

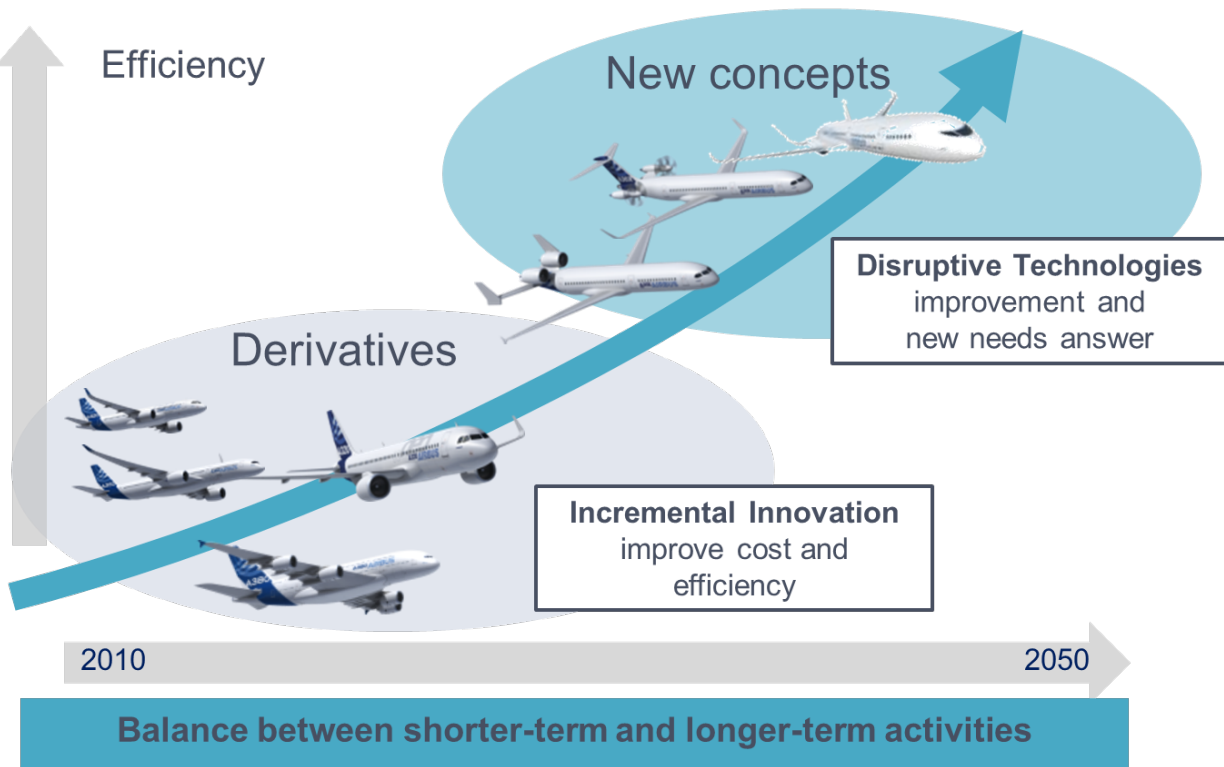
**Michel GUIGOU**

R&T Overall Systems Architect

## **Airbus Research Program**

### **Fuel Cells**

# Airbus R&T general goals and ambitions



- 50/75% CO<sub>2</sub> emission
- 80/90% NO<sub>x</sub> emission
- (in 2020/2050 vs. 2000 level)

**Environmental footprint**

CO<sub>2</sub> : fuel burn in flight  
and on ground

Noise

Banned materials

# Airbus Fuel Cell Strategy – Incremental Development

- $H_2$  consumption
- **Dependency on  $H_2$  infrastructure**



**$H_2$  powered  
GSE**

Inert gas  
Halon alternative

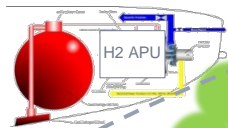


FC emergency  
power

FC in cabin

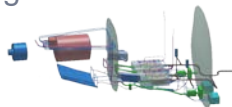
APU

replacement



Continuous power provision

FC for More Elec A/C  
large multi-function FC



Alternative Power  
for electrical A/C

- *FC power level*
- *Impact A/C architecture*

Multifunctional role of Fuel Cells and  $H_2$  will improve the balance of benefits vs. drawbacks

Transition paths:

- Moderate  $\rightarrow$  high or very high power
- Exceptional usage  $\rightarrow$  daily use
- Very low  $H_2$  consumption  $\rightarrow$  high

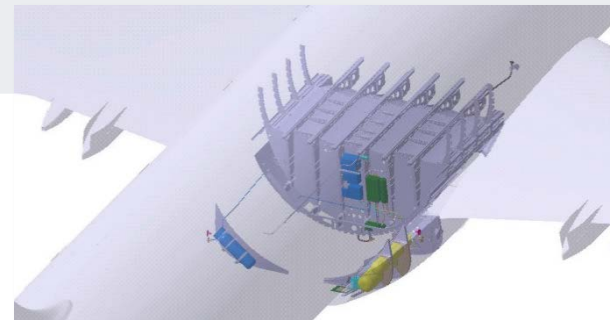
Ground infrastructure at airport is a mandatory enabling factor for large usage of  $H_2$  and Fuel Cells on board

**Development of  $H_2$  powered GSE  
favoured as best opportunity to  
trigger Airport  $H_2$  infrastructure**

# FCEPS+

- *Fuel Cell Emergency Power System*

- Ram Air Turbine Replacement
  - Few dozen kW electrical power
  - Dormant system, Exceptional use, very low H<sub>2</sub> volume, no regular H<sub>2</sub> refuel
- PEM Stacks
- Use of gaseous H<sub>2</sub> and O<sub>2</sub> as fuel
- typical gas storage 1-2 kg H<sub>2</sub>, 3 kg O<sub>2</sub>
- the “*Plus*” feature
  - Usage of Oxygen depleted air (by-product)
  - Cargo Fire suppression function : Halon replacement



- *TRL 5+ for components*
- *TRL 4+ for integrated system*
- *Competitive wrt. weight and recurring costs **vs. Halon-free reference***
- *Challenges:*
  - *Risk vs. Benefit for introduction in production*
  - *Development costs*

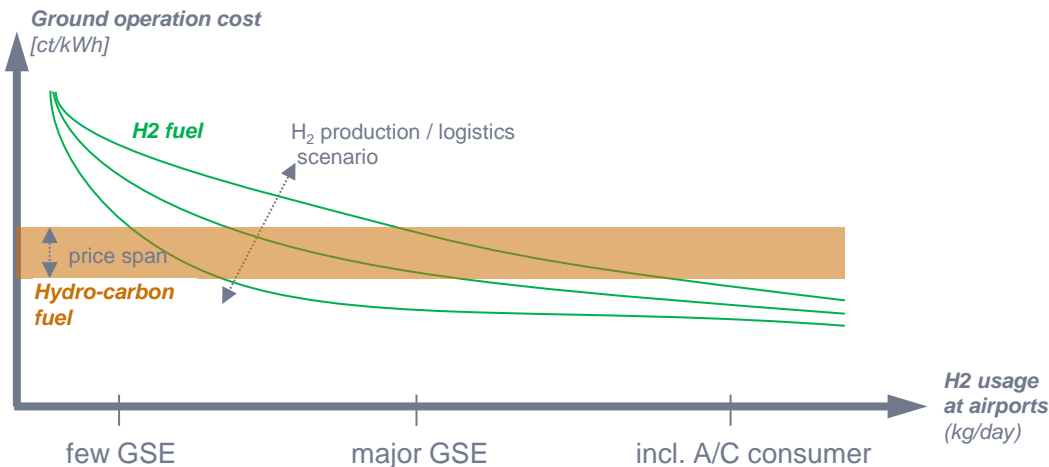
# AIRPORT INFRASTRUCTURE

- Airbus view: H<sub>2</sub> infrastructure build-up will start with ground based consumers at airports
- A/C consumer will be first follower to increase H<sub>2</sub> consumption
- Airbus intends to support H<sub>2</sub> GSE / other consumers at airports to increase H<sub>2</sub> volume



- Enabling elements for increase of ground based H<sub>2</sub> consumption
  1. Availability of GSE and other ground equipment as H<sub>2</sub> fuelled prototype or product
  2. Identification of business case potentials incl. threshold requirements (e.g. min H<sub>2</sub> turn-over)
  3. International projects and cooperation (e.g. European airport demonstration project)
  4. Global Incentives for “green” Airport infrastructures

# Key element: H<sub>2</sub> consumption quantity to drive H<sub>2</sub> cost down



## Questions to be answered:

- What is the most economic H<sub>2</sub> provision for a given volume?
- Quantify GSE based H<sub>2</sub> consumption per airport after GSE conversion.
- Which H<sub>2</sub> price curve can airports expect?

## Example for waved approach:

### Wave 1:

- GPUs
- small tractors
- ...

### Wave 2:

- push-backs tugs
- large tractors
- PAX bus

### Wave 3:

- public consumption
- A/C consumer

H<sub>2</sub> usage  
at airports  
(kg/day)

## Open topics:

- Identify most relevant consumers per airport
- Quantify overall H<sub>2</sub> consumption potential per airport

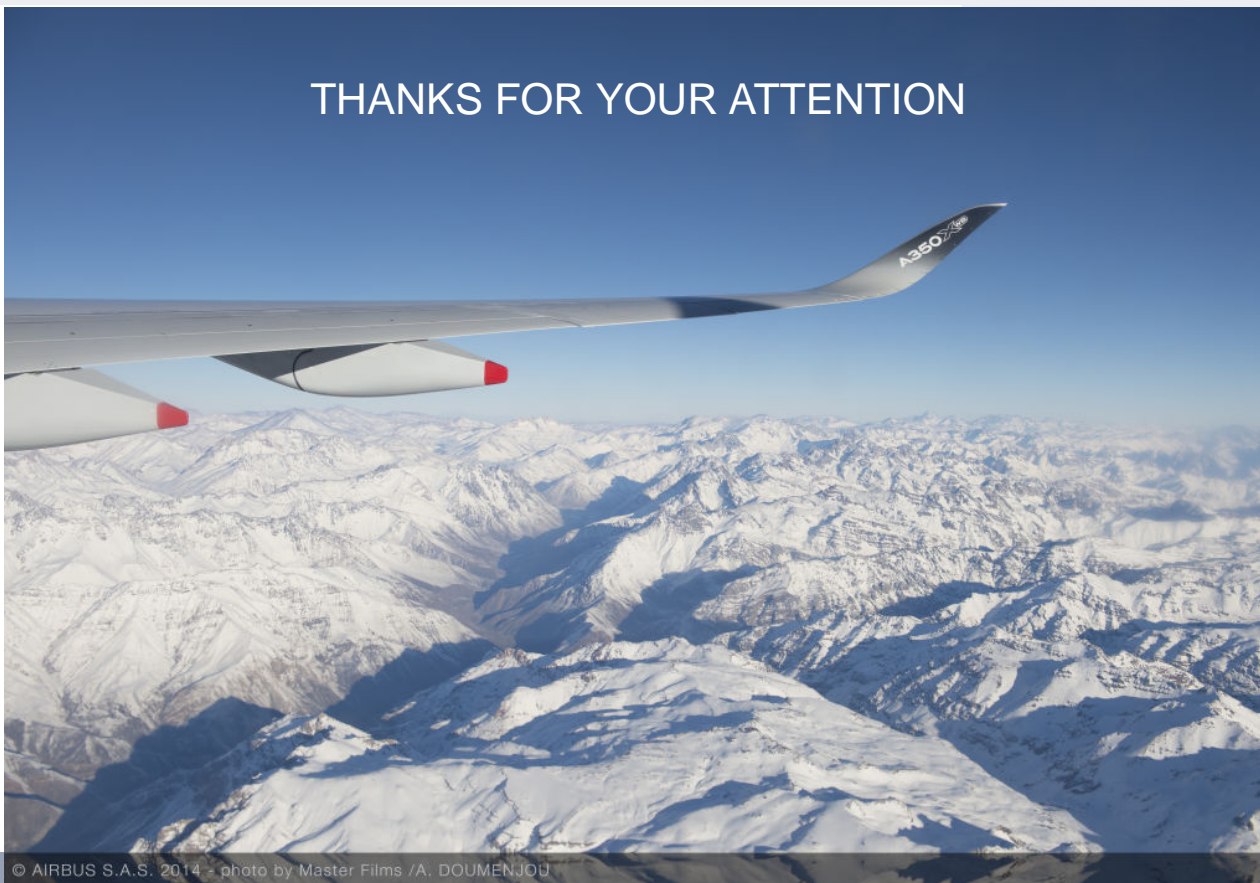
## CONCLUSIONS and “TAKE AWAY”

- Strong and continuing R&T effort in Airbus
- Maturity judged compatible with introduction in service in 2020-2025 window for first types of applications (*without significant ground infrastructure*)
- **Larger and continuous usage of H<sub>2</sub> + FC will request to address firstly the question of Airport infrastructure**
- Several initiatives and projects running and foreseen in Europe .
  - On board technologies , certification, aircraft integration,..
  - Cleansky2 focusing on aircraft-driven questions
- We expect FCH JU support to technology development for Airport infrastructure, involving aerospace and non-aerospace partners ;
  - Airbus motivated to contribute to such initiative at European level



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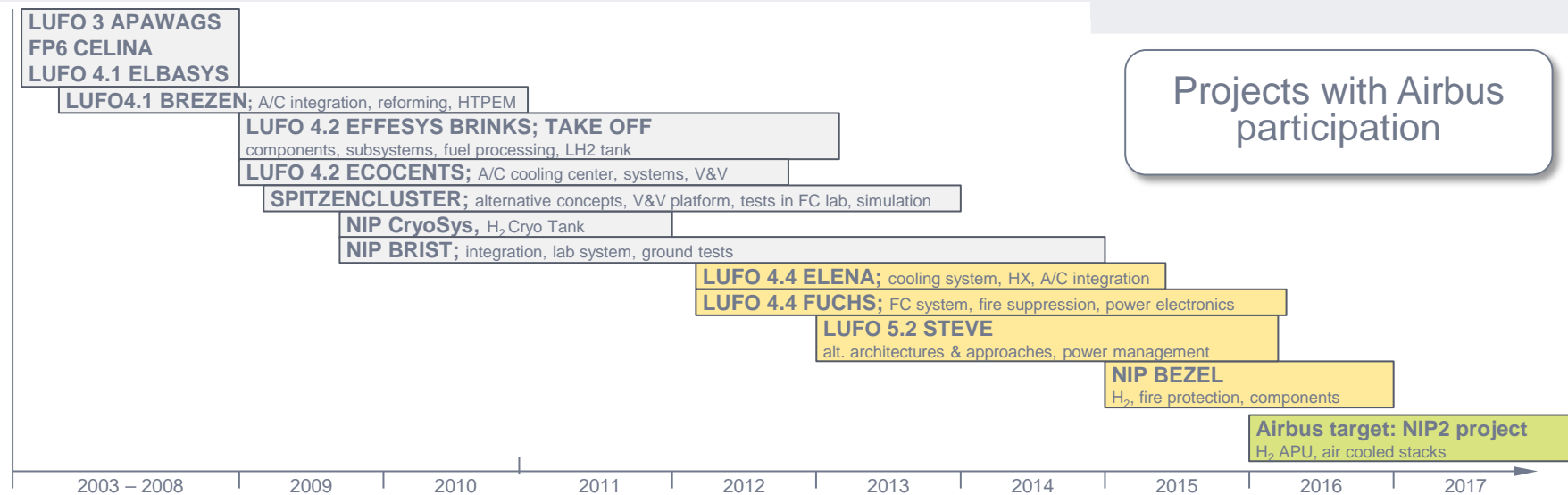
# THANKS FOR YOUR ATTENTION



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# (back up) COLLABORATIVE PROJECTS AND INITIATIVES



- EUROCAE/SAE WG80: international WG to generate industry standard for H<sub>2</sub> & FC safety on A/C
- FAA Aviation Rulemaking Committee (ARC) on Energy Supply Device starts in 09/2015 to generate agreed wording to be incorporated into the FAR 25 certification rules.
- Zodiac HYCARUS project on European level (05/2013 – 04/2016): FC system flight demonstrator for secondary power system
- French industry initiative : “white book” on H<sub>2</sub> and FC under preparation (Air Liquide / Safran / Zodiac / Dassault / Airbus / Air France / Aeroports de Paris) will show the landscape for potential French funded project – coordination at European level welcome