HONDA
The Power of Dreams

Comments on the LCFS Final Draft California Air Resources Board Meeting to Consider the LCFS

April 23, 2009
Ryan Harty
Honda R&D Americas, Inc

HONDA
The Power of Dreams

Summary of Comments

1. California Marginal Electricity Report Errors
   - There are several inconsistencies in the CA Electricity Report that should be corrected to clarify how "Marginal Electricity" is calculated.
   - The Marginal Electricity result seems artificially low.
     - Estimates by UC Davis using a dispatch model show much higher Marginal Emissions.
2. EER of EVs and FCVs is Too Low Relative to Gasoline Vehicles in the 2010 to 2015 Timeframe
   - LCFS EER table compares **2010** EVs and FCVs against **2015** gasoline vehicles. This is inconsistent, and it artificially lowers the credit for EVs and FCVs during the 2010 to 2015 timeframe.
3. PHEV Blended Mode Fuel Economy
   - LCFS should recognize blended mode PHEVs. SAE J1711 provides a method to break out the electricity use, and should be used.
4. EER of EVs is Too High
   - LCFS should use real laboratory dynamometer test results using existing standards for both City and Highway tests to build the EER comparisons.

California Marginal Electricity

California Marginal Electricity

- California Marginal Electricity Report Inconsistencies
  - There are several errors and inconsistencies in the calculation of the CI for CA Marginal Electricity in the Electricity Report[1].
    - 1) The MWh Share Percent is incorrect in Table 2.02. It should change from 43.1% to 78.7%. As well, the efficiency is listed incorrectly. It should be 51.8%.
    - 2) It is unclear whether the intent is to use 100% Natural Gas Combined Cycle powerplants. Table 2.01, Table 2.02, the paragraph following it, and the CA Greet Model[2] are inconsistent.
  - The CI for Marginal Electricity (104.71gGHG/MJ) is optimistically low
    - The assumptions behind the CA Marginal Electricity are overly optimistic.
      - EVs charged using off-peak electricity will use EXISTING generation resources, NOT NEW generation resources. Existing natural gas generation has a net efficiency closer to 38.9%, not 51.8%. The actual off-peak marginal generation mix should be used to calculate the emissions impact of this policy.
      - A thorough analysis by UC Davis[3] estimates the CI of CA Marginal Electricity in the range of 109g/MJ to 163g/MJ, depending on the month and time of day. The new results are comparable to the high and low ends of the UC Davis estimate.
        - » The real answer for Marginal Electricity in the near term is probably in between. A detailed study should be conducted to determine what this mix is likely to be in the near term as well as in the mid term.

1) http://www.arb.ca.gov/fuels/lcfs/022709lcfs_elec.pdf
2) http://www.arb.ca.gov/fuels/lcfs/ca_greet1.8b_feb09.xls
3) UC Davis STEPS program – McCarthy, Yang, Ogden

Details of the corrections are given in the following slides:

California Marginal Electricity

1) The CA GREET Model and the Electricity Report shows the MWh Shares of "Marginal Electricity" as 78.7% Natural Gas and 21.3% Renewable, but in the calculation in the Electricity Report the MWh shares are shown as 43.1%. In the Electricity Report, the MWh Shares in this table need to be revised.

Original Table

The MWh Shares column should add up to 100%

Table 2.02 Calculation of Direct Energy Consumption (Btu/mmBtu) to Produce Electricity

Process Fuel Type	MWh Shares	Avg Eff (LHV)	Calculation of Direct Energy Use per MJ Composite Electricity Produced	Direct Energy Use, Btu/mmBtu
Natural Gas	43.1%	38.9%	10^6 Btu/mmBtu/ (0.389) / (1-.081) * 0.431	1,653,215
Other	(These spaces should be filled in for clarity)			231,774
TOTAL DIRECT ENERGY USE				**1,884,989**
NET DIRECT ENERGY USE (less 1 mmBtu electricity produced)				**884,989**

Note: Other = hydro, wind, solar, geothermal and assumed Transmission Loss is 8.1%

MWh Shares for Natural Gas should be 78.7% in this table.

Possible Revision

Table 2.02 Calculation of Direct Energy Consumption (Btu/mmBtu) to Produce Electricity **REVISED – For 100% NGCC Turbines**

Process Fuel Type	MWh Shares	Avg Eff (LHV)	Calculation of Direct Energy Use per MJ Composite Electricity Produced	Direct Energy Use, Btu/mmBtu
Natural Gas	**78.7**	**51.8%**	10^6 Btu/mmBtu **/0.581** / (1-.081) * **0.787**	1,653,215
Other	**21.3**	**100%**	**10^6 Btu/mmBtu/(100%)/(1-0.081)*21.3%**	231,774
TOTAL DIRECT ENERGY USE				**1,884,989**
NET DIRECT ENERGY USE (less 1 mmBtu electricity produced)				**884,989**

Note: Other = hydro, wind, solar, geothermal and assumed Transmission Loss is 8.1%

If 100% Combined Cycle Turbines are used, the efficiency should also be adjusted to 51.8%.

1) http://www.arb.ca.gov/fuels/lcfs/022709lcfs_elec.pdf

California Marginal Electricity

2) The Plant Shares in the Electricity Report do not match the CA GREET model, and the Electricity Report is inconsistent. It is unclear whether the intent if ARB is to use 100% Natural Gas Combined Cycle Powerplants, or is the intent to use the existing plant share split?

2.1 Detailed Energy Consumption for the CA Marginal Electricity Pathway WTT

The first step in the electricity pathway is to determine direct fuel use at the electric power plants. Table 2.01 indicates how the different fuels are split by equipment type and the assumed unit efficiency (LHV basis) for each plant/fuel type combination. The weighted average efficiency for each fuel is shown in the last column. All power plant efficiencies shown are GREET defaults except slight adjustment to the natural gas combustion turbine efficiencies as follows:

- Simple Cycle Turbines: GREET default is 33.1% (LHV basis), the CA modified model uses 31.5%
- Combined Cycle Turbine: GREET default is 53% (LHV basis), the CA modified model uses 51.8%

Table 2.01 Power Plant Shares and Assumed Efficiencies for Each Fuel Type

Process Fuel Type	Power Plant Type	Plant Type Shares	Plant Efficiency (LHV)	Average Efficiency for Fuel (LHV)
Natural Gas	Boiler	20%	34.8%	39.0% ?
	Simple Cycle Turbine	36%	31.5%	
	Combined Cycle Turbine	44%	51.8%	

The Electricity Report is inconsistent with itself in what Marginal Electricity is!

The intent of the California Marginal case is to reflect the marginal resource mix of electricity consumed in California. This is assumed to be natural gas combusted in combined cycle combustion turbines (CCCTs) and renewables. Table 2.02 illustrates how CA-GREET directly utilizes these splits (shown in Fig. 2), the average power plant efficiency, and the transmission & distribution loss factor to calculate direct power plant fuel consumption. Note that 1,000,000 Btu/mmBtu electricity of the fuel consumed becomes electricity, so this is subtracted from the total direct energy use to arrive at a net direct energy use.

Generation Technology Shares in Power Plants

The Plant Shares in the Electricity Report do not match the Plant Shares in the CA GREET Model for CA Marginal Electricity.

Table from CA GREET Model

100.0%

5-year period	NG CC Share of Total NG Power Plant Capacity	Relative Efficiency (to yr 2010)
1990	5.0%	
1995	10.0%	
2000	20.0%	
2005	41.0%	
2010	100.0%	
2015	46.0%	
2020	48.0%	

CA GREET Model ca_greet1.8b_feb09.xls Fuel_prod sheet.

The Average Efficiency is inconsistent with 100% CCCTs as shown below.

Table 2.01 and 2.02 are inconsistent with the text in the report and with the inputs to the CA GREET Model. What is the intent?

California Marginal Electricity

- LCFS original estimate for CA Marginal Emissions was104.71gGHG/MJ.
- This is lower than the *lowest* estimate of CA Marginal Emissions by UC Davis – 109g/MJ to 162g/MJ, (136g/MJ Mean Marginal)
  - UC Davis assessed the marginal electricity emissions of the actual installed generation capacity of California using a dispatch model. This yields a detailed, hour-by-hour, month-by-month assessment of the likely emissions from California generation. This research is not finalized (this data is from an poster progress report), but it demonstrates the likely boundaries of the real answer. 104.71gGHG/MJ is much too low!
- The LCFS should reflect the actual emissions, not the desired emissions.

Marginal generation resources

Figure 5: Average GHG emission of the last generator online in CA (2010 demand with current grid mix and median hydro availability)

Hour	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg.
0	435	438	429	414	408	420	418	441	433	453	429	457	431
1	408	413	408	406	405	400	414	415	407	419	407	429	411
2	406	411	410	407	402	393	405	405	403	407	405	409	405
3	405	405	404	402	405	397	411	404	400	406	402	409	404
4	409	411	404	395	400	401	401	401	403	407	406	409	404
5	432	444	424	404	402	394	406	406	408	439	421	460	420
6	468	465	461	413	402	406	410	432	474	488	459	475	446
7	482	498	493	443	419	429	433	459	473	496	492	486	467
8	501	496	480	427	415	440	458	519	509	521	512	505	482
9	465	507	466	419	434	478	465	503	508	532	523	514	484
10	505	485	493	444	475	497	474	551	529	544	505	514	501
11	516	490	503	457	497	504	509	527	542	556	507	517	510
12	500	484	506	468	507	509	515	552	522	535	507	524	511
13	501	494	505	463	519	528	521	573	557	550	502	521	519
14	502	511	495	463	516	530	529	583	564	545	511	505	521
15	505	510	488	440	522	526	524	569	560	545	492	498	515
16	485	500	489	445	502	527	524	580	550	543	500	520	514
17	520	493	484	439	511	523	525	575	557	561	518	528	520
18	528	509	505	443	492	525	501	564	548	557	533	536	520
19	519	524	503	441	477	508	491	536	540	543	521	546	512
20	508	509	496	444	484	509	486	541	539	539	510	519	507
21	504	486	491	440	462	480	471	559	541	539	517	512	500
22	474	497	470	441	442	476	476	528	514	530	498	507	488
23	469	474	471	437	419	438	454	478	486	492	470	480	464
Avg.	477	477	470	433	455	468	467	504	499	506	481	491	477

Based on regional demand curves from the EPA's NEEDS database (EPA, 2006) using the current grid mix, listed in Table 1, and assuming median annual hydro generation (based on the distribution of annual hydro generation from 1983-2007).

Average marginal generation in 2010, based on the current grid mix, almost always comes from natural gas plants. Emissions range from 393-583 gCO_2/kWh, increasing in late summer afternoons when demand is high and hydro availability is low. In the near term, vehicles will use electricity that is more GHG-intensive than the average mix (in Figure 4), even if recharged at night.

(McCarthy, Yang, Ogden – UC Davis 2008 STEPS Program)

Real EVs plugged into a real grid in California will produce emissions much higher than the "Marginal Electricity" estimate of the LCFS for the near future.

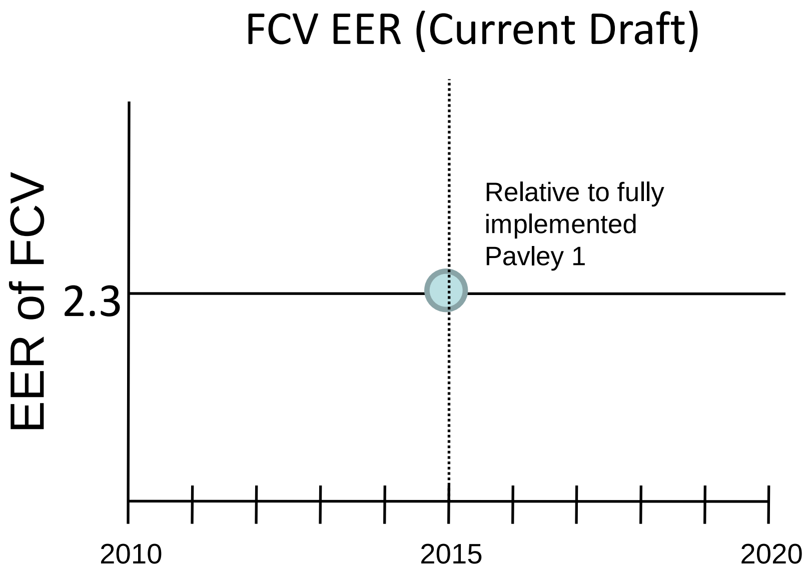
Note UC Davis' comment: "… In the near term, vehicles will use electricity that is more GHG-intensive than the average mix… even if recharged at night."

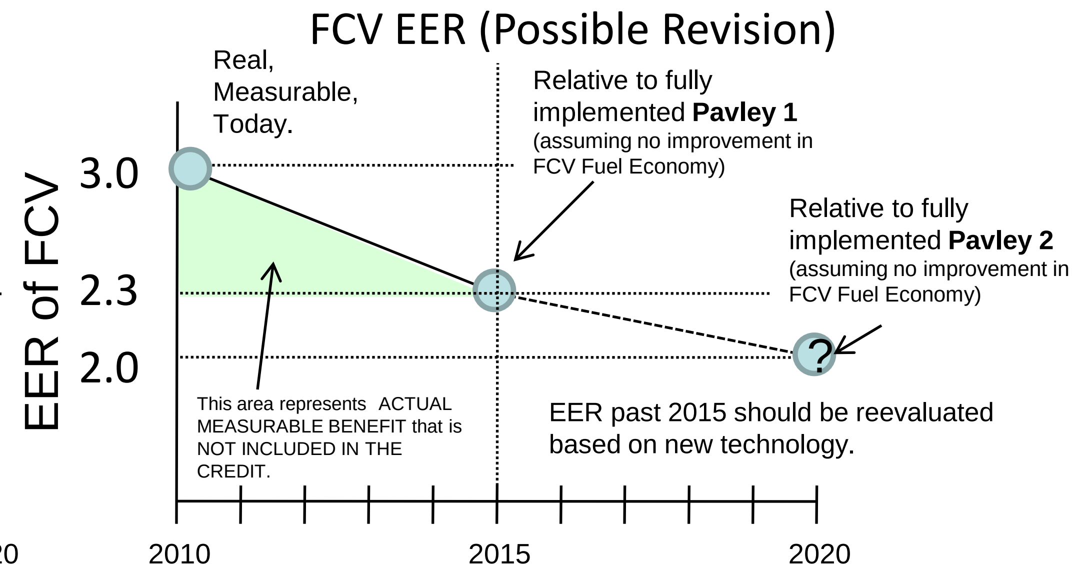
EER of FCVs and EVs is Too Low Relative to Gasoline Vehicles in the 2010 to 2015 Timeframe

EER of FCVs and EVs is Too Low

- EERs of FCVs and EVs are too low for 2010 to 2015.
  - To reflect the impact of AB 1493 (Pavley Regulations), the LCFS reduces the EER of FCVs and EVs in the 2010 to 2015 timeframe.
    - This effectively reduces the incentive to apply these vehicles and fuels in the early years.
    - Comparison of 2010 EVs and FCVs to 2015 gasoline vehicles puts today's advanced vehicles at a distinct disadvantage.
      - These vehicles actually DO have an EER of 3.0 to 3.5 vs regular gasoline vehicles in the 2010 timeframe.
  - Similar to how the CI for gasoline changes each year, the EER for FCVs and EVs should also change each year, to reflect the changing baseline.
  - The LCFS should re-evaluate the EER tables as new data becomes available.

EER of FCVs and EVs is Too Low





- FCVs actually **do** have an EER of 3.0 vs similar conventional gasoline vehicles **today** and should be rewarded as such. EVs have a similar higher EER today, approximately 3.5, not 3.0.
- The FCV EER of 2.3 in the LCFS Draft takes into account AB1493 regulations, which call for gasoline vehicle fuel economy increases from 2009 to 2015, and sets the 2015 fuel economy of the gasoline vehicle as the baseline against which the 2010 FCV is judged today.
  - This is effectively a disincentive to investments in FCVs and hydrogen stations for the next 5 years compared to the actual realizable benefit of these investments. This is opposite to the intent of the LCFS!
- One option would be to adjust the EER of the FCV each year, in a similar manner to the table shown above.
  - 2015 – EER of 2.3 may be appropriate, considering a 30% improvement in gasoline vehicle fuel efficiency.
  - 2020 – EER should be re-evaluated. Considering that by 2020, a significant portion of the gasoline vehicle fleet under Pavley 2 will be hybridized, an EER of 2.0 may be appropriate in the 2020+ timeframe.
- The LCFS should re-evaluate the EER tables every 2-3 years, as the state-of-the market is changing rapidly in automobiles today, and both EVs and FCVs will improve their fuel economy from today's numbers.

HONDA
The Power of Dreams

EER of FCVs and EVs is Too Low

This is the EER Calculation in the LCFS draft for Hydrogen Fuel Cell Vehicles:

Table C1-3
Summary of Basis for Calculating EERs for Fuel Cell Vehicles

FC Vehicle	mpgge	Reference Gasoline Vehicle	mpgge	EER	Adjusted EER[1]
2008 Honda Clarity FCX	74	2009 Honda Accord	25	3.0	2.3

1-The adjusted EER is equal to the EER divided by 1.3, under the assumption that the fuel economy of the reference gasoline vehicle will increase by 30 percent between now and 2016.

In 2010, the EER is 3.0. Credit for hydrogen fuel cell vehicles in 2010 should be 3.0.

In 2016, the EER is 2.3 (relative to a 2010 FCV!). Credit for hydrogen vehicles in 2016 should be 2.3, assuming there are no improvements in fuel economy of FCVs by 2016.

Proposed Regulation to Implement the Low Carbon Fuel Standard Volume II Appendices (March 5, 2009)
http://www.arb.ca.gov/regact/2009/lcfs09/lcfsisor2.pdf

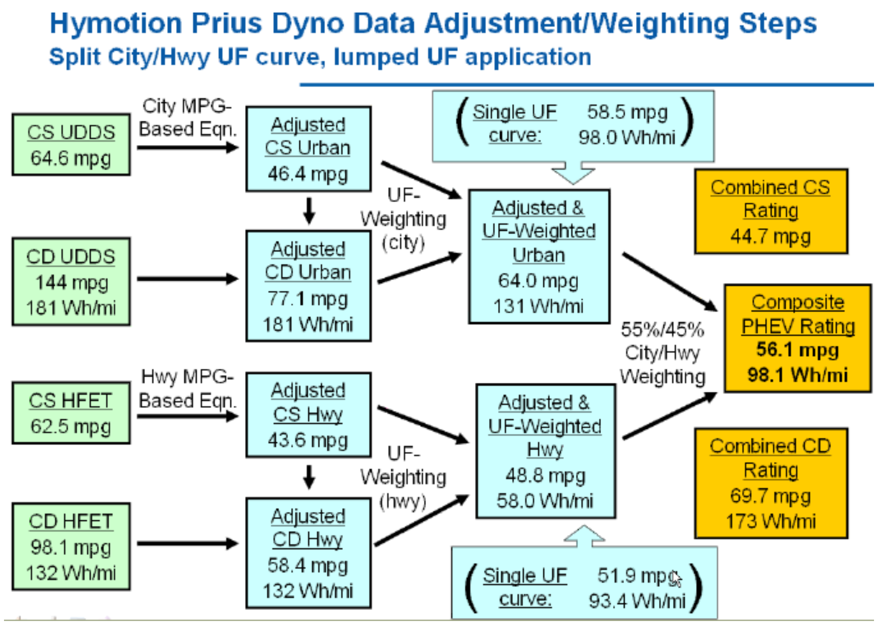
PHEV Blended Mode Fuel Economy

PHEV Blended Mode Fuel Economy

- PHEV Blended Type Electrical Fuel Consumption
  - LCFS makes no attempt to estimate the emissions of blended-type PHEVs.
  - Considering the potential cost advantages of designing a blended-type PHEV, it is likely that blended-type PHEVs will occupy a significant percentage of the total PHEV market in California. So their benefits should be recognized in the LCFS.
  - SAE J1711 includes a method to estimate the electrical use of a blended-mode PHEV, which is the same as CARB's own PHEV test procedures. Once published, SAE J1711 should be used to estimate the electricity use of a blended-type PHEV.
    - Note: As the Utility Companies are the regulated entities and are required to report the actual quantity of electricity delivered to transportation vehicles, some method to identify the type of vehicle to which the electricity is delivered should be considered.

PHEV Blended Mode Fuel Economy

- Blended mode PHEVs may have a distinct cost advantage over All-Electric PHEVs, and as such will likely hold a large place in the PHEV market. LCFS should include a method of measuring the electrical fuel economy and rewarding credit in the LCFS.
- The SAE J1711 Working Group has been meeting to discuss PHEV electrical and gasoline fuel consumption measurements and labeling, including for blended mode PHEVs.
- CARB members (Jeff Wong) are actively engaged in this discussion.
- Argonne National Labs (Mike Duoba) is the chair of this committee, and ANL is also engaged in measuring the fuel economy of PHEV vehicles.



Sample (preliminary) test results of ANL Hymotion Prius with one proposed method of calculating the electrical fuel consumption.

- When SAE J1711 is published, LCFS should adopt its method of measuring the electrical consumption of PHEVs in the blended mode, and some EER for blended mode vehicles should be included in the EER tables.
- These vehicles will ACTUALLY be in California, and will ACTUALLY use electricity.

1) SAEJ1711 Meeting Notes from Feb 2009 Meeting.

EER of EVs is Too High

EER of EVs is Too High

- The EER of EVs is too high
  - The LCFS should reference a specific test mode, or test procedure, to ensure that fuel economy comparisons to gasoline vehicles are being conducted on a fair basis.
    - 49CFR (EPA), ARB, SAE all have standard test modes. The methods used to calculate fuel economy in the LCFS are not consistent with any of these.
  - In the absence of data, the LCFS uses press release materials for sources in some instances.
    - Test conditions and procedures are rarely disclosed in press releases, so it is difficult to determine what the press release actually means!
  - In calculating the City/Hwy combined fuel economy, the LCFS makes the assumption that the City and Highway test data are equal in absence of measured data.
    - This is not a good assumption, as the City and Hwy tests usually result in very different results, especially for electrically driven vehicles.
    - Only comparable **City/Hwy Combined** fuel economy results should be used to generate the EER table.
  - These vehicles exist – it should be possible to get real data and to base the EER calculations on real data.
    - EPA is one source for vehicles that have been certified.
    - ARB has established a test procedure for PHEVs
    - Argonne National Labs has an extensive test vehicle database.

EER of EVs is Too High

- In building the EER Table, ARB lacks certain data, such as the HWY dynamometer test result for the GM Volt. The results are inaccurate.

Table C1-2[1]
Summary of Basis for Calculating EERs for Plug-In Hybrid Vehicles

PHEV Vehicle	mpgge	Reference Gasoline Vehicle	mpgge	EER	Adjusted EER[1]
Chevy Volt	128[2]	Chevy Cobalt	28	4.6	3.5

City is the **BEST** mode for the EV

City is the **Worst** mode for the Gasoline Vehicle

1 -The adjusted EER is equal to the EER divided by 1.3, under the assumption that the fuel economy of the reference gasoline vehicle will increase by 30 percent between now and 2016.

2 – Calculated using a range of 40 miles, a battery capacity of 8 kW-hr, and a charger efficiency of 80 percent. This is from a press release, not a laboratory test!

- This compares the BEST mode of the EV vs the WORST mode of the gasoline vehicle.
- The Hwy fuel economy test of the Cobalt is 43.4mpg[2], but the higher fuel economy of the Cobalt in Hwy mode is not captured in the EER table.
- This uses press release information for the City only fuel economy of the Volt versus the laboratory test result of the City fuel economy of the Cobalt.
- The LCFS is assuming that the Hwy test result of the Volt would be similar to the City result, but lacking any data, this assumption is not valid.

1) Proposed Regulation to Implement the Low Carbon Fuel Standard Volume II Appendices (March 5, 2009)
http://www.arb.ca.gov/regact/2009/lcfs09/lcfsisor2.pdf
2) http://www.epa.gov/otaq/tcldata.htm