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California's Air Resources Board (CARB) has just [enacted new regulations](#) that strengthen the state's Low Carbon Fuel Standard (LCFS). The LCFS is a major component of California's greenhouse-gas control strategy, but receives surprisingly little attention, compared to other policies like the statewide cap-and-trade system and the renewable portfolio standard for electricity. This ambitious, innovative, and controversial policy targets a large and growing emissions source not effectively reached by any other policy.

We recently published a [detailed review](#) of the LCFS. This post introduces a series of blog posts that will synthesize our work, including analysis of the program's design and future opportunities and challenges, as well as response to critiques of the concept behind the LCFS. Here, we provide a brief introduction to the policy, its history to date, and the content and rationale for the new revisions.

LCFS overview

Implemented in 2011, the LCFS aims to reduce GHG emissions from transportation fuels. It targets emissions from fuels not just when they are burned in the vehicle, but through their entire life cycle, including extraction, production, transport, and consumption. This design puts the LCFS among the first policies to be built around life-cycle assessment (LCA). The LCFS controls the average emissions intensity of fuels, defined as their total life-cycle emissions per unit delivered energy (measured in grams of CO₂-equivalent emissions per megajoule). It requires a progressive series of reductions in emissions intensity from 2011 to 2020, reaching 10 percent below the 2010 level in 2020. These reductions are implemented by a system of tradable permits that allow fuel marketers who exceed the standard any year to sell credits to others who fall short. The policy is projected to [cut total emissions by 15 million metric tons](#) carbon dioxide equivalent (CO₂e) in 2020, which is more than one quarter of projected reductions from all California policies that year. [The amendments enacted last week](#) include [further reductions in emissions intensity after 2020](#), reaching 20 percent below 2010 levels in 2030.

Reducing emissions from the transportation sector, reducing emissions from the fuel supply

Transportation is a major source of greenhouse gases, [accounting for more than any other sector both in California](#) (39 percent of state emissions) and, since early 2016, in the United States (27 percent of national emissions). Large reductions in total emissions thus require large cuts in transport, but this sector poses challenges that are distinct from, and more

severe than, those in other emission sectors. Transport relies almost entirely on petroleum-based liquid fuels, which generate high emissions but enjoy technical advantages over many alternatives due to their high energy density and easy transportability. Transport systems are complex networks including vehicles, fuels, rights-of-way, and fuel distribution systems, which depend on each other in ways that hinder piecemeal change. Achieving large emission cuts thus requires coordinated changes to multiple parts of these systems, while meeting the demanding technical and market requirements of each part. These interactions, as well as long development times for alternative fuel systems and associated uncertainties about technology, markets, and regulations, all discourage the needed long-term development investments.

Recognizing the unique sectoral challenges of transport emissions, a growing number of jurisdictions have decided that uniform economy-wide policies like emissions taxes or cap-and-trade systems—which in theory deliver reductions at minimum cost—will not achieve the required cuts in time, and so must be supplemented by policies that specifically target the transport sector.

These policies come in three main types, which aim to influence different decision points that contribute to transport emissions. The most common policies target vehicle efficiency, aiming to reduce emissions by reducing fuel consumed per unit travel. Other policies target the level of transport activity, aiming to reduce emissions by motivating reduction in travel or switching to more efficient transport modes. In view of evident limits to the ability of these approaches alone to achieve deep emission cuts, the LCFS targets a third point of potential influence, the emissions content of the fuel supply, which was previously neglected and poses particular challenges.

LCFS policy design

Several large-scale design elements of the LCFS help it effectively target this goal. By targeting transport fuels separately from other emissions sectors, 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 creating perverse incentives for fuel switching based on partial benefits that might be offset elsewhere in the life cycle. By being structured as an intensity standard, it requires technical improvements independent of the overall level of transport activity, i.e., requirements 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 finally, 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.

History and challenges

Now in effect for seven years, the LCFS has survived early legal challenges suffering only some implementation delays, and has generated large expansions of alternative fuel supply and significant reductions in overall carbon intensity in California's fuel markets. In response to a lawsuit and scheduled program review, CARB readopted LCFS regulations with revisions in September 2015. In effect since January 2016, the revised regulations were intended to set the policy's course through 2020. New legislation adopted in 2016 and 2017 then changed the context for further LCFS revisions, by tightening California's overall GHG target to 40 percent below 1990 by 2030 and giving the LCFS explicit statutory authorization through that year. Following a subsequent program review and an order from the California Court of Appeal that required CARB to revisit the environmental impact review of the LCFS standards for diesel and diesel substitute fuels, the agency just last week [adopted further revisions to LCFS regulations](#). The Ninth Circuit just heard oral argument in a pending federal lawsuit challenging the LCFS on constitutional grounds; supporters of the program are optimistic, as the Court recently [upheld a similar program in Oregon](#) in the face of related legal challenges. Challenges in California state courts are still pending as well.

The new revisions

The new regulations respond to both a required periodic program review and the need to comply with the Court of Appeal's mandate to revise its environmental impact analysis. In addition to various procedural and administrative changes, the amendments make several changes to the coverage and stringency of the program. The program goals, timetable, and modifications are detailed in this [staff presentation](#) from the CARB board meeting at which the [revisions were approved](#).

Most importantly, the changes state a new schedule for further tightening fuel carbon intensity targets beyond 2020. Starting from the 2018 target of 5 percent below 2010, the new schedule reduces CI a further 1.25 percent each year, to reach 20 percent below the 2010 baseline in 2030. This schedule smooths out a rather abrupt transition that would otherwise have occurred around 2020 – a consequences of previous court-ordered delays of

pre-2020 interim targets - by slightly weakening the targets previously in effect from 2019 to 2021, with new continuing reductions thereafter. CARB has published the impact it believes the program, with revised targets, will have on GHG emissions.



The new amendments also change the treatment of several fuels, with goals that include promoting infrastructure for zero-emission vehicles, promoting innovation in fuel supply chains, and enhancing incentives for other emission-reducing activities. For example, producers of alternative, low-carbon fuels used in jet aircraft and military vehicles, which were previously outside the program, will now be allowed to opt in to receive credits. In addition, a few fuels that were previously opt-in or exempt are now required to participate, notably compressed natural gas (CNG) and hydrogen from fossil sources, and liquefied petroleum gas (LP-gas, commonly called propane). This change in part was required by the tighter targets, because some fuels—in particular fossil CNG—whose emissions intensity was formerly assumed to be below the target can no longer be treated this way as the target grows more ambitious. The revisions also include a protocol for accounting and crediting emissions reductions from carbon capture and sequestration (CCS) projects, which will allow them to participate in the program for the first time, albeit in a limited way.

Finally, the proposals change the treatment of electricity used to charge EVs, aiming to strengthen incentives for renewably generated electricity and for charging at times when the overall CI of electrical generation is lower. To comply with the Court of Appeal's order, the revisions are accompanied by a new environmental analysis that addresses remaining, largely procedural, deficiencies identified by the Court. ARB will now ask the Court to discharge the writ, which would allow the amended regulations, including the new compliance schedule, to go into effect starting 2019.

Where we'll go with this

Despite—or perhaps because of—its potential to reduce GHGs and provoke a transformation in vehicle fuels in California, the policy remains controversial and faces continuing legal challenges and policy critiques of its effectiveness, cost, and legality.

In our recent paper, we evaluate and address the major policy critiques of the LCFS, finding them largely unpersuasive. We have concluded that the policy is an important and necessary component of California's GHG reduction program. In the same paper, we analyze in detail the difficult decisions about policy architecture and implementation that CARB has made to date. In subsequent posts, we will synthesize both our response to policy critics and our thoughts and recommendations about some specific aspects of policy design and implementation.