4. Mitigation Measures

Selection, Examples, and Expected Results

ICAO Secretariat

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Outline

- Origin of the Basket of Measures
- The Basket of Measures
- Guidance on Selecting Measures
- Examples of Mitigation Measures
- How to make the assessment

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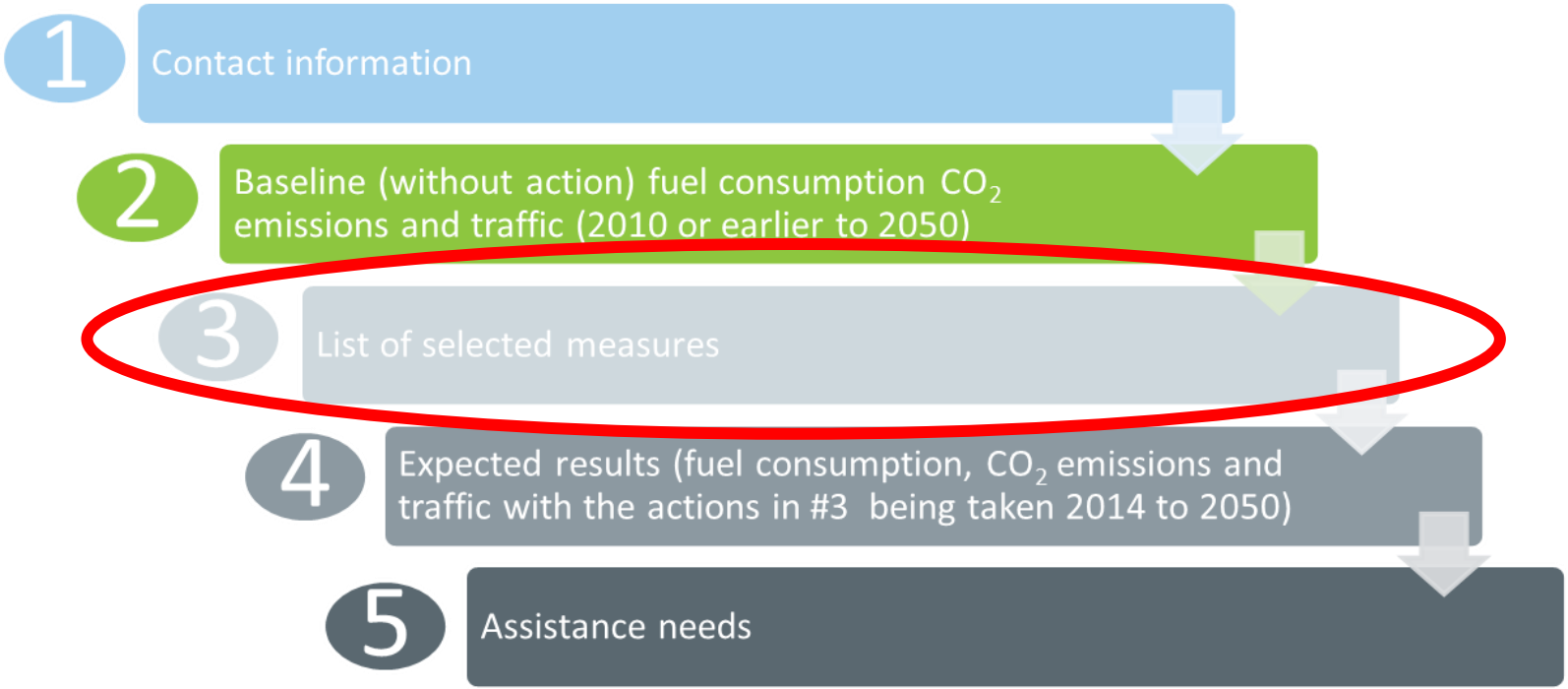
Context within the Action Plan Development Process



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Context within Doc 9988

- **Chapter 4** – Selection of measures and quantifying their expected results
- **Appendix A** – Basket of measures to limit or reduce CO2 emissions from international civil aviation
- **Appendix C** – Key stakeholders, analysis methods and tools
- **Appendix D** – Reference material relevant to the implementation of mitigation measures
- **Appendix E** - Examples of measures selected in action plans
- **Appendix F** – Costs and benefits related to the basket of measures

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ICAO 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.

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Measures

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

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ICAO Basket of Measures

As defined in the ICAO 39th Assembly Resolution A39-2:

- Technology and standards,
- Sustainable alternative fuels,
- Operational improvements, and
- Market-based measures

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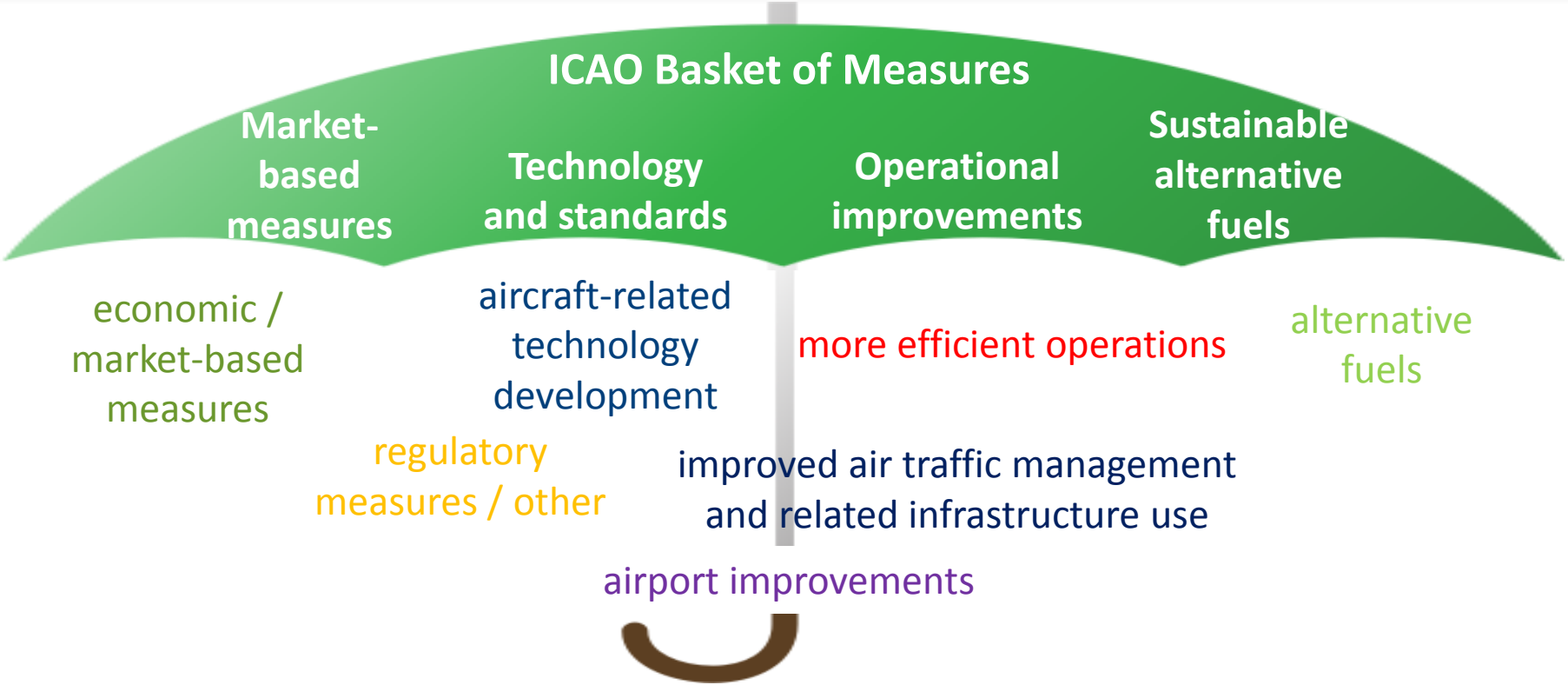
ICAO Basket of Measures
Market-based measures
Technology and standards
Operational improvements
Sustainable alternative fuels
economic / market-based measures
aircraft-related technology development
more efficient operations
alternative fuels
regulatory measures / other
improved air traffic management and related infrastructure use
airport improvements

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Guidance on Selecting Measures

- Reference material:
  - ***ICAO Doc 9988*** Appendices A, C, D, E and F
  - Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes – ***ICAO Doc 10031***
  - Operational Opportunities to Reduce Fuel Burn and Emissions – ***ICAO Doc 10013***
- Considerations:
  - Safety
  - Steps required
  - Resources needed (time, cost, human resources)
  - Timing of measures
  - Entity responsible for tasks
  - Environmental benefits

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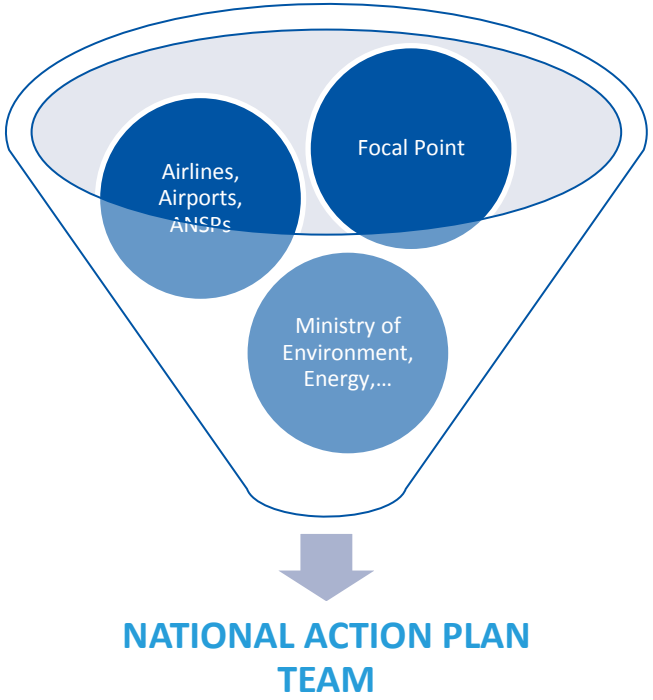
Selection of Mitigation Measures

- The Focal Point should always work in collaboration with the National Action Plan Team

- **Context** is key for the selection of appropriate mitigation measures



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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

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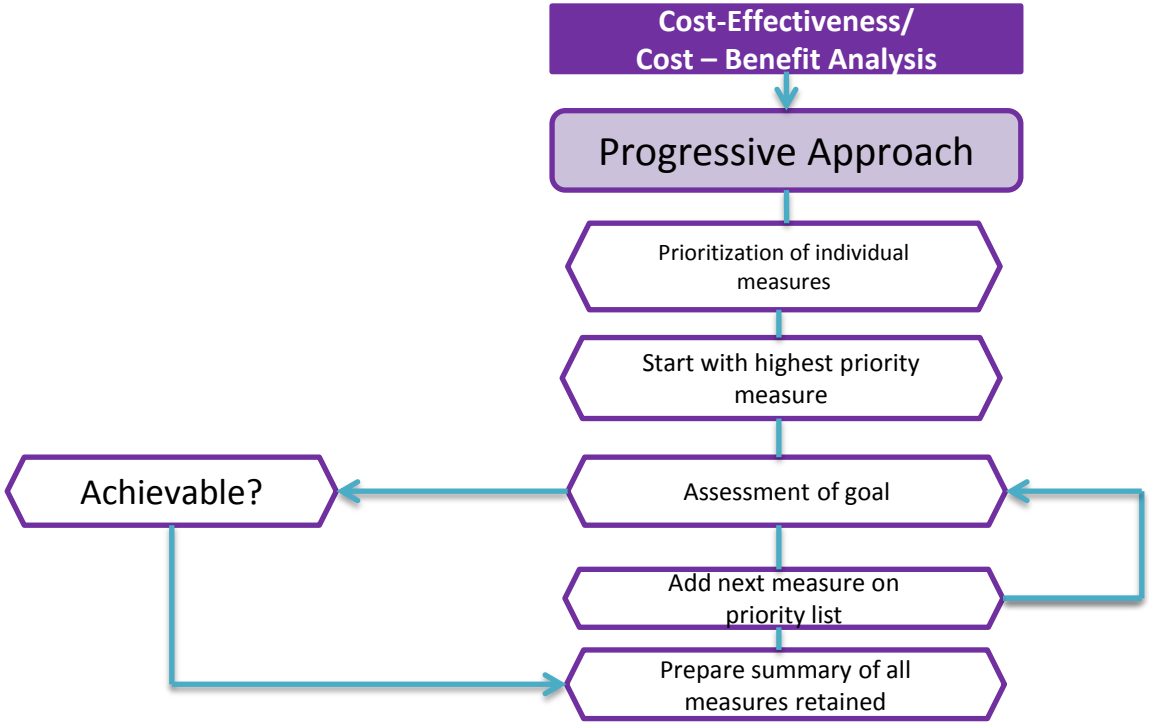
Prioritization

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



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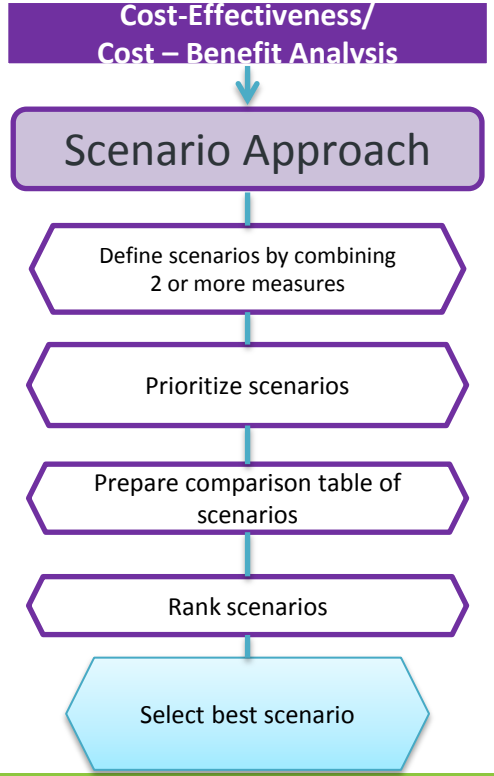
Prioritization

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



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Examples of Mitigation Measures

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Aircraft 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.

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Aircraft Technology Development

- To improve fuel efficiency there are continuous efforts in:
  - Structures
  - Propulsion
  - Aerodynamics

- Advanced technologies are already being incorporated into aircraft designs in order to contribute to carbon neutral growth by 2020.

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Aircraft Technology Development

- Reductions in weight are a key factor in reducing fuel burn:
  - Use of Carbon Fibre Reinforced Plastic (CFRP) and advanced alloys is increasing;
- Airbus A380 contains 25% composites.
- Boeing 787 and Airbus A350 have pushed the composite use to 50%.

Source: ICCAIA

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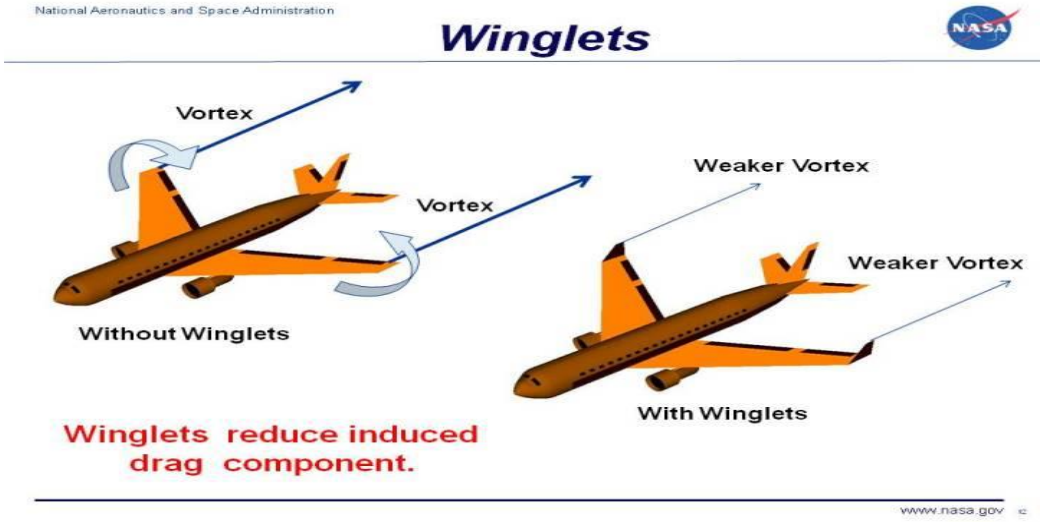
Aircraft Technology Development

- Aerodynamics, for example:
  - Drag reduction technologies
  - Wingtip devices



http://www.airlinereporter.com/

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Aircraft Technology Development

- Drive towards increased propulsive efficiency:
  - Higher by-pass ratio engines deliver thrust at lower fuel consumption
  - Lighter and higher temperature materials

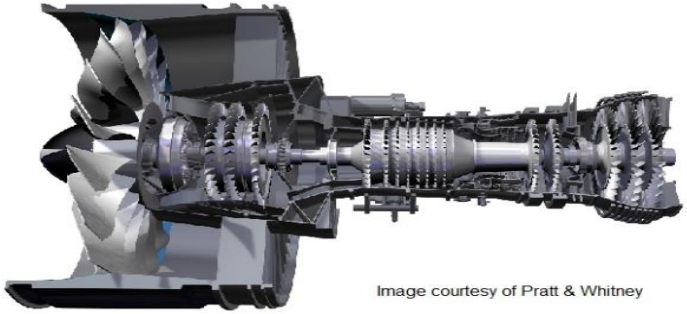
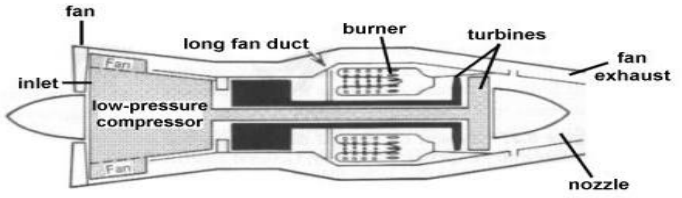
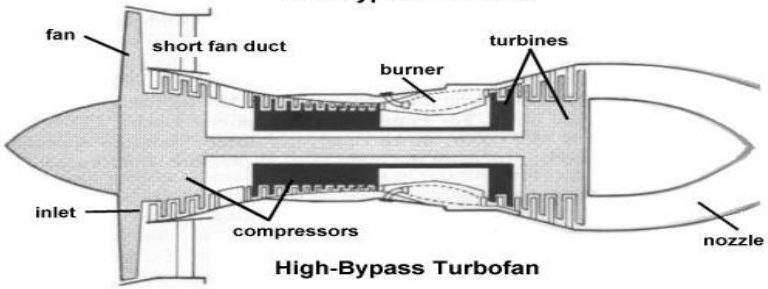


Image courtesy of Pratt & Whitney





http://www.ecomagination.com/portfolio/genx-aircraft-engine
http://machinedesign.com/archive/fewer-trips-fuel-truck

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Aircraft 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

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Sustainable Alternative Fuels

- development of biofuels;
- development of other fuels with lower life-cycle CO_2 emissions;
- standards/requirements for alternative fuel use.

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

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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

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Sustainable Alternative Fuels

More than 5,000 commercial flights have been flown on sustainable alternative fuels

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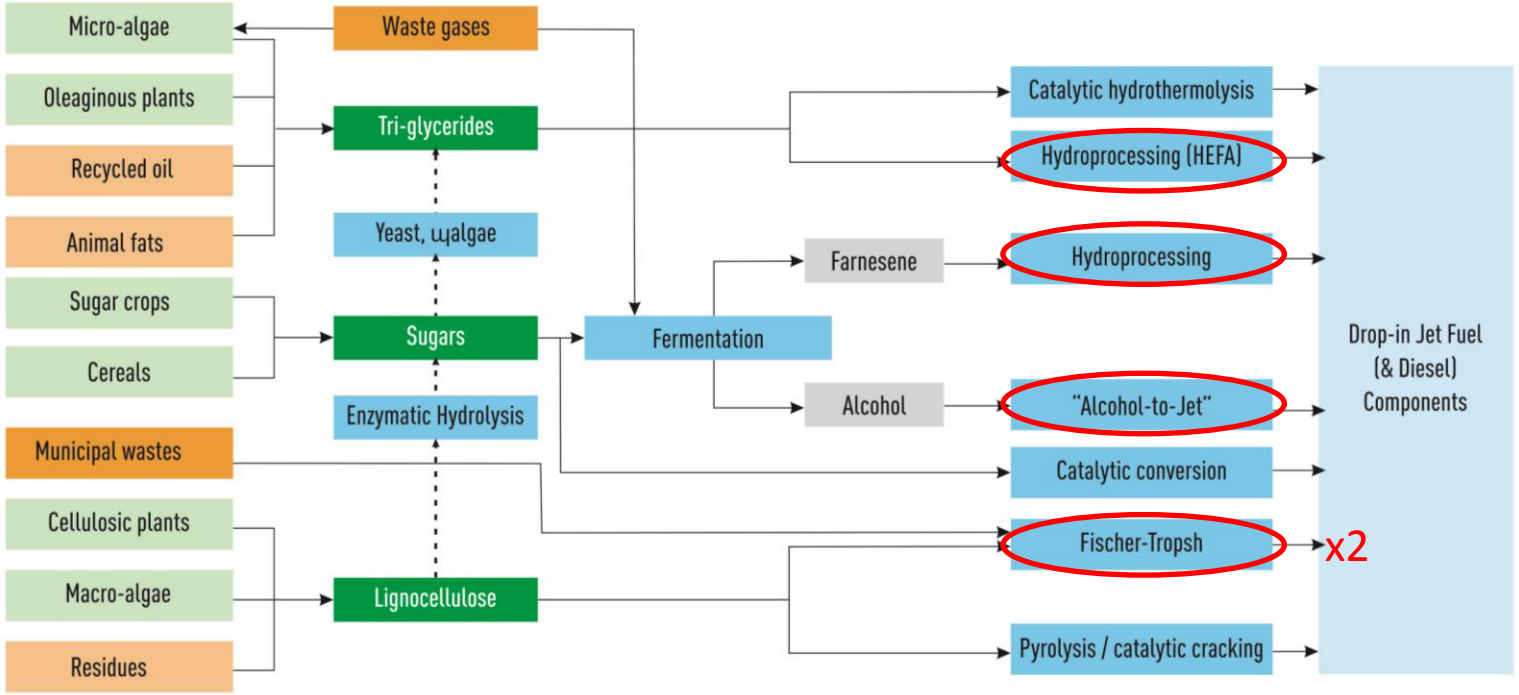
Sustainable Alternative Fuels

- Five fuel production processes are certified for use in aviation



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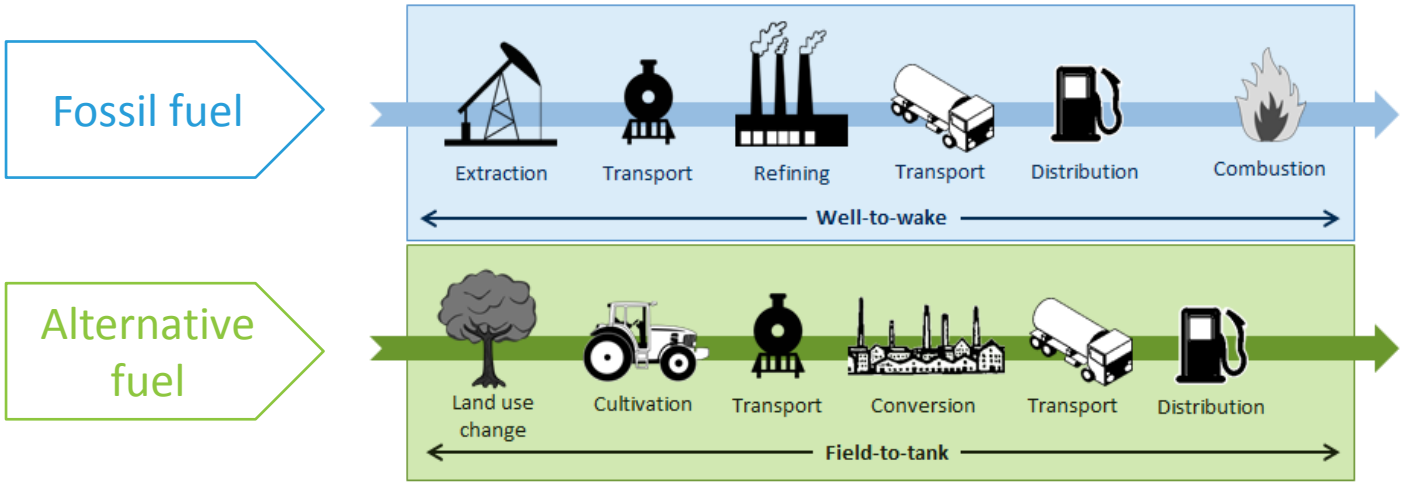
Sustainable Alternative Fuels

How can a drop-in fuel reduce CO_2 emissions?



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Sustainable Alternative Fuels

ICAO Global Framework for Aviation Alternative Fuels (GFAAF)

GFAAF
Global Framework for Aviation Alternative Fuels

- Started in 2009
- Database for relevant activities
  - Frequently asked questions
  - Facts and Figures
  - News and Activities
  - Initiatives and Projects

Current Activities

Or to see more information visit the News and Activities page.
*Zoom in for best results

Frequently Asked Questions

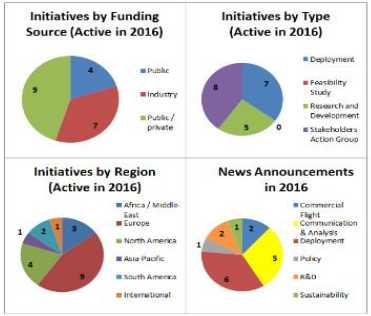
1. Why introduce alternative fuels in aviation?
2. What are sustainable alternative jet fuels?
3. What are the potential environmental benefit of alternative fuels?
4. Which alternative fuels can currently be used?
5. What are the challenges for the development and deployment of alternative fuels?
6. What are the initiatives worldwide for the development of alternative fuels?
7. What is ICAO doing in the field of alternative fuels?

Current Initiatives

Or to see more information visit the Initiatives & Projects page.

Facts and Figures

Click the image below to view Facts and Figures from 2016



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Improved air traffic management and infrastructure use

- more efficient Air Traffic Management (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.

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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.)

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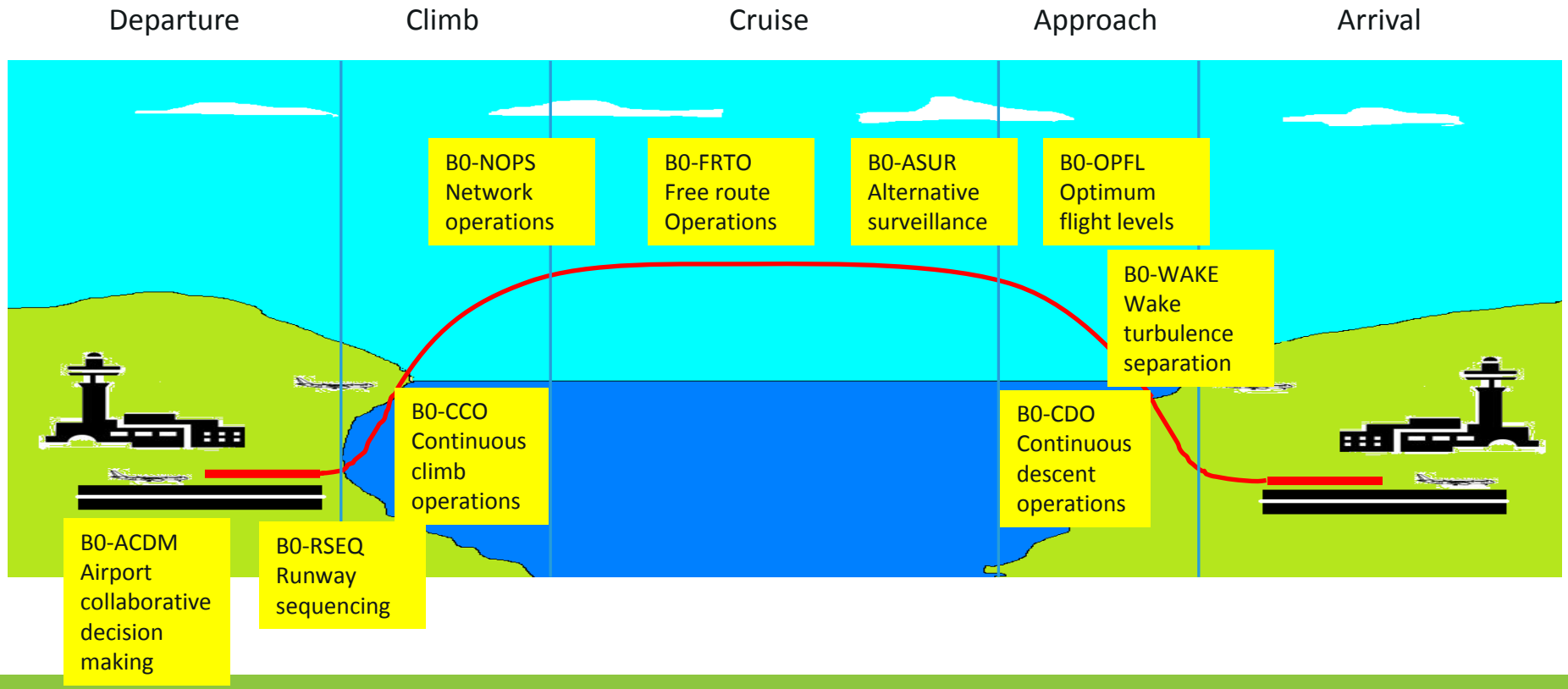
Improved air traffic management and infrastructure use



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Improved air traffic management and infrastructure use

Resource list:

- 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)
- Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes (Doc 10031)

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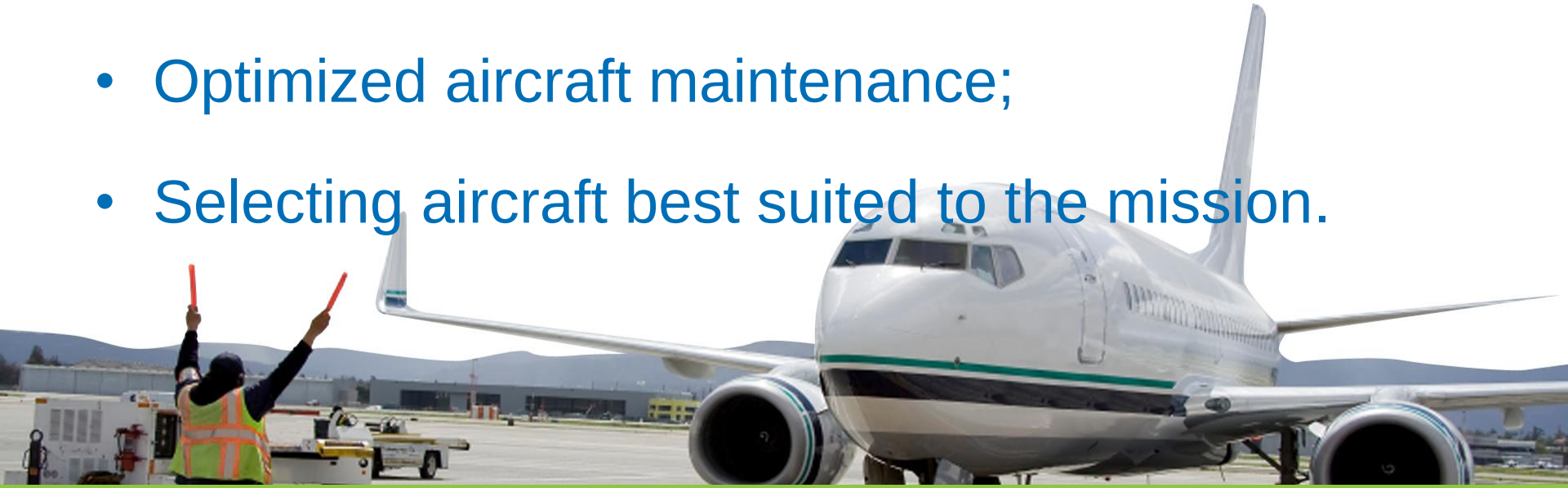
More Efficient Operations

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



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More Efficient Operations

Engine washing

Use of Ground Power Units

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

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More Efficient Operations

Green Taxiing

Taxi-bot

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

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

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

Wheel tug

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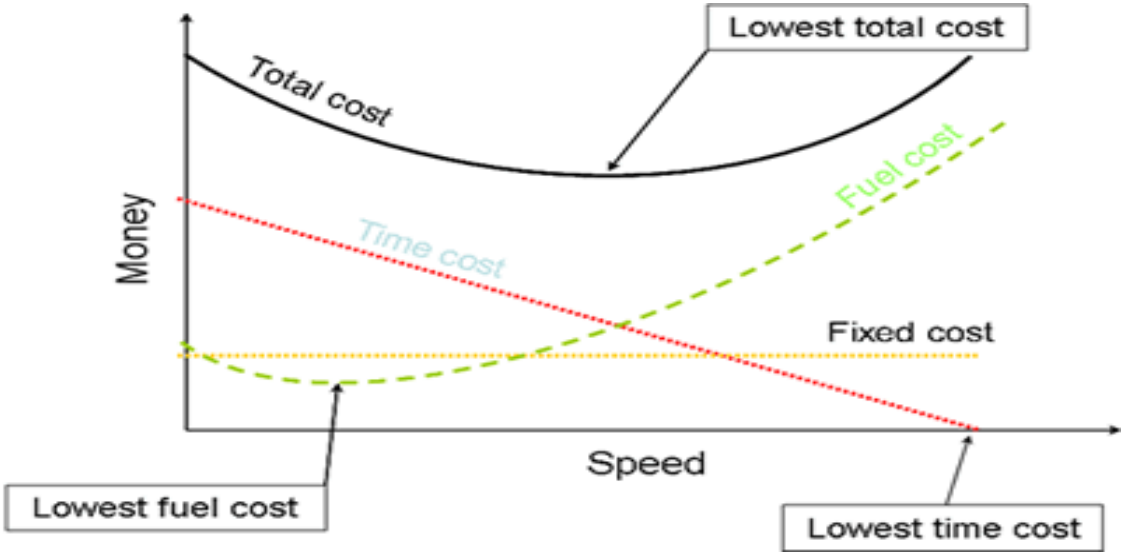
More Efficient Operations

Cost Index



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

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More Efficient Operations

Assessment

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

Resource List

- 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).

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Market-based measures

- Voluntary inclusion of aviation sector in market-based measures
- Establishment of a multilateral emissions trading scheme for aviation
- Emissions charges or modulation of landing/take-off (LTO) charges
- Positive economic stimulation by regulator
  - Research programmes
  - Special consideration and government programmes/legislation
  - Accelerated depreciation of aircraft
- Accredited offsetting schemes

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Market-based measures

The Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA)

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Regulatory measures/other

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

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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

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Airport Improvements

Airfield improvements

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

Use cleaner alternative sources of power generation (photovoltaic panels)

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

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Airport Improvements

Conversion of GSE to cleaner fuels

http://www.globalgse.com/

Improved public transport access

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

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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.”

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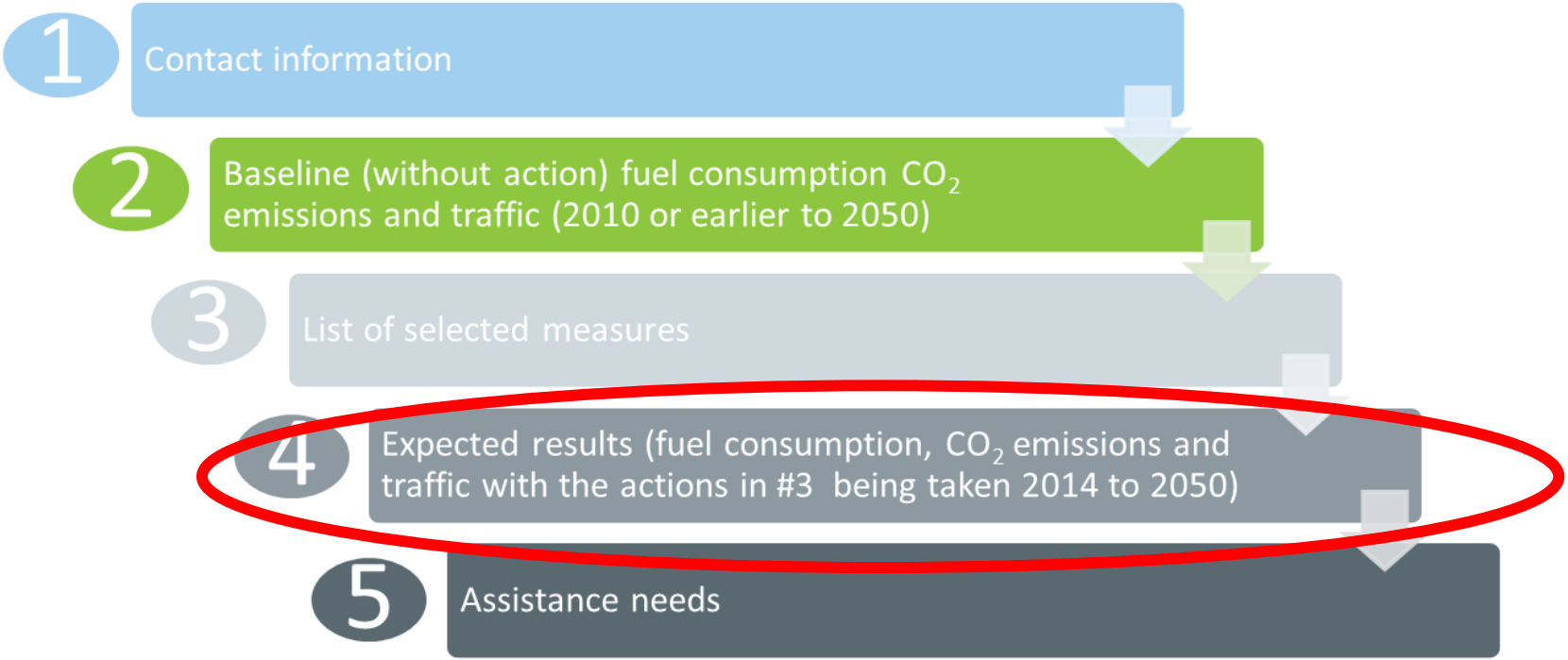
Context within the Action Plan Development Process



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About Expected Results

- ICAO Assembly Resolution A39-2, para 11 *“Invites those States that choose to prepare or update action plans to submit them to ICAO”* and in doing so, include *“quantified information on the expected environmental benefits from the implementation of the measures chosen from the basket”*
- Expected results are the effect of the implementation of the selected measures on the baseline
- Only aggregate expected results need to be submitted

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About Expected Results

- However, the techniques shown in the guidance allow the incremental benefits of each measure to be calculated
- encourage States to include this quantified information in the Action Plan
- promote the use of the Environmental Benefit Tool (EBT) available to Focal Points on the ICAO APER website.

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How to describe the selected measures in your Action Plan? ICAO Doc 9988

Measure	*Benefit/cost*
	Benefit: Relative potential gains: Co-benefits Cost: Cost range: Additional metric(s):

Title	
Description	
Category	
Measure	
Action	
Start date	
Date of full implementation	
Implemented by	(when there are benefits from the measures)
Economic cost	
Currency	
Reference to existing legislation	
Legislation is proposed	
Compliance	— voluntary — mandatory — N/A
Assistance needed	
Assistance needed (check more than one)	— finance — technology — technical support — education — research — other
Currency for financial assistance	
List of stakeholders involved	
Point of contact	

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- Quantified results needed to assess the plan

3.3 Incremental improvements/benefits of each measure

Please inscribe below the anticipated improvements/benefits associated with each specific measure. A measure can have several anticipated improvements for different years.

Year			
Improvement in total fuels (litres)			
Improvement in total fuels (%)			
Improvement in international fuels (litres)			
Improvement in international fuels (%)			
Improvement in total CO_2 emissions (kg)			
Improvement in total CO_2 emissions (%)			
Improvement in international CO_2 emissions (kg)			
Improvement in international CO_2 emissions (%)			
Anticipated co-benefits			

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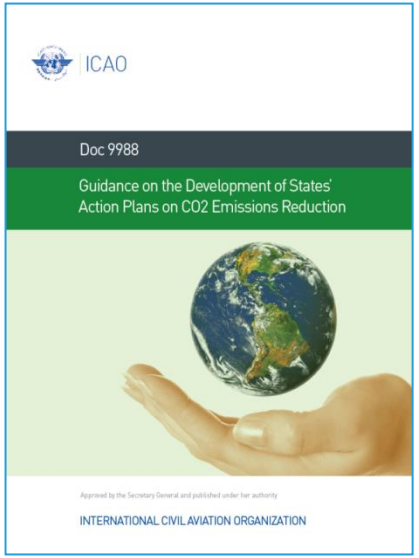
For More Information…

- See Chapter 4 and Appendix C of the Guidance, Second Edition



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Conclusion

- Based on today's presentations and Guidance Document 9988, *Chapter 4*, you are prepared to determine which mitigation measures are most appropriate for the aviation industry in your State

- After choosing your mitigation measures you will be able to use the EBT to estimate the impacts of their implementation on your baseline (calculate your expected results)

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