in many cases would require far larger volumes of alternative fuels to be available and supplied to California than has been forecast by CEC to be available.

Although the results of that analysis are not contained in the Draft Report, preliminary results were presented at the September 9, 2011 workshop focused on the Draft Report. What the preliminary results show is that compliance with the LCFS is not achievable until a third set of overly optimistic assumptions is invoked—those assumptions include U.S. production and import volumes that far exceed reasonable forecasts and/or assume that the bulk of the U.S. supply of specific fuels will be available in California. These assumptions are also overly optimistic in terms of the timing of the availability of fuel supply. For example, the supply of Brazilian ethanol into California in 2012 is assumed to be 1.5 billion gallons, even though Brazilian estimates of total U.S. imports in 2020 are

[4] From CARB, "Attachment B, 2050 Greenhouse Gas Emissions Analysis: Staff Modeling in Support of the Zero Emission Vehicle Regulation"

only 0.5 billion gallons. In addition, all assumptions in the CEC analysis are presented without any indication of their plausibility and many do not at this time have an associated cost for the fuels and fuel sources in question.

Instead of performing an analysis that focuses on showing how unreasonable assumptions must become in order to show LCFS compliance, CEC should instead analyze how far from LCFS compliance the California transportation fuel market will be, based on the CEC's best forecasts of actual fuel availability, supply to California, and cost.