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Changes to California's Low Carbon Fuel Standard Impact the Plug-in Electric Vehicle Market Including Electric Utilities, Charging Station Operators, Workplaces and Fleets

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Abstract

The California Low Carbon Fuel Standard (LCFS) launched in 2007 aims to encourage the development of low-carbon fuels to replace gasoline and diesel. The LCFS program regulates oil companies which must reduce the carbon intensity of gasoline and diesel by 10% by 2020 through either their own actions or by purchasing LCFS credits generated by entities including electric utilities. This paper explains the LCFS, the recent court actions, the recent LCFS changes and debates in detail, and makes conclusions. In December 2011, the California Air Resource Board (CARB) made substantial changes to the LCFS so that instead of third party charging station operators receiving the LCFS credit for electricity in most plug-in EV (includes BEV and PHEV) charging scenarios instead the revised LCFS provides the value of the LCFS credit to the utilities in the case of residential charging (80% of the market) and to public-access charging station operators in most public-access scenarios. Further, the revised LCFS gives the value of the LCFS credit to the fleet or workplace owner in the case of fleet and workplace charging. This paper details the conditions placed by CARB on utilities, fleets, workplace owners and charging station operators and how this impacts their role in the market. But generating LCFS credits is optional. Though it is known that LCFS credits will be monetized by selling them to oil companies, their value is unknown and could be in the $25-100 per metric ton of CO_2e range (or more) over the next decade. In the case of a battery EV the LCFS credit value over a 150,000 vehicle life (credits are earned quarterly) could be between $1500 and $6000 for an electric van or between $750 and $3000 for an electric sports car, and less for PHEVs. This value is significant and potentially a long-term replacement for tax credits and grants.

Keywords: PHEV (Plug-in hybrid electric vehicles), Battery Electric Vehicles (BEV), charging, infrastructure, regulation, LCA (Life Cycle Assessment),

1 Description of the Low Carbon Fuel Standard

California's Low Carbon Fuel Standard (LCFS) originated in January 2007, as Executive Order S-01-07, and was adopted as law (regulation) in mid-April 2010 [1]. Compliance schedules and enforcement began in January 2011. California's AB 32 statute gives broad authority for CARB to

require CO_2e reductions to meet 1990 levels by 2020 through complementary regulations including the LCFS. [2] In addition, CARB's goal is to reduce CO_2e from all sectors of society by 80% below 1990 levels by 2050.

Through the LCFS, the carbon intensity of most of California's transportation fuels (gasoline and diesel) must be reduced by at least 10% between 2011 and 2020 with the goal of encouraging the development of low-carbon alternative fuels and discouraging the import of high-carbon fuels, such as gasoline from tar sands. Specifically, it requires gasoline and diesel transportation fuel providers to meet annual carbon intensity requirements shown in Table 1 either by purchasing LCFS credits from low-carbon fuel credit generators (e.g. electric utilities in some cases) or delivering / providing low-carbon fuels or fuel blends themselves, but not from directly reducing the carbon intensity of gasoline or diesel. The specific requirements on gasoline and diesel producers / importers are to meet carbon intensity requirements shown in Table 1 and are expressed in grams CO_2e per megajoule (MJ). The values in Table 1 are from December 2011 and are still being updated by CARB. [3] [4] Low-carbon fuels include advanced biofuels, biofuel blends, biodiesel, electricity, compressed or liquefied natural gas, compressed or liquefied hydrogen and other more exotic fuels. One LCFS credit is generated by reducing the consumption of gasoline or diesel fuel by one ton of CO_2e.

Table 1 Carbon Intensity for Gasoline and Diesel

Year	Carbon Intensity for Gasoline (grams CO_2e/ Megajoule)	Carbon Intensity for Diesel (grams CO_2e/ Megajoule)
2011	95.61	94.47
2012	95.37	94.24
2013	96.42	95.40
2014	95.93	94.91
2015	94.95	93.95
2016	93.98	92.99
2017	92.52	91.54
2018	91.06	90.10
2019	89.60	88.65
2020 and subsequent years	87.65	86.72

The LCFS is based on determining the lifecycle CO_2e emission value for each fuel that voluntarily participates or must participate in the LCFS. The lifecycle assessment includes direct emissions associated with producing, transporting and using the fuels as well as significant indirect effects on CO_2e emissions, such as the changes in land use for some biofuels. CO_2e emissions include carbon dioxide, methane, nitrous oxide and other CO_2e contributors in the lifecycle. [3] The gasoline / diesel carbon intensity requirements in Table 1 reflect this lifecycle assessment and do not include current transportation fuel use by electricity, natural gas, propane, and bunker fuel. [3]

1.1 Carbon Intensity of Electricity

The carbon intensity of electricity (measured in grams CO_2e per megajoule) is substantially lower than gasoline or diesel, and that difference is used in the LCFS regulation to create an LCFS credit in metric tons (m-tons) of CO_2e. (The formula is detailed below.) Generating LCFS credits from the use of electricity is not required, but rather an opt-in process that subjects a party to various CARB requirements (discussed later). [5] Once LCFS credits are generated they are monetized by selling them directly (or through a broker) to gasoline and diesel producers / importers whose overall product mix must meet average carbon intensity as shown in Table 1.

CARB offers several options to calculate the carbon intensity of electricity. [3] Based on the method that includes 20% renewable electricity and 80% combined cycle natural gas, the carbon intensity of electricity is 30.8 grams CO_2e per MJ or 67.8 % less than gasoline. This methodology is also called the marginal default methodology and is essentially the same as what will be done under long term procurement plans required for California utilities. [3] In addition, CARB allows utilities with even cleaner electricity portfolios to benefit by seeking CARB approval for a

methodology specific to their situation. For example, due to requirements for 33% renewable electricity and other factors, by 2020 or sooner it may be feasible for a utility to use this alternative and achieve a carbon intensity of 23.5 grams CO_2e per MJ or 73% less than the 2020 gasoline standard and 75% less than the 2012 gasoline standard. Additionally, the default electricity carbon intensity will be changed in future years as the renewable electricity requirements increase. [8][10]

The calculation of the electricity LCFS credits (in m-tons of CO_2e) is a throughput-based calculation of the CO_2e produced by consuming electricity relative to the amount of CO_2e that otherwise would be produced in a given year by gasoline (or diesel) in Table 1 and depends on several factors:

- Annual kWh used at the charging location (residential, fleet, workplace or public-access)
- Carbon intensity of gasoline (see Table 1)
- Carbon intensity of electricity (calculated by the electricity intensity in grams CO_2e per MJ divided by the energy economy ratio (EER).
- Adjustment factor of 3.6 MJ per kWh

The actual formula for LCFS credits is:
KWh measured (or estimated if allowed) **x** 3.6 MJ /kWh **x** EER **x** [(annual carbon intensity requirement of the gasoline fuel as shown in Table 1 - (electricity carbon intensity in grams CO_2e per MJ / EER)]= grams of CO_2e. Grams CO_2e are then converted to metric tons. One LCFS credit equals a m-ton of CO_2e. [3]

1.2 Energy Economy Ratio (EER)

The factor in the formula above called EER is provided for vehicles powered by hydrogen, electricity, compressed natural gas and liquefied natural gas in order to account for the differences in energy economy among different types of fuels and vehicles. The 2007 California Governor's office white paper as well as other parties called for CARB to adopt this EER factor in order for the LCFS to be fuel-neutral and include all low-carbon fuels. [6] In the LCFS the EER for gasoline, diesel and most other types of alternative fuel vehicles is always equal to 1.0. The EER is a unitless number based on comparing a light duty BEV's energy use to the energy use of its gasoline or diesel vehicle counterpart. Similar comparisons with gasoline or diesel vehicle counterparts are done for light duty fuel cell vehicles and light duty PHEVs when operating in electric mode, as well as medium and heavy duty versions of these vehicles. [5] It is likely that EERs will be calculated for electric non-road equipment and similar electric technologies in future rulemaking, so that these technologies may also generate LCFS credits. [4] [7]CARB's goal is for the EER number to be data-driven based on energy conversion of comparable actual vehicles and to be updated with each LCFS revision presented to the CARB Board. [4][7][10]

1.3 KWh Measurement and Estimation

The LCFS requires fleets, workplaces and public-access locations to measure kWh for the PEV charging at that location and report it and use it as a factor in the above formula. [3] However, in the case of residences, the LCFS does not require kWh to be directly measured until 2015. Residential customers today have several metering options, and though a separate (parallel) meter for PEVs is one used today, CARB allowed time for the market to develop and for low-cost, accurate technical solutions (such as submeters in series) to emerge. In the meantime, estimation of the residential kWh for plug-in EV (PEV) charging is allowed once CARB approves an estimation methodology. [11] Because many utility customers are opting for electric rates that do not involve a separate PEV meter, estimation is an important source for generating LCFS credits. The California Electric Transportation Coalition has submitted a proposed estimation methodology on behalf of California utilities and is waiting for CARB approval.

1.4 LCFS Rulemaking Status

LCFS rulemakings have begun but are not complete in Oregon, Washington State, the North-eastern United States, Europe and the Mid-western United States. California is the only one in the U.S. where the LCFS is adopted as regulatory law. (In Canada, British Columbia Province also has a functional LCFS). However, in 2012, the U.S. District Court for the Eastern District has ruled that the California LCFS violates the U.S. Constitution's provisions that only the federal government can regulate interstate commerce, and has placed an injunction on enforcing LCFS. CARB has appealed this ruling and injunction to the 9th Circuit Court of Appeals. [9] However, CARB staff is able to continue with LCFS revisions in 2012. CARB staff expects to bring additional revisions to the LCFS to the CARB Board several times in the next few years, including a likely proposal to extend the LCFS past 2020 and make it more stringent [7] but resolution of the court case is required first.

2 Description of the Electricity Regulated Party and Related Revisions

The CARB Board on Dec 16, 2011 adopted many revisions to LCFS in order to streamline and clarify certain aspects of the program, though the vast majority of the LCFS remains unchanged. The changes that are not related to electricity but that impact gasoline and diesel fuels will not be covered in this paper.

2.1 Electricity Regulated Party Designations Revised

The CARB Board in April 2009 with Resolution 09-31 directed staff to review the designations in the LCFS for opt-in regulated party for electricity and make revisions where appropriate to involve more stakeholders and eliminate ambiguity. [10] CARB staff determined that the market had substantially evolved and that the California Public Utilities Commission regulations and the Legislature had impacted the market place, thus necessitating the revisions adopted by the CARB Board in December 2011. [5]

Table 2 shows the parties the CARB Board approved in December 2011 as the opt-in regulated parties for electricity (also known as the LCFS credit generator) and the requirements placed on these opt-in regulated parties. [5] [3] Table 2 also shows that utilities are opt-in LCFS credit generators in the major market segment of residential charging and are back-up LCFS credit generators in the other markets. CARB calls utilities the electric distribution utility (EDU) and defines the EDU as investor-owned utilities (IOUs), public-owned utilities or rural electric co-ops. The back-up credit generator provisions only apply when the primary credit generator cannot meet the CARB requirements, does not apply to be the primary credit generator or goes out of business. Also, the back-up credit generator must meet all the same requirements that apply to EDUs as the primary credit generator in the residential charging segment. The reasons behind CARB's decisions are detailed in Section 3.

CARB's requirements on the investor-owned utilities do not take effect until the California Public Utilities Commission (CPUC) and the individual municipal utility governing boards also rule on implementing these requirements. The CPUC proceeding on this has begun and is scheduled to be completed in late 2012. [11]

2.2 Energy Economy Ratios Revised

The CARB Board in the April 2009 Resolution 09-31 requested staff to make regular updates to the EER provisions because the EERs in the original LCFS were based on limited data from real vehicles, or in the case of BEVs and PHEVs a "placeholder." [8] [10] In December 2011, the revised EER for PHEVs when using off-board electricity and BEVs was adjusted to 3.4 instead of the prior 3.0. [3] CARB based the 3.4 EER on United States Environmental Protection Agency's data comparing the Chevy Volt (in electric mode) to the Chevy Cruz, and the Nissan Leaf to the Nissan Versa. [5]

Table 2. CARB Revised Electricity Provisions

CARB's revised LCFS Provisions on Generation of LCFS Credits from Electricity			
Location of BEV and PHEV Charging	**Primary Credit Generator (Opt-in)**	**Back-Up Credit Generator (Opt-in)**	**CARB requirements on the Credit Generator (Regulated Party)**
Single and Multi-unit Residential	Electric Distribution Utility (EDU)		1. Use all credit proceeds as direct benefits for current EV customers 2. Educate the public on the benefits of EV transportation (including comparative environmental benefits and costs of charging) 3. Provide rate options that encourage off-peak charging and minimize adverse impacts to the electrical grid 4. Estimation of the kWh for EV charging (prior to 2015) 5. Provide annual compliance report
Public Access	Charging station installer and maintenance provider (can be EDU or non-utility 3rd party)	EDU	1. Use all credit proceeds as direct benefits for current EV customers 2. Educate the public on the benefits of EV transportation (including comparative environmental benefits and costs of EV charging) 3. Provide rate options that encourage off-peak charging and minimize adverse impacts to the electrical grid 4. Measurement of the kWh for EV charging 5. Contract with the property owner or lessee where the charging is located to maintain the station during the 3 month reporting period 6. Provide annual compliance report
Workplace (employee)	Workplace owner	EDU	1. Educate employees on the benefits of EV transportation (including environmental benefits and costs of EV charging as compared to gasoline) 2. Measurement of the kWh for EV charging 3. provide annual report
Fleet	Fleet owner (or for fleets of 2 or fewer, the EDU)	EDU	1. Measurement of the kWh for EV charging 2. Provide annual report

3 2011 Debates on Electricity Regulated Party

In the 2009-2011 debates prior to the December 2011 revisions, CARB staff believed that clarity was needed in the original April 2009 LCFS designations of opt-in regulated party for generating electricity LCFS credits, as different parties were interpreting the LCFS language differently. For example, CARB staff explains, "While staff [in 2009] intended non-utility electric vehicle service providers [charging station operators or EVSPs] to receive [LCFS] credits only for fuel delivered through public charging equipment, the regulation [as written in 2009] can be interpreted to include residential charging [LCFS] credits to non-utility electric vehicle service providers (EVSPs)." [5] Part of the problem was due to the regulation construct in the original 2009 LCFS, where EVSPs with a subscription model received the electricity LCFS credits and if they did not want the credit, then the credit went to load serving entities (a term that includes utilities and others). [5][8][12] This LCFS construct did not meet staff's intent and did not account for the many charging stations that were not part of a subscription service (e.g. those being sold to residences and fleets through major retailers). [5]

After the 2009 adoption of the LCFS, the CPUC, which regulates the investor-owned utilities (IOUs) covering about 75% of California's electricity market, in 2010 and 2011 made rulings on the role of IOUs and non-utility EVSPs in the residential and commercial charging station market. The CPUC determined that non-utility EVSPs are not public utilities, but are subject to

specific CPUC jurisdiction and regulations. [13] This detailed CPUC proceeding also informed CARB's thinking in 2011 as it developed a revised designation for electricity opt-in regulated party. [5]

As part of the process of revising the definition of opt-in regulated party for electricity, CARB staff developed the following set of goals:

- Maintain relevancy as the EV charging market continues to evolve
- Incentivize electric transportation
- Limit the number of regulated parties to increase the possibility that credits will be captured and made available
- Include back-up regulated parties in the proposed regulation language to maximize the number of credits captured and made available (maximize the number of credits available for use in LCFS)
- Keep the proposed language simple to avoid confusion/eliminate ambiguity in the regulated party definition
- Ensure fair treatment of regulated parties
- Clearly award potential credits for residential and public-access charging
- Incorporate vehicle charging applications that were not foreseen when the regulation was adopted [5]

The above goals are much more detailed than the staff considerations for the 2009 version of LCFS which focused mainly on the need to incent development of charging stations. The above goals also explain why CARB substantially revised the LCFS and why they made EDUs the generator of LCFS credits in the residential segment and the back-up credit generator in the other segments. [5][8] These goals also explain why both utilities and charging station operators must provide the value of the LCFS credits back to the PEV customer, and also why the LCFS credit goes directly to the customer in the case of charging in workplaces and fleets.

To ensure these goals were satisfied and to encourage PEV market development CARB also put additional requirements on EDUs and charging station operators to educate the PEV owners on the benefits and costs of PEVs and to offer rate options to encourage off-peak charging. However, CARB does not allow the value of the LCFS credit proceeds to be used to pay for the education and outreach requirements on EDUs because of the risk of LCFS credit proceeds replacing funds allocated by the CPUC or municipal utility governing boards. [3] [5]

The utilities argued for the last several years that they should receive the LCFS credit in all the charging station market segments because EDUs:

- Are regulated entities and can ensure credit benefits are returned to PEV customers
- Have a 20-year history of helping transform the market and supporting PEV research and development
- Conduct extensive customer education and outreach which provides additional benefits to PEV market and PEV customers
- Are able to aggregate credits en mass to reduce the administrative burden to CARB staff
- Can achieve the provisions/requirements laid out by CARB (e.g. a few, stable regulated parties)
- Can prevent credits from going unclaimed in all market segments
- Have and will continue to serve as the trusted, neutral energy advisor to existing and potential PEV customers
- Help CARB achieve LCFS's simplicity and purpose as a "fuels" regulation
- Help CARB enact downward pressure on rates by sending time-of-use electricity price signals to customers [14] [15]

However, CARB preferred to have fleet and workplace owners opt-in as the primary LCFS credit generator (instead of utilities or third party charging station operators) because they are the consumer in these segments and should get the incentive directly and bear the responsibility of reporting and monetizing the LCFS credits. [5]

In the residential segment CARB believed this model of giving the LCFS credit generator role to the customer would not work because there were potentially too many individuals / entities that would have to opt-in as the primary credit generator and that these individuals would not be equipped to do this for the long-term. [5] In addition, CARB believed that the residential segment was increasingly handled by large retail stores supplying both Level 1 and 2 charging equipment (as opposed to third party charging station operators) who would not be operating the residential charging stations and not able to measure the kWh as required. [7] CARB also noted that many utilities have been preparing for PEV market growth by increasing education and outreach, developing PEV electricity rates, installing second meters, evaluating system impacts and upgrading distribution systems. Thus CARB believed that utilities (EDUs) would be best positioned in the residential segment in the long term to measure the kWh and meet the policy goals and other requirements. [5]

For the past several years, the charging station manufacturers and operators argued that they should receive the LCFS credits in all the charging market segments including the residential segment in order to help their business case. [16] While this argument was persuasive in 2009, it was not as persuasive in 2011. CARB believed workplaces and fleets could generate the credits directly, and that the residential market was partially served by large retail stores and electricians who did not have an on-going relationship with the PEV owner. In addition, CARB preferred to incentivize the PEV market by requiring that the LCFS credit proceeds be provided back to the current PEV owners for the residential and public-access charging market segments. [5]

For the public-access charging segment, CARB placed additional conditions including the requirement that the regulated party must maintain the charging station during the three month LCFS credit reporting period and other requirements in Table 2. [3] [5] Utilities may enter the charging station business can opt-in and become the LCFS credit generator in this segment, in part because of the interest of municipal utilities to serve this segment. [5] Or, if the CPUC approves IOUs to enter the charging station business, then IOUs can opt-in to become the LCFS credit generator in the public-access segment. (San Diego Gas & Electric has proposed to the CPUC to do this in a limited manner for underserved areas.) [17] However, the other IOUs in California do not have plans to enter into this market, and the CPUC in 2010 and 2011 rulings [13] [17] found all EV charging station markets should be competitive and served by customers directly or by non-utility EV service providers who are customers of the IOUs. Thus it is unlikely that IOUs will be charging station operators / maintainers for the 75% of the California end-users served by IOUs (with the possible limited exception of the SDG&E proposal). As a result of this complex market, CARB allows in both municipal utility and IOUs (if approved by utility regulators) and third party non-utility charging station developers / maintainers serving the public access charging station market to be the LCFS credit generators.

4 Other 2011 Debates

While the light duty PEV market develops and matures another segment of the LCFS market is on the horizon: electric buses, trains, and non-road equipment at ports, warehouses and similar locations. The LCFS adopted in 2009 very broadly defined transportation fuels to “mean any fuel used or intended for use as a motor vehicle fuel or for transportation purposes in a non-vehicular source”. Based on a plain reading of this definition, the above applications would be included.[12] However, CARB correctly pointed out that it will need to make many regulatory changes in order to allow electric non-road equipment, electric trains / buses. For example, CARB staff believes these types of electric transportation need to have their own EER number, and there are potentially issues of electrics replacing electrics or electric replacing propane or natural gas which require regulatory changes.[7] Because these markets can potentially provide millions of m-tons of CO2e (see section 5), the CARB Board in Resolution 11-39 directed

staff to work with stakeholders to investigate the feasibility of developing future regulatory changes to "issue LCFS credits for non-road electricity-based transportation sources including public mass transit." [4] However, CARB has not yet clearly defined "on-road" and "non-road." [3]

5 Findings

5.1 High-level findings:

1. The federal District Court ruling has created uncertainty for the LCFS in California and other states. However, California has much experience with lawsuits on its air pollution and climate change regulations. Yet even if the courts rule against the LCFS, California's LCFS will still influence other LCFS efforts at the US national level as well as in Europe and Canada. The California's LCFS is very detailed and sophisticated, and other government entities can build on California's effort.
2. One advantage of the California LCFS is that it is a fuel-neutral standard unlike the national Renewable Fuels Standard which only includes biofuels. However, by including all the fuels, the LCFS becomes very complex.
3. LCFS is considered by CARB to be a complementary measure, meaning that it exists in addition to "base" programs such as cap-and-trade program or command-and-control regulations. Thus, oil companies must comply with both LCFS and cap-and-trade requirements, just as utilities must meet a requirement for 33% renewable electricity and cap-and-trade requirements. LCFS is designed to encourage the development in the market place of low carbon fuels and discourage the import of high carbon fuels, such as gasoline from tar sands, which could negatively impact the benefits from vehicle fuel economy (CO_2e gram per mile) standards in absence of an LCFS.
4. LCFS credits do not track with the PHEV or BEV, but rather with the location of charging. For example, if the charging occurs at work, the owner of the PHEV or BEV does not see a direct cash incentive, as the LCFS credit goes to the workplace owner. On the other hand, if the charging occurs at a residence or at a public-access station, then the LCFS credit generator is required by CARB to pass the credit proceeds back to PHEV or BEV owner. This provision is different and more detailed than most other low-carbon LCFS fuels where the fuel provider is the opt-in regulated party (credit generator). CARB, however, does not allow the automakers to receive the LCFS credits for any of the low-carbon fuels, or to track the kWh because CARB has promulgated other regulations on automakers and because LCFS focuses on fuel production, distribution and/or stations.
5. By changing the designation of opt-in regulated party for electricity from one based on the subscription service business model, to one based on seven goals and four charging market segments, CARB has 1) eliminated much of the prior confusion, 2) increased the involvement of utilities, 3) added fleet and workplaces owners as opt-in regulated parties, and 4) decreased the role of non-utility charging station operators. The increased role of utilities (see section 3 for CARB's justification) is more in line with the Governor's office white paper on LCFS from 2007 [6] and the approach taken in the British Columbia LCFS.
6. Involving the utilities in LCFS should help as other jurisdictions adopt LCFS programs of their own modeled on the California approach. Utilities, environmental groups, other providers of alternative fuels all supported the LCFS in 2009 and the December 2011 changes. [18] Because of this broad support, a California-style LCFS has a chance to be adopted in other jurisdictions. Conversely, creating an LCFS in other jurisdictions that is different from the California approach could jeopardize the creation of a similar broad coalition in these jurisdictions.
7. Number of kWh is probably the most important factor in the LCFS credit formula and is influenced primarily by electric miles

driven per year and model chacteristics (mass and aerodynamics) of the PEV (which impacts a PEV's fuel economy in miles per kWh). The size of the credit for different sizes of vehicle is shown below in section 5.4.

8. The EER factor in the LCFS formula also substantially affects the total LCFS credit for electricity. Using the marginal electricity default carbon intensity value of 104.7 grams CO_2e per MJ, CARB's recent change in EER to 3.4 from 3.0 reduces the effective carbon intensity of electricity by 11 percent to 30.8 grams CO_2e per MJ from the prior 34.9 grams CO_2e per MJ.
9. Because most of the charging in the short-term will be at residences, utilities will be the primary regulated party of electric LCFS credits in the vast majority of PEV charging under the revised California LCFS assuming that utilities opt-in to generate these credits. However, as fleets and workplaces enter the charging market in the mid to long-term, the residential charging market segment will decline to roughly 80 – 85% of the total, workplace charging could capture 10%, fleet charging could capture a few percent and public-access charging could capture the rest.
10. Out of the 49 EDUs in California, only a few have opted-in in 2011 as the regulated party (credit generator), but it is likely the current court injunction is a factor, particularly for the many small municipal utilities and rural electric co-ops.
11. The impacts on utilities will be small in the short term because the number of PEVs is expected to be low due to the slow ramp-up of any new automotive technology in an industry with slow turnover of the car and truck fleet.
12. The long term benefit to utilities is potentially quite large (see section 5.4), especially as the utility is the entity that is delivering these new benefits to their customers. However, utilities are required by CARB to play a new role to meet the many requirements placed on them in order to generate LCFS credits (see Table 2), and will require resolving various issues (see section 5.2 and 5.3).
13. LCFS credits are unique because they are an outside optional source of funds for utilities and other parties (with many conditions) that are paid for by oil companies purchasing LCFS credits.
14. Owners of PEVs will not experience LCFS credits as a monetary incentive for all their kWh consumed, but just for their residential, fleet and public-access charging. Because workplace owners are not required to do so, they are not likely to provide the LCFS credit proceeds to directly to PEV owners as an incentive. CARB's intent was for LCFS credit proceeds from workplace charging to help the owners of the workplaces improve the economics of installing workplace PEV charging for employees.

5.2 Implementation issues

There are several implementation issues which have not yet been resolved.

15. Utilities must propose and regulators of the municipal and investor-owned utilities must approve a credit proceeds distribution means (e.g., on-bill annual credit, monthly rate reduction, etc.). In the administrative costs to quantify and monetize the LCFS credit must be understood and recovered.
16. There is some confusion in the 2011 revisions regarding which entity should be the opt-in regulated party generating the LCFS credits for scenarios where a single charging station is shared by several customer segments (e.g. residences and workplaces, or public-access and workplace, etc.).
17. In cases where the EDU can opt-in as the alternate (back-up) regulated party (because the primary regulated party cannot or will not generate LCFS credits), there are implementation details to be determined by CARB and the EDUs (e.g. identifying situations, securing CARB approval, etc.).
18. As the PEV market grows over the next several decades there may be hundreds of

thousands of fleets and workplaces offering PEV charging and are thus able to generate credits as regulated parties. It is unclear if CARB is willing to regulate such a large number of LCFS credit generators in the long term. Thus, utilities may be asked by CARB in the future to play a larger role in these segments.

5.3 Measurement issues, submeters and road taxes

19. Separate kWh measurement for PEV charging in residences may not be the long-term solution for LCFS even though CARB requires direct kWh measurement of the PEVs in single and multifamily residences starting in 2015 (currently estimation is allowed up to 2015). At the December 2011 Board hearing, CARB Board member, Dan Sperling, asked CARB staff to consider estimation of kWh as a long-term solution (i.e., past 2015) because of his concern that many PHEV owners and some BEV owners will continue to prefer to use 120 V, level 1 charging and not utilize a separate PEV electricity rate. [18]
20. While CARB has an interest in direct kWh measurement, using direct kWh consumption from some customers (or other industry information) may be sufficient as a proxy to estimating PEV kWh. As more data becomes available, estimation methods (that CARB can approve) will improve. Requiring all residential PEV charging to be separately measured will prove difficult as there always will be those who do not want such requirements, and the CPUC places a high value on offering electric rate choices to consumers.
21. Direct measurement of kWh from PEV charging in a residence by utilities today uses a separate meter in parallel. In the future this will likely be done with emerging submeter technology that uses subtractive billing from the main utility meter. A submeter protocol is being developed as part of recent CPUC requirements, but the timing for implementation is unclear pending further examination of costs, options, standards and regulatory issues. [17] [11]
22. While it might seem efficient to use a separate meter or submeter to create electricity bills, LCFS credits and government taxes (roads, bridges, police, fire, etc.), as noted above customers can and likely will choose other options. Also Level 1 charging enables the PEV owner at home to by-pass the submeter and charge using the home's residential electricity rate. Unless customers are required to directly meter PEVs (which is unlikely per finding 19), multiple optional rates for home PEV charging appear the more likely option. Thus, the calculation of government taxes from PEVs, when this is eventually required, will likely need to come from a different source such as an annual registration fee to ensure comprehensive collection. (Note some cities already collect a utility user's tax from electricity, including from PEVs, that pays for local government services.)

5.4 Value of LCFS Credits

23. CARB will consider adding other types of electric transportation to the LCFS with a future rule revision and this, if passed, would greatly expand the total m-tons of CO_2e created from electricity fuel. [4] According to a 2007 study TIAX completed the California Energy Commission, the statewide CO_2e benefits of light duty PHEVs could be a reduction of up to 4.5 million metric tons CO_2e by 2022 for light duty PEVs and up to 4.1 million tons CO_2e from electric forklifts, ship-to-shore electrification, truck stop electrification and electric truck refrigeration units). [19] More study is needed to refine this number for each utility area, expand the analysis to 2030 and add other technologies such as electric light rail, electric freight rail, and other types of small and large non-road electric equipment. Including these technologies in the program could allow the CO_2e reductions from these other types of

electric transportation to surpass the reductions from light duty PEVs.

24. The value of LCFS credits is hard to predict as the market has barely started. CARB staff estimates the range at $15 to $50 per m-ton of CO2e, while the others estimate as high as $100 to $200 per m-ton. [5]
25. The statewide benefits of monetizing the LCFS credit proceeds of the above 8 million m- tons per year of CO_2e (from PEVs and other electric transportation) is $200 million to $800 million per year in 2022 (based on LCFS credit prices of $25 to $100 per ton). The net present value, assuming $50 per m-ton value for LCFS credits, is about $1 billion statewide.
26. A BEV with low fuel economy such as an electric van (2 kWh/mile) will use 75,000 kWh over 150,000 mile vehicle life and reduce almost 60 m-tons of CO_2e. A BEV with high fuel economy such as an electric sports car (4 kWh/mile) will use 37,500 kWh and reduce almost 30 m-tons of CO_2e over a 150,000 mile life. As described in finding 7, the higher the kWh, the more CO_2e is reduced. In these comparisons, the LCFS credit formula, in effect, compares an electric van with a gasoline vehicle of similar efficiency, and an electric sports car with a gasoline sports car of similar efficiency, and does this via the unitless EER factor. Because a gasoline van emits higher lifetime levels of CO_2e than a gasoline sports car, the potential reductions from switching to electric is much higher from the gasoline van. Key assumptions used in findings 25 - 28 include the carbon intensity electricity decreases from 104.7 to 81 grams CO_2e per MJ by 2020, EER remains at 3.4, no charging at workplaces, and the gasoline carbon intensity decreases per Table 1.
27. The lifetime (150,000 mile) LCFS credit value for the two BEVs above assuming $25 and $100 per m-ton of CO_2e is about $1500 to $6000 for the electric van and about $750 to $3000 for the electric sports car. Electric SUVs and sedans have lifetime CO_2e reductions of about 50 and 40 m-tons, respectively, and lifetime LCFS credit values between $1000 and $4000. These values are substantial and show the potential value of the LCFS to commercialization of BEVs because the credit proceeds are required by CARB to be returned to the PEV owner when charging occurs at the residence, fleet or public-access locations.
28. A PHEV does not get LCFS credit for its gasoline miles. As there are many types of PHEVs, some can have 33% of their lifetime miles electric, while others may only have 80% of the lifetime miles. For example, a PHEV sedan with 40 mile per charge range would receive lifetime LCFS credits worth about $700 to $3200 at the prices above. A PHEV sedan with 15 mile range (or equivalent) would receive lifetime LCFS credits worth about $350 to $2000 at the prices above (assumes both 2 and 4 miles per kWh).
29. Price of LCFS credits is not the only variable for PHEVs. Total amount of charging is important for PHEVs because the more miles electric, the more kWh is measured, resulting in a larger LCFS credit. For example, a PHEV 40 might travel as much as 95% or as little as 50% of its miles electric. Similarly, for either PHEVs or BEVs, the annual miles and annual kWh are key factors determining annual LCFS credit proceeds returned to the consumer.
30. Residential consumers cannot go directly to CARB to receive LCFS credit proceeds, but must go through their local utility. As such there will be pressure on utilities to opt-in to generating LCFS credits. Conversely it is important that residential consumers are aware of this benefit and notify their utility that they have a PEV so they can receive the LCFS credit proceeds individually.
31. As tax breaks and grants for PEVs disappear, LCFS credits take on more importance to the consumer (assuming CARB wins the lawsuit or that LCFS becomes a national program or is adopted in other countries). LCFS is potentially long-term because it as part of a fuel-neutral environmental regulation addressing the need to diversify to low-carbon fuels and provides a funding source to

monetize an environmental benefit (CO_2e reductions). A national fuel-neutral LCFS could replace today's biofuels mandate (renewable fuels standard) that expires in 2022.

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