

What is the Role of Hydrogen in California's Zero-Emission Transportation Future?

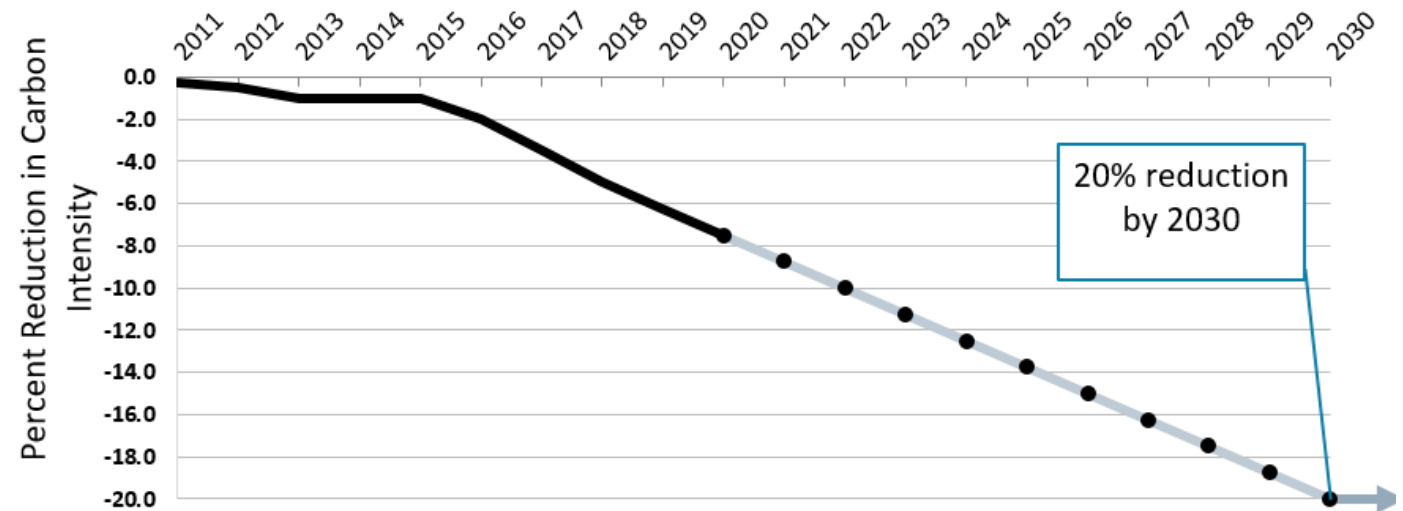
CHAIR RANDOLPH

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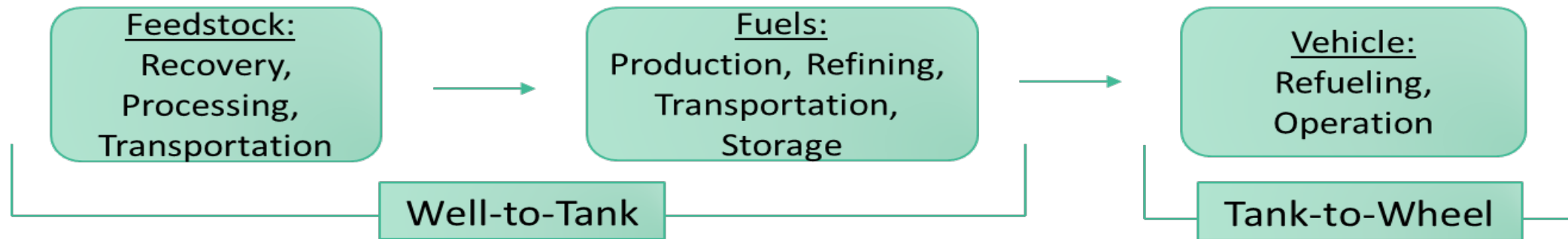
Low Carbon Fuel Standard (LCFS)

- California's primary program to promote alternative fuel use
- Goal: Reduce carbon intensity (CI) of transportation fuels and diversify the fuel mix
- Key Milestones:
 - Early action measure under AB 32
 - Original adoption in 2009
 - First compliance year in 2011
 - Re-adopted in 2015
 - Strengthened in 2018 and 2019
- Expected benefits:
 - Reduce greenhouse gases (GHG)
 - Transform and diversify fuel pool
 - Reduce petroleum dependency
 - Reduce emissions of criteria pollutants and toxics



LCFS: Life Cycle Approach

- Well-to-Wheel Carbon Intensity includes the “direct” effects of producing and using the fuel, as well as “indirect” effects that are primarily associated with crop-based biofuels
- Modeling approaches are reviewed and approved after extensive public process



LCFS: Hydrogen pathways



- Participation of hydrogen in LCFS is growing in the LCFS program. From 3,500 gallons of gasoline equivalent (gge) in 2015 to 1.3 million gge in 2020
- Expansion of renewable and low-CI hydrogen participation. Federal and state-level support for H2 fuel production and infrastructure development
- CI of hydrogen varies by production method and source of feedstock

H2 Pathways Examples for a Light Duty Vehicle	Avg Carbon Intensity (g CO2e/MJ)*
H2 from dairy biomethane via SMR	-94
H2 from electrolysis (wind/solar electricity)	4
H2 from landfill gas via SMR	46
H2 from natural gas via SMR	58
H2 from electrolysis (Grid electricity)	66

*Adjusted for use in a light-duty vehicle

CARB's Transportation Incentive Programs

Community Air Protection Program (AB 617)

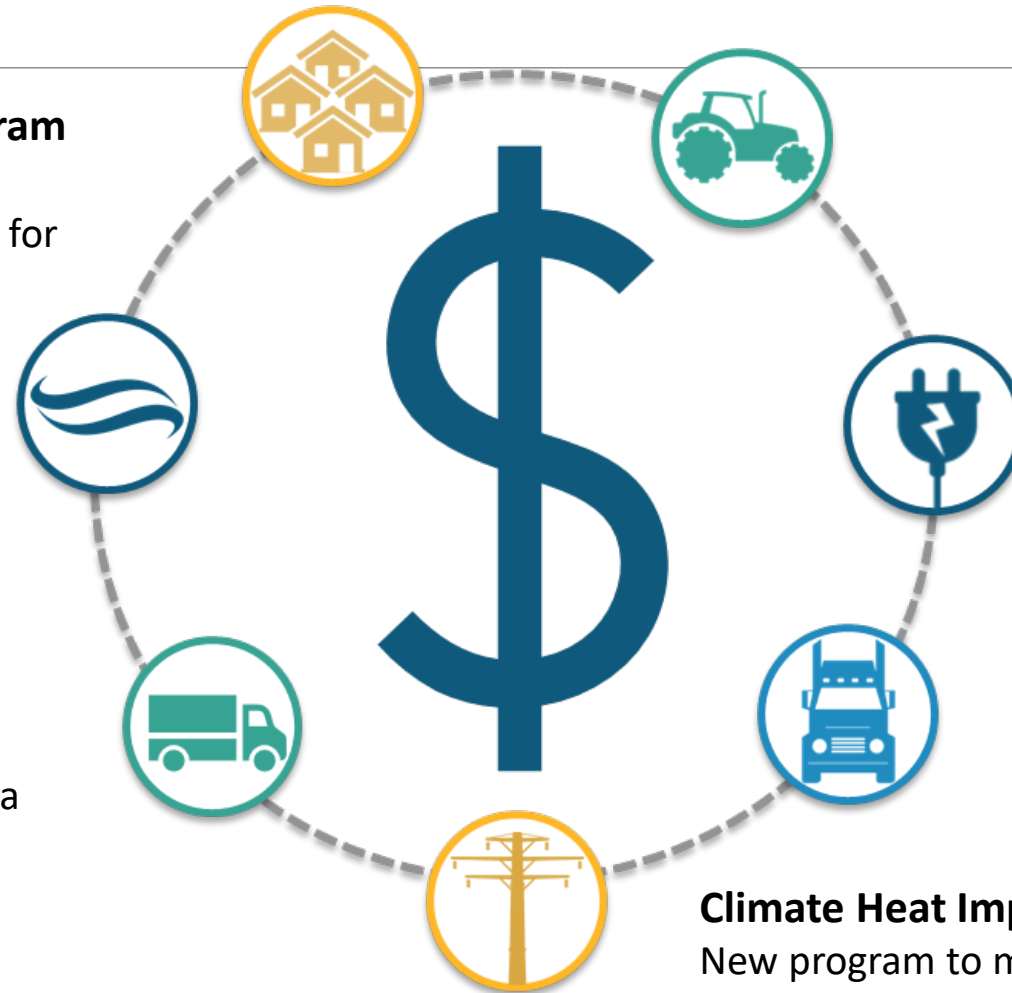
Criteria, toxics and GHG reductions for community goals

Air Quality Improvement Program (AQIP)

Criteria pollutant and toxics reductions

Carl Moyer Program

Cost-effective, SIP creditable criteria pollutant emission reductions



FARMER Program

Criteria, toxics and GHG reductions for the ag sector

Low Carbon Transportation

Advance technologies to provide GHG reductions and Priority Populations benefits

VW Mitigation Trust

NOx mitigation and zero-emission

Climate Heat Impact Response Program (CHIRP)

New program to mitigate emissions during CAISO grid events caused by extreme weather conditions

Hydrogen in Low Carbon Transportation Program and Volkswagen Mitigation Trust

- Eligible in consumer and fleet voucher/rebate programs
 - CVRP, HVIP, Clean Cars 4 All, and Financing Assistance for Low-Income Consumers
 - Higher incentive amounts for hydrogen fuel cell vehicles in CVRP and HVIP
 - Limited demand due to vehicle and infrastructure availability
- Volkswagen Mitigation Trust funding for fuel cell transit buses and light-duty hydrogen fueling stations
- Precommercial demonstration and pilot funding plays a key role in bringing hydrogen fuel cell vehicles to market
 - Over \$400 million in demonstration/pilot funding since 2014
 - Hydrogen fuel cell vehicles/equipment projects eligible to compete for funding

Commercially Available ZEVs

2B-3

(8,501 – 14,000 lbs.)

4-5

(14,001 – 19,500 lbs.)

6-7

(19,501 – 33,000 lbs.)

8

(33,000 lbs. and over)



Note: Excludes transit buses and all models not shown. Updated Sept. 2020.

A Closer Look at Heavy-Duty Hydrogen Demonstration and Pilot Projects

- Over \$125 million of demonstration and pilot project funding is supporting projects with heavy-duty fuel cell technology
 - 25 transit buses, 66 trucks, one ferry, and one heavy lift cargo handling equipment
 - 3 private and 2 public heavy-duty hydrogen fueling stations
 - 1 barge-mounted fuel cell-powered emissions capture and control system for tanker vessels
- Early investments provide a path to commercialization
- Investment in public heavy-duty hydrogen refueling stations is key

Thank you