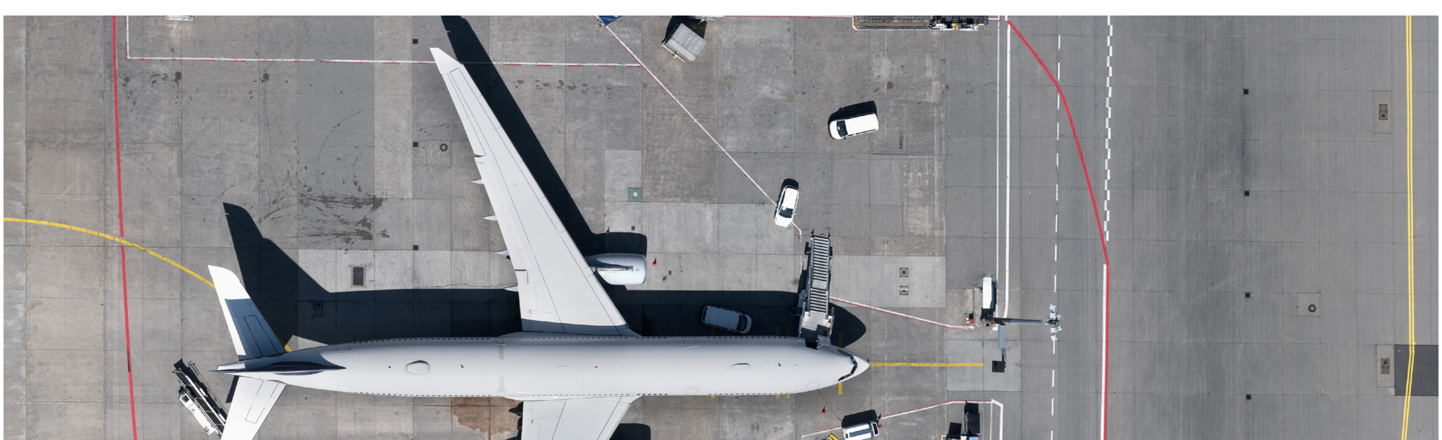
How the transition to electric Ground Support Equipment (eGSE) is clearing the path for new opportunities at airports globally

Introduction and global context

The aviation industry is under increasing pressure to decarbonise, driven by global commitments and stakeholder expectations. Organisations such as International Civil Aviation Organization (ICAO), International Air Transport Association (IATA) and Airports Council International (ACI) have set ambitious targets for achieving net-zero emissions by 2050, signalling a clear direction for the sector.



Airports have been responding by creating sustainability roadmaps, prioritising the reduction of Scope 1 and 2 emissions in their control, achieved through switching to renewable energy and e.g., improvements to waste and water management practices. Net-zero ground operations are becoming increasingly relevant, in part due to the growing emphasis on Scope 3 emission reductions. Transitioning ground support equipment (GSE) away from fossil fuels toward cleaner alternatives can in part help achieve this. When airports own and operate electric GSE (eGSE), the assets can be classified under Scope 1 emissions, which has led to the increase in preference and adoption of eGSE pooling across major hubs.

Regulatory bodies are also tightening mandates, compelling airports and operators to adopt more sustainable practices. Beyond compliance, there is a growing demand from airlines, passengers, and investors for visible progress on sustainability, making decarbonisation not only an environmental imperative but also a strategic business priority.

This evolving landscape makes clear that electrification is more than a sustainability requirement and rather it is creating new commercial, operational, and technological opportunities for airports as they prepare for the next generation of airside systems and propulsion solutions. The remainder of this paper examines these themes further, highlighting where electrification is opening new pathways.

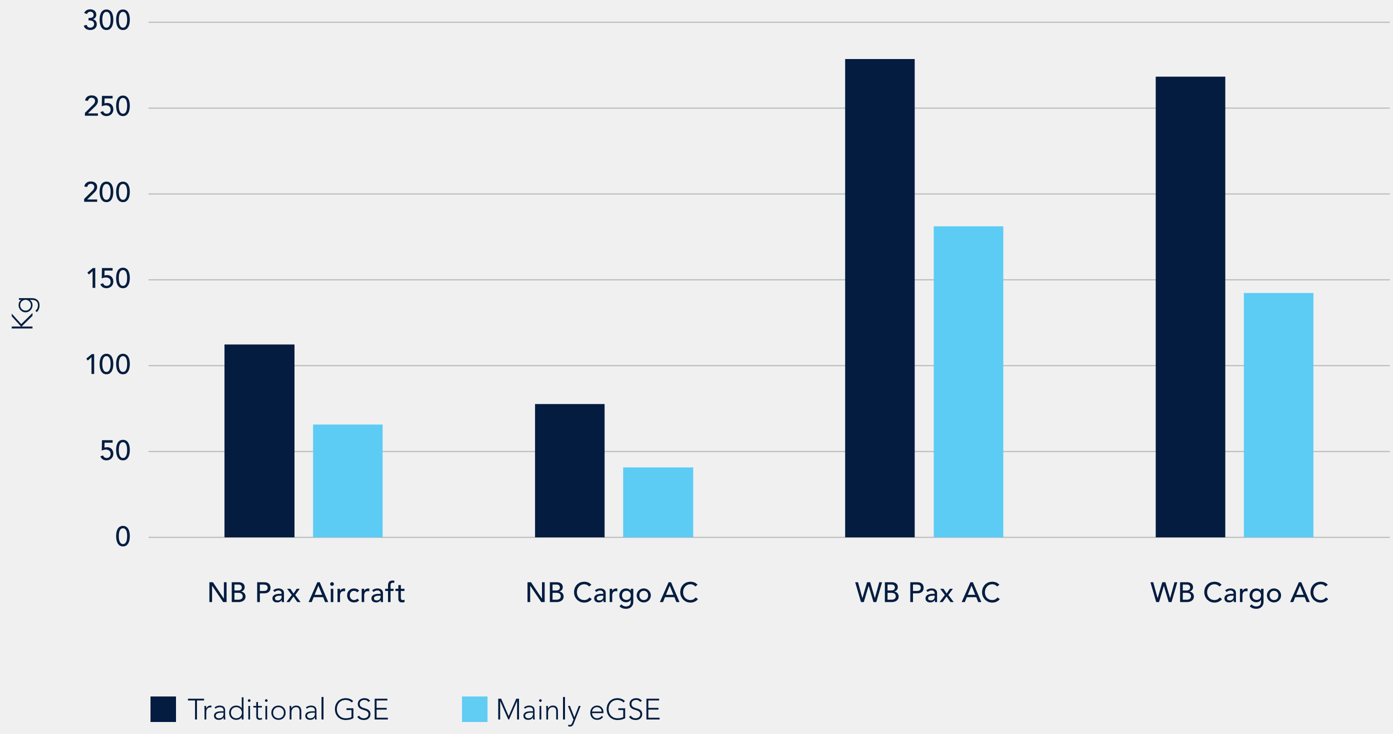
Electrification

Overview of electrification across GSE types

Electrification of GSE is emerging as one of the most impactful strategies for reducing emissions at airports, with an estimated 75% of non-aircraft airport emissions linked to ground handling activities.[1] Today, a broad range of GSE categories are transitioning to electric models, including baggage tractors, belt loaders, pushbacks, Ground Power Units (GPUs), and passenger steps. Electrification is progressing fastest in equipment categories that have predictable duty cycles and operate close to terminal infrastructure, where charging access is readily available. Heavy-duty units, such as high-reach loaders, certain pushback tractors, and catering trucks are also beginning to electrify as battery performance improves and hybrid systems become more commercially viable. This expanding equipment portfolio demonstrates that electrification is no longer limited to niche assets, rather it is becoming the new standard across airport operations, with hubs leading the transition.

[1] ACI World Insights, Does Pooling Make the Electric GSE Dream Come True? | ACI World Insights

Figure 1: CO_2 per turnaround[2]

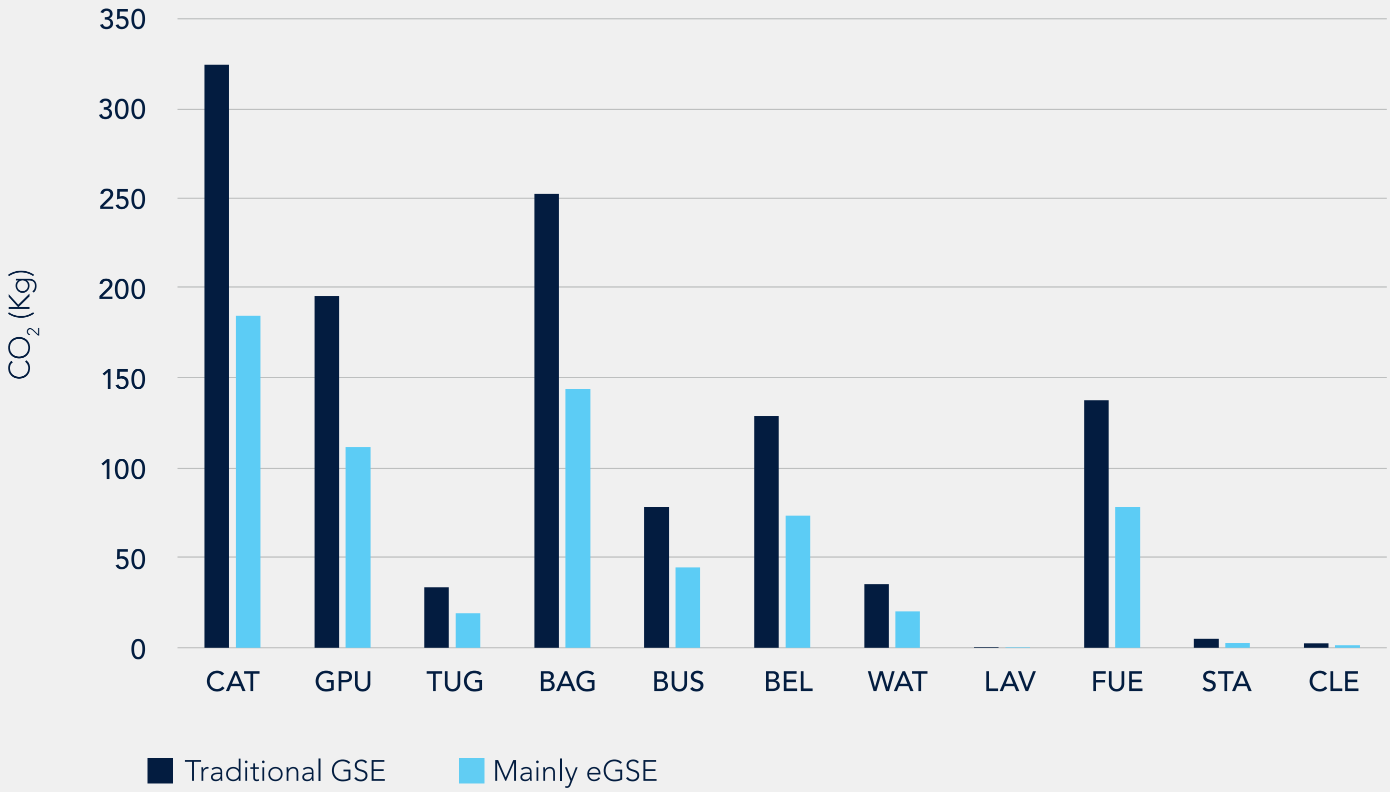


Recent modelling work by Sznajderman et al. provides further insight into how emissions vary across different types of GSE. Their Quantification Model of Airport Ground Support Equipment Emissions simulates real-world GSE movements and service cycles, estimating CO_2 outputs linked to each equipment category.[3] The study shows that heavier-duty service vehicles, such as cargo loaders, baggage tractors, and fuel trucks, tend to contribute the highest CO_2 emissions due to longer operation periods and higher engine loads, while lighter or more intermittent-use units such as lavatory trucks and stair units make comparatively smaller contributions. These differences highlight how operational duty cycles, engine characteristics, and apron layout patterns drive the carbon intensity of individual GSE types. By combining these baseline CO_2 outputs with reduction percentages derived from IATA in the chart above (Figure 1), we can calculate the expected CO_2 reductions for each GSE type by applying the percentage reduction directly to the modelled CO_2 values, producing an equipment-specific estimate of decarbonisation potential. An average reduction percentage of 43% was utilised in Figure 2, on the next page.

[2] IATA – Electric GSE, https://www.iata.org/en/programs/ops-infra/ground-operations/ground-support-equipment/electric-gse/

[3] Quantification model of airport ground support equipment emissions, Lucas Sznajderman (2022)

Figure 2: Illustrative example of potential impact of electrification on GSE[4]



GSE type	Label
GPU	GPU
Catering	CAT
Tug	TUG
Baggage	BAG
Belt load	BEL
Water truck	WAT
Lavatory truck	LAV
Fuel	FUE
Stair truck	STA
Bus	BUS
Cleaning	CLE

[4] ibid. p. 3

Global market momentum

Momentum for eGSE adoption is accelerating globally, driven by decarbonisation targets, regional regulations, and maturing supply chains. Europe remains the most advanced market, with airports in the Netherlands, the UK, the Nordic region, and Germany embedding eGSE into long-term net-zero strategies. This is driven by the ACI Europe Resolution, whereby European airports have committed to net zero emissions under their control by 2050. Asia-Pacific is rapidly catching up, particularly at major hubs such as Singapore, Hong Kong, and Sydney, where airports are directing investment toward low-emission operations. Despite the limited federal mandates for eGSE across North America, major programs at LAX and New York airports are leading the transition to electric equipment across the region. As Original Equipment Manufacturers (OEMs) production scales, airports across the Middle East are also beginning to formalise electrification plans, signalling that adoption is becoming global rather than regionally concentrated.

Ground handler and OEM collaboration

Independent ground handlers (IGHs) are becoming central actors in accelerating electrification. Large service providers such as dnata, Menzies Aviation, and Swissport have publicly committed to transitioning significant portions of their fleets to electric models and are integrating eGSE adoption into their sustainability strategies. In this context, it is important to note that IGH-operated GSE is accounted for differently compared to airport-owned fleets. Since airports do not directly control the assets, emissions are categorised as Scope 3, whereas airport-owned GSE falls under Scope 1.

These organisations are increasingly collaborating directly with OEMs to shape product development and deployment. For instance, Weihai GuangTai, a major Chinese GSE OEM, is collaborating with SATS, one of the world's largest ground handlers, to ensure that innovations in electric equipment match the operational needs of high-intensity ground handling operations.[5] Specialised OEMs are also following this trend. Cobus has worked with handlers to introduce electric passenger buses at major hubs, enabling reliable, large-scale service without sacrificing operational efficiency. These partnerships reduce risk, support tailored fleet solutions, and accelerate readiness for full-scale electrification.

OEM shift toward electric production

OEMs are scaling production at unprecedented levels to meet rising demand from airports and handlers. Major manufacturers such as GuangTai, TLD, JBT AeroTech, Charlatte, and Mallaghan have announced strategic pivots in recent years, increasing electric output across multiple equipment lines. Some OEMs have indicated that most of their new-production GSE will be electric from 2024 onward, reflecting both market pull and regulatory pressure. TLD, for example, announced that share of electric units sold has risen to 53% in 2024, up from under 25% in 2018.[6]

Rising demand is creating pressure on supply chains. Lead times for certain high-demand electric units, particularly belt loaders, tugs, and cargo tractors, have lengthened as OEMs expand production capacity. To address this, many manufacturers are investing in larger assembly facilities, battery integration partnerships, and more modular designs that can be produced at scale. The direction is unmistakable: eGSE is becoming the core of OEM strategy, and capacity is expanding each year to accommodate the industry shift.

[5] SATS collaborates with global GSE manufacturer Guangtai, https://payloadasia.com/2025/04/sats-global-gse-manufacturer-guangtai-drive-innovation-airport-ground-support-technologies/

[6] Alvest 2024 ESG Report

Airport decarbonisation

Airports around the world are setting ambitious decarbonisation targets and, as part of this, implementing innovative programs to accelerate the transition to eGSE. These initiatives not only demonstrate environmental leadership but also provide blueprints for others in the industry. Table 1 provides a sample of airports leading the transition to net-zero GSE. The timelines for each airport's eGSE transition are shown in Figure 3.

Table 1: Airport decarbonisation strategies

Airport group	Decarbonisation strategy
London Gatwick	Progressing from the initial "First Decade of Change" roadmap, as part of Gatwick's Second "Decade of Change" strategy, the airport is committed to achieve net-zero Scope 1 and 2 emissions by 2030. The policy sets out the requirement for all airport duty vehicles and ground support equipment to meet zero or ultra-low emission standards by 2030.[7] Diesel GSE has already been switched to hydrotreated vegetable oil (HVO), and as part of Gatwick's continued electrification programme, light duty vehicles, which are readily available on the market, are being switched to electric variants.
Manchester Airports Group (MAG)	MAG, which includes Manchester Airport, East Midlands Airport, and Stansted Airport, is a European leader in its decarbonisation efforts, having achieved carbon neutrality in 2016[8]. As part of its net-zero roadmap, MAG had pledged to achieve net-zero Scope 1 and 2 emissions no later than 2038, transitioning its fleet of GSE to ultra-low emission vehicles by 2030. In the roadmap, MAG has highlighted that for certain vehicle types, including snow-clearing and heavy-load towing vehicles, there are no suitable zero-emission vehicles available on the market.
Royal Schiphol Group	The airport has an ambitious target to make all Dutch airports emission-free by 2030.[9] This pledge includes eliminating emissions from all ground traffic, encompassing both the airport's own fleet and partner-operated vehicles. To achieve this, Schiphol is deploying large-scale eGSE fleets supported by centralised charging hubs, ensuring operational efficiency while reducing carbon output. This integrated approach highlights the importance of infrastructure planning alongside equipment electrification.
Port Authority of New York and New Jersey	The Zero-Emission Airside Vehicle (ZEAV) rule mandates the transition of all airside vehicles and motorised equipment to zero-emission models by 2030.[10] This policy is a cornerstone of the region's broader climate strategy and reflects a regulatory framework that incentivises operators to adopt electric technologies. By coupling clear timelines with compliance requirements, the Port Authority is creating a structured pathway for sustainable ground operations.
Singapore Changi Airport	Plans to electrify all new airside light vehicles, forklifts, and tractors starting in 2025. The airport's long-term vision is for all airside vehicles to operate on cleaner energy by 2040.[11] This phased approach balances ambition with practicality, allowing time for infrastructure development and stakeholder alignment. Changi's strategy underscores how airports in Asia are embracing electrification as part of their competitive and environmental positioning.
Hong Kong International Airport	HKIA's 2050 Net Zero Carbon Pledge and its Airside Vehicle Electrification Programme have made it a regional leader. Since 2013, HKIA has phased out fossil-fuelled fleets in stages, requiring EVs for all saloon cars in restricted areas (2017), replacing all airside private vehicles under 3 tonnes with EVs (2023), and planning to phase out non-electric vans, minibuses, and buses by 2030. Additionally, HKIA's GSE Pooling Scheme, where 95% of pooled GSE is electric, significantly reduces emissions and congestion across the apron. These initiatives demonstrate how mandates and airport-led procurement models can rapidly scale electrification.

[7] Gatwick Airport – Second Decade of Change, https://www.gatwickairport.com/on/demandware.static/-/Sites-Gatwick-Library/default/dw067967e7/images/Corporate-PDFs/Sustainability/Second_Decade_of_change_policy_to_2030.pdf

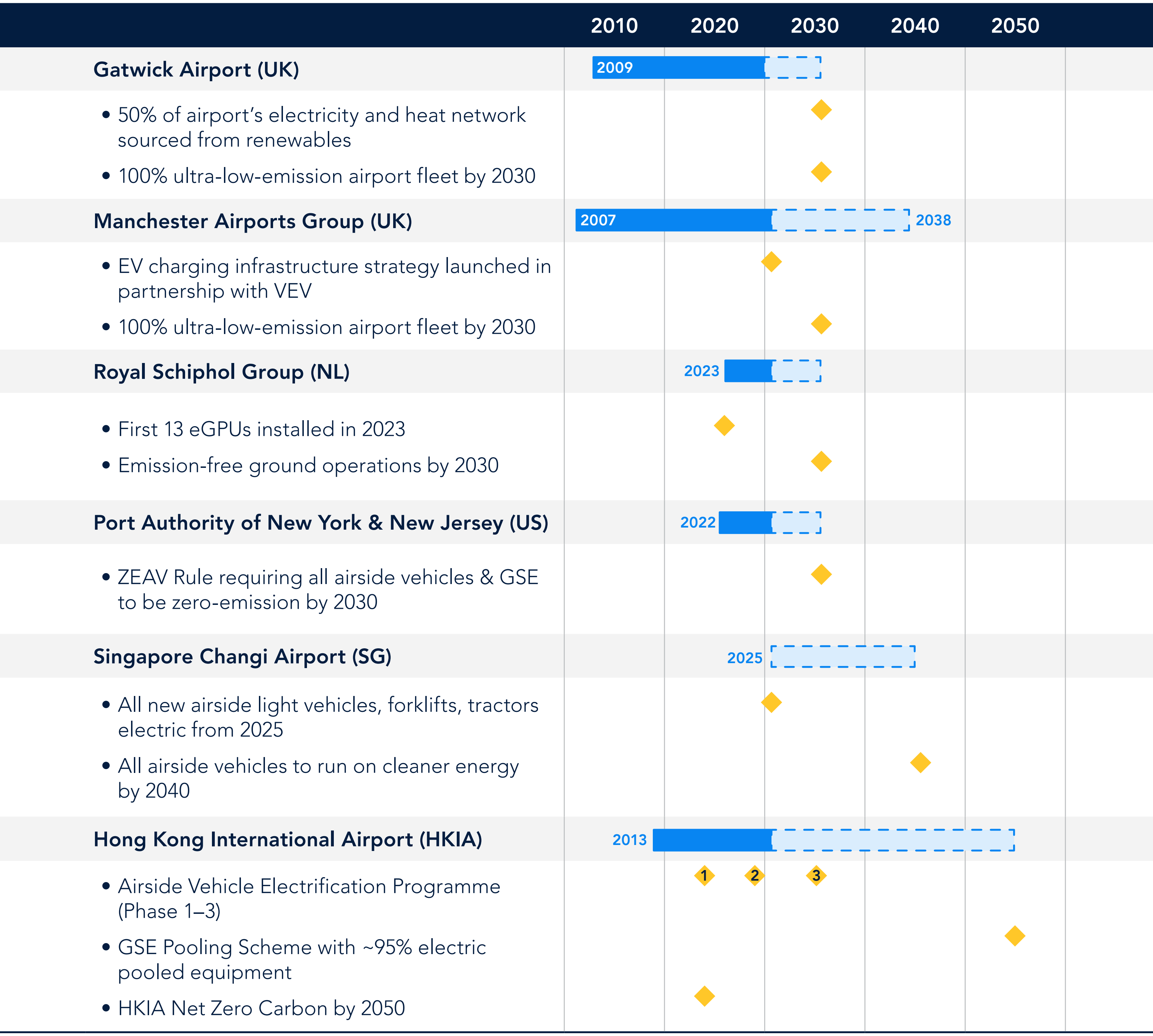
[8] Manchester Airports Group – Net Zero Carbon Roadmap, https://assets.live.dxp.maginfrastructure.com/f/73114/x/eb4273800d/mag-net-zero-carbon-roadmap-june-2024.pdf

[9] Schiphol Group – Emission free by 2030, https://www.schiphol.nl/en/schiphol-as-a-neighbour/emission-free-by-2030/

[10] Port Authority of NY, https://www.panynj.gov/port-authority/en/press-room/press-release-archives/2025-press-releases/the-port-authority-of-new-york-and-new-jersey-and-jfk-millenium-partners-developer-of-jfk-international-airport-terminal-6-announce-agreement-to-debut-pooled-fleet.html

[11] Sustainable Changi, https://www.changiairport.com/en/corporate/our-sustainability-efforts/environment/tackling-emissions.html

Figure 3: Timeline for GSE and airside vehicles decarbonisation strategies[12]



[12] Airside Vehicles Electrification Programme, Airport-wide Electric Charging Infrastructure & GSE Pooling Scheme - Airside Vehicles Electrification Programme, Airport-wide Electric Charging Infrastructure & GSE Pooling Scheme - HKIA 2050 Net Zero Carbon Pledge

Barriers to eGSE implementation

Figure 4: Key challenges of electrifying GSE

High initial cost

Significantly higher capex per unit for fleet electrification

Infrastructure constraints

Many airports lack apron-side electrical capacity for charging stations. Installation will create operational disruptions

Grid limitations

Utility upgrades required as existing grid capacity insufficient for large-scale eGSE adoption at most airports

Cost pressures

Electric fleets add costs such as peak-demand tariffs, and periodic battery replacements

As airports progress toward large-scale electrification, several operational, financial, and infrastructure-related challenges continue to shape the pace and feasibility of eGSE adoption. Some of these key barriers are outlined briefly below.

Higher upfront costs

A major barrier to GSE electrification is the higher upfront capital cost. eGSE typically carriers a 20%-30% higher upfront capital cost than equivalent diesel models due to battery systems, and limited global production scale, creating budgetary pressures for both airports and operators. However, when considering the total cost of ownership, eGSE delivers significantly lower fuel costs, reduced maintenance, and longer asset lifecycles resulting in lower long-term operating costs. Studies suggest that airports which delay their transition to eGSE could face up to 20% higher operating costs by 2028.[13] Access to leasing models, pooling schemes, airport-funded charging infrastructure, and government incentives is also helping spread or reduce capital requirements, making electrification financially viable despite the higher upfront investment.

[13] RNG Strategy Consulting, The Future of GSE

Electric infrastructure requirements

The successful transition to eGSE hinges on robust infrastructure planning. Charging stations are the cornerstone of this transformation, and their placement strategy is critical. Airports must ensure chargers are distributed to be conveniently located near gates, cargo areas, and maintenance zones to minimise operational disruptions and optimise turnaround times. At the same time, the limited premium airside space will constrain the size and distribution of charging stations, so robust planning will be paramount to their successful implementation. Centralised charging hubs, as seen in leading airports, can further streamline energy distribution and fleet management.

Grid capacity

Beyond physical infrastructure, grid capacity is a major consideration. Electrification introduces significant new energy demands, particularly during peak operational periods which will require maintenance workshops upgrades to support high-voltage charging systems. Airports will need to collaborate with utility providers to upgrade grid connections and incorporate fast-charging capabilities without compromising reliability. This challenge underscores the importance of forward-looking energy planning.

Energy management

Energy management systems (EMS) play a pivotal role in optimising charging schedules and reducing costs. Smart systems can balance loads, prioritise critical equipment, and integrate predictive analytics to optimise charging schedules based on utilisation patterns, ensuring efficient energy use. Coupled with renewable energy sources such as solar arrays and battery storage, airports can create a sustainable and resilient power ecosystem. These integrations not only reduce carbon emissions but also provide long-term cost stability and energy independence.

In short, electrification is not just about replacing equipment, it requires a holistic approach to infrastructure, energy strategy, and operational planning. Airports that invest early in scalable, intelligent systems will be best positioned to meet sustainability targets while maintaining operational excellence.

Opportunities from electrification

It is important to understand that electrification is more than just a sustainability initiative, it opens new revenue streams, operational efficiencies, and strategic advantages for airports.

Immediate revenue generating opportunities

Airports and GSE providers/lessors can monetise their charging infrastructure through Charging-as-a-Service models, offering airlines and ground handlers access to reliable charging for a fee. This creates a recurring revenue stream while supporting sustainability goals. Additionally, airports that integrate renewable energy sources such as solar panels and battery storage can explore energy trading, selling excess power back to the grid. This raises an important question: Can airports become energy producers? The answer is increasingly yes, as many airports are investing in on-site renewable generation to reduce reliance on external suppliers and create new financial opportunities.

Cargo opportunity

The rise of e-commerce has amplified the importance of efficient and reliable cargo handling, making it an increasingly strategic focus for airports. Electrified cargo equipment not only reduces emissions but also enhances operational resilience through improved reliability, lower maintenance requirements, and more predictable performance compared to diesel counterparts. This shift reduces operational risk for airports and handlers, particularly in intensive cargo environments where equipment downtime directly affects service levels and throughput. By offering greater uptime, smoother performance, and more stable operating costs, electric cargo GSE helps airports strengthen service agreements, minimise disruption, and support growing demand with lower financial and operational exposure. In this way, electrification positions airports to compete more effectively in the logistics market while lowering risk across day-to-day cargo operations.

Creation of space and resources

Transitioning away from fossil fuels reduces the need for large fuel storage facilities, freeing up valuable real estate. Airports can repurpose this space for commercial development, additional cargo capacity, or Advanced Air Mobility infrastructure, creating new revenue streams and operational flexibility.

Pooling

GSE pooling consolidates equipment into a single, shared fleet at a terminal or airport, and is used by both airline-owned handlers and IGHs. Pooling presents a significant opportunity, enabling airports to achieve a reduction in total GSE fleet, which lowers airport space demand and minimises ramp congestion. This typically shortens transit time between gates, reduces airside incidents, and improves airline punctuality—particularly as pooled contracts operate under a charge-per-turn model that incentivises efficiency. As highlighted in Section 1, the adoption of pooling results in GSE units being airport-owned, shifting emissions from Scope 3 to Scope 1. This change in emissions accounting is a key driver of GSE electrification, as demonstrated by airports in Europe and North America that have adopted pooling models.

Electrification is not just a compliance measure but a catalyst for innovation and growth. Airports that embrace these opportunities will position themselves as leaders in the next era of aviation.

Future opportunities

While electrification is the immediate priority, the future of sustainable ground operations will be shaped by emerging technologies and collaborative strategies.

Hydrogen hybrid GSE

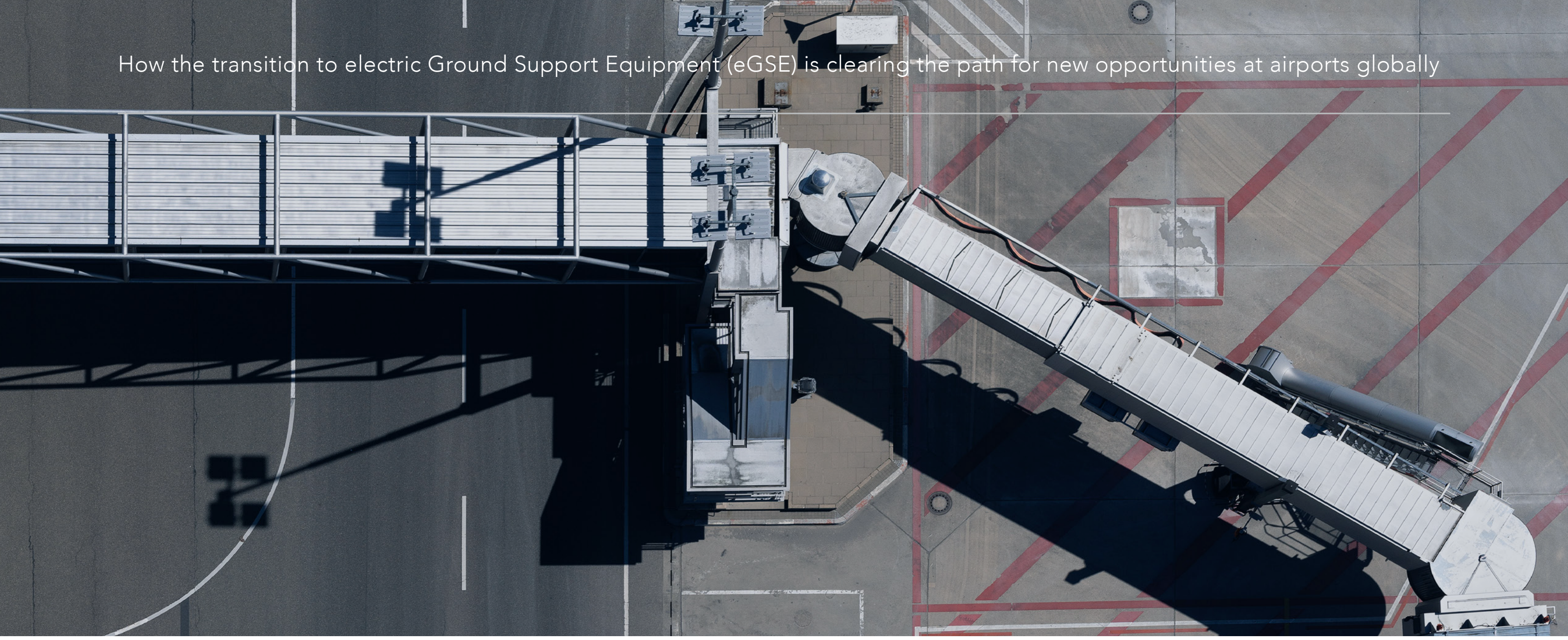
For heavy-duty applications where battery limitations persist such as high-torque tractors, continuous-use loaders, or equipment operating far from fixed charging points, hydrogen-powered or hybrid GSE offers a promising alternative. Hydrogen fuel cells provide longer operating durations, rapid refuelling, and strong performance in extreme temperatures, enabling more seamless integration into high-intensity airside environments. As infrastructure develops and green hydrogen production scales, airports exploring hydrogen today will be well-positioned to adopt future hybrid propulsion systems. This early preparation reduces long-term transition risk, ensures operational readiness, and creates a pathway for airports to diversify their propulsion portfolios beyond solely battery-electric solutions.

Advanced Air Mobility (AAM)

Electrification also lays a crucial foundation for the integration of AAM into airport ecosystems. eVTOL aircraft will require high-capacity charging, intelligent energy management, and strategically located vertiport infrastructure, all of which align closely with the systems airports are already deploying for eGSE. By investing early in the electrification needed for eGSE, airports are effectively building the backbone required to accommodate AAM operations. This creates new commercial opportunities in passenger connectivity, urban mobility partnerships, and intermodal transport integration. It also reduces future infrastructure risk, as airports that adopt scalable charging and energy systems today can expand into AAM with significantly lower incremental investment. In so doing, this increases the readiness for electric aviation technologies by reducing development lead times for AAM infrastructure. In this sense, eGSE electrification is an enabler for the next generation of airside mobility.

AI-driven fleet optimisation

Artificial intelligence will transform how airports manage electric fleets. Predictive maintenance powered by AI can reduce downtime and extend equipment life, while smart charging algorithms optimise energy use and minimise peak load costs. These capabilities will be essential as fleets grow and energy demands increase.



Integration with smart airports

Electrification aligns naturally with the broader evolution toward smart airport ecosystems. As fleets become increasingly digital, Internet of Things (IoT) sensors, telematics, and real-time analytics can optimise charging, track utilisation, and monitor equipment performance with far greater precision than traditional diesel systems. These tools support predictive maintenance, reducing downtime and improving asset longevity, while energy-management platforms provide visibility into load profiles, peak demand periods, and renewable generation. Together, these systems create a data-driven operational environment where airports can improve efficiency, automate key processes, and enhance sustainability reporting. Electrification, therefore, acts as a catalyst for airports to accelerate their smart-infrastructure roadmaps, lowering operational risk and enabling better-informed strategic decision-making.

Cross-sector collaboration

The scale of electrification requires partnerships beyond aviation. Collaborating with energy providers, technology firms, and infrastructure specialists will enable airports to deploy scalable solutions. These alliances can unlock innovations such as microgrids, renewable integration, and advanced storage systems, ensuring resilience and cost efficiency.

The future of GSE electrification is not just about replacing diesel engines but about building a smarter, cleaner, and more connected operational model. Airports that embrace these opportunities will lead the industry into a new era of sustainable aviation.

Conclusion

The transition to eGSE represents far more than a shift in power source technologies, rather it is enabling airports to build a smarter, cleaner, and more connected operational model. As electrification unlocks new commercial opportunities, strengthens operational resilience, and lays the foundation for next-generation airside systems, airports that embrace these changes early will be positioned at the forefront of sustainable aviation. Those that adapt now will not simply meet regulatory expectations, but they will help define the next era of airport innovation and competitiveness.

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