



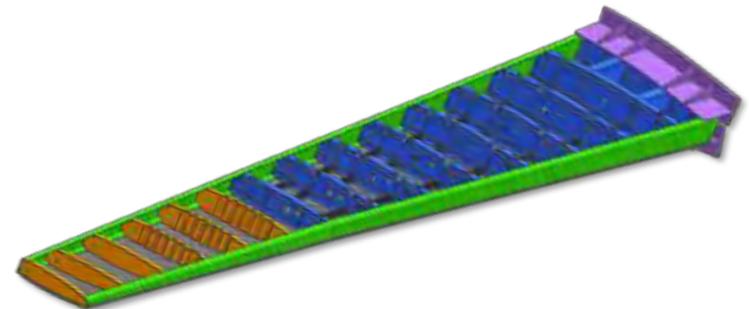
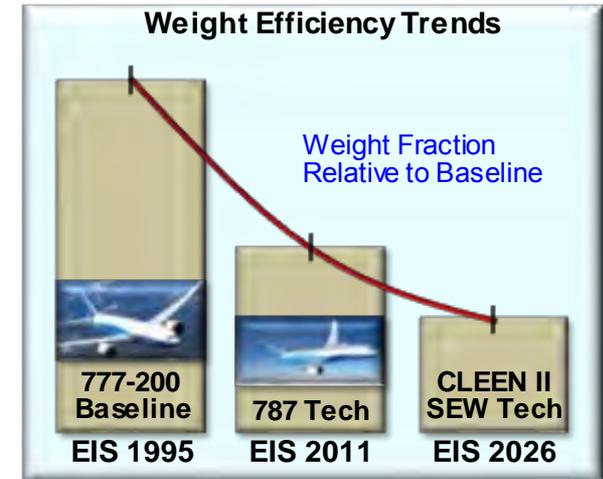
Boeing CLEEN II Program Update

Structurally Efficient Wing (SEW)

Consortium Plenary Session
Terry Richardson
November 7, 2018

Structurally Efficient Wing:

- Develop, build, and test a next-generation wing structure that demonstrates significant improvements in structural efficiency
- Show a continued weight reduction as compared to the 777-200 baseline
- Contribute to the FAA CLEEN II goal of reducing fuel burn, potentially reducing fuel consumption up to 3.5% through weight reduction of the wing.





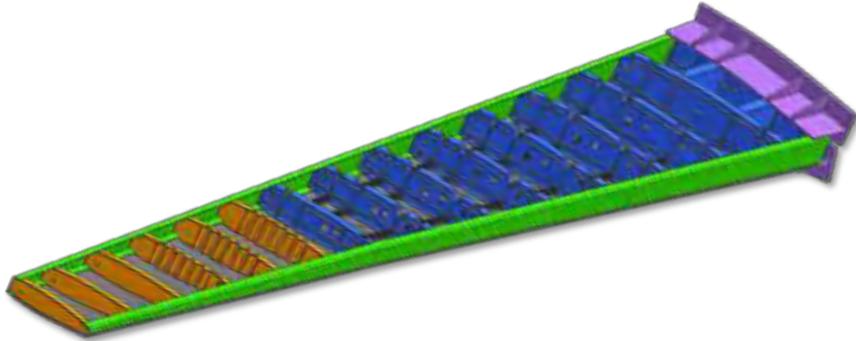
CLEEN II SEW Technologies

SEW CLEEN II Technology	Goal Impact	Benefits and Application
<ul style="list-style-type: none">• Advancing manufacturing technologies• Advanced prepreg composites• Resin-infused stitched blade stringers• Resin-infused hat stringers• Advanced alloy metallic ribs• Resin-infused sine wave rib• Stamped thermoplastic ribs	Fuel burn reduction CO ₂ Production Avoidance	Lower weight, higher performance wing

All technologies contribute to the fuel consumption reduction goal by reducing structural weight and/or Drag



Structurally Efficient Wing (SEW)



Anticipated Benefits: *Cumulative predicted impact over twenty years:*

- *Jet A fuel consumption savings of approximately 200 million tons*
- *CO2 production avoidance of approximately 660 million tons*

Risks/Mitigation Plans:

- *Risks Identified, mitigation plans in place*

Objectives: *Demonstrate a suite of material and structural technologies that will contribute to the FAA's CLEEN II goal of achieving fuel burn reductions by 2026.*

Work Statement: *Boeing's disciplined development and building-block test approach will mature structural wing technologies and will demonstrate via the Wing Component Test Article (WCTA).*

Accomplishments/ Milestones since Boeing initiated this technology/project:

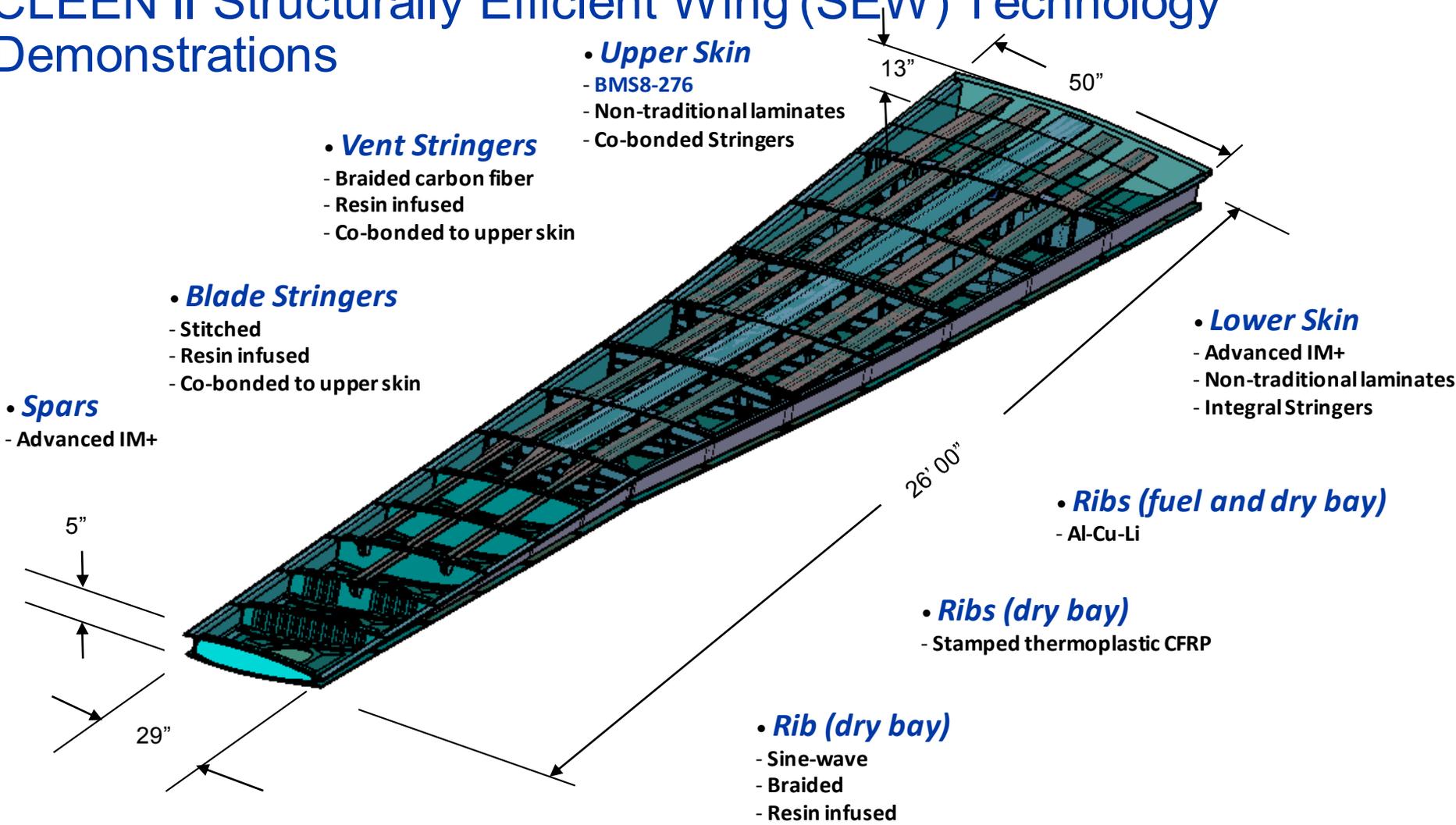
- *OTA Signed Oct 2015*
- *CoDR completed Mar 2016*
- *PDR completed Jan 2017*
- *DDR completed Jul 2017*

Schedule:

- *Oct 2015 ATP (completed)*
- *Mar 2016 CoDR (completed)*
- *Jan 2017 PDR (completed)*
- *Jul 2017 DDR (completed)*
- *Aug 2018 TRR (completed)*
- *Jun 2019 Program End*

- *Concept of Design Review (CoDR) completed early*
- *Preliminary Design Review (PDR) & Coupon Tests completed (TRL4)*
- *Building Block Tests Completed (TRL5)*
- *Detail Design Review (DDR) completed early*
- *Tooling, Part & Test Fixture Fab Completed*
- *Test Readiness Review (TRR) completed early*

CLEEN II Structurally Efficient Wing (SEW) Technology Demonstrations

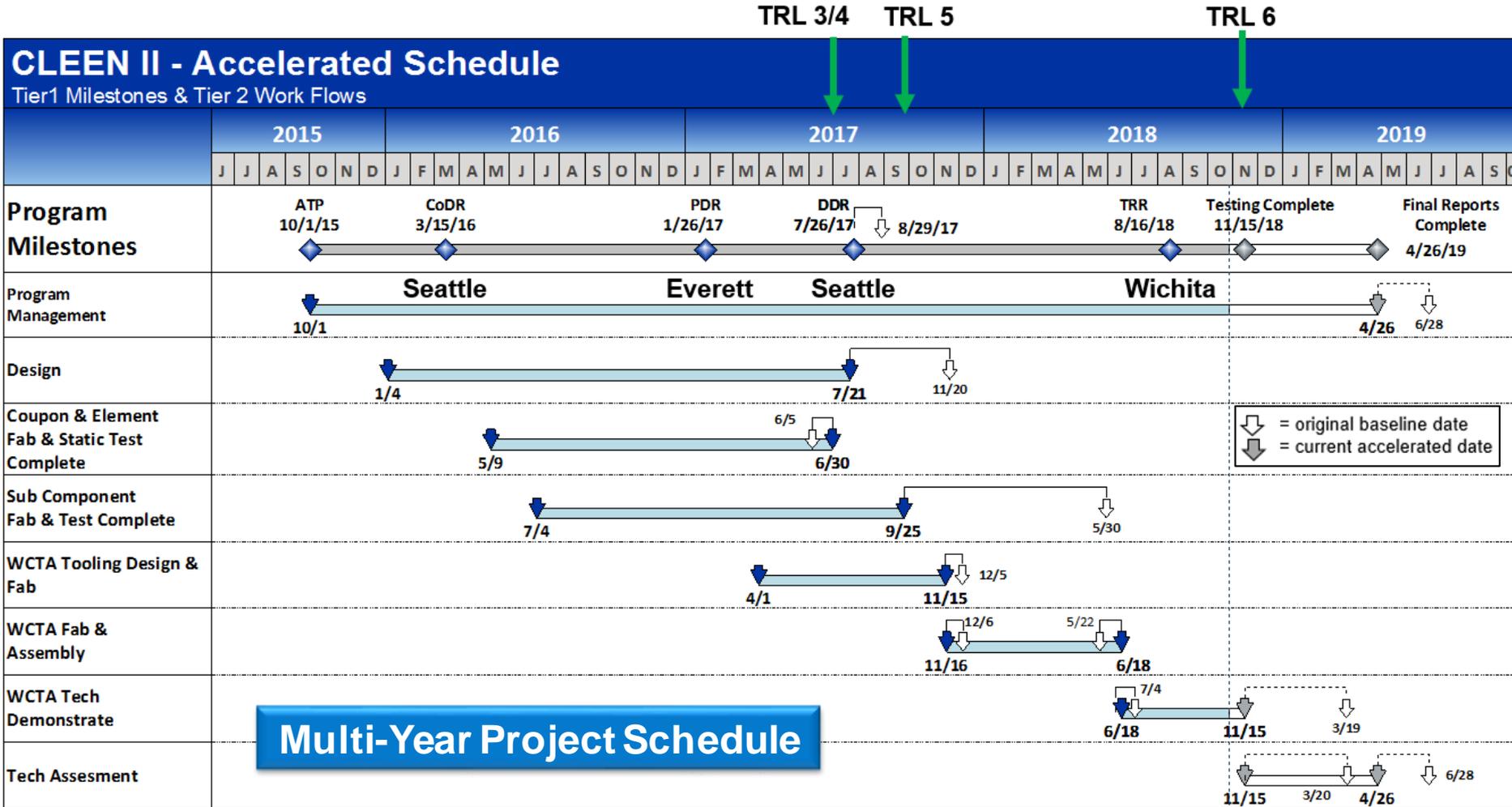


Reduce Weight up to 28% as Compared to the 777-200



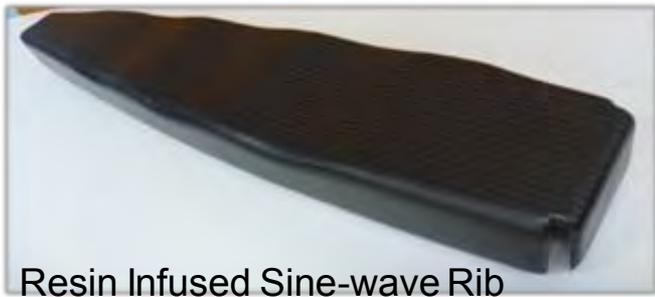
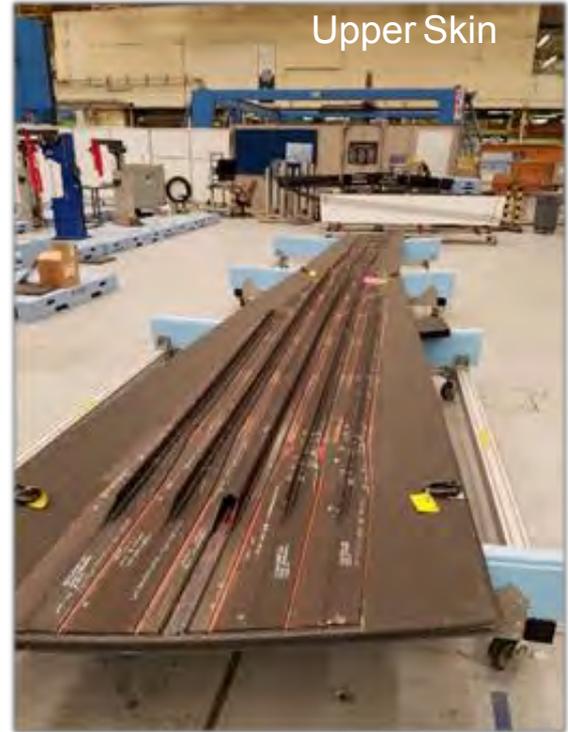
CLEEN II Boeing SEW – Accelerated Schedule

Technology Risk Reduction





SEW WCTA Assembly Preparation





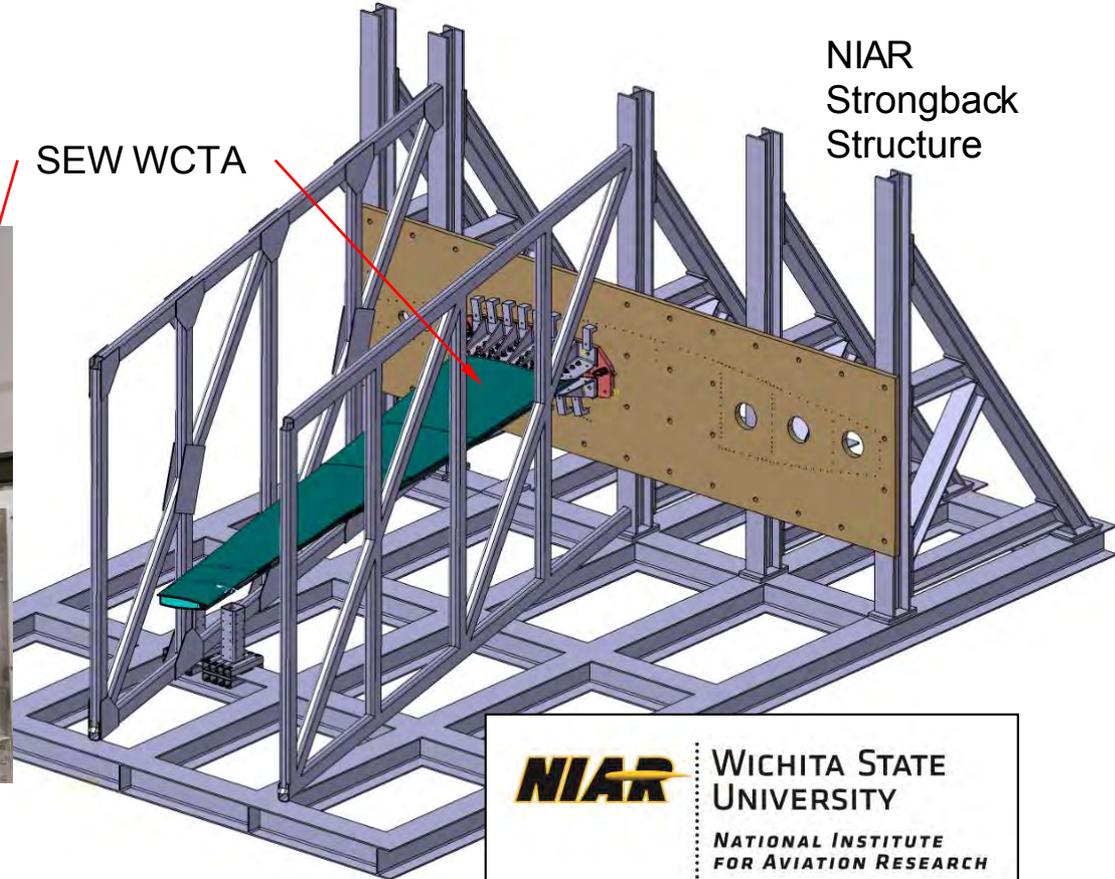
SEW WCTA Assembly





SEW Wing Component Test Article Test

WCTA Installed on NIAR Strongback Structure

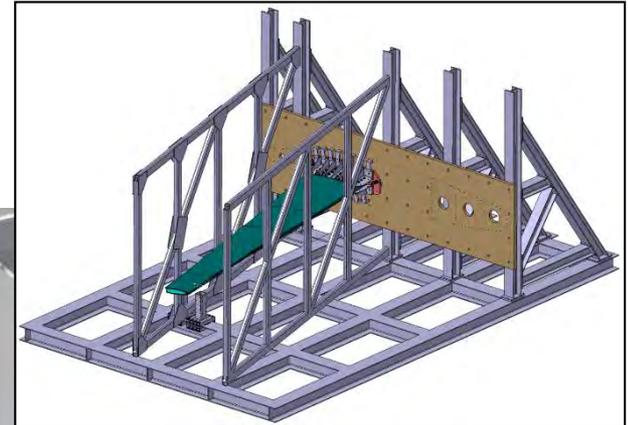




SEW Wing Component Test Article Test

Fore / Aft Framework Constructed

Load Pads Applied



WICHITA STATE
UNIVERSITY

NATIONAL INSTITUTE
FOR AVIATION RESEARCH



SEW Wing Component Test Article Test

Load Formers Installed



WICHITA STATE
UNIVERSITY

NATIONAL INSTITUTE
FOR AVIATION RESEARCH



SEW - TRR Exit Criteria

Criteria	Completed
WCTA Assembly Complete (test fixture, instrumentation assembled and delivered)	6/18/2018
WCTA Test Plan Complete (objectives, configuration, loads, test sequencing, inspections, instrumentation, and schedule all defined)	7/16/2018
WCTA Test Integration <ul style="list-style-type: none">• Test Setup Complete• Test Safety Reviewed, Agreed Upon and Complete• FAA/Boeing/NIAR Agree Test is Ready to Go	8/16/2018
Test Readiness Review (TRR) Complete	8/16/2018

Fatigue Testing Complete – 10/2/2018,

Full Scale Test – ECD 11/15/2018



CLEEN II Program Participation Advantages

Impacts of No FAA Funding

Benefits to Boeing for participation in CLEEN II

- Collaboration with FAA and visibility of Industry's collective progress toward shared goals
- Accelerates technology risk reduction and transition into the fleet.

Potential impact if projects were not funded by the FAA

- Reduced FAA visibility of industry tech development
- Reduced fidelity of System Level Models and Fleet benefits projections
- Overall influence on fleet would be under/overstated
- Reduced Visibility into Potential constraints on sustained aviation growth

- **Structurally Efficient Wing (SEW)**
 - *Broad applications across current/future Commercial & Defense programs*
 - *Accelerates Development & Validates Simulations*
 - *Thermoplastics*
 - *Resin Infusion*
 - *IM+ Material System*
 - *Advanced Fabrication and Assembly Techniques*



Summary

Boeings CLEEN II technologies represent some of our highest impact concepts with a clear path to certification and implementation.

- The building-block test approach on SEW will develop the selected technologies along the TRL scale, resulting in a TRL 6 demonstration when the Wing Component Test Article (WCTA) test is complete
- SEW contributes to the FAA's CLEEN II goal of reducing fuel burn
- FAA & Industry benefit from continued CLEEN program investment and collaboration.



Acronyms

ATP	Authority to Proceed
CoDR	Concept Design Review
DDR	Detailed Design Review
DLL	Design Limit Load
DUL	Design Ultimate Load
DSO	Design Service Objective
ECD	Estimated Completion Date
NIAR	National Institute for Aviation Research
PDR	Preliminary Design Review
SEW	Structurally Efficient Wing
TRL	Technology Readiness Level
TRR	Test Readiness Review
WCTA	Wing Component Test Article

