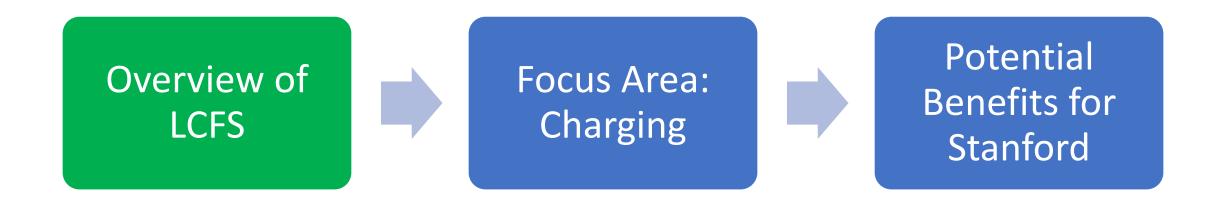
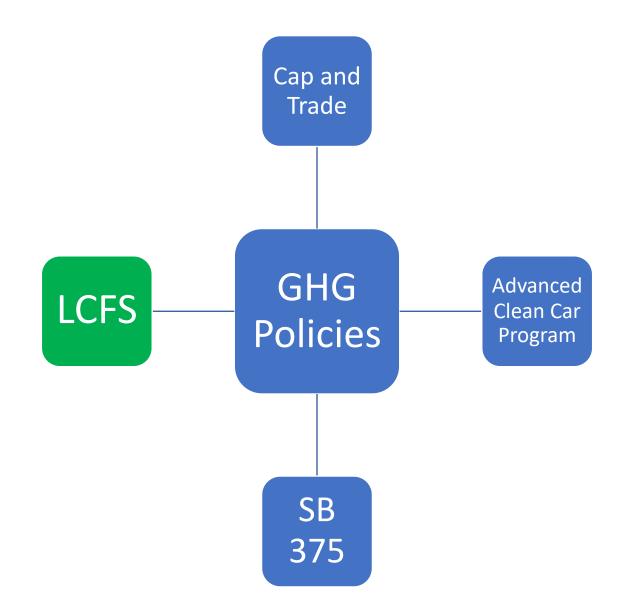
Low Carbon Fuel Standards (LCFS)

Application in the 24/7 carbon-free charging project

Topics Covered



LCFS is part of a portfolio of GHG Policies



Sets carbon intensity (CI) standards – g CO₂e/MJ – for transportation fuels

CI based on Life Cycle – production, distribution and consumption

LCFS Basics

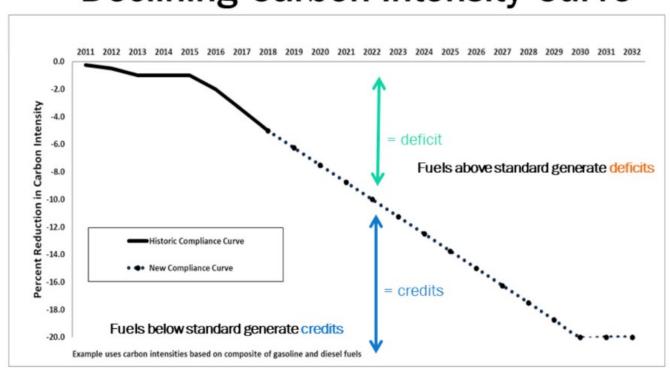
Fuel CI > benchmark – deficit

Fuel CI < benchmark – credit

Market decides mix of fuels needed

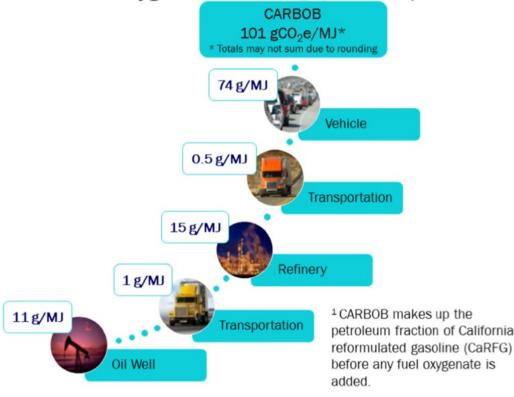
Goal: Reduce carbon intensity of transportation 20% from 2010 levels by 2030

Declining Carbon Intensity Curve

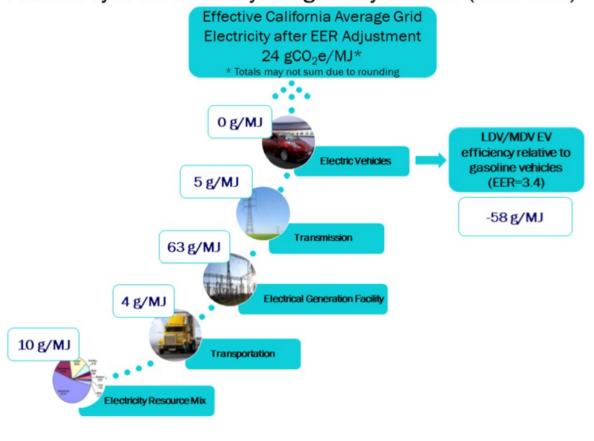


Life Cycle Assessment to calculate Carbon Intensity (CI)

Fuel Life Cycle for California Reformulated Gasoline Blendstock for Oxygenate Blending (CARBOB)¹



Fuel Life Cycle for Electricity in Light-Duty Vehicles (2017 data)



Projects

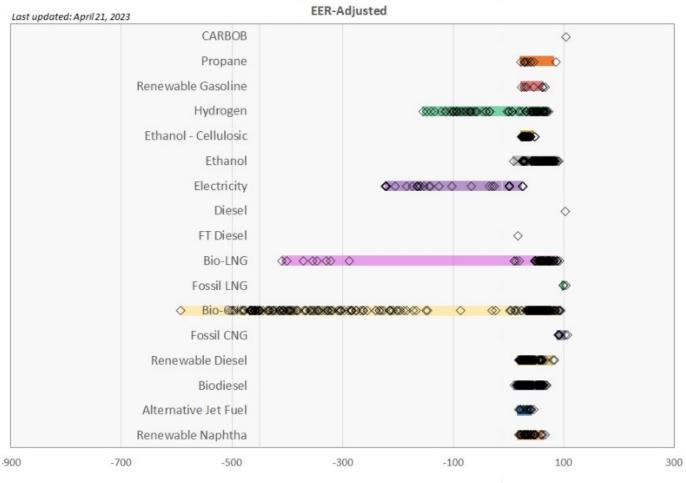
Fuel Pathways

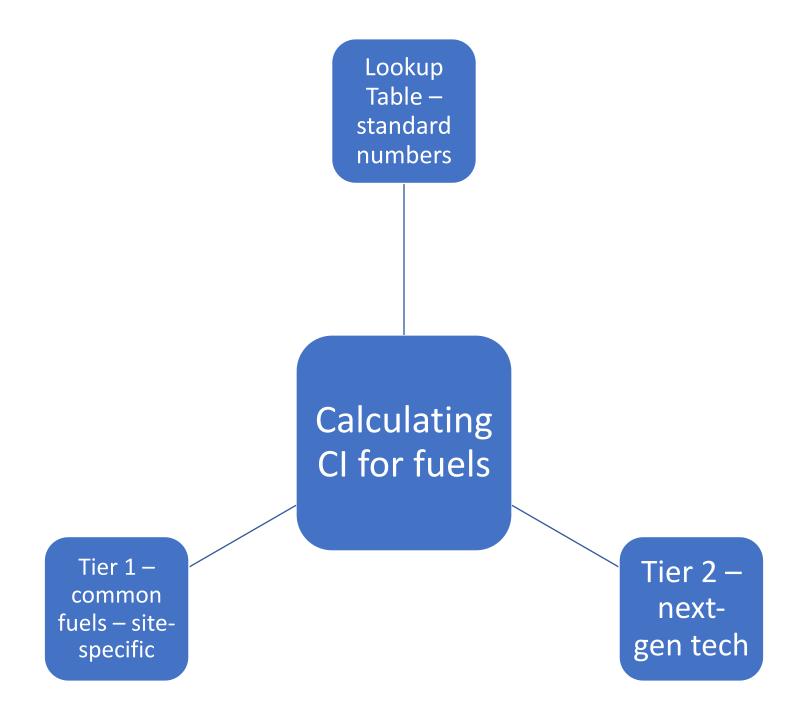
Capacity

Ways to generate credits

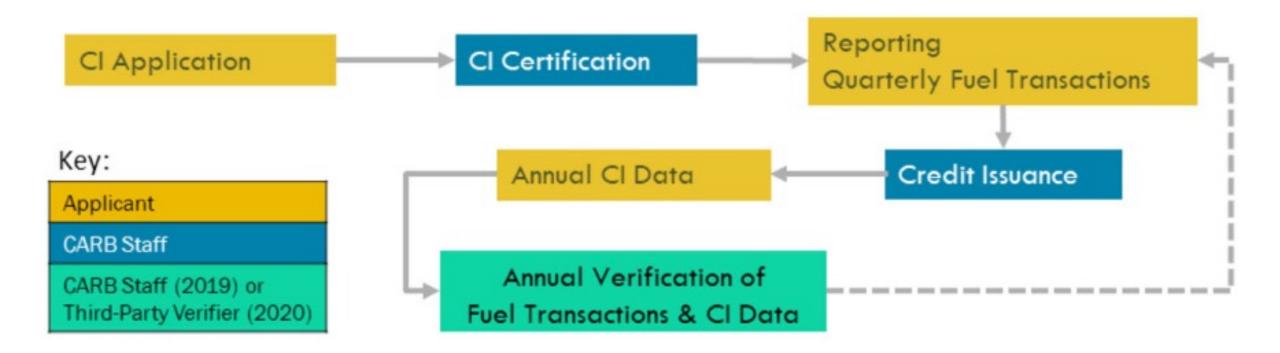
Fuel Pathways

Carbon Intensity Values of Certified Pathways





Application and Credit Generation Process



Solve chickenand-egg problem

Capacity Credits

Must have started operating after 1/1/2019

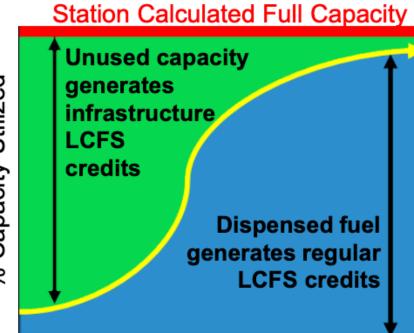
% Capacity Utilized

2500 kW

max, each

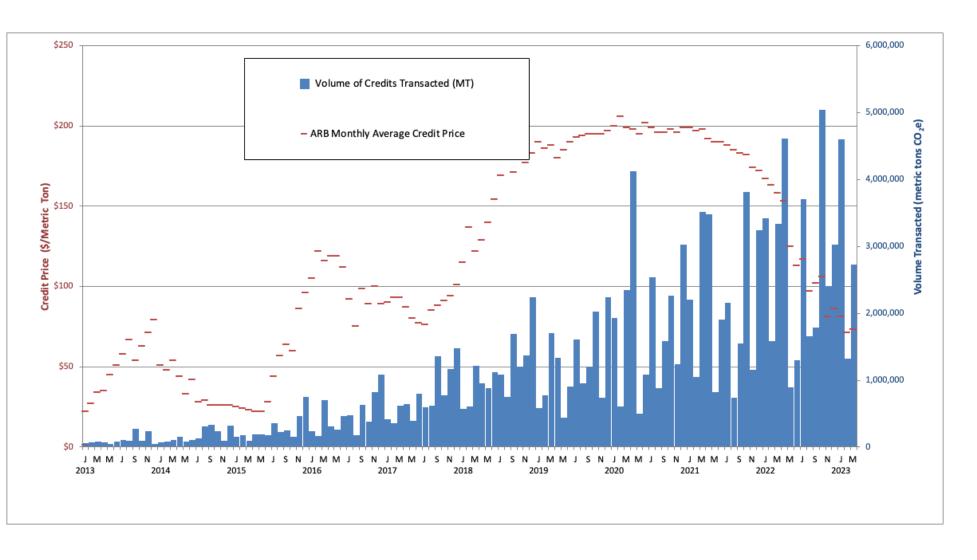
charger 50

kW minimum



Infrastructure Crediting Period (HRI: 15 yrs max; FCI: 5 yrs max)

Credit Price History (1 credit = 1 MT CO_2e)



Current Price: \$82/credit (or) \$82/MT CO₂

Topics Covered



Which category does Stanford fall in?

Electric Transportation Categories Eligible for LCFS Crediting

Residential Electric Vehicle (EV) Charging

Non-Residential Electric Transportation

Residential EV Charging (Base Credits)

- Only Electric Distribution Utilities (EDU) are eligible
- Based on ∆ between California
 Grid Avg. Electricity Cl and
 Gasoline Benchmark for the year

Residential EV Charging (Incremental Credits)

- Entity eligible to generate credit based on hierarchy
 - 1. Load Serving Entity (LSE)
 - 2. Automaker
 - 3. Others
- Based on ∆ between California Grid Avg. Electricity CI and low-CI electricity

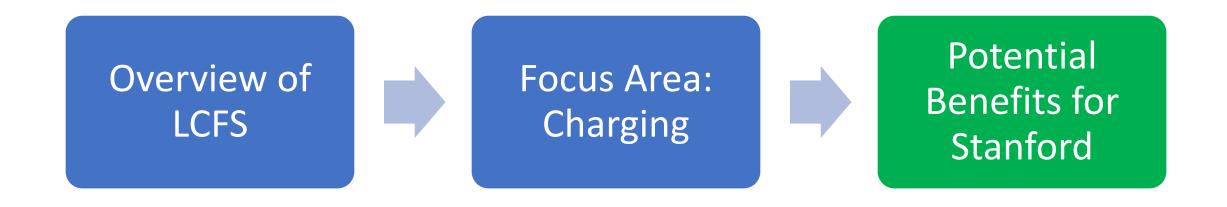
On-Road Transportation (Includes light and heavy-duty EV charging)

- Public EV Charging
- Workplace EV Charging
- EV Fleet Charging (Including Transit Fleet)

Off-Road Transportation

- Fixed Guideways (Transit)
- Electric Forklifts
- Electric Cargo Handling Equipment (eCHE)
- Electric Transportation
 Refrigeration Unit (eTRU)
- Shore Power to Ocean Going Vessels at-berth (eOGV)

Topics Covered

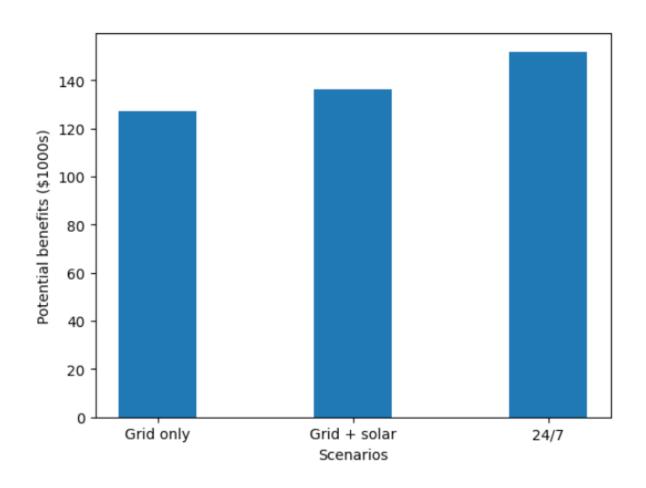


Calculation Sample – Grid Electricity – Fuel Pathways

- CARB Standard = $100.82 \text{ g CO}_2/\text{MJ}$
- California grid electricity CI = 81.49 g CO₂/MJ
- EER = 5 (electric bus, relative to diesel-powered bus)
- EER adjusted CI = $81.49/5 = 16.3 \text{ g CO}_2/\text{MJ}$
- Credit = Difference = $100.82 16.3 = 84.52 \text{ g CO}_2/\text{MJ}$
- Converting MJ to kWh and multiplying by current price (\$82/ton), we get benefit = \$0.025 / kWh
- Annual energy displaced (2022) = 1021057.5 kWh * 5 = 5.11e6 kWh/year
- Potential benefits for Stanford = 5.11e6 kWh/year * \$ 0.025/kWh =
- \$ 128k/year!

$$LCFS\ Revenue = \left[\left(CI_{Diesel} - \left[\frac{CI_{Electricity}}{EER_{BEV}} \right] \right) \times E \times EER_{BEV} \times C \right] \times Credit\ Price$$

Repeating similar calculations for grid + solar and 24/7 carbon-free....



Note: For grid + solar, 35% electricity from solar and rest from grid

Calculation Sample – Grid Electricity - Capacity

- CARB Standard = 100.82 g CO₂/MJ
- California grid electricity CI = 81.49 g CO₂/MJ
- EER = 5 (electric bus, relative to diesel-powered bus)
- EER adjusted CI = $81.49/5 = 16.3 \text{ g CO}_2/\text{MJ}$
- Credit = Difference = $100.82 16.3 = 84.52 \text{ g CO}_2/\text{MJ}$
- Converting MJ to kWh and multiplying by current price (\$82/ton), we get benefit = \$ 0.025 / kWh
- Annual charging capacity = 80 kW * 8760 h/year * 23 = 1.61e7 kWh/year
- Annual charging = 5.11e6 kWh/year
- Potential benefits for Stanford
- = (1.61e7 5.11e6) kWh/year * 5 * \$ 0.025/kWh
- = \$ 1.37 million /year!

$$Credits_{FCI} = (CI_{standard}^{XD} \times EER - CI_{FCI}) \times C_{Elec} \times (Cap_{FCI}^{i} \times N \times UT - Elec_{disp}) \times C$$