AFRL Advanced Power Technology Office (APTO)
Ground Support Energy
Electric / Hybrid Prototypes
&
Anticipated Future Demand Signal for Large Format Batteries

Tom Layne

AFRL/RXSC APTO – 11 February 2020

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PA Clearance: 88ABW-2020-0181

Agenda

- **Prototypes & Demos**
  - **Flightline Aircraft Power**
  - **Flightline Lighting and Convenience Power**
  - **Flightline Aircraft Loader**

- **Anticipated Future Demand Signal for Large Format Batteries**
  - **Terrestrial: Standardized & Common**
  - **Aviation**

All Prototypes Utilize Large Format Batteries

Motivation

F-105 Thunderchief

Using Same Vietnam-Era Aerospace Ground Equipment (AGE)

Motivation

"One drawback to current diesel generators is that they're loud; hearing conservation is a benefit" said Tilley. "Maintainers are important to the enterprise. The maintainer lays down at night and still hears the engine running in their head"

"The hybrid generator also has low emissions so maintainers don't have to go home smelling like smoke or JP-8 and stinky exhaust, and that's what the maintainer likes." said SMSgt Tilley

USAF Aerospace Ground Support Equipment Working Group (AGSEWG) Lead

https://www.edwards.af.mil/News/Article/1494886/hybrid-generator-could-make-aircraft-maintenance-more-efficient-effective-user/

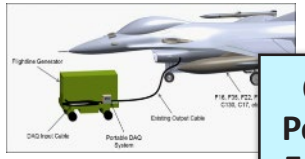
Flightline Aircraft Power

Prototype 1 *
Full-Electric Powerhead

412th Testing at Edwards AFB - 2017

Prototype 2 *
Hybrid Flightline Generator

412th Testing at Edwards AFB - 2018



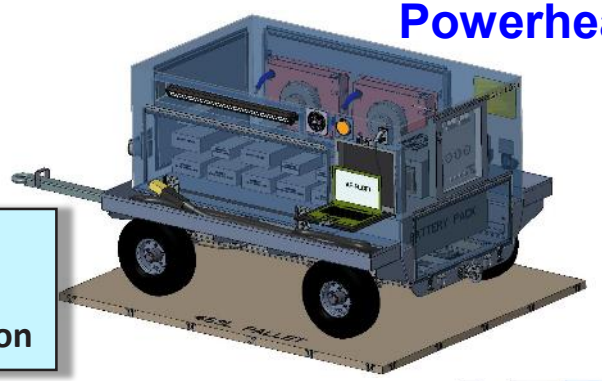
Optimal Power Size Evaluation

Demo Testing Edwards AFB

Continue? YES!

USAF Tiger Team Technical Definition

Flightline of the Future Powerhead *



All Powered with Battery

Reduce Continuously Running Diesel Engines

- https://www.edwards.af.mil/News/Article/1494886/hybrid-generator-could-make-aircraft-maintenance-more-efficient-effective-user/
- https://www.edwards.af.mil/News/Article/1093256/team-tests-ground-equipment-concept-demonstrator-here/

APTO U.S. Air Force ADVANCED POWER TECHNOLOGY

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Flightline Lighting and Convenience Power

USAF Aerospace Ground Support Equipment Working Group (AGSEWG) Lead demonstrating the partially-built AFPALS to USAF/A4 Executives at USAF Basing & Logistics Conference April 2019

https://www.wpafb.af.mil/News/Article-Display/Article/1828055/afrl-tech-expo-showcases-readiness-technologies/

Hybrid Prototypes

Diesel / Electric

- **Silent / Emission-Free Operation from Battery**
  - LED Lights: Immediate on/off
  - Convenience Power
- **Agile Re-charge**
  - Renewable-Solar
  - Grid
  - Onboard Diesel Engine
- **Autonomy, Wireless Controls & Monitoring**
  - Remote On/Off
  - Health / Status (fuel level, etc)
  - Improved Health & Safety

Reduce Continuously Running Diesel Engines

APTO U.S. Air Force ADVANCED POWER TECHNOLOGY

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Flightline Aircraft Loader

Hybrid Prototype
Diesel / Electric

- **Silent / Emission-Free Operation from Battery**
- **Agile Re-charge**
  - Grid
  - Onboard Diesel Engine
- **Improved**
  - Operator Health
  - Operator Safety
  - Energy Efficiency
  - Lifecycle Costs

Reduce Continuously Running Diesel Engines

- https://www.wpafb.af.mil/News/Article-Display/Article/1517802/hybrid-air-force-aircraft-loader-demonstration-on-the-horizon/
- https://www.bing.com/images/search?view=detailV2&id=4F04ACC4A38E16DBAE1AC5676F59D659F7C4DAEB&thid=OIP.sSv8r4sDlQSZZ0LXrJ4R_QHaGc&mediaurl=http%3A%2F%2Fwww.jbtc.com%2F-%2Fmedia%2Fimages%2Faerotech%2Fproducts-services%2Fmilitaryage%2Fcargoloaders%2Fcroppedhalvosenloader_1.ashx%3Fh%3D668%26w%3D767%26la%3Den%26hash%3D6C6DF5FA03266E3AF13E4B9B38F14D6D99D136C5&exph=668&expw=767&q=halvorsen+loader&selectedindex=5&ajaxhist=0&vt=0

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- Anticipated Future Demand Signal for Large Format Batteries
  - Terrestrial: Standardized & Common
  - Aviation

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Anticipated Future Demand Signal: Terrestrial

US Air Force: Maj Jake Bowen / brandon.bowen@us.af.mil
US Navy: Mr Eric Shields / eric.b.shields@navy.mil
US Army: Dr Larry Toomey / laurence.m.toomey2.civ@mail.mil

Standardized & Common

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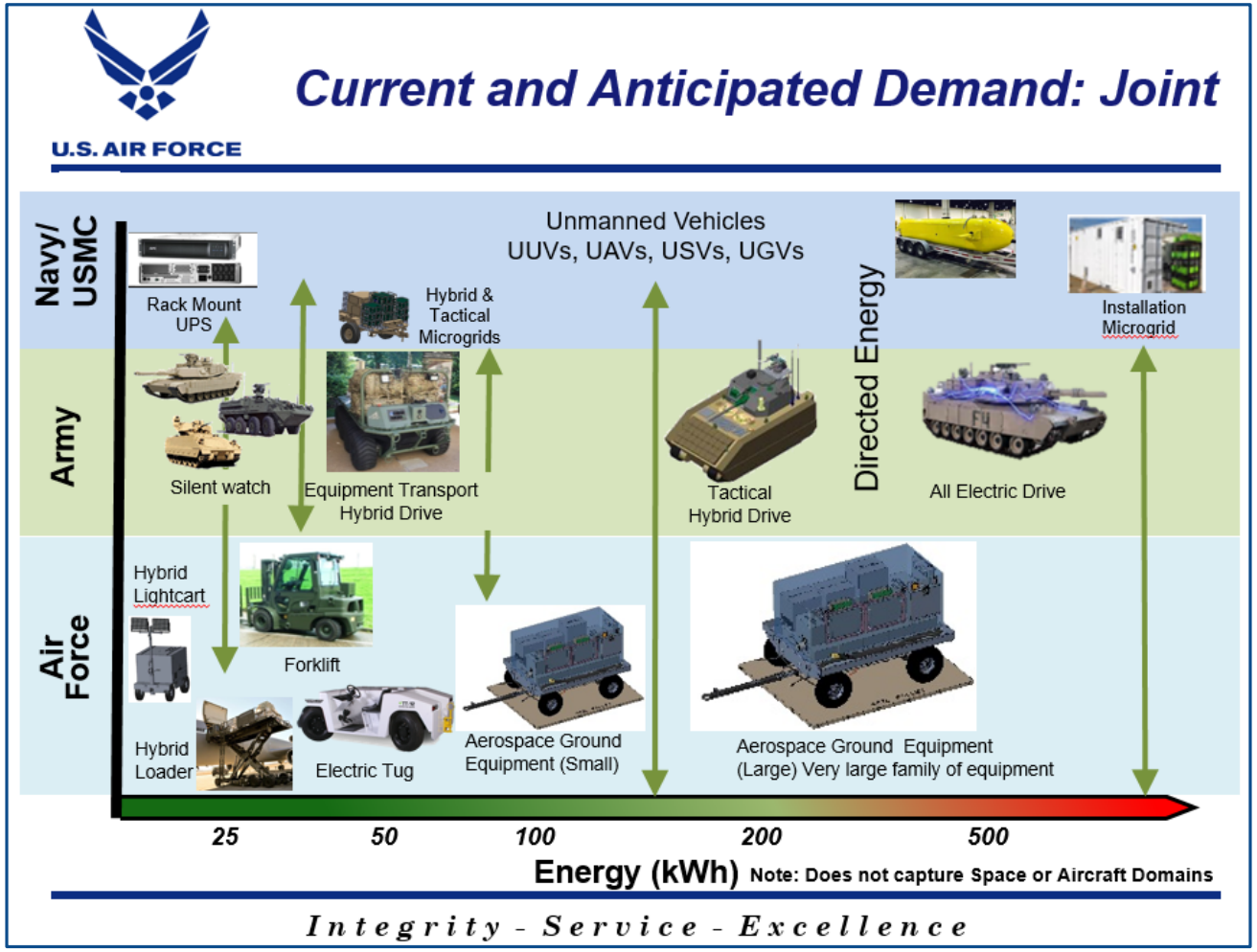
Anticipated Future Demand Signal: Terrestrial



Small, Medium, Large

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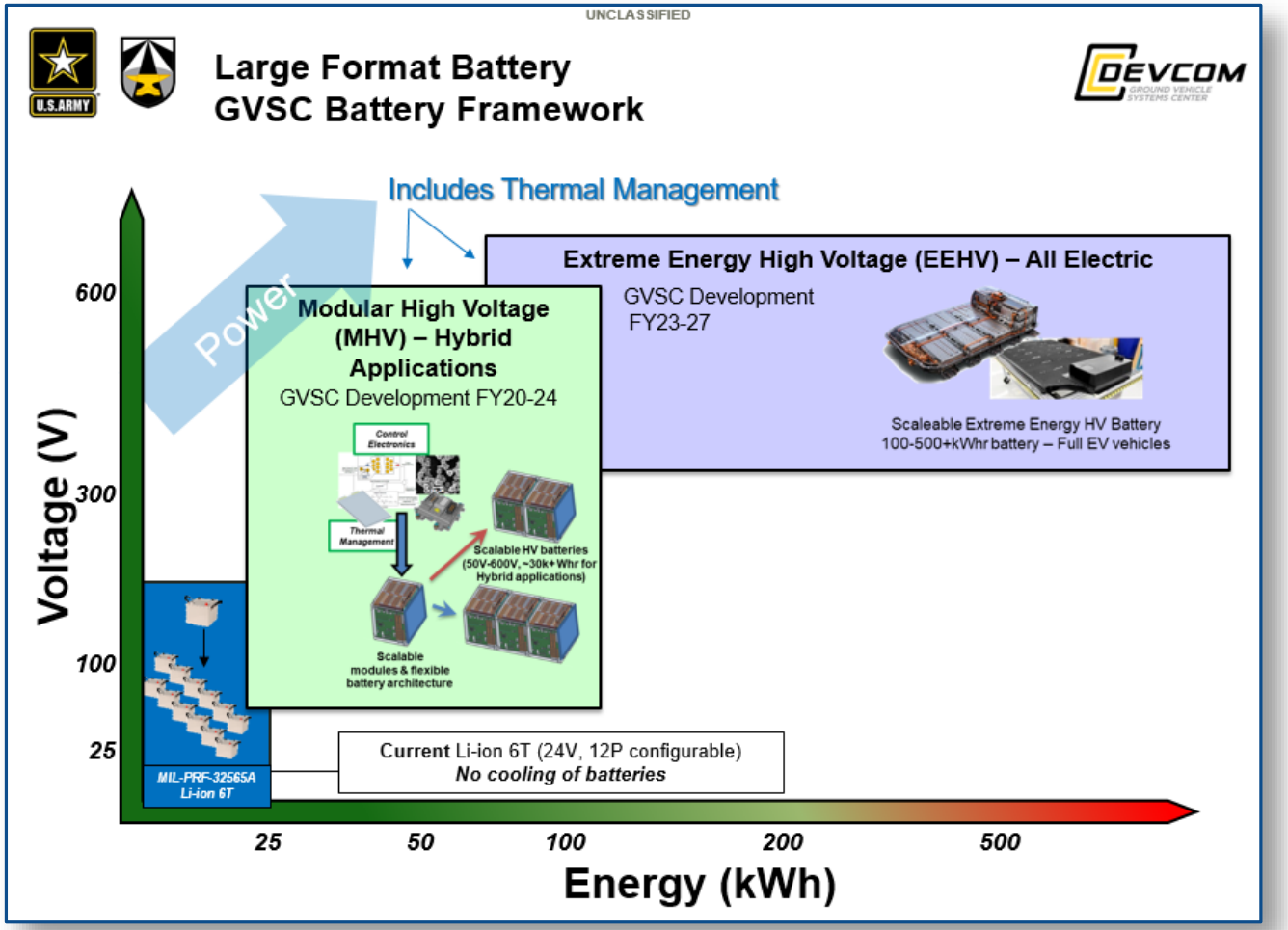
Anticipated Future Demand Signal: Terrestrial



US Army: Dr Larry Toomey / laurence.m.toomey2.civ@mail.mil

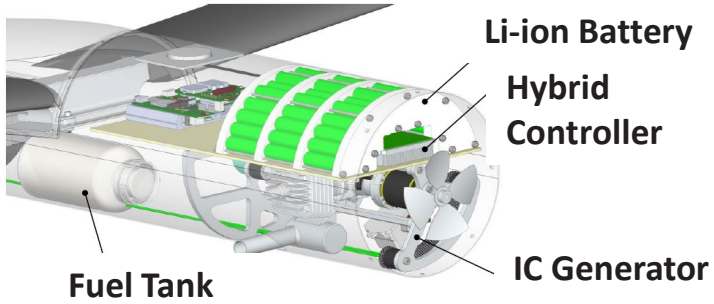
Small, Medium, Large – Safe, Affordable, Available

Anticipated Future Demand Signal: Aviation

Hybrid Unmanned Aerial System (UAS) Power System Desires

Ideal hybrid power system component characteristics (vs. current off-the-shelf):

- Hybrid Li-ion battery
  - Specific energy >300 Wh/kg (230 Wh/kg)
  - Specific power >2500 W/kg (1150 W/kg)
  - Fast charge up to 3C rate (1C charge)
  - Stable over a wide ambient temperature range:
    - -40°C to +60°C operation (-20°C to +49°C)
  - Cycle life: >500cycles @ 80% capacity (350 cycles)
- High energy power generation (i.e. generator, fuel cell, etc.)
  - Operating efficiency >30% (10% efficiency)
  - Specific power (dry) >800 W/kg (1200 W/kg)
  - Operating life >1000hrs (100hr MTBO)
- Lightweight hybrid power management
  - Specific power >5000 W/kg (3000 W/kg)
  - Operating life >1000hrs (<500hrs)
  - Tolerance to harsh environment: mechanical shock/vibration, high temperature, etc. (Limited)



Need for close integration of propulsion, power, and thermal
Better component doesn't always mean a better system

US Air Force: Mr. Greg Fronista / gregory.fronista@us.af.mil
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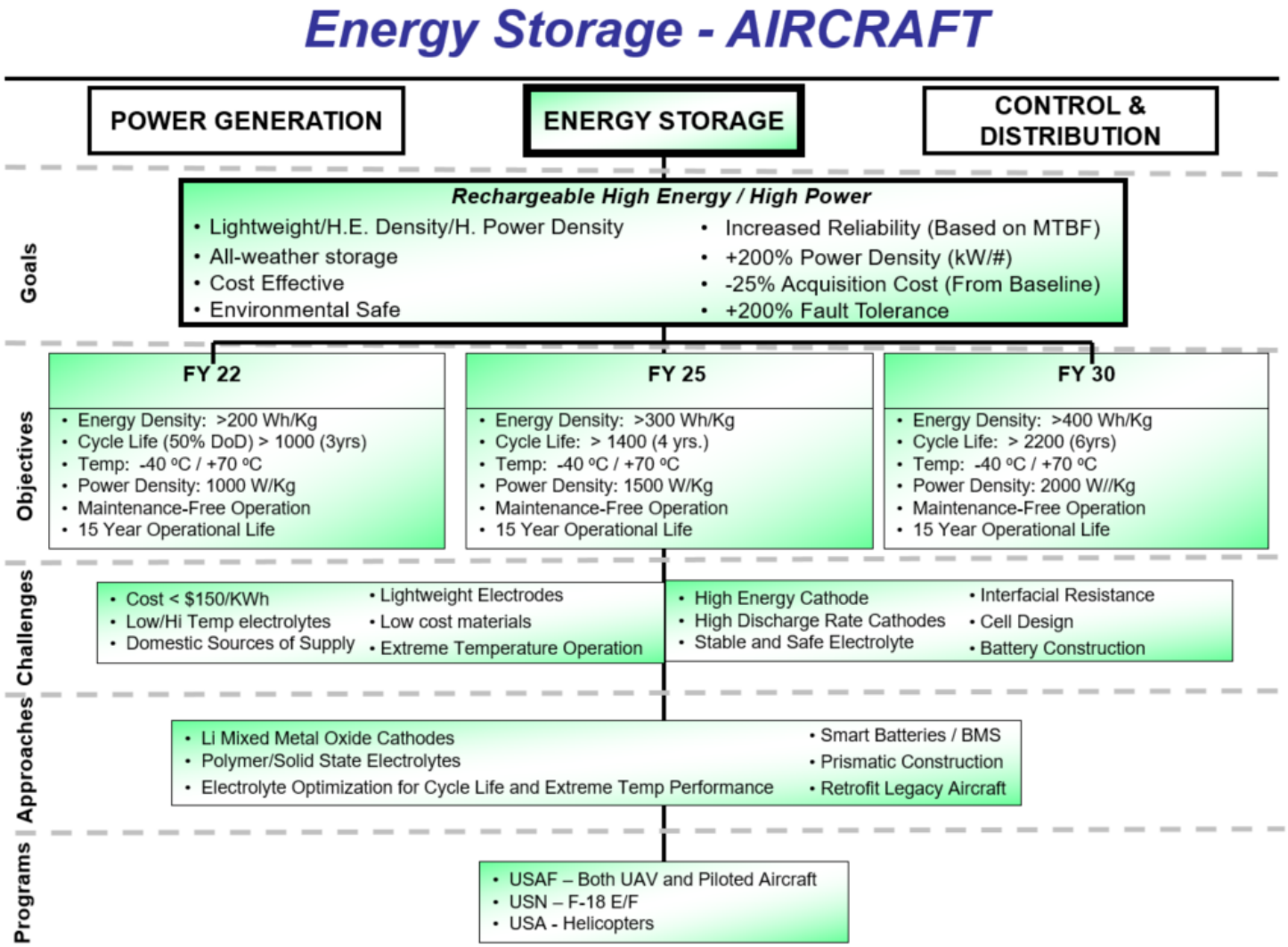
Anticipated Future Demand Signal: Aviation

Manned Aircraft



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"The AFRL (Battery) prototypes have allowed us to set a modernization vision that we were not able to see prior to their development."

CMSgt Jeff Richards
HQ AFMC/A4

https://www.wpafb.af.mil/News/Article-Display/Article/1828055/afrl-tech-expo-showcases-readiness-technologies/