DOE Advanced Microturbine Program Update

Recuperator Materials for Advanced Microturbines Workshop

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Why Establish a Distributed Energy Resources (DER) Task Force?

• Provide a single focal point for the various DER programs currently found in a number of EERE sectors

• Integrate and coordinate the DER programs and allow DOE to better position itself for the future
Distributed Energy Resources Task Force

Accomplishes Integration

• Natural gas and renewable technologies and fuels
• Natural gas generation and grid reliability
• Electricity and natural gas market outreach
• Allows for hybridization

Effective March 6, 2000 - Management responsibilities assigned to Office of Power Technologies
DER Task Force Programs Addressed

**Energy & Water**
- Storage
- T&D reliability
- DER Integration
- Electricity
- Restructuring

**Interior**
- Advanced Turbine Systems (ATS)
- Microturbines
- Reciprocating Engines
- Fuel cells
- Cooling, heating and power (CHP) and humidity control
- Enabling materials, combustion, sensors and controls
• Focus and expand DOE’s efforts in technology development and outreach of DER systems

• Employ a holistic approach and work to identify opportunities missed by the current sector approach in EERE (eg, gas cooling needs for gas turbines or optimization of microturbines with building needs)

• Assist in supporting the Secretarial initiatives on grid reliability and power quality
DER Program Planning

**Industry Input**
- Vision & Roadmap Process
- Program Reviews
- Conferences & Workshops

**Technology Development**
- Advanced Turbines
- Microturbines
- Engines
- Fuel Cells
- Wind
- Geothermal
- Hybrids
- Solar

**Technology Base Development**
- Combustion
- Materials
- Sensors and Controls

**System Reliability, Architecture & Integration**
- T&D
- Superconductivity
- Storage
- Interconnection
- Modeling & Simulation

**Systems Implementation & Outreach**
- CHP Challenge
- Utility Restructuring
- Siting & Permitting
- Interconnection Standards
- Tax Provisions
- Building Codes & Standards
- Federal Energy Management Program
- State Initiatives
- International PCAST

**Fuels**
- Bioenergy
- Natural Gas
- Hydrogen
DOE/OPT Microturbine Activities

- State-of-the-art technology assessments; industrial market studies only
- Baseline Microturbine Testing
  - University of California-Irvine & Southern California Edison
  - National Rural Electric Cooperative Association (NRECA)
- Advanced Microturbine Program Planning
  - Program plan and solicitation released
- Materials Technology base projects
- Collaborating/joint planning with CEC, NYSERDA, ASERTTI (under DOE MOUs)
Baseline Microturbine Evaluation Program

- Southern California Edison (SCE), University of California-Irvine; co-funded with CEC and EPRI
- Assess Operational Performance of Various Microturbine Generators
- Compare Measured Performance with Claims
- Analyze Test Results
- Provided Feedback to Manufacturers and Users
- Assess Field Application Value Technology
Microturbine Installations

- Test facility at UCI Combustion Laboratory; site includes natural gas, grid connections, and ability to handle thermal load requirements of cogen units
- Site capable of running 4 microturbines simultaneously
- Microturbines instrumented with sensors and meters to collect operational data automatically
- Installations include:
  - Bowman 35 & 60 kW
  - Capstone 28 kW
  - Honeywell 75 kW
NRECA Field Test Evaluation Program Objectives

- Collect test and operation information on installation and performance by NRECA participants
- Identify developmental needs re: permitting, interconnection and building code compliance
- Identify developmental needs re: technology, maintenance and operation
- Provide technology baseline to benchmark future improvements
Sites Being Considered

- Office/Warehouse
- Hospital
- Hotels & Motels
- Power Plants
- Nursing Homes
- Colleges & Schools
- Fast-food & Convenience Stores
- Mining Operations
- Manufacturing Plants
- Remote Village Settings
# Microturbines To Be Evaluated

<table>
<thead>
<tr>
<th>Number/Model</th>
<th>Installation</th>
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<tbody>
<tr>
<td>One 75-kW Allied-Signal/Honeywell</td>
<td>2000</td>
</tr>
<tr>
<td>Four 28-kW Capstone</td>
<td>2000</td>
</tr>
<tr>
<td>Three 45-kW Elliott/GE</td>
<td>2000</td>
</tr>
<tr>
<td>One 70-kW NREC Ingersoll-Rand</td>
<td>2000</td>
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Program Deliverables

- Test & Instrumentation Plan
- Site Characterization Reports
- Commissioning Test Reports
- Completion of 8,000 hours of Staged Tests
- Final Report
Co-development effort with DOE Energy Storage Program, National Rural Electric Cooperative Association (NRECA), EPRI

Development of simulator/model to mimic actual performance characteristics of a microturbine

Validate simulators at actual utility sites using data from commercial microturbines

Install simulators to test peak shaving, power quality, baseload, and other applications
Microturbine-related Materials Activities

- Recuperator Technology
  - SOA Materials Assessment
  - Advanced Metallics (Solar/ORNL CRADA)
- Materials Development (silicon nitride)
  - Optimization of AS-800 (HACC)
  - Database Development (UDRI, NASA, ORNL)
  - Life Prediction (NASA, HES, ORNL)
  - Hot Section Materials (HACC, KICC)
- Component Testing
  - Component Verification (ORNL)
  - NDE (ANL)
  - High Temperature Corrosion
Advance Microturbine Hot Section Materials Program Objectives

- Develop a design envelope of anticipated operating conditions for a Si3N4 rotor for an advanced microturbine.
- Evaluate the effects of temperature, pressure, water vapor, and other gas species typical of advanced microturbines on the environmental resistance and mechanical stability of candidate Si3N4 ceramics.
- Complete an assessment and initial evaluation of methods to improve or enhance the environmental stability of candidate Si3N4’s (coatings).
- Enhance current structural ceramic reliability and life prediction capabilities to incorporate environmental and coating issues.
- Develop advanced ceramic manufacturing approaches capable of reducing the development cost and time for the prototype-to-production transition (optional).
**Program Participants**

- **Honeywell Ceramic Components**
  - Phase I
    - Task 1: Advanced Microturbine Scoping Studies and Research Plan
  - Phase II
    - Task 1: Environmental Effects Evaluation (Uncoated)
    - Task 2: Technology Assessment for Environmental Protection
    - Task 3: Rapid Prototyping

- **Kyocera Industrial Ceramics Corporation**
  - Phase I: Develop Database of Application Requirements
  - Phase II: Provide Data on Performance of Materials in Microturbines
    - Evaluate Baseline (Uncoated), Coated, and Alternate Materials

Both teams include microturbine manufacturers
Advanced Microturbine Program Goals

- Next Generation Microturbine System (< 1,000 kW) by 2006:
  - **High Efficiency** - Fuel-to-electricity conversion efficiency of at least 40%
  - **Environmental Superiority** - NOx < 7 ppm (natural gas)
  - **Durable** - 11,000 hours of reliable operations between major overhauls and a service life of at least 45,000 hours
  - **Economical** - System costs < $500/kw, costs of electricity that are competitive with the alternatives (including grid) for market applications
  - **Fuel Flexible** - Options for using multiple fuels including diesel, ethanol, landfill gas, bio-fuels
Advanced Microturbine Program

• Six year program (FY 2000 - 2006), $60+ million Govt investment

• Program to include:
  – Competitive solicitation(s) for engine conceptual design, development, and demonstration
  – Competitive solicitation(s) for component, sub-sub-system development
  – Technology base in areas such as materials, combustion, sensors and controls, etc
  – Technology Evaluations and Demonstrations

• End-use applications open to include stationary power applications in industrial, commercial, institutional and residential sectors
Objectives For Advanced Recuperator Workshop

• Comments and feedback on “Assessment of Recuperator Materials for Microturbine” report
• Identify the RD&D needs for recuperators for advanced microturbines
• Contribute to planning of future high-temperature recuperator material R&D efforts
Microturbine Program
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