California Low Carbon Fuel Standard

SEPTEMBER 28, 2023

CALIFORNIA
AIR RESOURCES BOARD

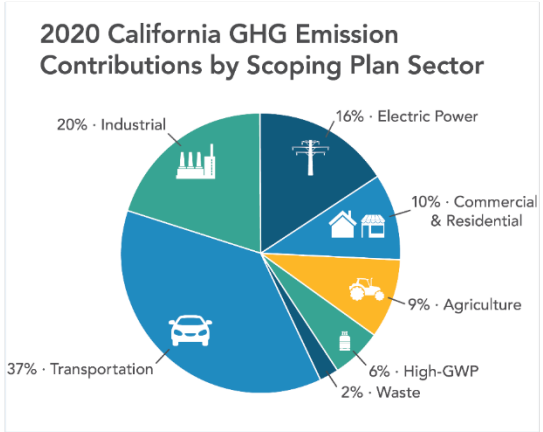
Agenda

- Decarbonizing the Transportation Sector Overview
- LCFS Overview
- Amendment Concepts

California's Climate Policy Framework

GHG Targets & Goals

Legislation & Executive Orders: Total GHGs (AB 32/SB 32/AB 1279) or sector targets (SB 1383/SB 100), etc.

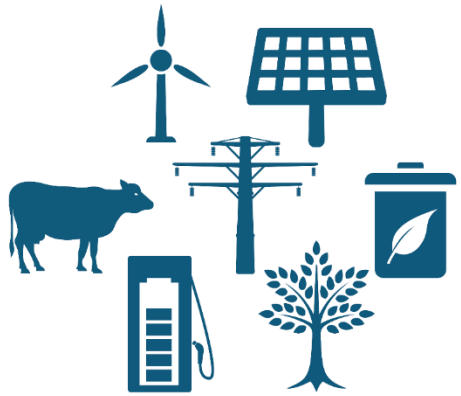


Scoping Plan

Actionable plan across all sectors

Action

Regulations & Incentives: Advanced Clean Cars, climate change investments, etc.



Projects

Examples: Zero-emission trucks, energy infrastructure and renewables, compost facilities, digesters, etc.

The Road *to Zero Emissions*

CARB has put a roadmap in place to drastically reduce our dependence on petroleum in the transportation sector by 2045.

AB 32

Requires we cut GHGs.

To reach goals, fuel use must be cut by 94%.

How cuts happen?

Zero emission cars, trucks and fuels.

ACT ACC ACF

CARB rules that make that possible:

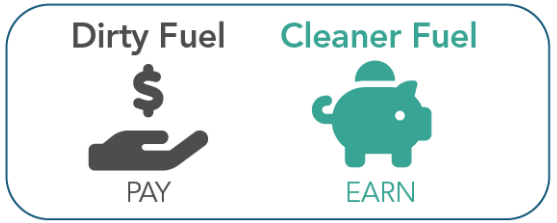
Advanced Clean Trucks, Advanced Clean Cars, Advanced Clean Fleets

- ACT: Phases out sale of most fuel-powered trucks by 2035
- ACC: 100% ZEV sales requirement by 2035
- ACF: Requires that trucks in CA be zero emissions by 2045

LCFS

Makes fuel less polluting and encourages production of cleaner alternatives

How it works:



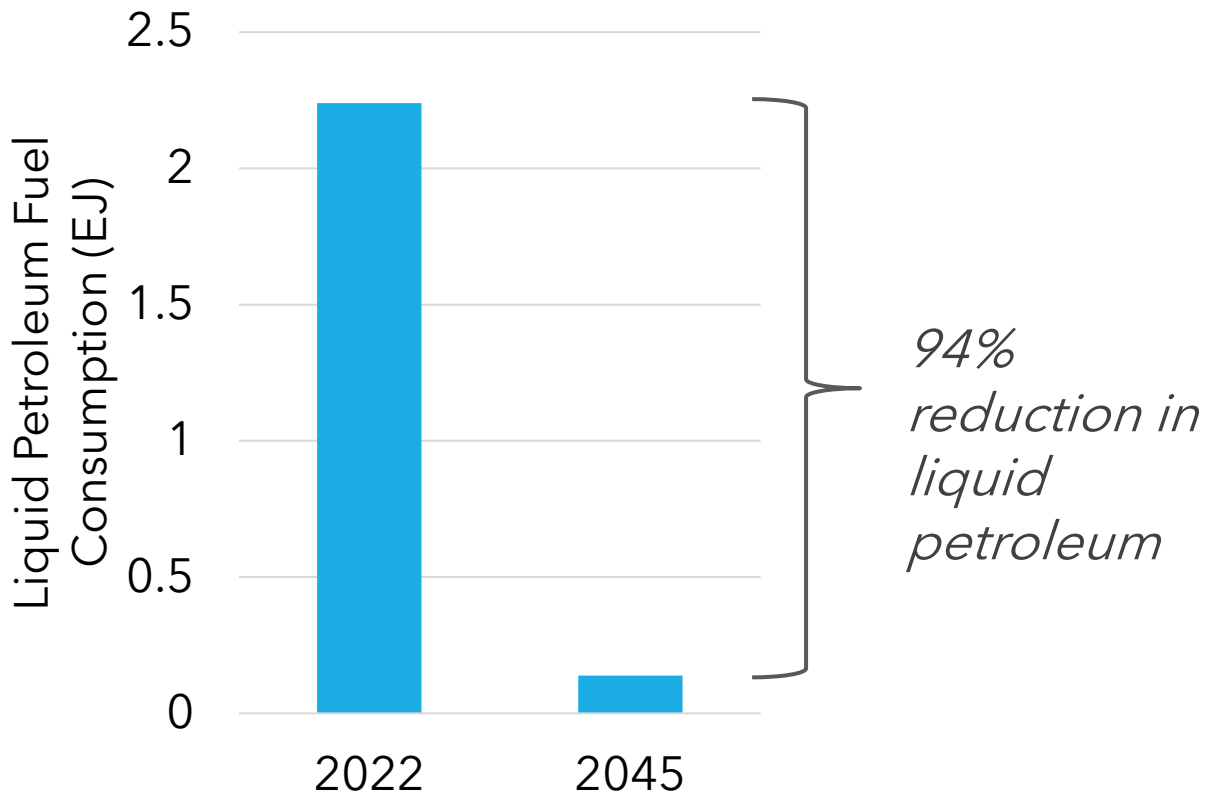
All together, these actions will help us build a cleaner, healthier California for current and future generations.

Governor Newsom creates new oversight committee to monitor oil companies

CARB

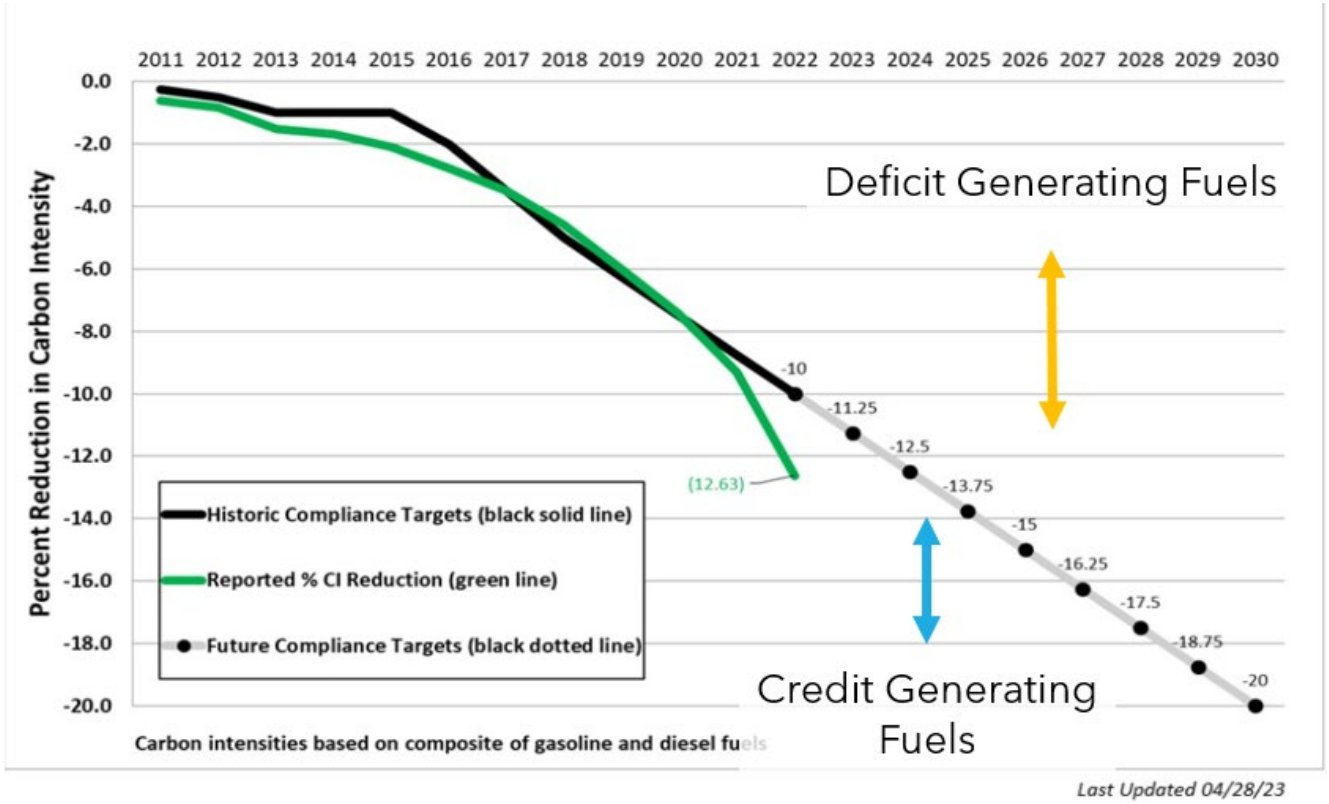
Scoping Plan: Key Outcomes for Transportation Sector

- 2022 Scoping Plan update identifies key outcomes to achieve carbon neutrality by 2045, including:
  - Over 30x as many ZEVs on the road in 2045 relative to 2022
  - Significant increase in hydrogen supply
  - Continued role for liquid biofuels for aviation, marine
  - Decreasing role for biomethane as a primary fuel



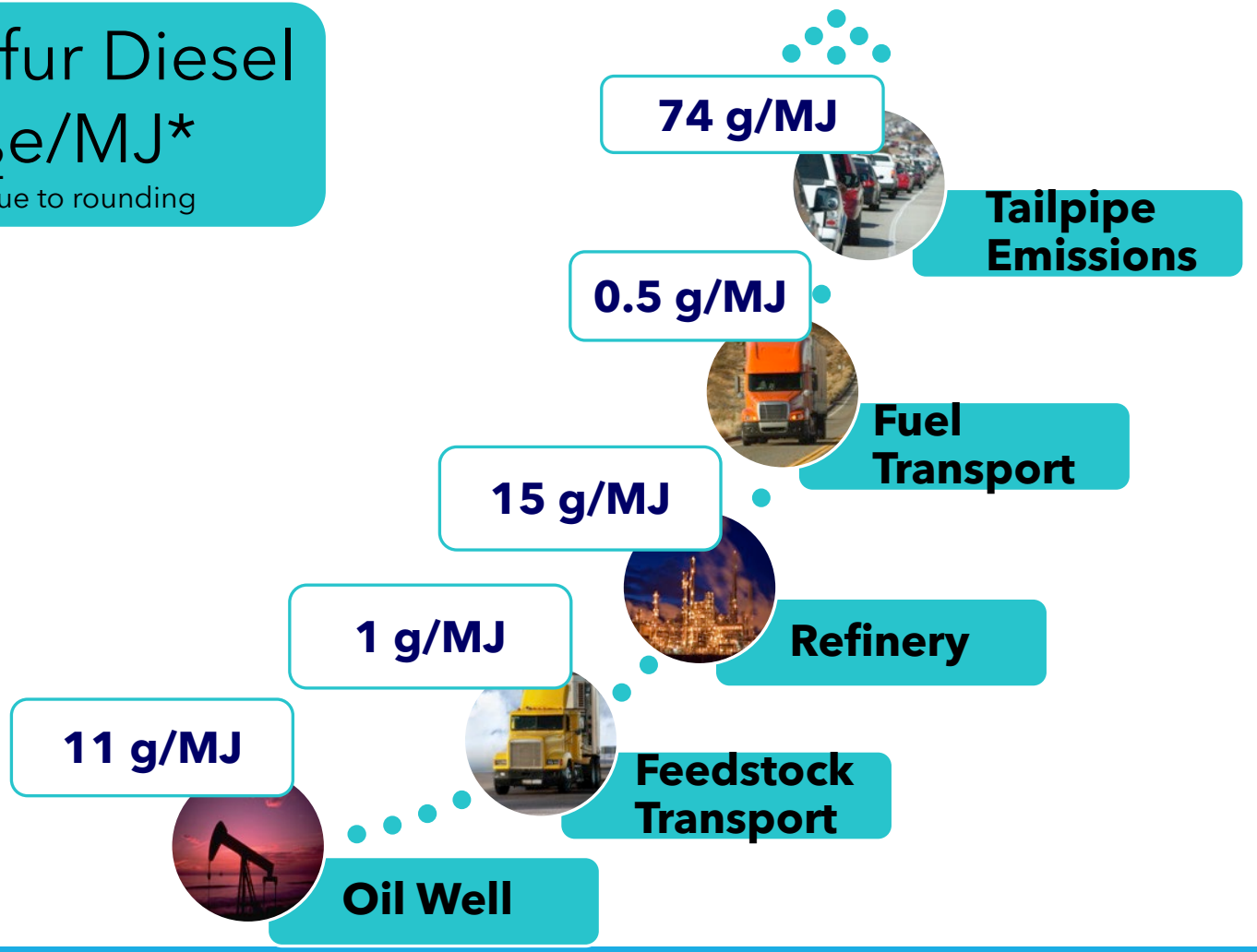
How the LCFS Works

- Establishes an annual, declining carbon intensity (CI) target for transportation fuels used in California
- Carbon intensity is the measure of life cycle GHG emissions
- The lower carbon a fuel is, the more credits can be generated
- Program increases cost of high-carbon fossil fuels and supports low-carbon fuels



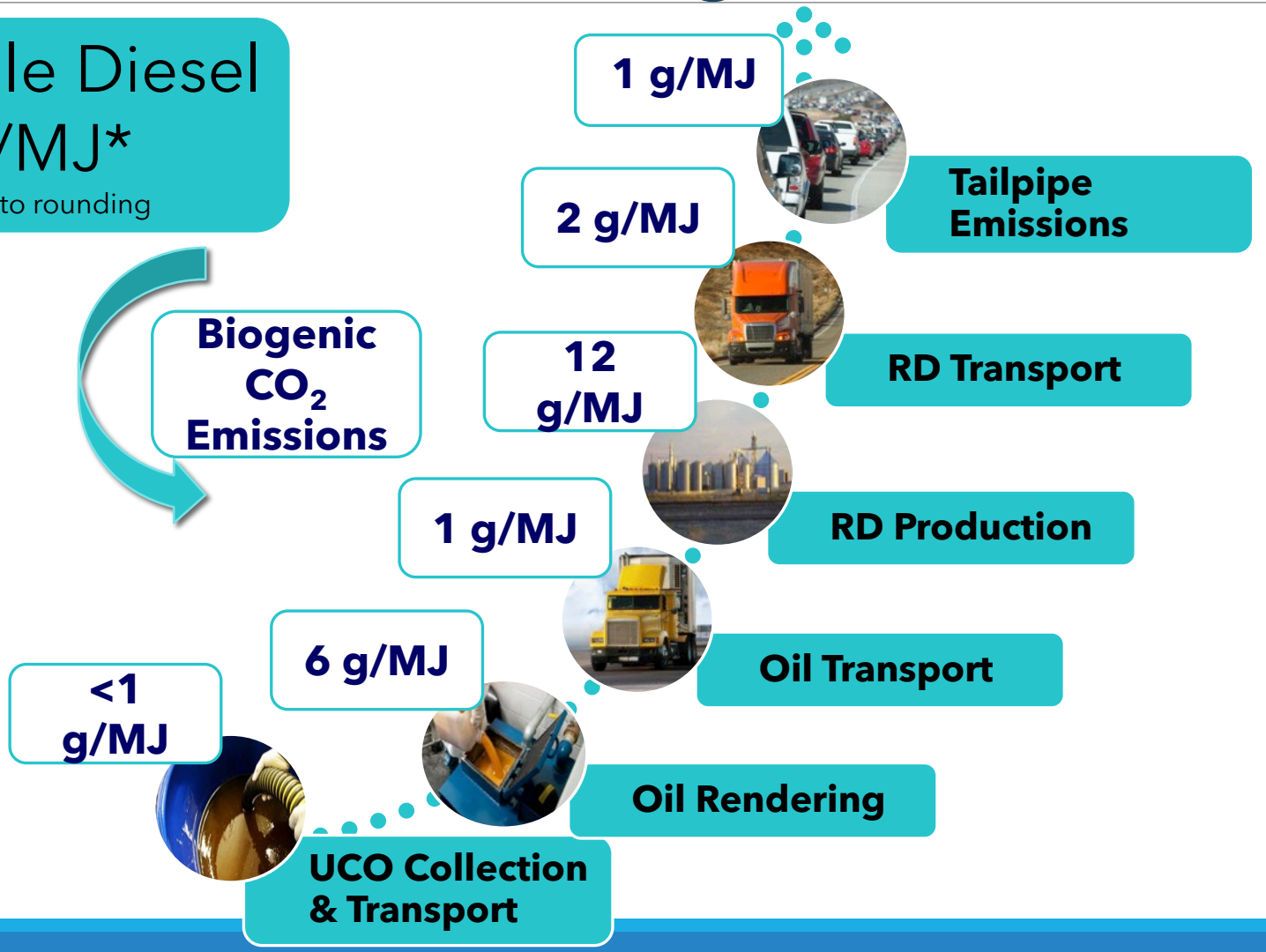
Example: Fuel Life Cycle for Fossil Diesel

Ultra Low Sulfur Diesel
101 gCO_2e/MJ*
* Totals may not sum due to rounding



Example: Fuel Life Cycle for Renewable Diesel from Used Cooking Oil

UCO Renewable Diesel
22 gCO_2e/MJ*
* Totals may not sum due to rounding



Fuel Pathway – Data Process

Applicant

- Submits operational site-specific data
- Calculates Carbon Intensity (CI) using CARB models

Third-Party Verifiers

- Check inputs
- Conduct site visits
- Verify data annually

CARB Staff

- Reviews fuel pathway production process and data
- Oversee verifiers
- Enforcement activities

Public

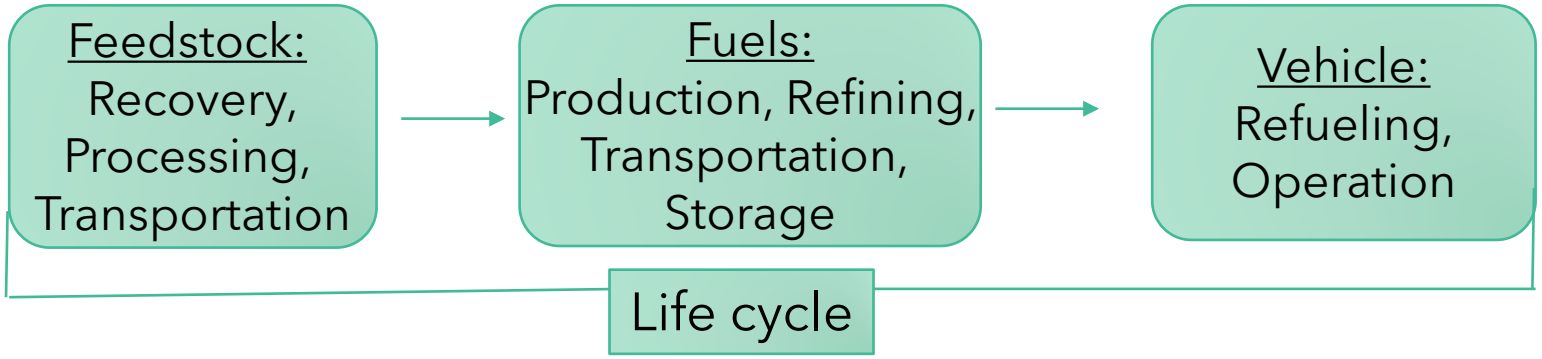
- Public comment period for complex pathways

Robust Verification Program

- LCFS requires annual third-party verification for fuel pathways and reported fuels transactions
- Verifiers are required to take robust training program and pass exams to become accredited for LCFS verification
- 285 individual verifiers currently accredited
- Fuel pathway inputs (energy use, feedstock source, transport distance, etc.) checked by verifiers and include site-visits
- Program includes robust data accuracy and meter calibration requirements

Carbon Intensity Life Cycle Analysis

- CI includes the "direct" effects of producing and using the fuel, as well as "indirect" effects that are primarily associated with crop-based biofuels
- Modeling 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) + Agro-Ecological Zone Emissions Factor (AEZ-EF) model: Used to estimate indirect effects associated with crop-based biofuels

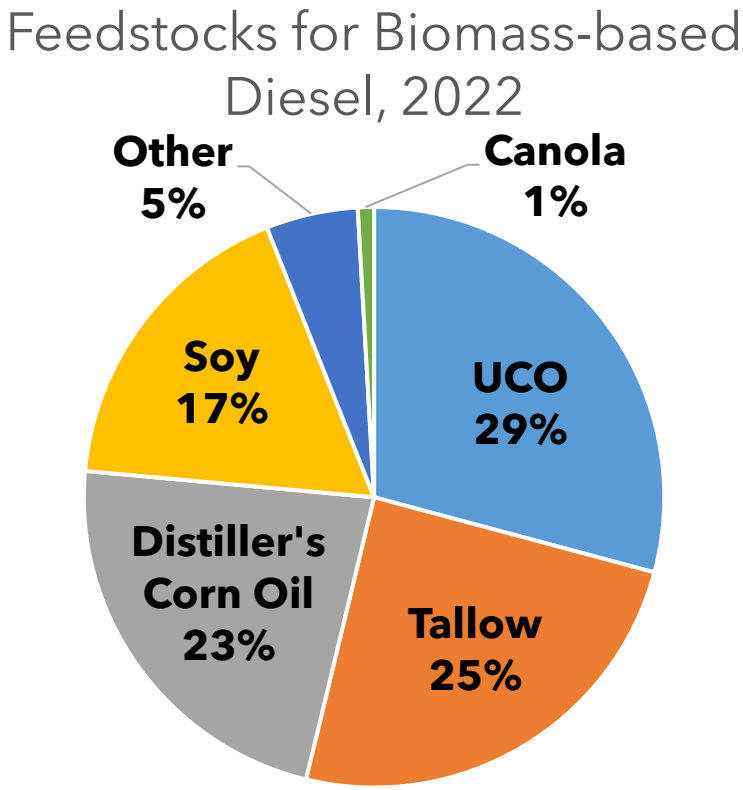


CA-GREET Model

- Key GHG life cycle analysis tool for LCFS program
- Based on GREET model developed by Argonne National Laboratory
  - Used by U.S. EPA for Renewable Fuel Standard, and Washington and Oregon LCFS programs
  - Includes publicly-available inputs and capacity to calculate over 100 types of fuel pathways.
  - Originally released in 1995 and updated frequently (most recently in 2022)
- CA-GREET used to model lifecycle methodologies for both first generation and advanced transportation fuels
- Customizations to GREET to model LCFS pathways
- Transparent public process prior to adopting CA-GREET

Land Use Change Analysis

- Demand for crop-based biofuels can indirectly incentivize land use change globally
- LCFS program accounts for land use change emissions associated with crop-based biofuels and incentivizes waste- and residue-based feedstocks (for which no indirect effects are assigned in LCFS)
- Majority of biomass-based diesel produced from waste feedstocks
- Land use change quantified in LCFS since 2011
- Extensive multi-year land use change expert workgroup informed updates to land use change values in 2015 rulemaking*

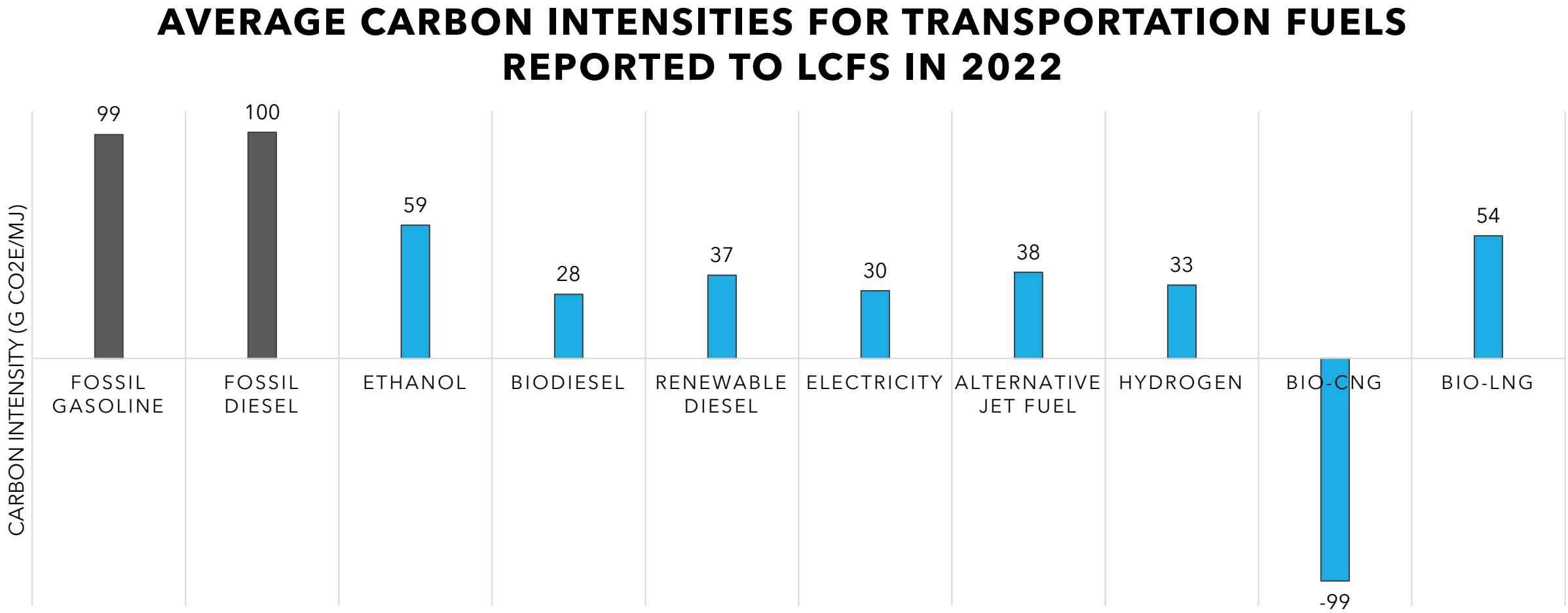


*Land use change documentation available here: https://ww2.arb.ca.gov/resources/documents/lcfs-land-use-change-assessment

GTAP Model for Land Use Change

- Global equilibrium economic model developed by Purdue University
  - Includes all sectors of the global economy (not limited to agriculture)
  - Global coverage and sectoral detail: 111 regions, 57 sectors
  - 6,500 people from >100 countries contributing data to model database
- Widely used for analysis of trade policy issues internationally
- Evaluates changes in global land use associated with changes in biofuel demand
- Emission factors for each land use type used to translate to land use change emissions

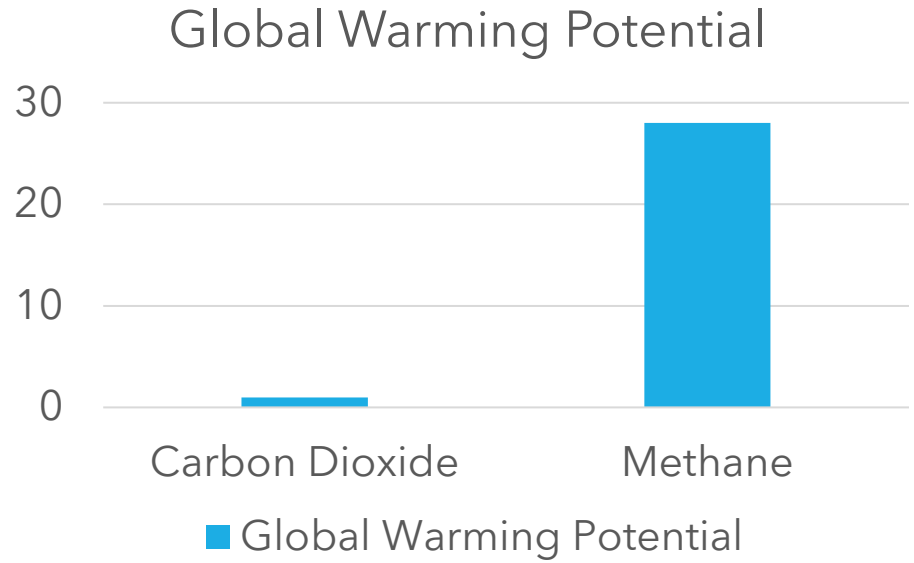
Carbon Intensities Relative to Fossil Fuels



Source: LCFS Quarterly Data Summary Spreadsheet: https://ww2.arb.ca.gov/resources/documents/low-carbon-fuel-standard-reporting-tool-quarterly-summaries

Methane is a Potent Greenhouse Gas

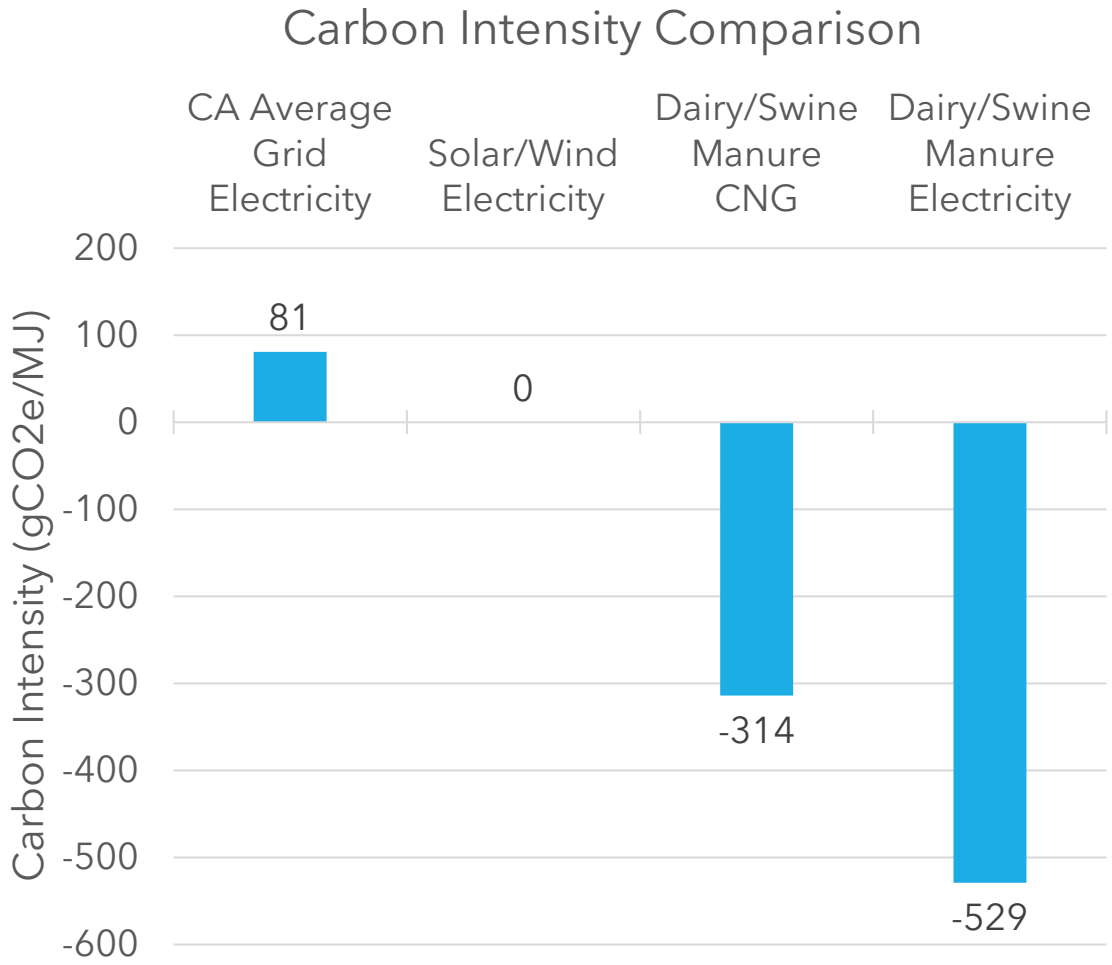
- CH_4 warming potential is **25x** the amount of CO_2
  - Recent IPCC reports estimate it closer to **28x**
- Cumulative impact from all SLCPs (including methane) on warming is close to that of CO_2
- $100M for methane satellites
- CA is part of multiple subnational and international efforts to reduce methane
  - Under2 MOU
  - Global Methane Pledge
  - Subnational Methane Action Initiative
  - Multiple subnational agreements



*"Deep GHG emissions reductions by 2030 and 2040, **particularly reductions of methane emissions**, lower peak warming, reduce the likelihood of overshooting warming limits and lead to less reliance on net negative CO_2 emissions that reverse warming in the latter half of the century."* *IPCC Sixth Assessment*

Biomethane

- Biomethane is a fuel derived from biogas released by organic sources
- Key sources include landfills, wastewater treatment plants, food and green waste diverted from landfills, and dairy/swine manure
- Carbon intensities vary by source
  - Dairy/swine manure and food/green waste pathways avoid venting of methane, recognized in life cycle with negative emissions
- 2022 Scoping Plan Update: Need to increase biomethane capture to meet SB 1383 methane reduction goals and put it to optimal use on path to carbon neutrality



Total Fuel Pathways Certified

Fuel Type	Total Certified Pathways
Alternative Jet Fuel	28
Biodiesel	172
Biomethane (gaseous and liquid)	451
Electricity	108
Ethanol	292
Hydrogen	120
Propane	6
Renewable Diesel	129
Renewable Gasoline	3
Renewable Naphtha	63
Total	**1,372**

Total pathways certified since January 2019 with current models, including recertification of previous pathways with updated assumptions.

LCFS Outcomes

12.6% reduction in the carbon intensity of California's transportation fuels

Over 25 billion gallons of petroleum fuels displaced by low-carbon fuels

Over 50% of fossil diesel displaced by biomass-based diesel, resulting in PM and NOx benefits

$4 billion annually to support low-carbon investments and public transit

Supports many State programs and goals, including cars and trucks going to zero-emission vehicles

Financial assistance for vehicle purchases at the state and local level

Then vs Now – Fossil Fuels Used in CA

2011

- 3.6 billion gallons diesel
- 13 billion gallons gasoline

2022

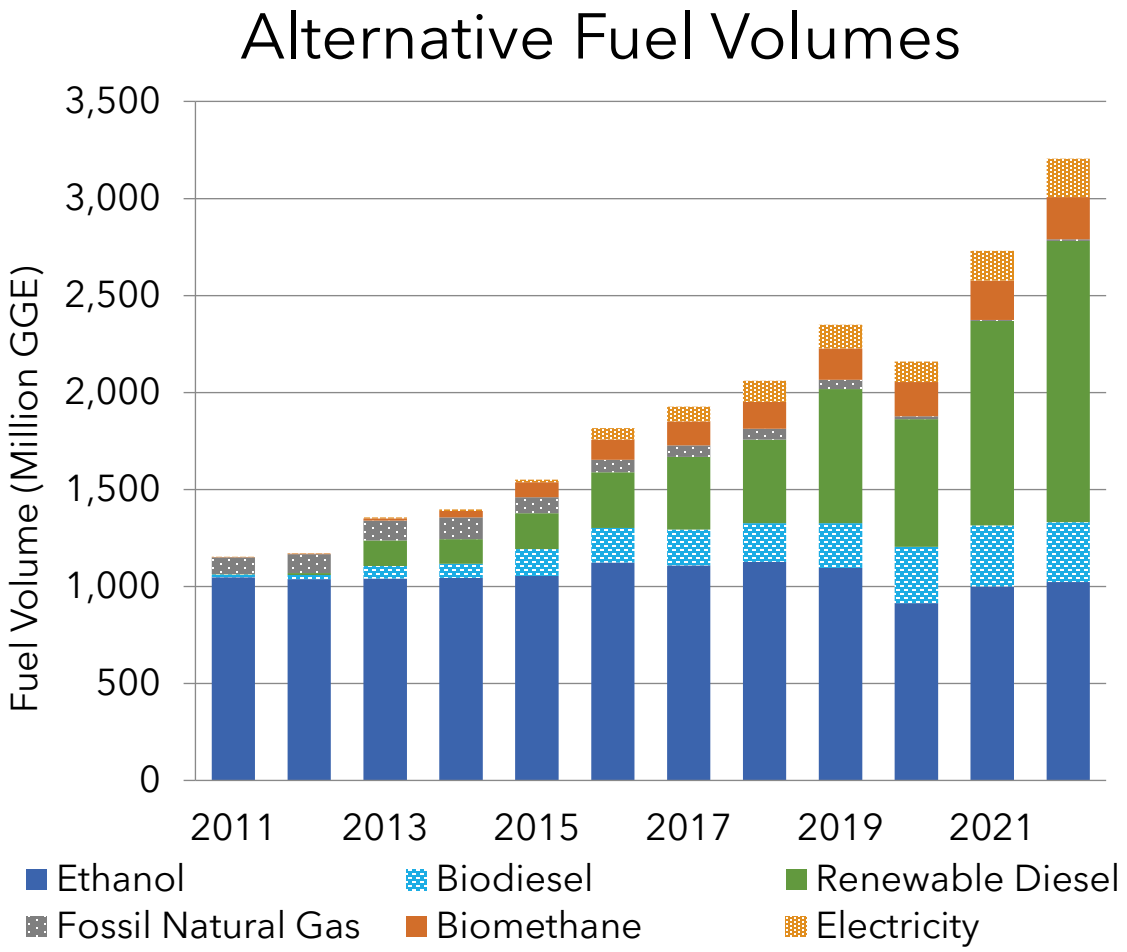
- 2.0 billion gallons diesel (1.6B less)
- 12.3 billion gallons gasoline (800M less)

Over a time period with increases in population and economic growth

Updates to the LCFS

LCFS Drives Investment & Fuel Diversification

- California has **doubled** the volume of low-carbon fuels in 10 years
- Growing role for electricity and hydrogen
- Investment opportunity to leverage federal dollars from the Bipartisan Infrastructure Law and Inflation Reduction Act



Key Concepts for Rulemaking

- Increase the stringency of the program to displace fossil fuels
- Strengthen equity provisions to promote investment in disadvantaged, low-income, and rural communities
- Support electric and hydrogen truck refueling
- Increase the use of alternative jet fuel in the State
- Incentivize more production of clean fuels needed in future, such as low-carbon hydrogen
- Support methane emissions reductions and deploy biomethane for best uses across transportation and other sectors
- Consider guardrails on crop-based fuels

Why Increasing Stringency Is Important

- AB 1279 requires carbon neutrality and an 85% reduction of GHG emissions from 1990 levels by 2045
- Scoping Plan calls for 94% reduction in petroleum and identifies LCFS as a key program
  - LCFS supports ZEV deployment by crediting electricity and hydrogen and refueling infrastructure
  - Credits for other alternative fuels support displacement of fossil fuels in vehicles today
- Critical opportunity to leverage Federal funding through Inflation Reduction Act and Infrastructure and Jobs Act

The California Transportation Supply (CATS) Model

- Developed by CARB staff to evaluate potential fuel market and policy assumptions and outcomes
- CATS is a transportation fuel supply optimization model
- CATS minimizes the cost of supplying fuel to meet the specified annual fuel demand
- CATS scenarios do not capture the California fuel markets perfectly; does not necessarily capture all factors that could impact costs and supply in the actual California fuel market

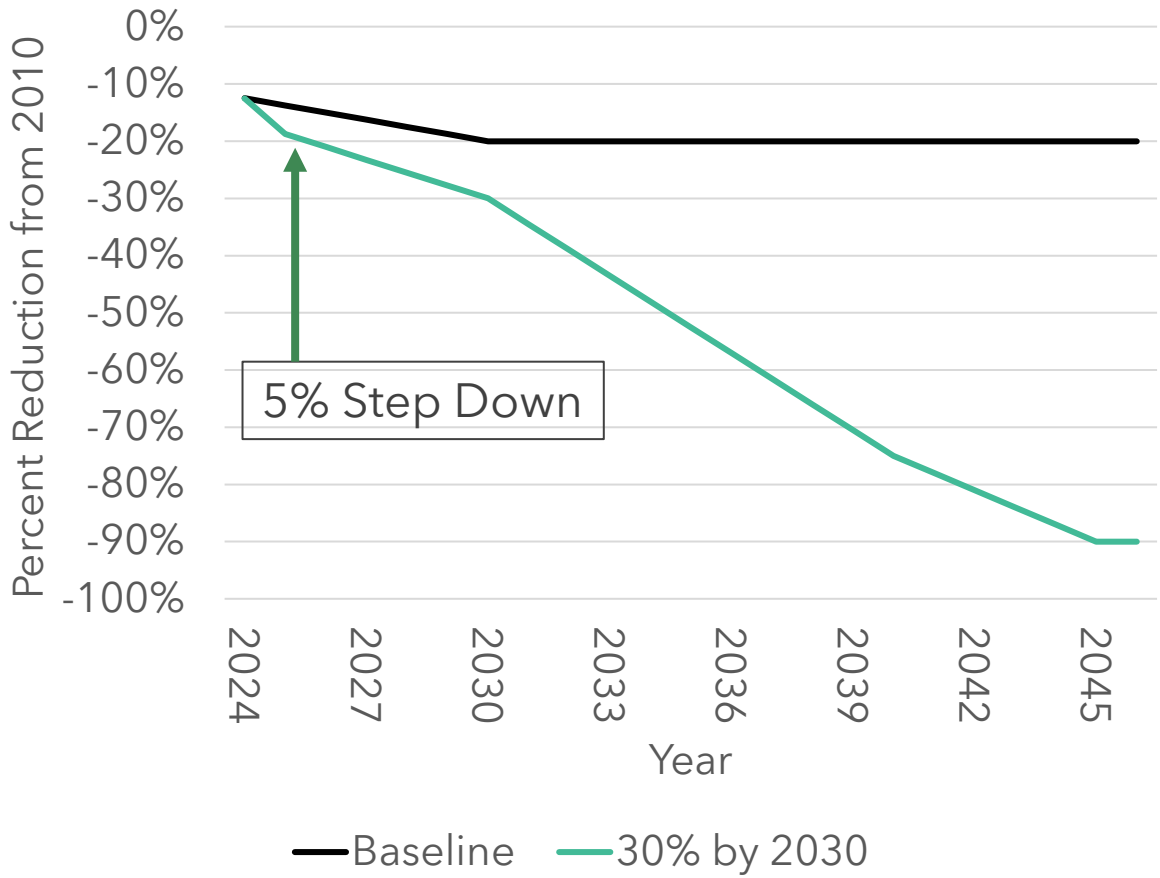
LCFS Modeling – CATS Model Updates

- Includes all existing regulations, including ACC II, ACT, ACF
- 3 workshops and extensive engagement with stakeholders to calibrate and refine model
- Used for scenario comparison and to understand potential impacts of regulatory changes to the market
  - Not expected to fully capture all real-world conditions

Example: 30% by 2030 CI Benchmark Schedule & Auto-Acceleration Mechanism

Example scenario in SRIA compared to current LCFS regulation

- 2.4 billion gallons gasoline reduction
- 8 billion gallons diesel reduction
- 7.2 billion gallons fossil jet fuel reduction
- 558 million tons GHG reduction



Other SRIA Scenarios Evaluated

- Alternative 1
  - 28% by 2030 with 3% step down in 2025
  - Limit and decline biomass diesel – 1.6B in 2025 to 180M in 2045
- Alternative 2
  - 35% by 2030 with 5% step down in 2025
  - No additional crediting constraints

Greater need for fossil diesel to fill demand for trucks

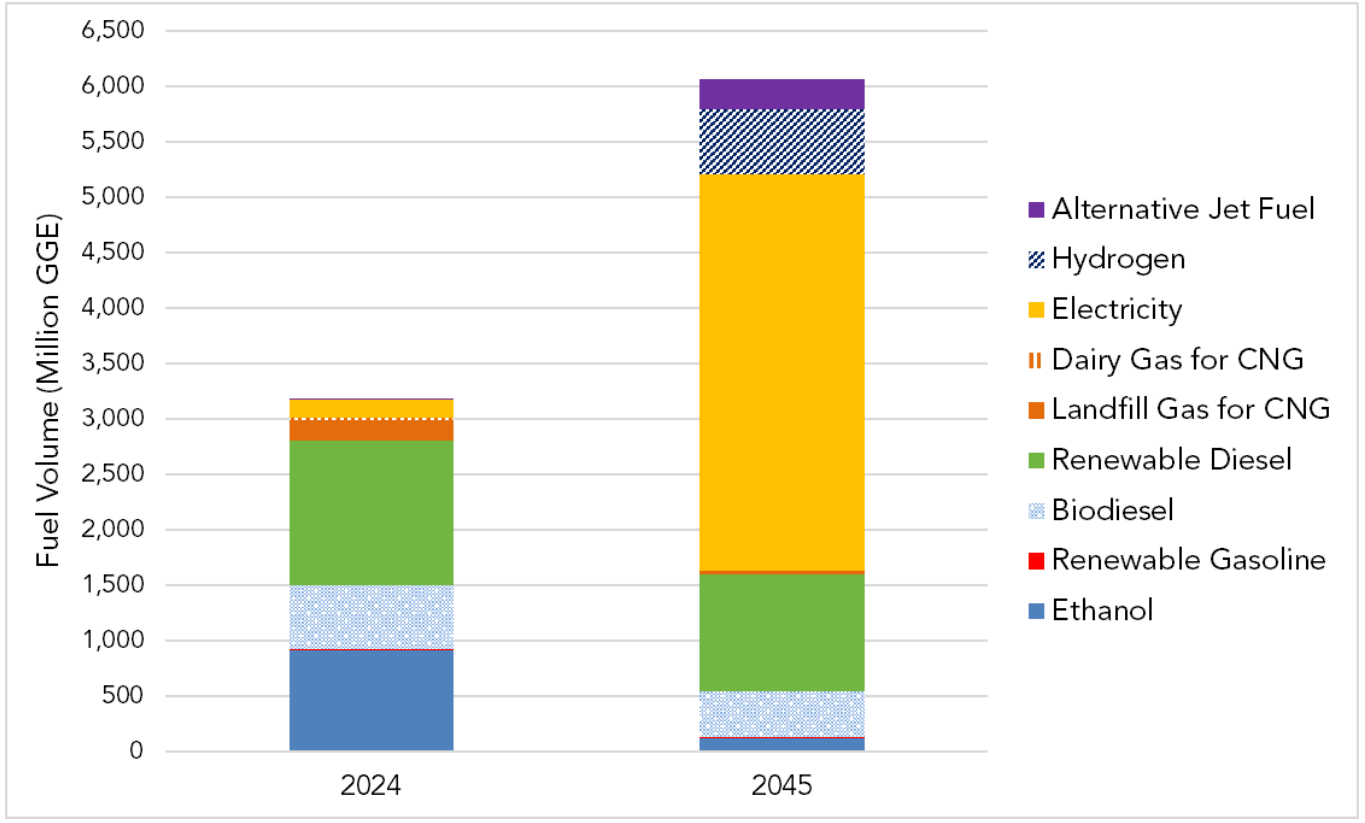
Highest cost scenario

Incentivizing Zero-Emission Infrastructure

- Since 2019 LCFS has supported light duty ZEV refueling infrastructure
  - 3,800 fast chargers, 67 hydrogen stations approved to date
- Refueling infrastructure will be essential to successfully implementing Advanced Clean Fleets (ACF) and Advanced Clean Trucks (ACT)
- LCFS concepts:
  - Create an infrastructure crediting provision for medium- and heavy-duty refueling for zero-emission vehicles (electricity and hydrogen)
  - Extend existing light-duty vehicle provision with focus on equity

Example of Transport Fuel Changes Under 30% CI Example Scenario

- Provides LCFS support for zero-emission vehicles (electricity and hydrogen) fueling
- Continued role for alternative fuels on path to carbon neutrality



Low-CI Hydrogen Deployment

- 2022 Scoping Plan Update identifies a large role for hydrogen in transportation and other sectors
- ACF, ACT, and ACC II allow for hydrogen fuel
- Low-CI hydrogen supply must ramp up to meet this demand and displace fossil fuels
- LCFS concept: Support low-CI hydrogen
  - Align carbon intensity thresholds with Inflation Reduction Act
  - Hydrogen from gas supply must be matched with biomethane

Decarbonizing Aviation

- Aviation sector is 1% of statewide GHGs
- Alternative jet fuel is an optional credit generator in LCFS (current volume is 15 million gallons per year)
- The Department of Energy's Sustainable Aviation Fuel Grand Challenge is targeting 3 billion gallons per year by 2030
- To further decarbonize aviation, staff are evaluating how to increase the use of alternative jet fuel in the State

Biomethane Crediting | Guiding Principles

- Biomethane supply needs to grow rapidly to support SB 1383 targets and then be deployed to other uses
- Need to avoid stranded assets that risk backsliding on GHG reductions, given warming impacts of methane
- Complementary policies will also be needed that value methane reductions and support biomethane demand in the future
- Biomethane as a hydrogen feedstock will remain important in LCFS

Avoided Methane Crediting

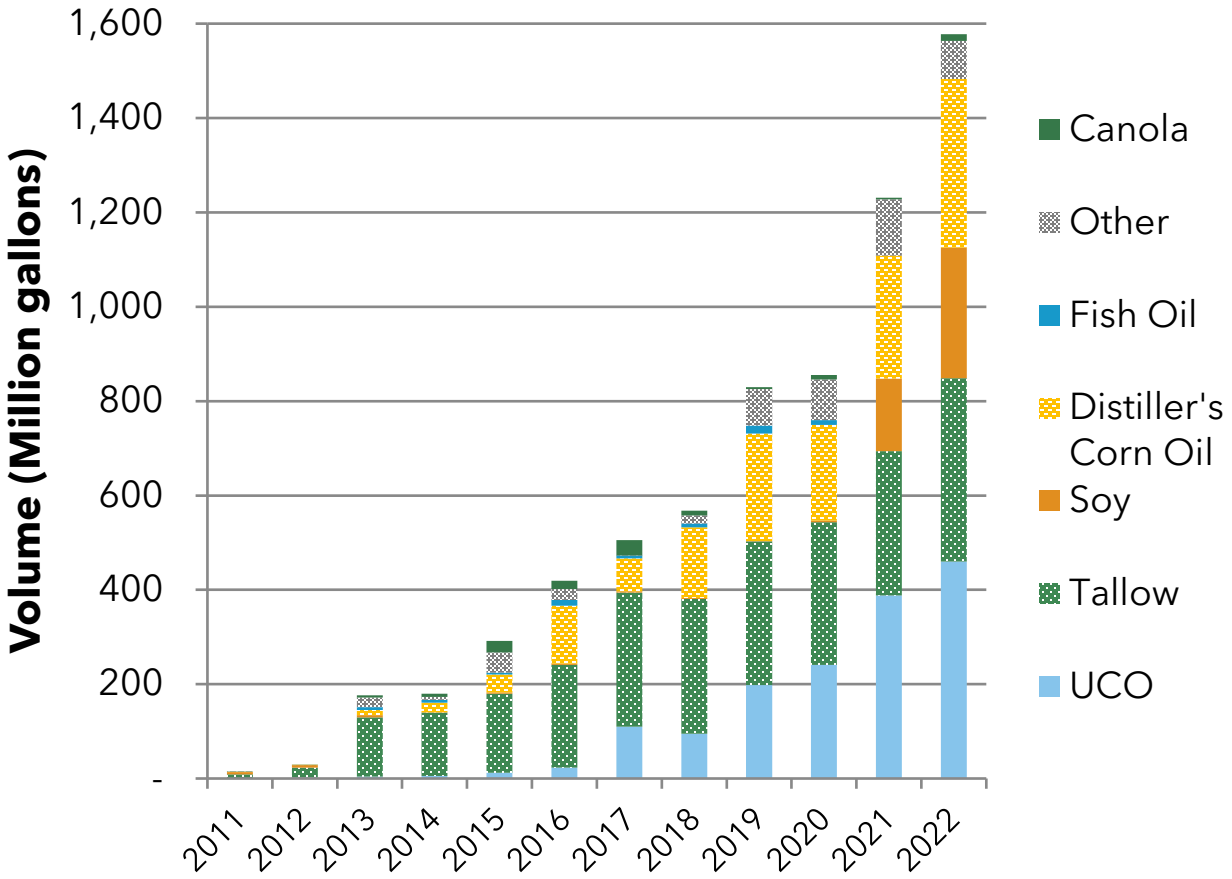
- LCFS concept: Avoided methane crediting available until 2040, new fuel pathways accepted through 2030
- Considerations:
  - Avoided methane crediting reflects the capture of methane that would have otherwise been released into the atmosphere
  - Avoided methane crediting provides important pathway for payback on initial capital costs that will be highest this decade to meet SB 1383, but ongoing operational costs will be lower
  - Supports development of methane capture projects in near-term while sending long-term signal to transition to other sectors

Biomethane Deliverability

- LCFS concept: Align deliverability requirements of biomethane used as a vehicle fuel with RPS and CPUC 1440 program (CPUC section 651(b)(3))
- Considerations:
  - Biomethane used as a transportation fuels should be physically delivered via common carrier pipeline to California for use as a primary fuel
  - Deliverability helps ensure California can reduce our fossil gas consumption and achieve carbon neutrality and emission reductions required by AB 1279

Considerations for Crop-Based Biofuels

- Biofuel production must not come at the expense of food production or forests
- Ongoing tracking shows crop-based fuel consumption has historically been steady in the California market, but has begun to increase in the last two years
- Staff requested feedback from stakeholders



Sustainability Criteria Case-Studies

- Other governments have implemented guardrails around use of crop-based fuels
- Guardrails include:
  - Volume-based limits
  - Credit limits
  - Feedstock sustainability criteria
  - Explicit bans of particular feedstocks
  - Bans of feedstocks from particular locations
- Staff is evaluating the appropriateness of these guardrails and others for the California LCFS program

Feedback Received from Stakeholders

Commentors:

- Raised concerns regarding use of food crops for biofuels
- Said increased crop demand could be met by crop yield increases or secondary/fallow land crops
- Highlighted the difficulty of isolating relationship between biofuel demand and food prices
- Identified mechanisms: reassess land use change and GTAP modeling; implement volume-based limits; require use of certification tracking systems

Health/Air Quality Benefits of 30% CI in 2030 Example Scenario

- Implementation of rulemaking concepts results in public health benefits for California
  - Displacement of fossil fuel use
- Conservative analysis includes:
  - NOx and PM2.5 emissions from feedstock and fuel transport, production, upstream reductions in fossil fuel extraction
  - Tailpipe reductions not included, part of vehicle regulations
  - Emission changes by air basin
  - Quantification of health outcomes from emission changes

Results of Example Scenario AQ/Health Analysis

- Total reduction in criteria pollutant emissions in all air basins from 2024 to 2046:
  - 17,000 tons of NOx reductions
  - 4,100 tons of PM2.5 reductions
- Total monetized health savings from avoided health outcomes: $5 billion
- Much higher health benefits when tailpipe reductions are included

Upcoming Rulemaking Milestones

- Q4 2023 – Staff Report
  - Notice of Proposed Action
  - Draft regulatory text
  - Draft Environmental Analysis
  - Economic and health analyses
  - 45-day comment period
  - Further edits and 15-day comment period (if needed)
- Q1 2024 – Board Hearing for vote on proposed amendments to regulation