

**PhD Project (04/2007 - 03/2010) :
Incentive structures and climate impacts of the planned
European CO₂ emissions trading scheme in aviation**



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Agenda

- **Background**
- **Research hypothesis and concept**
- **Work packages**
- **First analysis results**
- **Discussion**

Background

- **Aircraft emissions alter the concentration of GHG (CO₂, H₂O, O₃, CH₄) and trigger formation of contrails and cirrus clouds.**
- **Radiative forcing of aviation is 2-5 times as large as the one of aviation-induced CO₂.**
- **Aviation activities cause climate externalities.**
- **Global nature of aviation market hampers the introduction of binding climate policies.**
- **EU-Directive (Draft 12/2006): including aviation into CO₂ EU-Emissions Trading Scheme (ETS).**

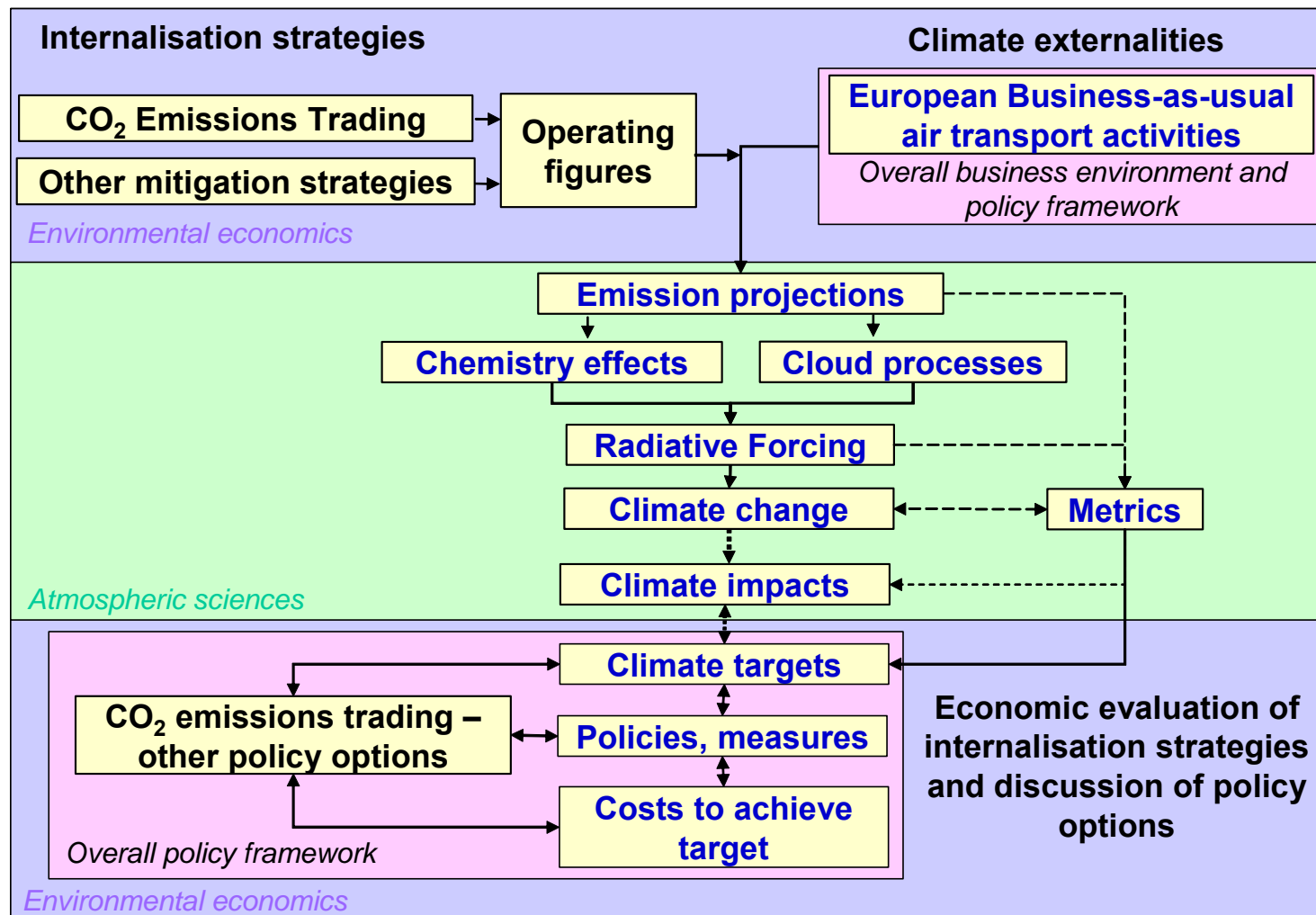


Research hypothesis

The planned inclusion of aviation into the CO₂ EU-ETS represents a fragmentary internalisation of climate externalities in aviation. It neglects to address important reduction potentials and might cause greenhouse relevant trade-offs.

These shortcomings can be addressed effectively by flanking policies and measures.

Concept of the PhD project



Work packages

WP1: Climate externalities of aviation.

WP2: Incentive structure of the planned EU-ETS in aviation.

WP3: Development of emission scenarios for European air traffic.

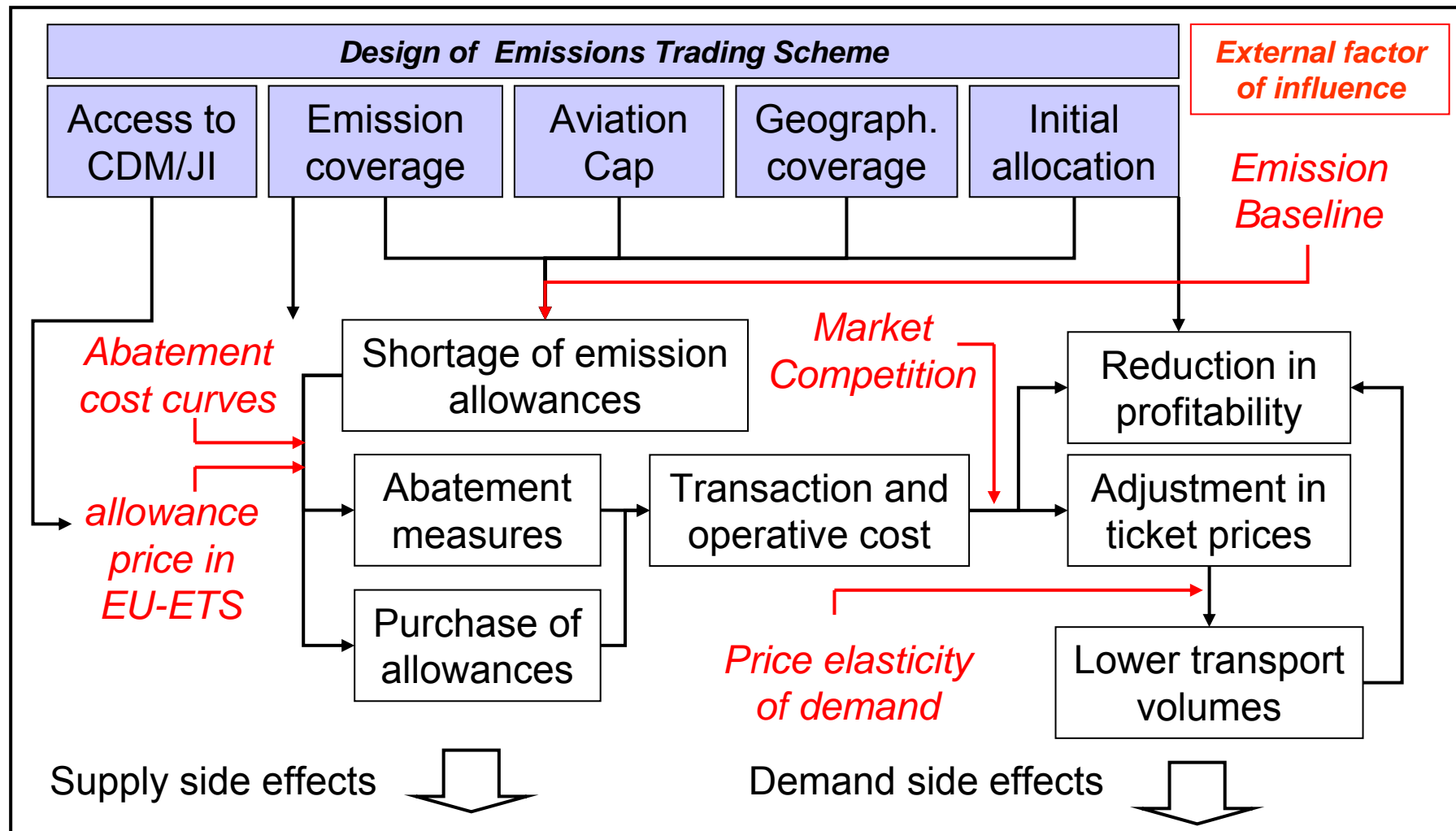
WP4: Quantitative assessment of climate impacts related to emission scenarios.

WP5: Economic evaluation of climate impacts and discussion of policy options

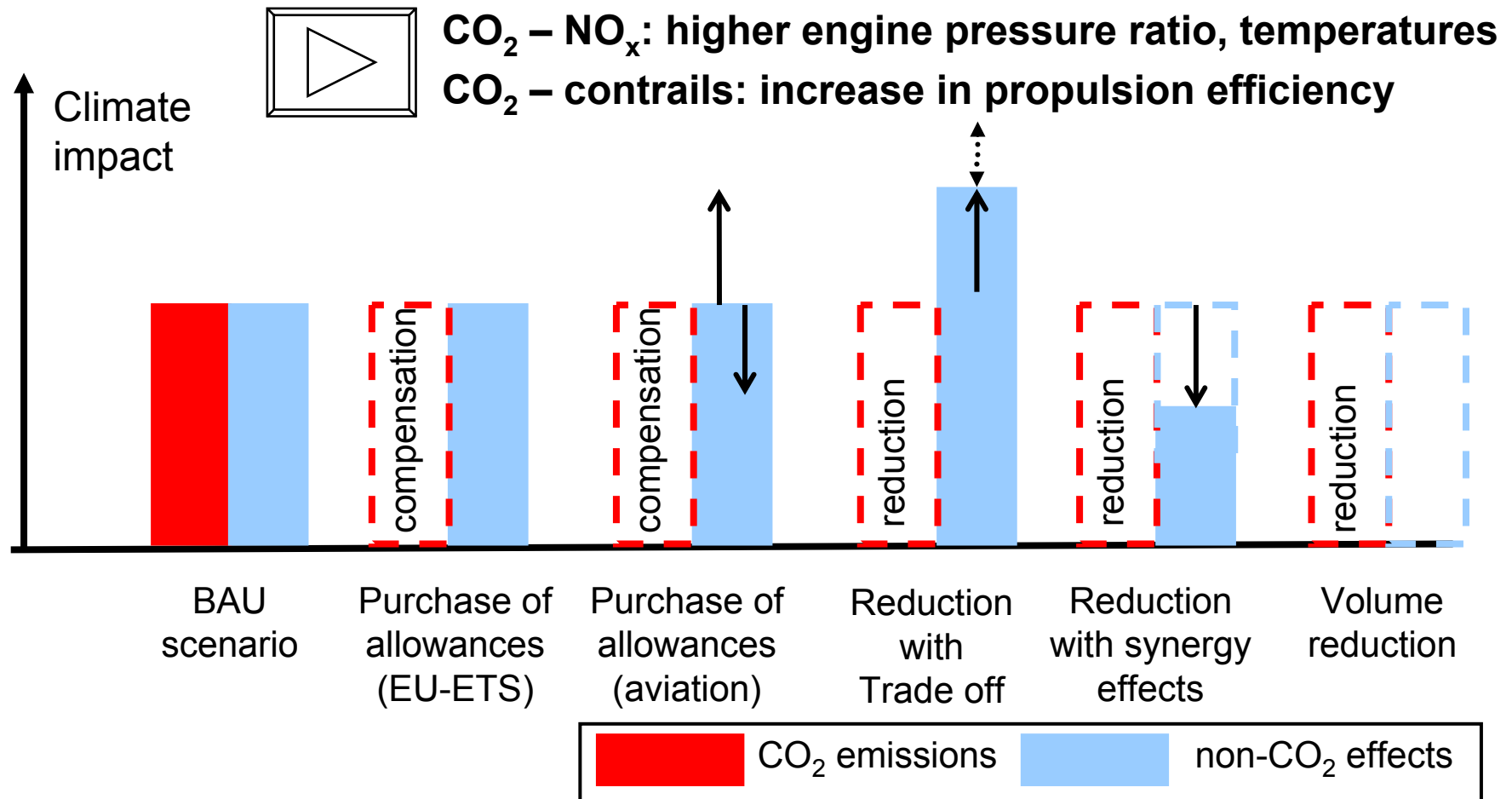
WP 1: Climate externalities of aviation

- **Aviation leads to different types of externalities.**
- **Climate externalities have special features: risk, long time horizons, uncertainty, global scale, non marginal changes.**
- **Aviation climate impacts take a special position in climate externalities due to high significance of indirect and short-term effects.**
- **Common metric would facilitate evaluation of climate externalities but currently not available.**

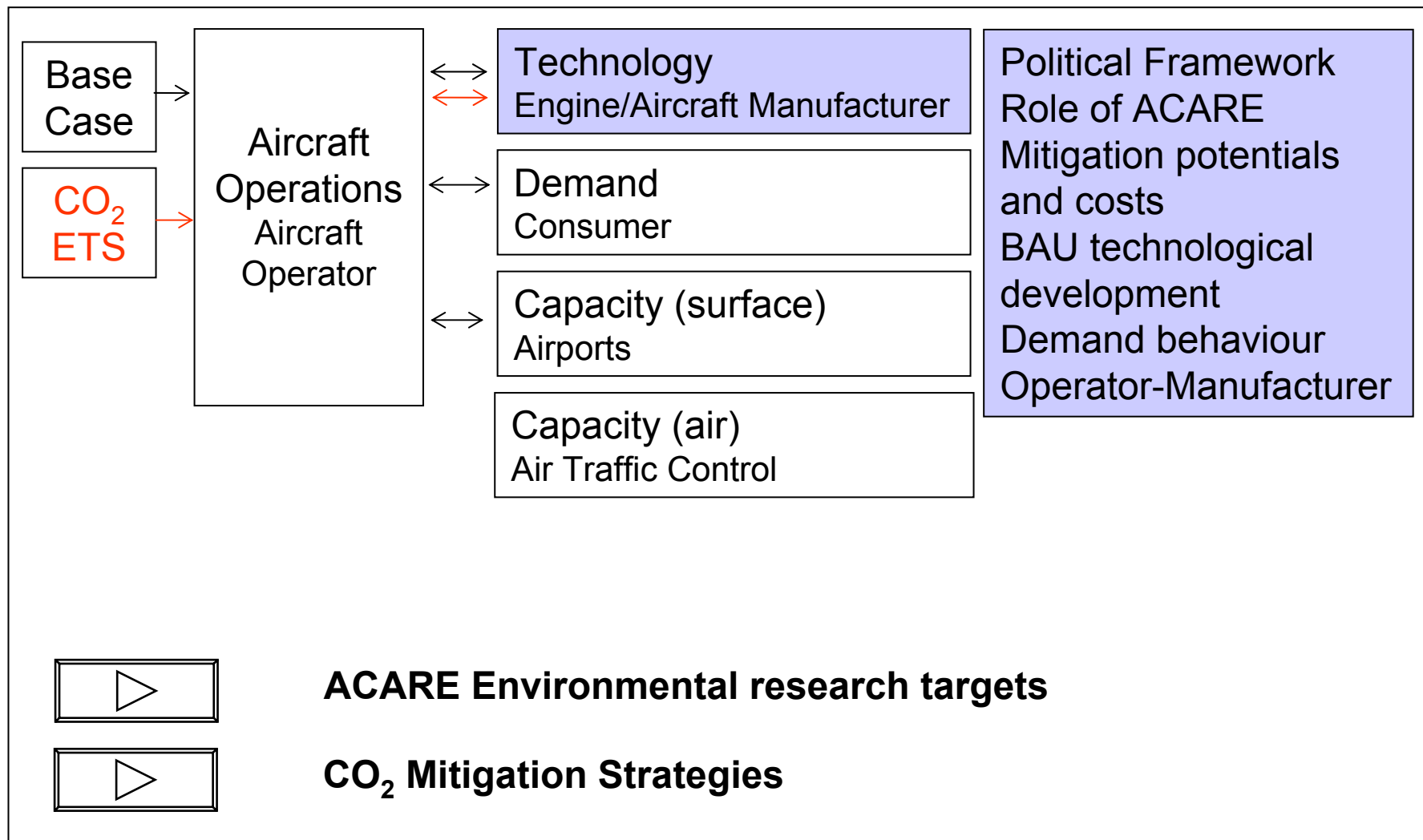
WP 2: Incentive structure of EU-ETS in aviation



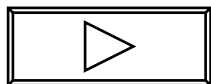
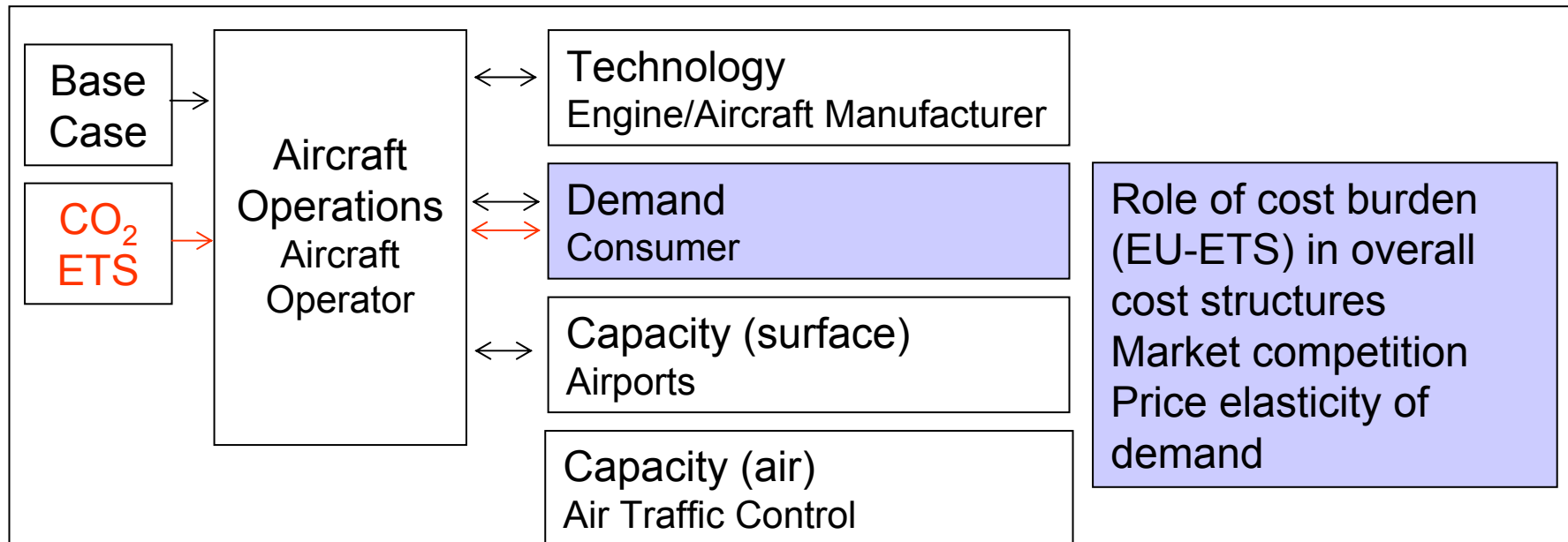
Climate impacts of supply and demand side effects



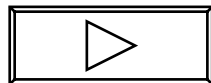
Incentive structure – Impact on technology



Incentive structure – Demand effects

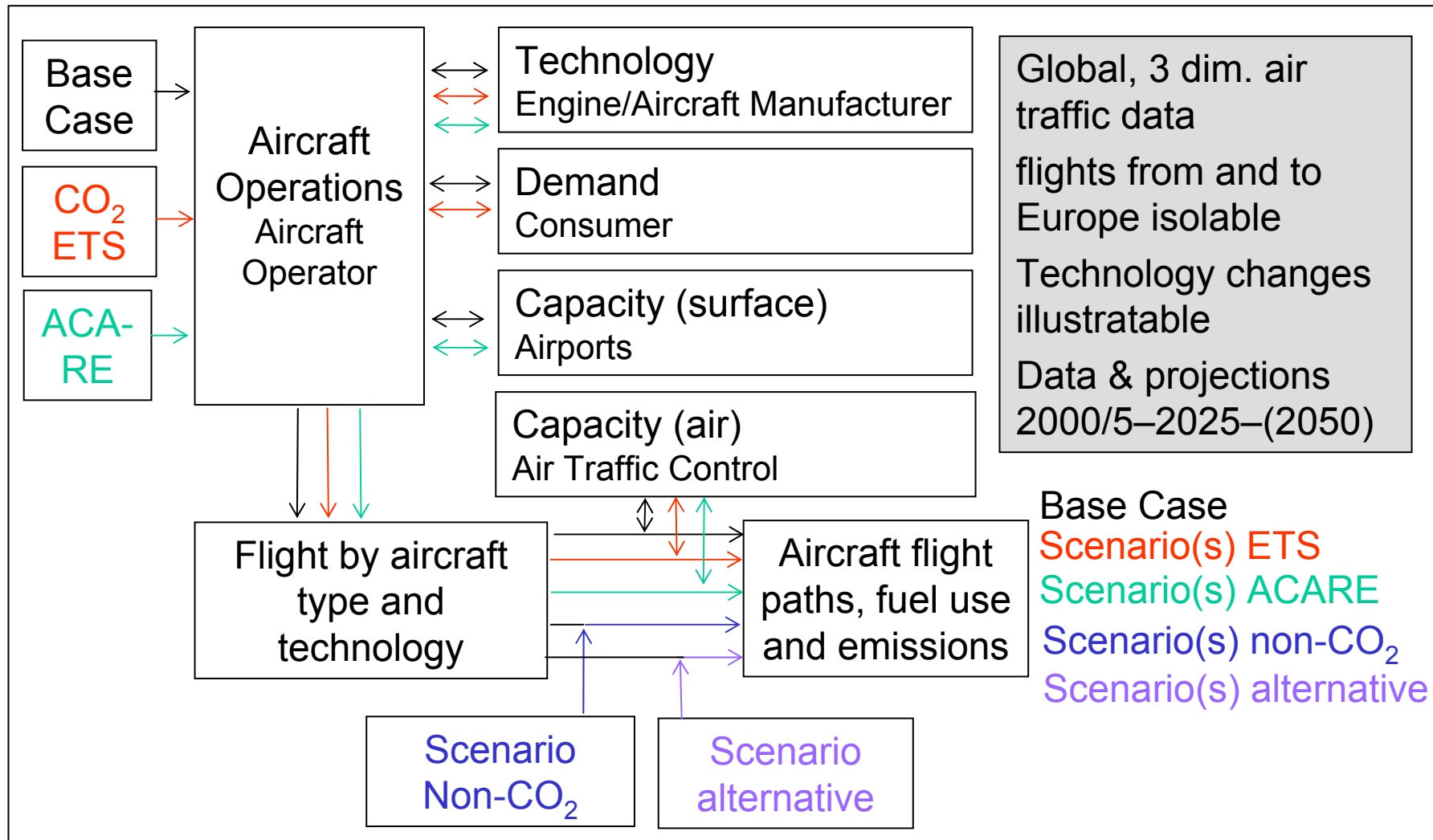


Past und projected trends of jet fuel prices in comparison to projected allowance prices

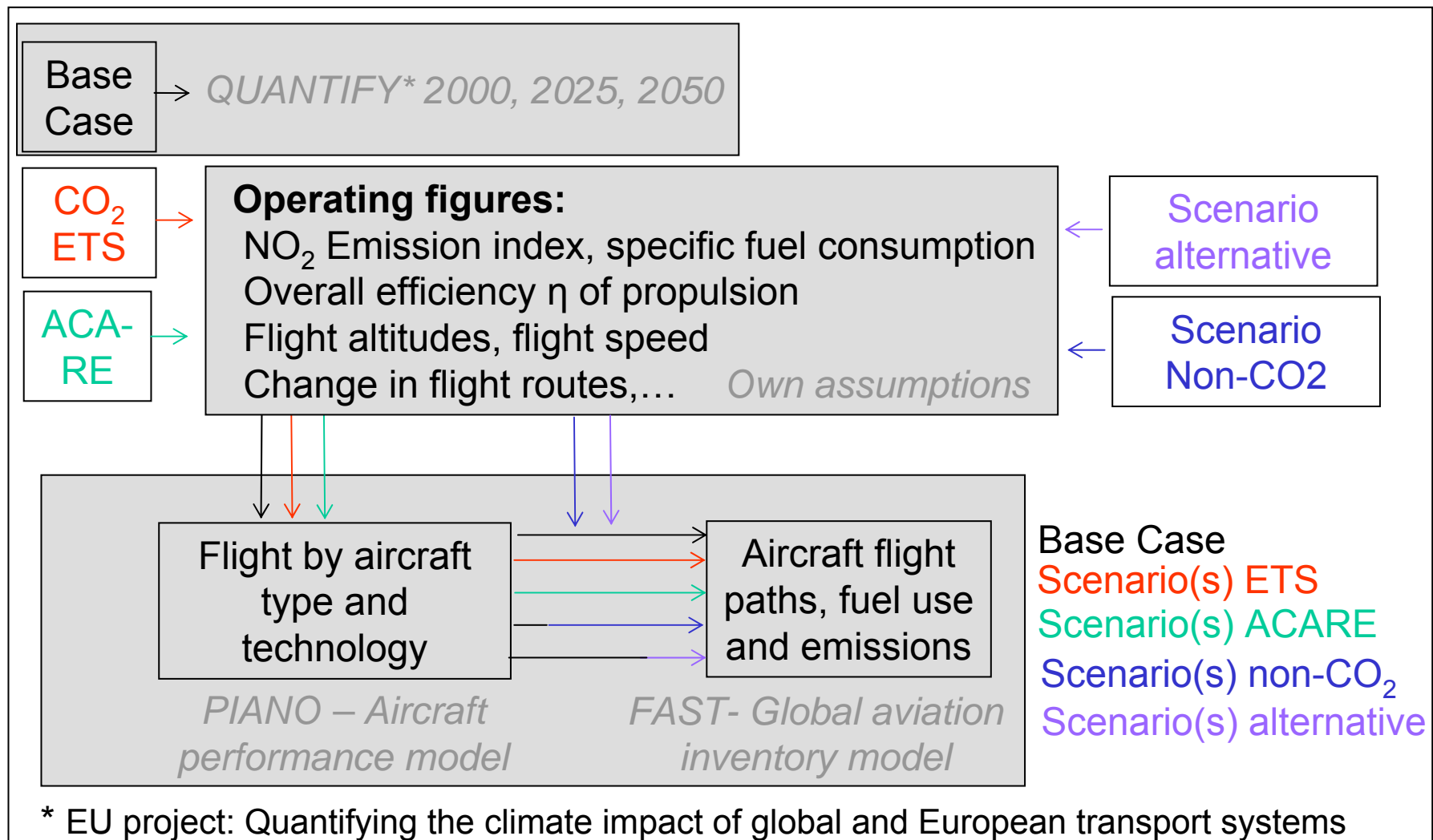


Development of kerosene prices (in US \$/ t CO₂) and the share of fuel costs in the operating expenditure (in %)

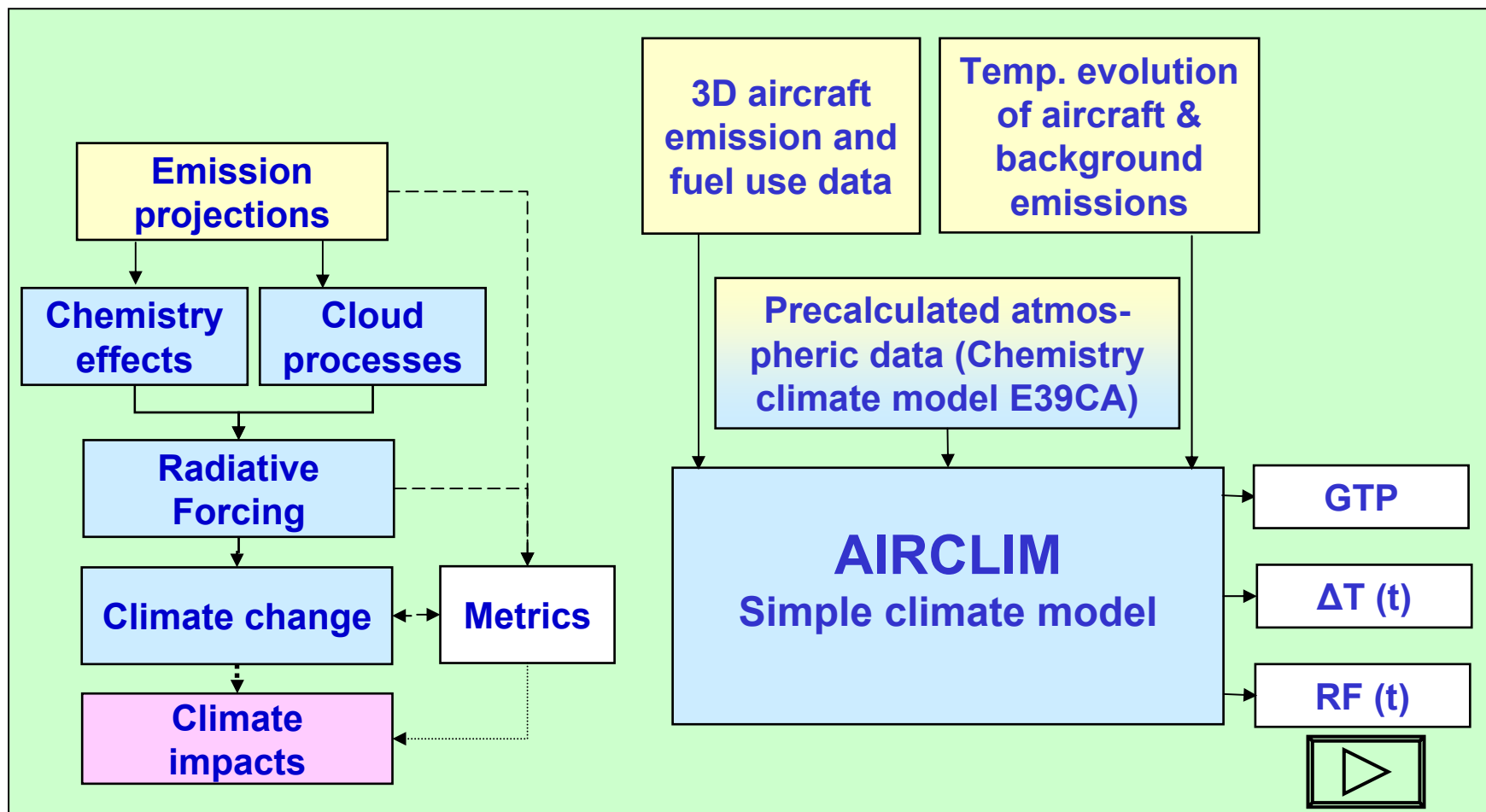
WP 3: Concept of emission scenario development



Emission scenarios: specification of data



WP 4: Climate Impact Assessment



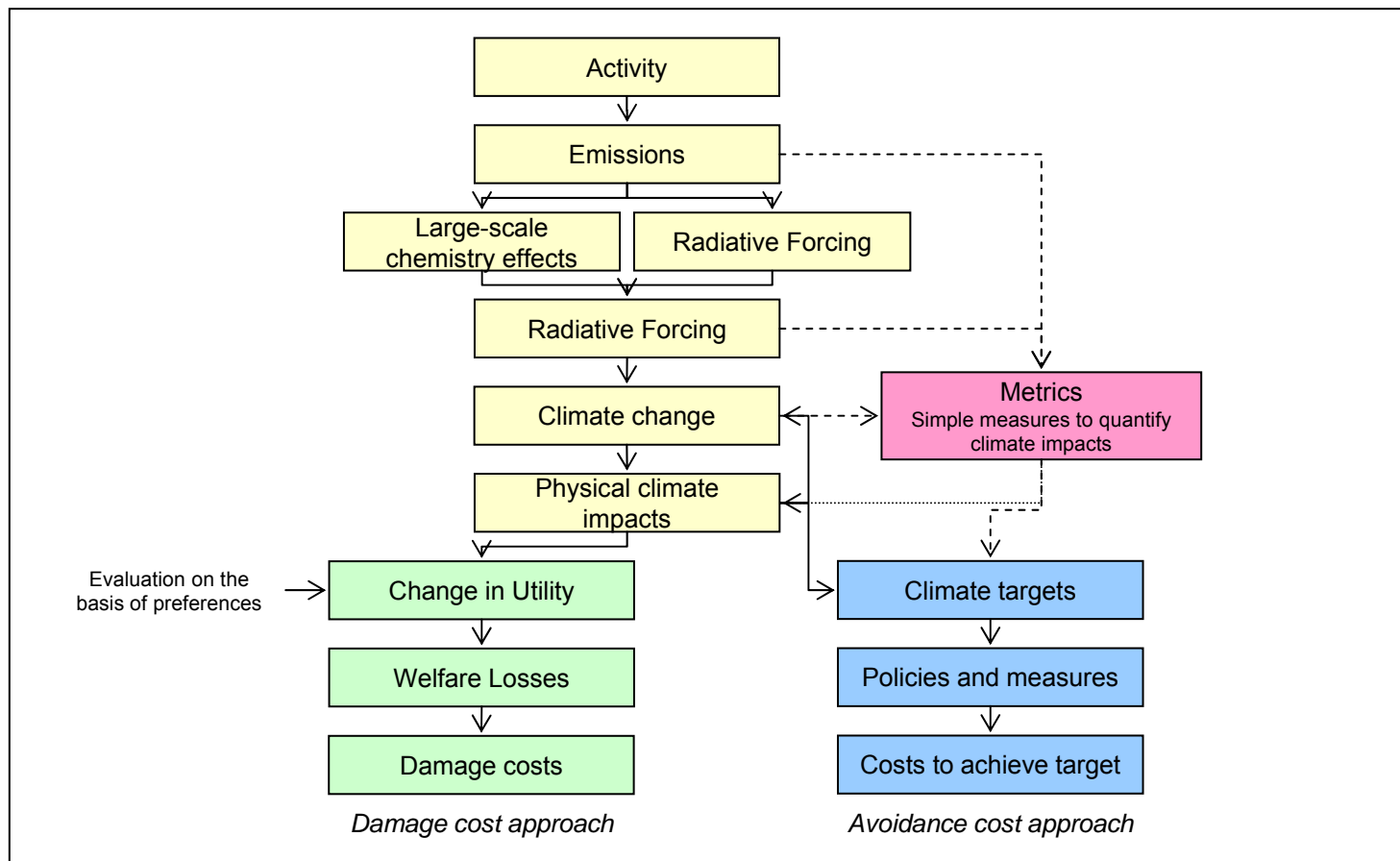
Role of metrics

- **Emissions and gases with different lifetimes and radiative properties are placed on a common scale.**
- **Any common metric premises a weighting of temperature changes overtime – a political, ethical question.**
- **The use of different time horizons lead to different perceptions of the relative importance of non-CO₂ effects.**
- **Adequacy of metric depend on research question.**
- **GWP only adequate for long-lived GHG. Currently no metric mature enough to compare long- and short-lived effects of aviation.**
- **Global Temperature Potential, once fully understood and developed, could be an adequate metric for market-based options in aviation.**

WP 5: Economic evaluation of climate impacts and discussion of policy options

- **Development of economic assessment criteria to evaluate the emission scenarios.**
- **Evaluation of internalisation strategies: pathway methodology, avoidance cost approach.**
- **Role of metrics (discount factors) in the context of economic evaluation of climate externalities.**
- **Discussion of policy options to internalise full climate impact of European air traffic.**

WP 5: Evaluation of climate externalities: Extended pathway methodology adjusted to climate externalities



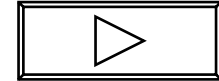


Thank you for your attention!

Publications

- **Deuber, O. (2007): Emissions trading in aviation – Assessment of incentive structures under the aspect of climate impact optimisation.**
Paper submitted to 5th International Research Workshop “Emissions Trading and Business” 7.-9. November 2007; Martin Luther University Halle-Wittenberg.
- **Deuber, O. (2008): Climate externalities of aviation – Particularities, economic evaluation methods and emissions trading as internalisation strategy. Working paper (unpublished).**

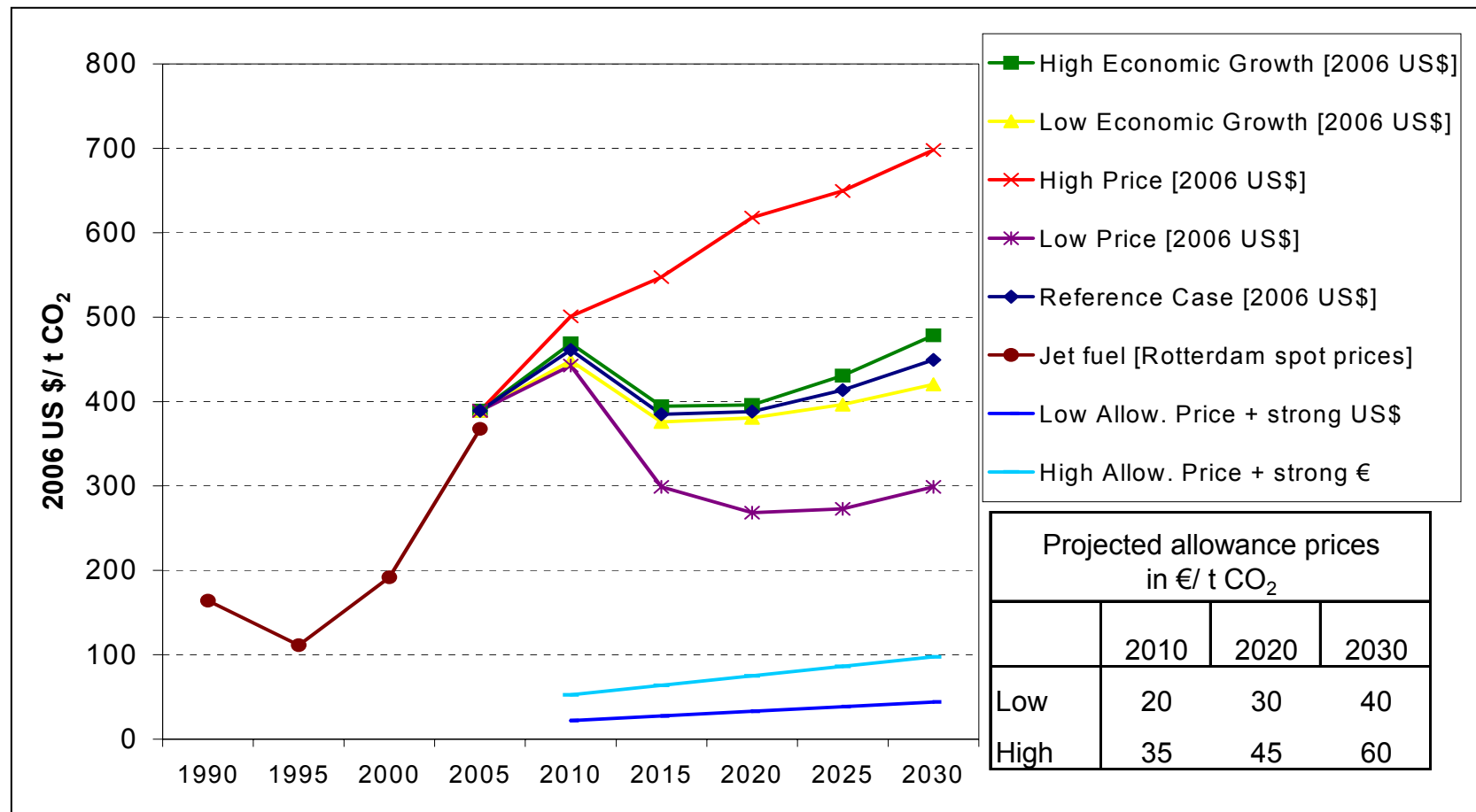
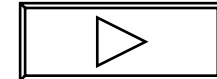
ACARE Environmental research targets



- Reduction of fuel consumption and CO₂ emissions by 50%
- Reduction of NO_x emissions by 80%
- Reduction of perceived external noise by 50%

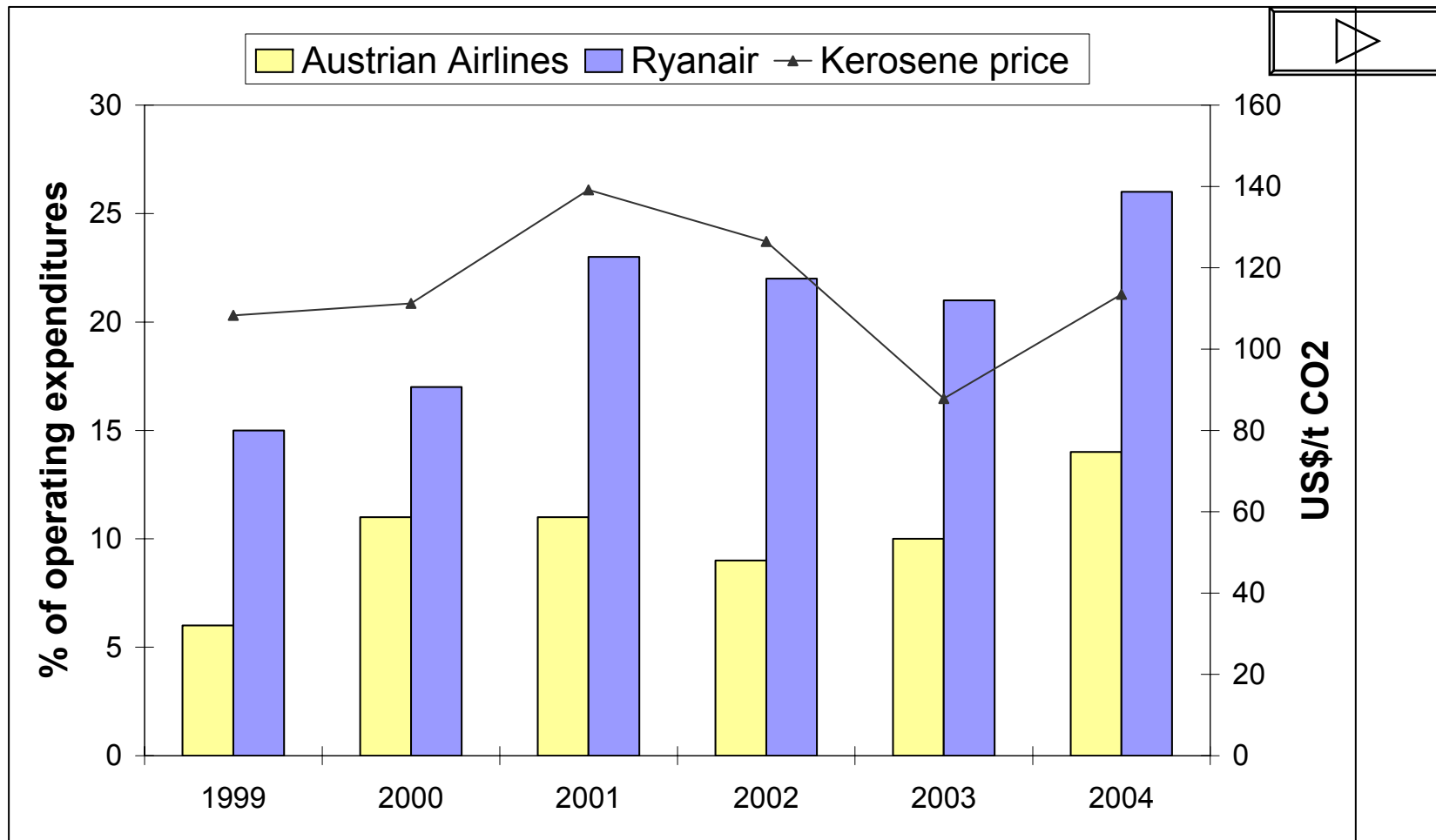
- Based on technological level of 2000
- Referring to revenue passenger km (RPKM)
- Doubling of historical rate of improvement

Past und projected trends of jet fuel prices in comparison to projected allowance prices



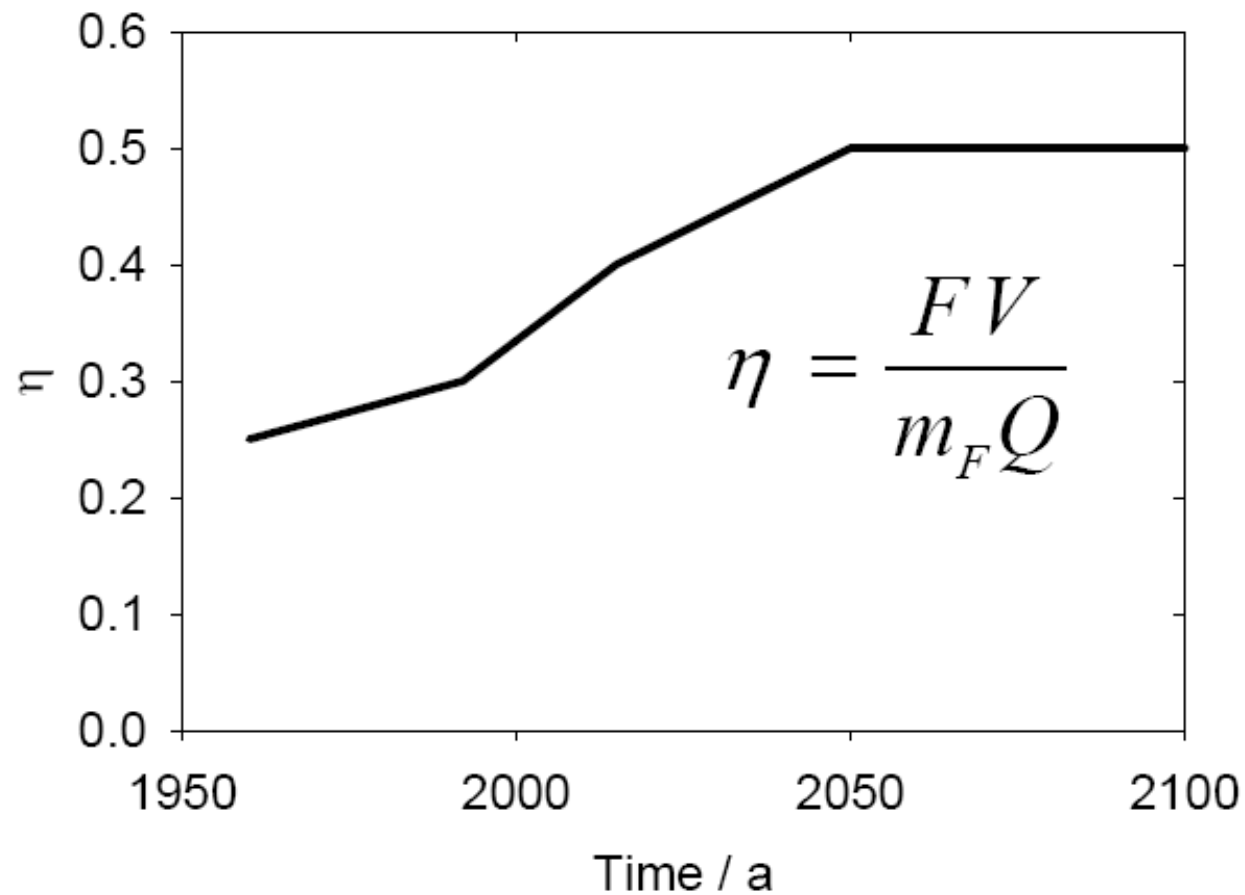
Source: EIA (2008); Matthes et al. (2007); own calculations

Development of kerosene prices (in US \$/ t CO₂) and the share of fuel costs in the operating expenditure (in %)

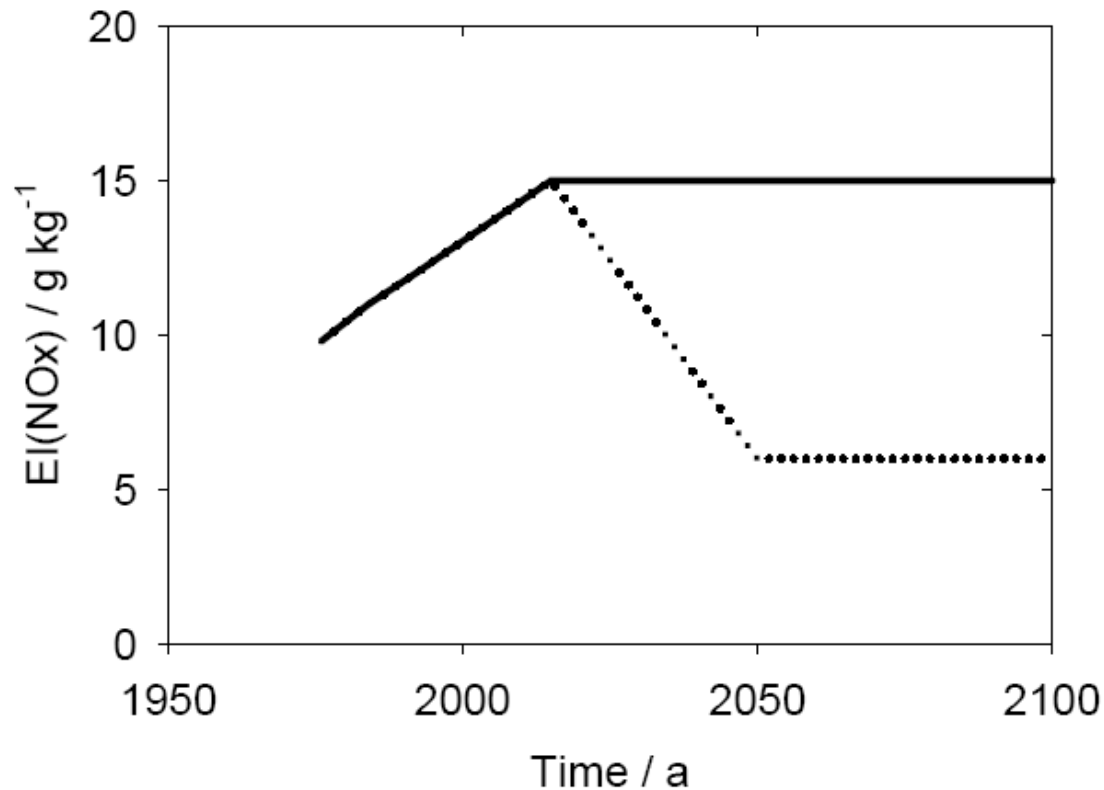


Source: Badura (2006)

Overall efficiency η of propulsion



Nitrogen oxides, NO_x (in mass units of NO₂), Emission-Index EI, with and without ACARE



ACARE:

80 % reduction
(factor 0.2)

reduced specific fuel
consumption by a
factor of 0.5

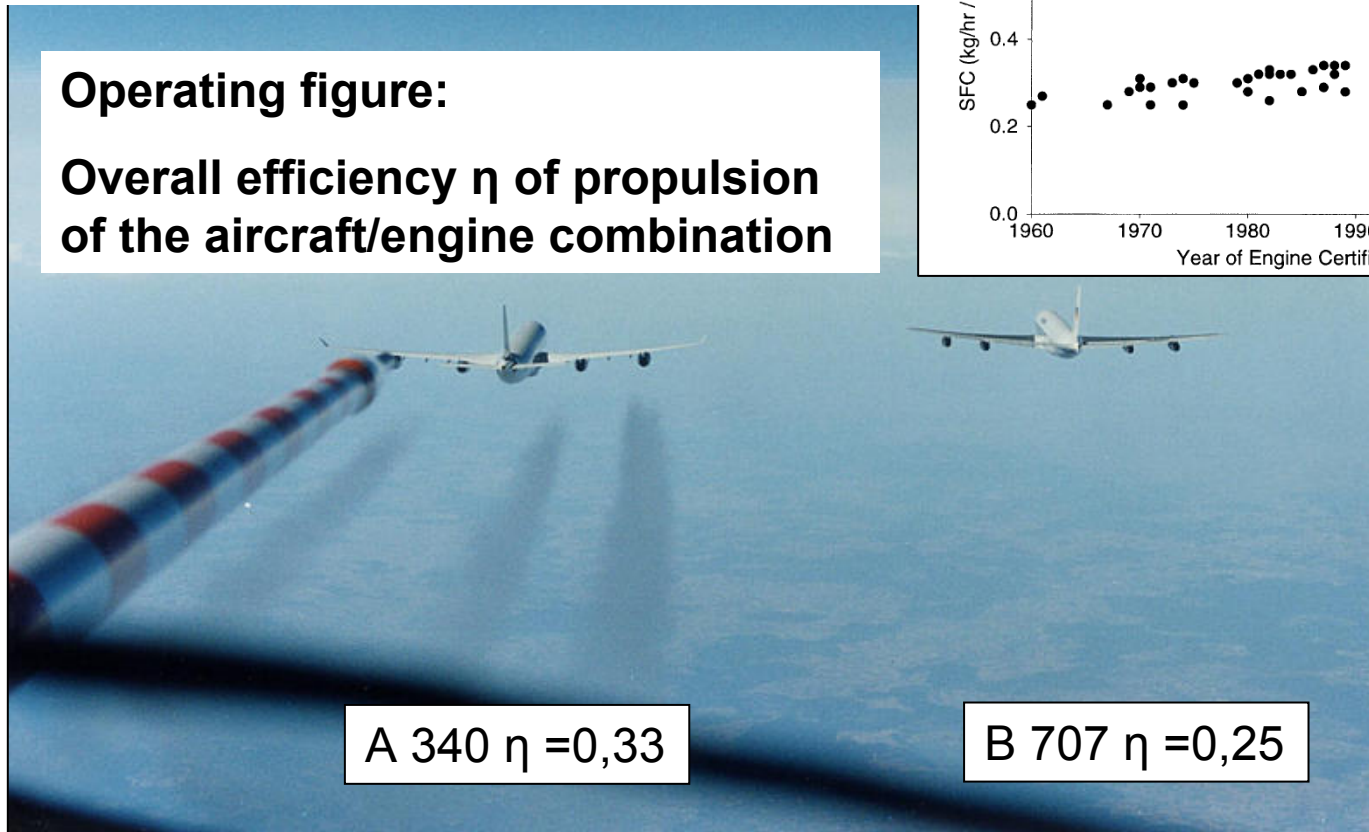
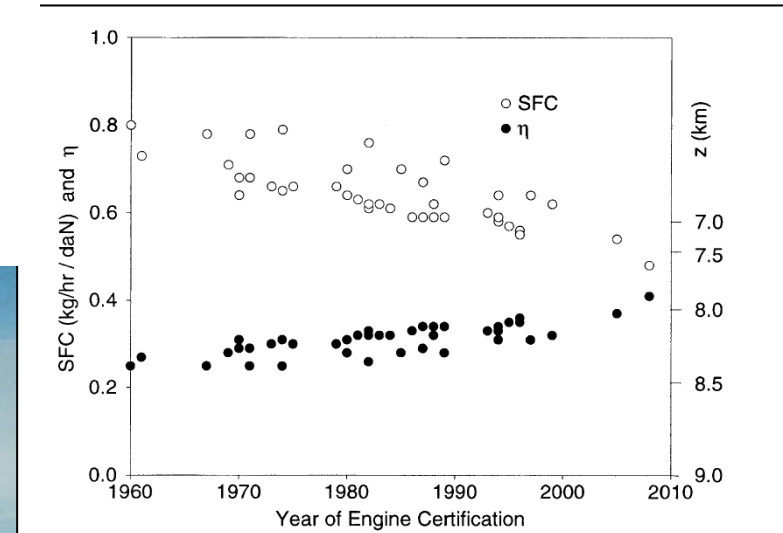
EI (NO_x) reduced by
a factor of 0.4

$$0.2 = 0.4 * 0.5$$

Trade-off: CO₂ reduction and contrail formation

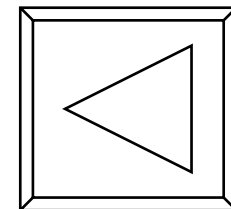
Operating figure:

Overall efficiency η of propulsion of the aircraft/engine combination



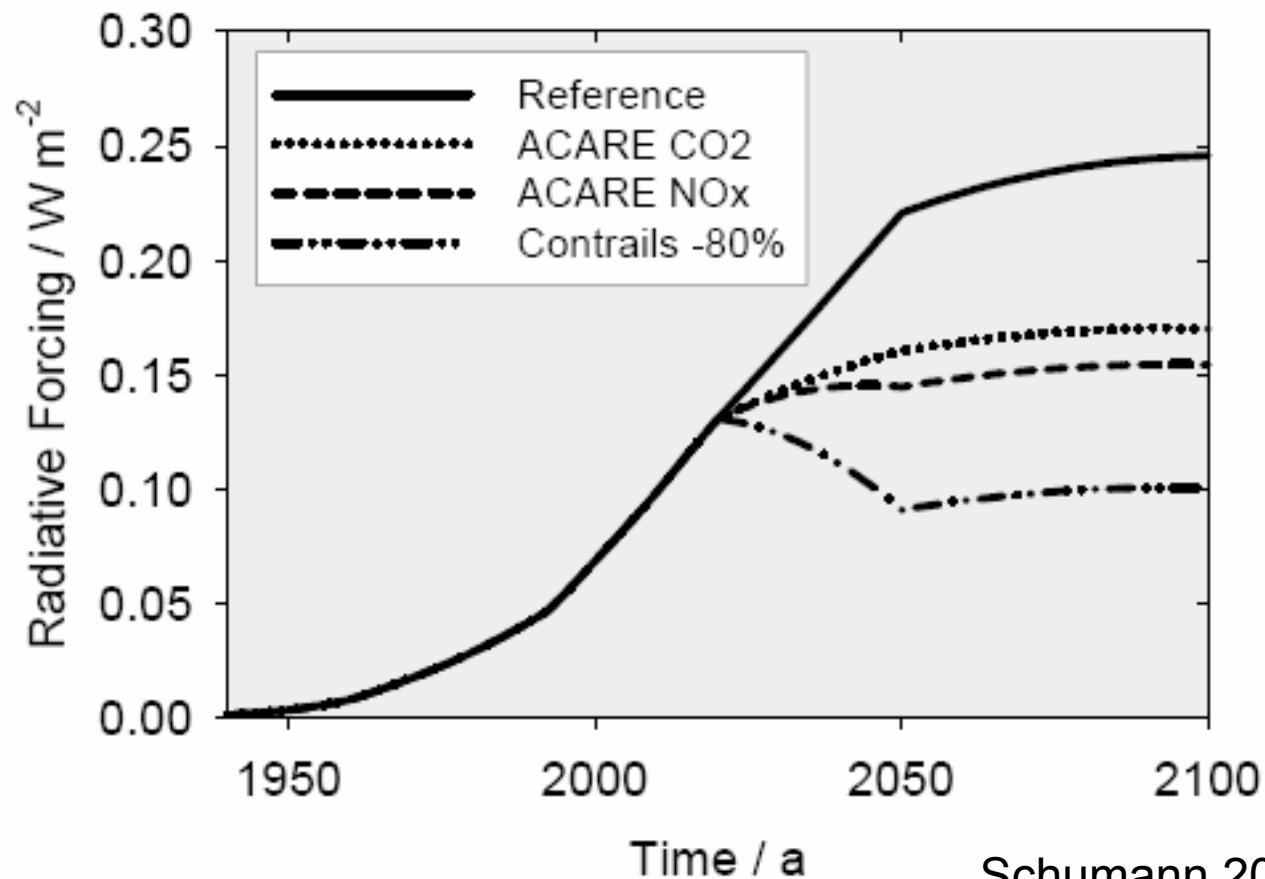
A 340 $\eta = 0,33$

B 707 $\eta = 0,25$



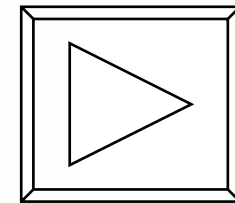
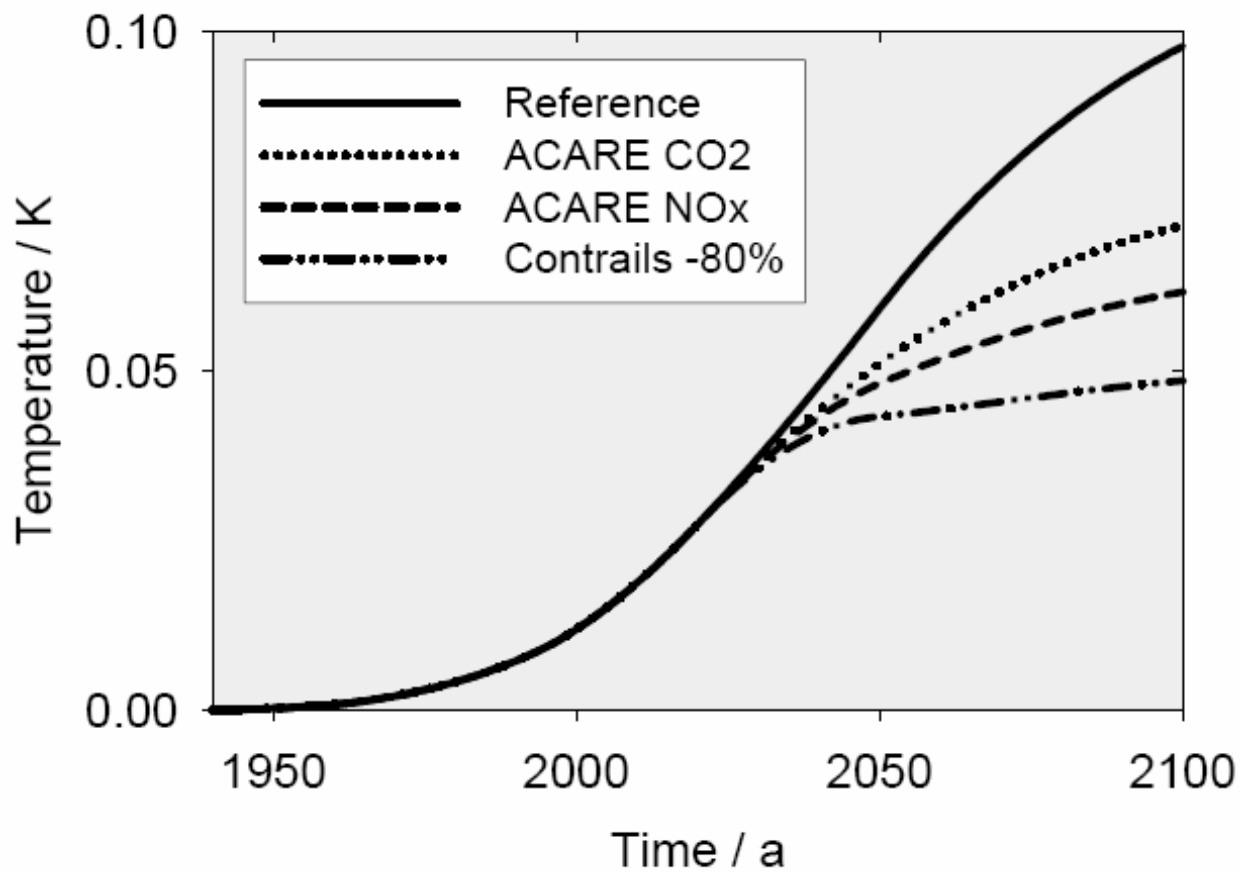
Source: Gierens et al. 1999; Schumann 2000

Schematic overview: Impact of ACARE and cloud avoidance strategy on radiative forcing of aviation

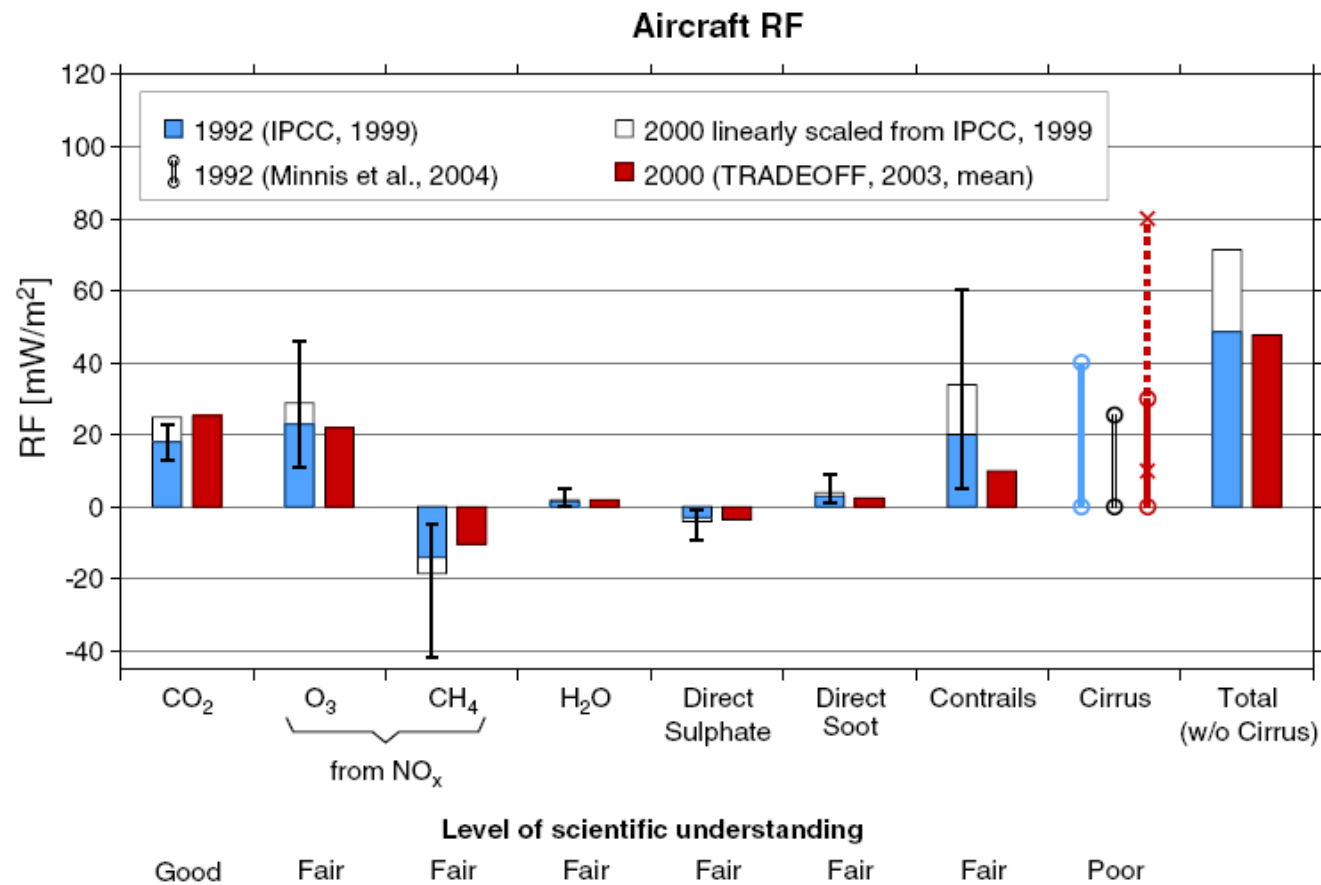


Schumann 2008

Schematic overview: Temperature change



Radiative Forcing from aviation [mW/m²] for 1992/ 2000



Sustained aviation emissions (2000): Temperature change (normalised to CO₂)

