



Zero-Emission Vehicle Readiness Roadmap & Intermodal Electrification Strategic Plan

2020 EXECUTIVE SUMMARY REPORT

A Message from Our Director

Figure ES-1. SFO Net Zero Pathway



San Francisco International Airport (SFO) has a responsibility to care for the communities around it, whether it be in the midst of a public health crisis or responding to climate change. While we are prioritizing SFO's response to the COVID-19 pandemic, we remain focused on advancing key projects that address the immediate and long-lasting impacts that climate change has on our global community.

SFO has already made remarkable progress toward reducing greenhouse gas emissions. Not only have we reduced emissions significantly already, we have laid the groundwork for ourselves and our partners—airlines and tenants—to achieve carbon neutrality. In fact, SFO remains on track to reduce greenhouse gas emissions by 50 percent from the 1990 baseline by 2021 and to advance carbon neutrality initiatives.

As we embark on our 10th Climate Action Plan alongside our COVID-19 recovery efforts, we are focused on documenting our progress and creating a roadmap to guide us and our partners to work collectively toward achieving our ambitious climate and public health goals. Key components are:

- Plan for a campus served by an entirely electric vehicle fleet that improves local air quality—outlined here in the Zero-Emission Vehicle Readiness (ZEV) Roadmap,

- Develop a capital plan that values embedded carbon and requires our contractors and partners to quantify reductions and identify measures to achieve the longest-term direct benefits and co-benefits,
- Conduct an electric Central Utility Plant study that examines cost-effective options for decarbonization and improving indoor air quality, and
- Establish a carbon offset investment plan to mitigate emissions we cannot eliminate (*Figure ES-1*).

Because no single action will allow us to meet our ambitious goal of campus- and industry-wide deep decarbonization, we intend to use several measures to achieve SFO's targets. This portfolio of measures will deliver social, economic and environmental results that will benefit SFO employees, members of surrounding communities, airline passengers and the rest of the planet. Our journey to achieve a zero-carbon future builds on our successful past, commits us to productive industry partnerships and helps us move toward a sustainable and healthy future.

Ivar C. Satero
Airport Director

Executive Summary

The State of California and the City and County of San Francisco have long been recognized as leaders in developing policies and programs to dramatically reduce emissions from mobile sources. With a focus on rapidly electrifying infrastructure to enable a shift in all modes of transport away from carbon-intensive petroleum fuels, the State has strategically reduced mobile sources of ozone and particulate matter. As the keystone in intermodal transit networks, airports can play an important role in ground transportation decarbonization and improving related local air quality (Figure ES-2). This Zero Emissions Vehicle Readiness (ZEV) Roadmap describes how San Francisco International Airport (SFO/Airport) can rapidly support regional fully-electric vehicle adoption rates by ensuring easily accessible, readily available, affordable charging stations for employee, passenger, fleet and operator use. In turn, meeting these goals would provide far-reaching social, economic and environmental results that would benefit a broad range of stakeholders.

SFO's ZEV Roadmap is intended to complement parallel workstreams in place at the Airport to broaden intermodal transit services to serve employees and passengers alike. This is important because, at SFO, **more than 20 percent of the annual GHG emissions generated through operations come from ground transportation and rental cars** (Figure ES-2, Table ES-1).

At SFO, roughly 259,000 metric tons of carbon dioxide this past fiscal year came from ground transportation and rental cars which are second only to emissions from aircraft activity. In addition, fossil fuels currently power a large percentage of ground transportation vehicles used by passengers, employees, tenants, airline staff and other airport partners. Each of these GHG sources represents an opportunity to reduce onsite emissions through the use of alternative transportation modes and zero-emission vehicles (ZEVs).

Figure ES-2. SFO and City/County Greenhouse Gas Reduction Goals

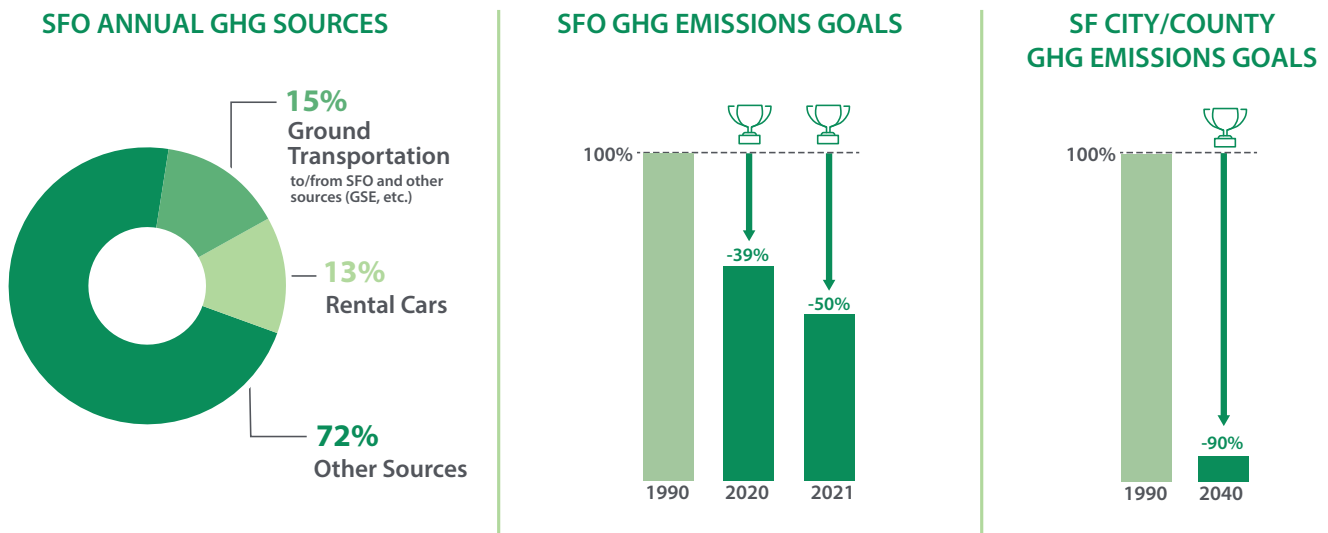


Table ES-1. Potential Greenhouse Gas Emissions Reductions Given in SFO’s Fiscal Year 2018 Climate Action Plan (by User Group)

User Group	Potential Greenhouse Gas Emissions Reduction (MT/yr)*	Target Year
SFO Fleet (passenger vehicles)	188	2022
Ground support equipment	18,000	2030
SFO Fleet (other on-road vehicles)	920	2035
Other vehicle groups	14,500	2040
Ride app vehicles	45,000	2040
Tenant/employee vehicles	58,000	2040
Personal vehicles	85,000	2040
Rental cars	260,000	2040
Total	481,608	-

* Assumes 100% ZEV availability and adoption of relevant fleet.

MT/yr = metric tons/year

Given that SFO’s electricity supply is **100 percent carbon free**, SFO is uniquely positioned to realize substantial GHG emission reductions by encouraging and supporting the use of EVs coming to and utilized across the Airport campus (*Table ES-1*). In doing so, SFO can address ZEV charging gaps and further expand this critical infrastructure to serve a region already recognized as having one of the highest ZEV adoption rates in the country.

The ZEV Roadmap guides SFO’s journey from its current baseline to a future state of campus-wide ZEV readiness. The Roadmap outlines the enabling policies, processes, and technologies that would be needed to encourage ZEV use and to provide the strategic deployment of electric infrastructure (EI) and support services. Because new technology appears quickly in this nascent market, ZEV infrastructure needs may prove to be a moving target. Thus, although the Roadmap defines key next steps to program ZEV infrastructure across the Airport campus, the longer-term structure is flexible, allowing periodic reassessment as industry and regulatory landscapes evolve.

The ZEV Roadmap is an element of the SFO Master Utilities Infrastructure Study (MUIS), the roadmap for SFO’s entire utility infrastructure, which includes the medium voltage power needed to serve all the proposed EV chargers in the locations desired.

Under executive leadership, SFO’s interdisciplinary ZEV Steering Group developed the following ZEV roadmap process (*Figure ES-3*):

Figure ES-3. ZEV Roadmap Development Process



BASELINING

The first step in charting the ZEV Roadmap was baselining the Airport’s current ZEV infrastructure, technologies and policies for both the airside and landside operations of the SFO campus—and also assessing the challenges and opportunities to make SFO ready for expanded ZEV use.

Existing ZEV infrastructure includes 306 EV charging ports, 256 charging ports for electric ground support equipment (eGSE), and arrival of its first electric shuttle bus fleet vehicles. Although SFO has made progress with transportation electrification, baselining determined that the campus, at a rate of 1% electrified parking stalls, is falling behind with respect to regional adoption rate and citywide fleet targets, so quick and steady progress is needed.

STAKEHOLDER ENGAGEMENT

The policy framework and associated strategic recommendations in the ZEV Roadmap are based on alternatives analysis and input from a broad spectrum of SFO stakeholders and on industry best practices, providing a complete picture of needs and opportunities. Consistent with SFO's Capital Improvement Plan (CIP), Strategic Plan and workplace culture, a stakeholder engagement process (SEP) was used to craft the ZEV Roadmap and associated work products. The ZEV Steering Group was established in early 2019 with interdivisional representation from Parking Management, Facilities, Information Technology and Telecommunications (ITT), Engineering, Safety & Security, and Sustainability & Environmental Policy.

A fundamental conclusion from the SEP was the need for an overarching roadmap with well-defined yet flexible administrative roles and processes. Consensus was reached on targets for electrical infrastructure planning, environmental permitting, budgeting, and ZEV infrastructure adoption.

POLICIES & GOALS

By implementing the ZEV Roadmap, SFO would continue to be an industry leader in sustainability and electrified transport, as well as to meet three important goals: (1) **reducing GHG emissions by 50 percent from 1990 levels by 2021**; (2) contributing to the **City and County of San Francisco's goal of achieving 100 percent sustainable transportation by 2040 and, by 2050, reducing overall emissions by 90 percent from 1990 levels¹**, and; (3) supporting a host of other emissions reductions and local air quality improvements. See *Figure ES-2*.

Stakeholders and leadership also agreed on a short-term **target of installing EV charging in at least 10 percent of SFO-owned parking stalls by 2023**, in alignment with CCSF's 2019 Commercial Garage Ordinance² for EV charging.

The conclusions and recommendations in the ZEV Roadmap are aligned with and build upon established SFO reports, including SFO's Principles of Revenue Enhancement and Customer Hospitality (R.E.A.C.H.), the Climate Action Plan, the Carbon Neutral Strategy, the Strategic Plan, the Sustainability Blueprint, and SFO's ZERO Annual Report. All these reports are collectively geared toward driving emissions reductions, carbon neutrality, and triple bottom line (social, environmental and financial) sustainability goals.

PROGRAMMATIC RECOMMENDATIONS & RESULTS

Key program-level recommendations and accomplishments from the ZEV Working Group, to date, include the following:

- **Establish technical standards.** In addition to facilitating capital and operational cost effectiveness, standards provide for consistency in technology selection, design and installation across projects and are essential for prioritizing future capital investment. The most important technical and administrative features identified in the SEP were incorporated into the Architecture and Engineering (A&E) standards and Design and Administrative Guidelines (DAGs). to be validated during an electric vehicle supply equipment (EVSE) pilot project targeted for the second quarter of 2021.
- **Accelerate load management.** Integration of ZEV load management (LM) with current and future Airport-wide electricity end uses would help SFO minimize peak demand and energy fees for EV charging. Integration would also significantly reduce upfront capital costs associated with EI upgrades.

¹ San Francisco's Focus 2030: A Pathway to Net Zero Emissions, July 2019: https://sfenvironment.org/sites/default/files/fliers/files/sfe_focus_2030_report_july2019.pdf

² Ordinance No. 244-19, Electric Vehicle Charging in Commercial Parking, amending the Environment Code and Police Code of the City and County of San Francisco, effective 12/02/2019: <https://sfbos.org/sites/default/files/o0244-19.pdf>

- **Ensure reliable electric distribution infrastructure.** The existing 12.47 kilovolt (kV) and 480 volt (V) EI has been evaluated and would be adequate to support the near-term ZEV adoption targets of 10 percent electrified stalls.

Further analysis will be required to determine the available site-specific capacity of existing 12.47 kV and 480 V EI to support future ZEV charging loads in alignment with the findings of the Master Utility Infrastructure Implementation Plan (MUIIP), as well as campus-wide electrical capacity in coordination with the Electrical Capacity Upgrade (ECU) program.

- **Create an ownership structure.** ZEV involves numerous individual projects and a high level of organizational complexity across budgeting, planning, engineering, procurement, program implementation, and operations. It will require new resources and business processes and reengineering of current processes. To provide guidance, this ZEV Roadmap identifies the main processes that would be affected, adjustments that would be required and some key staff roles that would likely need to be filled to effectively coordinate, manage and administer the work. Refer to Appendix L, Resource and Administration Analysis, for additional information.
- **Prioritize emissions reductions.** SFO's goal for reducing emissions is to achieve carbon neutrality within operations it directly controls (Scope 1), but SFO also aims to advance overall emissions across all scopes down to net zero through supporting infrastructure, policies, programs, and partnerships. The ZEV Roadmap recommends targets for Scope 1 GHG reductions and Scope 3 GHG reductions (those SFO does not own or control) across ZEV end uses and associated charging equipment targets.
- **Funding.** The estimated costs for the overall ZEV Program is \$100 million over the 10-year program timeline (not including soft costs). A CIP budget estimate for the near-term ZEV adoption plan was prepared and submitted for review by the SFO CIP Working Group and Executive Committee, and approval is pending COVID financial recovery. Further funding would

be secured via periodic CIP submittals, either independently or bundled with broader terminal, facilities, parking or other capital projects.

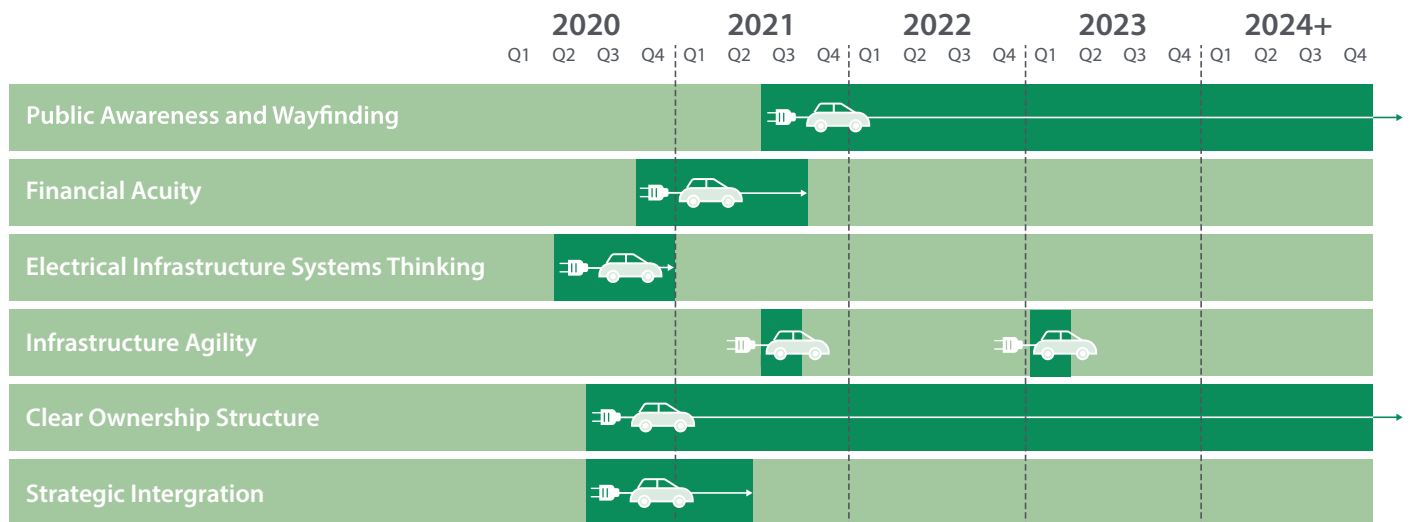
- **Implement cost recovery.** The ZEV Roadmap provides a recommended approach for recovering upfront capital costs and ongoing operations and maintenance (O&M) costs. The recommendations consider recovering costs via standardized rate mechanisms, incentives and industry-standard transactional charging fees.
- **Co-benefits.** Further health, safety, and economic benefits from implementing the ZEV Roadmap include reductions in local and regional criteria air pollutant emissions, indirect safety benefits from modernizing vehicle fleets, lower maintenance costs of EVs compared with internal combustion engine vehicles, enhanced guest experience, increased user satisfaction, reduced sourcing costs leveraged through scale-sourcing and maximum use of related incentives. Refer to Appendix O, Project Screening Methodology, for additional information.

STRATEGIC PLAN & TIMELINE

To guide program implementation and ongoing oversight, and to achieve alignment with the City and County of San Francisco's Electric Vehicle Working Group's Electric Vehicle Roadmap, SFO's ZEV Roadmap recommends six focused strategies and associated near-term proposed actions, each addressing an important barrier to ZEV adoption and EVSE deployment. These recommended priorities comprise a ZEV Strategic Plan, which is summarized as follows (*Figure ES-4*):

- **Public Awareness and Wayfinding.** Use the SFO campus as a platform to increase public awareness, prioritize ease of EV navigation and maximize accessibility, and demonstrate electric mobility options and benefits for its users.
- **Financial Acuity.** Leverage available incentives, economies of scale, standardization and best management practices (BMPs) to optimize net capital and operating costs, while achieving reasonable cost recovery for all priority EV/eGSE projects.

Figure ES-4. Phased Zero-Emission Vehicle Readiness Strategic Plan



- **Electrical Infrastructure Systems Thinking.**

Ensure EI is available to support charging in all parking and ground support equipment (GSE) staging areas, and fully integrate EV charging and LM with the SFO electrical distribution system and the upstream electrical grid to ensure reliable, affordable service.

- **Infrastructure Agility.** Ensure that standardized, state-of-the-art charging infrastructure for EVs and eGSE is available, more affordable and convenient for all landside and airside users.

- **Clear Ownership Structure.** Empower cross-divisional partners to develop a framework and governance structure to plan, budget, implement, operate, monitor and (re)calibrate the policies, targets, and proposed actions that can flexibly adapt to the current and future state of electric mobility.

- **Strategic Integration.** Develop an overarching strategic plan to integrate the broad range of tasks and responsibilities set forth in the ZEV Roadmap and continue to identify key alignments with SFO and regional transportation demand management.

A comprehensive proposed implementation timeline was developed, including the prescribed work phases, tasks within each phase, timelines to perform each task and the long-term (10+ year) outlook. The timeline is summarized in *Figure ES-4*.

IMPLEMENTATION TARGETS

Near-term and long-term adoption targets for implementing ZEV are as follows:

- **Near-term landside electric vehicle supply equipment adoption targets.** Establish near-term (by the start of 2023) EVSE adoption targets for priority user groups. Targets assume a phased adoption with installation provisions to facilitate future expansion if required. The targets are shown in *Table ES-2* and include:

- **Airport Commission fleet.** Provide approximately 100 Level 2 (L2)³ charging ports for fleet passenger vehicles by December 31, 2022, to facilitate compliance with the San Francisco ordinance⁴ mandating full fleet conversion of light-duty passenger vehicles to ZEVs.

³ Level 2 charging units deliver 240 charging volts on a 30-amp circuit. Level 2 charging adds about 25 miles of range per hour.

⁴ See San Francisco Environment Code §§ 403(b)(4) and 404(a)(2). While San Francisco Environment Code section 411 limits the applicability of these sections at SFO, SFO anticipates complying by the deadline of December 31, 2022.

- **Public and employee parking.** Increase L2 charging ports from the current condition of about 300 ports to approximately 2,300 ports. Mass transit isn't easily available to all SFO passengers and employees, so many rely upon single occupancy vehicles to access the campus.
- **Direct Current Fast Charging (DCFC) Stations⁵.** Pilot 14 DC Fast Charging Stations in appropriate public lots.

- **Long-term landside electric vehicle supply equipment adoption targets.** The long-term target for fleet vehicles is 100 percent electrification by 2030 with approximately 500 L2 charging ports for fleet vehicles. Additionally, provide EVSE for 25 percent of personal vehicle parking stalls and 70 Level 3 DCFC to serve the public, passengers, taxis and ride app drivers, as shown in *Table ES-2* and *Figure ES-4*.

Table ES-2. Landside Electric Vehicle Supply Equipment (EVSE) Adoption Targets (Cumulative) and Associated Costs

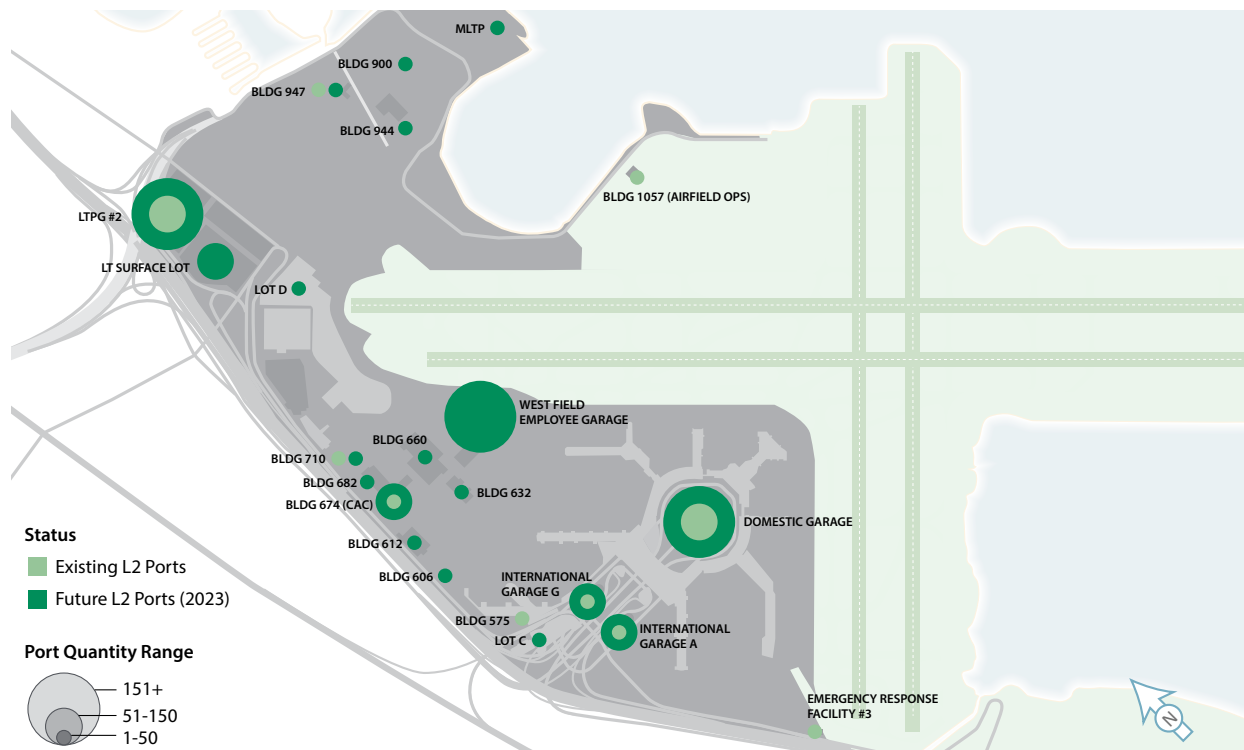
	Existing		2023 Near-Term		2030 Long-Term	
	Count	Percent ¹	Count	Percent ¹	Count	Percent ¹
Airport Commission Fleet Level 2 Ports	35	7%	~100	20%	~500	100%
Public & Employee Parking Level 2 Ports	271	1.2%	2,307	10%	5,728	25%
DCFC Stations			14 ²	--	~70 ³	--
Direct Costs With & Without Load Management			\$29M-\$40M		\$44M-\$93M	

¹ Percentage of fleet vehicles for fleet Level 2 ports; percentage of parking stalls for public and employee Level 2 Ports

² Pilot DCFC proposed to support 40% ride app fleet conversion and 10% drivers requiring a charge

³ Assumes 100% ride app EV fleet vehicles with 10% requiring a charge for ~15min

Figure ES-4. Landside Level 2 Charging Public and Employee Port Implementation Map



⁵ Level 3 chargers - also called DCFC or fast charging stations - are much more powerful than Level 1 and 2 stations. This 480-volt, ~100kW station can recharge an electric vehicle in as little as 30 minutes.

- **Near-term and long-term airside adoption targets.** Adoption targets for airside equipment (eGSE) are 70 percent near-term (by 2023) and 100 percent when electric versions of heavier GSE (e.g., towbarless tractors) become commercially available. Currently, SFO has 256 ports and about 34 percent of GSE operating at SFO are electric (see *Table ES-3* and *Figures ES-5*).

SFO has another 194 ports in development to support 70 percent eGSE (448 ports) by 2023. There is space around the boarding areas to install another 216 ports, but those ports are not yet funded. The combined total equals 664 ports (448 + 216), which equals the long-term (2040) goal of 100 percent eGSE adoption.

Table ES-3. Airside Electric Ground Support Equipment (eGSE) Adoption Targets (Cumulative)

	Existing	2023 Near-Term	2040 Long-Term
eGSE percent of Total GSE	34%	70%	100%
Number of eGSE Ports	256	448	664

Figure ES-5. Airside Electric Ground Support Equipment (eGSE) Implementation Map

