THE CLEAN SKY 2 TECHNOLOGY EVALUATOR
1ST GLOBAL ASSESSMENT

ICAS 2022

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Clean Aviation Joint Undertaking

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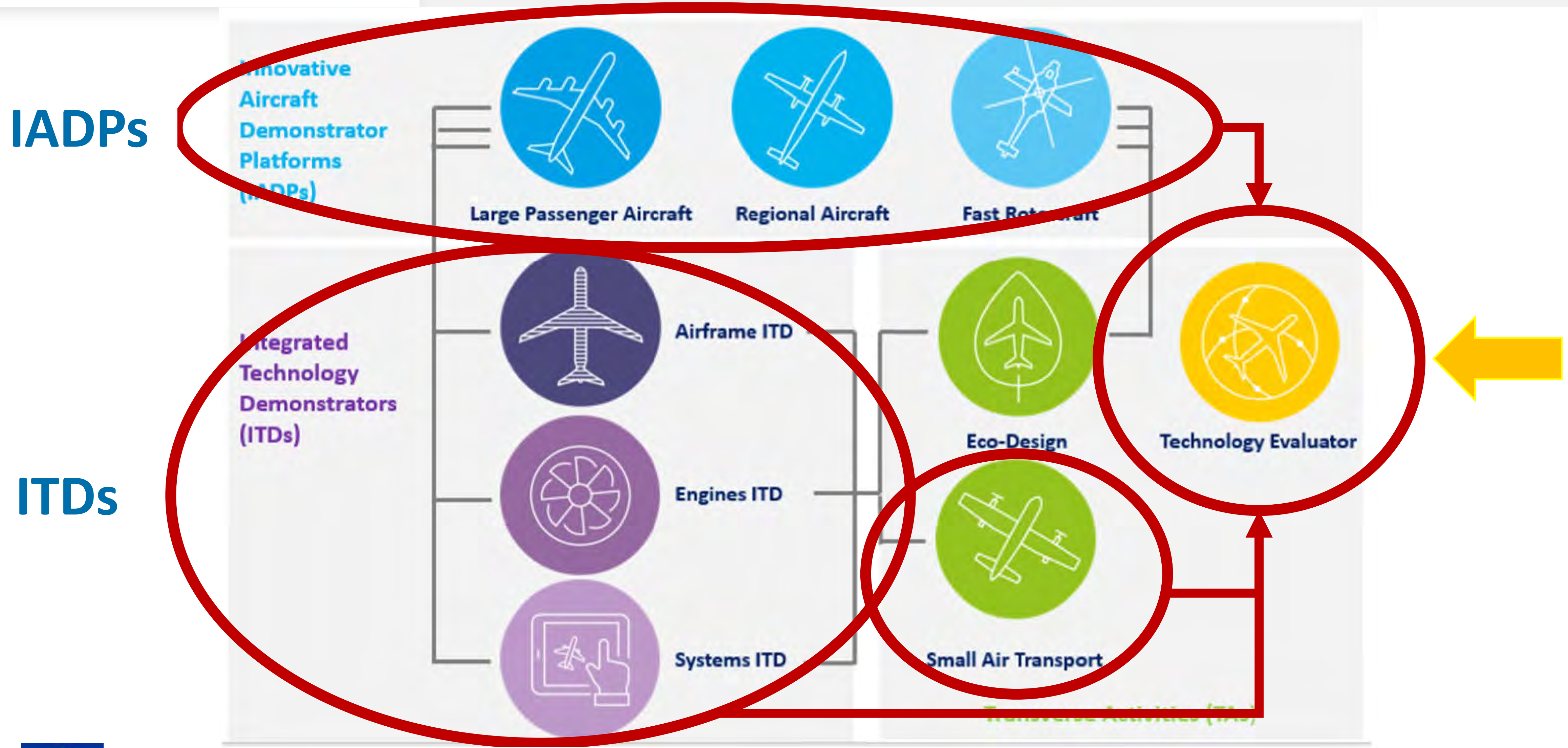
Technology Evaluator



- Clean Sky 2 Structure –

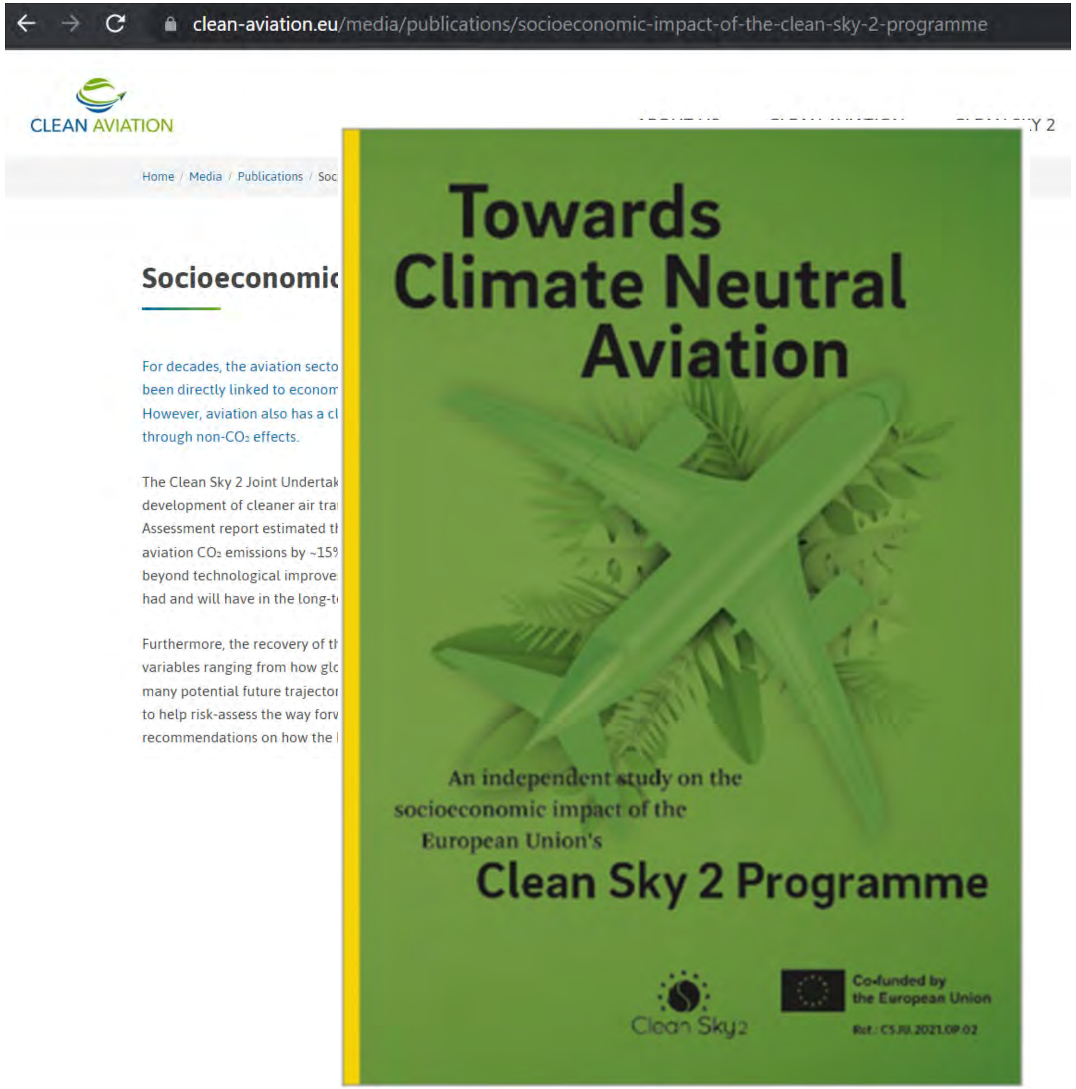
Clean Sky 2 First Global Assessment

Key Messages

First Global Assessment covers 2 major aspects:

- ➢ the ***environmental impact assessment***
- ➢ the ***socio-economic impact assessment***

First Global Assessment was performed before/during the outbreak of the pandemic.
COVID-19 Impact not considered.
See Note in Section 7 (Report) on potential impacts.
See R&B/OE Study available on web.



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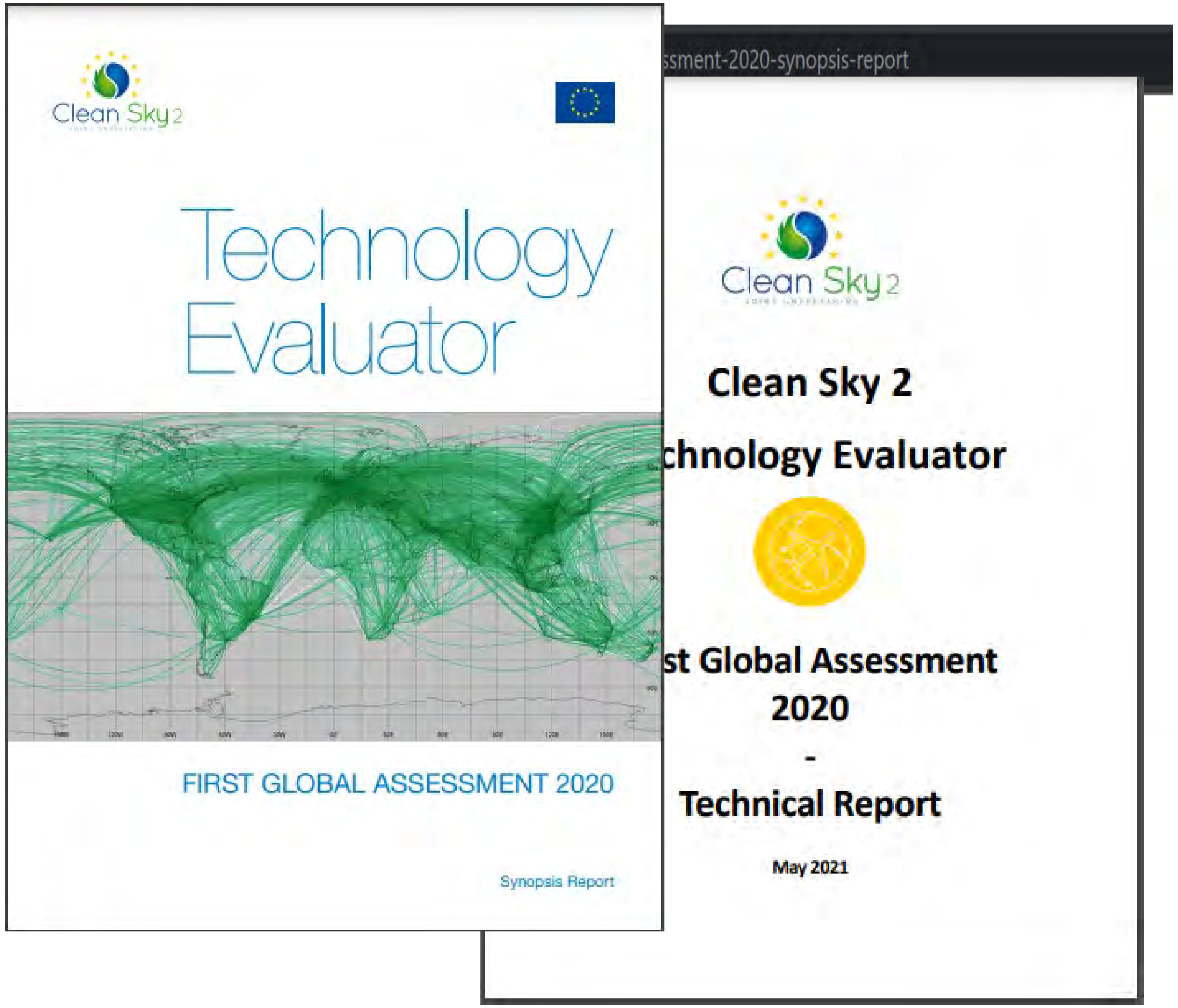
Clean Sky 2 First Global Assessment

Key Messages

First Global Assessment is available as an **interim progress report** (showing interim results) at CS2 programme mid-term (**2020**) before the final assessment at programme end, in **2024**.

First Global Assessment is available as a **synopsis report** of the full technical deliverable submitted by TE (DLR) July 2020.
It contains a high level Executive Summary.



Publication of 2 documents:

- **Executive Summary -> Short Synopsis (16 pages + images & graphs)**
- **Synopsis Report -> Technical Report (122 pages)**

ASSESSMENT METHODOLOGY
FORECAST & SCENARIOS

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Methodology (1/4)

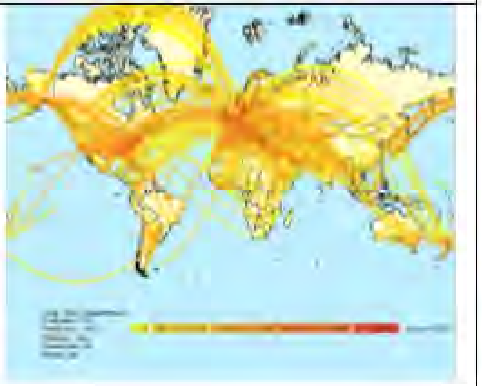
	Innovation potential at Mission level Clean Sky 2 Concept Aircraft are compared with 2014 Reference Aircraft on relevant missions regarding emissions and noise. The results are the basis to quantify the success level versus the CS2 environmental goals.	
	Realistic impact at Airport level A typical day at representative EU-airports (fleet mix from 2014 historical and 2035/2050 forecast data) is compared for a fleet with and without Clean Sky aircraft and analysed regarding emissions and noise.	
	Aviation footprint at Air Transport System (ATS) level A year with all global flights (fleet mix from 2014 historical and 2035/2050 forecast data) is compared for a fleet with and without Clean Sky aircraft and analysed regarding emissions and noise.	

Figure 4 - Assessment levels.

Methodology (2/4)

World Population (in billion)	8.5 / 9.2 / 9.7 *(2030 / 2040 / 2050)*	United Nations (2019): World Population Prospects 2019	GDP growth rates (p.a. in %, from 2014)	1.98 / 1.98 / 1.97 *(2030 / 2040 / 2050)*	IHS Global Markit (2017): Global GDP Growth Rates
Population growth rates (p.a. in %, from 2014)	1.05 / 0.93 / 0.86 *(2030 / 2040 / 2050)*	United Nations (2019): World Population Growth Rates			

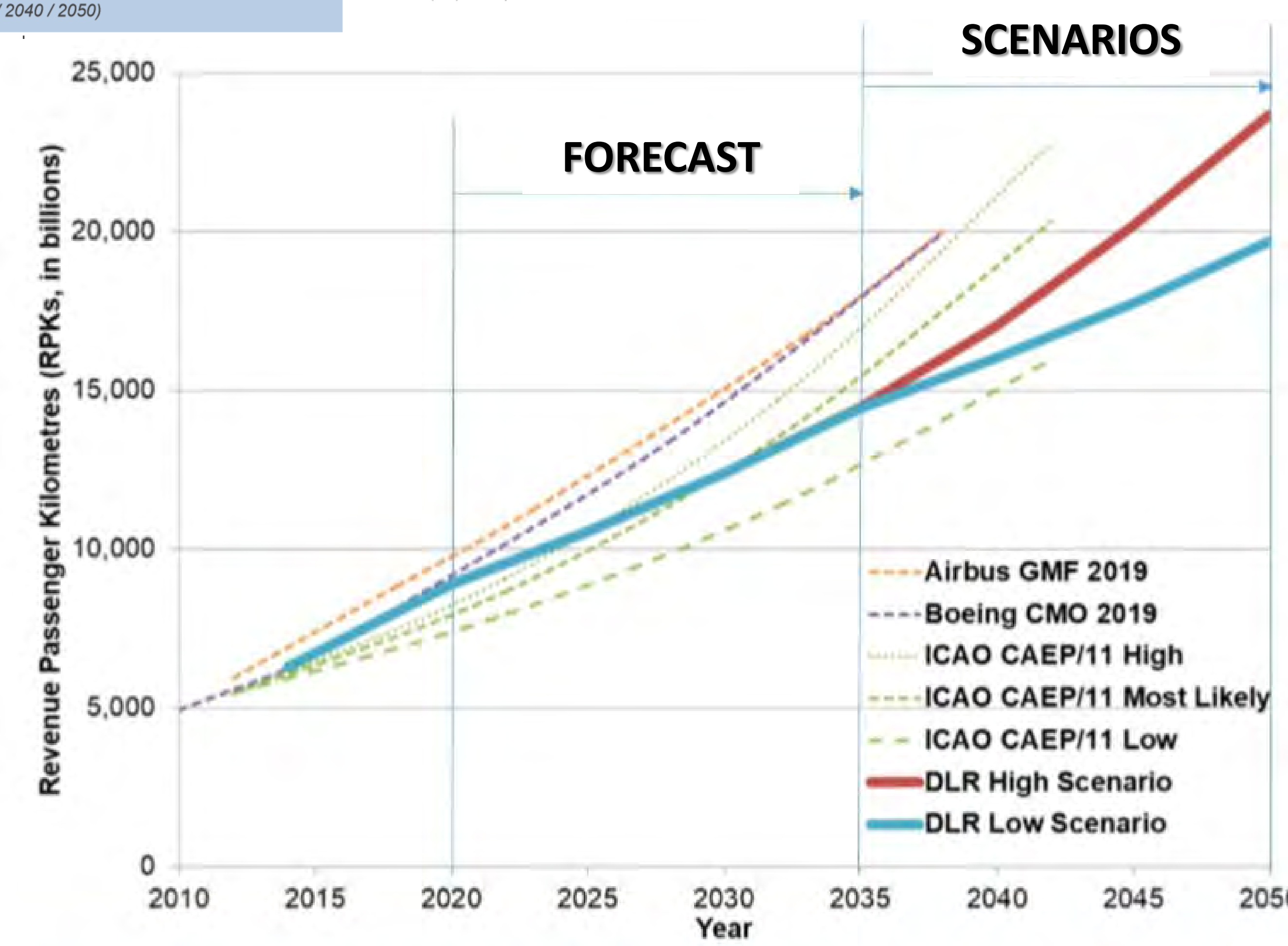


Figure 5 - Comparison of Forecast and Scenarios to other available air traffic predictions.

High

Low

AGR 2014 to 2050 :
<u>passenger volumes</u>
3.9% (High Scenario)
3.3% (Low Scenario)
<u>flight volumes</u>
2.0% (High Scenario)
1.7% (Low Scenario)

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Methodology (3/4)

Overall Assumptions:

- Economic conditions remain static (no war, **no COVID** …)
- Key drivers:
  - income per capita, GDP, population, airfare dvlpt.
- Tech. diffusion models to neighbouring seat classes (TeDiMo)
- A/C Retirements (ICAO model)
- Passenger Load Factors 80% -> 88% (ICAO model)
- Airport Hub Structure unchanged
- No SAF (TRANSCEND)
- No Policies (GLIMPSE2050)
- No Retrofit
- No UAV & No SST (OASyS)
- Airport Capacity Constraints
  - new (additional) runways
  - runway extensions deliver little additional capacity
  - probability of a runway expansion modelled differently across the world (India, China)
  - No new airports.

Key Message

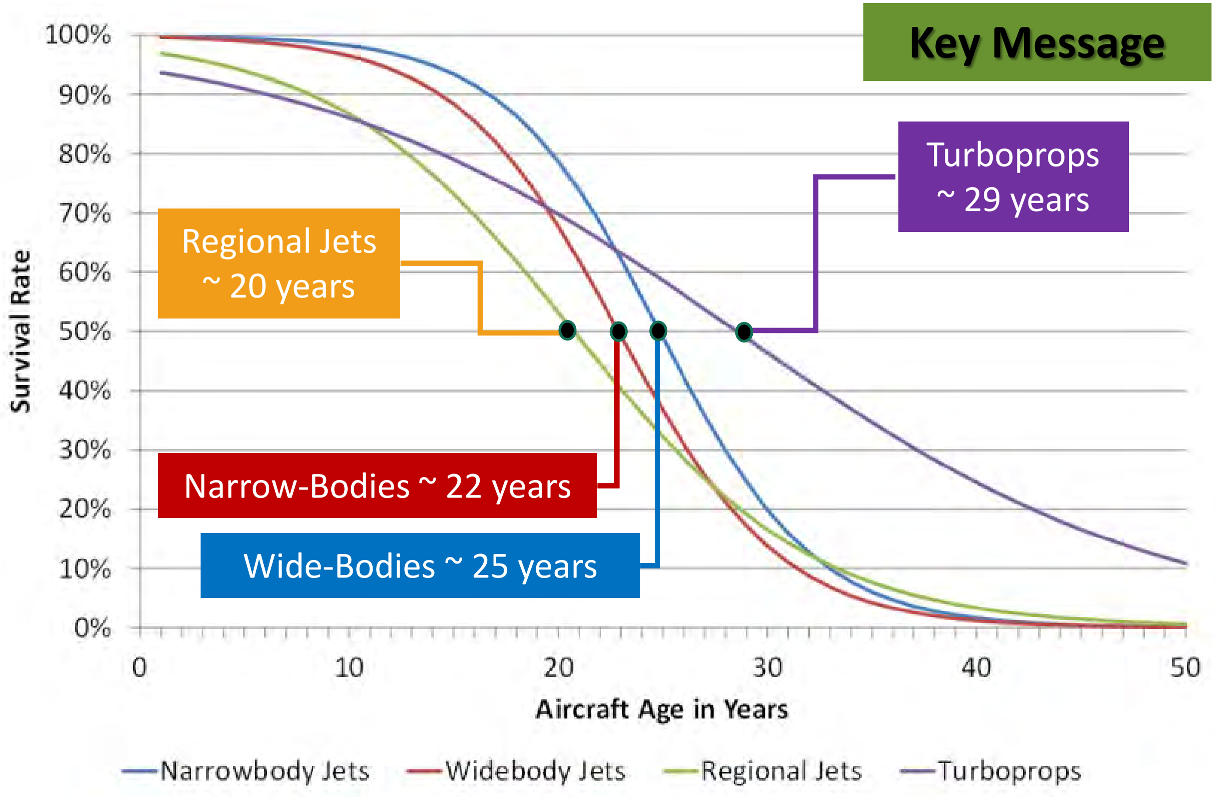


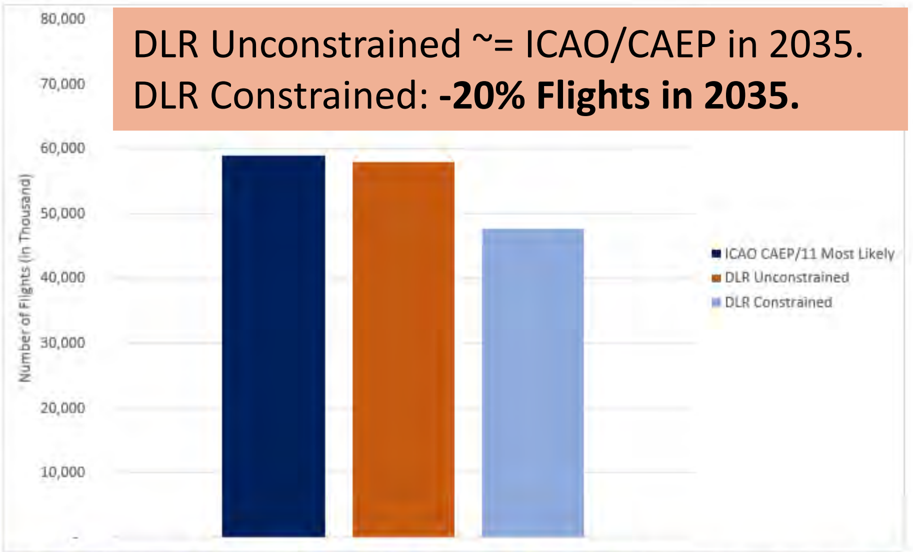
Figure 6 – Aircraft retirement curves.

Key Message

4 Full Fleet Calculations for 2050

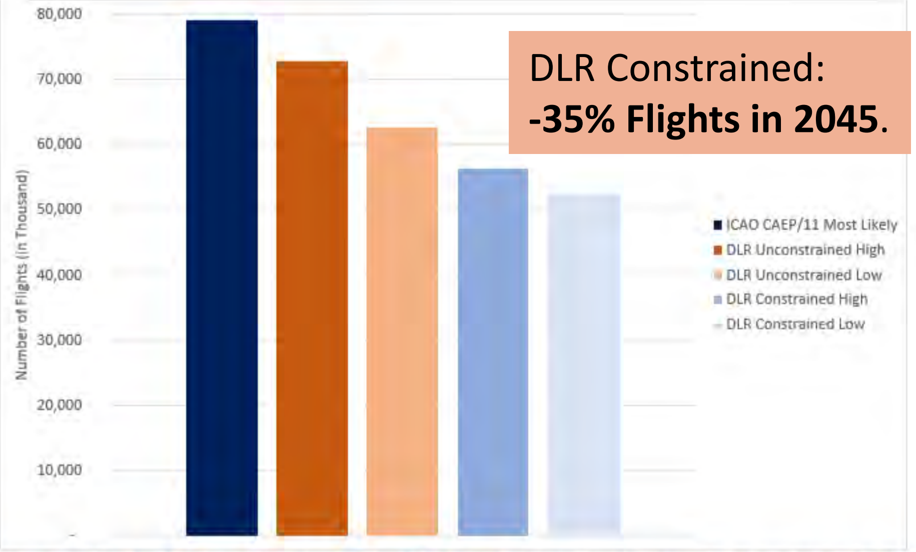
- DLR Unconstrained – High
- DLR Unconstrained – Low
- DLR Constrained – High
- DLR Constrained - Low

Methodology (4/4)



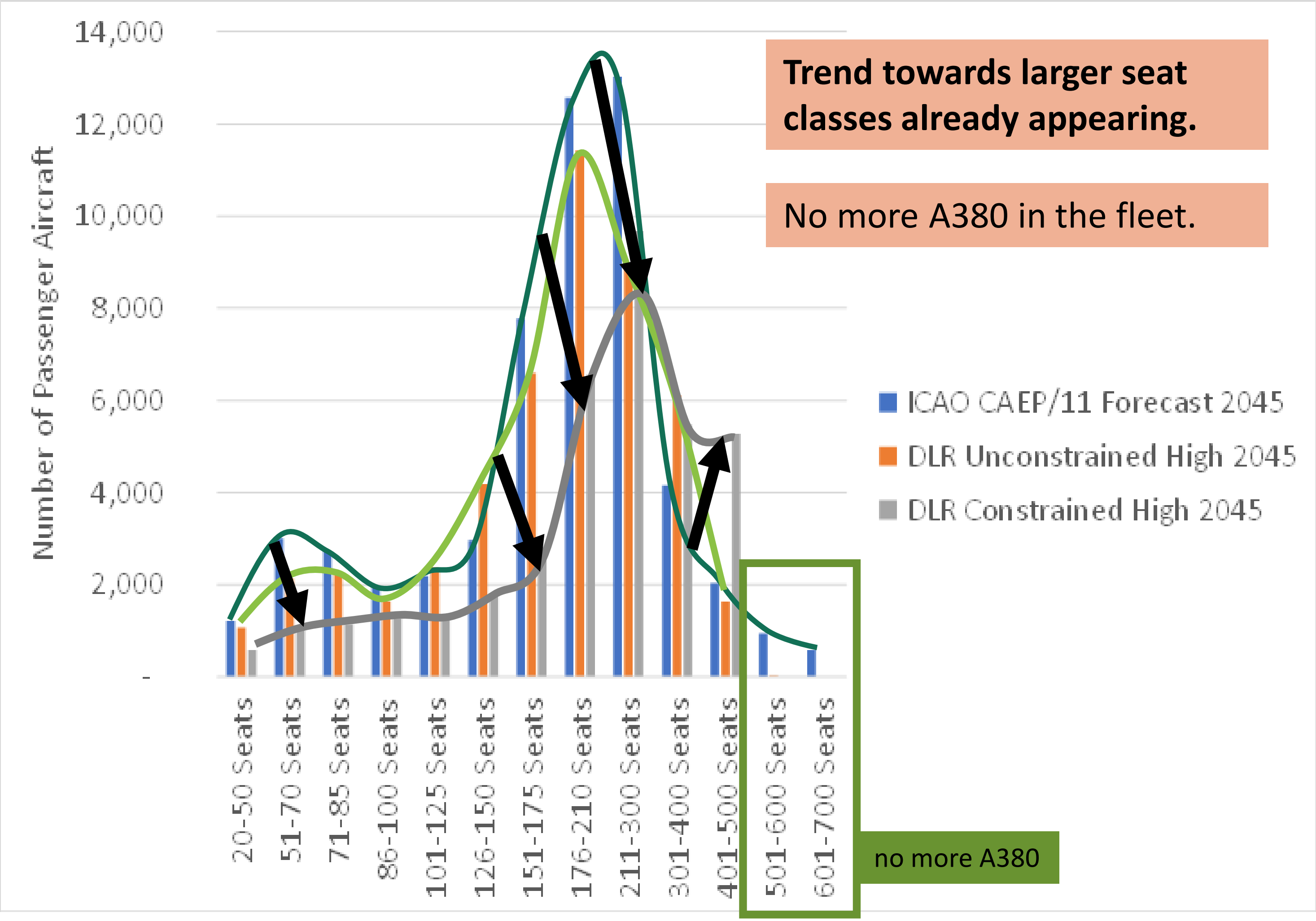
DLR Unconstrained ~= ICAO/CAEP in 2035.
DLR Constrained: **-20% Flights in 2035.**

Figure 7 - 2035 DLR Forecast vs. ICAO CAEP/11 Forecast in terms of number of flights.



DLR Constrained:
-35% Flights in 2045.

Figure 8 - 2045 DLR Scenarios vs. ICAO CAEP/11 Forecast in terms of number of flights.



Trend towards larger seat classes already appearing.

No more A380 in the fleet.

Figure 9 - 2045 DLR Scenarios vs. ICAO CAEP/11 Forecast in terms of in-service passenger aircraft by seat classes.

Take-Away (1)

AIRPORT TRAFFIC CONGESTION

Congested airports are already a reality today. **An overall reduction of 30% in terms of flight volumes** can be expected if ***airport capacity constraints*** are taken into account in the forecast model. This is an important novelty of the DLR methodology compared to other models dealing with air transport today.

Take-Away (2)

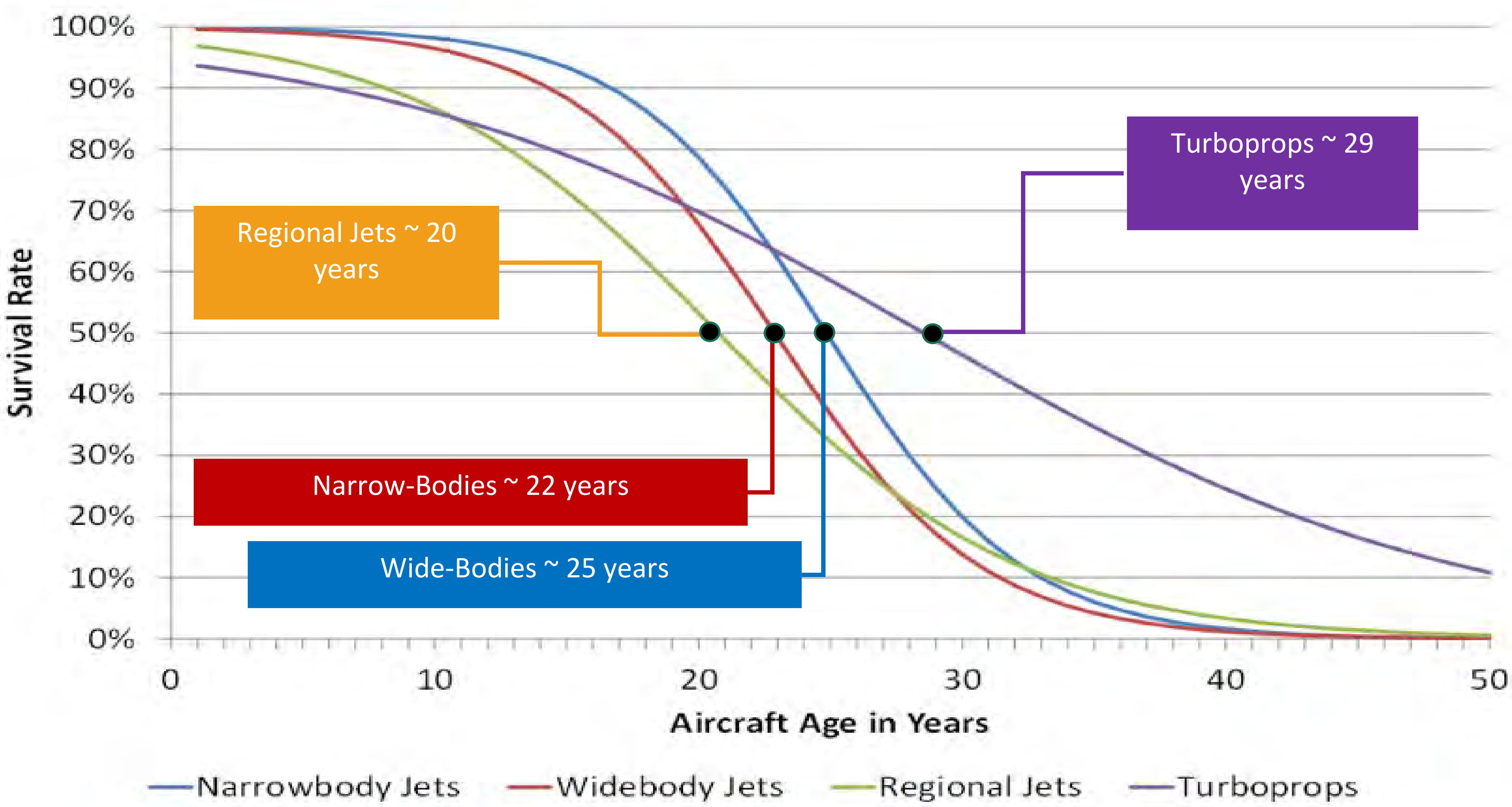


Figure 6 – Aircraft retirement curves.

ENVIRONMENTAL IMPACT

AIRCRAFT (MISSION) LEVEL

AIRCRAFT CONCEPTS

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Aircraft Concepts

The current fleet divided into several market segments:

- **Mainliners (4)** (covering **Long Range** and **SMR**),
- **Regional aircraft (3)** (different mission targets),
- **Small Air Transport (1)** (19 seats)
- **Business Jets (1)**,
- **Fast Rotorcraft (2)**

	Concept Aircraft				Reference Aircraft				Clean Sky 2 Environmental Goals			EIS* Window	TRL Target** @ CS2 close
SPD	Concept Vehicle	Range nm	Cruise speed	# PAX	Reference Vehicle	Range nm	Cruise speed	# PAX	ΔCO_2	ΔNO_x	Δ Noise		
LPA	Advanced Short-Medium Range SMR+	2000	0.78 Ma	200	SMR 2014 A321neo	2800	0.78 Ma	200	-20%	[illegible]	-20%	2030	5
	Ultra-Advanced Short-Medium Range SMR++	2000	0.75 Ma	200					[illegible]	[illegible]	-30%	2035+	4
	Advanced Long Range LR+	6700	0.85 Ma	315	LR 2014 A350-900	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]0%	2030	4
	Ultra-Advanced Long Range LR++	6700	0.85 Ma	315					[illegible]	[illegible]	[illegible]	2035+	3
REG	Advanced Turboprop 90 PAX	1200	0.56 Ma at 20 kft	90	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2025+	5
	Innovative Turboprop 130 PAX	1600	0.62 Ma at…	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	2035+	4
	Regional Multi Mission Turboprop 70 PAX – Transport Airline / T…	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	-20 to -30%	-20 to -30%	-20 to -30%	2025+	6
SAT	19 PAX Com…	[illegible]	[illegible]	[illegible]	[illegible]	800	0.34 Ma	19	-20%	-20%	-20%	2025	4-5
AIR	Low Sweep Busine…	[illegible]	[illegible]	[illegible]	Dassault Falcon 2000 like	2900	0.75 Ma	12	> -30%	> -30%	> -30%	2035	≥ 4
FRC	Airbus Helicopters Compound (RACER)	[illegible]	…kTAS	12	Twin-Engine Medium Baseline (TEM-B) generic helicopter	290	114 kTAS	12	-20%	-20%	-20%	2030	6
	Leonardo Helicopters Tiltrotor (NGCTR)	<1000	250 kTAS	24	Leonardo Helicopters AW139 like	570	145 kTAS	15	-50%	-14%	-30%	2030+	6

*All key enabling technologies at TRL 6 with a potential entry into service five years later.

**Key enabling technologies at major system level.

- ✓ Concept Aircraft defined (TLARs)
- ✓ Reference Aircraft defined
- ✓ Environmental Goals set
- ✓ Target EIS set
- ✓ TRL @ CS2 closure set

Clean Sky 2

Key Messages

Concept definition

Based on selection of technologies

> TRL3 **in 2018**

Concept EIS

- a few concepts EIS **2025+**
- next earliest EIS is **2030** (Adv.)
- **2035+** for Ultra-Adv. concepts.

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Reference Aircraft

Key Message

Choice of **Reference Aircraft** may be difficult.

- Ok for mainliners (A321 neo EIS2016 – A350-900 EIS2015).
- Regional needs upscaling of ref. a/c. (ATR-72-500 is 70 pax -> 90 pax).
- REG TP 130 (USF) compared CS-300 (GTF).
- REG MM TP 70 (EADS-CASA) compared to C-295 (50 pax) upscaled but Flying Test Bed #2 in AIR.
- SAT -> generic 19-seat SoA 2014 model created
- BJ -> ref 2000 -> ref 2020 (2nd Assessment)
- FRC no existing match for reference vehicle ! (Range, Cruise Speed, #PAX, max ceiling)

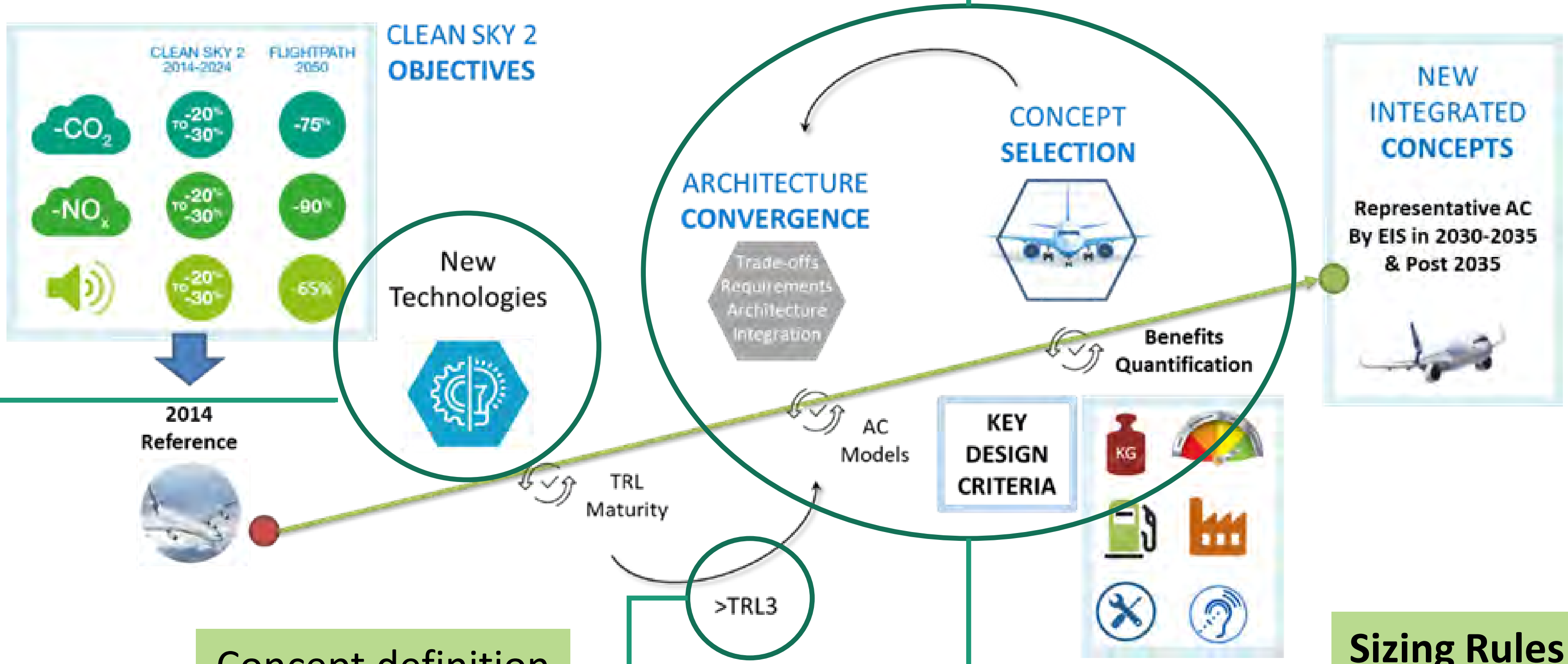
	Concept Aircraft				Reference Aircraft				Clean Sky 2 Environmental Goals			EIS* Window	TRL Target** @ CS2 close
SPD	Concept Vehicle	Range nm	Cruise speed	# PAX	Reference Vehicle	Range nm	Cruise speed	# PAX	ΔCO_2	ΔNO_x	Δ Noise		
FRC	Airbus Helicopters Compound (RACER)	<350	220 kTAS	12	Twin-Engine Medium Baseline (TEM-B) generic helicopter	290	114 kTAS	12	-20%	-20%	-20%	2030	6
FRC	Leonardo Helicopters Tiltrotor (NGCTR)	<1000	250 kTAS	24	Leonardo Helicopters AW139 like	570	145 kTAS	15	-50%	-14%	-30%	2030+	6

Mission Level Calculations

Key Messages

<u>Each Aircraft Concept is described in detail.</u>
including its technology insertions and from which CS2 IADP/ITD.

<u>Complex Design Optimisation !</u>
Impossible to optimize *simultaneously* for CO_2, NO_x and Noise.
=> Design compromise !



<u>Concept definition</u>
from technologies
> TRL3 **in 2018**

<u>Sizing Rules (#PAX – Range)</u>
are 12-14 years old.
To be updated for alignement with 2030 market expectations.

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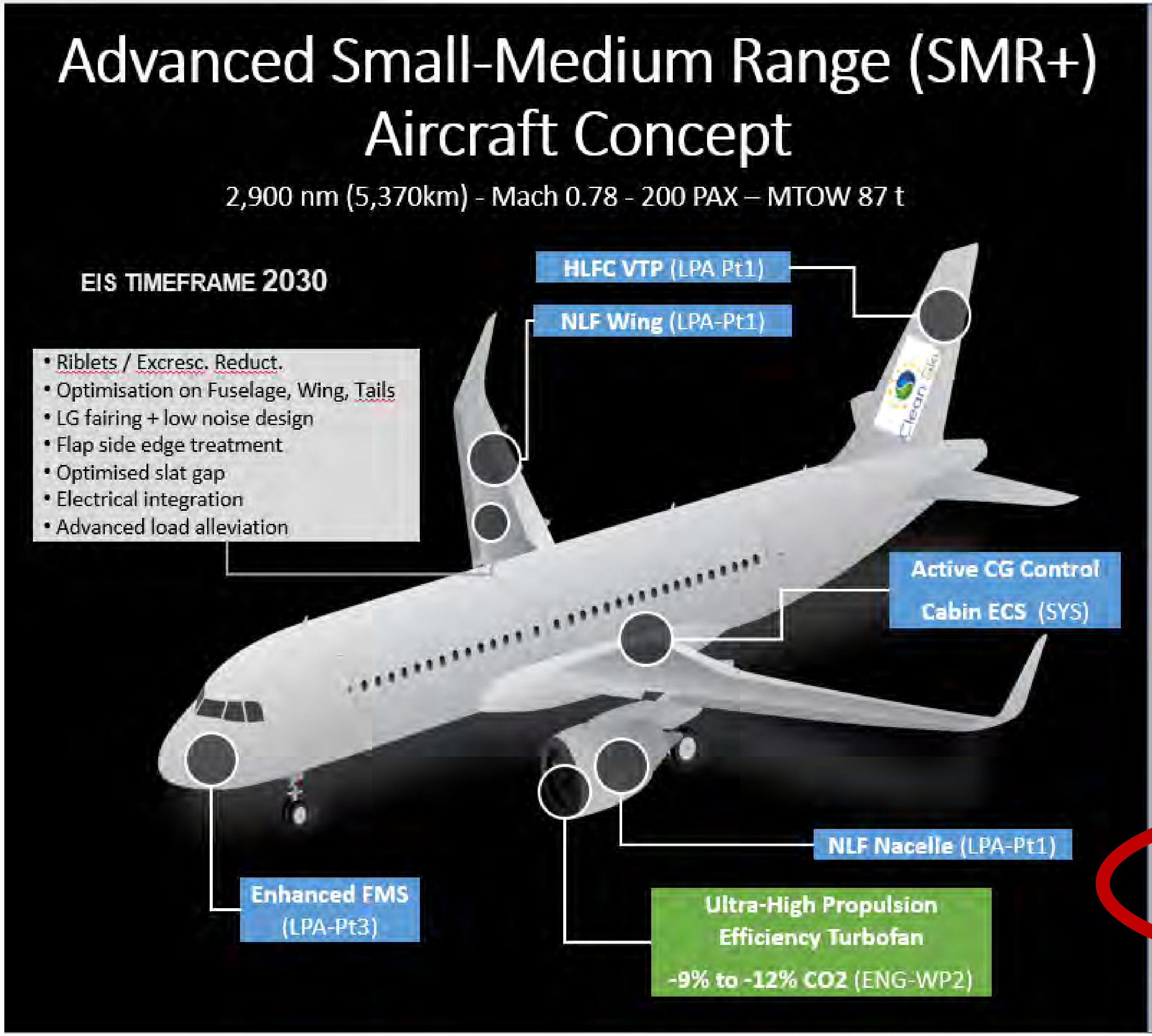
SMR+



Ref. SMR 2015 – A321neo

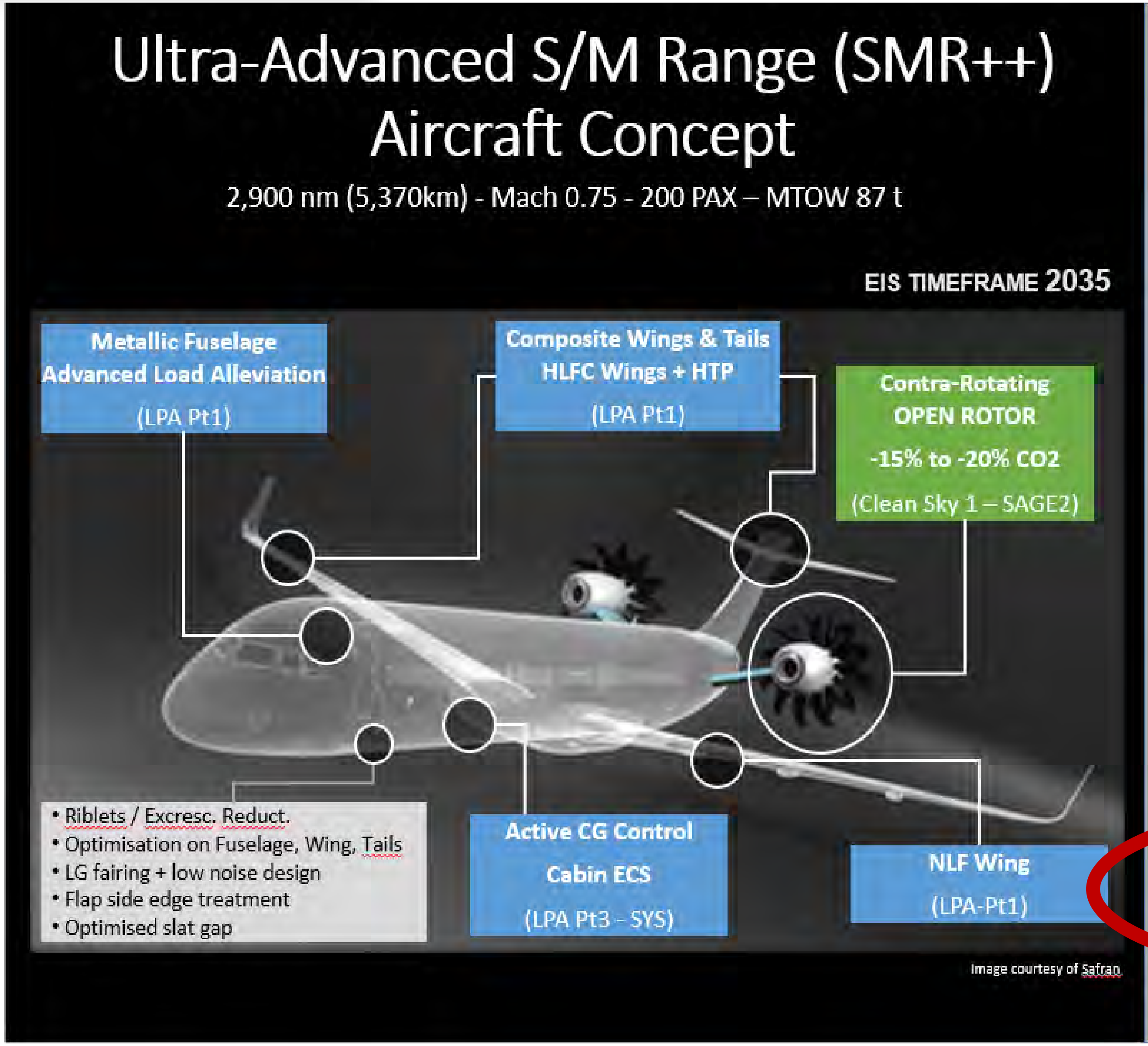
2,800 nm - Mach 0.78 - 200 PAX – MTOW 87 t

Benefits vs Platforms	SMR + Dec 2019		
PERFORMANCE	SFC	Mass (tons)	Drag
Aerodynamics High & Low speeds	-	↗	↘↘
Structure	-	↘↘	-
Systems	↘	-	↘
Improvements for noise	-	↗	↘
Engine	↘↘	↗	↗
Total Performance	-9.5%	-0.7t	-3.9%
Total IMPACTS avg %Reduction vs Ref 2014	CO_2	NO_x	NOISE
	-17%	-34%	TO~ -15% AP< -20%

TO : Take-Off

AP : Approach / Certification ICAO annex 16 conditions

SMR++



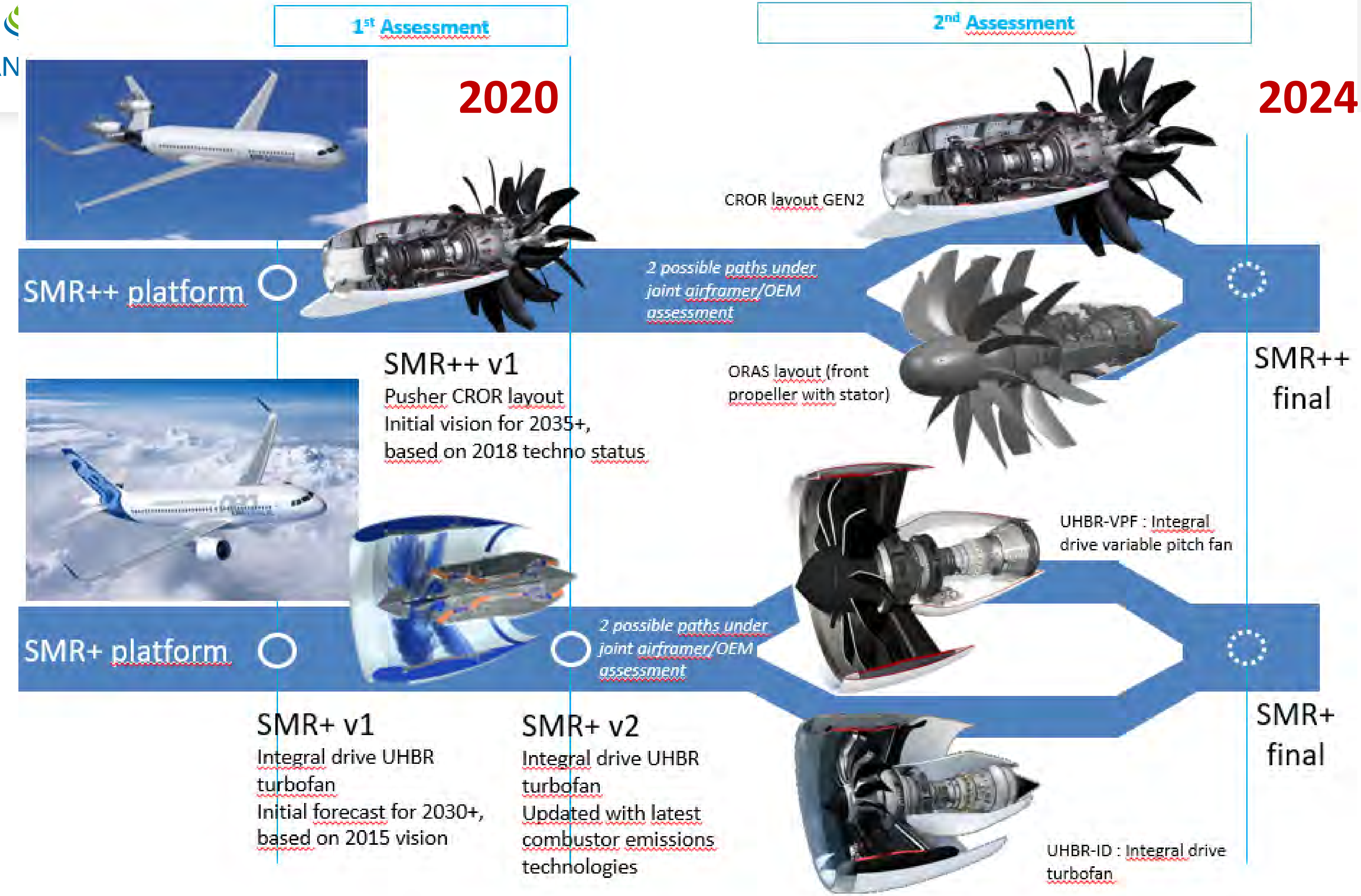
Ref. SMR 2015 – A321neo

2,800 nm - Mach 0.78 - 200 PAX – MTOW 87 t

Techno benefits vs Platforms	SMR ++ CROR 2019		
PERFORMANCE	SFC	Mass	Drag
Aerodynamics	-	↗	↘↘
Structure	-	↘↘	-
Systems	↘	-	↘
Noise improvements	-	↗	↘
Engine	↘↘	↗	↗
Total Performance			
Technical issues			
MTOW Ref 2014: 93.5t	82.7t		
Total impacts	CO_2	NO_x	NOISE
avg %Reduction vs Ref2014 Iso Pax sizing	-27%	-11%	TO ~ +2.2db AP ~ -3,4db

TO : Take-Off
AP : Approach / Certification ICAO annex 16 conditions

CLEAN



1st Assessment
2nd Assessment
2020
2024
SMR++ platform
SMR+ platform
SMR++ v1
Pusher CROR layout
Initial vision for 2035+,
based on 2018 techno status
CROR layout GEN2
2 possible paths under
joint airframer/OEM
assessment
ORAS layout (front
propeller with stator)
SMR++
final
UHBR-VPF : Integral
drive variable pitch fan
2 possible paths under
joint airframer/OEM
assessment
SMR+ v1
Integral drive UHBR
turbofan
Initial forecast for 2030+,
based on 2015 vision
SMR+ v2
Integral drive UHBR
turbofan
Updated with latest
combustor emissions
technologies
UHBR-ID : Integral drive
turbofan
SMR+
final

Regional TP90

ADVANCED REGIONAL TURBOPROP CONCEPT 90 SEATS

1200 nm (2222km) - Mach 0.56 - 90 PAX – MTOW 32,5 t

EIS TIMEFRAME 2025

Ref. 2014 Resized ATR72

1200 nm - Mach 0.56 - 90 PAX – MTOW 35.6 t

Techno benefits vs Platforms	ADV TP 90 2019		
PERFORMANCE	SFC	Mass	Drag
Aerodynamics	-	↗	↘
Structure	-	↘	-
Systems	↘	-	-
Noise improvements	-	-	↘↘
Engine	↘↘	↘	-
Total Performance			
Technical issues			
MTOW Ref 2014: 35.6t	32.5t		
Total impacts avg %Reduction vs Ref2014 Iso Pax sizing	CO_2	NO_X	NOISE
	-34%	-67%	CHAP14 - 15 epnDB

Regional TP130

INNOVATIVE REGIONAL TURBOPROP CONCEPT 130 SEATS

1600 nm (2963km) - Mach 0.62 - 130 PAX – MTOW 51 t

EIS TIMEFRAME 2035

Ref. 2014 Ex Bombardier CS-300

3300 nm - Mach 0.78 - 130 PAX – MTOW 67.5 t

Techno benefits vs Platforms	ADV TP 130 2019		
PERFORMANCE	SFC	Mass	Drag
Aerodynamics	-	↗	↘
Structure	-	↘	-
Systems	↘	-	-
Noise improvements	-	-	↘
Engine	↘↘	↘	-
Total Performance			
Technical issues			
MTOW Ref 2014: 67.5t	51.0t		
Total impacts avg %Reduction vs Ref2014 Iso Pax sizing	CO_2	NO_X	NOISE
	-26%	-56%	CHAP14 -9 epnDB

CLEAN AVIATION

Interim Results (2020) at Mission Level

Category	Seats	Concept Aircraft					Clean Sky 2 Environmental Goals			EIS* Window	Clean Sky 2 1st Assessment Results			TRL Target** @ CS2 close
		Concept Vehicle		Range nm	Cruise speed	# PAX	ΔCO_2	ΔNO_x	Δ Noise		ΔCO_2	ΔNO_x	Δ Noise	
SAT-FRC-BJ	0-19	19 PAX Commuter		300	0.34 Ma	19	-20%	-20%	-20%	2025	-21%	-27%	> -20%	4-5
		Low Sweep Business Jet		2900	0.78 Ma	12	> -30%	> -30%	> -30%	2035	-31%	-28%	-50%	≥ 4
		Airbus Helicopters Compound (RACER)		<350	220 kTAS	12	-20%	-20%	-20%	2030	+2 to +17%(4)	-24 to -36%	-16%	6
Regional (Extra-Small)	20-100	Leonardo Helicopters Tiltrotor (NGCTR)		<1000	250 kTAS	24	-50%	-14%	-30%	2030	-50 to -71%(5)	-12 to -50%	-86%	6
		Regional Multi Mission Turboprop 70 PAX	Transport Airline	1000	0.5 Ma	70	-20 to -30%	-20 to -30%	-20 to -30%	2025+	-20%	-59%	-20%	6
			Transport Freighter	1000	0.5 Ma	n/a								
			Search And Rescue (SAR)	400	0.5 Ma	15-25								
		Advanced Turboprop 90 PAX		1200	0.56 Ma at 20 kft	90	-19 to -25%	-19 to -25%	-20 to -30%	2025+	-34%	-67%	-68%	5
Small	101-210	Innovative Turboprop 130 PAX		1600	0.62 Ma at 30 kft	130	-35 to -40%	> -50%	-60 to -70%	2035+	-26%	-56%	-25%	4
		Advanced Short-Medium Range SMR+		2000	0.78 Ma	200	-20%	-20%	-20%	2030	-17%	-39%	-20%	5
		Ultra-Advanced Short-Medium Range SMR++		2000	0.75 Ma	200	-30%	-30%	-30%	2035+	-26%	-8%(3)	<-30%	4
Large - Medium	>300 / 211-300	Advanced Long Range LR+		6700	0.85 Ma	315	-20%	-20%	-20%	2035+	-13%(1)	-38%	<-20%	4
		Ultra-Advanced Long Range LR++		6700	0.85 Ma	315	-30%	-30%	-30%	2035+	-21%(2)	-45%(2)	n.a.	3

Not yet modelled

(*) LR+ CO2 reduction (-13%) is made versus the A350-900 as reference aircraft, EIS 2015, a very highly optimized platform.

(**) LR++ engineering assumption of an additional -8% on CO2 reduction and -7% on NOx reduction versus LR+ concept. LR++ not yet modelled.

(***) SMR++ (-8% NOx) as CROR core engine model does not yet include low NOx combustor technology, unlike SMR+ model (-39%).

n.a. - not yet available

n/a - not applicable

Key Messages

Substantial progress has already been achieved !

Most of the concepts **achieve or exceed their targets.**

FRC results preliminary: Issue of reference vehicle.

The Clean Sky 2 Programme is well on-track.

ENVIRONMENTAL IMPACT

AIRPORT LEVEL

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Airport Level Assessment

Noise impacts were estimated by comparing the noise performance of future airport-traffic scenarios with and without CS2 technologies in the year 2050 for the above mentioned airports. ***The reductions for 2050 in surface area of Lden contours for relevant noise levels (60-65 dB(A)) are about 10-15%*** (Figure 56).

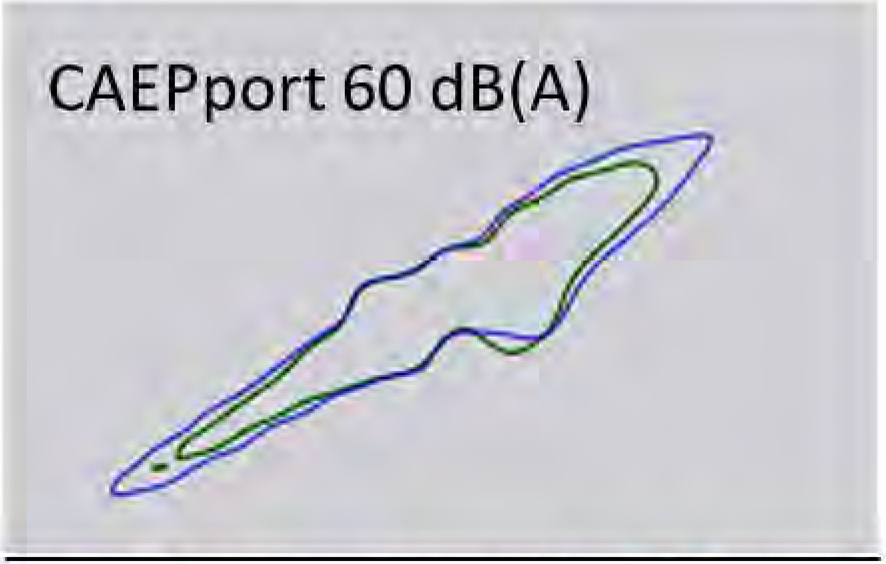


Figure 56 - Surface area reduction for 60 dB noise level.

Key Messages

For the same noise levels (i.e. 60-65 dB(A) Lden) the noise results also highlight ***significant reductions in 2050 of population exposed and population highly annoyed, i.e. in the range of 10-25%.***

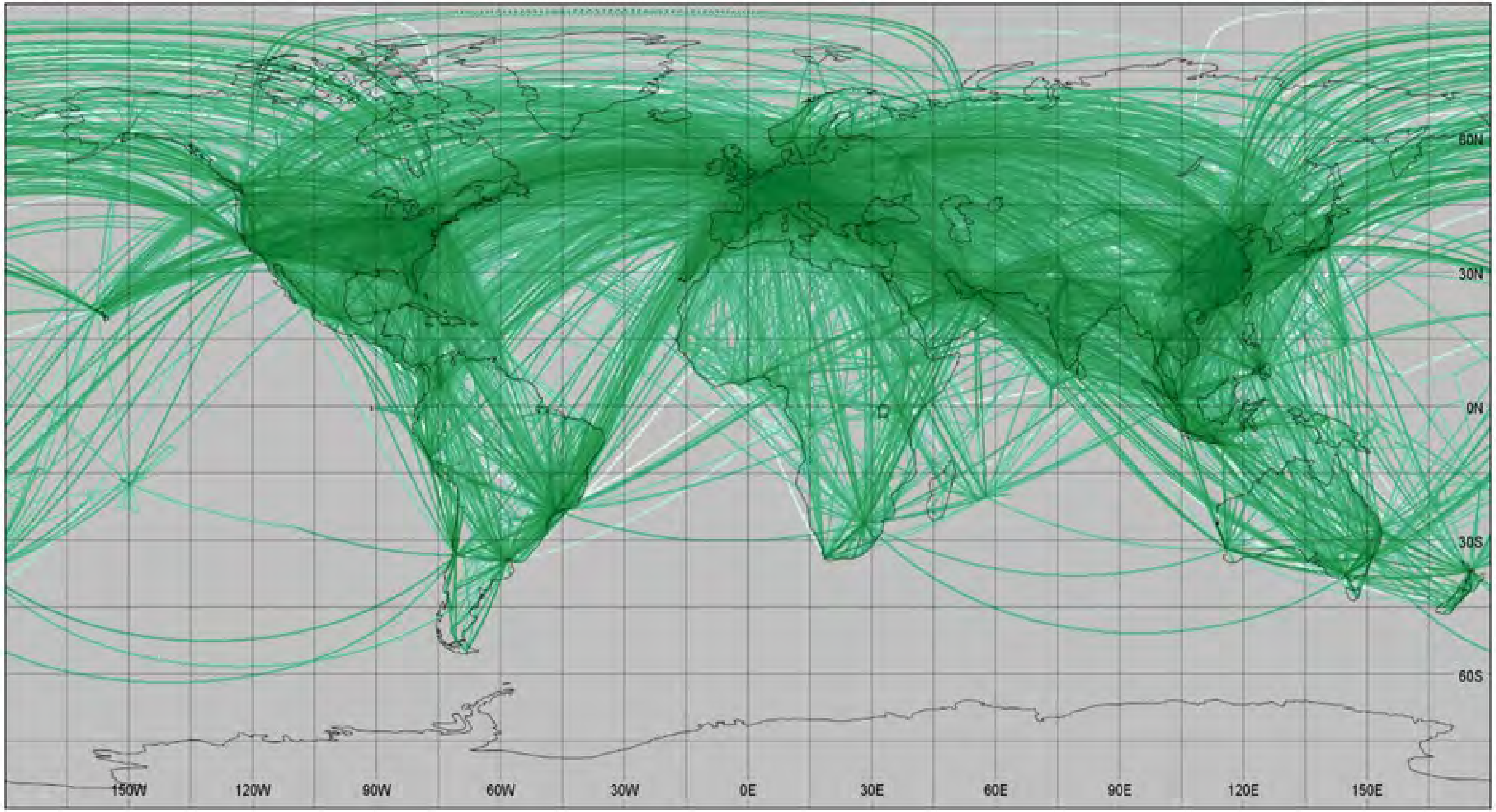
In 2050, ***reductions of CO_2 emissions amount to about 8-13.5% for the European airports considered, while the associated NO_x reductions are roughly in the range 6.5-10.5%.***

ENVIRONMENTAL IMPACT

FLEET LEVEL

Fleet Level Assessment (ATS)

2050 Clean Sky high scenario traffic network



Fleet Replacement

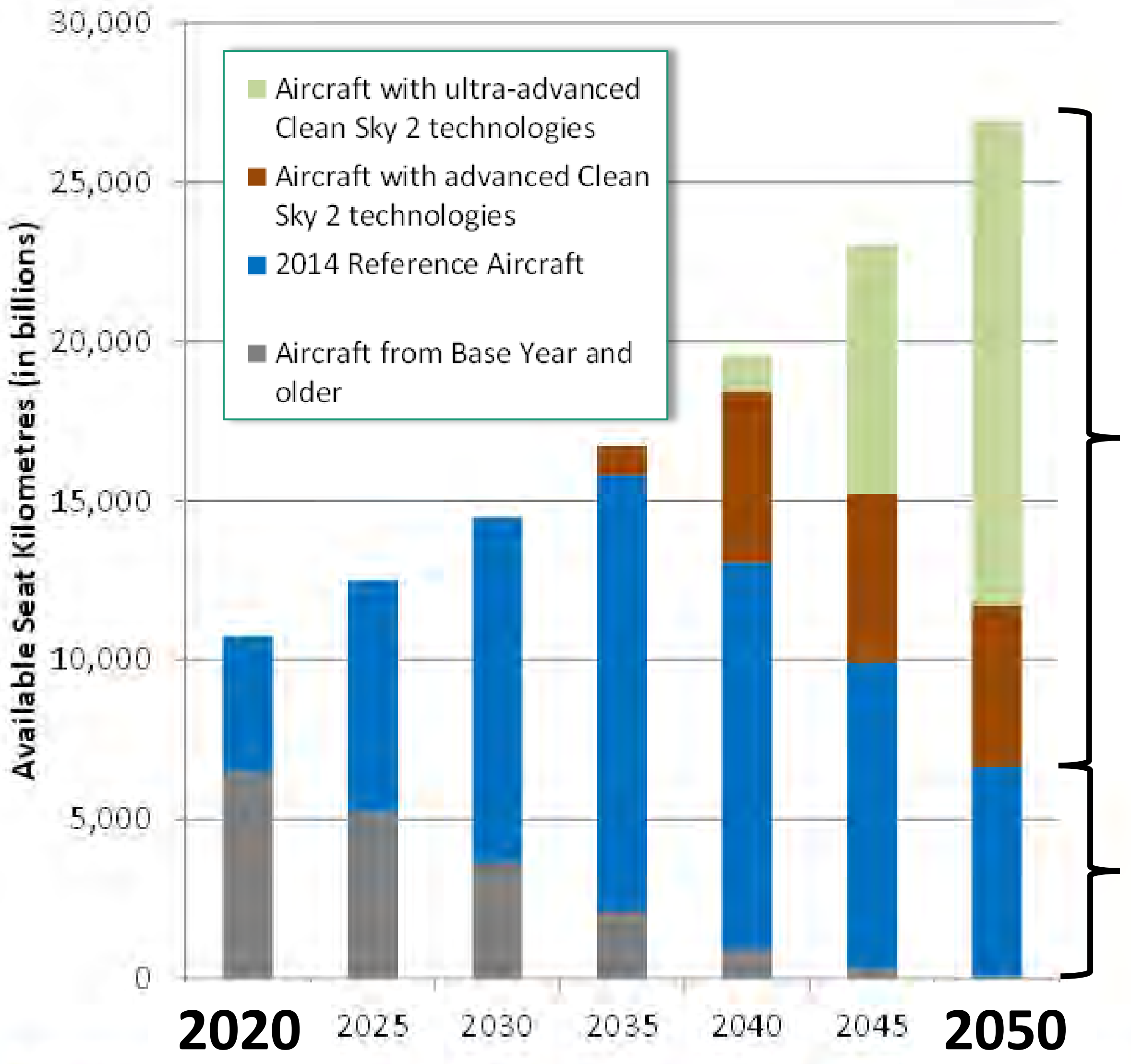


Figure 57 - Evolution of fleet replacement by CS2 aircraft up to 2050.

75%* (70%) of Fleet replaced by CS2 a/c by 2050 :

→ -15% (14%) CO_2 reduction/ASK

-31% (29%) NOx reduction/ASK

25%* (30%) of Fleet still SoA 2014 aircraft.

***High (Low) Scenarios**

Key Messages

*it is crucial to target the **earliest entry into service** date for the next generation of aircraft*.

*urgent need to **accelerate the technology maturation** process by promoting and supporting research investments, in order to **"skip a generation"***

Towards Larger Aircraft …

Key Message

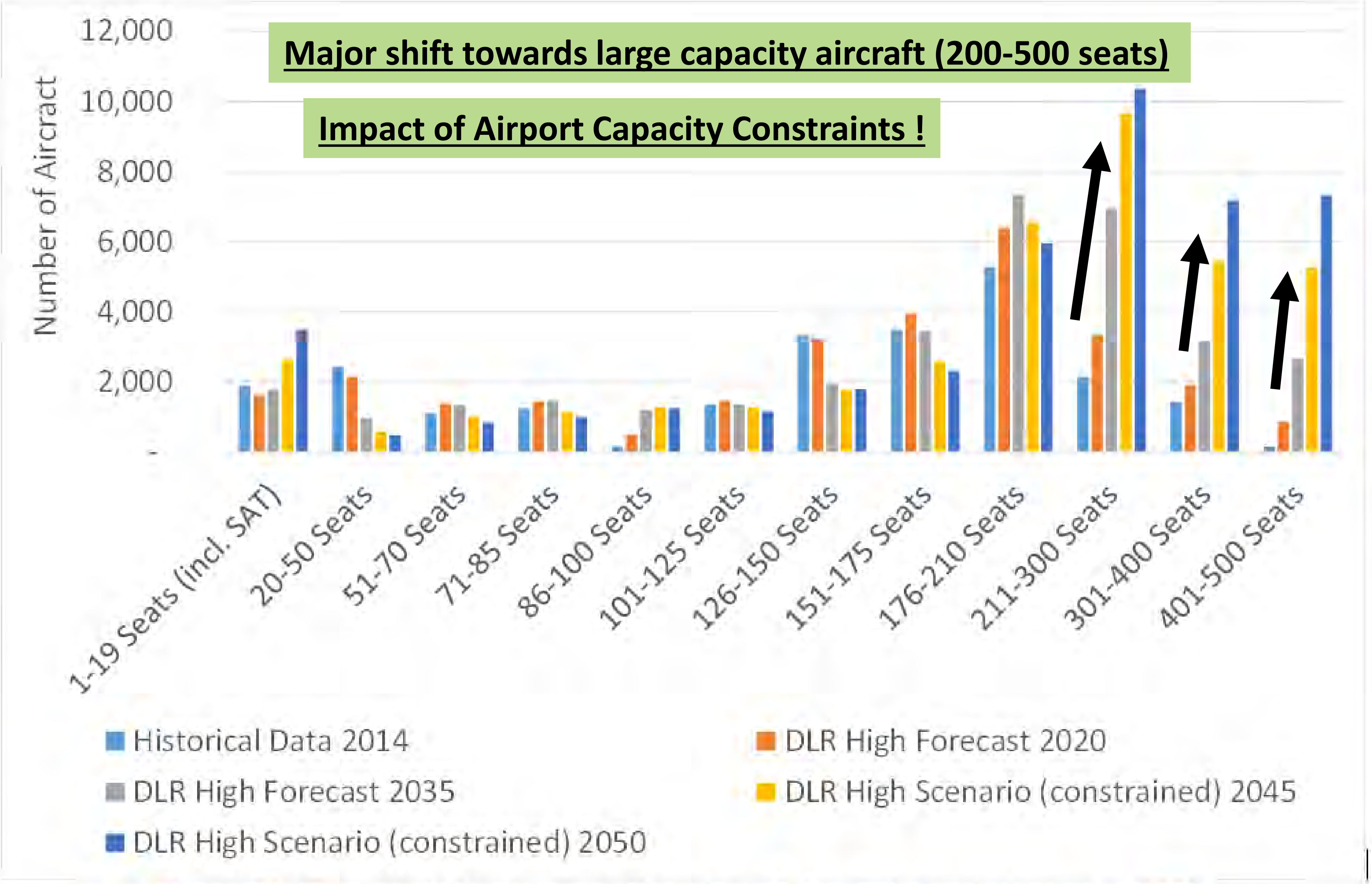


Figure 59 - Fleet evolution in terms of number of aircraft by seat class up to 2050.

Towards Shorter Range …

Today …

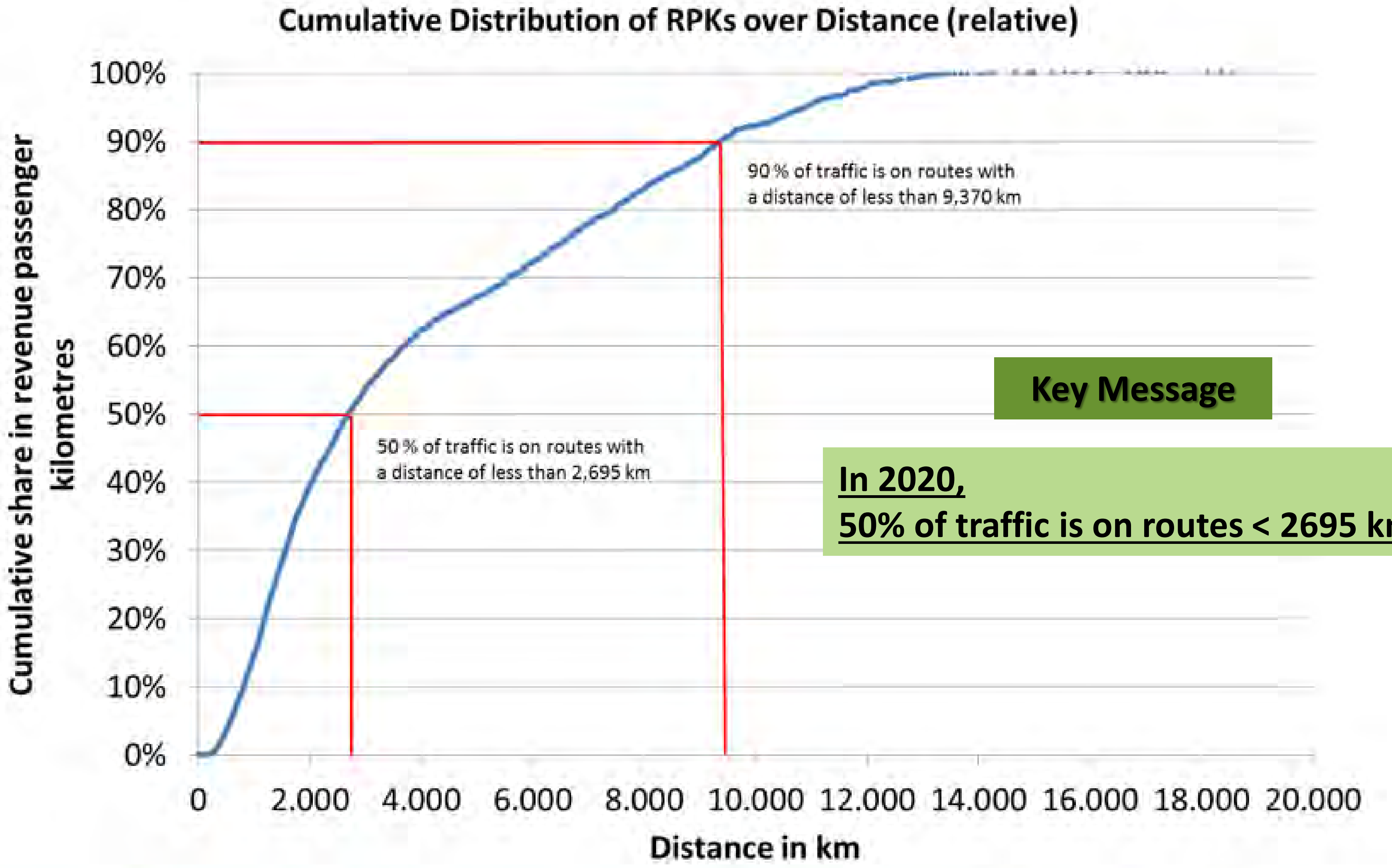


Figure 61 – Cumulative distribution of RPKs versus distance flown (Sabre Market Intelligence).

Key Message

<u>In 2020,</u>
<u>50% of traffic is on routes < 2695 km.</u>

		Flight Distance (km)													
Aircraft Class	Seats	0-1000	1000-2000	2000-3000	3000-4000	4000-5000	5000-6000	6000-7000	7000-8000	8000-9000	9000-10000	>10000	CO2	Flights	Passenger-km
Commuter	0-19												0,08%	2,0%	0,03%
Extra-Small	20-100												4,3%	23,1%	3,6%
Small	101-210												37,3%	58,9%	41,9%
Medium	211-300												25,6%	10,3%	24,5%
Large	>300												32,7%	5,6%	29,9%
CO2		17%	22%	12%	8%	5%	5%	6%	5%	5%	5%	9%	Share of total in 2020		
Flights		55%	28%	9%	3%	1%	1%	1%	1%	0%	0%	1%			
Passenger-km		15%	25%	14%	9%	5%	5%	6%	5%	5%	5%	8%	**2020**		

		Flight Distance (km)													
Aircraft Class	Seats	0-1000	1000-2000	2000-3000	3000-4000	4000-5000	5000-6000	6000-7000	7000-8000	8000-9000	9000-10000	>10000	CO2	Flights	Passenger-km
Commuter	0-19												0,04%	1,5%	0,01%
Extra-Small	20-100												1,1%	9,6%	0,8%
Small	101-210												11,7%	33,7%	12,3%
Medium	211-300												26,8%	28,1%	22,0%
Large	>300												60,3%	27,2%	64,8%
CO2		19%	26%	14%	8%	4%	5%	5%	4%	4%	4%	6%	Share of total in 2050		
Flights		54%	28%	8%	3%	1%	1%	1%	1%	1%	1%	1%			
Passenger-km		15%	25%	14%	9%	5%	5%	6%	5%	5%	5%	8%	**2050**		

Share of total flights

0%	0%-0.1%	0.1%-2%	2%-5%	5%-10%	10%-20%	20%-30%

Key Message

In 2050,
Flight Volumes are shifted
- **To large seat classes**
- **On short routes < 3000 km**

AIR TRAFFIC CARBON EMISSIONS IN 2050

-CO_2

*In 2050, more than 55% of CO_2 emissions will come from medium and large aircraft **on short-medium haul flights** (<4000km). **These two aircraft categories will account for about 55% of flights, compared to 15% in 2020.***

Aircraft Class	Seats	Flight Distance (km): 0-1000	1000-2000	2000-3000	3000-4000	4000-5000	5000-6000	6000-7000	7000-8000	8000-9000	9000-10000	>10000	CO2	Flights	Passenger-km
Commuter	0-19												0,08%	2,0%	0,03%
Extra-Small	20-100												4,3%	23,9%	3,6%
Small	101-210												37,3%	58,3%	41,9%
Medium	211-300												25,6%	10,2%	24,5%
Large	>300												32,7%	5,6%	29,9%
CO_2		17%	22%	12%	8%	5%	5%	6%	5%	5%	5%	9%			
Flights		55%	28%	9%	3%	1%	1%	1%	1%	0%	0%	1%	Share of total in 2020		
Passenger-km		15%	25%	14%	9%	5%	5%	6%	5%	5%	5%	8%	**2020**		

Aircraft Class	Seats	Flight Distance (km): 0-1000	1000-2000	2000-3000	3000-4000	4000-5000	5000-6000	6000-7000	7000-8000	8000-9000	9000-10000	>10000	CO2	Flights	Passenger-km
Commuter	0-19												0,04%	1,5%	0,01%
Extra-Small	20-100												1,1%	9,6%	0,8%
Small	101-210												11,7%	33,7%	12,3%
Medium	211-300												26,8%	28,1%	22,0%
Large	>300												60,3%	27,2%	64,8%
CO_2		19%	26%	14%	8%	4%	5%	5%	4%	4%	4%	6%			
Flights		54%	28%	8%	3%	1%	1%	1%	1%	1%	1%	1%	Share of total in 2050		
Passenger-km		15%	25%	14%	9%	5%	5%	6%	5%	5%	5%	8%	**2050**		

Share of total CO2 emissions: 0% | 0%-0.1% | 0.1%-2% | 2%-5% | 5%-10% | 10%-15%

Key Message

In 2050,
CO2 emissions are shifted
- **To large seat classes**
- **On short routes < 3000 km/4000km**

A VERITABLE "SKY-BUS" "People Mover"

Like the famous London double-deckers, high passenger capacity will be key to responding to air traffic demand in the future, especially on short-haul routes (<4,000km). As a result of airport capacity constraints, a veritable "aerial autobus" of large capacity will be required to move passengers from city to city mostly on intra-continental flights.

Outlook towards 2nd Assessment (2024)

- Overall Timeline, Technology Mapping and Update of Existing Models
  - All SPDs (Mapping) – All Concepts
- New/Updated Reference Vehicles
  - FRC (RACER / NGCTR)
  - BJ
- New Engine and Aircraft Models
  - SAT: Serial Hybrid-Electric Concept + SAT Conv TP (SAFRAN)
  - REG: Reg. 130 pax GTF – MTU (ADORNO)
  - SMR+: New Config. + New engine (VPF)
  - SMR++ update
  - LR++
  - **WB-SR (~500pax - ~3000/4000km) – People Mover**
- New/alternative assumptions for forecast and scenarios (COVID)
- Updated Socio-Economic Impact – See Roland Berger Study.
- Updated Environmental Impact

Take-Away (3)

Technology Evaluator First Global Assessment 2020

FIRST GLOBAL ASSESSMENT RESULTS – 2020

MISSION LEVEL ASSESSMENT			
CONCEPT MODEL	$-CO_2$	$-NO_x$	NOISE
Long Range	-13%	-38%	< -20%
Short-Medium Range	-17% to -26%	-8% to -39%	-20% to -30%
Regional	-20% to -34%	-56% to -67%	-20% to -68%
Commuter and Business Jet	-21% to -31%	-27% to -28%	-20% to -50%
AIRPORT LEVEL ASSESSMENT			
	$-CO_2$	$-NO_x$	NOISE AREA
Airport Level	-8% to -13.5%	-6.5% to -10.5%	-10% to -15%
FLEET LEVEL ASSESSMENT			
	$-CO_2$	$-NO_x$	FLEET RENEWAL
Global Fleet Level	-14% to -15%	-29% to -31%	70% to 75%**

** Percentage of aircraft replaced by Clean Sky 2 technology aircraft concepts by 2050

CLEAN AVIATION

Skip-a-Generation !

- **Clean Sky 2 is well on-track >** Substantial Progress already made
- **Keep pushing the envelope >** 'traditional' aeronautical sciences
- Non-traditional sciences > **key enablers**
- **Replacing ~75% of the global** fleet by 2050
- **Simulation, digital twin** and **innovative certification**
- **Life-cycle aspects** and recyclability

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