ADAC
Aerospace and Defense Alliance of CA

CMTA

Submitted via email to aircraft@arb.ca.gov

March 2, 2026

Lauren Sanchez, Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Subject: Comments on Draft Concepts – Statewide Clean Aviation Initiative (SCAI)

Dear Chair Sanchez and CARB Staff:

On behalf of the Aerospace and Defense Alliance of California (ADAC), who are members of the California Manufacturers & Technology Association (CMTA), we appreciate the opportunity to comment on the draft concepts under the Statewide Clean Aviation Initiative (SCAI).

California is home to a globally significant aerospace and defense industrial base supporting commercial aviation, national security, and high-wage manufacturing jobs. Our members understand the goal of reducing criteria pollutants and improving public health. However, any regulatory approach must recognize the federal framework governing aviation, operational safety requirements, infrastructure constraints, and national security considerations.

Federal Authority and Uniformity

Aircraft engine standards, certification, and flight operations are governed by the FAA and EPA under federal law. Measures affecting auxiliary power units (APUs), taxiing procedures, or takeoff and landing operations raise serious federal preemption concerns. Aviation requires a uniform national regulatory structure to ensure safety, certification integrity, and interstate commerce. California should avoid actions that risk conflict with federal authority or create operational fragmentation.

Explicit Military and National Security Exemptions

Any SCAI framework must include clear exemptions for all military aircraft and military ground support equipment. Military aviation operations are essential to national defense and national security and must retain full operational flexibility.

Similarly, military ground equipment and specialized support vehicles are often mission-specific, high-power, and not readily compatible with currently available zero-emission alternatives. Imposing state-level operational or equipment mandates on military aircraft or associated ground equipment could interfere with federal authority, mission readiness, defense preparedness, and national security. Coordination with the U.S. Department of Defense is essential before advancing any proposal that may affect military operations or national security interests.

Operational and Safety Constraints

APU usage, taxiing procedures, and other aircraft operations are often dictated by safety protocols, air traffic control, aircraft design, and security requirements. For military and defense-related operations, APUs and other systems may be necessary to maintain mission readiness and secure communications. Any proposal must include clear exemptions and coordination with federal agencies, including the Department of Defense.

Ground Support Equipment (GSE) and Infrastructure Readiness

We recognize continued progress toward cleaner GSE fleets where technologically and economically feasible. However, zero-emission alternatives for certain heavy-duty and specialized equipment remain limited. In addition, airport and adjacent industrial facilities face significant electrical infrastructure constraints. CARB should prioritize flexible compliance pathways, adequate lead times, and incentive-based programs rather than prescriptive mandates.

Economic and Supply Chain Impacts

The aerospace and defense sector is a cornerstone of California's economy. Policies that increase operational costs or create uncertainty risk shifting manufacturing, testing, or operations out of state. Regulatory proposals should carefully evaluate cumulative cost impacts, grid reliability, and effects on small and medium-sized manufacturers, including federal contractors operating under fixed-price agreements.

We encourage CARB to prioritize partnership-driven approaches, infrastructure investment, sustainable aviation fuel development, and alignment with federal standards to achieve environmental progress while maintaining safety, competitiveness, and national security.

We appreciate the opportunity to provide input and look forward to continued engagement.

Sincerely,

Elizabeth Esquivel
Vice President of Government Relations
California Manufacturers and Technology Association

Mark Taylor
Chair
Aerospace Defense Alliance of California

The Boeing Company
4000 N. Lakewood Blvd.
Long Beach, CA 90808

BOEING

March 2, 2026

Submitted via email to: aircraft@arb.ca.gov

Lauren Sanchez
Chair
California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Comments on the Statewide Clean Aviation Initiative Draft Concepts

Chair Sanchez,

The Boeing Company – a leading global aerospace company, top U.S. exporter, and major California employer – develops, manufactures and services commercial airplanes, defense products, and space systems for customers in more than 150 countries. Our employees and supplier base drive innovation, economic opportunity, sustainability, and community impact across the U.S. and globe. In California, Boeing employs more than 13,200 employees and purchases from more than 2,000 suppliers, creating an annual economic impact of nearly $12 billion and supporting an estimated 162,000 jobs.

Central features of Boeing's nearly 110 years are our core values of safety, quality and integrity and our commitment to efficiency and sustainable operations. Boeing supports the Statewide Clean Aviation Initiative's (SCAI) objectives of helping California meet federal air quality standards and protecting public health. However, Boeing has certain concerns with the draft concepts presented by the California Air Resources Board (CARB) for its SCAI. Boeing therefore submits the following comments and proposed revisions to the SCAI draft concepts.

I. Comments Regarding Auxiliary Power Unit (APU) Concepts

APUs play a critical role in supplying electricity power and/or bleed air to ensure undisruptive, sufficient supply to the airplane to start engines (if needed), cool avionics, and to provide comfortable cabin temperature/humidity. These functions are operational requirements and essential to preventing overheating and system failures. This critical need drives continuous power demand from APUs and Ground Support Equipment (GSE), beyond just passenger comfort considerations. Any restrictions on APU runtime or GSE emissions must account for these non-negotiable avionics cooling requirements.

Although aircraft coding by wingspan is related to airplane seating capacity, it is not a 1-to-1 relationship. CARB should refer directly to airplane seating capacity instead of aircraft coding. For example, some aircraft types within Code D classification with full passenger capacity would have required more APU running time to cool down the cabin than other aircraft types in the same code, which are both limited to 25 minutes within the draft concepts. This concept will require adequate mobile ground power units/pre-conditioned air units (GPU/PCA) to reduce the usage of APUs.

Additionally, Zero-emission APUs are not available for existing aircraft, and are unlikely in the foreseeable future, therefore this is not a viable strategy.
In some cases where pilots are not using GPU and/or PCA, it is due to insufficient or unacceptable quality of GPU and/or PCA to support the mission. Especially during hot or unusually cold ambient temperature conditions, demands for GPU power and/or PCA could be high. For instance, the 787 has significantly more electric infrastructure than other aircraft, making it much more efficient and reducing the requirement for fuel for key systems. Thus, the aircraft will need three sources of GPU or external power (if there is not adequate PCA) to supply conditioned air to the aircraft. These additional GPU requirements may create logistical issues for airports and operators unless sufficient GPUs are provided at each parking stand. Given these concerns, CARB, as well as airports, should consult with all operating airlines at their airports and/or airplane OEMs for the GPU and PCA requirements and equip each parking stand (including contact gates and remote stands) to meet such requirements within the timeframe required by CARB. CARB should also weigh the risks associated with increased GPU requirements against the benefits of reduced APU run time, including the demand on the local electric grid.

II. Comments Regarding Ground Support Equipment (GSE) Concepts

All GSE for military use should be exempt, regardless of who owns or operates the equipment, or if the aircraft is supporting combat or not. Contractors do not have control over government furnished equipment purchasing decisions and should not be held accountable for the type of GSE. Additionally, GSE is often shared use between contractors and the US military at military bases. At many bases, there are both combat and non-combat operations occurring simultaneously, creating an accounting challenge for tracking GSE usage.

These regulations should not pertain to fixed GSE (e.g. generators) due to the complexity of equipment replacement.

III. Comments Regarding Taxiing Concepts

Boeing releases Flight Operations Technical Bulletin (FOTB) and Flight Crew Operations Manual (FCOM), providing engineering data, factors and general procedures that airlines should consider before and during implementation of single engine taxi. Airlines should establish their own single engine taxi policy and operating procedures, and flight crews should have the ultimate authority to evaluate and determine when and where in the airfield to perform single engine taxiing based on the operating conditions they are facing at the time.

Some aircraft are not suitable for single engine taxi-out due to a more electric architectural design. In these cases, the aircraft requires starting both engines to ensure proper functionality of all systems. The requirement of a single engine taxi-out should only be implemented on aircraft that are capable of this function.

Requiring single engine taxi-out for taxi time for more than 5 minutes is aligned with the OEM recommended/required engine start-up and warm-up time. For example, certain aircraft/engines require a warm-up time for at least 5 minutes. An engine start-up time could be 2-2.5 minutes per engine, in addition to a 3-minute engine warm-up time requirement. At least a 3-minute cool-down timeframe is needed for taxi-in.

Zero-emission taxiing technologies are not readily available for widescale deployment by 2027 with many still in the development phase. CARB should adjust the requirement timelines based on technological feasibility.

IV. Comments Regarding Takeoff and Landing

While we believe that establishing requirements within this section is likely beyond CARB's current authority (see VI), we offer these comments on CARB's concepts for reducing emissions from takeoffs and landings.

CARB should eliminate the concept of differentiated landing fees. NOx correlation does not prove causation. NOx emissions at other airports that have implemented differentiated landing fees were achieved through the natural fleet replacement with newer, more efficient airplanes and lower NOx engines.

The statement, "Certain aircraft are already equipped with emissions control technology that achieves lower NOx emission rates," should be changed to, "NOx emissions are determined by the aircraft engine design and have generally been reduced as the combustor technology evolved." The emission characteristics are determined by the combustor design of the engine and optimized for use over the entire flight regime. As engine technology and combustor design have evolved, the emission characteristics have changed but there is no specific "emissions control technology". That terminology would normally apply to technology to clean up the exhaust after combustion, which is not the case for aircraft engines.

V. Comments Regarding Definition of "Military Tactical Support Aircraft"

Military Tactical Support Aircraft is under consideration for exemption; however, the aircraft exemption is undefined. Due to the critical role that military aircraft plays in national security, the unique operating requirements of military aircraft, and the economic benefit that these fleets have in California, CARB should exempt all military aircraft. Furthermore, military aircraft often require simultaneous use of both APU and GSE to complete preflight checks efficiently. Delaying these checks until after engine start can increase fuel consumption by approximately tenfold.

VI. Comments Regarding CARB's Scope of Authority

CARB must evaluate federal, State, and local authority with respect to the measures proposed in the SCAI Draft Concepts and ensure that any SCAI programs will comply with law. Clean Air Act Section 233 vests the authority to promulgate emission standards for aircraft or aircraft engines only in the Federal Government. States are preempted from adopting or enforcing any standard respecting aircraft or aircraft engine emissions unless such standard is identical to the EPA's standards.[1] Moreover, the FAA Administrator is the "final authority" for issuing regulations in furtherance of the FAA's duties, which include enhancing safety.[2] The FAA has general authority to prescribe regulations related to aircraft safety and minimum standards related to the design, material, construction, and performance of aircraft and aircraft engines.[3]

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[1] 42 U.S.C. § 7573.

[2] *See* 49 U.S.C. § 106(f); 49 U.S.C. § 40101(d).

[3] *See* 49 U.S.C. § 44701(a).

CARB has previously acknowledged that the Board on its own does not have authority to implement some or all the measures proposed in the SCAI Draft Concepts.[4] In the 2022 State SIP Strategy, CARB conceded that each of its proposed aviation measures (i.e., more stringent aviation engine standards, cleaner fuel and visit requirements for aviation, zero-emission on-ground operation requirements at airports, and airport aviation emissions caps) required federal action.[5] Accordingly, the Board's proposed SIP commitment for each of the proposed aviation measures was to "commit to petition and/or advocate to U.S. EPA that it promulgate these requirements to achieve the needed NOx emissions reductions…."[6]

Boeing appreciates the opportunity to provide these comments. If you have any questions or would like to discuss the comments further, please reach out to me via email at mark.taylor@boeing.com or phone at (562) 453-6731.

With sincere appreciation,

Mark W. Taylor

Senior Director – State Advocacy & Global Engagement

[4] *See* 2022 State SIP Strategy, at pp. 34, 115-16, 127.
[5] *Id.* at 8.
[6] *Id.* at 128-132.

March 2, 2026

California Air Resources Board
1001 I Street
Sacramento, CA 95814

Re: Statewide Clean Aviation Initiative (SCAI) – Draft Concepts

Dear Members of the California Air Resources Board:

On behalf of California's commercial service airports, the California Airports Council appreciates the opportunity to comment on the California Air Resources Board's (CARB) draft concepts under the Statewide Clean Aviation Initiative (SCAI).

California's airports are deeply committed to improving air quality, accelerating deployment of zero-emission technologies, and advancing Sustainable Aviation Fuel (SAF). Airports across the state are already implementing aggressive electrification programs, participating in MOUs with air districts, investing in gate electrification, and pursuing federal and state grants to reduce emissions. Many projects have been completed or well underway prior to CARB beginning the outreach and research leading to the announcement of the proposed SCAI.

However, we are concerned that the SCAI draft concepts were developed without sufficient consultation with airports, airlines, the Federal Aviation Administration (FAA), or Air Traffic Control. There are vitally important elements of feasibility, airfield operational safety, federal jurisdiction, and airport federal grant compliance that do not appear to have been given just consideration. Aviation is one of the most comprehensively federally regulated sectors in the country. Any state action that directly or indirectly regulates aircraft operations must be evaluated carefully for federal preemption and airport grant assurance compliance.

We respectfully submit the following comments that outline our overarching concerns.

I. Federal Preemption and FAA Jurisdiction

The draft concepts directly implicate areas of exclusive federal authority.
The FAA has consistently stated that "[c]ontrolling aircraft operation is an area preempted under federal law and is the exclusive responsibility of the FAA." (FAA Order 5190.6B,

Airport Compliance Manual). The federal government has long preempted airspace management, air traffic control, and aviation safety.

Several SCAI concepts risk intruding into those areas:

- State-Mandated Auxiliary Power Unit (APU) runtime limits.
- Required single-engine aircraft taxiing percentages.
- Required implementation of zero-emission taxiing technologies.
- Imposition of landing fee differentiation based on aircraft emissions.

Safety is the primary objective of airfield operations. The safety of aircraft passengers and personnel, aircraft and other mobile equipment and the physical infrastructure are the overarching objectives of commercial aviation. The proposed SCAI concepts regulate how aircraft operate on the movement area and apron, which are core areas of federal control. Airports cannot require pilots to taxi with one engine, limit APU use in a way that conflicts with aircraft manuals or deploy new ground movement technologies without FAA approval. Safety decisions ultimately rest with pilots and air traffic control, not airport operators nor air emission regulators.

Before advancing these concepts, CARB should conduct a formal federal preemption analysis in consultation with the FAA and U.S. Department of Transportation.

II. Grant Assurances and Economic Nondiscrimination

Airports that receive federal Airport Improvement Program (AIP) funds are subject to binding grant assurances, including:

- Grant Assurance 22 – Economic Nondiscrimination
- Requirements that airport fees be reasonable and not unjustly discriminatory
- Prohibition on revenue diversion

Compliance with FAA Policy Regarding Airport Rates and Charges (78 Fed. Reg. 55330). The draft SCAI concept to differentiate landing fees based on aircraft NOx emissions could create direct conflicts with Grant Assurance 22 regarding Economic Nondiscrimination. Instances that violate Economic Nondiscrimination can challenged through formal complaints to the FAA via the Part 16 process and would automatically call into question an airport's compliance with Grant Assurance 22.

There is no precedent in the United States for landing fees structured to favor or penalize aircraft based on emissions certification levels. Any fee structure that discourages use of certain aircraft types risks being deemed unjustly discriminatory and subject to a Part 16 complaint. Further, a “revenue neutral” structure does not cure potential discrimination if similarly situated users are treated differently.

Federal funding received by California airports varies, based on current capital projects, but total FAA grants can range from $260 million to upwards of $400 million annually. Airport operators will not impose landing fee structures or policies that knowingly create violations of their federal Grant Assurances and thus place federal funding at risk.

III. Aircraft Operations and Safety

CARB has acknowledged that the draft concepts were developed without safety as the primary design consideration. That is deeply concerning.

Aviation operations require constant coordination among:

- FAA Air Traffic Control
- Airlines
- Pilots
- Airport operations
- Ground handlers
- Safety and emergency responders

Examples of airfield operational practices not reflected in the draft include:

- Engine warm-up requirements vary by aircraft type.
- APU use is sometimes required for safety or aircraft diagnostics.
- Quick turns and irregular operations limit feasibility.
- Hot weather and undersized PCA systems require APU backup.
- Single-engine taxi may conflict with ATC sequencing or runway configuration.
- External taxi technologies require FAA certification, safety validation, and operational redesign.

Airports cannot and do not control pilot decisions regarding engine configuration or taxi operations. Any regulatory approach must be FAA-reviewed and safety-certified before consideration.

On hot temperature days in California, a pilot may choose to operate the aircraft APU in addition to the available PCA system to maintain a comfortable temperature for deplaning and enplaning passengers.

Implementation of operational mandates under SCAI would also require coordination with FAA Air Traffic Control Tower (ATCT) facilities to evaluate impacts to aircraft movement area procedures. Changes to taxiing or ground movement protocols may increase operational complexity, affect dispatch reliability, reduce gate utilization efficiency, and potentially exacerbate congestion during peak periods. These impacts must be evaluated through a safety-first lens in partnership with the FAA before any timeline is established.

IV. Infrastructure Feasibility and Grid Constraints

The draft concepts assume that airports can install extensive zero-emission infrastructure on aggressive timelines.

That assumption does not reflect:

- Utility interconnection timelines.
- Substation upgrades.
- Transformer procurement delays.
- Grid reliability concerns.
- Public Safety Power Shutoff (PSPS) events.
- Extreme heat load limitations.
- Capital funding constraints.

Several airports have already invested in electrified GSE only to find that slow charging and insufficient power capacity make equipment operationally impractical during peak periods.

Airports cannot guarantee 100% electrification without:

- Major utility upgrades.
- Significant capital investment.
- Long-term construction timelines.
- Reliable grid capacity.

These upgrades often require multi-year environmental review and utility coordination that can often be beyond airport control. For these reasons, it is impractical to require full fleet electrification.

In addition, airports must evaluate whether recently constructed or replacement passenger terminals have sufficient electrical capacity to support a 100% zero-emission GSE fleet at the gate level, or whether further infrastructure enhancements would be necessary. Future system expansion may require additional capital investment beyond current construction budgets.

Compliance feasibility also depends on airlines' and ground handlers' ability to convert their fleets within the proposed timeframe. Market availability of certain heavy-duty GSE categories remains limited, and smaller carriers and ground handlers may face disproportionate financial impacts due to limited access to capital.

Zero-emission GSE charging demand will compete with broader statewide electrification mandates, including electric vehicle adoption and building decarbonization initiatives. Utility capacity constraints beyond airport control may significantly affect implementation timelines.

Compliance deadlines must align with commercial availability and real-world operational feasibility.

V. One Size Does Not Fit All
California is geographically vast and environmentally diverse.

Airports operate under different:

- Local air district requirements.
- Water use restrictions.
- Wetlands protections.
- Community noise agreements.
- Legal Settlement agreements.
- Space constraints.
- Airfield geometries.
- Some airports are landlocked.
- Some lack room for parallel taxi corridors.
- Some cannot accommodate taxibots or additional service roads.
- Some operate in constrained environmental footprints.
- Long-term contractual relationships with tenants that govern compliance responsibilities.

For example, “fly quiet” programs designed to reduce community noise may require longer taxi routes—directly conflicting with CARB’s taxi-time reduction goals.
Environmental tradeoffs are real and must be balanced. Some of these programs are operated through legal settlements and agreements. Longer the aircraft taxi times can reduce noise impacts to communities, while increasing emissions on the ground.

Similarly, airports have long-term contracts with tenants that allocate responsibility for facilities, utilities, and capital improvements, and in some cases already require tenants, not the airport, to provide or fund charging infrastructure for their operations. A CARB-administered SCAI should not impose obligations on airports that conflict with, duplicate, or override existing contractual duties assigned to lessees.

VI. Reporting Burden and Administrative Feasibility
The quarterly reporting requirements described in the draft are operationally unworkable for airport personnel.

For example:
- Reporting APU runtime for every turnaround operation.
- Sub-metering individual gates.
- Reporting taxi operations by aircraft tail number.
- Seven-day exception reporting for infrastructure failures.
- Detailed GSE tracking by serial number and engine family.

Large airports operate hundreds of departures per day. There is currently no standardized, automated system to capture this data. The Los Angeles International Airport, for example, has 800 departures per day. The San Francisco International Airport has approximately 480 daily departures. The data loads from these two airports alone will be massive and it is unclear how this will be of use to CARB.

Smaller commercial airports have limited staff. In some municipalities, the Airport Director may have other duties, such as overseeing public works and other municipal services. Some smaller airports very small staffs, as little or 3-6 individuals. Staff time and processes to capture the data proposed would impose requirements on staff time that simply cannot be supported.

Implementation of Concept (1) would require the development of automated monitoring systems, expanded data capture platforms, and additional compliance staffing or consultant support. These administrative burdens should be considered in any cost analysis and would likely require future FTE allocations at both large and small airports.

Airports may also need to modify their Airport Rules and Regulations to establish enforcement mechanisms for airline non-compliance. This raises additional governance, legal, and staffing considerations.

Airports face compliance exposure under the proposal even where operational control rests with airlines and pilots. If airlines fail to report accurately or comply operationally, airports should not bear sole liability.

Increased electrical system use will also increase maintenance costs, and some airports may require backup power systems to avoid inadvertent compliance failures during outages.

These new mandates would compete directly with higher-priority capital projects, including safety and capacity improvements.

It is important to clarify the following:

- Airports do not own airline APUs.
- Airports do not own most GSE.
- Airports do not control taxi decisions.

The California Airports Council does not believe airports should be compelled to create systems to capture data around airfield operations that CARB does not have the authority to regulate. The question of CARB jurisdiction should be sorted prior consideration of any reporting requirements of data to the Board.

VII. General Aviation and Cargo Considerations

The draft scope appears to apply broadly to commercial large, small, and non-commercial jet aircraft

Further clarification is needed regarding:

- Dedicated cargo aircraft.
- General aviation jet operations.
- Fixed Based Operator (FBO) operations.
- Mixed-use airports with both GA and commercial service.

As currently framed, the SCAI creates a risk of inconsistent treatment of identical activity based solely on an airport's classification. Airports that host substantial passenger service, significant cargo throughput, and a meaningful general aviation presence could face unequal compliance burdens compared to airports with a narrower operational profile.

If an airport is required to impose operational or infrastructure conditions on certain classes of operators but not others, carriers may shift activity to airports with a different regulatory classification. In that scenario, aircraft operations, and their associated emissions, may simply relocate rather than decline. Such regulatory-driven traffic shifts could distort regional logistics patterns, affect employment and supply chains, and potentially increase overall emissions depending on where activity is displaced.

The issue is compounded at multi-use airports. Passenger carriers, cargo operators, and general aviation users operate under different federal certificates and business models, yet they share common runways and airfield infrastructure. State requirements that force differentiation among these users to achieve emissions outcomes risk creating tension with federal aviation law, including non-discrimination obligations imposed on airports. Airports do not control aircraft operations and cannot economically discriminate among similarly situated users under FAA grant assurances. A regulatory framework that effectively requires airports to do so could expose them to litigation and federal compliance risk.

Accordingly, any final rule should avoid assigning airports responsibility for federally governed aircraft operational decisions and should be carefully structured to prevent disparate impacts on integrated, multi-use airports.

GA operations differ significantly from scheduled commercial passenger air service. Compliance tiers should reflect operational realities.

VIII. Sustainable Aviation Fuel (SAF)

If CARB's goal is meaningful NOx reduction from takeoff and landing cycles, the most effective long-term pathway is accelerating cleaner engine and fuel adoption at the source. Investment in SAF production, engine technology, and federal coordination will yield greater emissions reductions than regulating gate-level and airfield operations.

Airports support continued collaboration on SAF deployment and incentives.

IX. Recommended Path Forward

We respectfully recommend:

1. A formal federal preemption analysis in consultation with FAA.
2. Joint working groups with airports, airlines, FAA, and utilities.
3. A safety-first framework with FAA concurrence before operational mandates.
4. Infrastructure feasibility studies reflecting utility constraints.
5. Flexible, airport-specific compliance pathways.
6. Reporting limited to practicable, automated data.
7. Protection of federal grant eligibility (AIP, VALE, ZEV programs).
8. Recognition that many emission-reduction initiatives must remain voluntary to preserve federal funding eligibility.

California's airports are partners in environmental progress. But progress must be legally sound, operationally feasible, and safety driven.

We look forward to continued engagement and a collaborative approach that advances emissions reductions without jeopardizing safety, federal compliance, or airport financial stability.

Respectfully submitted,
California Airports Council

CARB Comments

1) Controlling Emissions from Aircraft Auxiliary Power Units

These comments are specific to:

Non-commercial Jet Engine Aircraft: non-commercial jet engine aircraft of any size for private, corporate, or personal flying.

Controlling APU emissions is absolutely an attainable goal. This is done extensively in Europe for both noise and CO2 reduction. That said, there are significant carve outs for General Aviation or Corporate business jet aircraft depending on location and equipment available. Corporate jets do not utilize airline terminals and jetbridges, which is where the great majority of the infrastructure for GPU and PCA exist. Most fixed base operators (FBOs) only have a limited amount of external power carts. Most have few, if any, PCAs. Restrictions in Europe on use of APU prior to start-up can vary from no restriction up to 5 minutes prior to engine start. A happy medium is 30 to 45 minutes prior to engine start.

Why is 30-45 minutes more appropriate for Non-commercial aircraft? The majority of non-commercial aircraft in the medium to large category, i.e. Gulfstream G280 to Gulfstream 650 or Global Express have an APU (Code B and C aircraft). These aircraft were designed with the procedure to start the APU at least 30 minutes prior to engine start in order to complete all pre-flight safety checks and to initialize the cabin and avionics. Using a ground power source to complete those checks and then switch to the APU for engine start is a non-normal procedure that can have adverse consequences for the avionics and is a less safe method of flight preparation.

The great majority of European airports follow the 30-45 minute or longer guidance for aircraft parked in spots without fixed GPU and PCA equipment.

Another consideration is outside air temperature. This comment pertains to airliners as well. EKCH (Copenhagen) has a carve out on their APU restrictions when the outside air temperature is less than -10C (14F) or more than +25C (77F). It would be wise to include a temperature carve out as well because even the fixed PCA have a very difficult time keeping the aircraft cabin temperature at a comfortable level when the outside air temperature is outside of the above range.

For arrival the APU restriction can be shorter. A 15-30 minute window for non-commercial aircraft allows adequate time to properly de-plane passengers; service the aircraft; and run through shutdown checklists.

The document talks about reporting requirements for APU runtime and exceptions. This reporting requirement would be burdensome on all parties, from operators; to airports; to CARB themselves. The practice in Europe is that airport operations monitors APU usage of aircraft; allows exceptions when needed; and levies fines if warranted. Instead of reporting to some gigantic new bureaucratic entity (whose existence would increase emissions by itself), it would be better to allow individual airport operators to monitor without any reporting requirements.

Questions to Stakeholders

(1) Are the designated APU runtimes achievable? = No, as explained.
(2) Are there any other exceptions that should be considered? = Yes, as explained regarding stands at General Aviation FBOs without fixed GPU and PCA facilities and for outside air temperature ranges. Incentives and exceptions for aircraft that uplift Sustainable Aviation Fuel (SAF).

Reducing Emissions from Aircraft Taxiing at the Airport

The new technology to allow zero emission movement of aircraft from parking to runway is exciting, but not widely available and highly unlikely to be available by 2030. It was mentioned that this technology is in use at both New Delhi and Bengaluru. This commentor operates frequently to both of those airports and has never seen this technology in use.

Single engine taxi is definitely a good way to reduce fuel burn and emissions, in some cases. Airlines and operators of corporate aircraft will use this procedure when it is safe and when it is warranted. That said, mandating the use of single-engine taxi would be a significant reduction in safety for airlines and operators. The time limits stated in the draft proposal are unrealistic for many reasons. The first and foremost is engine warm-up and cool-down times. Most jet engine manufacturers recommend or require a minimum time from engine start until takeoff power is applied and also from achieving idle thrust on landing until engine shutdown is allowed. This time is typically between 3 and 5 minutes for takeoff or shutdown. Setting a limit of 5 minutes is unrealistic and unsafe to all operators. The guidelines also fail to consider outside ambient and taxiway surface conditions along with aircraft weight.

This commentor has operated both corporate jet aircraft and airliners up to the size of the B777. The use of single-engine taxi on a heavy B777 departing on an international flight is unsafe. The amount of break-away thrust required to move a 750,000 lb airplane on one engine produces hurricane force winds behind the engine for up to 300 feet. The damage and injury that can occur by blowing over baggage carts or other ground equipment, not to mention personnel, is very serious. Too, the amount of excess thrust to taxi on one engine versus taxiing with two engines negates the fuel savings that is assumed. It is not equal. Taxiing with two engines typically only requires minimal movement above idle thrust, whereas taxiing with one engine requires significant additional thrust on the one operating engine to begin taxi and to keep momentum.

On corporate jets the aircraft procedures were designed to start both engines at the ramp and to carry out pre-takeoff safety checks. There are very limited times that it would be considered safe to depart the ramp on one engine, and that would be when it is known that there is an extensive delay for takeoff. Knowing that there is an extensive wait for takeoff a crew would have ample time to start the second engine and complete their required checks, along with the aforementioned engine warm-up time. Given the average taxi-out time of 12.4 minutes there is very little actual savings in emissions from mandating single-engine taxi, but there is a significant reduction in safety in doing so.

A better approach to this area would be from the FAA and airport operations. If the taxi times are expected to be lengthy, it would be far more efficient to have the aircraft wait at their parking position and be given a start-up time and expected takeoff times. This would minimize engine run times and save fuel/emissions. This procedure is done at many international airports.

"Single engine practice would start when the aircraft has vacated the landing runway (i.e., main gear fully clear of the runway hold line) and maintained until the aircraft comes to a full stop and is chocked with the parking brake set at the assigned gate or parking stand." Again, this quote shows lack of knowledge on engine cool down requirements. It is typically a minimum of 3 minutes from idle thrust achieved after landing until engine shutdown is allowed.

Also, this concept area is trying to introduce an extremely burdensome reporting requirement that would create another bureaucratic entity with its own massive emissions profile.

(4) What are possible barriers that could hinder the single-engine taxi requirements specified above in section 3.I? = As discussed: Aircraft type; aircraft weight at departure; taxi surface conditions; aircraft design and procedures; engine manufacturer warm-up and cool-down time requirements.

(9) Are there procedures or technologies not discussed in these concepts that could be used to reduce taxiing emissions? = yes, FAA Air Traffic Control and airport operations coordination to meter aircraft start-up and taxi out so as to reduce time from engine start to takeoff.

(4) Reducing Emissions from Aircraft Takeoffs and Landings

Draft Concept

Under this draft concept, California airports would need to set or modify landing fees based on each aircraft's NOx emissions per landing and take-off (LTO) cycle for any newly acquired aircraft beginning January 1, 2030. Newly acquired aircraft refers to any aircraft that an operator begins to own or lease and that is approved for commercial operations in the United States on or after this date. Existing aircraft, or those acquired up through the end of 2029, would not be subject to modified emissions-based landing fees.

(4) What fraction of takeoff and landing operations are currently deploying operational strategies that reduce emissions, such as continuous descent/climb operations, de-rated take-offs, and/or optimized flight path angles? = The answer here is simply not enough. The primary obstacle is airspace design and air traffic control. There are some good procedures in California to some of the airports, but there are others where aircraft climb and/or descent are not efficient. This falls under the FAA for airspace and procedure design and is outside the control of aircraft operators.

Reduced thrust takeoff and reduced thrust climbs don't actually save fuel or reduce emissions. They merely reduce engine wear by reducing internal engine temperatures. There are good academic articles from Rolls Royce that detail the data. They do reduce noise impacts near the airport, which is an additional benefit to the reduced engine wear.

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5090
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March 2, 2026

Clerks' Office
California Air Resources Board
1001 I Street
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Dear Sir or Madam:

SUBJECT: MILITARY COMMENTS ON CARB'S SCAI DRAFT CONCEPTS

On behalf of the Military Services in California, thank you for the opportunity to comment on the Draft Concepts for the Statewide Clean Aviation Initiative (SCAI).

The Military Services recognize the California Air Resources Board's (CARB) leadership in working to reduce emissions from aviation and striving for a more secure and sustainable energy future. We share a commitment to these important goals. For its part, the Department of War (DOW) is actively working to improve our energy security, resilience, and efficiency, which inherently contributes to reducing our environmental footprint. Our mission readiness and effectiveness are inextricably linked to these efforts.

We are, however, concerned that the SCAI, as currently conceptualized, could have a significant impact on our ability to conduct our critical national security missions in California. We look forward to working with you and your staff to better understand the potential operational, infrastructure, and fiscal impacts that the SCAI may have on our installations and activities.

To that end, we have a question regarding the data presented in your public workshop. Could you please clarify the origin or database for the landing and takeoff data for the military airfields listed on Slide 16, "Additional Airports under Consideration"? Specifically, we are interested to know if this data is broken down by aircraft owner. The military services operate a number of civilian-equivalent aircraft in support of military testing and training, and it is important to distinguish their usage for military purposes.

Furthermore, we wish to highlight the unique nature of our ground-based aircraft support equipment, which is essential for mission readiness. Much of this equipment, specifically our Ground Support Equipment (GSE), is used for military training in the exact manner it would be utilized when deployed for combat. This equipment falls under the definition of a Tactical Support Equipment/Vehicle, as defined in CCR Title 13, § 1905: "...a motor vehicle owned by the U.S. Department of Defense and/or the U.S. military services and used in combat, combat support, combat service support, tactical or relief operations, or training for such operations." Other equipment, such as on-board Auxiliary Power Units (APUs), have similarly critical operational and training requirements that are unique to military aviation and essential for preparing aircrews for deployment.

Given this specific operational requirement for combat readiness, we respectfully request that any regulation developed under the SCAI include the same tactical support equipment/vehicle exemption that has been consistently included in other CARB mobile source regulations. This approach would ensure regulatory consistency and allow the Military Services to continue to meet our national security obligations without interruption.

We are confident that we can work with you to find a solution that protects our national security while advancing our shared goals. We would welcome the opportunity to meet with you and your staff to discuss our concerns in more detail.

Thank you for your time and consideration of this important matter. Should you have any questions regarding this letter please contact Jessica Palmer at (619) 705-5401 or jessica.n.palmer8.civ@us.navy.mil.

Sincerely,

J.C. GOLUMBFSKIE-JONES. P.E.
By Direction

March 2, 2026

Submitted via email: aircraft@arb.ca.gov

California Air Resources Board (CARB)

Subject: Comment Letter: Statewide Clean Aviation Initiative

Dear CARB staff:

Thank you for the opportunity to comment on the Draft Concepts Statewide Clean Aviation Initiative (SCAI) released January 2026. The Port of Oakland (Port) owns and operates Oakland San Francisco Bay Airport (OAK). The Port brings the unique perspective of also managing sustainability and zero emissions (ZE) projects and programs across a diverse landscape which includes not only OAK, but also the Oakland Seaport, and Commercial Real Estate areas within the Port's jurisdiction. The Port supports the comments submitted by the California Airports Council (CAC). This letter highlights the Port's highest-priority concerns regarding implementation of new requirements.

Existing Contracts & Settlements

Issue: Airports operate through long-term leases and operating agreements with airlines, tenants, and cargo operators such as FedEx and UPS. These contracts often allocate responsibility for facilities, utilities, and capital improvements to the tenants, not the airport. A CARB-administered SCAI should not impose obligations on airports that conflict with, duplicate, or override existing contractual duties assigned to lessees.

Recommendation: CARB should expressly account for these contractual frameworks and structure any new requirements so that compliance obligations are placed on the contracted party responsible for provision of infrastructure. This approach would align regulatory responsibility with operational control and avoid unintended contractual conflicts. Allow airports to continue to work collaboratively with tenants to assess and meet infrastructure needs without imposing strict mandates. Additionally, airports must not be held responsible for incomplete or inaccurate tenant reporting.

Issue: Requiring a 5-minute taxiing threshold could directly conflict with existing Settlement Agreements that implement noise-abatement programs. As part of several Settlement Agreements between the Port and multiple organizations and cities regarding the operations of OAK, the Port established the Oakland Airport-Community Noise Management Forum in 1998 to provide a committee comprised of elected officials and citizen representatives to address aircraft noise issues related to OAK. With a 20+ year history, this forum is now an important standing venue for communication between the Port and neighboring communities. Measures in the noise abatement program include voluntary "fly quiet" procedures that encourage pilots to depart from

OAK's main runway to avoid noise-sensitive areas such as residential areas. Implementing the "fly quiet" procedures could result in longer taxi-in and taxi-out times.

Implementation of a 5-minute taxiing threshold as proposed by SCAI requires pilots to choose between existing "fly quiet" procedures and shorter taxi times. Pilots may opt to depart from/arrive on a runway closer to their location to avoid non-compliance with SCAI rather than minimize noise as encouraged under existing agreements. This will be a detriment to the community, cities, and organizations and will compromise years of collaboration in addressing their concerns and minimizing noise impacts in their community.

Recommendation: Exemptions should be provided for airports with settlement agreements or tenancy agreements that conflict with the limitation on taxi times.

Airfield Space

Issue: Additional operational areas are needed on the airfield to operate and stage the new ZE taxiing technologies that are proposed to taxi the aircraft.

At OAK, there are approximately 493 acres of jurisdictional wetlands and other waters of the U.S./state. If ZE taxiing technologies are required, a large fleet size will be necessary to accommodate the taxiing operations of each air carrier; this would require a large operational area for equipment staging. It is likely that the Port will be required to fill in a portion of the wetlands and other waters of the U.S. or State to comply with the SCAI requirements due to the proximity to taxiways and runways. The Port will be required to comply with Sections 401 and 404 under the Clean Water Act which includes obtaining a water quality certification and permit from the San Francisco Bay Regional Water Quality Control Board and the U.S. Army Corps of Engineers, respectively. The Port will also be required to mitigate for the loss of jurisdictional wetlands and other waters of the U.S. or State which is costly and will require additional time to assess and receive regulatory agency approvals.

Recommendation: Additional conversation is necessary for CARB to understand land constraints and to avoid indirect impacts to the environment.

Airport classifications for multi-use airports

Issue: As currently framed, the SCAI creates a risk of inconsistent treatment of identical activity based solely on an airport's classification. Airports that host substantial passenger service, significant cargo throughput, and a meaningful general aviation presence could face unequal compliance burdens compared to airports with a narrower operational profile.

If an airport is required to impose operational or infrastructure conditions on certain classes of operators but not others, carriers may shift activity to airports with a different regulatory classification. In that scenario, aircraft operations, and their associated emissions, may simply relocate rather than decline. Such regulatory-driven traffic shifts could distort regional logistics patterns, affect employment and supply chains, and potentially increase overall emissions depending on where activity is displaced.

The issue is compounded at multi-use airports. Passenger carriers, cargo operators, and general aviation users operate under different federal certificates and business models, yet they share common runways and airfield infrastructure. State requirements that force differentiation among these users to achieve emissions outcomes risk creating tension with federal aviation law, including non-discrimination obligations imposed on airports. Airports do not control aircraft operations and cannot economically discriminate among similarly situated users under FAA grant assurances. A regulatory framework that effectively requires airports to do so could expose them to litigation and federal compliance risk.

Accordingly, any final rule should avoid assigning airports responsibility for federally governed aircraft operational decisions and should be carefully structured to prevent disparate impacts on integrated, multi-use airports.

Recommendation: CARB should structure the SCAI around activity-based or equipment-based standards that apply uniformly across similarly situated operations, rather than imposing differentiated obligations based solely on airport classification (e.g., passenger vs. cargo vs. general aviation). To accomplish this, requirements should be placed directly on the operator or equipment owner, not the airport.

Alternatively, CARB could include an explicit provision providing a safe harbor for multi-use airports that explicitly prohibits disparate treatment of similarly situated aircraft operations and only permits activities permitted under federal law.

Closing

The Port looks forward to working with CARB towards a common goal of feasible and equitable zero emissions airport operations through the rulemaking process. The Port encourages CARB to take the CAC comment document and the issues above into consideration prior to entering the rulemaking process. If you have any questions or if you would like to discuss further, please reach out to Angela Clapp at aclapp@portoakland.com.

Sincerely,

Colleen Liang
Director of Environmental Programs & Planning
Port of Oakland

icct

THE INTERNATIONAL COUNCIL ON CLEAN TRANSPORTATION

To: Mobile Source Emissions Program, Aircraft and Airports, California Air Resources Board, Sacramento, CA

Date: March 2nd, 2026

RE: Comments on Draft Concepts Statewide Clean Aviation Initiative (SCAI), January 2026

In January 2026, the California Air Resources Board (CARB) held a public workshop on its Draft Concepts developed under the Statewide Clean Aviation Initiative (SCAI). During this workshop, CARB presented detailed proposals for strategies introduced at the first public workshop in December 2024. The International Council on Clean Transportation (ICCT) commends the agency for its efforts to reduce aviation emissions to meet air quality and health targets.

The Draft Concepts are focused on four strategies – controlling auxiliary power unit (APU) emissions, reducing emissions from airport ground support equipment (GSE), reducing emissions from aircraft taxi operations, and reducing aircraft LTO emissions. We thank CARB for the opportunity to provide our comments and have provided several technical suggestions below on taxi-phase emissions, aircraft landing fees, and particulate matter emissions.

1. **Collect airport data before mandating single-engine taxiing (SET).** There is strong evidence that SET can reduce taxi fuel consumption. However, our modeling shows that SET impacts on NOx and particulate matter emissions are uncertain and vary by airport, aircraft type, and throttle setting. We recommend that prior to the imposition of a SET mandate that CARB collect data on throttle settings during conventional taxi and SET, airport taxi times, and aircraft-engine combinations at California airports. A data-driven, targeted approach will produce better outcomes than a universal SET requirement across all airports.
2. **Prioritize zero-emission electric taxi tug implementation over SET.** Electric taxi tugs deliver consistent, significant reductions in carbon dioxide (CO)$_2$, nitrogen oxides (NOx), and particulate matter across all aircraft types and airports. Unlike SET, their emissions benefits are not variable across pollutants. We recommend that the planned feasibility study includes a thorough cost- benefit analysis of infrastructure and operations of zero-emission tugs to assess electricity needs and changes at the airport level. These results

could be used to develop variable Capable Targets and Compliance Timelines for individual airports.

3. **Expand scope of NOx landing fees to include all aircraft, not just new deliveries and leases.** The current proposal only applies landing fees to aircraft delivered or leased after 2030, however, older deliveries will constitute most of the fleet for years. By exempting them, we risk increasing NOx emissions as older, higher-emitting aircraft could be used on California routes to avoid fees. Fees should apply to all aircraft operating at California airports to achieve meaningful near- and medium-term emissions reductions.
4. **Redesign the landing fee to fund zero-emission taxiing infrastructure.** We propose a revenue-neutral NOx landing fee framework where collected fees fund the procurement and deployment of electric taxi tugs. Airlines would recover their landing fee expenses through savings in taxi jet fuel from electric tug use. Our analysis estimates this would generate $85–$151 million annually and reduce statewide LTO NOx emissions by an additional 5.5% and fuel consumption by 17.6%.
5. **Consider a new draft concept targeting jet fuel composition to reduce particulate matter and sulfur emissions.** The current proposals focus on NOx reductions but do not prioritize other criteria pollutants, like non-volatile particulate matter (nvPM) and sulfur oxides (SOx), which have adverse health impacts and contribute to contrail formation. Since engine-related interventions will be gradual and SAF blend shares are expected to be low in the coming decade, we recommend exploring the regulation of fossil jet fuel composition as an interim measure to reduce these pollutants.

These policy recommendations are accompanied by a thorough technical analysis in the following sections. We are grateful for the chance to share our feedback and ideas with CARB as proposals are being considered under the SCAI. Please feel free to reach out to Nik Pavlenko (n.pavlenko@theicct.org) and Supraja Kumar (s.kumar@theicct.org) with any questions you may have.

Nikita Pavlenko
Fuels and Aviation Program Director
International Council on Clean Transportation

Reducing Emissions from Aircraft Taxiing at the Airport

Aircraft taxi phase operations account for a significant portion of landing and takeoff (LTO) emissions and can generate substantial air pollution, as jet engines operate inefficiently and at low power for extended periods. The Draft Concept identifies single-engine taxiing (SET) and zero-emission taxiing as potential strategies for reducing emissions from aircraft taxiing at the airport. We evaluated these strategies for their abilities to reduce CO2, NOx, and particulate matter emissions, and would like to share our preliminary findings from modeling potential implementation at California airports.[1]

Single-Engine Taxiing

For SET, we used ICCT's 2023 aircraft emissions inventory (JETSTREAM), the ICAO Engine Emission Databank (EEDB), and ICCT's mid-fidelity engine simulation framework (TurboMAP) to model representative aircraft in California's intrastate fleet.[2,3] TurboMAP allows us to simulate internal engine states under realistic operating conditions, providing a higher-fidelity estimate of pollutant emissions than using EEDB data for LTO operations. Prior studies have estimated large reductions in fuel consumption and NOx emissions from the use of SET; however, these studies assume that SET conditions are identical to a dual engine taxi with one engine simply switched off.[4,5] In our assessment, we account for parameters like higher engine loads, variable taxi times, and warm-up periods associated with SET.

Given the lack of operational data on actual power settings during SET procedures, we investigated two scenarios to cover the range of possible operating conditions – one where the active engine during SET operates at 8% throttle (the realistic scenario) and one where it operates at 14% throttle (the conservative scenario).[6] Throttle refers to the percentage of the

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[1] Rhode, D. & Mukhopadhaya, J. (2026), Strategies to Reduce Aircraft Taxi Emissions in California (forthcoming ICCT publication)

[2] Benoit, J., Mukhopadhaya, J., Rhode, D., Tietge, U., Sitompul, D. (2024). ICCT JETSTREAM Model Documentation. https://theicct.github.io/JETSTREAM-doc/

[3] Rhode, D., & Mukhopadhaya, J. (2026). TurboMAP: A Modular, Multi-Point Engine Modeling Framework for Mid-Fidelity Cycle and Emissions Analysis in Python. In *AIAA SCITECH 2026 Forum*. American Institute of Aeronautics and Astronautics. https://doi.org/10.2514/6.2026-2361

[4] Kumar, V., Sherry, L., & Thompson, T. (2008). Analysis of emissions inventory for 'single-engine taxi-out' operations. *Proceedings of the International Conference on Research in Air Transportation. Citeseer*, 1–6.

[5] Stettler, M. E. J., Koudis, G. S., Hu, S. J., Majumdar, A., & Ochieng, W. Y. (2018). The impact of single engine taxiing on aircraft fuel consumption and pollutant emissions. *The Aeronautical Journal*, *122*(1258), 1967–1984. https://doi.org/10.1017/aer.2018.117

[6] British Airways. (2026). *British Airways Technical Documents Relating to Aircraft Operations Supporting the Project for the Sustainable Development of Heathrow*. British Airways Environmental Affairs. https://www.britishairways.com/cms/global/pdfs/csr/PSDH_Technical_Reports.pdf

rated thrust of the engine. These throttle settings are used for the single operational engine during the taxi segment of departure and arrival.

As noted in the Draft Concepts, engines require warm-up period before takeoff. In our analysis, for the taxi-out case, a short warm-up period for the single engine is assumed at 3.5% throttle prior to taxiing out, with another warm-up period for the second engine at 3.5% throttle just before reaching the runway. Similarly for the taxi-in case, there is a short cool-down period during which one engine operates at taxi conditions and the other at 3.5% thrust. After the cool-down period, the second engine is fully shut down, while the aircraft taxis from the runway to the gate with SET.

To simulate the impact of using SET across California, we chose representative regional, narrowbody, and widebody aircraft. The aircraft and engine model used to represent each aircraft class are shown in Table 1. We also used the average taxi-in and taxi-out times for the 11 busiest airports in California from the FAA ASPM (Aviation System Performance Metrics) database to estimate the changes CO_2, NOx, and nvPM emissions for each representative aircraft.[7] Finally, we use departure data from each airport to scale each aircraft class's savings to reflect intra-state traffic.

Table 1 Notional Aircraft Models and Engines

Aircraft Class	Aircraft	Engine Model
Narrowbody	Boeing 737 MAX 8, MAX 9	CFM International LEAP-1B28
Widebody	Boeing 787-8	General Electric GEnx-1B70
Regional Jets	Embraer 170, 175	General Electric CF34-8E5A1

This analysis is done for both the conservative and realistic cases to provide a range of changes in emissions. This range is shown in Figure 1 for taxi-in (blue bars), taxi-out (yellow bars), and the total (gray bars). Negative values indicate a reduction in emissions. The realistic scenario (with SET at 8% throttle) informs the lower bound, indicating a reduction in emissions for every species. The conservative scenario (with SET at 14% throttle) results in reduced CO_2 emissions but increased NOx and nvPM emissions. When implemented across California for intrastate traffic, we estimate an 8-14% reduction in LTO CO_2 emissions.

[7] Federal Aviation Administration (FAA). "ASPM: Taxi Times." Accessed February 25, 2026. https://www.aspm.faa.gov/apm/sys/TaxiTimes.asp.

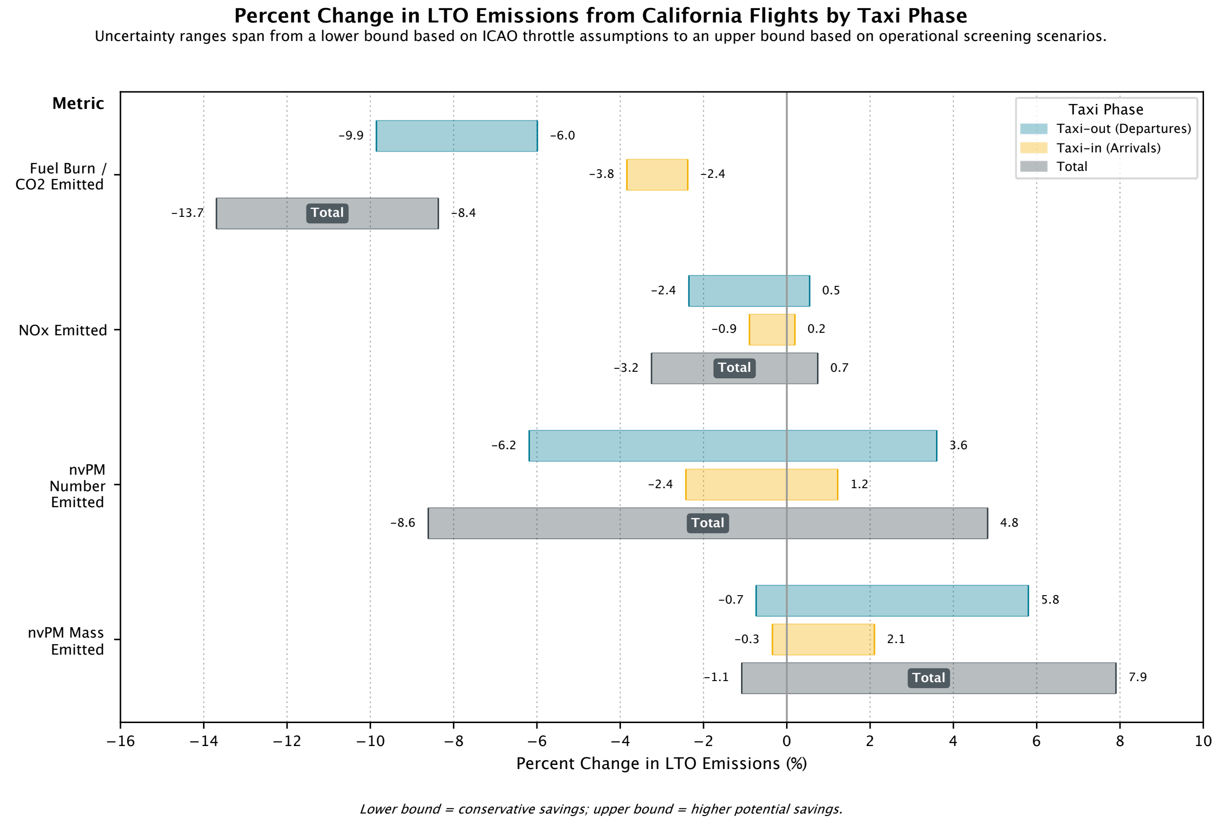

Figure 1 Percent Change in LTO Emissions with SET

When examining NOx emissions, our results indicate that SET use could lead to changes in total intrastate LTO NOx emissions ranging from a decrease of 3.2% to an increase of 0.7%. This is due to the nonlinear relationship between engine operating conditions (temperature and pressure) and thermal NOx formation. During SET, the higher throttle setting used during taxi results in combustion at higher temperatures, potentially leading to higher NOx emissions overall. The simulated changes in NOx are smaller than the differences seen in inter-model comparisons.[8]

We also see statewide changes in nvPM number emissions ranging from -8.6% to +4.8%, and in nvPM mass emissions ranging from -1.1% to 7.9% when considering the behavior of the notional engines. nvPM forms due to localized fuel-rich zones within the combustor. The higher throttle setting during SET may increase or decrease the formation of these zones, thereby creating a range of nvPM responses which are highly dependent on combustor design. The changes in nvPM are smaller than the differences observed between T4/T2 modeling and

[8] DuBois, D., & Paynter, G. C. (2006b). *"Fuel Flow Method2" for Estimating Aircraft Emissions* (SAE Technical Paper Nos. 2006-01–1987). SAE International. https://doi.org/10.4271/2006-01-1987

the experimental data.[9] Thus, we are unable to say with certainty whether SET operations will reduce or increase NOx and nvPM emissions.

We also find that the changes in emissions depend on both the taxi times at the airport and the throttle setting of the engine. This is exemplified in Figure 2 where we see changes in the emissions response to SET by airport, and the width of the bar represents the change in emissions based on the throttle setting of the single engine during taxi.

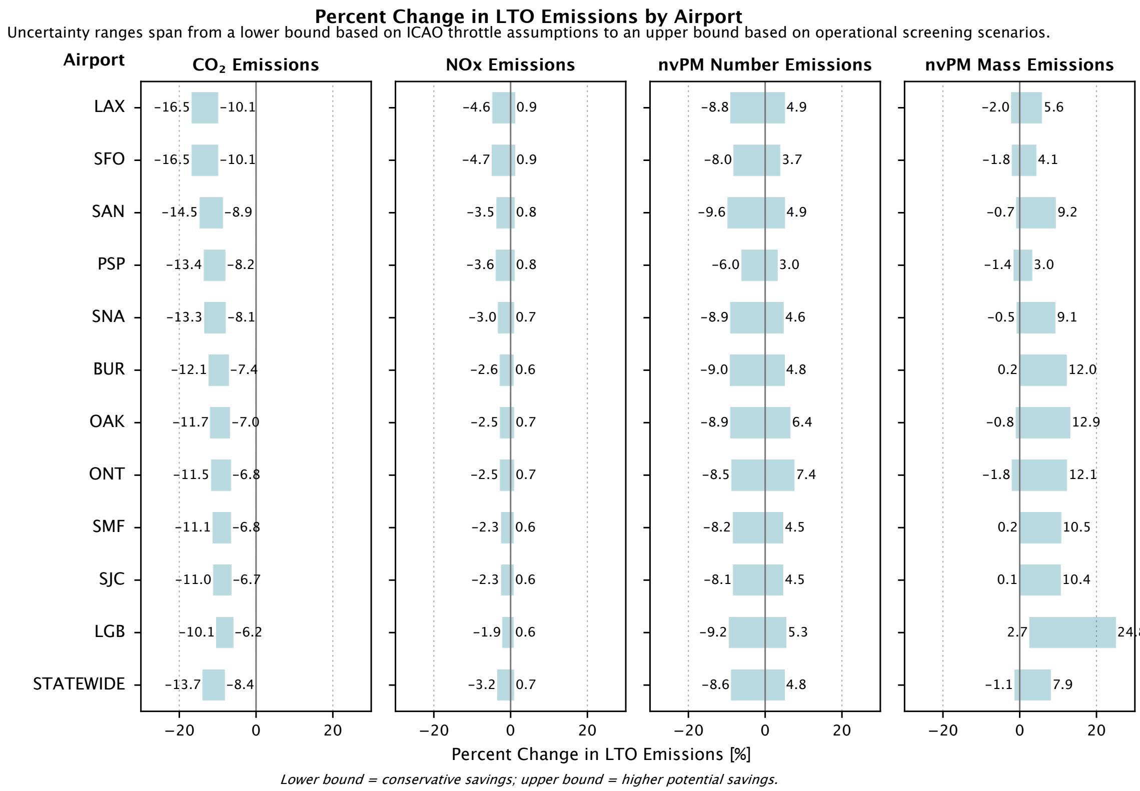

Figure 2: Percent changes in emissions when applying SET to all intra-state flights

Because these results are highly sensitive to SET throttle settings, engine technologies, and airport taxi times, we find that a generalized policy for SET operations may not have the intended benefits on local air quality. The Draft Concepts document proposes an 80% and 100% SET requirement for taxi-out and taxi-in procedures, respectively, in 2030. The document also suggests adding airport data reporting in 2031 to track SET use. Instead of collecting this data after SET implementation, we propose that airport data reporting begin immediately. In addition to taxi time and aircraft type information, we recommend collection of throttle setting

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[9] Dischl, Rebecca, Daniel Sauer, Christiane Voigt, et al. "Measurements of Particle Emissions of an A350-941 Burning 100 % Sustainable Aviation Fuels in Cruise." Atmospheric Chemistry and Physics 24, no. 19 (2024): 11255–73. https://doi.org/10.5194/acp-24-11255-2024.

data for conventional taxi and SET operations, along with the associated aircraft-engine combinations and taxi times. This data would help determine whether a targeted approach of rolling out SET for certain airports or aircraft types would deliver intended emissions reductions rather than a blanket SET requirement at all California airports.

Zero-Emission Taxiing

While SET use benefits operators through fuel savings and requires no infrastructure investment, the deployment of zero-emission tug technologies may require more direct regulatory intervention. One fully electric external tug system is already in use at San Francisco International Airport (SFO) and Los Angeles Airport (LAX), although they are not being used for the taxi-out operations. Based on our analysis, these technologies provide significant reductions in emissions across all pollutants. Since these tugs are electric, there are no direct CO_2, NOx, or nvPM emissions associated; however, we expect a small portion of taxi phase emissions to remain due to the necessary warm-up period for the aircraft engines prior to reaching the runway. Based on our analysis of taxi operations at SFO, an electric external tug could reduce taxi CO_2 emissions by 88% if used for taxi-in and taxi-out operations. This equates to a 29% reduction in CO_2 emissions relative to the entire LTO cycle. We include the emissions associated with powering the tugs with California grid-average electricity for which we assume a carbon intensity of 80.55 gCO_2e/MJ. We estimate electric tug NOx emissions reductions of 86-92%, nvPM mass reductions of 88-95%, and nvPM number reductions of 83-90% relative to SET, when modeling emissions from all departures at SFO.

Empirical trials lend support to the potential scale of such savings. Amsterdam Airport Schiphol's sustainable-taxiing program, Taxibot, reported fuel and NOx emission reductions of 50–65% compared with standard taxi procedures, with savings tending to be greatest for long taxi routes.[10] Electric taxi tug technologies provide a consistent and significant reduction in air pollutants compared to SET, which may yield variable results depending on aircraft technologies and operational scenarios. Broad implementation of electric taxi tugs across the state will require airport infrastructure development, capital investment, and statewide collaboration.

Given the inconclusive evidence on NOx and nvPM reductions from SET and the larger emissions savings from zero-emission taxiing technologies such as the external tug, we suggest prioritizing their deployment. We recommend that CARB's planned study be expanded to a comprehensive cost-benefit analysis including infrastructure needs, electricity, and capital expenditures at the airport level. The results of this study could help to better define

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[10] "Sustainable Taxiing: Taxibot Trial." April 2021. https://www.schiphol.nl/en/innovation/blog/sustainable-taxiing-taxibot-trial/.

Compatible Aircraft and Capable Targets as well as better inform attainable Compliance Timelines, which may vary for individual airports.

A Simplified Revenue-Neutral Framework for Landing Fees

The Draft Concept introduces a revenue-neutral NOx landing fee, proposing a structure that sets differentiated fees based on NOx emissions, with discounts for aircraft performing below the defined baseline and higher fees for aircraft that exceed it. The fee would only apply to aircraft acquired beginning January 1, 2030. The intention of the differentiated fee is to encourage the use of low-NOx emission technologies, thereby reducing the NOx emissions at California airports.

Recommendation 1: Expand the scope of NOx landing fees to all aircraft operating at relevant airports

Including all aircraft, rather than limiting the scope to aircraft deliveries and lease agreements made after 2030, would capture the full extent of NOx emissions and maximize reductions. Exempting aircraft delivered prior to 2030 would exempt the majority of the state's traffic from landing fees and would likely not provide significant emissions reductions in the near- and medium-term. This approach could even increase NOx emissions at California airports, as airlines could redirect older aircraft with higher NOx emissions acquired before 2030 to operate California routes to avoid landing fees applied to new aircraft. Last year, there were over 27,000 passenger and freighter aircraft operating in the global commercial fleet, and of those, only about 1,500 aircraft, or 5.5% of the fleet, were delivered in 2025.[11,12] Assuming the fleet makeup of California's commercial traffic is aligned with this trend, even with projected fleet growth, it would take nearly a decade for the majority of air traffic to fall under the 2030 applicability date of the current proposal. This slow uptake would prevent landing fees from penetrating the fleet's activity in the near term and have minimal impact on operator behavior.

Recommendation 2: Redesign the landing fee structure to incentivize the deployment of zero-emission taxiing technology.

Under the current definition, the only near-term option for reducing emissions is to redirect aircraft with lower NOx emissions to California airports. Longer-term reductions from acquiring new, low-NOx emitting aircraft will take time to permeate through a fleet where only a small portion of the fleet is renewed in a year.

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[11] IBA Insight Fleet Asset Report (2026). https://insightiq.iba.aero/fleet/report-builder

[12] Data Spotlight: Key Metrics on Deliveries, Orders, RPKs, & More (2026). https://aviationweek.com/air-transport/airlines-lessors/data-spotlight-key-metrics-deliveries-orders-rpks-more

There is no incentive to adopt new technologies, external to the aircraft, such as those that enable zero-emission taxiing discussed in the previous section. Instead, we recommend using revenue from a NOx landing fee to subsidize the cost of acquiring zero-emission tugs and developing charging infrastructure. As discussed in the previous section, zero-emission taxi tugs can greatly reduce CO_2, NOx, particulate matter, and other criteria pollutants during the LTO cycle; however, widespread implementation of these technologies in the state would require capital investments in equipment and charging infrastructure to charge the tugs. The landing fee is designed such that the increased landing cost is matched by fuel savings expected from the deployment of zero-emission tugs.

To motivate our recommendation, we first calculate the maximum NOx benefit expected from the current fee proposal. Then, we describe our proposed revenue-neutral framework supporting the adoption of zero-emission taxi technologies and calculate the expected NOx and fuel burn benefits with this approach.

Current fee structure

The current fee structure incentivizes airlines to reshuffle their fleet to use aircraft with lower NOx emission profiles at California airports. This limits the achievable NOx emissions reductions at an airport, as an airline's fleet is slow to change due long operational lifetimes of aircraft. Additionally, an airline's choice of aircraft to operate on a route are constrained by its fleet and factors such as mission feasibility, cost per seat mile, and scheduling constraints.[13]

Considering these limitations, the likely way an airline would respond to a NOx-based landing fee is to use the same aircraft type but equipped with a lower-NOx-emitting engine. Within a given aircraft type, different engine options can yield significantly different NOx emissions. Figure 3 shows the NOx emissions per LTO cycle of the 30 most used aircraft types in California. The bars represent the fleet-weighted average for an aircraft type, with the engine-variant range shown as error bars. The Boeing 787-800 (B788) has the largest inter-engine difference in NOx emissions with the GEnx-1B engine emitting 70% less NOx per LTO cycle than the Rolls Royce Trent 1000 engine.

[13] Mitchell, Alexander. "This Is How Airlines Choose Which Aircraft to Deploy." Simple Flying, December 3, 2025. https://simpleflying.com/how-airlines-choose-aircraft-deploy/.

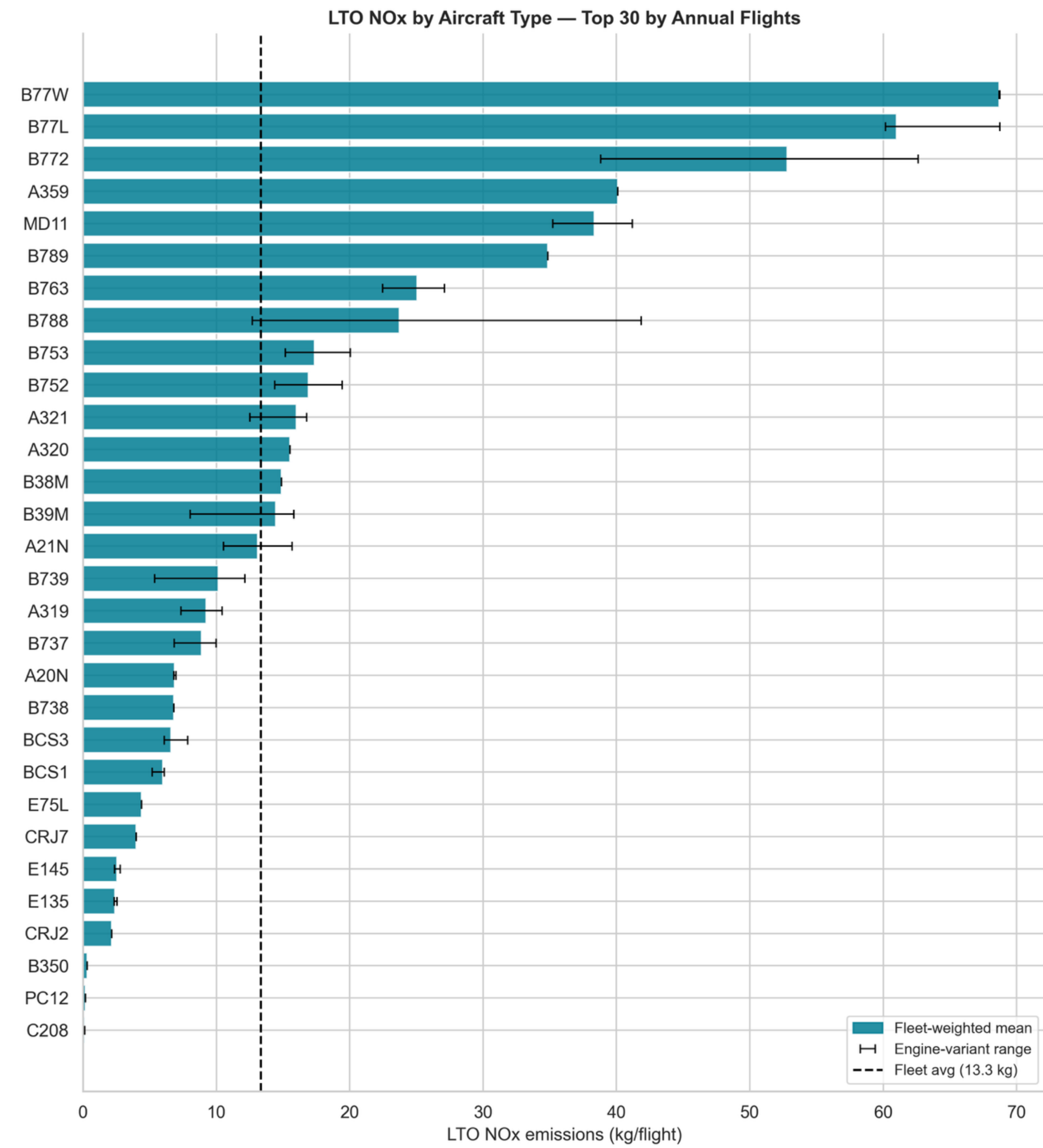

Figure 3 LTO NOx emissions by aircraft type

In the optimistic case, where each aircraft type operating in California is equipped with the lowest-NOx-emitting engine option, we model a 12.8% reduction in NOx emissions and a 3.3% reduction in LTO fuel consumption. However, this does not account for if an airline already has the better engine option elsewhere in their fleet. If we limit engine switching to only airlines that already have these better-performing engines in their California fleets, indicating that they may have the better engine option elsewhere in their fleet that they could redirect to California, the expected NOx savings are 7.4% alongside a 2% reduction in LTO fuel use.

Proposed Fee Structure to Subsidize the Transition to Zero-emission Taxiing

A NOx landing fee system that targets recycling of funds could further reduce emissions from aircraft taxi operations by supporting the deployment of zero-emission taxiing technology. The following sections describe the steps we take to design a new revenue-neutral landing fee. We start by calculating the landing and takeoff (LTO) cycle fuel use and NOx emissions while using reported average taxi times at California airports. Then, we assess the potential fuel, NOx, and cost savings from using electric taxi tugs across all taxi operations. We use the annual cost savings to define a target for funds raised by a NOx landing fee and derive a unit price per kilogram of NOx. We then propose a NOx landing fee, defined as a price on total NOx emitted by an aircraft during an LTO cycle. Finally, we end the section with an analysis of the environmental and financial impacts of the landing fee.

Estimating LTO Cycle Emissions

Below, we analyze the aviation activity in 2023 at the 15 California airports listed in Table 1 of the Draft Concepts report. Table 2 lists the number of commercial departures, the assumed taxi times for departures (taxi-out) and for arrivals (taxi-in), and the landing fees charged by the airport, expressed in dollars per 1000 lbs. of maximum gross landing weight (MGLW). The taxi times are for 2023 activity and are taken from the FAA's ASPM dataset.[14] The activity-weighted average taxi-out and taxi-in times are 16.8 minutes and 7.2 minutes, respectively. The activity-weighted average landing fee is $5.25 per 1000 lbs. MGLW.

Table 2 : Commercial Aviation activity in 15 of the busiest California airports

Departure Airport	Number of departures	Taxi-out time (min)	Taxi-in time (min)	Landing fee ($/1000 lbs)	Source for Landing fee
LAX	273,544	17.81	10.5	6.88	[1]
SFO	177,983	20.62	7.44	6.59	[2]
SAN	99,024	18.96	4.94	3.88	[3]
OAK	63,202	12.9	6.27	5.52	[4]
SMF	60,165	12.8	4.88	4.7	[5]
SJC	59,729	13.41	4.17	5.13	[6]
SNA	55,236	14.85	6.57	3.9	[7]
ONT	42,847	13.07	5.98	2.14	[8]
BUR	40,695	15.73	3.59	0.97	[9]
LGB	18,286	11.98	4.36	5.45	[10]
PSP	17,191	15.3	6.15	-	Unable to find

[14] Federal Aviation Administration (FAA). "ASPM: Taxi Times." Accessed February 25, 2026. https://www.aspm.faa.gov/apm/sys/TaxiTimes.asp.

FAT	16,306	14.23	5.63	3.96	[11]
SBA	10576	13.89	4.7	3.52	[12]
SBD	4875	14.63	6.19	1.71	[13]
VNY	3365	14.39	5	6.44	[14]

To estimate the LTO cycle emissions, we use the ICAO standard LTO cycle in conjunction with the ICAO EEDB but with airport-specific taxi times. [15,16] We estimate that about 276 million gallons of jet fuel were burned in the LTO cycle at California airports, producing 2.6 million tonnes of CO_2 emissions and 12.6 tonnes of NOx emissions. Our analysis based on SFO electric tug data indicates that taxi tug use could reduce aircraft taxi fuel consumption by about 88%, while demonstration projects suggest 50-65% taxi fuel savings.

Estimating Fuel and Cost Savings from Zero-Emission Taxi Operations

We consider three scenarios of fuel savings from electric tugs. The low, medium, and high cases have taxi-out fuel savings of 50%, 65%, and 88%, respectively. These are based on the observed range of fuels savings estimates from demonstration projects and our modeling results.

We include the cost of charging the electric tugs in our analysis. The electricity demand is calculated using operator-reported estimates for the energy requirement per mile for the taxi-out to the runway and the return journey. The energy requirements for each aircraft class are listed in Table 3. We estimate the distance traveled for SFO to be 1.5 miles (one-way) using Google Maps. For the other airports, we scale the 1.5 miles by the ratio of the taxi out time relative to SFO. For example, the taxi-out time for LAX is 14% less than for SFO, so we estimate the distance from the gate to the runway is 14% less than 1.5 miles, or 1.3 miles.

Table 3 Electricity requirements for an electric tug

Category	Maximum takeoff mass	Taxi out energy requirement (kWh/mile)	Return energy requirement (kWh/mile)
Regional jet	< 60 tonnes	3	1.5
Narrowbody	60–100 tonnes	6	1.5
Widebody	≥ 100 t	20	1.5

[15] European Union Aviation Safety Agency (EASA). "ICAO Aircraft Engine Emissions Databank." n.d. Accessed October 8, 2025. https://www.easa.europa.eu/en/domains/ environment/icao-aircraft-engine-emissions-databank.

[16] ICAO. "Local Air Quality Technology Standards." Accessed January 12, 2026. https://www.icao.int/environmental-protection/LAQ/technology-standards.

The electricity cost per departure is:

$$Electricity\ cost_{dep} = (Taxi - out\ energy\ + Taxi - in\ energy) \times Taxi\ distance \times Unit\ Rate_{electricity} \quad (1)$$

Where the unit rate for electricity is 26.92 cents per kWh based on EIA data for commercial electricity use in California.[17] We calculate the electricity cost to be 1.5% of the estimated fuel savings.

Calculating the NOx landing fee

Annual savings in fuel costs could serve as a target for funds raised by a potential NOx landing fee. This keeps the fee revenue-neutral, since operators would recover their landing fee expenses through avoided taxi fuel costs. The unit price per kilogram of NOx is calculated as:

$$Unit\ Price_{kg\ NOx} = \frac{Total\ Taxi{-}out\ fuel\ burn\ saved\ (gallons) \times Cost\ of\ jet\ fuel\ \left(\frac{USD}{gallon}\right) - Total\ electricity\ cost}{Total\ NOx\ emitted\ (kg)} \quad (2)$$

Here, “Total” refers to the statewide totals. This yields a constant unit price for NOx across the state. The Draft Concept proposes charging higher rates for airports in ozone nonattainment areas and/or disadvantaged communities. This is possible, however for simplicity, we conduct this analysis with a statewide unit price.

Fees per landing should be aligned with actual NOx emissions to incentivize reductions, so they could be calculated as a function of total LTO NOx emitted per engine, the number of operating engines, and the unit price per kilogram of NOx (Equation 2). This is in line with European Civil Aviation Conference (ECAC) Recommendation 27-4 in its “polluter pays” principle.[18] This approach, adopted by London Heathrow (LHR) and London Gatwick (LGW) airports, charges landing fees proportional to a given aircraft's actual emissions, with higher fees for larger aircraft.[19]

$$NOx\ Landing\ Fee = NOx\ emissions\ (kg)_{per\ engine\ and\ LTO\ cycle} \times n_{engines} \times Unit\ Price_{per\ kg\ NOx} \quad (3)$$

[17] US Energy Information Authority (EIA). “Electric Power Monthly - U.S. Energy Information Administration (EIA).” Accessed February 26, 2026. https://www.eia.gov/electricity/monthly/epm_table_grapher.php?t=epmt_5_6_a.

[18] European Civil Aviation Conference. (2011) NOx Emission Classification Scheme. Recommendation ECAC/27-4. https://www.ecac-ceac.org/images/documents/ECAC-Recommandation_274_Second_Edition_2012.pdf

[19] UK Civil Aviation Authority, “Environmental Charging – Review of Impact of Noise and NOx Landing Charges,” October 2013.

Impact of the NOx Landing Fee

These fuel savings range from $85 million to $151 million per year across the state. Based on these estimates for fuel savings, a NOx unit price ranging from $6.74/kg NOx to $11.85/kg NOx would result in a revenue-neutral fee.

Table 4. Estimated fuel savings from electric tug deployment

Scenario	Fuel saved (millions of gallons)	Fuel cost savings (millions of USD)	Resulting Unit price per kilogram NOx (USD)
Low	37.4	$85	$6.74
Medium	48.7	$112	$8.75
High	65.9	$151	$11.85

This fee structure also maintains the original objective of incentivizing airlines to switch to low-NOx-emitting aircraft. Airlines that already have these more efficient engines in their California fleets could swap out aircraft immediately, reducing their fee burden by $8 million per year, while reducing NOx emissions by 7.2% and reducing fuel consumption by 2%. The top 10 airlines with the greatest incentive to switch immediately are shown in Figure 4. Southwest, United, and Alaska Airlines would each have an incentive greater than $1 million.

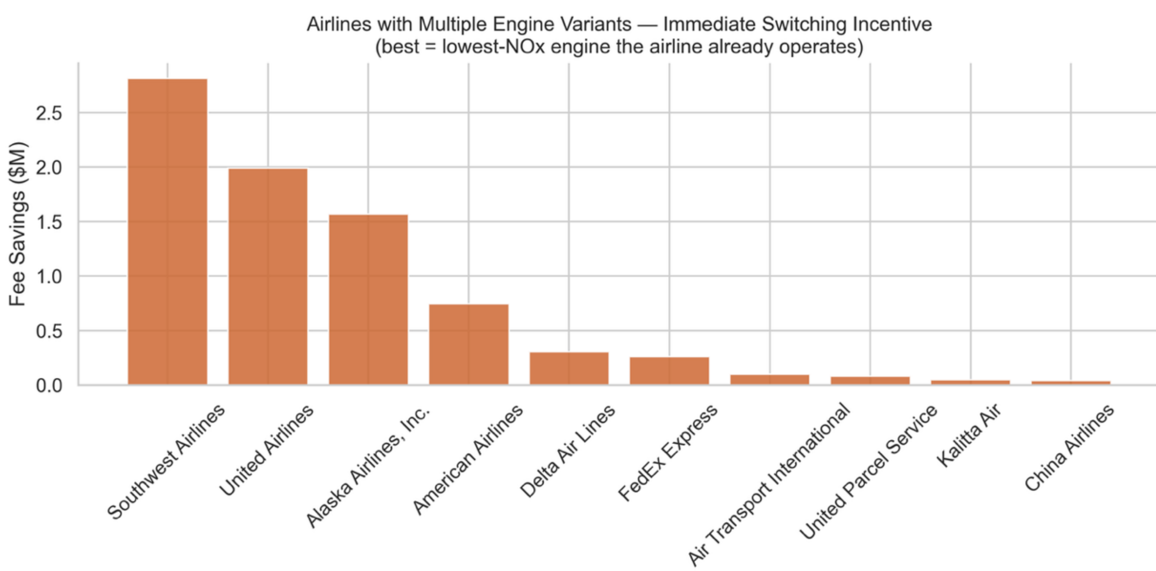

Figure 4 Airlines with the largest incentive for immediately switching aircraft

In addition to incentivizing the use of more NOx-efficient aircraft, this approach would raise funds for the deployment of zero-emission taxiing technology. Using the Medium scenario as an example, the NOx landing fee would generate $112 million in annual revenue for airports to fund the acquisition and deployment of zero-emission taxiing technology. Electric taxi tugs in use at SFO cost about $700,000 per unit, so one year of landing fee revenue could fund the purchase of up to 160 units.[20]

The statewide deployment of zero-emission taxi would further reduce the LTO cycle fuel consumption by 17.6% and the LTO cycle NOx emissions by 5.5%. It is important to note here that there is likely significant overlap in the charging infrastructure required to support zero-emission taxiing technologies and zero-emission ground support equipment. Any charging infrastructure deployment would benefit both initiatives.

Survey of Existing Landing Fee Structures at US airports

Within California and across the United States, there is a large range of fee structures that are applied to commercial aircraft activity. We will focus on how the NOx landing fee relates to the baseline landing fees at the airports. The Medium scenario of $8.75 per kg of NOx emission is, on average, 10% of the landing fees at the airports used in this analysis. Table 5 shows the ratio of NOx to Landing fees for California airports. The ratio varies from 0.086 for LAX to 0.51 for Hollywood Burbank Airport. The variation is owed in differences in landing fees between airports.

Table 5 Comparison of the revenue from Landing and NOx fees

Airport	Landing Rev ($M)	NOx Rev ($M)	Ratio of NOx and Landing Charges
LAX	490.51	41.94	0.086x
SFO	288.67	26.69	0.092x
OAK	66.73	6.44	0.096x
SAN	65.46	9.20	0.141x
SJC	46.87	4.50	0.096x
SMF	44.63	4.80	0.108x
SNA	30.49	3.72	0.122x
ONT	22.09	5.39	0.244x
LGB	15.38	1.42	0.092x
FAT	6.91	0.88	0.128x
BUR	5.09	2.60	0.510x
SBA	3.57	0.47	0.132x
SBD	2.83	0.85	0.301x

[20] "The super tug of the future not leaving a mark at SFO." (2024). https://www.nbcbayarea.com/news/local/climate-in-crisis/super-tug-sfo/3738022/

VNY	0.46	0.04	0.097x
Total	**1,089.69**	**108.95**	**0.100x**

This variation in landing fees extends beyond California airports. Within New York City, LaGuardia airport charges $19.64 per 1000 lbs. MGLW, while John F. Kennedy airport (JFK) charges $8.47 per 1000 lbs. MGLW.[21] On the other hand, equally busy airports like Atlanta International Airport (ATL) charge $1.72 per 1000 lbs. MGLW.[22] Additionally, individual airports have different aircraft weight categories, with some applying fixed rates for smaller aircraft and others maintaining a constant unit rate per 1000 lb. MGLW across all aircraft types. Depending on the size and traffic at a given airport, some also implement a tiered approach with lower rates for signatory carriers, those with lease agreements, and higher rates for other operators. Based on this observed variance in landing fee structures, we find that introducing a NOx landing fee in the proposed range would not create market distortions, particularly given that this fee would be offset by reduced fuel use.

Prioritizing Particulate Matter Emissions Reductions from Aviation

The Draft Concepts focus on achieving statewide NOx reductions, which we recognize to be a priority area to meet federal ground level ozone standards. However, the SCAI's larger goals include lowering health risks to airport workers and nearby communities, as well as reducing GHG emissions from airport operations. When considering aviation's complete health impacts, a portion of this comes from particulate matter and sulfur oxide (SOx) emissions formed as products of jet fuel combustion. Research indicates that these emissions have both air quality and climate impacts, as they act as condensation nuclei in the formation of contrails.[23,24]

While SAF can provide reductions in nvPM and SOx emissions, the benefits only become meaningful at high blend percentages. In 2024, CARB and Airlines for America set a goal of using 200 million gallons of SAF in the state by 2035, which is about 40% of intrastate

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[21] Port Authority of New York and New Jersey. "Operator Resources." Accessed February 26, 2026. https://www.panynj.gov/content/airports/en/operator-resources.html.

[22] Hartsfield-Jackson Atlanta International Airport. "Fiscal Year 2026 Rates & Charges." Accessed February 26, 2026. https://www.atl.com/wp-content/uploads/2025/08/FY26_Rates-Charges-Book.pdf.

[23] Andrews, Siân, Joey Cathcart, Andrew Chen, et al (2024). *Understanding Contrail Management: Opportunities, Challenges, and Insights*. RMI Contrail Impact Task Force.

[24] Daan van Seters, Stefan Grebe, and Jasper Faber. 2024. *Health Impacts of Aviation UFP Emissions in Europe*. CE Delft.

demand.[25] However, this comprises a relatively small share of the state's overall jet fuel consumption. Based on the California Governor's Sustainable Aviation Fuel Tax Proposal within the 2026-2027 Fiscal Budget, the state estimates that in 2028, SAF would contribute up to about 4.2% of total jet fuel use in the state.[26]

Since low blend percentages are expected in the near- to medium-term, SAF use will have minimal air quality benefits, as the majority of the fossil jet fuel would still contain high levels of aromatics and sulfur. Jet fuel composition is a promising lever for reducing aviation nvPM and SOx emissions, since formation of these pollutants is linked to a fuel's hydrogen, aromatic, and sulfur content. The ASTM D1655 specification limits jet fuel sulfur content to 3,000 parts per million (ppm) and aromatic content to between 25-26.5%. When fossil jet fuel is blended with SAF, the ASTM D7566 specification requires a minimum aromatic content of 8% and has no minimum requirement for sulfur content.[27,28] As an interim measure while SAF volumes ramp up in the coming decades, hydroprocessing of fossil jet fuel can help to reduce aromatic content from the fossil-derived share of jet fuel and eliminate sulfur.[29]

CARB first adopted regulation for diesel fuel composition in 1988, reducing the allowable limits on aromatic and sulfur content to 10% by volume and 500 ppm, respectively. The CARB diesel sulfur limit was further reduced to 15 ppm in 2006. CARB also introduced regulations to cover marine distillate fuels in ocean-going vessels in 2008.[30] We recommend expanding the scope of CARB's fuel composition regulations to include aromatic and sulfur limits for jet fuel compliant with ASTM's allowable range in order to target reducing criteria pollutants from aviation. CARB could consider an additional draft concept proposing jet fuel composition standards as part of the SCAI to further progress its goals to reduce GHG emissions and improve public health in California.

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[25] CARB and nation's leading airlines announce landmark partnership for a sustainable aviation future (2024). https://ww2.arb.ca.gov/news/carb-and-nations-leading-airlines-announce-landmark-partnership-sustainable-aviation-future

[26] The 2026-2027 Fiscal Budget: Governor's Sustainable Aviation Fuel Tax Credit Proposal (2026). https://lao.ca.gov/Publications/Report/5139

[27] ASTM. "Standard Specification for Aviation Turbine Fuels." 2025. https://store.astm.org/d1655-25a.html.

[28] ASTM. "Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons," 2022. https://store.astm.org/d7566-22.html.

[29] Kumar, Supraja (2025). "Cloudy with a Chance of Soot: The Role of Fuel Composition in Aviation's Non-CO2 Impact." *ICCT Staff Blog*. https://theicct.org/role-of-fuel-composition-in-aviations-non-co2-impact-sept25/.

[30] CARB. "California Low Sulfur Diesel Fuel Fact Sheet | California Air Resources Board," December 27, 2018. https://ww2.arb.ca.gov/resources/fact-sheets/california-low-sulfur-diesel-fuel-fact-sheet.

NCBAA
NORTHERN CALIFORNIA
BUSINESS AVIATION
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Date:
2 March 2026

Via Email
CALIFORNIA AIR RESOURCES BOARD
Email: aircraft@arb.ca.gov

Dear Ladies and Gentlemen:

The Northern California Business Aviation Association ("NorCal BAA") in an Internal Revenue Code Section 501(c)(6) professional organization. We are the Northern California affiliate of the National Business Aircraft Association (NBAA), and our members include air carriers, air taxi and charter operators, aircraft maintenance facilities, airport fixed base operators and individuals and companies who operate aircraft in furtherance of their businesses.

In response to your solicitation of comments regarding the Draft Statewide Clean Aviation Initiative (SCAI), we offer the following for your consideration:

At the outset, we support efforts to reduce emissions and protect public health. However, these efforts must be realistic, technologically feasible, economically reasonable and consistent with existing and future aircraft and engine design, infrastructure capabilities, Federal Aviation Administration (FAA) requirements and best safety practices.

At the present time, the FAA's Terminal Flight Data Manager (TFDM) program improves flow of aircraft on the ground, reduces taxi delays and lowers fuel burn. Additionally, modern flight planning systems optimize routing, winds, altitude and runway selection to minimize fuel burn and carbon footprint. We are confident that emerging technologies and infrastructure development will facilitate additional emission reductions.
Without dismissing the need to reduce emissions and protect public health, it cannot go without mention that operations of non-commercial jet aircraft comprise a very small percentage of total aircraft operations. According to FAA's Air Traffic Activity Data System (ATADS) and data prepared by the airports identified below:

In 2024, San Francisco International Airport (SFO) averaged approximately 1000 operations per day; Los Angeles, approximately 1,500 per day. The vast majority of these are air carrier operations, not corporate or business aircraft.

Compare these numbers with the numbers of operations at the following Northern California Airports which are more likely to be used by corporate and business aircraft:

-Sacramento Executive (SAC): approximately 268 operations/day; primarily general aviation with flight training being a major activity;
-Sonoma County / Charles M. Schulz (STS): approximately 227 operations/day; including commercial service, corporate, and general aviation (GA), with spikes in activity from firefighting aircraft during wildfire season;
-Livermore Municipal (LVK): approximately 496 operations/day; mostly GA;
-Napa County (APC): approximately180 operations/day; primarily GA and corporate jets;
-Monterey Regional (MRY):approximately155 operations/day; reflecting a mix of, air taxi, commercial and military.

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We respectfully submit that these limited numbers of operations of corporate and business aircraft belie the need to impose upon this relatively small aviation user community administratively burdensome, expensive and technologically infeasible solutions which will produce little or no benefit.

The draft SCAI contains four key elements:
1.Controlling emissions from aircraft auxiliary power units (APU's);
2.Reducing emissions from airport ground support equipment (GSE);
3.Reducing emissions from aircraft taxiing; and
4.Reducing emissions from takeoffs and landings.

With your indulgence we will address each of these elements.
1. Controlling Emissions from Aircraft Auxiliary Power Units (APUs)
SCAI would apply to non-commercial jet aircraft (private, corporate, personal), particularly medium and large business jets (e.g., Gulfstream, Global Express aircraft).

Controlling APU emissions can be achievable and efforts to limit APU usage is widely practiced in Europe; however, those policies include important operational carve-outs for general aviation (GA) and corporate aircraft.

a.Unavailability of APU Alternatives:
Unlike airlines, GA and corporate aircraft operate primarily from Fixed Base Operators (FBOs), not airline terminals. Most FBOs:
·Do not have fixed ground power units (GPU) or pre-conditioned air (PCA);
·Have limited mobile GPU carts; and
·Rarely have PCA capability at parking stands.

b.Pre-Departure APU Run Time:
European airports commonly allow 30-45 minutes of APU use prior to engine start, especially where fixed GPU/PCA infrastructure is unavailable. This timeframe aligns with aircraft design and safety procedures.
For most medium and large business jets, the APU is designed to be started at least 30 minutes before engine start to:
·Complete required safety checks;
·Initialize avionics; and
·Condition the cabin.

Using ground power for checks and then switching to APU for engine start is a non-standard procedure and may introduce risk to aircraft avionics systems and components and thereby reduce operational reliability and safety. As such, a 30-45 minute pre-start window is appropriate for non-commercial aircraft.

c.Temperature Exceptions:
Airports such as Copenhagen (EKCH) allow APU exemptions when outside air temperature is:
·Below -10°C (14°F), or
·Above +25°C (77°F)
Temperature carve-outs are necessary, as even fixed PCA systems may struggle to maintain safe cabin temperatures outside these ranges.

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a.Post-Arrival APU Runtime:
A 15-30 minute post-arrival window is reasonable to allow:
·Passenger deplaning;
·Aircraft servicing;
·Completion of aircraft shutdown checklists.

b.Reporting Requirements
Requiring detailed APU runtime reporting would create significant administrative burden for aircraft operators, airports, and CARB. In Europe, airport authorities monitor APU use and issue fines, when necessary, without centralized reporting systems. A localized enforcement model would be more practical and efficient.

In essence we believe that the designated APU runtimes as proposed are not achievable without compromising safety and practicality. Additional exceptions are needed for (1) operations from FBO's lacking fixed GPU/PCA and (2) for temperature extremes.

2. Reducing Emissions from Airport Ground Support Equipment (GSE)
Acquiring, installing and implementing 100% zero-emission ground power units (GPUs) would require extensive and costly infrastructure upgrades, including ramp-wide electrical receptacles and charging capability at all parking locations.

California airports could not facilitate 100% zero-emission GSE today or at any foreseeable time in the near future as current infrastructure is inadequate and full electrification would require significant capital investment and phased implementation.

3. Reducing Emissions from Aircraft Taxiing
a. Zero-Emission Taxi Technology:
Electric taxi technologies are promising but are not widely available and are unlikely to be broadly deployable by 2030.
b. Single-Engine Taxi:
Single-engine taxi is already used when safe and appropriate. However, mandating it would introduce safety risks and unrealistic operational constraints, including:

(1) Engine Warm-Up and Cool-Down Requirements:
Manufacturers typically require:
·3-5 minutes from engine start before takeoff power
·3-5 minutes at idle after landing before shutdown
A strict 5-minute taxi limit does not account for these requirements and would be unsafe.

(2) Aircraft Type and Weight
Heavy aircraft (e.g., B777) require substantial thrust to taxi on one engine. Breakaway thrust can produce extremely high exhaust velocities, posing serious risks to ground personnel and equipment. In some cases, the higher thrust required negates assumed fuel savings.

(3) Aircraft Design and Procedures
Corporate jets are designed to start both engines at the ramp and complete required safety checks prior to taxi. Departing the ramp and taxiing on one engine is only appropriate when long delays are anticipated.
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Given average taxi-out times (~12 minutes), emissions savings from mandated single-engine taxi are minimal compared to the associated safety risks.

c. Reporting Requirements:
Additional reporting requirements in this area would create unnecessary administrative burden.

d. A Better Alternative: Flow Management:
A more effective emissions-reduction strategy would be:
·FAA and airport-coordinated startup metering;
·Gate-hold procedures; and
·Reduced taxi delay through improved surface flow management
Many international airports already use such procedures successfully.

4. Reducing Emissions from Takeoffs and Landings (LTO)
a. Operational emissions-reduction strategies (continuous descent, optimized climbs) are often limited by:
·Airspace design; and
·Air traffic control constraints
These are governed by the FAA and are largely outside operator control.
b. Reduced Thrust Takeoffs
While reduced thrust procedures may reduce engine wear and noise, there is little evidence that they, in fact, reduce fuel burn or emissions.

In conclusion, we believe that APU restrictions, taxi mandates, and electrification requirements must reflect aircraft design, infrastructure realities, safety requirements, and FAA operational authority. Collaborative, flow-management-based solutions and infrastructure development offer more practical and effective emissions reductions than rigid runtime mandates and burdensome reporting systems. To this end, Northern California Business Aviation Association would be happy to meet with CARB and discuss these issues in greater detail.

We thank you for the opportunity to comment on this important proposal. Should you wish to discuss this, please feel free to give me a call at (510) 775-3418.

Regards,

Otto Wright

Otto Wright
NCBAA President