11th EASN Virtual International Conference on
Innovation in Aviation & Space to the
Satisfaction of the European Citizens
1 - 3 SEPTEMBER 2021

New challenges for aviation after Corona

Prof. Dr. Dieter Schmitt

Dr. Dieter Schmitt - ARTS
Aeronautical Research & Technology Consulting

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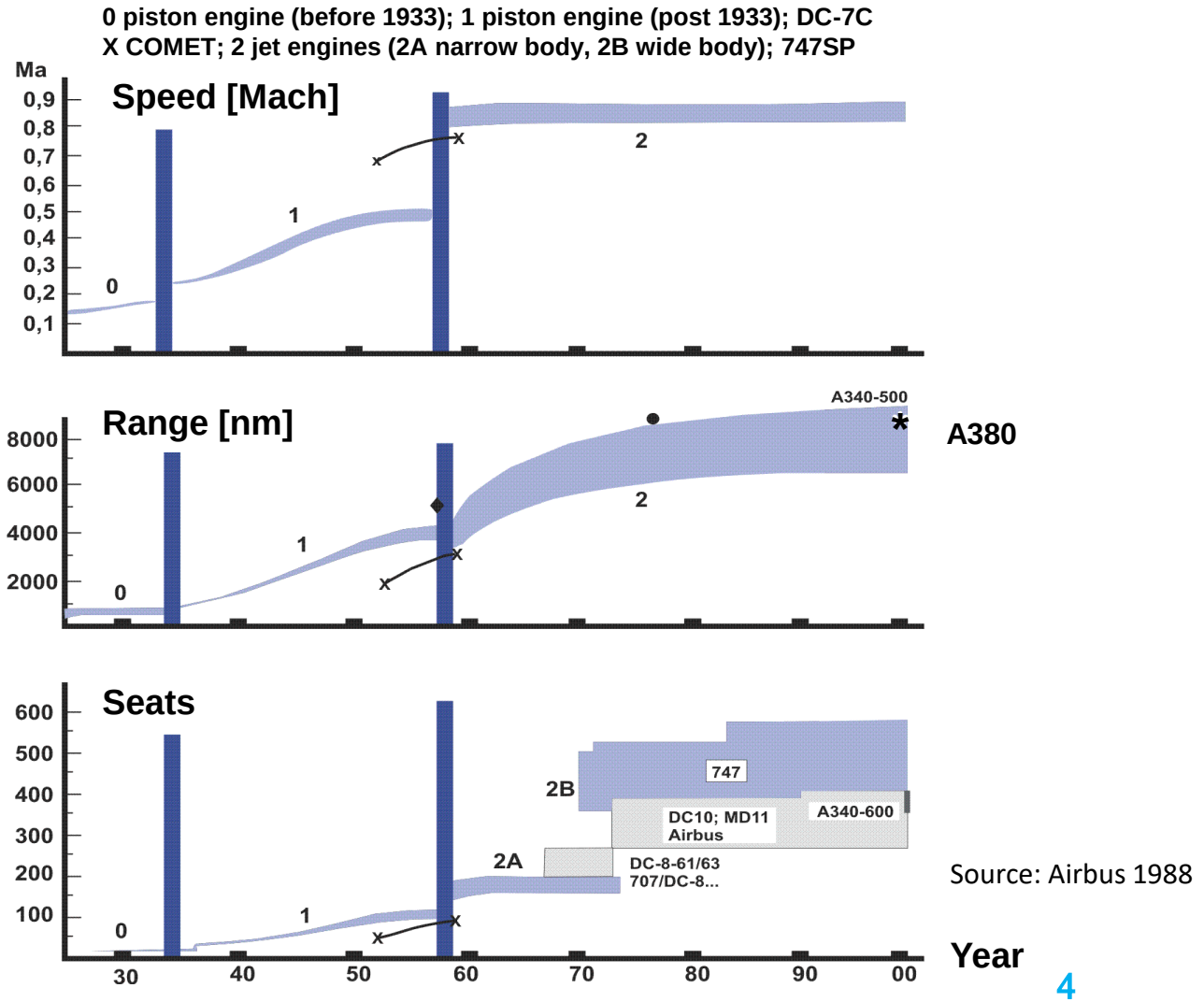
Historical Success Story of European Aviation

- Drivers for aviation:
  - range
  - speed
  - size
- Main driver:
  - economical benefit
- Secondary driver:
  - environmental benefit
- In a professionally oriented transport business:

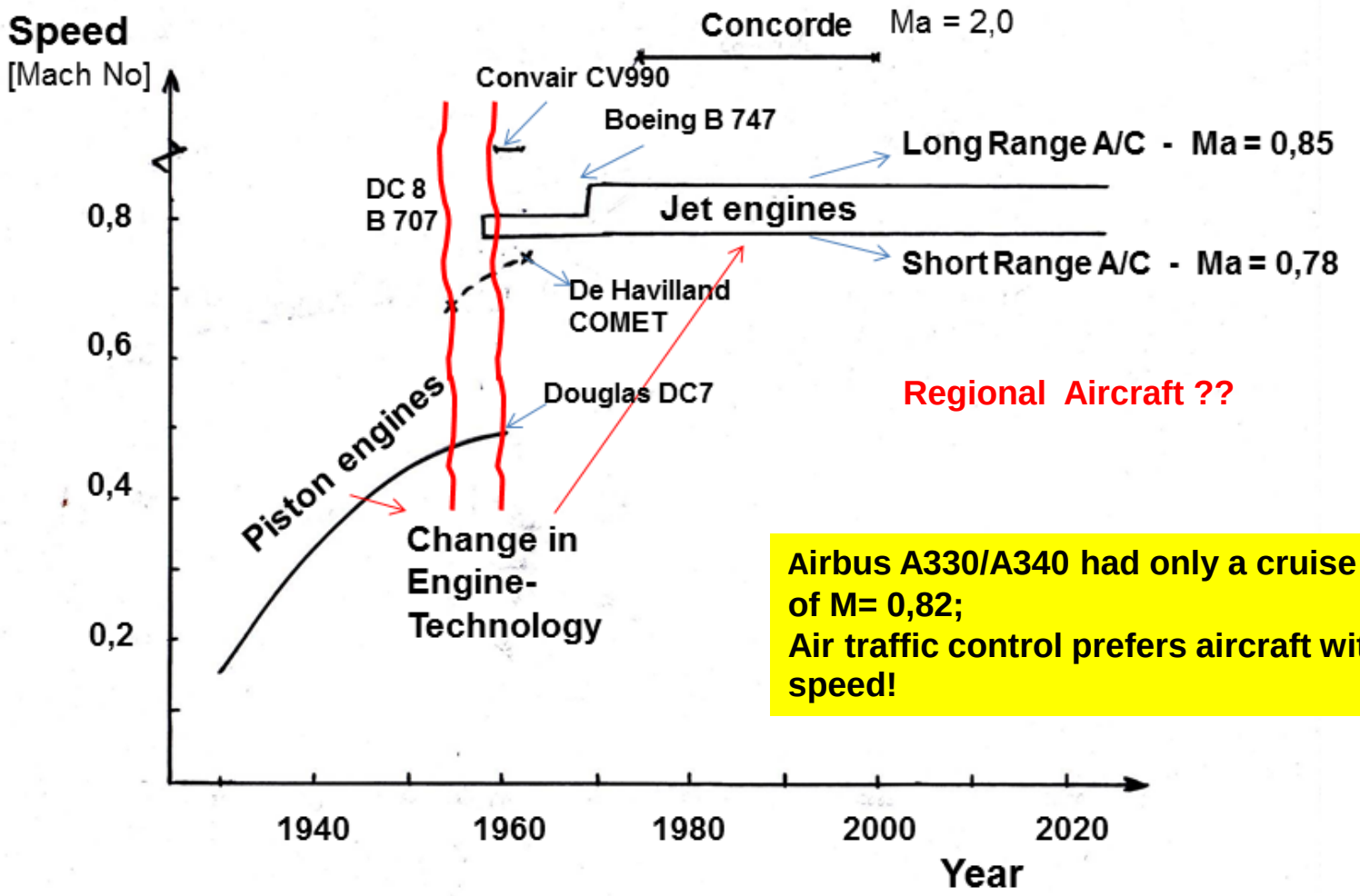
⇒ **Ecology profits from Economy**

Historical Development of Air Transport



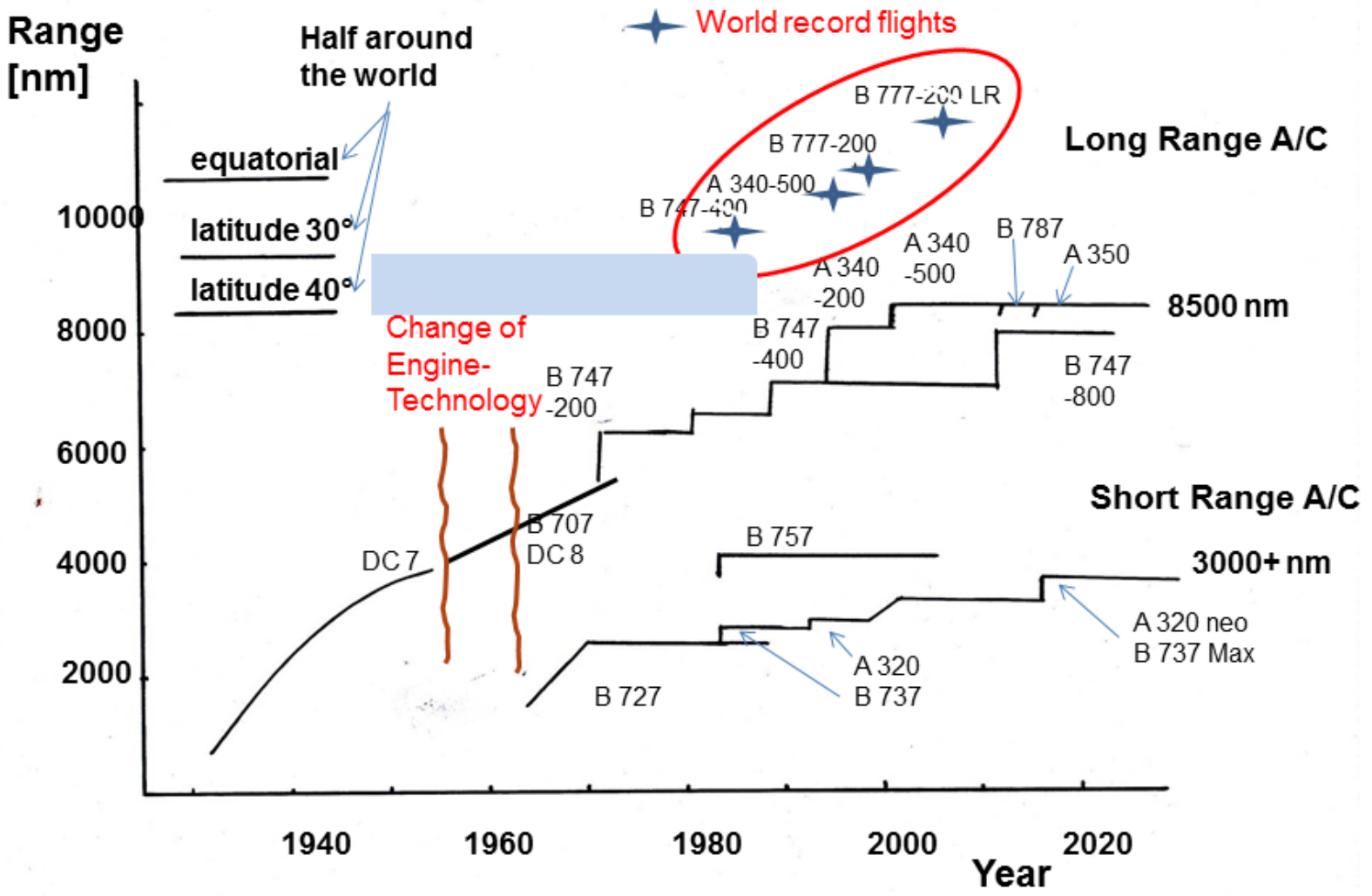
Source: Airbus 1988

Development of Cruise Speed



Airbus A330/A340 had only a cruise speed of M= 0,82;
Air traffic control prefers aircraft with higher speed!

Development of Range



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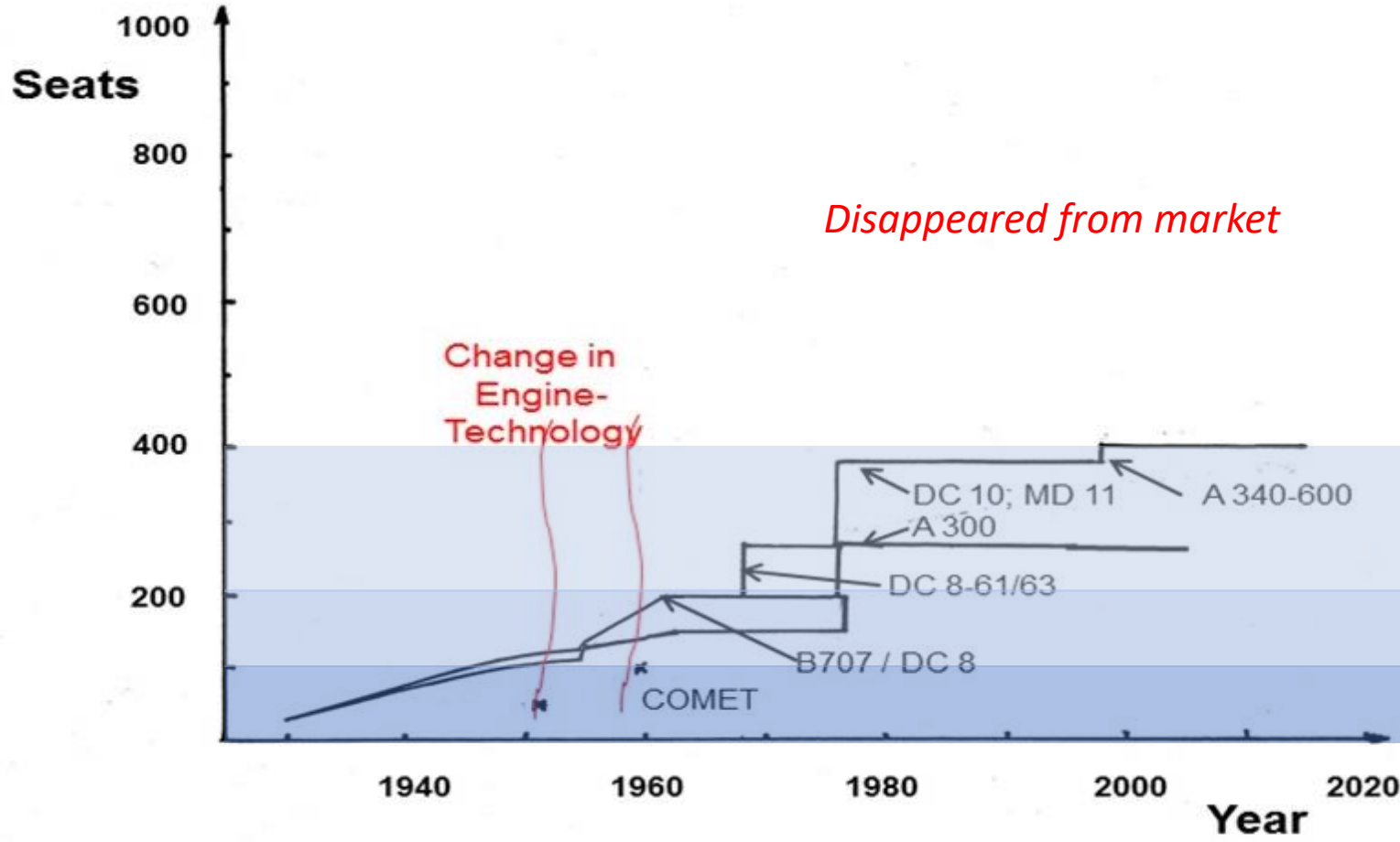
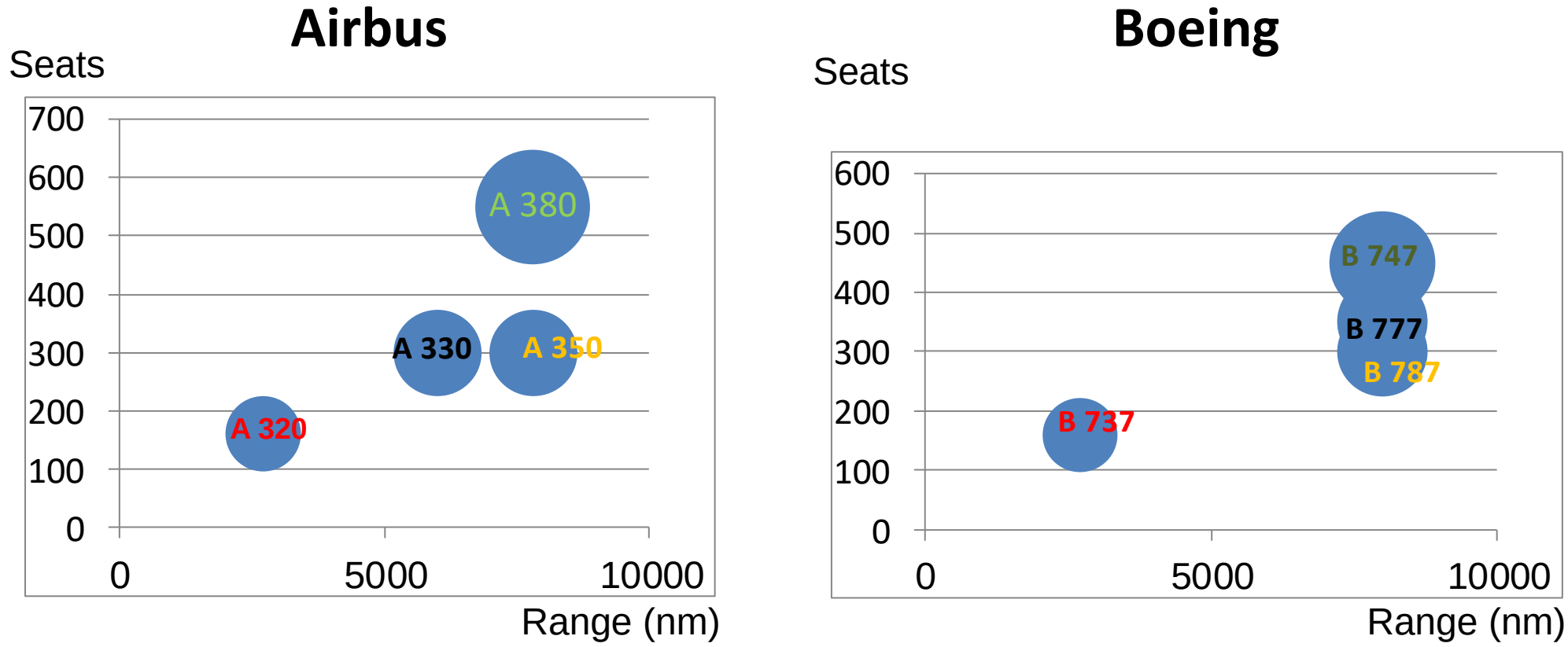
Development of Aircraft Size



Disappeared from market

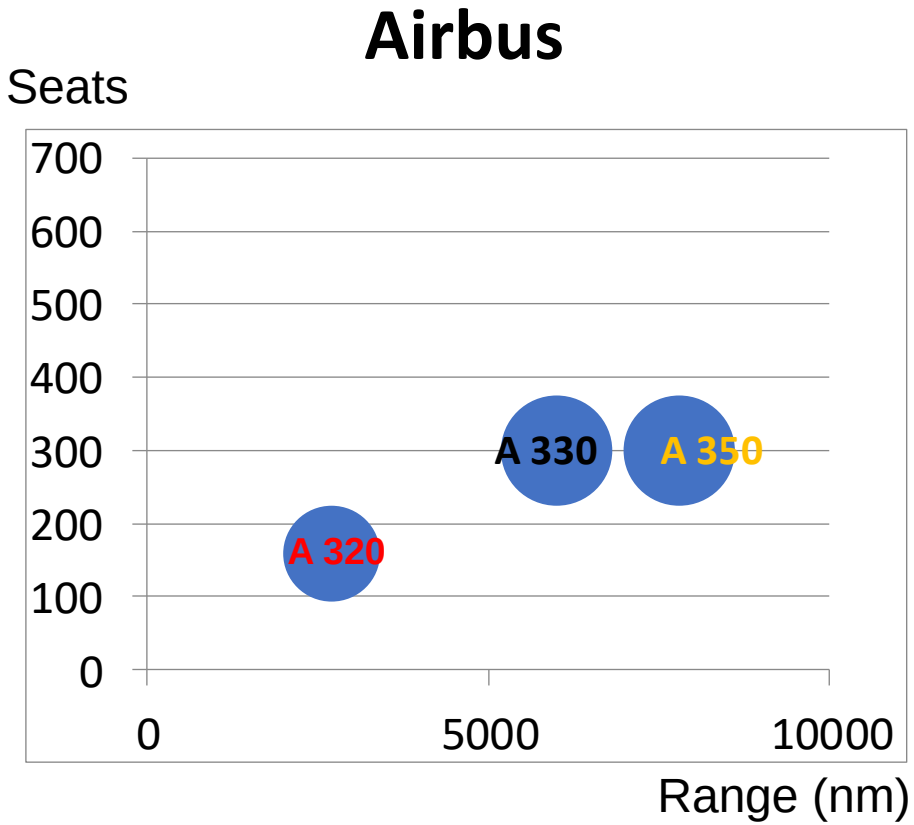
	Abreast
Twin Aisle B787 – A350	8
Single Aisle B737 – A320	6
Regional EHP	4-5

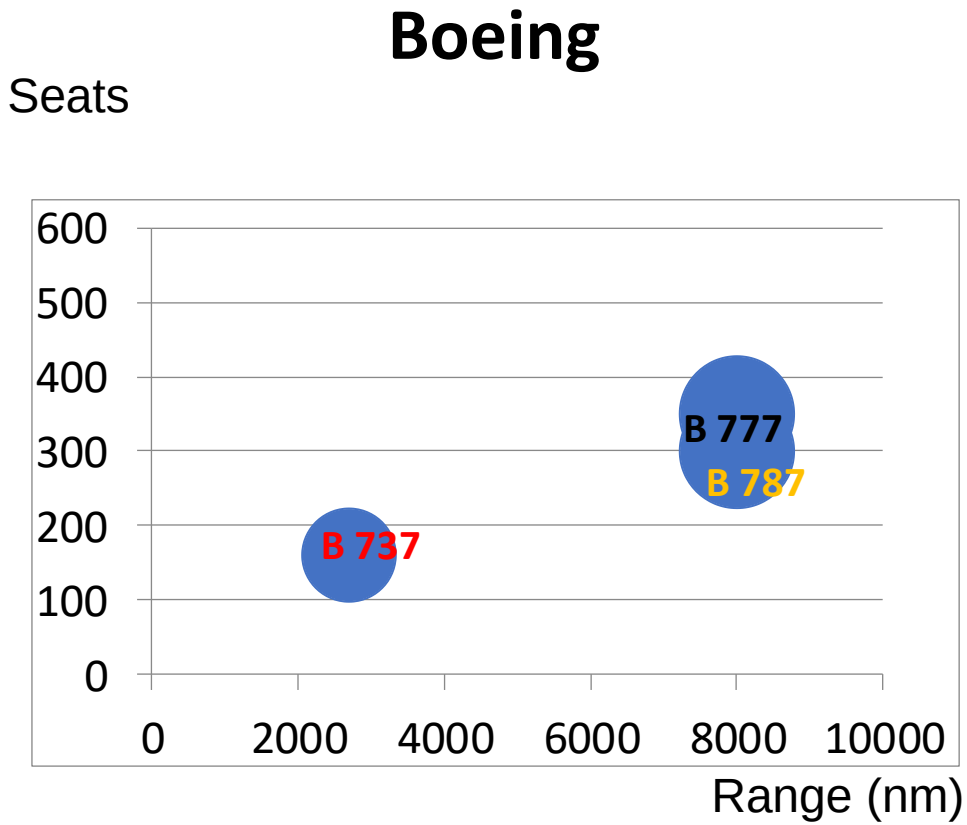
The competition between Airbus and Boeing



Airbus vs. Boeing in 2010

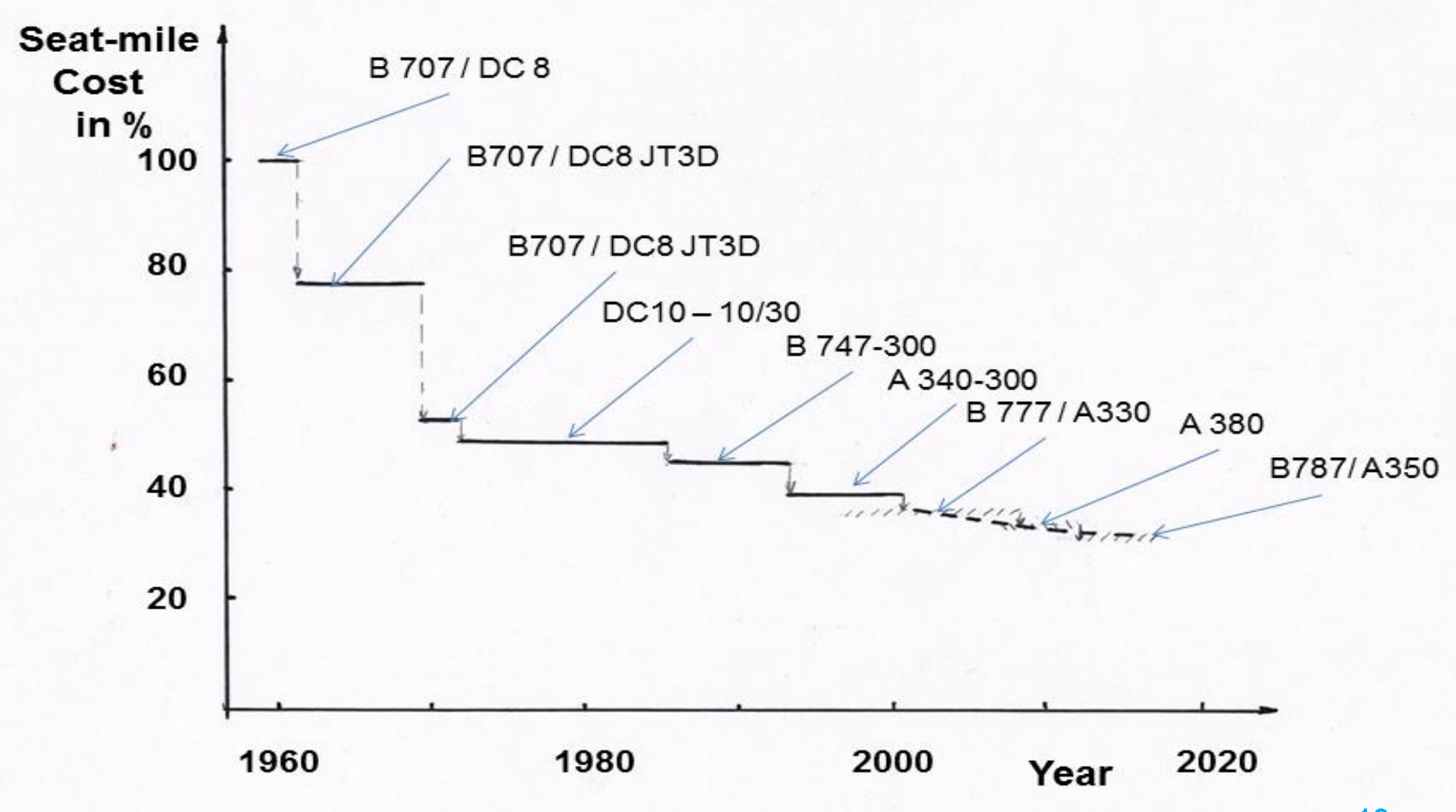
The competition between Airbus and Boeing





Airbus vs. Boeing in 2021

Development of seat mile cost



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Corona Crisis

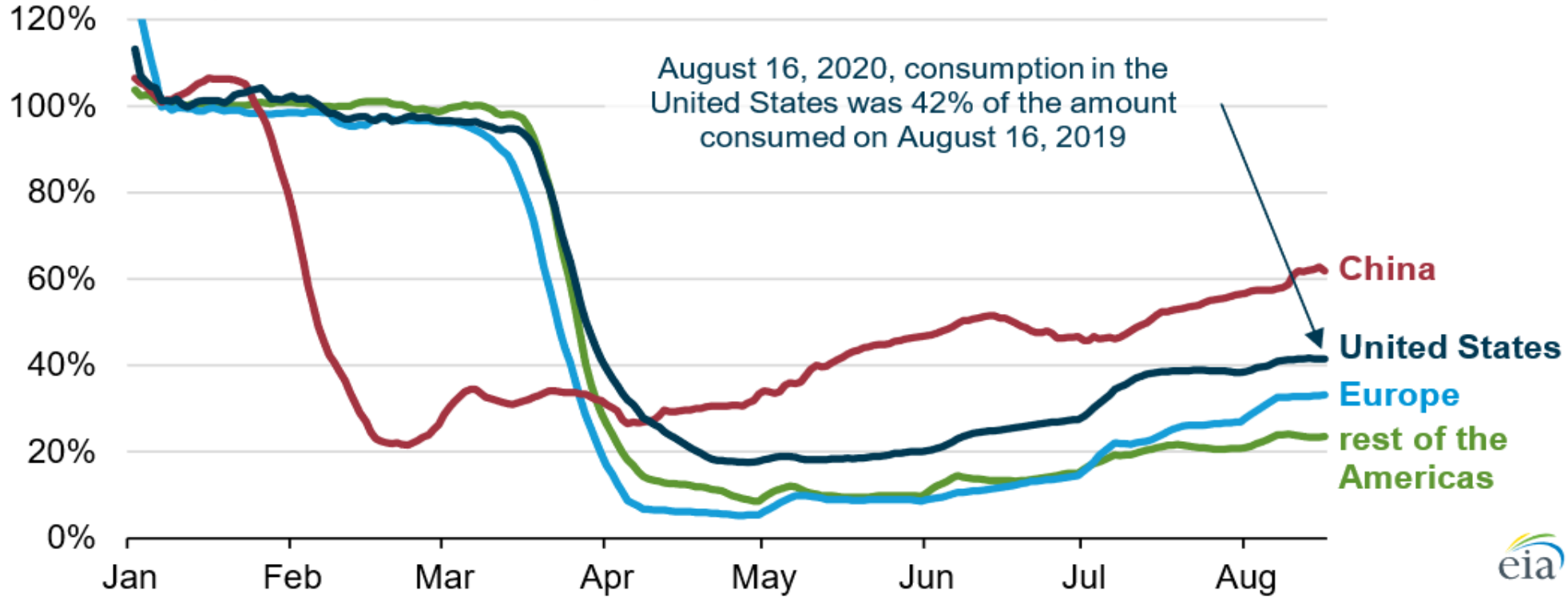
- Dramatic reduction of demand → up to -80% !!
- A business with 8 years of production (backlog) looses nearly all contracts.
- The unbelievable – most dramatic recession in aviation !!

  ⇒ **the end of a long success story!?**

Jet fuel consumption: 2020 vs. 2019

Ratio of 2020 jet fuel consumption by commercial passenger jets to 2019 consumption, seven-day moving average (January 1, 2020–August 16, 2020)

2020 consumption relative to same day in 2019



Source: U.S. Energy Information Administration, using raw flight data from Cirium
Note: China* inclusive of Hong Kong and Macau; consumption assigned to the region from which each flight departed.

Technological Options for Horizon 2050

Several options for the Year 2050:

I. Business as usual

II. Use of „alternative fuels“: Bio Kerosene, Methane, CxHy, ??

III. Hybrid-Electric propulsion

IV. Hydrogen powered aircraft

Option I: Business as usual

- Aircraft are well optimised today! A change of basic aircraft concept will not provide any major advantages!
- Clean Sky 2 (2014-2023) has identified another 15-20 % in fuel burn improvement.
- The main improvement potential will come from the propulsion technologies!
- These novel technologies can be integrated in new aircraft concepts (SMR/LR) in 2035+!
- A taxation of CO_2 or Emission Trading Systems will be a mean to increase air transport cost and provide a considerable contribution to the aviation sector's large CO_2 impact!
- The air transport will become more expensive! The predicted air traffic growth will be impacted by this higher cost and should be flattened to go to zero !!
- Holiday and leisure travels will become more expensive and will only be affordable for wealthy families! Is this tolerable from the political side?

Option II: Use of alternative fuels (SAF, Biofuels,..)

- Sustainable aviation fuels (SAF) have the potential to make an important contribution to mitigating the current and expected future environmental impacts of aviation. (FAA-US)
- Fuels must be certified in order to be used in commercial flights.
- Regular flights using blends of bio-based aviation fuel are already being performed from several airports in the EU, albeit at very low percentages of the total fuel uplift.
- Recent policy developments and industry initiatives aim to have a positive impact on the uptake of sustainable aviation fuels in Europe.
- The EU Emissions Trading System (EU ETS) provides an incentive to aircraft operators to use SAF that comply with the sustainability criteria
- The use of SAF thereby reduces an aircraft operator's reported emissions, and the number of ETS allowances it has to purchase. This provides a financial incentive for aircraft operators to use SAF instead of conventional aviation fuels.

Option III: Hybrid-electric aircraft

Several interesting HEP concepts are being studied and promoted at the moment:

a) wing tip propellers → reduce the induced drag by counter rotating tip props *(indirect increase in aspect ratio!)*

b) multiple upper or lower wing propellers
   → the propeller have to serve two functions: lift and thrust
   → the high lift system can be simplified, higher C_L at take-off and landing!
   → reduced wing area

⇒ **Key question: how to provide electricity on board?? Batteries? SAF? Hydrogen?**

Option III: Hybrid-Electric Propulsion

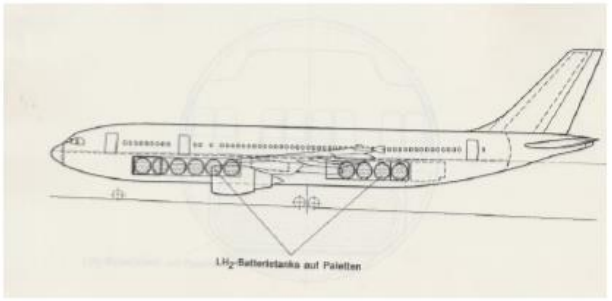
- Potential application: **Regional aircraft**
  - Range: 1000 km to start → 2000 km 10 years later
  - Size: 40 pax to start → 80 pax 10 years later
  - Speed: Ma 0,5 → later Ma 0,6
  - Crew: 1 pilot + 1 cabin crew

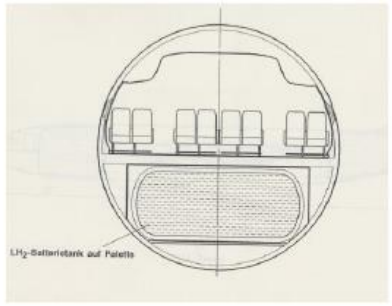
Advantages:

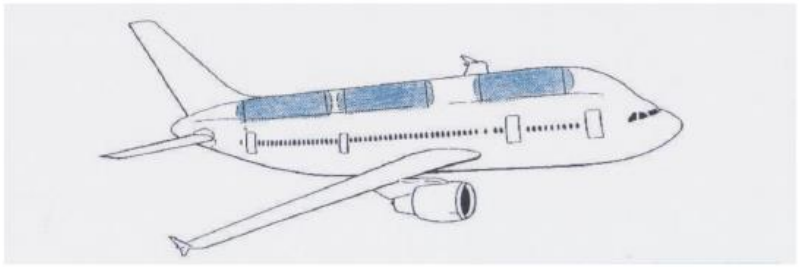
- For Europe, the HEP Aircraft could be the basis for a very flexible and environmentally friendly transport system which supports small airports and holiday regions
  - These HEP aircraft could open up new regional networks in Europe
  - High Speed Railway systems as the alternative would require heavy investments in infrastructure

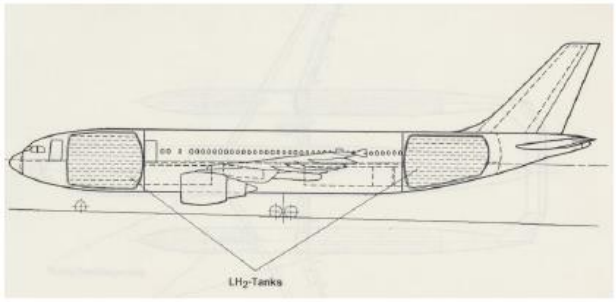
Option IV: Hydrogen Powered Aircraft

„**Cryoplane**“ studies in 1990 at DASA Airbus in Hamburg









Final conclusion:

A310 stretched with H2-tanks above the cabin

A Cryoplane will be feasible, but the modifications are major: engines & airframes have to be adapted. However, the H_2-infrastructure at the airports will be critical! It is a condition, that Europe will have already a H_2 supply infrastructure, coming from automotive, which can be used in aviation.

Research Items for the Future

1. Awareness, where are we flying in actual operations? Troposphere or stratosphere??
   Is it more critical for climate aspects, when aircraft are operating in the stratosphere?
   → If the answer is yes? (This is my perception!) Then:

   ⇒ Develop a sensor, which will clearly indicate, when we reach the tropopause and help to avoid entering into the stratosphere!
2. Digitalisation (design, production, maintenance, operations; cyber security; booking)
3. Optimised Freighter Aircraft concepts…
4. Intermodality (seamless transport, knowledgeable choice between transport modes [educated passenger]; one ticket for all)
5. Highly integrated airspace (airliners, UAM, drones, …)

Conclusion (1)

Europe is strongly advocating to change from Kerosene to Hydrogen!! Cost??

⇒ Who else is interested to support this change??

- China has sufficient coal, but interest to invest in green H_2 ???
- Russia has sufficient gas and petrol! Interest to invest in green H_2 ???
- Arabic countries have sufficient petrol, why change to green H_2??
- US have sufficient oil sand to continue with fracking technologies! Green H_2! ????
- If Europe alone uses green hydrogen aircraft? Will this scenario help the climate ??
- Will Europe alone be strong enough to go the way to green H_2 ??
- CO_2 Taxes will increase the price for flight tickets considerably!

Conclusion (2)

My personal conviction:

- Even if Europe will have to start alone the initiative with hydrogen as basic alternative energy for air transport,
  Europe should be strong and courageous enough to go the way to green H_2 !!
- There will be the direct conflict between Climate impact and Air transport !!
  ⇒ Will the increase in air Travel be political acceptable? Will there be sufficient support from the democratic parties to increase cost for "Holiday and leisure travels" ???
- The big players in the touristic business (Mediterranean Countries and the lobbyist from touristic business) will support the air transport and ask for tax exemptions!
- **Hopefully, convincing research programmes can provide solutions!**
- **However, better communication with public is required!**

Thank you

for your attention!