Project 66

Evaluation of Engine Fuel Burn and Thermal Management Benefits with Use of High Thermal Stability Fuels

University of Dayton

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Objective:

Evaluation of Engine Fuel Burn and Thermal Management Benefits with Use of High Thermal Stability Fuels

Project Benefits:

Quantifying advantages of sustainable alternative fuel (SAF) supports argument to promote accelerated implementation.

An energy savings of a least 0.5% is predicted when superior thermal stability is leveraged by straight-forward design changes

Research Approach:

Monte Carlo Simulation (fuel composition)

Fuel properties from composition

1D thermal model of fuel system (FSTM)

Brayton cycle model of engine (EPM)

5 engine design configurations considered

Major Accomplishments (to date):

Proof of concept, paper submitted:

R. Boehm, L. Scholla, J. Heyne "Sustainable Alternative Fuel Effects on Energy Consumption of Jet Engines" Fuel, submitted Mar 17, 2021

Future Work:

Leverage OEM engine performance models and mission mix to substantiate savings estimates

Integrate methodology with JudO to suggest fuels that are optimized with respect to both engine efficiency and aircraft efficiency (weight)

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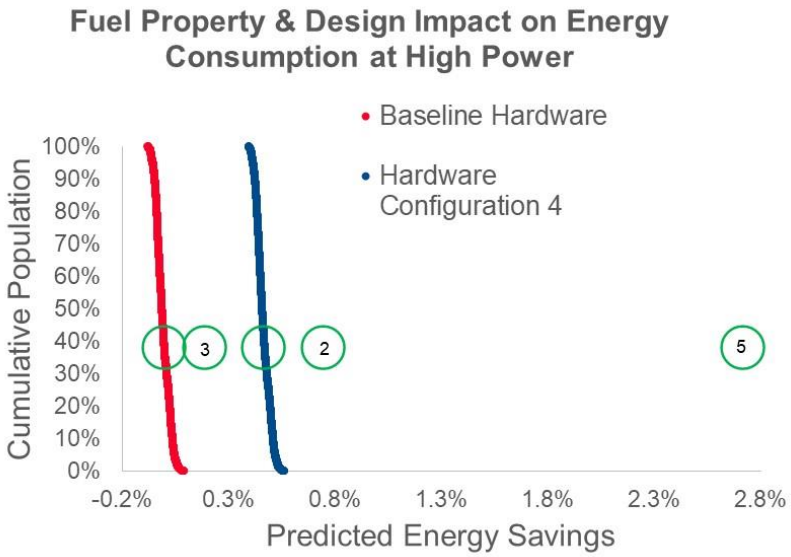
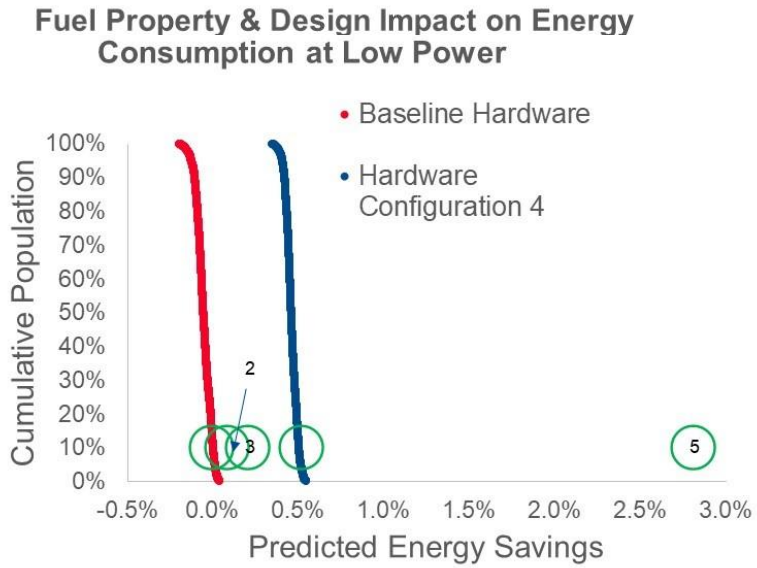
Recent Accomplishments

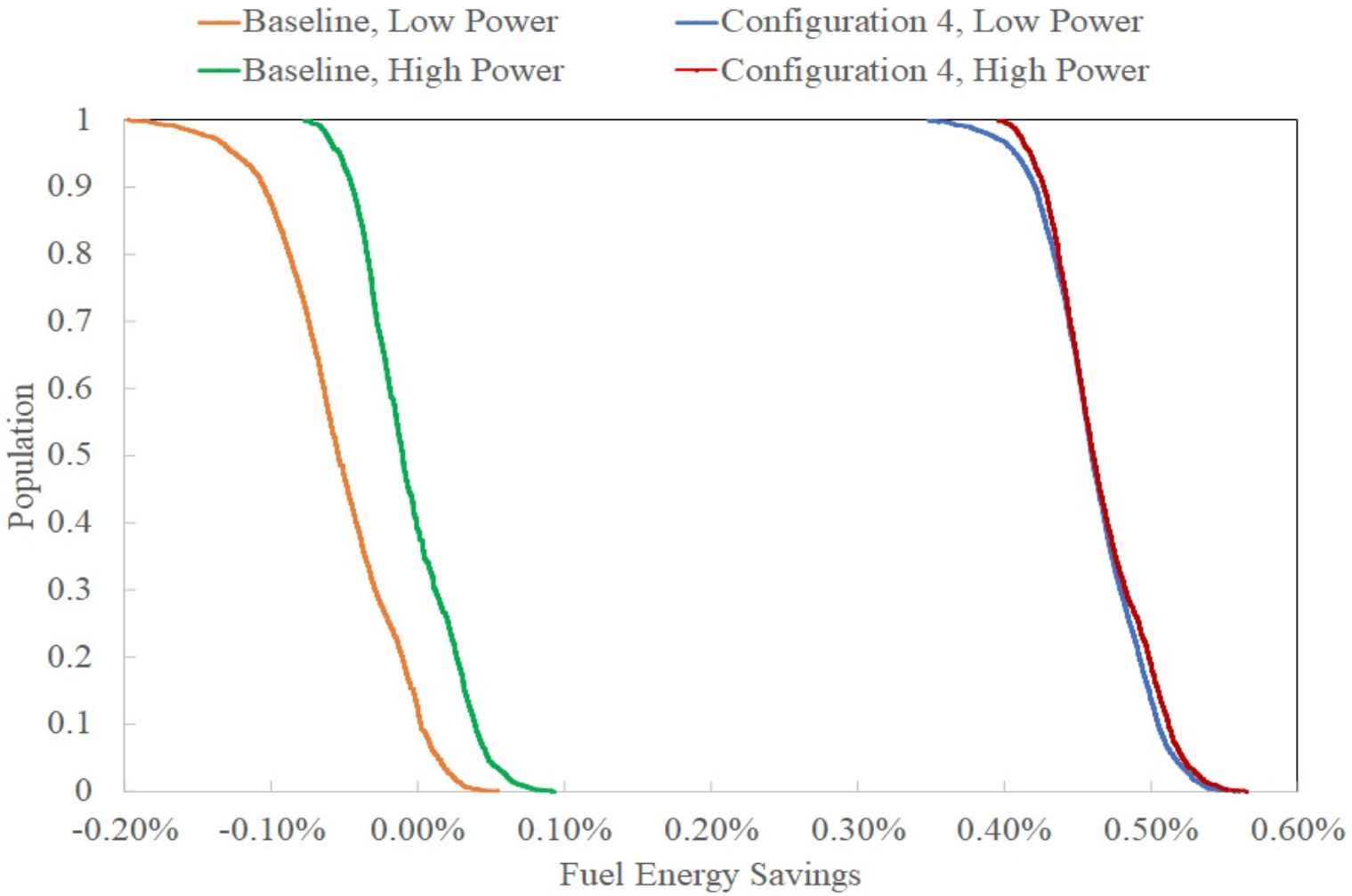




Design Options Considered

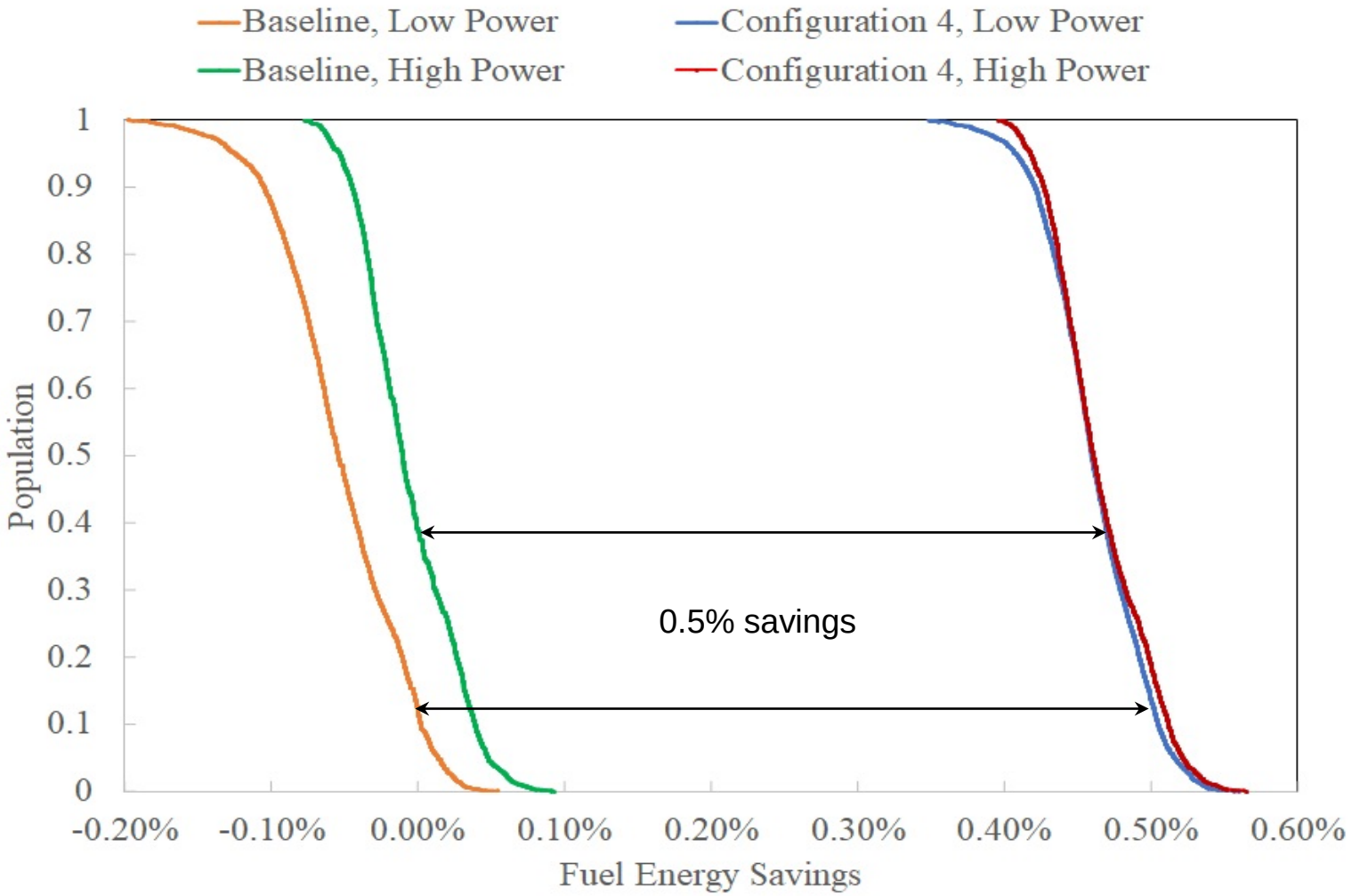
1. Baseline configuration has an FCOC and an air-cooled oil cooler (ACOC), and results in a fuel temperature of 127 °C at min fuel flow (max residence time)
2. Double the size of the FCOC, remove the ACOC
3. Add an FCAC to the baseline configuration, but do not change the cooling air flow to any part of the engine
4. Add the FCAC, and reduce (globally) the turbine cooling flow such that its cooling authority at max power is conserved through the design change
5. Add the FCAC, and *notionally* re-optimize the turbine cooling air flow splits to decrease the clearance gap between the rotating and stationary parts of the turbine

Recent Accomplishments



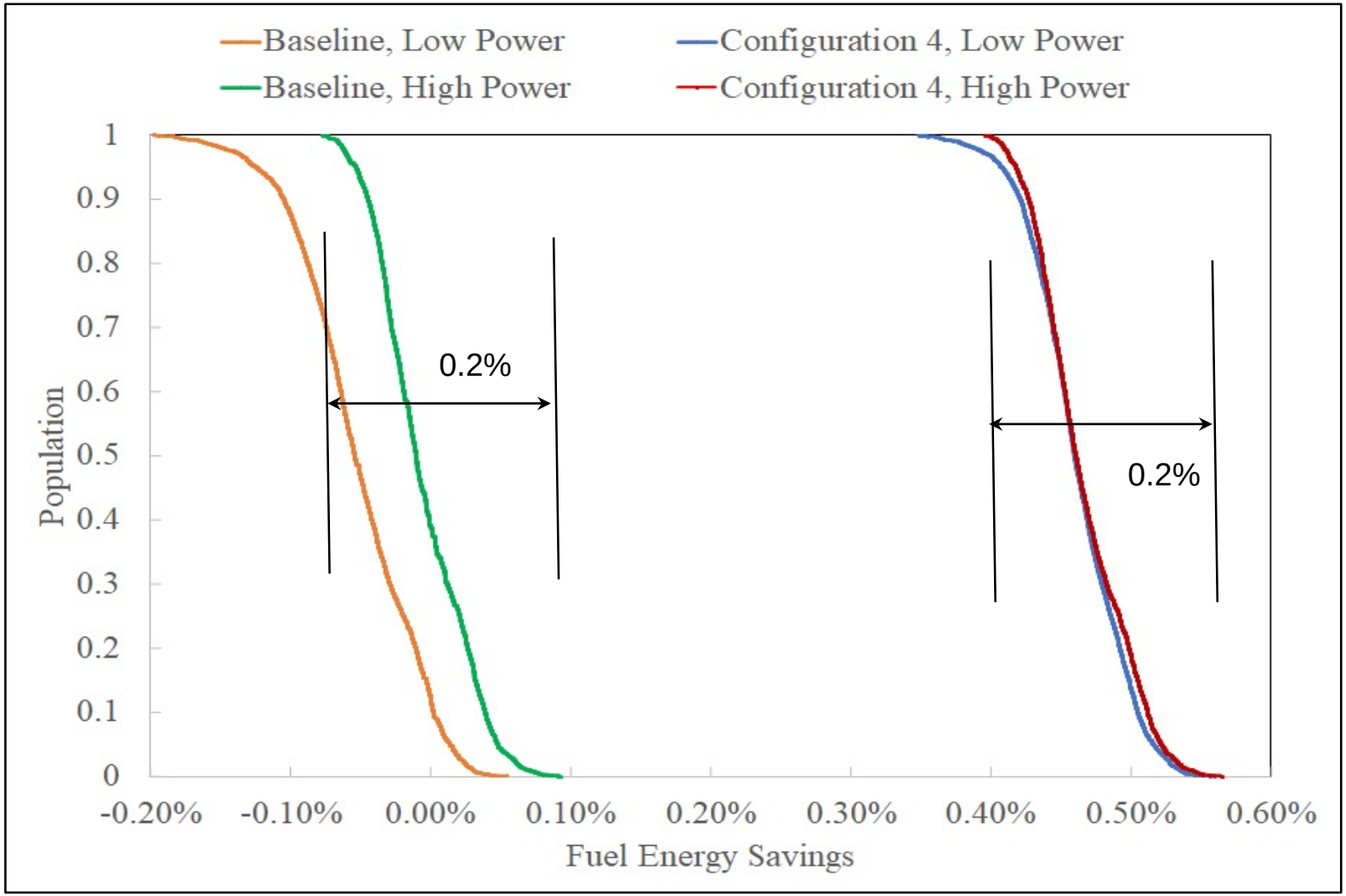
2x2x2501 DoE {EPM configurations, mission points, fuels}

Recent Accomplishments



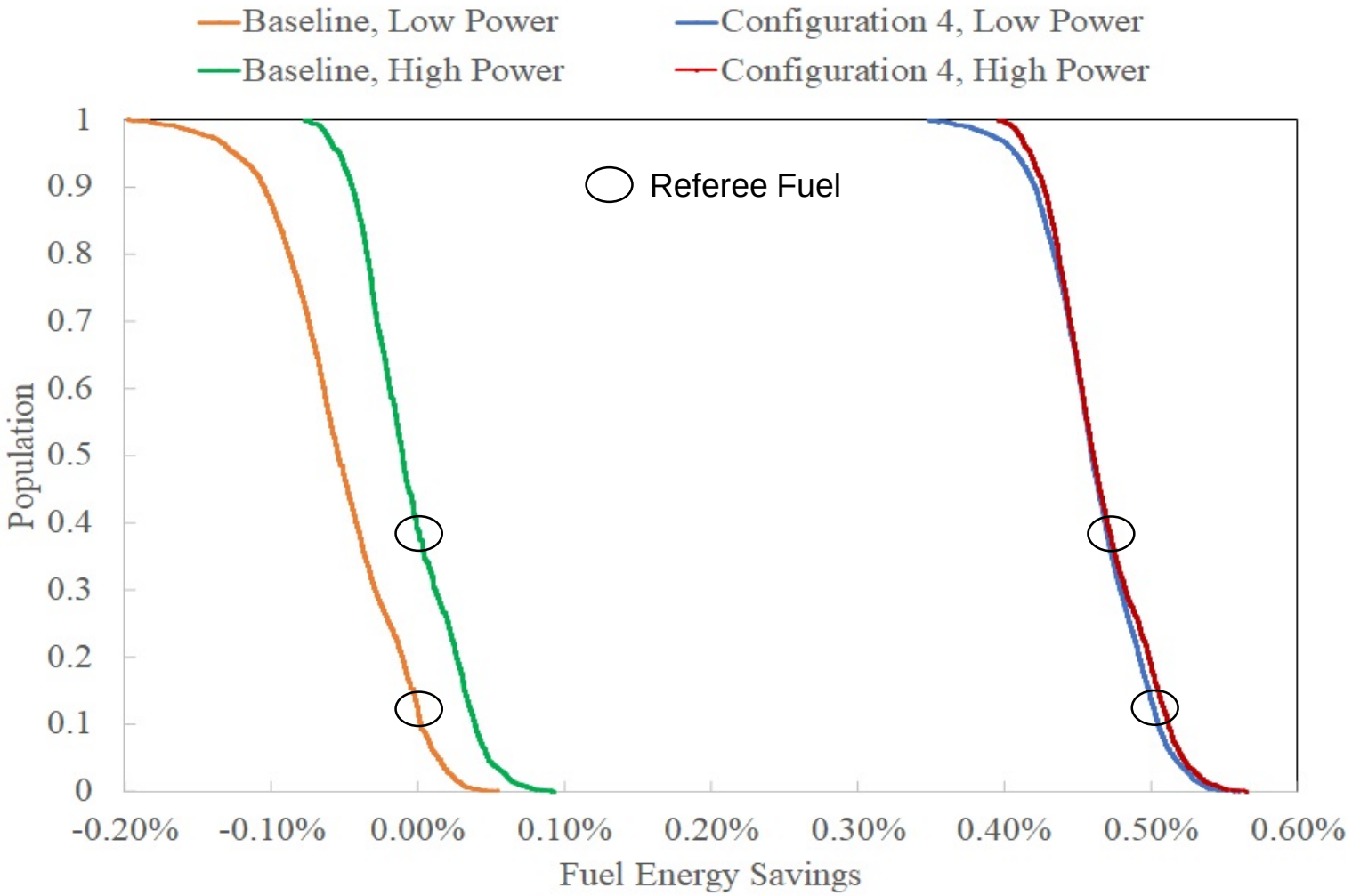
Designing to higher thermal stability fuel is the largest effect

Recent Accomplishments



Full range of fuels sampled has ~0.2% variation in savings

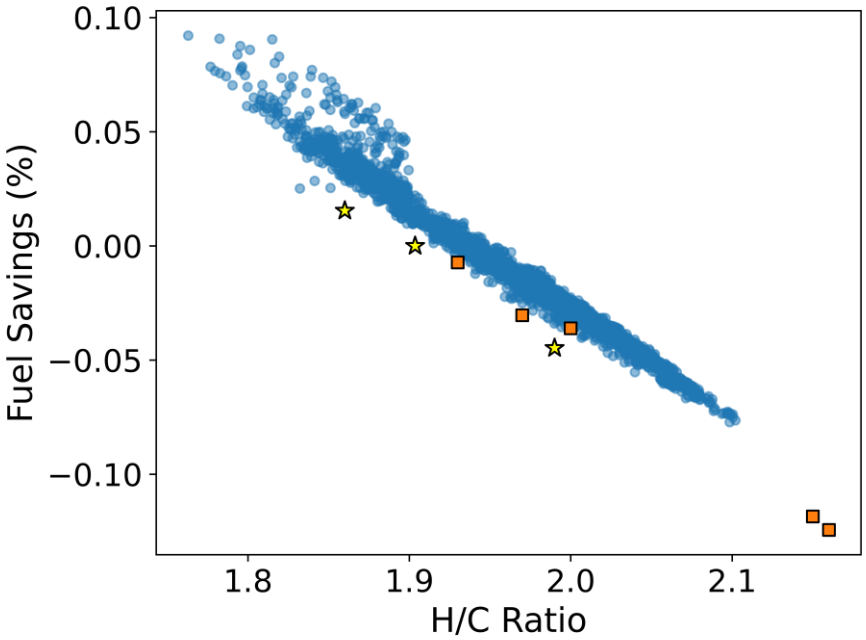
Recent Accomplishments



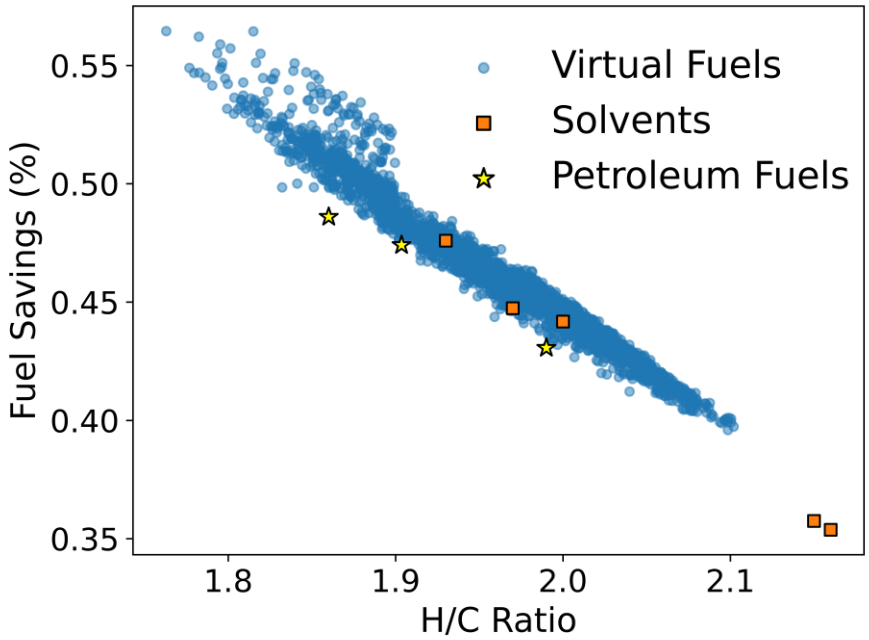
Rank order of fuel invariant to EPM option, but not to mission point

Recent Accomplishments

Baseline Configuration



Configuration 4

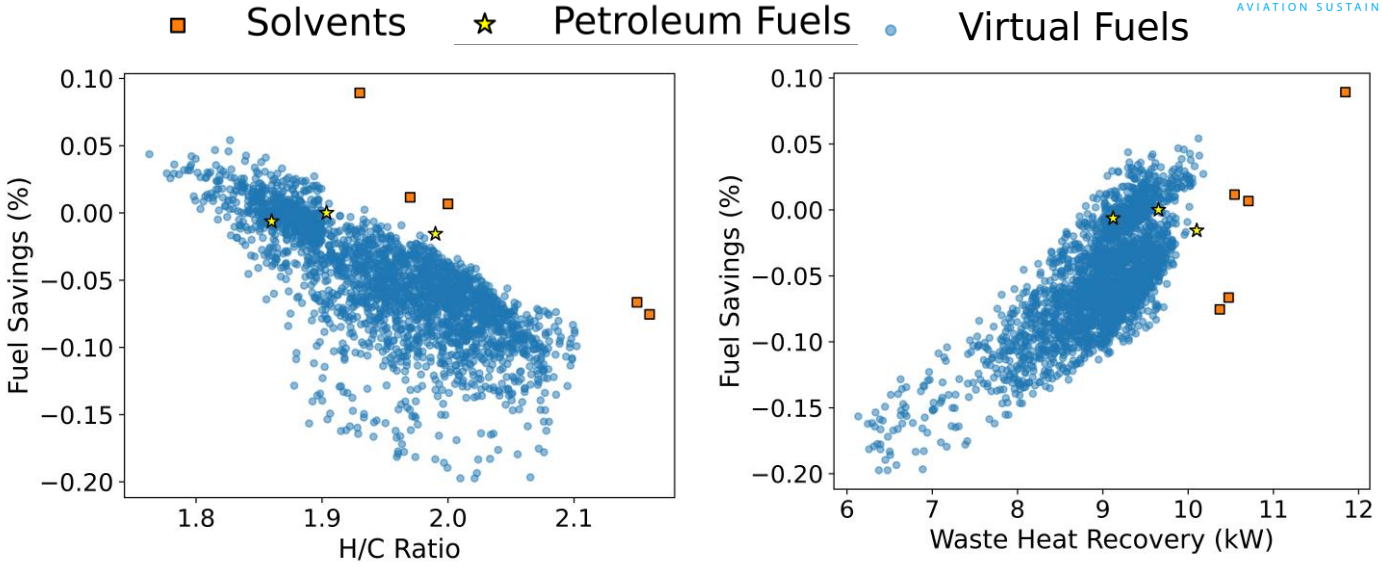


At high power, savings depends mostly on H/C

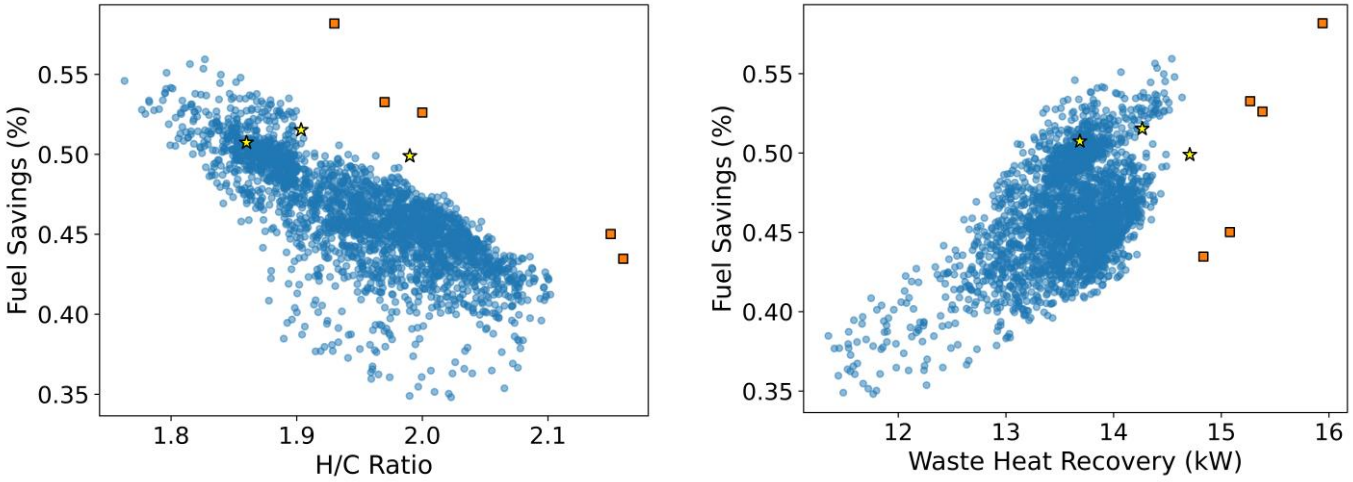
- Combustor exhaust gas composition
- Note: H/C is not correlated with WHR

Recent Accomplishments

Baseline Configuration



Configuration Four



At low power, savings depends on H/C & WHR, ~equal weight