Fuel efficiency of commercial aircraft

An overview of historical and future trends

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(Mis-)conceptions fuel efficiency

- Per seat-km fuel consumption is now 70% less than of early jets (IPCC)
- Continuous improvement fuel efficiency of jets (IPCC)
- Aviation industry always uses technology geared to maximum fuel efficiency (Bisignani/IATA)
- Efficiency improvement is a constant % per year (IPCC, Lee)
- In 2020 new aircraft will be 50% more efficient (Lee).
The original IPCC graph
Micro analysis

Index per pkm (Comet 4 = 100)

- IPCC
- Jets
- Piston
- A380
- A380 opt wing
- Annual red. 3%
- Powercurve
- Research target
Macro analysis

Energy consumption (MJ / skm)

Share of turbine powered aircraft (%)

1930 1950 1970 1990 2010

ATA reports ▲ BTS data ▲ Lerner 1975 ▲ Turbine aircraft
Why were jets introduced?

- Lower fuel price
- 80% higher average speed
- Slightly higher range
- Higher passenger comfort
- Lower direct operating cost
- Less vulnerable to weather conditions
(New) conceptions fuel efficiency

• Modern jet fuel consumption/seat-km is 55% less than of early jets (IPCC), but only 0-15% less than last piston-engined airliners. Macro efficiency development between 1955 and 2000: -25%

• Discontinuity in fuel efficiency of aviation due to introduction of the jet engine

• Fuel efficiency is only one of a set of design features to be considered by aircraft designers

• Efficiency improvement follows a powercurve showing gradually reduced annual improvements

• In 2040 new aircraft may be 20-25% more efficient, much less than industry proposed targets like 50% in 2020.
Discussion

• Will peak-oil petroleum prices bring the fuel cost change required for introduction of high-speed propeller/propfan and fuel savings of up to 50%?
• Is 50% saving in 30-40 years enough to compensate for air transport growth?
• Is another speed increase (supersonic, space travel) at hand and will it cause a new backward discontinuity in fuel efficiency?
• How about mitigating climate change? What technological developments are required and what economic incentives may induce these?