

Energy Science and Technology

Buildings and Transportation Science

Propulsion Science

Accelerating the development of combustion, electric, and hybridized propulsion systems to enable an efficient, clean, and low carbon transportation future

1. *Engine Technologies Research* – Leadership in advanced engine technologies including application-specific on-road and off-road implementations such as hybridization, transient operation, and integrated energy systems.
2. *Combustion and Fuel Science Research* – Leadership in combustion and fuels research from fundamental science to application.
3. *Applied Catalysis and Emissions Controls Research* – Leadership in emissions control catalysts and strategies to enable near-zero emissions from high efficiency powertrains, advanced combustion engines, and alternative fuels.
4. *Electric Drives Research* – Leadership and unique facilities on motors and power electronics for electric propulsion systems including materials modeling, design, in-house prototyping and characterization.

Vehicle and Mobility Systems Research

Accelerating the development of advanced vehicles and complex mobility systems through advances in connected and autonomous vehicle technologies, communications, systems integration, and decision science.

1. *Vehicle Systems Integration Research* – Leadership in advanced hardware-in-the-loop research to accelerate the development of transportation technologies from component-level to full vehicle.
2. *Vehicle Connectivity & Autonomy Research* – Leadership in virtual and advanced vehicle research to accelerate the development of transportation technologies from vehicle-level to full traffic network for connected and automated vehicles.
3. *Vehicle Power Electronics Research* – Leadership and unique facilities in power electronics for mobility characterization, modeling, and design from concept to build to evaluation.
4. *Transportation Analytics & Decision Science* – Approaches the challenges of future transportation demand in multidisciplinary teams to illuminate historical performance of the transportation system with multiple metrics, to predict future performance under various scenarios, and to search for optimal pathways to sustainable futures.

Building Technologies Research

Accelerating the development and integration of innovative advanced building equipment and novel dynamic envelope materials and systems to enable affordable, efficient, and resilient buildings

1. *Building Equipment Research* – Develop advanced building equipment for energy efficiency and improved life cycle climate performance focused on reimagined thermodynamic processes and cycles.
 2. *Multifunctional Equipment Integration* – Develop and integrate state-of-the-art building equipment to include functionalities such as grid integration, advanced energy storage and energy conversion systems.
 3. *Building Envelope Materials Research* – Develop and deploy advanced envelope systems comprising novel low thermal conductivity materials and assemblies enabling dynamic insulation systems.
 4. *Integrated Building Performance* – Develop innovative methods for residential and commercial whole-building energy performance and systems integration.
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Manufacturing Science

Energy Efficient Manufacturing Science

Manufacturing scale up of fiber and composite processing technologies for fabrication of functional components in energy applications

1. *Advanced Fibers Manufacturing* – Develop scale up science and technologies for fiber manufacturing and associated fabrication of functional components for energy applications.
2. *Advanced Composites Manufacturing* – Develop scalable composite manufacturing technologies for high volume energy efficient fabrication of functional components through the integration of core capabilities.
3. *Chemical Process Scale Up* – Develop scalable chemical and material manufacturing technologies to enable energy efficient process intensification and modularized/ distributed systems.
4. *Manufacturing Energy Efficiency Analysis* – Develop analytical tools for energy use in traditional and advanced manufacturing processes and the potential for energy savings.

Precision Manufacturing and Machining

Designing, implementing and scaling next generation manufacturing systems and processes through the integration of robotics, automation, controls, and machine tools

1. *Robotics and Intelligent Systems* – Design, develop and fabricate robotic systems for intelligent manufacturing systems.
2. *Intelligent Machine Tools* – Development of next generation machine tools, and enhancement and modernization of current and legacy machine tools in support of an energy efficient U.S. manufacturing base.

3. *Manufacturing Systems Design* – Design and fabrication of large-scale complex manufacturing systems via integration of mechanical, electrical and digital elements.
4. *Manufacturing Automation & Controls* – Development of automated manufacturing systems leveraging data analytics, sensing, and control systems technology to ensure a highly efficient U.S. manufacturing ecosystem.

Secure and Digital Manufacturing

Developing a digital manufacturing platform and a cyber-secure manufacturing ecosystem by integrating a wide variety of manufacturing systems enabled by advanced data analytics, process control and secure communications

1. *Deposition Science and Technology* – Design, development and fabrication of next generation advanced components and energy systems with additive metal and polymer processes through integration of core capabilities.
2. *Digital Manufacturing and Analyses Frameworks* – Integration of capabilities in communication, computing, storage and user interface for advanced manufacturing process analysis, modeling and control to ensure an energy efficient and secure manufacturing ecosystem.

Electrification and Energy Infrastructures

Electrification

Developing innovative energy storage technology solutions and charging infrastructures at scale for transportation and grid

1. *Emerging and Solid-State Batteries* – Conceives, researches and develops disruptive chemistries and materials for high energy and power density solid-state batteries and emerging electrochemical storage systems.
2. *Energy Storage and Conversion Manufacturing* – Develops advanced manufacturing schemes and pilot scale devices into emerging energy storage and conversion research.
3. *Electronics & Embedded Systems* – Conducts advanced research, development, test and evaluation of electronic devices/systems.

Energy Systems Integration & Controls

Advancing energy systems integration and controls to improve the efficiency and resiliency of systems-of-systems architectures

1. *Power Systems Resilience* – Conducts transformational research and development for energy security and resilience through advancement of modeling, simulation, and real-time monitoring of the electric grid.
2. *Grid Components and Controls* – Designs, develops, and implements advanced control systems (e.g. microgrids, protection and controls) and integration of novel energy system components.
3. *Power Electronics Systems Integration* – Designing, developing, and deploying power electronics for grid-connected systems through packaging, magnetics, hardware prototyping, system architecture and integration (e.g. power electronics-based substation), and real-time power electronics systems simulation.

4. *Grid Communications and Security* – Conducts the research, development, test and evaluation of modern communication devices and systems for energy applications.
5. *Grid-interactive Controls* – Designs, develops, and deploys advanced control algorithms and methods for building energy efficiency and grid connectivity.

Energy Sensing, Analytics and Communications

Developing sensing and communications solutions through advanced sensor discovery/development, computational sensing and analytics

1. *Electrical Signals and Processing* – Designs, develops and deploys state-of-the-art signal capture, interrogation, and analysis techniques for energy systems characterization and security applications.
2. *Sensors and Controls* – Designs, develops, tests and evaluates sensor devices and sensory systems for real-time situational awareness.
3. *RF & Intelligent Systems* – Designs and develops advanced and intelligent systems utilizing radio frequency communications and machine learning for small electromagnetic signature systems.
4. *Energy Systems Analytics* – Designs, develops, deploys and analyzes advanced machine learning and decision science algorithms and techniques for energy applications.
5. *Multimodal Sensor Analytics* – Conducts advanced research, design and development of algorithms and systems employing computational sensing approaches with Images and signals.