Energy & Power Community of Interest
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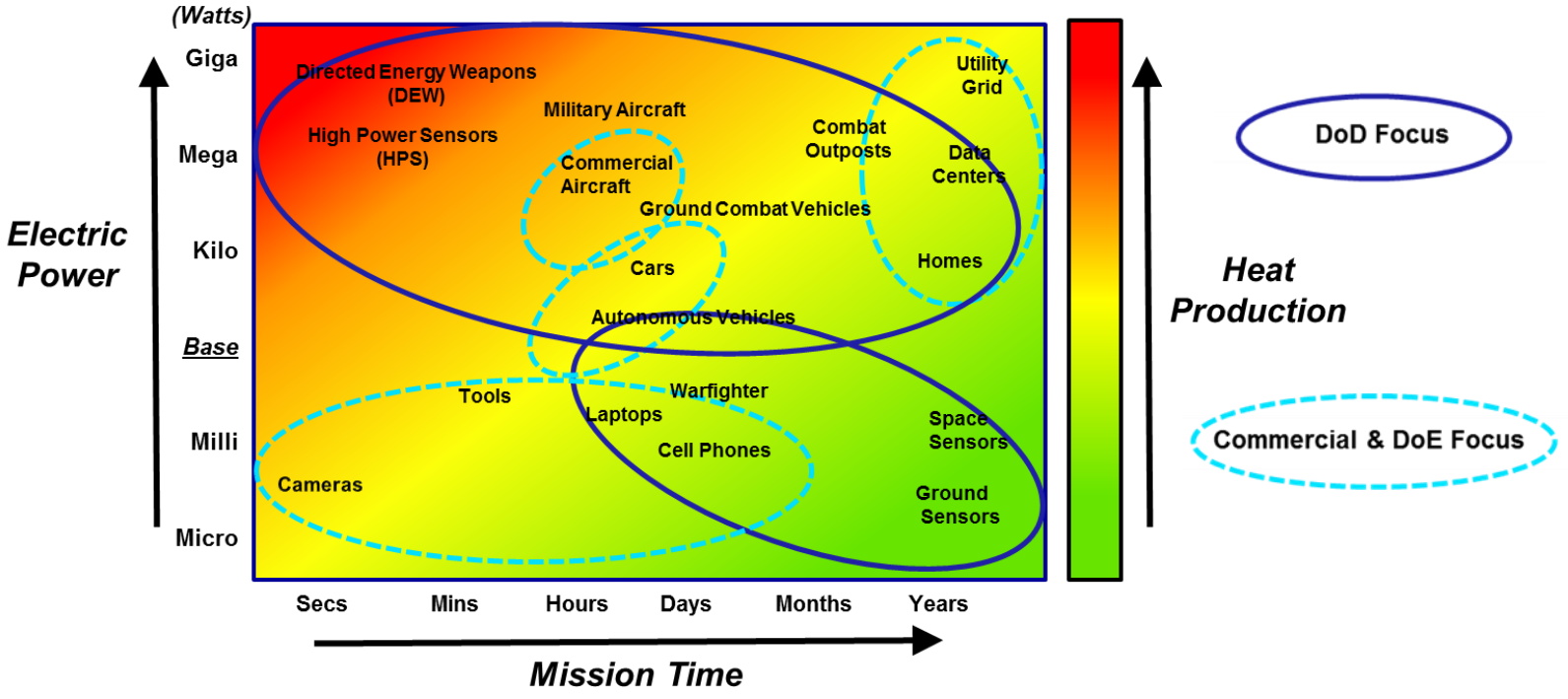
Energy & Power S&T Enables DoD Capabilities

Technical Taxonomy

Power Generation/Energy Conversion
Energy Storage
Power Control and Distribution
Thermal Transport and Control
Electromechanical Conversion

Warfighter Opportunity Areas (WOA)

Energy Optimized Platforms
Electric Weapons and High Power Sensors
Adaptive Power Networks
Autonomous Systems Power
Tactical Unit Energy Independence



Energy & Power CoI Warfighter Opportunity Areas (WOA)

Energy Optimized Platforms: *Optimizing platforms for a more lethal joint force.*

- Novel Metal-Ion and Aqueous Battery Chemistries
- Electric Ship Research and Development Consortium (ESRDC)
- MegaWatt Tactical Aircraft (MWTA) Program

Electric Weapons and High Power Sensors: *Enable asymmetric capabilities.*

- Ultra High Density Hybrid Energy Storage Module (UHD HESM)
- Open System for Controls of Integrated Propulsion, Power, and Thermal (OSCIPPT)
- Thermally Enabling Architecture for Pulse-Power Systems (TEAPPS)

Autonomous Systems Power: *Enable long-duration, autonomous operation in unique and challenging environments.*

- Compact Military Power (UGV)
- Hydrothermal Vent Exploitation for Undersea Energy (HTVE-UE)
- Quiet Propulsion (Great Horned Owl, GHO) & Eyes Below the Weather (Tactical Off-Board Sensing, TOBS)
- Multi-Day Endurance of Group 2 Unmanned Aerial System (Hybrid Tiger)

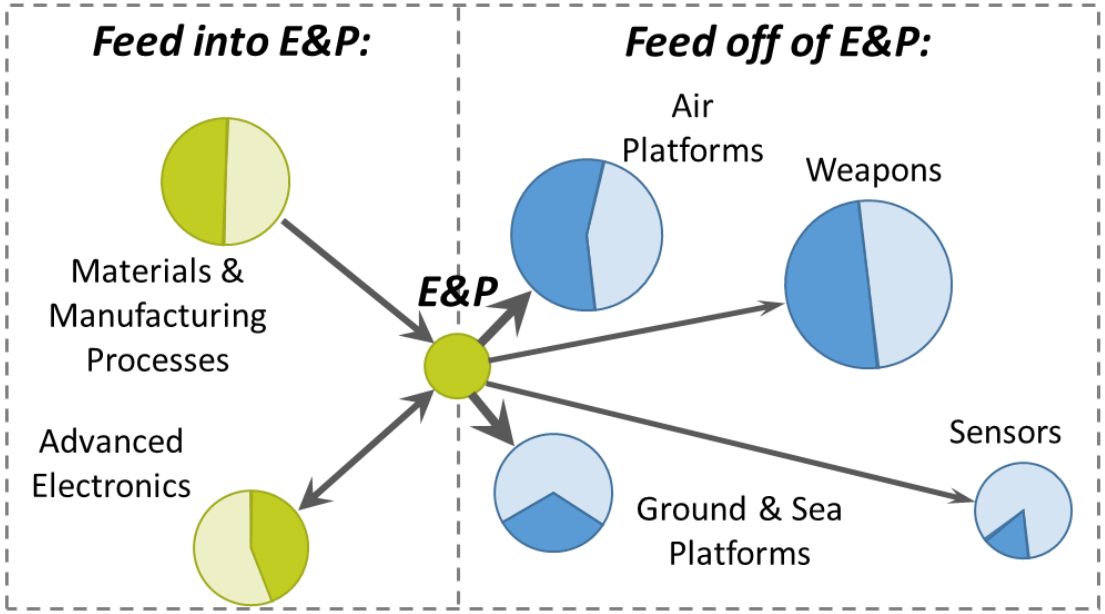
Tactical Unit Energy Independence: *Extending the reach of energy and power systems to untether Warfighters.*

- Advanced Integrated Solider Power (AISP) Science & Technology Objective (STO)
- Self-Sustaining Soldier Power (S3P) STO
- Multifunctional, Structurally Integrated Flexible Energy Storage

Adaptive Power Networks: *Automating energy management for optimized mission performance.*

- Energy Informed Operations (EIO)
- Intelligent Power Components & Integration
- Tactical Microgrid Standards Consortium (TMSC)

Energy & Power CoI S&T Portfolio Interdependency



The remaining CoIs have a second-order relationship (e.g., C4I through Sensors & Processing)

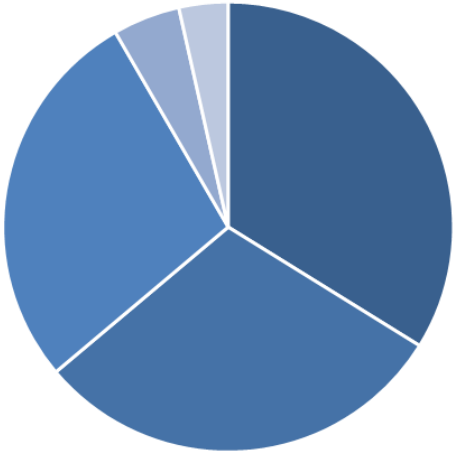
E&P develops fundamental technologies, which

- directly feed into the capabilities developed in the non-Space platforms, Weapons and Sensors CoIs
- and rely on improvements in materials, manufacturing, and electronics.

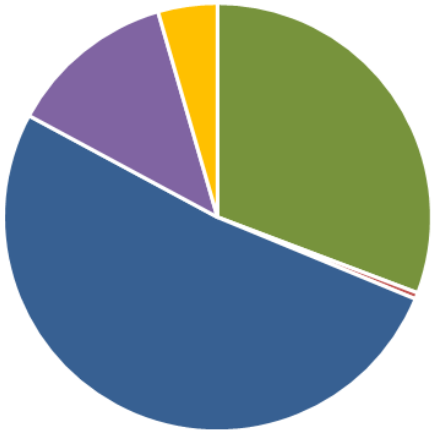
New advancements will result additional direct relationships:

- Cyber CoI on the cyber resiliency of intelligent power and energy systems
- Autonomy CoI on advanced energy behaviors for Autonomous systems

Energy & Power CoI FY18 Funding

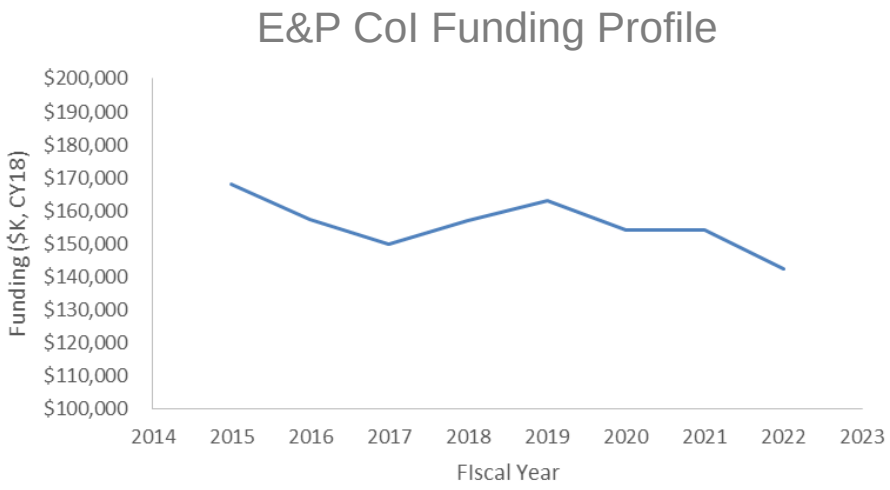


Power Control and Distribution	34%
Energy Storage	30%
Power Generation/Energy Conversion	28%
Thermal Transport and Control	5%
Electromechanical Conversion	4%



Army	31%
MDA	<1%
Navy	52%
OSD	13%
SOCOM	4%

Air Force $$ binned under Air Platforms CoI



Investment profile:

- PB18 $156.8M, 54% BA 2 & 46% BA 3
- Significant USAF Thermal Transport and Control funding aligned with Air Platform CoI.

Energy & Power CoI Recent Impact

- **Ongoing collaborative projects between the Services and ODASD(OE) to address identified high risk S&T challenges through OECIF**
  - **Open Syst. for Ctrls. of Integrated Propulsion, Power, and Thermal (OSCIPPT)**
    Provide common baseline controls interface for future platforms.
  - **Ultra High Density Hybrid Energy Storage Module (UHD HESM)**
    Examine HESM-enabled Laser Weapon Syst. & EW operation in power hardware-in-the-loop demonstrations with Army and USAF, plus transition to Navy Multifunctional Energy Systems FNC
  - **Thermally Enabling Architectures for Pulse Power Systems (TEAPPS)**
    Deliver advanced thermal management system architectures and components for transition to 100+ kW HEL efforts: HELIOS, SHiELD, HELMTT.
- **Collaborating with Other Government Agencies**
  - **AFRL/NASA: manned/unmanned aircraft hybrid-electric propulsion**
  - **Joint/DOE/NASA/NIST/NSF: High-voltage GaN semiconductors road-mapping**
  - **Army/JPL/NASA: Lithium Sulfur and Ultracapacitor power sources for Soldiers**
  - **Army/DOE: Advanced Vehicle Power Technology Alliance - leveraging automotive advances for combat vehicles**

Energy & Power CoI Current S&T Priorities

- **Improve power density and thermal management for air and ground platforms with significant size and weight constraints to enable high power capabilities**
  - **Army Hybrid Energy Storage System**
    Navy Multi-function High Density Shipboard Energy Storage FNC
    USAF MegaWatt Tactical Aircraft
    OSD Operational Energy Capability Improvement Fund
  - **Outreach to platform CoIs for application and transition opportunities**
- **Secure interfaces (including cyber-physical) to mission capabilities for intelligent power and thermal control**
  - **"Assessment of Operational Energy Systems Cybersecurity Vulnerabilities"**
    Study executed using USD(R&E) CoI discretionary funds.
  - **Investigating opportunities to collaborate within DoD and DOE National Labs**
- **On-station energy harvesting/scavenging for autonomous systems**
  - **Working with Autonomy and platform CoIs to determine near-term responsibilities and long-term direction**

DoD Energy & Power S&T Risks

- **Risk: New capability development without sufficient focus on power and thermal infrastructure requirements to support and sustain**
  - **Mitigation Action: Cross-CoI "Enabling DEW & HPS" TEM validated and raised awareness of S&T challenges**
  - **Mitigation Action: E&P CoI planning a Cross-CoI TEM on Autonomous Systems Power with Autonomy and platform CoIs**
- **Risk: Limited resources for platform E&P systems integration and testing**
  - **Recommendation: Continued investment in improved M&S tools to affordably enable platform capabilities**
  - **Recommendation: Leverage prototyping and experimentation resources for integrated system testing to buy-down risk**
- **Risk: Unknown vulnerability of global supply chain**
  - **Mitigation Action: "Critical Energy & Power Technologies Domestic Marketplace Survey" and accompanying analysis tool**
    Study executed with USD(R&E) CoI discretionary funds
  - **Recommendation: M&MP CoI examine and validate findings from E&P CoI Survey**

Energy & Power CoI Summary

E&P CoI Priorities:

- **Improve power density and thermal management for air and ground platforms with significant size & weight constraints**
- **Secure interfaces (including cyber-physical) to mission capabilities for tactical microgrids and surface ship power & energy networks**
- **On-station, autonomous energy harvesting/scavenging**

Potential Future Research Areas:

- **Power and thermal requirements of collaborative electric weapon effects**
- **Energy recharge of autonomous systems**
- **Enabling increased platform design flexibility and scalability through more capable power and thermal systems**
- **Multifunctional energy structures**
- **Flexible, conformal, and robust power for the augmented Warfighter**

Engagement Opportunities:

- **Army Research Laboratory Open Campus effort**
- **Defense Innovation Marketplace**
- **NDIA Annual Science and Technology Conference**
- **ARPA-E Annual Energy Innovation Summit**

Link to download 2017 S&T Roadmap: http://www.defenseinnovationmarketplace.mil/coi_energypower.html

Backup

Tier 1 Taxonomy Brief Descriptions

Power Generation/Energy Conversion:
Develop tactical, deployable power systems using available fuel and renewable/ambient sources to generate electrical energy.

Energy Storage:
Improve electrical and electrochemical energy storage devices to decrease device size, weight, and cost as well as increase their capabilities in extreme temperatures and operating conditions.

Power Control and Distribution:
Enable smart energy networks for platforms, forward operating bases, and facilities through new, greater capability and efficiency components as well as modeling & simulation tools.

Thermal Transport and Control:
Efficiently manage heat and enable higher power density systems through advanced thermal science and technology: advanced components, system modeling, and adaptive or hybrid-cycle technologies.

Electromechanical Conversion:
Increase the power density, efficiency, and robustness of motors, generators, and actuators while also reducing their life cycle costs.