CLEEN (Continuous Lower Energy, Emissions and Noise) Program

Program Overview and Coordination with NASA

Presented to: NASA Green Aviation Summit
By: Jim Skalecky
Federal Aviation Administration
Office of Environment and Energy
Date: September 8, 2010
Aviation Environmental Goals and Challenges

*NextGen goal to increase mobility 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
- Achieve carbon neutral growth by 2020 compared to 2005 baseline for **climate change**
- 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
Key FAA Environment & Energy R&D Initiatives

• Development of Integrated Analytical Models
  – EDS: Environmental Design Space
  – AEDT: Aviation Environmental Design Tool
  – APMT: Aviation environmental Portfolio Management Tool

• CLEEN: Continuous Lower Energy, Emissions and Noise

• CAAFI: Commercial Aviation Alternative Fuels Initiative
• ACCRI: Aviation Climate Change Research initiative
• AEC: Aviation Emissions Characterization Roadmap
• Noise Research Framework
• Operations Research Framework
• Environmental Management System
FAA CLEEN Program

- Address NextGen environmental goals in partnership with industry
- Mature and demonstrate promising energy efficient, clean and quiet technologies
- Advance sustainable alternative fuels for aviation
- Assess technology suitability for retrofit or re-engine
- Meet national R&D goals
# CLEEN Program Goals

Develop and demonstrate (TRL 6-7) certifiable aircraft technology

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<tr>
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<tbody>
<tr>
<td><strong>NOISE</strong></td>
<td>-32 dB cum below Stage 4</td>
<td>-42 dB cum below Stage 4</td>
<td>-71 dB cum below Stage 4</td>
</tr>
<tr>
<td><strong>LTO NOX EMISSIONS (BELOW CAEP 6)</strong></td>
<td>-60%</td>
<td>-75%</td>
<td>better than -75%</td>
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<tr>
<td><strong>AIRCRAFT FUEL BURN</strong></td>
<td>-33%</td>
<td>-50%</td>
<td>better than -70%</td>
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CLEEN Program Goals (continued)

Advance use of “drop-in” alternative fuels in aircraft systems focusing on renewable options

- No compromise in safety
- Successful demonstration
- Quantification of environmental impacts, costs and benefits
CLEEN Timeframe and Funding

- Timeframe: CY 2010-2014
- Total Budget: $125M (1:1 Cost Share)
- Market Research Conference: May 2008
- Solicitation released: May 12, 2009
- Solicitation closed: July 21, 2009
- Awards Completed: June 22, 2010
- CLEEN Companies: Boeing, GE, Honeywell, P&W and Rolls-Royce
<table>
<thead>
<tr>
<th>Company</th>
<th>Technology</th>
<th>Goal Impact</th>
</tr>
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<tbody>
<tr>
<td>Boeing</td>
<td>Ceramic Matrix Composite Acoustic Nozzle</td>
<td>Fuel-burn, Noise</td>
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<td></td>
<td>Adaptable Trailing Edges</td>
<td>Fuel-burn, Noise</td>
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<tr>
<td></td>
<td>Fuel system material swell &amp; fuel absorption</td>
<td>Alt Fuels</td>
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## CLEEN Technologies

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<tbody>
<tr>
<td>GE</td>
<td>Open Rotor</td>
<td>Fuel-burn</td>
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<tr>
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<td>TAPS II Lean Combustor</td>
<td>Noise</td>
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<tr>
<td></td>
<td>Flight Mgt System /Air Traffic Mgt System Optimization</td>
<td>Emissions Fuel-burn Noise</td>
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<tr>
<td>Honeywell</td>
<td>Engine weight reduction; high T3 impeller; advanced materials</td>
<td>Fuel-burn</td>
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<tr>
<td></td>
<td>100% HRJ &amp; bio-aromatic assessments &amp; flt test</td>
<td>Alt Fuels</td>
</tr>
<tr>
<td>P&amp;W</td>
<td>Ultra-high Bypass Ratio Geared Turbo Fan</td>
<td>Fuel-burn</td>
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<tr>
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<td>Emissions</td>
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<tr>
<td>Rolls-Royce</td>
<td>Dual wall turbine blade</td>
<td>Fuel-burn</td>
</tr>
<tr>
<td></td>
<td>Ceramic Matrix Composite turbine blade tracks</td>
<td>Fuel-burn</td>
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<tr>
<td></td>
<td>HRJ Characterization &amp; flight test of alternative fuel (business jet)</td>
<td>Alt Fuels</td>
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<tr>
<td></td>
<td>Engine tests of future alternative fuels (twin-aisle aircraft)</td>
<td>Alt Fuels</td>
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FAA/NASA Coordination

NASA has provided support to FAA on CLEEN, including:

- Market Research Conference
- Helping to develop solicitation
- Serving on proposal evaluation panel
- Participating in kick-off meetings
FAA/NASA Coordination (cont)

FAA has provided support to NASA on ISRP/ERA, including:

- Participating in ISRP/ERA program reviews
- Participating in N+2 Advanced Vehicle Concepts Bidders conference
- Serving on proposal evaluation panel
Continued coordination going forward, including:

- CLEEN Consortium
- CLEEN data sharing with NASA
- FAA and NASA program reviews
- Continuation of biweekly telecons to coordinate programmatic and technical issues
- Future workshops
Summary

• FAA R&D initiatives addressing NextGen and National R&D environment and energy goals

• CLEEN Program is off and running

• FAA and NASA are coordinating closely in environment and energy research