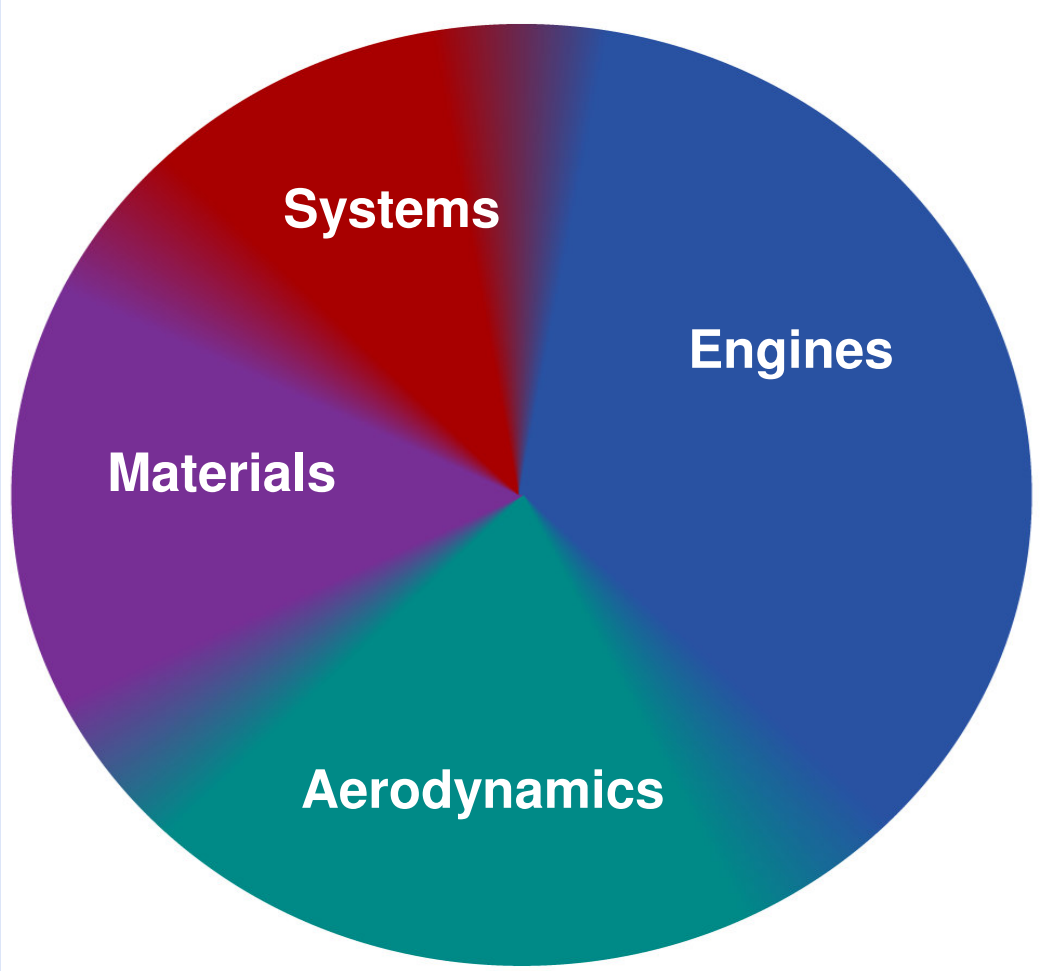
Advanced Technology Contributions to Airplane Efficiencies

Presented by ICAO
in cooperation with ICCAIA

Ghana, Accra, 23 August 2008

Airplane Efficiencies

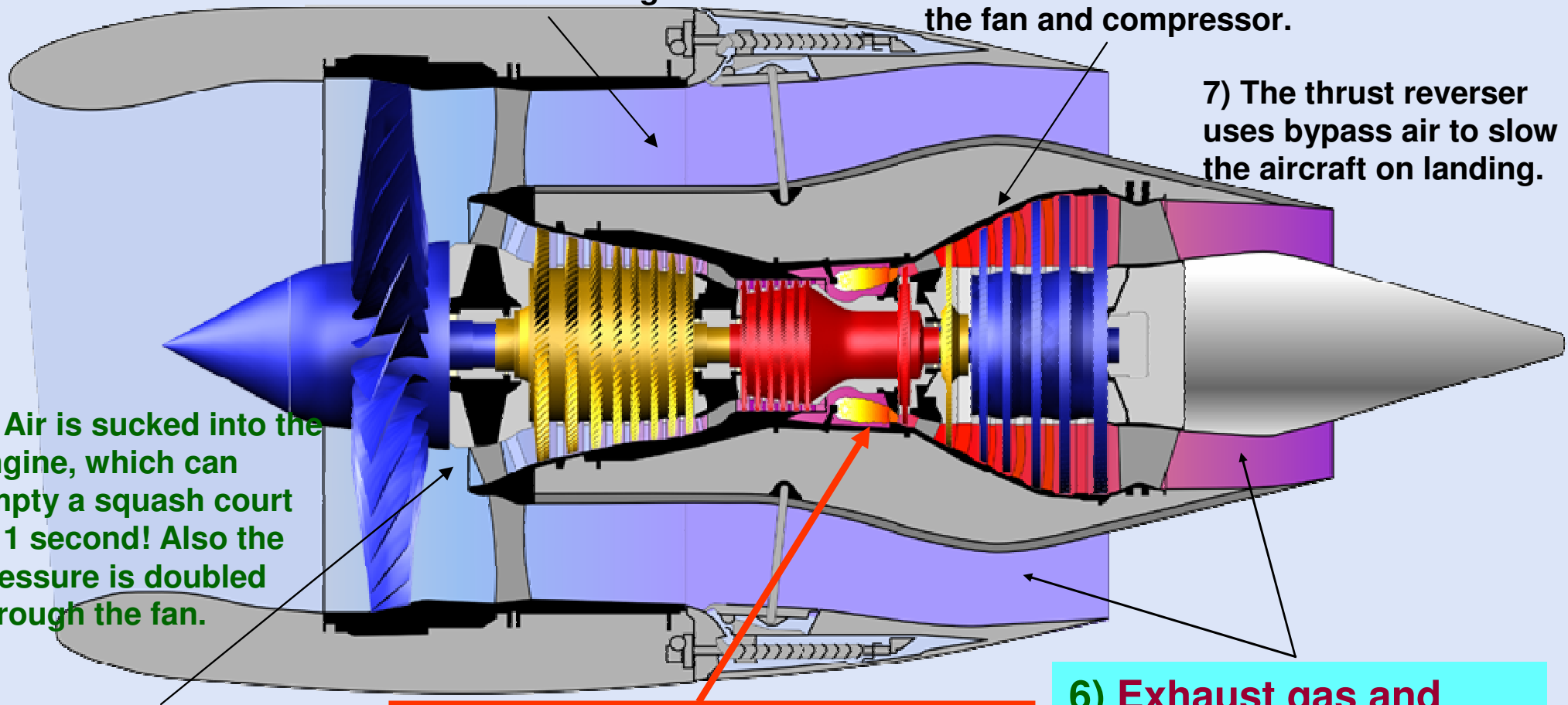
- Fuel-efficiency is a win–win situation for aviation
- As fuel is a substantial part of the operational cost and less fuel means less pollution, airplane and engine manufacturers have continuously improved the efficiency of aircraft
- Under record oil prices, the search for a breakthrough in fuel savings is paramount for the survival of the industry
- Many areas are being researched.



What Drives the Industry?

How aviation emissions are produced

Typical Turbofan Engine



3) 85% of the air bypasses the core and exits the engine.

5) The hot gas expands through the turbine which takes energy out to drive the fan and compressor.

7) The thrust reverser uses bypass air to slow the aircraft on landing.

1) Air is sucked into the engine, which can empty a squash court in 1 second! Also the pressure is doubled through the fan.

2) 15% of the air enters the core and is compressed to 40 times atmospheric pressure.

4) In the combustion chamber fuel is mixed with air and burnt at temperature ≈ 1900 °K with peak ≈ 2600 °K.

6) Exhaust gas and bypass air mix through hot and cold nozzles to produce thrust.

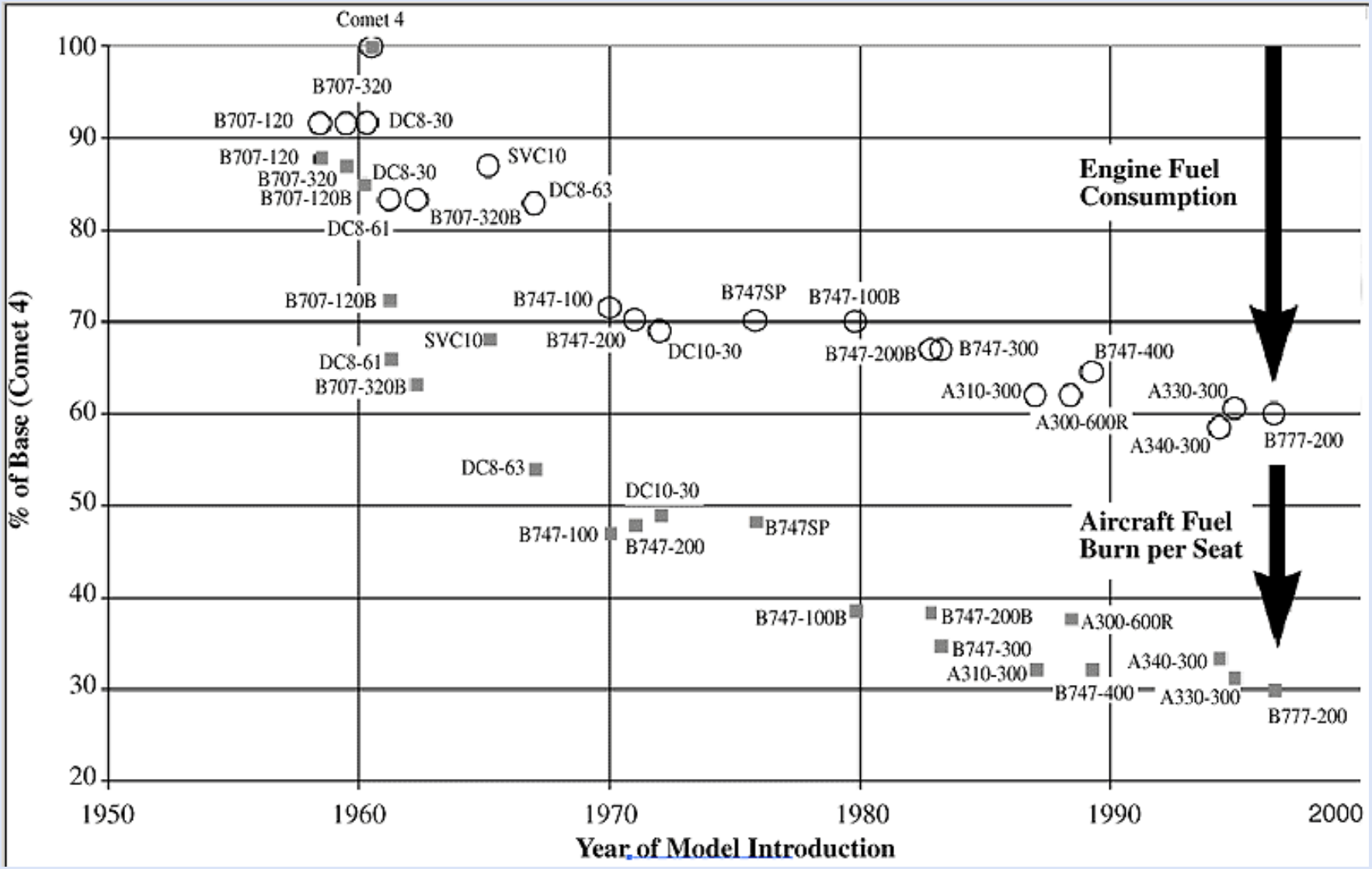
Environmental Policy Must be Consistent

- Safety of operations is paramount and
- All environmental concerns need to be addressed
  - **Global Climate**
  - **Local Air Quality**
  - **Aircraft Noise**
  - Land-Use
  - Water Quality

} **Manufacturer Focus**

The solution for meeting one concern cannot constrain meeting other concerns (interdependencies)

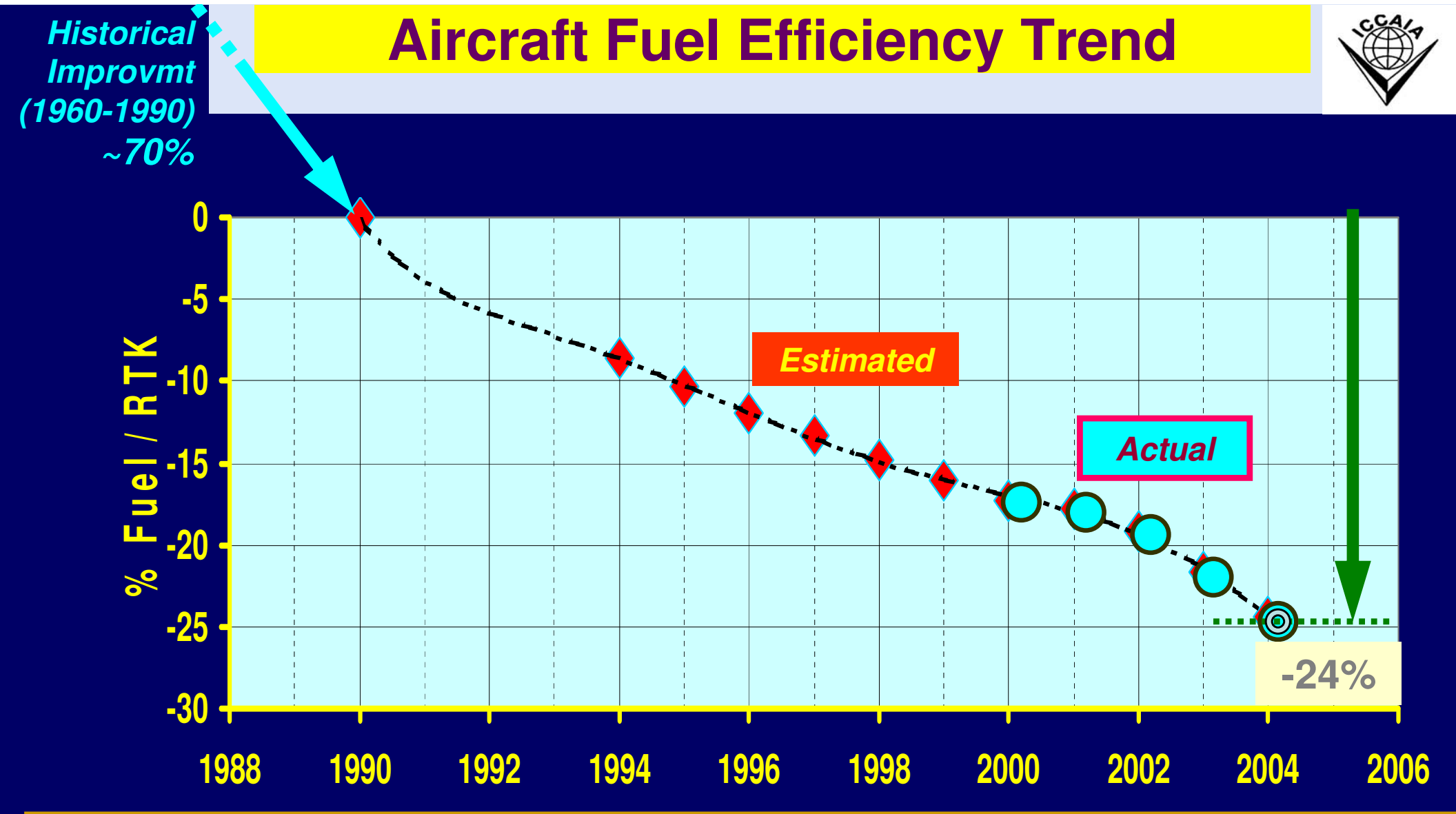
Fuel Efficiency



IPCC Special Report on Aviation And the Global Atmosphere

Figure 9-3: *Trend in transport aircraft fuel efficiency.*

Aircraft Fuel Efficiency Trend



~ 70% Fuel Efficiency improvement up to 1990 at product level

Continuing improvement reflected at fleet level (average > 1.5%/year)

Driven by strong & efficient market forces, combined with inherent fast-evolving high technology & improved operational practices

Needs sustained research & technology funding from Industry & Governments

Manufacturers Commitment at GIACC

- **At least 15% CO2 improvement in new generation aircraft while continuing to significantly reduce NO_X and noise**

- **Gains will come from aircraft and engine designers as they create and produce the new generation of aircraft**

- **Partner with**
  - **Airlines to achieve their environmental goals**
  - **Industry and government to transform the air transportation system and to qualify alternative fuels for aviation**

A few Initiatives from Industry

New generation regional jets

Bombardier CSeries

Bombardier C110/130:110/130 seats
with a range of 3,330km (Ext.R 5,556km)
Entry in service planned for 2013-2014,
CSeries engines expected to deliver 16
to 20% fuel savings

Bombardier
CSeries

2009 - ARJ21

ARJ21-700 : 70 to 80 seats
stretched ARJ21-900: 90 to 100 seats.
range of 2,225km and the extended-range
version has a range of 3,704km
In China alone domestic airlines are expected to purchase
almost 3,500 new aircraft by 2025.
CF34-10 engine

A few Initiatives from Industry

New generation wide bodies (for long haul)

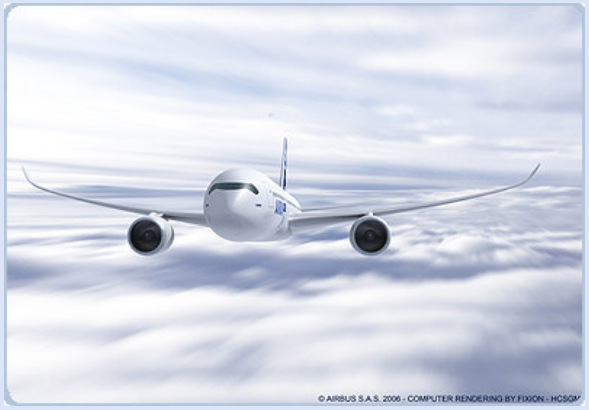
October 2007- A380

•Typical: 555 pax
•All-economy: 853 pax
•Future stretched version: A380-800 - 1,000pax
• Range: 15200 km
•Fuel consumption all-economy: **3 l/pax/100 km**

Customers expect at least a 15% improvement in costs per seat-mile compared to similar aircraft

End 2009: B787

•B787-8:210 - 250 pax (14,200 to 15,200 Km)
•B787-9:250 - 290 pax (14,800 to 15,750 Km)
•B787-3:290 - 330 pax (4,600 to 5,650 Km)
•Expected to use **20% less fuel** for comparable missions than today's similarly sized airplane



2013 - A350 XWB

•A350-800 for 270 pax;A350-900 for 314 pax
•A350-1000 for 350 pax;A350–900F (freighter)
•Range of up to 15,380km
•Expected to deliver **30 percent more fuel efficiency,** 20% lower cash operating costs per seat and fuel efficiency improvements of up to 25 per cent per seat.

A few Initiatives from Industry

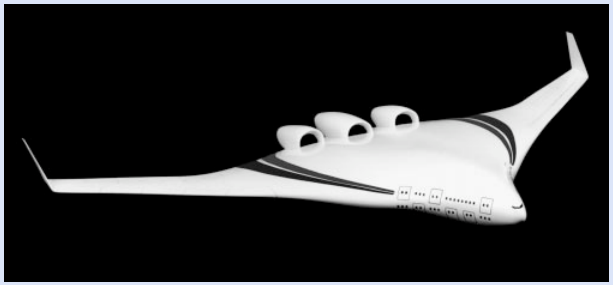
Pratt & Whitney's geared turbofan engine **(PW1000G engine)** to be used in Bombardier Inc.'s CSeries and the Mitsubishi Regional Jet - is said to **reduce fuel burn by 12 per cent** compared to the company's most efficient engine on the market.

GE Aviation, which produces engines for the Boeing 777 and B787, recently-announced the expected results of the eCore program. ECore, to be used in the CFM engines GE co-produces with France's Snecma, are touted to deliver **16 per cent better fuel efficiency** than the company's best existing models.

Rolls-Royce BR725 - Compared with the highly successful BR710, the BR725 is more powerful, has **4 per cent better specific fuel consumption and shows a 21 per cent improvement in NOx emissions**. Design features include a 50-inch diameter fan assembly made up of 24 “swept” titanium blades for improved aerodynamic efficiency and lower noise. Flight test engines being delivered to Gulfstream towards the end of 2008.

More Radical Technologies

- Blended wing body
- Blended Winglets will save up to 6.5% on fuel consumption per aircraft annually on long-segment flights
- Hybrid Laminar Flow Control
- Nano-tailored Materials and Structures
- Advanced Fuel Cells
- Liquid Hydrogen
- etc.

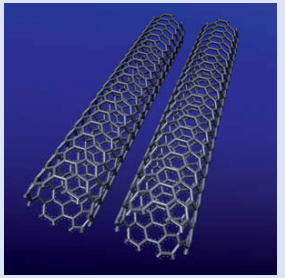


Source: NASA

Source: Airbus

Source: Airbus

Source: HAW Hamburg



Aviation Environment – Ongoing Research Initiatives

EU

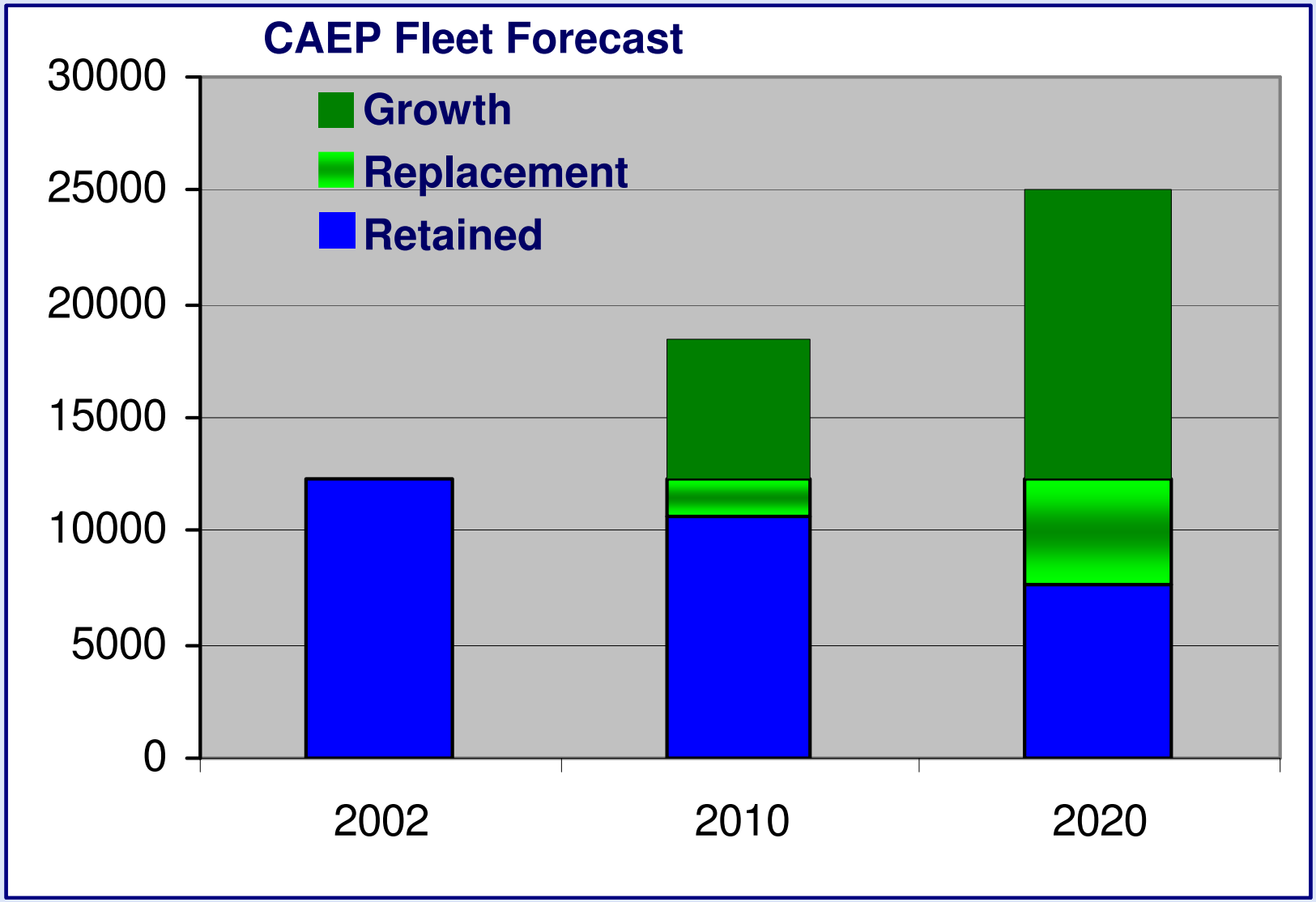
- **Clean Sky**
  - Reduce fuel burn and CO2, NOx and noise, Green product lifecycle
- **SESAR**
  - Improved trajectory efficiency and navigation capability
- **7th Framework Programme**
  - Various different projects (Aerodynamics, Structure, Systems, Engines, etc.)

US

- **NASA's National Plan for Aeronautics Research and Development**
  - Reduced engine fuel consumption, noise and emissions, alternative fuels
- **NextGen**
  - Transformation of the US national air transportation system

Penetration of Technology into Global Fleet

As aircraft fleet is likely to double in 20 years the achieving a max fuel efficiency in the next generation aircrafts is paramount



Alternative Fuels

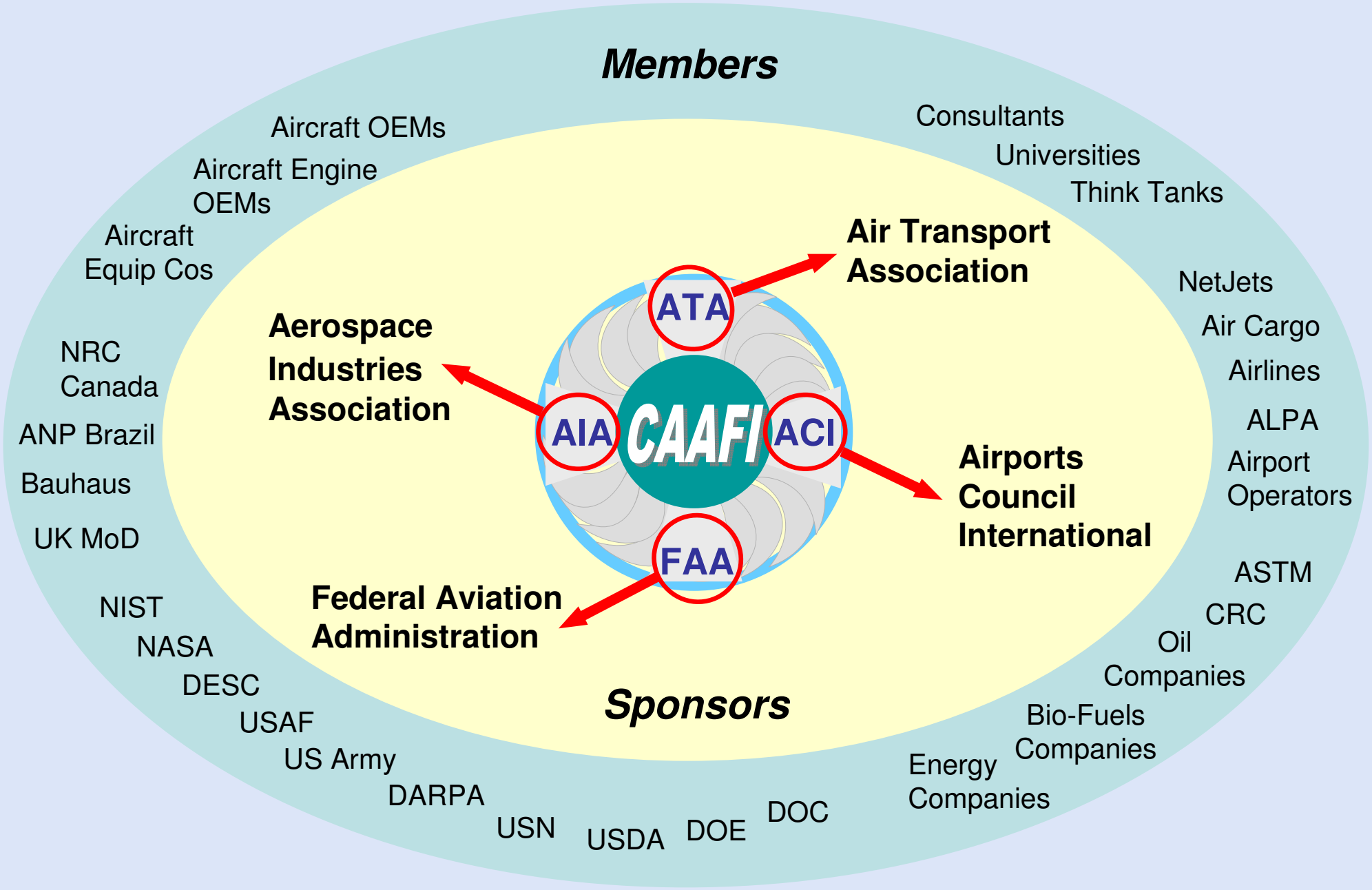
- Aviation has no viable non-carbon fuel substitute in the short term
- Goal is gradual introduction of lower carbon content fuel over ten (10) years
- Emphasis is on synthetic biofuels and biomass
- Manufacturers are investing in their development

Industry Alternative Fuel Initiatives

Biofuel Flight Demonstrations Planned for 2008 - 09

- **GE / Boeing / Virgin Atlantic - 1Q 2008** ✓
  - B747-400 Partially Fueled with a Mix of Coconut Oil and Babassu Oil
- **Airbus /Rolls Royce / Shell - 1Q 2008** ✓
  - A380 successfully completed the world's first ever flight on Gas to Liquid (GTL)
- **Rolls Royce /Boeing / Air New Zealand - 4Q 2008**
  - To test this year on a Boeing 747 using jatropha oil
- **IAE / Airbus / Jet Blue / Honeywell – 2009**
  - pursue development of a sustainable second-generation biofuel for use in commercial aircraft
- **P&W / Boeing / JAL Test Flight Using 2nd Gen Bio Fuel**
  - Demonstration flight scheduled by end of 1Q 2009

Commercial Aviation Alternative Fuels Initiative



Technology = Continuous Emissions Reductions

- Technology is an essential part of the response to climate change
- Consideration of interdependencies is needed for the development of new technologies
  - 15% CO_2 improvement in each new generation
  - Along with further NOx & Noise reductions
- Technological breakthroughs require additional investment in R&D

The future,
you do not have to foretell it,
but to enable it.

Antoine de Saint Exupery

Thank You