FAA Perspective on ICAO's Progress on NOx Emissions as well as on Efforts for CO_2, Particulate Matter, and Noise Standards

Presented to: EPA's Mobile Sources Technical Review Subcommittee (MSTRS)

By: Curtis Holsclaw
Manager, Emissions Division
AEE-300

Date: May 4, 2010
Crystal City, VA

Federal Aviation Administration

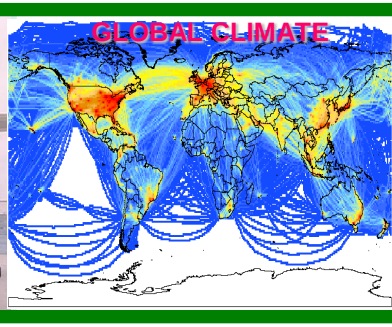
Key Drivers

- **Next Generation Air Transportation System**

- **International Civil Aviation Organization's Committee on Aviation Environmental Protection (CAEP)**

Environmental Challenges

NextGen goal to increase capacity is dependent upon addressing & mitigating aviation environmental impacts & dealing with related energy issues



NextGen environmental goals

- Absolute reduction of significant ***community noise*** and ***air quality*** emissions impacts
- Improve NAS ***energy*** efficiency and, supply of and access to, alternative fuel sources
- Limit or reduce the impact of aviation GHG emissions on the ***global climate***
- Reduce significant aviation impacts associated with ***water quality***

5-Pillar approach to develop solutions

P1 Improved science and modeling

P2 Accelerated maturation of new aircraft technologies

P3 Renewable fuels

P4 Accelerated ATM Improvements and Efficiencies

P5 Policies, Environmental Standards, Market Based Measures and Environmental Management System

Environment & Energy R&D Program Structure

Characterize the problem and assess related risks

- **P1:** Improved science and modeling capability
- **P1:** Aircraft noise and emissions analyses
- **P1:** Aviation noise and emissions impacts metrics & characterization

Develop solutions and analyze their benefits

- **P2:** Mature certifiable aircraft technologies
- **P3:** Develop alternative fuels
- **P4:** Environmentally efficient operational procedures
- **P5:** Environmental standards, market based options and policies
- **P2-P5:** Local to NAS-wide assessment of environmental benefits

Manage environmental goals

- **P5:** Develop and implement Environmental Management Systems (EMS) and verify performance against dynamic environmental targets

Key Areas of Emissions Research

- **CO_2 emission metrics for commercial aircraft certification**
- **Gaps associated with aviation climate impacts, focusing on non-CO_2**
- **Sampling/measurement of particulate matter emissions**
- **Emission scenarios to support NextGen Goals/Targets**
- **Plume-regional scale change in air quality**
- **Impacts of non-LTO emissions on air quality and health**
- **Reducing the sulfur content of conventional jet fuel and alternative fuels**

Key Areas of Development

- Technology
  - **CLEEN**
  - **NASA**
- Fuels
  - **Commercial Aviation Alternative Fuels Initiative (CAAFI)**
- Operations
  - **Surface Management**
  - **Continuous Descent Arrivals**
  - **En route Optimization**

Perspective On NO_x Emissions

- **Decision taken at CAEP/8 to increase the stringency of the NO_x emissions standard highlighted:**
  - Primary and secondary impacts
  - Greater number of current engines effected
  - Expanded view of technologically feasible
  - Industry costs
- **Moving forward there may be more focus placed on the goal-setting process**

Key Outcomes from CAEP/8

- **CAEP/6 NOx production cutoff effective 12/31/2012**
- **Increased stringency of the NOx emissions standard effective 12/31/2013**
  - no production cut-off before year end 2018
- **Future work on developing an aircraft CO_2 emissions standard by 2013**
- **Future work on engine certification requirement for non-volatile particulate matter emissions**
- **Future work on aircraft noise stringency**

Perspective on PM Emissions

- **FAA fully supports the work conducted by SAE E-31**
- **Sampling and measurement methods for future certification requirements**
- **Research gaps identified in AIR6037 have been funded in support of E-31**
- **Coordinated/shared funding responsibilities with other agencies**
- **Dedicated R&D resources to develop measurement procedures that address total PM, underpinned by:**
  - sound science related to PM emissions,
  - feasibility of implementation, and
  - efficiency of implementing within an engine certification regime

Perspective on PM Emissions

- **Development of ARPs for total PM measurement techniques can most effectively be addressed in stages**
- **Develop techniques that address both direct emissions of non-volatile PM and the gaseous precursors at the exit plane**
  - NON-VOLATILE PM: FAA, EPA and EASA strongly encourage E-31 to complete the ARP on non-volatile PM by end of 2011
  - GASEOUS SOx PRECURSORS: Controlled via more stringent fuel sulfur content standards
  - GASEOUS HC PRECURSORS: Controlled via more stringent HC emission standards
  - GASEOUS NOx PRECURSORS: Controlled via more stringent NOx emission standards
- **Develop a singular total PM measurement technique(?)**

Perspective on CO_2 Emissions

- **An aviation related CO_2 emissions certification standard must be based on the aircraft versus the engine**
- **Similar to other environmental standards for aviation, the CO_2 standard should be developed under ICAO**
- **The expected timescales for developing the standard are overly aggressive and will require dedicated resources and priority**

Aircraft CO_2 Emissions Standard

- **In 2009 FAA initiated a project under the PARTNER Center of Excellence to study aircraft CO_2 emissions metrics**
- **Identify and assess a set of aircraft CO_2 emission metrics and evaluate potential use for:**
  - setting standards for the certification of new commercial aircraft (and benchmarking existing aircraft)
  - monitoring the operational performance of the fleet
- **Inform decision-making processes of domestic and international aviation communities**
  - developing metrics and setting standards are related yet distinctively separate steps

Objectives

I. **Generate** *options for CO_2 metrics*

II. **Identify** *judging criteria* **(cost, fairness, robustness, etc.)**

III. **Assess relationship of metrics to the** *current fleet*

IV. **Assess impacts these metrics may have on** *future vehicle development and fleet evolution*

V. **Identify and assess** *equity issues*, **and provisions that might allow for** *unintended manipulation* **and** *negative incentives*

VI. **Analyze** *interdependencies* **with other environmental objectives**

VII. **Provide a** *comprehensive assessment* **of the metrics as part of a basis for considering standards**

Potential Implications

- *Poorly defined metrics* **can create equity issues and opportunities for manipulation, potentially reducing the effectiveness of policies and resulting in unintended consequences**

- **From a policy standpoint, an aircraft CO_2 standard is only *part of the solution* in achieving far-term targets. Consideration of the broader framework for CO_2 reductions is important**

- **The concepts on which *levels* of a standard is based on**
  - Existing technology
    - New certification
    - Current production
    - In-service aircraft
  - Technology forcing

Perspective on Noise

- **Premature to develop more stringent standards beyond Chapter 4 at this time**
- **Uncertainty in configurations, and low level of technological maturity for new replacements, especially open rotor engines and geared turbofans**
- **Significant number of aircraft would be unable to meet even a modest increase of stringency**
  - the minimum stringency increase was 9 dB cumulative between Chapters 2 and 3, and 10 dB cumulative between Chapters 3 and 4
- **ICAO has other higher priorities (e.g. CO_2 emissions)**
- **A significant amount of preparatory work needed in order to assess technology response**

Conclusions

- **FAA commitment to assessing and mitigating environmental impacts of aviation**
- **Working through ICAO to establish and maintain emissions standard for aircraft and aircraft engines**
- **Conducting research and development through the 5-pillar approach**
- **Aviation environmental issues becoming more complex and challenging with multiple interdependencies**

Appendix

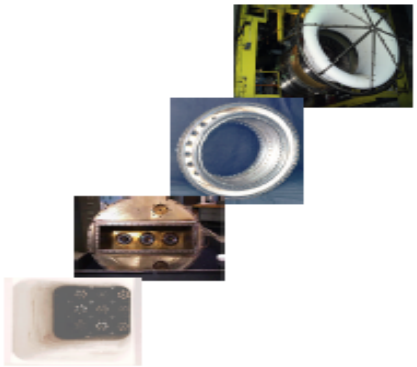
Goal-Setting Process

- **Underlying ICAO CAEP principles for standard-setting**
  - Technological feasibility
  - Economic reasonableness
  - Environmental benefits
  - Environmental interrelationships and tradeoffs
- **Technology goals for emissions reduction; complement the long-standing standard-setting process**
- **Degree to which emissions could be reduced including potential benefits and tradeoffs, taking into account the likely timescale for introduction**
- **Relationship between goals and standard-setting processes**

Goal-Setting Process

- **Use of the Technology Readiness Level (TRL) scale**
- **Transition from long term to mid term goals, to consideration of certification standards**
- **Transition points**
- **Recognition that goal-setting will involve some degree of judgment on the performance outcome**
- **Independent Expert process employed to facilitate goal-setting**

Technology Readiness Scale



9 Actual system "flight proven" on operational flight

8 Actual system completed and "flight qualified" through test and demonstration

7 System prototype demonstrated in flight environment

Industry Applies Technology to Their Products

Research Program Stops

6 System/subsystem model or true dimensional test equipment validated in a relevant environment

5 Component and/or breadboard verification in a relevant environment

4 Component and/or breadboard test in a laboratory environment

3 Analytical and experimental critical function, or characteristic proof-of-concept

2 Technology concept and/or application formulated (candidate selected)

1 Basic principles observed and reported

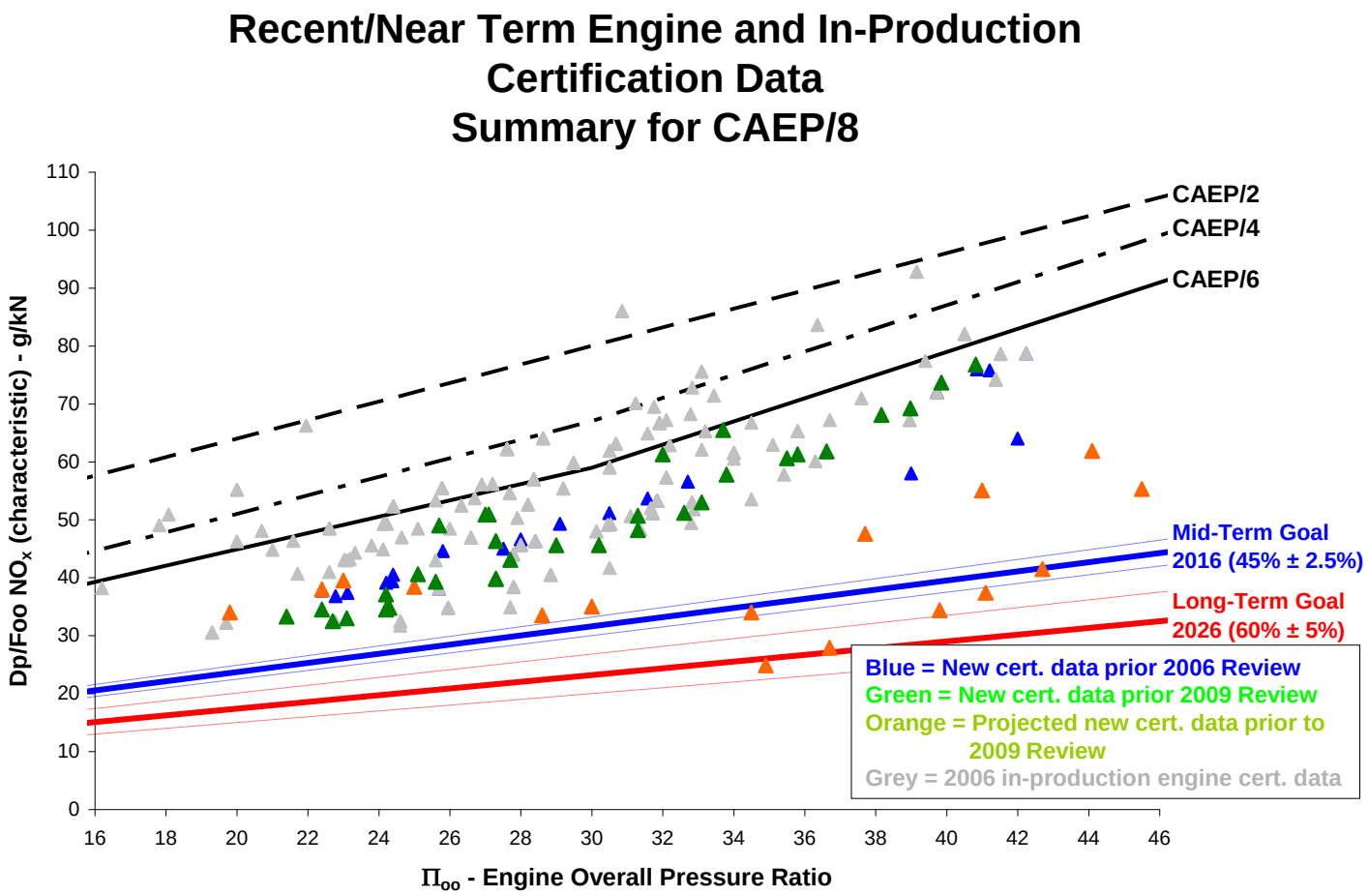
Complexity & Maturity

Industry Role

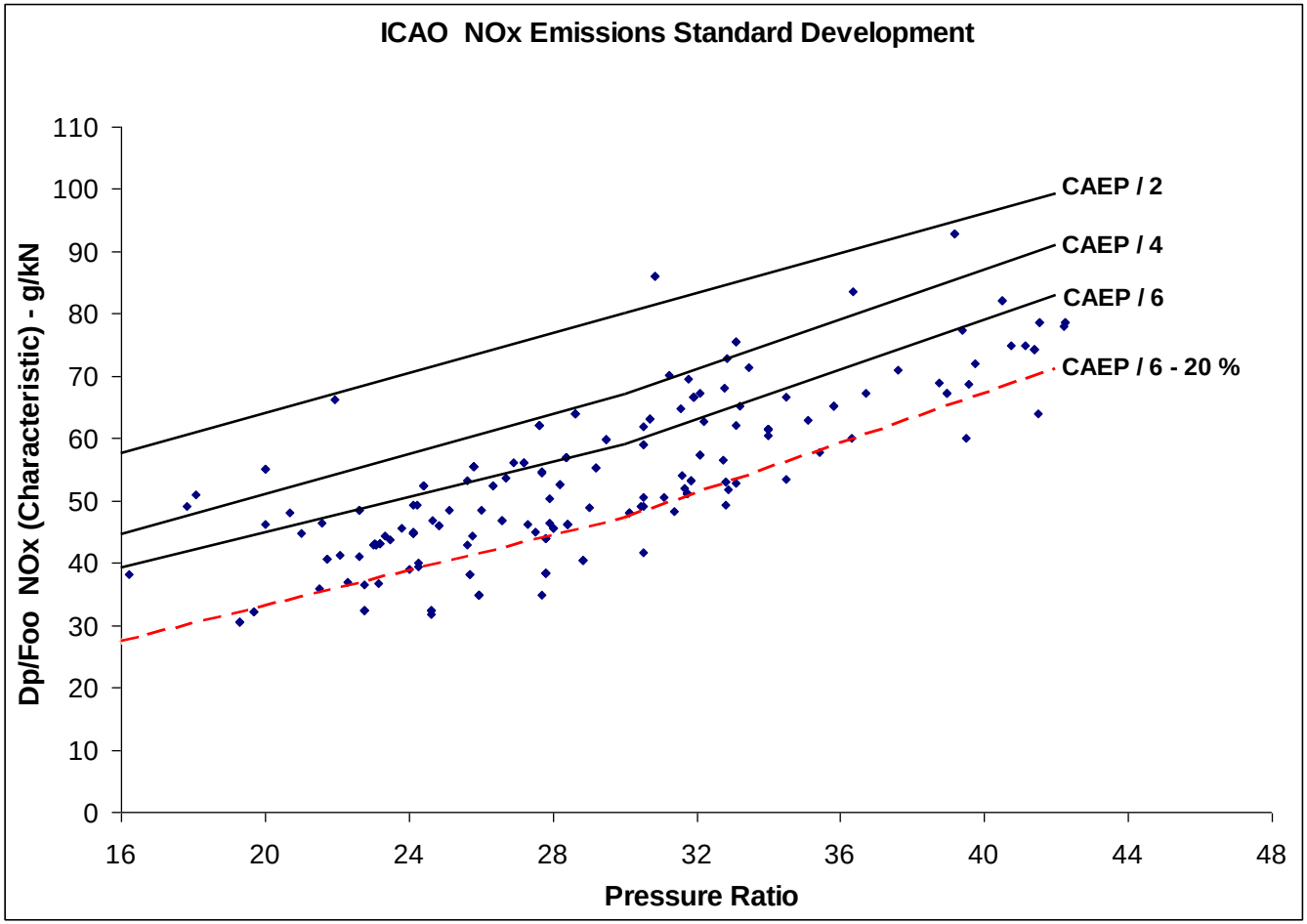
Government Role

Figure 1. Technology readiness levels

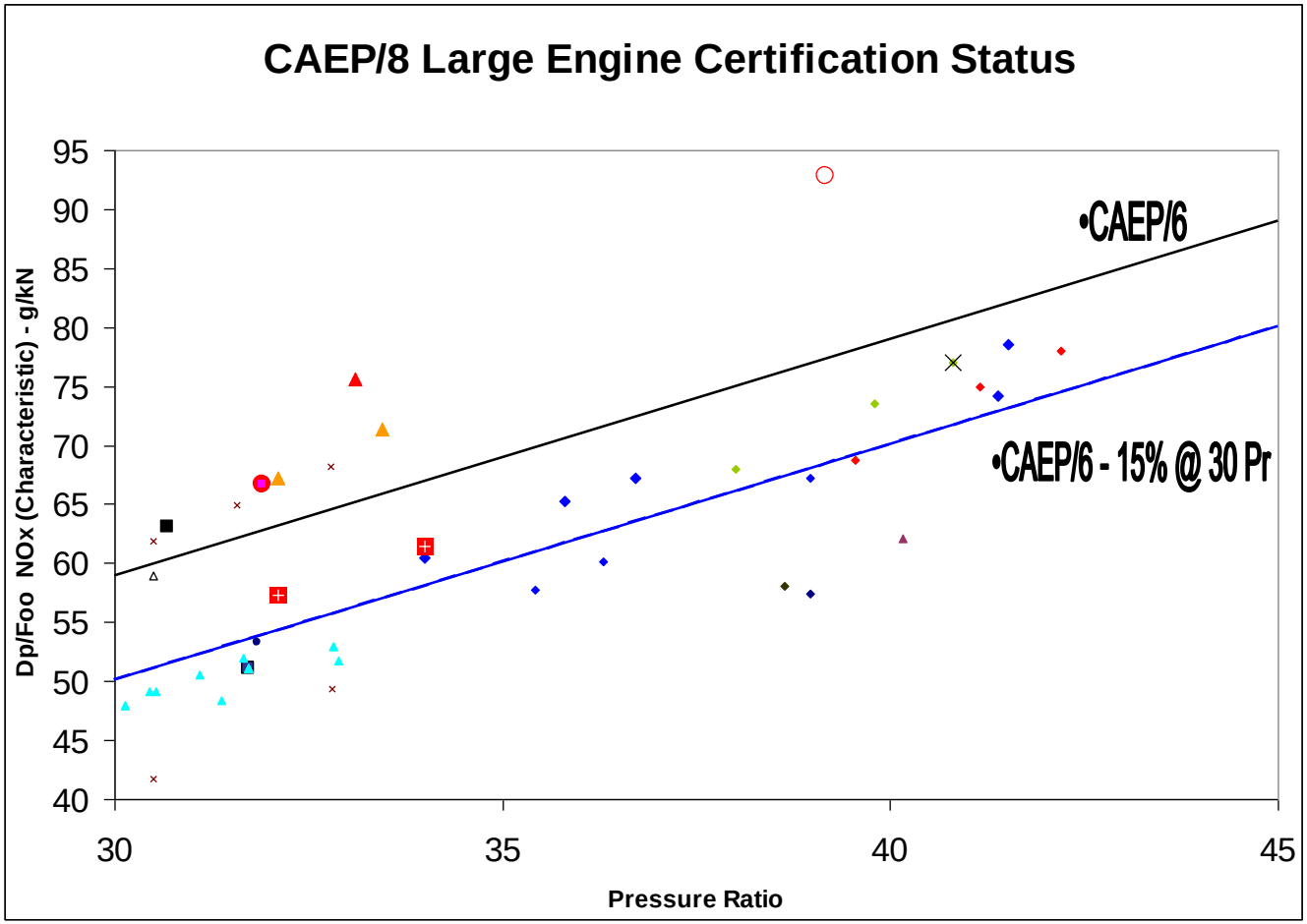
Technology Goals for NOx Reduction



Standard Development

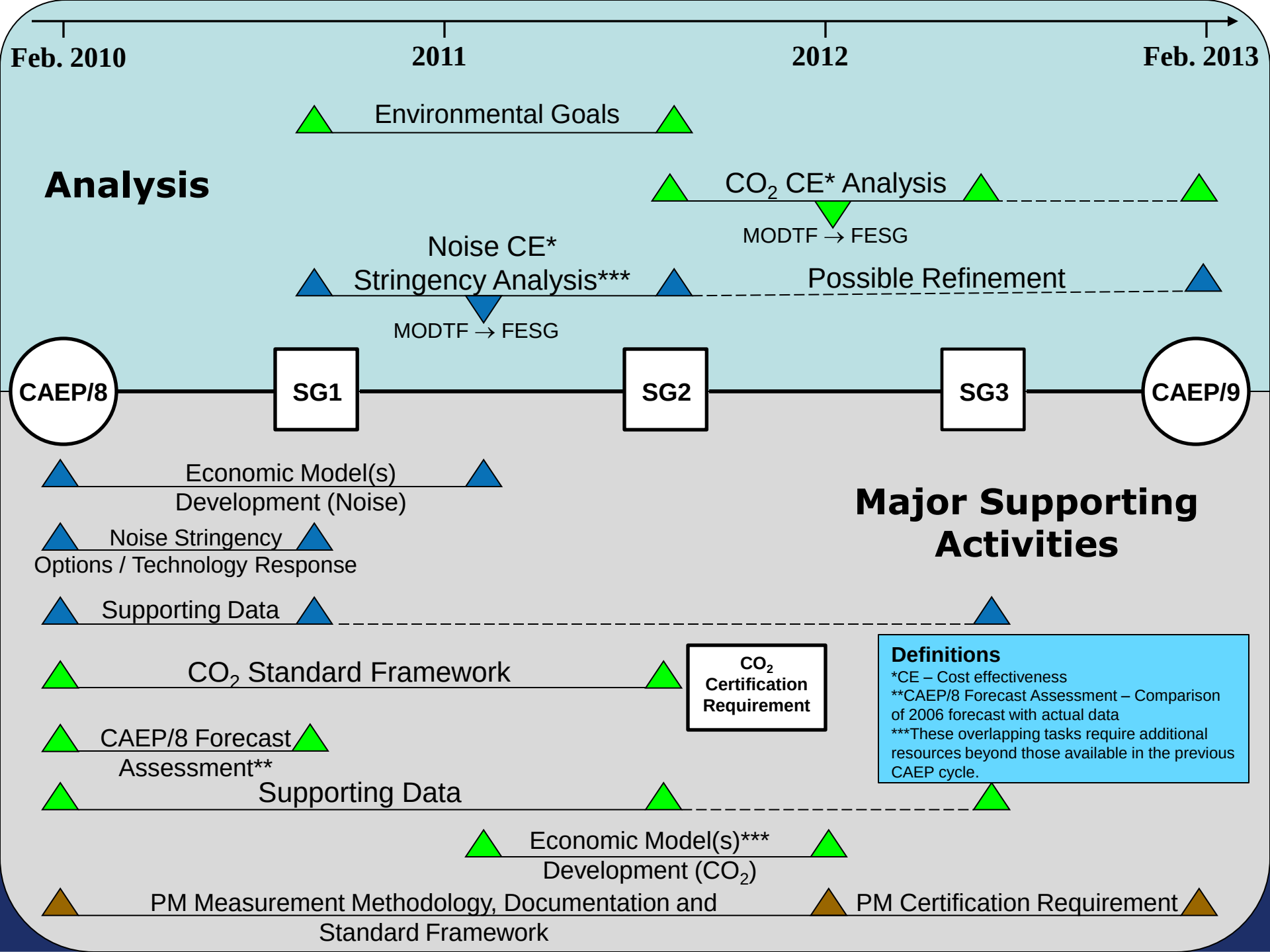


Standard Development



Decision on NOx Stringency

- **Aircraft contribution to local air pollution and move meaningfully towards the long term technology goals**
- **Tension for fuel efficiency improvements and NOx emissions reduction**
- **Cost-effectiveness in line with previous decisions; APMT-Economics confirmed**
- **Qualitative use of APMT-Impacts analysis indicated a more stringent scenario**


Feb. 2010
2011
2012
Feb. 2013
Environmental Goals
Analysis
CO2 CE* Analysis
MODTF → FESG
Noise CE*
Stringency Analysis***
Possible Refinement
MODTF → FESG
CAEP/8
SG1
SG2
SG3
CAEP/9
Economic Model(s)
Development (Noise)
Major Supporting Activities
Noise Stringency
Options / Technology Response
Supporting Data
CO2 Standard Framework
CO2 Certification Requirement
Definitions
*CE – Cost effectiveness
**CAEP/8 Forecast Assessment – Comparison of 2006 forecast with actual data
***These overlapping tasks require additional resources beyond those available in the previous CAEP cycle.
CAEP/8 Forecast
Assessment**
Supporting Data
Economic Model(s)***
Development (CO2)
PM Measurement Methodology, Documentation and
Standard Framework
PM Certification Requirement