CALIFORNIA
AIR RESOURCES BOARD

Staff's Suggested Modifications to 2018 Amendments Proposal

Low Carbon Fuel Standard Regulation

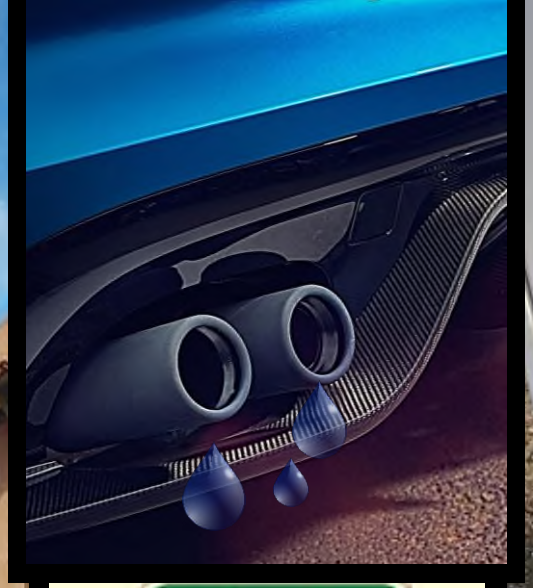
and to the

Regulation on Commercialization of Alternative Diesel Fuels

JUNE 11, 2018
WORKSHOP
SACRAMENTO, CA

Presentation Overview

- LCFS ZEV Fueling Infrastructure Crediting Provisions
  - Hydrogen Refueling Infrastructure (HRI) Crediting
  - DC Fast Charging Infrastructure (FCI) Crediting
- Other Modifications to March 6th Proposal
  - Other Electricity Crediting Provisions
  - Alternative Diesel Fuels Regulation Sunset
  - Protocol for Carbon Capture and Sequestration Projects
  - Refinery Investment and Innovative Crude Crediting Provisions
  - Updates to Lifecycle Analysis Modeling Tools and Pathway Applications
  - Credit Trading Provisions
  - Third-party Verification Program
- Timeline and Next Steps: 15-day Comment Period




ELECTRIC
VEHICLE
CHARGING
ONLY
DC FAST

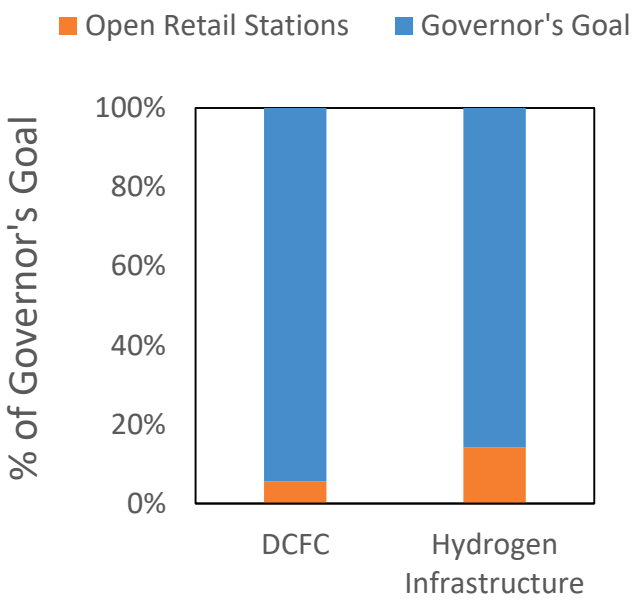

50 DC CHAdeMO 1
50 DC CCS 2
DANGER

Executive Order Calling out LCFS to support ZEV Infrastructure

Executive Order B-48-18:

*"All State entities work with the private sector and all appropriate levels of government to spur the construction and installation of **200 hydrogen fueling stations** and 250,000 zero-emission vehicle chargers, including **10,000 direct current fast chargers**, by 2025.*

Recommend ways to expand zero-emission vehicle infrastructure through the Low Carbon Fuel Standard Program."



Board Resolution directs the Executive Officer to support ZEV infrastructure

Resolution 18-17 reflected April 27, 2018 CARB direction:

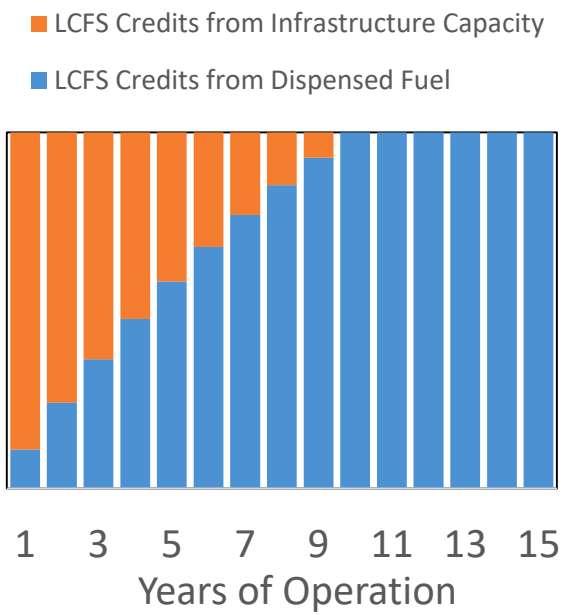
Work with interested stakeholders to develop a calculation method, accounting process and related requirements to allow hydrogen stations and direct current fast chargers for electric vehicles to earn credits on the basis of the capacity of ZEV infrastructure. Such credits should be issued in addition to credits received for fuel dispensed through such ZEV infrastructure. The purpose of such capacity credits would be to support the expansions of such infrastructure as directed by the Governor's Executive Order B-48-18.

Infrastructure Crediting Concept

Concept: Provide LCFS credits to fuel dispensing infrastructure up to a certain level which will support infrastructure until it is well-utilized

Rationale: To resolve barrier to EV adoption resulting from the lack of ZEV fueling infrastructure

- Provides a reliable level of credit generation for early-stage infrastructure buildout
- Infrastructure credits will decline over-time. As vehicle deployment for technologies increase, more fueling at a station occurs. The station generates more LCFS credits based on dispensed fuel, and fewer infrastructure-derived credits over time



Limits on Infrastructure Credits

- CARB will stop approving applications for hydrogen refueling stations if infrastructure credits exceed 2.5 percent of deficits generated in previous quarter
- CARB will stop approving applications for DC chargers if infrastructure credits exceed 2.5 percent of deficits generated in previous quarter
- Applications will only be accepted until December 31, 2025
- As hydrogen and electricity utilization goes up, infrastructure credits will automatically decrease

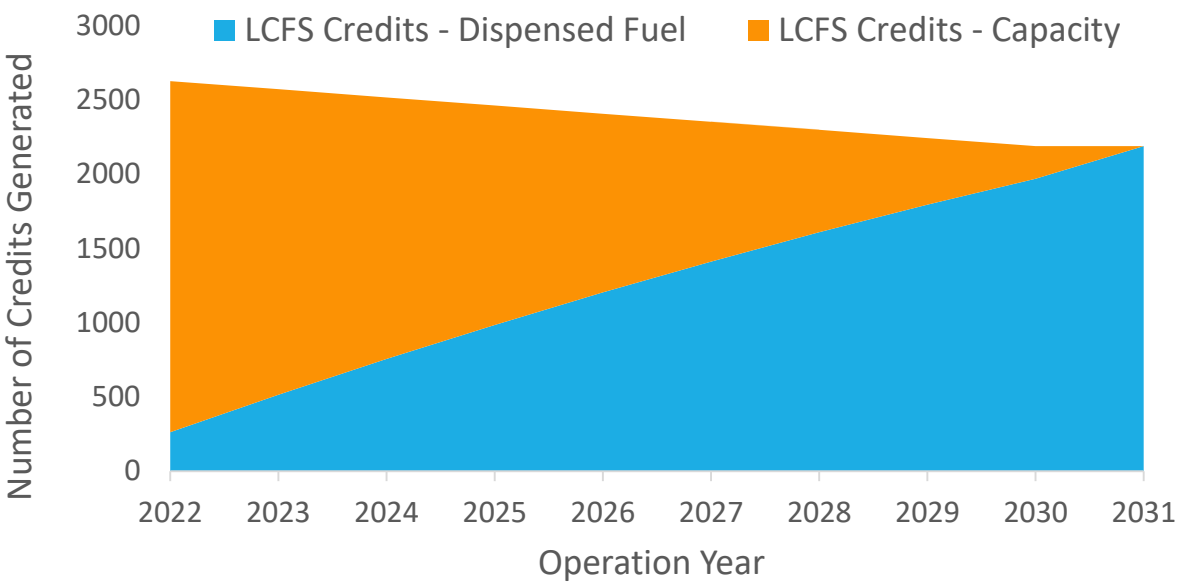
Hydrogen Refueling Infrastructure (HRI) Crediting

Illustrative Example: HRI Crediting

Capital Cost:
~4.0 million

LCFS Fuel Credits:
~$1.6 million in cumulative value

Infrastructure Credits:
~$1.4 million in cumulative value



- *For 400 kg/day station with utilization ramping up from 10% to 100% in year 10*
- *CI of hydrogen assumed to be 75 gCO2e/MJ for dispensed and infrastructure crediting*
- *LCFS Credit price of $125/ton*

Important Factors To Consider For Crediting

Useful Capacity: How is capacity defined? What is an expected full-deployment utilization level?

Crediting Period: For how many years will infrastructure credits be generated?

Station Availability: How is the station's operational status verified? How is uptime measured such that infrastructure credits are only provided for a station once it is operational and only for periods in which it remains operational?

Carbon Intensity: Based on dispensed fuel CI for H_2?

Proposed Design: Hydrogen Station Capacity Calculation

- Capacity for infrastructure crediting will be based on the amount of hydrogen that can be dispensed over a 12-hour period
- Capacity will be calculated using a consistent methodology across all stations
- A capacity calculation tool is currently in development by NREL with funding provided by the CEC
- When a final version of the capacity tool is available, staff plans to propose to incorporate it into the regulation by reference

Proposed Design: Duration of Crediting and Station Availability

- Infrastructure credits will be generated for a period of up to 15 years starting with the quarter following application approval
- Stations must be connected to the Station Operational Status System (SOSS) and report their uptime status
- Uptime will be calculated as the fraction of time (from 6 am to 9 pm or the hours that the station is permitted to operate, whichever is less) during the quarter that the station is available
- Partial station availability must be pro-rated based on the proportion of station capacity available

Proposed Design: CI used for HRI Crediting

- Infrastructure credits will be calculated using the weighted average Carbon Intensity (CI) for hydrogen dispensed at all stations registered by the company under the LCFS

- Eligibility for infrastructure crediting is subject to a maximum CI of 75 gCO_2e/MJ (non-EER adjusted)

- Minimum CI to be used for infrastructure crediting is 0 gCO_2e/MJ

Proposed Design: Additional Eligibility Requirements and Restrictions

- **Application:** Applications must be received on or before Dec 31st 2025. The station must be operational within 24 months of application approval
- **Capacity Limitation:** HRI crediting will cover up to the first 1,200 kg/day of capacity at a station
- **Access Requirements:** Stations must be open and accessible to the public and accept major credit and debit cards. No private key codes or barriers that limit access will be permissible
- **Renewable Content Requirements:** HRI credits will only be granted if a minimum of 40% renewable content is demonstrated for all fuel dispensed by the company
- **Enforcement Actions:** Fueling infrastructure receiving funds pursuant of any enforcement settlement to any California or Federal regulation will be excluded from receiving HRI credits
- **Expanded Capacity:** Infrastructure expansion projects will receive additional HRI credits within the initial 15-year crediting period. Demonstrate 50% throughput

Proposed Design: HRI Credit Calculation

$$\boldsymbol{Credits_{HRI}\,(MT) = \left(CI^{XD}_{standard} \times EER - CI_{HRI}\right) \times E_{H2} \times \left(Cap_{HRI} \times N \times UT - H2_{disp}\right) \times C}$$

Where:

$Credits_{HRI}$ = **Quarterly HRI credits (MT/qtr)**

$CI^{XD}_{standard}$ = **LCFS carbon intensity standard for gasoline for the given year in g/MJ**

EER = **Energy economy ratio (dimensionless) for light duty hydrogen vehicles (i.e. 2.5 for LDVs)**

CI_{HRI} = **Carbon intensity used for HRI crediting**

E_{H2} = **Energy density for hydrogen (120 MJ/kg)**

Cap_{HRI} = **12-hour refueling capacity for the station up to a maximum 1200 kg/day**

UT = **Station uptime - fraction of time (6am to 9pm) the station is operational**

N = **Number of days in given quarter (day/qtr)**

$H2_{disp}$ = **quantity of hydrogen dispensed during a quarter (kg/qtr)**

C = **Conversion factor of 1X10^{-6} MT/g**

H_2 Station Economics

- Economic Analysis of hydrogen stations was done using H2Fast Tool (Spreadsheet Version), which is available for download at: https://www.nrel.gov/hydrogen/h2fast/

- Staff made few modifications to the spreadsheet including:
  - Changed the capacity to 400 kg a day
  - CAPEX cost changed to $4,000,000 per station
  - Assumed a one-time capital incentive of $2,000,000 per station
  - Assume project will start in 2022
  - Calculated LCFS incentive for hydrogen assuming annual inflation of 1.9% and a declining CI standard based on the proposed amendments

H_2 Station Economics: Average Station Return on Investment

Scenarios				Results		
	Utilization in Year 10	Delivered H_2 Cost	Retail H_2 Price	No HRI	Constant HRI	Declining HRI
1	80%	$6/kg	$9/kg	8.1%	16.2%	15.3%
2	50%	$6/kg	$9/kg	Negative	13.7%	11.8%
3	80%	$7/kg	$9/kg	1.40%	13.1%	11.9%
4	80%	$8/kg	$9/kg	Negative	7.4%	4.0%

H_2 Station Economics: Preliminary Conclusions

- Without HRI, hydrogen station economics are tough under low utilization
- Constant HRI capacity provides a modestly higher ROE than a declining HRI capacity
- A combination of low gross margins and low ramp up of utilization might make projects uneconomic
- Staff proposes utilizing a constant HRI capacity as it is: 1) simpler to understand, 2) provides a reasonable ROE that is not excessively small or large under most scenarios

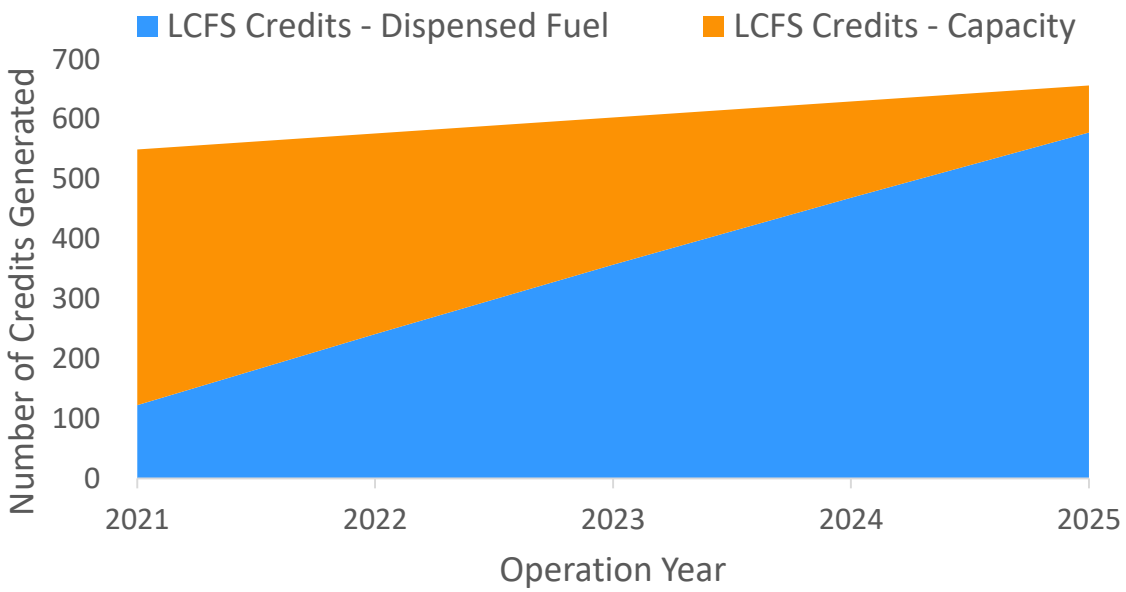
DC Fast Charging Infrastructure (FCI) Crediting

Illustrative Example: FCI Crediting

Capital Costs:
~420K

LCFS Fuel Credits:
~$220K in cumulative value

Infrastructure Credits: ~$160K in cumulative value



- *For a station with 6 chargers, 50 kW each.*
- *Utilization ramps up from an average of 1 hour/day to 5 hours/day in 5 years*
- *CI for dispensed electricity 0 gCO2e/MJ, CI for Infrastructure crediting 93.42 gCO2e/MJ*
- *LCFS Credit price of $125/ton*

Important Factors to Consider for Crediting

Useful Capacity: How is capacity defined? What is an expected full-deployment utilization level?

Duration of Credits: For how many years will infrastructure credits be generated?

Station Availability: How is the station's operational status verified? How is uptime measured such that infrastructure credits are only provided for stations when they are operational?

Carbon Intensity: Crediting based on California average grid CI for DC FCI

Proposed Design: DC Fast Charging Capacity Calculation

- Capacity will be calculated based on the maximum simultaneous power throughput for each charging unit or per Fueling Supply Equipment (FSE)
- Capacity will be calculated using a consistent methodology across all sites
- Each FSE must have a minimum simultaneous power capacity of 50kW
- Each FSE will be credited up to a capacity maximum of 150 kW of simultaneous power
- Each site will be credited up to a capacity maximum of 1,500 kW of simultaneous power

Proposed Design: Duration of Crediting and Station Availability

- FCI credits will be generated for up to 5 years starting with the quarter following application approval

- FSEs need to be connected to a system that maintains a verifiable record of uptime and availability for each FSE

Proposed Design: CI used for FCI Crediting

- FCI credits will be calculated using the carbon intensity of the California average grid electricity Lookup Table pathway

Proposed Design: Additional Eligibility Requirements and Restrictions

- **Application:** Applications must be received on or before Dec 31st 2025.
- **Connector Types:** Each charger must support at least two of the three commercial fast charging connectors - CHAdeMO, SAE CCS and/or Tesla.
- **Access Requirements:** Stations must be open and accessible to the public and accept major credit and debit cards. No private key codes or barriers that limit access will be permissible
- **Enforcement Actions:** Fueling infrastructure receiving funds pursuant of any enforcement settlement to any California or Federal regulation will not be eligible to receive FCI credits
- **Expanded Capacity:** Infrastructure expansion projects will receive additional FCI credits within the initial 5-year crediting period.

Proposed Design: FCI Credit Calculation

$$\boldsymbol{Credits_{FCI}(MT) = \left(CI^{XD}_{standard} \times EER - CI_{FCI}\right) \times C_{ELEC} \times \left(P^{i}_{FCI} \times 6\frac{hr}{Day} \times N \times UT - Elec_{disp}\right) \times C}$$

Where:

$CI^{XD}_{standard}$ **= LCFS carbon intensity standard for gasoline the given year in g/MJ**

EER **= Energy economy ratio (dimensionless) for light duty electric vehicles (i.e. 3.4 for LDVs)**

CI_{FCI} **= Carbon intensity used for FCI crediting (grid-average CI for the quarter fuel was dispensed)**

C_{Elec} **= Energy density for electricity (3.6 MJ/kWh)**

P^{i}_{FCI} **= Simultaneous power rating for the FSE up to a maximum of 150 kW**

N **= Number of days in given quarter (day/qtr)**

UT **= the uptime multiplier which is the fraction of time the FSE was available for charging during the quarter**

$Elec_{disp}$ **= quantity of electricity displaced during the quarter (kWh)**

C **= Conversion factor of 1.0X10-6 MT/g**

DC Fast Charger Economics

- High variability in costs
- Data limitations – to conduct better economic analysis staff requests the following:
  - Better estimates of the capital cost for DCFCs
  - Estimates of grid upgrade charges to DCFCs
  - Estimates of average cost of electricity including demand charges in various utility service territories

DC Fast Charger Economics - NPV

Scenarios			Results		
	Utilization	Power Rating	NPV of FCI Credits	NPV of Credits for Dispensed Fuel	NPV of all LCFS Credits
1	Up to 6 hours/day in 6 years	50 kW	$23,612	$116,120	$139,732
2	Up to 6 hours/day in 12 years	50 kW	$33,991	$53,051	$87,042
3	Up to 6 hours/day in 6 years	150 kW	$70,836	$348,360	$419,196
4	Up to 6 hours/day in 12 years	150 kW	$101,973	$258,953	$360,926

Based on a discount rate of 10%, inflation rate of credit prices of 1.9%, 5 year capacity crediting, and 20 year project life.

Other Modifications to March 6 Amendments Proposal

EV Charging: Hierarchies of Credit Claims

Incremental Credits for Residential EV Charging

- Staff is proposing to use VIN number on EV to avoid duplicate claims
- In case of duplicate claim, entities will get priority in the following order to claim the incremental credits for residential EV charging:
  - First – LSE supplying to EV with metered data through separate charging equipment
  - Second – Manufacturer of the EV with vehicle telematics
  - Third – Any other entity with metered data through separate charging equipment

Credit generator for Non-Residential EV Charging

- The owner of the charging equipment (FSE) is the default credit generator
- The owner can designate any other entity to claim credits on its behalf

EV Charging: Other Changes

EV Charging at Multi-family Residences

- A separate category will allow the owner of the FSE or its designee to generate the credits
- Utilities will receive credits not claimed by any other entity
- Incent faster deployment of charging infrastructure in multi-family residence structures

Reporting for residential base credit calculation

- Staff is proposing to issue base credits for non-metered residential EV charging on quarterly basis
- Utilities to provide separately metered data for the calculation of base credits within 45-day after the end of quarter

Energy Economy Ratio (EER) Updates

New Electric Transportation Applications

- Proposing new EER values to allow crediting for the following applications:

Application	EER
Electric Cargo Handling Equipment (eCHE)	2.7
Auxiliary Electric Engines of Ocean Going Vessels At-berth (eOGV)	2.6

EER-adjusted CI Values Through Tier 2 Application

- Proposing to allow applicants to request EER-adjusted CI values through the Tier 2 application process for a vehicle-fuel combination not included in Table 5
- Methodology used must compare useful output from the alternative fuel technology to that of comparable conventional fuel technology
- Would allow innovative technologies using low carbon fuels for transportation to be recognized

Alternative Diesel Fuels (ADF) Regulation Sunset Provisions

- Staff's original proposal: Sunset provision occurs when both on and off-road sectors are predominantly (90%) New Technology Diesel Engines (NTDEs)

- Now proposing to bifurcate the sunset provisions for On- and Off-Road applications
  - On-Road sunset triggered separately from off-road sunset
  - Sunset occurs when 90 percent of that sector is NTDEs
  - Projected sunset:
    - On-Road: likely 2023
    - Off-Road: likely 2030 or later

Carbon Capture and Sequestration (CCS): Updates to Buffer Account

All projects contribute to the buffer account based on their risk rating:

- Prior proposal: 3% (least risky) to 11% (most risky) contribution
- New proposal: 8-16% contribution due to full reliance on the buffer account after 50 years post injection:

< 50 years post-injection (no change)	> 50 years post-injection (new addition)
1. Credits taken from the buffer account to match the quantity leaked up to the project's contribution 2. Project operator makes up any delta between the amount leaked and the project's contribution 3. If operator is unable to make up the delta, CARB retires credits from the buffer account contributed from other sources	1. CARB retires credits from the buffer account (without regard to the project's individual contribution)

CCS: Proposed Updates to Modeling and Monitoring Provisions

Proposing updates to:

- Add requirement to model plume and CO_2 leakage risk for 100 years post-injection and clarified risk analysis
- Link risk assessment more explicitly to monitoring
- Performance requirements or flexibility for most monitoring rather than specific technologies
- Replace most references to “AOR” with “storage complex”

No proposed changes to:

- Liability for damage to physical environment remains project specific
- Monitoring must occur through 100 years post-injection

CCS Protocol: Proposed Terminology Changes

- Increased detail and improved clarity:
  - Accounting
  - Data collection
  - Monitoring provisions
- Definitions:
  - “Pressure front” changed to “Elevated pressure” and clarified
  - “Confining layers” changed to “Confining system” and clarified
  - Plume stabilization defined
- Other clarifying changes
  - Removed dissipation interval requirement
  - Specified process for determining plume stabilization has occurred

Provisions for Petroleum-Based Fuels (1)

Proposed Changes to Amendments for Crude Oil Provisions

- OPGEE and Table 9. Carbon Intensity Lookup Table for Crude Oil Production and Transport
  - Updating 2010 baseline and crude lookup table CI values
  - Adding several new crudes and their CI values
  - Updating default parameters (reservoir pressure, wellhead pressure, and steam quality) for California and Canadian fields using thermal enhanced oil recovery (TEOR)
  - Correcting an error in unit conversion that results in a CI change for TEOR
- Innovative crude
  - Clarifying that transport projects (e.g., pipeline) and storage of solar or wind electricity is eligible
  - Proposing to recognize additional innovative energy sources
  - Adding a lower steam quality bin (45-55%) for solar steam and updated the avoided emissions values for all steam quality ranges
  - Revising reporting requirements for California producers

Provisions for Petroleum-Based Fuels (2)

Proposed Changes to Amendments for Refinery Investment Credit Provision

- Process Improvement Projects
  - Adding clarification on qualifying project types
  - Proposing to apply the eligibility threshold only to process improvement projects. Modifying the threshold from a CI-based threshold (0.1 gCO_{2e}/MJ) to a quantity based threshold (10,000 MT/year), and a 1% threshold as an option for smaller facilities
  - Increasing the limit on the amount of credits generated from process improvement projects that can be used to meet an entity's annual compliance obligation to 10 %
  - Staff is proposing to extend the period of time for which a refinery process improvement project can receive credit to 15 years from the date CARB approves the application.

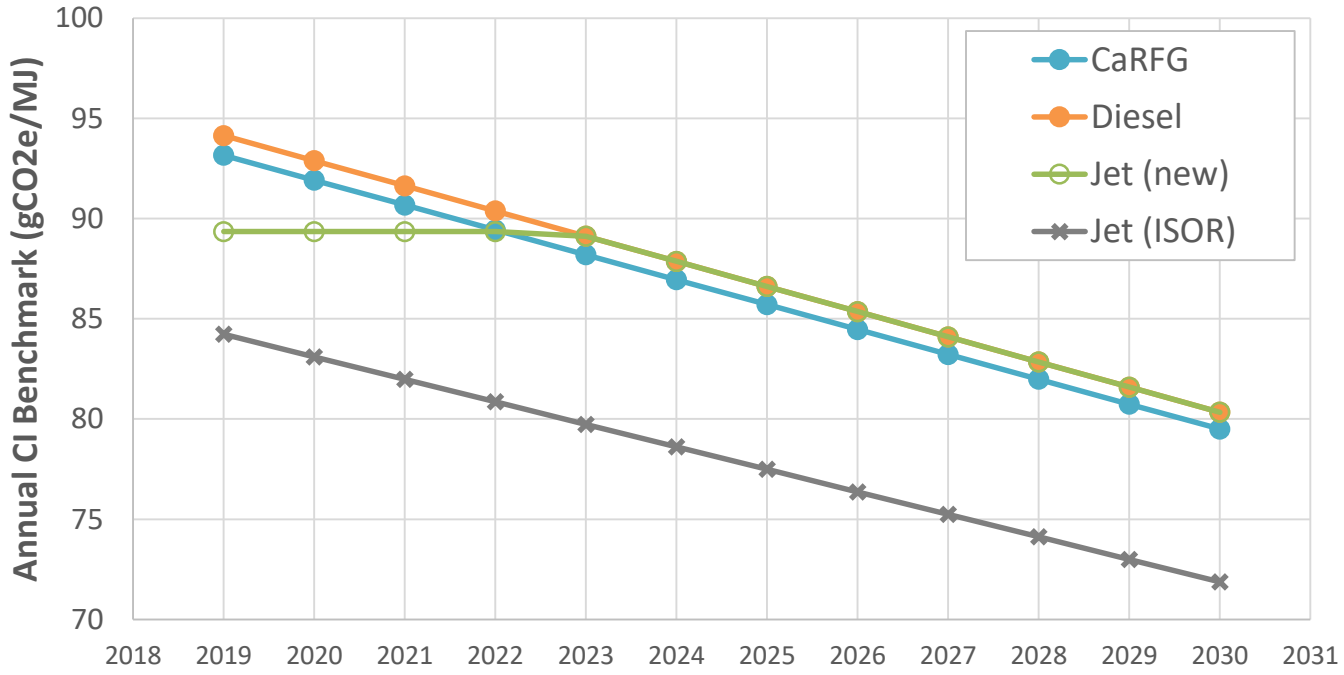
Provisions for Petroleum-Based Fuels (3)

Proposed Changes to Amendments for Refinery Investment Credit Provision

- Application Contents and Submittal
  - Proposing to allow quarterly credit generation if an entity chooses to obtain quarterly verification statements
  - Adding an application requirement to demonstrate that second or higher order indirect impacts are not significant beyond the identified project system boundary
  - Adding an expiration date for receiving refinery process improvement project applications

Proposed Baseline CI and Benchmark Updates

- Baseline CI values (Tables 1 through 3) are recalculated to align with the latest updates to OPGEE and CA-GREET models
- Modifying benchmarks for conventional jet fuel substitutes



Proposed Technical Updates to CA-GREET3.0 and Simplified CI Calculators

- Proposing transport-related model updates
  - Adding back-haul for rail transport and revising values for other transport modes
  - Increasing fuel economy for heavy and medium duty trucks
  - Updating truck capacity for corn/soybean/canola transport and ocean tanker payload for BD/RD feedstock and fuel transport
  - Decreasing corn transport distance to 40 miles in Midwestern corn-growing states, and deleting user-defined transport option; updating corn/sorghum rail transport distance to California to 1,900 miles
  - Adding user-defined ocean tanker transport size for BD/RD feedstock and fuel transport
- Updating eGRID electricity generation data to reflect EPA's corrected values for 2014
- Updating emission factors in all Simplified CI Calculators to align with CA-GREET updates

Proposed Updates to CI Values

- Proposing to recalculate Lookup Table CI values to align with CA-GREET3.0 and OPGEE updates
  - Proposing to change the "solar or wind" electricity Lookup Table pathway to recognize additional zero-CI energy sources
  - Correcting an error in hydrogen liquefaction

- Proposing updates to Temporary Fuel Pathways Table CI values:
  - Biomethane from Dairy/Swine Manure:

    Bio-CNG, LNG, or L-CNG: –150 gCO2e/MJ
  - Biomethane from Municipal Wastewater Sludge:

    Bio-CNG: 50 gCO_2e/MJ

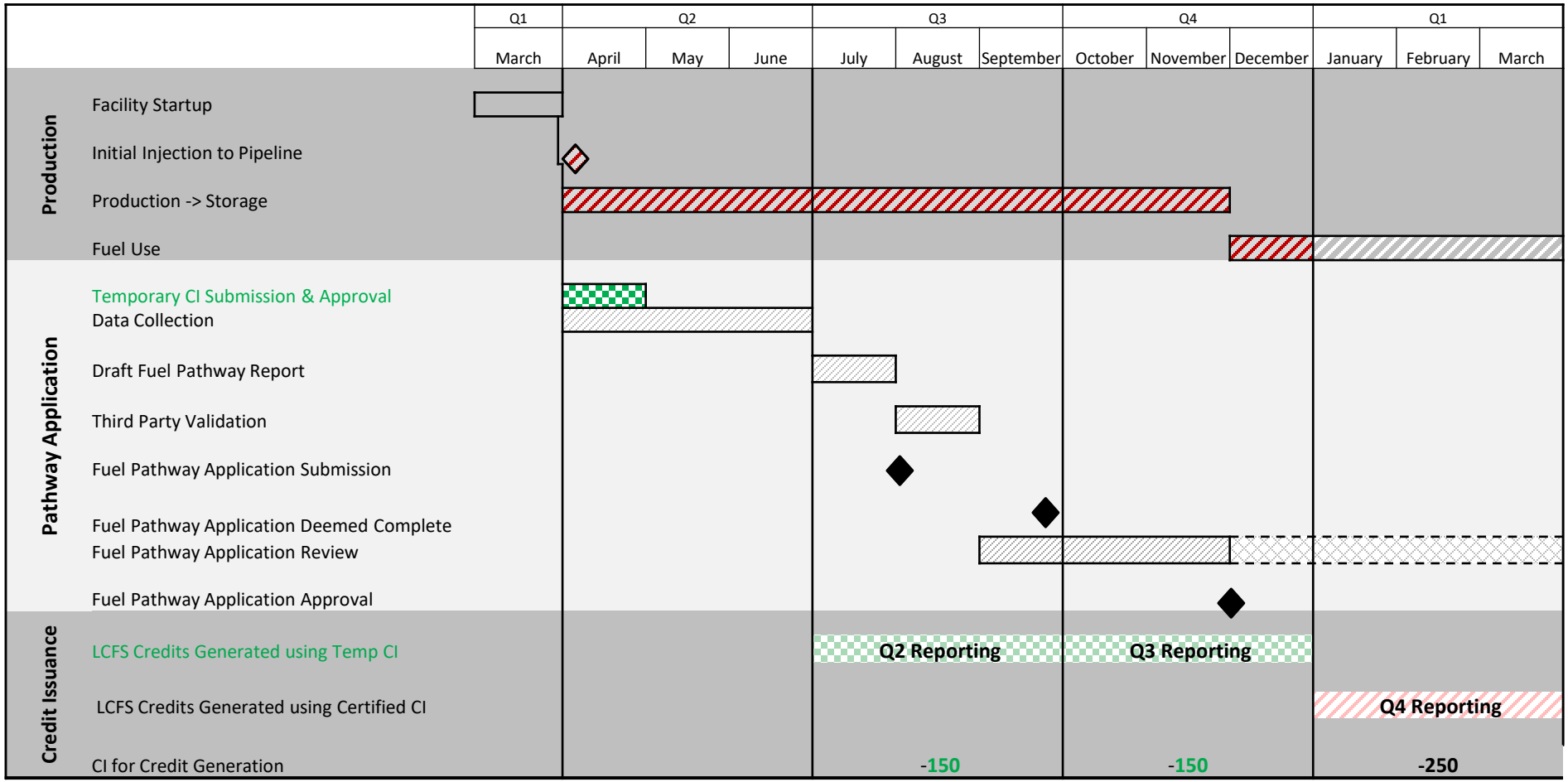
    Bio-LNG: 65 gCO_2e/MJ

    Bio-L-CNG: 70 gCO_2e/MJ

New Tier 1 Simplified CI Calculators

- Staff is proposing three additional Tier 1 Simplified CI Calculators for Biomethane from Anaerobic Digestion
  - Wastewater Sludge
  - Dairy and Swine Manure
  - Food, Green, and Other Organic Waste
- Supports Implementation of State's Methane and Organics Diversion Goals
  - Short Lived Climate Pollutant Reduction Strategy (SLCP)
  - SB 1383 (Lara, Chapter 395, Statutes of 2016)
    - Organic Wastes Diversion Targets for Landfills to Reduce SLCP
    - 75 Percent Reduction in Statewide Disposal of Organic Wastes by 2025
    - 2020 and 2025 Reduction Targets Take Effect in 2022
  - Commercial Organics Diversions Goals (AB 1826) (Chesbro, Chapter 727, Statutes of 2014)
    - Local Jurisdictions must Implement an Organic Waste Recycling Program
    - 50 Percent Reduction in Statewide Disposal of Organic Wastes by 2020

Tier 2 Dairy RNG Project Crediting Timeline: *Three Quarter Flexibility and Temp CI*



Proposed Reporting Eligibility and Registrations

Exemption for Small Fossil CNG and Fossil Propane Stations

- Stations with 50,000 GGE or less annual throughput will be exempt from LCFS until the respective fuel starts generating deficits

Clearly Identifying Fueling Supply Equipment (FSE)

- FSE for each fuel application type is clearly identified:
  - CNG,LNG, Propane and Hydrogen – each station is an FSE
  - EV charging – equipment capable of measuring dispensed electricity is an FSE (including utility meter/sub-meter, smart charger and vehicle telematics)
  - Incremental credits for residential EV charging – VIN numbers are required for FSE registration
  - For Forklifts, eCHE and eOGV – each facility or location of charging is an FSE
  - For eTRU – each unit is an FSE
- Enhances double-counting avoidance capability

Proposed Updates to Credit Provisions

Forward and future trade of LCFS credits

- Clarify contracting for future delivery of LCFS credits is allowed

Simplifying Credit Transfer Reporting

- Clarify reporting requirements for the three types of credit transfers:
  - Type 1 - OTC with delivery within 10 days from the date of agreement
  - Type 2 - OTC with delivery beyond 10 days from the date of agreement
  - Type 3 - Credit transfer facilitated by an exchange
- Provide total of 10 calendar days to both Seller and Buyer from the date of transaction agreement to report the proposed trade in the LRT-CBTS

Proposed Updates to Third-Party Verification

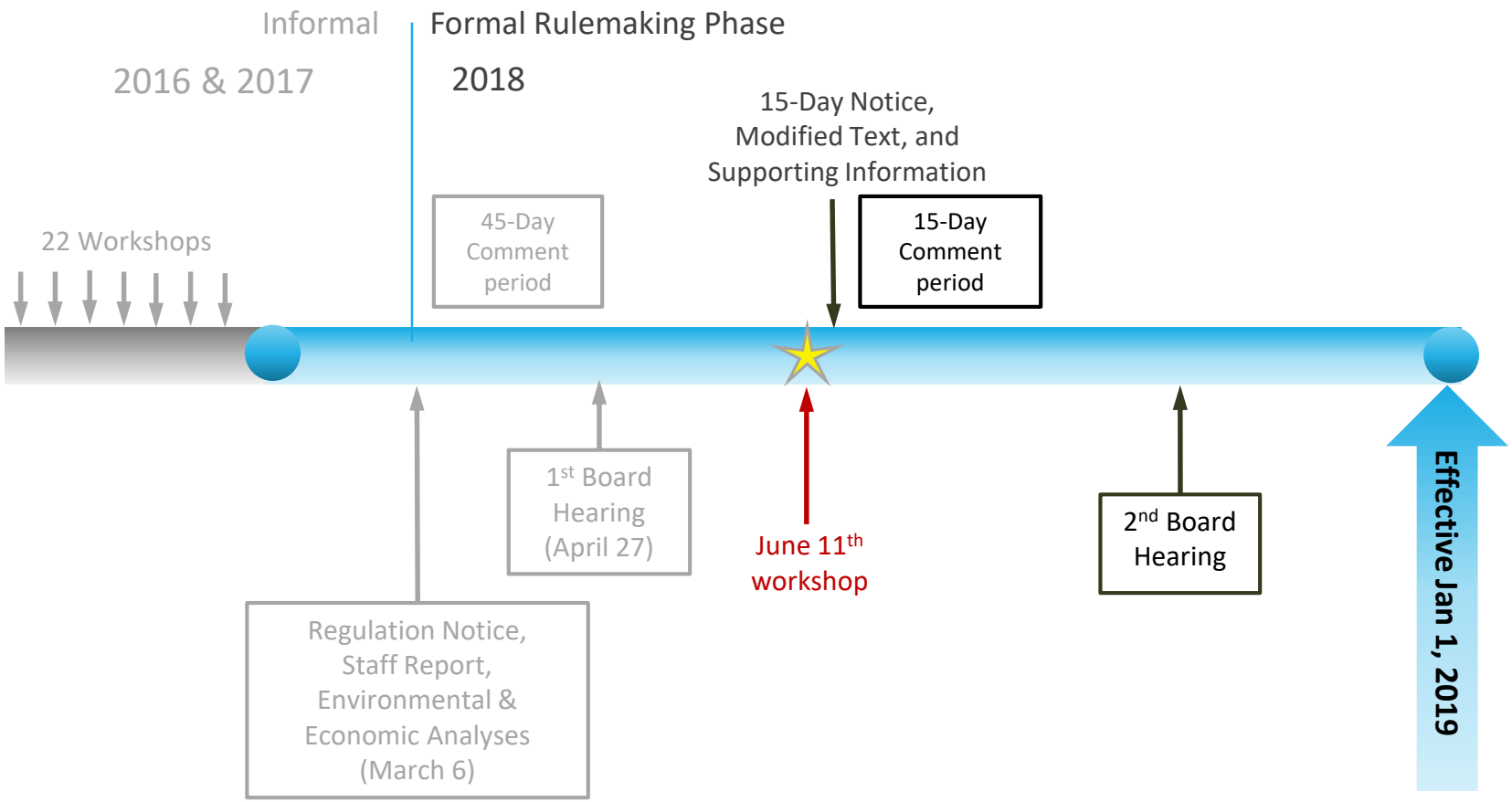
Verification schedule

- Clarifying requirements for deferred verification for fuel pathway holders reporting below threshold
- Including deadlines for submitting verification statements for Project Reports
- Adding requirements to allow verifier quarterly review of submitted data in the context of annual verification services

Conflict of Interest

- Extending phase-in period for certain services to January 1, 2023
- Clarifying language for certain high-risk services in response to stakeholder comments

Rulemaking and Implementation Timeline



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