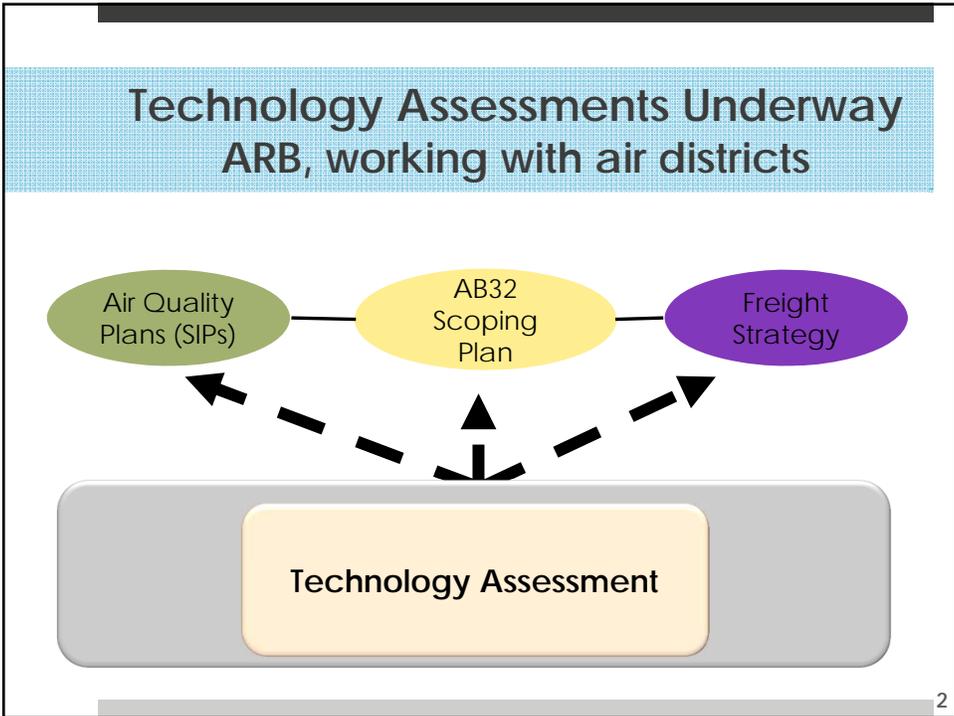


CALIFORNIA
SUSTAINABLE FREIGHT INITIATIVE



Public Forum
Technology Assessments
May 5, 2014

California Environmental Protection Agency
Air Resources Board



Build on What Others Have Done

- Technology assessments
- Freight system description/logistics
- Operational strategies
- Research and testing
- Demonstration/pilot projects
- Fuels availability and demand
- Emissions inventories

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Collaborate Moving Forward

- Reach out to:
 - Technology providers
 - Industry
 - National labs
 - NGOs
 - Local, State, federal government
- Collaborate with partners
 - SCAQMD, BAAQMD, SJVAPCD
 - CEC, CalTrans

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Technology Assessment Sectors



- Trucks
- Transport Refrigeration Units
- Rail
- Ocean Going Vessels
- Commercial Harbor Craft
- Cargo Handling Equipment
- Aviation
- Ground Support Equipment
- Fuels

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Technology Assessment Elements

- Technology description
- Readiness - current development status
- Fueling needs, strengths and limitations, key performance parameters
- Cost and new vehicle emission levels (per vehicle)
- Next steps to demonstrate and deploy technology, fill knowledge gaps
- Sector summary – technology highlights, set the stage for Freight Strategy and SIPs

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Technology Assessment Schedule

Review literature, discuss with technology providers, meet with stakeholders	Spring 2014 – On
Technology assessment workshops	August 2014
Technology assessment document	October 2014

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Trucks (On-Road Heavy-Duty)



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Understanding the Trucking Sector

- Large variability in configurations and driving cycles
- Short vs. long haul
- Captive vs. national fleets
- National purchasing patterns
- Technology development timeframes

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Truck Technology Categories

- Advanced combustion
- Engine and vehicle efficiencies
- In-use
- Hybrids
- Zero tailpipe
- TRUs

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Advanced Combustion Technologies - Diesel

- Advanced aftertreatment
 - NOx adsorbers
 - Exhaust thermal management
 - Improved SCR
- Engine optimization/enhanced certification
- Electrification of accessories

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Advanced Combustion Technologies – Natural Gas

- Advanced aftertreatment
 - 3 way catalyst with cooled EGR
 - SCR
 - Lean NOx traps
- Engine optimization
 - Dedicated EGR
 - Advanced fuel delivery
 - Improved sensors

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Truck Technology Categories

- Advanced combustion
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Advanced Powerplants, Drivetrain Optimization

- Engine technologies
 - Multiple on-board engines/microturbine engines/camless engines
- Engine downspeeding/engine downsizing
- Variable valve actuation/cylinder deactivation
- Advanced combustion cycles
- Free piston engines or alternators
- Advanced transmissions
- Advanced cycle-specific electronic controls

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Truck and Trailer Efficiency

- Aerodynamics
- Lightweighting
- Vehicle speed limiters
- Tires
 - auto-inflate
 - low-rolling resistance
- Auxiliary load reduction
- Improved AC/idle reduction/auxiliary electrification



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Truck Technology Categories

- Advanced combustion
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In-Use Emissions /Maintenance/ Reduced Deterioration

- Need for enhanced Heavy-Duty Inspection and Maintenance Program
- Goals – ensure fleets have preventive maintenance/ID and repair high emitters



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Truck Technology Categories

- Advanced combustion
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- Hybrids
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- TRUs

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Hybrid Electric Trucks

- Understanding hybrid sector
- Types of hybrids
- Hybrid electric vehicle demonstration projects
- Need for systems integration
- Key next steps for development and deployment



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Truck Technology Categories

- Advanced combustion
- Engine and vehicle efficiencies
- In-use
- Hybrids
- Zero tailpipe
- TRUs

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Battery Electric Trucks

- Battery technologies
- Battery charging technologies
- Battery electric vehicle demos to date
- Range/applicability for vocations
- Key next steps for development and deployment



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Fuel Cell Trucks

- Fuel cell technology
- Fuel cell demos to date
- Potential vocational applications
- Hydrogen production and vehicle fueling infrastructure
- Key next steps for development and deployment



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Truck Technology Categories

- Advanced combustion
- Engine and vehicle efficiencies
- In-use
- Hybrids
- Zero tailpipe
- TRUs

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Transport Refrigeration Units

- Understanding TRUs – for trucks, trailers, rail
- Technologies
 - Fuel cells
 - Electric - plug-in, battery, solar/battery
 - Alternative fuels
 - Energy efficiency improvements – insulated van, operational changes
 - Advanced combustion
 - Reduced deterioration
 - Tier 5 for less than 25 hp off-road



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Other Technology Assessment Sectors



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Rail Technology Assessment Overview

- North American rail operations
- U.S. freight locomotive fuel and fuel infrastructure
- U.S. diesel-electric freight locomotives
- California freight rail operations
- Historical locomotive technology development
- Advanced locomotive technologies
- Key performance parameters and technology assessment

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Rail Technology Assessment Advanced Locomotive Technologies

- Tier 4 diesel-electric
- Tier 4+ aftertreatment diesel-electric
- Natural gas
- Battery hybrid
 - battery augmented
 - tender car
- Catenary Electric
- Fuel cell technologies
- Advanced train/locomotive propulsion systems

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Ocean-Going Vessels

- Engine and engine support technologies
- Aftertreatment
- Lower emission diesel and alternative fuels
- Shoreside technologies
 - Shore power, emission control
- Alternative supplemental power
 - wind, fuel cells, battery
- Vessel efficiency improvements
- Maintenance/reduced deterioration

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Commercial Harbor Craft

- Lower emission diesel and alternative fuels
- Hybrids
- Battery electric
- Lower emission diesel
- Shore power
- Vessel efficiency improvements
- Aftertreatment retrofit



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Cargo Handling Equipment

- Lower emission alternative fuels
- Hybrids
 - Electric hybrid, hydraulic hybrid, diesel or alt fuel
- Electric
 - Battery electric, direct grid connection, or wayside power
- Lower emission diesel
- Efficiency improvements
 - Terminal automation, automated queuing, idle reduction

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Aviation Airplanes & Ground Support Equipment

- Understanding the Sector
 - Airport logistics
 - Types of aircraft and activity
 - Airplane operation and logistics
 - Ground Support Equipment (GSE) characteristics
 - Other airport related emission sources
 - Passenger, air cargo

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Airplanes and Airports

- Aircraft technologies
 - Structural, aerodynamic, material
- Engine technologies
 - Material, design
- Alternative fuels
 - Bio-derived, hydrogen, aviation gas replacements
- Operational changes
 - Ground strategies - APU, taxi process
 - Flight path optimization



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Ground Support Equipment

- Engine technologies
- Hybrids
- Electric
- Other advanced equipment



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Fuels Assessment



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Fuels Assessment – Overview

- Fuel demand across heavy-duty sectors
- Fuel supply of conventional and alternative fuels
- Alternative fuel distribution systems
- Alternative fuel techno-economic analysis
- Well-to-wheel emission factors
- Natural gas leakage sensitivity study

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Fuels Assessment – Well-to-Wheels Basics

- Historically tailpipe and fuel production and distribution emissions controlled separately
- Now looking at them together and considering the full lifecycle
- Well-to-tank emissions includes fuel extraction, refining, and distribution (and analogous for production of electricity and biofuels)
- Tank-to-wheel emissions include tailpipe and fugitive emissions
- Well-to-wheel is the full lifecycle

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Fuels Assessment – Well-to-Wheel Emission Factors

- New California specific analysis
- Criteria emissions from fuel production
 - Using CA facility inventory emissions
 - GREET 2013 for non-CA facility processes
 - Will specify which processes are in-state
- Greenhouse gas emissions
 - Using ARB LCFS carbon intensity values
 - Will specify which processes are in-state for AB 32 inventory

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Fuels Assessment – Supply & Distribution

- Long-term fuels outlook
 - Alternative fuel supply potential
 - Industry trends, feedstock options, etc
 - Aligned with LCFS regulation update
- Alternative fuel distribution networks
 - Utilizing existing fuel network for alternative fuels
 - Identifying key upgrades of existing or creation of alternative fuels distribution system
 - Challenges associated with the roll-out of alternative fuel distribution systems

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Cross Sector Topics

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Funding and Financing

- Sustainable Freight Strategy will begin looking at funding and financing issues
 - Leveraging federal funding
 - Public/private partnerships
 - Market mechanisms
- Incentive funding for vehicle and fuels pilot and demonstration projects

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Advanced Technology Incentive Funding

- **AB 118 funding** through 2023
 - ARB AQIP ~\$20-\$25 million for mobile source technology advancement
 - CEC Program ~\$100 million for vehicles, alternative and renewable fuels
- **Cap-and-Trade Auction Proceeds proposed FY 2014-15** allocation for low carbon transportation
 - \$120 for light-duty ZEV/plug-in hybrid rebates and pilots
 - \$30 million for hybrid and zero-emission truck and bus vouchers and pilots
 - \$50 million for advanced technology freight demonstrations

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Using the Technology Assessments

- Technology assessment document will include all sectors and address overarching issues
- Technology assessments will inform the Sustainable Freight Strategy and SIP development
- These documents together will help us address broader policy questions

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Broader Questions

- Role of natural gas?
 - Potentially lower tail-pipe emissions, but methane leakage GHG issue
- Low-carbon biofuels in-state production?
 - GHG emission reductions, but if produced in-state, adds facility & agricultural NOx emissions
- Pace of technology rollout?
 - Scenarios to highlight when technology may be needed

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Broader Questions

- Technology/fuel mixes?
 - Which technology/fuel mixes will get us to our air quality and public health goals?
- Actionable next steps?
 - What actions can ARB and our partners could take now to start us on the path?
- Funding/financing?
 - What is the most strategic use of state incentive funds, and what other funding/financing is available?

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Broader Questions

- Defining zero?
 - How do we define zero – power plant equivalent emissions?
- Biofuels availability?
 - What is the projected availability of renewable fuels and how does that impact our technology options?

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Contacts

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