



Selection of measures



Outline

- Basket of measures
- Feasibility and emissions reduction potential of measures
- Prioritisation and selection of measures
- Expected results: Quantifying the effects on fuel consumption and CO₂ emissions from the measures selected
- Metrics
- Implementation



Basket of Measures

- High-level Meeting on International Aviation and Climate Change in October 2009 (HLM-ENV/09) endorsed the Programme of Action on International Aviation and Climate Change, which included:
 - global aspirational goals;
 - a basket of measures; and
 - the means to measure progress.



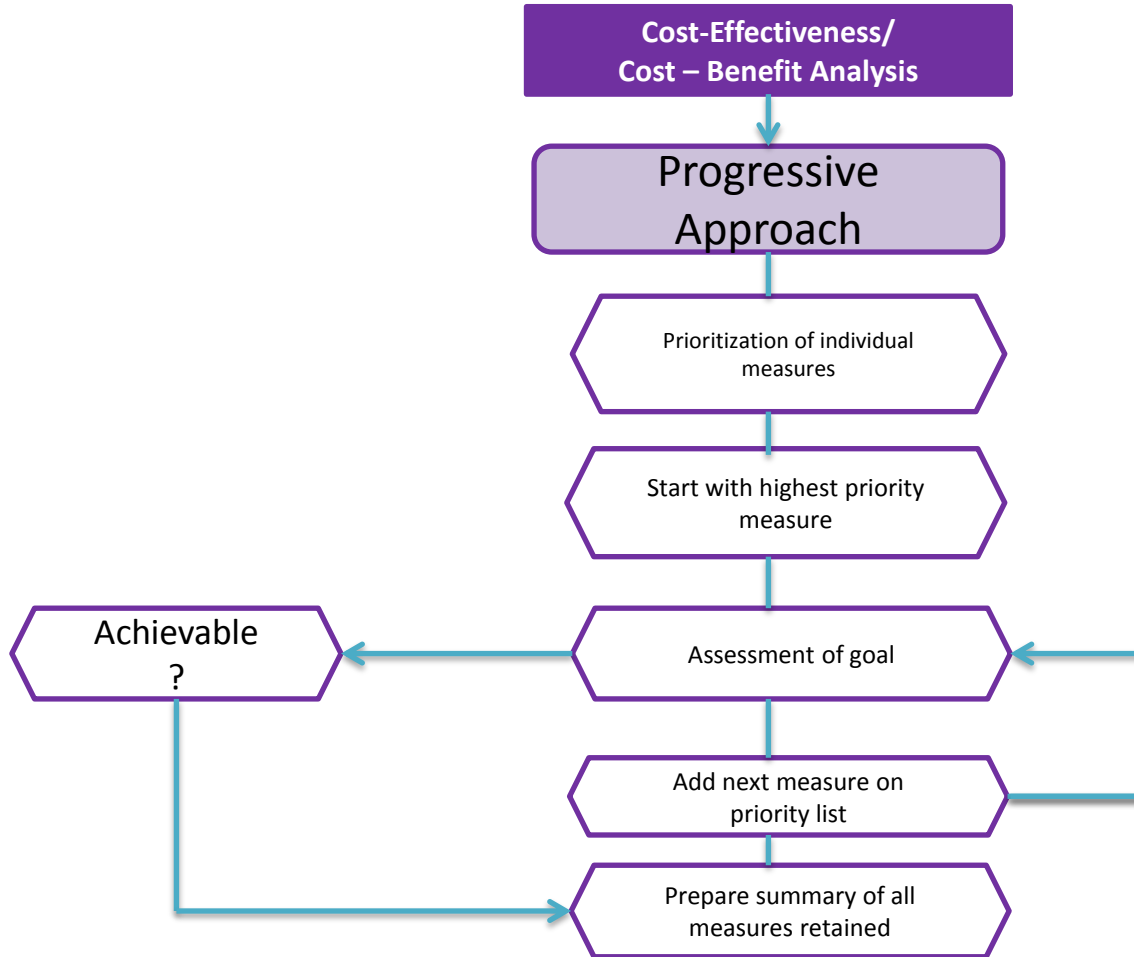
Prioritization and selection of mitigation measures

Key steps

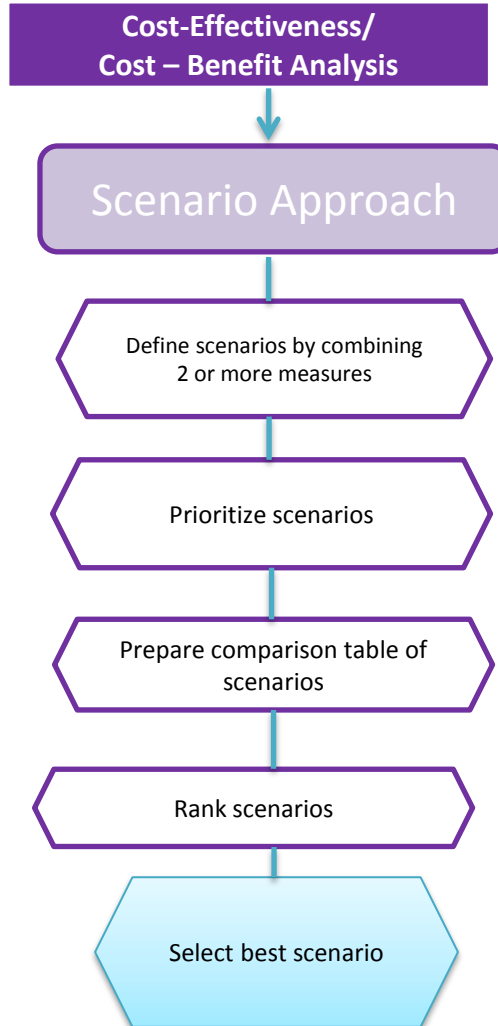
- Establish a team to develop an action plan, including:
 - Administrative and organizational arrangements
 - Identification of national conditions
- Estimation of historical CO₂ emissions from international aviation
- Establishment of a baseline



Indicative sequence of steps for a cost-effectiveness or cost-benefit analysis



Indicative sequence of steps for a cost-effectiveness or cost-benefit analysis



Prioritization and selection of mitigation measures

A cost-effectiveness or cost-benefit analysis may be performed prior to the prioritization exercise (see Appendix F) . There are two possible approaches to select measures:

- *Progressive approach*
 - Measures are ranked individually and added progressively to achieve the goal(s)
- *Scenario approach*
 - Measures are combined in scenarios and ranked in combination



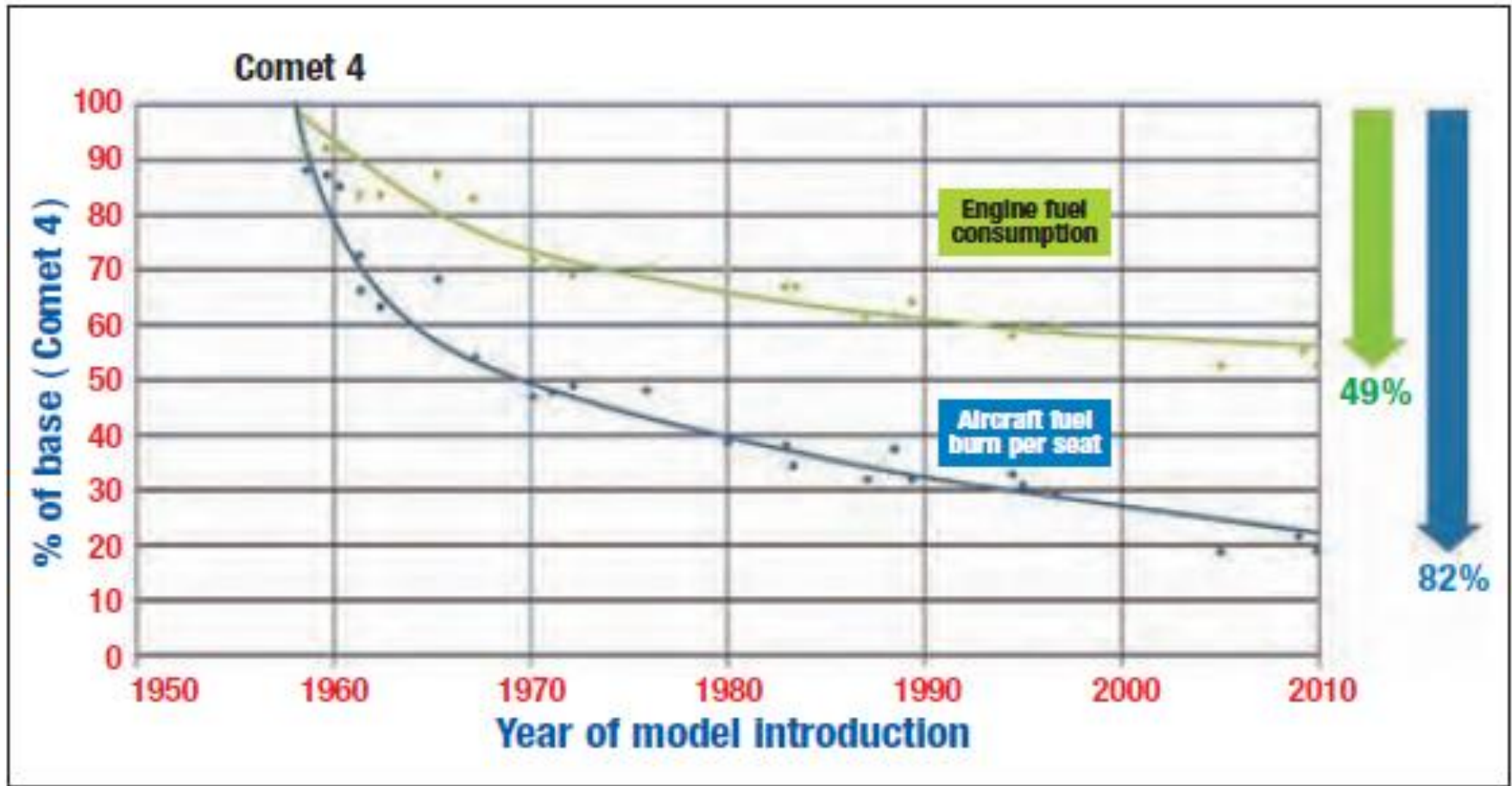
- Seven (7) categories of measures:
 1. aircraft-related technology development;
 2. alternative fuels
 3. improved air traffic management and related infrastructure use
 4. more efficient operations
 5. economic/market-based measures
 6. regulatory measures/other; and
 7. airport improvements
- Reference material: Appendices D, E and F.



Aircraft-related technology development

- Aircraft minimum fuel efficiency standards;
- Aggressive aircraft fuel efficiency standards, setting standards for the future;
- Purchase of new aircraft;
- Retrofitting and upgrade improvements on existing aircraft;
- Optimizing improvements in aircraft produced in the near- to mid-term;
- Avionics;
- Adoption of revolutionary new designs in aircraft/engines, and
- Other





Aircraft-related technology development - *Engine Technology*

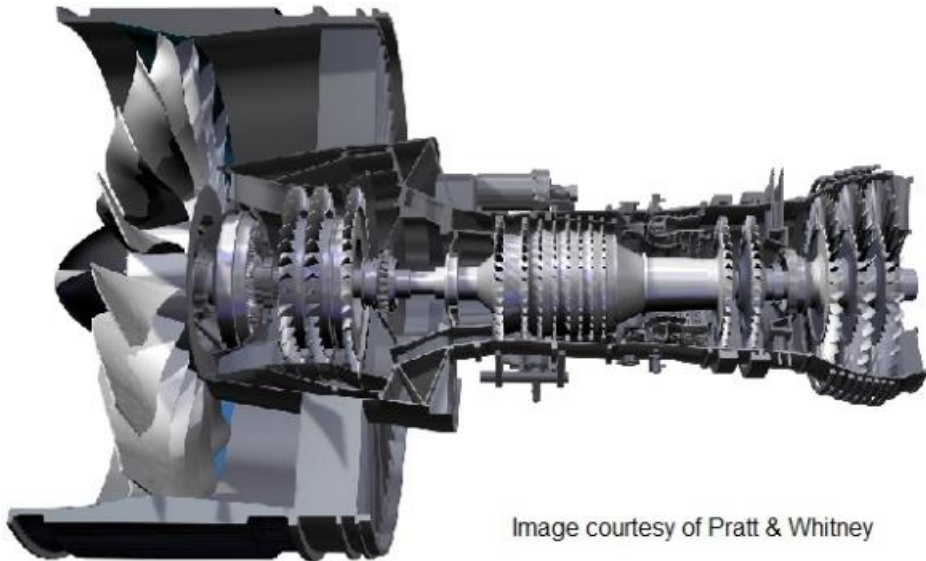


Image courtesy of Pratt & Whitney



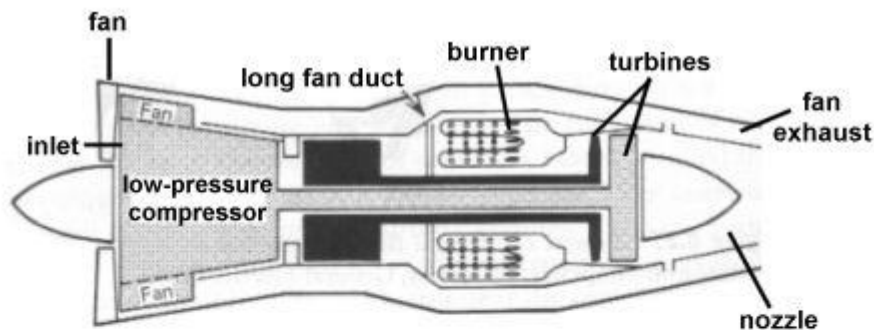
CFM International

<http://www.ecomagination.com/portfolio/genx-aircraft-engine>

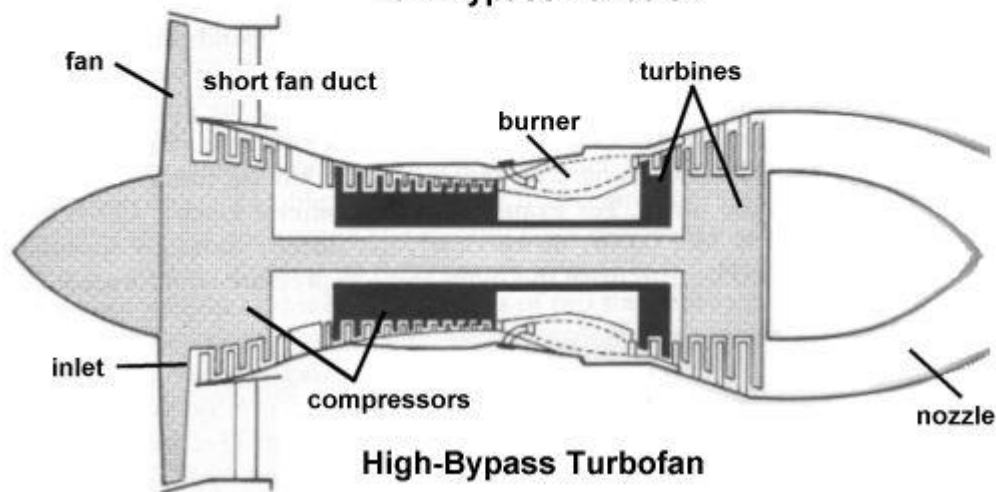
<http://machinedesign.com/archive/fewer-trips-fuel-truck>



Aircraft-related technology development - *Engine Technology*



Low-Bypass Turbofan

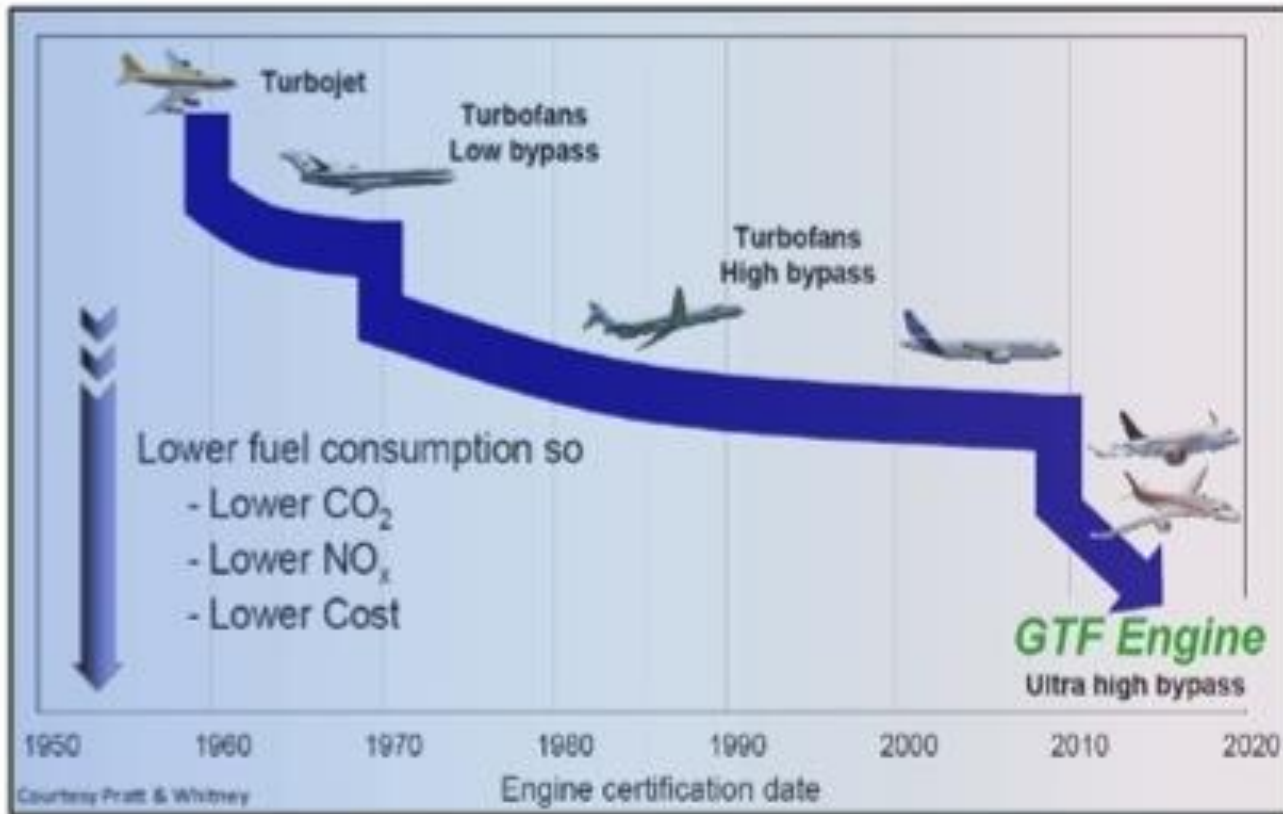


High-Bypass Turbofan

<http://www.aerospacweb.org/question/propulsion/q0033.shtml>



Aircraft-related technology development - *Engine Technology*



<http://theenergycollective.com>

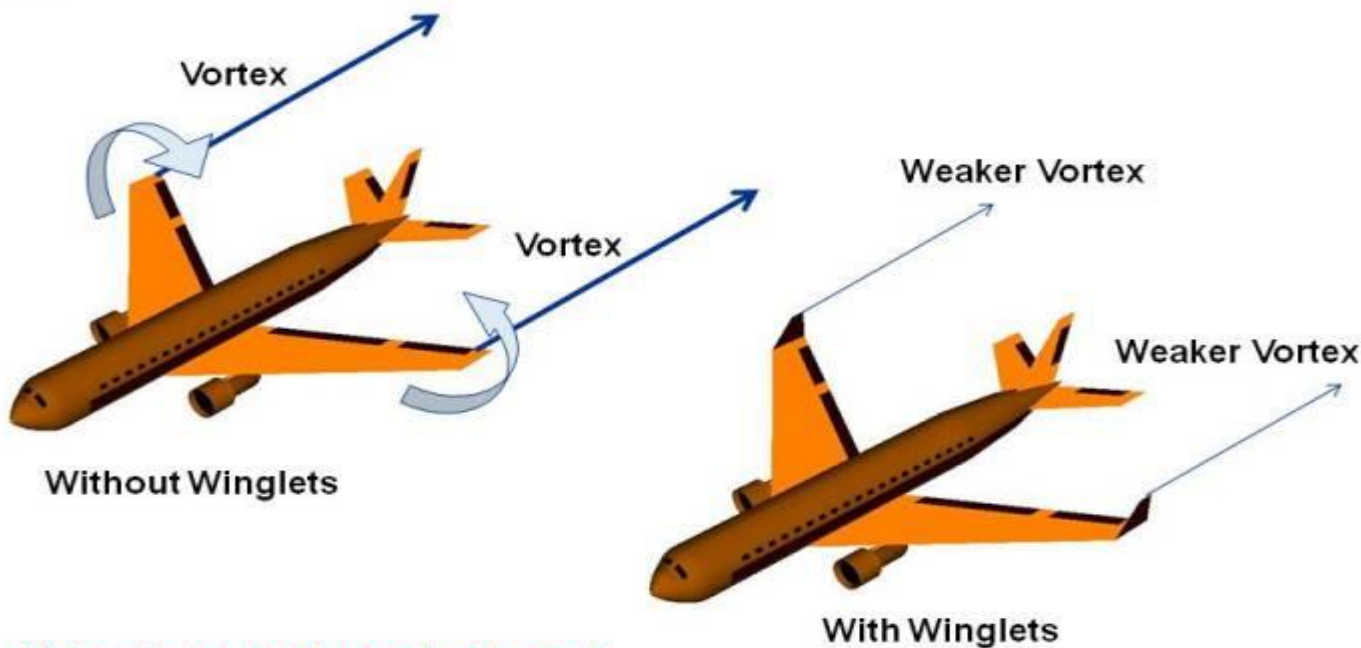


Aircraft-related Technology Development - *Engine technology*

National Aeronautics and Space Administration



Winglets



Winglets reduce induced drag component.

<http://www.grc.nasa.gov/WWW/k-12/airplane/winglets.html>

www.nasa.gov



Aircraft-related Technology Development – Aerodynamics

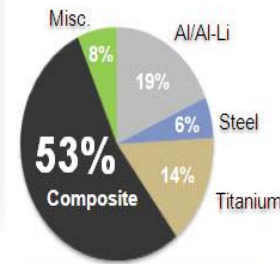
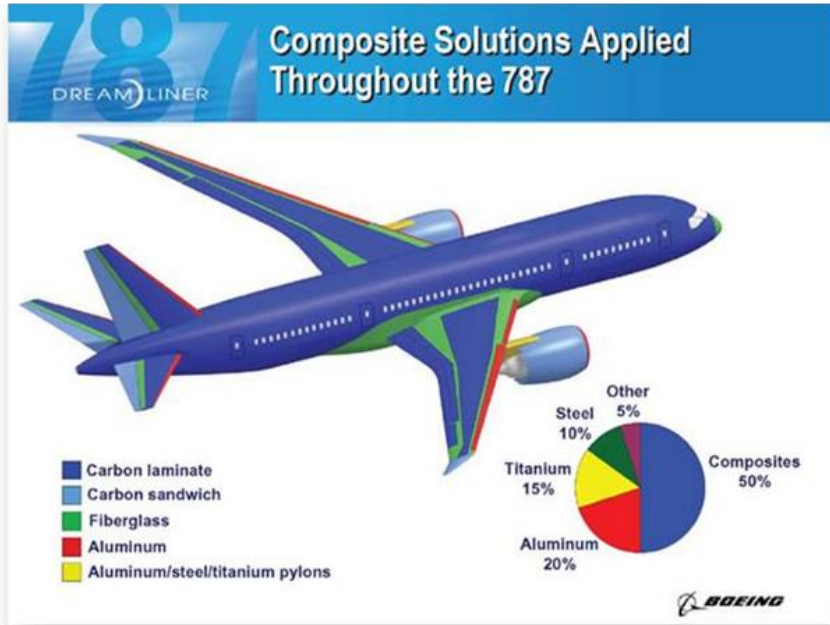


Winglet installation

<http://www.airlinereporter.com/2012/07/photo-of-note-boeing-737-max-winglet/>



Aircraft-related Technology Development – Airframe



- **Titanium**
 - High load frames
 - Door surroundings
 - Landing gear
 - Pylons
- **No corrosion tasks**

- **CFRP**
 - Wings
 - Centre wing box and keel beam
 - Tail cone (Section 19)
 - Skin panels
 - Frames, stringers and doublers
 - Doors (Passenger & Cargo)
- **No corrosion & fatigue tasks**

Information courtesy of ICCAIA



Aircraft-related Technology Development - Green Taxiing



<http://www.bbc.co.uk/news/business-22992654>



<http://www.planet-trucks.com/truck-news/a32889/taxibot-causes-zero-fuel-emission-and-zero-noise-pollution-html>

On engaging with the TaxiBot, the nose wheel of the aircraft enters the vehicle turret and is quickly clamped securely into position. The turret is able to rotate freely and can hence take steering and braking requests directly from the nose wheel - the flight crew can thus manoeuvre the aircraft around the taxi-ways of the airport without using the plane's main engines

EGTS



http://www.aviationpros.com/press_release/10705890/altalia-and-wheeltug-sign-electric-taxiing-partnership

Wheel tug

Taxi-bot



Aircraft-related technology development

- Lead to significant emissions reductions
- Require substantial investment
- Medium-term, long-term, longer-term
- In some cases, cannot be justified solely on the grounds of environmental goals
- May be more feasible and attractive should funding and other assistance be made more accessible



Aircraft-related technology development

ICAO global CO₂ Certification Standard for aeroplanes:

- agreement on a metric system that can be used to characterize the CO₂ emissions from aircraft of varying types and technologies (July 2012)
- agreement on the certification requirement and procedures supporting a new CO₂ standard for aeroplanes (February 2013)
- Next steps:
 - Development of stringency options
 - Applicability of the standard
 - Environmental Benefit and Cost effectiveness analysis

The Aeroplane CO₂ Emissions Standard is aiming for completion in 2016.



Alternative Fuels

- development of biofuels;
- development of other fuels with lower life-cycle CO₂ emissions;
- standards/requirements for alternative fuel use.
- other



<http://lae.mit.edu/alternative-fuels/>



Sustainable alternative fuels

- Potential for significant emissions reductions
 - Depends on feedstock type and cultivation, conversion process...
- Emissions reductions achievable with existing aircraft
- Benefits will depend on:
 - the availability of such fuels and the time profile of their deployment;
 - their actual lifecycle emissions reduction
- Challenges
 - Decreasing production cost
 - Investment in feedstock production and conversion facilities
 - Ensuring a sustainable deployment
- States' policy support is required



Sustainable alternative fuels

- **Global Framework on Aviation Alternative Fuels (GFAAF)**



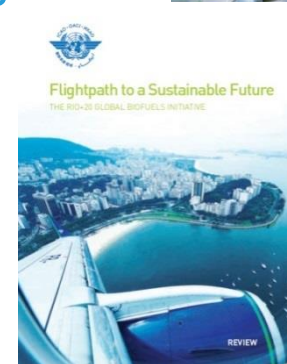
- A database on aviation alternative fuels

<http://www.icao.int/environmental-protection/GFAAF/Pages/default.aspx>



- **ICAO's SUSTAF Experts Group**

- Analysis of the challenges and recommendations
- Outcomes available on the GFAAF



Improved air traffic management and infrastructure use

- more efficient ATM planning, ground operations, terminal operations (departure, approach and arrivals), en-route operations, airspace design and usage, aircraft capabilities;
- more efficient use and planning of airport capacities;
- collaborative research endeavours.
- other



Improved air traffic management and infrastructure use

- Lead to moderate emissions reductions (significant in some cases)
- Involve substantial investments (ANSPs, air carriers)
- Other performance dimensions (safety, reliability, cost, capacity, etc.)



Improved air traffic management and infrastructure use

- ICAO's Global Air Navigation Plan (Doc 9750)
ICAO's Global Air Navigation Report – April 2014
- ICAO's PIRGs' environmental initiatives
- ICAO's Aviation System Block Upgrades
- The Global Air Traffic Management Operational Concept (Doc 9854)
- Manual on Air Traffic Management System Requirements (Doc 9882)
- Manual on Global Performance of the Air Navigation System (Doc 9883)





Improved Air Traffic Management and Infrastructure Use

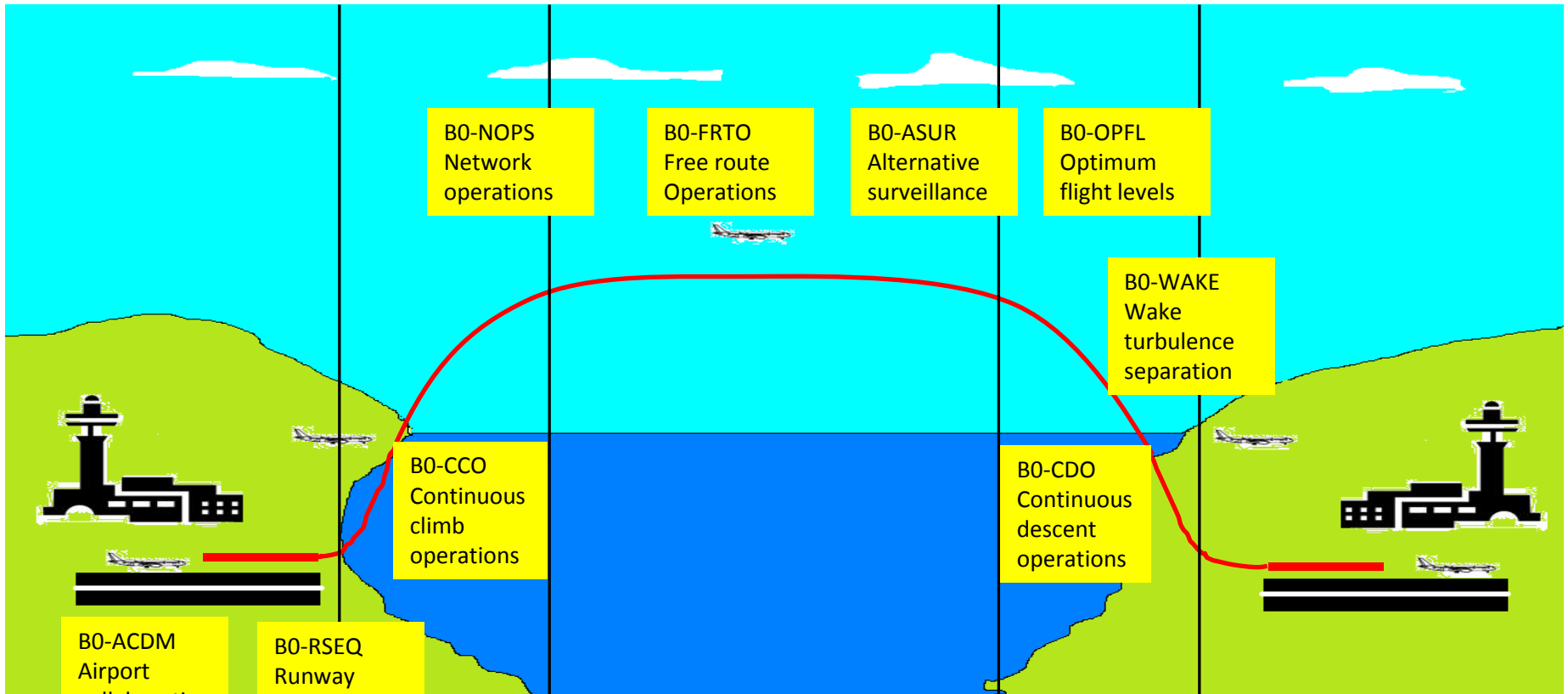
Departure

Climb

Cruise

Approach

Arrival



B0-ACDM
Airport collaborative decision making

B0-RSEQ
Runway sequencing

B0-CCO
Continuous climb operations

B0-NOPS
Network operations

B0-FRTO
Free route Operations

B0-ASUR
Alternative surveillance

B0-OPFL
Optimum flight levels

B0-CDO
Continuous descent operations

B0-WAKE
Wake turbulence separation



More Efficient Operations

- Best practices in operations – ICAO Doc 10013;
- Optimized aircraft maintenance;
- Selecting aircraft best suited to the mission.
- other





Engine washing

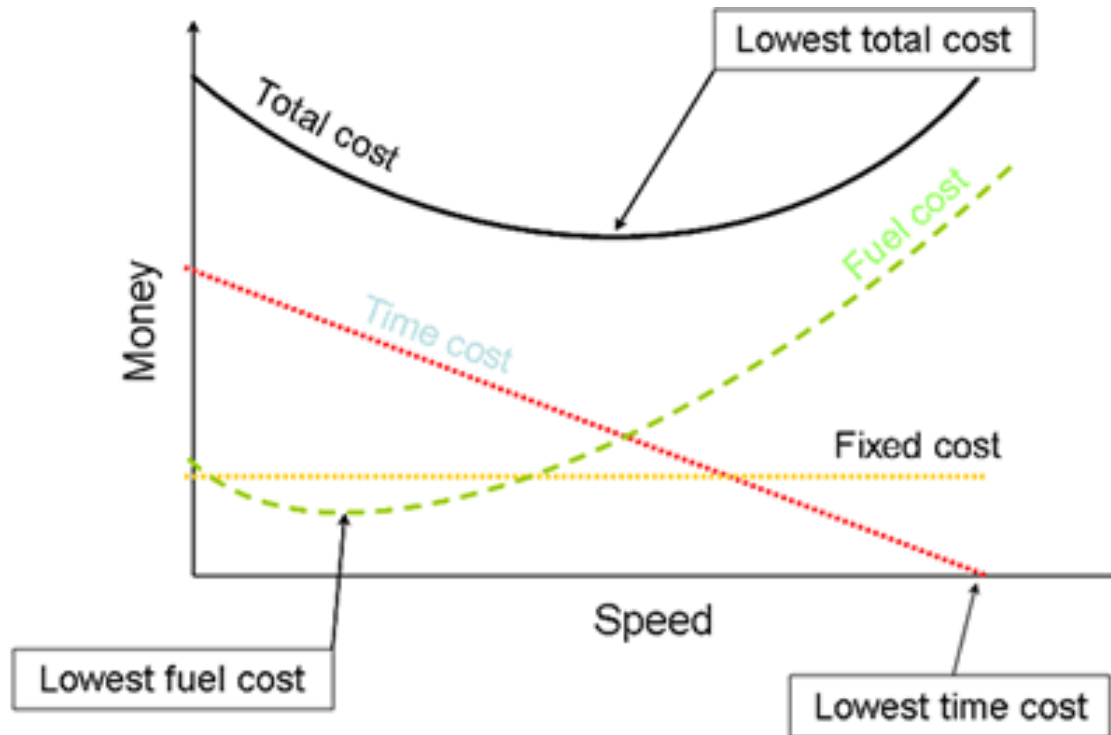


Use of Ground Power Units

<http://www.anahd.co.jp/en/csr/environment/effort.html>



More efficient operations - *Cost Index*



http://www.airways.co.nz/aspire/_content/cost_index.asp



More Efficient Operations

- Short-term
- Lead to moderate emissions reductions (significant in some cases)
- Require minimal (or no) investment

- ICAO's *Procedures for Air Navigation Services — Aircraft Operations* (Doc 8168),
- *Operational Opportunities to Minimize Fuel Use and Reduce Emissions* (Doc 10013),
- Airbus' *Getting to Grips with Fuel Economy* (and technical documentation and guidance)
- Boeing's *Fuel Conservation Strategies: Descent and Approach* (and technical documentation and guidance).



Market-Based Measures (MBMs)

- Policy tools to achieve environmental goals at a lower cost and in a more flexible manner.
- ICAO has been:
 - developing policies and guidance material; and
 - collecting information on various market-based measures, including:
 - emissions trading;
 - emission-related levies (charges and taxes); and
 - emissions offsetting



ICAO's Work on a Global MBM Scheme

- Exploring feasibility – quantitative analysis
- Design Features
- 38th Assembly decision – development of a global MBM scheme



Regulatory measures/other

- airport movement caps/slot management;
- enhancing weather forecasting services;
- requiring transparent carbon reporting;
- conferences/workshops.
- other



Airport Improvements

- Airfield improvements
- Reduced energy demand and preferred cleaner energy sources
- Enhanced GSE (Ground Support Equipment) management
- Conversion of GSE to cleaner fuels
- Improved transportation to and from airport
- Other



Airport Improvements

Airfield improvements



Use cleaner alternative sources of power generation (photovoltaic panels)



<http://www.passengerterminaltoday.com/viewnews.php?NewsID=36516>

<http://arabianindustry.com/construction/photos/2012/mar/20/pictures-chinas-hefei-xinqiao-airport-project-3534908/>



Airport Improvements

Improved public transport access

Conversion of GSE to cleaner fuels



<http://www.globalgse.com/>



<http://www.rtcwashoe.com/section-public-transportation>



Airport Improvements

- offer significant potential for emissions reduction, however, not all of those changes will directly affect international aviation emissions
- States are encouraged to include them in their action plans as well, while differentiating between those that will contribute to reduced fuel consumption by aircraft flying internationally and those that offer “co-benefits.”





ICAO

ENVIRONMENT

Thank you

