Headquarters U.S. Air Force

Integrity - Service - Excellence

Fueling More Fight Through Innovative Energy Solutions

Mr. William Spacy
Chief of Aviation Energy Operations Policy
Office of the Deputy Assistant Secretary of the Air Force (Operational Energy)

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What is Operational Energy?

- DOD Operational Energy
  - Energy required for training, moving, & sustaining military forces and weapons platforms for military operations

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Office of Air Force Operational Energy

- Provides policy, guidance, and oversight on energy required to operate aviation assets and aerospace ground equipment

- Mission: Break barriers by connecting Airmen with technology, data, and innovative thinking to develop and champion energy-informed solutions for the Air Force

- Vision: Create an energy optimized Air Force that maximizes combat capability for the warfighter

It's about more than saving fuel!

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Ultimate Objective

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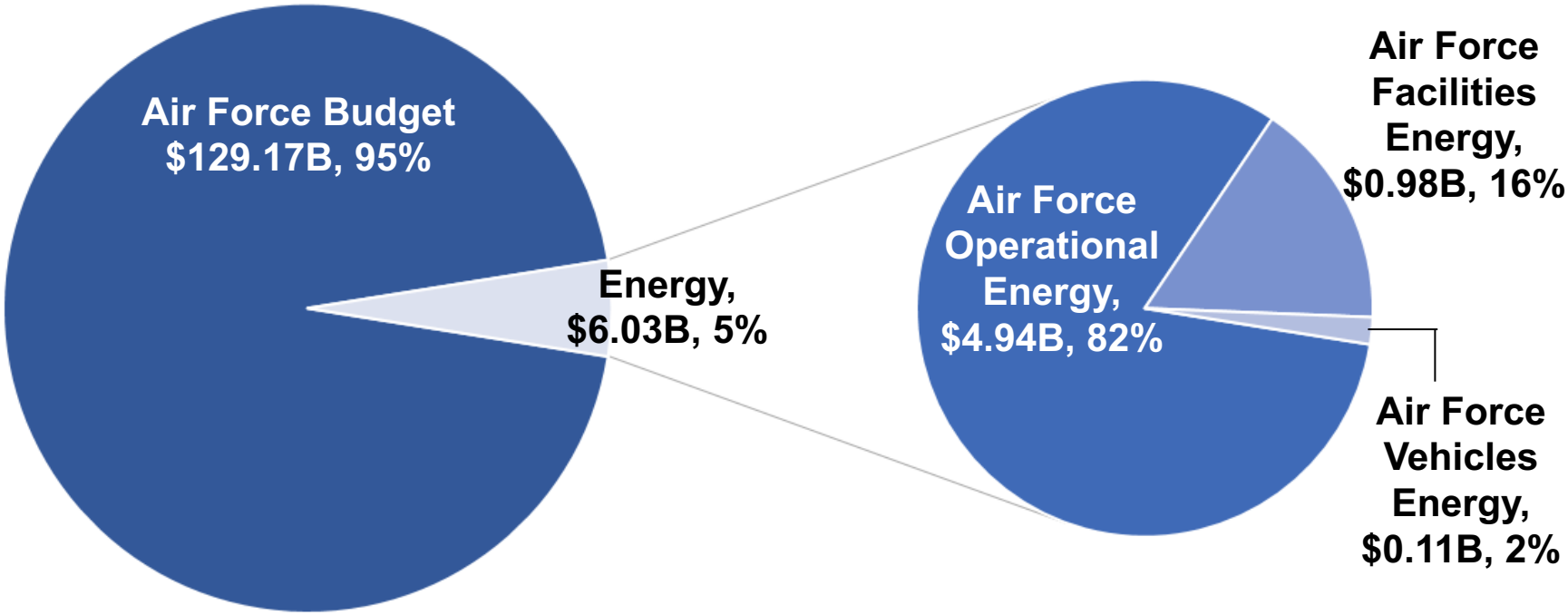
Air Force Consumption



Air Force uses ~ 2B gallons annually on ~800K sorties

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Defense Strategy, Air Force Priorities, and OE Goals

2018 National Defense Strategy

Rebuild Military Readiness--Strengthen Alliances--
Reform Business Practices
"Deliver Performance at the Speed of Relevance"

2018 USAF Priorities

Restore Readiness--Cost Effectively Modernize--Drive Innovation--
Develop Exceptional Leaders--Strengthen Alliances

Air Force Operational Energy Goals

1. Identify & deliver optimal operations planning & execution solutions for existing gaps
2. Provide innovative energy solutions for new and legacy aircraft and systems
3. Furnish energy-efficient weapons systems sustainment analysis
4. Support the production of energy-informed war plans
5. Educate the Force and build the culture for operational energy

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Air Force OE Goals

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Deliver Optimal Operations Planning & Execution Solutions

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Operations Planning & Execution Solutions

- Leading AF-wide effort to execute fuel data collection strategy
- Teaming with combatant & major commands to optimize flying operations through 21st century technology
- Analyzing mission operations and recommending optimized processes and policies
- Developing strategies to incentivize efficient mission execution

Data is critical to optimizing planning & execution

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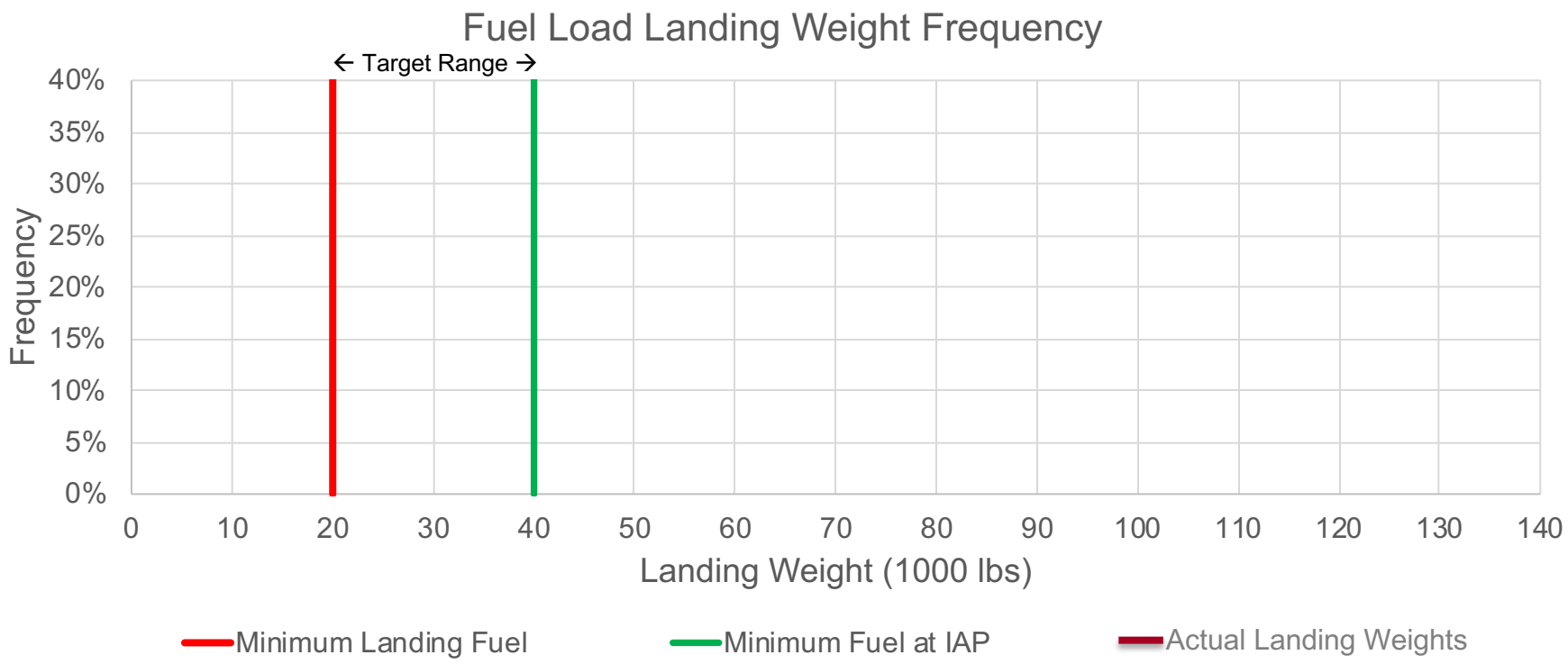
Power of Data



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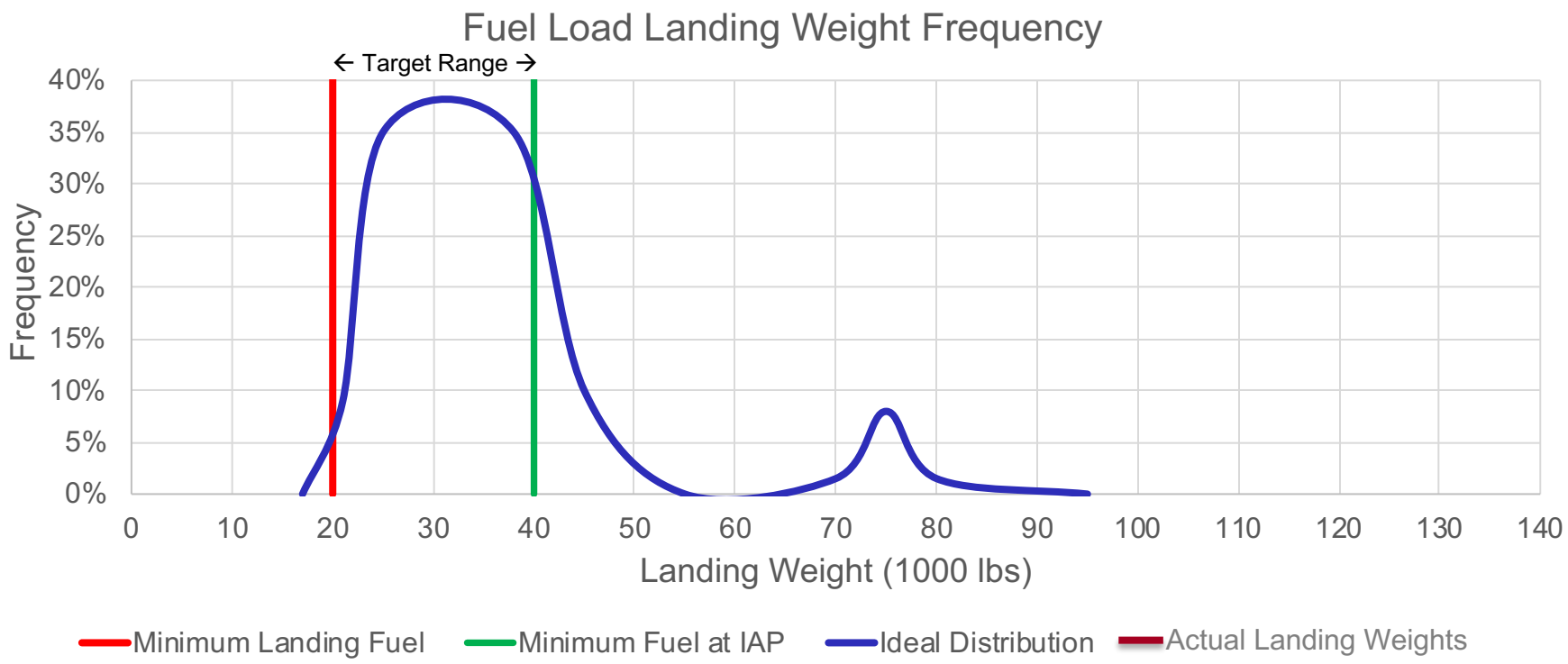
Power of Data



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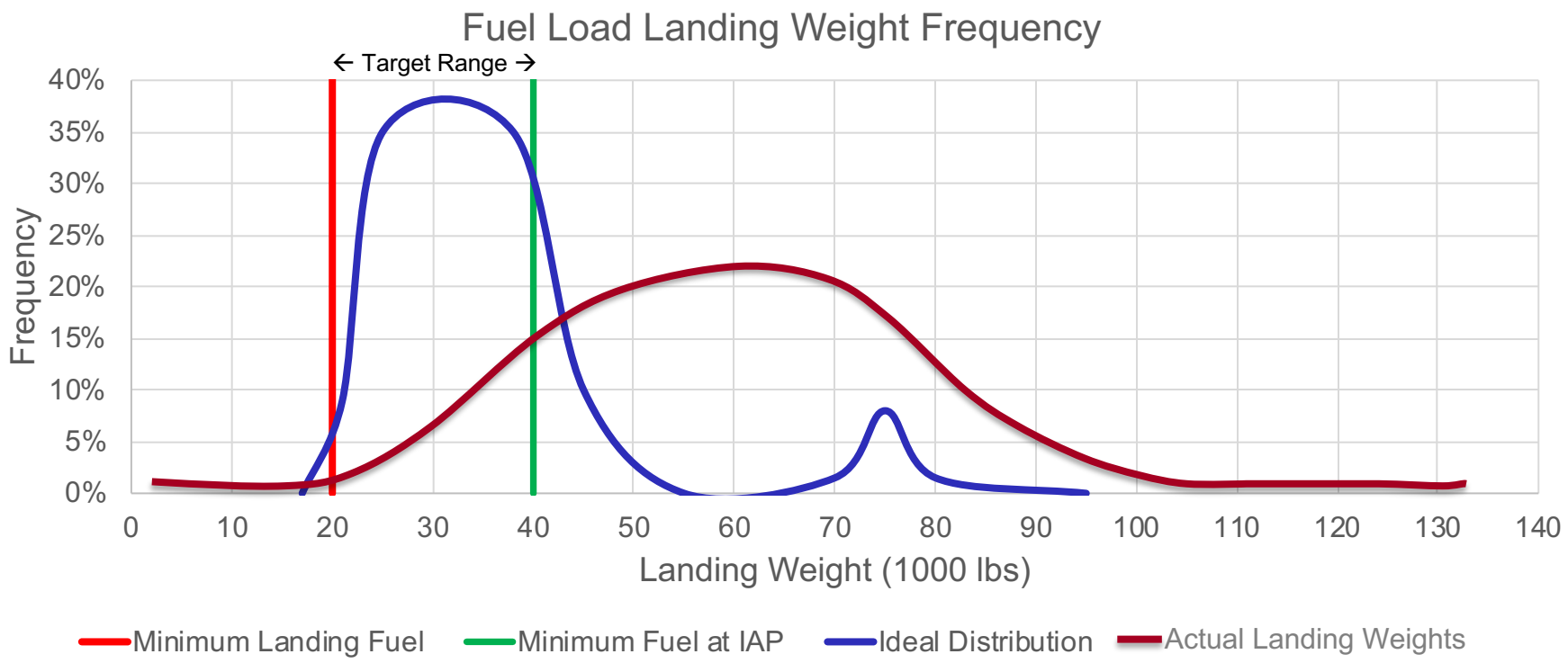
Power of Data



Addressing inefficient operations = Increased combat capability & enhanced readiness

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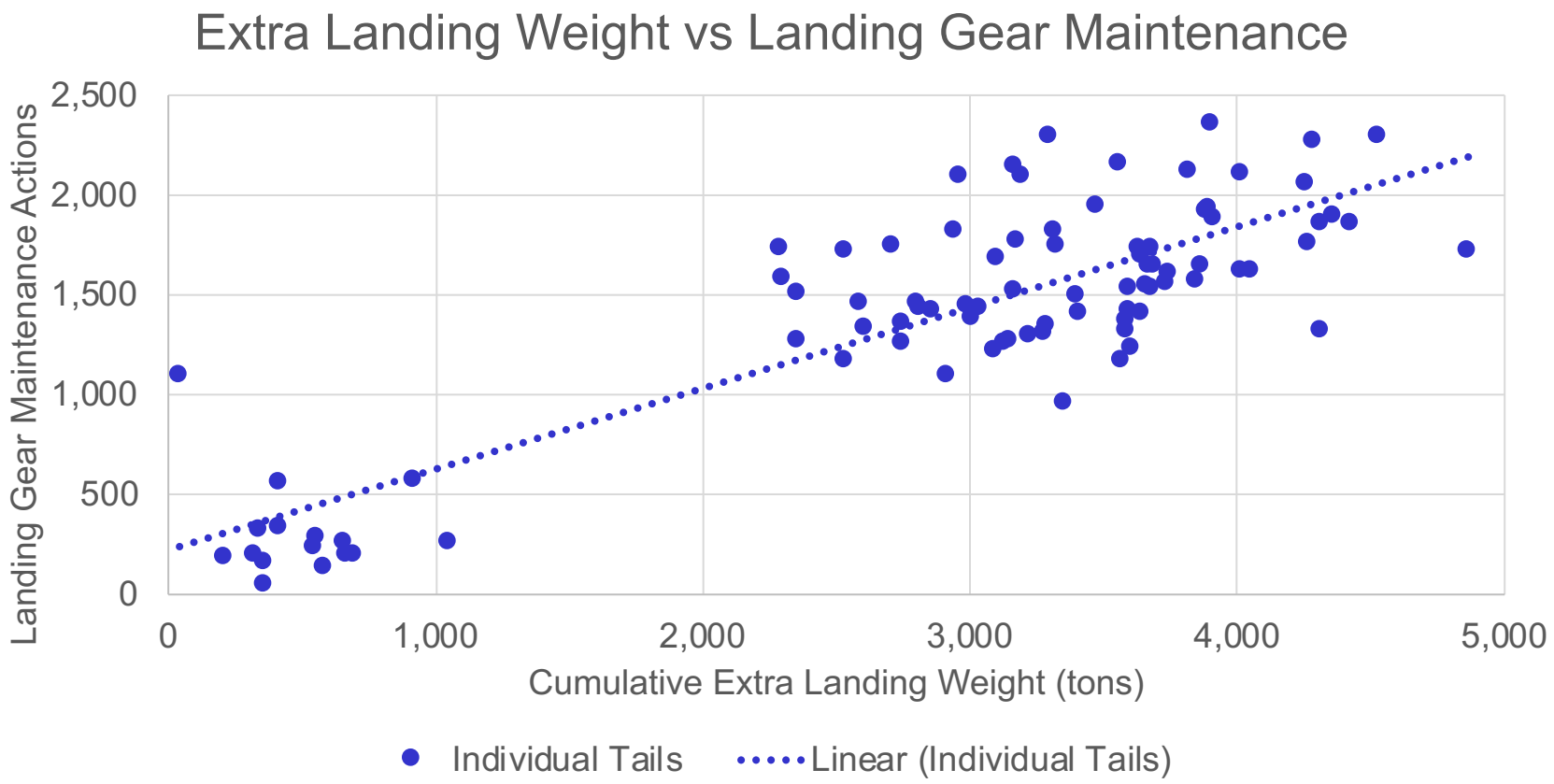
Fusing Operational and Maintenance Data



Avg 350 extra maintenance hours/aircraft per year
41 days a year non-mission capable across the fleet

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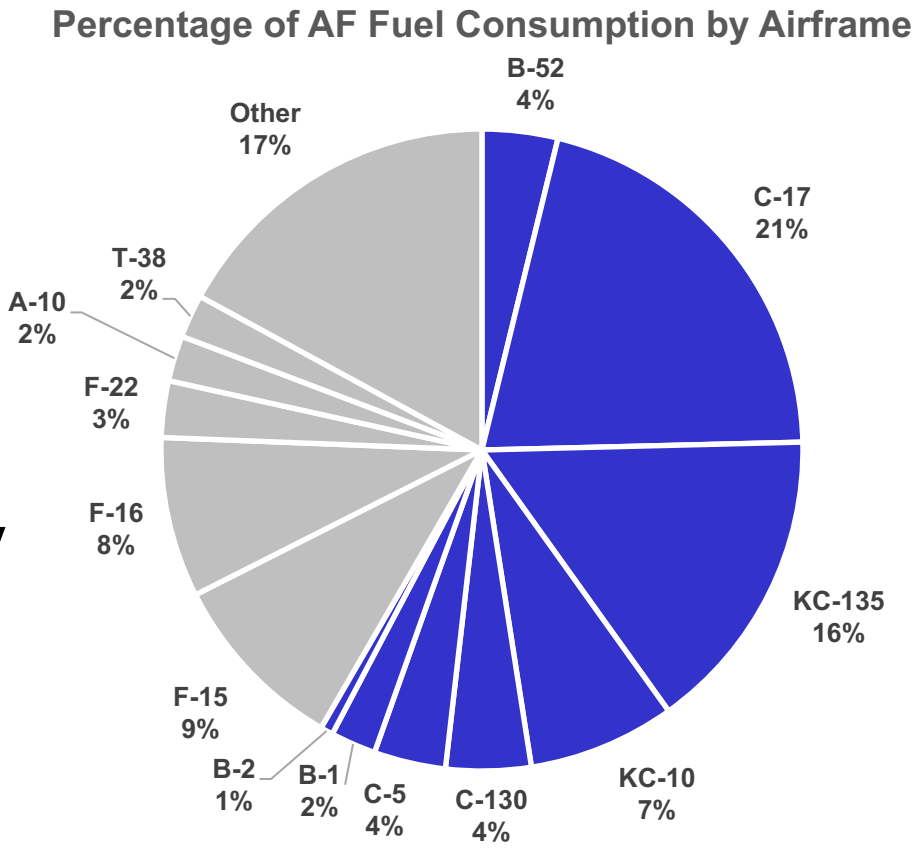
Fusing Operational and Maintenance Data

Impact of 'cost to carry' excess fuel

(based on one aircraft type)

- 350+ extra maintenance hours per aircraft annually
- 41 days per year non-mission capable across the fleet



Most heavy aircraft carry more fuel than required which negatively impacts efficiency, maintenance, and readiness

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Tanker Planning

"JIGSAW" -- Replacing pencil power

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Tanker Planning

Optimized operations planning

Innovative Energy Solutions for New and Legacy Aircraft

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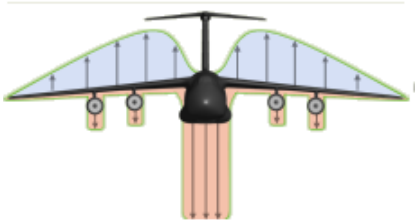
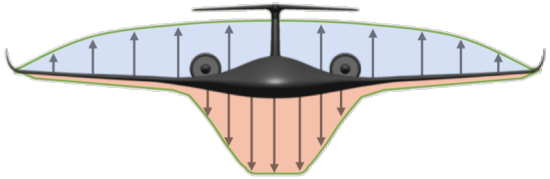
Enabling Technologies for Next-Gen Mobility & Tankers

- **Advanced Air-Vehicle Concepts**
  - Efficient span-loading designs / lifting wing bodies
  - Advanced materials & manufacturing
  - Noise shielding





Credits: NASA/Lockheed Martin Aeronautics Company

Credits: NASA/Aurora Flight Sciences

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Enabling Technologies for Next-Gen Mobility & Tankers

- **Airframe-Integrated Propulsion**
  - **Over-wing / over-body nacelles**
  - **Ultra-high bypass ratio turbofans**
  - **Boundary-layer ingestion**

Credits: NASA/The Boeing Company

Credits: NASA/DZYNE Technologies/Brendan Kennelly

Legacy Aircraft Modernization

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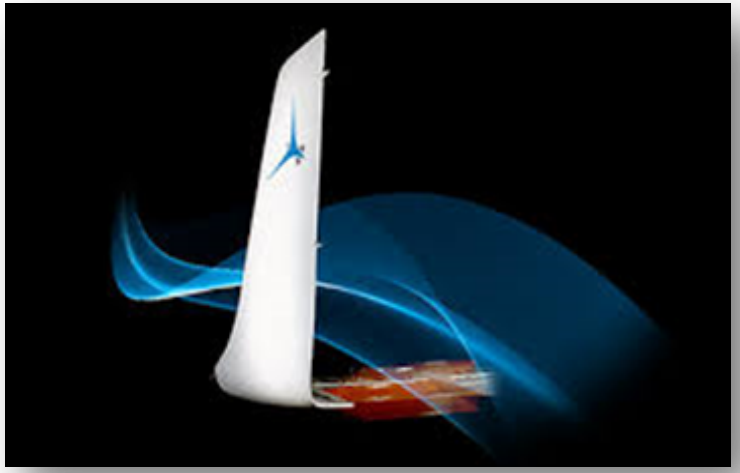
Lightweight Tie-downs

Active Winglets



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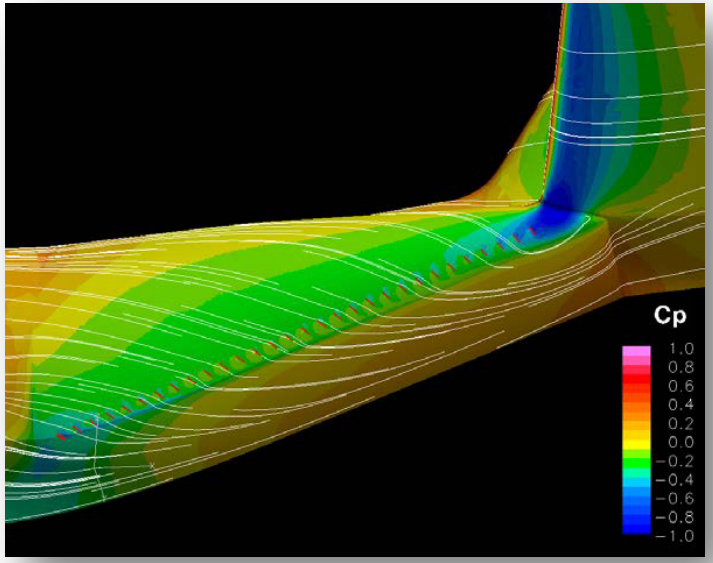
Legacy Aircraft Drag Reduction

- Computational Fluid Dynamics Analysis
- Aft Body Drag Reduction Devices Program



C-17 fleet installation = ~5M gallons per yr avail for other missions

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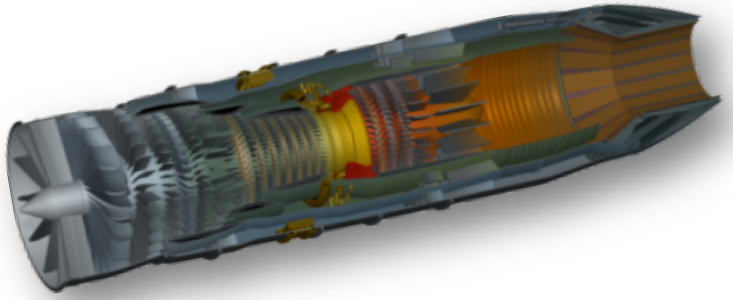
Aircraft Power & Thermal Optimization

- AETP, ADAPT, MegaWatt Aircraft



- Advanced APUs
  - Small Turbines
  - Fuel Cells
  - Turboelectric generators

Credits: Jet Central/ChiefAircraft.com

SOFC

Credits: Parker/FuelCellsWorks..com

- Airframe-Integrated Solar

Credits: Bye Aerospace & SolAero

Energy-Efficient Weapons Systems Sustainment Analysis

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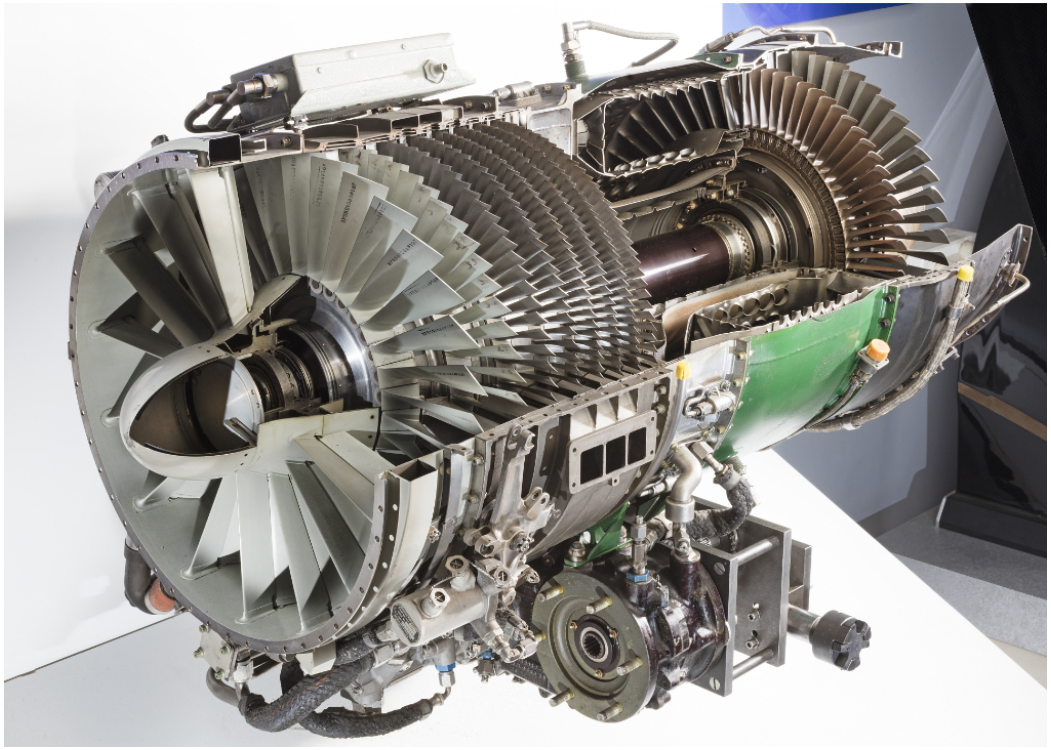
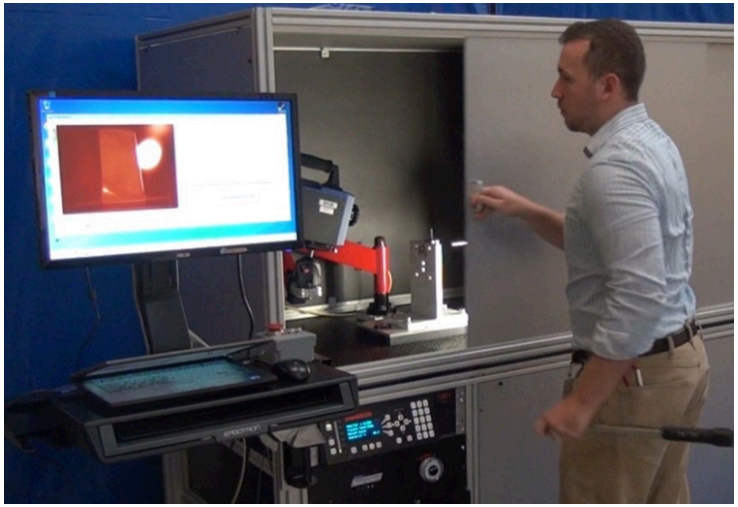
Turbine Engine Efficiency, Reliability, & Maintainability



IR Scanning Compressor Blade



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Turbine Engine Efficiency, Reliability, & Maintainability

Coated vs. Uncoated Compressor Blade

With coating

Without coating

Support Production of Energy Informed War Plans

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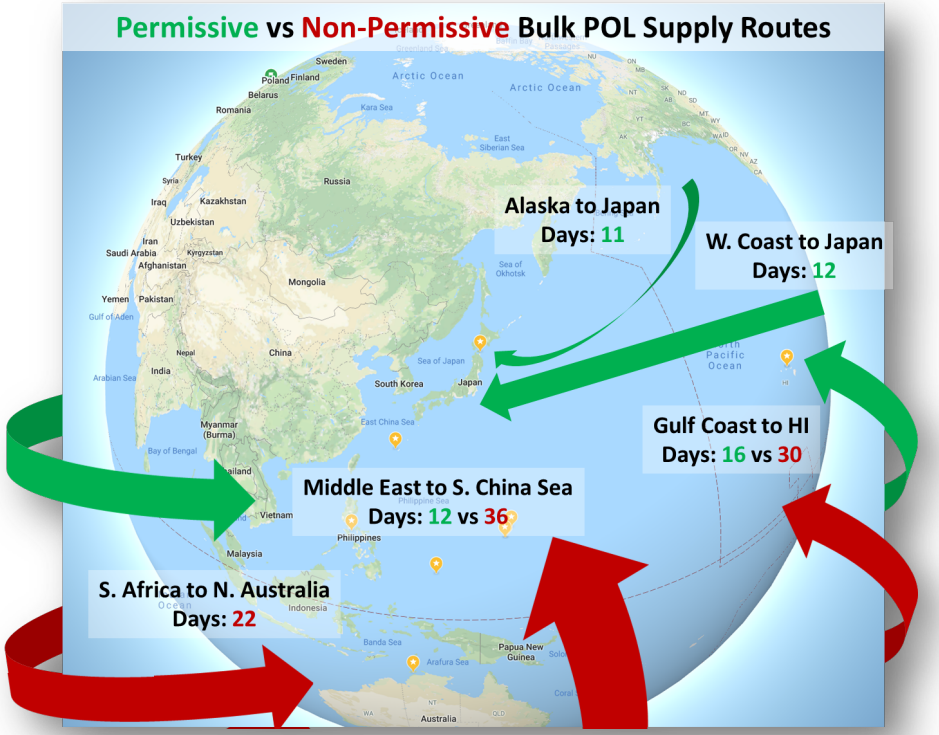
Operational Energy & the Tyranny of Distance



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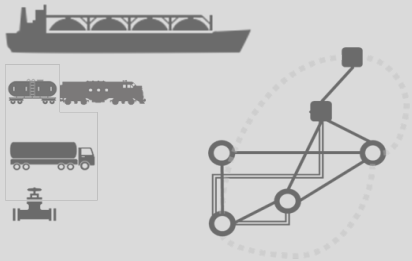
Energy Informed War Plans

1. Crude Oil Recovery

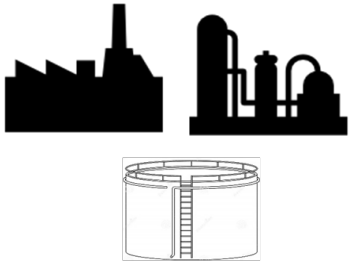
Extraction & Storage **[~45 Days]**

2. Commercial Transport



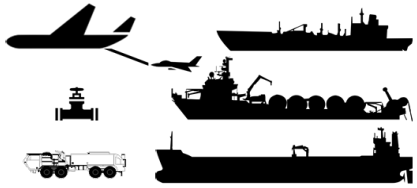
Multi-Modal Distribution through a Transport Network **[~69 Days]**

3. Crude Oil Refinement



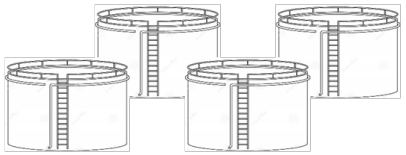
Refinement & Storage
[BBD Receipt and Prod. Rates]

6. Military Transport



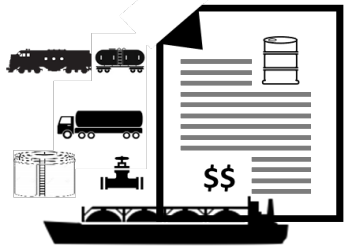
Multi-Domain, Tactical & Expeditionary Energy Logistics
[Hours – Days]

5. Military Storage



Primary & Intermediate Defense Fuel Supply Points
[Demand-Dependent]

4. Bulk Fuel Procurement



Contracting, Direct Purchasing & Multi-Modal Comm. Transport
[Days – Weeks]

Defining OE supply network back to refinery production and not just fuel storage at a given base

Educate the Force and Build the Culture for OE

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Educate the Force and Build the Culture for OE

MORE THAN JUST FUEL SAVINGS…

[ENERGY EFFICIENCY + INNOVATION = MORE FLIGHT HOURS]

OPERATIONAL ENERGY INNOVATION

FLY FAST, SAVE GAS?

Two F-22 CORONET demonstrations showed flying at a faster airspeed, including during air refueling, not only reduces transit time, but also saves fuel.

In January 2014, Maj Sterling Boyer and Mr. Don Reese, working with TACC and the AOS, developed the concept of flying and air refueling F-22 CORONETs near the F-22 maximum endurance airspeed of 335 KIAS instead of the standard 310 KIAS. The first demonstration flew 12 F-22s with KC-10 and KC-135 tanker support from Langley to Hickam, then on to Kadena, measuring a range of factors including fuel use, flight hours, and aircraft stability. Results indicated significant savings in not only flight time, but also net fuel, which could have a large impact if the method is implemented across the fleet.

"I think that's awesome on many counts…Saves gas, saves time, empowers innovation."

– Gen Mike Holmes, ACC Commander

A second demonstration was requested by ACC and AMC to validate these findings. In August 2017, a CORONET, consisting of six F-22s and two KC-10s, divided into two cells and flew from Elmendorf to Hickam at different speeds; one cell at 335 KIAS and the other at 310 KIAS. Under the same conditions, the side-by-side comparison showed that the faster cell saved nearly 9.5K lbs of fuel (approximately $3K) and 1.5 hours of flight time (about $40K). What's more, the F-22 pilots reported greater stability while air refueling at the higher speed and the KC-10 crew reported no degradations to maneuverability or air refueling effectiveness. The next steps are to conduct analysis on other CAF platforms to determine their optimum air refueling speeds and incorporate the optimized speeds into planning standards.

FAST FACTS

- Overall: 10% decrease in flight time, 6% decrease in fuel used
- F-22: Greater AR stability

WHY IT MATTERS – Optimizing operational energy matters. The 10% flight time decrease and 6% fuel savings highlighted in these proof-of-principle missions means more hours for flight training/combat and less wear and tear on the aircraft. Applying this concept to approximately 130 annual F-22 movements and other CAF platforms could reallocate 800+ hours of flight time annually back to the squadrons. Identifying these operational energy efficiencies is how we improve readiness and increase combat capability.

We must unleash the military from the tether of fuel" – James Mattis, Secretary of Defense

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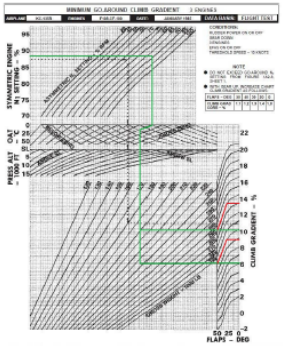
MORE THAN JUST FUEL…

[CRITICAL ANALYSIS + COLLABORATION = OPERATIONAL ENERGY SOLUTIONS]

INNOVATIVE RESOURCE SOLUTIONS

The max landing weight for the KC-135 is now 235,000 pounds because of the initiative displayed by one Airman in the CAOC. Concerned by the high incidences of fuel dumping, he was determined to reduce fuel dump frequency and avoid wasting an increasingly valuable resource. He came up with an innovative solution to change the 1950s-era 200,000 pound landing weight restriction, thereby reducing AOR dump frequency by 80% and volume dumped by 90%.

In his research, he found the 200K restriction was driven by A-Model engine-out climb performance. The J57 engines have long since been replaced by the R-model (CFM-56) engines, which produce about twice the thrust and completely change the engine-out go-around climb profile. With the increased performance, the KC-135 can safely land and execute an engine-out go around at 235K eliminating most fuel dumping events.



He worked with maintenance, sustainment professionals, and operators to ensure there were no hidden costs or safety issues associated with the proposed increase. When none were identified, he successfully worked to change AFI-11-2KC-135V3 to reflect the new max landing weight.

This success story is just one example of how the current generation of aviators and maintenance professionals are embracing the smart use of operational energy resources. One of your roles is to support and apply this mindset throughout the Air Force, thus changing the culture and creating an operationally energy efficient force. Your leadership and endorsement of smart operational energy use creates an atmosphere where people are internally motivated to critically analyse and solve OE challenges.

"Unleash us from the tether of fuel" – Secretary of Defense James N. Mattis

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Educate the Force and Build the Culture for OE

Promoting smart energy practices and policies

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Closing

- **USAF will continue to be DoD's largest fuel consumer**
- **Developing and championing innovate energy solutions is critical to improving combat capability and increasing readiness**

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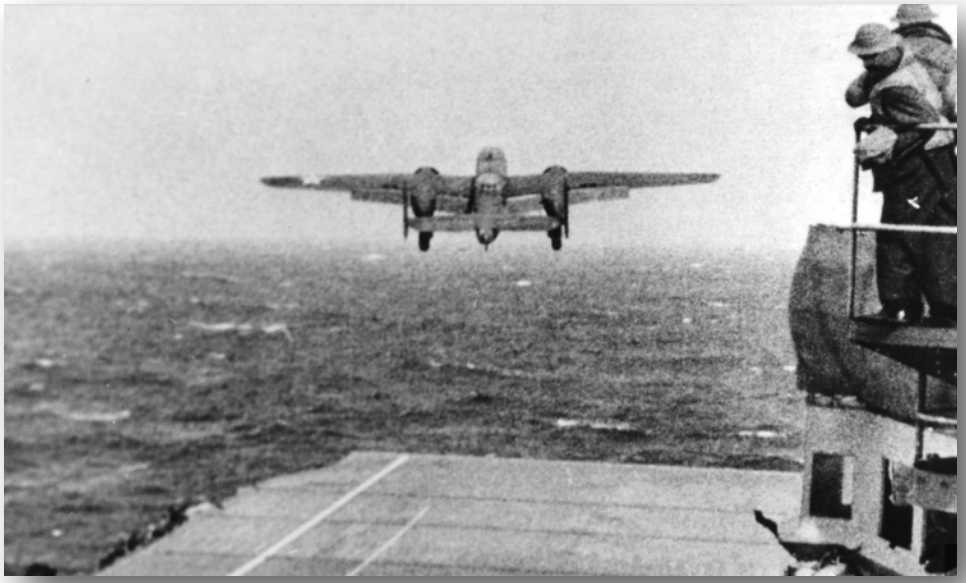

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QUESTIONS