Joint Roadmap Zero Emission Airside Operations

2023 – 2030

Version 1.0

31/05/2023

The joint roadmap discusses the following chapters

Multiple developments require a joint roadmap to achieve zero emission airside operations in 2030

Quality of Life & Work

Roadmap Sustaining Your World

Sustainable Aviation Table

License to Operate

Netherlands Labour Authority*

Nederlandse Arbeidsinspectie
Ministerie van Sociale Zaken en Werkgelegenheid

Joint Roadmap Zero Emission Airside Operations 2030

GSE leasing
General handling
Cargo handling
Refueling services
Line maintenance
Cleaning services
Catering services
Crew transport
General Aviation
Main contractors
Royal Schiphol Group

*Nieuwsbericht | Nederlandse Arbeidsinspectie
Link to background information

This roadmap provides recommendations to achieve zero emission airside operations in 2030 together

THE ASSIGNMENT
Describe what is required to achieve a zero emission* ground operation on airside by 2030 in collaboration with all parties that operate on airside.

GOAL OF THIS DOCUMENT
Provide clear recommendations, by the research team, for AAS and all parties that operate on airside to realize the shared goal. However, every party has different types of equipment and vehicles. Therefore, the importance of recommended actions could vary for each party involved.

METHODS
To establish the recommendations in this roadmap, interviews with parties on airside and AAS have been held by the research team, as well as interviews with equipment suppliers and manufacturers. In these interviews, parties have shared their equipment overviews, sustainability plans and challenges. Furthermore, desk and field research, data analysis and feedback sessions have been held to create the joint roadmap with its recommendations.

FOLLOW-UP OF THE ROADMAP
AAS and all parties on airside commit to make a best effort in executing the actions of the joint roadmap and acknowledge that achieving zero emission airside operations in 2030 might have financial and operational consequences. As this roadmap is based on the current knowledge and availability of equipment, the roadmap will be updated annually. The deadlines mentioned in the recommendations are subject to developments (e.g., of the Netherlands Labour Authority, other legislation or innovations).

*Link to Glossary explaining our definition of zero emission

In collaboration with parties active on airside, e.g.:

Act now to achieve zero emission airside operations

There are several reasons why we collaborate to achieve zero emission airside operations:

- **Sustainable and healthy work environment** for employees.
- **Concrete actions** to combat climate change and improve local air quality.
- Anticipate on **upcoming legislation.**
- Anticipate on **expected enforcement** from Dutch government.
- **Shared vision** of AAS and parties active at airside.
- **Coordination of actions** amongst parties in the coming years.
- Using **shared knowledge** to find creative solutions.
- **Contribute to a joint roadmap** and **accelerate the right actions.**

Existing collaborations already work towards zero emission airside operations

Sustainable Aviation Table

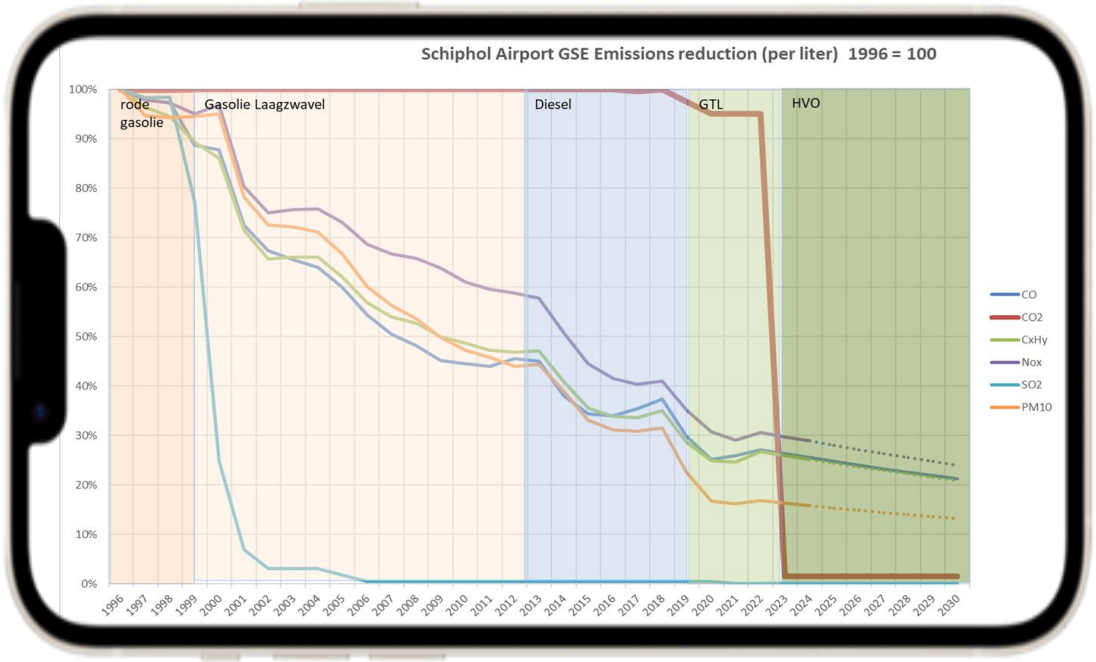
Collaboration group UFP

Smart and sustainable

TULIPS

TULIPS

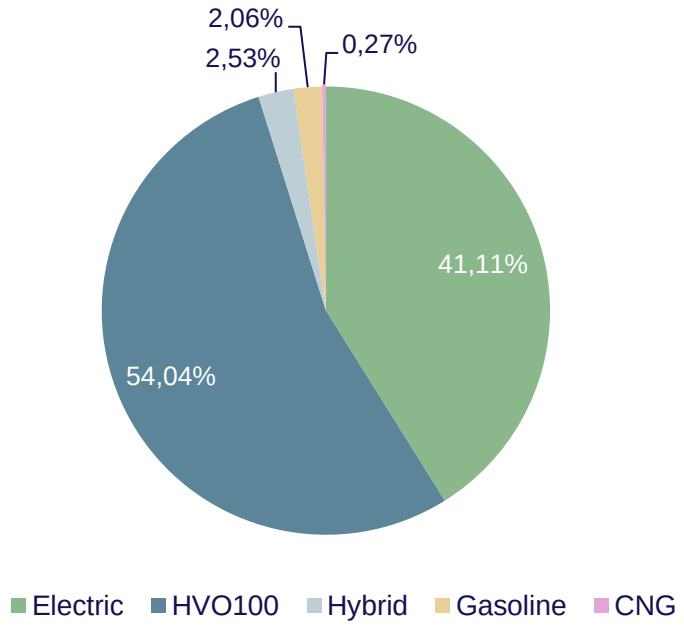
All parties have already done a lot to reduce emissions

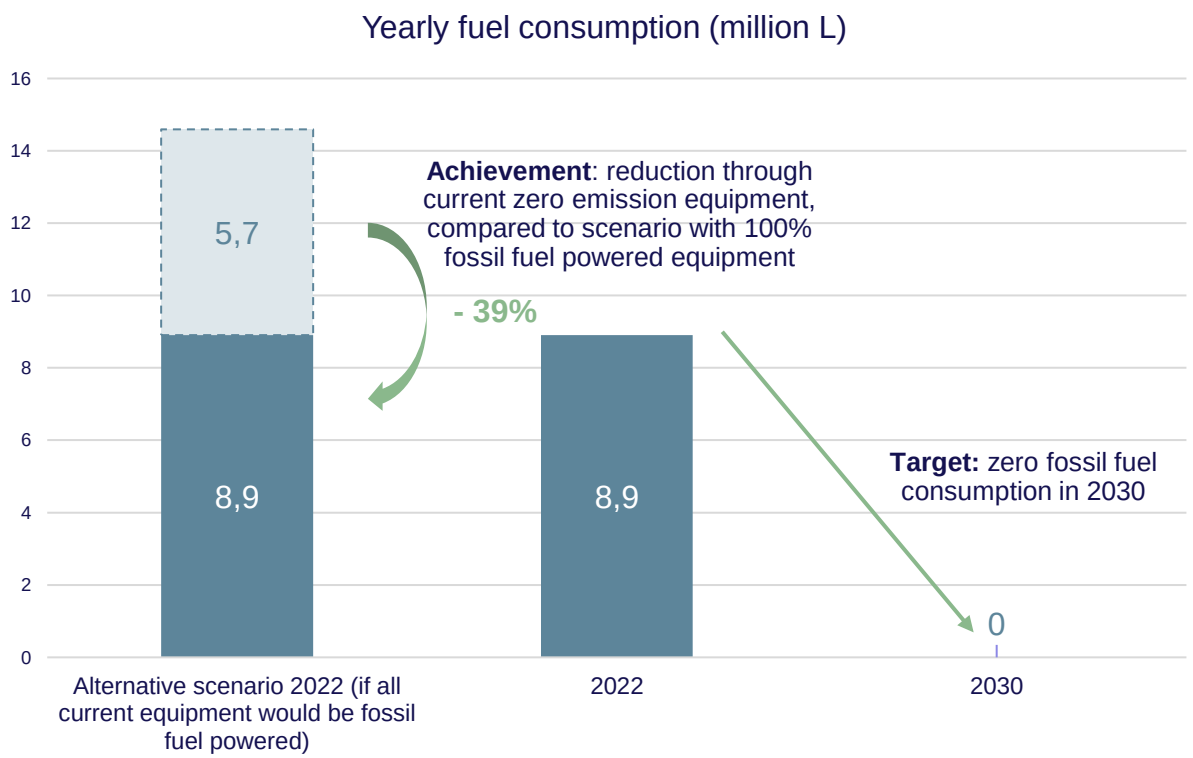


A lot of equipment has already been replaced by electric alternatives

Current efforts have led to a reduction of 5,7 million L fuel consumption per year, now 8,9 million L fuel to go

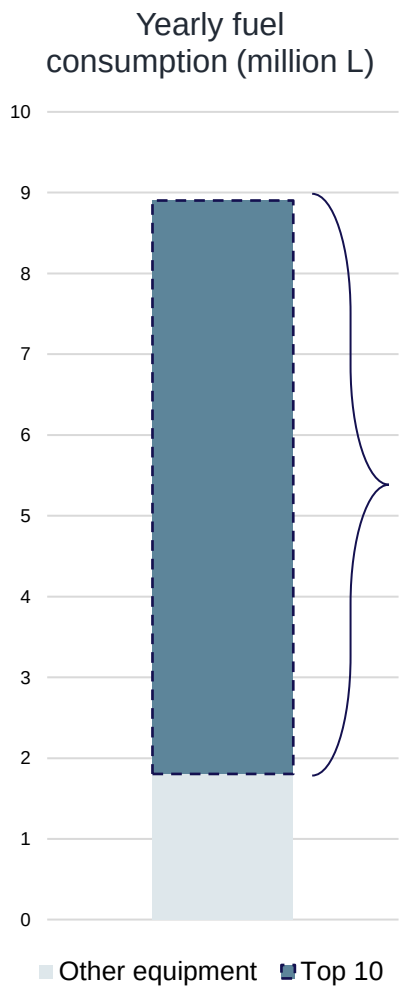
Type of engine of current equipment
(% out of total of 2576 units collected)*



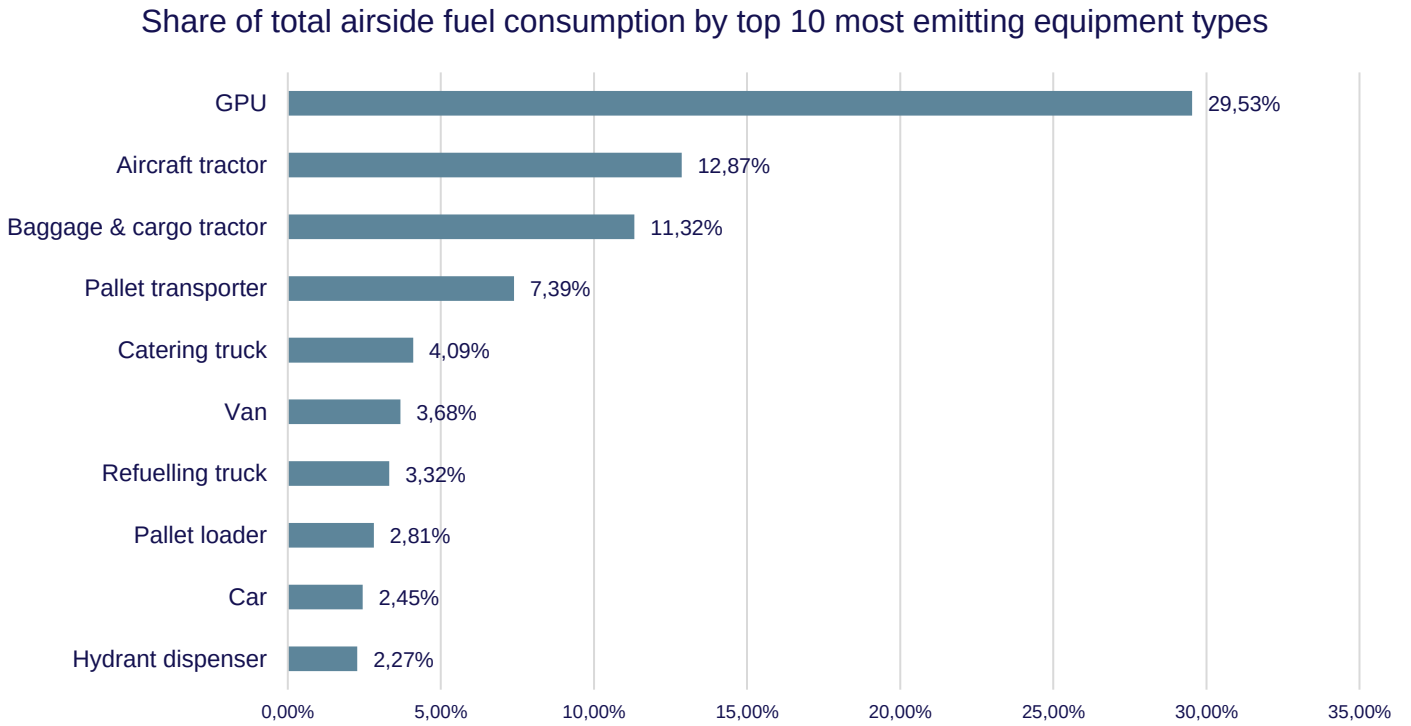


* Based on information received by parties that operate on airside during the interview process.
Link to background information

Top 10 major emitters consume 80% of total yearly fuel



80% of total fuel consumption caused by 10 equipment types



Equipment types that are part of the top 10 will be marked by a yellow star in the remainder of the roadmap

Link to background information

We acknowledge the mutual challenges for all parties

CHALLENGES ON THE ROAD TO ZERO EMISSION AIRSIDE OPERATIONS

- **Delivery times:** Long delivery times of zero emission alternatives (currently up to 15-24 months) could put the milestones and goals at risk.
- **Availability of zero emission alternatives:** For some types of equipment, zero emission alternatives are not yet (widely) available on the market. For some types of aircraft that are no longer produced (e.g., A380), no new (zero emission) equipment will be developed anymore. Hence, zero emission alternatives might never be available on the market.
- **Availability of charging infrastructure:** On some parts of the airport, sufficient charging infrastructure might not yet be available. This can create an operational challenge for handlers once zero emission alternatives have arrived.
- **Operational feasibility:** Zero emission alternatives might not yet be operationally feasible in the current operation, due to long distances that need to be driven and limited battery capacity.
- **Financial challenges:** The replacement of current equipment with zero emission alternatives before the end of its natural depreciation period, can cause a large financial burden on handlers due to the early write-off of equipment. Additionally, zero emission alternatives can be more expensive than fossil fuel versions.
- **Contractual obligations:** Contracts between parties on airside and equipment leasing companies about the number of years the equipment needs to be used could create difficulties for early replacement.
- **No 1-on-1 replacement**: The zero emission alternative of fossil fuel equipment does not in always function exactly the same, meaning that 1-on-1 replacement is not always possible. Due to this, some types of equipment require a bigger number of zero emission equipment, leading to more equipment in total at airside.

Several opportunities for accelerating the roadmap

OPPORTUNITIES FOR THE IMPLEMENTATION OF THE ROADMAP

- **Retrofitting of existing equipment** to zero emission equipment offers the opportunity to avoid long delivery times of new equipment and avoids the need to get rid of fuel equipment before the end of its depreciation period. This could be an opportunity to avoid a) long delivery times, b) reduce replacements costs/investments and c) provide a solution for equipment where an alternative is not yet available on the market (especially for aircraft that are no longer produced and where zero emission alternatives never become available on the market).
- A **subsidy scheme** from the government could accelerate the replacement of fuel equipment by reducing the financial burden caused by the early replacement of equipment and the higher costs of zero emission alternatives. A subsidy scheme could also accelerate the construction of smart charging installations and hydrogen storage facilities.
- A **development fund** from the government could accelerate the development of zero emission equipment by the suppliers that are not currently available yet.
- The existing **Sustainable Aviation Table** is a way to share knowledge and know-how within and outside the sector to broaden the innovation opportunities and gain access to research and innovations in other sectors.
- **Technological break throughs** of innovative solutions for zero emission equipment could lead to the opportunity to pilot these innovations at Schiphol quicker than initially expected.

Link to background information

Two enabling actions allow us to work on the reduction principles that serve as the foundation for our recommendations

Enabling action 1: Charging infrastructure and policy

Reduction principle 1: If electric alternatives are operationally feasible, replace as soon as possible

Reduction principle 2: If electric alternatives are not yet operationally feasible, keep piloting and find creative solutions

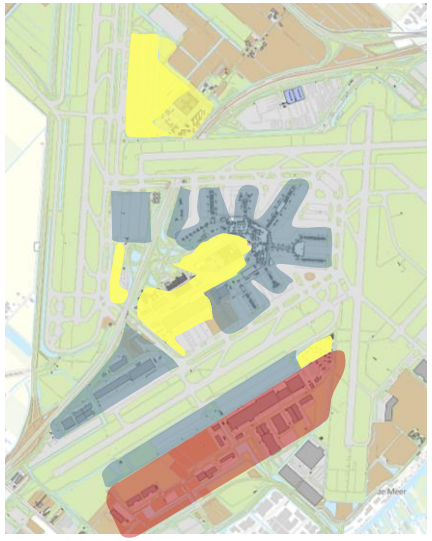
Reduction principle 3: If electric alternatives do not exist, further explore other solutions

Enabling action 2: Improve collaboration amongst parties

Link to background information

Enabling action 1: Charging infrastructure and policy

Until the increased capacity of power grid is realized, alternative solutions can ensure more power



Context:

Schiphol Netbeheer (part of Schiphol Nederland BV) manages the electricity grid on the Schiphol site and ensures a reliable, safe energy supply for all users at the Airport.

Projects were started a few years ago together with public grid operators Liander and Tennet, to address a (future) shortage of transport capacity and facilitate the expected growth with new main stations. It is expected that these projects are finished by mid-2027.

Current situation:

On landside in the southeast area of Schiphol (red), one of the substations has reached the maximum transport capacity until the projects are finalized. For another substation (yellow), a prior notice for the maximum transport capacity has been issued. At this moment, other substations (grey) have not yet reached the transport capacity and the available electricity should be requested per location.

According to enabling action 1, the following actions are recommended:

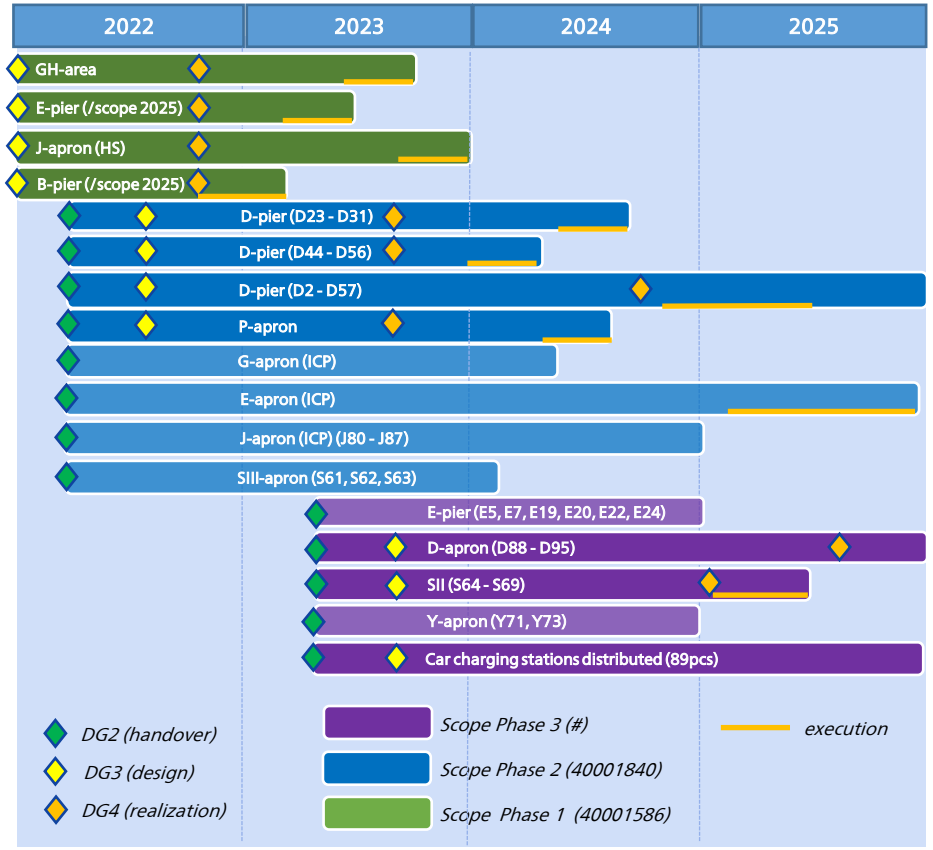
1. AAS will submit all currently known power requests at grid operator (Schiphol Netbeheer), before 1-1-2024, to gain insights in the availability of transport capacity and to accelerate the electrification of airside. After that, the grid operator needs to confirm the requests to secure power capacity on time.
2. AAS will explore the creation of a smart power grid with energy management systems, to gain insights in efficient use of available power, by 1-1-2024. If a smart power grid will be implemented, all parties commit that all new equipment on airside will be able to function in a smart way and be configurable with smart energy management systems.

Link to background information

Facilitate the ability to charge all electric equipment by creating common-use charging points on airside

According to enabling action 1, the following actions are recommended:

3. AAS continues to carry out the electrification airside program, in which it is installing charging points, fixed power units and PCA sockets at every pier and apron on airside within 6 phases (2022-2029). Also, AAS updates the program in line with the latest technical and operational know-how, also retrieved from contact with parties on airside.
4. Even if the capacity of the power grid is not yet sufficient at a certain location, charging points should already be built to ensure the ability to charge electric equipment when the capacity is increased.
5. If no grid capacity or infrastructure for charging points are available, AAS facilitates that electric equipment can be charged by 1-1-2024, using the following alternatives to bridge the gap (in this preferred order);
    1. Battery energy storage systems (iron flow battery or Li-ion battery)
    2. Hydrogen generators
    3. Fuel generators
6. AAS will, together with key users, explore including common-use fast-charging points at airside in the electrification program and research the power requirements of future charging points.
7. AAS will, together with key users, explore the construction of fast-charging stations (e.g., in the South-East area, reserved for heavy cargo equipment and aircraft tractors, for which current battery ranges require fast-charging to make electric alternatives operationally viable).



Planning of Electrification airside*, updated on 16-5-2023
(this is the current expectation, no rights can be derived from this planning)

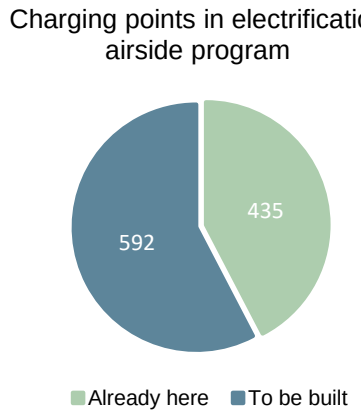
Link to background information

*Details of the phases can be found in the appendix

Facilitate the ability to charge all electric equipment by optimizing the demand and capacity balance

According to enabling action 1, the following actions are recommended:

8. AAS only focusses on creating common-use charging points on airside that can be used by all parties, instead of individual charging points.
9. AAS should explore what exactly are the operational peaks for the power demand and inform parties about these peaks before 1-1-2024.
10. All parties explore possibilities to reduce the peak of their operational power demand. All parties commit to using the charging points efficiently (e.g., by only connecting to the charging point while charging).
11. Furthermore, AAS will explore the development of a strategy of charging slots based on operational requirements of airside parties to better balance power demand and supply throughout the day.
12. AAS will explore the standardization of plug types and should inform all parties about this before 1-1-2024.

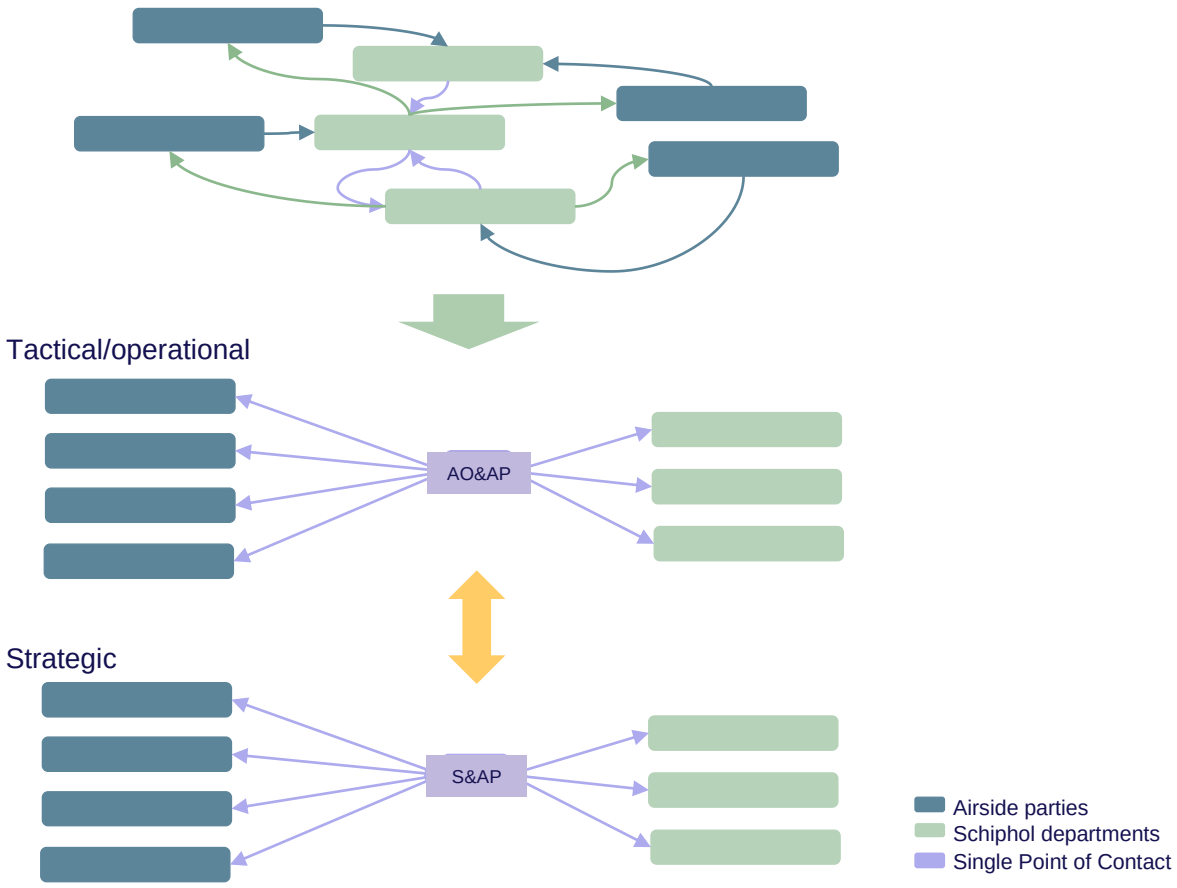


	16 amps	32 amps	63 amps
NaBo stand	2	2	-
NaBo stand regional	1	2	-
WiBo stand	2	2	2
Central side pier/apron	-	-	1
Cargo stand	1	1	6

Charging points in electrification program AAS (from 2024 onwards, this overview keeps being updated over time)

Link to background information

To share information about electrification of airside between AAS and parties on airside, dedicated points of contact are appointed



According to enabling action 1, the following actions are recommended:

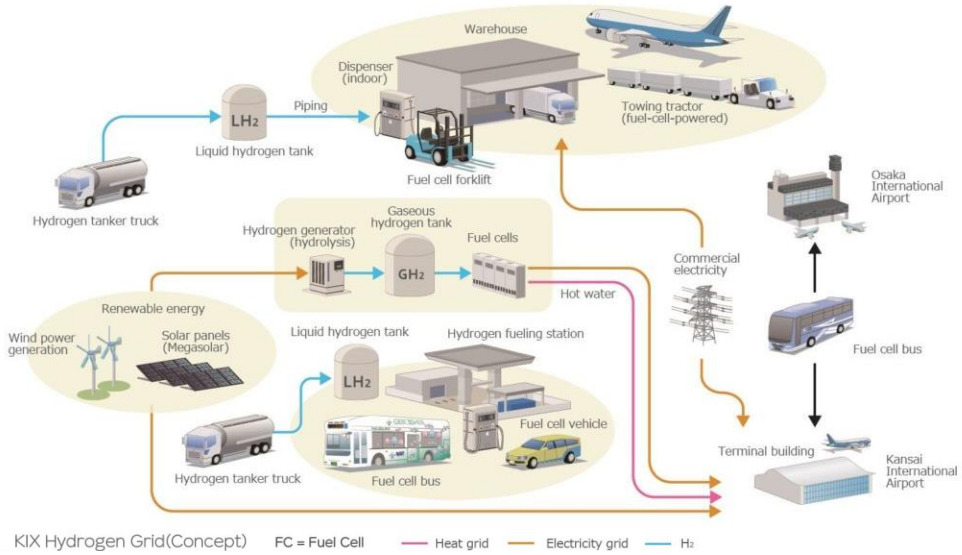
13. AAS informs all parties about updates about the electrification airside program.

14. All parties inform AAS about new equipment as soon as possible, at last when the order is placed.

15. AAS establishes a communication plan between the electrification airside program and airside parties, starting 1-7-2023.
    1. Parties will have dedicated points of contact within AAS to communicate about their needs on electrification of airside. For information about the long term, innovation and electrification, a point of contact will be appointed within the strategy department (S&AP). For information about the operations, a point of contact will be appointed within the operations department (AO&AP).
    2. All parties on airside receive semi-annual updates of the electrification airside program and provide updates regarding the electrification of their fleet.

Link to background information

Invest in hydrogen for a future of sustainable airside operations



Source: International Airport Kansai

Based on interviews with equipment manufacturers as well as desk research and current innovations which are currently being tested we expect that hydrogen equipment will be available. Especially for heavy specialized equipment hydrogen is likely to be an operationally feasible solution.

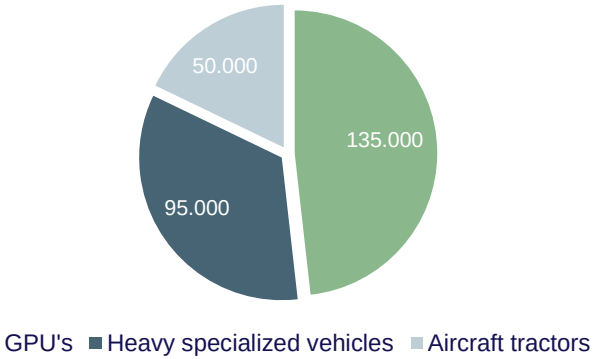
Hydrogen gas tube trails is a possible solution on the short-term to refuel equipment types which are currently not operationally feasible in an electric alternative (specialized heavy equipment, H_2-GPU's and aircraft tractors).

Based on current insights, it is expected that 2 to 4 tube trucks daily are necessary to bring sufficient hydrogen to airside (710 kg daily demand H_2). Also, when demand of hydrogen rises above 4 full gas tube trucks per day, liquid hydrogen tanks which are fueled by trucks would be more efficient and safer.

According to enabling action 1, the following action is recommended:

16. AAS continues to actively contribute to the project in the TULIPS program, Naco and ACI Europe and make use of the knowledge and relevant contacts to keep exploring the possibilities for hydrogen and hydrogen infrastructure.

Expected yearly hydrogen needs in 2030 (in kg)*



*Estimation based on 23% of total GPU fuel usage, total fuel usage of specialized heavy equipment and 20% of aircraft tractors

Link to background information

With these recommendations, the implementation of the reduction principles are facilitated

The following recommendations are important for the success of the reduction principles:

17. Apart from replacing equipment with zero emission alternatives, all parties on airside will optimize the efficiency of their operation to minimize the demand of fuel, electricity or hydrogen – according to the first step of the *trias energetica* principle.

18. AAS will enforce that next to the equipment refuelling on airside (where HVO100 is the only available fuel), all equipment refuelling outside of airside that drives on airside must be fuelled with HVO100 from 1-1-2024.

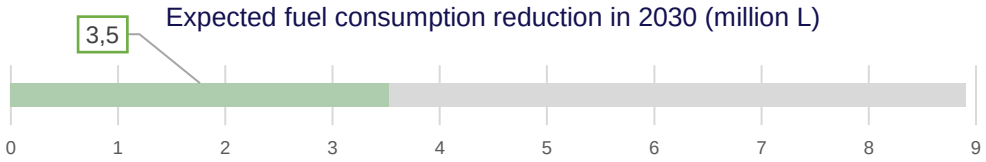
19. AAS and handlers keep exploring the use of equipment pooling. Results of the current pilot will lead to a plan for future equipment pooling and ownership structure.

20. AAS will explore the facilitation of an (autonomous) electric shuttle service for employees working at airside to reduce movements and required passenger vehicles and inform all parties about this before 1-1-2024.

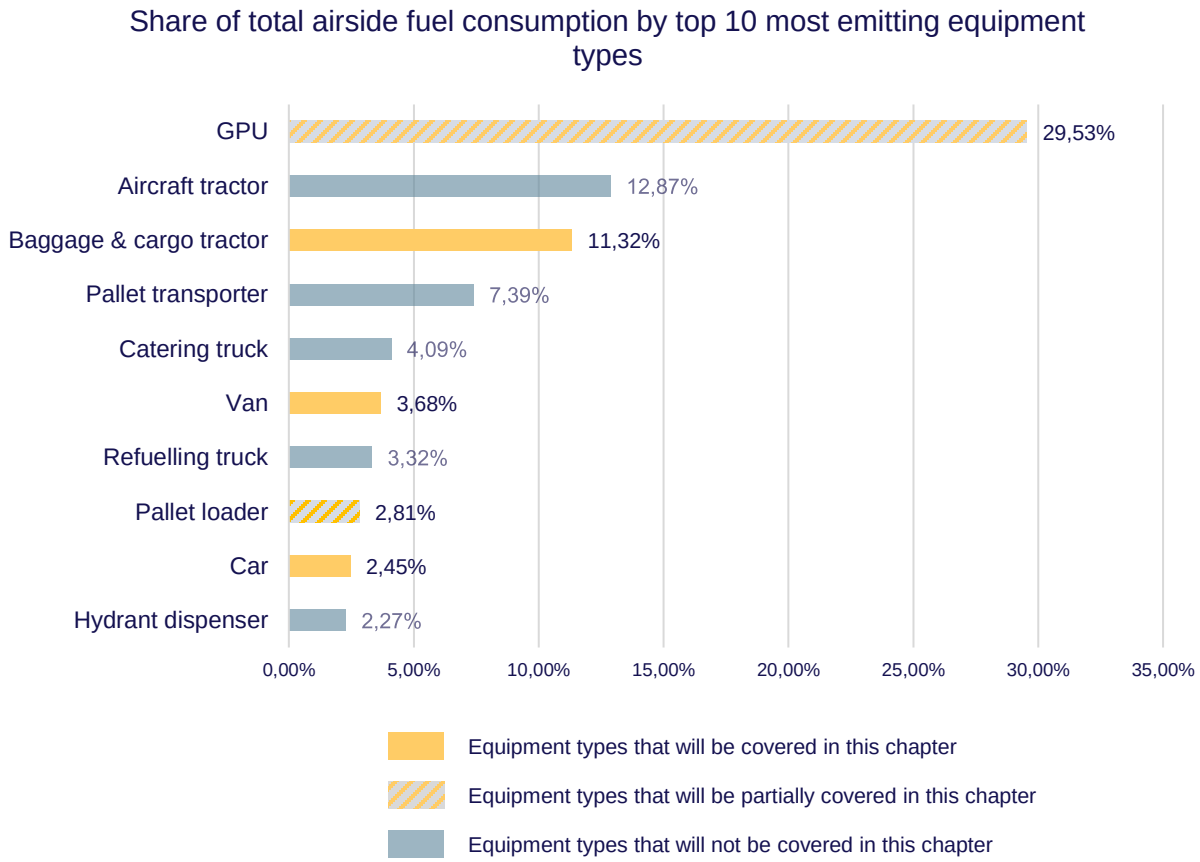
21. AAS continues exploring setting up a vehicle registration system in for all users of airside, including information on the type of engine.

Reduction principle 1: If electric alternatives are operationally feasible, replace as soon as possible

Five out of the ten biggest emitters have electric alternatives available and therefore will be phased out as soon as possible

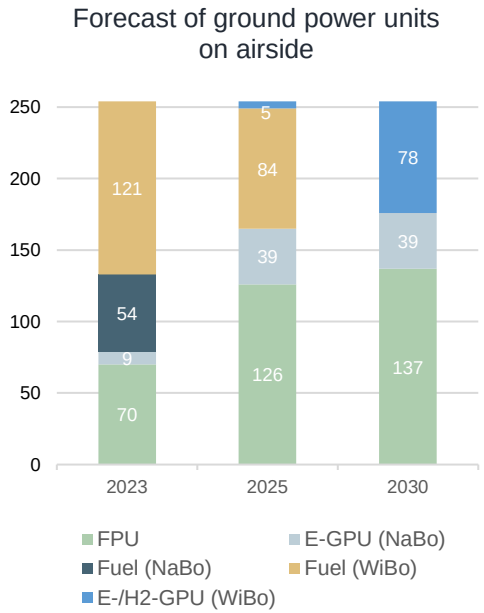


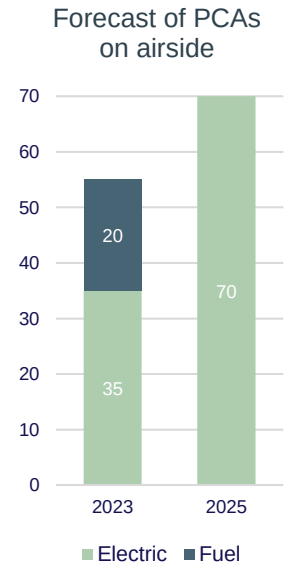
Link to background information

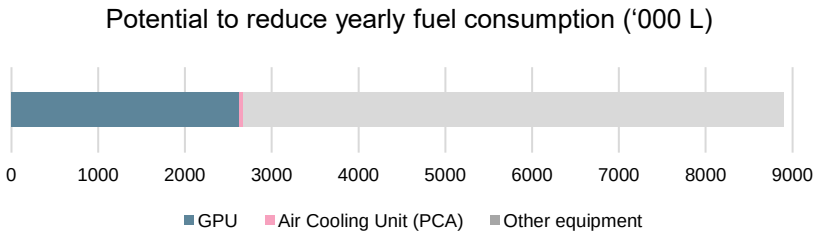


Equipment types that are part of the top 10 will be marked by a yellow star

Focus on FPUs and if not possible E-GPUs to save more than 2,6 million L fuel per year





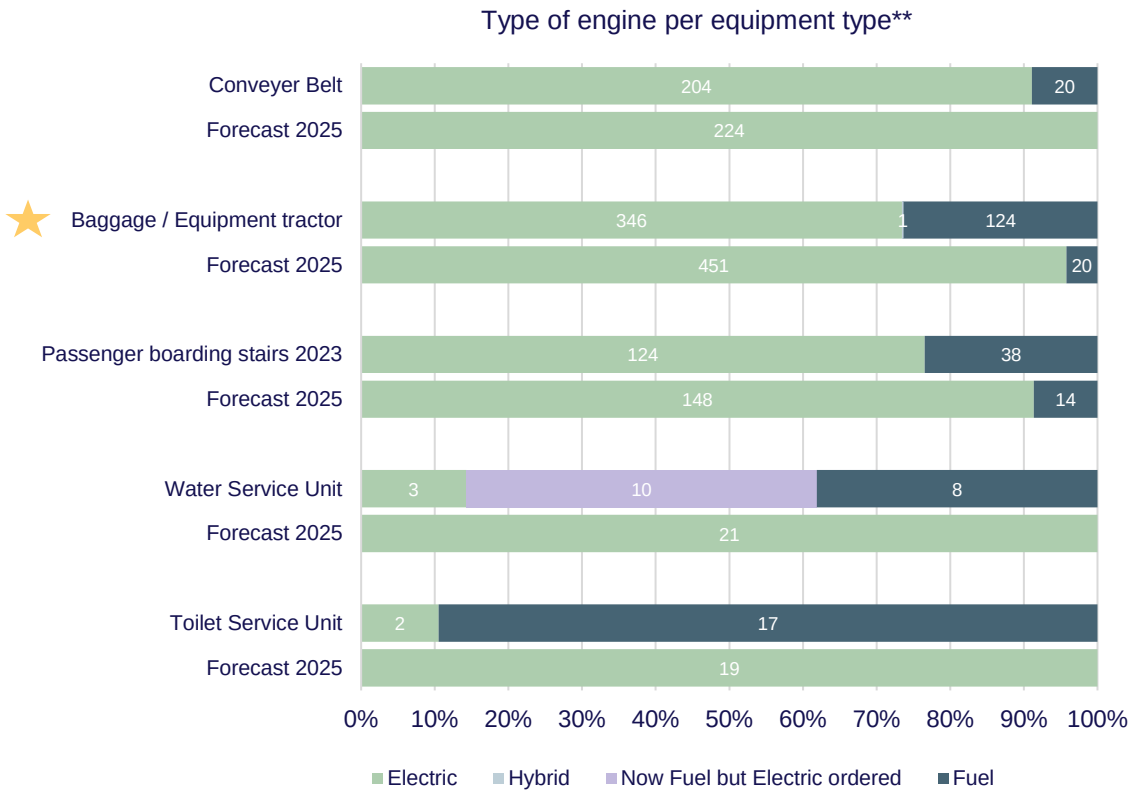


According to reduction principle 1, the following actions are recommended:

1. FPUs are the preferred replacement for GPUs on fossil fuel and AAS keeps installing these as soon as possible, latest before 1-1-2030.
    1. When a NaBo stand does not have a FPU (yet), E-GPUs are the preferred solution (with KES being the facilitator of the E-GPU pool).
    2. When a WiBo stand does not have a FPU (yet), H_2-GPUs or WiBo E-GPU are the expected solution.**
2. All parties commit to not purchase NaBo GPUs and PCAs on fossil fuel from 1-6-2023, because this alternative is already available.
3. AAS and KES will continue piloting with H_2-GPUs and WiBo E-GPU, including safety assessment.
4. AAS will supply electric PCAs, in line with the action plan AAS submitted to IL&T.***
5. All parties commit to phase out all aircraft facilities (GPUs and PCAs) on fossil fuel within the green zone in Schiphol centre in accordance with the Netherlands Labour Authority* (by 1-1-2024). Exceptions are:
    - The inside of Pier D: latest 1-1-2025
    - Apron A/B, Pier B and buffer DE: 1-1-2026
    - Pier C: completed in parts, in accordance with own schedule (2026-2032)
    - For all other areas (stands outside the green zone): 1-1-2027

*Netherlands Labour Authority
**See reduction principle 3
***Actieplan voor minder gebruik van ingebouwde hulpmotor vliegtuigen (APU) op Schiphol
Link to background information

Save up to 1 million L fuel by removing all fossil fuel light equipment before 2026

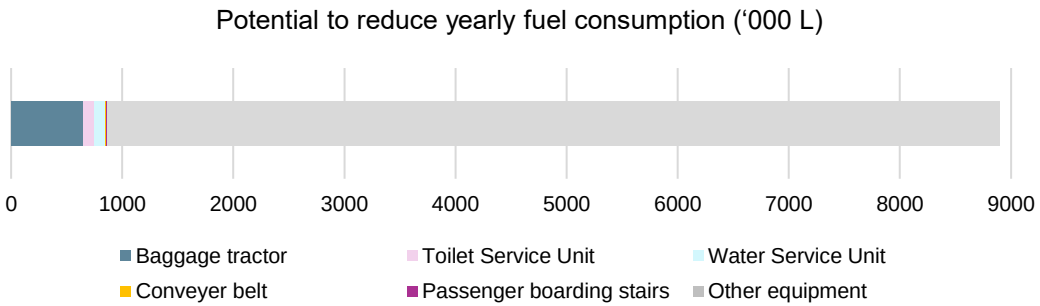


According to reduction principle 1, the following actions are recommended:

6. All parties commit to not purchase light equipment (boarding stairs, conveyor belt loaders, baggage/equipment tractors, water service units and toilet service units) on fossil fuel from 1-6-2023, because the electric alternative is already available.

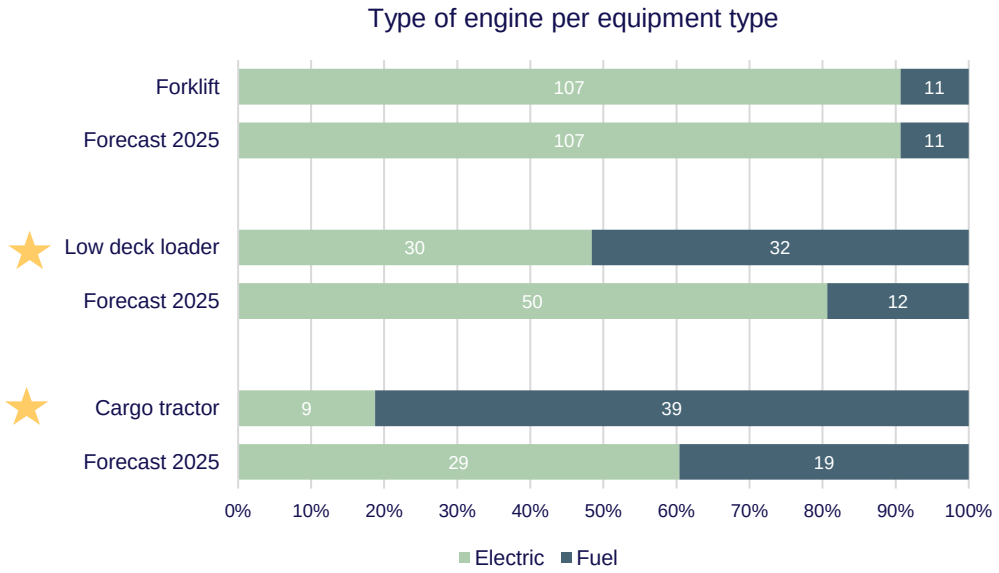
7. Generic handlers commit to phase out all light equipment on fossil fuel for passenger aircraft handling in accordance with the Netherlands Labour Authority* (by 1-1-2024). If electric alternatives have been ordered but have not yet been delivered, fuel equipment may be used until zero emission alternatives have been delivered.

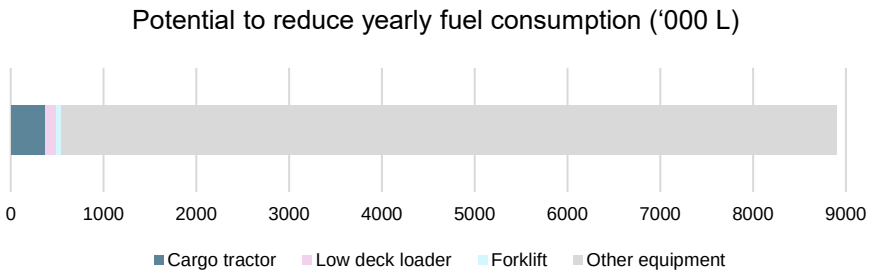
8. All parties commit to phase out all light equipment on fossil fuel operating as soon as possible, at last before 1-1-2030.



*Netherlands Labour Authority
**The numbers in this and following graphs are based on data from interviewed parties (thus, there might be more equipment units on airside)
Link to background information

By removing light cargo equipment, we save 540.000 L fuel per year





According to reduction principle 1, the following actions are recommended:

9. All parties commit to not purchase all light cargo equipment (low deck loaders, forklifts and cargo tractors) on fossil fuel from 1-6-2023, because the electric alternative is already available.

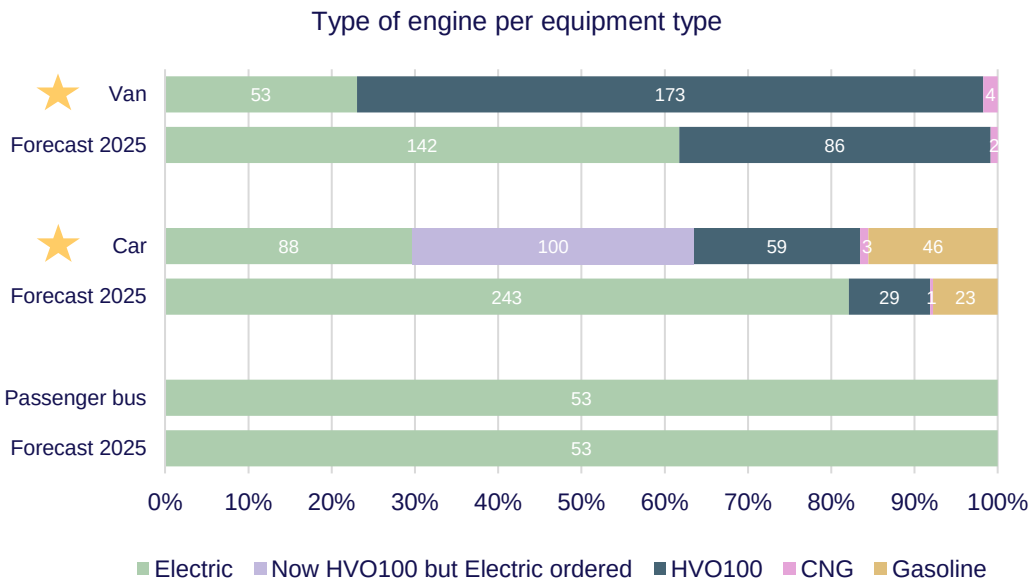
10. All parties commit to phase out all light cargo equipment (low deck loaders, forklifts and cargo tractors) powered by fossil fuels operating in the green zone in accordance with the Netherlands Labour Authority* (by 1-1-2024). Exceptions are:
    - If electric alternatives have been ordered but have not yet been delivered, fuel equipment may be used until zero emission alternatives have been delivered.
    - Equipment that needs to use the Kaagbaantunnel during its operation.

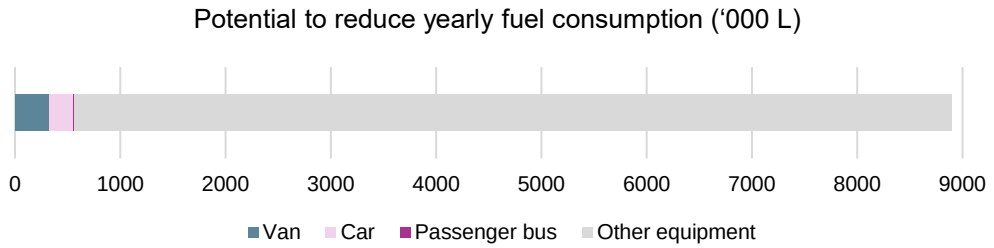
11. All parties commit to phase out all light cargo equipment (low deck loaders, forklifts and cargo tractors) powered by fossil fuels operating outside the green zone as soon as possible, latest before 1-1-2030.

*Netherlands Labour Authority

Link to background information

Phase out all fossil fuel passenger and utility vehicles to save 550.000 L fuel per year





According to reduction principle 1, the following actions are recommended:

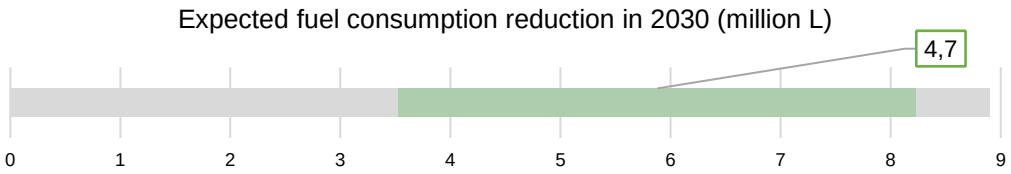
12. All parties commit to not purchase fossil fuel cars and vans from 1-6-2023, because the electric alternative is already available.

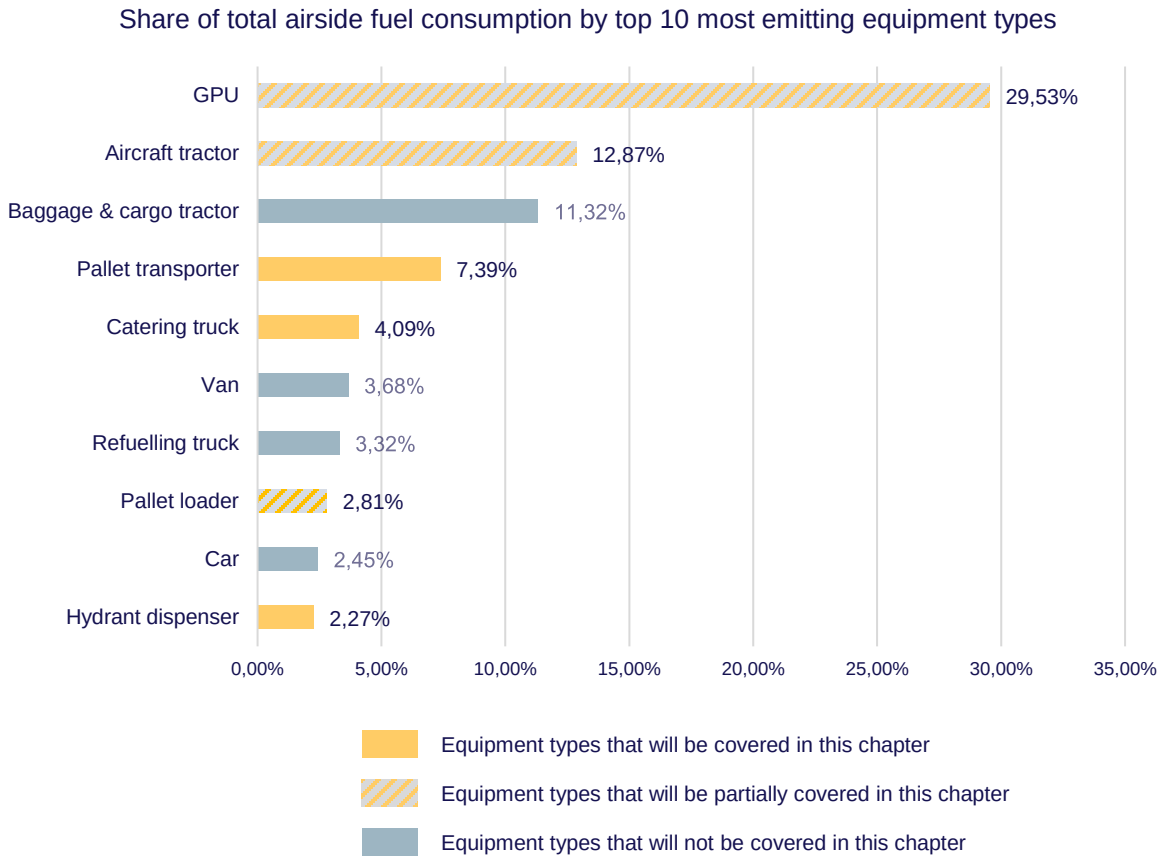
13. All parties commit to phase out all fossil fuel cars and vans by 1-1-2024. Exceptions are:
    - If before 1-1-2024, the motor is replaced by a variant with Euro6/Stage IV/V norm or if a particulate filter with a 95% effectivity is installed, in accordance with the Netherlands Labour Authority*
    - If electric alternatives have been ordered but have not yet been delivered, fuel equipment may be used until zero emission alternatives have been delivered
    - If zero emission alternative is not technically and operationally feasible (e.g., maintenance vans), fuel powered vans may be used until zero emission alternative becomes available, if they comply with the first exception

*Netherlands Labour Authority
Link to background information

Reduction principle 2: If electric alternatives are not yet operationally feasible, keep piloting and find creative solutions

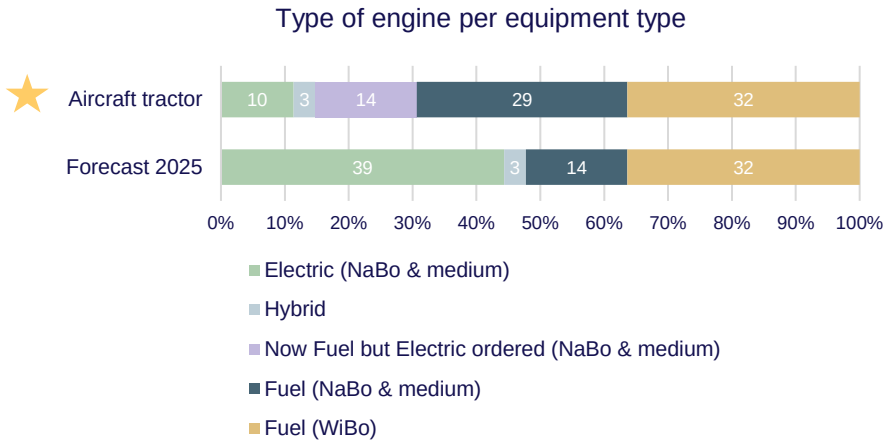
Five out of the ten biggest emitters have zero emission alternatives but are operationally challenging, thus creative solutions will bridge operational challenges

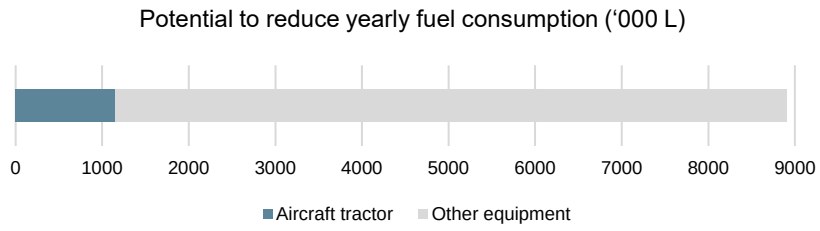




Equipment types that are part of the top 10 will be marked by a yellow star

Focus on electric pushback operations and invest in hydrogen for aircraft towing over long distances to save 1,2 million L fuel per year





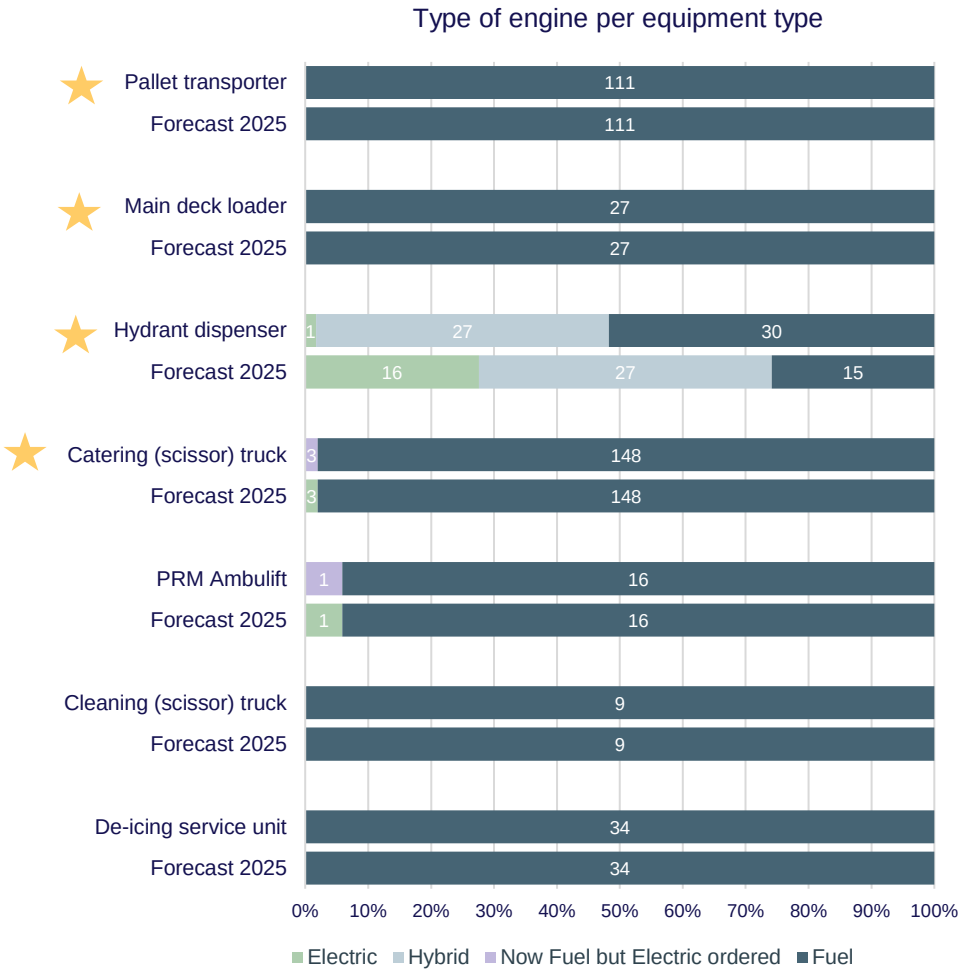
According to reduction principle 2, the following actions are recommended:

1. All parties commit to not purchase fossil fuel narrow- and medium-body aircraft tractors for pushback operations from 1-6-2023, because the electric alternative is already available.
2. All parties commit to not purchase fossil fuel wide-body aircraft tractors for pushback operations as soon as zero emission alternatives are technically and operationally feasible and available on the market.
3. All parties commit to phase out all aircraft tractors on fossil fuel as soon as possible, latest before 1-1-2030.
4. Handlers and AAS should continue piloting with zero emission aircraft tractors for long distance towing and taxi bots (to contribute to sustainable taxiing) and find creative solutions (e.g., retrofitting of existing equipment).

Around 25% of aircraft tractors are used for towing over long distances (+/- 23 tractors)

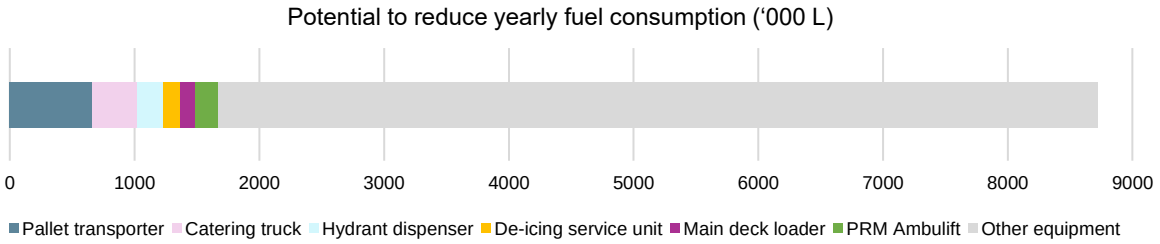
Link to background information

Accelerate replacement of cargo and specialised equipment to save 1,7 million L fuel per year (1/2)



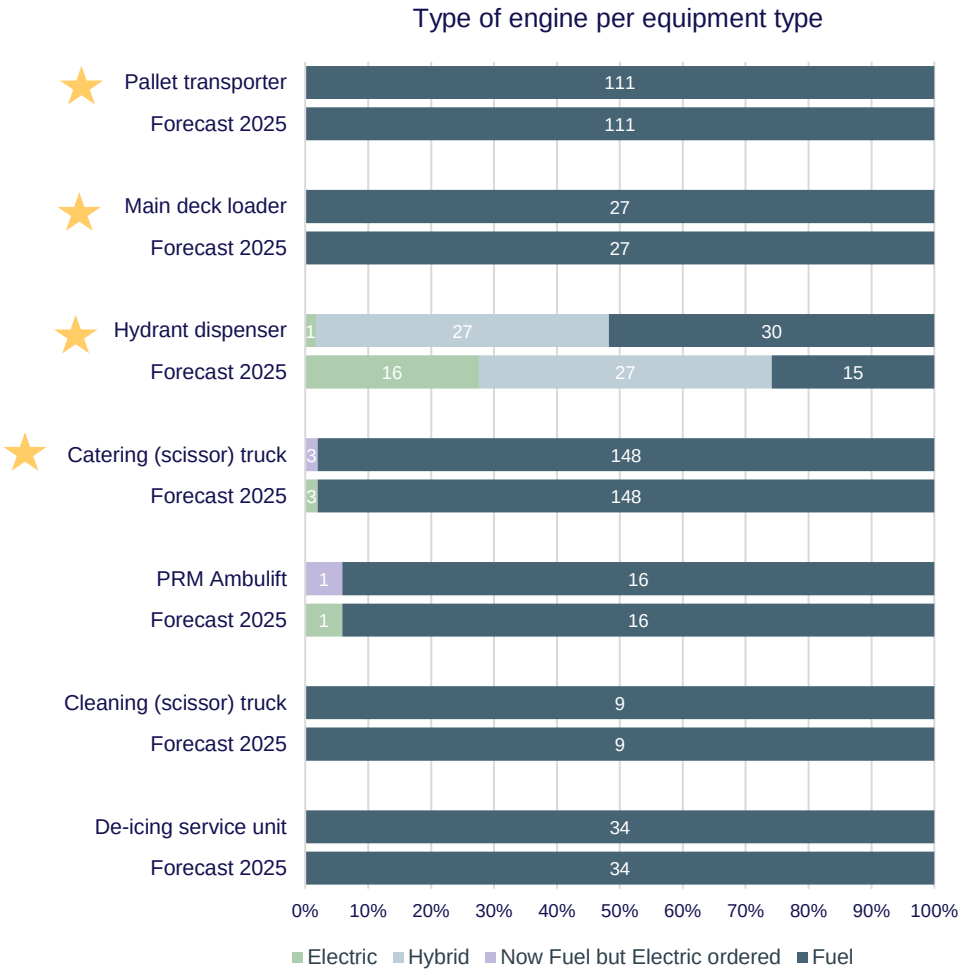
According to reduction principle 2, the following actions are recommended:

5. All parties commit to not purchase cargo and specialised equipment on fossil fuel as soon as zero emission alternatives are technically and operationally feasible and available on the market.
6. All parties commit to phase out all cargo and specialised equipment on fossil fuel as soon as possible, latest before 1-1-2030.
7. Refuelling services should explore the use of stand-based non-motorized hydrant carts to reduce the use of motorized hydrant dispensers.
8. Catering, cleaning and PRM services should continue piloting with electric scissor trucks and find creative solutions (e.g., retrofitting of existing equipment).



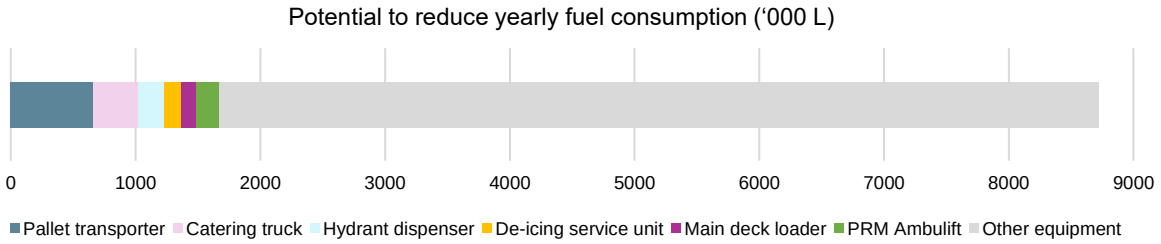
Link to background information

Accelerate replacement of cargo and specialised equipment to save 1,7 million L fuel per year (2/2)



According to reduction principle 2, the following actions are recommended:

9. Handlers should pilot with electric de-icing service units, pallet transporters and main deck loaders as soon as possible and find creative solutions (e.g., retrofitting of existing equipment).
10. AAS will explore opening another de-icing apron on the apron R at which de-icing equipment can be pooled between the handlers which leads to less de-icing equipment necessary and better de-icing water quality and should inform all parties about this before 1-1-2024.



Link to background information

A European consortium, led by RSG, accelerates innovations for a more sustainable aviation industry

TULIPS: A consortium with 29 parties, led by Royal Schiphol Group

The European Commission has awarded €25 million in funding to TULIPS. The funding is part of the European Green Deal, to develop innovations that facilitate the transition to low-carbon mobility and enhance sustainability at airports. To realize these challenges in the aviation sector, commitment from the entire chain is required.

The collaboration of airports, airlines, knowledge institutes and industrial parties in this unique European consortium makes it possible to contribute significantly to sustainable aviation. The TULIPS program executes innovative demonstration projects and research between 2022 and 2025 in line with the RSG roadmap Most Sustainable Airports.

The program is executed together with 28 parties and led by RSG as coordinator of the consortium. Gained knowledge and the TULIPS innovations will be transferred to other EU airports. It consists of 17 designed demonstrations and further research in 7 working packages, which will be assessed and supported through monitoring, dissemination, deployment and building an EU roadmap towards 2030. One of the working packages focusses on zero emission airside operations.

TULIPS project: iron flow battery

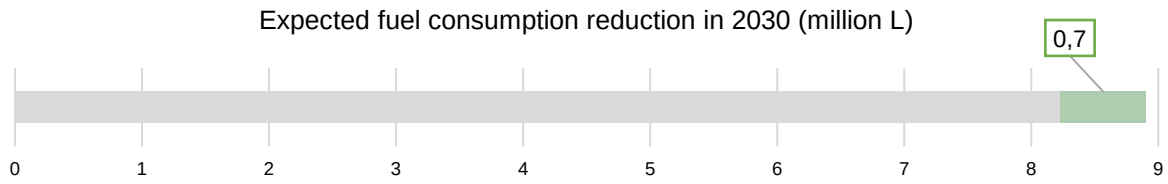
According to reduction principle 2, the following action is recommended:

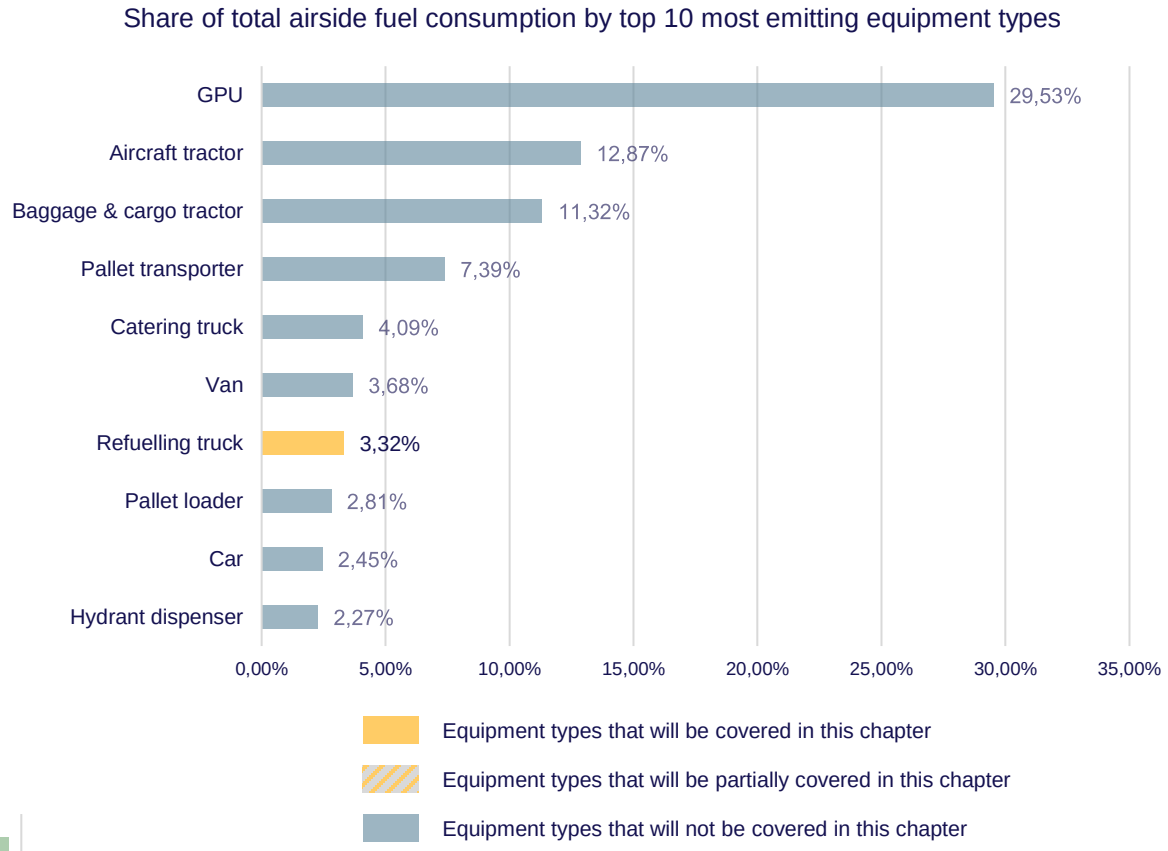
11. AAS will keep contributing to the demos of the TULIPS programme, like the hydrogen GPU, the iron flow battery, hydrogen aircraft tractor and the smart energy power grid*. Contributing to the TULIPS program facilitates knowledge and information sharing that leads towards sustainable innovations. This knowledge can be used to create possible zero emission alternatives for equipment now powered by fossil fuel.

*Projects - TULIPS (tulips-greenairports.eu)
Link to background information

Reduction principle 3: If electric alternatives do not exist, further explore other solutions

One out of the ten biggest emitters does not have an electric alternative, therefore hydrogen solutions should be explored

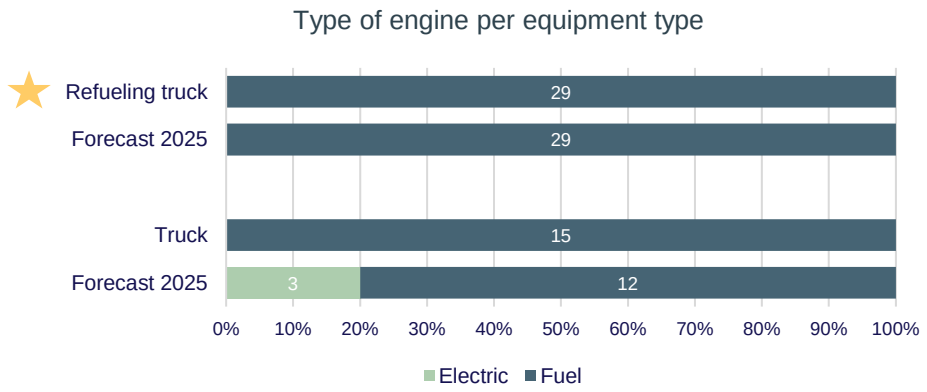


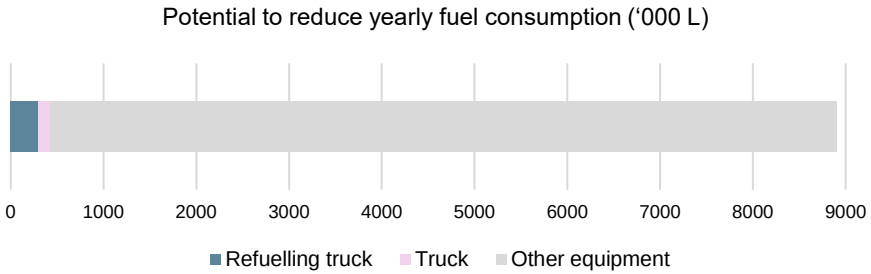


Equipment types that are part of the top 10 will be marked by a yellow star

Reduction principle 3: If electric alternatives do not exist, further explore other solutions

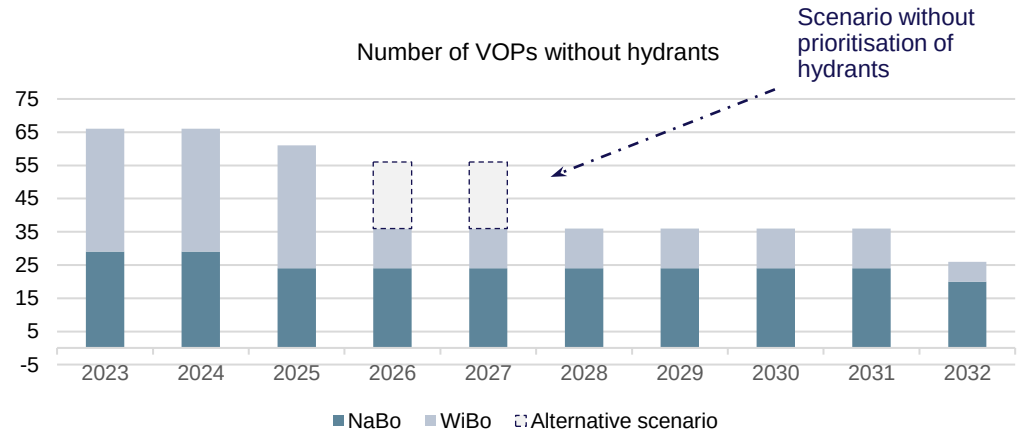
For heavy specialized equipment, reducing emissions is step one and hydrogen is step two to save 420.000 L fuel





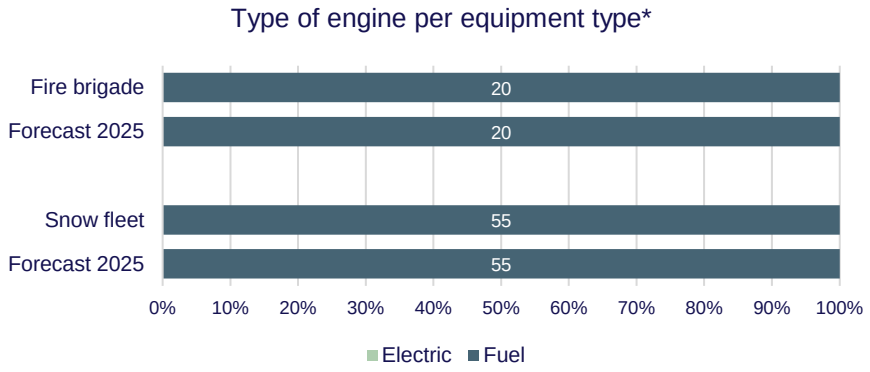
According to reduction principle 3, the following actions are recommended:

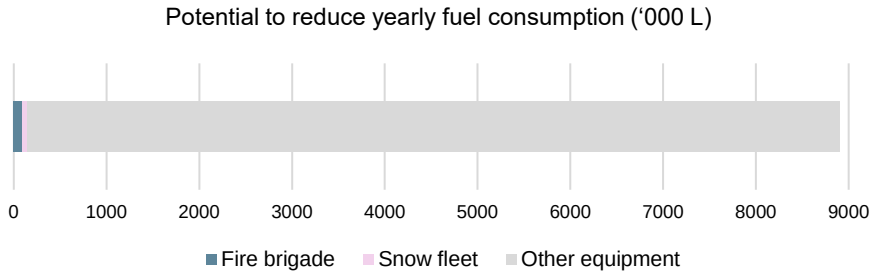
1. AAS should prioritize the completion of hydrants planned for 2026 at the Apron S, which minimizes the use of refueling trucks and should inform all parties about its final decision before 1-1-2024.
2. The Sustainability Aviation Table should explore the possibilities of a development fund for equipment part of reduction principle 3 to invest in projects that ensure zero emission alternatives in the future.
3. Fuel services should explore the use of small electric refueling trucks for Apron A, Apron R, Apron Y and Apron J.
4. All parties commit to phase out heavy specialized equipment as soon as possible, latest before 1-1-2030.



Link to background information

Contributing to relevant projects could accelerate the development of alternative specialized equipment to save 140.000 L fuel





According to reduction principle 3, the following actions are recommended:

5. The owners of equipment that are part of reduction principle 3 commit to contact equipment manufacturers on a regular basis to discuss the development of zero emission equipment.
6. AAS will continue to facilitate tests for research purposes for specialized heavy equipment owned by AAS.
7. AAS will contribute to the ‘autonomous airside project’ to experiment with an autonomous snow fleet to decrease unnecessary movements (such as by training) and decrease the emissions in the short run.
8. In the procurement process of the new AAS snow fleet in 2023, an autonomous fleet should be chosen.
9. AAS commits to phase out fuel-powered specialized equipment as soon as possible, latest before 1-1-2030.

*It should be noted that the categories fire brigade and snow fleet include several types of equipment

Link to background information

Enabling action 2: Improve collaboration amongst parties

Collaboration is of great importance for facilitating zero emission innovations in the future

To make innovation work, all sector parties at Schiphol must collaborate, like in the existing Sustainable Aviation Table. Collaboration with parties on airside does not only allow parties to follow developments in the market and respond to those, but it also establishes an environment of joint learning, innovating and moving forward. However, as a sector, we need the knowledge of experts within every party to work together towards innovation. Collaboration only works when every party involved actively participates in working towards the common goal; zero emission airside operations.

Calendar of collaboration moments

Time Moments	Q1	Q2
	• Working group Zero Emission Airside with AAS and all parties at airside • Update roadmap within Sustainable Aviation Table	• Working group Zero Emission Airside with AAS and all parties at airside • Align roadmap within existing tactical meetings
Time Moments	**Q3**	**Q4**
	• Working group Zero Emission Airside with AAS and all parties at airside • Update roadmap within Sustainable Aviation Table	• Working group Zero Emission Airside with AAS and all parties at airside • Inspiration sessions together with relevant parties, airports, research institutes, and manufacturers

According to enabling action 2, the following actions are recommended:

1. AAS establishes a cooperation plan between AAS and airside parties to create insight in progress of zero emission airside roadmap by setting up a dashboard including the following information:
    1. A dedicated point of contact for the airside users to contact regarding the roadmap zero emission airside operations. When necessary, this point of contact will refer the question or concern to the right person.
    2. A communication tool in which Schiphol sends updates on the roadmap and in which the airside users can find FAQ's, zero emission milestones that are required to reach and (if they desire) contact details to reach each other and cooperate.
2. In order to continue the actions of this roadmap, AAS will establish another working group together with all parties at airside. In this working group the developments and the progress of the roadmap zero emission airside will be monitored and, if needed, adjusted. Furthermore, AAS will explore the need for a steering group.

Link to background information

Possible means of implementation and monitoring

	Session	Objective	AAS	Generic Handlers	All other parties	Collaborate	Monitor/ Control
Strategic	Working group Zero Emission Airside (new)	Monitoring of the roadmap, if needed adjusting the roadmap and updating the roadmap annually.	✓	✓	✓	✓	✓
Strategic	Sustainable Aviation Table (existing)	Discussing innovations regarding principle 3. Furthermore, hydrogen infrastructure is part of the agenda.	✓	✓		✓	
Strategic	Inspiration sessions (new)	Collaboration on sharing innovations and inspire all parties on airside to come up with zero emission alternatives for the operation.	✓	✓	✓	✓	
Operational	All tactical meetings (existing) (e.g., Tactisch Handler Overleg, Airport Fuel Committee, Air Cargo Netherlands)	Alignment on performance of all parties regarding the recommendations of the roadmap.	✓	✓	✓		✓

Link to background information

Yearly | Half yearly | Quarterly

✓ Parties that are included in the respective session

✓ Type of activity taking place in the respective session

Future research and follow up

Recommendations for future research

During the drafting of the joint roadmap several topics were identified that require further research. The following research studies are recommended to be executed by AAS as soon as possible:

Recommended research study	Goal of research
Charging points and power (amp)	Forecasting the type of charging points that need to be build at airside in the coming years, taking fast charging points and the development of new electric equipment and higher battery capacities (e.g., demand for charging points of 125 or 250 amp) into consideration.
Standardized type of plugs/charging connection	Determining a standardized type of plug/charging connection for all equipment to ensure that all charging points remain common-use.
Stand-based equipment	Modelling the expected impact of substituting the operation to more stand-based equipment to decrease movements. This research will conclude on the 1) desirability of stand-based equipment for different types of equipment and 2) the operational execution of implementing stand-based equipment and 3) the amount of equipped required for optimal use of stand-based equipment.
One on one replacement	Considering 1) equipment pooling, 2) stand-based equipment and 3) limited space at airside, predicting the desired number of zero emission equipment needed for an efficient operation.
Battery capacity cargo equipment	Determining to what extent equipment used for cargo handling can be electrified and what is required (e.g., bigger batteries or multiple batteries) to make electric cargo handling at AAS operationally feasible. Besides that, concluding what current research initiatives AAS should invest in to accelerate fully electric cargo handling.
Available transport capacity of substations until 2027	Possibilities to monitor the available transport capacity of every substation of the DGS, to later use this information in allocating charging facilities to the other parties
Effective implementation of actions	Determining which type of implementation mechanism is most suitable for the specific actions stated in this roadmap. Besides that, determining how monitoring of the desired roadmap actions will be done.
Lead acid and lithium batteries	Research the advantages and disadvantages to lead acid and lithium batteries.
Exploring government subsidies	Research all possibilities to receive subsidies from the government for replacing fuel equipment to zero emission alternatives.

Follow up of the roadmap

For equipment types not mentioned specifically in the roadmap, all parties commit to phase out the equipment powered by fossil fuels as soon as possible, latest before 1-1-2030.

Furthermore, all parties contribute to updating the roadmap to ensure zero emission airside operations as soon as possible and at least before 2030.

Overall follow up of this roadmap falls under the responsibility of AAS department AO&AP. In appendix E. for all recommended actions it is stated whether they are already ongoing, should be started or whether more research is required. Also, it shows which AAS department is the owner of specific types of actions. These departments have oversight when it comes to the actions that fall under the specific theme and will monitor the extent to which these actions are executed.

Link to background information

In collaboration with parties active on airside, e.g.:

Appendix

Appendix

List of appendices

Appendix

A. Glossary of acronyms and abbreviations

Term	Definition
AAS	Amsterdam Airport Schiphol
ACI Europe	Airports Council International Europe
Airside	Includes all areas accessible for aircraft, including runways, taxiways and ramps. Does not include private property/terrain of third parties that are adjacent to the apron.
AO&AP	Airport Operations & Aviation Partnerships, the department of Royal Schiphol Group responsible for the operation of Schiphol
APU	Auxiliary Power Unit, allows an aircraft to operate autonomously without reliance on ground support equipment such as GPU
Charging point	A fixed piece of equipment (asset) with an attached cable and plug for charging electric vehicles
CNG	Compressed Natural Gas
E-GPU	Electric Ground Power Unit, a type of aircraft ground support equipment which powers the aircraft electrically while on the ground
Electricity grid	An interconnected network for electricity delivery from producers to consumers
Enabling action 1	Enabling action 1 entails electricity grid, charging points, communication and hydrogen infrastructure
Enabling action 2	Enabling action 2 entails improving cooperation amongst parties
FPU	Fixed Power United, a fixed version of the GPU
GPU	Ground Power Unit, a type of aircraft ground support equipment which powers the aircraft while on the ground
Green zone	The green zone comprises the area surrounded Schiphol Center including the piers. See appendix E. for a detailed image
HVO100	Hydrotreated Vegetable Oil, a type of more sustainable diesel which is produced from vegetable oil, waste
Major emitters	In this joint roadmap we consider ten types of equipment as major emitters because together they cause 80% of total fuel consumption. The major emitters are, from big to small: GPU, aircraft tractor, baggage & cargo tractor, pallet transporter, catering truck, van, refuelling truck, pallet loader, car and hydrant dispenser
NACO	Netherlands Airports Consultants
PMO	Project Management Organization
PRM	Passenger with reduced mobility
Reduction principle 1	Reduction principle 1 states that if electric alternatives are available, replace as soon as possible
Reduction principle 2	Reduction principle 2 states that if electric alternatives exist but are operationally challenging, create a work around
Reduction principle 3	Reduction principle 3 states that if electric alternatives do not exist, further explore other solutions
Retrofitting	Is the mechanical operation of replacing a fuel engine and fuel tank of a vehicle with an electric engine and battery, thereby turning fuel powered equipment into electric equipment.
S&AP	Strategy and Airport Planning, the department of Royal Schiphol Group working on the future of Schiphol
SMART (energy system)	Smart energy is the intelligent optimization of energy costs and efficiency using innovative technology to build and operate a sustainable energy management system
Stand (VOP)	Vliegtuig Opstel Plaats, the aircraft stand at which turnaround takes place
To phase out	Withdrawing the use of [equipment] in gradual stages
TULIPS	Stands for: DemonsTrating lower pollUting soLutions for sustaInable airPorts acrosS Europe. Consortium aimed to contribute to the transition to low-carbon mobility and enhance current sustainability actions at airports
Zero emission	In this roadmap, we define zero emission as zero carbon emissions and diesel engine emission, as other emissions like UFP will not become zero in 2030. However, other emissions will decrease when removing fuel from airside.

Appendix

B. Equipment codes and types

Reduction principle	KES code	KES description	IATA code	IATA description
1	A-CAR	Passenger vehicle	CAR/UTV/LCV	Car/Small utility vehicle/Light commercial vehicle
1	A-/I-PB	Passenger bus	APB/BUS	Airport passenger bus/Transit bus
1	A-VAN	Passenger van	CBS/LCV	Crew bus/Light commercial vehicle
1	A-ASU	Air Start Unit	ASU	Air Start Unit
1	G-BT	(Baggage/Towing) tug / Tractor	BTU	Baggage tractor
1	G-CB	Belt loader	CBL/CBH	Belt loader/ Belt loader with in-hold conveyor system
1	G-GPU	Ground power Unit (narrow body)	GPU	Ground power unit
1	G-ACU	Air Cooling Unit (PCA)	ACU	Aircraft airconditioning unit
1	G-PL	Container and Pallet loader / Highloader	LDL	Low deck loader
1	G-PS	Passenger stairs	MSR/PBS	Maintenance stairs/ Passenger boarding stairs
1	G-TSU	Toilet Service Unit	LAV	Lavatory service vehicle
1	G-WSU	Potable water truck / Water Service Unit	WAT	Potable water service vehicle
1	I-FL	Forklift	FKL	Forklift
1	I-CLEANE	Sweeper	-	-

Appendix

B. Equipment codes and types

Reduction principle	KES code	KES description	IATA code	IATA description
2	A-FST	GSE refueling tanker	GFT	GSE fueling truck
2	G-AFSUD	Hydrant dispenser / Aircraft Fuel Service Unit Unit	FDP	Aircraft fueling dispenser (pump)
2	G-AT	Aircraft/Pushback tug/ Aircraft Tow Tractor	TWT/TWL	Pushback tow tractor/Towbarless tractor
2	G-CT	Catering truck	CAT	Catering truck
2	G-AMLI	PRM vehicle/Ambulift	PBV	Passengers with Disabilities (PWD) boarding vehicles
2	G-GPU	Ground Power Unit (wide body)	GPU	Ground power unit
2		Scissor lift truck	CCT	Cabin cleaning truck
2	G-MP	Maintenance platform	MWP	Elevating work apron
2	G-PL	Container and Pallet loader / Highloader	MDL	Main deck loader
2	G-PT	Container and Pallet Transporter	CPT	ULD transporter
2	I-COMP	Compressor	-	-
2	I-FAC	Aerial work platform (hoogwerker)	-	-
2	G-DSU	De-icing service unit	DAI	Deicer and deicing/anti-icing vehicle
2	A-ATR	Agricultural tractor		

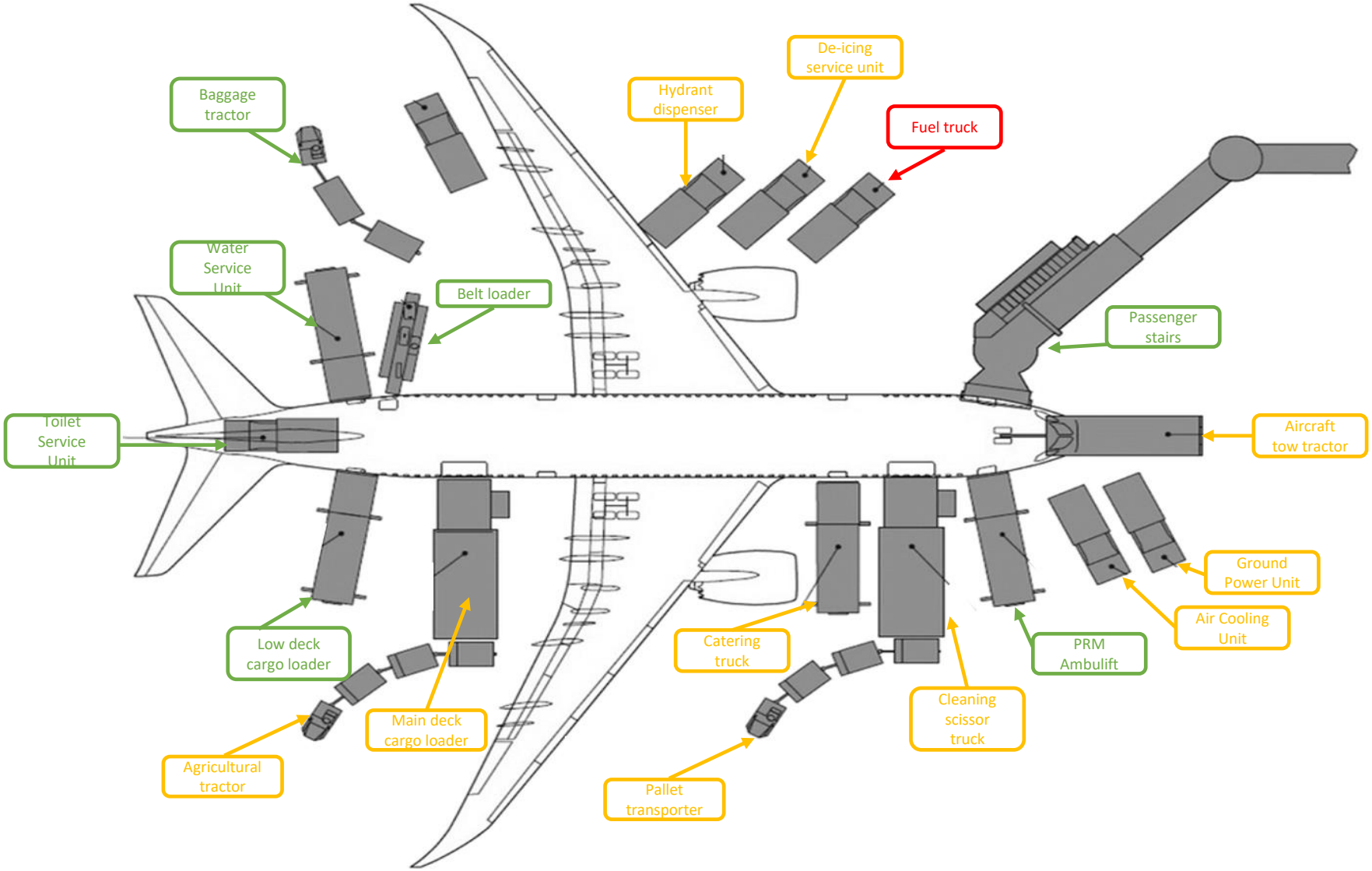
Appendix

B. Equipment codes and types

Reduction principle	KES code	KES description	IATA code	IATA description
3	G-AFSUT	Fuel truck/ Aircraft Fuel Service Unit Tank	FTK	Aircraft fueling tanker
3	I-GEN	Generators (Aggregaten)	-	-
3	A-/I-TRUCK	Truck	-	-
3	I-RUNW	Fire brigade Crashtender, ambulance, B14 rescue vehicle)	-	-

Appendix

C. Market research GSE



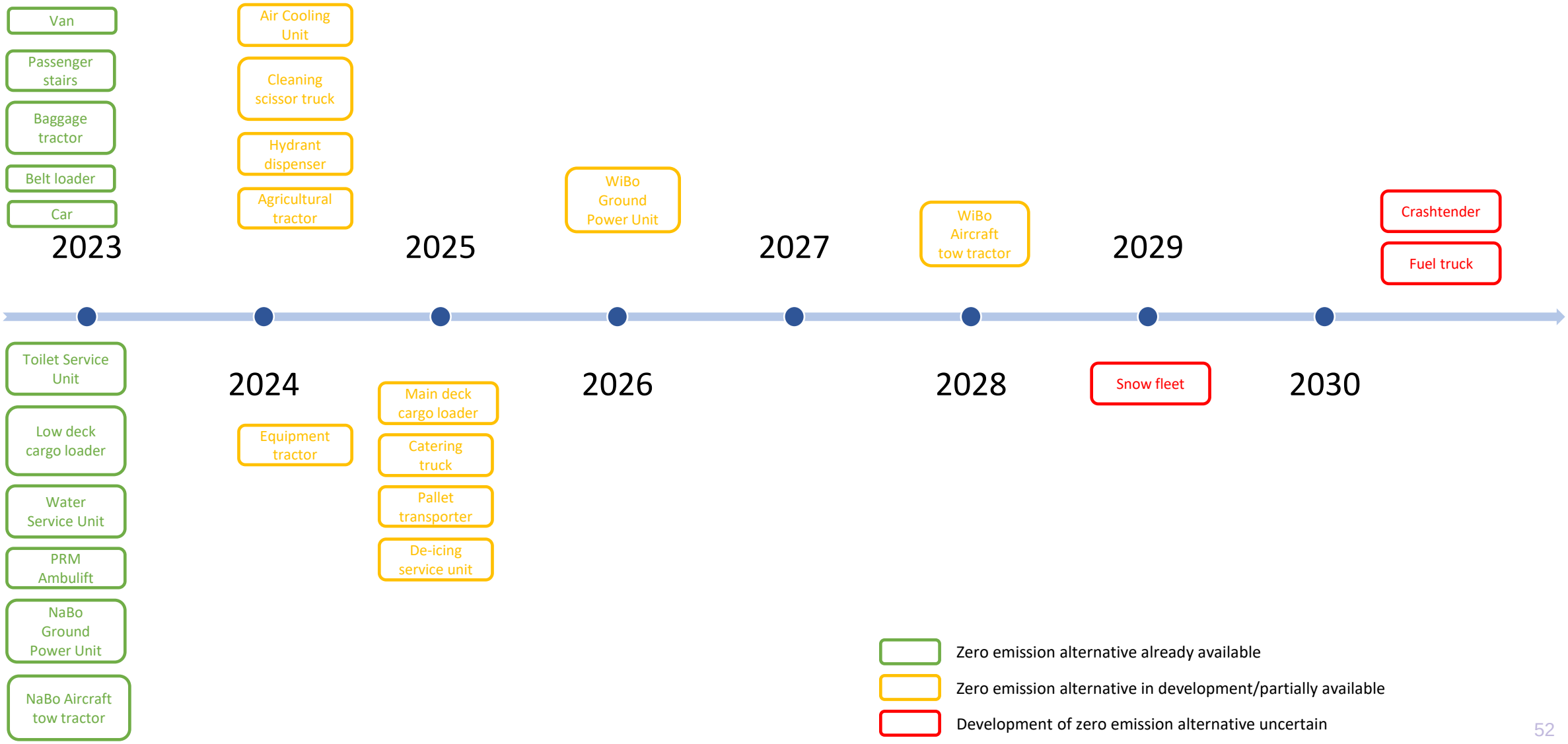
Zero emission alternative available

Zero emission alternative partially available

No zero emission alternative available

Appendix

C. Market research GSE



Appendix

D. Background information slide 3

Quality of Life & Work[1]
Royal Schiphol Group's (RSG) Vision 2050 is structured around three pillars, Quality of Life, Quality of Network and Quality of Service. Maximising the societal value of aviation requires RSG to carefully balance Quality of Life and Quality of Network while maintaining Quality of Service and ensuring safe operations a robust organisation at all times. One key element of the vision is to operate the most sustainable and high-quality airports in the world.

Roadmap Sustaining Your World[2]
"Sustaining Your World" elaborates on RSG's vision for Quality of Life and outlines its sustainability strategy in more detail. RSG aims to operate the most sustainable airports in the world by 2050 by focusing on four themes: circular economy, energy positive, sustainable aviation and communities. The goals include ensuring that own operations are zero-carbon and zero-waste by 2030, reducing CO2 emission from aviation to 2005 levels by 2030 and improving the balance between airports and the local communities. Part of these goals is to reduce airside emissions to zero by 2030, including the emission caused by own equipment as well as of third parties. In addition to reducing CO2 emissions, projects reducing local air quality emissions (NOx and UFP) will be prioritised.

Sustainable Aviation Table[3]
Civil aviation is currently responsible for 2-3% of global CO2 emissions. In order to reduce these emissions, the aviation sector will have to contribute to a solution. Therefore, the Ministry of Infrastructure and Water Management, the aviation sector and knowledge institutions drew up the Draft Sustainable Aviation Agreement. This contains agreements to make Dutch aviation and airports emission-free. This is the translation of the Paris agreement to the Dutch aviation sector. The agreement became final in November 2020 with the adoption of the Aviation Memorandum 2020-2050 by the Dutch cabinet.

Licence to Operate[4]
The Licence to operate (LtO) sets out the terms and conditions for Ground Handling Service Providers (GHSP) to conduct services at Amsterdam Airport Schiphol (AAS) and the GHSP's obligations to promote the proper functioning of the airport. In the LtO, GHSP and RSG have committed to collaborate on an integral sustainability roadmap to provide an answer on how to realize zero emission on airside by 2030. This collaborative approach is important due to several dependencies, such as charging points and electric capacity.

Netherlands Labour Authority[5]
The Netherlands Labour Authority has decided that fuel-powered equipment needs to be replaced with alternatives on short notice, if technically feasible. These requirements have been imposed on Schiphol Nederland B.V. and 8 ground handlers operating at AAS. The inspection makes use of a green zone in which shorter replacement periods are used, to protect employees with regards to exposure to dangerous fuel engine emissions. A large part of fuel-powered vehicles needs to replaced by the end of December 2023. A thorough description of the requirements of the Netherlands Labour Authority can be found on the slide below.

1. "Our Vision 2050"
2. "Sustaining Your World"
3. "Sustainable Aviation Agreement"
4. "License to Operate"
5. "Op Schiphol moet diesel aangedreven arbeidsmiddelen worden vervangen"

Link back to slide 3

Appendix

D. Background information slide 3

Detailed requirements imposed by the Netherlands Labour Authority
The Netherlands Labour Authority has decided that diesel-powered equipment needs to be replaced with alternatives on short notice, if technically feasible. These requirements have been imposed on Schiphol Nederland B.V. and 8 ground handlers operating at AAS. As some parties have objected against this, the requirements of the Netherlands Labour Authority could change in the future. Below the requirements imposed by the authority will be explained in further detail:

1. Replacement of diesel vehicles and work equipment

a) Aircraft facilities: By **31-12-2023** all diesel-powered aircraft facilities on airside need to be replaced with a version with alternative propulsion. This applies to: GPU's, PCA's and other fuel generators. This term applies to the green zone for stands equipped with FPUs. Exceptions:

- Inside of Pier D: latest **31-12-2024**
- Apron A/B, Pier B and buffer DE: **31-12-2025**
- Pier C: completed in parts, in accordance with own schedule (**2026-2032**)
- For all other areas (stands outside the green zone): **31-12-2026**

b) Vehicles and other work equipment: By **31-12-2023** all diesel-powered vehicles and other work equipment need to be replaced with a version with alternative propulsion. If opting for an electric version, this must be done until a maximum peak load of 95% of the power supply has been reached. After the completion of the Rozenburg-Zuid substation, all diesel-powered vehicles and other work equipment need to be replaced by **31-12-2025** with a version with alternative propulsion.

For diesel-powered equipment for which it is technically not feasible to be replaced within this period, requirement 2 is applicable.

Source: the Netherlands Labour Authority*

2. Minimize degree and duration of exposure
For diesel-powered work equipment and vehicles for which replacement is not technically feasible by the set terms, this must be substantiated in written and measure must be taken that comply with one of the following points – latest by **31-12-2023**:

- Replacement of the engine with a variant with Euro 6 standard
- Replacement of the engine with Euro 5 standard if power exceeds 19kW (engine Euro 4 standard)
- Installing a particulate filter with an effectiveness of at least 95%

In addition, timely maintenance and/or replacement of electrical facilities (according to manufacturer's instructions) must take place in order to prevent unnecessary use of diesel equipment due to defects.

* Op Schiphol moeten diesel aangedreven arbeidsmiddelen worden vervangen | Nieuwsbericht | Nederlandse Arbeidsinspectie (nlarbeidsinspectie.nl)

Link back to slide 3

Appendix

D. Background information slide 10

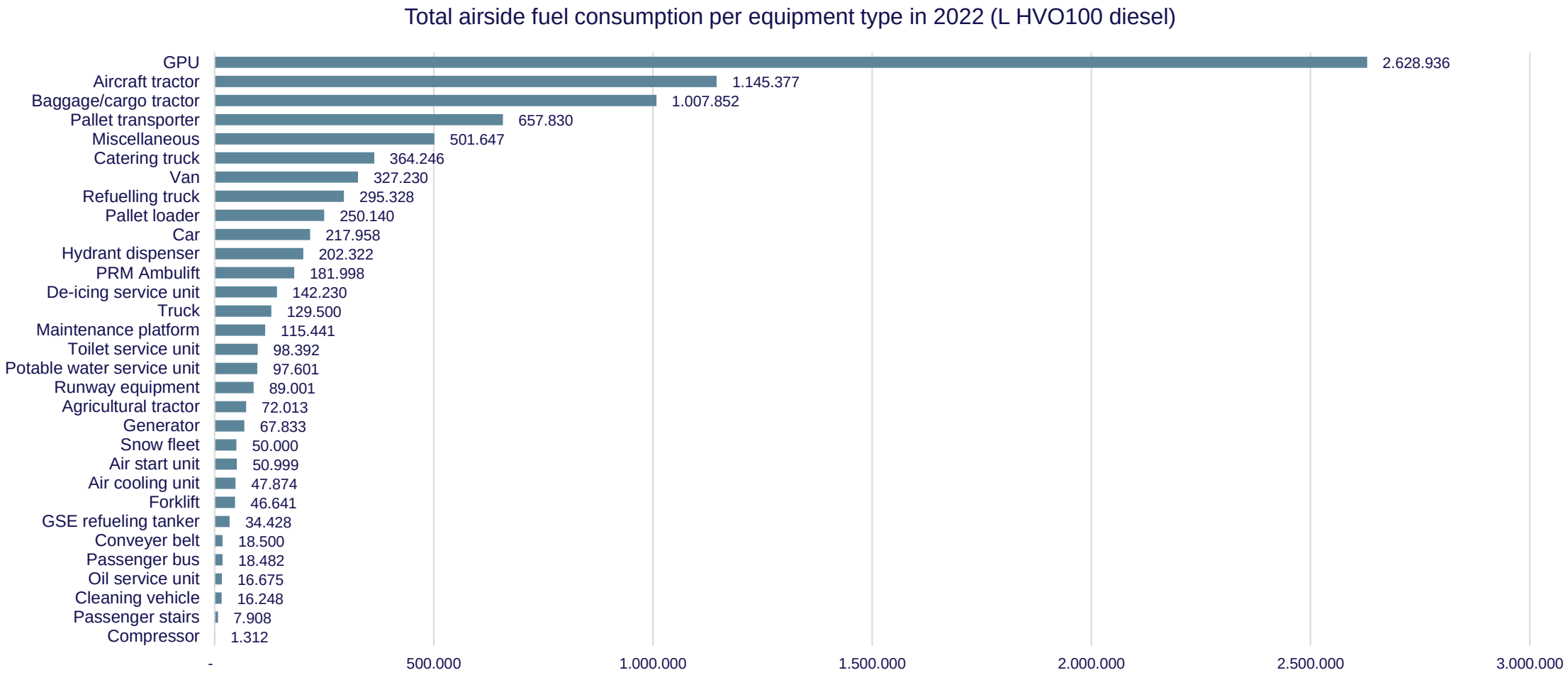
The current reduction in fuel consumed on airside has been calculated by comparing the total fuel consumption of 2022 with an alternative (fictional) scenario in which all electric vehicles that were part of the fleet in 2022, would be replaced by fuel-powered alternatives.

	Current situation (2022)		Alternative situation without any zero emission equipment/vehicles	
Equipment type	**% zero emission in 2022**	**Fuel consumption in 2022 (L per year)**	**% zero emission in alternative scenario**	**Fuel consumption in alternative scenario (L per year)**
GPU	30%	2.628.936	0%	3.755.623
Aircraft tractor	10%	1.145.377	0%	1.272.641
Baggage/cargo tractor	75%	1.007.852	0%	4.031.408
Pallet transporter	0%	657.830	0%	657.830
Miscellaneous	24%	501.647	0%	660.062
Catering truck	0%	364.246	0%	364.246
Van	20%	327.230	0%	409.038
Refuelling truck	0%	295.328	0%	295.328
Pallet loader	33%	250.140	0%	373.343
Car	30%	217.958	0%	311.369
Hydrant dispenser	0%	202.322	0%	202.322
PRM Ambulift	0%	181.998	0%	181.998
De-icing service unit	0%	142.230	0%	142.230
Truck	0%	129.500	0%	129.500
Maintenance platform	0%	115.441	0%	115.441
Toilet service unit	0%	98.392	0%	98.392
Potable water service unit	0%	97.601	0%	97.601
Runway equipment	0%	89.001	0%	89.001
Agricultural tractor	0%	72.013	0%	72.013
Generator	0%	67.833	0%	67.833
Air start unit	0%	50.999	0%	50.999
Snow fleet	0%	50.000	0%	50.000
Air cooling unit	63%	47.874	0%	129.389
Forklift	91%	46.641	0%	518.233
GSE refueling tanker	0%	34.428	0%	34.428
Conveyer belt	95%	18.500	0%	370.000
Passenger bus	30%	18.482	0%	26.403
Oil service unit	0%	16.675	0%	16.675
Cleaning vehicle	50%	16.248	0%	32.496
Passenger stairs	80%	7.908	0%	39.540
Compressor	0%	1.312	0%	1.312
Total		**8.901.942**		**14.596.694**

Link back to slide 10

Appendix

D. Background information slide 11



Link back to slide 11

Appendix

D. Background information slide 13

Retrofitting of existing fuel powered equipment to electric equipment is possible for many different types of equipment, but is especially useful in the following cases:

a) New zero emission equipment has long delivery times: In case of long delivery times of new zero emission equipment, retrofitting of fuel powered equipment with an electric energy pack can accelerate the electrification of the current fleet.

b) Equipment is not (yet) available as zero emission alternative on the market: In case zero emission alternatives are not yet on the market, retrofitting of fuel powered equipment to electric versions is often already possible. This is especially the case for pallet transporters, cargo tractors and aircraft tractors and equipment for aircraft types that are no longer produced (A380) and for which new (zero emission) equipment is no longer developed.

c) Equipment has been bought recently and is not yet due to be replaced: Replacing fuel powered equipment before the end of its depreciation period with zero emission alternatives can be costly due to the early write-off of the investments made. Retrofitting existing equipment with electric engines can be more cost-effective as it avoids the write-off of earlier made investments and has a lower additional cost than purchasing new electric alternatives.

Retrofitting of existing equipment to electric equipment is not recommended for the following cases:

a) Ground power units

b) Equipment that has passed its useful life

c) Equipment for which zero emission alternatives are easily available on the market without long delivery times

The creation of a **subsidy scheme** from the government to replace fuel powered equipment and vehicles and could accelerate the replacement. The legal possibility for such a subsidy scheme is created in the EU's Guidelines on State aid for climate, environmental protection and energy 2022[1] (CEEAG). This is the rulebook for public support in the energy and environmental sectors setting out which projects can be supported with public funds.

Section 4.3 of the CEEAG sets out the conditions for State aid for certain investments to reduce or avoid CO2 emissions in the air transport sector. Under section 4.3, aid may be granted for the acquisition or leasing of new and used clean vehicles and vehicle equipment. Aid may also be granted for the retrofitting, refitting and adaptation of vehicles or mobile service equipment, where it allows them to qualify as clean vehicles.

Aid may also be granted for the construction, installation, upgrade or extension of recharging or refueling infrastructure. Projects may also include installations for smart charging operations and for the on-site production of renewable electricity or renewable or low-carbon hydrogen, as well as on-site storage units for storing electricity or renewable or low-carbon hydrogen to be supplied as transport fuels.

1. "Guidelines for State aid for climate, environmental protection and energy 2022".

Link back to slide 13

Appendix

D. Background information slide 14

The roadmap has been divided into 5 chapters, containing 2 enabling actions and 3 reduction principles.

Enabling actions are actions that support the transition from fuel-powered equipment to zero emission alternatives.

Reduction principles are actions that directly lead to a reduction in fuel consumption at airside. All recommendations made in these chapters lead to the elimination or reduction of fuel consumption. These actions have been split up between 3 major principles based on the level of difficulty to switch to zero emission alternatives in terms of their availability on the market, the timing of possible replacements and the operational challenges that arise from switching to electric alternatives.

- **Enabling action 1: Charging infrastructure and policy**

The first enabling action covers the required infrastructure and communication to enable a quick and smooth switch to zero emission equipment on airside. In order for reduction principles to be possible in practice, the required infrastructure, that enables charging of zero emission equipment, is needed. The actions required for this are covered in enabling action 1.

- **Reduction principle 1: If electric alternatives are operationally feasible, replace as soon as possible**

If electric alternatives for equipment are currently available on the market and operationally feasible, fuel-powered version should be replaced as soon as possible. Focusing first on replacing all equipment that is already available will lead to several quick gains in terms of a reduction in fuel consumption and local air pollution. Available is defined as being available for purchase on the market, operationally feasible and legally permitted to operate at AAS. Operationally feasible is defined as being able to perform the same activities as the fuel powered version with the same amount of equipment needed for a single operation.

- **Reduction principle 2: If electric alternatives are not yet operationally feasible, keep piloting and find creative solutions**

Reduction principle 2 tackles those types of equipment for which electric alternatives are not yet fully operationally feasible at this moment. This could be because only few electric alternatives exist now, and future developments are expected soon, because new alternatives have not yet been tested extensively or because battery ranges are not yet sufficient for the use in the current operational design. For these types of equipment all parties should keep piloting and work arounds (like retrofitting existing equipment) should be explored.

- **Reduction principle 3: If electric alternatives do not exist, further explore other solutions**

The last reduction principle covers equipment types for which currently no electric alternatives exist on the market and for which developments in the market are expected to happen only in the long-term, if at all. This principles covers many specialized and heavy vehicles for which electric batteries do not offer a solution due to the power they require. For these vehicles other solutions should be further explored, going beyond electrification and looking into alternative zero emission techniques (like hydrogen).

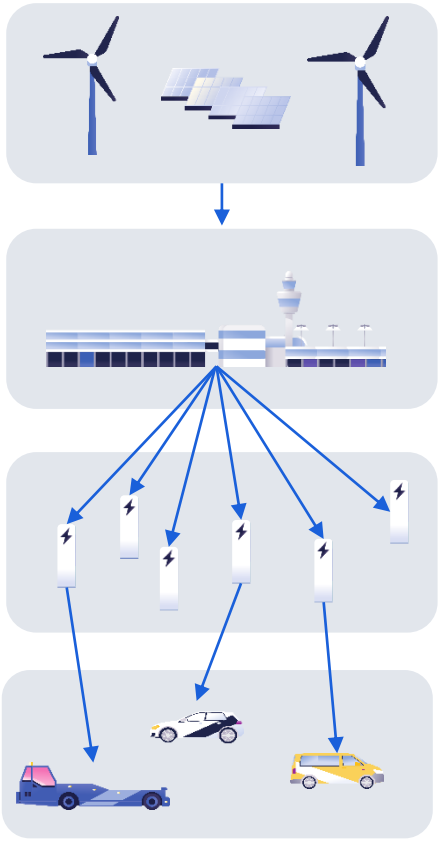
- **Enabling action 2: Improve collaboration amongst parties**

The second enabling action covers the collaboration between all parties operating at airside and Schiphol. In order to achieve the goals as outlined in this roadmap collaboration amongst parties is key. Only through collaboration amongst parties, will it be possible to properly implement the reduction principles in practice.

Link back to slide 14

Appendix

D. Background information slide 16



Example of conventional energy grid [2]

Conventional energy grid at Amsterdam Airport Schiphol

Schiphol Nederland B.V. operates a closed distribution system (CDS) for the geographical service area of Amsterdam Airport Schiphol and is therefore responsible for ensuring a reliable, safe energy supply for internal and external users at the airport. The CDS provides electricity to various demand centers (e.g. buildings, mobility, airside services etc.). The service area is divided in several main- and subareas. A conventional power grid is supply-driven and the transport capacity is set for longer term, similar to the left illustration. There is always power supply to the charging points.

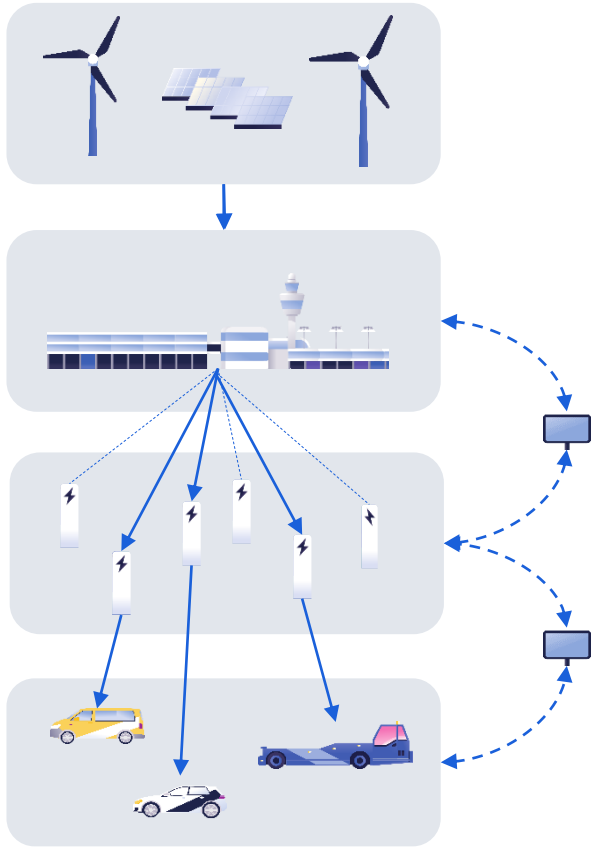
Smart grid definition

The smart grid is an electricity network that uses (digital) information technology to supply electricity to the end user. By controlling the power demand, a smart grid can match the instantaneous supply. A two-way digital communication allows this system to monitor, analyze and control within the electricity supply chain. A smart grid can help improve efficiency, reduce energy consumption, and maximize the transparency and reliability of the energy supply chain[1]. As shown in the illustration on the right, only the charging points connected to vehicles are provided power.

Key features of smart grid

A smart grid's key features include:

- Load balancing of in and output
- If vehicle is fully charged, a smart grid can automatically switch of the power supply to that vehicle. And can therefor use this transport capacity to charge other equipment.
- Vehicle to grid possibility: vehicles as temporary (battery) buffers if they
- Clear monitoring of state of charge and used capacity and costs
- (Battery) energy storage systems can be integrated smart grid.



Example of smart energy grid [2]

1: https://www.techopedia.com/definition/692/smart-grid
2: grid illustrations are examples only for explanatory purposes

Link back to slide 16

Appendix

D. Background information slide 17 & 18

AAS started the **Electrification Airside program**, in which it is installing charging points, fixed power units (FPUs) and PCA sockets at every pier and apron on airside within 6 phases (2022-2029). See the planning (subject to unforeseen changes) of the first three phases can be found in the figure on the right of slide 15. In the table on slide 16, the number of charging points per stand are shown that will be built from 2024 onwards. This information will be updated over time, as the market changes. The stands that have been electrified before 2024 can have other types of charging points. After all stands are electrified, the type of charging points will be upgraded.

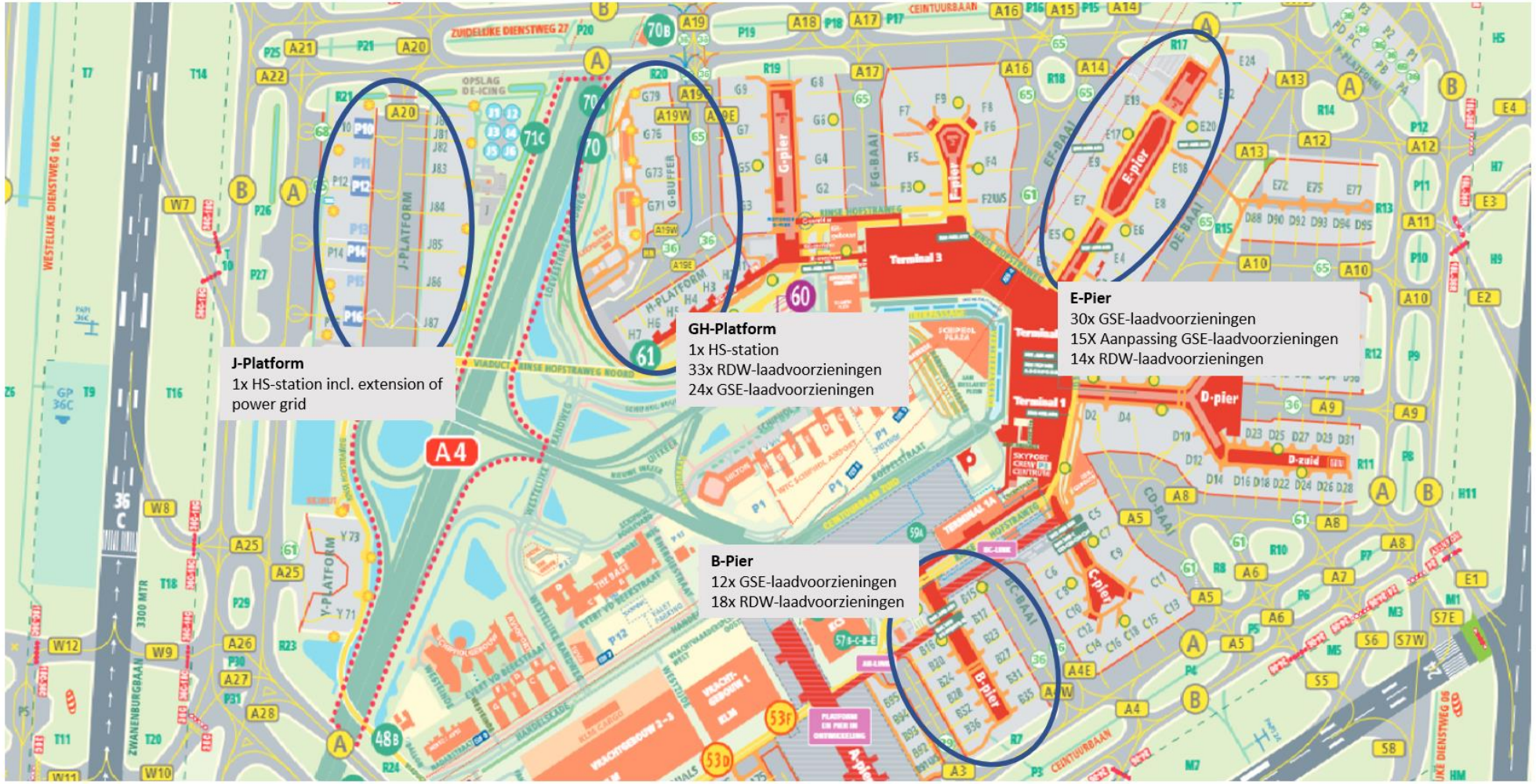
3. AAS continues to carry out the electrification airside program and should update the program in line with the latest technical and operational know-how.
4. Before the extension of the power grid in 2027, charging points should be built even if they can not be used yet (so they can be used the moment the grid has expanded).
5. To ensure that parties on airside can switch to electric equipment as soon as possible, the following alternatives for charging points should be used in this preferred order;
    1. Battery energy storage systems, like iron flow batteries and li-ion batteries, are rechargeable batteries that can store electricity and discharge it when needed. They do not emit emissions and lose less energy than hydrogen generators.
    2. Hydrogen generators use hydrogen to produce electricity. These are also zero emission but have more energy loss than battery energy storage systems.
    3. If no charging points, battery energy storage systems or hydrogen generators are available, fuel generators should be used to generate enough electricity to charge all electric equipment. This is the least preferred option, as they use fuel.
6. Fast-charging points need a higher amount of ampere than the current charging points.
7. Dedicated fast-charging stations enable the efficient use of fast-charging points. These could be built at locations where fast-charging is necessary because of the type of operation (e.g., cargo handling or aircraft tractors). These dedicated fast-charging stations should be reserved at all times only for the specified type of equipment in order to ensure a smooth operation and enable quick recharging between handlings.
8. Common-use charging points are located on airside and are not claimed by one party, thus can be used by all parties. This means that also the connection to the plug should be common-use.
9. For all parties to know when the operational peaks at airside are, AAS should explore this and inform parties as soon as possible.
10. All parties should explore possibilities to change their operations to reduce the peak of their operational power demand at charging points.
11. A strategy of charging slots could be created based on operational requirements of airside parties. This charging slots strategy will determine who can use certain charging points at a certain time of the day.
12. Research on standardized plugs is important as it enables the common-use of charging points.

Link back to slide 17

Appendix

D. Background information slide 17 & 18

Electrification Airside: Phase 1



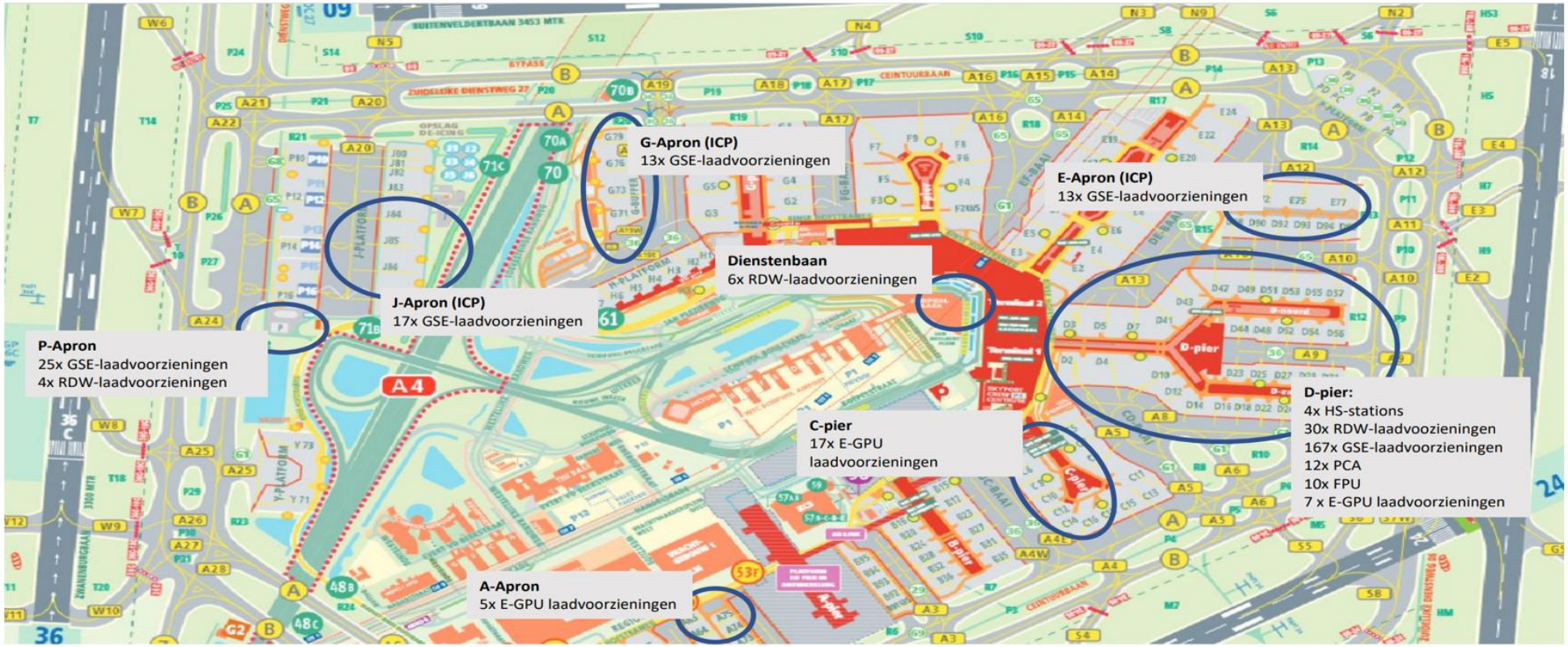
(this is the current expectation, no rights can be derived from this planning)

Link back to slide 17

Appendix

D. Background information slide 17 & 18

Electrification Airside: Phase 2

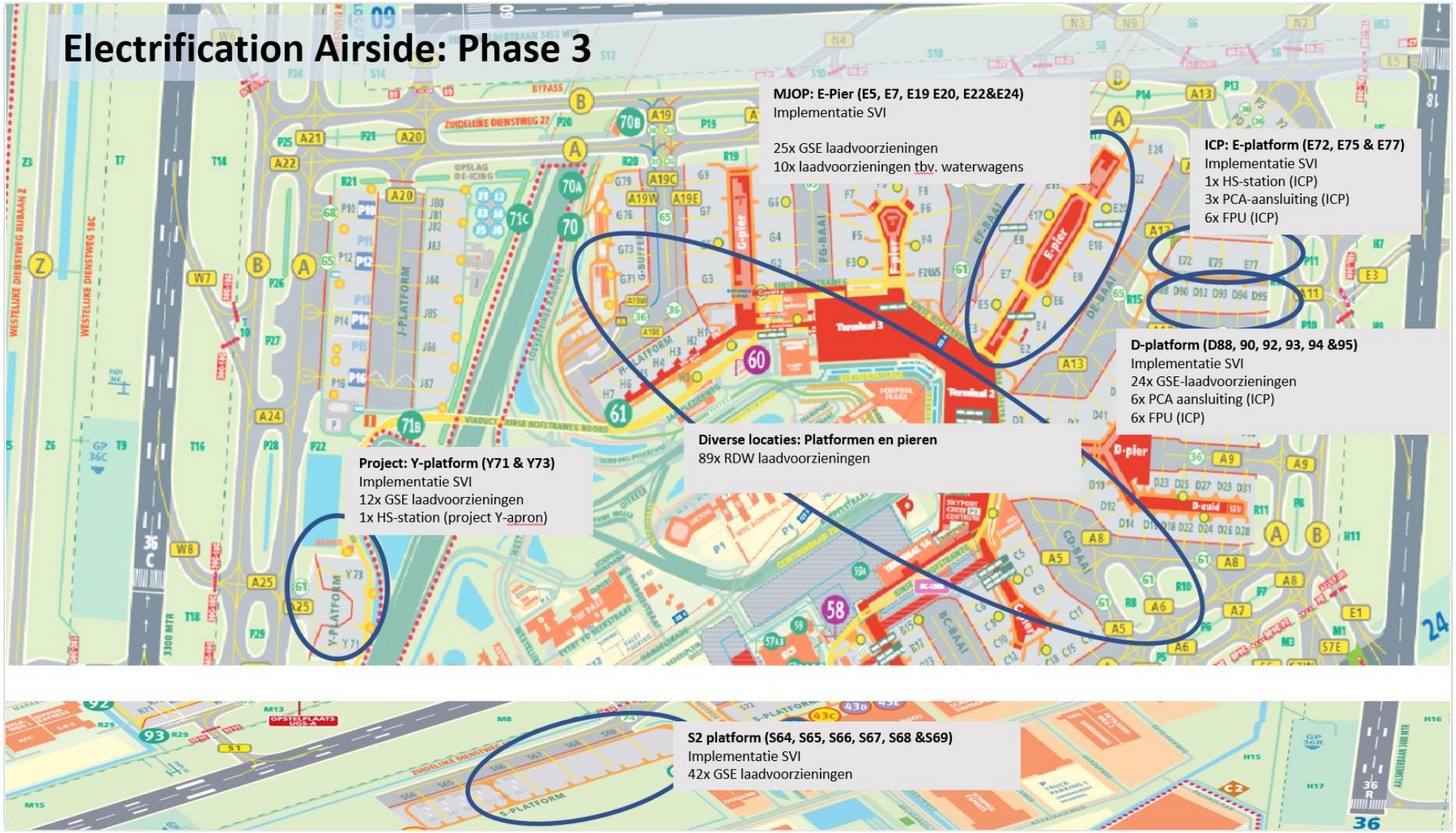


(this is the current expectation, no rights can be derived from this planning)

Link back to slide 17

Appendix

D. Background information slide 17 & 18



(this is the current expectation, no rights can be derived from this planning)

Link back to slide 17

Appendix

D. Background information slide 19

Sharing information about electrification of airside

13. AAS continues to carry out the electrification airside program and should inform all parties on airside about developments in the program.

14. All parties inform AAS about the arrival of new equipment when the replacement commitment is made/the party knows it is going to order new equipment. Because for AAS to anticipate on the required charging points as soon as infrastructurally possible, the desired amount of charging points should be known as soon as possible.

15. A communication plan between the electrification airside program and airside parties should be established before 1-7-2023, because it is very important.
    1. For information about the long term, like the location and type of charging points in the coming electrification phases and innovations in electric equipment, Paul Schüren (within the strategy department, S&AP) will be the point of contact, as long as he stays in this position.

       For information about the short term, like placing one extra charging point and other operations, Theo Hafmans (within the operations department, AO&AP) will be the point of contact, as long as he stays in this position.
    2. All parties on airside should receive semi-annual updates of the electrification airside program and provide updates regarding the electrification of their fleet, so the phases in the program that are made will fit the needs as much as possible.

For information about the long term, like the location and type of charging points in the coming electrification phases and innovations in electric equipment.

Paul Schuren, Program Expert Airside,
Strategy & Airport Planning

paul.schuren@schiphol.nl

For information about the short term, like placing one extra charging point, changing equipment and other operations.

Theo Hafmans, Service Owner Aircraft,
Airport Operations & Airline Partnerships

theo.hafmans@schiphol.nl

Link back to slide 19

Appendix

D. Background information slide 20

The expected hydrogen needs in 2030 have been calculated based on the actions outlined in this roadmap. Hydrogen is expected to be a solution for 3 equipment types:

- **Ground Power Units (GPU):** Widebody GPUs at remote stands without fixed power units are expected to be replaced by hydrogen-powered alternatives, rather than e-GPUs. This leads to an expected 59 hydrogen GPUs in 2030, based on the current number of fuel GPUs, remote stands and the electrification program. This would result in ~23% of GPUs in 2030 being powered by hydrogen.
- **Aircraft tractors**: It is expected that electric aircraft tractors are a viable option for pushback operations, but that electric versions will not be operationally feasible for aircraft towing over longer distances. Therefore, it is expected that hydrogen-powered aircraft tractors will be needed for part of the operations. For the sake of calculating the expected hydrogen needs, it is expected that 20% of the current fuel consumption caused by aircraft tractors will be transformed to hydrogen needs.
- **Heavy specialized vehicles**: As identified under principle 3, it is expected that for heavy specialized vehicles such as the snow fleet and the fire brigade as well as refuelling trucks.

Conversion of fuel consumption to hydrogen needs:
The current diesel (GTL) consumption can be converted to power consumption with the following assumptions: 1 L GTL equals 8,4 kWh with an engine efficiency of 35%, thus 1 L GTL is converted to 2,94 kWh by diesel engines[1]. 1 kg of hydrogen contains around 33,33 kWh of usable energy2, and hydrogen fuel cells have an efficiency of around 55%[3], meaning 1 kg of hydrogen leads to around 18,3 kWh of usable energy. Comparing this to GTL diesel, 1 kg hydrogen equals approximately 6,2 L GTL diesel. According to Alstom, a French manufacturer in the rail market and manufacturer of the first fully hydrogen-fuelled passenger train, 1 kg of hydrogen replaces around 4,5 L diesel fuel[4], while other sources convert 1 kg of hydrogen to 4 L diesel[5].

For the purpose of this calculation, a conversion factor of 1 kg hydrogen = 4,5 L diesel, is assumed.

Type of equipment	Current fuel consumption (L per year)	Hydrogen equivalent (kg per year)
GPU (23,22% of all)	23,22% of 2.628.936 = 610.658	135.701
Aircraft tractor (20% of all)	20% of 1.145.377 = 229.075	50.905
Heavy specialized vehicles	437.112	97.136

1. KES
2. "Liquid Hydrogen Outline" Integrated Design for Efficient Advanced Liquefaction of Hydrogen
3. "Benefits of hydrogen" Millenium Reign Energy
4. "Hydrogen on track to replace diesel locomotives" Day, P. 2022. Reuters Events
5. "Green hydrogen pathway through Stage One Solar production" Listcorp. 2022.

Link back to slide 20

Appendix

D. Background information slide 23

Ground power units (GPU) can be divided into GPUs for narrow body aircraft (90 kVA) and GPUs for wide body aircraft (180 kVA). Due to the higher power requirement of wide body GPUs, these consume a higher amount of fuel per hour in use. Furthermore, while electric narrow body GPUs already exists and are currently in use at Schiphol Airport, tests with electric wide body GPUs have not yet been successful. For wide body GPUs that will not be replaced by fixed power units (FPU), no electric replacement is yet operationally feasible and available on the market. This means that wide body GPUs that cannot not be replaced by FPUs can be considered to be part of principle 2, meaning that further piloting ad testing is required before zero emission alternatives become available and operationally feasible.

While all actions regarding the use of GPUs are entirely treated in principle 1, for the purpose of indicating the potential fuel consumption reduction, the yearly fuel consumption of all GPUs at Schiphol Airport is divided between principle 1 and principle 2.

Total yearly fuel consumption : 2’628’639 L

Wide body GPUs are assumed to consume twice the amount of fuel of narrow body GPUs per hour.

All 54 narrow body GPUs are considered to be part of principle 1. Of the 121 wide body GPUs, 43 will be replaced by FPUs and are therefore considered part of principle 1, while the other 78 wide body GPUs are considered to be part of principle 2. This results in the following split:

- GPU fuel consumption considered under principle 1: (54+2*43)/(54+121*2) * 2’628’639 L = 1’243’416 L
- GPU fuel consumption considered under principle 2: (2*78)/(54+121*2) * 2’628’639 L = 1’385’520 L

Example of a 90 kVA GPU

Example of a 180 kVA GPU

Link back to slide 23

Appendix

D. Background information slide 24

Equipment types that belong to aircraft facilities:

Name	IATA code	KES code	Examples of zero emission alternatives
Ground power unit	GPU	G-GPU	ITW, TLD GPU-409-Ibs, Dynell & Zepp Waterstof GPU, Tulips Hydrogen GPU
Air cooling unit (PCA)	ACU	G-ACU	TLD CF 40
Air start unit	ASU	G-ASU	Rheinmetall eMSU

Ground power units (GPUs) are the equipment that uses the most fuel of all equipment. GPUs located on connected stands (at the piers) will be replaced by fixed power units (FPUs). GPUs located on stands not connected to piers can now be replaced with electric ground power units (E-GPUs) for narrow body (NaBo) aircrafts. For widebody (WiBo) aircrafts, GPUs located on stand not connected to piers cannot yet be replaced by a zero emission alternative. Research is being done on hydrogen GPUs (H_2-GPUs) and E-GPUs for WiBo aircrafts. Because of a stricter APU ban, more PCAs will be needed in the coming years. Because of this, it is even more important that PCAs on fossil fuel should be replaced by electric PCAs.

1. AAS should keep installing FPUs, as they are the preferred replacement for GPUs on fossil fuel (but they can only be installed at connected stands). At Apron G FPUs are installed early 2024, at Apron D and E and Pier D FPUs are planned for 2025. Apron J will include FPUs planned for 2026. The Pier C rebuild will include FPUs when completed by 2032. In the meantime, both Pier C and Pier D will have E-GPUs as an alternative source of power.
    1. KES is the facilitator of the E-GPU pool and has recently bought 30 E-GPUs that will have to be delivered. GPUs on NaBo stand that do not have an FPU (yet) should be replaced by E-GPUs from 1-1-2024, because this alternative is already available. Additionally, an emergency buffer of E-GPUs should be maintained for the case that FPUs on narrow body stands are temporarily out of order.
    2. When a WiBo stand does not have an FPU (yet), GPUs may still be used until a replacement by H_2-GPUs or WiBo E-GPU becomes available. Additionally, an emergency buffer of widebody GPUs should be maintained for the case that FPUs on wide body stands are temporarily out of order.
2. Only zero emission NaBo GPUs and PCAs should be bought from 1-6-2023, because the zero emission alternatives are already available.
3. Tests with H_2-GPUs and WiBo E-GPU should continue. Safety risks will be included in the tests.
4. The Human Environment and Transport Inspectorate (IL&T) monitors APU and GPU usage at Schiphol. It is prohibited at Schiphol to use fuel GPUs if there is a cleaner alternative and APUs should be used as little as possible.* The action plan AAS submitted to IL&T clarifies that AAS will supply more electric PCAs over the coming years. AAS is responsible for maintaining a buffer of fuel powered PCA's in case the electric PCA is out of order.
5. As the Netherlands Labour Authority has imposed, all parties should phase out all aircraft facilities on fossil fuel within the green zone in Schiphol centre by 1-1-2024, with some exceptions (written on slide 22). All parties should phase out all aircraft facilities on fossil fuel by 1-1-2027, because it is more difficult to replace aircraft facilities on non-connected stands (outside of the green zone).

*https://eaip.lvnl.nl/web/2023-05-04-AIRAC/html/index-en-GB.html

Link back to slide 24

Appendix

D. Background information slide 25

Equipment types that belong to light equipment:

Name	IATA code	KES code	Examples of zero emission alternatives
Conveyor Belt / Belt loader	CBL/CBH	G-CB	TDL RBL, Mulag Orbit 9
Bagage/equipment tractor	BTU	G-BT	TLD Tracteasy, TLD JET-16, Volk Electric EFZ 25 N, Spijkstaal Elektrotrekker 308, Spijkstaal ATA Elektrotrekker, Charlatte TE206 NEO, Charlatte T135 EVO, Jungheinrich EZS 570, Still LXT 120/350, Goldhofer Sherpa E, MULAG Comet 4E
Passenger boarding stairs	MSR/PBS	G-PS	TLD ABT-2045-E, SPS SOLAR Stairs, Tips RUNWAY1842Ce
(Potable) water service unit	WAT	G-WSU	Vestergaard e-WS
Toilet / Lavatory service unit	LAV	G-TSU	Vestergaard e-VTS
Cleaning equipment / Sweeper	-	I-CLEANE	Dulevo D.Zero

6. Because the electric alternative is already available, all parties should commit to not purchase light equipment (as mentioned above) on fossil fuel from 1-6-2023.
7. The generic handlers should remove all light equipment on fossil fuel for passenger aircraft handling by 1-1-2024, as the Netherlands Labour Authority has imposed. Given the currently long delivery times and the timing of investment decisions, fuel powered equipment might still be used if electric alternatives have been ordered but have not been delivered yet.
8. All other parties should commit to remove light equipment powered by fossil fuels as soon as possible, at last before 1-1-2030.

Link back to slide 25

Appendix

D. Background information slide 26

Equipment types that belong to light cargo equipment:

Name	IATA code	KES code	Examples of zero emission alternatives
Forklift	FKL	I-FL	
Low deck loader	LDL	G-PL	TLD TXL-838 reGen, JBT Commander 30i Electric Cargo Loader, Trepel Champ 35e, Trepel Champ 70e NEO,
Cargo tractor	CTU	G-BT	TLD JST-E, Volk Electric EFZ 100 N, Spijkstaal 425 Elektrotrekker, Goldhofer Sherpa E, MULAG Comet 6E, MULAG Comet 6 E-HV
Agricultural tractor	-	A-ATR	Rigitrac

9. Because the electric alternative is already available, all parties should commit to not purchase low deck loaders, cargo tractors and forklifts on fossil fuel from 1-6-2023.
10. All parties should commit to remove all light cargo equipment powered by fossil fuels operating in the green zone in accordance with the Netherlands Labour Authority* (by 1-1-2024). Exceptions are:
    - Due to long delivery times, if electric alternatives have already been ordered but not yet delivered, the fuel version may still be used until the electric alternative has been delivered.
    - Equipment that needs to use the Kaagbaantunnel during its operation is exempted from this due to the limited battery capacity of electric equipment and the power required to pass the tunnel.
11. All parties should commit to remove all light cargo equipment powered by fossil fuels operating outside the green zone as soon as possible, latest before 1-1-2030.

Link back to slide 26

Appendix

D. Background information slide 27

Equipment types that belong to passenger and utility vehicles:

Name	IATA code	KES code	Examples of zero emission alternatives
Van / Crew bus	CBS/LCV	A-VAN	Mercedes Benz eVito Tourer, Opel Vivaro Electric, Mercedes Benz e-Sprinter, Mercedes Benz EQV, Volkswagen ID. Buzz (Cargo), Fiat e-Scudo
Car / Passenger vehicle	CAR/UTV/LCV	A-CAR	Volkswagen ID.4, Rivian R1T, Rivian R1S, Volkswagen ID.5 GTX
Passenger / Transit bus	APB/BUS	A-PB	eCobus3000, Urbino 18 hydrogen
Industrial Busses	-	I-PB	

12. Because the electric alternative is already available, all parties should commit to not purchase fossil fuel cars and vans from 1-6-2023.
13. All parties should remove all fossil fuel cars and vans by 1-1-2024 , in accordance with the Netherlands Labour Authority*. Exceptions are:

- If before 1-1-2024, the motor is replaced by a variant with Euro6/Stage IV/V norm or if a particulate filter with a 95% effectivity is installed, in accordance with the Netherlands Labour Authority*
- If electric alternatives have been ordered but have not yet been delivered, fuel equipment may be used until zero emission alternatives have been delivered
- If zero emission alternative is not technically and operationally feasible (e.g., maintenance vans), fuel powered vans may be used until zero emission alternative becomes available, if they comply with the first exception

Link back to slide 27

Appendix

D. Background information slide 30

Equipment types that belong to aircraft tractors:

Name	IATA code	KES code	Examples of zero emission alternatives
Aircraft tractor	TWT/TWL	G-AT	Goldhofer Phoenix AST-2E, TLD TMX-350-E, Kalmar TBL 800

1. Because aircraft tractors for pushback operations of narrow- and medium-body aircraft are already available, all parties should commit to not purchase fuel powered narrow- and medium-body aircraft tractors anymore from 1-6-2030 as the electric alternative is already available.
2. All parties should commit to not purchase fossil fuel powered wide-body aircraft tractors for pushback operations as soon as they become available and are technically and operationally feasible.
3. All parties should commit to phase out all aircraft tractors on fossil fuel as soon as possible, latest before 1-1-2030 to reach the zero emission goal of 2030.
4. Electric aircraft tractors cannot yet be used for long distance towing of aircraft, as battery capacity is not sufficient to tow aircraft over such long distances. Therefore, AAS and handlers should continue piloting with zero emission aircraft tractors that could be suitable for long distance towing and taxi bots (to contribute to sustainable taxiing). Furthermore, creative solution such as the retrofitting of existing fuel powered equipment could offer a solution, if electric alternatives are not yet ready on the market.

Link back to slide 30

Appendix

D. Background information slide 31 & 32

Equipment types that belong to cargo and specialised equipment:

Name	IATA code	KES code	Examples of zero emission alternatives
Pallet transporter	CPT	G-PT	JBT CPT-7 Electric Cargo Transporter, MULAG Pulsar 7E, AVIOGEI TVP 7000
Main deck loader	MDL	G-PL	JBT Commander 30i Electric Cargo Loader, Trepel Champ 70e NEO, Trepel Champ 140e, Trepel Champ 350e
Agricultural tractor	-	A-ATR	Rigitrac
Hydrant dispenser	FDP	G-AFSUD	Titan Aviation TITAN-eHD150,
Catering truck	CAT	G-CT	
PRM Ambulift	PBV	G-AMLI	Aviogai Thunderlift 6000E, Bulmor E SideBull XXLe
Cleaning (scissor) truck	CCT		
De-icing service unit	DAI	G-DSU	Vestergaard Elephant e-BETA, Vestergaard e-Mini MY Lite
GSE refuelling tanker	GFT	A-FSU	
Oil service unit		G-OSU	
Maintenance platform	MWP	A-/G-MP	
Compressor		I-COMP	

5. All parties commit to not purchase cargo and specialised equipment on fossil fuel as soon as zero emission alternatives are technically and operationally feasible and available on the market.

6. All parties commit to phase out all cargo and specialised equipment on fossil fuel as soon as possible, latest before 1-1-2030.

Link back to slide 31

Appendix

D. Background information slide 31 & 32

7. A large share of energy consumed by fuel dispenser is caused by driving movements between stands. To reduce the amount of energy used and accelerate the reduction in fuel consumption, the use of stand-based non-motorized hydrant carts should be explored. These hydrant carts are solar-powered and would eliminate the need for motorized hydrant dispensers entirely.

   Hydrant carts are non-motorized hydrant dispensers that are available for narrow body and wide body aircraft. They are parked on an aircraft stand and powered by a small battery pack that is charged by solar panels. Therefore, hydrant carts can be a replacement for motorized hydrant dispensers and lead to a reduction in both fuel consumption and airside traffic movements.

8. Catering, cleaning and PRM services should pilot with electric scissor trucks as soon as possible to accelerate the replacement of fossil fuel powered vehicles, as electric scissor trucks are already available, but further testing is required regarding their application to catering services*. Other creative solutions could include the retrofitting of existing equipment to electric versions by replacing the fuel engine with an electric engine.

9. Handlers should pilot with electric de-icing service units, pallet transporters and main deck loaders as first electric alternatives are available on the market, but more testing is needed to enable a transition to zero emission. Other creative solutions could include the retrofitting of existing equipment to electric versions by replacing the fuel engine with an electric engine.

10. To reduce driving movements of de-icing service units, at-gate de-icing should be phased out and an additional de-icing apron should be opened on Apron R, where de-icing equipment can be pooled. This will lead to fewer driving movements and less equipment, leading to a more efficient use of the battery capacity.

* Cleaning company Asito is already undertaking pilot tests: Delta Air Lines start proef met eerste elektrische highlift truck op Schiphol (verkeersbureaus.info)

Link back to slide 31

Appendix

D. Background information slide 33

Royal Schiphol Group in Amsterdam and its fellow airport partners Avinor in Oslo, Hermes at Cyprus and SAGAT in Torino focus on seven topics or challenges. Together these challenges result in 17 demonstrator projects to accelerate sustainability at or around the airport. Several of these demonstrator projects are mentioned in this document.

Workpackage 3: Smart Energy Hub

Smart Energy Airport:
An overall system analysis of the energy system for airports, also a design is made for a smart resilient energy system , integrating electricity, and heat, and hydrogen, and the first phase implementation of it at Schiphol and fellow airports in the TULIPS consortium.

Energy Storage System with Iron Flow Battery:
Implementing improved airside electricity traffic including storage, smart energy management systems and photovoltaic (solar panel) charging to operate the Electrical Ground Power Unit (eGPU). The Iron Flow Battery will be operated at Schiphol to test the use of battery energy storage systems. For the tests, the Iron Flow Battery will be placed on the AB apron, where aircraft are remotely handled. Consequently, Schiphol will be able to deploy e-GPUs on this location. In a second test, we plan to simulate the solar panels at the U-apron providing the Iron Flow Battery with energy.

Workpackage 4: Zero Emission Airside Operations

Hydrogen fuel cell technology integrated into current fuel-electric ground support equipment to enable zero emissions operation for two of the most emitting GSE.

A H_2 GPU powered by a hydrogen fuel cell, is developed and operated as part of this work package in collaboration with other TULIPS partners. Also, a large size tow tractor which uses hydrogen powered fuel cells is developed.

Link back to slide 33

Appendix

D. Background information slide 36

Equipment types that belong to heavy specialized equipment:

Name	IATA code	KES code	Examples of zero emission alternatives
Refuelling truck	FTK	G-AFSUT	Art Aircraft Refueler
Truck	-	I-TRUCK/A-TRUCK	DAF XD/XF Electric truck, DAF LF Electric truck
Generators	-	I-GEN	GEH2 electro-hydrogen generator,

Reduction principle 3 is set up for equipment without a zero emission alternative available in the near future.

1. By prioritizing the completion of hydrants at Apron S, the number of stands that require refueling by refueling trucks can be reduced significantly. Therefore, reducing emissions already before being able to replace refueling trucks with zero emission alternatives.
2. Establishing a development fund can lead to the acceleration of the development of zero emission alternatives for equipment that is currently not yet available in an electric version.
3. The remaining stands without hydrants are predominantly narrow-body stands, for which small-/medium-sized refueling trucks are needed. The electrification of suck trucks is expected to be easier than large-sized refueling trucks. Several developments are known regarding electric small-/medium-sized refueling trucks (Initiative by Skytanking & Stuttgart Airport).
4. All parties commit to phase out heavy specialized equipment as soon as possible, latest before 1-1-2030 in order to reach the goal of zero emission in 2030.

Link back to slide 36

Appendix

D. Background information slide 37

Equipment types that belong to alternative specialized equipment:

Name	IATA code	KES code
Fire brigade	-	I-RUNW
Snowfleet	-	I-RUNW

5. By getting in close contact with manufacturers, the demand of handlers are clarified. Therefore, manufacturers can respond to this demand by developing zero emission equipment.
6. By facilitating tests for research purposes for specialized heavy equipment, new zero emission alternatives can be tested first at Schiphol, further accelerating the development of ready-to-market alternatives.
7. By experimenting with an autonomous snow fleet, unnecessary driving movements, such as during the yearly trainings, can be decreased. This leads to a reduction in fuel consumption in the short-run, even before fully zero emission alternatives are available on the market.
8. By choosing an autonomous snow fleet in the procurement process, unnecessary driving movements, such as during the yearly trainings, can be decreased. This leads to a reduction in fuel consumption in the short-run, even before fully zero emission alternatives are available on the market.
9. AAS commits to phase out fuel-powered specialized equipment as soon as possible, latest before 1-1-2030.

Link back to slide 37

Appendix

D. Background information slide 39 & 40

Improve cooperation amongst parties

1. Denise Pronk within AAS will be the dedicated points of contact for communication about the roadmap zero emission airside operations. Parties on airside can contact here for questions about the roadmap or the follow-up.
2. Explanation of the calendar of collaboration moments:

Denise Pronk, Head of Sustainability, Strategy & Airport Planning
pronk_d@schiphol.nl

Existing sessions

Sustainable Aviation Table
The Ministry of Infrastructure and Water Management, the aviation sector and knowledge institutions drew up the Draft Agreement on Sustainable Aviation. This contains agreements to make Dutch aviation and airports emission-free. This is the translation of the Paris agreement to the Dutch aviation sector. The Sustainable Aviation Table has a specific working group on ground operations. Twice a year new innovations (that fall under principle 3 of this roadmap) as well as hydrogen infrastructure are discussed and further explored.

Existing tactical meetings
In the existing tactical meetings, future plans of all parties and the progress of projects are discussed. Ongoing or future initiatives from handlers are also retrieved. In these various meetings, the recommendations from this roadmap could be used as input for the agenda. These meetings include THO (Tactical Handler Group), ACN (Air Cargo Netherlands) and AFC (Airport Fuel Committee).

Recommended sessions

Working group Zero Emission Airside with AAS and external parties
AAS will establish a quarterly working group together with all parties at airside. In this working group the developments and the progress of the roadmap zero emission airside will be monitored and. In this monitoring, the performance of the parties at airside will be reviewed to check to what extent the reduction of emission is on the right track. Once a year, the recommendations in the roadmap will be reviewed according to the latest know-how and insights and, if needed, adjusted. Also, in the working group the organization of inspiration sessions will be planned.

Inspiration sessions together with relevant parties, airports, research institutes, and manufacturers
These inspiration sessions should take place at the end of each year. During these inspiration session, multiple parties are invited to talk about sustainable innovations, challenges in sustainable alternatives and brainstorm about fitting solutions for the operation. Organization of the inspiration sessions will be discussed during the working group Zero Emission Airside

Link back to slide 39

Appendix

E. The following themes belong to the following AAS departments

Every action to do with…	Owner Amsterdam Airport Schiphol department:
Overall follow up of the roadmap zero emission airside	**AO&AP**
Phasing out and arrival of new equipment	AO&AP
(Increased) power requests, electrification airside program and charging points (strategic)	S&AP
Carry out electrification airside program and building of charging points	ASM
Charging strategy (working model)	AO&AP
Tulips program WP4 (including hydrogen infrastructure), innovations, research and pilots	ASM
Vehicle registration	AO&AP
Funding, growth funds and contact with the government	S&AP
Working groups, communication tool and point of contact	AO&AP

Link back to slide 43

Appendix

E. List of action status (enabling action 1)

Action number	Action text	Ongoing action	Action to be started	Action for which further research is needed
E 1.1	AAS will submit all currently known power requests at grid operator (Schiphol Netbeheer), before 1-1-2024, to gain insights in the availability of transport capacity and to accelerate the electrification of airside. After that, the grid operator needs to confirm the requests to secure power capacity on time.	X		
E 1.2	AAS will explore the creation of a smart power grid with energy management systems, to gain insights in efficient use of available power, by 1-1-2024. If a smart power grid will be implemented, all parties commit that all new equipment on airside will be able to function in a smart way and be configurable with smart energy management systems.			X
E 1.3	AAS continues to carry out the electrification airside program, in which it is installing charging points, fixed power units and PCA sockets at every pier and apron on airside within 6 phases (2022-2029). Also, AAS updates the program in line with the latest technical and operational know-how, also retrieved from contact with parties on airside.	X		
E 1.4	Even if the capacity of the power grid is not yet sufficient at a certain location, charging points should already be built to ensure the ability to charge electric equipment when the capacity is increased.		X	
E 1.5	If no grid capacity or infrastructure for charging points are available, AAS facilitates that electric equipment can be charged by 1-1-2024, using the following alternatives to bridge the gap (in this preferred order); 1. Battery energy storage systems (iron flow battery or Li-ion battery) 2. Hydrogen generators 3. Fuel generators		X	
E 1.6	AAS will, together with key users, explore including common-use fast-charging points at airside in the electrification program and research the power requirements of future charging points.			X
E 1.7	AAS will, together with key users, explore the construction of fast-charging stations (e.g., in the South-East area, reserved for heavy cargo equipment and aircraft tractors, for which current battery ranges require fast-charging to make electric alternatives operationally viable).			X
E 1.8	AAS only focusses on creating common-use charging points on airside that can be used by all parties, instead of individual charging points.	X		
E 1.9	AAS should explore what exactly are the operational peaks for the power demand and inform parties about these peaks before 1-1-2024.			X
E 1.10	All parties explore possibilities to reduce the peak of their operational power demand. All parties commit to using the charging points efficiently (e.g., by only connecting to the charging point while charging).			X

Link back to slide 43

Appendix

E. List of action status (enabling action 1)

Action number	Action text	Ongoing action	Action to be started	Action for which further research is needed
E 1.11	Furthermore, AAS will explore the development of a strategy of charging slots based on operational requirements of airside parties to better balance power demand and supply throughout the day.			X
E 1.12	AAS will explore the standardization of plug types and should inform all parties about this before 1-1-2024.			X
E 1.13	AAS informs all parties about updates about the electrification airside program.	X		
E 1.14	All parties inform AAS about new equipment as soon as possible, at last when the order is placed.	X		
E 1.15.1	AAS establishes a communication plan between the electrification airside program and airside parties, starting 1-7-2023. Parties will have dedicated points of contact within AAS to communicate about their needs on electrification of airside. For information about the long term, innovation and electrification, a point of contact will be appointed within the strategy department (S&AP). For information about the operations, a point of contact will be appointed within the operations department (AO&AP).	X		
E 1.15.2	All parties on airside receive semi-annual updates of the electrification airside program and provide updates regarding the electrification of their fleet.		X	
E 1.16	AAS continues to actively contribute to the project in the TULIPS program, Naco and ACI Europe and make use of the knowledge and relevant contacts to keep exploring the possibilities for hydrogen and hydrogen infrastructure.	X		
E 1.17	Apart from replacing equipment with zero emission alternatives, all parties on airside will optimize the efficiency of their operation to minimize the demand of fuel, electricity or hydrogen – according to the first step of the trias energetica principle.	X		
E 1.18	AAS will enforce that next to the equipment refuelling on airside (where HVO100 is the only available fuel), all equipment refuelling outside of airside that drives on airside must be fuelled with HVO100 from 1-1-2024.		X	
E 1.19	AAS and handlers keep exploring the use of equipment pooling. Results of the current pilot will lead to a plan for future equipment pooling and ownership structure.	X		

Link back to slide 43

Appendix

E. List of action status (enabling action 1)

Action number	Action text	Ongoing action	Action to be started	Action for which further research is needed
E 1.20	AAS will explore the facilitation of an (autonomous) electric shuttle service for employees working at airside to reduce movements and required passenger vehicles and inform all parties about this before 1-1-2024.			X
E 1.21	AAS continues exploring setting up a vehicle registration system in for all users of airside, including information on the type of engine.	X		

Link back to slide 43

Appendix

E. List of action status (reducing principle 1)

Action number	Action text	Ongoing action	Action to be started	Action for which further research is needed
P 1.1	FPUs are the preferred replacement for GPUs on fossil fuel and AAS keeps installing these as soon as possible, latest before 1-1-2030. 1. When a NaBo stand does not have a FPU (yet), E-GPUs are the preferred solution (with KES being the facilitator of the E-GPU pool). 2. When a WiBo stand does not have a FPU (yet), H_2-GPUs or WiBo E-GPU are the expected solution.	X		
P 1.2	All parties commit to not purchase NaBo GPUs and PCAs on fossil fuel from 1-6-2023, because this alternative is already available.	X		
P 1.3	AAS and KES will continue piloting with H_2-GPUs and WiBo E-GPU, including safety assessment.	X		
P 1.4	AAS will supply electric PCAs, in line with the action plan AAS submitted to IL&T.	X		
P 1.5	All parties commit to phase out all aircraft facilities (GPUs and PCAs) on fossil fuel within the green zone in Schiphol centre in accordance with the Netherlands Labour Authority* (by 1-1-2024). Exceptions are: - The inside of Pier D: latest 1-1-2025 - Apron A/B, Pier B and buffer DE: 1-1-2026 - Pier C: completed in parts, in accordance with own schedule (2026-2032) - For all other areas (stands outside the green zone): 1-1-2027	X		
P 1.6	All parties commit to not purchase light equipment (boarding stairs, conveyor belt loaders, baggage/equipment tractors, water service units and toilet service units) on fossil fuel from 1-6-2023, because the electric alternative is already available.	X		
P 1.7	Generic handlers commit to phase out all light equipment on fossil fuel for passenger aircraft handling in accordance with the Netherlands Labour Authority* (by 1-1-2024). If electric alternatives have been ordered but have not yet been delivered, fuel equipment may be used until zero emission alternatives have been delivered.	X		
P 1.8	All parties commit to phase out all light equipment on fossil fuel operating as soon as possible, at last before 1-1-2030.	X		

Link back to slide 43

Appendix

E. List of action status (reducing principle 1)

Action number	Action text	Ongoing action	Action to be started	Action for which further research is needed
P 1.9	All parties commit to not purchase all light cargo equipment (low deck loaders, forklifts and cargo tractors) on fossil fuel from 1-6-2023, because the electric alternative is already available.	X		
P 1.10	All parties commit to phase out all light cargo equipment (low deck loaders, forklifts and cargo tractors) powered by fossil fuels operating in the green zone in accordance with the Netherlands Labour Authority* (by 1-1-2024). Exceptions are: • If electric alternatives have been ordered but have not yet been delivered, fuel equipment may be used until zero emission alternatives have been delivered. • Equipment that needs to use the Kaagbaantunnel during its operation.	X		
P 1.11	All parties commit to phase out all light cargo equipment (low deck loaders, forklifts and cargo tractors) powered by fossil fuels operating outside the green zone as soon as possible, latest before 1-1-2030.	X		
P 1.12	All parties commit to not purchase fossil fuel cars and vans from 1-6-2023, because the electric alternative is already available.	X		
P 1.13	All parties commit to phase out all fossil fuel cars and vans by 1-1-2024. Exceptions are: • If before 1-1-2024, the motor is replaced by a variant with Euro6/Stage IV/V norm or if a particulate filter with a 95% effectivity is installed, in accordance with the Netherlands Labour Authority* • If electric alternatives have been ordered but have not yet been delivered, fuel equipment may be used until zero emission alternatives have been delivered • If zero emission alternative is not technically and operationally feasible (e.g., maintenance vans), fuel powered vans may be used until zero emission alternative becomes available, if they comply with the first exception	X		

Link back to slide 43

Appendix

E. List of action status (reduction principle 2)

Action number	Action text	Ongoing action	Action to be started	Action for which further research is needed
P 2.1	All parties commit to not purchase fossil fuel narrow- and medium-body aircraft tractors for pushback operations from 1-6-2023, because the electric alternative is already available.	X		
P 2.2	All parties commit to not purchase fossil fuel wide-body aircraft tractors for pushback operations as soon as zero emission alternatives are technically and operationally feasible and available on the market.			X
P 2.3	All parties commit to phase out all aircraft tractors on fossil fuel as soon as possible, latest before 1-1-2030.	X		
P 2.4	Handlers and AAS should continue piloting with zero emission aircraft tractors for long distance towing and taxi bots (to contribute to sustainable taxiing) and find creative solutions (e.g., such as retrofitting existing equipment).	X		
P 2.5	All parties commit to not purchase cargo and specialised equipment on fossil fuel as soon as zero emission alternatives are technically and operationally feasible and available on the market.			X
P 2.6	All parties commit to phase out all cargo and specialised equipment on fossil fuel as soon as possible, latest before 1-1-2030.			X
P 2.7	Refuelling services should explore the use of stand-based non-motorized hydrant carts to reduce the use of motorized hydrant dispensers.			X
P 2.8	Catering, cleaning and PRM services should continue piloting with electric scissor trucks and find creative solutions (e.g., such as retrofitting existing equipment).	X		
P 2.9	Handlers should pilot with electric de-icing service units, pallet transporters and main deck loaders as soon as possible and find creative solutions (e.g., such as retrofitting existing equipment).			X
P 2.10	AAS will explore opening another de-icing apron on the apron R at which de-icing equipment can be pooled between the handlers which leads to less de-icing equipment necessary and better de-icing water quality and should inform all parties about this before 1-1-2024.			X
P 2.11	AAS will keep contributing to the demos of the TULIPS programme, like the hydrogen GPU, the iron flow battery, hydrogen aircraft tractor and the smart energy power grid. Contributing to the TULIPS program facilitates knowledge and information sharing that leads towards sustainable innovations. This knowledge can be used to create possible zero emission alternatives for equipment now powered by fossil fuel.	X		

Link back to slide 43

Appendix

E. List of action status (reduction principle 3)

Action number	Action text	Ongoing action	Action to be started	Action for which further research is needed
P 3.1	AAS should prioritize the completion of hydrants planned for 2026 at the Apron S, which minimizes the use of refueling trucks and should inform all parties about its final decision before 1-1-2024.	X		
P 3.2	The Sustainable Aviation Table should explore the possibilities of a development fund for equipment part of reduction principle 3 to invest in projects that ensure zero emission alternatives in the future.			X
P 3.3	Fuel services should explore the use of small electric refueling trucks for Apron A, Apron R, Apron Y and Apron J.			X
P 3.4	All parties commit to phase out heavy specialized equipment as soon as possible, latest before 1-1-2030.		X	
P 3.5	The owners of equipment that are part of reduction principle 3 commit to contact equipment manufacturers on a regular basis to discuss the development of zero emission equipment.	X		
P 3.6	AAS will continue to facilitate tests for research purposes for specialized heavy equipment owned by AAS.	X		
P 3.7	AAS will contribute to the ‘autonomous airside project’ to experiment with an autonomous snow fleet to decrease unnecessary movements (such as by training) and decrease the emissions in the short run.	X		
P 3.8	In the procurement process of the new AAS snow fleet in 2023, an autonomous fleet should be chosen.			X
P 3.9	AAS commits to phase out fuel-powered specialized equipment as soon as possible, latest before 1-1-2030.			X

Link back to slide 43

Appendix

E. List of action status (enabling action 2)

Action number	Action text	Ongoing action	Action to be started	Action for which further research is needed
E 2.1	AAS establishes a cooperation plan between AAS and airside parties to create insight in progress of zero emission airside roadmap by setting up a dashboard including the following information:	X		
E 2.1.1	A dedicated point of contact for the airside users to contact regarding zero emission airside. When necessary, this point of contact will refer the question or concern to the right person.		X	
E 2.1.2	A communication tool in which Schiphol sends updates on the roadmap and in which the airside users can find FAQ's, zero emission milestones that are required to reach and (if they desire) contact details to reach each other and cooperate.		X	
E 2.2	In order to continue the actions of this roadmap, AAS will establish another working group together with all parties at airside. In this working group the developments and the progress of the roadmap zero emission airside will be monitored and, if needed, adjusted. Furthermore, AAS will explore the need for a steering group.			X

Link back to slide 43