#### **Quantitative Assessment of Technology Impact on Aviation Fuel Efficiency**

Knowledge for Tomorrow

IATA's Technology Roadmap update with current manufacturers' calendar for new aircraft entry into service

Peter Nolte (DLR) Arno Apffelstaedt, Volker Gollnick (DLR) Thomas Rötger (IATA)

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#### Outline

- The IATA TERESA project
  - Review (Phase I and II)
    - Subject matter experts technology assessment (qualitative)
    - Quantitative technology assessment process (quantitative)
    - Comparison of the two approaches
- Technology Roadmap Update (Phase III)
  - World fleet modeling
  - Technology Roadmap Update
- Summary and Conclusion

(TERESA: Technology Roadmap for Environmentally Sustainable Aviation)



## The IATA TERESA Project Review

- 2007: Vision of a carbon emission free aviation
- 2008: Introduction of a four-pillar strategy (technology, operations, infrastructure, and economic measures) start of the TERESA project focusing on the technology sector with the four technology fields:



- 2009: Publication of the Technology Roadmap and Annex





#### The IATA TERESA Project Review – cont'd

- 2009: A global approach to reducing aviation emissions commitment to a set of high level goals



- Carbon neutral growth from 2020 on
- . An average improvement in fuel efficiency of 1,5% per year from 2009 to 2020
- 3. a reduction in  $CO_2$  emissions of 50% by 2050 relative to 2005 levels



#### The IATA TERESA Project The Phases I to III





#### The IATA TERESA Project Comparison of qualitative and quantitative approach

# Baseline 2005 Retrofit Modifications Before 2020 After 2020

#### **Qualitative Assessment**



#### **Quantitative Assessment**

	Qualitative		Quantitative	
	Min	Max	Min	Max
Baseline	0%	-1,5%	0%	-1,5%
Retrofit	-7%	-13%	-5,9%	-9,5%
Modification	-7%	-18%	-8,5%	-20,4%
Before 2020	-20%	-35%	-23%	-29,4%
After 2020	-25%	-50%	-27,1%	-39,8%



#### - Bottom-up forecast based on year-to-year dynamics





- Major case-specific forecast assumptions for TERESA Phase-III

- World Fleet = Passenger, Airline Service, 50+ Seats
- Base Year = 2006 (Index = 100)
- Information Set: Year End 2011
- Future Retirements: FESG Retirement Curves
- Future Deliveries: According to following schematic





- Fleet in service per technology group 2006-2030 (forecast)



- Current technology keeps dominating the world fleet (current orders meet demand)

Technological uncertainty is relatively small in the next decade

- Yearly deliveries per technology group and seat category 2006-2030





 Market shares (delivery shares) per technology and seat category 2012 – 2030 (forecast)



- Assumptions concerning fuel efficiency improvement of new (fixed) aircraft models

New Technology	Technology Factor	Reference
A320neo/737max/CSeries	0.85	A320/737/CRJ
A350/787	0.8	767/777
747-8	0.85	747-400
MRJ90	0.87	CRJ-900
SU95/ARJ21	1	CRJ-900
MS21/C919	0.9	A320

- Fuel reduction potential for a generic aircraft model (results from TERESA technology studies)





- Technology scenarios: assumptions on yearly fuel consumption of generic aircraft (representing assumptions on market shares, fuel reduction potential, new aircraft projects and ramp-up times)





- Technology frontier: fuel efficiency of aircraft entering (being delivered to) the world fleet (forecast)





#### - Average fuel efficiency of the entire world fleet (forecast)



## Update (Phase III) From Technology Readiness Level to a timeline

- Technology readiness level maturation timeline



#### **TRL Maturation Timeline**



#### Update (Phase III) When will a new aircraft program enter the market

 Development costs of aircraft programs – new design / redesign (the cost is given per seat)







#### Update (Phase III) When will a new aircraft program enter the market

 development costs of aircraft programs – new design / redesign (the cost is given per seat / built)



Development Cost Per Seat Built for different Aircraft Programs

#### **Summary & Conclusion**

- Next generation aircraft projects (B787, A350, A320neo) being already technologically frozen and demand being nearly fully saturated (due to fixed orders) the focus on new technologies can only be on aircraft projects with market entry dates
  - Beyond 2020 (for the medium sized aircraft)
  - Beyond 2030 (for the large to very-large aircraft)
- Considering the efficiency improvement gain to development cost ratio, a reengined aircraft can bring surprisingly high total benefits, therefore it is necessary to also pursue research into technologies than can bring benefits without requiring an entire new aircraft model



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#### The END



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