

Certification Flexibility for Innovative  
Heavy-Duty Engine and Vehicle Technology and  
Certification and Installation Procedures for  
Medium- and Heavy-Duty Vehicle Hybrid  
Conversion Systems  
(Innovative Technology Regulation)

Public Workshop  
September 28, 2015  
El Monte, CA

# Agenda

- Background and Overview
- Optional Low NOx Heavy-Duty Engines
- Hybrid Heavy-Duty Engines and Vehicles
- Possible Technology Diversity Provisions
- Hybrid Conversion Systems
- Potential Economic Impacts
- Next Steps

# Potential Innovative Technology Regulation (ITR)

## *Objectives*

# California's Long-Term and Air Quality Challenges

- California needs additional NO<sub>x</sub> and GHG reductions beyond what can be achieved by existing technologies
  - Significant NO<sub>x</sub> reduction needed by 2031 to attain 8-hour ozone standard in South Coast
  - 40% GHG reduction by 2030, 80% by 2050
- Accelerated, broad deployment of innovative, new zero- and near-zero emission technologies needed

# Innovative Technology Rulemaking

Certification: Existing certification/on-board diagnostics requirements geared towards traditional technologies

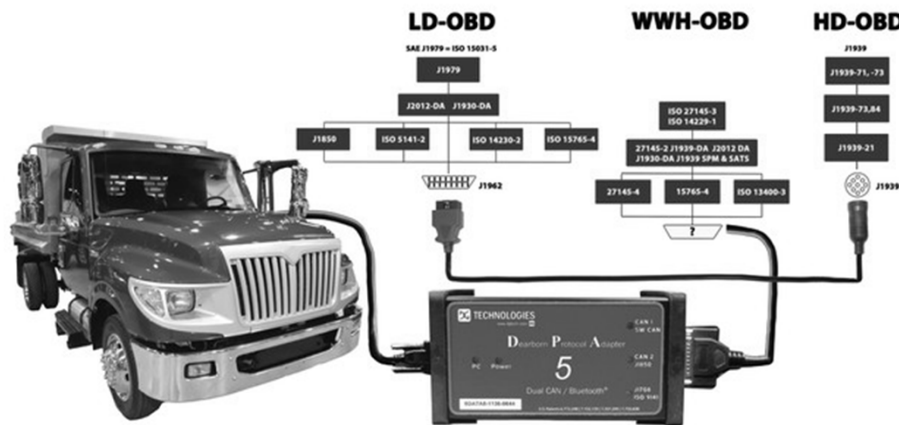
- May pose challenge for emerging new engine and vehicle technologies

Aftermarket Conversions: ARB certification procedures do not exist specifically for aftermarket hybrid conversions

- Case-by-case consideration based upon 1990 regulation

# On-Board Diagnostics (OBD)

- OBD is an important emission control system that is critical to achieving California's air quality goals
- OBD Systems Required on All Vehicles
  - *Light- and medium-duty* → 1996+ model years (MYs)
  - *Heavy-duty (14,000+ lbs GVWR)* → Gasoline and Diesel: 2013+ MY  
→ Alt. Fuel: 2018+ MY



# Innovative Technology Regulation Objectives

- √ Provide new engine OBD/certification flexibility and hybrid conversion system certification pathway to accelerate market launch of needed truck and bus technologies, while maintaining ability to ensure anticipated air quality benefits



# Innovative Technology Regulation

## Potential Technologies

- New Heavy-Duty Engines and Vehicles
  - New engines meeting California's optional low-NOx standards
  - New hybrid engines and vehicles
  - Other new, innovative engine or vehicle technologies with CO<sub>2</sub> or NOx emission benefit (Technology Diversity Element)
- Medium-Duty Hybrid Vehicles (tbd)
- Medium- and Heavy-Duty Vehicle Hybrid Conversion Systems



# Innovative Technology Regulation

## Potential Conceptual Framework

- Encourage early technology deployment with targeted certification flexibility
  - Tier 1: Initial market volumes = greatest certification flexibility
  - Tier 2: Diagnostics and other requirements ramp up as market matures
  - Beyond Tier 2: Full certification/OBD requirements apply
- Each manufacturer could progress through Tier 1 → Tier 2 → full certification as market matures
- Each new technology's ITR flexibility would sunset 4 to 6 years after its "market launch"

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Purposes Only

# New Heavy-Duty Engine Certification

*Possible ITR General Requirements*

# New Engine Certification

## Possible General Requirements

- Participating manufacturers submit ITR Compliance Plan each MY, demonstrating for each engine family:
  - Surplus emission reductions
  - No OBD backsliding
  - Anticipated California sales volume
  - Meet applicable labeling requirements and other criteria
- ARB approval of the MY Compliance Plan enables engine family certification with applicable ITR flexibility
- Manufacturer's end-of-MY report demonstrates compliance with annual sales allowance

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# Innovative Technology Regulation

## *Heavy-Duty Engines Meeting the Optional Low-NO<sub>x</sub> Standard*

# Six Possible Optional Low-NOx Engine Technology Categories

Heavy-Duty Engine Type	NOx Certification Level (g/bhp-hr)		
	0.10	0.05	0.02
<b>Compression Ignition</b>	√	√	√
<b>Otto Cycle</b>	√	√	√

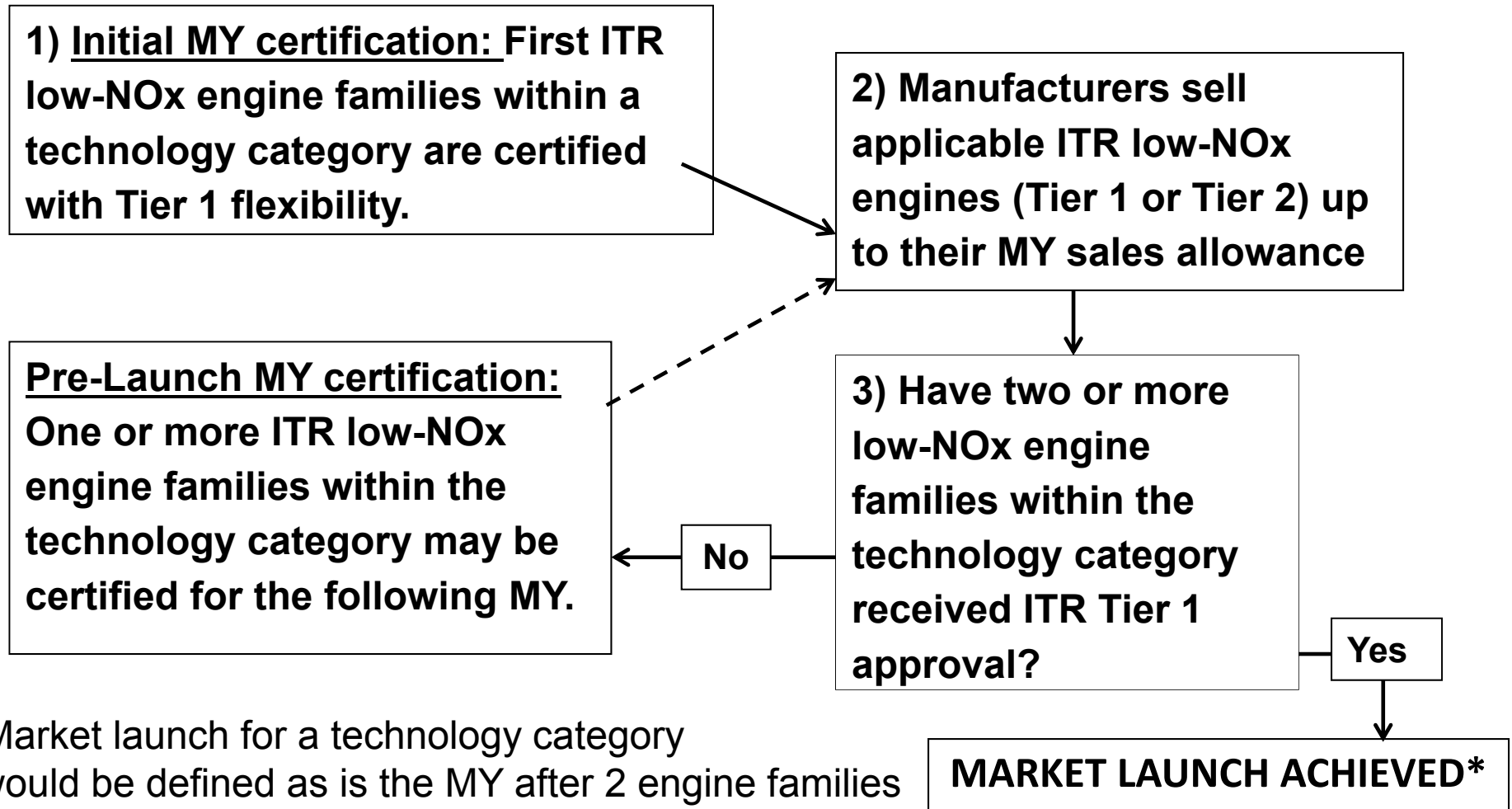
## Possible California Sales Allowance

(sum within all low-NOx technology categories receiving ITR flexibility per MY )

- 10% of average annual sales volume or 200 engines, whichever is greater.
- Average annual sales volume = annual average of total California heavy-duty engine sales over the three most recent MYs, not including the immediately preceding MY (e.g., for MY 2017, average based on MYs 2013, 2014, and 2015).

# Possible ITR Process for Low NOx Engines

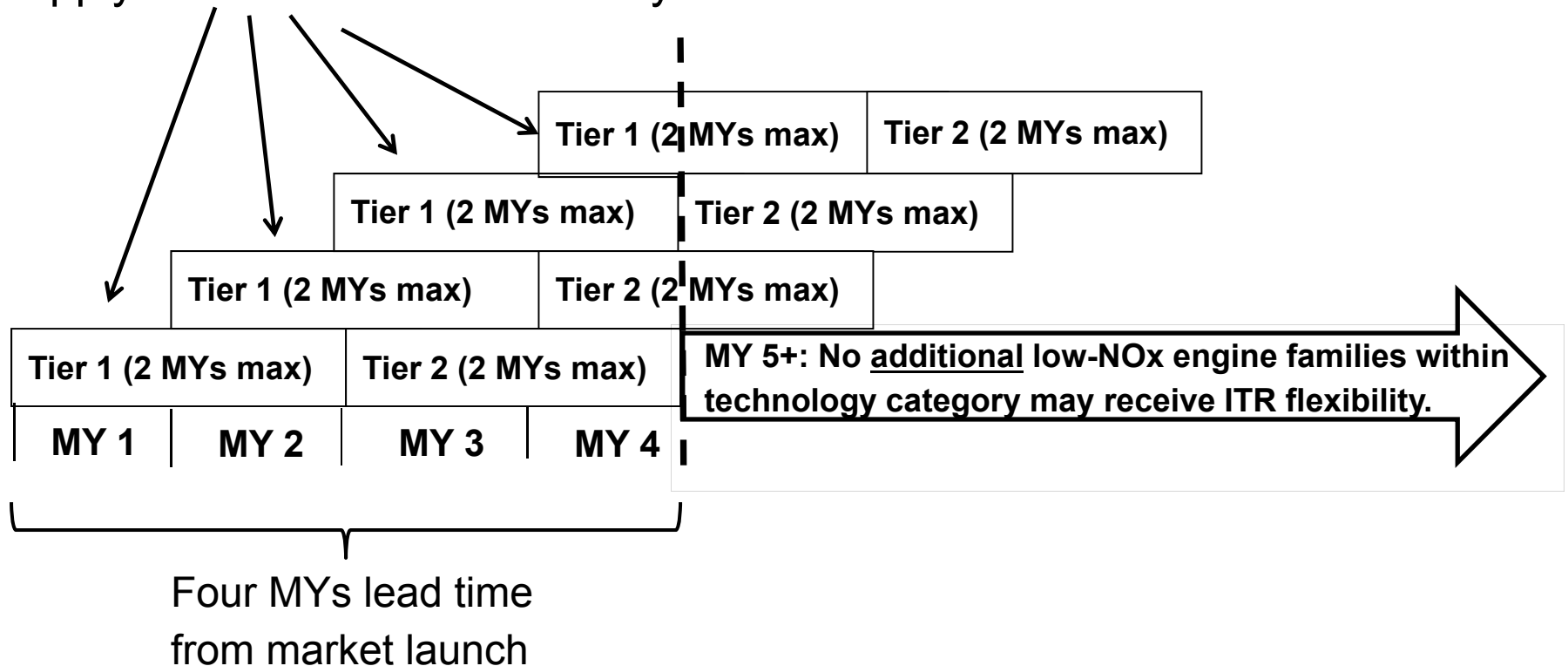
## Potential Pre-Market Launch Period



\* Market launch for a technology category would be defined as is the MY after 2 engine families within that technology category are Tier 1 approved.

# Possible ITR Process for Low NOx Engines Subsequent to Market Launch

Any low-NOx engine family that is first certified within 4 MYs of market launch would be eligible to apply for 4 MYs of ITR flexibility.



# Low-NOx Heavy-Duty Engines

## Possible Tier 1 Requirements

Existing Certification Requirements Apply  
Plus the Following Flexibility Provisions:

1. OBD Emission Test Data Sets: One engine family may be excluded from section 1971.1(i)(2.2.3) calculation
2. In-Use Monitoring Performance Ratio (IUMPR) for evaluation purposes only
3. 1065-certified cells not required for OBD purposes
4. Forgo fines pursuant to 1971.1(k)(3) for up to five deficiencies related to low-NOx engine
5. Allow use of assigned deterioration factors (DFs)

*This is a straw man proposal to generate stakeholder feedback*



# Low-NOx Heavy-Duty Engines

## Possible Tier 2 Requirements

Existing Certification Requirements Apply  
Plus the Following Flexibility Provisions:

1. OBD Emission Test Data Sets: One engine family may be excluded from section 1971.1(i)(2.2.3) calculation
2. IUMPR for evaluation purposes only
3. Forgo fines pursuant to 1971.1(k)(3) for up to three deficiencies related to low-NOx engine

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# Innovative Technology Regulation

## *Heavy-Duty Hybrid Engines and Vehicles*

# Possible Hybrid Technology Categories and Associated Tier 1/Demonstration Volumes<sup>1</sup>

<b>Vehicle Type</b>	<b>Hybrid with &lt;35 Miles All-Electric Range</b>	<b>Hybrid with 35+ Miles All-Electric Range</b>
<b>Class 2b/3 Pickup or Van</b>	TBD	TBD
<b>Class 4 – 8 Vocational Vehicle</b>	100	200
<b>Class 8 Urban Bus</b>	TBD	100
<b>Class 8 Tractor (non-vocational)</b>	50	100

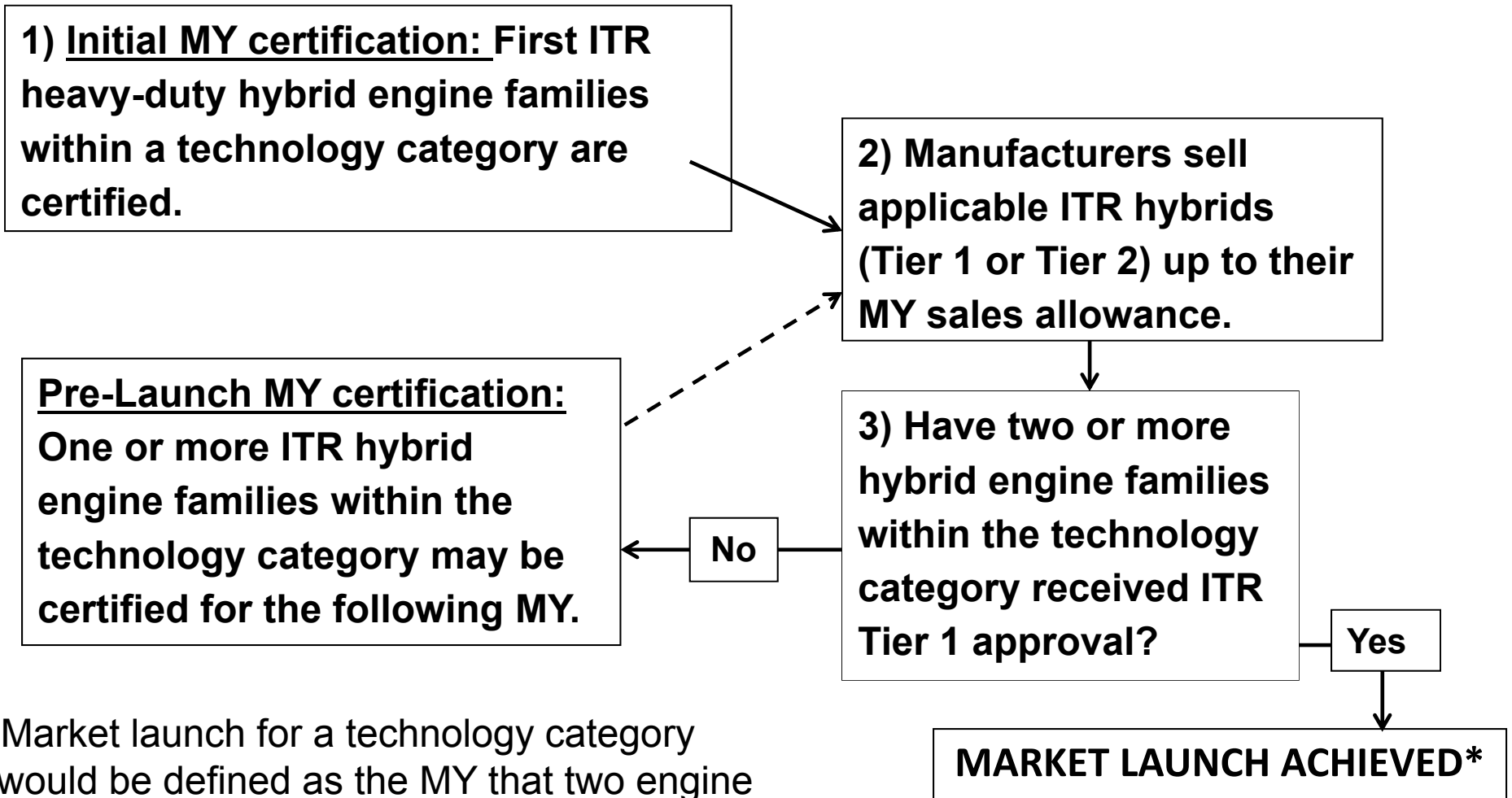
1 – Demonstration Volumes would be cumulative (i.e., not per model year), per engine manufacturer.

## Possible ITR Engine California Sales Allowance

- Hybrids in Demo/Tier 1: Subject to sales allowances shown above.
- Sum of hybrids in all tiers and technology categories:  
10% of average annual sales volume or 200 engines, whichever is greater.
- Hybrid + Optional Low NOx Engines: 12.5% of average annual sales volume or 250 engines, whichever is greater.

# Possible ITR Process for Heavy-Duty Hybrids

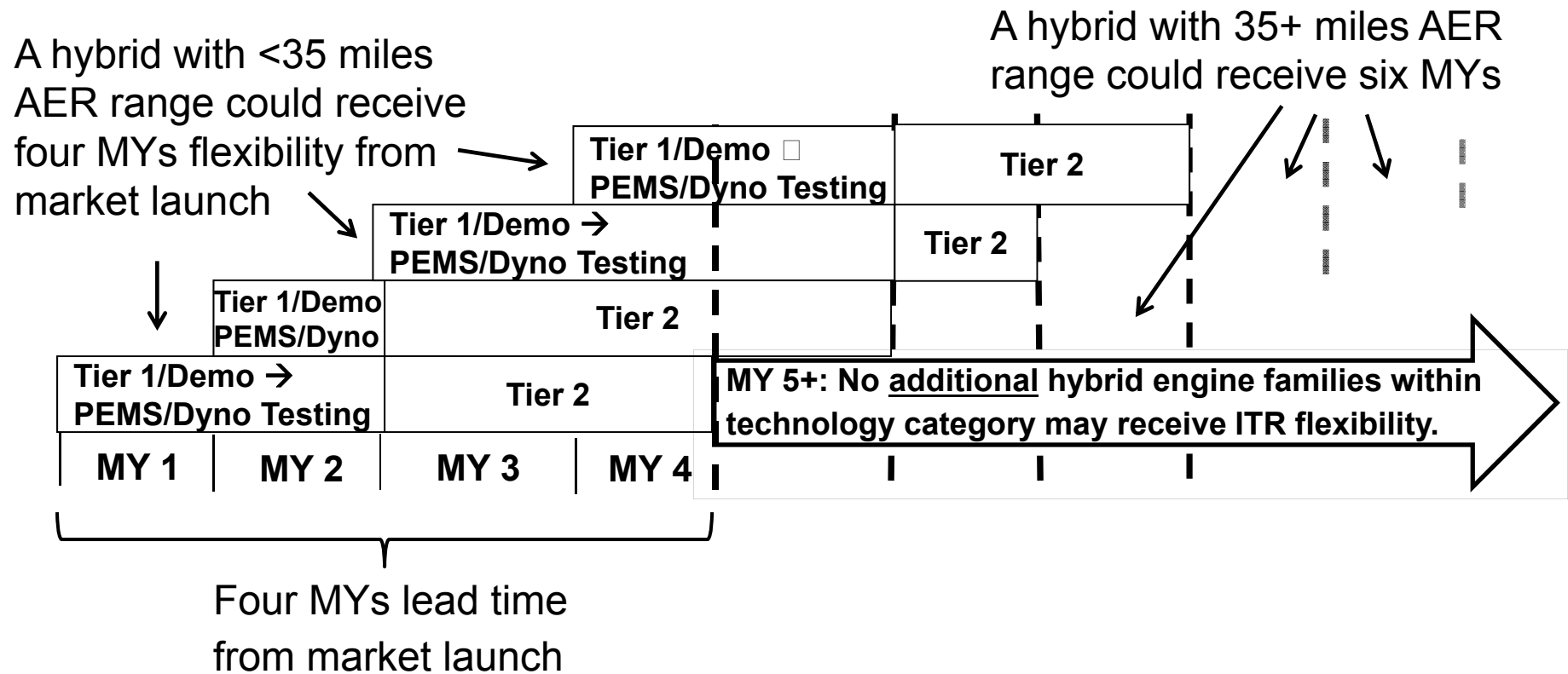
## Potential Pre-Market Launch Period



\* Market launch for a technology category would be defined as the MY that two engine families within that technology category are Tier 1 approved.

# Possible ITR Process for Low NOx Engines Subsequent to Market Launch

All heavy-duty hybrid engine families that are first certified within four MYs of market launch would be eligible to apply for four to six MYs of ITR flexibility.



# Hybrid Heavy-Duty Engines

## Possible Tier 1 Requirements

Existing Certification Requirements Apply  
Plus the Following Flexibility Provisions:

1. EMD+ rather than heavy-duty OBD requirements
2. Allow use of assigned deterioration factors (DFs)

## Additional Tier 1 Eligibility Requirements

1. Agree to collect and share with ARB upon request required engine parameter and vehicle telematics data
2. Submit an approvable plan for chassis dynamometer or in-use PEMS testing (as required to proceed to Tier 2)

*This is a straw man proposal to generate stakeholder feedback*

# Hybrid Heavy-Duty Engines

## Proceeding from Tier 1 to Tier 2

Must demonstrate no increase in any criteria pollutant via vehicle A to B emission testing

- Chassis dynamometer
  - Based upon *Heavy-Duty Hybrid-Electric Vehicle Certification Procedures* (Dec. 2013)
  - Staff evaluating alternatives: Use of SAE J2711 protocols?
  - Include more vocation-specific duty cycles
- PEMS testing
  - Staff welcomes input regarding development of possible heavy-duty hybrid PEMS testing criteria
- Drivetrain testing (similar to Phase 1 GHG)
  - Staff welcomes stakeholder comment regarding appropriateness of these procedures for ITR

# Hybrid Heavy-Duty Engines

## Possible Tier 2 Requirements

Existing Certification Requirements Apply  
Plus the Following Flexibility Provisions:

1. Basic OBD: Circuit and functionality checks required, may light separate MIL and use proprietary scan tools
2. Demonstrate OBD readiness
3. OBD Emission Test Data Sets: One engine family may be excluded from section 1971.1(i)(2.2.3) calculation
4. IUMPR for evaluation purposes only
5. Allow use of assigned DFs

*This is a straw man proposal to generate stakeholder feedback*



# Hybrid Medium-Duty Vehicles

8,501 – 14,000 lbs. GVWR

- Should ITR address Class 2b/3 hybrid vehicles?
- Stakeholder feedback needed regarding:
  - What, if any, certification or OBD challenges do hybrid medium-duty vehicle manufacturers face?
  - How might the ITR help accelerate market launch of vertically-integrated hybrid medium-duty vehicles?
  - Other reasons ITR is needed to enable market launch of robust, medium-duty hybrids

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# Innovative Technology Regulation

## *Possible Technology Diversity Element*

# Possible Technology Diversity Element Overview

- More modest, targeted flexibility for other innovative heavy-duty engine technologies
- Potential eligibility criteria
  - Engine or driveline technology with ability to achieve CO<sub>2</sub> or NOx reductions
  - Not previously commercialized in medium- or heavy-duty vehicle
  - Presents significant certification or OBD challenge

# Possible Technology Diversity Element Potential Eligibility Categories

## Existing Engine Architecture

- Examples might include: advanced engine transmission, engine downsizing, engine down-speeding, advanced waste heat recovery, cylinder deactivation, or predictive cruise technology

## Novel Heavy-Duty Vehicle Propulsion Technology

- Examples might include: opposition piston engine, free piston engine, camless engine, or microturbine

# Possible Technology Diversity Element

## Existing Engine Architecture

### Potential Certification Flexibility

- One MY of the Tier 1 and one MY of Tier 2 flexibility similar to that afforded low NOx engines, maximum 200 engines per manufacturer per MY

### Potential Sunset Provisions

- The technology (from any manufacturer) would be ineligible for ITR flexibility if first ARB-certified more than four MYs subsequent to market launch

*This is a straw man proposal to generate stakeholder feedback. Staff is also evaluating other potential strategies and encourages stakeholder feedback regarding other approaches to enable evaluation and certification of promising new technologies.*

# Possible Technology Diversity Element

## Novel Heavy-Duty Vehicle Propulsion Technology

### Potential Certification Flexibility

- Two MY of the Tier 1 and two MY of Tier 2 flexibility similar to that afforded hybrid engines, maximum 200 engines per manufacturer per MY

### Potential Sunset Provisions

- The technology (from any manufacturer) would be ineligible for ITR flexibility if first ARB-certified more than four MYs subsequent to market launch

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# Off-Road Engines in HD Hybrids

- Must demonstrate no emissions increase relative to applicable on-road base vehicle
- Potential eligibility criteria
  - 56kW or greater engine
  - Steady state operation, engine does not directly propel vehicle
  - Installed on vehicle with 35+ miles zero-emission range
  - Engine meets most stringent NOx emission standard and 0.01 g/bhp-hr PM standard
  - If diesel engine, equipped with certified DPF calibrated for steady state operation
- Also consider light-duty or stationary engines?

# Innovative Technology Regulation

*September 28, 2015 Public Workshop*

*10 minute break*

For online access and to submit comments or questions,  
please register at:

<https://attendee.gotowebinar.com/register/8994048364784771073>

CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY



**Air Resources Board**



# Aftermarket Conversion Systems

*Background*

# Aftermarket Conversions

## Background

- California certification requirements ensure new engines and vehicles meet expected emission limits when new and in-use
- Anti-tampering requirements prohibit modification of a certified vehicle or engine without an aftermarket exemption
  - Must demonstrate no emission increase from original vehicle or engine design and no adverse impact to emission controls and OBD

# Aftermarket Conversions

## Existing Provisions

ARB has adopted aftermarket part certification requirements for two specific technologies

- Hybrid to Plug-In Hybrid Conversion Procedures
- Alt Fuel Conversion Procedures
  - Include more strict emission testing and other criteria for certifying the alt fuel conversion achieves an emission benefit in-use

# Innovative Technology Regulation

*Possible Medium- and Heavy-Duty  
Vehicle Hybrid Conversion System  
Certification Requirements*

# Hybrid Conversion Systems

## Possible Conceptual Framework

- Defines ARB approval pathway for truck and bus hybrid aftermarket conversions
- Requirements could increase within CA sales volumes
  - Tier 1/Demo: Basic requirements facilitate tech launch
    - Emission testing required prior to Tier 2
      - Must demonstrate no criteria pollutant increase
      - If CO<sub>2</sub> benefit > 20%, ARB Executive Order identifies CO<sub>2</sub> benefit upon manufacturer request; must retest to demonstrate durability within two years
  - Tier 2/Pilot: OBD and other requirements ramp up
  - Tier 3: Full aftermarket certification requirements

# Six Possible Hybrid Conversion System Technology Categories and Tier 1 and 2 Sales Allowances<sup>1</sup>

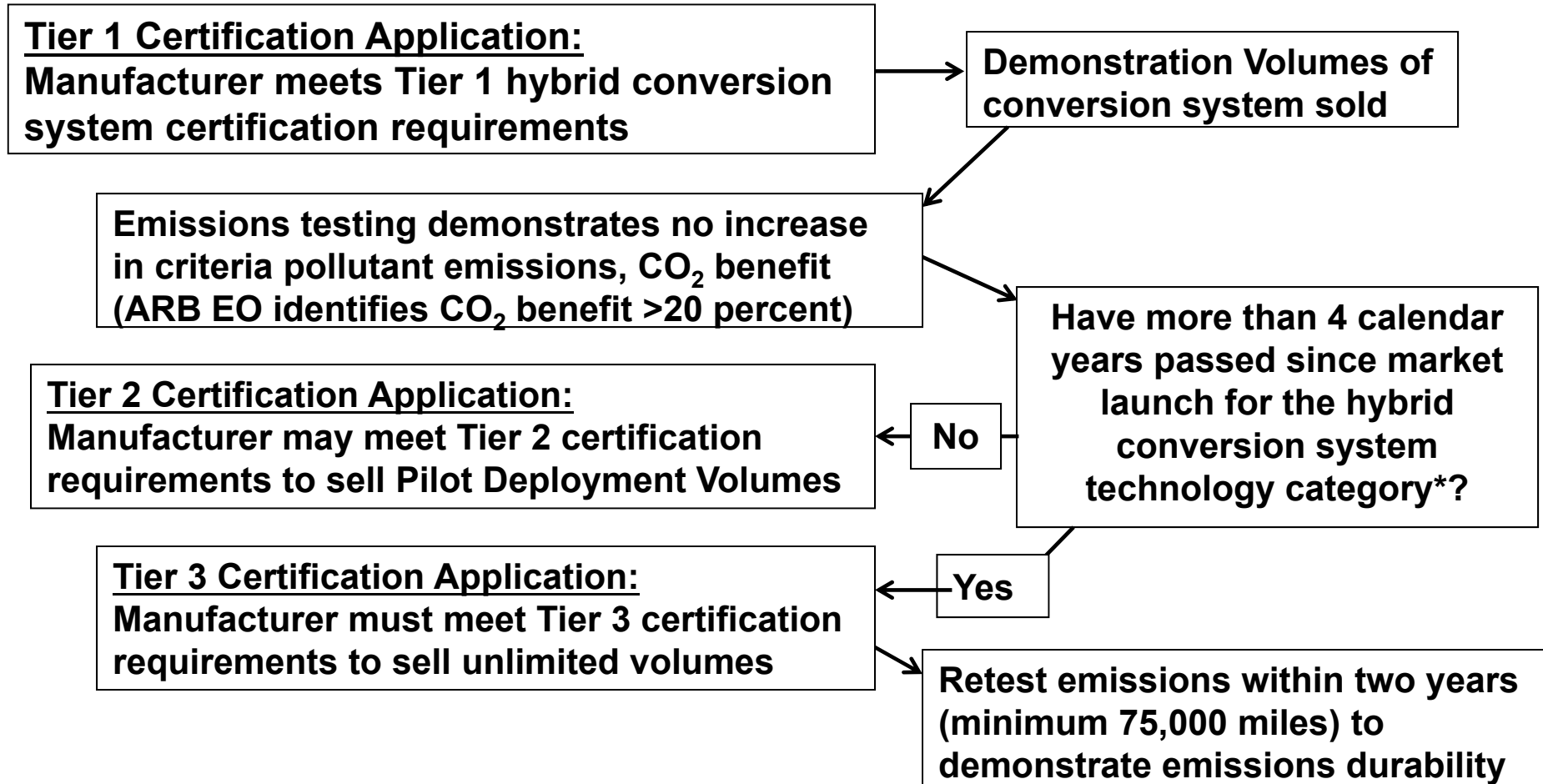
Vehicle Type	Hybrid with <35 Miles All-Electric Range		Hybrid with 35+ Miles All Electric Range	
	Tier 1/ Demo Volume	Tier 2/ Pilot Volume	Tier 1/ Demo Volume	Tier 2/ Pilot Volume
<b>Class 2b or 3 Vehicle</b>	10	500	25	1,000
<b>Class 4-8 Vocational Vehicle</b>	10	500	25	1,000
<b>Class 8 Tractor (non-vocational)</b>	10	500	25	1,000

1 – Volumes would be cumulative (i.e., not per model year).

Possible Eligibility Criteria: The maximum power available from the hybrid's rechargeable energy storage system during a standard ten second pulse power or equivalent test would have to be:

- at least 10 percent of the vehicle's total traction power for a vehicle that has a GVWR of between 8,501 and 14,000 lbs; and
- at least 15 percent of the vehicle's total traction power for a vehicle that has a GVWR of more than 14,000 lbs

# Possible ITR Process for Hybrid Conversion Systems



\* Market launch for a technology category would be defined as the calendar year after 2 conversion systems within that category receive Tier 1 certification.

# Aftermarket Conversions

## Possible Tier 1 Requirements

- Meet minimum criteria for energy storage, potential CO<sub>2</sub> benefit
- Commit to and submit plan for emission testing
- Demonstrate evaporative emissions meet base vehicle standard
- On-Board Diagnostics
  - Do not disable base vehicle OBD
  - No false MIL from base vehicle
  - IUMPR data within 12 months, no enforcement

*This is a straw man proposal to generate stakeholder feedback*



# Hybrid Conversion Systems

## Proceeding from Tier 1 to Tier 2

Must demonstrate no increase in any criteria pollutant

- Chassis dynamometer
  - Based upon *Heavy-Duty Hybrid-Electric Vehicle Certification Procedures* (Dec. 2013)
  - Staff evaluating alternatives: Use of SAE J2711 protocols?
  - Include more vocation-specific duty cycles
- PEMS testing
  - Staff welcomes input regarding development of possible heavy-duty hybrid PEMS testing criteria
- Drivetrain testing
  - Could be modeled after US EPA Phase 1 GHG procedures

# Aftermarket Conversions

## Possible Tier 2 Requirements

Tier 2 flexibility would sunset four years after technology category market launch. After that, the conversion system would proceed directly from Tier 1 → Tier 3

- Continue to meet Tier 1 OBD requirements
- Monitors originally calibrated to an emission threshold must detect total lack of function
- Demonstrate readiness in-use  
(non-representative conditions okay)
- Additional IUMPR data may be required  
(no enforcement)
- Approved plan to meet Tier 3 OBD requirements

*This is a straw man proposal to generate stakeholder feedback*

# Aftermarket Conversions

## Possible Tier 3: Full Certification

- Base vehicle fully OBD compliant and basic diagnostics for conversion technology
  - Full OBD for base vehicle
  - Light single MIL
  - Use standardized scan tools
  - Comprehensive component monitoring for hybrid conversion system
  - IUMPR meets requirements of CCR, section 1968.2 or 1971.1

*This is a straw man proposal to generate stakeholder feedback*

# Aftermarket Conversions

## Potential Warranty & Reporting Requirements

<b>Conversion System Approval Level</b>	<b>Hybrid Conversion System Minimum Product and Installation Warranty Period</b>
<b>Tier 1</b>	3 years or 50,000 miles, whichever comes first <sup>1</sup>
<b>Tier 2 or Tier 3 (no CO<sub>2</sub> emission benefit)</b>	5 years or 60,000 miles, whichever comes first <sup>1</sup>
<b>Tier 3 (for defined CO<sub>2</sub> emission benefit)</b>	7 years or 75,000 miles, whichever comes first <sup>2</sup>

1 – Hybrid conversion systems with ePTO may include a 3,000 hour warranty period.

2 – Hybrid conversion systems with ePTO may include a 4,200 hour warranty period.

- Possible installation and installation warranty requirements
- May require reporting of warranty claims exceeding one percent
- Possible conversion system recall criteria

# Potential Economic Impacts

- For what technology are you most interested in ITR flexibility?
- Are your customers requesting these technologies now? Do you anticipate high demand?
- When is the earliest you might consider certifying an ITR technology?
- What would be the most cost-prohibitive part(s) of this regulation?

Please provide feedback at:  
[www.surveymonkey.com/r/J5N3VWP](http://www.surveymonkey.com/r/J5N3VWP)

# Next Steps

## Ongoing

- Continue individual stakeholders meetings

## Late 2015 (dates tbd)

- Additional Public Work Group meeting(s)

## Early 2016

Proposed Regulation released for  
45-Day Public Comment Period

## Spring 2016

- Board Consideration of Proposed Regulation
- If adopted, ARB to request early effective date

# Contacts

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obdprog/obdprog.htm](http://www.arb.ca.gov/msprog/obdprog/obdprog.htm)

# Innovative Technology Regulation

## *September 28, 2015 Public Workshop*

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