

JCCTRP

Joint Clean Climate Transport Research Partnership
Partenariat de recherche conjoint sur le climat et les transports



Comparison of the Proposed Canadian Clean Fuel Standard with Low-Carbon Fuel Standards in California and other jurisdictions: Preliminary Findings

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Engineering

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- **Goal**

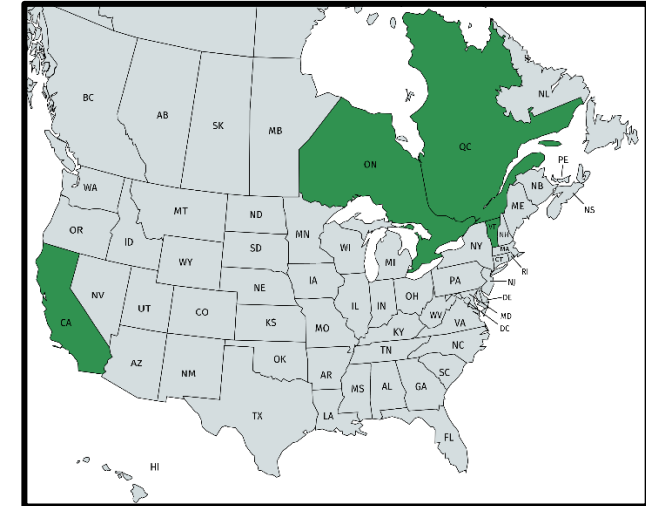
- To identify technical, economic and political factors shaping the potential for environmentally effective, economically efficient, and politically viable low-carbon transport and climate mitigation policy.

- **Partner organizations**

- Leading universities, private research institutions, businesses and non-profit organizations
- **Quebec, California, Ontario and Vermont**
- Includes jurisdictions of the WCI, RGGI and TCI

- **Funding**

- Recipient of a Partnership Development Grant from the Canadian Social Sciences and Humanities Research Council (SSHRC)



Introduction

- **Introduction**
- **Objectives and scope of fuel carbon intensity standards**
- **Targeted policy actors and credit market**
- **Credit generation protocols**
- **Comparison with carbon pricing**
- **Conclusion**

Overview of Canadian Clean Fuel Standard

- **Primary Goal**

- Primary goal of the CFS is a 10-12% reduction in average fuel carbon intensity in Canada relative to a 2016 base year by 2030
- Expected to lead to annual emissions reductions of approximately 17.5 MtCO₂e* by 2030

- **Timeline**

- Initiated in 2016
 - Initially targeted liquid, gaseous and solid fossil fuels
- Currently under development
 - Published in Gazette, Part 1 (December 2020)
 - Focus narrowed to only liquid fossil fuels, with limited opportunities for gaseous and solid fossil fuel displacement
- Coming into force by December 2022

*Updated since webinar⁴

Fuel Carbon Intensity (CI) Standards in North America

Jurisdiction	Instrument Name	Base Year	First Year of Regulation	2020 Average CI Reduction	2030 Average CI Reduction
California	Low Carbon Fuel Standard	2010	2011	-7.5% (orig. -10%)	-20%
British Columbia	Renewable and Low Carbon Fuel Requirements Regulation	2010	2011	-9.1% (orig. -10%)	-20%
Oregon*	Clean Fuels Program	2015	2016	-2.5%	-20%
Canada	Clean Fuel Standard	2016	December 2022	NA	app. -12.5%*

*Updated since webinar

Objectives and Scope of Fuel Carbon Intensity Standards

Increasing Importance of Regulations for Climate Change Mitigation

- **Carbon price gap**
 - A substantial difference between the damages caused by a ton of CO₂ emissions and the price paid for emissions
- **Regulations to fill the gap?**
 - Regulations convey the costs of climate change mitigation differently across stakeholders
 - Regulations appear to have political advantages over carbon pricing
 - Supplier-focused regulation
 - Passive public support

Fuel Carbon Intensity Standards are an Example of Flexible Regulations

- **“Flexible regulations”**
 - Mimic the flexibility of carbon pricing by focusing on a sector-wide outcome “without dictating the specific behavioural or technological choices of individuals and firms” (Jaccard 2020)
- **Flexibility of promoted through a credit market**
 - Focus on reducing average fuel carbon intensity in a jurisdiction
 - Credit market across actors with a jurisdiction
- **Focus on reducing emissions of GHGs throughout the entire lifecycle of liquid fossil fuels**
- **Key metric is carbon intensity measured in terms of gCO₂e/MJ**

Liquid Fossil Fuel Lifecycle

Point of
Production



Point of
Distribution



Point of
End-Use
Consumption



Post-
Consumption



Upstream
GHG Emissions

Downstream
GHG Emissions

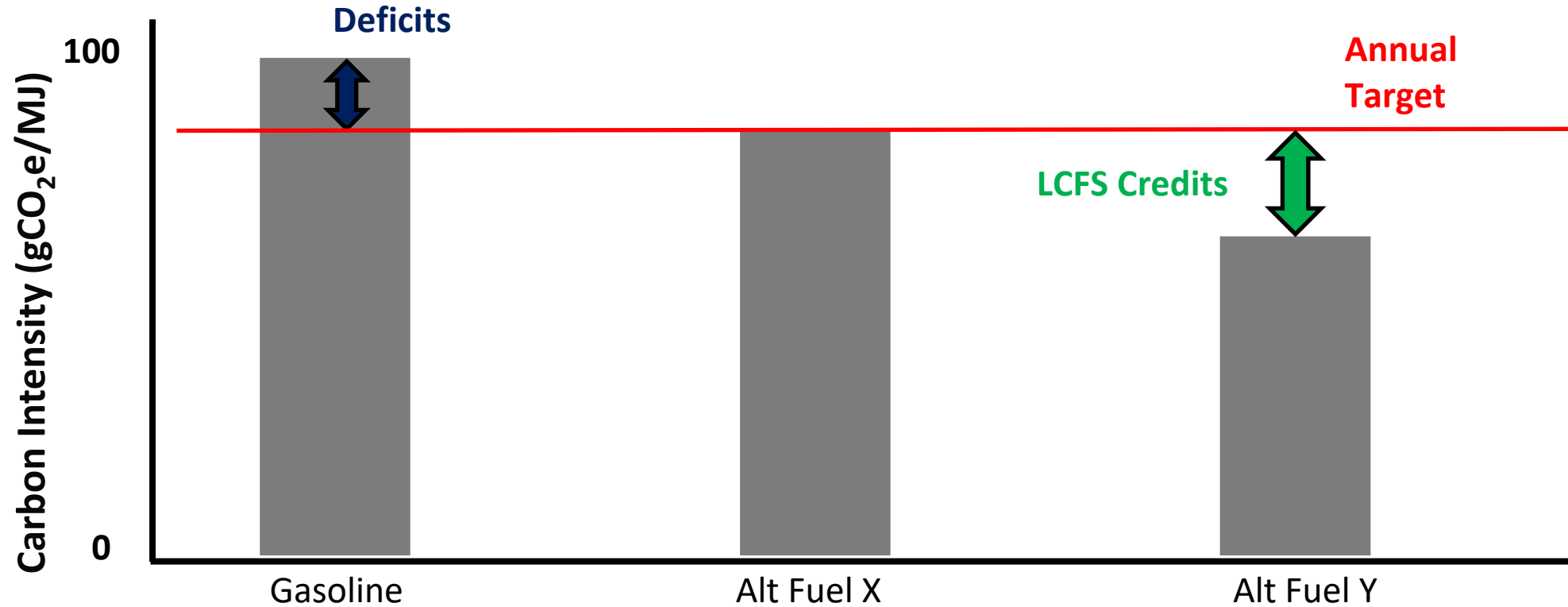
Recognized Liquid Fossil Fuel Types across Instruments

Fuel Type	Canada CFS*	California LCFS	BC LCFS
1) Gasoline	✓	✓	✓
2) Diesel	✓	✓	✓
3) Kerosene	✓	✓	✓
4) Light Fuel Oil	✓	Not Included	Not Included
5) Heavy Fuel Oil	✓	Not Included	Not Included
6) Jet Fuel	TBD**	Optional	Not Included

*Important under CFS

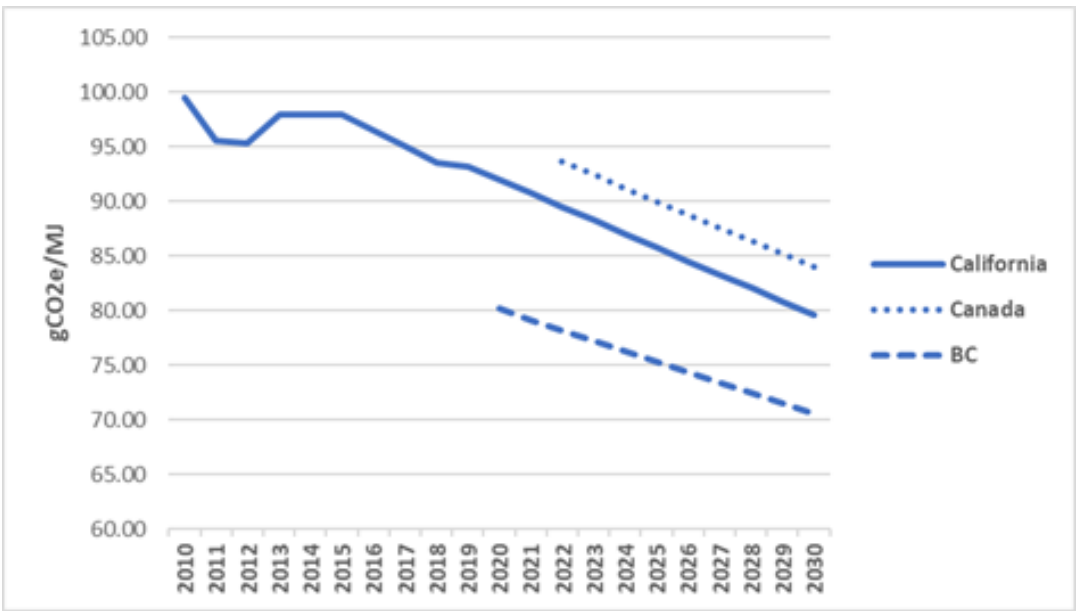
- Does not apply to Canadian fossil fuels for export
- Remote communities in Canada are exempt but not the industrial use of fuel in remote communities
- Domestic jet fuel may be included in some form in final rule

Fuel CI Standard sets a target, measures fuels against it

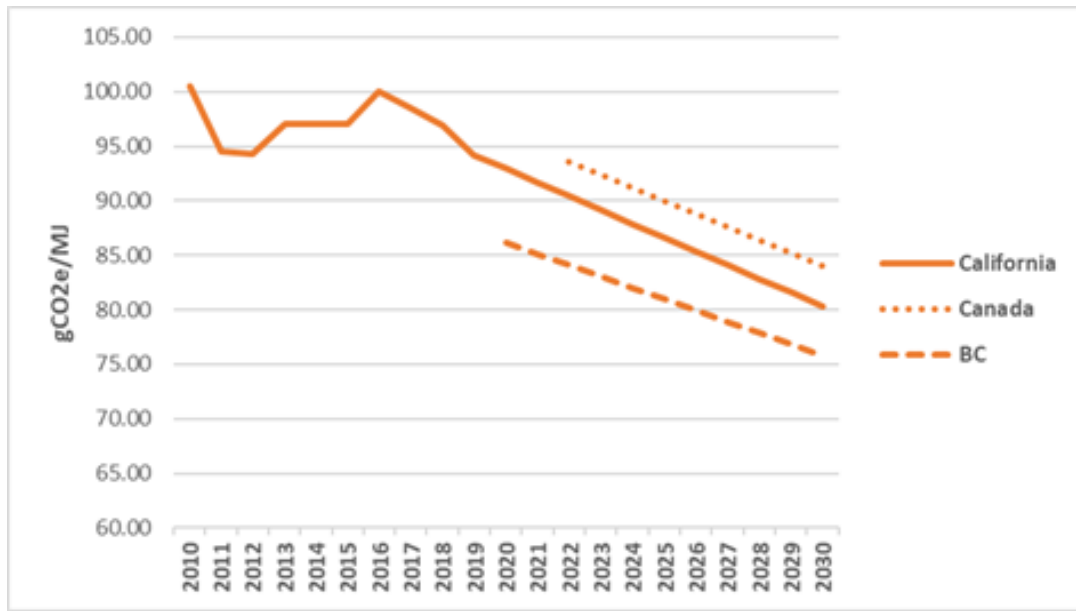


Comparison of Carbon Intensity Benchmarks in Canada, California and BC (2010-2030)

Gasoline (gCO2e/MJ)



Diesel (gCO2e/MJ)



Recognized Low-Carbon Fuel Types & Alternative Energy Sources

	Canada CFS	California LCFS	BC LCFS
<u>1) Low-carbon liquid fossil fuels</u> <ul style="list-style-type: none"> • Carbon capture and storage (CCS) • Low CI electricity integration • Enhanced oil recovery • Co-processing of biocrudes in refineries and upgraders 	✓	✓	Not Directly Included
<u>2) Low-carbon liquid alternative fuels</u> <ul style="list-style-type: none"> • Biofuels • Synthetic fuels 	✓	✓	✓
<u>3) Low-carbon alternative energy sources</u> <ul style="list-style-type: none"> • Natural gas • Propane • Hydrogen • Renewable natural gas • Renewable Propane • Electricity 	✓	✓	✓
<u>4) Low-carbon Supporting Infrastructure</u>	Not Directly Included	✓	✓

Targeted Policy Actors and Credit Market

CFS Credit Market

- **Regulated parties must meet an annual average carbon intensity standard for their respective fuel pools**
 - Demonstrated via a balance of program credits and deficits
 - Ensure that debits incurred from supplying higher carbon intensity fuels are offset by credits generated from supplying lower carbon fuels
- **To comply, regulated parties may generate credits, purchase fuels that carry credits with them, or buy credits in the market**
- **Credits are fully fungible between fuel types, tradable, and bankable for future program use**

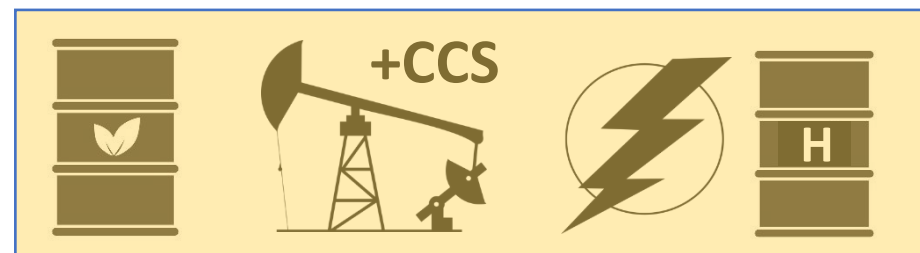
Two Sets of Policy Actors Targeted

Liquid fossil fuel producers and distributors

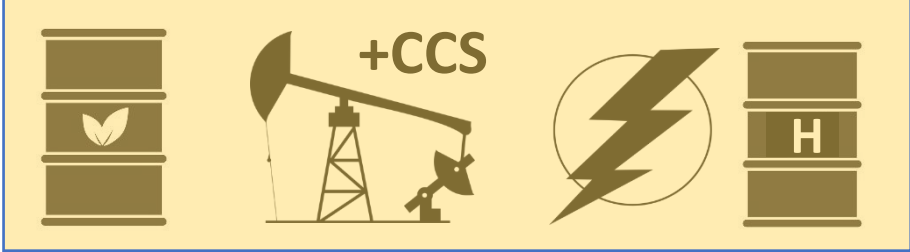
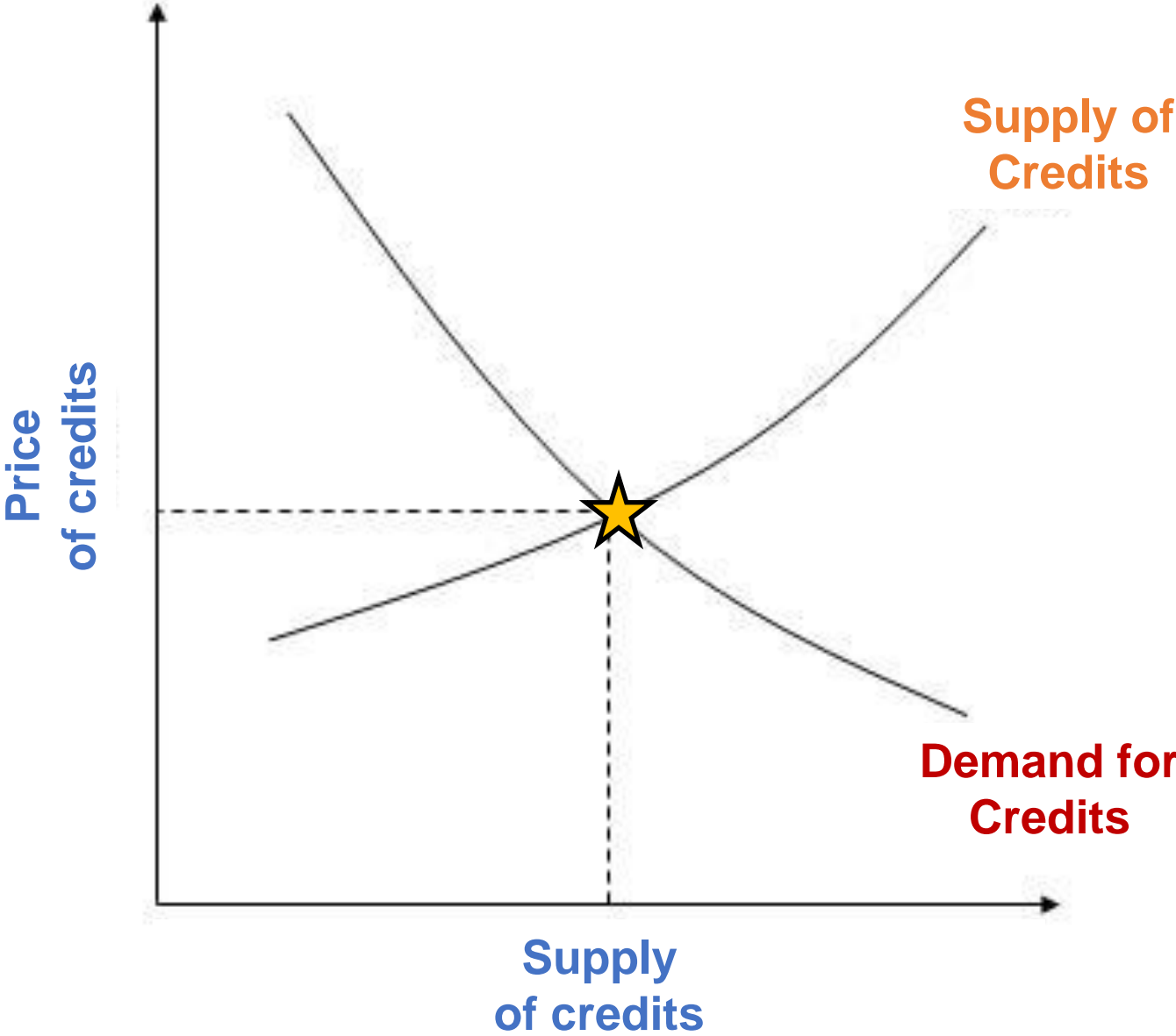
- Participation required
- Incumbent firms producing and distributing liquid fossil fuels within a jurisdiction
- Their activities lead to market deficits

Firms producing or importing alternative low-carbon fuels and energy sources

- Participation voluntary
- Might include new entrants but might also include incumbent firms currently producing liquid fossil fuels but transitioning towards the production of low-carbon ones
- Their activities produce market credits



Supply and Demand for Credits for the Provision of Low-carbon Fuels and Alternative Energy



Regional Impacts of Canada-Wide CFS Credit Market

- Canadian regions differ considerably in low-carbon energy opportunities → more diverse credit market than California or BC
- Different regional economic impacts anticipated from CFS credit market
- Would require further research

Credit generating protocols

Credit Generating Protocols Vary Across Jurisdictions

- **Credit generating protocols are a regulatory tool designating how a low-carbon fuels carbon intensity is determined and/or how credits are generated.**
 - The Canadian CFS refers to three “compliance categories”
 - The California LCFS refers to three types of “credit generation activities”
 - BC LCFS suggests two categories, including fuel pathway-based crediting and “Part 3 Agreements”
- **Credit generating protocols are highly technical and approaches between jurisdictions are not directly comparable**

Recognized Credit Generating Protocols

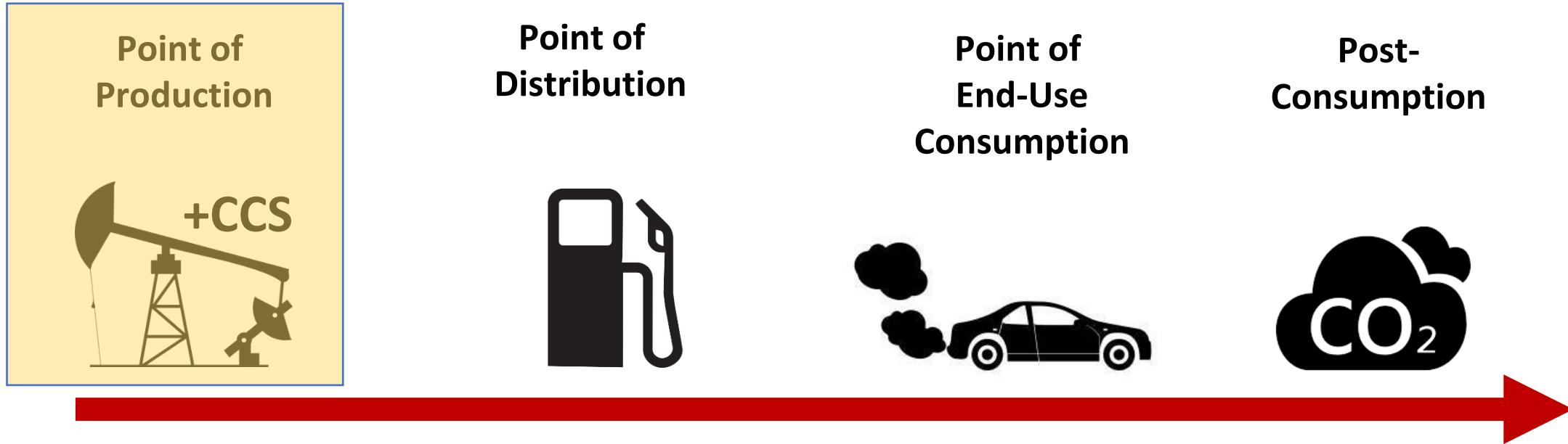
	Canada CFS	California LCFS	BC LCFS
<u>1) Low-carbon liquid fossil fuels</u> <ul style="list-style-type: none"> • Carbon capture and storage • Low CI electricity integration • Enhanced oil recovery • Co-processing in refineries and upgraders 	Compliance Category 1 (Project-based, but coprocessing equivalent to (2))	Project-Based Crediting, except coprocessing, treated as (2)	No, except co-processing, treated as (2)
<u>2) Low-carbon liquid alternative fuels</u> <ul style="list-style-type: none"> • Biofuels • Synthetic fuels 	Compliance Category 2	Fuel Pathway-based Crediting	Fuel Pathway-based Crediting
<u>3) Low-carbon alternative energy sources</u> <ul style="list-style-type: none"> • Natural gas • Propane • Hydrogen • Renewable natural gas • Renewable Propane • Electricity 	Compliance Category 3		
<u>4) Low-carbon Supporting Infrastructure</u>	Not Available	ZEV Fueling Infrastructure Crediting	Part 3 Agreements

Comparison of CFS Compliance Category 1:

Low-Carbon Liquid Fossil Fuels

- Credits generated from projects that reduce the full lifecycle carbon intensity of liquid fossil fuels produced through projects that reduce upstream or downstream emissions
- Only available to Canadian producers for projects in Canada; unavailable to firms importing liquid fossil fuels
- While various types of projects are envisioned, ECCC is developing quantifications methodologies for the following project types:
 - (i) carbon capture and storage
 - (ii) low-carbon intensity electricity integration
 - (iii) enhanced oil recovery
 - (iv) co-processing of biomass in refineries and upgraders*
 - (v) generic quantification methodology (for regulated party to opt in with new technique)**
- **Credit generation protocol similar to carbon offsetting**
 - A project that reduces upstream or downstream emissions would be credited for generating emission reductions that are additional to a base case or reference level of a scenario where the project had not been introduced *except (iv), which is credited against CI target

Category 1 Credit Generation: Low Carbon Fossil Fuel Supply

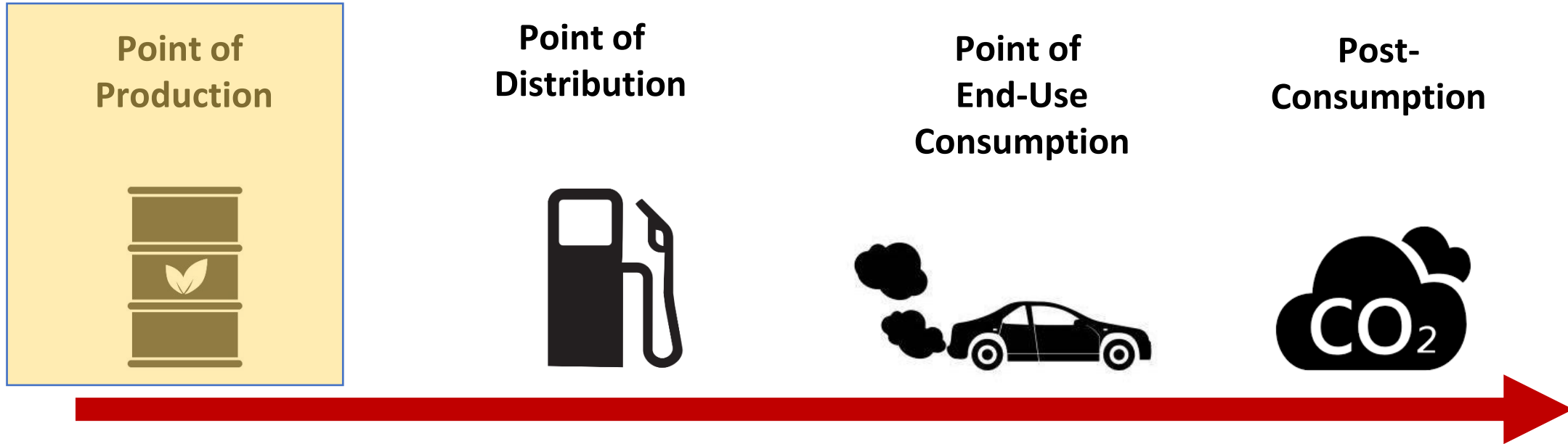


Credits accrue to
firm producing fuel
(importation not allowed)

Comparison of CFS Compliance Category 2: **Low-Carbon Liquid Alternative Fuels**

- **To incentive the production and importation of:**
 - Conventional biofuels
 - Synthetic fuels, such as those made from CO₂ sourced via direct air capture or syngas generated from any biomass resource
- **All low-carbon alternative liquid fuels supplied to the Canadian market would be able to create credits**
 - Amount of credits generated would be based on the amount of alternative fuel supplied (in MJ), the difference between its lifecycle carbon intensity and the reference carbon intensity value for the liquid fossil fuel being displaced
- **There are two quantification methods for calculating lifecycle CIs**
 - Fuel Lifecycle Assessment (LCA) Model being developed by ECCC
 - Default values that will be made available for specific types of low-carbon alternative liquid fuels

Category 2 Credit Generation: Low Carbon Liquid Fuel Supply



Credits accrue to
firm producing or
importing fuel

Different Lifecycle Analysis Approaches Across Jurisdictions

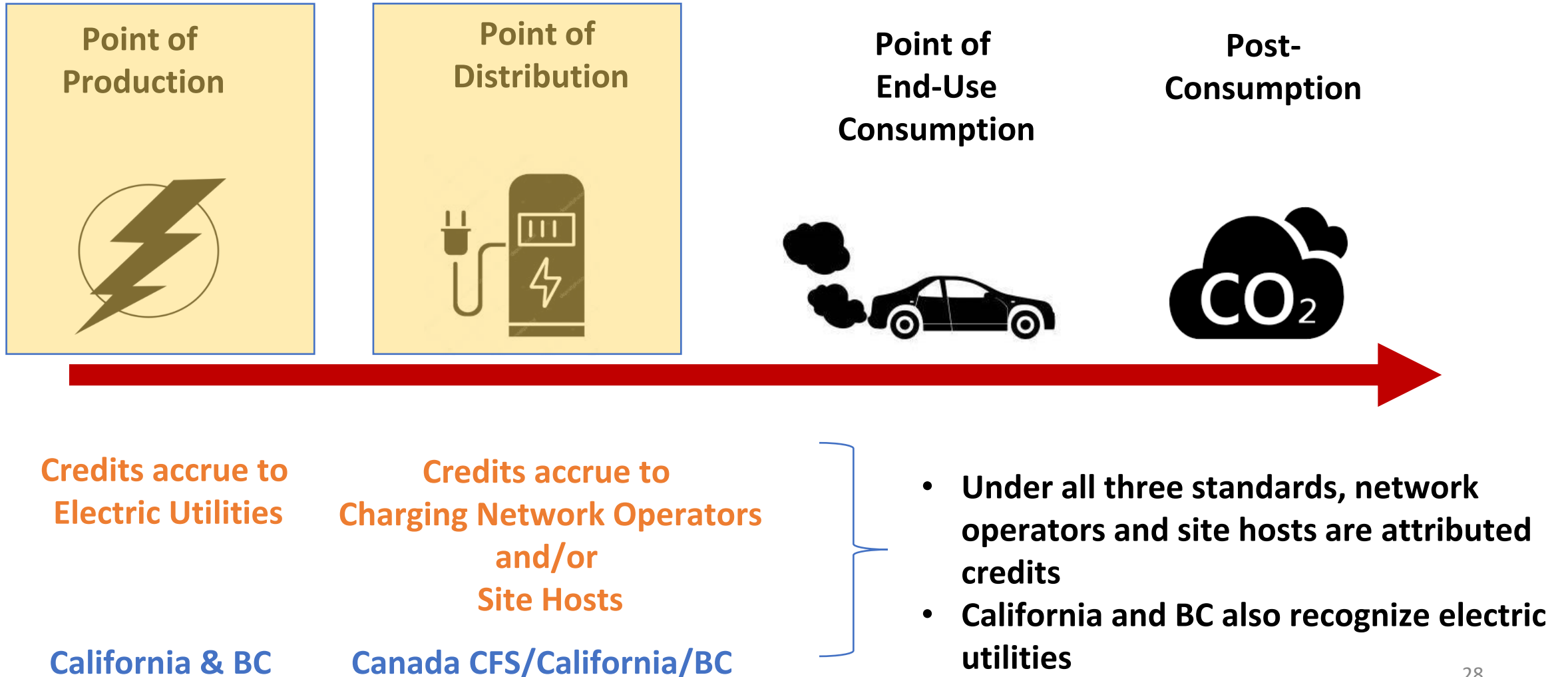
Canada CFS	California LCFS	BC LCFS
Model being developed by ECCC*	GREET Model+	GHGenius
No Indirect Land Use Change	Includes Indirect Land Use Change	No Indirect Land Use Change
Land use and biodiversity criteria		--

- Omission of indirect land use may lead to underestimates of emissions
- Indirect land use change is challenging to estimate with accuracy
 - Modeled in California via economic general equilibrium model (GTAP-BIO) plus land use type conversion factor model (AgroEcological Zone Model)

Comparison of CFS Compliance Category 3: **Low-Carbon Alternative Energy Sources**

- **Compliance achieved by replacing liquid fossil fuels for road transportation with low-carbon and non-liquid energy sources**
- **The CFS currently considering the following types of policy actors**
 - Owners or operators of fueling facilities for hydrogen, natural gas, RNG, propane and renewable propane
 - Producers and importers of low carbon intensity alternative fuels
 - For electric vehicles
 - Network operators supplying electricity for residential and public charging stations
 - Charging station hosts for supply electricity for private charging stations
- **Under CFS, credits for end-use fuel switching to electric vehicles are calculated using lifecycle CI electricity values by province**

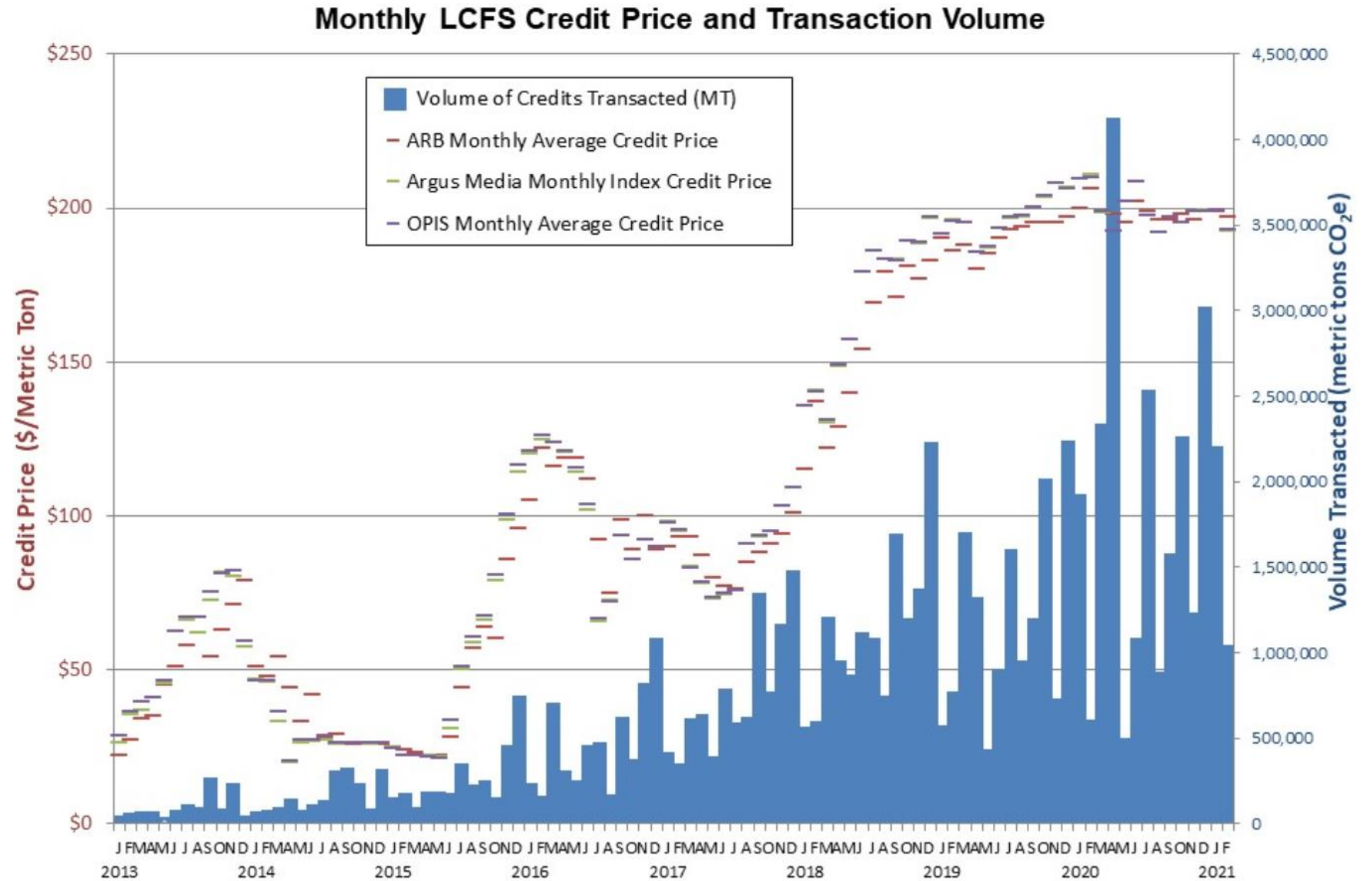
Category 3 Credit Generation: Example of Incentives for Electric Vehicles



Comparison with Carbon Pricing

Prices on California's LCFS Credit Market

- Prices on the LCFS credit market started at under \$50 USD per tCO₂e
- About \$200 USD per tCO₂e since 2019



CFS/LCFS Credits are Not Fungible with Emission Allowances and Carbon Credits

How It's Like Cap-and-Trade

- Credits measure total carbon mass
- Provides monetary value for reducing emissions
 - More reductions=more \$
 - Incentive for low carbon tech
- Regulated parties can trade compliance credits
 - Allows market to find efficient reduction opportunities

How It's Not

- Only affects transportation fuels
- Credits measure relative reduction
- Revenue neutral to state
 - Credit value stays in transportation
 - \$ transfer from high-carbon to low-carbon fuel providers
- Stronger push-back against dirty fuels
- Intended to support fuel tech change (vs. near-term least cost CO₂ reduction)

Numerical Example

Comparison of Changes to the Cost of Supplying Transport Fuels between Cap-and-Trade and LCFS at an 10% CI reduction level

Fuel Type	Carbon Price	Carbon Intensity	Energy Density	Production Costs	Changes to Cost of Producing Fuels		Total Supply Costs after Policy	
	\$USD/tCO ₂ e	gCO ₂ e/MJ	MJ/gallon	\$USD/gallon	Cap-and-Trade	LCFS	Cap-and-Trade*	LCFS**
Carbon Price of \$20 USD per tCO₂e								
Diesel	\$20	100	135	\$3.00	+\$0.27	+\$0.027	\$3.27	\$3.03
Renewable Diesel	\$20	40	125	\$4.00	+\$0.10	-\$0.125	\$4.10	\$3.87
Carbon Price of \$200 USD per tCO₂e								
Diesel	\$200	100	135	\$3.00	+\$2.70	+\$0.27	\$5.70	\$3.27
Renewable Diesel	\$200	40	125	\$4.00	+1.00	-\$1.25	\$5.00	\$2.75

Conclusion

Preliminary Conclusions

- **Comparable carbon intensity reduction pathways across jurisdictions**
 - Comparable rate of carbon intensity reduction anticipated for Canadian CFS, California LCFS and BC LCFS
 - Canada making effort to decarbonize fuel to a similar degree but in less time than other jurisdictions*
 - Canadian CFS aiming to achieve only 12.5% carbon intensity reduction by 2030 relative to 2016 base year while California and BC seeking 20% reduction relative to 2010 base year.
- **Subtle but potentially significant differences between recognized credit generation activities across jurisdictions**
- **Credits not directly comparable with carbon pricing**
- **Regional differences potentially more important for CFS credit market than instruments in California and BC**



Merci! Thank you!!

JCCTRP Webinar Series

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- **May 2021**
 - Webinar: Modeling carbon pricing and policy sequencing in Quebec and Ontario
- **June 2021**
 - Webinar: Comparative Investigation of Urban Transport Planning in Montreal, Toronto and LA
- **July 2021**
 - Webinar : Road-map for addressing technical, economic and political dimensions of low-carbon transport and climate change mitigation policy
- **Past Webinars and Events**
 - February Webinar: Urban Transit Modeling
 - Working paper: Modeling the impact of electric vehicle penetration on energy demand in Quebec



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