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OVERVIEW OF LOW CARBON FUEL STANDARD

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IEPR WORKSHOP
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CARB's Climate Portfolio for 2030 Target

Double building efficiency

More clean, renewable fuels

Cleaner zero or near-zero emission cars, trucks, and buses

Walkable/bikeable communities with transit

Cleaner freight and goods movement

60% renewable power

Slash potent "super-pollutants" from dairies, landfills and refrigerants

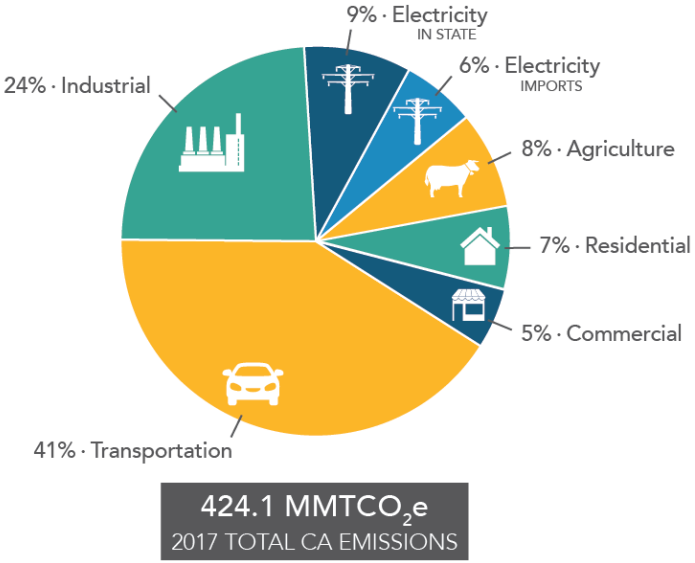
Cap emissions from transportation, industry, natural gas, and electricity

Invest in communities to reduce emissions

Protect and manage natural and working lands

Low Carbon Fuel Standard (LCFS)

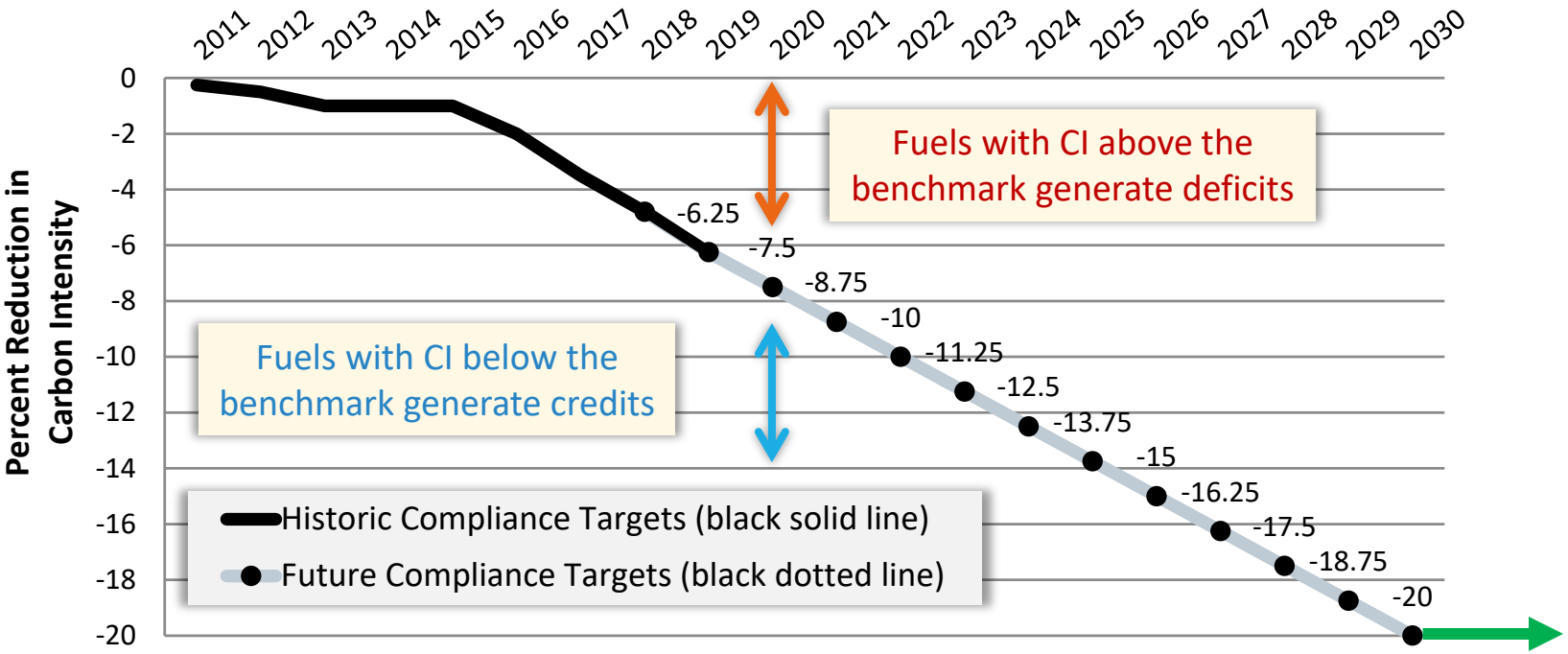
California's primary program to promote alternative fuel use in the transportation sector



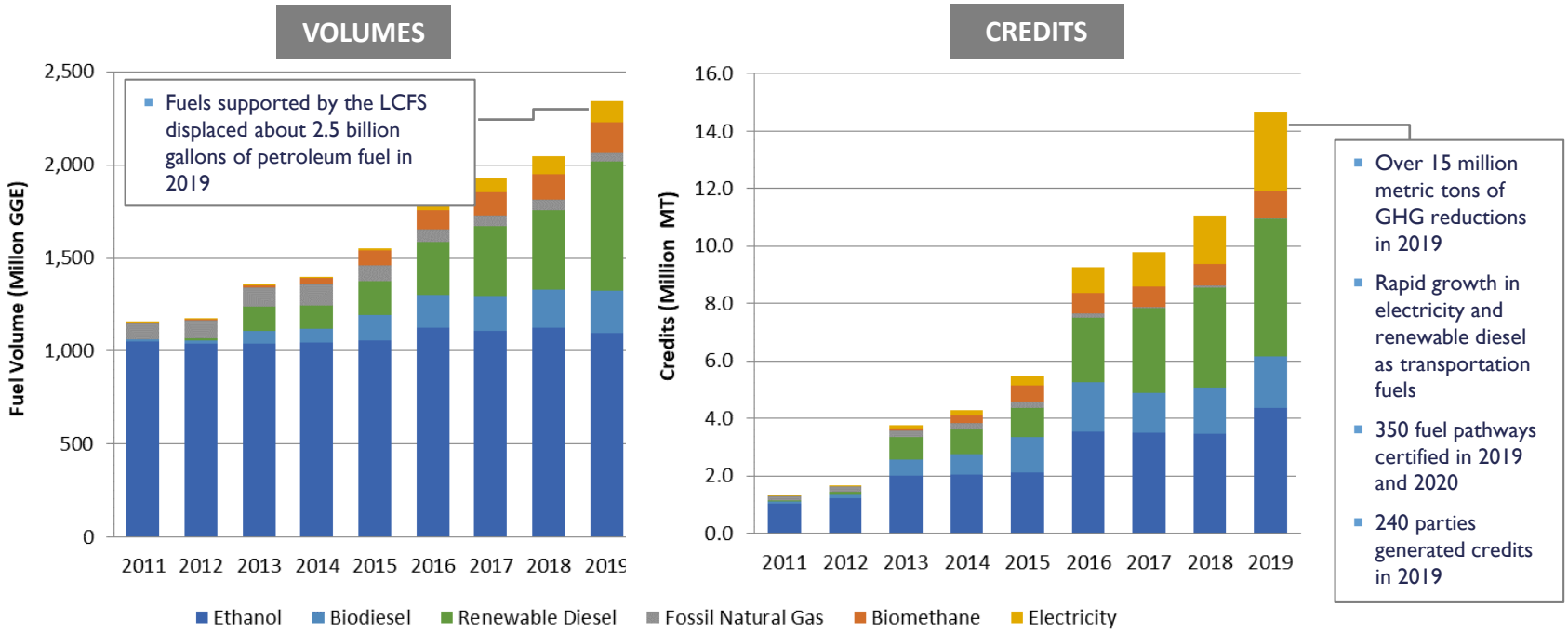
- Reduce carbon intensity of transportation fuels
- Transform and diversify fuel pool
- Reduce petroleum dependency
- Reduce emissions of criteria pollutants and toxics

Transportation sector accounts for 50% of State's GHG inventory when industrial emissions from refining and oil production are included

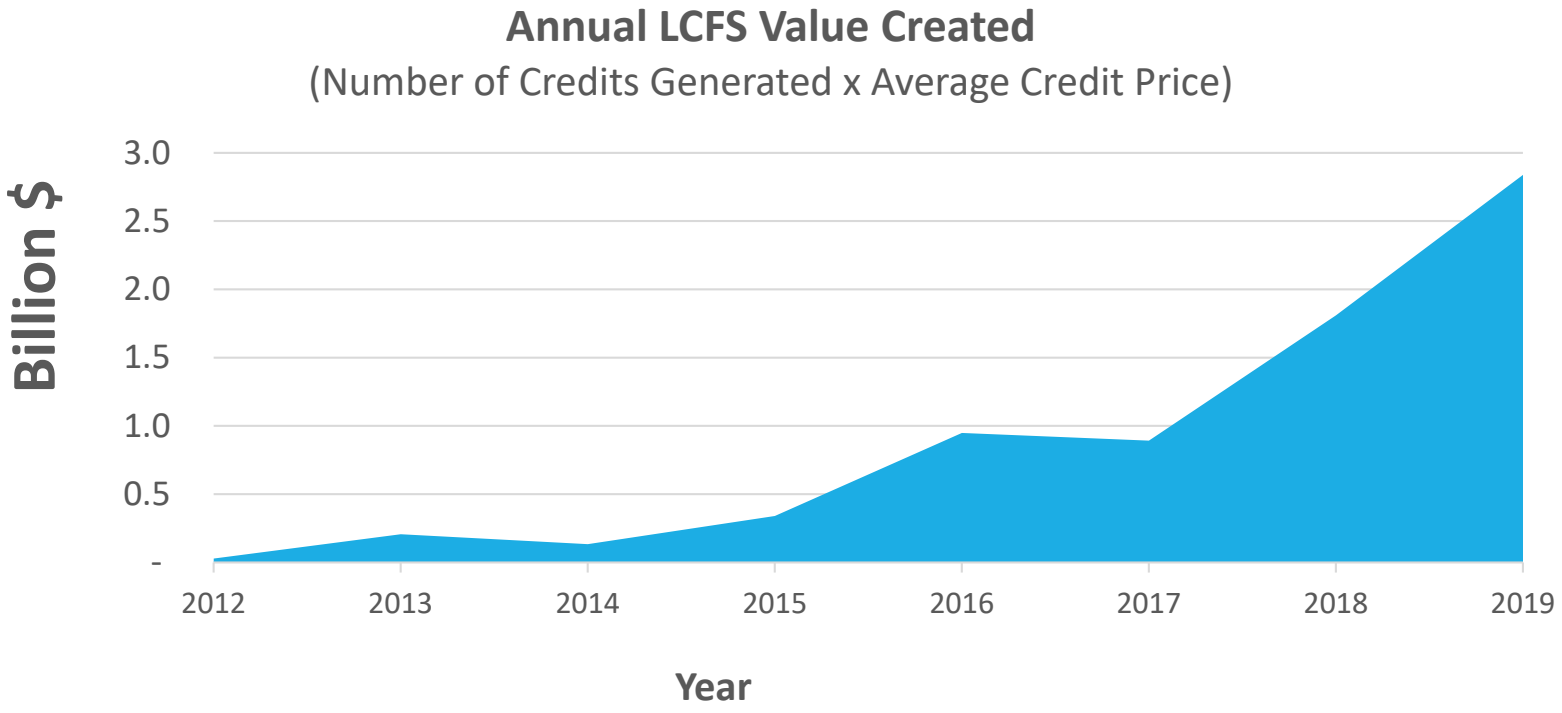
How LCFS Works – Credit and Deficit Generation



Diverse and Growing Alternative Fuel Pool

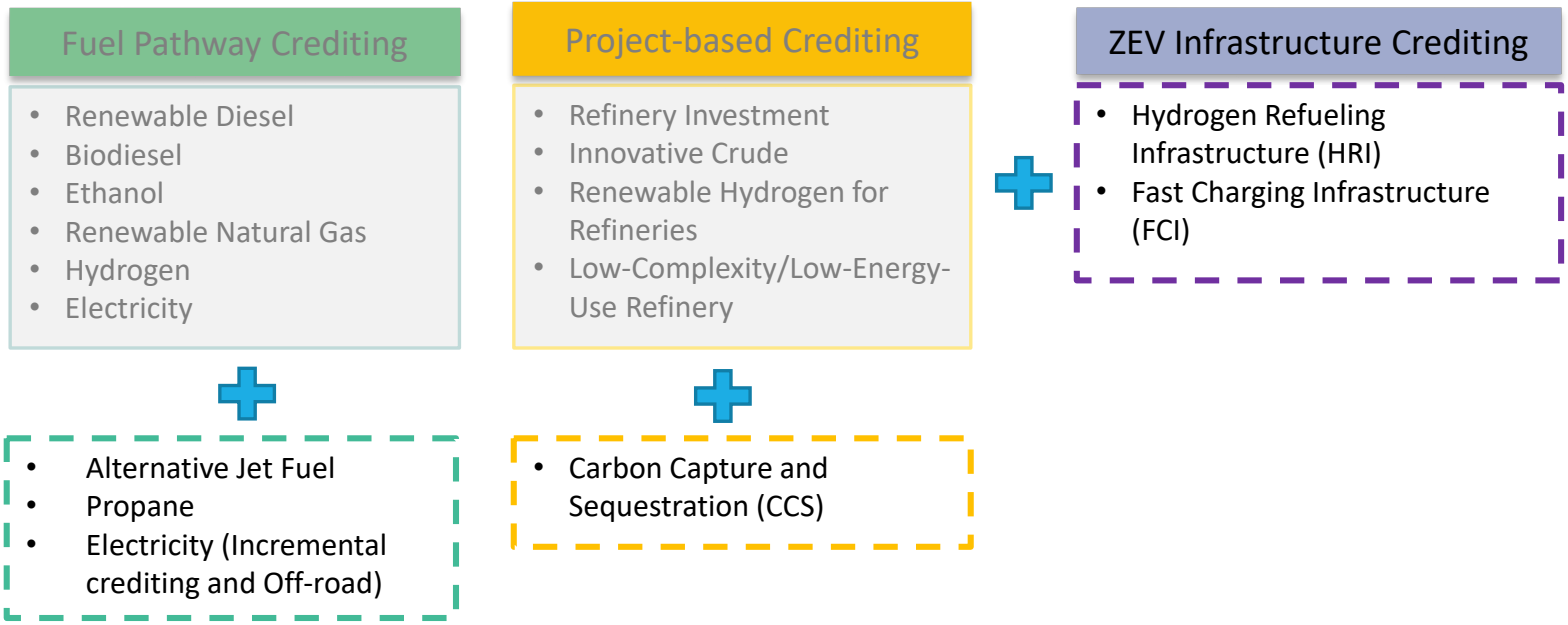


LCFS Promotes Investment in Low Carbon Fuels



LCFS Program - 2018 Rulemaking

- Established a 2030 target of 20% reduction in carbon intensity
- LCA models revised; third-party verification requirements added
- Additional crediting opportunities added starting 2019 (see schematic)

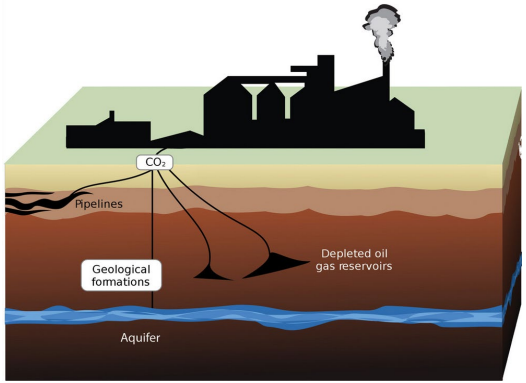


Alternative Jet Fuel

- Alternative Jet Fuel added as an opt-in fuel and starting 2019 eligible for LCFS credits
- Fossil-based conventional jet fuel not subject to the LCFS and does not accrue deficits
- Investment and interest in alternative jet fuel is increasing
  - Amazon to buy 6 million gallons from World Energy
  - Neste delivered AJF to San Francisco airport via pipeline
- **Implementation Status:** Four pathways certified to date with CI range of 24 - 43 g/MJ

Carbon Capture & Sequestration (CCS)

- CCS essential for long-term GHG reduction goals, especially carbon neutrality by 2045
- CCS protocol approved in 2018, providing opportunities for LCFS credit generation for several CCS types
  - LCFS credit potential from CCS projects at biorefineries, oil fields and petroleum refineries, and direct air capture projects
  - Rigorous accounting and permanence requirements, including 100-year post-injection monitoring
- **Implementation Status:**
  - First CCS permanence application submitted in November 2019; several other applications expected soon
  - Design-based pathway certified for CCS at ethanol biorefinery



Renewable Natural Gas (RNG) Projects

- Streamlined application process for Renewable Natural Gas (RNG) projects, utilizing methane derived/captured from low-CI sources including:
  - Dairy and swine manure
  - Organics separated from waste streams
  - Wastewater sludge at public treatment works

Biogas Source	Pathways Received	Pathways Certified
Dairy/swine manure	41	25
Organic waste	6	0
WWTP	6	6

Incremental Crediting for Residential EV Charging

- Incremental credits represent CI reductions from the CA Avg. Grid CI for residential EV charging
  - Now allow for matching of low-CI electricity (e.g. solar or wind electricity) to charging of EVs
- Crediting based on metered charging data (off-vehicle or on-vehicle metering)
- Several value providers can claim based on hierarchy
  1. Load-serving entities (EDU and CCA)
  2. Auto manufacturers
  3. Others (Charging network providers, aggregator, etc)
- **Implementation Status:**
  - Over 300,000 VINs each representing an EV have been registered by 9 entities (including 5 major automakers)
  - Around 370 million kWh reported and 110,000 credits claimed

New Electricity Crediting Categories

- New off-road electric transportation categories added for LCFS crediting:
  - Shore power to Ocean-going Vessels At-berth (eOGV)
  - Electric Cargo Handling Equipment (eCHE)
  - Electric Transport Refrigeration Units (eTRU)

New crediting type	Entities generating credits
eOGV	6
eCHE	2
eTRU	2

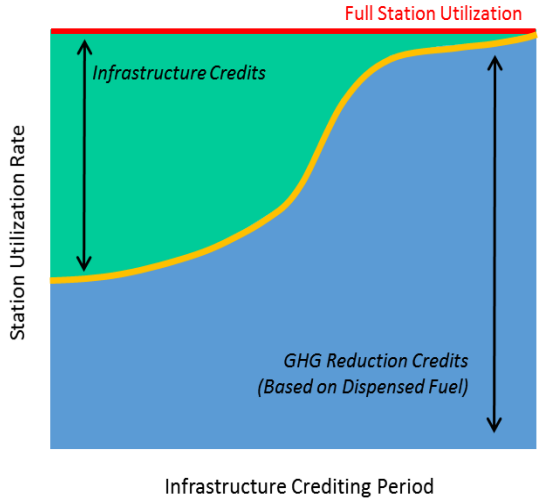
- Smart charging/smart electrolysis pathway to support grid resiliency and provide grid benefits

Pictured: electric-powered cargo handling equipment at Port of Long Beach

ZEV Infrastructure Crediting

- Provision for crediting Hydrogen Refueling Infrastructure (HRI) and DC Fast Charging Infrastructure (FCI)
  - Credits refueling or charging capacity minus dispensed fuel
  - Infrastructure credits decline as stations reach full utilization
  - Total credits limited to 2.5% each of total deficits in prior quarter
- **Implementation status:**

	Approved Stations/Chargers	Approved Daily Refueling Capacity	Cumulative Infrastructure Credits
HRI	48 Stations	31,260 Kg/day	15,424 credits through Q4 2019
FCI	484 DCFC's at 55 sites	175,000 kWh/day	

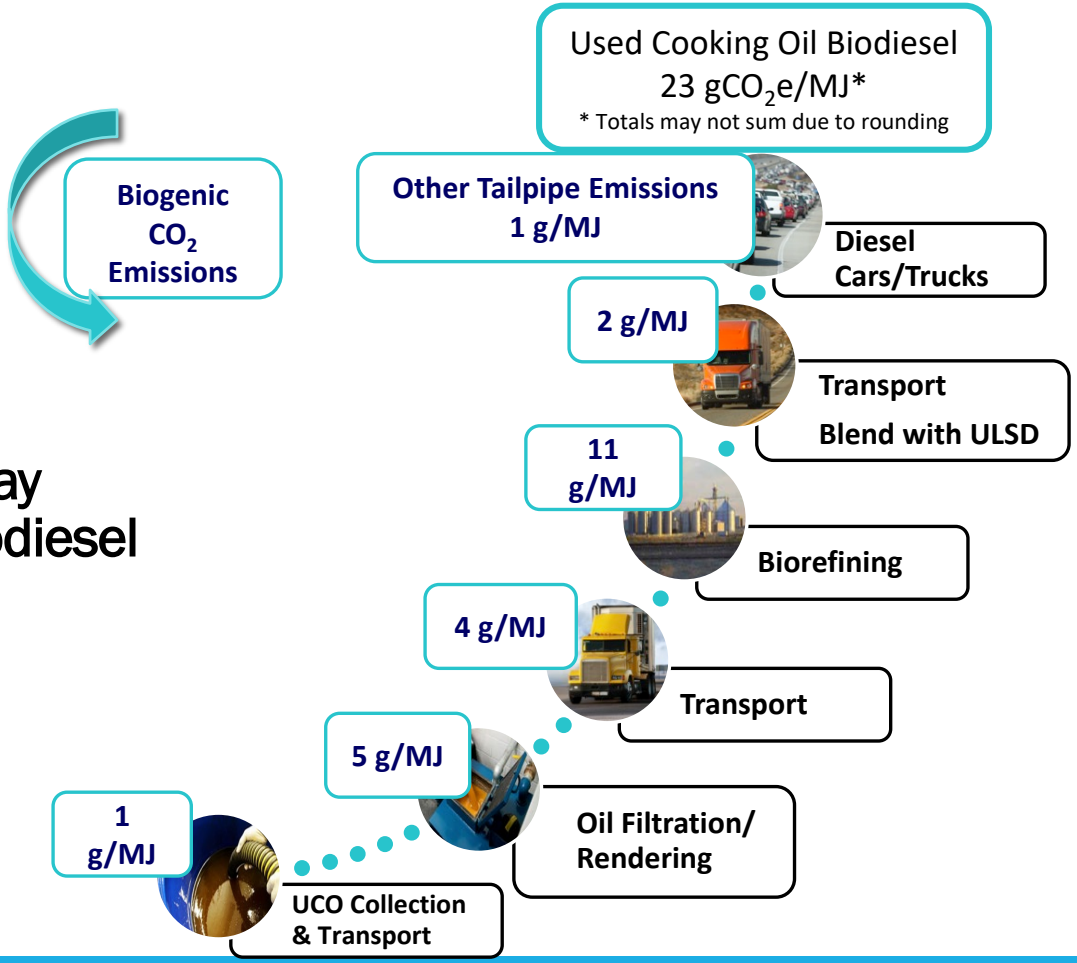


Carbon Intensity Modeling

- CI includes the “direct” effects of producing and using the fuel, as well as “indirect” effects including land use change associated with crop-based biofuels, and the avoided fate associated with by-products and residues of other products

- CI is calculated using the following tools
  - **California Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (CA-GREET):** Direct carbon intensity of fuel production and use
  - **Oil Production Greenhouse Gas Emissions Estimator (OPGEE):** Direct carbon intensity of crude production and transport to the refinery
  - **Global Trade Analysis Project (GTAP):** Indirect land use change
  - **Agro-Ecological Zone Emissions Factor (AEZ-EF):** Matches land conversions estimated by the GTAP model with corresponding carbon releases from soil and biomass

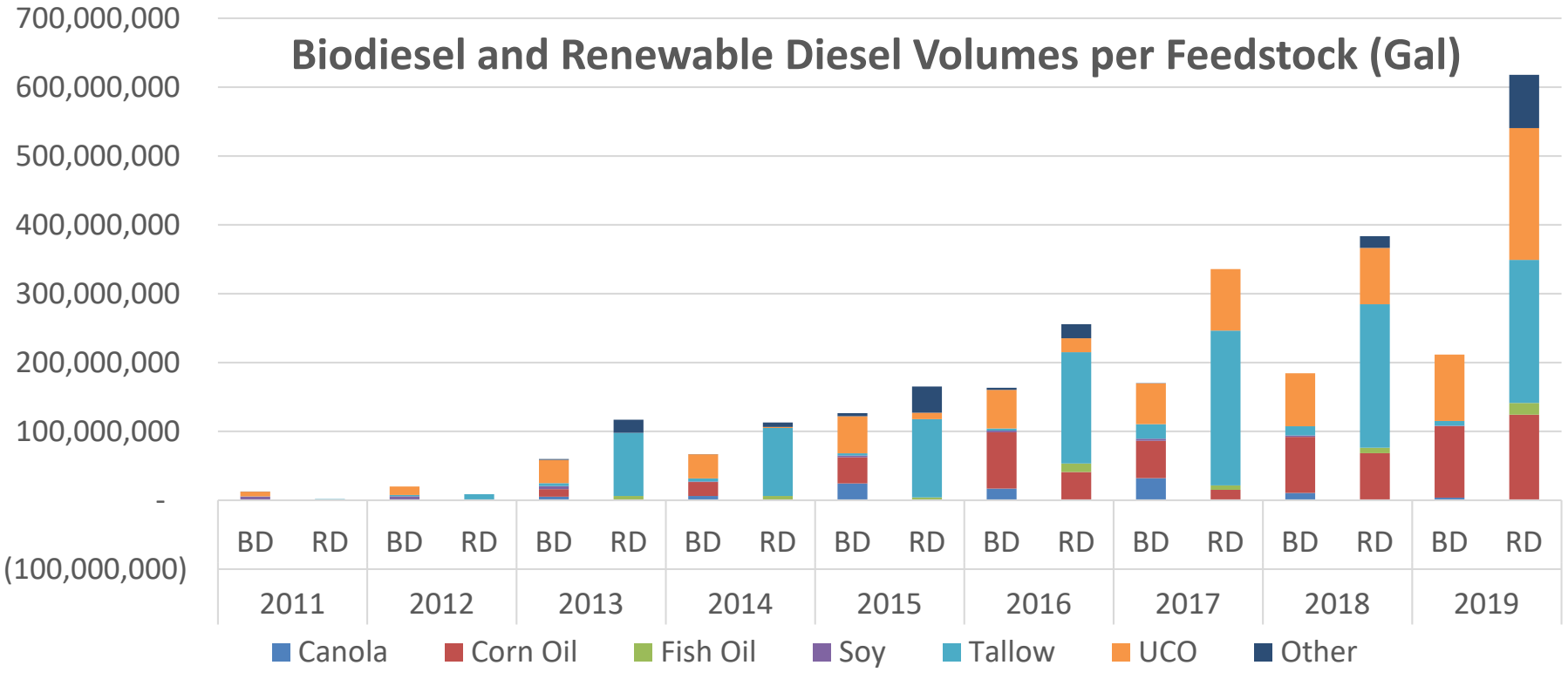
Example Fuel Pathway
Used Cooking Oil Biodiesel



Indirect Effects are a Big Driver in LCFS CI Scores

- Demand for crop-based biofuels can indirectly incentivize land use change globally
  - Expanding cropland at expense of carbon-rich land cover can result in large GHG emissions releases and destruction of biodiverse ecosystems
- Conducted robust analysis of land use change impacts associated with major crop-based fuels
- Failing to account for land use change emissions sends incorrect market signals and may undermine emissions reduction goals

Low-CI Feedstocks Dominate for Biomass-based Diesel



Low Carbon Biofuels will Continue to Play a Critical Role

- Low carbon biofuels must displace fossil fuels in the short term while the ZEV population increases
- Will play significant role in reaching the aggressive 2030 LCFS target and may remain the fuel of choice for certain technologies in a low carbon future
- Critical for sectors where ZEV penetration may be limited like aviation, marine, heavy-duty and off-road transportation
- Several low carbon fuels can potentially help decarbonize other sectors of economy on path to carbon neutrality (for example, renewable gas can replace fossil fuel in heavy industry)

THANK YOU