Headquarters U.S. Air Force

Integrity - Service - Excellence

Air Force Operational Energy

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AF Research Laboratory Energy Office
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U.S. AIR FORCE

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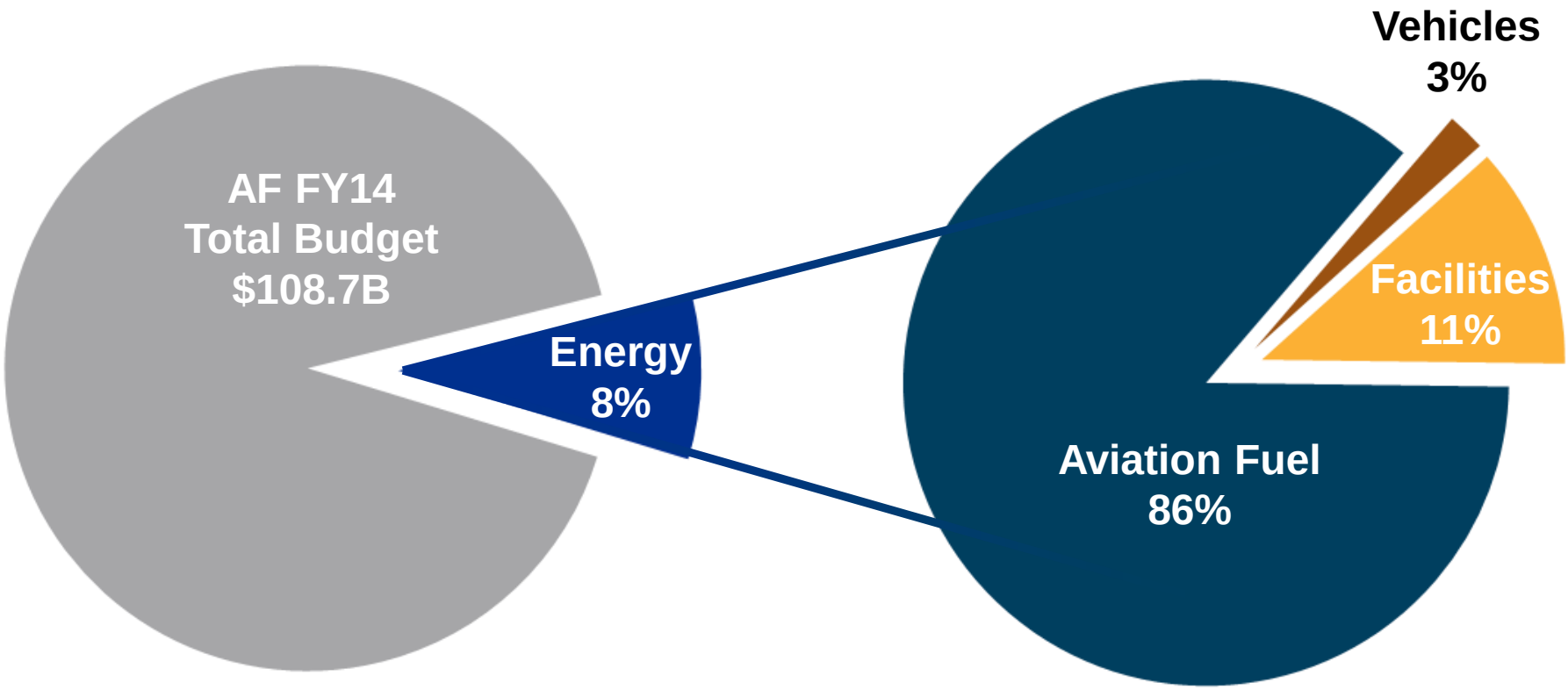
The Cost of Energy



Energy is a significant portion of the budget

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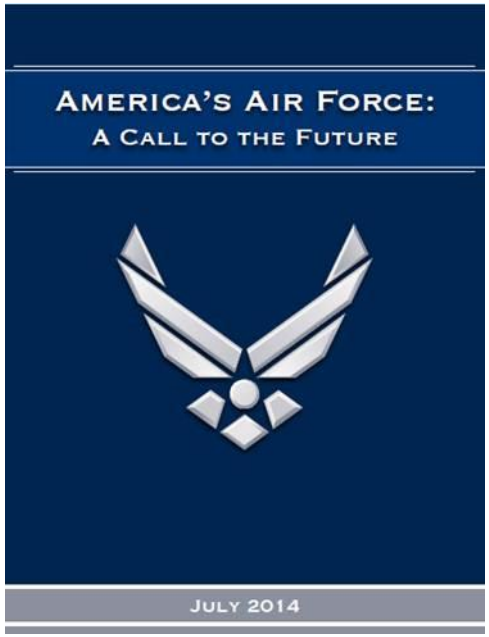
Coming out of the weeds by 30,000 feet or so…

Air Force 30-Year Strategy lays out four Emerging Global Threats. Each one shapes how we think about energy at the Air Force.



- **Rapidly emerging technological breakthroughs**
- **Geopolitical Instability**
- **Wide range of operating environments**
- **Increasing importance and vulnerability of global commons**

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What does the Air Force of the Future look like?

STRATEGIC AGILITY

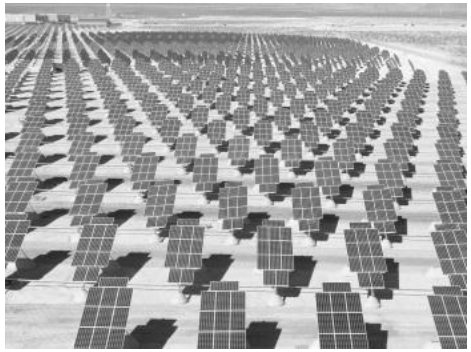
Resiliency

Adaptability

Flexibility

Partnerships

Inclusiveness



Mission Assurance through Energy Assurance

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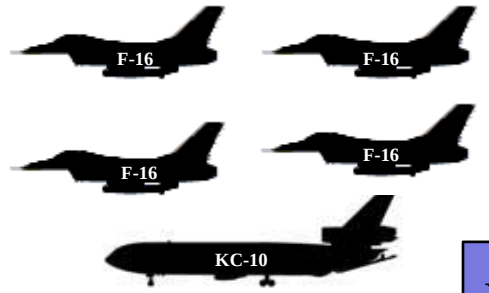
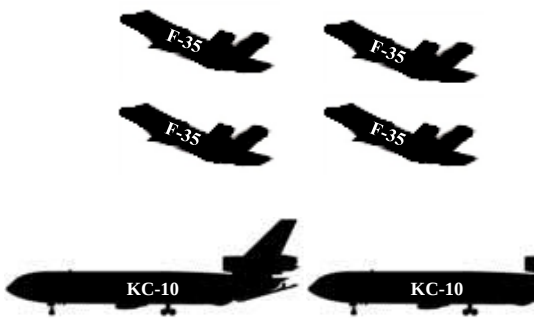
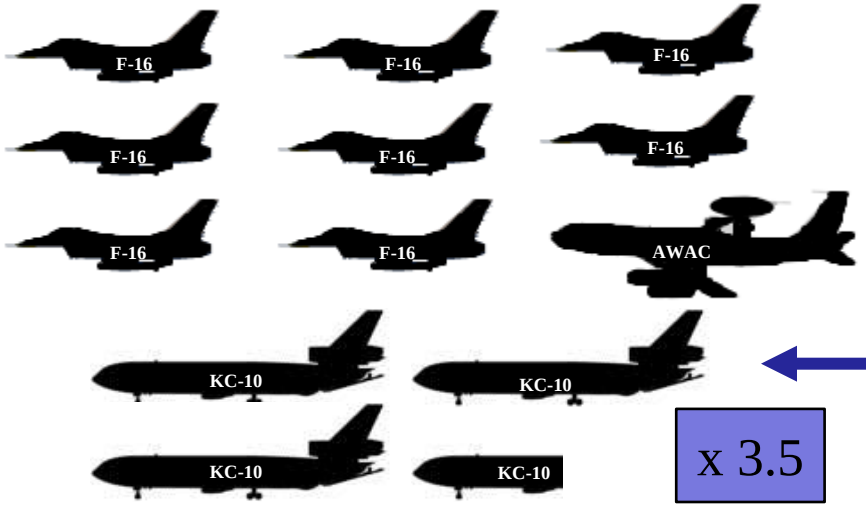
How we operate will change…

	Legacy	Future
Fuel Demand Comparison	 x 1.0	1 for 1 Fighter Replacement 
Capability Comparison	 x 3.5	Capability x 1.8

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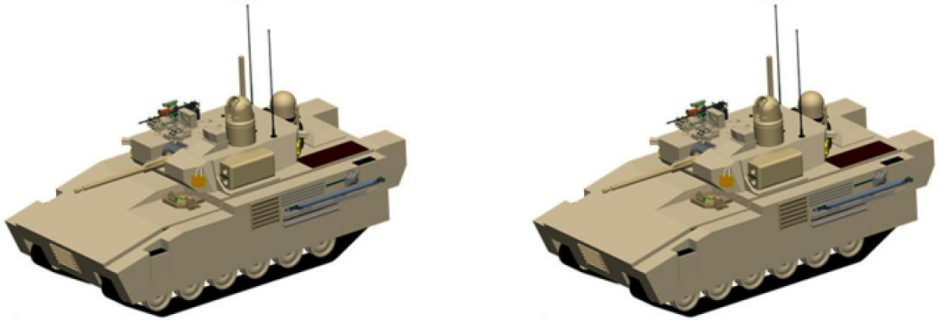
We Don't Fight Separately

M2A2 Bradley Fighting Vehicle

C-5M

Army Ground Combat Vehicle

C-5M



Operational considerations can be driven by other services force structure and procurements

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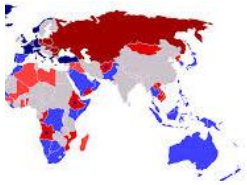
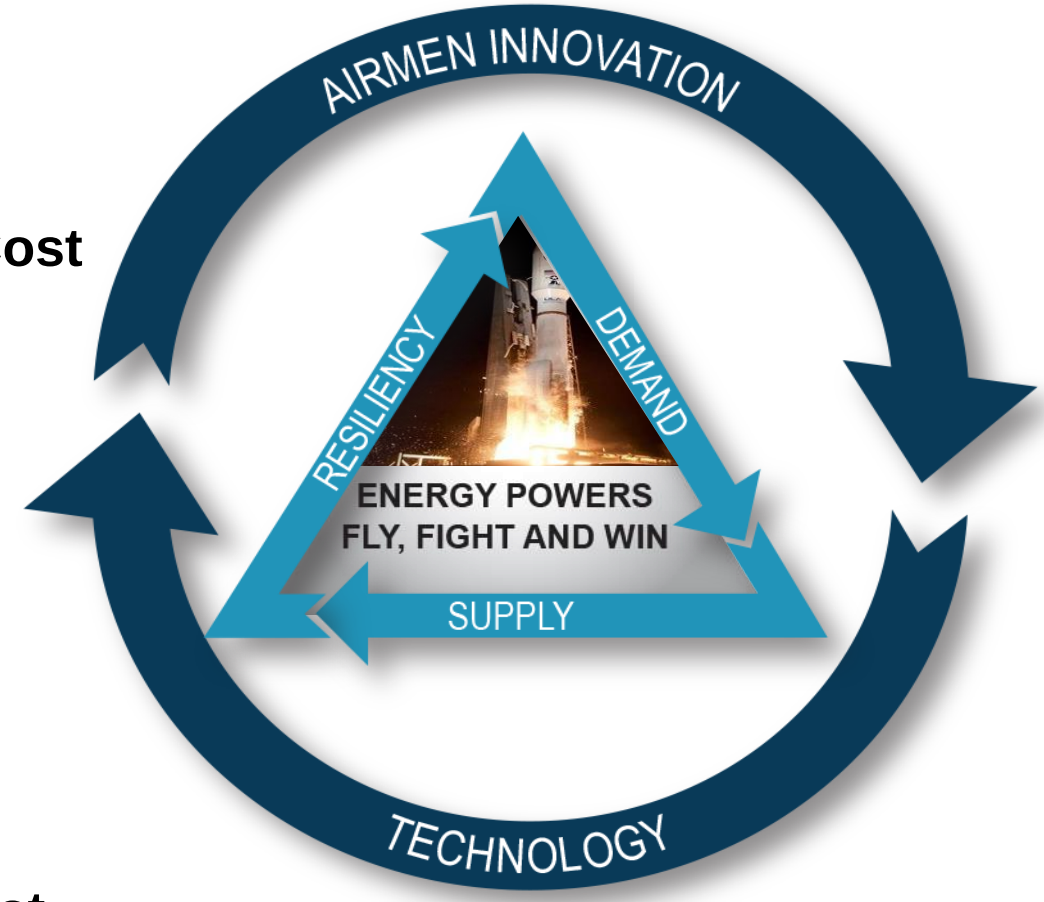
Why, What, and How



Geopolitical Cost



Mission Cost

Financial Cost

Environmental Cost

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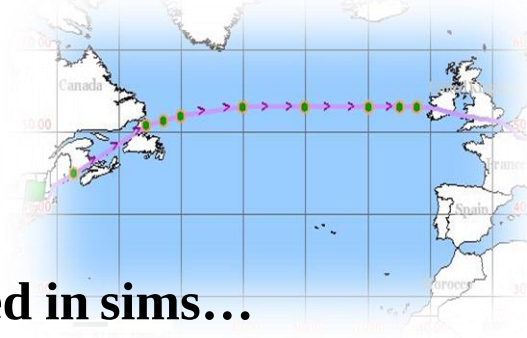
Fuel Efficiency Initiatives

- **MAJCOM Policy: AFI's, Ground Power Unit usage, Alternate destination fuel requirements...**
- **Operations: Air refueling optimization, Optimized diplomatic cleared routings …**
- **Training: More requirements and currencies completed in sims…**
- **Aircraft: Weight reduction, aircrew electronic publications…**
- **Wargames: Unified Engagement, Futures…**
- **Investments: Integrated air refueling simulator, KC-135 Propulsion Upgrade Program, …**
- **NextGen: Airspace access and efficient flight operations**



Initiatives realize absolute savings & cost avoidance

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MAF Policy/Low-Cost Initiatives

Initiative	Start date	FY 15 Savings (Gal/$)	
Optimized Diplomatic Clearance Routes	Oct 07	0.06M	$0.22M
Aircraft Weight Reductions	Feb 09	0.43M	$1.58M
Reduce KC-135 Zero Fuel Weight	Jan 10	1.70M	$6.27M
Reduced APU Use	Aug 10	0.22M	$0.81M
Contingency Fuel Reduction (15 Min)	Sep 10	0.71M	$2.61M
Overfuel Elimination/Precise Fuel Loading	Sep 10	0.16M	$0.58M
Mission Indexed Flying / ACFP Overlay	Oct 10	2.76M	$10.2M
Alternate Fuel Requirements Change	Jun 11	0.25M	$0.92M
Category I Fuel Elimination	Oct 11	0.64M	$2.38M
MAF Cost Avoidance Tankering	Jul 12	n/a	$14.1M
Surfing Aircraft Vortices for Energy ($AVE)	Sep 12	>FY15	>FY15
KC-135 Landing Weight Reductions	Aug 13	0.33M	$1.2M

FY15 Projected Savings/Cost Avoid ~ 7.3M Gal/$40.9M

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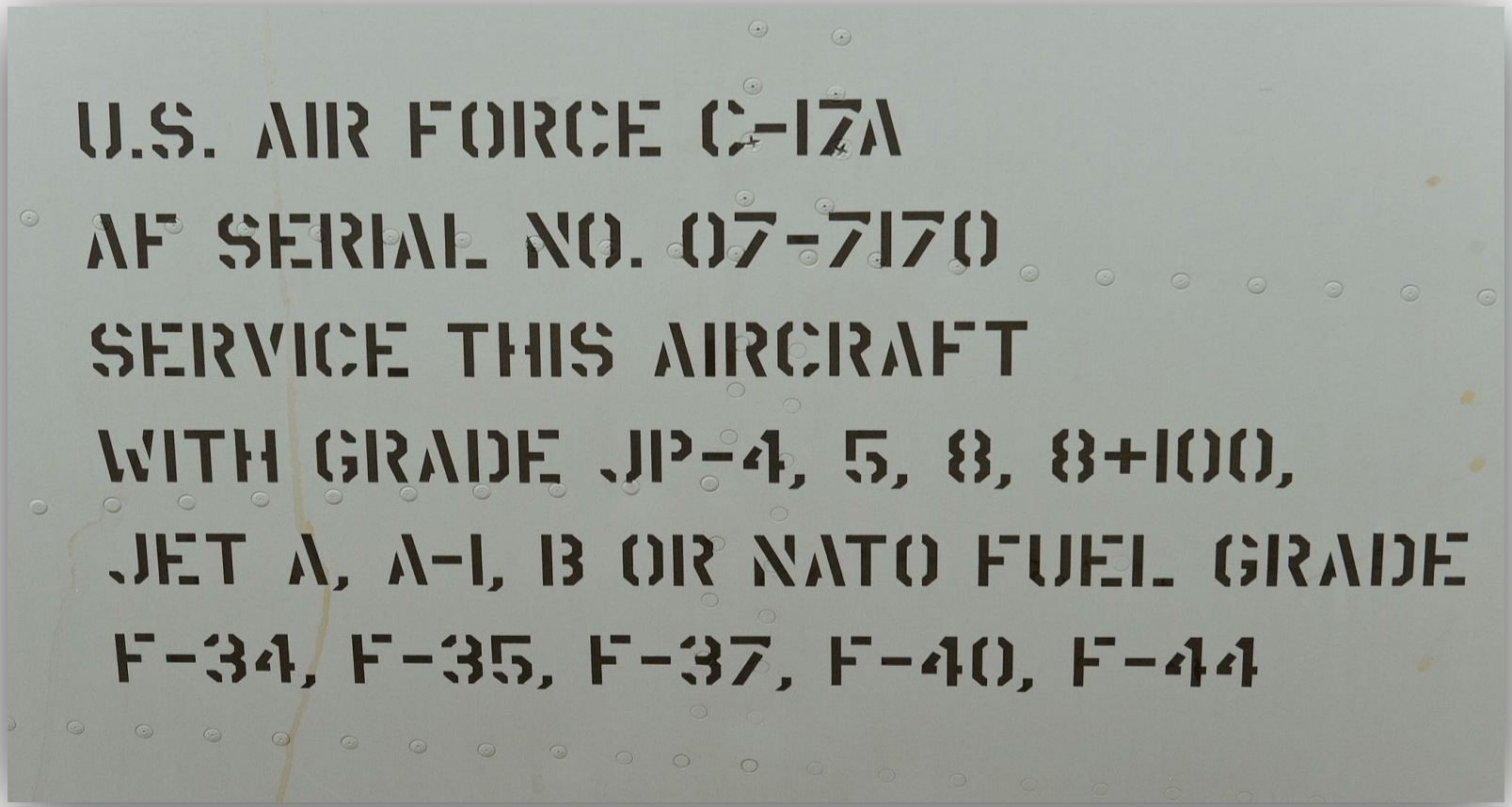
Examining Alternative Fuels



Significant experience with using different fuels – it's an operational necessity

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Approach to Technology

- **Three priority categories:**
  - **Technology Leader**
  - **Fast Follower**
  - **Technology Watcher**
- **Current technology initiatives include:**
  - **Aircraft and engine design**
  - **Renewable energy**
  - **Microgrids**
  - **Best practices in planning & operations**

Air Force focuses on core capabilities in innovation

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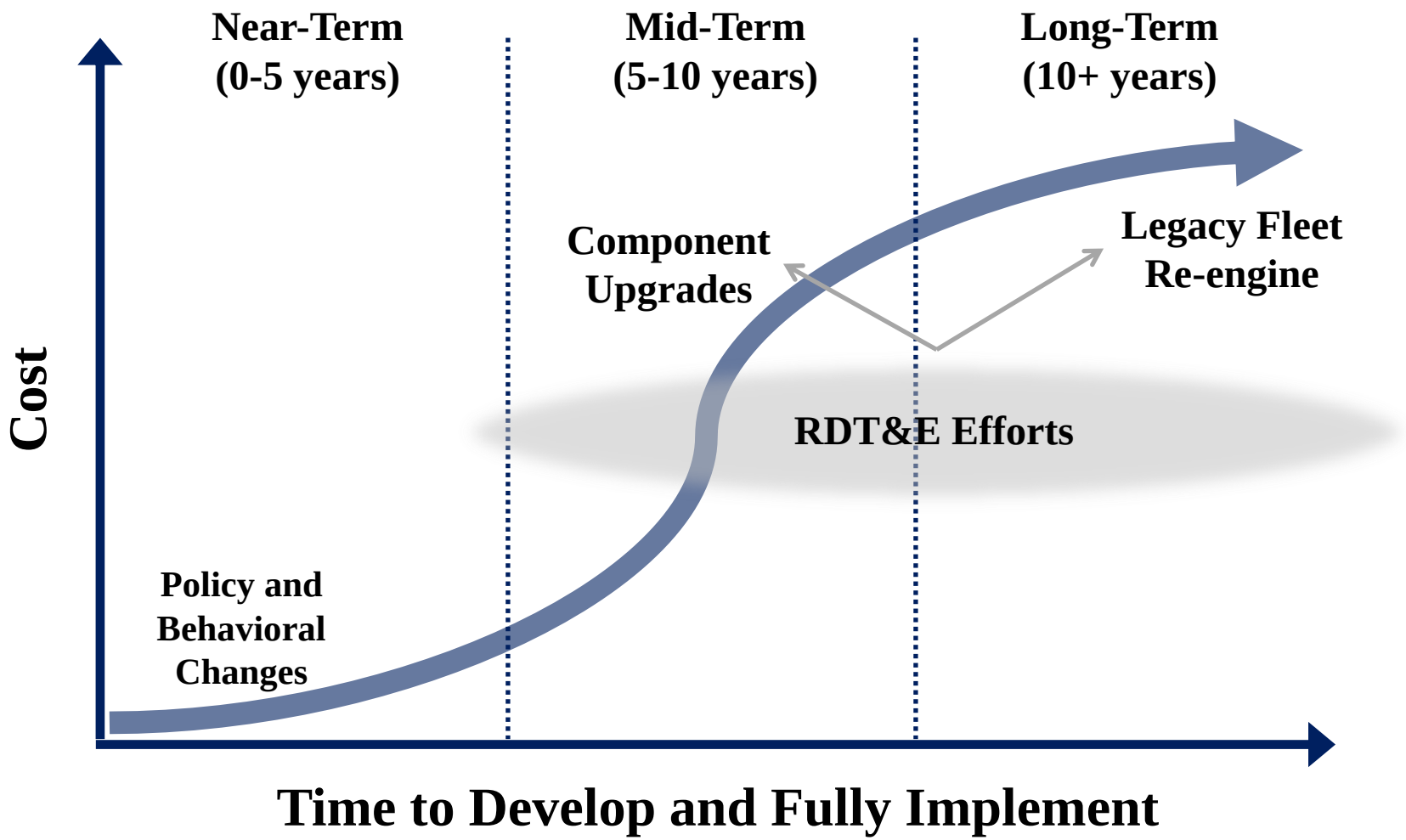
Utilizing Technology



Fuel Assessment and Evaluation

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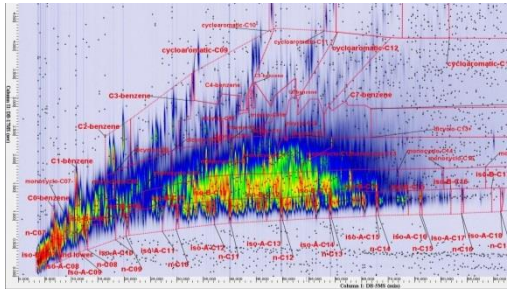

Fuel Composition

Specification Properties

Emissions Evaluations

Component/Rig Testing – Operability/Durability

Adv Combustion Research – Fuels/Emissions & Operability

Motivation

- Conversion to commercial Jet A completed (2014)
- Challenges of jet fuel changes
  - Linking changes in fuel composition to performance
  - Updating consensus-based specifications
  - Complex logistics infrastructure
  - Specialty fuels for hypersonics, missiles

Key Events and Demonstrations

- FY14: JP-8 spec change to reduce allowable FSII but maintain icing inhibition and reduce maintenance
- FY14: 3rd alternative fuel approved for Jet A based on AFRL data (previous in 2009, 2011)
- FY14: Next Gen JP-7 for hypersonics ops & testing
- FY15: SAE E31 draft ARP for particulates (soot) released for ballot
- FY15: Complete sustainment program for JPTS thermal stability instrumentation (for U-2)
- FY16: Fuel Microbial Sensor

Revolutionary Configurations for Energy Efficiency

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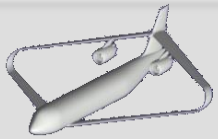
Phase I: Develop 90% Fuel Savings Fleet & Rank Highest Pay-Off Fuel Saving Technologies

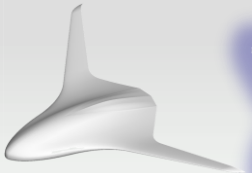
Best Performing Configuration

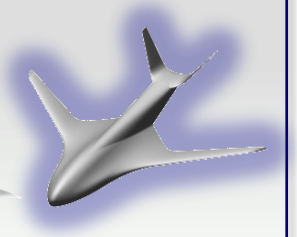

Conventional


Box Wing

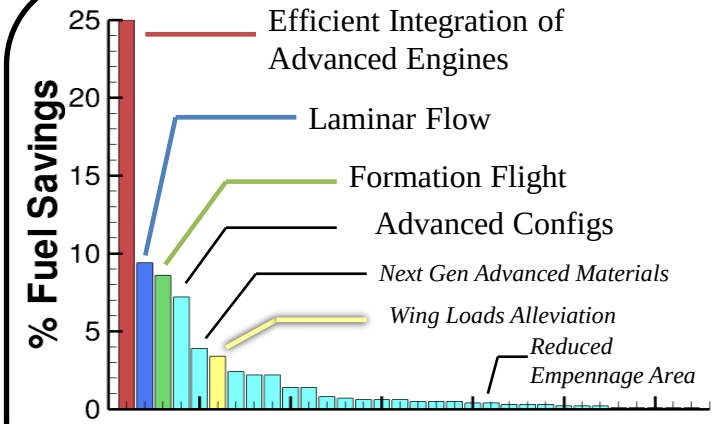

Hybrid Airship


Strut-Braced


Flying Wing


HWB

Highest Payoff Technologies



Phase II: Mature Technologies & Configurations

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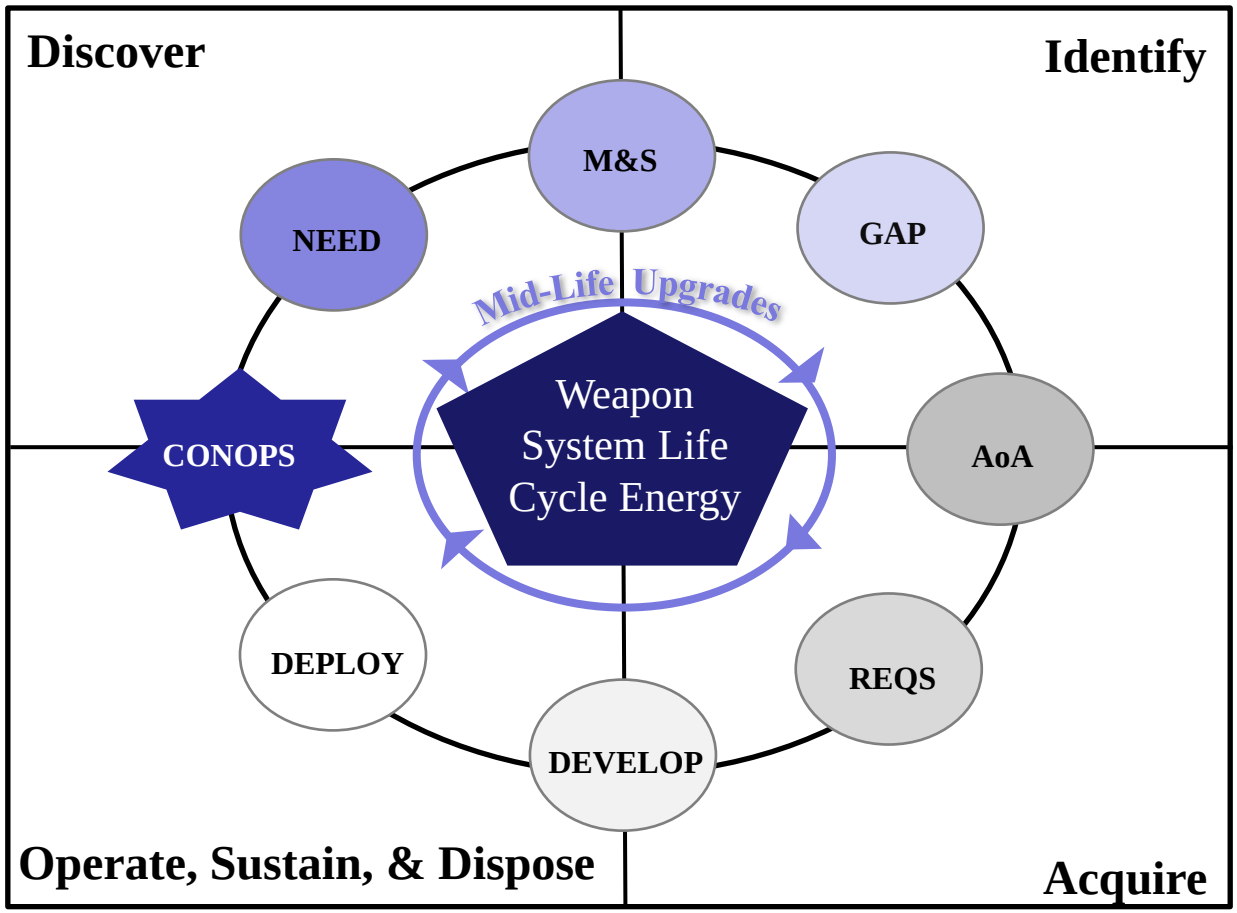
When do we address energy?



Once an asset is deployed, opportunities for energy efficiencies are limited

Conclusion

We must have millions of gallons of gasoline a day to do our job!

- Gen Hap Arnold

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