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# A Review of Low Carbon Fuel Policies

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# Overview

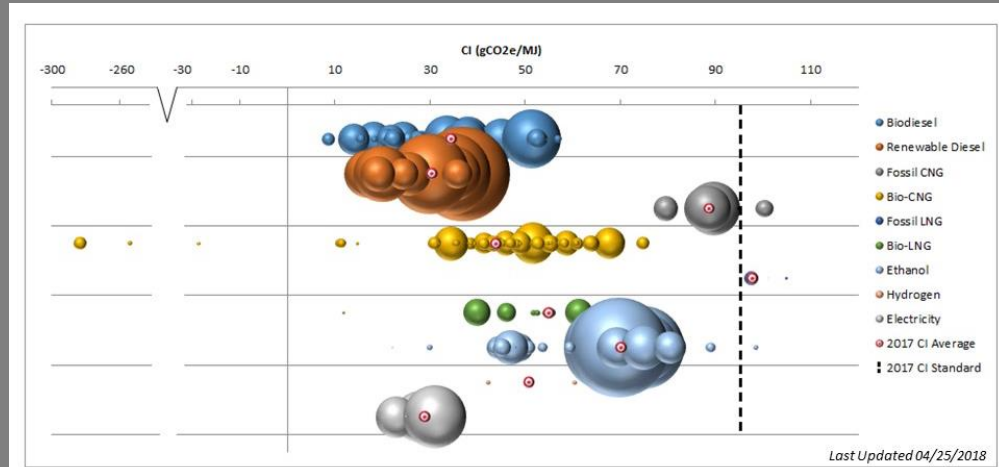
- Introduction of the LCFS
- Progress and status
- Compare the design principles of a carbon tax vs. LCFS
- The potentials for LCFS in the shipping sector? Hopes and considerations

## Overview of the LCFS /Clean Fuel Standard

- A performance-based approach that incents the use of a broad range of low carbon fuels, energy sources and technologies in transportation
- Carbon intensity: lifecycle emissions (basis for fuels generating credits or deficits)
- Jurisdictions implementing LCFS include California, Oregon, and British Columbia.
  - Canada announced on November 25, 2016 that it would develop a clean fuel standard (include industry and building). A draft version of the regulatory framework was published in December 2017

# Key features and status of California's LCFS

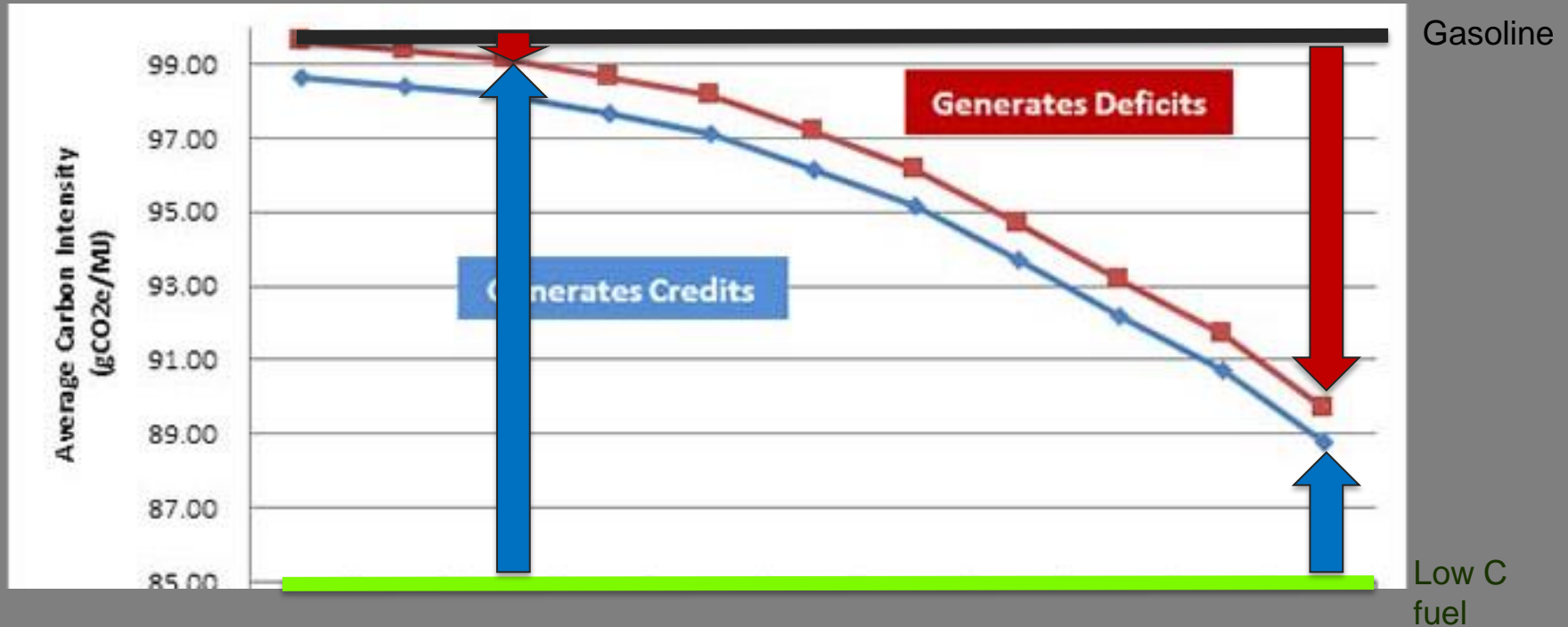
- LCFS accounts for the full lifecycle of fuel carbon emissions
- Requires: 10% reduction in carbon intensity (gCO<sub>2</sub>-eq/MJ) by 2020
- Biofuels the largest source of credits, followed by biogas, electricity, and natural gas



This figure provides perspective on the performance of actual quantities of fuel consumed in California. Each sphere represents a certified fuel pathway; the size of the sphere represents the reported volume of the fuel in 2017, while its position on the horizontal axis indicates the carbon intensity of that fuel.

<sup>1</sup> The alternative fuel's CI value is divided by its Energy Economy Ratio (EER) in order to obtain the EER-adjusted CI value, representing the emissions which occur from the alternative fuel per MJ of conventional fuel displaced.

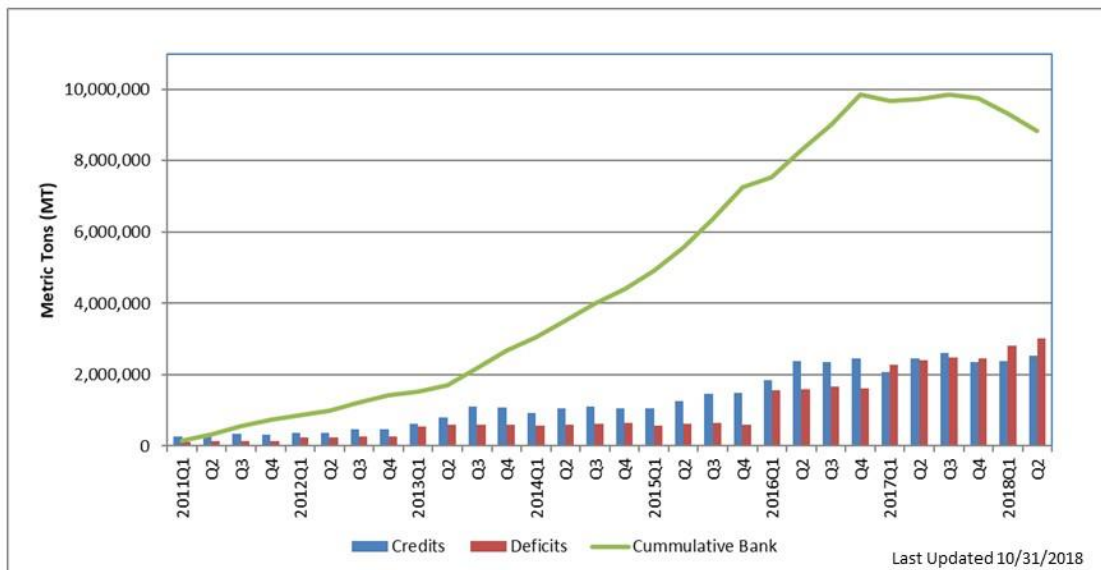
## Fuels generate LCFS carbon credits/deficits



## Credits and deficits

- Up to 2017, regulated parties have consistently over-complied with the standard.
- Large banked credits, though the standard is becoming more stringent.

**Total Credits and Deficits for All Fuels Reported and Cumulative Credit Bank  
Q1 2011 – Q2 2018**



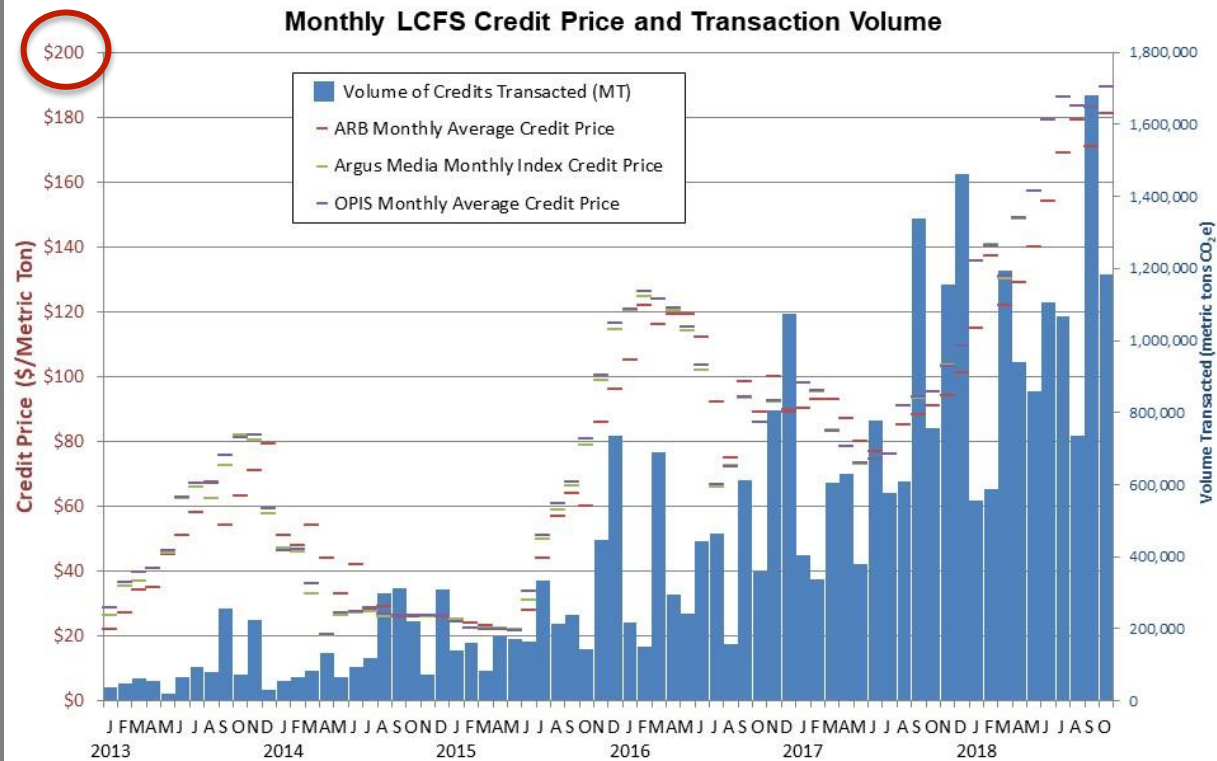
This chart shows the total deficits (in red) and credits (blue) generated during each quarter. The green line tracks the total number of banked credits.

Regulated parties have consistently over-complied with the standard, generating a bank of credits which can be sold or retired to meet compliance obligations at any time. At the end of Q2 2018, the bank stood at nearly 8.8 million credits. Not all 2017 and no 2018 Q1 and Q2 Low Complexity / Low Energy Use Refining credits have been included as of this publication. As the standard becomes more stringent in order to reach the targeted reductions by 2020, regulated parties can rely on these banked credits to ease compliance.



# Credit price and transaction volume are increasing

- Over 30 MMT LCFS credits generated.
- The overall nominal value of all credit transfers is over 3.1 billion USD to date.



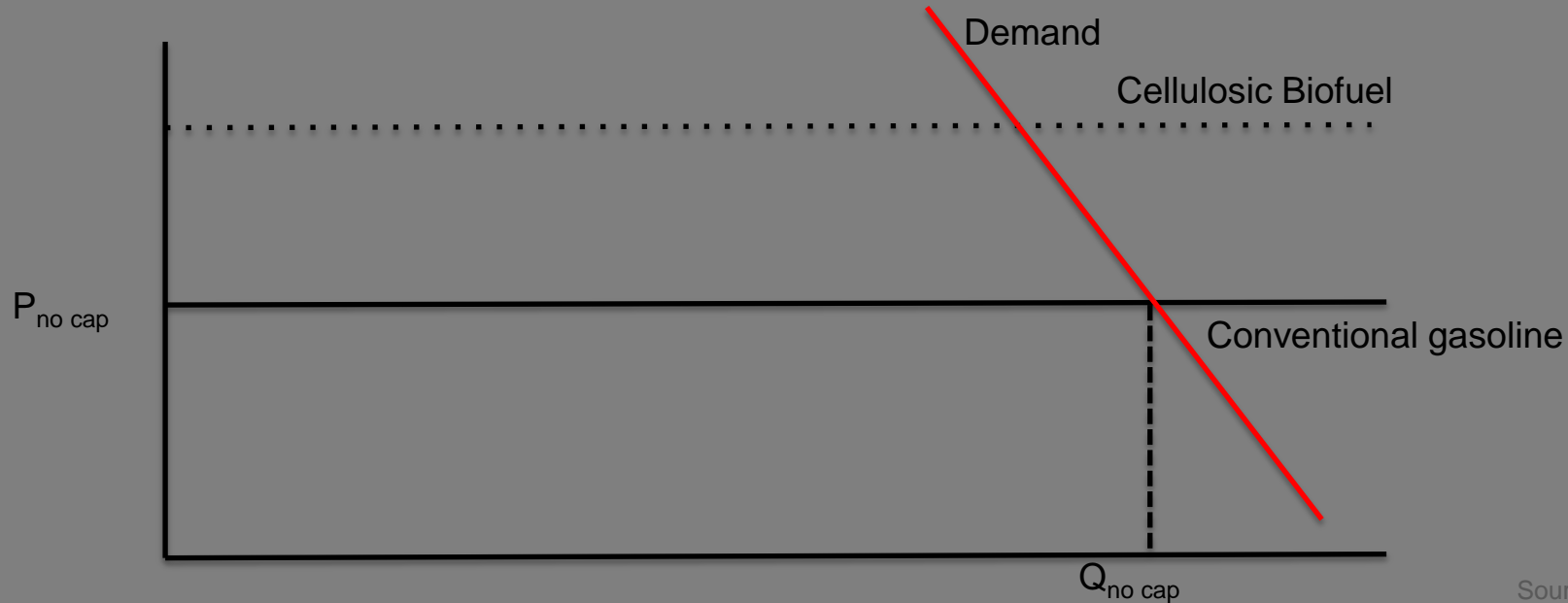
*Last Updated 11/14/2018*

This chart tracks credit prices and transaction volumes over time. Monthly average credit prices reported by Argus Media and OPIS [used with permission] are shown along with ARB monthly average price.

# Standards and Caps in Fuels: What are the differences?

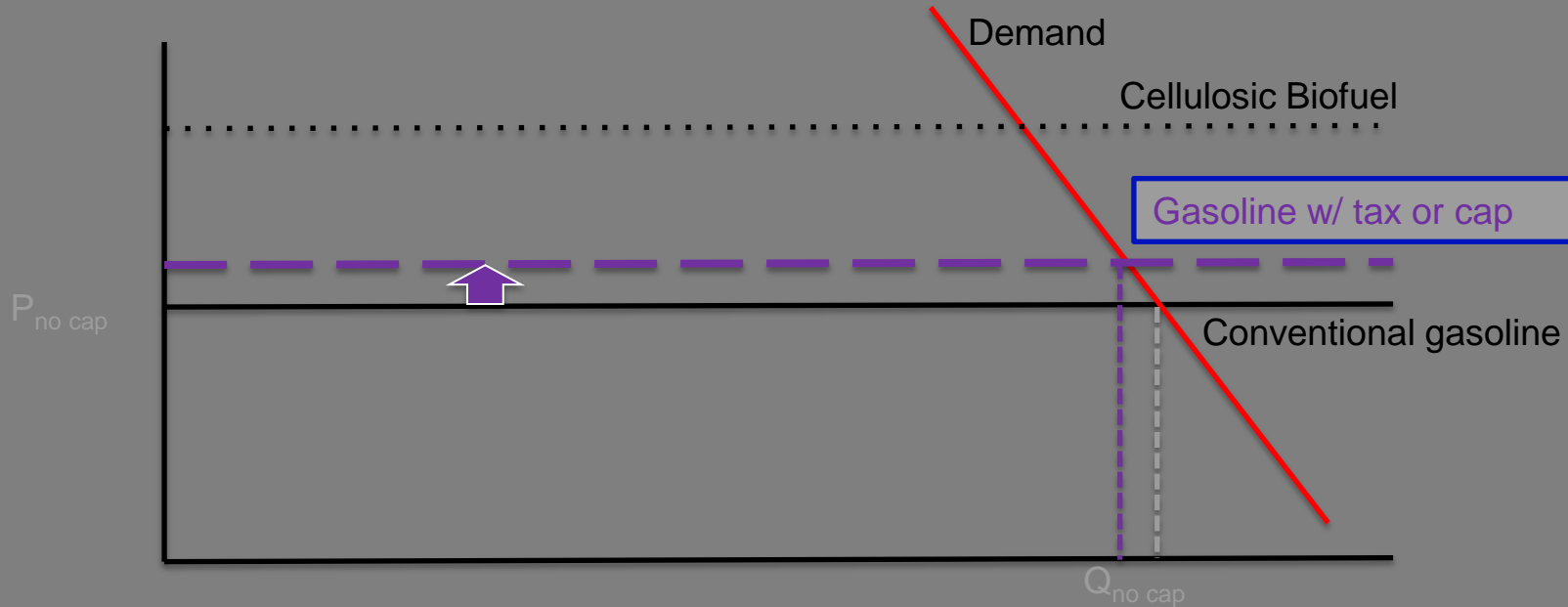


## Two Fuels – No policy: consumes only gasoline, not cellulosic

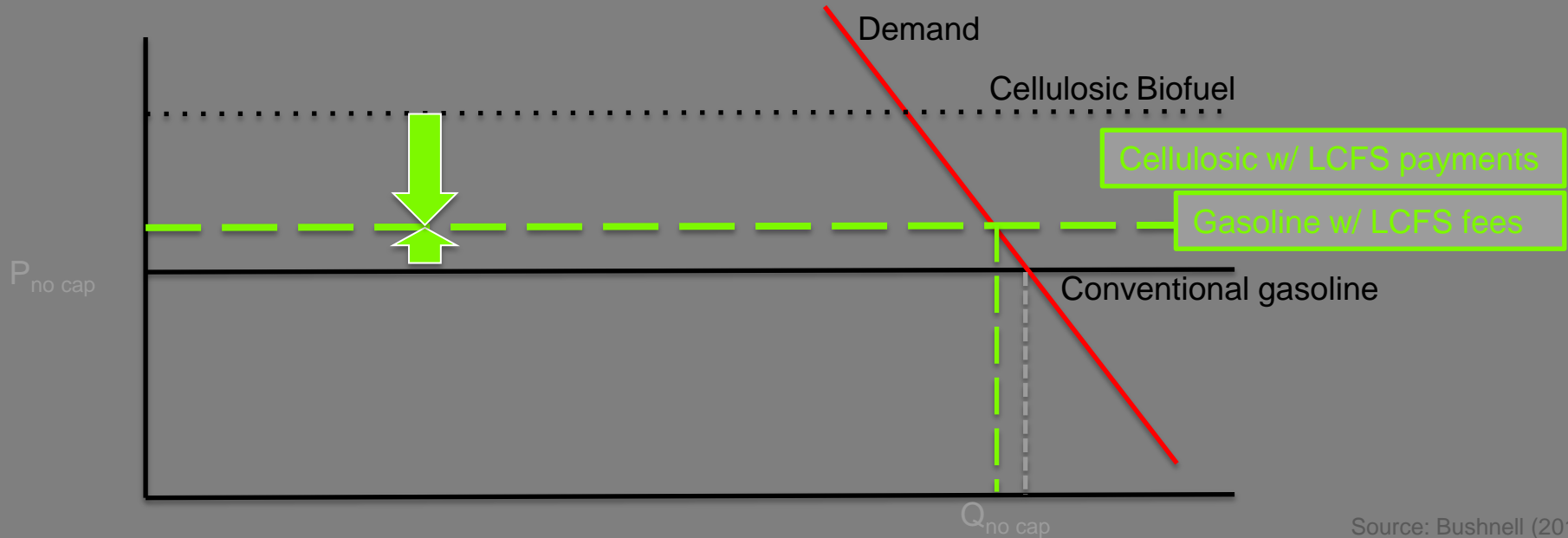


Source: Bushnell (2015)

# Carbon Tax or Cap raises costs of dirtier fuels



# LCFS raises costs of dirtier fuels and lowers costs of cleaner fuels



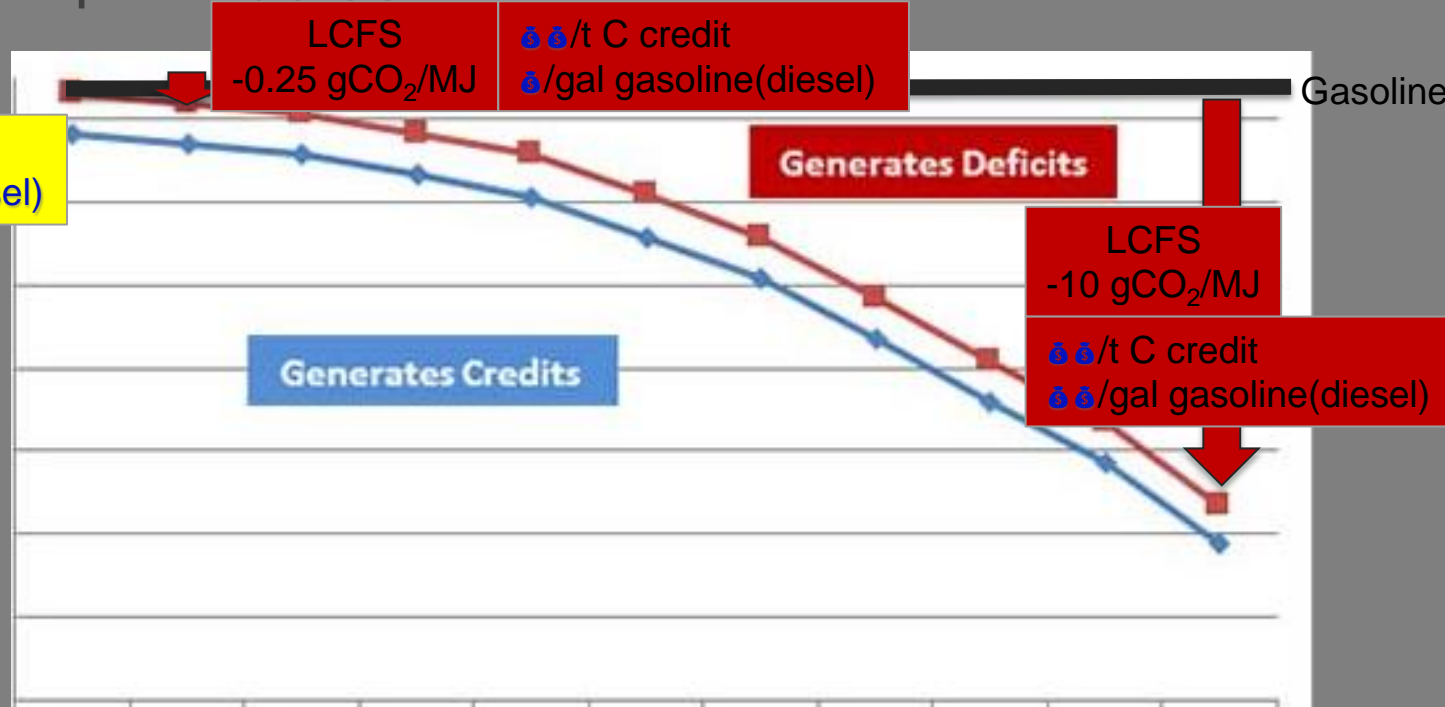
Source: Bushnell (2015)

# LCFS vs. Cap-and-trade: (1) different quantities of carbon emissions are priced; (2) price levels are different

Cap-and-trade  
+73 gCO<sub>2</sub>/MJ

1/t C credit  
11111/gal gasoline (diesel)

73 gCO<sub>2</sub>/MJ  
Combustion emissions



## LCFS vs. Cap-and-trade

	Cap-and-Trade	LCFS
Allowance/Credit price	\$12.5/allowance (floor)	
Equiv tax: gasoline/diesel	11 cents/gal (0.02 Euro per liter)	
Equiv tax: ethanol	0	
Equiv tax: E10 (Gasoline w/ 10% ethanol)	9 cents/gal	

## Alternative jet fuels (AJF) as opt-in credit-generating fuels

- AJF not subject to the LCFS regulation and would therefore not generate deficits
  - opt-in AJF pathways would be eligible to generate credits for the total volume loaded to planes in California, whether the destinations are in California or out of the state
- Benefits
  - reductions in global GHG emissions
  - Increase in investment and off-take agreements
  - reduce criteria pollutant emissions during taxi, takeoffs, and landings, which could improve air quality

# Maritime

- Fuels in ocean-going vessels are exempted
  - fuel in recreational and commercial harbor craft are not exempt
- Some options to cover electricity-at-berth — shore power to ocean-going vessels



## Credit Value Calculator: Estimated LCFS Premium at Sample LCFS Credit Prices

Alternative Fuel Premiums at Sample LCFS Credit Prices (\$/gal gasoline-equivalent for fuels used as gasoline substitutes)						
CI Score (gCO <sub>2</sub> e/MJ)	Credit Price					
	\$110	\$80	\$100	\$120	\$160	\$200
151	-\$0.71	-\$0.52	-\$0.65	-\$0.78	-\$1.04	-\$1.30
10	\$1.08	\$0.79	\$0.98	\$1.18	\$1.58	\$1.97
20	\$0.96	\$0.70	\$0.87	\$1.04	\$1.39	\$1.74
30	\$0.83	\$0.60	\$0.75	\$0.90	\$1.21	\$1.51
40	\$0.70	\$0.51	\$0.64	\$0.76	\$1.02	\$1.27
50	\$0.57	\$0.42	\$0.52	\$0.63	\$0.83	\$1.04
60	\$0.45	\$0.32	\$0.41	\$0.49	\$0.65	\$0.81
70	\$0.32	\$0.23	\$0.29	\$0.35	\$0.46	\$0.58
80	\$0.19	\$0.14	\$0.17	\$0.21	\$0.28	\$0.35
90	\$0.06	\$0.05	\$0.06	\$0.07	\$0.09	\$0.12

€/liter

0.46 ← price of HFO

0.40

0.35

0.29

0.24

0.19

0.13

## Other considerations

- Risks:
  - **Leakage** in the face of regulation, or **shuffling** in the face of voluntary opt-in.
- Opportunities:
  - Alternative fuels such as fossil- or bio-methane in the face of MARPOL Annex VI regulation could already generate low-C fuel.
  - Credits generated through LCFS improve the economics of fuels.
- Unknowns:
  - Outside of California, who should be the regulatory body developing rules such as baseline, credit generations and trade, credit prices, fuel carbon intensity, etc.?

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