CALIFORNIA
AIR RESOURCES BOARD

California Tier 5: Off-Road Diesel Averaging, Banking, and Trading (ABT) Concept

December 14, 2022

Outline

- Off-Road Averaging, Banking, and Trading (ABT)
  - Background
  - Purpose
- Need for an Independent California Program
- Current Federal ABT Statistics
- Independent California ABT Concept
- Incentives

ABT Background and Purpose

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ABT Background

- ABT is a federal certification provision that allows engine manufacturers the flexibility to comply with emission standards through averaging, banking, or trading of emission credits
- ABT has been in effect since the first federal nonroad diesel engine standards were implemented in 1996 (Tier 1), and applies to Particulate Matter (PM), Oxides of Nitrogen (NOx), and combined Non-Methane Hydrocarbons and NOx (NMHC+NOx) pollutants
- Under ABT some engine families may be certified to emission levels less stringent than the standard so long as any excess emissions are offset

ABT Background Cont'd

- California is a participant in the federal ABT program along with the other 49 states (and U.S. territories), and does not require separate emissions accounting
- There are no limits to the number of ABT credits that can be banked for future use under the federal program
- ABT is a perpetual compliance option without an end date
- Banked credits do not expire nor is their value discounted over time
- Generally, credits may only be used within an averaging set
  - Engines ≤ 560 kW, or
  - Engines > 560 kW
- Considerable credits have already been banked by some manufacturers
- Credits generated from Tier 1 engines, and Tier 2 engines from 37 to 560 kW, cannot be used to certify Tier 4 engine families

ABT Purpose

- ABT significantly improves the cost-effectiveness of the regulations by not requiring every engine model to be upgraded
- ABT allows manufacturers to conserve resources by overdesigning a portion of their product line so that some existing products may continue to be sold as is
- ABT can provide the opportunity for longer phase-in periods without decreasing emission benefits on a national basis
- Nationwide emission levels remain at or below emission standards on average
- ABT incentivizes the development of cleaner engines than otherwise required, which can later become the basis for more stringent emission standards

Need for an Independent California ABT Program

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Need for an Independent California Program

- Off-road diesel engine emission standards may no longer be aligned between CARB and U.S. EPA after CARB adopts Tier 5 requirements
- The federal ABT program does not include credits for tailpipe Carbon Dioxide (CO_2), which may become a regulated pollutant under Tier 5
- Federal credits do not have to be used proportionally by State
- Theoretically, a manufacturer could use its credits generated from all 50 states in just California to circumvent compliance with the Tier 5 requirements

Federal ABT Credit Equation

Credit (kilograms) = (**STD - FEL**) * **Volume** * **Avg Power** * **UL** * 10^{-3}

Where:

STD = the applicable emission standard, in grams per kilowatt-hour, that applies for engines not participating in the ABT program

FEL = the family emission limit for the engine family, in grams per kilowatt-hour (usually the previous Tier standard)

Volume = the actual U.S.-directed end-of-year production volumes within the given engine family during the model year

Avg Power = the average value of maximum engine power values for the engine configurations within an engine family, calculated on a sales-weighted basis, in kilowatts

UL = the useful life for the given engine family, in hours

10^{-3} = the grams to kilograms conversion factor

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Current Federal ABT Statistics

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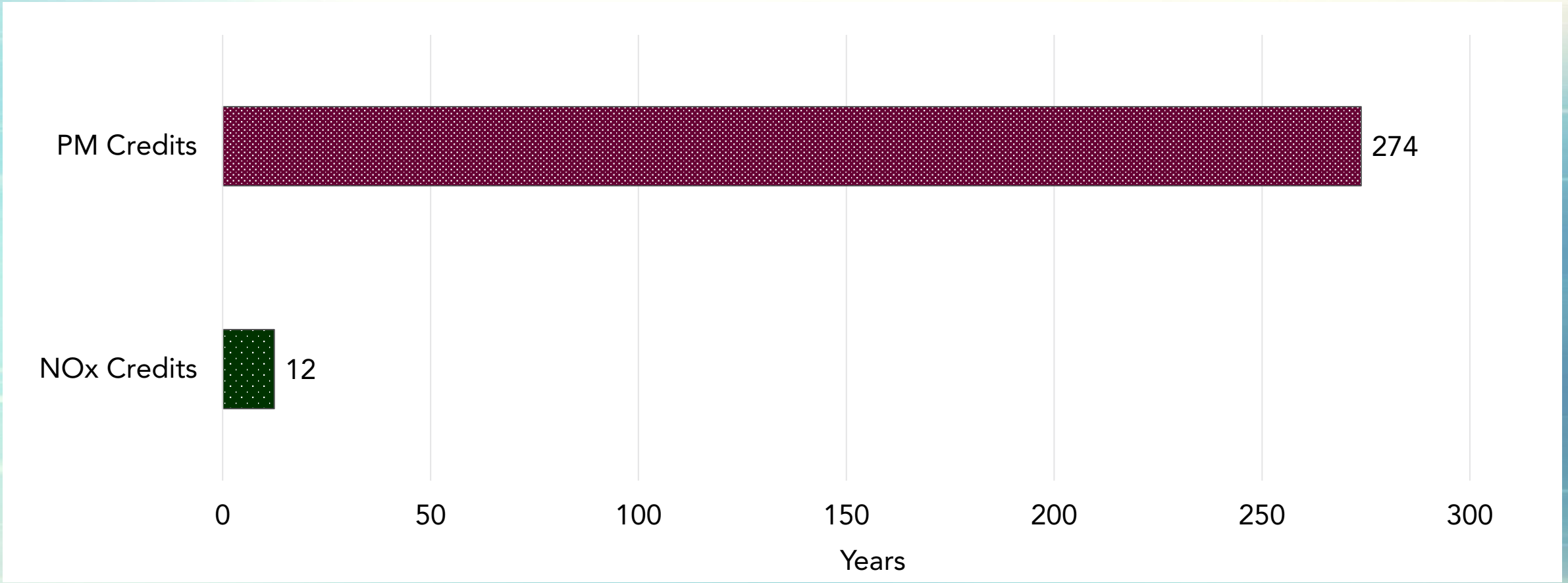
Potential Tier 5 Delay if Federal ABT Balances Used Solely in CA

(Average of 3 Manufacturer Largest Credit Balances for ≤ 560 kW)



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Conclusions from the Federal ABT Balances

- If California remains in the federal ABT program, some manufacturers could potentially delay Tier 5 PM standards for centuries using banked Tier 4 credits
- Similarly, some manufacturers could potentially delay meeting Tier 5 NOx standards for decades by using banked Tier 4 credits
- These conclusions assume that the manufacturers with these banked credits would decide to use all their credits solely in California, which is not prohibited under the current federal ABT program

Independent California ABT Concept

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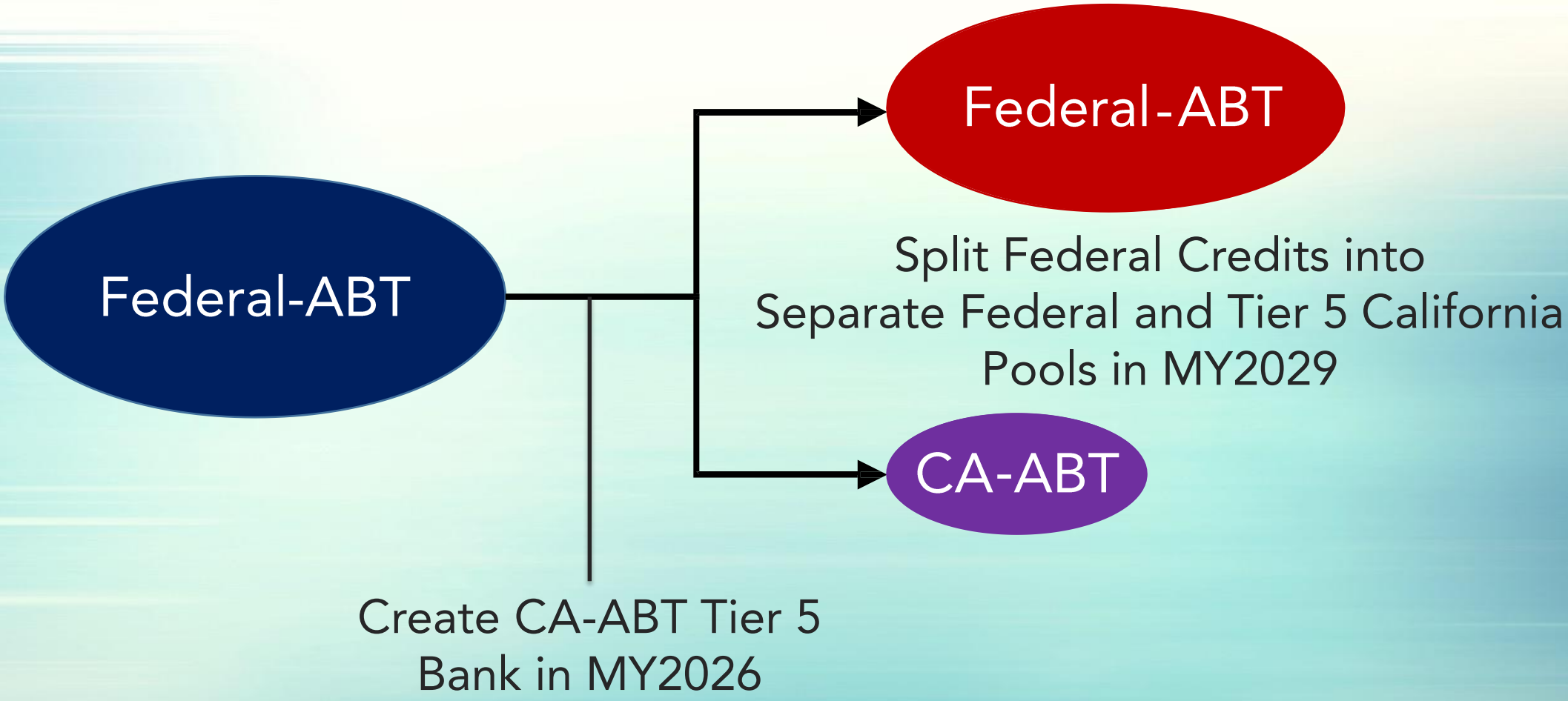
Independent California ABT Concept

- Staff is considering an ABT program that would balance emissions at the State level
- Existing federal credit balances would be split into federal and California banks with the California bank equal to the percentage of California sales for each manufacturer
- Only credits generated from Tier 4 final or Tier 5 engine families would be available to use in California to certify Tier 5 engines
- The current averaging sets would be retained in California and the new family emission limit cap would be the Tier 4 final standard for each power category
- A credit sunset date of five years is being considered to protect against future Tier 5 circumvention from the banking of credits
- In addition to NOx and PM, new ABT provisions for CO_2 credits, and possibly N_2O and CH_4 credits, are being considered for Tier 5
- Credit multipliers are being considered for early Tier 5 compliance and implementation

Tier 5 ABT Split Banks



Incentives for Early Tier 5 Compliance

- NOx Credit Multipliers
  - 1 year early
    - ➢NOx credit multiplier = 1.25x
  - 2 years early
    - ➢NOx credit multiplier = 1.5x
  - 3 years early
    - ➢NOx credit multiplier = 1.75x
- No Multipliers for PM or CO_2

Conceptual CA ABT Credit Equation

Credit (kilograms) = (**MULT**) * (**STD - FEL**) * **Volume** * **Avg Power** * **UL** * 10^{-3}

Where:

MULT = Early Tier 5 compliance credit multiplier (only to generate CA NOx credits):

1.75x for MY2026, 1.5x for MY2027, 1.25x for MY2028, 1x for MY2029+ for power categories with mandatory compliance in MY2029

1.5x for MY2026, 1.25x for MY 2027, 1x for MY2028+ for power categories with mandatory compliance in MY2028

STD = the applicable emission standard, in grams per kilowatt-hour, that applies for engines not participating in the ABT program

FEL = the family emission limit for the engine family, in grams per kilowatt-hour

Volume = the actual California-directed end-of-year production volumes within the given engine family during the model year

Avg Power = the average value of maximum engine power values for the engine configurations within an engine family, calculated on a sales-weighted basis, in kilowatts

UL = the useful life for the given engine family, in hours

10^{-3} = the grams to kilograms conversion factor

Examples of Credit Calculations in the Conceptual California ABT Program (1/5)

Example 1 (2-year early compliance to Tier 5 NOx)

Engine family is certified exactly to the Tier 5 NOx Standard = 0.04 g/kW-hr
250 units sold in engine family
Average Maximum Engine Family Power = 200 kW
Useful life is 8,000 hours
Certifies for MY2026 with Mandatory Compliance in MY2028

Credit Equation

Credit (kg) = (MULT) * (STD - FEL) * Volume * Avg Power * UL * 10^{-3}

Credit (kg) = (1.5) * (0.40 – 0.04) * 250 * (200) * 8,000 * 0.001

Credit (kg) = 216,000 kg to the California bank – Tier 5 credits would be generated and deposited into the California bank using the 2-year multiplier of 1.5x

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Examples of Credit Calculations in the Conceptual California ABT Program (2/5)

Example 2 (1-year early compliance to Tier 5 NOx)

Engine family is certified exactly to the Tier 5 NOx Standard = 0.04 g/kW-hr
250 units sold in engine family
Average Maximum Engine Family Power = 200 kW
Useful life is 8,000 hours
Certifies for MY2027 with Mandatory Compliance in MY2028

Credit Equation

Credit (kg) = (MULT) * (STD - FEL) * Volume * Avg Power * UL * 10^{-3}

Credit (kg) = (1.25) * (0.40 – 0.04) * 250 * (200) * 8,000 * 0.001

Credit (kg) = 180,000 kg to the California bank – Tier 5 credits would be generated and deposited into the California bank using the 1-year multiplier of 1.25x

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Examples of Credit Calculations in the Conceptual California ABT Program (3/5)

Example 3 (Carry over from Example 1/2 Tier 5 NOx)

Engine family is certified exactly to the Tier 5 NOx Standard = 0.04 g/kW-hr
250 units sold in engine family
Average Maximum Engine Family Power = 200 kW
Useful life is 8,000 hours
Certifies for MY2028 with Mandatory Compliance in MY2028

Credit Equation

Credit (kg) = (MULT) * (STD - FEL) * Volume * Avg Power * UL * 10^{-3}

Credit (kg) = (1.00) * (0.04 – 0.04) * 250 * (200) * 8,000 * 0.001

Credit (kg) = 0 kg to the California bank – the Tier 5 NOx standard would be mandatory in MY2028 therefore the credit multiplier would no longer apply

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Examples of Credit Calculations in the Conceptual California ABT Program (4/5)

Example 4 (Early, but slightly higher than Tier 5 NOx)

Engine family is certified to more than the Tier 5 NOx standard = 0.05 g/kW-hr
1000 units sold in engine family
Average Maximum Engine Family Power = 65 kW
Useful life is 8,000 hours
Certifies for MY2028 with Mandatory Compliance in MY2029

Credit Equation

Credit (kg) = (STD - FEL) * Volume * Avg Power * UL * 10^{-3}

Credit (kg) = (0.40 – 0.05) * 1,000 * (65) * 8,000 * 0.001

Credit (kg) = 182,000 kg to the Federal bank – only federal Tier 4 NOx credits would be generated because the FEL 0.05 g/kW-hr is higher than the Tier 5 STD 0.04 g/kW-hr

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Examples of Credit Calculations in the Conceptual California ABT Program (5/5)

Example 5 (Certifying to the Maximum Tier 4 FEL)

Engine family is certified to the maximum Tier 4 NOx FEL = 0.80 g/kW-hr
800 units sold in engine family
Average Maximum Engine Family Power = 465 kW
Useful life is 8,000 hours
Certifies for MY2027 with Mandatory Tier 5 Compliance in MY2028

Credit Equation

Credit (kg) = (STD - FEL) * Volume * Avg Power * UL * 10^{-3}

Credit (kg) = (0.40 – 0.80) * 800 * (465) * 8,000 * 0.001

Credit (kg) = (-1,190,400) kg from the Federal Bank – this family would need to certify using federal Tier 4 banked credits. No multiplier would apply.

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Potential Credits in California
ABT Bank

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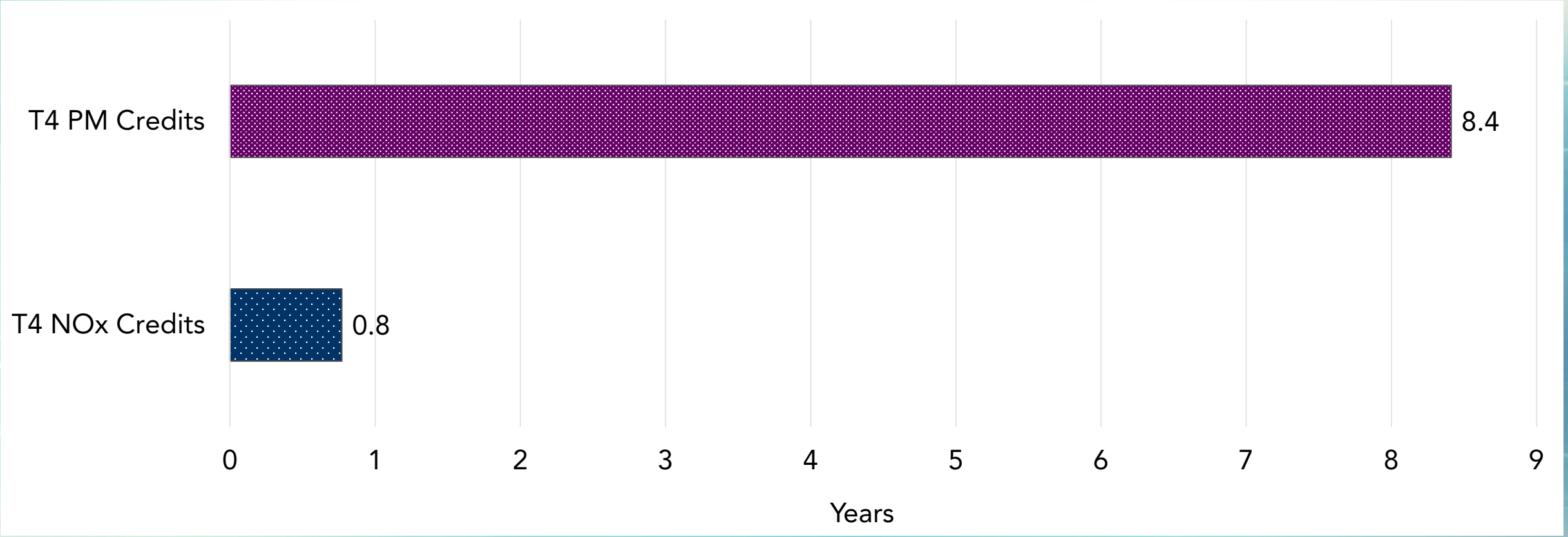
Potential Tier 5 Delay with California ABT Banks Limited to Tier 4 Credits

(Average of 3 Manufacturer Largest Credit Balances for ≤ 560 kW)



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Next Steps

- Consider additional measures to minimize the potential adverse impacts from NOx and PM credit balances on Tier 5 implementation
  - Implementation delays should be less than a year for any individual manufacturer
  - Get feedback from stakeholders on an equitable solution for limiting the use of ABT credits in California from its members with banked credits versus members without banked credits
  - Continue to evaluate the need to adopt a credit provision for capping standards for tailpipe Nitrous Oxide (N_2O) and Methane (CH_4)

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Next Steps Cont'd

- Questions/Requests for Industry Feedback:
  - Would GHG credits be necessary for a combined CO_2, N_2O, and CH_4 standard?
  - How should a combined off-road tailpipe GHG credit approach be weighted to address differences in global warming potential (GWP) and lifetime of pollutants, e.g., 1 GWP for CO_2 to 273 GWP for CH_4, and 12 years for CH_4 to 200 years for CO_2, respectively?
  - Do Zero Emission Vehicle (ZEV) credits make sense in an engine-only regulation?
  - How would CARB offer ZEV emission credits applicable to engine families given the diversity of off-road diesel applications
  - Would ZEV credits incentivize the replacement of diesel engines with ZEV powertrains or just provide credits to ZEV applications that are already available in California, potentially slowing the transition to Tier 5 without an actual emissions benefit?