

# Caltrans initiatives and goals contributing to the ZEHTRANS vision and mission

## ZEHTRANS



### Vision

Competitive and equitable zero-emission rail in California



### Mission

Work in partnership across government, communities, and industry to transition to a zero-emission rail system supportive of a sustainable, carbon neutral economy.



Air Resources Board



Department of Transportation



Energy Commission



GO-Biz

***Become an innovation leader in ZE rail vehicles***

### Partnership

- Lead innovative initiatives in ZE rail vehicles
- Integrate state-wide efforts to accelerate rail projects
- Coordination and cooperation through ZEHTRANS, particularly for rail
- Strive to facilitate coordination between agencies to achieve transition to ZE

### Transition

- Develop and propose strategies to achieve ZE intercity rail fleet by 2035
- Implement operational efficiencies to reduce emissions
- Continually reduce emissions with equipment upgrades, renewable fuels, and ZE technologies
- Provide technical assistance





Preliminary

# Caltrans Intercity Passenger Rail

Our strategy towards zero-emission (Draft)

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# Caltrans Owns the Equipment for Three Intercity Passenger Rail Corridors – Services Are Managed by Regional Joint Powers Authorities

## California's Intercity Passenger Rail



## Intercity diesel-electric locomotive fleet

15



F59PHI (EMD)

Year introduced: 1991 / 2001  
Emission standard: Tier 2

22



SC-44 (SIEMENS)

Year introduced: 2017  
Emission standard: Tier 4

*Focus of our zero-emission (ZE) strategy*



# Become an Innovation Leader in Zero-Emission Mobility

Contributing to a livable environment

# Strategic Goals for Our Intercity Fleet to Become an Innovation Leader in Zero-Emission Mobility

- PRELIMINARY -



## Decarbonizing our transportation system and improving our air quality

- Substitute fossil with renewable energy, thereby reducing GHG emissions
- Pilot and deploy hydrogen-hybrid motive power vehicles to achieve zero-emissions – as an intermediate solution, and consider adding batteries to the existing diesel trains

1

## Increasing our energy efficiency

- Invest in technology and procedures to enable energy-efficient driving as well as regenerative braking
- Invest in ground power for expanded use at layover facilities
- Invest in energy efficient railcars, reducing HEP<sup>1</sup> requirements

2

## Fostering leadership and facilitating collaboration in sustainable mobility

- Lead and promote pioneering initiatives in zero-emission vehicles
- Integrate state-wide efforts to accelerate implementation
- Engage in public outreach and promote the benefits of rail to encourage modal shift and increase load factor (thereby decreasing emissions per passenger mile)

3

(1) HEP = head-end power (e.g. for HVAC, lighting)

Develop Strategies to Reduce GHG and criteria pollutants by 2035

100%

Reduction of fuel usage per train mile by 2030

35%

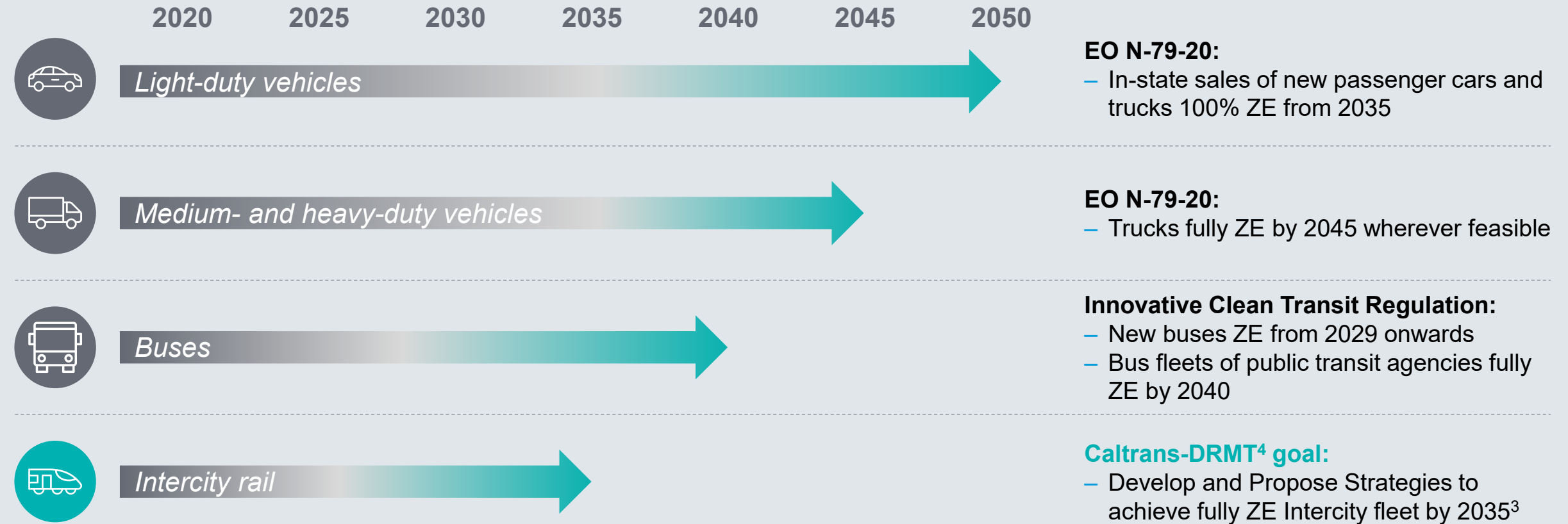
Work with passenger rail agencies to coordinate zero-emission action plan

by 2021



# Our Goal: Develop Strategies to Achieve a 100% Emission-Free Intercity Fleet by 2035 - Taking the Lead Among Other Modes of Transportation

## 100% emission reduction targets



(1) No intermediate targets (linear interpolation) (2) No fleet-wide target (3) Develop Strategies for Off-Road Vehicle to achieve ZE by 2035 per EO N-79-20 (4) DRMT = Division of Rail and Mass Transit  
Sources: CARB, Caltrans, Governor's office



# Primary Power for Caltrans Intercity Fleet: Renewable Diesel to Reduce Emission and Hydrogen to Achieve Zero-Emission

Hybrids next slide

Dimension	Diesel	Ren. Diesel	Natural Gas	Ren. Nat. Gas	Hydrogen	Batteries	Electrification <sup>2</sup>
Environmental	Red	Yellow	Yellow	Yellow	Dark Green	Light Green	Light Green
Technical / operational	Dark Green	Dark Green	Light Green	Light Green	Light Green	Yellow	Dark Green
Economical (LCC)	Orange	Yellow	Yellow	Yellow	Light Green	Light Green	Red
Synergistic	Orange	Yellow	Orange	Yellow	Light Green	Light Green	Orange
	⚡ <b>Status quo</b>	✓ <b>Feasible</b>	⚠ <b>Impractical</b>	⚠ <b>Impractical</b>	✓ <b>Preferred</b>	⚠ <b>Impractical</b> (as stand-alone)	✗ <b>Not feasible</b> (system-wide)
	Emission targets cannot be achieved even with after-treatment systems	Emission reduction compared to regular diesel, likely transition technology, limited modifications needed	Possibly transition technology but requires new re-fueling infrastructure and motive power modifications	Possibly transition technology but requires new re-fueling infrastructure and motive power modifications	Most suited option according to initial analysis	Suited for hybrid solution but not suitable as sole power source for intercity due to long range requirements	Electrification requires large capital investment and has ROW <sup>1</sup> -implications but can be utilized where available in dual-mode.

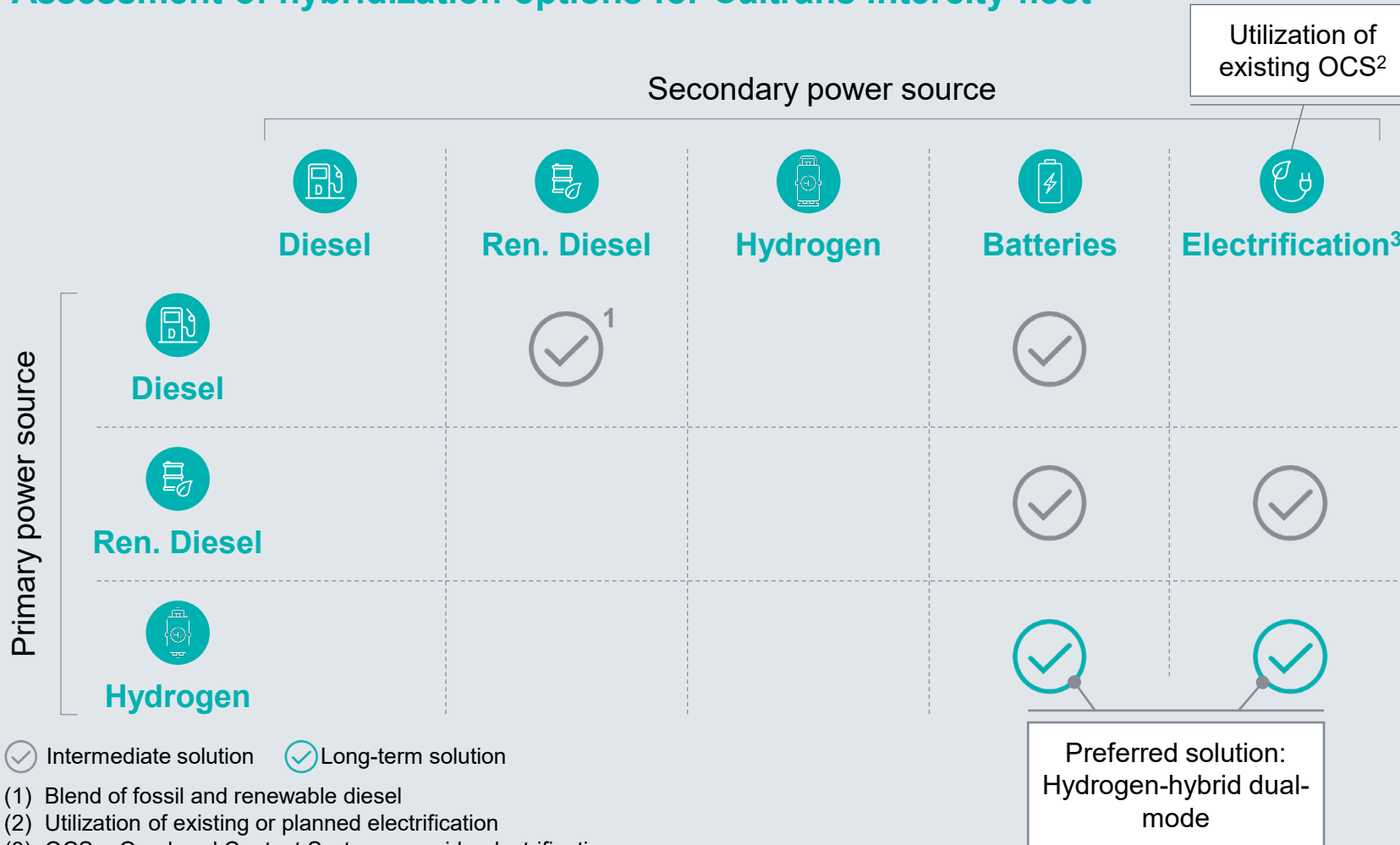
(1) ROW = Right of Way  
 (2) Considering system-wide electrification  
 Source: DB assessment

Rating: ■ Excellent ■ Good ■ Mediocre ■ Inferior ■ Requirements not fulfilled



# Hybrid Solutions Create More Options: Hydrogen-Hybrid with Batteries and Dual-Mode Capability Using Electrification Where Available

## Assessment of hybridization options for Caltrans intercity fleet



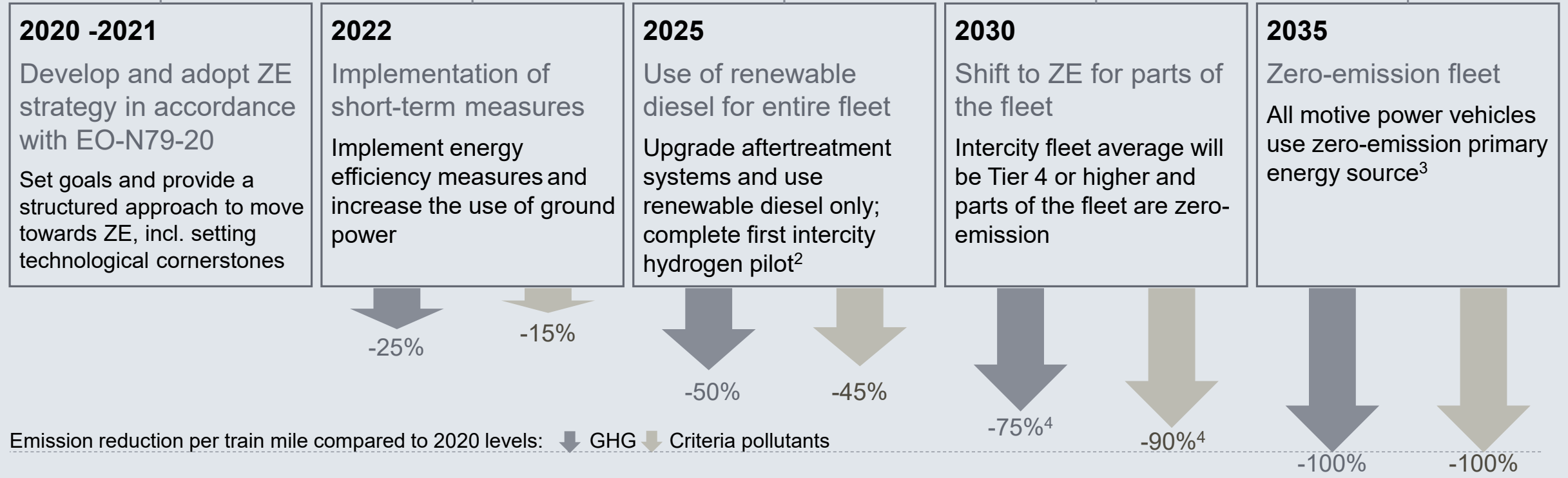
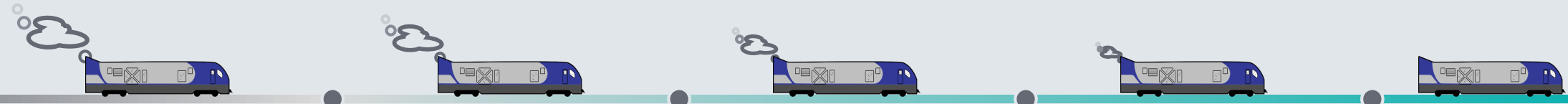
## Explanation

- A hybrid powertrain has at least two power sources
- Various combinations are possible:
  - **Energy storage hybrids.** Primary powerplant combined with on-board energy storage (e.g. hydrogen fuel cell and batteries)
  - **Dual-mode.** Power provision from wayside infrastructure and on-board generation (e.g. OCS electric and diesel, OCS electric and hydrogen fuel cell)
- Hydrogen (H<sub>2</sub>) and batteries enable significant energy reduction while achieving ZE goals.
- Hydrogen and dual-mode capability enable use of existing OCS infrastructure.





# Driving toward Zero-Emission Caltrans Intercity Rail: Start with Energy Efficiency Measures, Followed by Engine Upgrades and Renewable Diesel, and Hydrogen Powered Trains<sup>1</sup>



Emission reduction per train mile compared to 2020 levels: ↓ GHG ↓ Criteria pollutants

(1) Adjustment of strategy possible, if technological breakthrough occurs

(2) Retrofitting existing F59 locomotive with H<sub>2</sub> powertrain – if successful, consideration of rollout to remaining motive power equipment

(3) Currently, hydrogen-hybrid (hydrail) is the best option, supplemented with dual-mode where feasible

(4) Achieving remaining reduction in emissions is even more challenging (similar to the transition from Tier 3 to 4, to 5)

# Summary and outlook



The presented strategy could be used as a blueprint for other passenger railways



Joint efforts in the development and deployment of zero-emission motive power possible, enabling synergies



Caltrans strives to lead efforts towards an integrated, statewide zero-emission rail network in collaboration with other railway and infrastructure agencies





**Thank you**