Memo

Sustainable Taxiing

Version 1.0

Over the past two years, sector partners have collaboratively researched the possibility of Sustainable Taxiing at Amsterdam Airport Schiphol. An extensive feasibility study – which included pilot operations at airside, as well as capacity and runway predictions – concluded that the concept is infeasible in its current form, but might be feasible with adjustments.

As a result, two roadmaps should be created to 1) determine the viability of the solutions and changes under investigation – a detailed project roadmap for the months ahead, and 2) describe the implementation of Sustainable Taxiing as standard procedure at Amsterdam Airport Schiphol before 2030 (pending a feasible outcome) – a strategic roadmap. This memo serves to highlight the sector-wide ambition on Sustainable Taxiing and introduce the two roadmaps, which paint a picture of the key stakeholders' strategy for rolling out Sustainable Taxiing over time and thus achieving our shared vision. An ambition underpinned by the Akkoord Duurzame Luchtvaart and the Luchtvaartnota.

By signing this document, we ask the various stakeholders to:
1. Endorse and commit to the overall sector-wide ambition for Sustainable Taxiing operations at Amsterdam Airport Schiphol by 2030;
2. Agree to pass GO / NO GO 1: creation and alignment of the shared vision & roadmap, and therefore endorse and commit necessary resources to progress towards GO / NO GO 2 and the accompanying operational milestone O1: standardised Sustainable Taxiing operations for the 737 & A320 at 18R / 36L for some carriers with 2 Sustainable Taxiing solutions. Therefore also committing to the efforts up to GO / NO GO 2, which have already been drafted in the project roadmap, and a.o. include shared actions to perform a more detailed feasibility study and carry out new Taxibot trials as part of ALBATROSS SESAR Very Large Demonstrator.

Shared ambition for Sustainable Taxiing

We, the Sustainable Taxiing task force, realise aircraft ground movement where all avoidable emissions have been eliminated. In close collaboration with the aviation ecosystem, we meet our own sustainability ambitions and societal & political demands for the benefit of airlines and our local community – now and in the future.

Two roadmaps

The two roadmaps shared in this memo are interlinked with one another and paint the same picture on a different level.

- The strategic roadmap provides a complete overview of the current approach to roll-out Sustainable Taxiing operations at Amsterdam Airport Schiphol towards 2030. This roadmap is most relevant in the context of policy-making and sharing our ambition.
- The project roadmap provides a more detailed view of the necessary deliverables and perceived workload for the coming 24-36 months. A rolling roadmap (which will be updated more frequently), it currently details the efforts to determine the viability of the solutions and changes under investigation, and the steps towards the first operational milestone in 2022. This roadmap is most relevant in the context of project management.
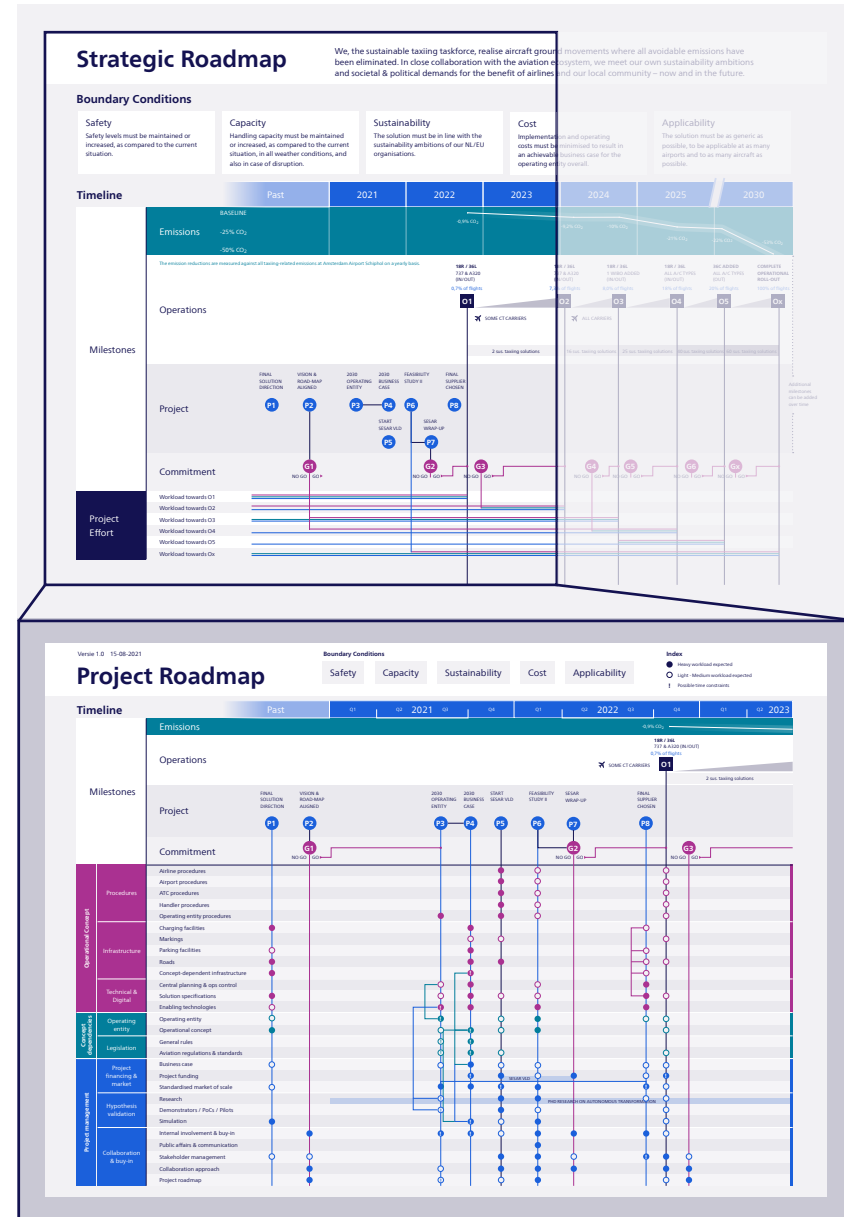
Collaborative risk mitigation and continuous development

Next to the shared ambition, the strategic and product roadmaps both share a few elements that allow the sector to collaboratively work towards implementation, while mitigating risks where possible. The project is built on five boundary conditions, knows several milestones and related GO / NO GO moments and all required effort is detailed over three project building blocks and 30 subsequent key deliverables.

The boundary conditions

In achieving the shared ambition, all sector partners agreed that the concept of Sustainable Taxiing at Amsterdam Airport Schiphol is subject to a number of boundary conditions. These conditions apply to the concept in its final form, as well as during roll-out, at any stage.

Safety
Safety levels must be maintained or increased, as compared to the current situation.

Capacity
Handling capacity must be maintained or increased, as compared to the current situation, in all weather conditions, and also in case of disruption.

Sustainability
The solution must be in line with the sustainability ambitions of our organisations and fit national and European climate goals.

Cost
Implementation and operating costs must be minimised to result in an achievable business case for the operating entity overall.

Applicability
The solution must be as generic as possible, to be applicable at as many airports and to as many aircraft as possible.

Milestones

The milestones as set out in these roadmaps are an indication of the results necessary at a certain point in time, for the sector to realistically be able to achieve our shared ambition by 2030. Based on current knowledge, they represent the most realistic roll-out strategy. As a combination of our fixed ambition and ever-evolving knowledge on the subject, these milestones do not serve as markers to grade the sector and our efforts, but as guidelines towards the ambition, and markers for our shared GO / NO GO decisions.
As we learn more by testing and implementing Sustainable Taxiing operations step-by-step, these milestones might change to better reflect knowledge developed over time.
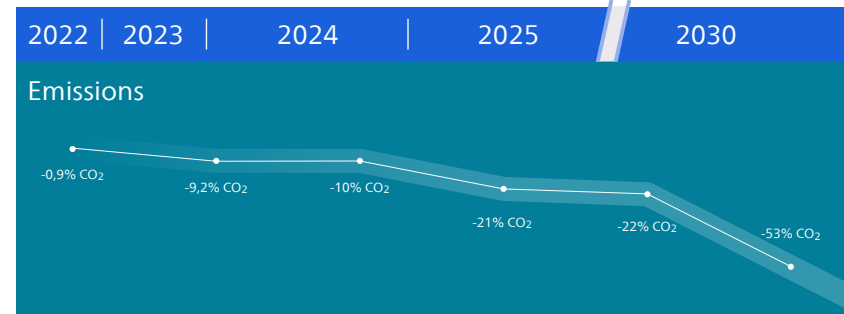
Emission reduction goals

The main driver for the roll-out of Sustainable Taxiing is the sector's wish to reduce its emissions. By 2030, the amount of taxiing-related emissions (CO_2, CO and NO_x) at Amsterdam Airport Schiphol can be reduced by over 50% if all taxiing manoeuvres are carried out by Sustainable Taxiing – according to the feasibility study carried out in 2020. This would mark a solid step on Royal Schiphol Group's path towards a net-zero carbon aviation sector by 2050. Based on the operational milestones, as detailed below, various emission reduction goals can be set before that time.
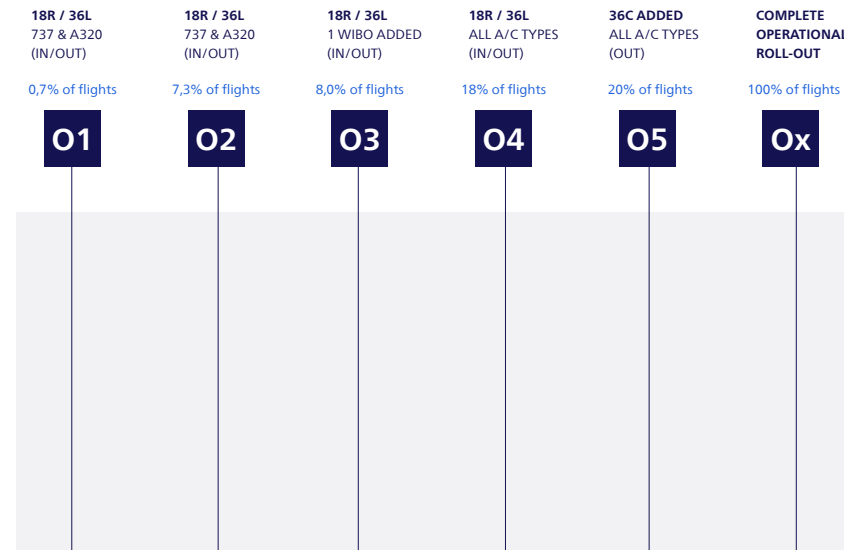
Operational milestones

Based on expert judgement, the operational milestones indicate the most realistical build-up of Sustainable Taxiing operations over time, while taking all boundary conditions into consideration. Operational milestones O1 through O5 mark the moments in time our taskforce expects to have achieved certain operational standards at Amsterdam Airport Schiphol. Each operational milestone is preceded by a gradual ramp-up in which small-scale operational testing of the new conditions take place. Based on future learnings, we expect to add several operational milestones between O5 and Ox in the coming years; on our way towards full operational roll-out on all runways and with all airlines and aircraft types in 2030 (Ox). Operational roll-out is primarily based on runway configurations, followed by airline and/or aircraft type rollouts. We believe this allows the impact of Sustainable Taxiing to scale as quickly as possible, with the least amount of capital-intensive infrastructure changes and equipment purchase/lease needs necessary for early milestones.

To achieve the operational milestones, a certain number of available Sustainable Taxiing solutions (such as TaxiBots) must be available at airside to carry out the required number of sustainable movements. The roadmaps show a rough estimate of the amount of simultaneous sustainable movements required from each operational milestone onwards – a number of solutions must be available earlier for the gradual ramp-up towards each milestone.

2022	2023	2024	2025	2030

Emissions

-0,9% CO_2 -9,2% CO_2 -10% CO_2 -21% CO_2 -22% CO_2 -53% CO_2

Milestones

18R / 36L 737 & A320 (IN/OUT)	**18R / 36L** 737 & A320 (IN/OUT)	**18R / 36L** 1 WIBO ADDED (IN/OUT)	**18R / 36L** ALL A/C TYPES (IN/OUT)	**36C ADDED** ALL A/C TYPES (OUT)	**COMPLETE** **OPERATIONAL** **ROLL-OUT**
0,7% of flights	7,3% of flights	8,0% of flights	18% of flights	20% of flights	100% of flights
O1	**O2**	**O3**	**O4**	**O5**	**Ox**

Project milestones

To arrive at the various operational milestones and GO / NO GOs, various project milestones must be reached. Such project milestones relate less to the operational concept of Sustainable Taxiing, and more to the way the sector is organized and works towards 2030. Since this often requires much work at an early stage, project milestones are mentioned separately.
As future operational milestones and GO / NO GO moments draw nearer, additional project milestones might be added.

Timeline

| | Past | 2021 | 2022 | 2023 | 2024 | 2025 | 2030 |

Emissions

BASELINE
-25% CO_2
-50% CO_2

-0,9% CO_2 -9,2% CO_2 -10% CO_2 -21% CO_2 -22% CO_2 -53% CO_2

The emission reductions are measured against all taxiing-related emissions at Amsterdam Airport Schiphol on a yearly basis.

| 18R / 36L 737 & A320 (IN/OUT) 0,7% of flights | 18R / 36L 737 & A320 (IN/OUT) 7,3% of flights | 18R / 36L 1 WIBO ADDED (IN/OUT) 8,0% of flights | 18R / 36L ALL A/C TYPES (IN/OUT) 18% of flights | 36C ADDED ALL A/C TYPES (OUT) 20% of flights | COMPLETE OPERATIONAL ROLL-OUT 100% of flights |

Operations

O1   O2   O3   O4   O5   Ox

✈ SOME CT CARRIERS   ✈ ALL CARRIERS

2 sus. taxiing solutions | 16 sus. taxiing solutions | 25 sus. taxiing solutions | 40 sus. taxiing solutions | 60 sus. taxiing solutions

Milestones

Project

FINAL SOLUTION DIRECTION — P1
VISION & ROAD-MAP ALIGNED — P2
2030 OPERATING ENTITY — P3
2030 BUSINESS CASE — P4
FEASIBILITY STUDY II — P6
FINAL SUPPLIER CHOSEN — P8
START SESAR VLD — P5
SESAR WRAP-UP — P7

Additional milestones can be added over time

Commitment milestones: GO / NO GOs

The radical and innovative nature of this project makes it impossible to provide a very detailed and accurate estimate of all necessary actions, investments and manhours required. Even more importantly, the operational performance of the end-result, though estimated based on trials, remains uncertain. Large sector-wide investments are necessary to achieve our ambition, both in terms of capital and labour. For this reason, various GO / NO GO moments are proposed, to mitigate the risk of further exploration and step-by-step implementation. These GO / NO GO moments are linked to upcoming operational milestones – after attaining a certain GO, the final (capital) investments can be made to progress towards a new operational milestone.

The urgency to achieve a zero-emission airside and roll out a Sustainable Taxiing operation as set out by the Akkoord Duurzame Luchtvaart *and the* Luchtvaartnota*, and the fact this is a sector-wide roadmap and project mean such GO / NO GO decisions can only be made collaboratively.*

Please note that sector-wide work towards achieving a certain operational milestone must almost always start before the related GO / NO GO moment has been reached. For example, the work to acquire wide-body certification of the Sustainable Taxiing solution to achieve O4, must start years in advance (so, shortly after the sector has committed to the above). Also, the large-scale automation required to achieve full-scale roll-out without a decrease in operational capacity, will require efforts on a similar timeline.

Because of this, smaller (in-kind) commitments will be necessary at earlier stages in the project. At this point in time, it is hard to estimate the required efforts. As a sector, we must look for and build on the way forward together. Moreover, we will collaboratively look for alternative funding opportunities, such as public and/or private grants, to limit capital investments as much as possible. In case financial commitments pop up ahead of their perspective GO / NO GO moment, such opportunities help limit the impact and risk. In any case, all early-stage commitments will be cautiously monitored and closely shared within the sector based on the latest available developments and knowledge.

As explained, commitment is currently requested on the sector-wide ambition, the overall strategic roadmap and passing GO / NO GO 1.
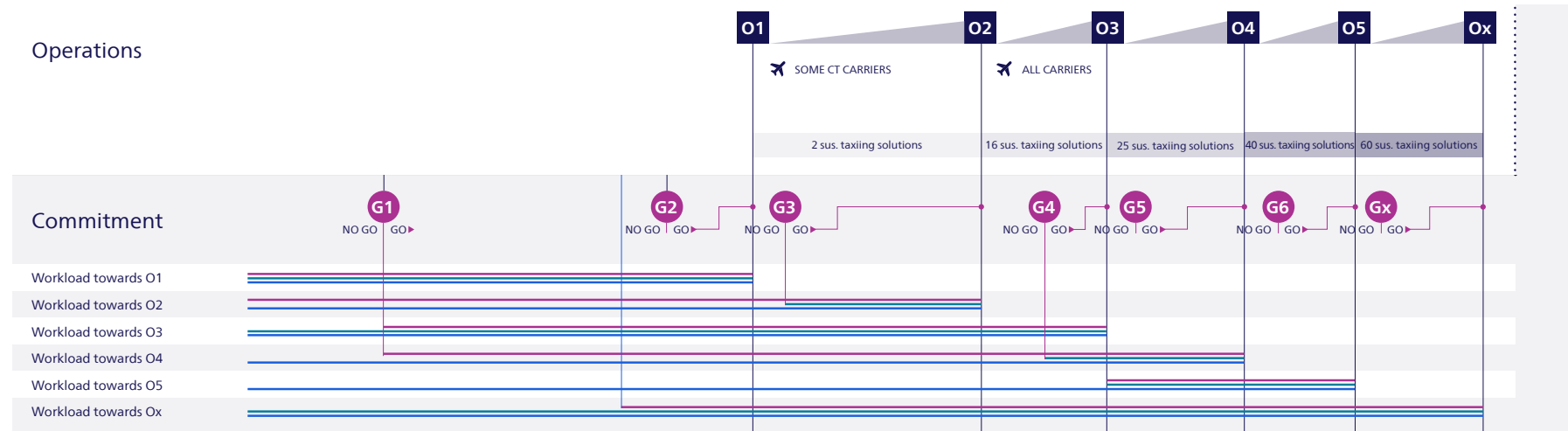
Project building blocks

The roadmaps and project have been built on several project building blocks, which subsequently consist of key deliverables. Actions / deliverables can be placed on these key deliverables over time. These key deliverables are universal over time and help understand and keep track of necessary actions to achieve milestones in a distant future, for which many uncertainties still exist.

Building blocks

Operational concept
All actions required to achieve the physical operation of Sustainable Taxiing at the airport.

Concept dependencies
All actions necessary to support a Sustainable Taxiing operation.

Project management
All actions to manage the project for roll-out of Sustainable Taxiing and working on our sector wide ambition.

Key deliverables

Procedures

Infrastructure

Technical & Digital

Operating entity

Legislation

Project financing & market

Hypothesis validation

Collaboration & buy-in

Estimated workload

The estimated workload from sector partners is higher than previously committed efforts. The required work moving from a GO / NO GO to the next operational milestone (and subsequent GO / NO GO), will probably be comparable to the previously completed feasibility study. And just like during the previous phase of our collaboration, efforts will consist of a combination of hypotheses validation (research activities aimed at the long term) and operational actions (airside activities related to the day-to-day operations).

However, as explained, some milestones further down the line also require a lot of (very) long-term effort. So, in moving towards our shared ambition for 2030, such actions must be picked up well in advance of the specific GO / NO GO moment for that objective. The scope and effort of such actions are hard to estimate and will vary per topic. What is certain however, is that this workload comes on top of the workload to achieve any upcoming operational milestone.

Since the (project) roadmap is a rolling roadmap any future insights can lead to updated versions of the roadmap, which will help all partners better understand the (amount of) upcoming effort.

Strategic Roadmap

We, the sustainable taxiing taskforce, realise aircraft ground movements where all avoidable emissions have been eliminated. In close collaboration with the aviation ecosystem, we meet our own sustainability ambitions and societal & political demands for the benefit of airlines and our local community – now and in the future.

Boundary Conditions

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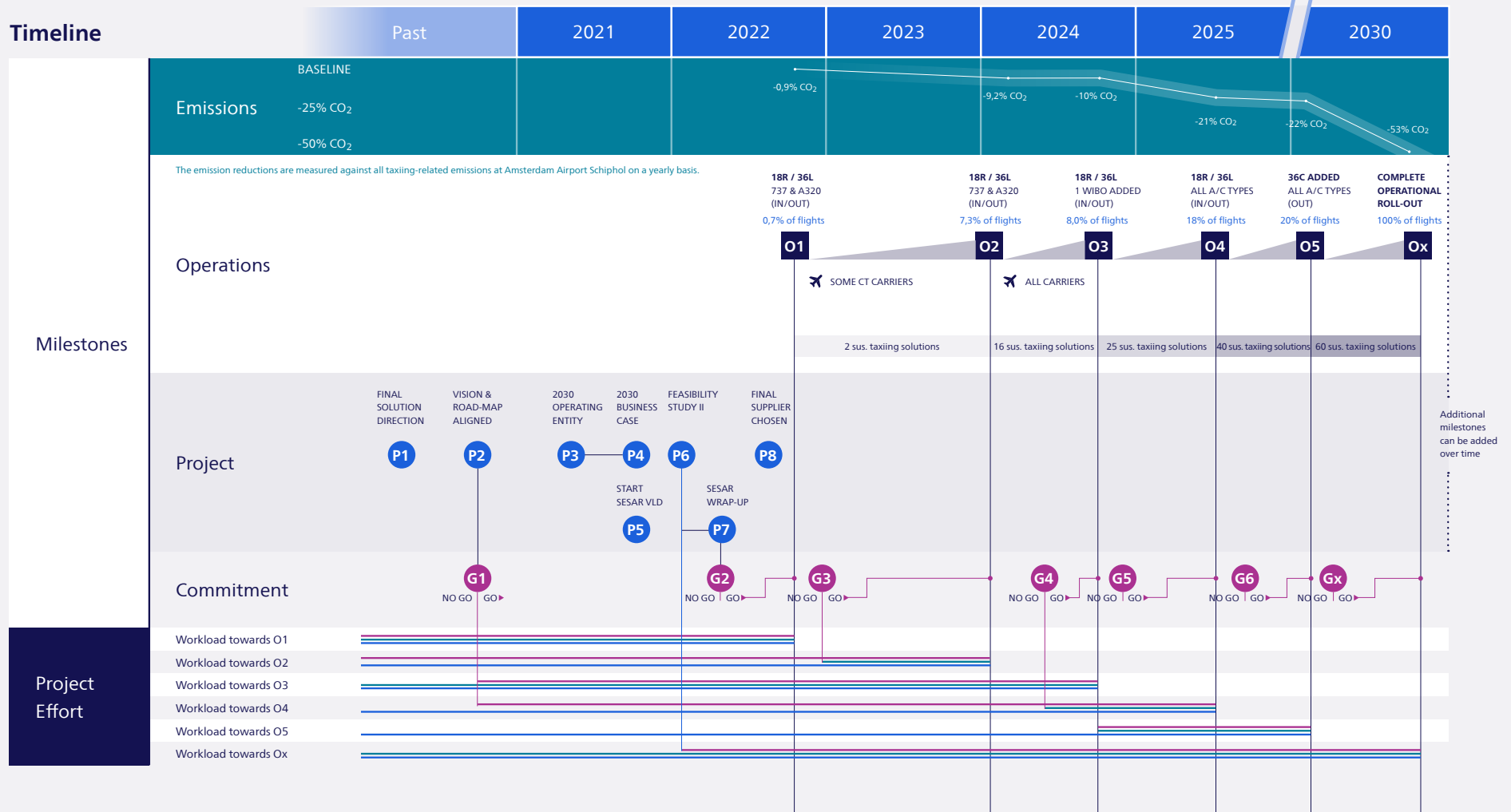
Cost
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Timeline

| Past | 2021 | 2022 | 2023 | 2024 | 2025 | 2030 |

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-50% CO$_2$

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O1   **O2**   **O3**   **O4**   **O5**   **Ox**

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Milestones

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Additional milestones can be added over time

Commitment

G1 NO GO | GO ▶
G2 NO GO | GO ▶
G3 NO GO | GO ▶
G4 NO GO | GO ▶
G5 NO GO | GO ▶
G6 NO GO | GO ▶
Gx NO GO | GO ▶

Project Effort

Workload towards O1
Workload towards O2
Workload towards O3
Workload towards O4
Workload towards O5
Workload towards Ox

Project Roadmap

Boundary Conditions
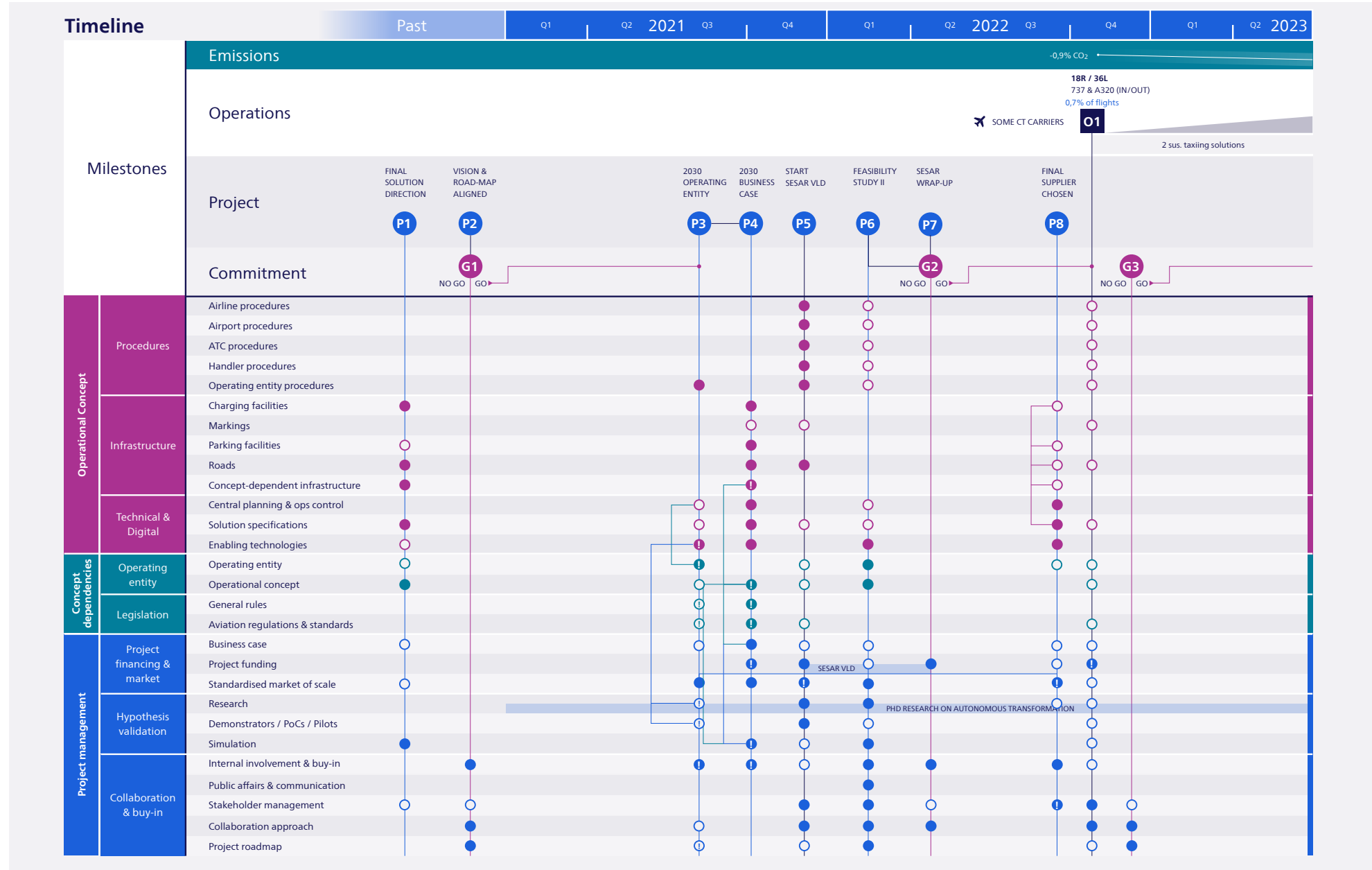
Safety | Capacity | Sustainability | Cost | Applicability
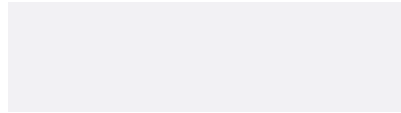
Index
- ● Heavy workload expected
- ○ Light - Medium workload expected
- ! Possible time constraints

Timeline	Past	Q1	Q2 2021 Q3	Q4	Q1	Q2 2022 Q3	Q4	Q1	Q2 2023

Emissions — -0,9% CO₂

Operations
18R / 36L
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Milestones

Project

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	P1	P2	P3	P4	P5	P6	P7	P8

Commitment
G1 NO GO GO ▶
G2 NO GO GO ▶
G3 NO GO GO ▶

Operational Concept

Procedures
- Airline procedures
- Airport procedures
- ATC procedures
- Handler procedures
- Operating entity procedures

Infrastructure
- Charging facilities
- Markings
- Parking facilities
- Roads
- Concept-dependent infrastructure

Technical & Digital
- Central planning & ops control
- Solution specifications
- Enabling technologies

Concept dependencies

Operating entity
- Operating entity
- Operational concept

Legislation
- General rules
- Aviation regulations & standards

Project management

Project financing & market
- Business case
- Project funding   SESAR VLD
- Standardised market of scale

Hypothesis validation
- Research   PHD RESEARCH ON AUTONOMOUS TRANSFORMATION
- Demonstrators / PoCs / Pilots
- Simulation

Collaboration & buy-in
- Internal involvement & buy-in
- Public affairs & communication
- Stakeholder management
- Collaboration approach
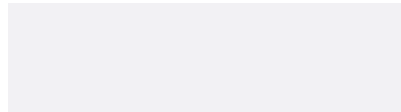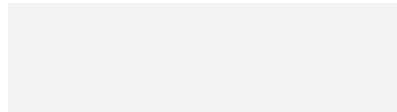- Project roadmap

As committed to by

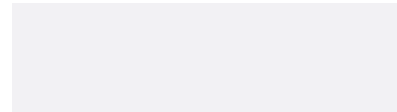Royal Schiphol Group
Dick Benschop
President & CEO
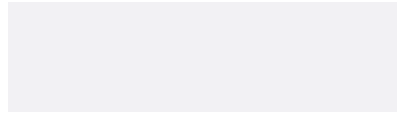
Royal Schiphol Group
Patricia Vitalis
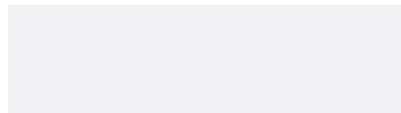Director Airport Operations
& Aviation Partnerships

KLM
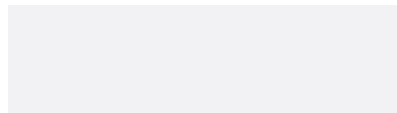**René de Groot**
COO & Managing Director

KLM
Vincent van Hooff
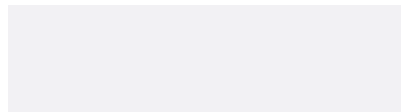Executive Vice President
Flight Operations

KLM Ground Services
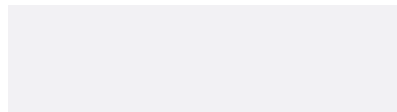**Maarten Stienen**
Senior Vice President

LVNL
Jurgen van Avermaete
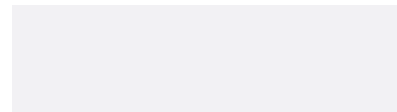General Manager Procedures
(approve)

LVNL
Michiel van Dorst
CEO (accept)

Transavia
Petra de Ruiter
COO

dnata
Jan van Anrooy
Managing Director

Corendon Dutch Airlines
Freek van der Pal
Managing Director

Colophon

This memo Sustainable Taxiing, the Strategic Roadmap Sustainable Taxiing and the Project Roadmap Sustainable Taxiing were co-created by representatives of the Dutch aviation sector.
In particular, employees from KLM Royal Dutch Airlines, KLM Ground Services, LVNL, Transavia, dnata, Corendon Dutch Airlines and Royal Schiphol Group were involved in the development of the memo & roadmaps. Other input was gathered where possible, and if needed. This document is a logical sequel to the Feasibility Study Sustainable Taxiing at Schiphol.