Medium and Heavy Duty Vehicles Under California’s LCFS

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LCFS Sets a Declining Carbon Intensity Target

![Diagram showing life cycle carbon intensity and LCFS targets for gasoline and alternative fuels X and Y.](image-url)
LCFS Has Diversified the Fuel Mix

![Graph showing Alternative Fuel Volumes and Credit Generation from 2011 to 2018.](image)
LCFS – Projecting the Next Decade

Source: California’s Clean Fuel Future
Medium and Heavy Duty Electrification
Electricity Under the LCFS

• Revenue from Electricity Credits must be spent supporting the expansion of the EV market, including:
  • Paying for chargers or EVs
  • Reducing the cost of charging to the consumer
  • Advertising benefits of electricity and EVs

• Credits from residential charging goes to the utility serving the home

• Credits from non-residential charging, or hydrogen fueling, generally goes to the owner of the charger or fueling station
  • Can be assigned elsewhere, by contract, e.g. to a charging service provider or aggregator
Hydrogen Under the LCFS

• Hydrogen CI determined through more conventional LCA using GREET model

• Hydrogen produced from electrolysis using renewable electricity, or from steam methane reforming of renewable natural gas, can be very low CI.

• California has a requirement that 33% of hydrogen fuel must come from renewable sources
  • Very little electrolysis at this point
  • Many competitors for limited RNG resource, ultra-low NO\textsubscript{x} natural gas engines viewed as key strategy for near-term NO\textsubscript{x} reduction for legally mandated targets
Infrastructure Capacity Credits

• 2018 amendments added infrastructure capacity credits for public DC Fast charging or hydrogen fueling infrastructure
  • Hydrogen and electricity credits capped at 2.5% of previous year’s deficits each.
  • Subject to public access and uptime requirements

• Electricity Capacity Credit Provisions
  • Public DC Fast chargers receive LCFS credits as if utilized at specified capacity, regardless of actual use.
  • Generally should have at least 2 types of connector
  • Eligible to receive infrastructure credits for 5 years, up to capital cost of equipment

• Hydrogen Capacity Credit Provisions
  • Receive LCFS credits as if full rated capacity was dispensed every day
  • Each station eligible for 15 years, including existing stations
  • Likely to provide value well above infrastructure cost
Electricity & Hydrogen Under the LCFS

- Alternative Fuel CI is adjusted by an Energy Efficiency Ratio (EER) which reflects the different engineering and system efficiency for different vehicles and powertrains.
  - Passenger vehicle EER for electricity is 3.4. Heavy Duty Trucks and Buses are 5.0
  - Passenger vehicle EER for hydrogen is 2.5. Heavy Duty vehicles are 1.9

- The full life cycle carbon intensity of electricity is assessed on a statewide average basis, updated yearly, but charger owners can use alternatives
  - Apply for a fuel pathway in which a specific piece of infrastructure charges a specific set of vehicles. The CI is then based on that combination of equipment.
  - Opt in to “Renewable Energy” charging program. Procure renewable electricity above state requirements to charge the vehicle at 0 g/MJ CI (done by retiring Renewable Energy Certificates)
  - Opt in to “Smart Charging” program, CI is determined according to hourly grid average carbon intensity, seasonally adjusted.
Calculating Credits

\[ Credits(\text{tonne } CO_{2e}) = (CI_{\text{Target}} - \frac{CI_{\text{Fuel}}}{EER}) \times (\text{Energy} \times EER) \times 10^{-6} \quad \text{tonnes} \quad g \]

\( CI: \) Carbon Intensity (g CO\(_{2e}/MJ) \quad \text{EER: Energy Efficiency Ratio} \quad \text{Energy: Total energy consumed (MJ)} \)

Or, more simply: Credits and deficits represent tonnes emissions reductions above or below that year’s target.

At current LCFS credit prices and targets, the effective subsidy for light duty vehicles is about $0.17/kWh and for trucks and buses it is about $0.27/kWh.

Recent analysis by ICF estimated that this would sum to about $60,000-70,000 over the first five years of life for a heavy duty freight truck in drayage service.
Figure III-1. Class 8 Tractor TCO Analysis Results

Total Cost of Ownership for a Class 8 Drayage Truck in 2020 (left) and 2030 (right)

Source: CalETC/ICF *Comparison of Medium and Heavy Duty Technologies in California*
Challenges for MD/HD Electrification

• Industry is still immature, not enough manufacturers, models, technicians
  • Longer range applications don’t have a clear “winner” technology yet

• Current logistics models don’t always fit need for extended charge times
  • Locating chargers at loading/unloading/queueing areas may be important

• Near-term competition from low-cost 1st generation biofuels

• Electricity rate design in critical
  • Demand charges can be massive, but rapid cycling of high-power loads can be tough on grids and lead to high demand charges (possibly a U.S. issue)
Resources

CARB LCFS Website: https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard

CA-GREET Model: https://ww2.arb.ca.gov/resources/documents/lcfs-life-cycle-analysis-models-and-documentation


Thank You!

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