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EU Transport GHG: Routes to 2050?

Technical options for aviation

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Partners

www.eutransportghg2050.eu



Overview of presentation

1. Introduction to the presentation
2. Technical options for aviation
3. Alternative fuels for aviation
4. Conclusions/discussion/questions

Introduction to the Presentation

- Based on:
 - Paper 2 – Alternative Energy carriers and Powertrains to reduce GHG emissions from transport (Nik Hill, et al, incl Tom Hazeldine)
 - Paper 3 - Technical options to reduce GHG emissions for non-road transport modes (Tom Hazeldine et al, inc. Huib van Essen)
- Presentation is based on draft findings set out in the papers
- Aim of subsequent discussion is to:
 - Agree what we know and do not know
 - Identify any omissions in our information/sources
 - Review the conclusions that are emerging

Technical options for aviation: Overview

- 'Adjustments' to current aircraft design
 - Turboprops
 - Advanced aircraft materials
 - Improved aircraft design (e.g. winglets, riblets, improved shaping)
- 'New' aircraft design
 - Blended wing-body (e.g. Flying Wing aircraft concept)
 - Pro green aircraft
 - Wing-in-ground effect vehicles
- Something different.....
 - Airships



‘Adjustments’ to existing aircraft designs (1)

- Open rotors/turboprops
 - 25-30% reduction, concept designs, in use by 2015-2020? (SBAC, 2008)
 - Can only be applied to certain aircraft types
 - Noise and NOx benefits too (Easyjet ecojet)



- Advanced aircraft materials
 - Options includes composites, metal alloys, ceramics, nano- and smart materials
 - Ongoing research
 - Emissions reduction varies but composites give up to 20% reduction
 - Cost an issue at present
 - Generally longer-term options, i.e. post 2020 at least

‘Adjustments’ to existing aircraft designs (2)

Improved aircraft design:

- **Winglets:**
 - Currently being introduced
 - 4-6% reduction (Flight Global, 2008)
 - Concerns over long term performance (Marks, 2009)
- **Electric aircraft systems:**
 - 3-5%, at the research and development stage
- **Riblets:**
 - Micro-grooves on aircraft that reduce drag
 - 2% but could require increased maintenance
- **Improving laminar flow:**
 - Various additions to an aircraft’s wings and fuselage being explored
 - 10–20%, currently being researched – links to new designs



'New aircraft' designs

- **Blended wing body**
 - 20-30%, minimises skin friction drag
 - Requires a viable market case due to significant costs
- **Pro-green**
 - Aims to achieve a 25% per seat km reduction
 - Uses forward swept wings
- **Wing-in-ground**
 - Flies close to the surface making use of high pressure air caused by aerodynamics at this altitude
 - Information on emission savings not identified
 - Operating height restricted by wingspan
- Long potential timescales for implementation



Alternative approaches: Airships



- Using helium rather than hydrogen?
- Identified as better suited for some trips
- Cargo lifter has been designed, but no successful one has been built

Alternative energy carriers/fuels for aviation: Biofuels

- Need to be of a type that require no aircraft modifications
- Short-medium term viable options: Biofuel produced from hydrotreated vegetable oil (HVO) and synthetic kerosene from Biomass-to-liquid (BtL) processes
- Long-term potential: Uncertain, as depends on competing demands and development of new feedstocks
- Potentially significant GHG reductions
- Some industry stakeholders believe: 30% take up of biofuels by 2030 needed to meet industry's longer-term CO2 reduction targets
- Number of ongoing industry initiatives to accelerate commercialisation of biofuels
- Barriers for BtL: Need to develop cost-effective and sustainable supply; high capital costs of plants – HVO more viable short-term option
- Issue: How demand for aviation biofuel will impact on/by demand in other sectors

Source: (AEA, 2009)

Alternative energy carriers/fuels for aviation: Other

- **CNG and LPG:** Not suitable as too low energy density
- **Pure electric aircraft:** No information identified
- **Hydrogen fuel cells:** Some interest (e.g. by NASA), but many barriers, including:
 - Need for large storage tanks (due to low density of H₂)
 - Need for a heavier power system
 - Stringent safety requirements to satisfy

Conclusions

Short term (i.e. existing aircraft), i.e. pre 2020:

- Winglets: 4-6% reduction
- Riblets: 2%
- Biofuels?

Long term (i.e. new aircraft), i.e. post 2020:

- Open rotors/turboprops: 25-30% reduction
- Advanced aircraft materials (composites): up to 20% reduction
- Electric aircraft systems: 3-5%?
- Laminar flow: 10–20%??
- New designs and airships: As yet, unproven

Conclusions/Discussion/Questions

- In the **short-term**, there appears to be some potential to achieve some GHG reductions – Do you agree?
- If not, where are we wrong in our numbers? Do you have other information?
- In the **longer-term**, there appears to be potential significant savings from open rotors, advanced materials and potentially new concepts – Do you agree?
- If not, where are we wrong in our numbers? Do you have other information?
- What are the key barriers to these (short- and long-term) options?
- There appears to be limited proven, potential for alternative energy carriers/fuels, other than perhaps biofuels – Do you agree?