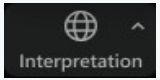
Concepts for In-Use Locomotive Regulation Workshop Day 1

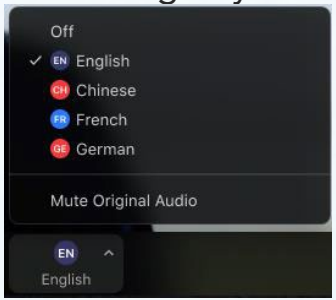
October 29, 2020

Cómo escuchar la interpretación de un idioma

1. En los controles de la reunión o el seminario web, haga clic en **Interpretación**. Esto se puede localizar en la parte de abajo.



2. Haga clic en el idioma que desee escuchar. Para esta reunión, va a poder ver la opción de inglés y español.

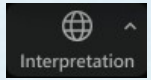


3. Para escuchar solo el idioma interpretado, haga clic en **Silenciar audio original**. (Mute Original Audio)

Si tiene preguntas durante la reunión, utilice la función de chat y escriba su pregunta. El personal de CARB traducirá la pregunta para que los presentadores respondan. Si no puede utilizar el cuadro de chat, informe al intérprete de su pregunta levantando la mano y el personal de CARB lo interpretará y lo escribirá en el cuadro de chat.

Listening to Language Interpretation

1. In your meeting/webinar controls, click **Interpretation**. It can be located at the bottom of the screen.



2. Click the language that you would like to hear. For this meeting, you will have English and Spanish as your options.

3. To only hear the interpreted language, click **Mute Original**

If you have questions during the meeting, please use the chat feature and type in your question. CARB staff will translate the question for the presenters to respond. If you are not able to use the chat box, let the interpreter know of your question by raising your hand and CARB staff will interpret and type it into the chat box for you.

Tech Support

Please reach out for help if you have any technical challenges!

- Use Zoom **Chat** to contact Alyssa or just message Everyone

Reminders

- Meeting is being recorded
- Private chats are archived

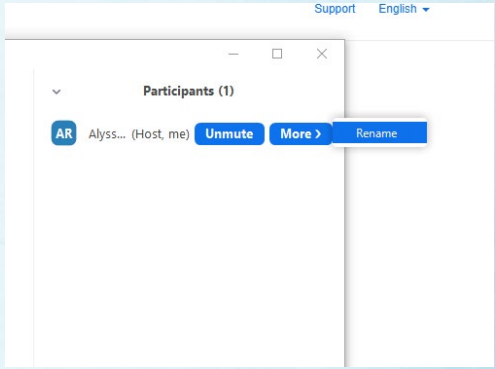
Staff Introductions

- Ajay Mangat – Facilitator and CARB Presenter
- Shannon Downey – Q&A Moderator
- Alyssa Rhodes – Zoom Technical Assistance
- Justin Hwang – CARB Presenter

Before We Get Started…

- Please **mute yourself** and make sure your full name and affiliation are showing as your screen name
- To **rename**, click on the top right side of your picture/video.
- Use this naming convention, **Affiliation - First Last (e.g. CARB - Jane Doe)**
    - **P** – for General Public (e.g. P - John Smith)

To rename, find your name on the participant list. Hover over the right side and click more for the rename option.



- **Need help?** Use the Chat function to request assistance

CARB

Zoom Orientation

Mute/Unmute

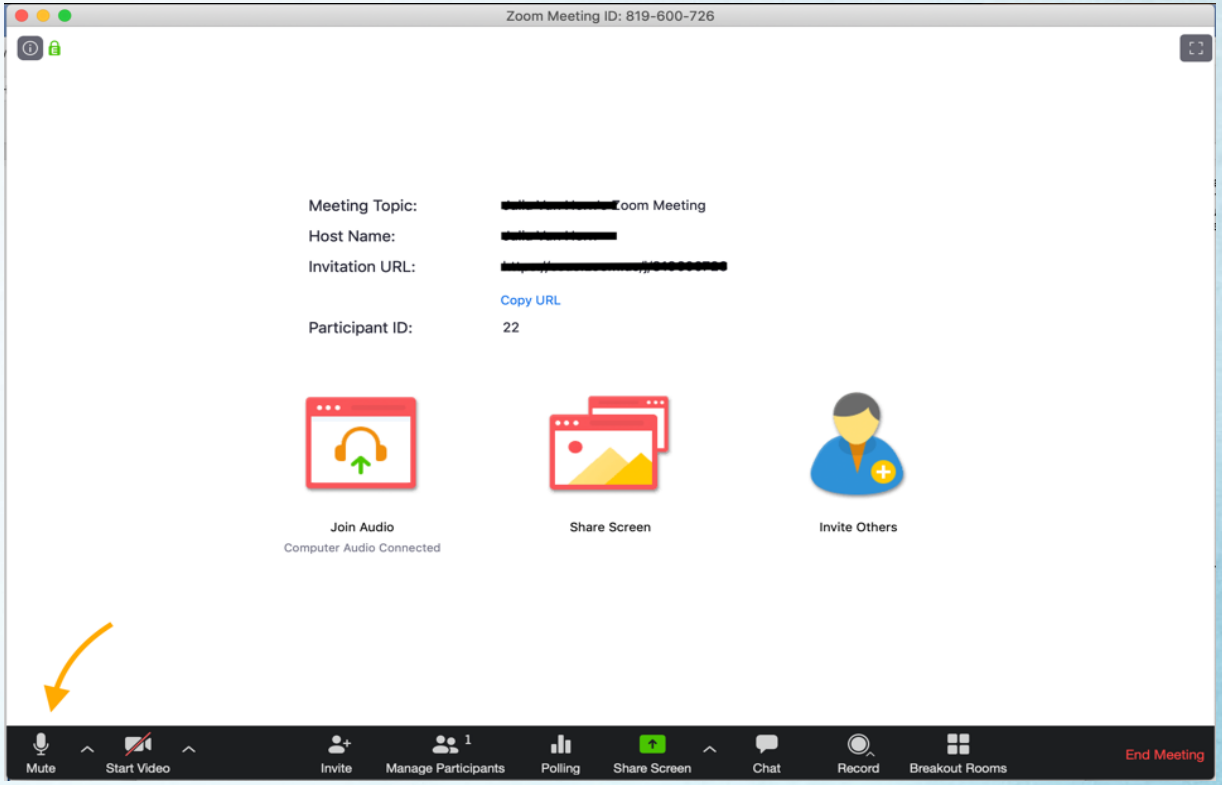
Please remain on mute unless your name has come up in the speaking queue

- Zoom:

Mute button at bottom left

- On phone:

Dial ***6** to mute/unmute



CARB

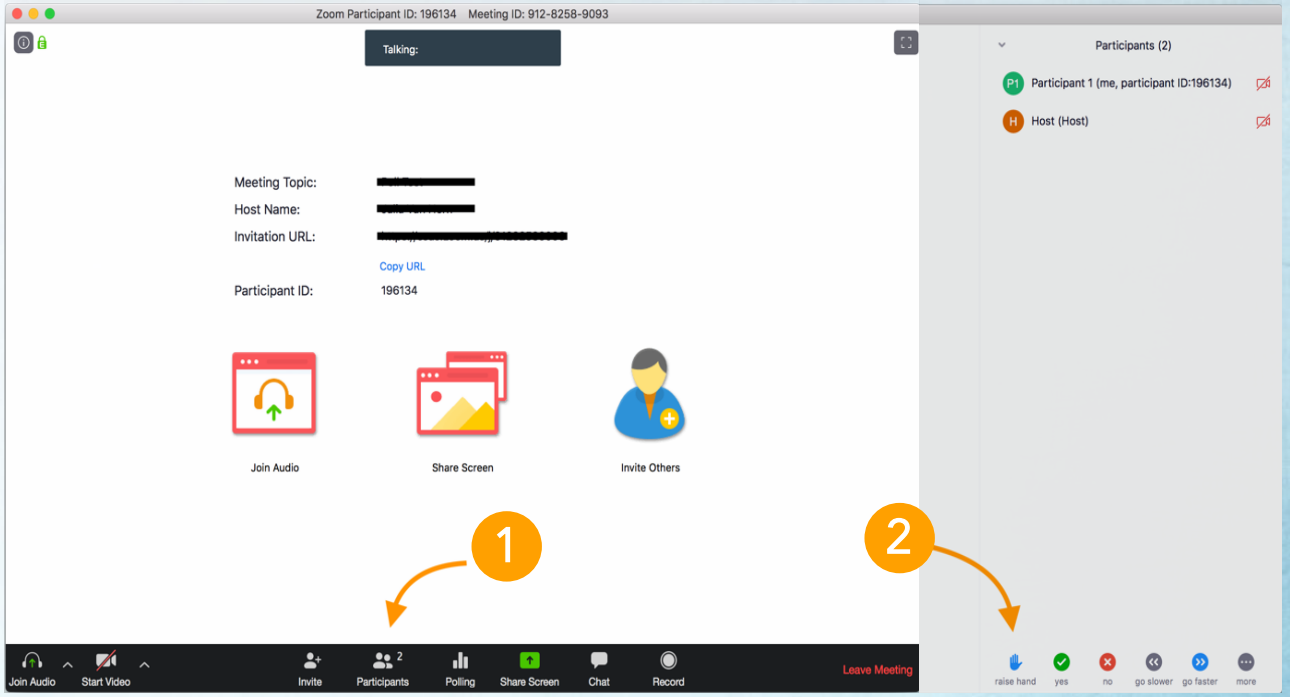
How to Ask a Question

Raise Hand

To be added to the speaking queue, please use Raise Hand

Click **Participants**, then **Raise Hand**. We'll also ask those on the phone.

On the phone Press *9 to Raise your Hand



CARB

How to Submit Questions

- Please submit all questions to the general chat
  - When possible, please identify slide number you want to discuss

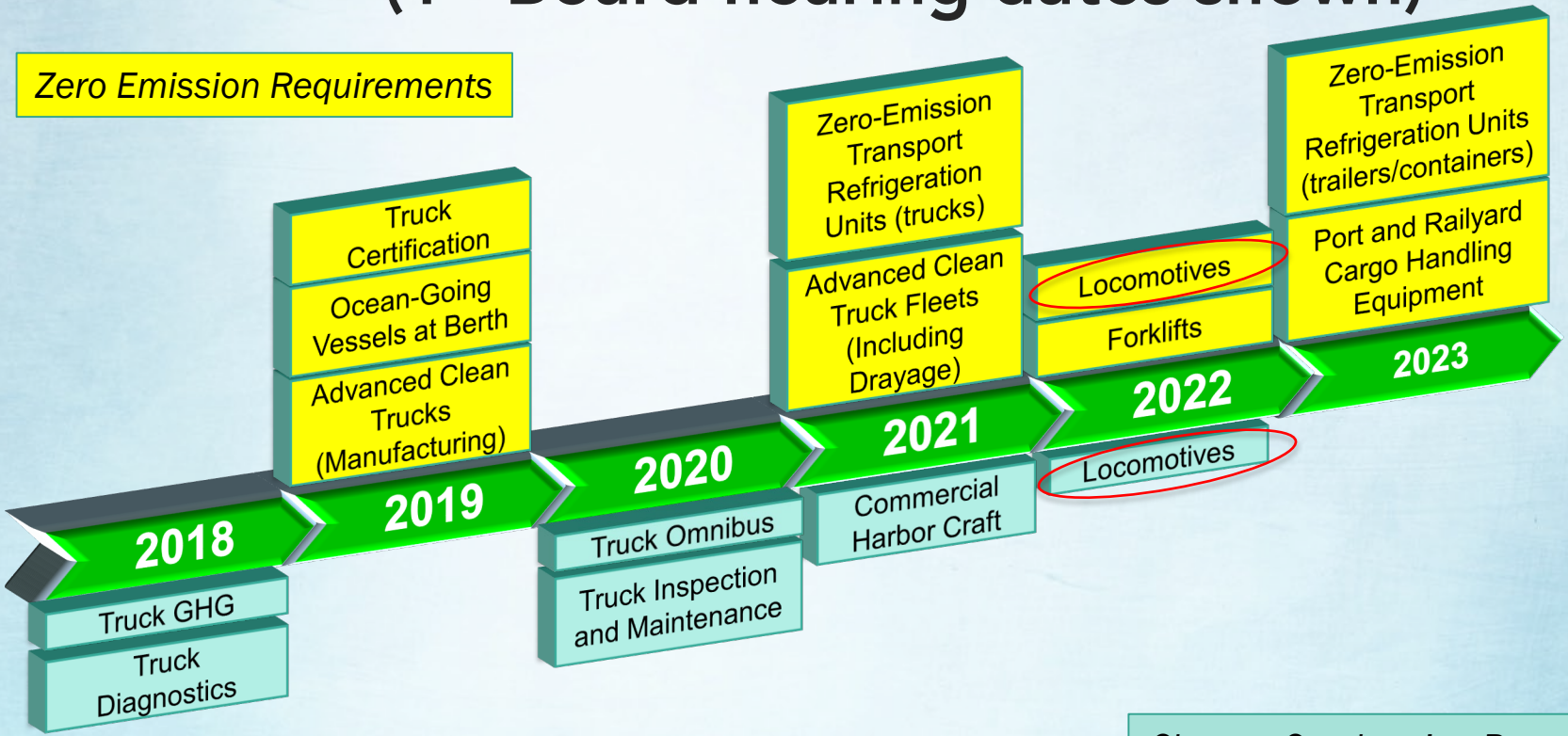
Goals for CARB Freight Actions

Cut community health risk

Attain regional air standards

Mitigate climate change

New CARB Freight Regulatory Actions
(1st Board hearing dates shown)



CARB

Updated: 10/23/2020

Governor's Executive Order

- On September 23, 2020
- The State Air Resources Board, to the extent consistent with State and federal law, shall develop and propose:
  - Strategies, in coordination with other State agencies, U.S. Environmental Protection Agency and local air districts, ***to achieve 100 percent zero-emission from off-road vehicles and equipment operations in the State by 2035***.

Two Day Locomotive Workshop

- Day 1 – State of Locomotive Technology and Emissions

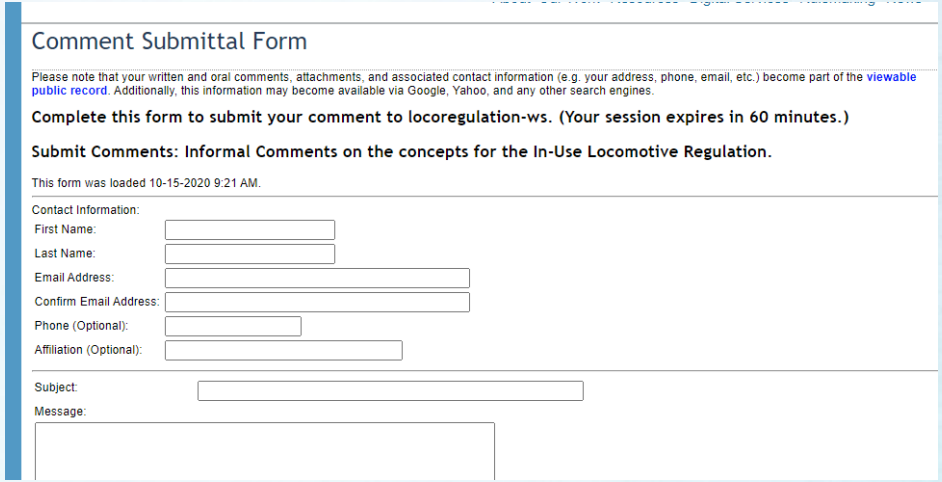
- Day 2 – Locomotive Proposed Regulatory Concepts and Health Impacts

Outreach

- Workshops in November and December 2019
- Stakeholder meetings prior to workshop
- Continued stakeholder outreach during development
- Submit comments through website or contact freight@arb.ca.gov

Comment Log on CARB's Website

- https://www.arb.ca.gov/lispub/comm2/bcsubform.php?listname=locoregulation-ws&comm_period=1



Comment Submittal Form

Please note that your written and oral comments, attachments, and associated contact information (e.g. your address, phone, email, etc.) become part of the viewable public record. Additionally, this information may become available via Google, Yahoo, and any other search engines.

Complete this form to submit your comment to locoregulation-ws. (Your session expires in 60 minutes.)

Submit Comments: Informal Comments on the concepts for the In-Use Locomotive Regulation.

This form was loaded 10-15-2020 9:21 AM.

Contact Information:

First Name:

Last Name:

Email Address:

Confirm Email Address:

Phone (Optional):

Affiliation (Optional):

Subject:

Message:

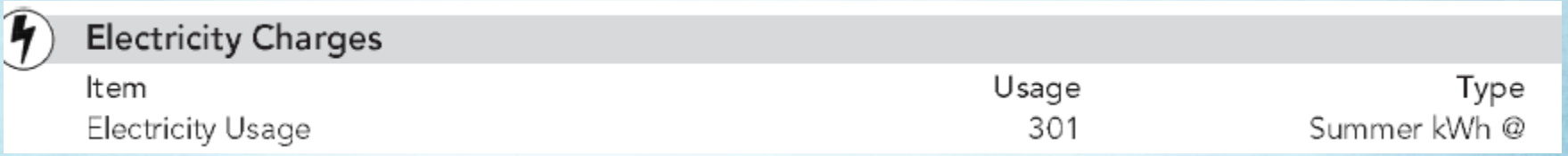
CARB

Meeting Agenda

- 9:00 – 9:15 Housekeeping
- 9:15 – 9:40 Locomotive Context and Background
- 9:40 – 9:50 Q&A
- 9:50 – 10:30 Researchers/Academia Presentations
- 10:30 – 10:40 Q&A
- 10:40 – 11:30 California Agencies Presentations
- 11:30 – 12:00 Q&A

Locomotive Lingo: megawatt-hours (MWh)

- Amount of energy used by a locomotive when it is moving
  - Similar to what you see on your power bill
  - 1 MWhr = 1,000 kWhr



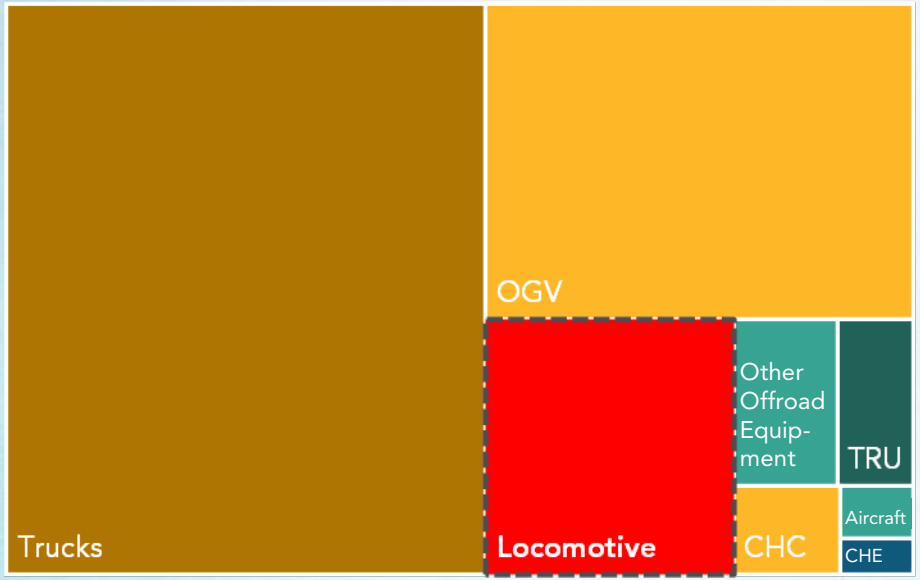
Electricity Charges

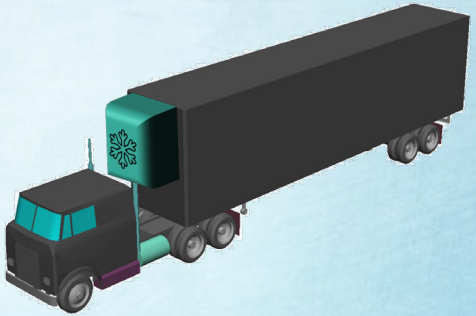
Item	Usage	Type
Electricity Usage	301	Summer kWh @

Locomotives Emissions in Context

- Locomotive NO_x is 12% of statewide freight emissions.

NO_X Emissions from Freight Source Categories (2018)



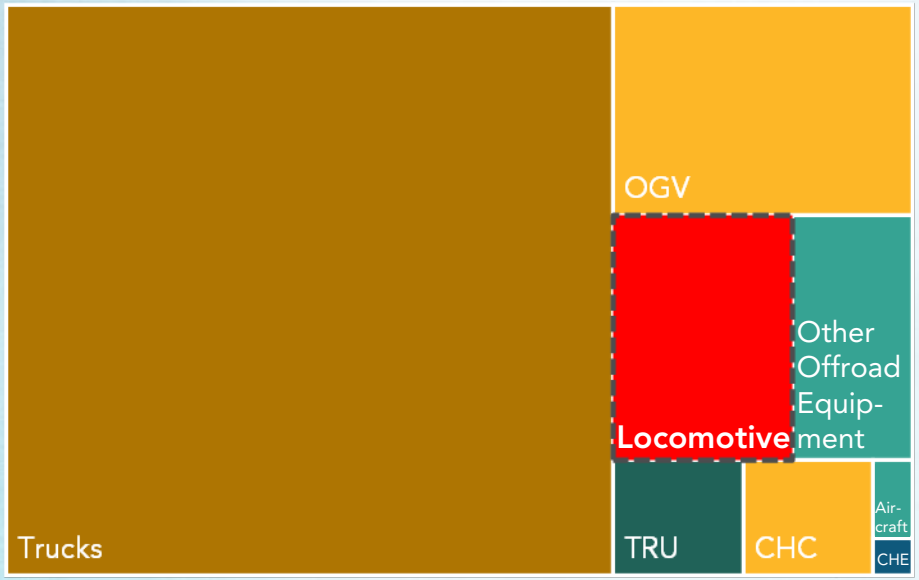


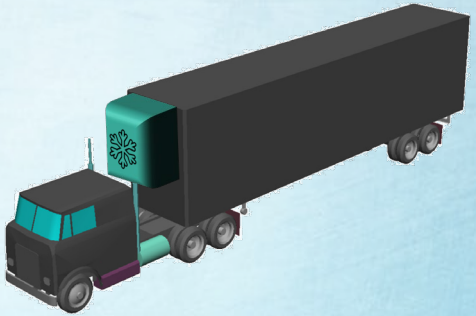
CARB

Locomotives Emissions in Context

- Locomotive $PM_{2.5}$ is 8% of statewide freight emissions.

$PM_{2.5}$ Emissions from Freight Source Categories (2018)

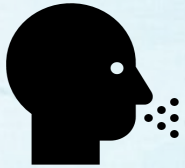


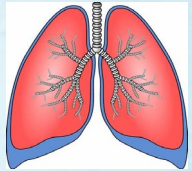


CARB

Health Impacts of Diesel and Rail Activity

- Many locomotives emit diesel exhaust, a complex mixture of:
  - Diesel particulate matter (DPM), which is a subset of $PM_{2.5}$ and consists of over 40 known cancer-causing compounds.
  - Gaseous pollutants, including:
    - Volatile organic compounds
    - Oxides of nitrogen (NOx)
- Studies show health impacts of DPM, $PM_{2.5}$, and rail activity include, but are not limited to:
  - Lung cancer
  - Asthma & respiratory effects
  - Cardiovascular effects
  - Premature death



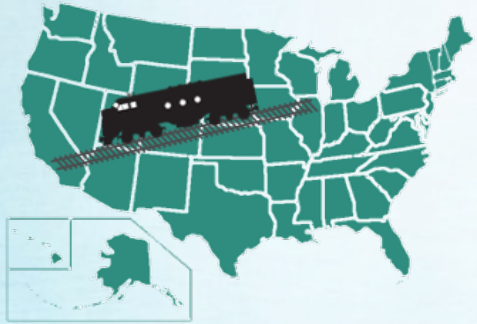


- Some disadvantaged communities experience a disproportionate burden of exposures and health impacts from locomotives.

Locomotive Lingo

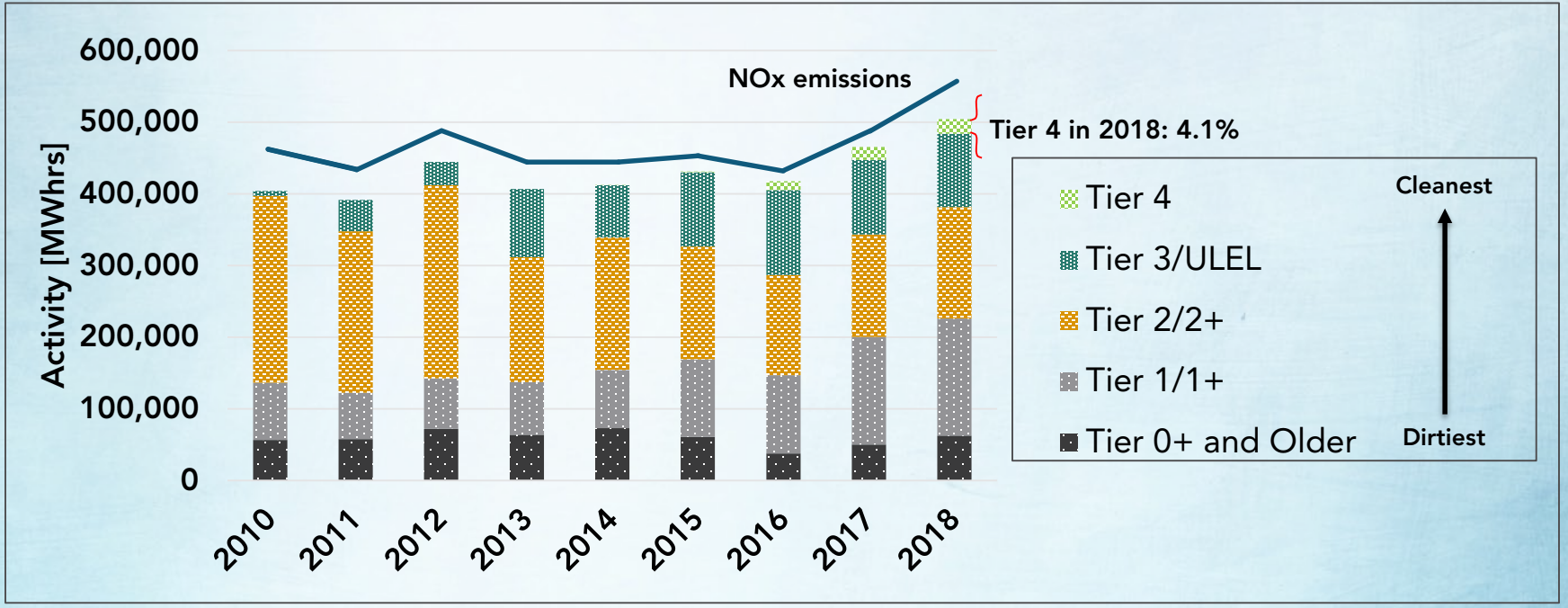
Line Haul Locomotives			
Emissions Tier	Year of Manufacture	NOx Standard (g/bhp-hr)	PM Standard (g/bhp-hr)
Pre-Tier 0	1973-1999	13.5	0.6
Tier 0	2000-2001	9.5	0.6
Tier 0+	Ongoing	8.0	0.22
Tier 4	2015	1.3	0.03

Switch Locomotives			
Emissions Tier	Year of Manufacture	NOx Standard (g/bhp-hr)	PM Standard (g/bhp-hr)
Pre-Tier 0	1973-1999	17.4	0.72
Tier 0	2000-2001	14.0	0.72
Tier 0+	Ongoing	11.8	0.26
Tier 4	2015	1.3	0.03



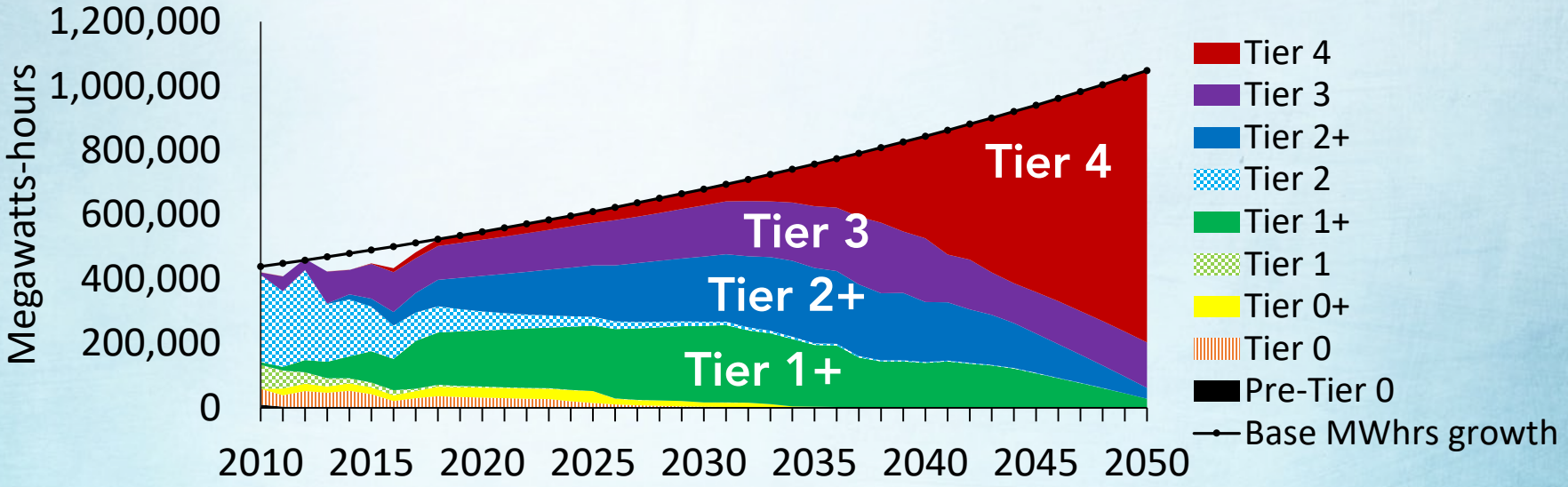
CARB

Locomotive Emissions in the South Coast



Draft Statewide Locomotive Emissions Inventory

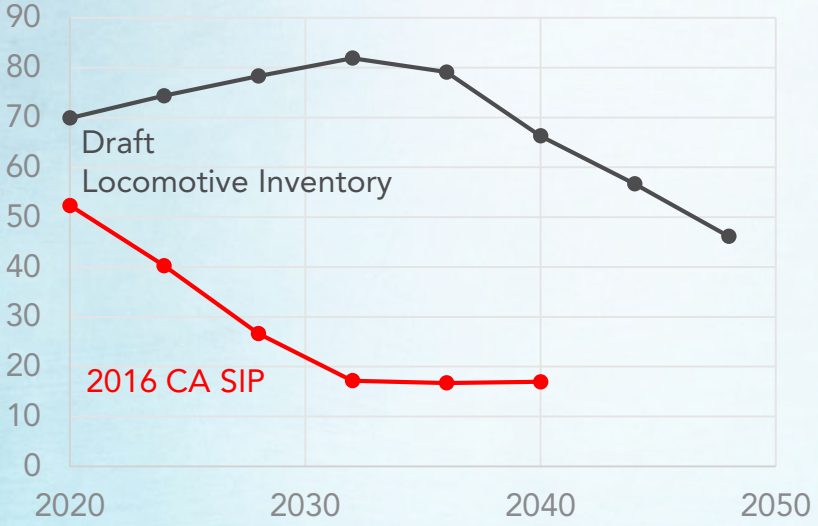
- Draft Class 1 line haul inventory from *2020 Locomotive Emissions Inventory* Public Workshop (September 3, 2020)



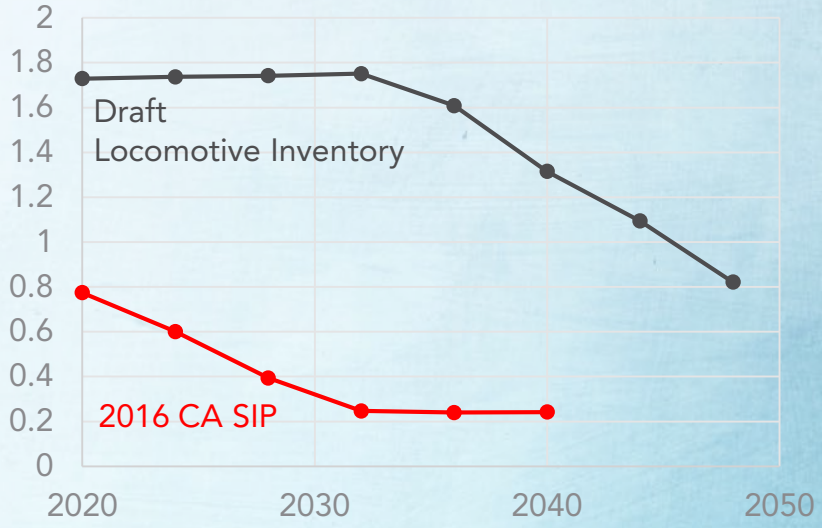
Draft Statewide Locomotive Emissions Inventory

- Draft inventory from *2020 Locomotive Emissions Inventory* Public Workshop (September 3, 2020)

Statewide NO_X Emissions (tpd)



Statewide PM_{10} Emissions (tpd)



CARB

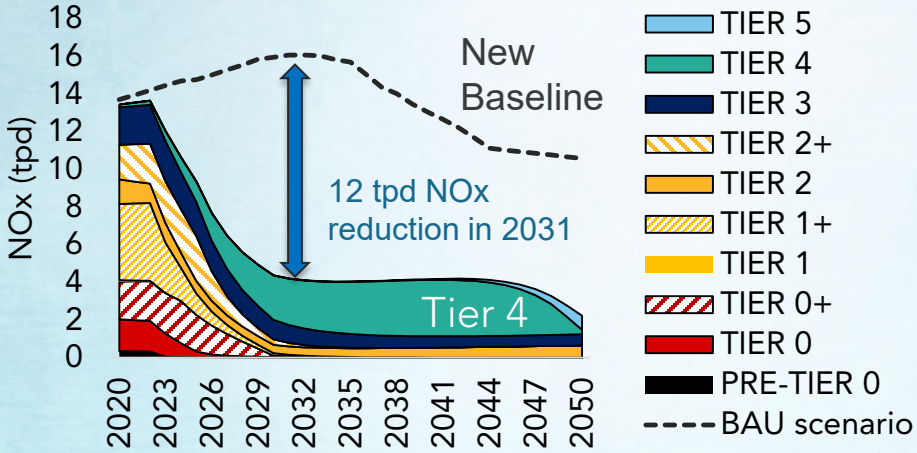
Draft 2020 CARB Mobile Source Strategy

- Required by Senate Bill 44
- CARB must update the Mobile Source Strategy (MSS) to include a comprehensive strategy for the deployment of medium- and heavy-duty vehicles in the State
  - In consultation with CEC, GoBiz, Caltrans
  - Public Process

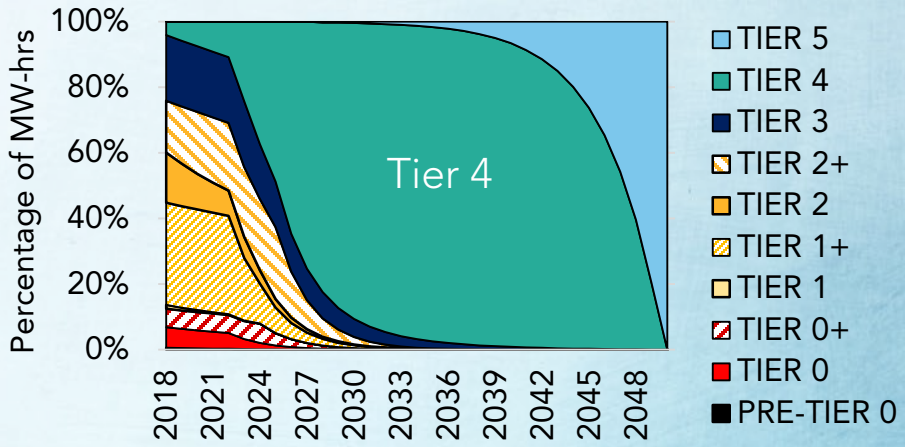
Draft MSS: Locomotive Scenario

- Adopt Tier 5 locomotive standard in 2028
- Significantly accelerate the turnover of all line-hauls operating in California to Tier 4/5
- Replace Tier 0/0+ switchers in railyards with Tier 4/5 by 2030

SC NOx Emissions from Locomotives: MSS Scenario



SC Locomotive Energy Use: MSS Scenario



*Tier 4 only accounts for **4%** of loco activity in 2018*

CARB

Locomotive Lingo

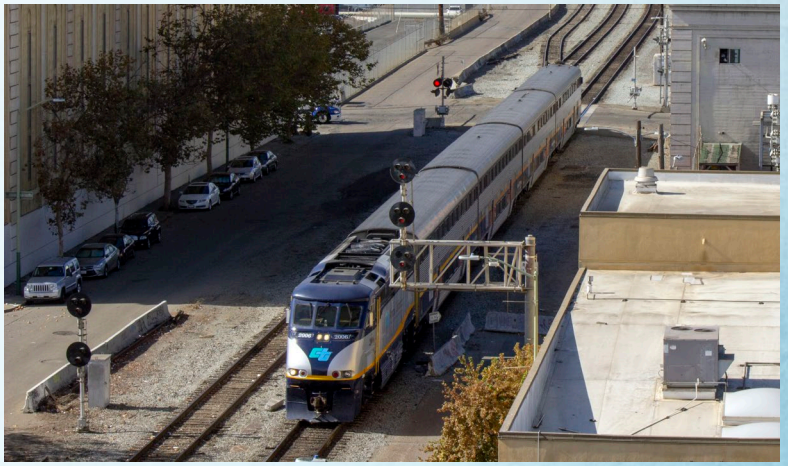
	Line Haul	Switcher	Passenger
			
Power	High	Low	High
Operation	Moving heavy freight	Moving railcars in and around railyards	Higher speed Lighter load Additional engine for A/C etc (HEP)
Distance (Range)	Nationwide (Class 1) – Local (Class 3)	Railyards	Nationwide - Local

Categories of Railroads

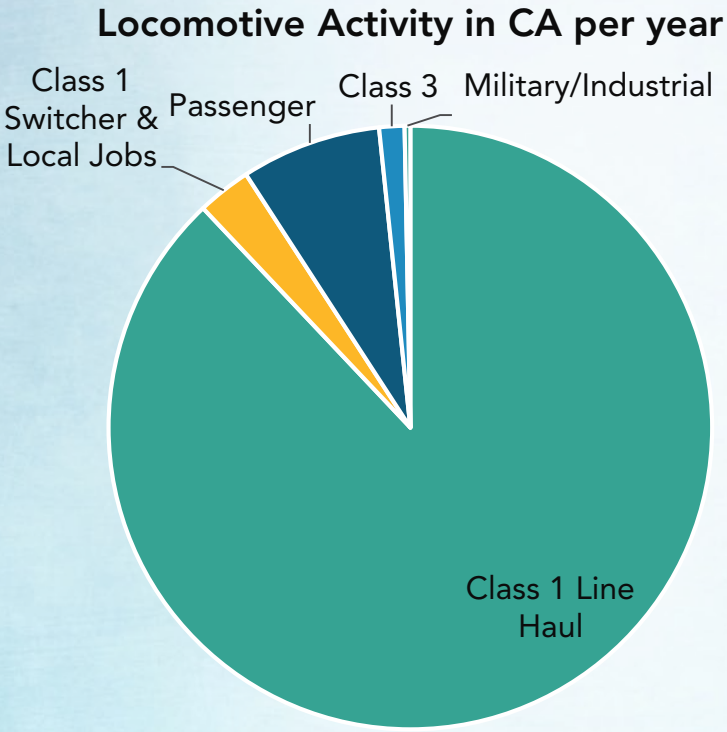
- Class 1:
  - 24/7 activity
  - Pulling heavy freight nationwide
- Class 3:
  - Daily activity
  - Pulling heavy freight within California

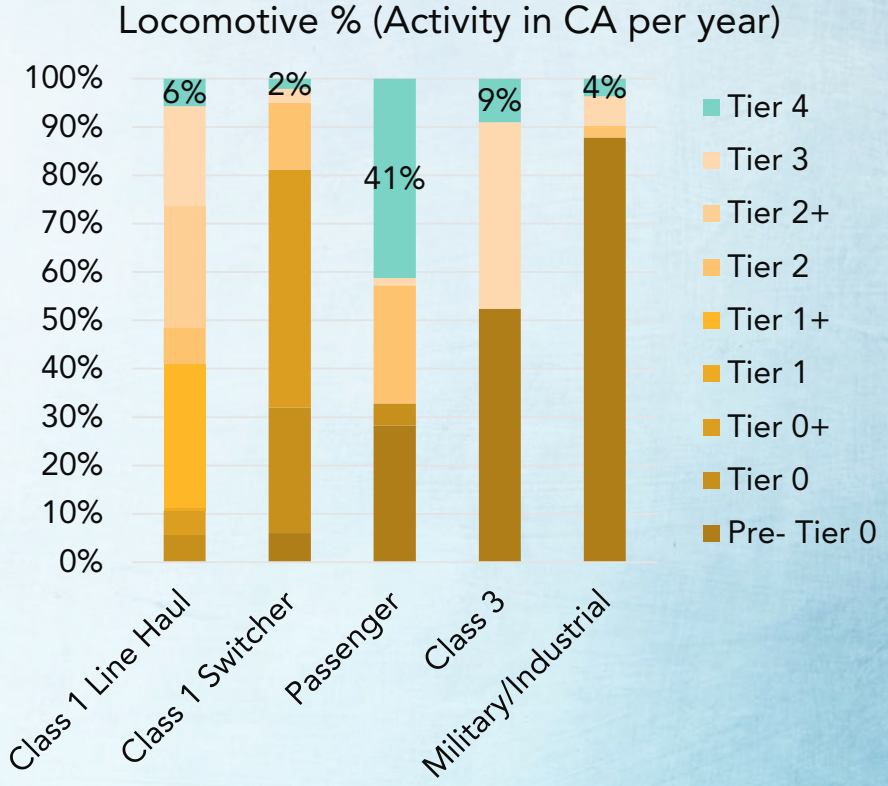
Categories of Railroads

- Military and Industrial:
  - Used as needed for goods delivered to facilities
  - Pulling a few cars within the facility
- Passenger railroads:
  - Daily activity
  - Pulling passengers and prioritizing speed, mostly within California, captive routes



Annual Locomotive Activity in California



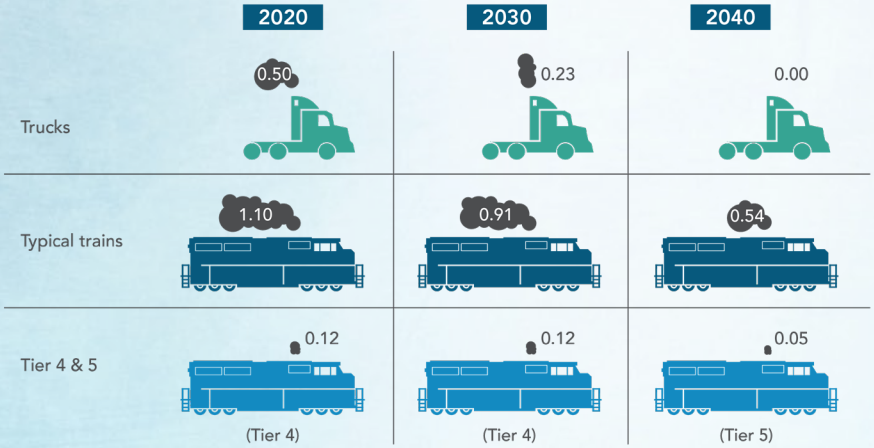


Draft Truck vs Train Emissions Analysis

- Current draft released September 23, 2020
  - Overview
  - Draft methodology
- https://ww2.arb.ca.gov/resources/fact-sheets/draft-truck-vs-train-emissions-analysis
- Submit comments/questions to freight@arb.ca.gov

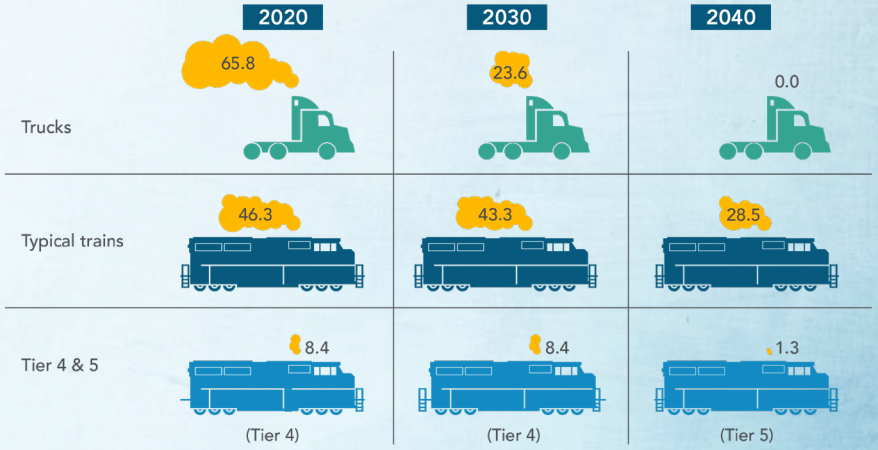
Draft Truck vs Train Emissions Analysis

Total $PM_{2.5}$ Emissions in Communities within 20 Miles of the Ports



All emissions are in pounds

Total NO_x Emissions in Communities within 20 Miles of the Ports



All emissions are in pounds

CARB

Draft Truck vs Train Emissions Analysis

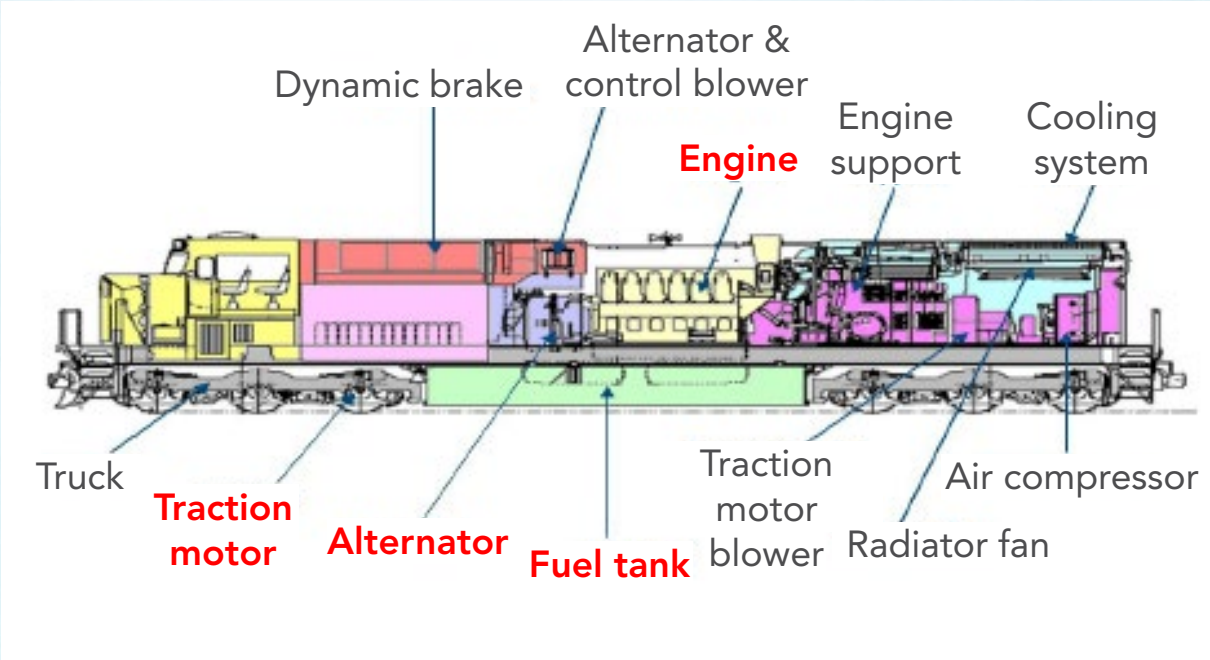
- Reminder: we want your comments/questions freight@arb.ca.gov
- Recent comments
  - Include brake and tire wear emissions from trucks.
  - Include VOC and GHG emissions.
  - Suggestions on graphics.

Comments/Questions

- 10 minutes

- Submit to general chat
  - When possible, please identify slide number you want to discuss

How Locomotives Work



Zero-emissions Locomotive Options and Challenges

	Line Haul	Switcher	Passenger
			
Overhead Catenary System (OCS)	Cost Interoperability		
Battery Electric Locomotives (BEL)	Range		Range
PEM Fuel Cell (PEMFC)	Power Density (Size) Barrier		
Solid Oxide Fuel Cell Gas Turbine (SOFC-GT)	Technology readiness	Cost Technology readiness	
Pathway	Unclear: Need to diversify.	OCS is commercialized. Continue development of BEL and PEMFC.	

Researchers and Out-of-State Agency Speakers

Current State of Technology and Pathways to Zero Emission Locomotives

Andreas Hoffrichter

DB Engineering

Kyle Beauliua

Transport Canada

Jack Brouwer

University of California Irvine

CARB Strategies

- Foster and incentivize technology
  - Wabtec-BNSF battery electric hybrid consist

CARB Strategies

- EMD Joule Battery Electric Switcher

Comments/Questions

- 10 minutes

- Submit to general chat
  - When possible, please identify slide number you want to discuss

State Agency Speakers

California Vision and Pathways to Zero Emission Locomotives

Momoko Tamaoki

Caltrans

Peter Chen

California Energy Commission

Kielan Rathjen

California Governor's Office of Business and Economic Development (GO-Biz)

CARB 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

Partnership

- Connect key stakeholders.
- Coordination and cooperation through ZEHTRANS.

Transition

- Identify technology pathways for various duty cycles and sectors.
- Foster and incentivize ZE rail technology.
- Scale up technology by building on previous projects.

Eligibility of Locomotives for Incentives Funding

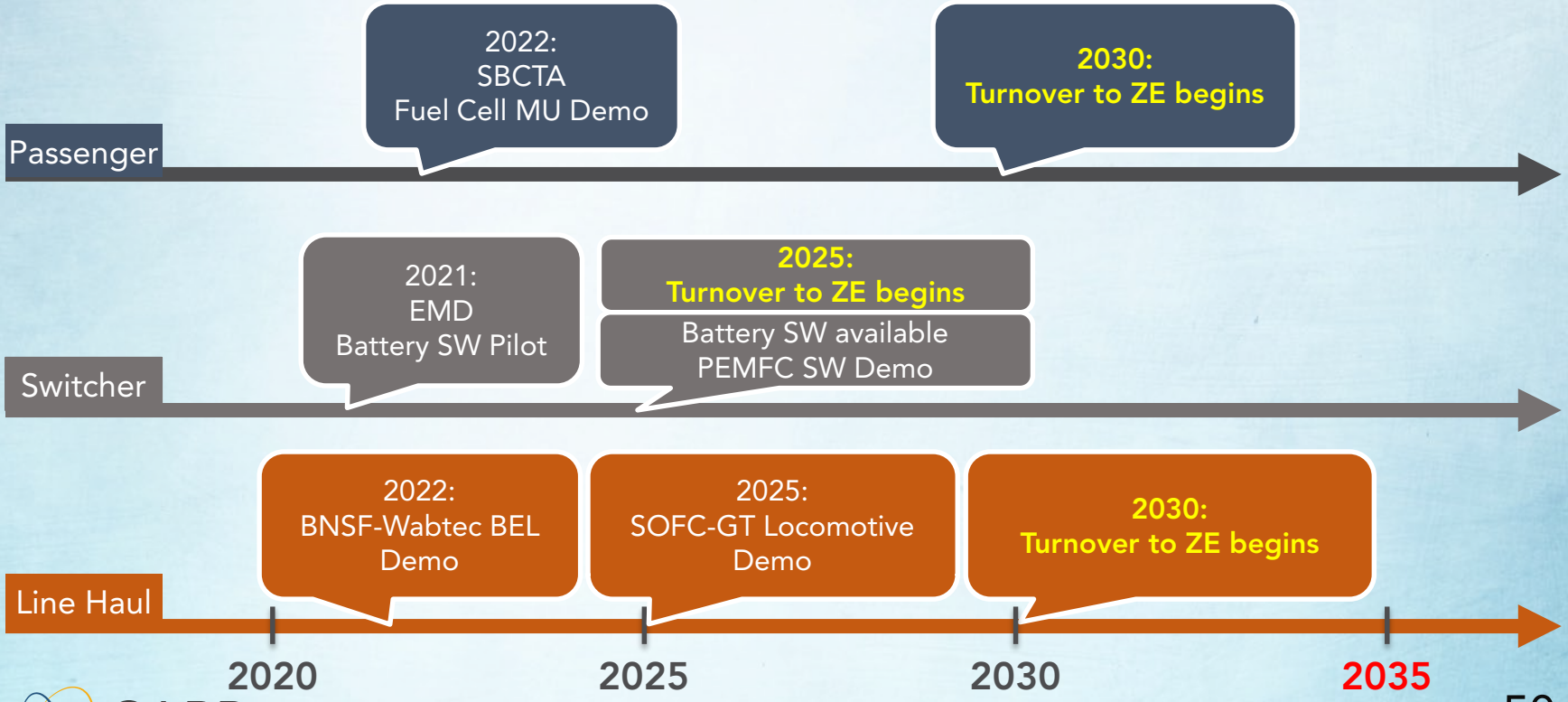
Incentives Program	Funded Equipment	Class 1	Class3/ Industrial	Passenger	website
Carl Moyer Program	Tier 4 locomotives	case by case basis	√	√	https://ww2.arb.ca.gov/guidelines-carl-moyer
Community Air Protection (CAP)	Tier 4 locomotives	case by case basis	√	√	https://ww2.arb.ca.gov/resources/documents/community-air-protection-incentives-guidelines
VW mitigation trust funds	Tier 4 locomotives	case by case basis	√		https://ww2.arb.ca.gov/resources/documents/californias-beneficiary-mitigation-plan
California Energy Commission (CEC)	Electric infrastructure	√	√	√	https://www.energy.ca.gov/funding-opportunities/solicitations
Diesel Emission Reduction Act (DERA)	Tier 4 locomotives	√	√	√	https://www.epa.gov/dera/state

Zero-emissions Rail Vision - Pathways

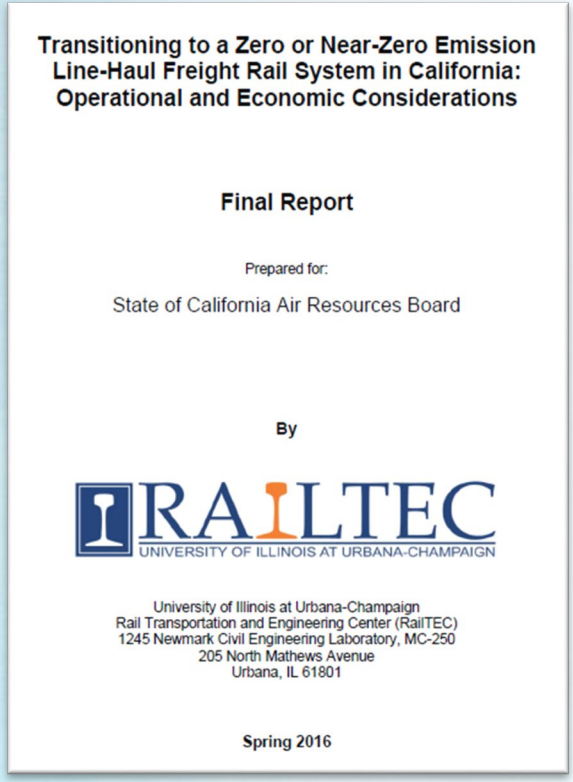
	Switchers		Passenger Locomotives	Freight Line Haul
	Class 3, Military & Industrial	Class 1		
Operations	• Low power • Short range • Captive	• Low/medium power • Short range • Captive	• Medium/high power • Captive	• High power • Long range • National network
	Longer range and higher power required			
Pathways	• Battery Electric • Fuel Cell • ZE Railcar Mover	• Battery Electric • Fuel Cell	• Battery Electric • Fuel Cell • Multiple Units	• Solid Oxide Fuel Cell – Gas Turbine (SOFC-GT)
	Battery Electric	PEMFC		SOFC-GT

- Scale up: laboratory → Switcher demo → Medium hp locomotive demo → Line Haul demo → Commercialization

Expected Timeline for Zero-emissions Technology Development and Adaptation



University of Illinois Freight Rail Report



Transitioning to a Zero or Near-Zero Emission Line-Haul Freight Rail System in California: Operational and Economic Considerations

Final Report

Prepared for:

State of California Air Resources Board

By

RAILTEC
UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN

University of Illinois at Urbana-Champaign
Rail Transportation and Engineering Center (RailTEC)
1245 Newmark Civil Engineering Laboratory, MC-250
205 North Mathews Avenue
Urbana, IL 61801

Spring 2016

- https://www.arb.ca.gov/railyard/docs/uoi_rpt_06222016.pdf

Call to Action

- Time is Now.
  - Achieve zero-emission off-road equipment by 2035
  - Technology advances
  - California agencies coordinating towards ZE rail
- Wide spread coordination among OEMs, railroads, and agencies is necessary

Next Steps

- Technology discussions with stakeholders
- Comment log is open
  - Closes November 13, 2020
- Board presentation in early 2022
- Stakeholders can also continue to comment through the formal regulatory process

Next Steps

- Draft regulatory package is planning to be released in late 2021
- Can still provide public comment via email anytime
  - freight@arb.ca.gov
- https://ww2.arb.ca.gov/our-work/programs/reducing-rail-emissions-california

Comments/Questions

- 30 minutes
- Submit to general chat
  - When possible, please identify slide number you want to discuss
- Raise hand on Zoom
  - Please keep comment to 1 minute to allow everyone to speak