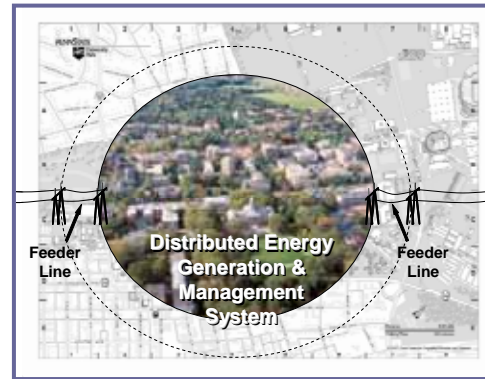


Overview of Capabilities

- ❖ Conversion System Technology
 - Power System Demonstrations
 - Systems Integration
 - System Modeling, Design, and Optimization
 - Turbomachinery Design and Testing
 - Compact heat exchanger design
- ❖ Prototype Testing Facilities
 - Water & Wind Tunnels
- ❖ Manufacturing & Materials
 - Materials Processing
 - Advanced Composites
 - Laser Processing
 - Advanced Coatings and Coating Evaluation
 - Drivetrain Technology Center
 - Gear Research Institute
- ❖ Systems Operation & Autonomy
 - Sense and Respond Logistics
 - Condition Based Maintenance
 - Integrated Health Management
- ❖ System Design & Optimization
 - Automated Conceptual Design/Trade Space Exploration
 - Simulation Modeling for Manufacturing
 - Hybrid Energy Systems



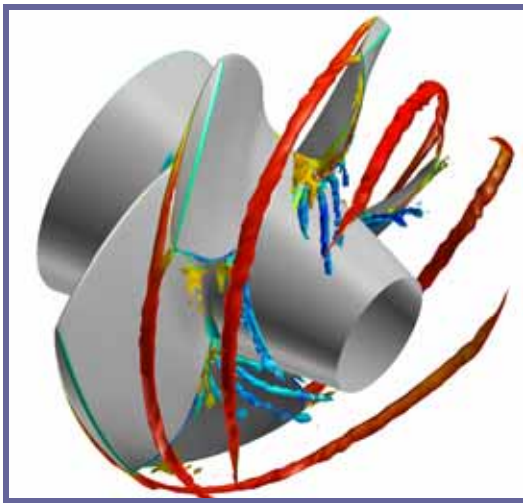
Alternative Energy Capabilities



Advancing innovative energy and power system design, development, integration and testing for over 60 years.

PENNSTATE
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Marine Renewable Energy

Unique technical capabilities to support development of underwater power generation systems:

- ❖ Turbomachinery design
 - Blade design
 - CFD, hydrodynamic analysis
 - CAD/CAM/CAE
- ❖ Experimental facilities
 - Water tunnels & tanks
 - Pump loops
 - Towing tanks
 - Anechoic chambers
 - At-Sea testing
- ❖ Hydroacoustics
- ❖ Erosion and deposition testing
- ❖ Advanced coatings
- ❖ Embedded diagnostics for condition based maintenance

Solar Energy & Thermal Energy Storage (TES)

Concentrating Solar Power:

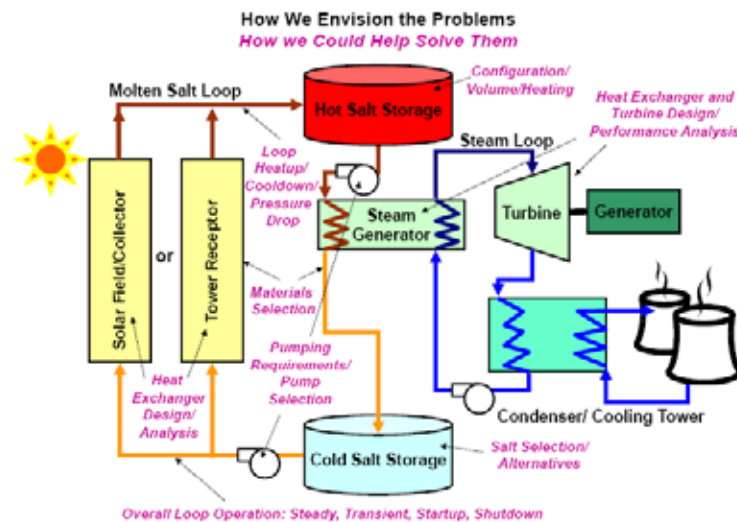
- ❖ Stirling engines
- ❖ Compact Rankine cycles
- ❖ Heat exchanger design and optimization

TES Material Integration & Optimization:

- ❖ Solar power plant design for power tower or field collector systems
- ❖ Phase change materials for Stirling engine integration
- ❖ Material interactions and alternatives

PV materials & manufacturing:

- ❖ Material design and characterization
- ❖ Laser fabrication processes



Wind Energy

Improving Reliability, Performance and O&M:

- ❖ Autonomy and control
- ❖ Condition based maintenance
 - Embedded diagnostics
 - Wind farm maintenance management
- ❖ Testing - experimental facilities
 - Gear Research Institute
 - Drivetrain Technology Center
 - Water & Wind tunnels
- ❖ Unsteady atmospheric loading characterization and modeling

Materials & Manufacturing:

- ❖ Material design and characterization
- ❖ Process development
- ❖ Advanced composite materials
 - Concurrent engineering approach
 - Process optimization
 - NDI, repair
 - Full-scale composite structures
- ❖ Advanced coatings
- ❖ Laser processing

Distributed Generation & Smart Grid

Broad capabilities to model, design, develop, integrate, test, control, and maintain energy systems, specializing in technology demonstration and transition to application.

- ❖ Modeling and control architecture of the SmartGrid
- ❖ Analysis of hybrid renewable designs
- ❖ Extensive systems integration expertise
- ❖ Battery, ultracapacitor, and flywheel energy storage system experience