CALIFORNIA
AIR RESOURCES BOARD

Zero-Emission Motorcycle Staff Proposal

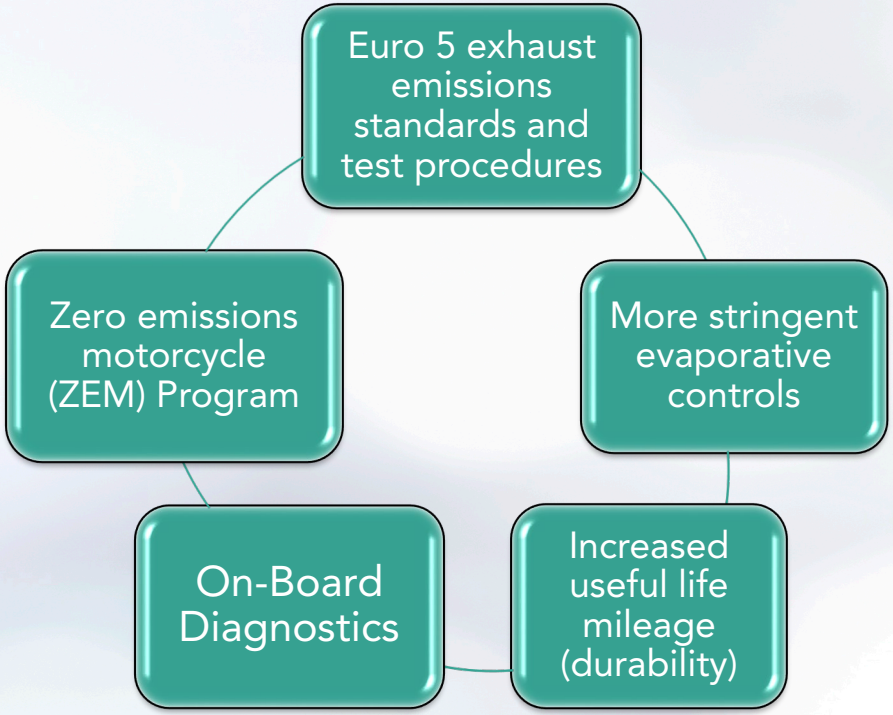
June 9, 2021

Workshop Outline

- Background and Need for Zero-Emission Motorcycles (ZEM)
- Current State of ZEMs
- Overview of the ZEM Credit Program
- How to Calculate Annual Sales
- How to Generate and Use ZEM Credits
- Certification and Administration Requirement
- Impacts of Proposal
- Q & A

CARB Staff Proposal for Updated Motorcycle Regulations

- CARB staff is developing comprehensive amendments to existing emissions regulations
- Proposal based on Euro 5
  - Includes some requirements that go beyond Euro 5
- Expected Board Date: Spring 2022
  - The proposal discussed today is tentative until formally adopted by the Board
- Requirements could be effective starting with MY 2024
  - More stringent requirements would phase in through MY 2030.



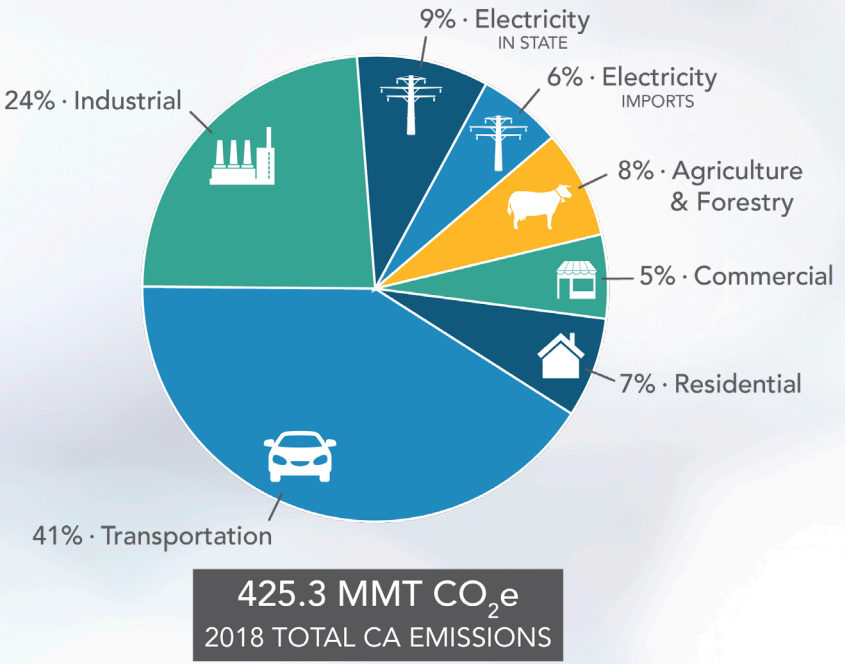
Background

- California's Governor issued that all new cars and light trucks sold in the state be zero-emission by 2035
  - Motorcycles are not included in this mandate, but CARB is working to transition all mobile sources toward zero emissions
- CARB staff has targeted 50% zero emissions motorcycle (ZEM) sales by 2035
- At the current market growth rate, ZEMs will not reach the proposed 50% target by 2035
- Staff is proposing a ZEM program based on CARB's Light-Duty ZEV program
  - ZEM proposal includes elements unique to the on-road motorcycle (ONMC) industry

Why Zero-Emissions Motorcycles?

- Transportation is the largest contributor to California greenhouse gases
- Electrification of the fleet will significantly reduce direct greenhouse gases
- California's Renewable Portfolio Standard requires 50% of electricity generated to be from renewables by 2030 thus ensuring a reduction of indirect emissions

2018 GHG Emissions by Main Economic Sector



CARB

Why Zero-Emissions Motorcycles?

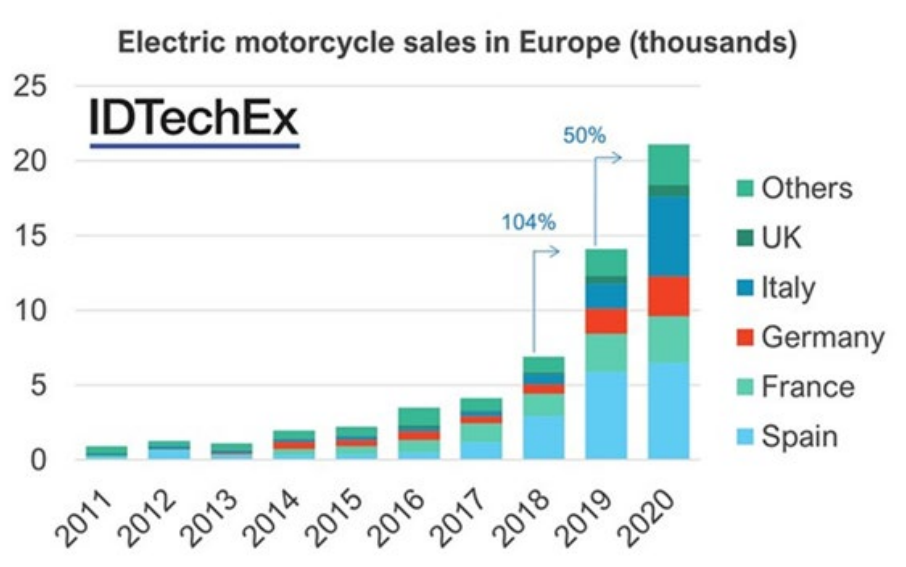
- ZEMs eliminate tailpipe and evaporative emissions of criteria pollutants
  - Transportation is a major source of ozone precursors
    - Oxides of Nitrogen (NOx)
    - Reactive Organic Gases (ROG)
- ZEMs don't require a costly inspection/maintenance program to ensure continued emissions reductions

Current State of ZEM Market

- Current ZEM performance is similar to internal combustion engine (ICE) motorcycles
- Price, range, and charging infrastructure are limiting factors to widespread consumer adoption
- ZEMs currently qualify for various incentive programs
  - Clean Vehicle Rebate Program, California Clean Fuel Reward, federal tax credits

Global ZEM Market

- ZEMs are seeing global growth
  - India is pushing for full electric to replace 150cc motorcycles by 2025 [1]
  - Electric motorcycle sales in Europe grew 50% year over year in 2020 [2]



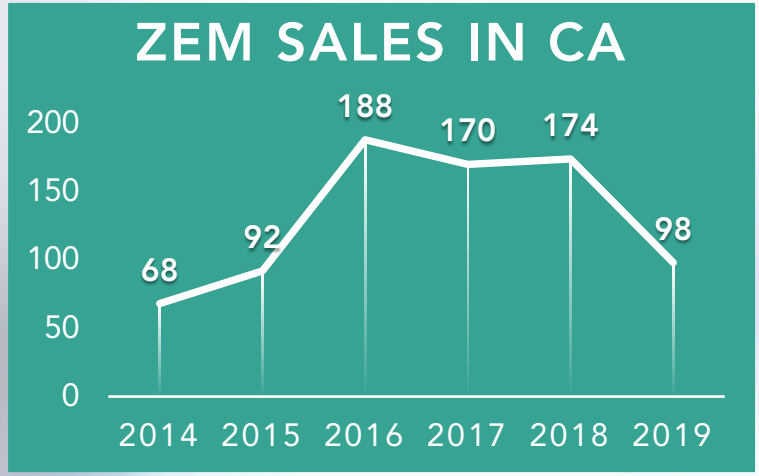
[1] https://asia.nikkei.com/Business/Business-trends/Indian-bike-makers-cry-foul-over-impractical-EV-proposal

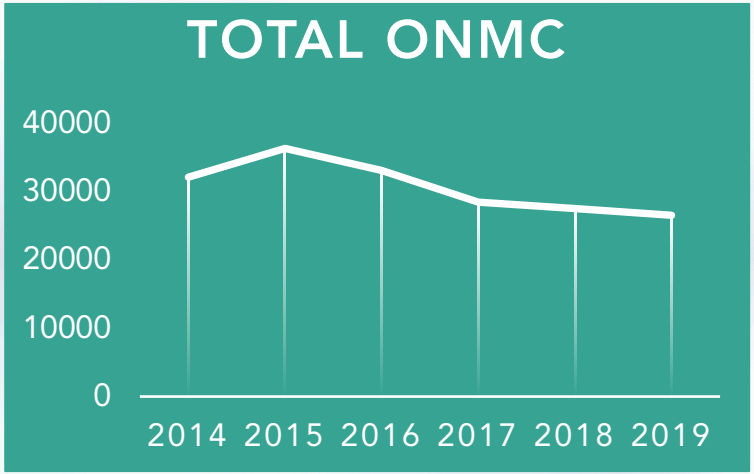
[2] www.prnewswire.com/news-releases/europes-electric-motorcycle-market-surges-mirroring-electric-cars-reports-idtechex-301231164.html

CARB

CA ZEM Market

- ZEM sales growth has outperformed conventional ONMC sales growth
  - Current growth rate for the ZEM market at ~ 18%
  - Current growth rate for the ONMC market at ~ -3%
  - ZEMs make up ~ 0.4% of the total ONMC market
- CARB staff assume a 15% annual ZEM sales growth as baseline for this proposal





*Based on CA DMV data

Purpose of ZEM Credit Program

- Accelerate growth in the Zero-Emission Motorcycle (ZEM) industry
- Establish a credit trading program that will incentivize ZEMs
- Reward early ZEM manufacturers by adding value (credits) to current ZEMs
- Provide flexibility for manufacturers to comply with proposed requirements by using ZEM credits

ZEM Proposal

- Starting in 2023, all qualifying ZEMs sold in California will be awarded ZEM credits that can be:
  - Sold or traded to another manufacturer
  - Used for compliance with ZEM credit obligations
  - Banked for future use
- Starting in 2028, all large manufacturers must use ZEM credits to meet their ZEM credit obligation
  - Large manufacturer ≥750 motorcycles/year sold in CA (based on a 3 year rolling average)

Proposed Timeline for ZEM Requirements

- **2023-2027**
  - No ZEM credit obligations
  - All manufacturers can generate, trade, and bank credits
- **2028-2035+**
  - Large manufacturers must meet the annual ZEM credit obligation
  - ZEM credit obligation is based on a percentage of manufacturer's annual sales

Percentages for Annual ZEM Credit Obligation

2028	2029	2030	2031	2032	2033	2034	2035 +
10%	(+5%) 15%	(+5%) 20%	(+5%) 25%	(+6%) 31%	(+6%) 37%	(+6%) 43%	(+7%) 50%

CARB

Calculating Annual Sales

- Manufacturer size and ZEM credit obligations will be calculated based on a rolling 3-year CA sales average
  - Includes conventional motorcycles and ZEMs
  - Does NOT include smaller Local Zero Emission Motorcycles (LZEM)
- Multi-brand companies will be combined under one parent company
- Rebadged motorcycles will be counted under the badged name
- Using this criteria, there are 10 large manufacturers in California
  - Large manufacturers account for ~91.5% of total ONMC sales

Manufacturer's Requirements

- All requirements will be based on the previous year's 3-year rolling average
- Moving between small and large manufacturer classifications is based on two consecutive years of 3-year average sales
  - Change in manufacturer status is effective the following year
- For initial classification in 2028, the two previous years (2026 and 2027) **of 3 year average sales** will be used
  - If in both years of 3 yr average sales <750 units are sold ➔ small
  - If in both years of 3 yr average sales ≥ 750 units are sold ➔ large
  - If in one year <750 units are sold and in the other >750 units are sold ➔ small
- Ensures adequate time to develop and implement a compliance plan

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

CARB

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

Example Calculations

Year	Annual CA Sales	3-year Average CA Sales	Manufacturer Size	ZEM Credit Obligation %	ZEM Credit Obligation
2023	575				
2024	590				
2025	600				
2026	750	588			
2027	612	647			
2028	900	654	Small	10%	NA
2029	825	754	Small	15%	NA
2030	624	779	Small	20%	NA
2031	642	783	Large	25%	194.8
2032	696	697	Large	31%	242.7
2033	579	654	Large	37%	257.9
2034		639	Small	43%	NA

CARB

Generating ZEM Credits

- **Minimum Criteria to Qualify for ZEM Credits**:
  - Must be a registerable motorcycle under CA DMV
    - no electric bicycles, stand-up scooters, etc.
  - Must be pure zero emissions
    - electric, hydrogen fuel cell, etc.
  - Must be CARB certified
    - Meets all applicable warranty and administrative requirements
- **Two categories of ZEMs can qualify for credits:**
  - Full ZEM: Range ≥ 50 miles, Top Speed ≥ 70 MPH
  - Local ZEM: Range ≥ 25 miles, Top Speed ≥ 25 MPH

Comparison of ICE and ZEM Classifications

Excluded

Class IA (<50cc)

Class IB (50-169cc)

Class II (170-279cc)

Class III (279+cc)

Excluded

LZEM

- Range ≥ 25 miles @ 55mph or top speed
- Top speed ≥ 25 mph

Full ZEM Credit

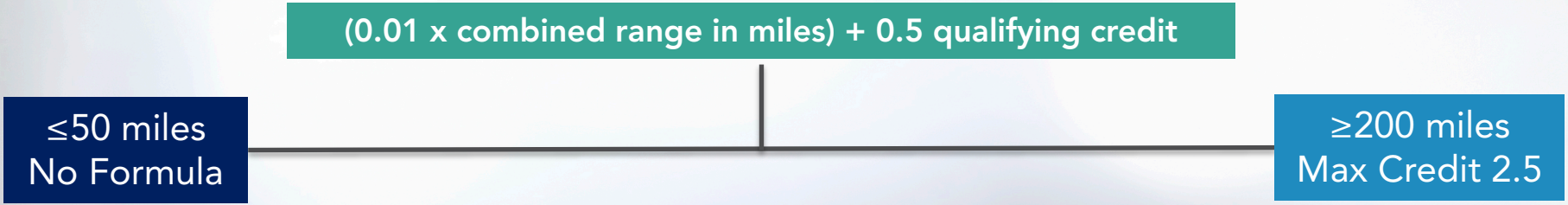
- Range ≥ 50 miles range
- Top speed ≥70mph

CARB

Credit Formula for Full ZEM

- Credit for full ZEMs will be awarded based on range

Basic Formula: (0.01 x combined range in miles) + 0.5 qualifying credit



- Max Range that qualifies for credits
  - ZEMS with range of 200 miles or above will only generate a maximum of 2.5 credits.

CARB

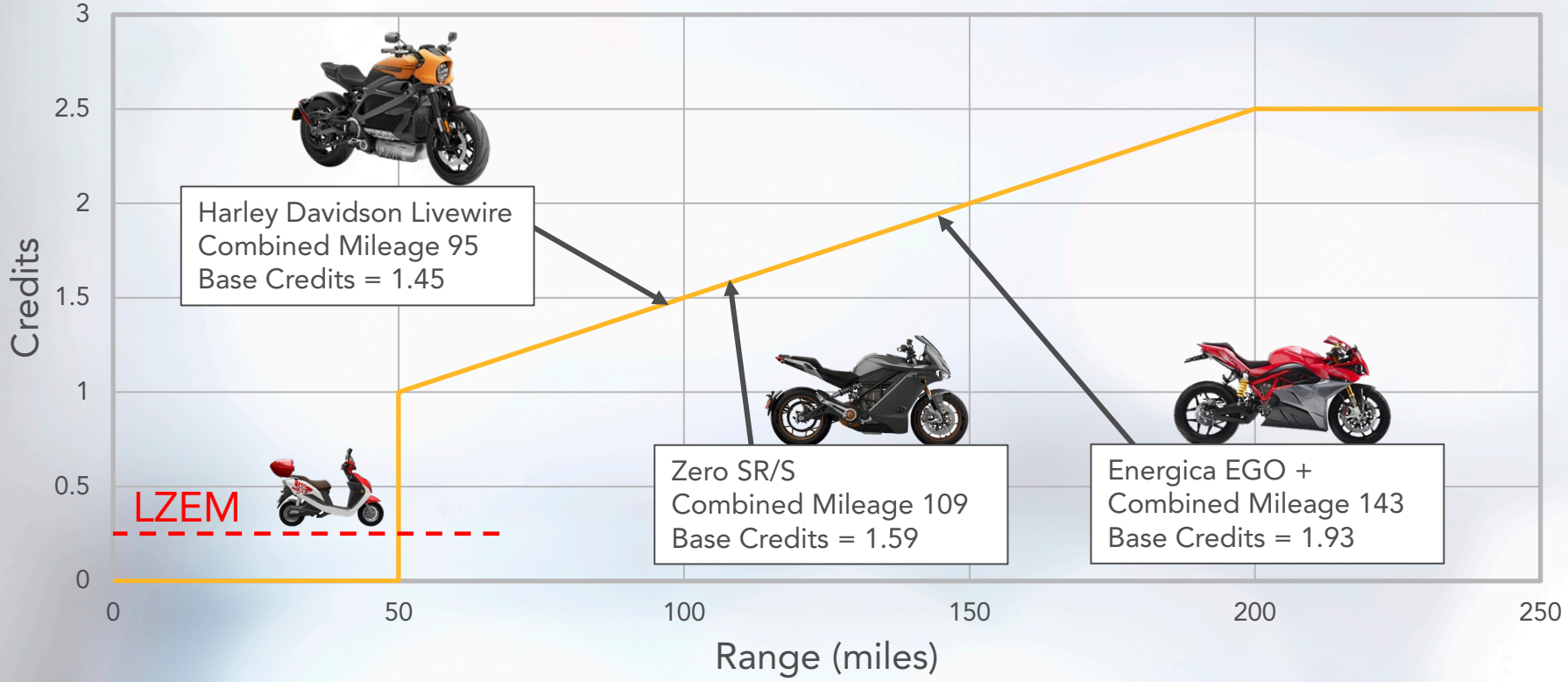
Local Zero-Emission Motorcycle (LZEM) Requirements

- **LZEMs will be awarded a flat rate of 0.25 credits each**
  - Top speed ≥ 25 mph
  - Range of ≥ 25 miles at 55 mph, or at top speed, whichever is lower
  - LZEMs do not qualify for fast charge bonus credits or early adoption multipliers
- CARB Staff are proposing to disallow sales of Class IA ICE motorcycles (<50cc) starting in 2028
  - Greater demand for LZEMs may result from eliminating Class IA ICE models from the market

Test Procedures to Determine Range

- Battery Electric ZEMs - SAE J2982
  - Developed specifically for motorcycles
  - Dyno based test, uses UDDS (city speeds) with freeway speed operation
  - Does not account for regenerative braking, but is currently under revision
  - CARB staff will review revised version when completed
- Hydrogen ZEMs – SAE J2572
  - Developed for passenger cars, would need to be amended to accommodate motorcycles
  - CARB staff seeking input on how representative this procedure is, and what alternatives may be more suitable
- Range, as determined per CARB regulatory procedure, will be listed on CARB EOs
  - This value may differ from EPA range and the range claims found on the manufacturer's website and promotional materials

ZEM Range Credit Comparison



CARB

Early Adoption Multipliers

- Rewards proactive manufacturers
- Ensures adequate credits available for compliance in early years of the program

2023-2027	2028-2030	2031+
6X Multiplier	3X Multiplier	No Multiplier

Fast Charge Credit Bonus

- Additional 0.50 ZEM credits for each ZEM with fast charge
- Ability to rapid-charge using existing Light Duty EV infrastructure
    - Level 2 or DC fast charging capabilities, SAE J1772, CCS
    - Meeting CCR, Title 13, section 1963.3
  - Hydrogen ZEMs
  - Rapid swap batteries
  - Does not apply to LZEMs
- Early adoption multiplier does **NOT** apply to the fast charge bonus

Example Formula with ZEM Credits

{[(0.01 x Range) + 0.5] x early adoption multiplier} + fast charge bonus

Motorcycle	ZEM / LZEM	Range	Base Credits	Fast Charge Bonus	2023-2027 (6x)	2028-2030 (3x)	2031+
A	LZEM	30	0.25	0	0.25	0.25	0.25
B	LZEM	75	0.25	0	0.25	0.25	0.25
C	ZEM	50	1.00	0.5	6.5	3.5	1.5
D	ZEM	50	1.00	0	6	3	1
E	ZEM	150	2.00	0.5	12.5	6.5	2.5
F	ZEM	150	2.00	0	12	6	2
G	ZEM	200	2.50	0.5	15.5	8	3
H	ZEM	275	2.50	0.5	15.5	8	3

Example Formula with ZEM Credits

{[(0.01 x Range) + 0.5] x early adoption multiplier} + fast charge bonus

Motorcycle	ZEM / LZEM	Range	Base Credits	Fast Charge Bonus	2023-2027 (6x)	2028-2030 (3x)	2031+
A	LZEM	30	0.25	0	0.25	0.25	0.25
B	LZEM	75	0.25	0	0.25	0.25	0.25
C	ZEM	50	1.00	0.5	6.5	3.5	1.5
D	ZEM	50	1.00	0	6	3	1
E	ZEM	150	2.00	0.5	12.5	6.5	2.5
F	ZEM	150	2.00	0	12	6	2
G	ZEM	200	2.50	0.5	15.5	8	3
H	ZEM	275	2.50	0.5	15.5	8	3

Example Formula with ZEM Credits

{[(0.01 x Range) + 0.5] x early adoption multiplier} + fast charge bonus

Motorcycle	ZEM / LZEM	Range	Base Credits	Fast Charge Bonus	2023-2027 (6x)	2028-2030 (3x)	2031+
A	LZEM	30	0.25	0	0.25	0.25	0.25
B	LZEM	75	0.25	0	0.25	0.25	0.25
C	ZEM	50	1.00	0.5	6.5	3.5	1.5
D	ZEM	50	1.00	0	6	3	1
E	ZEM	150	2.00	0.5	12.5	6.5	2.5
F	ZEM	150	2.00	0	12	6	2
G	ZEM	200	2.50	0.5	15.5	8	3
H	ZEM	275	2.50	0.5	15.5	8	3

Example Formula with ZEM Credits

{[(0.01 x Range) + 0.5] x early adoption multiplier} + fast charge bonus

Motorcycle	ZEM / LZEM	Range	Base Credits	Fast Charge Bonus	2023-2027 (6x)	2028-2030 (3x)	2031+
A	LZEM	30	0.25	0	0.25	0.25	0.25
B	LZEM	75	0.25	0	0.25	0.25	0.25
C	ZEM	50	1.00	0.5	6.5	3.5	1.5
D	ZEM	50	1.00	0	6	3	1
E	ZEM	150	2.00	0.5	12.5	6.5	2.5
F	ZEM	150	2.00	0	12	6	2
G	ZEM	200	2.50	0.5	15.5	8	3
H	ZEM	275	2.50	0.5	15.5	8	3

CARB

Example Formula with ZEM Credits

{[(0.01 x Range) + 0.5] x early adoption multiplier} + fast charge bonus

Motorcycle	ZEM / LZEM	Range	Base Credits	Fast Charge Bonus	2023-2027 (6x)	2028-2030 (3x)	2031+
A	LZEM	30	0.25	0	0.25	0.25	0.25
B	LZEM	75	0.25	0	0.25	0.25	0.25
C	ZEM	50	1.00	0.5	6.5	3.5	1.5
D	ZEM	50	1.00	0	6	3	1
E	ZEM	150	2.00	0.5	12.5	6.5	2.5
F	ZEM	150	2.00	0	12	6	2
G	ZEM	200	2.50	0.5	15.5	8	3
H	ZEM	275	2.50	0.5	15.5	8	3

CARB

ZEM Credit Use

- ZEM credit obligations can be met using manufacturer-generated credits, purchased credits, or a combination of both
- There are no ZEM production requirements
- ZEM Credits are valid for 5 years from the year generated
  - Credits that are not used within 5 years will expire
  - All credits generated prior to 2028 (2023-2027) will be treated as though they were generated in 2028
    - These credits must be used by 2033

ZEM Certification Process

- To qualify for credits, all ZEMs must be CARB certified
- CARB ZEM certification procedure will start with MY2023
- Certification requirements will include:
  - Range determination per SAE J2982 or SAE J2572
  - Top speed determination per Euro 5 procedure
    - Appendix 1 and 1.1 of Annex X of 134/2014
  - Warranty and labeling
  - Certification fee
- Starting in 2028, large manufacturers must also submit a ZEM fleet compliance plan

ZEM Warranty Requirements

- To be eligible for ZEM credits, all ZEMs and LZEMs must include a 5yr/50,000 mile battery warranty
- Warranty for all other powertrain components is based on current ONMC warranty requirements:
  - LZEMs - five years or 18,000 kilometers (11,185 miles), whichever occurs first (based on Class II)
  - ZEMs - five years or 30,000 kilometers (18,641 miles), whichever occurs first (based on Class III)

Financial Responsibility

- All motorcycle manufacturers must demonstrate adequate financial resources to meet warranty and compliance obligations
- Requirement can be met in two ways:
  1. Financial statement documenting adequate resources
  2. Bond from a 3rd party surety
- Program will be similar to current CARB small off-road engine (SORE) requirements – CCR, Title 13, section 2774
- Proposal would apply to all ONMC, not just ZEMs

ZEM Compliance Requirement

- A manufacturer that submits fewer ZEM credits than required in a given model year shall make up the deficit by the end of the next model year
- Any manufacturer that fails to submit an appropriate amount of ZEM credits and does not make up ZEM credit deficits within the specified time period shall be subject to the Health and Safety Code section 43211 civil penalty
  - civil penalty shall not exceed $5,000 per zero-emission vehicle credit.
- Paying this penalty does not bring the manufacturer into compliance. The manufacturer must still submit the required ZEM credits in addition to the penalty.

ZEM Reporting Requirement

- Each manufacturer shall submit a report to CARB annually verifying status of compliance with ZEM requirements
- This report must include delivery and placement data, with VINs, of all ZEMs/LZEMs generating credits
- This report must also include:
  - Total annual sales of conventional motorcycles, ZEMs, and LZEMs
  - All ZEM credits generated, transferred, or used for compliance

Tracking ZEM Credits

- CARB Staff will track all ZEM credit generation, transfers and usage based on manufacturer reporting
  - Staff will prepare and publish an annual report detailing ZEM credit market activity
  - Report will include ZEM credit balances for all manufacturers
- CARB staff will NOT track or report prices of ZEM credits
  - Credit prices are negotiated between buyer and seller
  - Credit pricing is not disclosed to CARB

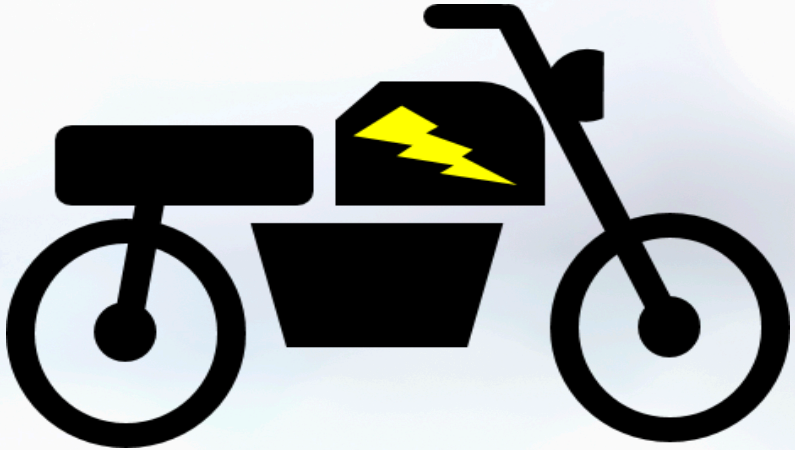
Economic Impact Assumptions

- Cost analysis is currently underway
  - Results will be discussed in a future workshop
- Key assumptions:
  - Class III ICE and ZEM cost difference ~ $6,600
    - Potentially offset by ZEM incentives and reduced maintenance costs
  - Annual battery cost drop ~ 15%
    - Batteries are ~ 1/3 vehicle price
  - Annual base ZEM market increase (absent regulation) ~ 15%
- Analysis based on 2019 ONMC California sales
    - ICE ~ 27,000
    - California ZEM sales ~ 175
    - 2019 LZEM sales ~ 50
- Please let us know if you have additional information to improve these numbers

Expected Impact of ZEM Proposal

- Staff projects a surplus of credits will be available through 2032
  - Assumes 15% ZEM growth rate and flat overall motorcycle sales
  - Projected from 2019 baseline of ZEM sales and overall motorcycle sales
  - 80 miles average combined range
  - 75% of ZEMs qualify for fast charge bonus
- ZEM market growth must accelerate for industry to achieve compliance beyond 2032
  - Additional ZEM manufacturers and models
  - Reduced cost differential between ZEM and ICE models

Thank you



Contacts and Questions

ZEM Program Lead:
Kevin Richardson
(951) 550-0613
kevin.richardson@arb.ca.gov

OMNC Regulation Lead:
Jason McPhee, P.E.
(916) 323-1104
jason.mcphee@arb.ca.gov

Manager, Engineering & Regulation Development Section:
Scott Bacon
(916) 322-8949
scott.bacon@arb.ca.gov

CARB