APEP RESEARCH EXAMPLES

ADVANCED POWER AND ENERGY PROGRAM
University of California
Irvine, California  92697-3550

Scott Samuelsen
Director

April 1, 2010
• BUILDING ENERGY CONTROLS

• IRVINE SMART GRID DEMONSTRATION PROJECT

• RENEWABLE ENERGY BASED SECURE COMMUNITIES
BUILDING ENERGY CONTROLS

GOAL
DEVELOP AND DEMONSTRATE NOVEL ALGORITHMS AND CONTROL SYSTEMS TECHNOLOGY FOR OPTIMAL ECONOMIC USE OF CLEAN COMBINED COOLING HEATING AND POWER (CCHP) SYSTEMS IN LIGHT INDUSTRIAL, COMMERCIAL AND INSTITUTIONAL APPLICATIONS

FOCUS
• GAS TURBINES AND HIGH TEMPERATURE FUEL CELLS
• CCHP SYSTEMS WITH ELECTRICAL AND THERMAL LOAD FOLLOWING

U.S. DEPARTMENT OF ENERGY
CALIFORNIA ENERGY COMMISSION
BUILDING ENERGY CONTROLS

OBJECTIVES

• DEVELOP DYNAMIC PHYSICAL AND ECONOMIC MODELS FOR INDUSTRIAL CCHP SYSTEMS AND COMPONENTS

• MEASURE THE DYNAMIC ELECTRICAL AND HEATING DEMANDS OF EXISTING LIGHT INDUSTRIAL GAS TURBINE CCHP APPLICATIONS WITH SUFFICIENT TEMPORAL RESOLUTION

• SIMULATE EXISTING CCHP SYSTEMS AND COMPARE TO MEASURED RESULTS FOR MODEL VERIFICATION

• DEVELOP NOVEL ALGORITHMS AND ARCHITECTURE FOR ECONOMIC DISPATCH OF COOLING, HEATING AND POWER FROM CCHP SYSTEMS

• TRANSLATE AND APPLY THE NOVEL ALGORITHMS AND ARCHITECTURE TO SIEMENS CONTROL TECHNOLOGY

• APPLY THE NEW TECHNOLOGY AND VERIFY PERFORMANCE BY TESTING THE ALGORITHMS AND CONTROL HARDWARE IN AN EXISTING CCHP SYSTEM

• EXTEND THE APPROACH TO ANALYZE ECONOMIC DISPATCH WITH THE INTEGRATION OF A HIGH TEMPERATURE FUEL CELL, ULTRA-CAPACITORS AND/OR OTHER EMERGING ENERGY CONVERSION OR STORAGE TECHNOLOGY
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ISGP PROJECT OVERVIEW

• DOE AWARDED FUNDING FROM THE AMERICAN RECOVERY AND REINVESTMENT ACT FOR PROJECTS DEMONSTRATING ADVANCED SMART GRID TECHNOLOGIES AND INTEGRATED SYSTEMS

• THE “IRVINE SMART GRID DEMONSTRATION” (ISGD) PROJECT WILL DEMONSTRATE AN INTEGRATED, SCALABLE SMART GRID SYSTEM THAT INCLUDES ALL OF THE INTERLOCKING PIECES OF AN END-TO-END SMART GRID SYSTEM, FROM THE TRANSMISSION AND DISTRIBUTION SYSTEMS TO CONSUMER APPLICATIONS LIKE SMART APPLIANCES AND ELECTRIC VEHICLES

• COLLABORATION BETWEEN UCI, GE, AND BOEING WITH SOUTHERN CALIFORNIA EDISON LEAD

U.S. DEPARTMENT OF ENERGY
ISGP LOCATION
ISGP PROJECT SCOPE

• ENERGY SMART CUSTOMER DEVICES
  – Subproject 1 - Zero Net Energy (ZNE) Home on the Grid
  – Subproject 2 - Plug-in Electric Vehicle (PEV) Charging

• Y2020 Distribution System
  – Subproject 3 - Distribution Circuit Constraint Management Using Energy Storage
  – Subproject 4 - Enhanced Circuit Efficiency and Power Quality through Volt/VAR and Frequency Control
  – Subproject 5 - Self-Healing Distribution Circuits
  – Subproject 6 - Deep Grid Situational Awareness for Transmission Operators Using Phasor Technology

• Secure Energy Network (SENet)
  – Subproject 7 - End-to-End Cyber Security and Interoperability of Primary Networks (Inter-Utility, Intra-Utility, Field Area)

• Workforce of the Future
  – Subproject 8 - Organizational Impacts and Educational Curriculum Development to Produce the Future Utility Worker
ISGP: EVALUATE ZERO NET ENERGY HOMES

- FOUR SETS OF HOMES WITH PROGRESSIVE FEATURES

- HOMES TO BE RETROFITTED WITH EDISON SMARTCONNECT™ METERS, SMART APPLIANCES, PV SYSTEMS, ENERGY STORAGE, AND OTHER SMART GRID TECHNOLOGIES

- TEST CIRCUIT IMPACTS
• BUILDING ENERGY CONTROLS

• IRVINE SMART GRID DEMONSTRATION PROJECT

• RENEWABLE ENERGY BASED SECURE COMMUNITIES
RENEWABLE ENERGY BASED SECURE COMMUNITIES (RESCO)

1. AN ENERGY INFRASTRUCTURE ROADMAP (ELECTRIC POWER, TRANSPORTATION, WASTE, BUILDING) FOR THE UCI COMMUNITY THAT WILL MAXIMIZE THE DEPLOYMENT AND UTILIZATION OF RENEWABLE ENERGY RESOURCES, WHILE SATISFYING RELIABILITY CRITERIA, ENHANCING AND SUSTAINING POWER QUALITY, AND MINIMIZING THE COST-OF-ELECTRICITY (COE)

2. AN ENERGY INFRASTRUCTURE ROADMAP FOR COMMUNITIES WHO ASPIRE TO DEVELOP ENERGY INFRASTRUCTURES THAT MAXIMIZE THE DEPLOYMENT AND UTILIZATION OF RENEWABLE ENERGY RESOURCES WHILE SATISFYING RELIABILITY CRITERIA, ENHANCING AND SUSTAINING POWER QUALITY, AND MINIMIZING THE COST-OF-ELECTRICITY.

3. THE ISSUES FOR POLICY MAKERS AND INDUSTRY LEADERS THAT MUST BE ADDRESSED TO FACILITATE THE IMPLEMENTATION OF RENEWABLE-BASED ENERGY SECURE COMMUNITIES THROUGHOUT CALIFORNIA.

CALIFORNIA ENERGY COMMISSION
RESKO: PILOT BASES

- UCI RESKO Roadmap
- Pilot Projects
## RESCO: PILOT BASE

<table>
<thead>
<tr>
<th>PILOT PROJECT</th>
<th>DESCRIPTION</th>
<th>EXISTING OR NEW</th>
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<tbody>
<tr>
<td>Preferred Substation and Circuit Configurations</td>
<td>Evaluate substation and distribution circuit components and configurations that best support RESCO communities.</td>
<td>E</td>
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<tr>
<td>UCI Substation and Distribution Grid</td>
<td>Establish a flexible circuit to enable the interconnection of distributed energy resource on the UCI micro-grid.</td>
<td>E</td>
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<tr>
<td>Interconnection of DER and UCI Distribution Circuit</td>
<td>Disseminate practical insights garnered from the “Greenbox” development on DER-grid interconnections in a field installation.</td>
<td>E</td>
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<tr>
<td>Dynamic Price Signal</td>
<td>Evaluate dynamic price signals and communication infrastructure to enable effective dispatch of DER.</td>
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<tr>
<td>Electricity, Heat and Cooling Monitoring</td>
<td>Analyze available electric, heat and cooling load demand data to identify energy management possibilities.</td>
<td>E</td>
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<tr>
<td>Flexible BEV Charger</td>
<td>Develop a BEV charger that given a price signal and charge time the charger will minimize vehicle charge cost.</td>
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<tr>
<td>Smart Dispatch Air Conditioning</td>
<td>Evaluate how dispatchable air conditioning system can help manage intermittent renewable generation.</td>
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<tr>
<td>MW Solar PV System</td>
<td>Monitor MW of PV generation on the UCI campus.</td>
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<tr>
<td>Concentrated PV Demonstration</td>
<td>Pilot the installation of concentrated PV systems.</td>
<td>N</td>
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<tr>
<td>Biogas CHP Plant with H₂ Co-Production</td>
<td>Quantify the value of a CHP and hydrogen co-production energy station operating on biogas.</td>
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<tr>
<td>Zero Emission Vehicle – Network Enabled Transportation (ZEV•NET)</td>
<td>Evaluate the carbon and energy footprint of student and faculty that utilizes public and alternative vehicle transportation.</td>
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<tr>
<td>Operation of bus fleet on biodiesel</td>
<td>Evaluate the carbon and energy footprint of student, staff, and faculty that utilize public transportation.</td>
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<tr>
<td>Land-Use Design Effect on Energy Intensity</td>
<td>Evaluate the carbon and energy footprint of student and faculty that live on campus.</td>
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<tr>
<td>Efficient building design and operation</td>
<td>Develop building design and operational criteria to aid renewable penetration.</td>
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<tr>
<td>Renewable Integration and Management Modeling</td>
<td>Evaluate the holistic integration of renewable resources as well as strategies to manage high renewable penetrations.</td>
<td>N</td>
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<tr>
<td>Thermal Energy Storage</td>
<td>Characterize the role of TES in supporting the RESCO requirements.</td>
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<tr>
<td>Electric Energy Storage</td>
<td>Quantify the magnitude of energy storage that will be required to achieve a RESCO.</td>
<td>N</td>
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<tr>
<td>Solar Heating</td>
<td>Compare solar heating and combined heat and power.</td>
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RESCO: LIVING LABORATORY
Minimize cost, maximize reliability, and maintain simplicity
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