

**Unlocking greater near-term efficiency, while transitioning to the next generation of planes  
“There is no quick fix”**

Melkert, Joris

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# Unlocking greater near-term efficiency, while transitioning to the next generation of planes

“There is no quick fix”



Joris Melkert  
Faculty of Aerospace Engineering

# Spot the differences



1967



1987



2017

# Content

- Snowball effect in aviation
- Developments so far
- Electric aircraft
- Alternative fuels
- New configurations
- Conclusion

# Snowball effect in aviation

1 kg more mass

-> 1 kg more lift required

lift is not for free -> more aerodynamic drag

more drag -> more thrust

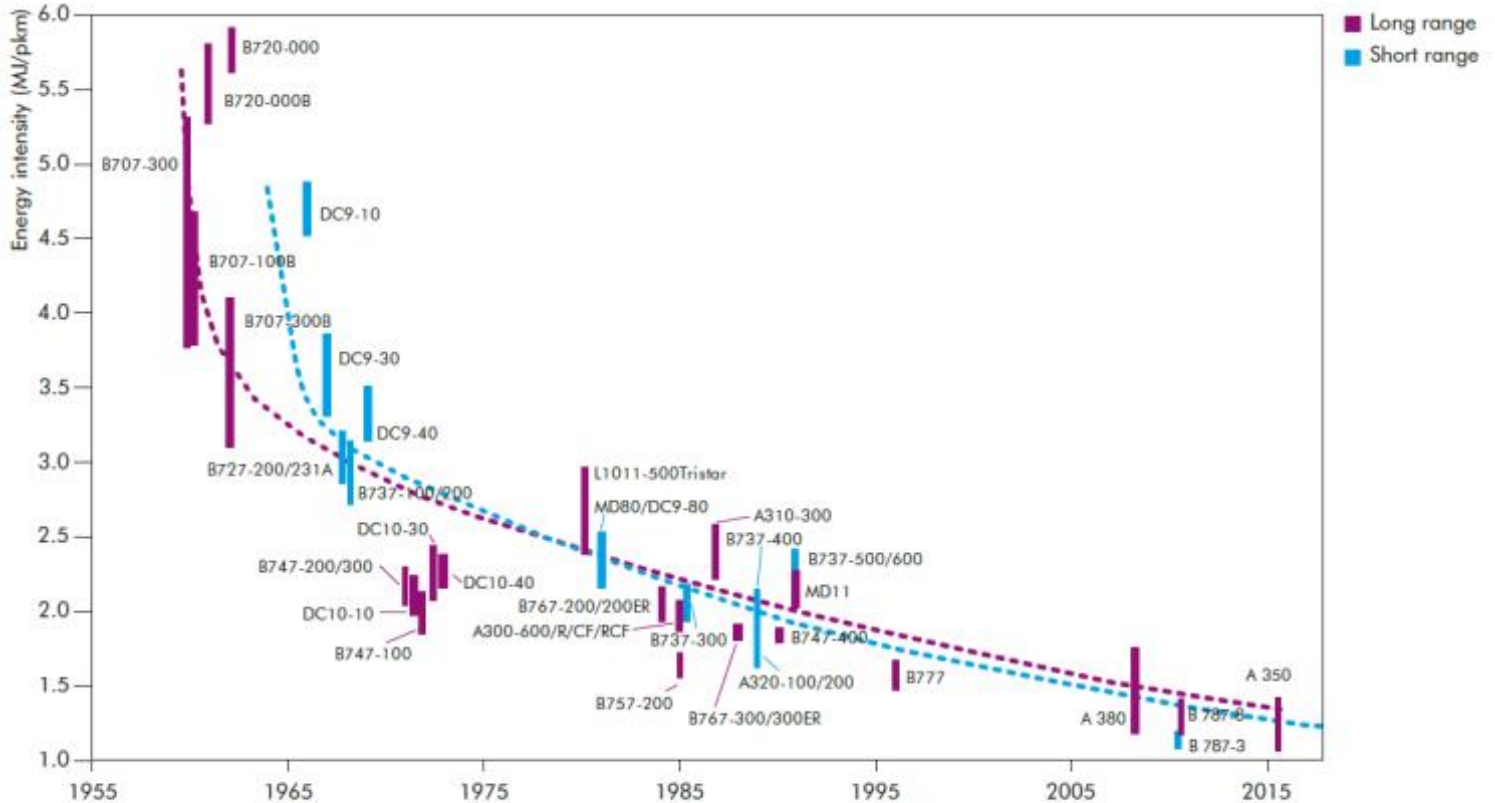
more thrust -> bigger engines

-> more fuel

-> more mass



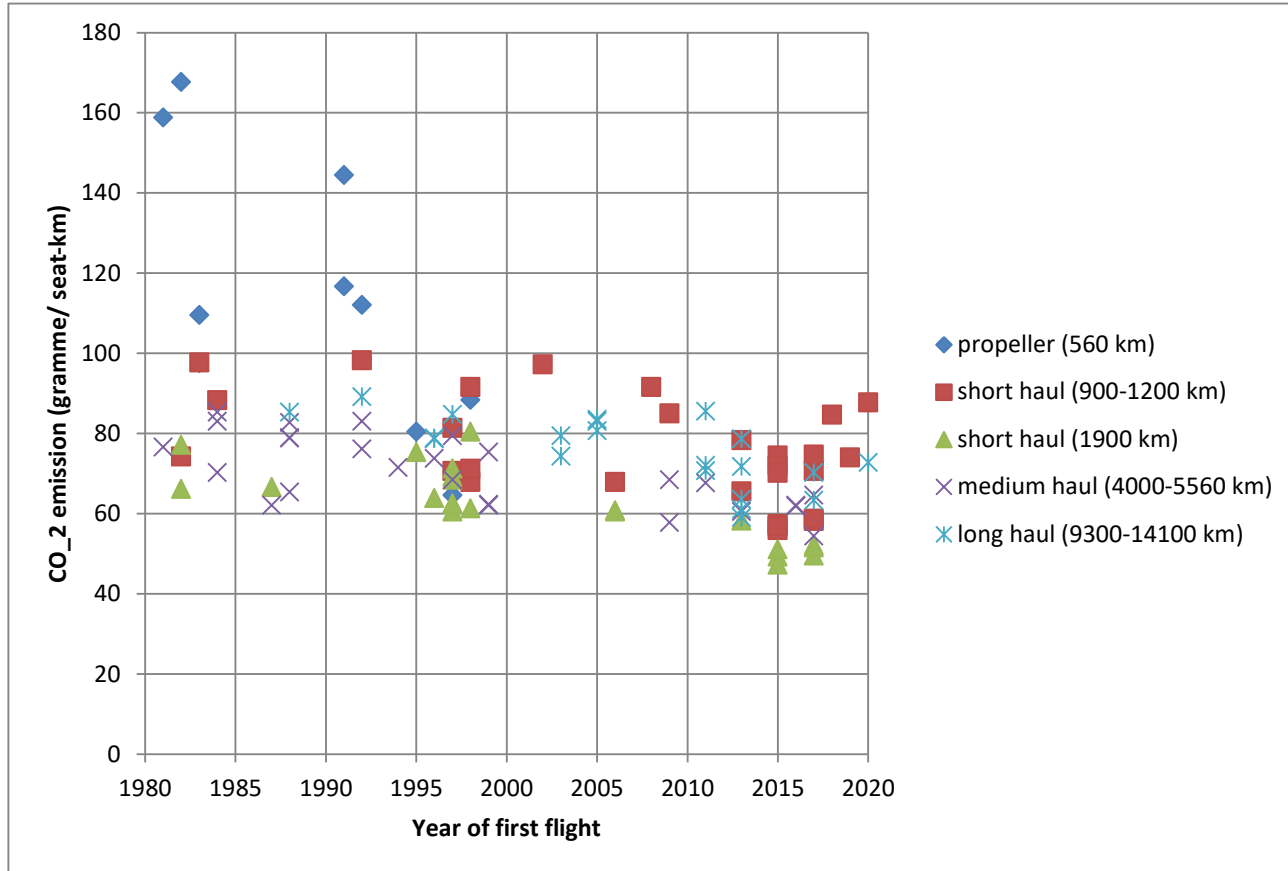
# Developments so far – fuel consumption



Note: The range of points for each aircraft reflects varying configurations; connected dots show estimated trends for short-and long-range aircrafts.

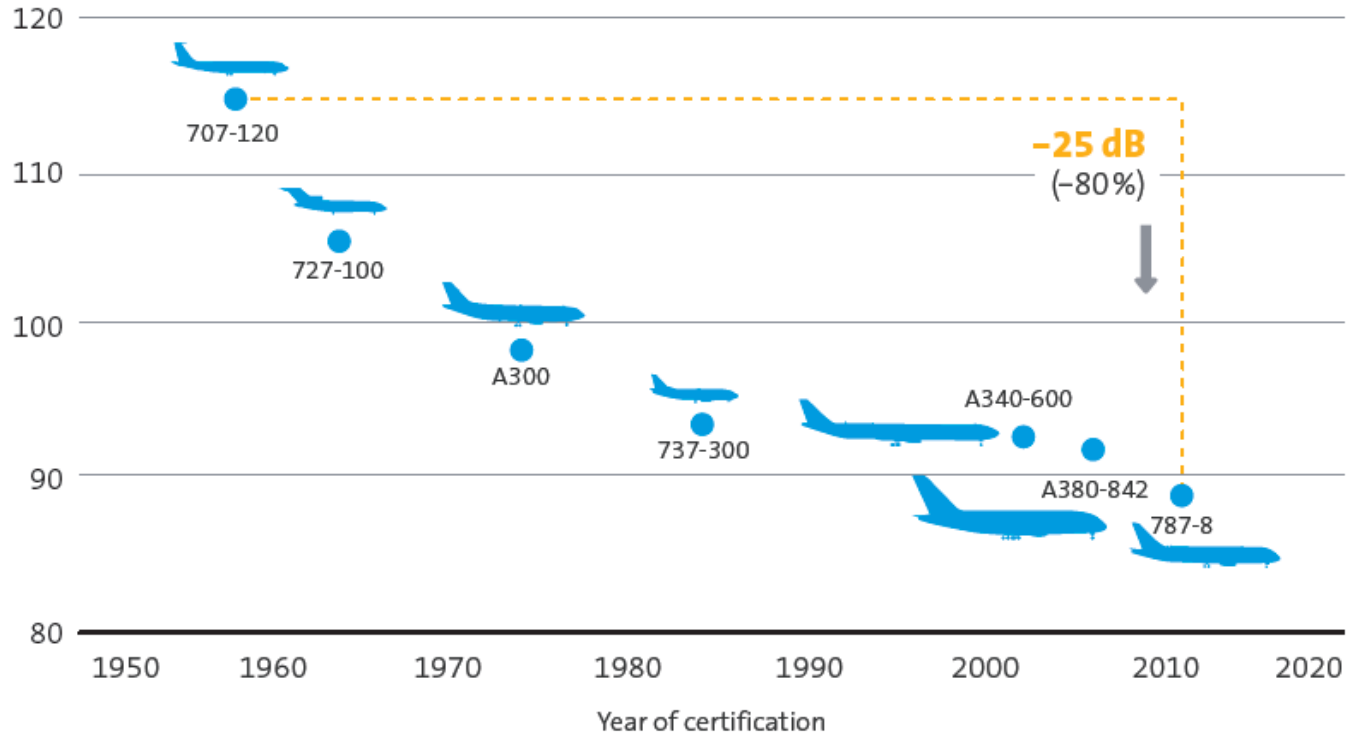
Sources: Lee, et al., 2001 IEA updates.

# Developments so far – fuel consumption



# Developments so far - noise

Lateral noise level standardised  
to 500 kN in EPNdB





# Developments so far - manufacturers

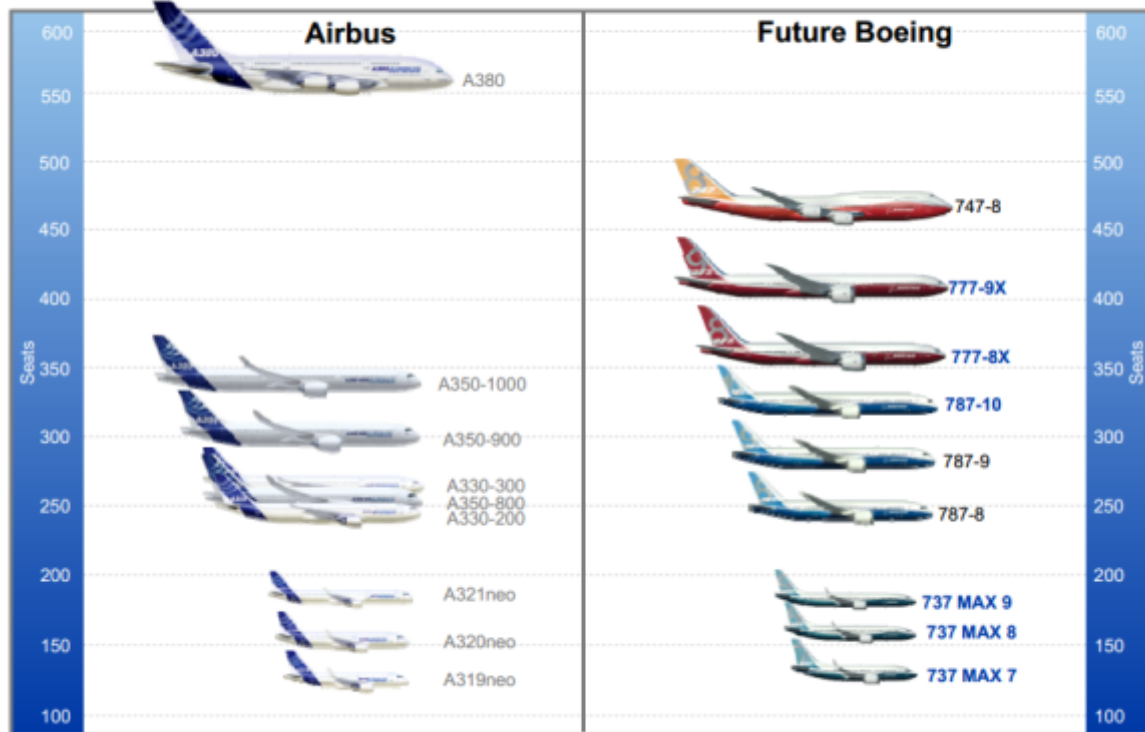
## Competitive widebody positioning



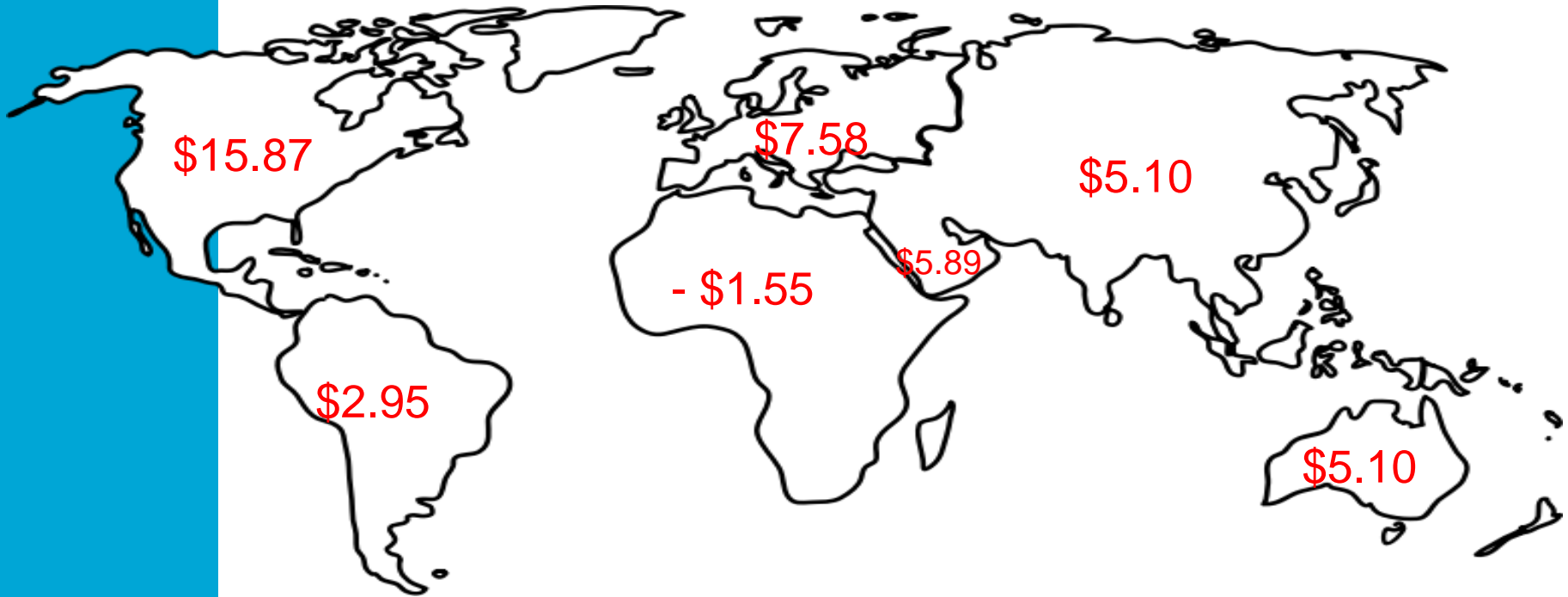
# Developments so far - manufacturers

## Boeing product line-up vs. the competition

Superior value, efficient market coverage



# Developments so far - airlines



Net profit per ticket

# Electric Aircraft



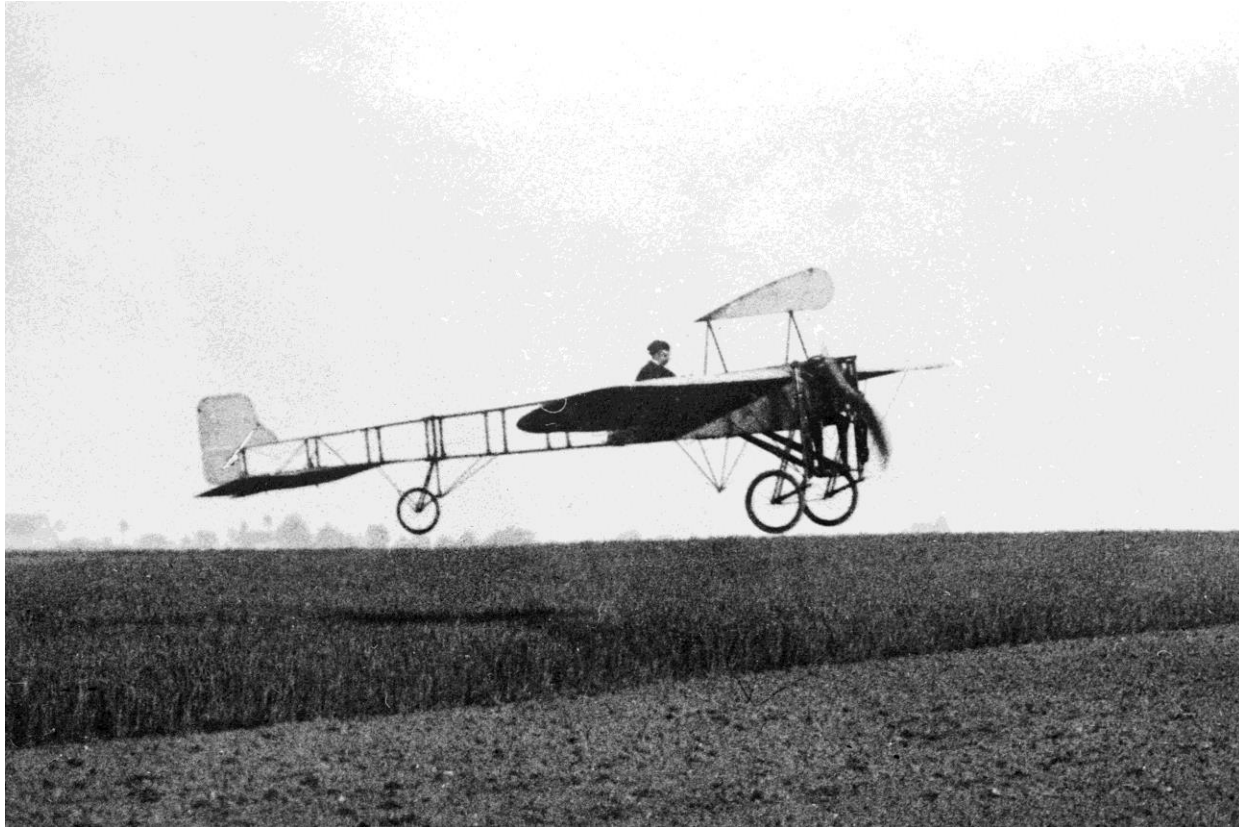
# Electric Aircraft



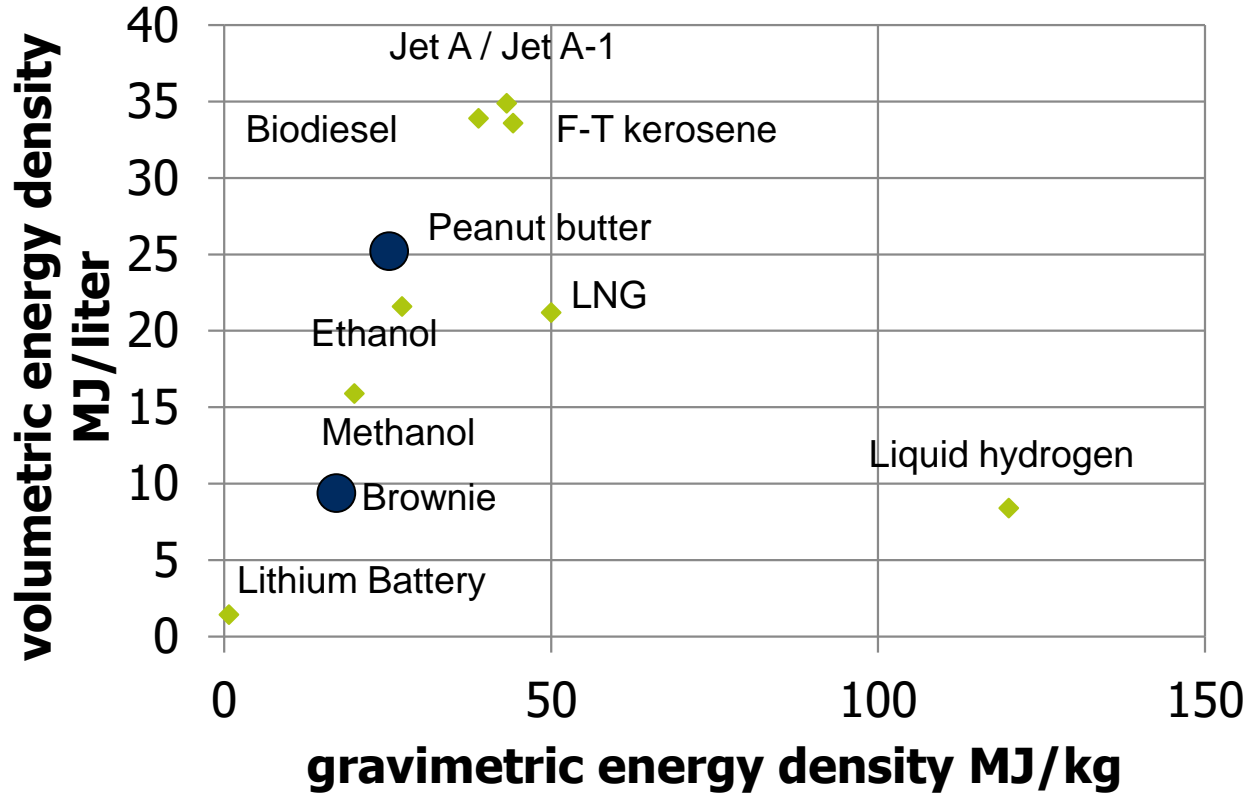
# Electric Aircraft



# Electric Aircraft



# Electric Aircraft





# Electric Aircraft

Electric flight will be there!

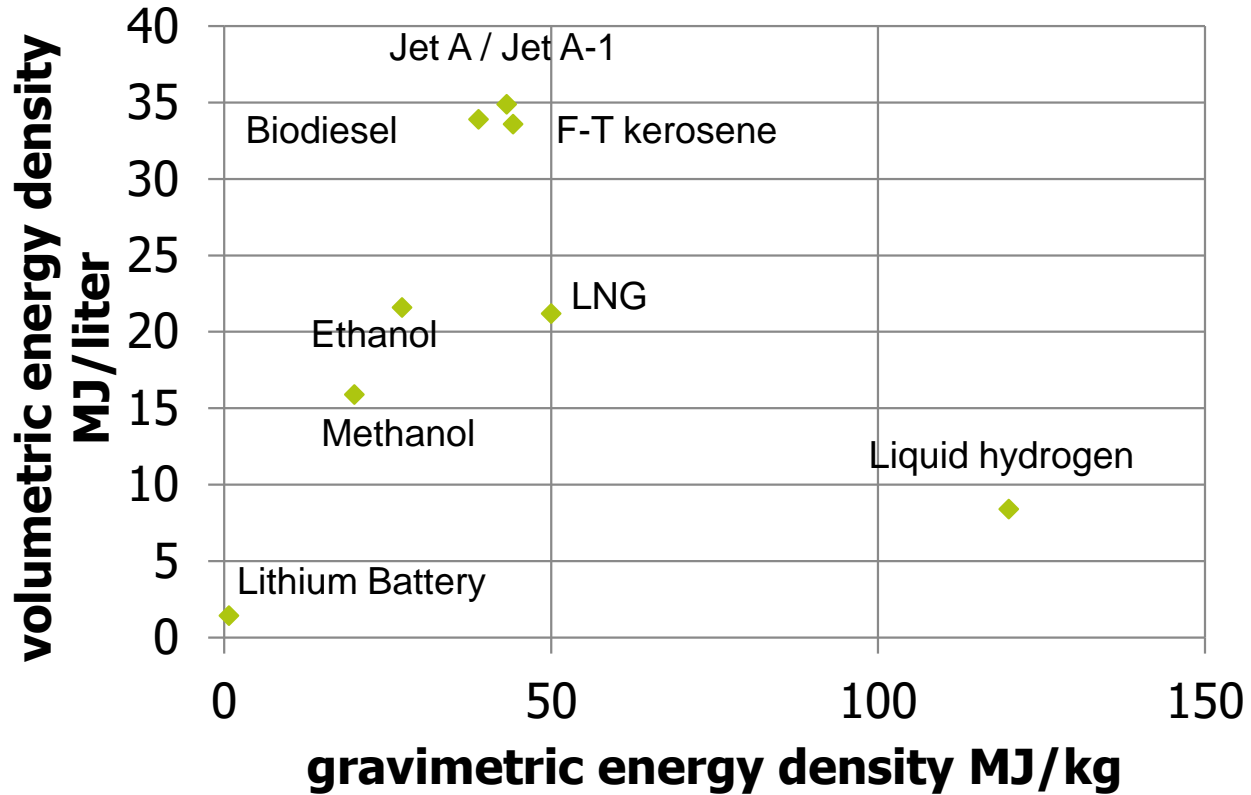
However:

- It will not be the next generation aircraft
- It will come via two routes
  1. General aviation
  2. Hybrid passenger aircraft

# Alternative fuels



# Alternative fuels



# Alternative fuels



Area-averaged probe

Measurement of ICAO LTO emissions by DLR

Direct particle size and number

- Cessna Citation II - P&W JT15Ds
- GTL 0-50% in two base fuels (ground tests)
- GTL 0-90% in flight tests

# Alternative fuels



# Alternative fuels

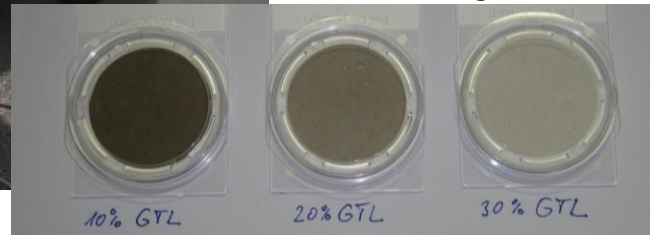


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Area-averaged probe

Measurement of ICAO LTO emissions by DLR

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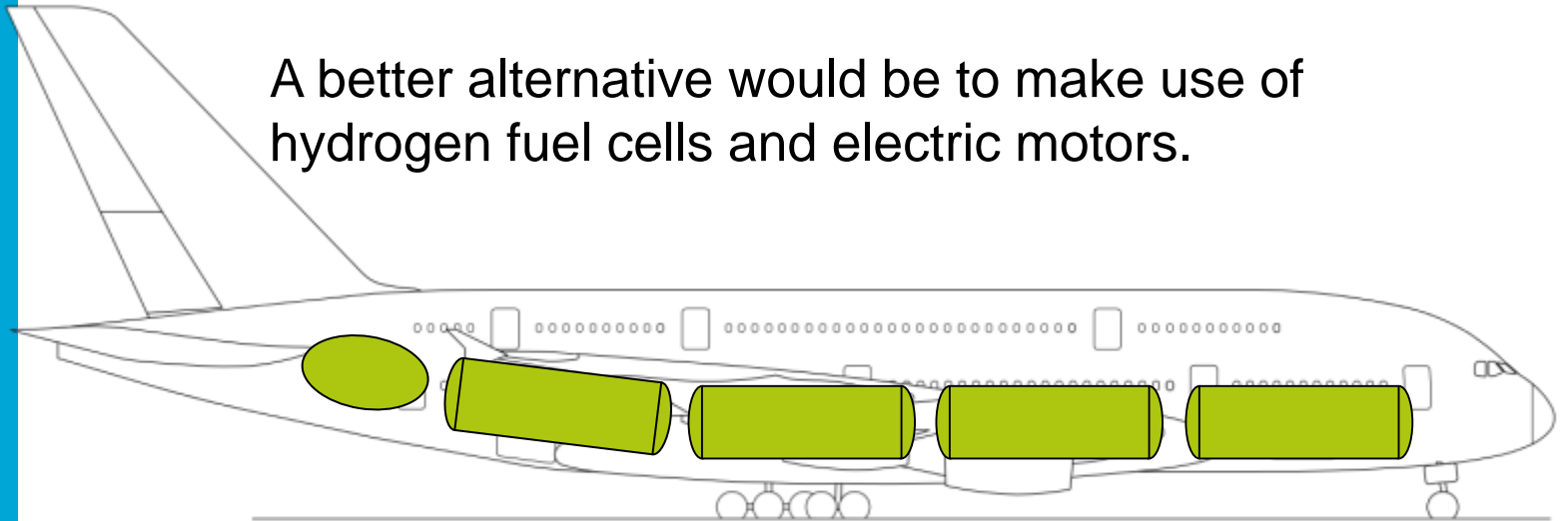
Soot filters in undiluted flow

# Alternative fuels

Is hydrogen an option?

Yes, you can use hydrogen in jet engines.  
But you will need some modifications.

A better alternative would be to make use of  
hydrogen fuel cells and electric motors.



# New configurations

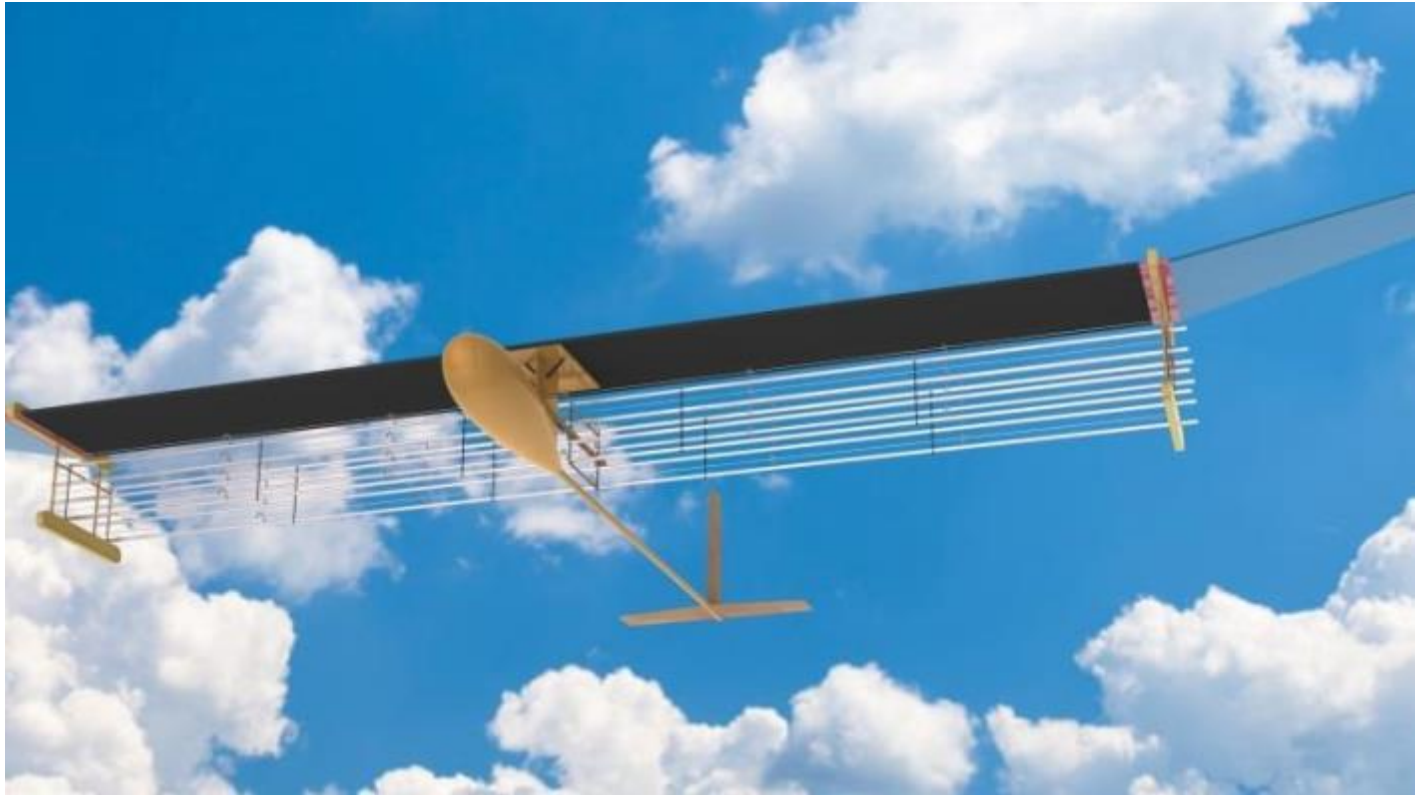




# New configurations



# New configurations



# New configurations



# New configurations



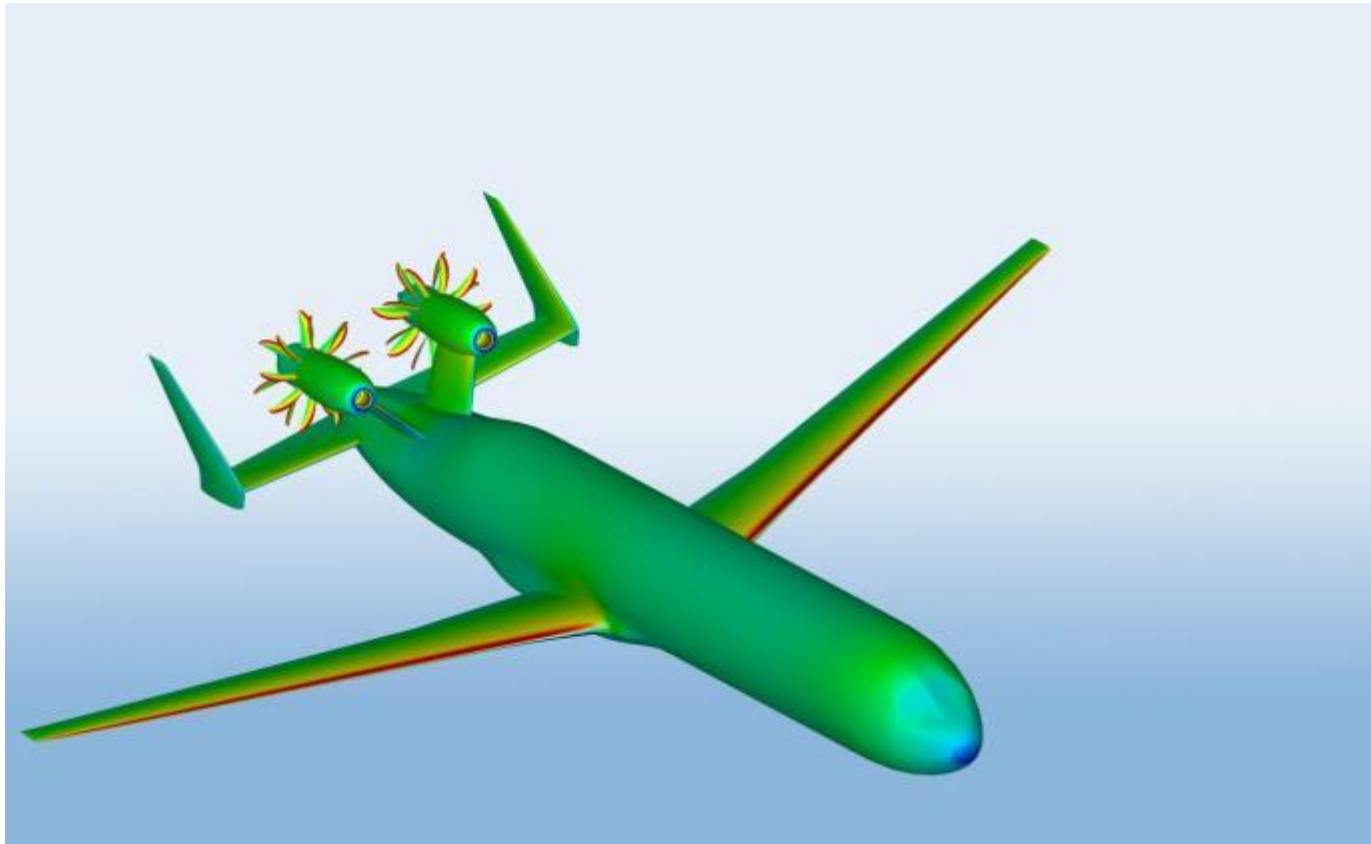
# New configurations



# New configurations



# New configurations



# New configurations





# New configurations – quick fixes



# New configurations – quick fixes



# New configurations – quick fixes



# New configurations – quick fixes



# New configurations – quick fixes



# New configurations – quick fixes



# Conclusions

There is no quick fix

We need more research and development

+

We replace old aircraft sooner (fleet renewal)

+

We need to look into alternative “drop-in” fuels

+

We need better procedures (climate optimized routing)

+

We need to compensate (CORSIA and beyond)

+

We need stronger incentives (legislation + societal pressure)

+

We need to limit the growth, preferably reduce soon

