CALIFORNIA
AIR RESOURCES BOARD

Lowering NOx Emissions from Aircraft and Ground Support Equipment (GSE)

Introductory Remarks by Ramin Tohidi
March 14, 2025

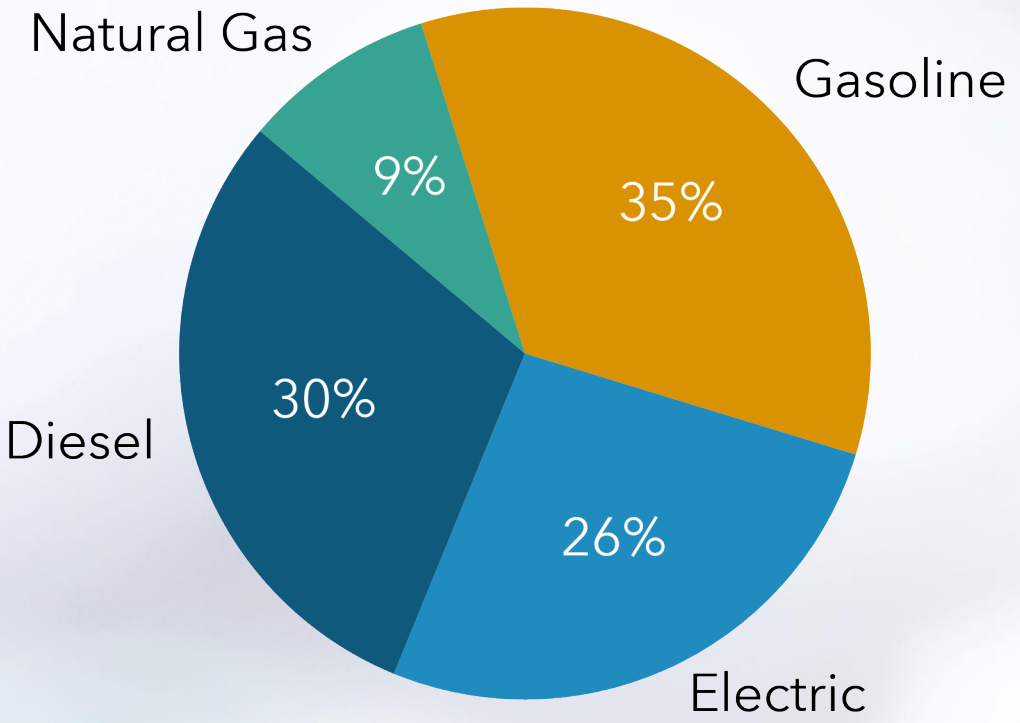
Transition GSE Fleets to 100% Zero-Emission

- Airport GSE includes all motorized equipment on airside surfaces, supporting aircraft, passenger, cargo, and ground operations.
- Many categories of Zero-Emission GSE today are commercially available and operationally feasible.

CARB

Fuel Type Breakdown of California GSE Inventory

- CARB's inventory estimates a total of **12,000** GSE statewide.
- Smaller GSE (e.g., carts and baggage tugs) are transitioning more quickly to electric power, and improving battery technology can extend this shift to heavier GSE like aircraft tugs and loaders.



GSE Emission Control Measures in California

- CARB's Large Spark Ignition (LSI) and Off-Road Diesel (ORD) rules have set fleet average emission targets that covers gasoline and diesel GSE.
- South Coast AQMD developed Memorandums of Understanding (MOUs) with five major airports in the South Coast Air Basin to reduce NOx emissions from GSE by setting performance targets for **2023 and 2031**, lowering fleet-average emissions to specific levels.
- LAX has committed to **100% zero-emission GSE by 2033** and is working with tenants to reaching that goal*.

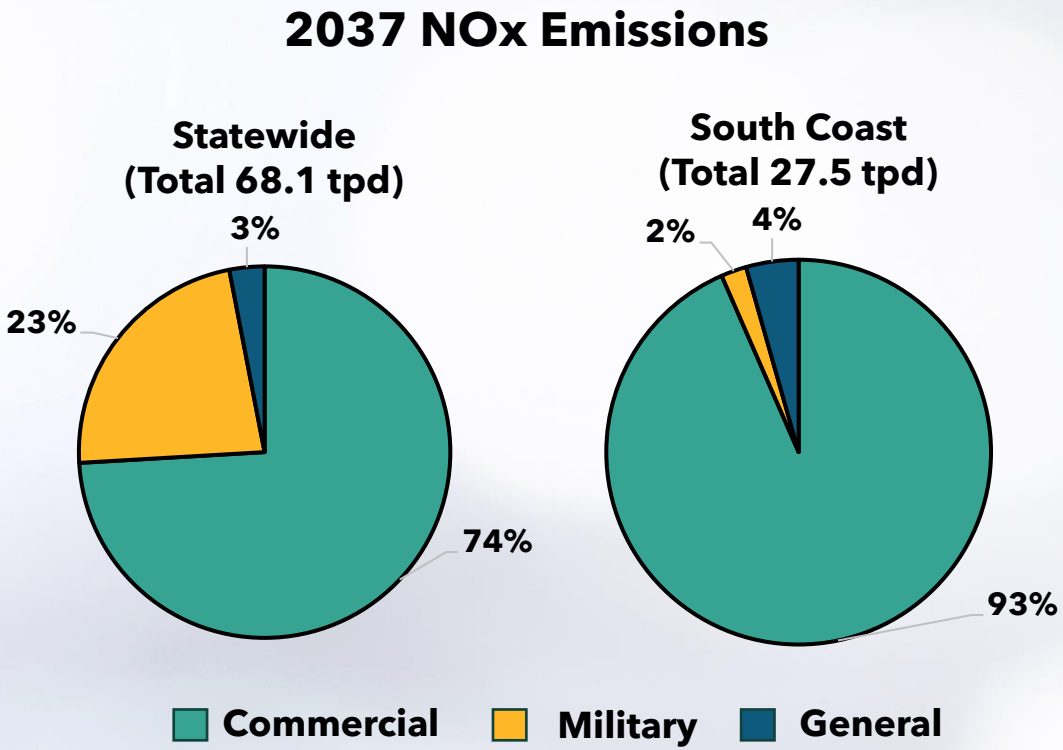
*Unless exempt or zero-emission replacements are not operationally feasible or commercially available

GSE Emission Control Measures Beyond California

- Port Authority of New York and New Jersey's 2022 **Zero-Emission Airside Vehicle Rule** mandates 100% zero-emission GSE at major airports **by 2030**; JFK's New Terminal One (2026) will debut the world's first centralized all-electric GSE fleet.
- Royal Schiphol Group, which operates Amsterdam Schiphol and other Dutch airports, has committed to making all airport ground traffic emission-free by **2030**.
- London Heathrow aims to achieve a zero-emission airside fleet by the **mid-2030s**.

California Needs Significant Reductions in Aircraft Emissions

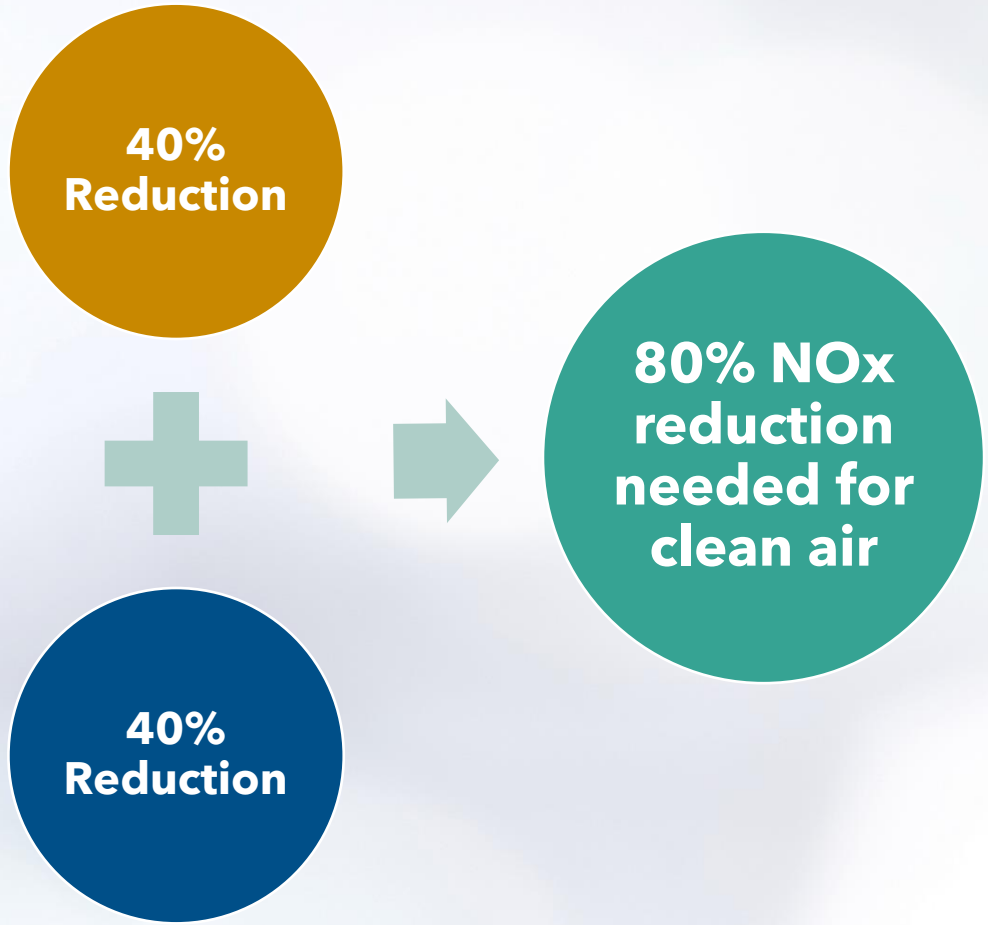
- As outlined in 2022 State SIP Strategy, California needs an 80% reduction in aviation emissions to meet the 2015 ozone standard.
- An 80% reduction is achievable in the South Coast Air Basin solely by reducing commercial aviation emissions.



Pathways to >80% NOx Reduction

Cleaner Visits: Using the cleanest available aircraft/engines for flights into critical areas and adopting operational practices that minimize NOx during landings and takeoffs.

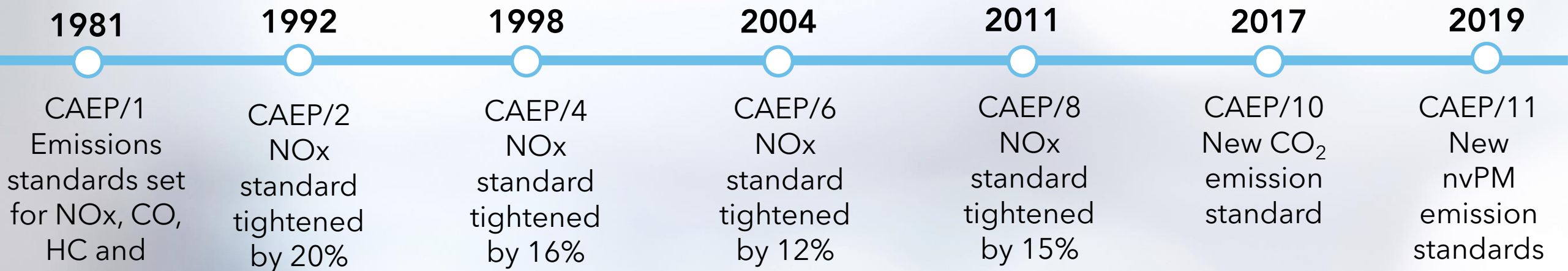
New Engine Standards: Technological innovation must bridge the gap that operational adjustments alone cannot. To achieve clean air goals, significantly deeper cuts beyond the CAEP/8 baseline are essential.



Evolution of Aircraft Engine Emission Standards

- International Civil Aviation Organization (ICAO) sets standards with a technology-following approach.
- U.S. EPA adopts ICAO standards but can set stricter domestic rules.
- CAEP/13 concluded in February 2025, with CAEP/14 running from 2025 to 2028.

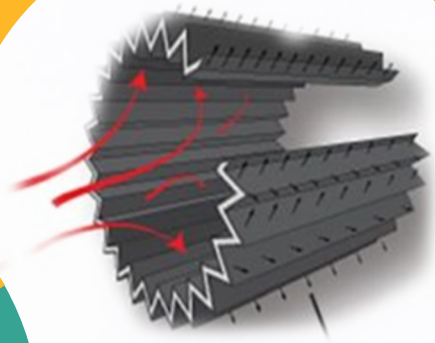
Without an ~80% cut in CAEP/8 NOx, California won't meet federal air standards.

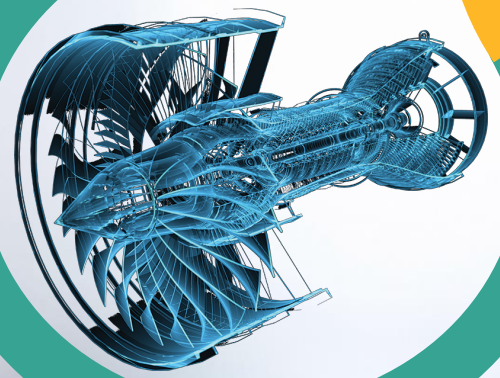


CAEP: Committee on Aviation Environmental Protection

Technological Options to Reduce Aircraft NOx

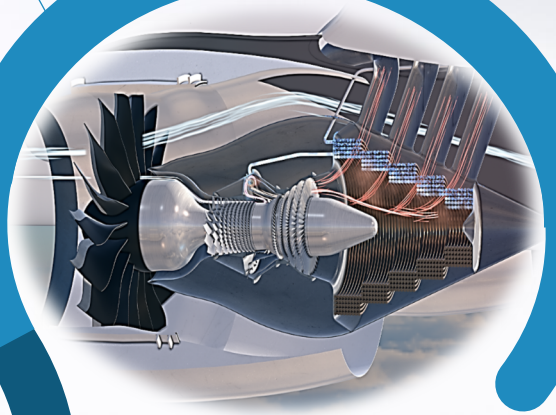
Selective Catalytic Reduction





Advanced Low-NOx Combustors

Water Injection



Fuel Additives or Alternative Fuels

CLEEN & ASCENT: Promising Tools, But Are They Enough?

CLEEN Program:

- Demonstrated advanced combustor technology—in both prototype and in service—proves that significant NOx reductions are technically achievable.
- De-risks technologies and provides data for updated standards but doesn't mandate production.

ASCENT Program:

- Developing new emissions metrics and modeling tools.
- Supports rulemaking by assessing the environmental and cost-benefit impacts of emission reductions.

Aviation Technology Forum

Session 3: Zero-Emission Ground Support Equipment

Moderated by Sang-Mi Lee, South Coast AQMD

Amylou Canonizado

Los Angeles World Airports

Sanjiv Malhotra

Sparkz

Nic Brown

Toyota Tsusho America

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Session 4: Advancements in Aircraft Propulsion

Jeff Moder
NASA

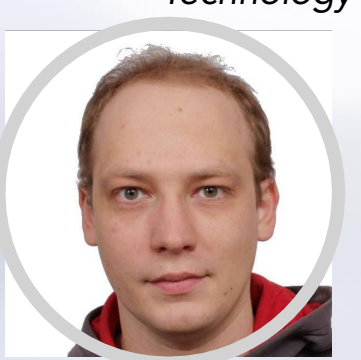
Timothy S. Snyder
Pratt & Whitney

Adam Steinberg
Georgia Institute of Technology

Prashanth Prakash
Massachusetts Institute of Technology

Arvind Gangoli Rao
Delft University of Technology

Dave Gill
DeltaHawk



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