Reducing Aviation $\text{CO}_2$ Emissions
Challenges and Opportunities

Neil Dickson
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ICAO Basket of Measures

- Aircraft Technology Improvements
- Operational Improvements
- Sustainable Aviation Fuels
- Market-Based Measures (CORSIA)
Key Parameters for Reducing Aviation CO₂ Emissions

Individual to global practices

Potential
- Of each individual measure – 5%, 10%, 30% reduction?

Applicability
- Potential Entry Into Service

Maturity
- CO₂ Reduction Possibility

Fleet Roll-Over
- Does the approach depend on fleet replacement?

Requirements
- For additional infrastructure, regulations, etc.
Aircraft Technologies

Challenges & Opportunities
Advanced Aircraft Technology
Challenges & Opportunities

- Short term (2020-2035), reductions up to 25% or 30% - BUT harder each time!

- More feasible to implement than “Novel” concepts

- High applicability and compatibility

Examples:
- Propulsion: Higher by-pass ratio, GTF, higher turbine temperature
- Aerodynamics: Winglets, foldable wings
- Materials: Additive manufacturing, composites

Images courtesy of Boeing, Airbus
Novel Aircraft Technology

Challenges & Opportunities

**Opportunities**
- Reductions in emissions up to 100%
- Long term reductions
- Also benefits on local air quality

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**Challenges**
- Often require extra infrastructure
- Dependent on life-cycle emissions
- Depend on long fleet roll-over times
- High development costs

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**Examples:**
- Electric/ hybrid propulsion
- Blended wing body – Strut-braced wing
- Hydrogen propulsion

Images courtesies of: EnableH2, Eviation Alice, Airbus
Novel Aircraft Technology Examples

Electric Aircraft

Opportunities
- Long term (>2040)
- Reductions in up to 100%
- Reduction of Local Air Quality pollutants
- Reduced maintenance cost

Challenges
- Availability of clean electrical energy
- Transportation and network
- Storage, battery capacity, lithium availability
- Depend on energy mix
- Applicability very limited by power density
- Infrastructure required

Key energy figure
- Per day, electrification of all flights from YUL would need ~3X the household energy usage of Montreal.

Images courtesies of: Lilium, Alpha electro Pipistrel

Sources: - https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510006001
Novel Aircraft Technology Examples

Electric Aircraft Video

Company: NASA
Presenter name: James Heidmann
Novel Aircraft Technology

Electric Aircraft – Battery specific energy development

- If a cell phone battery had the same specific energy as kerosene (kJ/kg) the battery would last for nearly 2 months without charging! A long way to go to match batteries to Jet-A1!

Hypothetical scenarios, very optimistic

Currently: ~4%

Improvement per year

Energy density required for a commercial aircraft, for a 900NM (~1670 km), 190 passengers

- Start of certification process 5-9 years before EIS
- Potential dates for Electric Aircraft Entry Into Service (EIS)
Novel Aircraft Technology Examples

Electric Aircraft Videos

Company: AMPAIRE
Novel Aircraft Technology Examples

Hydrogen Aircraft

Opportunities
- Long term (>2050)
- Reductions in up to 100%
- Wide applicability: Long and short haul
- High specific energy fuel

Challenges
- Availability of clean hydrogen
- Highly dependent on fleet roll-over
- Large investment & infrastructure required
- Reductions depend on energy mix
- Cost competitiveness

Key energy figures
- Aviation 2019 fuel consumption: ~290 MT
- Hydrogen production 2019: ~120 MT (<1% renewable)
- Hydrogen has 2.8 times more energy per unit mass than aviation fuel. By energy content, the world supply of Hydrogen needs to increase by 80%

*Image courtesy of EnableH2, receiving funding from the European Union Horizon 2020 research and innovation programme

Sources – ATAG; IRENA- Hydrogen a renewable energy perspective
Novel Aircraft Technology Examples

Hydrogen Aircraft Video

Company: **EnableH2**
Presenter name: Bobby Sethi
Sustainable Aviation Fuels

Challenges & Opportunities
Sustainable Aviation Fuels
Challenges & Opportunities

Opportunities

• High emissions reduction potential
• Wide applicability
• No delay due to fleet roll-over
• >240,000 flights already operated

Challenges

• Availability of feedstock
• Environmental sustainability
• Cost competitiveness
• Endorsement of the 2050 ICAO Vision for Sustainable Aviation Fuels
• Calls for a significant proportion of SAF use by 2050
• A quantified long-term goal for SAF to be defined in CAAF/3 (by 2025)
• A Stocktaking process will support the definition of this goal
ICAO stocktaking Results 2019

ICAO Vision has a view to include a quantified proportion of SAF use by 2050.

CAAF/2 encouraged States to develop policies that promote the use of SAF, or promote policies that strive to establish a level playing field between aviation and other transportation sectors on the use of sustainable fuels.
Sustainable Aviation Fuels Examples

Videos

Company : **Neste**

Company : **SAF+**

Presenter name : Jean Paquin
ATM & Aircraft Operations

Challenges & Opportunities
**ATM & Aircraft Operations**

**Challenges & Opportunities**

**Opportunities**
- **Wide** applicability
- **Cost effective** to implement
- **Lower dependency** to fleet roll-over
- **Often Reduced** A/C maintenance cost
- **Route** efficiency

**Challenges**
- **Safety**
- **Regulatory constraints**
- **Constant limitations** (weather, equipment, facilities, military activity, traffic)
- **Site-specific requirements**
- **Limited airport capacity** -> Congestion and delays

**Examples:**
- **Continuous** climb and descend
- **Harmonized** airspace - Direct routing
- **Big data** and AI to optimize operations
ATM & Aircraft Operations Examples

Videos

Company: OpenAirlines
Presenter name: Alexandre Feray

Company: Signol
Presenter name: Daniel White
ATM & Aircraft Operations Examples

- Engine and airframe maintenance (e.g. engine wash)
- Reducing aircraft mass
  - Fuel (tankering)
  - Payload (magazines, seats etc.)
- Reducing engine idling time
- Emission-free taxiing
- Reducing APU operational time (e-GSE)
- Training personnel on emission friendly practices

Source – Indianapolis International Airport
ATM & Aircraft Operations Examples

Videos

Company: Smart Airport Systems
Presenter name: Maxime Mahieu

Company: Airbus
Other Examples
Technologies, Fuels, Operations and beyond

- More videos available on [the Stocktaking Seminar’s webpage](#)
- To submit a new video, please contact [officeenv@icao.int](mailto:officeenv@icao.int)
Conclusions

• Strong synergies

• Long term sustainable solutions

• Holistic approach

• Interdependencies with other sectors
Thank You