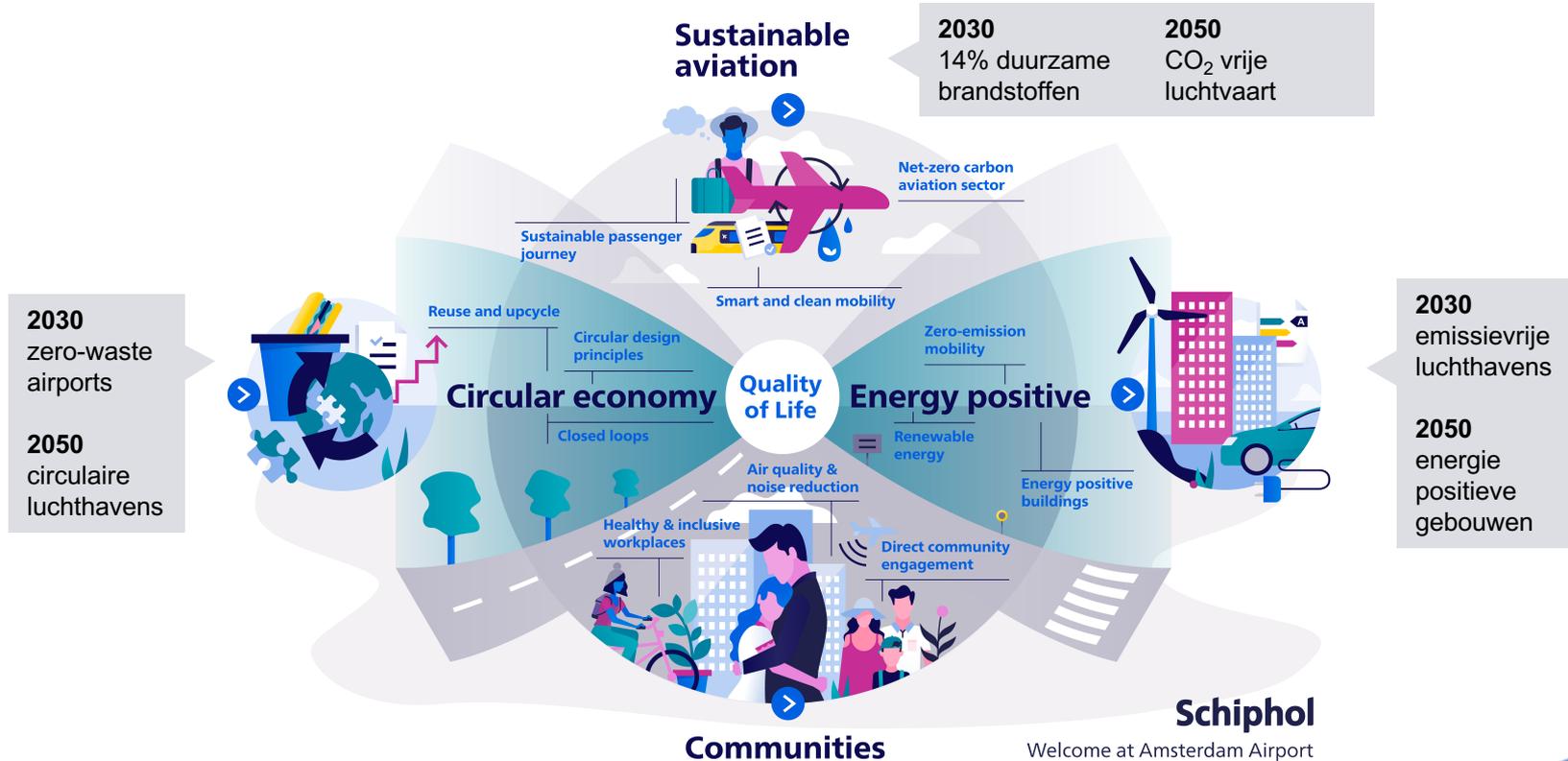


Main document

December 2019

Sustainability Roadmap 2030

Roadmap Most Sustainable Airports



Circulaire economie

Wat

Verminderen en upcyclen

Circulair design

Kringlopen sluiten

Hoe

Minimaliseren, scheiden en upcyclen

Circulair ontwerpen om materialen te herbruiken

Hergebruik van materialen in kwalitatief hoogwaardige toepassingen

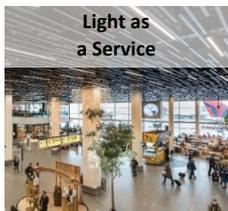
Doel 2030

Zero-waste airports

Doel 2050

Circulaire luchthavens

Done



Doing



To do



Energie Positief

Wat

Emissievrije mobiliteit

Energie positieve gebouwen

Hernieuwbare energie

Hoe

Afhandel materieel en eigen wagenpark emissievrij

Uitfasen gas en verbeteren energie efficiency

21 MWp zone-energie opgewekt op de luchthavenlocaties

Doel 2030

Emissievrije
luchthavens

Doel 2050

Energie
positieve
gebouwen

Done

100% NL wind stroom



Elektrische bussen
airside

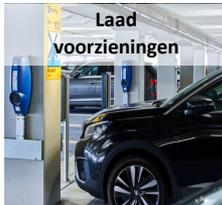


Doing

Elektrische
GPU



Laad
voorzieningen



To do

Energie neutrale terminal



Airside CO₂
emissie vrij



LED
verlichting



Energie
efficiency



Warmte Koude Opslag



Uitfasen
gas



Zonne-energie
op luchthaven



Duurzame luchtvaart

Wat

CO₂ neutrale luchtvaartsector

Slim en schoon vervoer

Duurzame passenger journey

Hoe

Verlagen van luchtvaart emissies

Stimuleren slim en schoon vervoer op landzijde

Aanbieden van duurzame opties en vergroten kennis

Doel 2030

14% duurzame brandstoffen

Doel 2050

CO₂ vrije luchtvaartsector

Done



Doing



(Inter)nationaal beleid



Clean Skies for Tomorrow



Duurzaamheid in havengelden



To do



Lange termijn klimaatdoel ICAO GA 2022



Net-zero carbon aviation sector 2050

Action plan to get to net-zero carbon aviation sector

1. Policy framework that combines investments, fuel mandates, R&D and carbon pricing, at least at European level with long time horizon
2. Scale up SAF production
3. Strengthen EU ETS for aviation sector
4. Research & Development in radical fleet renewal, hybrid and electric propulsion and sustainable aviation fuels
5. Fleet renewal – airports can incentivize via airport charges
6. Realise Single European Sky
7. Optimize airside procedures
8. Immediate high quality offsetting of aviation emissions (international and domestic). Roll out of CORSIA to realise carbon neutral growth. Corporates and passengers can contribute via offsetting and multi-year agreements to off-take SAF. Next to offsetting, carbon capture via natural climate solutions is crucial measure.

Executive Summary (1/8)

- **Introduction – Sustainability Roadmap 2030 is the next step in our ambition**
Royal Schiphol Group (RSG) aims to operate the most sustainable airports in the world. Following on earlier improvements, this Roadmap provides the actions required to realise the 2030 objectives, as a next step to realise Vision 2050, and thus improve the Quality of Life of all stakeholders. RSG believes this is essential for our license to develop further and attract talent
- **Reducing CO₂ is central in our approach for both energy usage and materials**
CO₂ is emitted in both energy production and production of the raw materials we use, e.g. concrete. Reduction of CO₂ by shifting from kerosene & diesel to other fuels/energy sources also leads to reduction in noise and other emissions – e.g. nitrogen, Ultra Fine Particles (UFP). Reducing CO₂ is thus central in our approach
- **Six principles to realise targets in an economically sensible way**
We start with measures that have the largest impact for the effort and prioritise actions that have ‘triple impact’ – e.g. also reduce UFP, nitrogen and noise. We make use of natural moments of change and use the Trias Logic (avoid use, use efficiently and strive for circularity/renewables)
- **Schiphol and Regional Airports each have a role, thus strengthening the Group**
All Dutch RSG airports are part of this Roadmap. Eindhoven Airport (EA), Rotterdam-The Hague Airport (RTHA) and Lelystad Airport (LA) will in many cases apply similar solutions as Schiphol (AAS), and test new solutions that are then transferred to the other airports. Also, as in the case of solar power at RTHA, an airport can contribute to sustainability goals ‘beyond its weight’

Executive Summary (2/8)

- **To realise the goals, collaboration with sector partners and business partners is crucial**
Activities of RSG are strongly intertwined with activities of business partners (MC2019, concessionaires, handlers, energy suppliers). RSG has to be clear to business partners about its commitments, and collaborate actively to achieve the RSG sustainability goals
- **The Roadmap is structured around three themes of Quality of Life**
The Roadmap covers three themes: Circular Economy, Energy Positive, and Sustainable Aviation. The fourth theme, Communities, has a separate action plan (D/CD manages any interconnections).
- **Circular Economy: reduce material usage and keep materials in use**
 - **Infrastructure:** circular design and reuse of construction materials
RSG will implement circular design (training, standards, tools) as this determines the ability to reuse products and materials later on. We will reuse residuals to the highest level as reasonably possible. And improve capturing data on residuals and materials used (material passports) as this is a key enabler for circular practices and a precondition for target setting
 - **Operational:** minimize, separate and upcycle everyday food and beverage, office and aircraft residuals
For residuals from horeca, retail and office activities, we focus on higher separation rates through better registration, technology and the 'polluter pays' principle. These allow higher-value next life applications. Also, we will stimulate the market to reduce (harmful) residuals and phase out selected single-use products

Executive Summary (3/8)

- **Energy Positive: shift from diesel and gas to renewable fuels and electricity**

- **Mobility:** replace diesel by ZE as the norm; review developments for heavy duty GSE
Electrification of most Ground Service Equipment (GSE) has a positive business case and is increasingly available. Key is to invest in charging facilities and possibly in supporting handlers who may have difficulty with the higher capex required. Heavy duty equipment is the exception; the market is not ready yet. Advice is to review heavy equipment later and focus on the other equipment now – especially on GPU's that are responsible for almost half the CO₂ emissions. Intermediate solutions (GTL, HVO biodiesel) are available.
Apart from GSE, ZE is to be stimulated for RSG staff commute and business travel

- **Building conditioning:** replace gas by ZE heating and cooling with ATES
Heat-cold storage (ATES) is the preferred solution to reduce gas usage at AAS with similar electricity needs. For new buildings ATES is also financially more attractive than gas heating. For existing buildings, the financial business case varies from positive to negative. For sensible investments in line with our principles, some peak heating may still be required by 2030 – possibly with renewable fuel. Overall, Total Cost of Ownership (TCO) is expected to be similar; albeit with higher capex and lower opex
- **Electricity use:** increase efficiency, produce more solar power and strengthen grid
We will further increase energy efficiency and produce solar power in line with our share of the Dutch overall target. Both the shift from diesel to electricity and further development will increase demand for electricity – with a smaller difference between winter and summer demand. As a result of the additional demand, the electricity grid will need to be strengthened

Executive Summary (4/8)

- **Sustainable Aviation: net-zero carbon aviation sector mid-century and facilitate sustainable passenger journey**
 - **Sustainable Aviation:** 14% SAF in the Netherlands in 2030 and optimize airside procedures
Net-zero carbon requires a joint roadmap that consists of (inter)national policies and investments in new technologies such as electric propulsion and sustainable aviation fuels and operational excellence by optimizing airside procedures for carbon (next to capacity)
 - **Sustainable Passenger Journey:** actively inform passengers about sustainability and offer sustainable travel options
Facilitate sustainable choices for passengers and create awareness on how to increase positive social and decrease negative environmental impact. Fighting wildlife and human trafficking, and conservation of nature are important themes. Customer experience reflects RSG's sustainability performance
- **Smart and clean mobility:** stimulate and incentivize use of efficient and clean transport modes
Mobility sector is in transition to become more sustainable, including logistics for cargo and concessionaires and construction companies. We facilitate this transition by incentivizing and stimulating the use of smart and sustainable light and heavy vehicles and improve accessibility by public transport and road
- **Embedding sustainability in daily work activities to become 'business-as-usual'**
In addition to the actions identified for the three core themes, we have to embed sustainability in daily activities. This requires training, baselines and targets, reporting and performance evaluation systems.

Executive Summary (5/8)

- **Implementing the Roadmap: actions assigned to Directors to realise progress**

To realise our objectives, a set of actions has been defined with suggested work plans. These have to be assigned to Directors, with implementation managed and tracked carefully.

- **Conclusion: 2030 objectives are achievable in an economically sensible way**

With currently available and almost market-ready solutions, the largest part of our objectives for 2030 are achievable in an economically sensible way. For the remainder, the market is already developing new solutions. We expect the overall Total Cost of Ownership (TCO) to be similar, albeit with higher capex and lower opex. It is thus essential that TCO is the key metric to base our decisions upon – also in Consultation on Airport Charges related investments.

Executive Summary (6/8)

– timing and key milestones

Year	Circular Economy	Energy Positive	Sustainable Aviation
	Material passport for all new buildings		
	Materials hub implemented for concrete	ISO 50001 energy management certified, continuing efficiency improvement	<ul style="list-style-type: none"> European policy on decarbonization Proof of concept electric taxiing
	Complete insight in materials and residual streams	<ul style="list-style-type: none"> Airside registration zone realised Regional airports ACA accredited 	Improved check-in procedures for high-speed train passengers
	Single-use PET water bottles phased out		<ul style="list-style-type: none"> ICAO GA 2022 for advanced environmental target setting Revised airport charges with incentive for cleaner aircraft SAF production in Delfzijl (SkyNRG)
	New waste processing contract in place, based on 'polluter pays'	<ul style="list-style-type: none"> GPU replaced by FPU at conn. stands All buildings renovated to label C+ 9 MWp PV (~40% of 2030 target) 	<ul style="list-style-type: none"> SAF pilot factory in R'dam (Zenid) Sustainable passenger journey offered
	Circular design fully embedded	<ul style="list-style-type: none"> Airside low emission zone active Diesel GPU replaced by e-GPU/ FPU Light GSE and RSG fleet 100% ZE Full rollout of charging facilities GSE All new buildings energy neutral 	Increased capacity train & bus station AAS (MKS)
	Sustainable asphalt & concrete measures implemented at scale		Low emission zone for logistics (construction, cargo, ...)
		ATES KWS2 operational (or earlier)	
2030	Zero waste: <ul style="list-style-type: none"> -50% virgin materials 100% reuse/recycling 	Zero emissions: <ul style="list-style-type: none"> Airside zero emission zone Natural gas phased out 21 MWp PV installed 	<ul style="list-style-type: none"> 14% sustainable aviation fuels -49% CO₂ emissions landside

Executive Summary (7/8)

– environmental impact

▪ 'Zero emissions' by 2030 is feasible

- With the actions identified for energy positive, we can reduce the remaining carbon footprint by ~85%, from 75 kt to 11 kt CO₂
- The remaining ~15% is more difficult to address and requires technological innovation, e.g. hydrogen, but can be eliminated through biodiesel & biogas as fallback options, thus reaching 'zero emissions' in 2030
- In addition, RSG will install 21 MWp solar PV on-site, to become **energy positive**

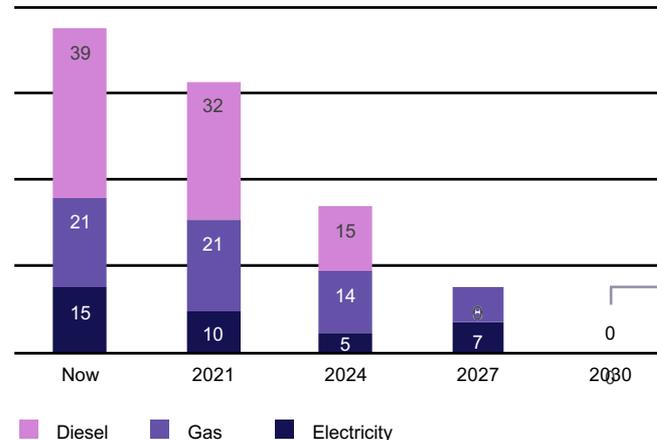
▪ 'Zero waste' by 2030 is feasible

- With **better separation** of residuals (primarily operational residuals), we will achieve as high as possible next-life applications by 2030: avoiding landfill, minimizing incineration and (close to) 100% recycling, to achieve 'zero waste'
- In addition, the actions taken for circular economy will **reduce the quantity** of materials flowing in and out of RSG, and will raise the quality level of the **next-life applications** of the materials

▪ Substantial CO₂ reduction through sustainable aviation actions

- The actions taken for sustainable aviation will contribute to a CO₂ reduction of 1.5M tons through sustainable aviation fuels and ~50k tons through landside mobility measures

CO₂ remaining, in kton

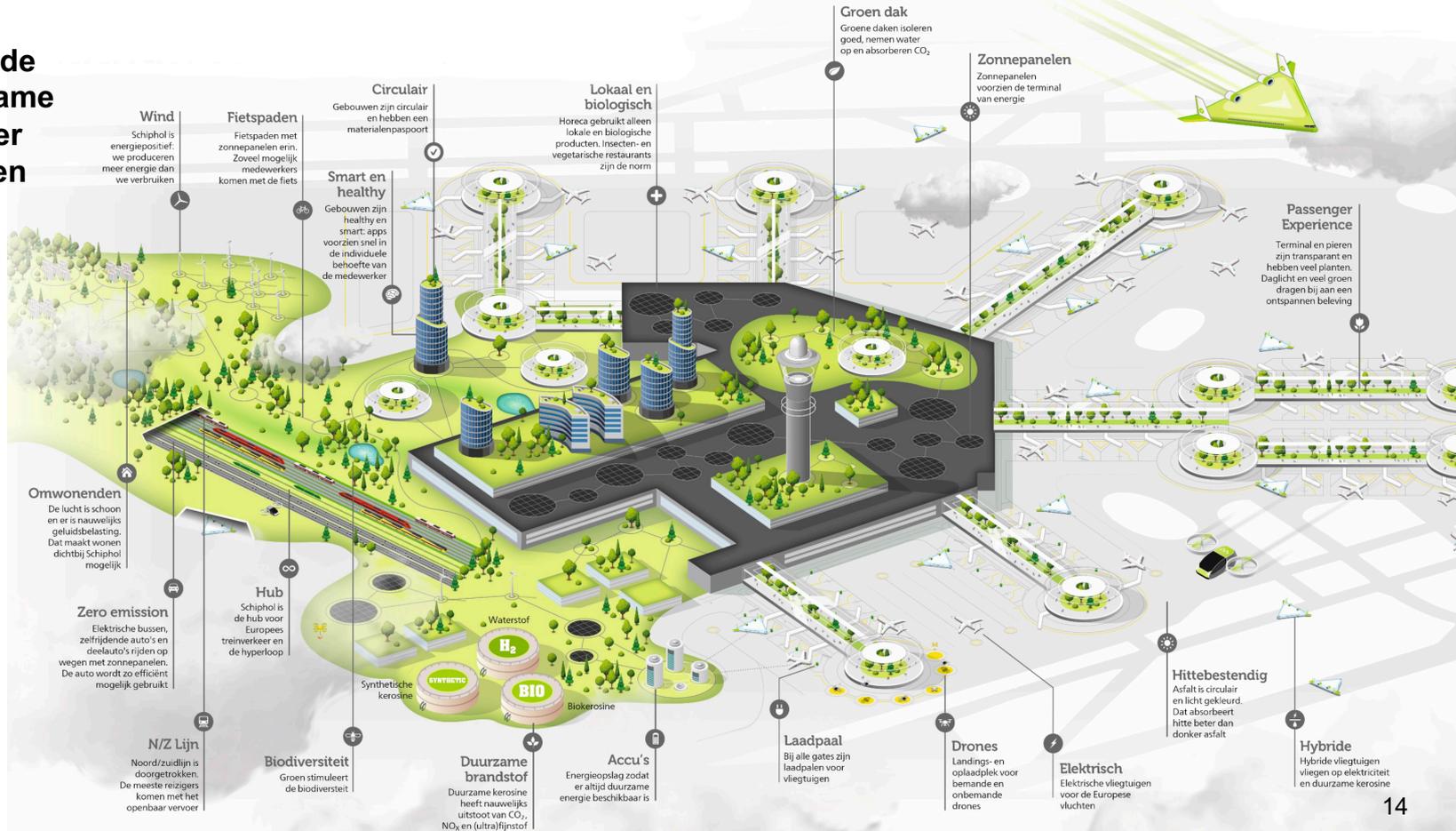


INDICATIVE

11 kt remaining (7 gas, 4 diesel), with biogas/biodiesel as fallback options to reach zero emissions

Executive Summary (8/8) – towards our 2050 Vision

Schiphol wil de meest duurzame luchthaven ter wereld worden



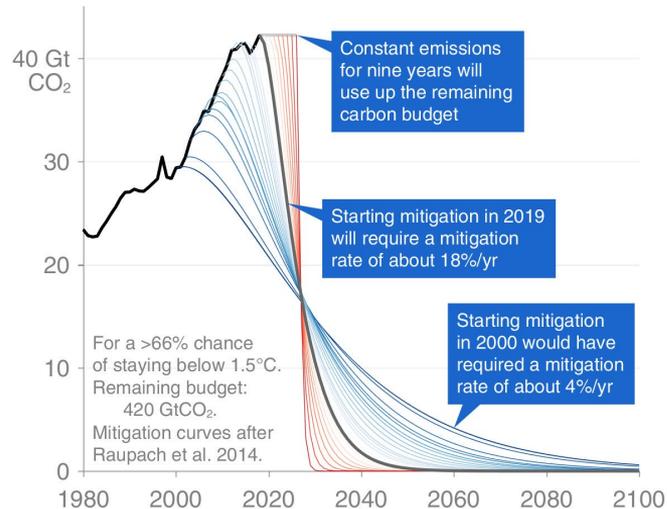
Background Sustainability Roadmap 2030

- Royal Schiphol Group (RSG) aims to safely and seamlessly operate the world's most sustainable hub and regional airports thus connecting the Netherlands in a responsible way
- RSG is committed to the IPCC report (2018) Paris Climate Agreement (2015), the Dutch Climate Agreement and the Climate round table Sustainable Aviation ('Luchtvaarttafel'), this means that RSG is committed to net-zero carbon for own emissions in 2030 and for the aviation sector mid-century
- In recent years, RSG has achieved progress by many, bottom-up actions improving sustainability. To operate the world's most sustainable airports these initiatives need to be guided and supplemented with a clear, central roadmap
- A joint RSG-SDP multidisciplinary team has developed the Sustainability Roadmap 2030 to realise the following objectives:
 - **Circular Economy:** zero waste from buildings and airport operations and climbing the 'ladder of Lansink'
 - **Energy positive:** zero CO₂ of airport operations and increased energy efficiency and renewable production
 - **Sustainable Aviation:** net-zero carbon aviation sector and facilitate sustainable passenger journey
- This document contains the key analyses and actions required to realise the objectives. It is the main Roadmap document. The appendices (available upon request) provide more extensive analyses, suggested work plans and related investments and deadlines

Sustainability becomes a key element of all of our lives – and for a reason

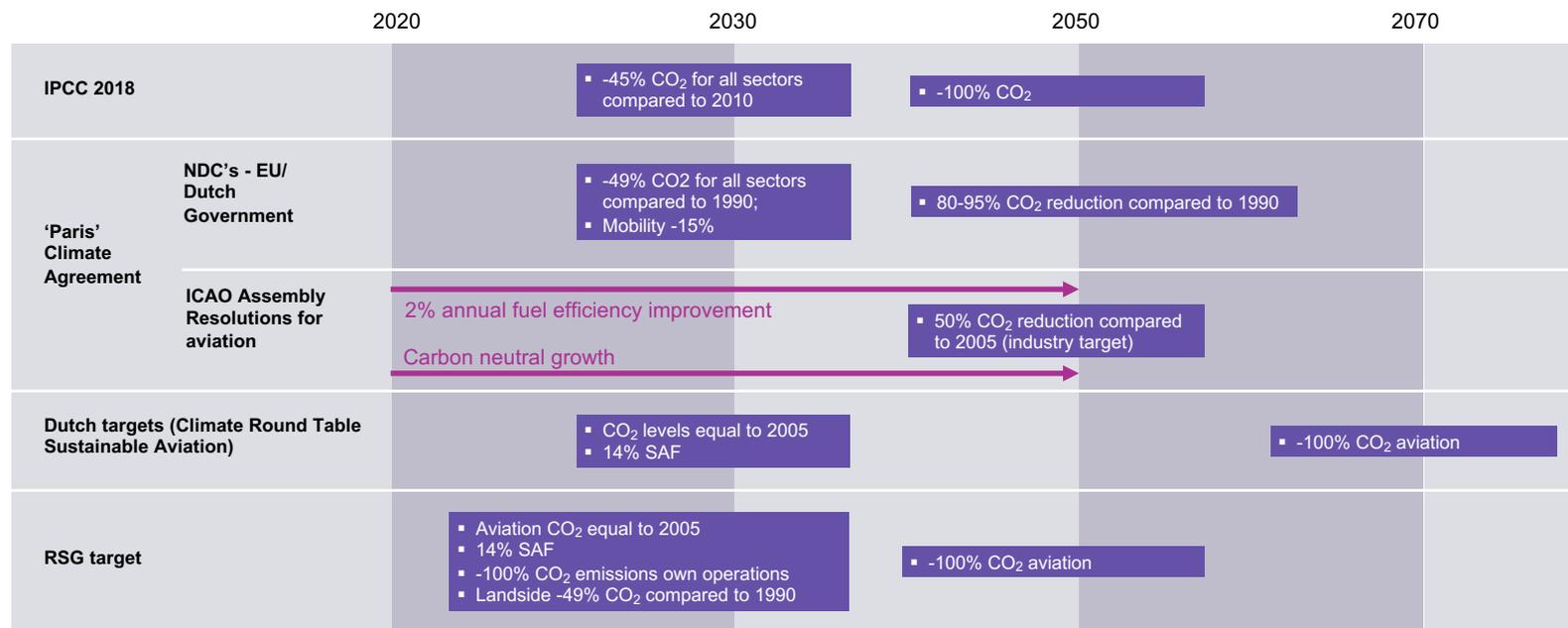
- A rise in global temperature of 1.5 °C can have major negative impacts on health, livelihoods, food security, water supply, human security, and economic growth (IPCC October 2018 report)
- The Paris Climate Agreement of 2015 urged to keep temperature rise well below 2.0 °C. While nationwide targets are developed, ambitions exclude international aviation and shipping emissions
- Additionally, CO₂ has entered the political and societal debate (taxation, flight shame). Also, failure to limit global warming threatens location Schiphol (below sea level) and aviation business (disruptions from extreme weather, mass migration, political instability)
- To limit temperature increases below 1.5 °C, net-zero CO₂ is required by 2050. To achieve 2.0 °C, net-zero CO₂ is required by 2070.

Global CO₂ mitigation curves for 1.5 °C temp. increase



The European Union, the Netherlands, aviation sector and RSG committed to several climate agreements

Agreements and commitments



Source: IPCC 2018; Climate Agreement Paris (COP21, 2015); ICAO Assembly Resolutions (2010 (A37- 19); 2013 (A38-18); 2016 (39-2 en A39-3); Climate Round Table Sustainable Aviation + Smart and Sustainable action agenda; Nationally Determined Contributions.

These four elements contribute to six key Sustainable Development Goals (SDGs) RSG focuses on

RSG Focus out of the 17 Sustainable Development Goals* (SDGs) of the United Nations



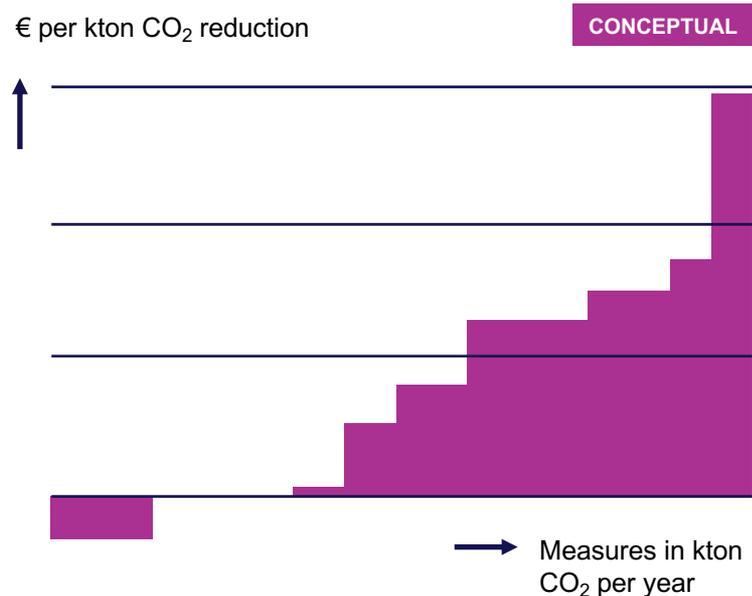
*SDGs 2015-2030 succeed the Millennium Goals 2000-2015
Source: Schiphol 2018 Annual Report; RSG-SDP team analysis

Some general principles have been applied to realise targets in an economically sensible/ optimal way

Guiding principles for the Roadmap

- Start with the measures that have the **largest impact for the effort** (€, time & complexity) as visualised in an abatement curve (example on the right)
- **Prioritise 'double impact' projects** – for example both effect on CO₂, UFP, nitrogen and working conditions
- Make use of **natural moments** of change (new contracts, renovations, price development of new technologies etc.) and apply the EVABAT principle ¹⁾
- **Real improvements** – using CO₂ costs in business cases is a long term solution; 'off-setting' is not
- Use the **Trias logic**
 - **Trias Energetica**: reduce, use efficiently, use and produce renewable energy
 - **Trias Materialica**: use materials efficiently, use sustainable materials, reutilize materials

Abatement curve example



1) EVABAT = Economically Viable Application of Best Available Technology. Source: RSG-SDP team

Focus of the roadmap is on CO₂; this generally also positively affects UFP, nitrogen and sometimes noise

- In the roadmap, focus is on CO₂ emissions and residuals. However, other emissions most notably UFP and nitrogen are also important
- Reduction of CO₂ by shifting from kerosene and diesel to other fuels/ energy sources also leads to reduction in other emissions such as UFP and nitrogen, even though it is not a direct link (e.g. the mix of CO₂, UFP and nitrogen differs by type of engine and specific circumstances such as the humidity)
- Such a shift often also reduces the noise level.
This positively affects working conditions and quality of service to passengers
- As such CO₂ reduction* from engines is also effective for UFP, nitrogen and noise, and beneficial for the health of employees and passengers. The Roadmap prioritises actions aimed at power source shifts away from kerosene and diesel engines

*CO₂ can also be reduced by more efficient engines. For aircraft, however, more efficient engines generate less CO₂ but more UFP
Source: RSG nitrogen study; RSG-SDP team

AAS is by far the largest airport and often used in analyses – principles are similar for Regional Airports

- Most of the analyses are based on residuals and emissions of **Amsterdam Airport Schiphol (AAS)** – these are significantly larger than those of the three regional airports Eindhoven (EA), Rotterdam-The Hague (RTHA) and Lelystad (LA) combined
- Principles, however, are largely similar and most actions are **relevant for all airports**. Certain actions may be easier to carry out at AAS, others at regional airports – e.g. GSE at regional airports is generally used for smaller aircraft and less intensively, enabling earlier implementation of battery powered GSE than at AAS
- In addition, regional airports can also function as a **pilot location** for new initiatives, e.g. DC (direct current) systems at LA. And certain airports can **contribute** ‘beyond their weight’ to objectives, e.g. solar power at RTHA.
- Regional RSG airports, alliances and participations make use of **resources and expertise** of AAS, e.g. by using ASM resources for developing new assets – in that way, part of the sustainability efforts will ‘automatically’ trickle through
- In addition, a key action for regional airports is to develop their **own implementation plan** for the Roadmap actions in Energy Positive and Circular Economy – in collaboration with AAS counterparts and D/CD
- Sustainability principles of RSG should apply to all RSG airports, alliances and participations

Many actions require close cooperation with partners

- A significant part of reaching the sustainability goals requires cooperation with partners, as they control large part of the emissions or residuals, for example
 - **Circular Economy:** operational residuals also caused by airlines, concessionaires and tenants, waste handler processes residuals; infrastructural residuals are usually recycled by contractors
 - **Energy Positive:** handlers own and operate GSE, tenants decide on which energy they purchase
 - **Sustainable Aviation:** kerosene used by airlines; landside transportation operated by PT-companies and taxi-companies and influenced by government
- RSG can play an important role in cooperating with and stimulating partners
 - **Regulate** (APU, landside logistics, polluter pays)
 - **Cooperate** (international cooperation with Eurocontrol and other airports - more efficient use of the skies, ...)
 - **Stimulate:** being a catalyst for action (SAF investments, ...)

Regular review and update of roadmap is necessary as energy and sustainability transitions develop (1/2)

- The world is in an energy and sustainability transition. New solutions to existing problems are constantly being developed
- While most research with respect to climate change has been done on CO₂, other greenhouse gases (GHG) such as methane and nitrous oxide contribute to global warming as well. Their role is still subject to research, but typically the impact is higher than that of CO₂ while the emitted amount is relatively low
- The roadmap looks at solutions that are either readily available or will become available in the near future. Because of the uncertainty in other GHG emissions, the focus is on CO₂. However, it does not rule out other emissions or solutions emerging in the future
- The energy transition is challenging on different scales
 - The transition differs per country, depending on geographical situations (solar, geothermal, wind, etc.) and public opinion (e.g. nuclear energy)
 - Legislation in The Netherlands is continuously changing (i.e. new energy law, climate act, ETS IV, carbon price in electricity production)
 - For RSG specifically, congestion of the energy grid is expected due to increasing demand and the need for feedback of solar energy. A bi-directional energy supply and storage is needed to minimize congestion (i.e. smart grid)

Regular review and update of roadmap is necessary as energy and sustainability transitions develop (2/2)

- Because of the many uncertainties and different interests at stake, there is no agreed transition path. Some examples of uncertainties and stakeholder interests are:
 - Natural gas is much cleaner than coal-based electricity. However, its extraction in the Northern Netherlands causes earthquakes which has led to an accelerated phaseout
 - Public opinion influences solutions as well. For example, hydrogen or nuclear energy are clean energy carriers, but are perceived as a high safety-risk or as unsustainable
 - Carbon capture and storage is a new technique and is expected to play an important role to achieve net-zero carbon. However, environmental risks and the high energy-demand are still a concern
- Certain parties prefer to delay investments as long as possible, to benefit from new developments and price drops in techniques when innovations become mainstream. Others will only accept true sustainable alternatives and won't be in favour of using green gas or HVO diesel
- In this roadmap we focus on phasing out natural gas and diesel, by substituting these with renewable electricity. It is important to **regularly review new solutions and update the roadmap** with new insights. For example, in the foreseeable future it could be possible for the current gas network to transport H₂. However since the market for H₂ is still immature, it is not possible to include it as a solution for the roadmap