Environment – Aircraft Technology Assessment

Presented to: Public Meeting for Center of Excellence for Alternative Jet Fuels and Environment

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Accelerating technology development

Product

TRL

7

6

5

4

- Partner with industry
- Mature tech via demos
- Industry initiates product development

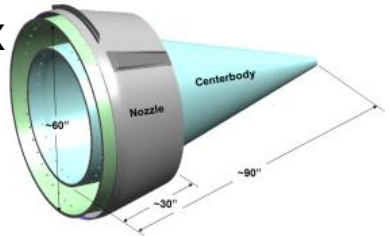
Technology in service

2010	2011	2012	2013	2014	…	2018

Continuous Lower Energy, Emissions and Noise (CLEEN)

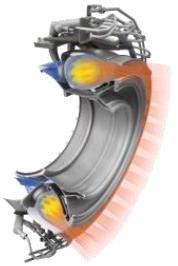
- 5 yr effort to accelerate technology commercialization
- Reduces aircraft fuel burn, emissions and noise
- 50% cost share; total FAA budget: ~$125M

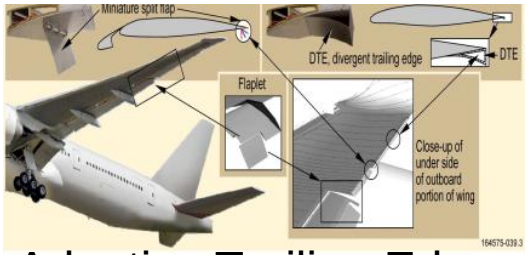
Ceramic Matrix Composite (CMC) Nozzle



- CMC Blade Tracks
- Dual-Walled Turbine Blade
- Future alt fuels

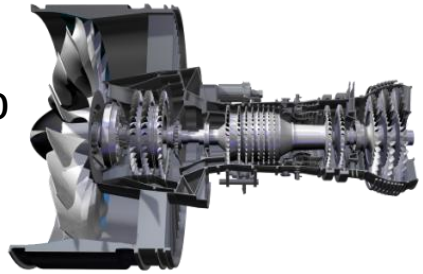
TAPS II Low NOx Combustor

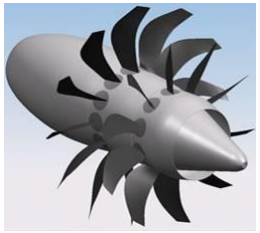




Adaptive Trailing Edge

Ultra-high Bypass Ratio Geared Turbofan





Open Rotor

- Lighter weight, higher temp engine
- 100% Hydroprocessed Renewal Jet (HRJ) alt fuel engine tests
- Flt Mgt Sys / Air Traffic Mgt Sys Integration

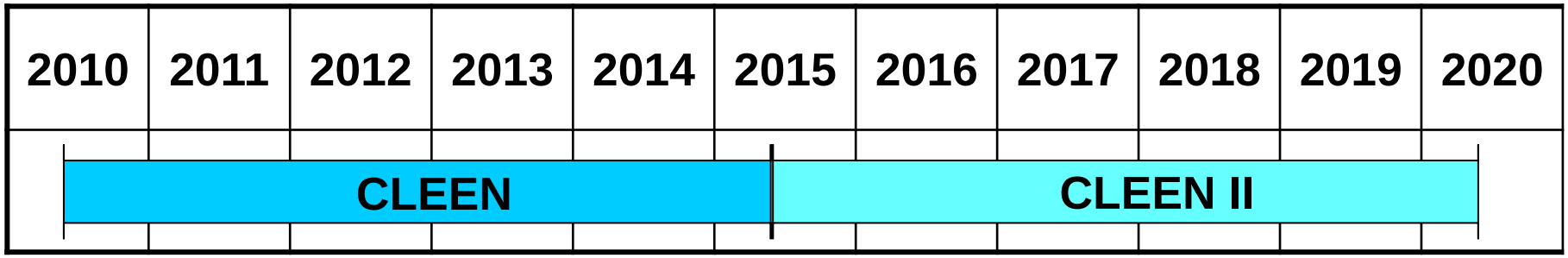
Boeing | GE | Honeywell | Pratt & Whitney | Rolls-Royce

CLEEN Program Goals

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

CORNERS OF THE TRADE SPACE	CLEEN (N+1) (EIS 2015-18) Ref: B737/CFM56-7B	N+2 (2020)* Ref: B777-200/GE-90	N+3 (2025)*
Noise (cum below Stage 4)	-32 dB	-42 dB	-71 dB
LTO NO_x Emissions (Below CAEP 6)	-60%	-75%	better than -75%
Aircraft Fuel Burn	-33%	-50%	better than -70%

* Technology Readiness Level for key technologies = 4-6

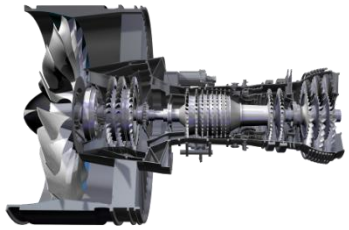


Role of Technology Assessment

- **Develop tools for effective technology assessment**
- **Assess suitability, environmental benefits and impact of aircraft technologies & alternative fuels on**
  - Aircraft performance
  - Fleet operations
  - Environmental and economic policy
  - Global climate change
- **Evaluate production costs & timeframes for new aircraft designs**
- **Compare tool results with CLEEN company estimates**
- **Foster collaboration and consensus among academic, commercial and governmental institutions**

Technology Assessment Criteria

- **Vetted tools compatible w/ AEDT**
- **Environmental perf & benefits at aircraft & fleet level**
- **Can identify synergistic technologies**
- **Can refine models with proprietary data**



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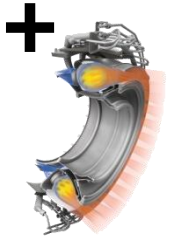

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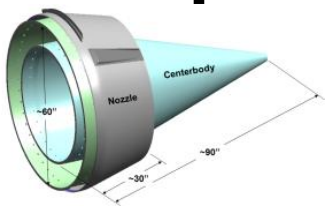


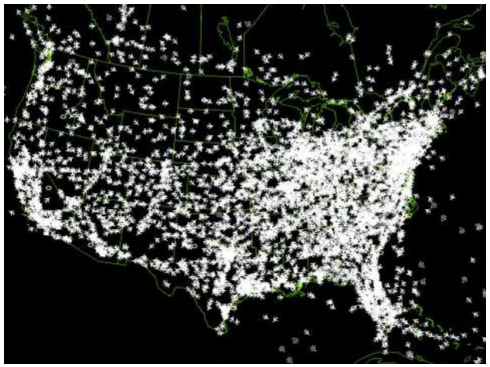
Regional Jet

Single-Aisle

Small Twin-Aisle

Large Twin-Aisle

Very Large Aircraft



Subsystem Technology Impacts → **Technology Effects on Vehicle** → **Fleet Level Implications**

Technical Areas of Interest

- Conduct assessment & model V/V of environmental benefits of aircraft technologies & op concepts
- Explore, develop & demonstrate (via simulation) flight control algorithms & models that have potential to improve aircraft and fleet environmental performance
- Explore advanced tech options to leverage the more precise or enhanced performance properties of alternative jet fuels
- Explore advanced tech options & integration of new/existing tech to maximize environmental & energy performance
- Enhance component & sys level design modeling capabilities within the aviation environmental tool suite to examine aircraft & fleet level fuel burn, emissions & noise and related tradeoffs and interdependencies
- Conduct fleet & aircraft level analyses of new & existing aircraft tech combinations & how they will affect sys-wide environmental performance
- Transition results from aircraft tech assessment to enhance the aircraft design tools that are a part of the aviation environmental tools suite
- Evaluate production costs and timeframes for new aircraft designs