Quantitative Assessment of Technology Impact on Aviation Fuel Efficiency

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

Peter Nolte (DLR)
Arno Apfelstaedt, 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

1. Carbon neutral growth from 2020 on
2. An average improvement in fuel efficiency of 1,5% per year from 2009 to 2020
3. a reduction in CO₂ emissions of 50% by 2050 relative to 2005 levels
The IATA TERESA Project
The Phases I to III

TERESA

Phase 1
Subject Matter Expert - Environment
(2008)

Phase 2
Physics – Based Environment
(2009 - 2010)

Phase 3
Model Impact on Worldfleet
(2011)
The IATA TERESA Project
Comparison of qualitative and quantitative approach

<table>
<thead>
<tr>
<th></th>
<th>Qualitative</th>
<th>Quantitative</th>
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<tbody>
<tr>
<td></td>
<td>Min</td>
<td>Max</td>
</tr>
<tr>
<td>Baseline</td>
<td>0%</td>
<td>-1,5%</td>
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<tr>
<td>Retrofit</td>
<td>-7%</td>
<td>-13%</td>
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<tr>
<td>Modifications</td>
<td>-7%</td>
<td>-18%</td>
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<tr>
<td>Before 2020</td>
<td>-20%</td>
<td>-35%</td>
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<tr>
<td>After 2020</td>
<td>-25%</td>
<td>-50%</td>
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</table>
Update (Phase III)
World Fleet Modeling

- Bottom-up forecast based on year-to-year dynamics
Update (Phase III)
World Fleet Modeling
- 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

1. Orderbook
   - Seats on Order from Fixed Orders at Year End 2011
   - Specific Make & Model (e.g. A320Neo)
   - ASCEND Fleet Data

2. Traffic Forecast 2030
   - Seats required to satisfy Projected Traffic Growth
   - Generic Aircraft with average Seats per A/C
   - IATA + FESG (2006)

3. Final Forecast
   - Seats delivered:
   - Fixed Orders enter as projected
   - Gap to Projected Traffic Growth is filled with Generic Aircraft
   - On Seat Category Basis
Update (Phase III)
World Fleet Modeling

- 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
Update (Phase III)
World Fleet Modeling

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

- Market shares (delivery shares) per technology and seat category 2012 – 2030 (forecast)
Update (Phase III)
World Fleet Modeling

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

<table>
<thead>
<tr>
<th>New Technology</th>
<th>Technology Factor</th>
<th>Reference</th>
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<tr>
<td>A320neo/737max/CSeries</td>
<td>0.85</td>
<td>A320/737/CRJ</td>
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<tr>
<td>A350/787</td>
<td>0.8</td>
<td>767/777</td>
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<tr>
<td>747-8</td>
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<td>CRJ-900</td>
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<tr>
<td>MS21/C919</td>
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<td>A320</td>
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</table>

- Fuel reduction potential for a generic aircraft model (results from TERESA technology studies)
Update (Phase III)
World Fleet Modeling

- 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)
Update (Phase III)
World Fleet Modeling

- Technology frontier: fuel efficiency of aircraft entering (being delivered to) the world fleet (forecast)
Update (Phase III)
World Fleet Modeling

- 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**

Years to Maturity

Current TRL

- airframe technologies
- engine technologies
- flight control (aircraft based)
- flight control (ground based)
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)
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
The END
Acknowledgements

- Our strategic collaboration partner

- Our sponsor