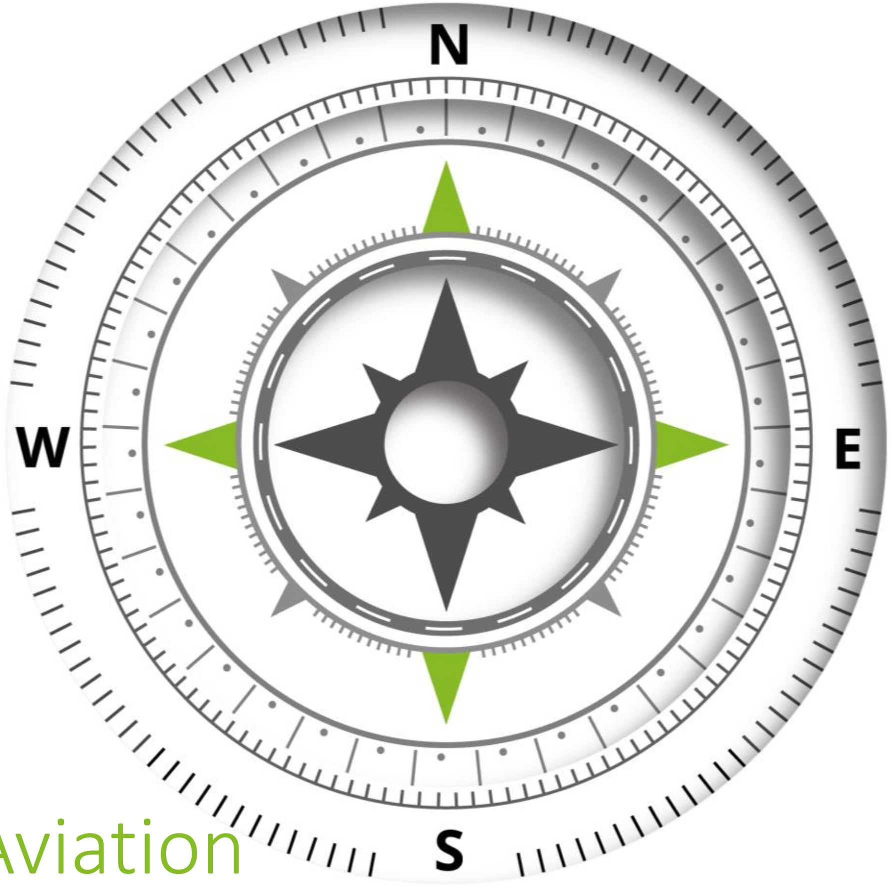
Monitor **Deloitte.**



Commercial Electric Aviation

Battery-electric and hydrogen fuel cell

Quantitative quick scan on electric flight below 500km

December 1, 2022

Future confident

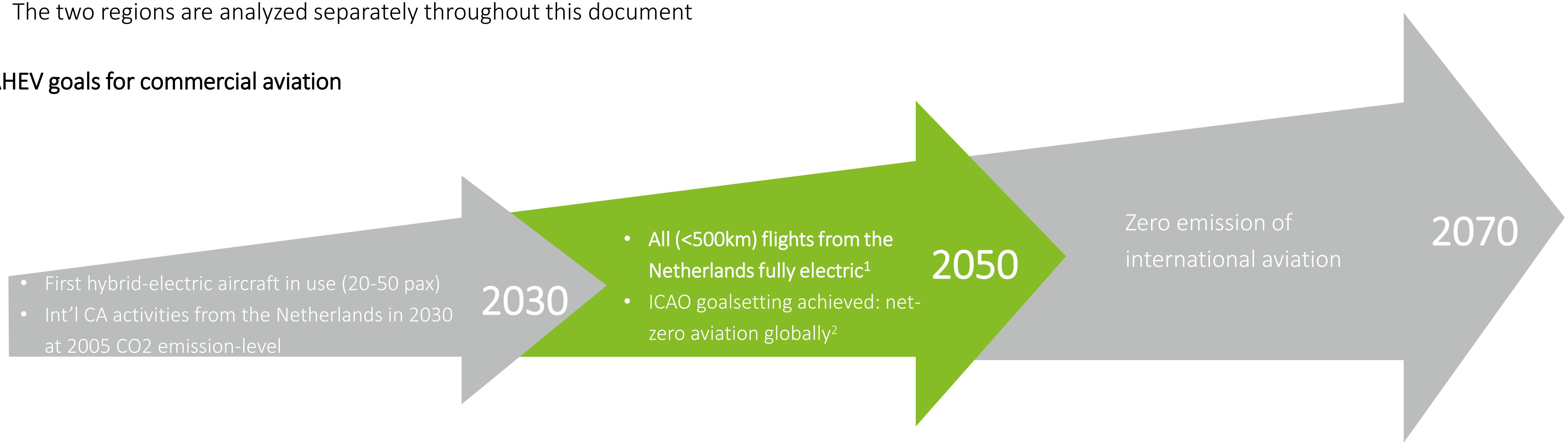
Introduction

This quantitative quick scan assesses the feasibility for commercial electric aviation in 2050 for flights with a flight distance below 500 km

Scope of this quick scan

- This quantitative quick scan is performed in the context of the AHEV[1] Progress Update and focuses on the AHEV goal of all short distance flights from the Netherlands <500 km fully electric
- The scope of the assessment is the Kingdom of the Netherlands. Within the Kingdom of the Netherlands, we distinguish two regions:
  - the Netherlands mainland: all European destinations <500km
  - the Dutch Caribbean: internal flights between Aruba, Bonaire and Curaçao (ABC) and internal flights between st Maarten, st Eustatius and Saba (SSS)
- The two regions are analyzed separately throughout this document

AHEV goals for commercial aviation



Note: 1) Concept Actieprogramma Hybride Elektrisch Vliegen, page 7; 2) https://www.icao.int/Newsroom/Pages/States-adopts-netzero-2050-aspirational-goal-for-international-flight-operations.aspx

Approach

The quick scan tests feasibility of electric aviation across two technological and three demand scenarios

Step 1: Technological availability

What aircraft capacity is expected to be available?

Analysis of the current state of technology and expected availability of aircraft types with battery electric and hydrogen fuel cell in scope. The analysis results in two technology scenarios with different availability of aircraft capacity over time.

Step 2: Demand

What is the expected demand for aviation capacity?

Analysis of the total number of air traffic movements (ATMs) and the capacity of flights that go back and forth from the Netherlands within 500 km travel distance. This is assessed under three scenarios for the development of demand

Step 3: Feasibility & Alternatives

What does adoption of electric flight mean for the number of ATMs and aircraft?

The quick scan expresses the number of ATMs and minimum number of aircraft needed for electric aviation compared to the current situation. Additionally, the quick scan assesses the potential to reduce ATM demand.

Technological Availability

Electric aviation is expected to take off in the coming years; experts assume availability of 9- and 19-pax battery-electric by 2030 and 40- and 80-pax hydrogen-electric by 2040

Currently various initiatives are at an early stage (especially the larger aircraft); smaller aircraft aim to use battery-electric propulsion, while larger aircraft tend to use hydrogen-electric propulsion (see appendix for context)

Timeline of announced electric aircraft[1]

Battery-electric aircraft | Hydrogen-electric aircraft (fuel cell)

New built aircraft / retrofits


Pipistrel VelixE
2-pax / 140 km
EIS[4] actual: 2020


Bye eFlyer2
2-pax / 400 km
EIS[4] target: 2023


Eviation Alice
9-pax / 815 km
EIS[4] target: 2025


Tecnam PVolt
9-pax / 157 km
EIS[4] target: 2026


Zero Avia
40-pax / 1800 km
EIS[4] target: 2026


Embraer E9-HE
9-pax / 925 km
EIS[4] target: 2030


Maeve 01
40-pax / 550 km
EIS[4] target: 2030

(Scalable) powertrains


Uni. Hydrogen
40-60-pax / 750 km
EIS[4] target: 2025


GKN H2GEAR
40-pax / 750 km
EIS[4] target: 2026


HAPSS
40-80-pax / 750 km
EIS[4] target: 2028

2020 → 2030

Considerations of the roadmap

- Aircraft have specific sizes due to regulations: 9-pax is the limit for one pilot, 19-pax needs one pilot and one cabin crew
- Due to physical limits, there are increasingly diminishing returns for aircraft size, that are worse for battery-electric than for hydrogen-electric. Fully battery-electric is therefore expected to be only feasible for 9- or 19-pax aircraft, while hydrogen-electric could be used for larger aircraft. Breakthrough battery innovations could change this outlook and make an aircraft like Maeve 01 (40-pax) technically and commercially feasible (see appendix)
- Hybrid battery electric / SAF configurations, e.g. with electric propulsion as take-off assist, are feasible to reduce fuel burn for larger propeller aircraft. However, as they cannot result in zero emission aviation and therefore are out of scope for this quick scan

Expert's conclusions[2,3]

- In 2030 commercial up-to 19-pax battery-electric aircraft are feasible
- In 2035 newbuilt commercial 40-pax hydrogen electric aircraft are feasible. Retrofits could be available from 2028-2030, provided these are commercially viable against not retrofitted fossil fuel counterparts
- Potentially 80-pax hydrogen electric aircraft are feasible by early 2040's
- Smaller aircraft (<19-pax) may be suitable for flights between ABC or between SSS as currently used aircraft are also smaller
- Larger aircraft (40- or 80-pax) may be suitable for NL flights < 500 km
- In NL economies of scale are assumed to be positive up to a capacity of 118 passenger seats (current average). For the 40-80 pax range, this means an airline will prefer larger aircraft to realize lower cost/passenger-km

Source: 1) Market scan performed up to 30/11/2022; Unified International; 2) Expert interviews with TO70, Unified International; 3) Monitor Deloitte analysis; Note: 4) Entry into Service as indicated by producer

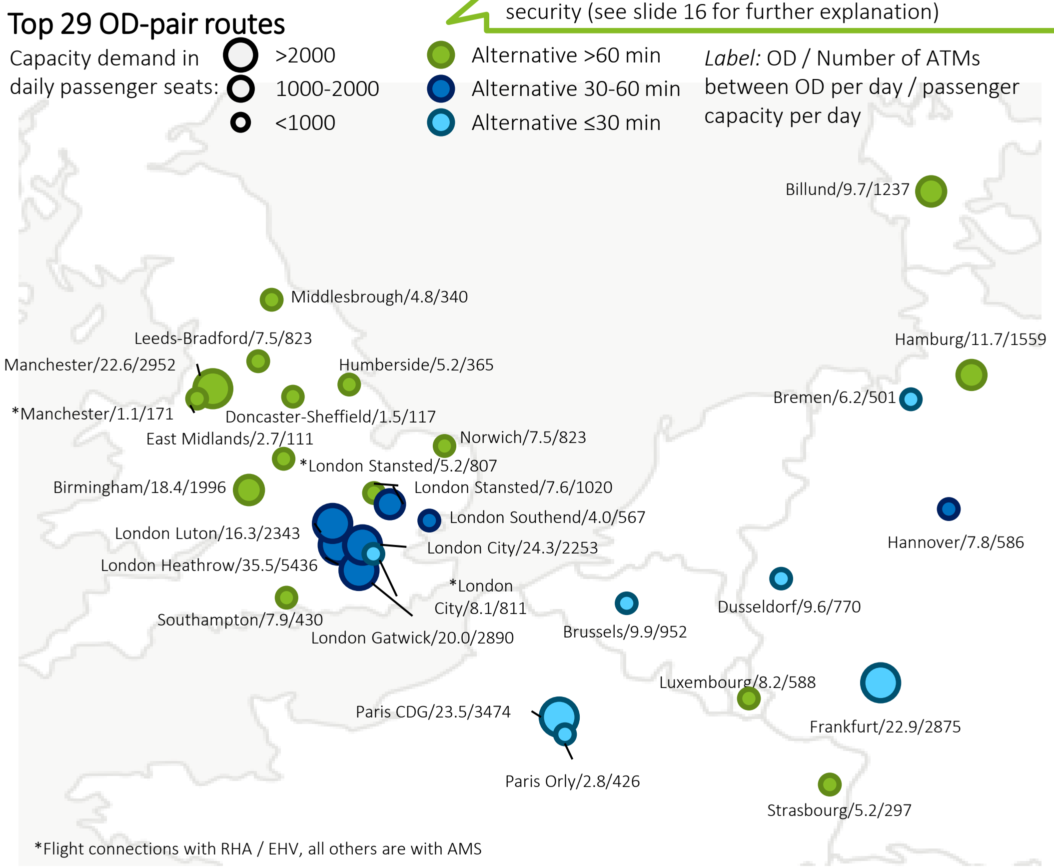
Analysis on Netherlands mainland

Netherlands mainland – Demand

In 2019, 19% of air traffic movements to or from the Netherlands have a distance below 500 km; this comprises 317 air traffic movements and 37k passengers per day

In scope of this quick scan are air traffic movements (ATMs) to and from NL of which the origin-destination pairs (OD-pairs) are <500 km

'Alternative' entails the difference in travel time between rail and air transport, including required time for check-in and security (see slide 16 for further explanation)



Metrics international flights

- The 29 OD-pairs in scope of this quick scan account for 99.8% of the <500km daily capacity in the mainland Netherlands; Schiphol Airport is part of an OD-pair in 26 instances, Eindhoven Airport in two, and Rotterdam the Hague Airport in one
- Both the outbound ATMs from the Netherlands and the equivalent inbound ATMs were considered in this quick scan, as the aircraft flying out of the Netherlands must eventually return via an inbound ATM
- Flight data is taken from a Eurocontrol dataset, using 2019 data as representative, due to the COVID-19 pandemic. Four months of data have been used and extrapolated to a full year. More information on the dataset and assumptions can be found in the appendix
- The OD-pairs with the largest current demand can be determined using aircraft capacity as a proxy. Transition to electric flight is assumed not have an impact on occupancy rates, therefore the required capacity will scale 1:1 with passenger demand

Metrics 2019	<500 km[1,3]	Total[4,5,6]
ATMs in NL	317 ATMs per day (19% of total)	~1654 ATMs per day
Capacity in NL	37k passengers per day (capacity)	278k passengers per day (*estimate based on 222k actual passengers and 80% occupancy rate*)

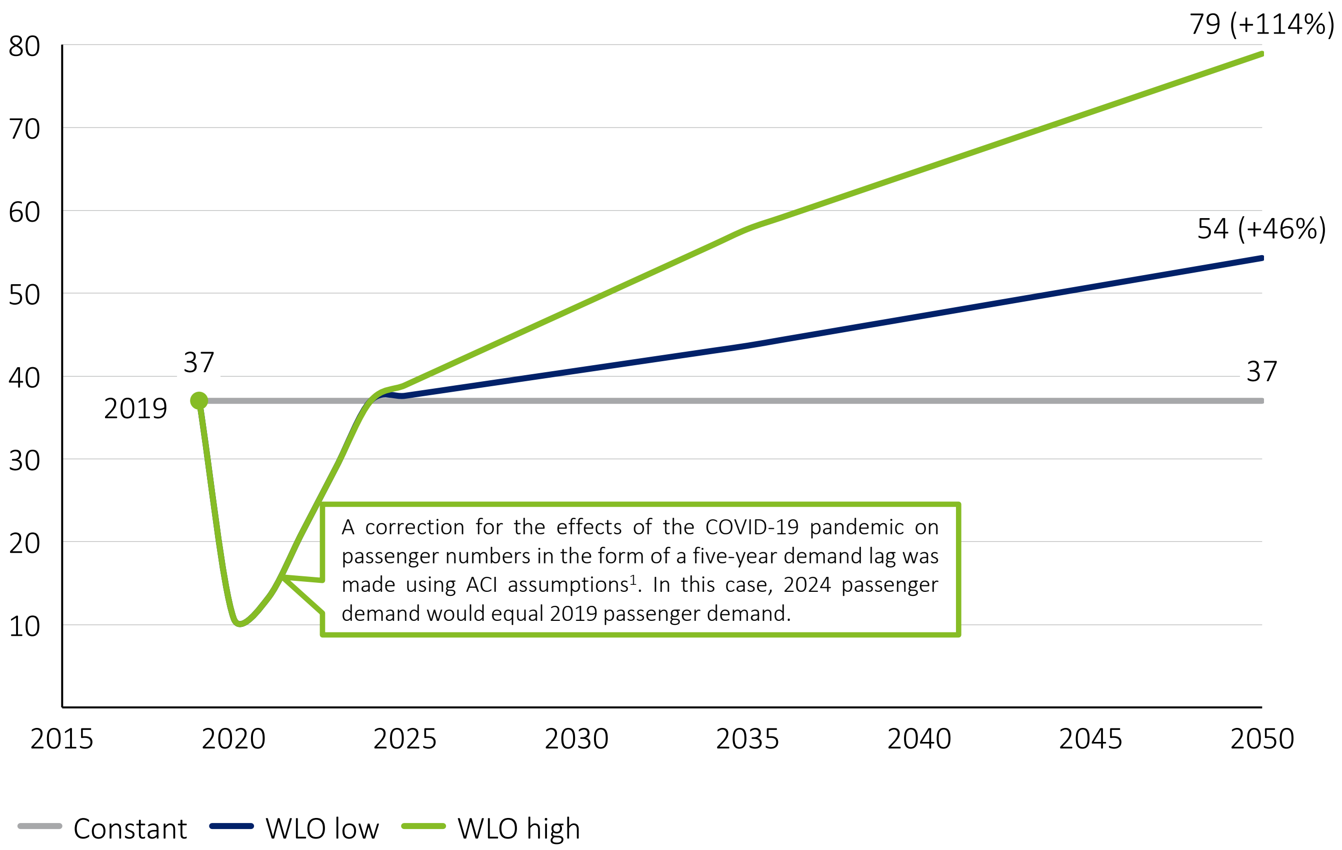
Source: 1) Eurocontrol 2019 Dataset, 2) Publicly available Flightaware data; Note: 3) Daily ATMs derived from average of Eurocontrol 2019 Dataset, 4) All int'l airports in NL, 5) https://opendata.cbs.nl/#/CBS/en/dataset/37478eng/table?dl=30C5B; 6) https://www.cbs.nl/en-gb/news/2022/45/nearly-19-million-air-passengers-in-q3-2022

Netherlands mainland – Demand

Demand for flights within <500 km is expected to grow between 0% and 114% by 2050 to 37k -79k passengers

Using the WLO high and low air traffic demand scenarios, 2019 demand for flights <500km is extrapolated to estimate demand towards 2050, in addition a constant demand scenario is included

Estimated 2050 demand (in # passengers per day) for ATMs in mainland NL <500km (x1,000)



- The development of air traffic demand for flights <500 km towards 2050 is uncertain. As part of this quick scan three scenarios are considered
- Two scenarios are based on the WLO outlooks (total capacity in daily passengers, corrected for COVID-19). The WLO projected 2050 air mobility demand for Schiphol airport given 2013 market conditions[1]
- Assuming passenger demand increases proportionally to Schiphol at other airports in the Kingdom of the Netherlands, the result is two demand scenarios that are directly comparable to 2019 average daily seat capacity
- However, the WLO scenarios did not anticipate the limited capacity at airports and regulation of the number of flights in the Netherlands, hence a constant demand scenario is introduced at the level of 2019 (100% factor between 2019 and 2050) to account for these changes
- More information on the calculations and the scenario’s can be found in the Appendix

Source: 1) ACI - The impact of COVID-19 on airports and the path to recovery

Netherlands mainland – Feasibility & alternatives

Given the lower capacity of electric aircraft, more Air Traffic movements (ATMs) are needed to accommodate the future demand; at least ~47% more ATMs are required by 2050 using only electrical aircraft

Replacing all flights <500 km with a 40-pax aircraft would mean an ATM increase of +613 (+193%) in the most conservative (constant demand) scenario. In case of an 80-pax aircraft +149 additional ATMs are needed (+47%)

Impact of switching to electric aviation on required # of ATMs per day <500km in mainland NL

		Only using current (nonelectric) aircraft (~118-pax)		Only using electrical aircraft (40-pax)		Only using electrical aircraft (80-pax)	
	Scenario	2019	2050	2050	2050 (%) vs 2019	2050	2050 vs 2019
Forecasted demand	Constant	37k	37k	37k	*n.a.*	37k	*n.a.*
	WLO low	37k	54k	54k	+17k (+46%)	54k	+17k (+46%)
	WLO high	37k	79k	79k	+42k (+114%)	79k	+42k (+114%)
Required ATMs[1]	Constant	317	317	930	+613 (+193%)	466	+149 (+47%)
	WLO low	317	466	1364	+1047 (+330%)	683	+366 (+115%)
	WLO high	317	675	1985	+1668 (+526%)	993	+676 (+213%)

- Replacing all non-electrical flights <500km with electrical aircraft would require more ATMs as the capacity of electrical aircraft by 2050 is expected to be lower than current non-electrical aircraft
- For NL, accommodating all demand for <500km by electrical 40-pax in 2050 would require tripling the ATMs in the most conservative (constant demand) scenario
- **Accommodating all demand for <500km with 80-pax hydrogen-electric aircraft would require 47% more ATMs in the most conservative (constant demand) scenario**, any growth in air traffic demand would result in a larger increase in required ATMs

1) Numbers based on analysis of individual OD-pairs; and are consequently more accurate than results obtained by dividing the overall demand by the capacity per flight

Netherlands mainland – Feasibility & alternatives

Depending on consumer willingness to accept additional travel time, for specific OD pairs replacement by rail travel can reduce the required number of ATM's

Impact of passengers accepting add'l travel time for travel by train on # of ATMs needed per day[1] for the constant demand scenario

	Scenario's of add'l minutes a passenger accepts		
	No change	Max. 30 add'l mins (e.g. Paris, Brussels	Max. 60 add'l mins (e.g. London, Hannover)
Passengers assumed to switch to travel by train (in # passenger seats per day)[2]	*N/A*	*~10k*	*~25k*
Remaining demand for air travel <500 km (in # passenger seats per day)[2]	*~37k (100%)*	*~27k (74%)*	*~12k (33%)*
Current (avg. 118-pax) # ATMs needed per day	317	231	103
80-pax aircraft # ATMs needed per day	466	343	154
40-pax aircraft # ATMs needed per day	930	685	308
Feasibility rail services[3]	*N/A*	*Possible within existing rail slots*	*Railway infrastructural adjustments required*

Perspective on the increase in ATMs

- The increase in ATMs in 2050 compared to 2019 due the lower capacity of electric aircraft is substantial with +193% or +47% in case of full substitution with a 40-seater and 80-seater respectively
- The cost of flying compared to alternative modes of transport is yet uncertain, although expectations are that flying - being energy intensive - will become more expensive towards 2050 compared to rail
- In the future the acceptance of additional travel time may change - an increase in acceptance of 30 minutes leads to a reduction of 26% in passenger capacity demand, while an acceptance of 60 minutes of additional travel time for rail compared to flying could lead to a reduction of 67%
- The analysis is based on the existing international high speed network. Additional rolling stock and some adjustment to infrastructure is required to sufficiently increase rail capacity.

Note1) Detailed analyses including assumptions regarding travel time can be found the appendix; 2) For this quick scan, it is assumed that all passengers switch from air travel to train travel if the train travel time takes less than (or equal to) the air travel time plus the accepted additional time (30 or 60 minutes); 3) Preliminary expert estimation Ministry of Infrastructure and Water management

Netherlands mainland – Feasibility & alternatives

Transition to electric flight ideally starts at the OD-pairs with no feasible alternative mode of transport and high volumes to leverage economies of scale. This includes flights to Manchester, Birmingham, and Hamburg

#	Origin Airport (ordered by capacity flown)	Destination Airport	2019 daily ATMs
1.	Amsterdam Schiphol	Manchester	23
2.	Amsterdam Schiphol	Birmingham	18
3.	Amsterdam Schiphol	Hamburg	12
4.	Amsterdam Schiphol	Billund	10
5.	Amsterdam Schiphol	Leeds Bradford	8
6.	Eindhoven	London Stansted	5
7.	Amsterdam Schiphol	Luxembourg-Findel	8
8.	Amsterdam Schiphol	Norwich	7
9.	Amsterdam Schiphol	Southampton	8

Drivers for viability of electric aviation

- Electrification of aviation should start where (1) feasible alternatives to flying do not exist, and (2) demand for transport is high

1) The table on the left shows the selected 9 OD-pairs within a range of <500 km that have an additional train travel time above 120 minutes, and therefore have no (feasible) alternative to flying
2) These OD-pairs have a significant passenger volume. Volume is important to leverage economies of scale to cover the investments associated with electric aviation (aircraft and infrastructure)
3) High Speed 2 train line from London tot Birmingham and Manchester (expected to be in operation by 2030-40) is not taken into account, however, impact is expected to be limited

Conclusions *(further explanation and analysis can be found in the Appendix)*

- Various flights between **large UK cities** and **NL** have **no viable alternative mode of transport** while they **represent large volumes** of passengers (e.g. Schiphol – Manchester or Schiphol – Birmingham), these OD-pairs should be the first to pilot hydrogen electric flying
- Also, flights between **Schiphol and Hamburg, Billund and Luxembourg** account for a **significant volume** while they **do not have a viable alternative mode** of transport

Netherlands mainland – Feasibility & alternatives

Adoption of electric flight by airlines in the Netherlands will depend on total cost of ownership compared to fossil fuel aviation

The number of aircraft necessary for the transition to electric flight seems feasible with 40-pax and 80-pax aircraft. Feasibility from a cost perspective would suggest 80-pax aircraft are the most viable option for the Netherlands

Feasibility in terms of feet replacement

- Depending on the demand scenario and the availability of 40-pax or 80-pax electric aircraft the minimum number of aircraft needed varies strongly[1,2]
- The absolute number is acceptable. The replacement cycle is ~30 years; given the small share of the current fleet, Eurocontrol data shows 1302 unique tail numbers in four months, it should be possible to replace enough aircraft between expected introduction in 2040 and ambition in 2050.
- Technology is not yet available or proven, availability after 2040 will reduce the replacement timeline and thereby the feasibility of replacement
- Adoption of 40- or 80-pax hydrogen-electric aircraft is currently estimated to be commercially unviable given the current market conditions

	# aircraft required for destinations <500km[1]		
	Constant scenario	WLO low	WLO high
Current aircraft (~118 pax)	43	63	92
40-pax	134	196	287
80-pax	67	98	143

Feasibility in terms of market conditions

1. **Change in relative cost of hydrogen-electric aviation and alternatives**

- Currently, hydrogen-electric aviation is expected to be more expensive than traditional air travel. Due to the smaller aircraft size associated with electric flying, costs per seat are higher than for larger aircraft. Demand is only expected to rise if relative costs of hydrogen-electric aviation drop. Some passengers have a higher willingness to pay for sustainable aviation, therefore hydrogen-electric flying could be sold at a premium price - yet full-scale adoption is only expected when (hydrogen)-electric is cheaper per passenger when compared to alternatives
- Operational costs of battery-/hydrogen-electric aviation compared to traditional methods are yet unclear for the future and difficult to estimate. Hence, it could be an opportunity or a risk regarding costs

2. **Government intervention**

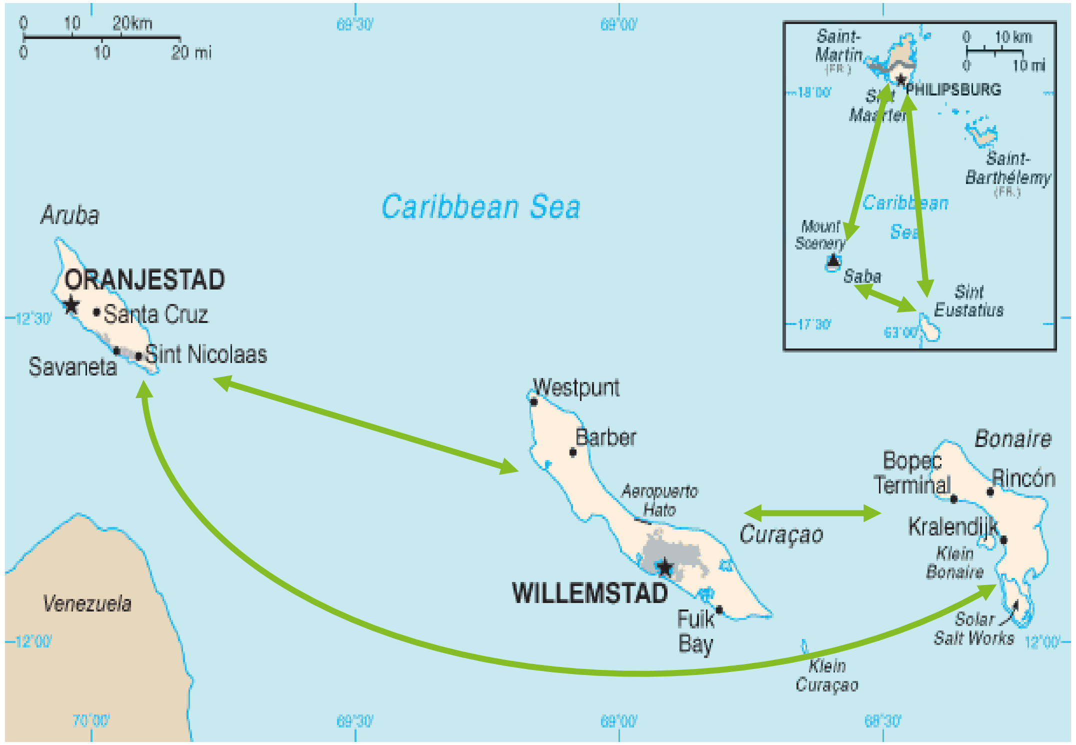
- Using concession rights, incentives or regulation (in the Netherlands) or by changing pricing of alternatives the government can influence adoption. Given the timelines of the drop of relative total cost of ownership associated with these flights, it is estimated government intervention will be necessary to ensure adoption
- Other European countries start regulating their domestic markets, for example, Norway is aiming for all domestic short-haul flights to be electric by 2040

Note: 1) Hydrogen-electric aircraft are expected to be only viable on shorter distances, whereas current aircraft fly a mix of both shorter and longer distances. Hence, the adoption of electric aircraft requires different routing; 2) minimum number of aircraft estimated based on flight times, typical turnaround times, and typical operational time per day

Analysis on Dutch Caribbean

Dutch Caribbean – Demand

Flights in the Dutch Caribbean are relatively short haul (25% of the ATMs between the ABC-islands) and low capacity, therefore fit for battery-electric aviation



Source: 1) Publicly available Flightaware data – 2 week data (last two weeks of august 2022) extrapolated to a full year, not taking into account seasonal (weather) effects; 2) Flights between island for ABC and for SSS. Flight number and capacity based on estimates – see p. 22; 3) https://www.cbs.nl/en-gb/figures/detail/82332ENG?dl=337B8; 4) https://www.cbs.cw/transport-communications; 5) https://www.airportaruba.com/press-releases/aruba-airport-authority-nv-sees-recovery-2021; 6) https://www.curacao-airport.com/news/press-releases/q4-and-year-end-overview-2021; 7) http://www.sintmaartengov.org/

Metrics international flights

- Only internal flights within the ABC- or SSS-island groups are in scope of this quick scan. For the SSS-islands, out of a total of 1,9 million travelers, 1,83 million are travelers from St. Maarten. Due to a hurricane in 2017 and its present effects of that (the airport is not yet fully restored), data from 2015 is used.
- The average plane size used is much smaller than the ones used for <500 km flights in the Netherlands; the average capacity for the Netherlands is 118-pax / flight, for ABC-islands 26 and SSS-islands 20
- The Dutch Caribbean is suitable for battery-electric flight due to this limited range and capacity; battery-electric aircraft are available sooner than hydrogen-electric aircraft that are needed for the Dutch market
- Flight data is taken from FlightAware, from which 2 weeks of data[1] has been used and extrapolated towards a full year. Corrections for weather circumstances are out of scope for this quick scan. More information on the dataset, assumptions, and corrections made can be found in the Appendix

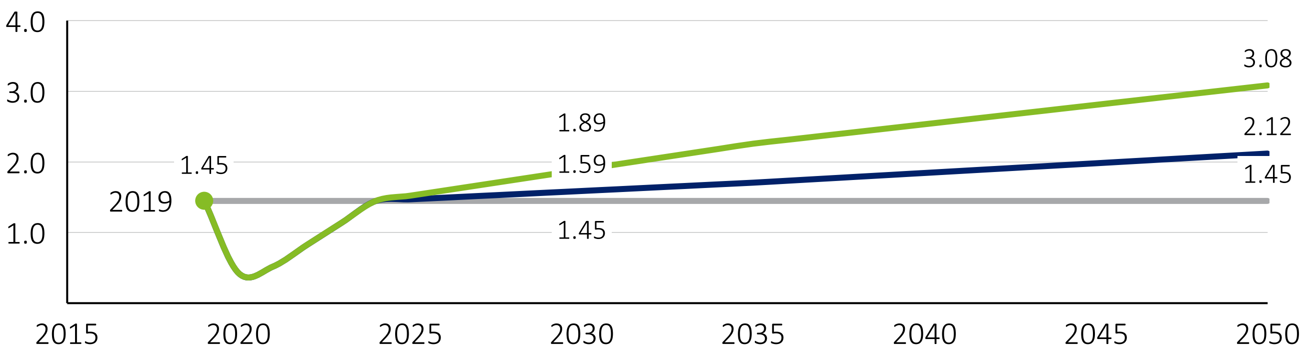
Metrics 2019	Air travel between islands (<500 km)[1,2]	Total air travel[3,4,5,6,7]
Flights ABC	54 ATMs per day (25% of total)	216 ATMs per day
Capacity ABC	1.446 passenger seats per day	-
Flights SSS	7 ATMs per day (3% of total)	192 ATMs per day
Capacity SSS	146 passenger seats per	-

Dutch Caribbean – Demand

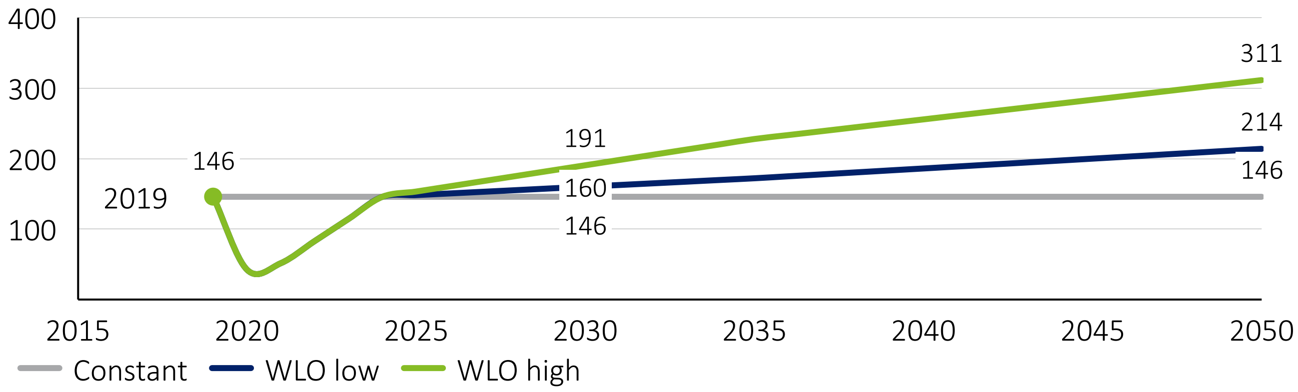
Demand for flights between islands is expected to grow between 0% and 114% by 2050 to 1.4k-3.1k passenger seats for the ABC-islands and 146-311 passenger seats for the SSS-islands

Using the WLO high and low air traffic demand scenarios, 2019 demand for flights <500km is extrapolated to estimate demand towards 2050, in addition a constant demand scenario is included

Estimated 2050 demand (in # passenger seats per day) between ABC-islands (x1,000)



Estimated 2050 demand (in # passenger seats per day) between SSS-islands



- The development of air traffic demand for flights <500 km towards 2050 is uncertain. As part of this quick scan 3 scenarios are considered
- Two scenarios are based on the WLO outlooks (total capacity in daily passengers, corrected for COVID-19). The WLO projected 2050 air mobility demand for Schiphol airport given 2013 market conditions[1]
- As there is no specific data concerning the Dutch Caribbean, the same assumptions as used for the Dutch mainland are used. Consequently, assuming passenger demand increases proportionally to Schiphol at other airports in the Kingdom of the Netherlands, the result is three demand scenarios (constant 2019 demand, WLO low and WLO high)
- More information on the calculations and the scenario's can be found in the Appendix

 Source: 1) ACI - The impact of COVID-19 on airports and the path to recovery

Dutch Caribbean – Feasibility & alternatives

Given the lower capacity of electric aircraft, more ATMs are needed to accommodate the future demand; at least ~19% and 14% more ATMs are required by 2050 for the ABC- and SSS-islands, respectively

Future demand is translated into required ATMs based on reduced capacity of electric aircraft

Impact of switching to electric aviation on required # of ATMs per day between ABC-islands

		Current (~26-pax)	Electrical aircraft (9-pax)		Electrical aircraft (19-pax)	
	Scenario	2019	2050	2050 (%) vs 2019	2050	2050 vs 2019
Forecasted demand	Constant	1.446	1.446	*n.a.*	1.446	*n.a.*
	WLO low	1.446	2.120	+674 (+46%)	2.120	+674 (+46%)
	WLO high	1.446	3.084	+1,638 (+114%)	3.084	+1,638 (+114%)
Required ATMs[1]	Constant	54	135	+81 (+150%)	64	+10 (+19%)
	WLO low	54	198	+144 (+267%)	94	+40 (+74%)
	WLO high	54	289	+235 (+435%)	137	+83 (+154%)

Impact of switching to electric aviation on required # of ATMs per day between SSS-islands

		Current (~20-pax)	Electrical aircraft (9-pax)		Electrical aircraft (19-pax)	
	Scenario	2019	2050	2050 (%) vs 2019	2050	2050 vs 2019
Forecasted demand	Constant	146	146	*n.a.*	146	*n.a.*
	WLO low	146	214	+68 (+46%)	214	+68 (+46%)
	WLO high	146	311	+165 (+114%)	311	+165 (+114%)
Required ATMs[1]	Constant	7	16	+9 (+129%)	8	+1 (+14%)
	WLO low	7	24	+17 (+243%)	11	+4 (+57%)
	WLO high	7	35	+28 (+400%)	16	+9 (+129%)

- Replacing all non-electrical flights between island groups with electrical aircraft would require more ATMs as the capacity of electrical aircraft by 2050 is expected to be lower than current non-electrical aircraft
- For ABC islands the availability of a 19-pax battery-electric aircraft would prove – based on this quick scan – a feasible option with regards to the number of daily ATMs required (an increase of +10 ATMs, i.e. +19%). If only a 9-pax aircraft would be available this would mean an increase of +81 ATMs per day (+150%)
- For SSS islands the availability of a 19-pax battery-electric aircraft would prove – based on this quick scan – a feasible option with regards to the number of ATMs per day required (an increase of +1 ATM, i.e. +14%). If only 9-pax aircraft would be available, transition is also feasible given an increase of +9 ATMs per day (+129%)

1) Numbers based on analysis of individual OD-pairs; and are consequently more accurate than results obtained by dividing the overall demand by the capacity

Dutch Caribbean – Feasibility & alternatives

9- and 19-seater battery-electric aircraft seem a viable option to replace fossil fuel flight between the Dutch Caribbean Islands

Feasibility in terms of fleet replacement

- For the ABC islands fourteen 9-seater aircraft or seven 19-seater aircraft would be needed to fulfill demand.
- For the SSS islands two 9-seater aircraft or two 19-seater aircraft would be sufficient to fulfill demand.
- The transition timeline between availability in 2030 and ambition in 2050 is 20 years
- Assuming economic lifetime of 30 years, the fleet transition should be feasible with limited depreciation
- A bottleneck is the timely availability of 9-/19-pax aircraft. However, current estimates are the commercial availability of battery-electric aircraft in 2030 which is well ahead of the AHEV goal of zero emission in 2050
- When 9-/19-pax aircraft will be commercially available (around 2030), market adoption of electric flight will depend on total cost of ownership. If the total cost of ownership is too high government intervention could incentivize adoption

	Only 9-pax aircraft available in 2050	Max 19-pax aircraft available in 2050
Total # aircraft needed[1]		
ABC	16	8
SSS	2	2

Feasibility in terms of market conditions

1. **Change in relative cost of hydrogen-electric aviation compared to alternatives**

- At this moment there is no battery-electric aviation available, early models could be more expensive compared to traditional air travel. If so, there will be no natural adoption at scale. Without government intervention adoption will only occur if the costs of battery-electric aviation is low compared fossil fuel aviation
- In the long term operational and maintenance costs for airlines of battery-/hydrogen-electric aviation compared to traditional methods are expected to be lower. Manufacturers expect a 50 – 75% reduction in these costs[2].

2. **Government intervention**

- The government has tools to stimulate electric flying, for example by sing a Public Service Obligation (PSO) or influence the pricing of alternatives

3. Availability of green energy and charging infrastructure

- Although there is a high potential for wind and solar energy, supply on the islands of green energy is still limited
- Infrastructure for energy and charging will have to be developed

Note: 1) Values are based on the constant scenario. These aircraft are only viable on short distances, whereas current aircraft can fly both shorter and longer distances, resulting in a challenge for flight routing; 2) source: Masterplan electric flight in the Kingdom of the Netherlands

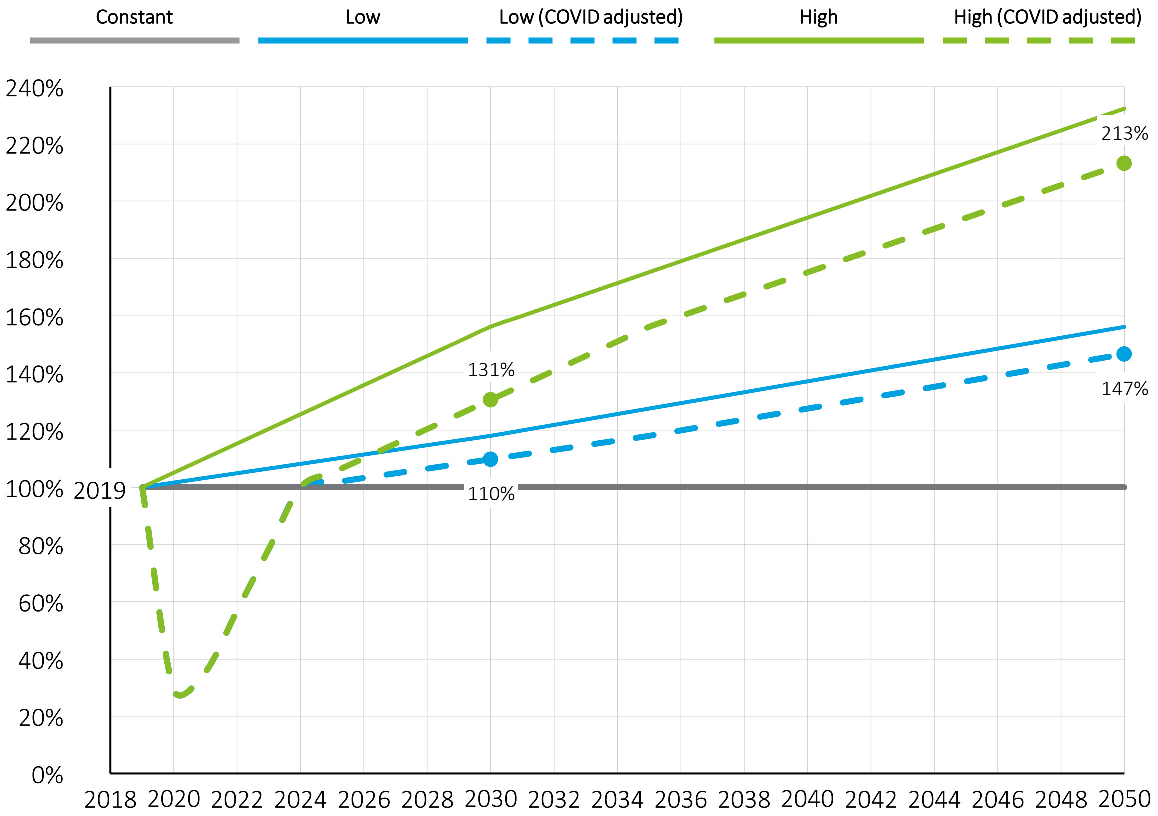
Appendix

Appendix

WLO high and low air traffic demand scenarios are adjusted to reflect the impact of COVID pandemic

The WLO high and low scenarios do not take into account any limitations in the number of flights. Effectively, a limitation in flights would roughly lead to a no-growth scenario, e.g., a constant air mobility demand at the 2019 level

Air mobility demand factor per year (2019 = 100%)



Demand approach: 2050 Demand

- The WLO projected 2050 air mobility demand for Schiphol airport given 2013 market conditions[1]
- A correction for the effects of the COVID-19 pandemic on passenger numbers in the form of a five-year demand lag was made using ACI assumptions[2]. In this case, 2024 passenger demand would equal 2019 passenger demand.
- Assuming passenger demand increases proportionally to Schiphol at other airports in the Kingdom of the Netherlands, the result is two demand scenarios that are directly comparable to 2019 average daily seat capacity
- The WLO scenarios did not anticipate the limited capacity at airports and regulation of the number of flights in the Netherlands, hence a constant demand scenario is introduced set at the level of 2019 (100% factor between 2019 and 2050) to account for these changes

Air mobility demand factor scenarios

Demand scenario	Demand 2030 (2019 = 100%)	Demand 2050 (2019 = 100%)
Constant demand	100%	100%
WLO Low (COVID adjusted)	118%	147%
WLO High (COVID adjusted)	131%	213%

Source: 1) https://www.wlo2015.nl/, 2) ACI - The impact of COVID-19 on airports and the path to recovery
Note: this is based on the Dutch market and, for lack of a better forecast, the assumption is made for this quick scan that similar growth scenarios hold for the Dutch Caribbean

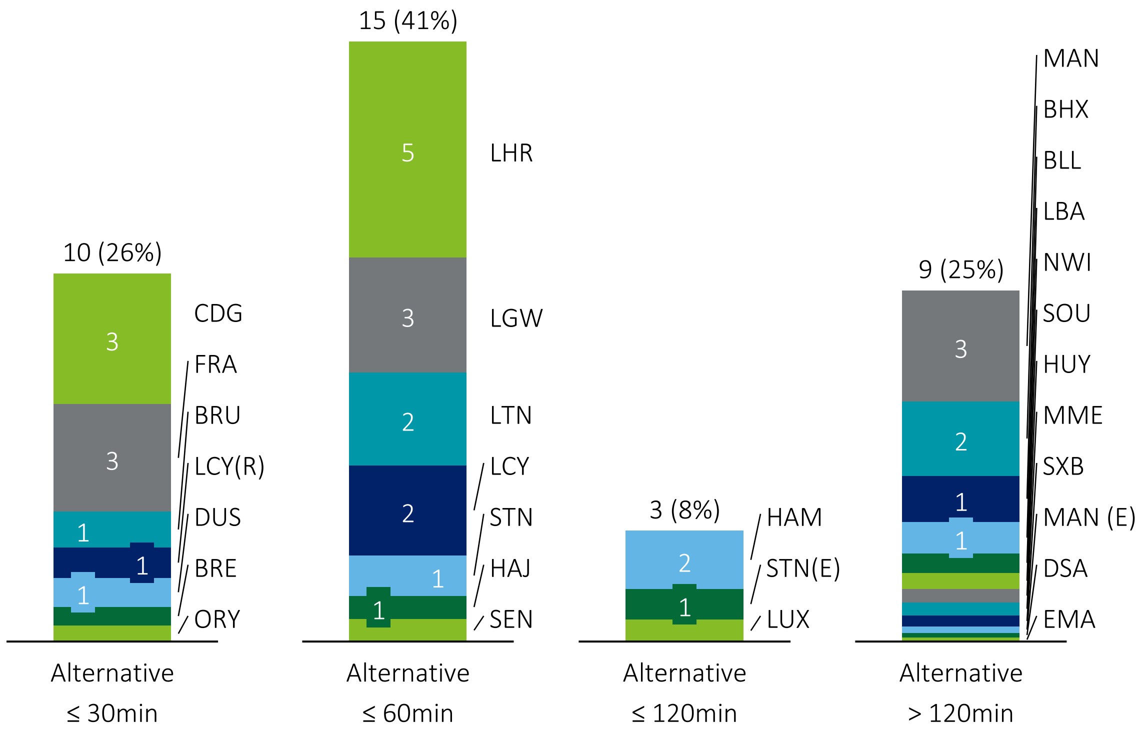
Alternative transport: travel time analysis

To understand the feasibility of alternative modes of transport a travel time analysis was carried out between OD-pairs in scope of the quick scan

Demand approach: Alternative transport

- The additional travel time of alternative transport (train or bus) compared to aircraft flight was used to assess the feasibility of alternative modes of transport
- 120 minutes were added to the flight time to account for the recommended time to arrive at an airport prior to the scheduled departure time, as well as a further 40 minutes of assumed additional travel time to and from the airport to account for airports often being much farther away from city centers than bus or train stations
- Train travel times were assumed to be the shortest available train time on Raileurope and assume no improvement over time (i.e. assuming current schedules). If no train time is available, a bus time was used by assuming a 20% higher travel time than the fastest route from the city-centers of the OD-pairs as determined by Google Maps car travel time
- Additional security checks on trains to and from UK have not been taken into account
- The more additional travel time the alternative mode of transport for an OD-pair has compared to aircraft flight, the less feasible the alternative mode of transport is

Daily capacity demand covered by alternative transport (in 1000 seats)[1,2]



Note: 1) R= Rotterdam the Hague Airport, E = Eindhoven Airport;

Appendix

Results: Mainland OD-pairs (Additional train travel time > 60 min)

15 OD-pairs have more than 60 minutes of additional travel time for the alternative mode of transport, of which 12 have more than 120 minutes of additional travel time

OD-pairs in order of daily demand in seats per day and additional train travel time (1/3)[1,2,3]

% Total demand	Add. train travel time (min)	Origin Airport	Destination Airport	2019 daily flights	Constant demand (=2019)			WLO Low demand (adjusted)			WLO High demand (adjusted)		
					2050 demand (seats/day)	80-seater daily flights	40-seater daily flights	2050 demand (seats/day)	80-seater daily flights	40-seater daily flights	2050 demand (seats/day)	80-seater daily flights	40-seater daily flights
7.9%	211	Amsterdam Schiphol	Manchester	22.6	2952	36.9	73.8	4326	54.1	108.2	6294	78.7	157.4
5.4%	198	Amsterdam Schiphol	Birmingham	18.4	1996	25.0	49.9	2926	36.6	73.1	4257	53.2	106.4
4.2%	76	Amsterdam Schiphol	Hamburg	11.7	1559	19.5	39.0	2284	28.6	57.1	3324	41.5	83.1
3.3%	312	Amsterdam Schiphol	Billund	9.7	1237	15.5	30.9	1813	22.7	45.3	2638	33.0	66.0
2.2%	309	Amsterdam Schiphol	Leeds Bradford	7.5	823	10.3	20.6	1206	15.1	30.2	1755	21.9	43.9
2.2%	94	Eindhoven	London Stansted	5.2	807	10.1	20.2	1182	14.8	29.6	1720	21.5	43.0
1.6%	106	Amsterdam Schiphol	Luxembourg-Findel	8.2	588	7.3	14.7	862	10.8	21.5	1254	15.7	31.3
1.4%	208	Amsterdam Schiphol	Norwich	6.7	524	6.5	13.1	768	9.6	19.2	1117	14.0	27.9
1.2%	192	Amsterdam Schiphol	Southampton	7.9	430	5.4	10.8	631	7.9	15.8	917	11.5	22.9
1.0%	293	Amsterdam Schiphol	Humberside	5.2	365	4.6	9.1	535	6.7	13.4	779	9.7	19.5
0.9%	320	Amsterdam Schiphol	Durham Tees Valley	4.8	340	4.3	8.5	499	6.2	12.5	726	9.1	18.1
0.8%	131	Amsterdam Schiphol	Strasbourg	5.2	297	3.7	7.4	435	5.4	10.9	633	7.9	15.8
0.5%	330	Eindhoven	Manchester	1.1	171	2.1	4.3	251	3.1	6.3	365	4.6	9.1
0.3%	222	Amsterdam Schiphol	Doncaster Sheffield	1.5	117	1.5	2.9	172	2.1	4.3	250	3.1	6.2
0.3%	164	Amsterdam Schiphol	East Midlands	2.7	111	1.4	2.8	162	2.0	4.1	236	2.9	5.9
33.2%	**Total (additional train travel time > 60min)**			**118**	**12317**	**154**	**308**	**18052**	**226**	**452**	**26265**	**328**	**657**

Source: 1) Eurocontrol 2019 flight data; 2) Deloitte analysis; Note: 3) Daily flights derived from average of Eurocontrol 2019 Dataset, adjusted for number of seats relative to 2019 average and demand per scenario

Appendix

Results: Mainland OD-pairs (Additional train travel time 30 – 60 min)

7 OD-pairs have 30-60 minute additional travel time for the alternative mode of transport

OD-pairs in order of daily demand in seats per day and additional train travel time (2/3)[1,2,3]

% Total demand	Add. train travel time (min)[4]	Origin Airport	Destination Airport	2019 daily flights	Constant demand (=2019)			WLO Low demand (adjusted)			WLO High demand (adjusted)		
					2050 demand (seats/day)	80-seater daily flights	40-seater daily flights	2050 demand (seats/day)	80-seater daily flights	40-seater daily flights	2050 demand (seats/day)	80-seater daily flights	40-seater daily flights
14.6%	60	Amsterdam Schiphol	London Heathrow	35.5	5436	67.9	135.9	7967	99.6	199.2	11592	144.9	289.8
7.8%	60	Amsterdam Schiphol	London Gatwick	20.0	2890	36.1	72.3	4237	53.0	105.9	6164	77.1	154.1
6.3%	60	Amsterdam Schiphol	London Luton	16.3	2343	29.3	58.6	3435	42.9	85.9	4997	62.5	124.9
6.1%	60	Amsterdam Schiphol	London City	24.3	2253	28.2	56.3	3302	41.3	82.5	4804	60.1	120.1
2.7%	60	Amsterdam Schiphol	London Stansted	7.6	1020	12.7	25.5	1495	18.7	37.4	2175	27.2	54.4
1.6%	33	Amsterdam Schiphol	Hannover	7.8	586	7.3	14.6	859	10.7	21.5	1249	15.6	31.2
1.5%	60	Amsterdam Schiphol	London Southend	4.0	567	7.1	14.2	831	10.4	20.8	1209	15.1	30.2
40.6%	**Total (additional train travel time 30 – 60 min)**			**116**	**15095**	**189**	**377**	**22126**	**277**	**553**	**32190**	**403**	**805**

Source: 1) Eurocontrol 2019 flight data; 2) Deloitte analysis; Note: 3) Daily flights derived from average of Eurocontrol 2019 Dataset, adjusted for number of seats relative to 2019 average and demand per scenario; 4) All Amsterdam-London routes have identical additional train travel time– assuming the city London as destination/origin

Appendix

Results: Mainland OD-pairs (Additional train travel time ≤ 30 min)

7 OD-pairs have equal or less than 30-minute additional travel time for the alternative mode of transport

OD-pairs in order of daily demand in seats per day and additional train travel time (3/3)[1,2,3]

% Total demand	Add. train travel time (min)	Origin Airport	Destination Airport	2019 daily flights	Constant demand (=2019)			WLO Low demand (adjusted)			WLO High demand (adjusted)		
					2050 demand (seats/day)	80-seater daily flights	40-seater daily flights	2050 demand (seats/day)	80-seater daily flights	40-seater daily flights	2050 demand (seats/day)	80-seater daily flights	40-seater daily flights
9.3%	-28	Amsterdam Schiphol	Charles de Gaulle	23.5	3474	43.4	86.9	5092	63.7	127.3	7409	92.6	185.2
7.7%	12	Amsterdam Schiphol	Frankfurt am Main	22.9	2875	35.9	71.9	4214	52.7	105.3	6131	76.6	153.3
2.6%	-91	Amsterdam Schiphol	Brussels	9.9	952	11.9	23.8	1396	17.4	34.9	2030	25.4	50.8
2.2%	26	Rotterdam The Hague	London City	8.1	811	10.1	20.3	1188	14.9	29.7	1729	21.6	43.2
2.1%	-76	Amsterdam Schiphol	Dusseldorf	9.6	770	9.6	19.3	1129	14.1	28.2	1642	20.5	41.1
1.3%	26	Amsterdam Schiphol	Bremen	6.2	501	6.3	12.5	735	9.2	18.4	1069	13.4	26.7
1.1%	-36	Amsterdam Schiphol	Paris-Orly	2.8	426	5.3	10.7	624	7.8	15.6	909	11.4	22.7
26.3%	**Total (additional train travel time ≤ 30min)**			**83**	**9809**	**123**	**245**	**14378**	**180**	**359**	**20919**	**262**	**523**

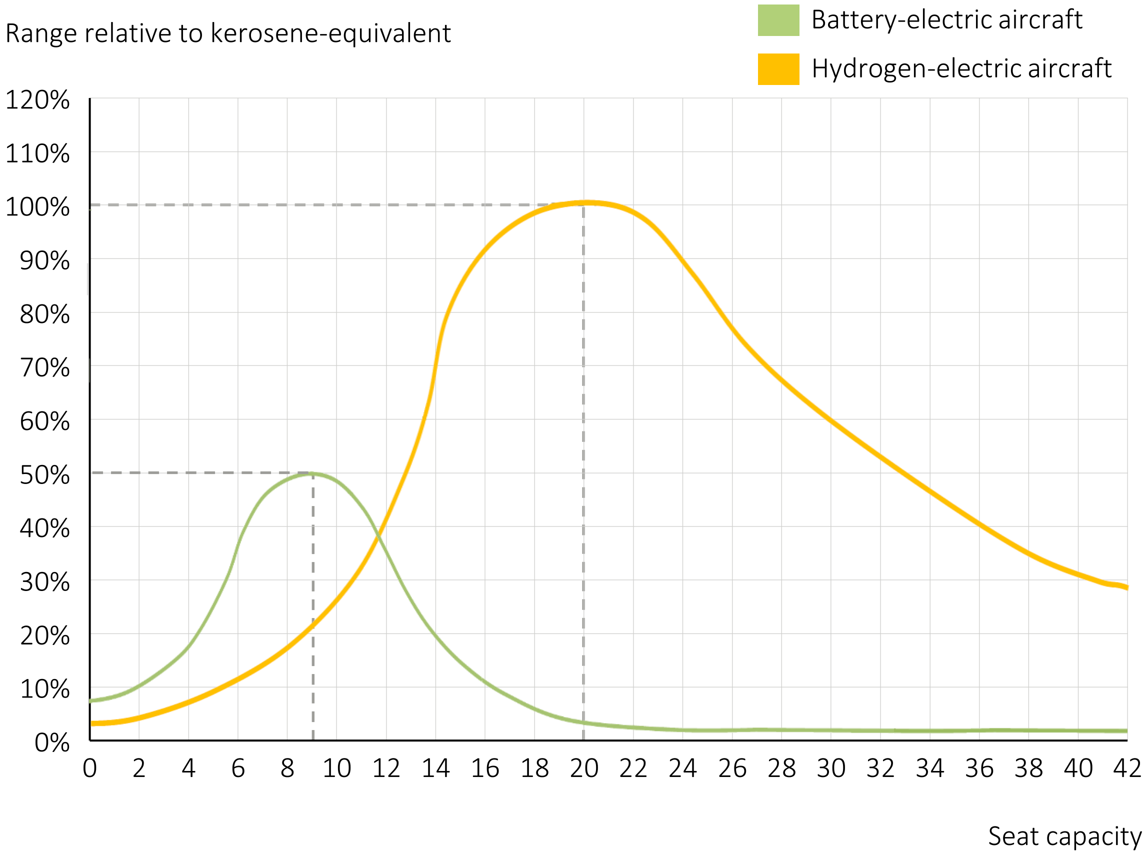
Source: 1) Eurocontrol 2019 flight data; 2) Deloitte analysis; Note: 3) Daily flights derived from average of Eurocontrol 2019 Dataset, adjusted for number of seats relative to 2019 average and demand per scenario

Appendix

Technological adoption

To ensure the 2050 ambition is met, both battery electric and hydrogen fuel cell aircraft must be considered as a technology enabling emission-free flight

Range relative to kerosene aircraft vs seat capacity (retrofit)[1]



Advantages of hydrogen-electric aircraft[2]

- **Commitment**: Several reputable aircraft manufacturers have committed to developing hydrogen-powered electric aircraft with long-range capabilities and expect them to be operational around 2040
- **Energy density**: Hydrogen has a mass energy density that is 2.8 times higher than gasoline. However, due to its low volumetric density, compressed hydrogen gas requires around six times more volume for the equivalent amount of kerosene
- **Scalability**: With today's technology, 20-passenger hydrogen-electric aircraft can achieve at least the same range as the equivalent kerosene-fueled aircraft, with a gentler drop-off relative to battery-electric aircraft with increasing passenger numbers
- **Feasibility**: Though hydrogen-electric aircraft face similar challenges in terms of certification and qualifications of personnel as battery-electric aircraft, experts believe we could see 80-passenger hydrogen electric aircraft in operation by 2040

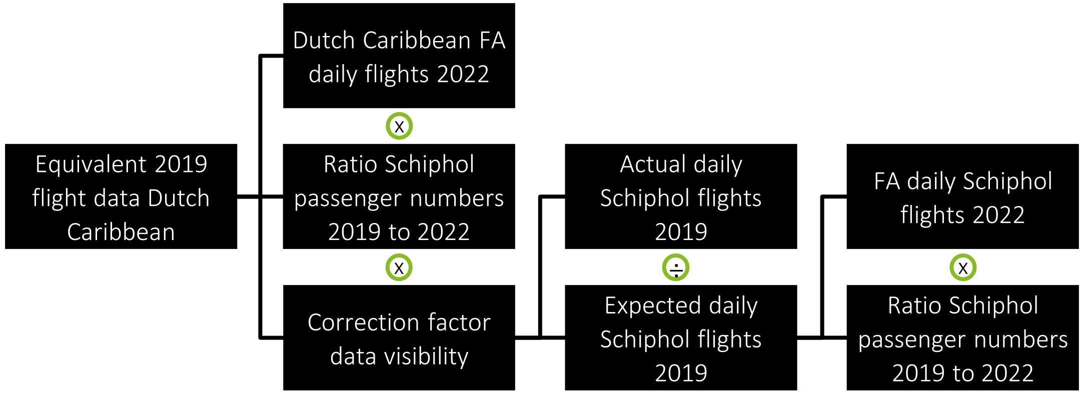
Source: 1) Interpolated from Broekema Aviation - Aircraft Retrofit Market Potential & Social Relevance. Subject to change as technology further develops, 2) Expert interviews To70, Unified International;

Air mobility demand

Air mobility demand for the Dutch Caribbean was estimated similarly to that of the Mainland Netherlands, with the addition of several corrections to the FlightAware data used to arrive at a dataset of comparable quality to the Eurocontrol dataset

Dutch Caribbean flights correction

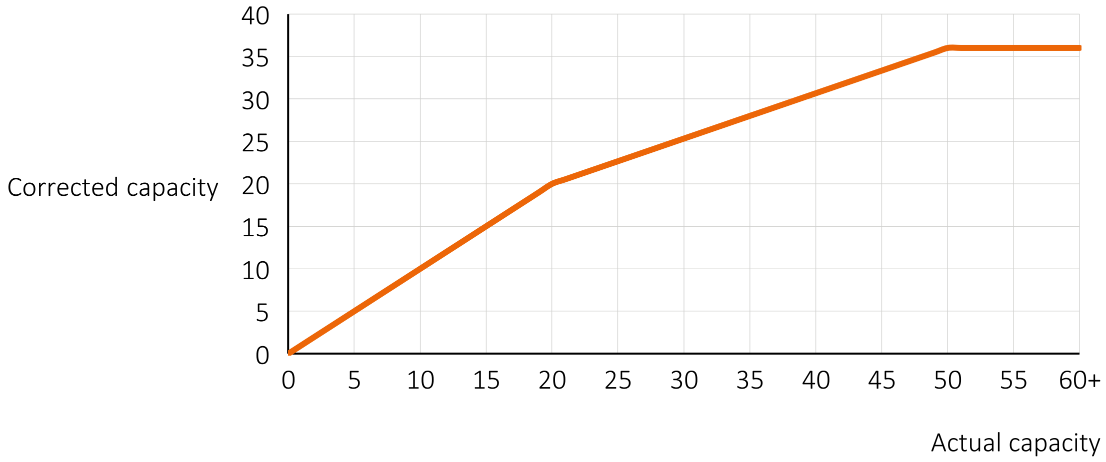
- The flight data for the Dutch Caribbean was obtained from FlightAware (FA) and contains 8 days worth of airport departure and arrival data
- As this data is from 2022, has a small sample size, corrections were made to the number of flights flown to arrive at a 2019-equivalent dataset. Using the FA data for Schiphol as a proxy, a correction factor was applied to Dutch Caribbean FA data based on 1) the number of passengers in 2019 compared to 2022 (71 vs. 53 million), and 2) based on the quality of FA data, as shown in the below diagram
- The second factor involved creating a 2019-equivalent Schiphol flight dataset from FA and comparing it to the 2019 Eurocontrol dataset. This resulted the FA dataset showing around 10% less flights than expected, which was then corrected for



Source: 1) NACO & NLR: Roadmap Electric flight in the Kingdom of the Netherlands

Dutch Caribbean capacity correction

- Unlike in Europe, the Dutch Caribbean sees a very low load factor (ratio of passengers onboard relative to seat capacity) for high-capacity aircraft. To prevent overestimating demand, we correct for large aircraft flying mostly empty by correcting the daily capacity offered for average load factor
- As no passenger data was available, the average load factor per aircraft size was taken from NACO & NLR1 and equated to a capacity given a 75% load factor
- For example: an aircraft with 150 seats and an average load factor of 10% would carry 15 passengers on average, and its capacity would be equated to a 20-seater aircraft with a 75% load factor



Monitor **Deloitte.**