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To the Clerk of the Board, California Air Resources Board:

Attached is a revised version of our Comment on Proposed Amendments to the Low Carbon Fuel Standard, incorporating some non-substantive changes to the comments previously filed. Please refer to this version, which supersedes the version filed and docketed on April 23, 2018.

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Comment on Proposed Amendments to the Low Carbon Fuel Standard

Emmett Institute on Climate Change and the Environment, UCLA School of Law

April 23, 2018 – revised April 26, 2018

On behalf of the Emmett Institute on Climate Change and the Environment at the UCLA School of Law, we submit the following comments on proposed 2018 revisions to the Low Carbon Fuel Standard. These comments are based on a forthcoming Emmett Institute study on the LCFS, "Controlling Greenhouse Gas Emissions from Transport Fuels: the performance and prospects of California's Low Carbon Fuel Standard," by Edward A. Parson, Julia Forgie, Jesse Lueders, and Sean Hecht. The study reviews the history, design and performance of the LCFS, summarizes and evaluates the major policy critiques that have been levelled against it, and discusses four major points of policy design that will pose continuing challenges for managing and implementing the LCFS under evolving fuel market conditions and tighter carbon intensity targets after 2020.

Major policy critiques of the LCFS and their limitations:

The LCFS is a major pillar of California's climate policies, which has survived its early legal challenges, been strengthened, and generated large expansions of alternative fuel supply and significant reductions in overall carbon intensity in California's fuel markets.

The LCFS incorporates several large-scale design elements that contribute to its survival and effectiveness in advancing its central goal of promoting long-term reductions in transport fuel emissions. By separately targeting transport fuels, it enables marginal incentives strong enough to induce the required investments in exploratory, low-carbon alternatives. By controlling the complete fuel life cycle, it avoids fuel switching based on partial benefits that might be offset elsewhere in the life cycle. By its structure as an intensity standard, it requires technical improvements that do not vary with the activity level—i.e., that do not tighten when transport expands and weaken when it contracts. By maintaining internal budget neutrality between the costs and subsidies it distributes among fuels, it reduces consumer price impact and remains separate from larger-scale political and economic risks associated with the general state budget. And by using a market-based approach based on tradable credits within this structure, it brings the general advantages of market-based policies—flexibility, cost minimization relative to the specified policy goal, and incentives for innovation—into the context of a sectoral rather than an economy-wide policy. Its innovativeness and ambition have attracted widespread interest, and it increasingly serves as a model for policies elsewhere.

Yet the LCFS remains controversial. In addition to several legal challenges (on which it has largely prevailed, suffering only procedural burdens and a few years implementation delay), the policy has attracted various policy critiques that assert it is fundamentally wrong-headed.

Policy critiques have mainly targeted either the LCFS's ambition or its design. Those based on ambition are familiar from many other environmental issues and policies. They claim the targeted reductions are infeasible or excessively costly because the required quantities of low-CI fuel cannot be available in time, even in response to the strong incentives the policy will create. These criticisms are weakened by the history of similar claims advanced since the policy's inception, all refuted thus far by the progress achieved. Moreover, multiple plausible compliance scenarios have been identified to reach the proposed tighter 2030 target, and the credit clearance will ease short-term compliance if these prove too optimistic. None of these counter-arguments proves there cannot be a sharp increase in difficulty and cost under tighter targets post-2020, of course. But should this occur, ARB has the tools and record of making small adjustments as needed to manage this risk, while also keeping strong incentives in place.

The critiques based on LCFS policy design are more variable in details and in sophistication, but all are based in one way or another on the policy's focus being too narrow. In early years, the form of narrowness most criticized was that the policy was enacted by California, rather than nationwide or internationally.[1] Greenhouse-gas policies at larger jurisdictional levels are preferred, because cuts in smaller jurisdictions (even as large as California) can have only small effect on global emissions, and are vulnerable to "emissions leakage" – partly offsetting increases elsewhere, induced through world fuel or product markets. This is correct in principle, but not persuasive as a basis to reject California-level policies. Empirical estimates of leakage vary widely across sectors, and can be reduced by details of policy design.[2] And although the critique is typically employed to argue that smaller jurisdictions should simply wait for action at larger scale, it is silent on what to do if effective action at the preferred larger jurisdictional scale is not available – i.e., if the choice is between California action impaired to some degree by leakage, and no action.

More recently, as the LCFS has survived early legal challenges and been strengthened, its critics have shifted to charging that it is inefficient – inferior in its balance of environmental benefits and costs – because it is targeted too narrowly within California. Either it is too narrow in targeting the transport sector, and is thus more costly than policies that seek the cheapest cuts economy-wide via a broad emissions price.[3] Or it is too narrow in targeting fuel life-cycle emissions within the transport sector, and is thus more costly than policies that seek the cheapest cuts sector-wide via some form of emissions-based fuel tax.[4] There are two closely related causes for this claimed inefficiency within the transport sector, one again concerned with scope, the other with policy form. In its scope, the LCFS targets one of three points to influence transport emissions: the emissions intensity of fuel, not the energy efficiency of vehicles or transport activity levels. If there are cheaper reduction opportunities at these other decision points, the LFCS does not achieve minimum-cost reductions even within the transport sector. In its form, the LCFS is designed as an intensity standard. It controls an average quantity for each

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1 See, e.g., L.H. Goulder, R.N.Stavins, "Challenges from state-federal interactions in US climate change policy", *Am. Econ Rvw.* 101:3 (May 2011), 253-257; J. Bushnell, C. Peterman, C. Wolfram, "Local Solutions to Global Problems: Climate Change Policies and Regulatory Jurisdiction," *Rvw. Envt. Econ & Pol.* 2:2 (Summer 2008), 175-193; M.L. Fowlie, "Incomplete Environmental Regulation, Imperfect Competition, and Emissions Leakage." *Am. Econ. Jrnl: Economic Policy* 1:2 (2009), 72-112.

2 Meredith Fowlie, Mar Reguant, Stephen P. Ryan, Measuring Leakage Risk. Report for ARB, May 2016, *available at* https://www.arb.ca.gov/cc/capandtrade/meetings/20160518/ucb-intl-leakage.pdf

3 See, e.g., C.R. Knittel, "Markets point to leaning more on cap-and-trade", Sacramento Bee op-ed, Jan 31, 2017.

4 Critics do not always explicitly state their preferred policy, but the best alternative for their case would be a fuel tax levied on fuels' life-cycle emissions content: this would require doing the same LC analysis for each fuel as done under the LCFS, but would then apply a uniform tax per embedded unit of LC emissions to all fuel delivered, rather than an average intensity constraint at the point of fuel import or distribution.

fuel producer rather than total or marginal emissions, equivalent to a combined tax on high-CI fuels (above the standard) and subsidy on low-CI fuels. Because the subsidy component increases production of low-CI fuels, the policy cannot achieve a given reduction at minimum cost. Moreover, as with any intensity standard, if low-CI fuel markets are highly responsive to the subsidy it is theoretically possible for the standard to increase total current-period emissions.[5]

These critiques have figured prominently in regulatory debates, and have been widely and uncritically repeated as allegedly showing the policy to be wasteful, ineffective, or otherwise wrong-headed. But the critiques do not succeed at making this case, for several reasons. First, the policy's claimed inferiority depends strongly on details of the modeling formulation. Even within the static, comparative-cost framework employed by the most sophisticated critics, the LCFS's inefficiency can be readily reversed under various plausible alternative formulations: for example, in a macroeconomic framework that considers the excess burden of input taxes;[6] in the presence of market power or incomplete emissions control across jurisdictions;[7] or if economy-wide emissions prices are held below their socially optimal level by political constraints.[8]

There are also two more basic weaknesses of these critiques that make their rejection of the LCFS unpersuasive, one concerned with the economics of policy design and one with the political economy of regulation. First, they all depend, informally or through formal modeling, on a static comparative-cost framework that presumes the goal of the LCFS is, or should be, to cut emissions either in the current period, or in a timeless world with no dynamics. Within this framing, the critiques are correct: current-period reductions under the LCFS cost more than an equal quantity of reductions chosen for minimum current-period cost over all decision points in the transport sector, or over the whole economy. But the critiques mistake the goal of the LCFS, which is to promote larger, longer-term reductions. Moreover, their comparative-static analytic framework cannot represent the distinct technical and market conditions that motivated development of the LCFS: multiple potential technological pathways, all subject to large uncertainties, long development times, and strong network and system effects. To the extent transport fuel reductions are needed to achieve deep overall emissions cuts, and these conditions impair the response of transport fuels to broad incremental policies, then critiques that ignore these conditions – and their conclusions that the LCFS is inferior to broader policies – are irrelevant to evaluating the policy in view of its actual goals and the conditions in which it operates.

Second, the broader policies critics identify as preferable to the LCFS face severe political obstacles that have thus far prevented them from being enacted, in effective form and at

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5 See, e.g., G.E. Helfand (1991), "Standards vs. standards: the effects of different pollution restrictions" *Amer. Econ Rvw* 81:3(622-634); see also S.P. Holland (2012), "Taxes and trading versus intensity standards: second-best environmental policies with incomplete regulation (leakage) or Market Power" *Jrnl of Envt Econ and Mgt* 63:3(375-387); D Lemoine, "Escape from Third-Best: Rating Emissions for Intensity Standards", *Envt and Res Econ* (24 February 2016). No empirical example of this perverse effect has ever been identified, and it is difficult to demonstrate even in quantitative simulations. For example, the simulations of Holland et al (Tables 2 and 2, pp. 133-134) demonstrate the opposite effect: various LCFS targets, while highly costly in their analysis, reduce total emissions by ***more*** than the required fractional reduction in fuel CI.

6 L.H. Goulder, M.A.C.Hafstead, and R.C.Williams, "General equilibrium impacts of a clean energy standard", *Amer Econ Jrnl: Econ Policy* 8:2, at 186-218 (2016).

7 S.P. Holland 2012, supra note 5.

8 J.D.Jenkins and V.J.Karplus, "Carbon pricing under binding political constraints," UNU-WIDER Working Paper 44/2016, April 2016.

the required level, in any jurisdiction. The allegedly superior policies would impose a uniform emissions price, either economy-wide or across the transport sector. To assess the plausibility of such policies as alternatives to the LCFS, it is instructive to consider how high a broad emissions price would have to be to achieve the LCFS's targets. The most prominent academic criticism of the LCFS provides estimates of that price level in its quantitative simulations: to achieve the LCFS's original 2020 target of a 10 percent CI reduction, the required emissions price ranges from about $1,000 to $12,000 per ton CO_2, corresponding to a fuel price increase of 60 cents to $12.50 per US gallon, under different assumptions about ease of substitution in the economy.[9] If you reject that target – either because you reject a separate fuel CI target, or because a 10 percent is too large – using economy-wide emissions prices even to achieve weaker, widely accepted near-term reduction goals has thus far been politically unachievable. No jurisdiction has enacted a broad emissions policy strong enough to match recent estimates of social damage of emissions, despite arguments for the theoretical superiority of such policies being well known for forty years. All such policies in force are either impaired by broad exemptions, or held far below estimates of socially optimal levels.[10]

Unlike these hypothetically superior but nowhere-enacted emissions policies, the LCFS is in force, at a level that is deploying strong incentives to reduce fuel-related emissions. It is likely that the same design elements that are major targets of criticism, notably its internal budget neutrality, have contributed to its enactment and survival. In addition to considering the conditions that motivated the enactment of the LCFS, criticisms of the policy would also be more persuasive if they considered these evident, long-standing constraints on feasible alternative policies. Otherwise, even if their technical claims are stronger than we argue they are, these wholesale attacks on the LCFS are effectively equivalent to advocating continued inaction on transport-sector greenhouse-gas emissions.

Yet even rejecting these wholesale attacks on the policy, the LCFS still faces significant challenges of policy design to effectively pursue its goal of promoting large long-term reductions in fuel CI. Taking the major structural elements of the LCFS as given – focusing on transport fuels, controlling life-cycle emissions via an intensity standard, and providing flexibility via tradable credits – four major points of policy design will pose continuing challenges for managing and implementing the LCFS: fuel and technology neutrality; the scope of the policy; the trajectory of reduction targets over time; and managing the LCFS's interactions with closely related policies.

Neutrality

The LCFS is intended to be neutral over the fuels and technologies it covers, imposing benefits or burdens only in proportion to each fuel's calculated life-cycle emissions. The mix of

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9 Holland 2012, Tables 2 and 3, pp. 133-134. The quoted values are the shadow value of an additional ton of emissions under the specified LCFS constraint.

10 The most recent "Social Cost of Carbon" exercise estimated marginal damage from 2015 emissions (model average at 3% discount rate) as $36/tCO_2$ (Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866 (May 2013, Revised August 2016), *available at* https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon-technical-documentation_.html. By contrast, a recent survey of emissions policies worldwide found that only four jurisdictions (Sweden, Switzerland, Finland, and Norway) had policies with nominal emissions prices above $31/tCO2e, all impaired by large exemptions. (World Bank Group, Carbon Pricing Watch 2016, *available at* https://openknowledge.worldbank.org/handle/10986/24288).

fuels supplied under the overall CI target is then driven by market decisions, as suppliers balance CI reduction, cost, and other factors. Although the great variability of factors and conditions that determine each fuels' calculated CI make neutrality a challenging aim to achieve in practice, ARB has done a good job realizing neutrality and addressing significant departures. The only explicit departure from neutrality in the LCFS is that petroleum-based fuels are regulated collectively rather than individually: while alternative fuels have individualized CI calculations, gasoline and diesel are assigned statewide average CIs, subject to periodic updating.

Neutrality is a useful design principle for the current state of knowledge on reducing fuel emissions: confidence that large CI reductions will be required, but substantial uncertainty over the relative prospects and benefits of various alternatives to realize these reductions. Given this state of knowledge, a fuel-neutral policy like the LCFS can advance two linked near-term objectives: providing incentives to develop a broad range of low-CI alternative fuels; and promoting learning and eliciting information about the prospects of various alternatives, without pre-judging which will be preferred. Over time, as knowledge advances about the likely or preferred fuel mix for the future low-carbon transport system, the value of a neutral policy will decline. As knowledge about the preferred endpoint emerges, policies should shift away from neutral promotion of a broad set of alternatives, toward managing the transition to the preferred endpoint effectively and efficiently.

Scope

Defining policy scope is fundamental to managing a separate policy for transport fuels. The LCFS's nominal scope is all fuels used for road transport in California, but it also includes a few low-CI off-road fuels. As a separate policy imposing higher marginal costs on transport fuel emissions than others, the LCFS must define a coherent boundary, and defend the boundary from attempts at arbitrage to exploit the large marginal-cost disparity. ARB has succeeded in managing the LCFS's scope so far, although some of its scope decisions appear mainly to have addressed concerns about short-term credit shortage by adding more low-CI, credit-generating fuels, such as electricity used in forklifts and some rail systems, and current proposals to include renewable jet fuel and low-CI alternative fuels used in off-road military vehicles. In the future, the credit clearance mechanism will ease this concern, while tighter targets and sustained higher credit prices will make other boundary-drawing challenges more prominent. High credit prices will strengthen incentives both for alternative fuel development, and for other activities less aligned with the policy's goals, such as developing technologies and systems that blur or dissolve the boundary, as well as fuel shuffling and related forms of emissions leakage.

Future boundary-drawing challenges will be highly technology specific, as illustrated by electric drive and carbon capture and removal technologies. Electric drive has seen rapid growth in light-duty vehicles, to a lesser extent in heavy road transport, especially transit buses. It has the potential for continued strong expansion, particularly in light vehicles, but still faces enough continuing barriers related to cost, performance, consumer acceptability, and infrastructure, that it is not assured to be the preferred or successful low-carbon option, even for light vehicles. The prospects for electric drive are strong, but still uncertain: they clearly merit continued and expanded LCFS crediting, but do not call for re-focusing low-carbon fuels policy preferentially on electricity rather than continuing to promote a wide range of low-CI alternatives through the LCFS.

But the design and implementation challenges of promoting electric drive through the LCFS while maintaining neutrality are substantial. For light-duty vehicles, where technical prospects are strongest and growth is fastest, LCFS incentives are hard to target effectively. The present targeting of LCFS electric credits on EV purchase decisions is sensible, since these drive production growth and cost reductions, but LCFS incentives can target only some of the associated barriers and are relatively weak. For the subsequent factors determining emissions – how much EVs are driven, and the CI of charging electricity – the targeting of LCFS incentives is weak. After vehicle purchase, most residential charging is not separately metered so LCFS credits must rely on weak proxies for actual vehicle use, although these can be improved with better charging data, via separate meters or direct collection from vehicles. The challenges of heavy transport are the reverse of those for light-duty vehicles. Technical challenges to electrification are greater, but separate charging improves the targeting of incentives from LCFS credits, while heavy commercial usage makes them more valuable. Additional CI reductions for any electrified transport modes will also depend on the mix of electrical generating sources. As an end-use-oriented policy in the integrated electrical grid, the LCFS will have limited ability to influence these decisions. They will require other policies to promote continued electrical decarbonization and electric-transport interactions, such as role of vehicle charging in energy storage and load management.

Carbon capture and atmospheric removal technologies may offer large reductions in net emissions but also present scope and boundary challenges for the LCFS. Some carbon capture opportunities fit squarely within transport fuel production: capturing and sequestering existing emissions streams from fuel production or processing, and producing low-CI synthetic fuels using carbon removed from the atmosphere. But the larger potential contributions of carbon capture or removal lie outside transport fuel production as presently defined. Counting carbon removal elsewhere or in other processes as reducing the CI of a transport fuel would require drawing artificial system boundaries for the CI calculation, under which the carbon capture or removal function more like offsets than emissions reductions. The associated boundary-drawing challenges are not just theoretical matters of what cuts really count as being in transport fuel. They also affect high-stakes practical issues of potential harms or scale limits in total carbon removal, when billions of tons of annual removals are already widely assumed and using carbon removal to offset substantial continuing gross emissions from transport fuels would represent a further large increase.

These concerns highlight the importance of keeping careful control over the pace of expansion of LCFS crediting for technologies, like carbon capture and removal, that may have large potential and flat marginal costs, but that may be judged not to comprise complete solutions to reducing transport emissions. The treatment of CCS in the current proposed amendments, crediting removals on site with fuel production processes or atmospheric removals incorporated into fuel products, strikes an appropriate and prudent balance. Further expansion of crediting for carbon capture or removal may be judged warranted in the future, but must be carefully controlled and gradual.

Target trajectory

A key element of LCFS policy design is its CI target and how this is tightened or otherwise adjusted over time to provide strong, steady incentives for development and expansion of low-CI fuels. Thus far, target adjustments have mainly responded to legal challenges and concerns about short-term credit shortages, but these are likely to be less prominent considerations in the future. The LCFS's basic market-based structure with credit banking, as well as the credit clearance mechanism, pass some responsibility for managing the time trajectory of fuel development to private market actors. But ARB still has the responsibility to set and periodically adjust the CI target trajectory, as it did when the policy was adopted and has now proposed through 2030. Such a pre-announced target schedule is necessary to signal the policy's ambition, create appropriate incentives, and provide context for market actors' decisions to use or bank credits. With such a target trajectory in place, the credit market then both mediates the incentives for low-CI fuel development and provides information about realized and anticipated progress. Sustained high credit prices both make the incentives stronger, and signal difficulty responding in the short term.

There will always be unavoidable uncertainty on future progress in low-CI alternatives, and thus on the trajectory of future credit prices. To deal with these, ARB needs the discretion to adjust previously announced target schedules in response to large departures from projected progress. Given this uncertainty, the most basic design decision regarding targets is how to set the advance schedule relative to current projections of future progress: should the initial target schedule be biased toward greater ambition, with accompanying risk that future relaxations will be needed; or toward less ambition, with increased risk that future tightening will be needed?

This decision can be analyzed in terms of the relative cost of the two types of error. Starting too weak then tightening means missing available reduction opportunities; giving inadequate incentives, so weak initial projections may become self-fulfilling prophecies; and later imposing unanticipated lump-sum burdens on fuel distributors who have deficits. Starting too strong then loosening risks weakening the credibility of initial targets, and gives incentives to firms that expect to have deficits to resist and conceal progress in order to get targets weakened. These two concerns may have limited impact, in practice, however. Risks to credibility of targets may not be consequential because target relaxation would only occur under conditions of sustained tight credit markets, and so would impose only small losses from highly favorable positions on low-CI investors. And obstruction might not be a serious risk because the divergence of interests between firms marketing high and low-CI fuels suggests that those with the strongest interests in target relaxation would have little influence on the pace of low-CI development. On balance, the cost and disruption from setting initial target trajectories ambitiously then later making small relaxations if needed are likely to be less than those from setting initial targets too weak and later having to tighten them. For the proposed target trajectory through 2030, since several plausible scenarios have been identified to reach the proposed 20 percent reduction or more,[11] this reasoning suggests that ARB should consider an initial trajectory with somewhat stronger targets, reaching a few percent beyond 20 percent CI reduction by 2030.

If future relaxations are required, these can be implemented in a few different ways. One possible approach would be to modify the credit clearance mechanism to drop the five-year constraint on carrying forward deferred obligations. This would broaden the quantitative relaxation available at the $200 price, making the mechanism more closely resemble a true price

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[11] Initial Statement of Reasons, Chapters 5 and 8, *available at* https://www.arb.ca.gov/regact/2018/lcfs18/isor.pdf; See also C. Malins, "California's clean fuel future: assessing achievable fuel carbon intensity reductions by 2030," March 2018. *Available at* https://nextgenamerica.org/wp-content/uploads/2018/03/Cerulogy_Californias-clean-fuel-future_March2018-1.pdf

cap, but this change would raise two concerns. First, by letting participants accumulate open-ended quantities of deferred obligations, it would increase risk of compliance failure, by bankruptcy or other means. A compromise approach to limit this risk would be for ARB to grant such relaxations only case-by-case, subject to participant-specific assessment of default risk. Second, relying on the credit clearance mechanism as the vehicle for future relaxation would make most sense if ARB remained confident that the $200 credit price is the appropriate maximum: high enough to motivate major investment in innovations, but not so high as to risk serious disruption of fuel markets. If this is not the case, or if ARB does not want to rely on the clearance mechanism for this purpose, future loosening can also be achieved either by small explicit relaxation of forward CI targets, or implicitly by incremental expansions of the policy's scope to bring in additional low-CI fuels and uses, as was done for electric forklifts and rail system and is proposed for alternative jet fuel. Limited expansions in credit eligibility for carbon capture and removal would be one way to achieve such small relaxation, subject to the caution above that such carbon removal crediting must be kept under careful quantitative control. Whatever method is considered, ARB must carefully resist too-easy or too-early relaxation, because sustained high credit prices will be necessary to generate the needed development and investment in low-CI alternatives.

Managing policy interactions

The LCFS operates, and will continue to operate, in the context of other related policies. Managing interactions with these will be a major continuing challenge for the LCFS, affecting many elements of design and implementation. Thus far, the LCFS's major interactions have been with the federal Renewable Fuel Standard (RFS) and California's greenhouse-gas cap-and-trade system. These will remain significant in the future, in addition to increasing interactions with LCFS-like policies in other jurisdictions. The RFS differs in scope and policy structure from the LCFS. It has generated a large supply of mostly conventional biofuels that eased LCFS compliance under early weak targets, but is not designed to provide incentives for incremental improvements in CI within fuel types. The RFS is likely to be less relevant as LCFS targets tighten, unless it is modified to provide more effective incentives for low-CI biofuels.

The LCFS has interacted strongly with California's cap-and-trade system since the cap was expanded in 2015 to include fossil-fuel combustion emissions. These fuels now fall under both the stronger requirements of the narrower LCFS and the weaker requirements of the broader cap-and-trade system. Under this double coverage, it is highly likely that the LCFS suppresses cap-and-trade allowance prices and thus impairs the ability of the cap-and-trade system to motivate reductions in other sectors. Given that this double coverage is in place, the interaction can also be weakened or eliminated by introducing a cap adjustment mechanism, which would reduce the cap to track estimated reductions in cap-covered emissions achieved by the LCFS. Given the likelihood of inelastic short-run allowance demand, such adjustment need not reduce allowance auction revenues, but estimating the detailed response would require quantitative modeling of specific adjustment mechanisms.

Continuing enactment of LCFS-like policies in other jurisdictions, as now in place and proposed in several jurisdictions, will bring two types of potential interaction: interactions through linkage of trading systems, and market effects via demand for low-CI fuels. LCFS credit markets can in principle be linked, following the existing model of expanding inter-jurisdictional linkage of cap-and-trade systems. Such linkages can make larger and more liquid credit markets, but would require careful attention to coordination of both administrative trading mechanisms (to avoid double-counting), and policy stringency and design (to avoid arbitrage). Such linkages are not presently feasible, due to inconsistent design between the LCFS and other systems now in force and proposed. In particular, other current and proposed LCFS systems exclude indirect land-use change from calculated CI of biofuels, so those systems will generate significantly stronger incentives for production of those biofuels whose CI includes a large iLUC component.

The more immediate interactions will be through effects of increased demand on low-CI fuel markets. Additional LCFS policies, like tightening of California's CI targets, will strengthen incentives for production of low-CI fuels and bid up their prices if production cannot expand apace. The additional policies will also increase incentives for fuel shuffling, since the new jurisdictions will compete with California for both newly produced and shuffled fuels. But because shuffling is an artifact of CI variation among the initially existing fuel supply mix, shuffled fuels are in fixed supply and will decline in relative importance as demand for low-CI fuels expands. As expansion of LCFS-like policies squeezes out claimed reductions of little merit or future promise, it will also clarify how much of present reductions is coming from shuffling, or from low-CI fuels that are real but also in relatively fixed supply, such as fuels produced from waste oils. As these sources reach their limits, the supply profile of other low-CI fuel options will be revealed more clearly. This will represent an additional source of uncertainty in future credit markets, although the response mechanisms already discussed – the credit clearance mechanism plus ARB's discretion to make small target relaxations under conditions of sustained shortage – are likely to provide adequate ability to respond to these conditions, as they do to uncertainties generated solely within California's credit market.