

# Alternative Energy



## S&T Campaign: Materials Research Tier 2 Energy and Power

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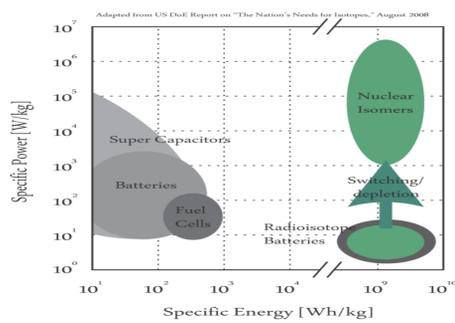
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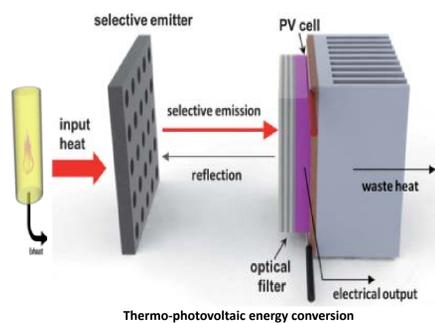
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## Research Objective

- Development of *new scientific and technical approaches in emerging fields and scales* that *have the potential to be game changing enablers* for future energy systems and military applications.
- Exploring *unique SOA energy retrieval methods* such as : multimodal energy harvesting in thermoelectric, thermophotovoltaics, piezoelectric, wireless systems; alternative routes to fuel: water splitting, CO<sub>2</sub> reduction; nuclear effects in ultraenergetic materials: isomer switching, isotope batteries; single quantum systems: quantum dots, quantum molecules for energy conversion in PV systems; multifunctional materials: structural energy storage and other alternatives for device and energy management implementations.



Possibility of long-term energy storage using nuclear isomers



Thermo-photovoltaic energy conversion

## ARL Facilities and Capabilities Available to Support Collaborative Research

- Experimental laboratory facilities:** State of the art III-V MBE system for PV, PEC materials and IV-VI MBE system for TE materials; ultrahigh vacuum variable temperature STM for tunneling spectroscopy and atomic imaging; unique thermoelectric materials zT characterization and device efficiency evaluation; catalytic fuel conversion for catalyst materials preparation and evaluation; in-situ time resolved FTIR; x-ray effects lab; clean room facility
- Specialized modeling/simulation tools and facilities:** DoD High Performance Supercomputing Center



Clean room facility

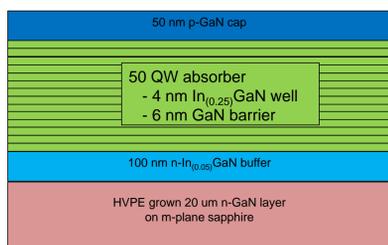


III-V MBE System

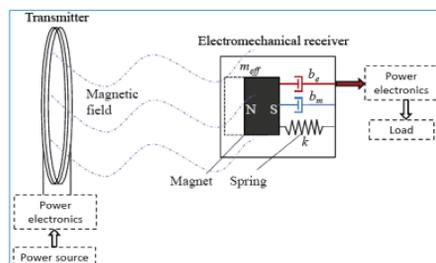
- Unique ARL expertise:** thermal energy conversion and harvesting; fuel flexible combustion based power sources; ultra-energetic radionuclides; solar and multimodal energy harvesting; structural capacitors; micropower components for power management; water splitting and CO<sub>2</sub> reduction; wireless energy transfer and networks
- Significant early findings:** Thermoelectric materials and devices operating at higher temperatures (patented); extended spectral range using nano-enhanced absorber materials in QD PV systems; wireless power transfer in stretchable, flexible and dynamic systems; characterized physical mechanism responsible for switching of energy-storage state to a higher-power output state in nuclear isomers; created COTS tritium-based battery prototype producing 40  $\mu$ We, capable of powering unattended sensors for decades

## Challenges

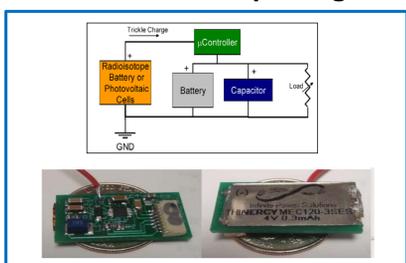
- Increased power conversion efficiencies
- Improved materials and devices design
- Enhanced fundamental understanding of the governing energy conversion mechanisms
- Developing advanced models and algorithms for highly efficient energy conversion systems



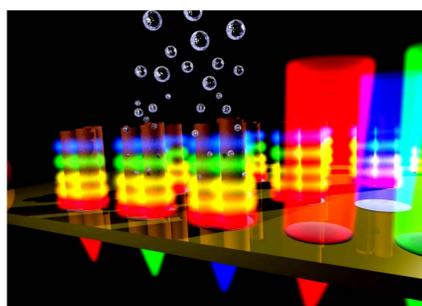
Wide bandgap engineered materials for H<sub>2</sub> production via water splitting



Wireless power transfer



Power management architecture for long lived radioisotope battery or PV cell



Plasmonic photoelectrochemical cell for H<sub>2</sub> generation

## Complementary Expertise/ Facilities/ Capabilities Sought in Collaboration

- Specialized laboratory facilities not available at ARL:** Neutron Scattering/Reflectivity, Angular Resolved High Resolution X-ray Photoelectron Spectroscopy; Advanced Photon Source
- External expertise in a specific scientific or technical area:** Optical modeling of nanostructure-based devices; catalysis, combustion modeling, & compact multi-fuel combustors; highly mismatched alloys; MEMS passive components and circuits; electromagnetic meta-material development for enhanced wireless power transfer