CALIFORNIA POLICY BRIEFING MEMO

COMPLEMENTARY INTERACTION OF CALIFORNIA'S LOW CARBON FUEL STANDARD (LCFS) AND CAP-AND-TRADE (C&T) REGULATIONS ON MOTOR VEHICLE FUEL COSTS AND DEPLOYMENT OF ALTERNATIVE FUELS

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Executive Summary

Over the past 7 years, since the passage of AB 32, California has designed and implemented two landmark fuels policies which work to reduce carbon pollution from the state's transportation system: a cap-and-trade regulation (C&T) and a Low Carbon Fuel Standard (LCFS). These regulations work alongside a suite of complementary policies that reduce overall fuel use and diversify the fuel mix with lower carbon alternatives.

Compliance responses associated with C&T and the LCFS often times overlap, yielding opportunities that cut emissions, modernize the state's fuel mix, and reduce overall implementation costs. Overlapping solutions exist in both the lifecycle of fossil fuel production as well as in alternative fuels like biofuels, natural gas, electricity, and hydrogen. These solutions can reduce lifecycle fuel carbon emissions upwards of 80 – 90% in some cases, and also push the state towards achieving the overall pollution limit enshrined in AB32.

While carbon controls in C&T and the LCFS may have an incremental effect on consumer fuel prices, the net effect of these policies on gasoline and diesel prices, when combined with complementary measures, is likely negligible. As evaluated, the factors contributing to lower pricing effects include:

- Significant overlapping compliance responses to the C&T and LCFS
- Market mediated responses associated with consumer reductions in fossil fuel use
- Market mediated responses associated with increased deployment of alternative fuels
- Complimentary policies in California decreasing overall fuel demand
- Existing price control included in the C&T and LCFS
- Decreased costs of many alternative fuels compared to gasoline and diesel

Working in tandem, the C&T and LCFS are projected to result in minimal overall pricing effects, while dramatically cutting pollution. These policies provide an important signal that benefits consumers – both at the pump and in improved environmental quality.

I. Introduction

California has made steady progress towards a more diverse mix of transportation fuels. When AB 32 was adopted in 2006, 97% of the energy used to power cars and trucks on California roadways came from liquid fossil fuels. By 2013, this number had dropped to about 93%, an alternative fuel increase equal to about 500 million gallons of gas and diesel.[i]

According to the verified statewide inventory, climate pollution from on-road sources equaled 172 million metric tons of carbon dioxide (MMT CO_2e) in 2006.[ii] By 2011, the pollution from on-road vehicles had decreased to 155 MMT CO_2e, and the 2013 data is expected to show even further declines.[iii] While these decreases are impressive, much greater reductions in fossil fuel emissions are needed. For on-road transportation to return to 1990 levels, the sector would need to reduce drop its carbon emissions to about 138 MMTCO_2e, a further decrease of about 17 million additional metric tons.

To further diversify the fuel mix and cut climate pollution, California is implementing two landmark fuels policies: a cap-and trade regulation (C&T) and a Low Carbon Fuel Standard (LCFS). These regulations are also being implemented alongside vehicles programs that will reduce overall fuel use through increased efficiency, grant programs that are yielding the deployment of new fuel types and business models, and federal programs to increase the share of liquid biofuels in the state's fuel mix. In tandem, California's C&T and LCFS have created a market signal for innovation that provides incentives to seek low-cost and transformational solutions within the transportation sector, making the state's economy less vulnerable to price spikes and overseas events that threaten supply.

Since both the C&T and LCFS seek out emissions reduction opportunities within the transportation sector, in some instances, compliance responses for one regulation will assist compliance in the other. Accordingly, the costs of these two regulations are not simply additive, nor need they be equal. In short, implementation of the C&T (and the compliance responses that arise from it) can make compliance with the LCFS cheaper, and vice versa.

This memo describes the California C&T and LCFS regulations as they pertain to transportation fuels, and discusses various compliance responses for each. The memo discusses how each regulation, separately as well as in tandem, may affect transportation costs for consumers.

- How the California C&T and LCFS regulations regulate transportation fuels (p.3)
- How overlapping responses for the C&T and LCFS can yield pollution reductions within both regulatory programs (p.6)
- How overlapping compliance responses can reduce overall costs (p. 10)
- How existing and proposed carbon price controls in each regulation work to moderate the effect on gasoline and diesel prices (p. 14)
- How alternative fuel prices compare to gasoline and diesel prices (p. 15)

II. Treatment of Transportation Fuels under the AB 32 C&T Regulation

The C&T sets a state-wide cap on emissions, with implementation starting in 2013 for the first two-year compliance period. Starting in 2015, the program expands to include approximately 78 distributors of transportation, natural gas, and other fuels.[iv],[v] Every year, these businesses must report the amount of pollution associated with their activity and must surrender emissions permits (allowances) sufficient to cover the amount of pollution that is released. The pollution cap will decrease by 3 percent each year between 2015 and 2020, at which point the current regulation requires no further reductions. At some point in the future the C&T regulation may be modified to require reductions past 2020, but that is beyond the scope of this memo.

Pursuant to the C&T, covered entities in 2015 include deliverers of reformulated gasoline blendstock for oxygenate blending (RBOB) and distillate fuel oil (generally diesel), and suppliers of liquefied petroleum gas.[vi] According to regulation, regulated entities include both position owners - those that own fuel dispensed at fueling racks - as well as those entities that bring fuel in from outside the state. Additionally, in order for a fuel supplier to be covered under AB 32, at least 25,000 metric tons of carbon dioxide equivalent (CO_2e) must be released annually from combustion or oxidation of the fuels they sell.[vii]

Suppliers of gasoline and diesel fuel have a compliance obligation for every metric ton of CO_2e released from the combustion or oxidation of the fuel they sell. An exception is made for those volumes that are demonstrated to be used in vehicles outside the state.[viii] Suppliers of blended fuels have a compliance obligation that is aggregated and based on the metric tons of CO_2e of GHG emissions for each separate constituent of the blend. Data are taken from emission reports that have been verified or from emissions assigned based on full combustion or oxidization of fuel imported.[ix]

Entities that sell biomass-derived fuels are required, under the California mandatory reporting rule (MRR), to report and verify emissions for every metric ton of CO_2e associated with the combustion of fuel they sell. However, emissions of virtually all biomass derived fuels, such as biofuels made from cellulose, corn starch, and sugar cane (i.e. ethanol) and biofuels derived from virgin oils, animal fats, waste oils and tallow (i.e. biodiesel) do not have a compliance obligation.[x] Put another way, under C&T, combustion of biofuels is generally treated as carbon neutral and does not require sellers to acquire or surrender any emissions allowances. As discussed below in the section on the LCFS, biofuels are not necessarily carbon neutral on a lifecycle basis due to emissions associated with activities like production, transport and land use change.

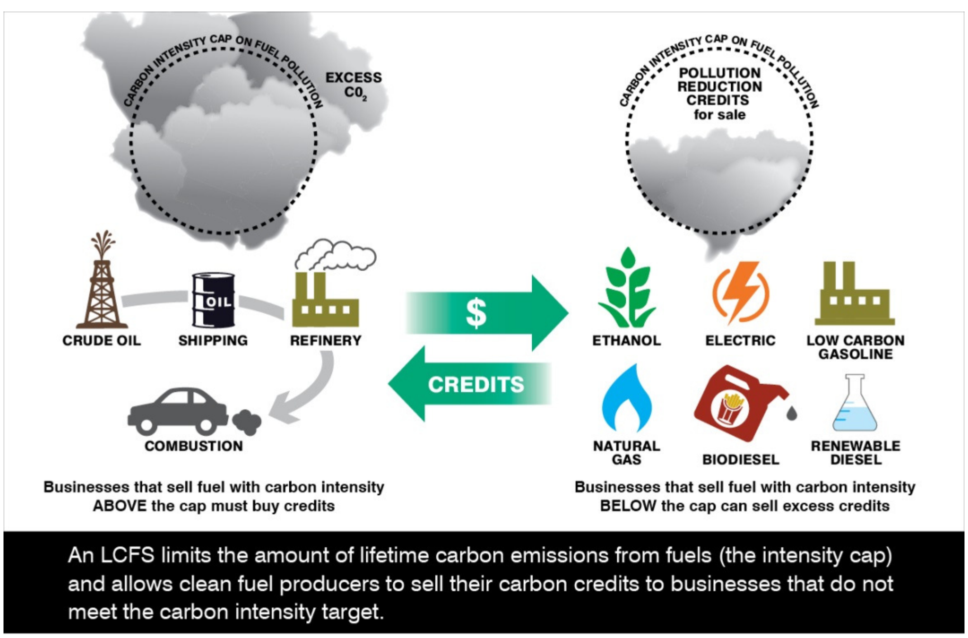
By its nature, C&T does not require emissions reductions be achieved from any one business or sector of the economy. Any regulated business may trade credits with any other regulated business or approved entity, meaning the lowest cost solutions located anywhere in the economy can be used to cut pollution and allow the state to meet the statewide cap. For this reason, C&T is considered to be a regulatory program that achieves pollution cuts in the least cost manner. For the transportation sector, this means that cap-and-trade, acting alone, does not require transformation of the state's fuel mix even though it establishes a price on carbon that low-carbon fuel providers can utilize to finance the development and deployment of their product. Furthermore, it incentivizes actions to diminish carbon emissions in the production of traditional fuel products (see Section IV).

III. Treatment of Fuels under the California LCFS

California's LCFS is a performance-based regulation requiring transportation fuel providers (fuel producers and importers to California) to reduce the average carbon intensity (CI) of the state's overall fuel mix by 10% by 2020. The regulation achieves pollution reductions by establishing a declining lifecycle CI target for gasoline and diesel sold in the state, as well as their substitute fuels. Producers who sell fuel with a CI above the declining statewide limit accrue deficits, while producers that sell fuel below the limit earn credits. At the end of each year, fuel providers must surrender enough credits to make up for their deficits, thus guaranteeing the overall CI limit is met.

The lifecycle approach used in the LCFS is based on peer-reviewed models that calculate the total amount of emissions released during all aspects of fuel production, delivery, and use. For fossil fuels, lifecycle emissions include, but are not limited to, those from activities at oil and gas wells, pipelines, processing plants and refineries, trucks used to deliver the fuel to stations, and tailpipes of vehicles that combust the fossil fuels. For biofuels, lifecycle emissions include, but are not limited to, those associated with activity at the farm, plants that make fertilizer used at the farm, processing plants and biorefineries, trucks used to deliver the fuel to stations, and the tailpipes of vehicles that combust the biofuels.[xi] Accordingly, to the extent that some of these activities take place outside of California, the LCFS incorporates and achieves reductions outside the state.

Figure 1: Description of the California LCFS



Through the LCFS mechanism, regulated parties have several options to meet the standard – they can: produce fuels that meet or beat the declining CI limit; purchase and blend fuels from other producers that meet the CI declining limit; purchase LCFS credits generated by producers that sell fuels under the CI limit; or use some combination of these strategies. This use of a mix of strategies, including trading between entities that sell fuel both under and over the declining CI limit, creates a market signal for transportation providers to develop and use the lowest cost fuels that also achieve the fastest and deepest reductions.

At present, approximately 100 different entities are registered with CARB to participate in credit trading within the LCFS. These include fuel producers and importers, as well as entities to which an LCFS compliance obligation has been transferred.

As written in the LCFS regulation at §§ 95482 and 95483, reductions of 0.25%, 0.5%, and 1% were required in 2011, 2012, and 2013, respectively. The standard then requires a 2.5% CI reduction in 2015, and increases in stringency in subsequent years (reaching 10% reduction in 2020) – allowing for a smooth transition into the regulation while new low-carbon alternative fuels are deployed to market scale. By 2020, the standard is expected to achieve approximately 17 MMT CO_2e per year from the transportation sector.

It is often said that the LCFS utilizes a market-based framework similar to a C&T program, though instead of placing a cap on overall emissions, it places a cap on the carbon emissions associated with each gallon of gasoline, diesel and their replacement fuels. The LCFS therefore creates a market signal to require emissions reductions in the transportation sector, an element that necessarily fosters innovation and transformational change. Unlike the AB 32 C&T program, however, the LCFS cannot guarantee aggregate emissions reductions from the transportation sector because the amount of overall emissions may rise if overall use rises. As a result, LCFS cannot be considered a replacement for the overall emissions cap associated with C&T because it cannot guarantee the mandated emissions limit included in AB 32 is met.

IV. Overlapping Compliance Responses of the C&T and LCFS

In general, many of the solutions being implemented to cut emissions from the transportation sector in California have dual benefits under C&T and the LCFS. For these solutions, the state records emissions reductions within each program, making the overall cost of implementing both regulations less than if they were implemented separately. Put another way, the costs of these two regulations are not simply additive, and implementation of each can be mutually reinforcing. At the same time, California consumers receive the benefit of a diversified fuel mix and decreased pollution that threatens the climate and impairs air quality.[xii]

A. Production of lower carbon gasoline and diesel within California.

Almost half of the fuel used by California drivers is produced from in-state oil deposits. With roughly 50,000 active oil wells and 18 refineries in the state, the combined carbon emissions from these facilities account for more than 10 percent of the state's emissions, or an estimated 48 million metric tons of carbon dioxide annually.[xiii]

According to the most recently available statistics, about 70% of California oil is produced using steam injection to make the oil flow more easily out of the ground and into pipelines.[xiv] Typically, this steam is made from burning coal, crude oil, or natural gas at the oil field, emitting CO_2 and other air contaminants in the process. Recently, however, lower carbon practices such as making steam from concentrated solar collectors have been developed and are being implemented in California oil fields by companies such as BrightSource and GlassPoint to get the oil out of the ground in more environmentally friendly ways. In C&T, these technologies are rewarded because they are zero carbon and displace fossil fuel emissions associated with the stationary combustion devices at oil fields. Accordingly, they reduce the overall amount of emissions in the economy and make C&T reductions more able to be met. In the LCFS, use of the innovative technologies like solar steam can reduce the lifecycle CI of gas and diesel made from the crude oil that is pumped out of the ground, meaning fossil fuel providers have fewer deficits to make up and less costs under the program.

According to a 2012 letter from GlassPoint to CARB related to the LCFS:

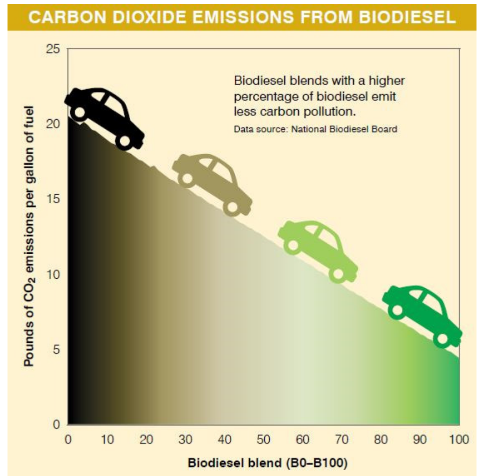
> *"Solar EOR substantially reduces or eliminates the need to burn fuel to supply the steam needed for enhanced oil recovery, and can reduce total emissions associated with oilfield steam by 15 to 50%. Solar EOR projects can deliver long-term cost savings for oil producers in California, and help maintain California's technology and economic leadership in the energy sector."*
>
> *John O'Donnell, Vice President of Business Development*
> *GlassPoint*

B. Advanced biofuels that displace gasoline and diesel

Since biofuels are made from feedstocks that took carbon out of the atmosphere during cultivation, these fuels are treated as zero carbon within the C&T program. When blended into gasoline and diesel, or used as substitutes, these biofuels reduce the overall carbon from the transport sector and help the state achieve the statewide limit. Under the LCFS, when these biofuels are produced using low carbon methods, such as when they are made in efficient processing plants or from cellulosic sources, CARB assigns a low CI score compared to gas and diesel, and producers earn LCFS credits that can be used or traded from regulatory compliance. Further, when fuels are made from materials that would otherwise have been considered waste or are produced as co-products of other processed, CARB has calculated a dramatically lower CI score, in some cases 90% below that of gasoline and diesel. Accordingly, these fuels not only reduce the carbon emissions counted under C&T, they represent a real compliance option under the LCFS.

According to a 2013 report from EDF on the California biodiesel industry, as the amount of biodiesel blended into gasoline increases, the carbon intensity and emissions associated with that fuel decreases. This has led to a large upswing in biodiesel production in California.

Figure 2. Effect of Biodiesel Blends on Fuel GHG Emissions



"California's LCFS has had a huge impact on the biodiesel industry. Biodiesel now leads the renewable fuel market, reducing CO_2 emissions and strengthening the economy."

James D. Levine, CEO,
North Star Biofuels, LLC

C. Electrification of cars and trucks

When compared to gasoline and diesel engines that use combustion to create movement (losing heat in the process), electric vehicle (EV) engines are vastly more efficient and do not emit any pollution from the tailpipe. According to CARB, this efficiency improvement is approximately 3.4 to 1 compared gasoline powered vehicles.[xv]

Accordingly, even though upstream emissions are not negligible since the production of electricity used to power vehicles releases climate pollution when generated from coal or natural gas, on balance the total amount of pollution released from EVs in California is far less than that which would have been emitted had that vehicle used liquid fossil fuels – meaning electrification yields reduced emissions under the cap. Therefore, for C&T, electrification can be an important tool in decreasing emissions and meeting the overall statewide carbon pollution cap.

Like C&T, in the LCFS, electricity used to power EV's results in significant progress toward overall compliance because the standard uses an adjustment that takes into account the efficiency improvement of electric engines over internal combustion engines. Through this adjustment, use of electricity as a fuel is upwards of 70 – 80% less carbon intensive than gasoline or diesel. Furthermore, when made from renewable energy, electricity may receive an even greater carbon benefit compared to gasoline and diesel going forward. Accordingly, the rapid deployment of EVs, whether or not that electricity is made from fossil fuels or renewable resources, yields significant progress towards meeting the mandated LCFS reductions, improves the public health and creates significant jobs in California while also serving to cut carbon pollution that is required under C&T.

According to a September 2012 UC Berkeley report[xvi]

> *"Light-duty vehicle electrification can be a potent catalyst for economic growth, contributing up to 100,000 additional jobs by 2030. … Unlike the fossil fuel supply chain, the majority of new demand financed by PEV fuel cost savings goes to in-state services, a source of diverse, bedrock jobs that are less likely to be outsourced."*
>
> *David Roland Holst, PhD*
> *UC Berkeley, Department of Agricultural and Resource Economics*

According to a November 2012 analysis by TIAX LLC for the California Electric Transportation Coalition (CALETC):[xvii]

> *Assuming 75% of plug-in electric vehicle miles are in electric mode, "Light duty PEV on-road electrification yields almost 1.5 million credits in 2020."*
>
> *TIAX LLC*

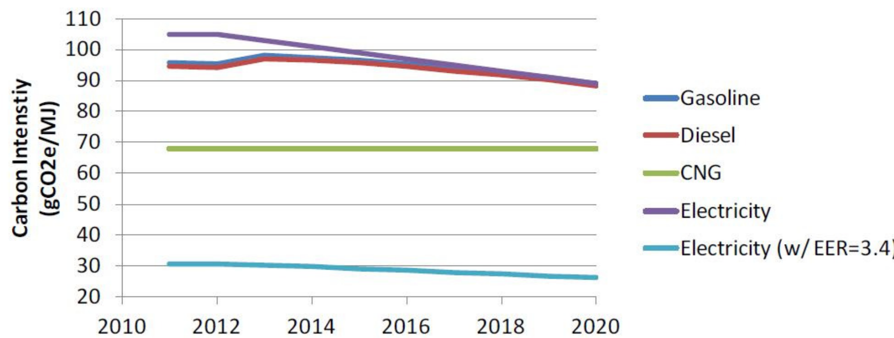


Figure 3. Lifecycle GHGs from Fuels (source TIAX)

D. Use of hydrogen in cars and trucks

Similar to use of electricity, hydrogen powered vehicle engines are more efficient and do not emit climate pollution from the tailpipe. According to CARB, this efficiency improvement is approximately 2.3 to 1 compared gasoline powered vehicles, and 1.9 to 1 compared diesel powered vehicles[xviii]

Accordingly, even though upstream emissions are not negligible since the production of hydrogen used to power vehicles releases climate pollution when generated from fossil fuel sources or natural gas, on balance the total amount of pollution released from hydrogen vehicles is far less than that which would have been emitted had that vehicle used gasoline or diesel – meaning deployment of hydrogen vehicles yields reduced emissions under the cap. Therefore, for C&T, hydrogen vehicles can be an important tool in decreasing emissions and meeting the overall statewide carbon pollution cap.

Like C&T, in the LCFS, hydrogen used to power vehicles results in significant progress toward overall compliance because the standard uses an adjustment that takes into account the efficiency improvement of hydrogen engines over gasoline engines. Through this adjustment, under the 2010 LCFS, use of hydrogen produced using North American natural gas is 35 - 41% less carbon intensive than gasoline and 21 - 28% less carbon intensive than diesel.[xix] When produced using renewable energy, hydrogen may receive an even greater carbon benefit compared to gasoline and diesel going forward. Accordingly, like EVs, the rapid deployment of hydrogen vehicles, whether or not that hydrogen is made from fossil fuels or renewable resources, yields significant progress towards meeting the mandated LCFS reductions, improves the public health and creates significant jobs in California while also serving to cut carbon pollution that is required under C&T.

According to DriveClean.ca.gov, a buying guide for hydrogen vehicles,[xx]

> *"When operating directly with hydrogen, there are no polluting emissions and no greenhouse gases from a fuel cell – only water and heat. If the hydrogen is generated by reforming fossil fuels, some greenhouse gases are released, but much less than the amount produced by conventional vehicles. In addition to these benefits, fuel cells could dramatically reduce urban air pollution, decrease oil imports, reduce the trade deficit and produce American jobs."*
>
> *DriveClean.ca.gov*

Furthermore, according to the California Fuel Cell Partnership in a September 2012 report, "Well to Wheels, A guide to understanding energy efficiency and greenhouse gas emissions", the emissions of hydrogen powered vehicles may be even lower than as reported by CARB:

> *"The well-to-wheels reports show that hydrogen made from natural gas and used in a fuel cell vehicle reduces greenhouse gases (GHGs) by 55%-65% compared to gasoline used in a conventional vehicle, and by about 40% compared to gasoline in a hybrid engine. When using hydrogen made from clean energy sources, greenhouse gases are zero."*
>
> *California Fuel Cell Partnership*

E. Use of natural gas and biogas in cars and trucks

Although a fossil fuel in its own right, natural gas (or more accurately, compressed natural gas, or CNG) can be a much cleaner transportation fuel than conventional gasoline or diesel. Using CNG in cars and trucks can yield lower overall greenhouse gas pollution[xxi] along with significant cuts in air contaminants like fine particulate, VOCs, NOx and SOx. Under C&T, providers of natural gas must account for and surrender emission allowances sufficient to cover the carbon pollution released form the tailpipe when the natural gas they sell is combusted in vehicles.

On balance, since emissions from natural gas used in cars and trucks are less than emissions from an equivalent amount of gasoline and diesel, the use of natural gas for transportation can help lower overall emissions in the state and help meet the statewide emissions targets.

Furthermore, biogas made from biological resources like decomposing organic matter in landfills and water treatments plants, has no compliance obligation in C&T – yielding even lower overall emissions in the state. In the LCFS, the CI of natural gas is typically 10 - 35% below that of liquid fossil fuels, and biogas is upwards of 80% below - meaning it is a viable pathway for regulatory compliance there as well.

According to a January 2014 peer-reviewed report titled "Pathways to Near-Zero-Emission Natural Gas Heavy Duty Vehicles" by Gladstein, Neandross & Associates (GNA) produced on behalf of the Southern California Gas Company:[xxii]

> *"The use of heavy-duty engines powered by natural gas offers a unique, viable and complementary "pathway" to help meet California's aggressive reduction goals for NOx and GHG emissions. It also supports a variety of other state and national goals, such as reducing the public's exposure to toxic diesel exhaust and reducing the nation's dependence on foreign energy sources. Natural gas-fueled trucks, buses, and off-road equipment can serve as a key element of California's smog reduction and climate mending programs, while dramatically decreasing the mass of cancer-causing chemicals in our air."*
>
> *Gladstein, Neandross & Associates*

V. Pricing effects of the C&T and LCFS and how overlapping compliance responses can reduce overall costs

Both the C&T and LCFS seek out emissions reduction opportunities within the transportation sector though carbon pricing. In some instances, compliance responses for one regulation will assist compliance in the other. Accordingly, the costs of these two regulations are not simply additive. In short, implementation of the C&T (and the compliance responses that arise from it) can make compliance with the LCFS cheaper, and vice versa.

What follows are explanations of the pricing mechanisms and estimated effects for each regulation followed by an explanation of the reductions associated with simultaneous implementation as currently planned.

A. Mechanism of Pricing Effect in the C&T and LCFS

Although both establish a carbon price for fuels, California's C&T and LCFS rely on different mechanisms established through the respective programs. These mechanisms affect the carbon price associated with each regulation, and therefore the overall prices seen by consumers.

In the C&T program, *all* carbon in covered sectors is subject to a carbon price – with combustion of fuel used in the transportation sector starting from 2015. Since the allowance (credit) price accrues to *every* ton of covered carbon emitted throughout the system, the fundamental driver of the C&T allowance price, and thus the price per gallon impact of the regulation, is the cost of reducing the last (i.e., most expensive) ton of carbon emissions in *all* covered sectors in order to meet the cap. As discussed above, this means that low cost reductions occurring anywhere in the California economy can be used to satisfy compliance obligations.

In contrast, the LCFS imposes a carbon price only on fuel emissions *exceeding* the annual standard, and uses the same carbon price to establish a market signal to develop and deploy fuels that result in emissions *below* the standard. The fundamental driver of LCFS credit prices, and thus the price per gallon impact of the regulation, is therefore difference between the cost of the last (marginal, or most expensive) unit of fuel used to meet the standard and the cost of the conventional fuel.[xxiii] The marginal fuel could be any one of a number of low carbon options such as ethanol, biodiesel, natural gas, electricity, or any other fuel, and depends on the relative price differences across fuels, capacity constraints to deploy certain fuel technologies, and differences in consumer preferences for alternative fuels and alternative fuel vehicles. Based on this construct, the LCFS credit price puts a value on carbon that "bridges" the fuel cost difference by adding to the cost of the conventional fuel while lowering that of the low-CI fuels.

Despite the fact that the carbon price is higher under LCFS than C&T, the added fuel costs to gasoline are smaller under the LCFS than under C&T. This is because, in part, the LCFS carbon price applies only to emissions *exceeding* the standard, while the C&T carbon price applies to *all* fossil energy emissions.[xxiv] In addition, when the carbon price increases under the LCFS, the cost to fossil fuel producers also increases but the incentive for renewable fuel producers increases as well – causing an increase in alternative fuels which counteracts some of the production cost price increases experienced by fossil fuel producers.[xxv] Furthermore, as the LCFS standard becomes more stringent over time, the effects of the LCFS on fuel prices and alternative fuel market signals will likely become more significant. That noted, the pricing impacts under both C&T or LCFS are markedly smaller than the variation in fuel prices at the pump over the course of a typical year.

B. Overlapping and Market Mediated Effects of the C&T and LCFS and Conventional Fuel Pricing Effects

Under C&T, beginning in 2015, for every gallon of conventional fossil fuel produced or imported, refiners will be required to purchase permits to cover the emissions associated with the fuel. Since transportation fuels are included in an economy wide program, the pricing impact on fuel is correlated to the state-wide abatement cost of greenhouse gases in all sectors covered.

Under the LCFS, the difference between the CI of conventional fuels (gasoline and diesel) and the declining CI target will affect the pricing impacts on that fuel; because the regulation requires increased CI reductions, the CI gap between the average conventional fuel and the regulation increases, resulting in an increasing pricing impact.

To the extent that reductions achieved by the LCFS take place in California through some of the overlapping compliance responses identified in Section IV above, the success of the LCFS would affect C&T allowance prices by depressing the demand for allowances under the cap. Similarly, if the LCFS falls short or achieves only out-of-state reductions, the effect on C&T may be to increase overall allowance prices.

With respect to market mediated responses of the C&T and LCFS on gasoline and diesel demand, there is a significant literature that demonstrates how even modest price changes can lead to significant consumer responses in the long run. Assuming a long-term consumer demand response (elasticity) of -0.75, an amount agreed to by many academic experts, an allowance price of $15 / ton can achieve 4.5 million tons of reductions (a reduced consumption of approximately 507 million gallons of gasoline assuming 0.00886 MTCO2e / gallon).[xxvi] According to Knittle (2013), at a demand elasticity of -0.75, the response from a $30/ton carbon price would result in 9 million tons of $CO2_e$, or approximately 1 billion gallons of gasoline (about 6.5 % of today's overall gasoline consumption).

Furthermore, since California is also pursuing measures whose implementation will make consumer decisions like purchasing fuel efficient vehicles, carpooling, and mode shifting easier over time, demand elasticity in California is likely to increase. Accordingly, efforts like SB375, Zero Emission Vehicle standards, Vehicle GHG standards and national fuel economy standards work alongside C&T and LCFS to dampen the overall pricing effect by working to depress overall fuel demand, and by extension, fuel prices. According to CARB, by 2020, these combined strategies will reduce GHG emissions from light duty vehicles and fuel use by about 30% from current levels.[xxvii]

Although C&T and the LCFS may result in an incremental increase in fuel costs due to carbon reduction requirements, the reduction in demand due to the complementarity vehicle policies in place in CA, coupled with an increase in alternative fuel availability and use, may even cause a decrease in prices.

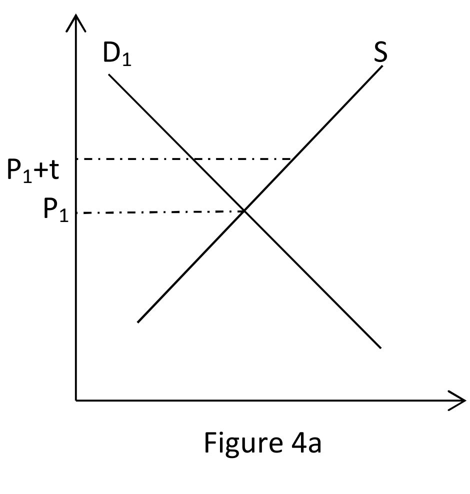


Figure 4a

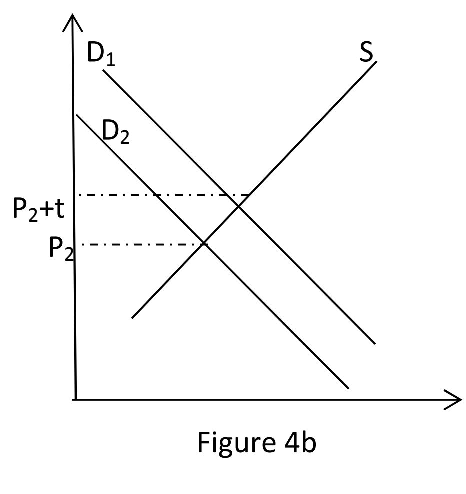


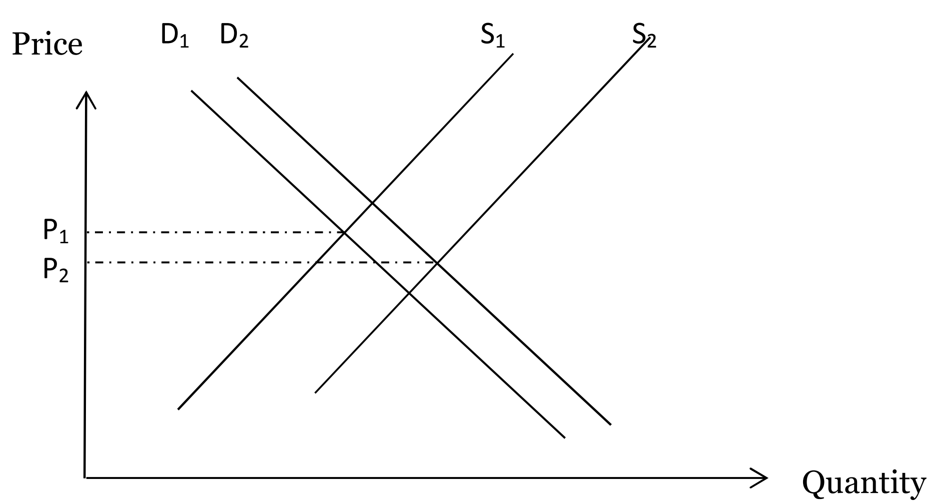
Figure 4b

Figure 4a represents the impact of C&T and the LCFS on gasoline prices, while Figure 4b demonstrates the combined impact of these policies with a subsequent shift in demand due to complementary vehicle policies. The effect of C&T and LCFS is to increase the price of carbon; this will partially be passed through to fuels, increasing the initial price P_1 by a set amount t. This price increase lowers quantity demanded; it does not directly affect the demand curve. However, complementary policies shift the demand curve in, from D_1 to D_2, as seen in Figure 4b. This inward shift in demand serves to dampen the degree to which the price of carbon is passed through to the fuel price. Indeed, if the inward shift in demand resulting from the complementary policies shift is sufficiently dramatic, the final price of gasoline could be lower than P_1.

<u>With respect to market mediated responses of the C&T and LCFS on alternative fuels</u>, because renewable fuel emissions have no emissions obligations under the cap in C&T, the program will incentivize an expansion of renewable fuels in the market relative to conventional fuels. As a result, LCFS credit prices will experience downward pressure as C&T permit prices increase and more alternative fuels are deployed. According to researchers at UC Davis, the overlapping nature of the C&T and LCFS may reduce the overall cost of implementing the LCFS by 40% when compared to the implementing the LCFS alone.[xxviii]

As both C&T and LCFS promote the expansion of alternative fuels in the market, there will be a demand response given that alternative fuels will become cheaper relative to conventional fuels. This demand response will occur several ways: through diminished vehicle miles travelled for traditional gasoline and diesel vehicles; through an increase in purchases of more fuel efficient vehicles; and through a shift in demand towards alternative fuel vehicles. As portrayed in the figure below, these responses cause a drop in demand for gasoline and diesel, which given a fixed or decreasing supply will thereby cause a resulting mediating decrease in gasoline and diesel prices in the long run. For alternative fuels, these programs will decrease their price overall and relative to gasoline and diesel, leading to an increase in demand for these products. An increasing demand leads to higher prices; however, since the supply of these fuels is expanding the resulting alternative fuel price may still be lower than without the programs.

Figure 5 – Alternative Fuel Supply and Demand Curve Shifting in Response to the LCFS and C&T



In Figure 5 above, demand for alternative fuels shifts out (from D_1 to D_2) due to a relative price decrease compared to gasoline and diesel. While this would cause a price increase in the alternative fuel pool, supply has also shifted out (from S_1 to S_2), due to the policies, leading to an overall decrease in the price of alternative fuels.

VI. How existing and proposed price controls in each regulation work to moderate the pass-through effect onto gas prices

A. Cost containment in C&T

California's C&T program explicitly includes a cost control mechanism, the Allowance Price Containment Reserve (APCR), which works to limit carbon prices in a specific range, thereby maintaining price stability. The ACPR sets aside a percentage of allowances from 2013–2020 and releases them at auction if the program carbon price exceeds three pre-set price tiers: $40, $45, and $50, increasing by 5% annually plus the rate of inflation. Once all of the allowances in the first price tier are sold, allowances will then be sold at the second tier price and so forth. In short, the APCR works to help manage carbon prices in the C&T below these price tiers.[xxix]

The C&T program also includes several implicit features that do not explicitly set carbon price limits but do work to smooth short run (i.e. one year) carbon prices. These provisions include allowance banking, multiyear compliance periods, a broad program scope, use of regular credit auctions, emissions offsets, and administrative allocation of allowances to major stationary businesses and energy generators.

B. Cost containment in the LCFS

Similar to the C&T program, the LCFS includes a number of cost control mechanisms. These mechanisms help contain costs while establishing a carbon price necessary to facilitate the development and deployment of innovative low-carbon fuels. Implicitly, the LCFS controls prices by allowing for trading among regulated entities, banking of early year over-compliance, a broad program scope that encompasses nearly 16 billion gallons of transportation fuels, and a smooth transition in early years leading to deeper reductions in later years.

At present the LCFS does not include any explicit price controls that place a ceiling on the overall cost of the program. However, CARB is evaluating whether a hard price cap is appropriate for the regulation and what level, if any, that cost control limit should be. Discussion and consideration of inclusion of explicit cost controls in the LCFS is scheduled for 2014.

VII. How alternative fuel prices compare to fossil fuel prices

Over the last decade, the emergence of a range of alternative fuels and technologies has increased consumer access to low carbon solutions. These fuels, produced from feedstocks and technologies in various stages of market development are also have a range of prices on an equivalent gasoline gallon basis. As presented by the US Department of Energy, several alternative fuels are lower cost when compared to gasoline and diesel on an equivalent gallon basis.[xxx, xxxi]

Table 6: Fuel Prices presented on $ per equivalent gallon basis

	West Coast Average Price		West Coast Average Price
Gasoline	$3.49 (February 2014)	Diesel	$4.07 (February 2014)
Ethanol (E85)	$3.27 (October 2013)	Biodiesel (B20)	$4.26 (October 2013)
CNG	$2.09 (October 2013)	Biodiesel (B99-B100)	$4.40 (October 2013)
Propane	$3.06 (October 2013)	CNG	$2.57 (October 2013)
Electricity	$1.55 (February 2014)		

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[i] Gasoline consumption data collected from the CA State Board of Equalization, available at http://www.boe.ca.gov/sptaxprog/reports/mvf_10_year_report.pdf

[ii] CARB, California Greenhouse Gas Inventory, available at http://www.arb.ca.gov/cc/inventory/data/data.htm

[iii] Although significant emissions reductions are tied to the economic downturn at the end of the last decade, the economic rebound coupled with growth in the use of alternative fuels means that not all emissions reductions are due to decreased driving and can be attributed to the growth of lower carbon fuels and more efficient vehicles.

[iv] CARB, List of registered entities in the LCFS credit market, available at http://www.arb.ca.gov/cc/capandtrade/covered_entities_list.pdf.

[v] Cap-and-trade also covers suppliers of natural gas that may be used for transportation fuel, including natural gas utilities and operators of intrastate pipelines, though the treatment of natural gas as a transportation fuel is not covered in this memo.

[vi] Proposed Regulation Order § 95811(d)-(e).

[vii] Proposed Regulation Order § 95812(c)(4).

[viii] Proposed Regulation Order § 95852(d).

[ix] Proposed Regulation Order § 95852(f).

[x] Proposed Regulation Order § 95852.1.

[xi] Within the LCFS, tailpipe emissions of biofuels are treated as zero-carbon, adding nothing to the lifecycle carbon intensity of those fuels.

[xii] Of course, emissions regulated under the C&T and LCFS do not overlap completely. Whereas C&T only covers emissions from entities in state with a provision for a limited number of offsets, the LCFS provides an incentive for reduced emissions from all aspects of the fuel lifecycle, such as those from the oil field or train used to bring the fuel to California. Accordingly, although the C&T and LCFS may incent some of the same reductions, they also incent reductions not applicable to the other

[xiii] http://www.nrdc.org/energy/california-petroleum-carbon-reduction.asp
[xiv] California Department of Conservation, Division of Oil, Gas, and Geothermal Resources, 2009 Annual Report of the State Oil & Gas Supervisor, available at ftp://ftp.consrv.ca.gov/pub/oil/annual_reports/2009/0101summary1_09.pdf.
[xv] §95495(a) Table 5, California Low Carbon Fuel Standard
[xvi] Roland-Holst, Plug-in Electric Vehicle Deployment in California: An Economic Assessment, September 2012, available at http://are.berkeley.edu/~dwrh/CERES_Web/index.html
[xvii] TIAX LLC, Presentation to: California Electric Transportation Coalition (CalETC), November 14, 2012, available at http://www.caletc.com/wp-content/uploads/2012/12/TIAX_CalETC_LCFS_Electricity_Potential_FINAL.pdf
[xviii] §95495(a) Table 5, California Low Carbon Fuel Standard
[xix] CARB, Detailed California Modified GREET Pathway for Compressed Gaseous Hydrogen from North American Natural Gas, v 2.1, February 27, 2009 available at http://www.arb.ca.gov/fuels/lcfs/022709lcfs_h2.pdf
[xx] DriveClean.ca.gov (accessed February 5, 2014)
[xxi] Due to the high global warming potential of methane, although the use of natural gas (which is about 99.9% methane) in cars and trucks lowers climate pollution compared to gasoline and diesel, those emissions reductions can be undercut by leaks in the natural gas extraction, processing, transmission and distribution infrastructure. To ensure a climate benefit, emerging research suggests that fugitive emissions of natural gas from upstream sources must be minimized to a point where leaks are no greater than 0.8% of the total amount delivered to the vehicle.
[xxii] Gladstein, Neandross & Associates, Pathways to Near-Zero-Emission Natural Gas Heavy-Duty Vehicles, January 2014, available at http://www.gladstein.org/pdfs/Pathways_to_Near-Zero_Emissions_1-24-14.pdf
[xxiii] Lade and Lin, A Report on the Economics of California's Low Carbon Fuel Standard and Cost Containment Mechanisms, October 2013, available at http://www.its.ucdavis.edu/research/publications/publication-detail/?pub_id=1996
[xxiv] Lade and Lin, A Report on the Economics of California's Low Carbon Fuel Standard and Cost Containment Mechanisms, October 2013, available at http://www.its.ucdavis.edu/research/publications/publication-detail/?pub_id=1996
[xxv] Pouliot and Babcock, Impact of Increased Ethanol Mandates on Prices at the Pump. January 2014, available at http://www.card.iastate.edu/publications/synopsis.aspx?id=1218
[xxvi] Knittle, The Importance of Pricing Transportation Fuels Within California's Cap-and-Trade Program, 2013, available at http://web.mit.edu/knittel/www/papers/CATransportationFuels.pdf
[xxvii] CARB, AB 32 Scoping Plan Update, February 2014, available at http://www.arb.ca.gov/cc/scopingplan/2013_update/draft_proposed_first_update.pdf
[xxviii] Lade and Lin, A Report on the Economics of California's Low Carbon Fuel Standard and Cost Containment Mechanisms, October 2013, available at http://www.its.ucdavis.edu/research/publications/publication-detail/?pub_id=1996 (assuming a carbon price of $100 / ton)
[xxix] California Emissions Market Assessment Committee, Price Containment in the California Cap & Trade Market, November 2013, stating the chance of high prices in excess of the California APRC levels is "small but not insignificant" available at http://www.arb.ca.gov/cc/capandtrade/emissionsmarketassessment/price-containment.pdf,
[xxx] US Department of Energy, in the October 2013 Clean Cities Alternative Fuel Price Report, available at http://www.afdc.energy.gov/uploads/publication/alternative_fuel_price_report_oct_2013.pdf
[xxxi] US Department of Energy eGallon website: Compare the costs of driving with electricity, available at http://energy.gov/maps/egallon, also see ChargeAheadCa.org at http://www.chargeahead.org/faq/