Post-2020 Carbon Constraints: Modeling LCFS and Cap-and-Trade

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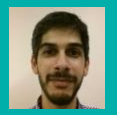

Agenda

1. Context of Report
2. Summary of Findings
3. Background: Modeling

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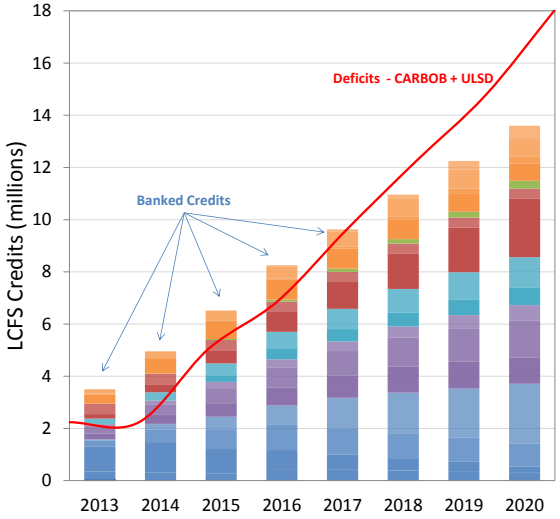
Context of Report

ICF previously analyzed the LCFS and its outlook to 2020

Various pathways to compliance



Modest economic impacts

Geography	Employment Impacts
California	3,700—4,100
	0.02%
Rest of US	17,600—31,500
	0.01—0.02%

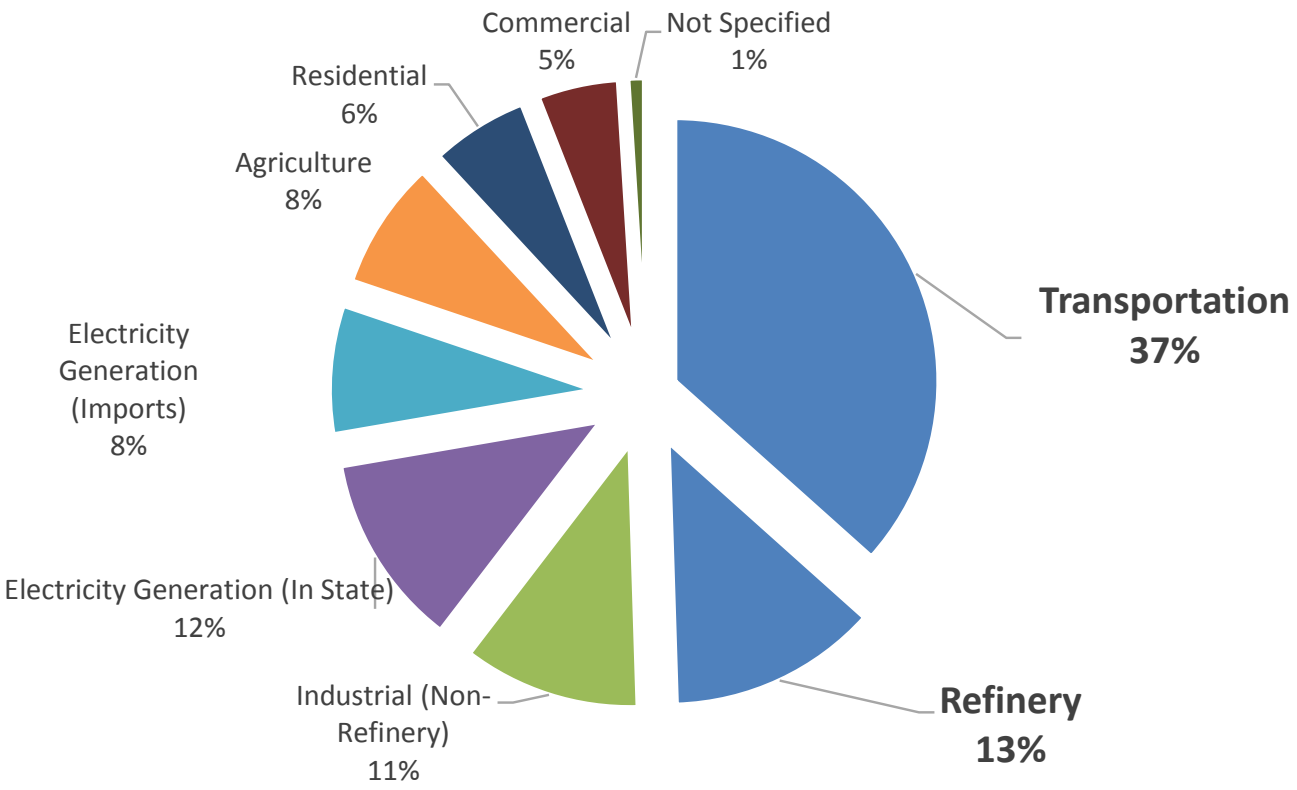
Significant criteria pollutant benefits

Scenario		Monetized Externalities			
		GHG Emissions SCC[1]	Criteria Air Pollutants	Energy Security	Total
Scenario 1	low	$502	$253	$844	$1,599
	high	$3,220	$346	$1,059	$4,625
Scenario 2	low	$502	$63	$796	$1,360
	high	$3,260	$68	$1,017	$4,345
LCFS Enhanced	low	$497	$258	$980	1,736
	high	$3,204	$359	$1,230	$4,793

[1] For the low SCC estimates, ICF used the values reported at a 5 percent social discount rate; for the high SCC estimates, ICF used the 2.5 percent discount rate.

Previous ICF work on LCFS

50% of GHG emissions attributable to transportation sector

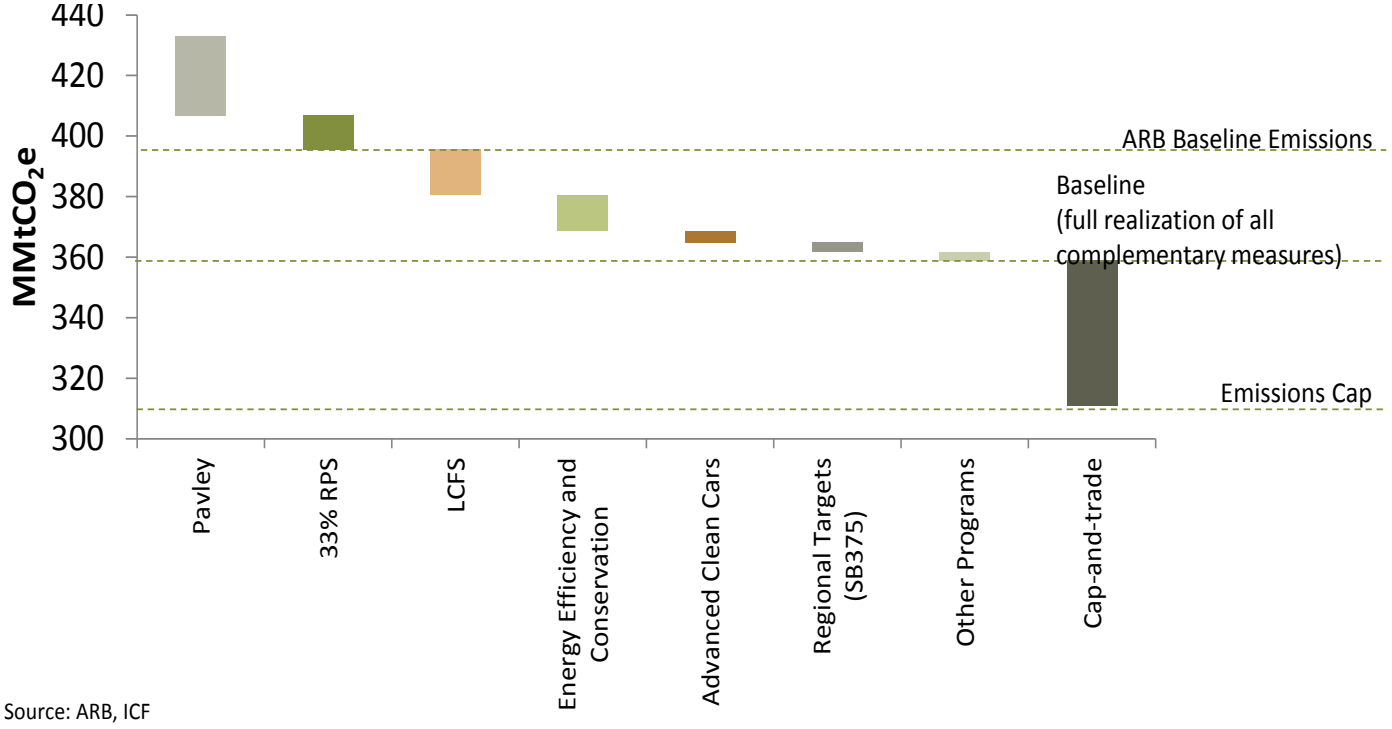


In a post-2020 carbon constrained market, the transportation sector will play a key role in determining how and whether California meets its GHG reduction targets.

GHG Emissions in Transportation Sector

Assume that same approach is used for post-2020:

Cap-and-trade as the cornerstone, with complementary measures in place. Most notably, an expanded Low Carbon Fuel Standard.



Source: ARB, ICF

Achieving targets post-2020

Report Objective

Quantify the cost and emission impacts of the LCFS as a complementary mechanism to a Cap-and-Trade program.

Tools Used to Conduct Analysis

Combination of LCFS compliance modeling (using an optimization framework) and the IPM Plus® model.

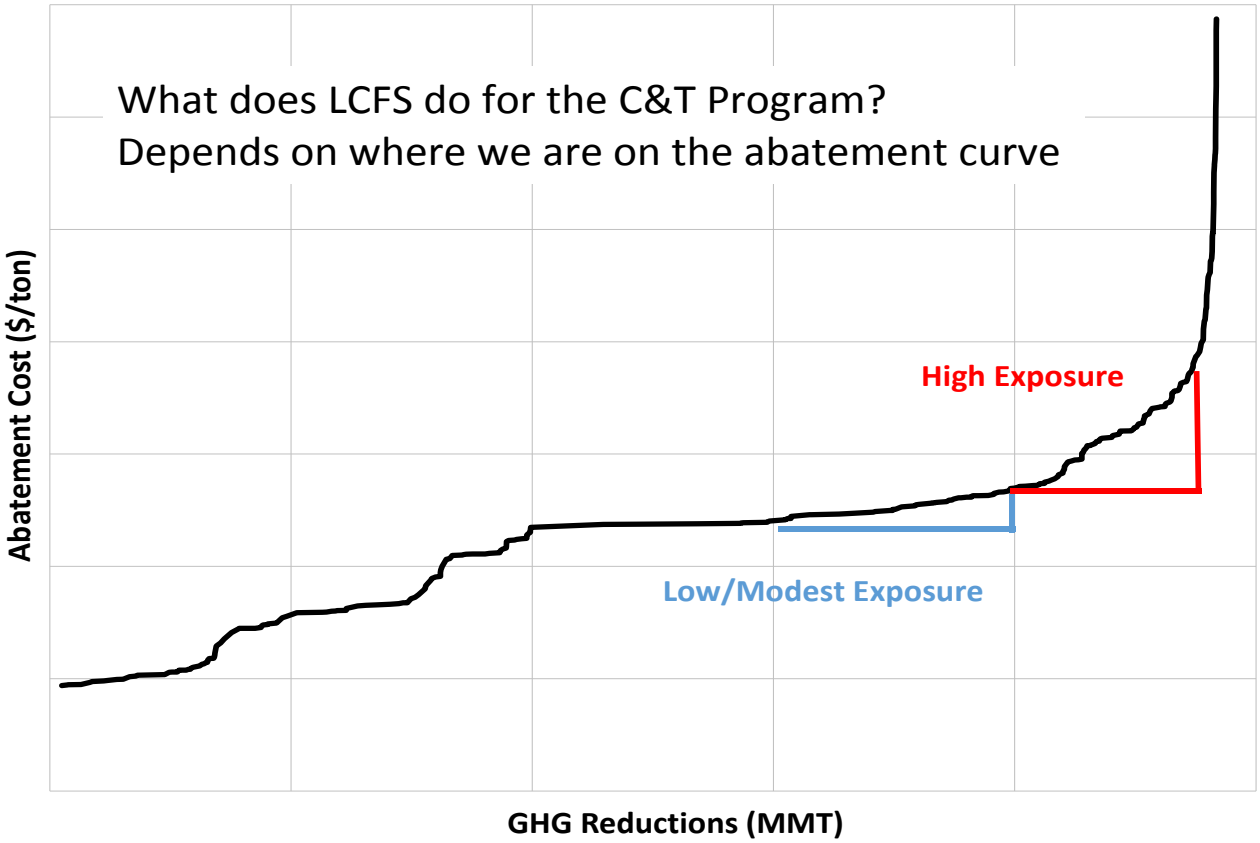
Modeling Conditions

Lower GHG emissions 40 percent below 1990 levels by 2030. LCFS program considered with different carbon intensity targets (10%, 15%, 20%, and 25%).

Overview of Approach

Carbon Abatement and Compliance Costs

The relationship between cost and abatement is referred to as the marginal abatement cost curve. This helps understand the allowance price in the cap-and-trade market, which we use as a proxy for compliance costs.



Conceptualization of the Challenge

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Summary of Findings

- The marginal abatement cost curve, which is used to estimate the market clearing price for allowances, is quite steep in 2030.
- A reduction of 3—14 MMT in transportation emissions in 2030 yields a reduced allowance price spread of $5—29/ton by 2030.

Scenario	Historical	Projected Allowance Price ($/MT)				
	2014	2016	2018	2020	2025	2030
10% CI reduction	10	11	12	33	40	52
15% CI reduction		11	12	29	36	47
20% CI reduction		11	12	15	18	23
25% CI reduction		11	12	15	18	23

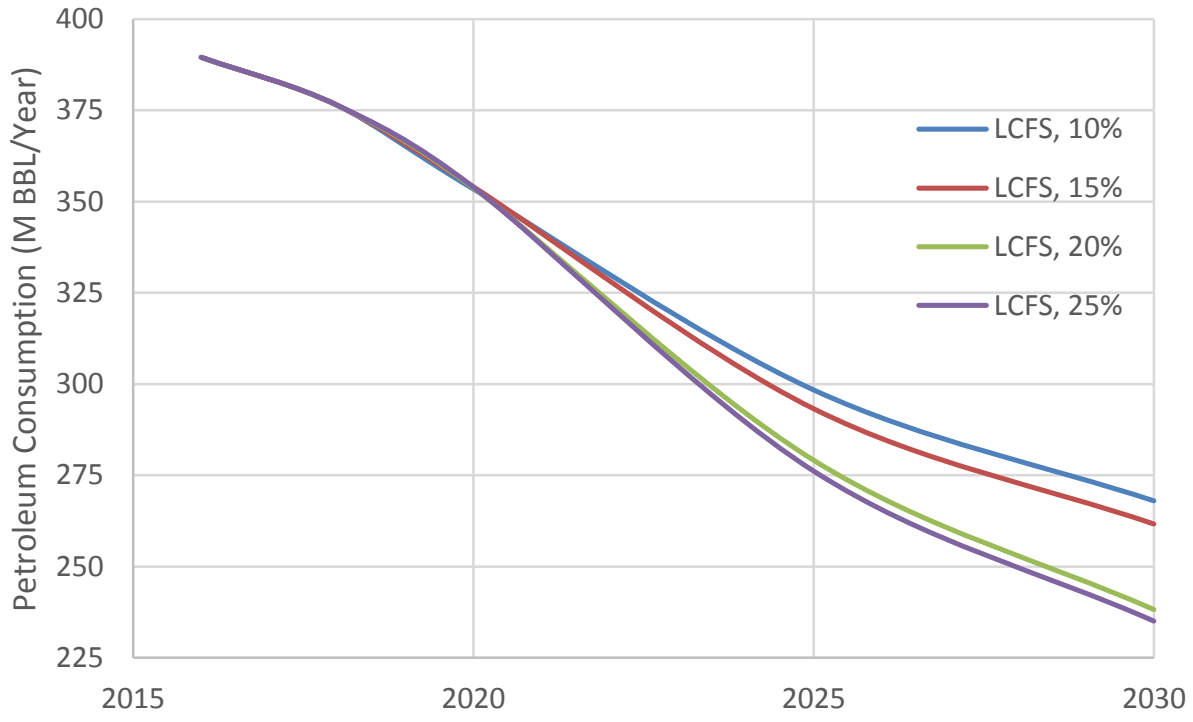
Extending the LCFS program will lower the allowance price in the cap-and-trade market.

- The LCFS does not substantially raise overall GHG compliance costs in the transportation sector, especially in the short- to medium-term future.
- The moderately stringent LCFS targets considered report (i.e., a 15—20% target) deliver ongoing long-term abatement that we do not observe in a scenario with cap-and-trade on its own.

Scenario	Compliance Costs ($M)			
	2025		2030	
	Absolute	$/BBL	Absolute	$/BBL
10% CI reduction	$8,300	$27.7/BBL	$8,000	$29.8/BBL
15% CI reduction	$8,700	$29.6/BBL	$9,900	$38.0/BBL
20% CI reduction	$6,300	$22.5/BBL	$7,800	$32.7/BBL

The LCFS program will not substantially raise compliance costs in the transportation sector

- The scenarios with more stringent LCFS targets (i.e., 15%, 20%, and 25% carbon intensity targets) will reduce petroleum consumption by 18—26% when compared to the current 10% target.
- The LCFS program can help ease compliance in the cap-and-trade program, while also making significant contributions to petroleum reduction.



The LCFS program paired with Cap-and-Trade will yield more substantial petroleum reductions by 2030.

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Background: Modeling

The model dynamically solves for a low-cost, lowest emission solution while considering inter-temporal trading and banking behavior in the LCFS program.

Low Carbon Fuel	Feedstocks / Applications	Considerations
Ethanol	Corn, sugar cane, molasses, sorghum, wheat, waste beverage, and cellulosic materials	• Generally blended to 10%; option to increase to as much as 15% by no earlier than 2025 • E85 option included in modeling
Electricity	Light-duty vehicles, off-road electrification, limited electrification in HD sectors	• Model assumes at least ZEV Program compliance; can exceed compliance • Off-road opportunities limited to forklifts and fixed guideway applications
Hydrogen	Light-duty vehicles	• Model assumes at least ZEV Program compliance; can exceed compliance

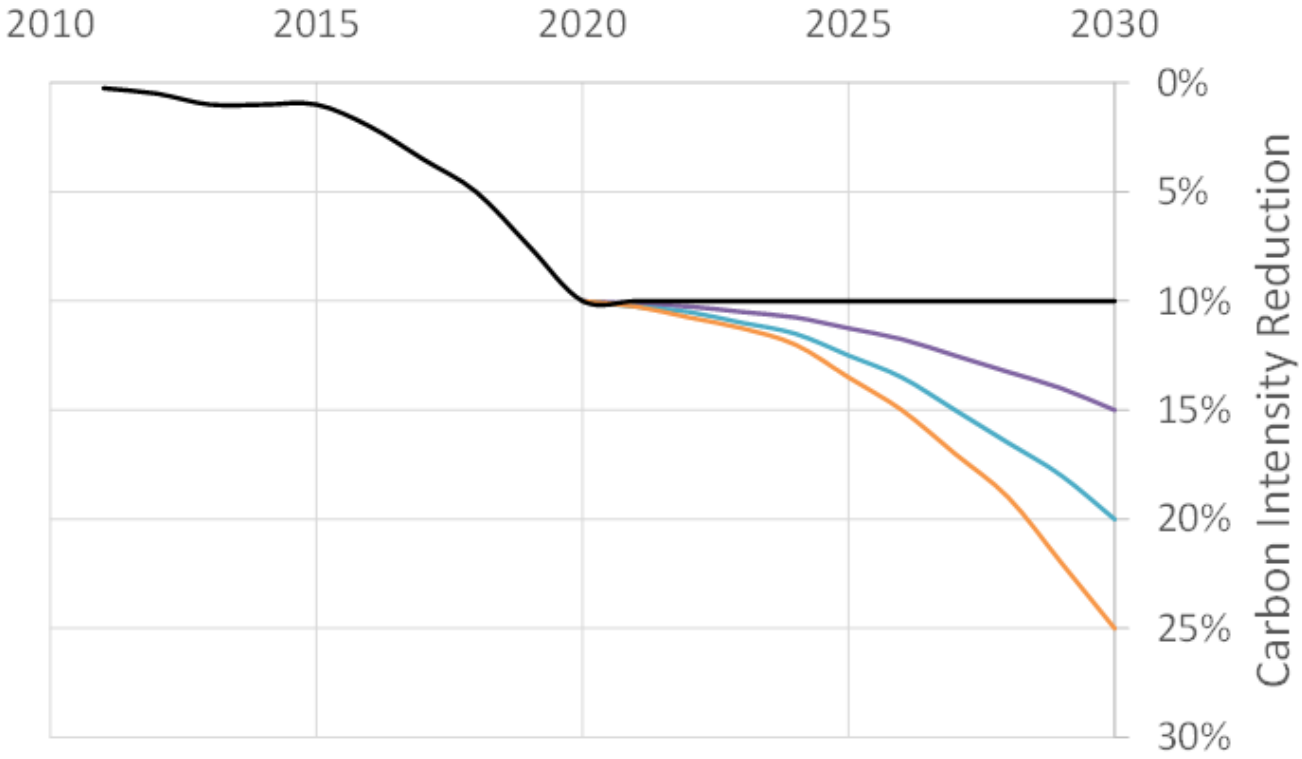
LCFS Modeling

LCFS Modeling, continued

Optimization model is driven by LCFS compliance, and the supply curves for various alternative fuels and technologies. The *maximum potential* for each fuel pathway is likely greater than what our modeling assumes will be deployed.

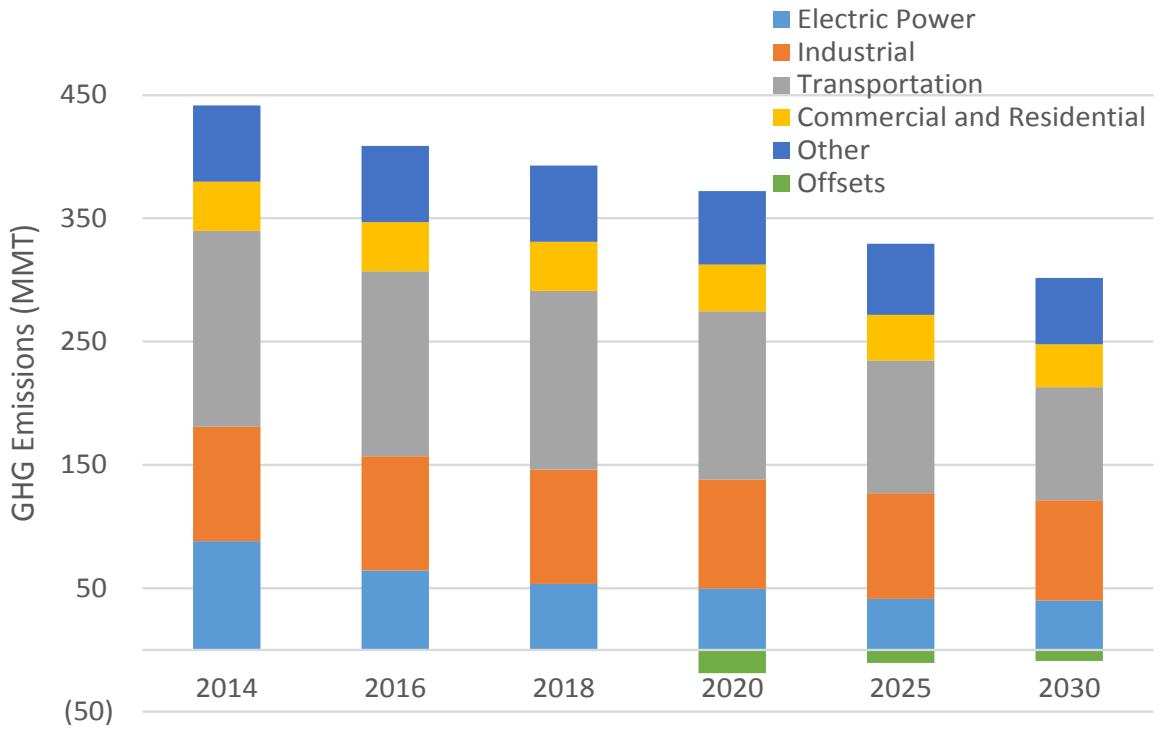
Low Carbon Fuel	Feedstocks / Applications	Considerations
Natural gas	• Includes fossil and renewable natural gas • Includes CNG and LNG options • Focused on HD sectors	• Model varies share of renewable natural gas (as a function of total natural gas) based on fuel demand and fuel price • Model includes fleet turnover considerations for more than 15 HD truck types (from EMFAC)
Biodiesel	Soy oil, canola oil, used cooking oil, corn oil, tallow	• Model includes blend limitations, with a maximum of B20 by 2030 • Assumed blending with conventional diesel and renewable diesel is OK
Renewable diesel	Tallow, soy oil, used cooking oil, other	• No blend limitations imposed

Compliance curves implemented on a non-linear basis.



LCFS Compliance Curves

IPM Plus® considers emissions from the following sectors: electric power, industrial, transportation, commercial and residential energy, uncapped sectors, and offsets. For the purposes of ICF's analysis, we considered the business as usual emissions trajectories from CARB's Scoping Plan Update



Modeling Cap-and-Trade with IPM Plus

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