Renewable and Distributed Systems Integration Demonstration Projects

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Department of Energy RDSI Projects

- **Nine projects selected in 2008**
- **Projects are either microgrids or are developing technologies that will advance microgrids**
- **Objective: To encourage use of distributed resources to provide power during peak load periods and for other functions and services. Minimum 15% reduction in peak load on distribution feeder or substation.**
- **Systems must be capable of operating in both grid parallel and islanded modes**
- **$55 million of DOE funds over five years (total value of awards will exceed $100 million, including participant cost share)**

Benefits

- ✓**Increases grid reliability**
- ✓**Addresses vulnerability of critical infrastructure**
- ✓**Helps manage peak loads and defers T&D investment**
- ✓**Lowers emissions and utilizes fuel resources more efficiently**
- ✓**Helps customers manage energy costs**

Peak Load Reduction Microgrid Projects

Chevron Energy Solutions
What: CERTS Microgrid Demonstration
Where: Santa Rita Jail, Alameda County, California
Technologies: Microgrid technology, large-scale battery storage, photovoltaics, fuel cell, wind turbines

ATK Space Systems
What: Powering a Defense Company with Renewables
Where: Promontory, Utah
Technologies: Hydro-turbines, compressed air storage, solar thermal, wind turbines, waste heat recovery system

City of Fort Collins
What: Mixed Distributed Resources
Where: Fort Collins, Colorado
Technologies: Photovoltaics, combined heat and power, thermal storage, fuel cell, microturbines, PHEV, demand response

Illinois Institute of Technology
What: The Never-Failing Perfect Power Prototype
Where: Illinois Institute of Technology, Chicago, Illinois
Technologies: Advanced meters, intelligent perfect power system controller, gas fired generators, demand response controller, uninterruptable power supply, energy storage

SDG&E
What: Beach Cities Microgrid
Where: San Diego, California
Technologies: Demand response, energy storage, outage management system, automated distribution control, advanced metering infrastructure

Consolidated Edison
What: Interoperability of Demand Response Resources
Where: New York City, New York
Technologies: Demand response, PHEVs, fuel cell, combustion engines, intelligent islanding, dynamic reconfiguration, fault isolation

University of Hawaii
What: Transmission Congestion Relief
Where: Maui, Hawaii
Technologies: Intermittency management system, demand response, wind turbines, dynamic simulations modeling

University of Nevada, Las Vegas
What: "Hybrid" Homes - Dramatic Residential Demand Reduction
Where: Las Vegas, Nevada
Technologies: Photovoltaics, advanced meters, in-home dashboard, automated demand response, energy storage

Allegheny Power
What: West Virginia Super Circuit - Dynamic Feeder Reconfiguration
Where: Morgantown, West Virginia
Technologies: Biodiesel combustion engine, microturbine, photovoltaics, energy storage, advanced wireless communications, dynamic feeder reconfiguration

ATK Space Systems

Integrated Automated DG Demonstration

Project Purpose and Objectives

- Develop and demonstrate a diverse system of renewable distributed generation technologies that are integrated into an intelligent automation system with two-way communications to the utility and that will produce an on-demand reduction of 15% of substation load.

Project Partners

- ATK Space Systems – Project Management/Host
- P&E Automation (San Diego, CA) – Technology/Experience
- Rocky Mountain Power – RMP - (Division of PacifiCorp) – Gateway/Incentives

Project Location

- Promontory, Utah

Project Funding and Cost Share

- 5 years
- $1.6M Federal Funds
- $2M Industry Funds/non-Federal

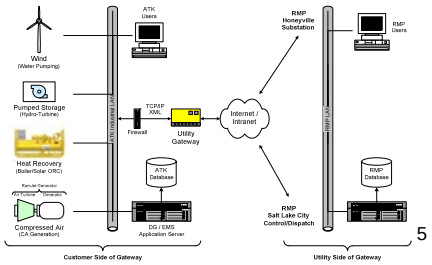
ATK Launch Systems Project Technologies

Renewable Energy Sources

- **Waste Heat Recovery Systems - 1400kW Total Capacity**
  - Steam Supplied by three sources
    - Low Pressure Steam from the central steam distribution system
    - Concentrating solar thermal arrays (summer steam boost)
    - Air compressor exhaust
- **Wind Turbines (water pumping/compressed air storage) - 144 kW total capacity**
- **Pumped Storage - 1040 kW Total Capacity for 4 hours**
  - 2 million gallon elevated storage capacity
  - 5 hydro turbines – 200 kW each
  - 4 micro-hydro turbines – 10 kW each
- **Compressed Air Storage & Generation 80 kW total capacity for 30-60 minutes**

Control System Components

- Load Aggregation and monitoring
- Fault detection and diagnostics
- Remote monitoring and control
- Two-way customer-Utility web interface
- Provide utility with real-time visibility into customer-owned renewable, distributed generation
- Black Start
- Historical trending and reports
- Alarm and event notification



ATK Launch Systems Schedule and Status

<u>Phase 1</u>: Development (Year 1; FY2009)

- Design and testing of reliable and effective DG controls
- Design and preliminary testing of Utility gateway hardware and software
- Collect/compile historical baseline data
- Provide full design, engineering, drawings, specifications and permitting of DG
- Design and installation of sufficient generation equipment to validate Phase II feasibility

<u>Phase 2</u>: Demonstration (Years 2-3 Installation Years 4-5 M&V; FY10 – FY13)

- DG Implementation
- Data collection
- Commercialize to other RMP customers and/or other utilities

<u>Current Status</u>

- Nearing completion of Phase I
- Design of 2.5 mW of renewable distributed generation and controls
- Design of microgrid (automatic controls, two-way utility/customer gateway)
- Installation of 34 kW of pilot DG for testing generation, controls and microgrid concepts

Consolidated Edison of NY

Interoperability of Demand Response Resources Demonstration

Project Purpose and Objectives

- The project will utilize a demand response command center to aggregate multiple DR resources at retail electric customer sites to supply critical services, under tariff-based and market-based programs, to the electric distribution company and to the regional transmission operator.

Project Partners

- Consolidated Edison of New York
- Innoventive Power
- Verizon
- Infotility

Also Part of EPRI Demo

Project Location

- New York City, NY

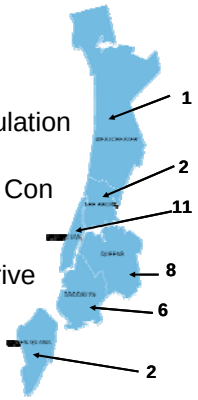
Project Funding and Duration

- 3 years
- $6.8 million Federal Funds
- $6 million Industry Funds
- $1 million New York State Energy R&D Administration (NYSERDA)

Consolidated Edison of NY
Project Technologies

Demand Response in 30 Facilities

- 1 facility to operate in parallel with, and inject power into, the distribution network
- Use multiple engine types
  - Diesel
  - Combustion turbines
  - Fuel cells
- 1 CHP project to supply baseload and regulation
  - three 400 kW fuel cell units
- Load reduction at 29 telecom facilities and Con Ed headquarters by changing AC set-points, rectifier voltages and variable frequency drive speeds
- Retrofit 2 facilities, with old engines, for NOx control.



Consolidated Edison of NY Schedule

- **Phase 1**: Gather Data & Study Feasibility - October 1, 2008 thru September 30, 2009
  - Develop Interconnection Plans
  - Design Interoperability Approach for DR supply of ancillary services
  - Evaluate Fuel Cell & Wind Facility Integration
- **Phase 2**: Design & Construct - October 1, 2009 thru June 30, 2010
  - Design/Install remote monitoring/control equipment/software, interconnection equipment, wind turbine, load reduction systems, fuel cell.
- **Phase 3**: Operate, Measure & Report - October 1, 2010 thru September 30, 2011

Illinois Institute of Technology

The Perfect Power Prototype

Project Purpose and Objectives

- Create a self healing, learning, and self aware SmartGrid that identifies and isolates faults, reroutes power to accommodate load changes and generation, and dispatches generation and reduces demand based on price signals (PJM real time), weather forecasts, and loss of grid. Demonstrate a 20% permanent peak load reduction and a 50% peak load reduction on demand.

Project Partners

- Galvin Energy Initiative
- Illinois Institute of Technology (IIT)
- Exelon
- S&C
- Schweitzer
- Endurant Energy

Project Location

- Chicago, IL

Project Funding and Duration

- 5 years
- $7M Federal Funds (Department of Energy)
- $5M Industry Funds/non-Federal

Illinois Institute of Technology
Project Technologies

The IIT prototype will be the first of a kind integrated MicroGrid system that provides for full islanding of the entire campus load based on PJM/ComEd market signals. Specific innovative technology applications include:

- **High Reliability Distribution System** (HRDS) – High-speed, intelligent, automated switches will be installed to detect and isolate a fault without loss of power to the building. S&C Vista™ UDS fault-clearing switchgear in a closed-loop system with SEL-351 directional over current protection relays. A Permissive Over-reaching Transfer Trip scheme (POTT) will be used to protect the underground feeder cables.
- **Intelligent Perfect Power System Controller** (IPPSC) – IIT will design and provide a low cost means for coordinating a diverse set of demand response and pricing signals to optimize the facility response.
- **Advanced ZibBee Wireless** – IIT will leverage ZigBee two-way communications to monitor, collect, and analyze data on energy usage by certain devices at IIT. At the same time, Exelon can send a signal to IPPSC which will transmit signals to ZigBee devices to control devices at IIT.
- **Advanced Distribution Recovery Systems –** IIT will leverage dNetSim, a software-based distribution network simulator, with an agent-based control system for fault detection, location and isolation; feeder reconfiguration; volt/VAR management; service restoration; emergency response; and integration of distributed resources.
- **Buried Cable Fault Detection and Mitigation** – IIT will develop a fast Fault Detection and Mitigation (FDM) system

Illinois Institute of Technology
Schedule and Status

Phase 1: Establish the basis for Perfect Power

Phase 2: Address key technology gaps
- Task 1.0 – Advanced Distribution Automation and Recovery System
- Task 2.0 – Buried Cable Fault Detection and Mitigation
- Task 3.0 – Intelligent Perfect Power System Controller
- Task 4.0 – Advanced ZigBee-Based Wireless

Phase 3: Prepare IIT for real time pricing and ancillary markets

Phase 4: Deploy the advanced campus distribution system

Phase 5: Deploy campus distribution level peak load reduction

Current Status:
- Completed the conceptual design for year one
- Initiated manufacturing of switchgear for High Reliability Distribution System
- Completed the cost estimating of installation projects
- Began underground location work and site coordination for the project installations
- Established autonomous agent-based perfect power controls and unbalanced three-phase distribution system simulator
- Designed the IPPSC for campus energy and control system
- Completed the design of ZigBee sensor controls and wireless communications for the building automation

City of Fort Collins

Research Development & Demonstration of Peak Load Reduction on Distribution Feeders Using Distributed Energy Resources

Project Objectives

- Develop and demonstrate a coordinated and integrated system of mixed distributed resources for the City of Fort Collins
- Reduce peak loads by 20%-30% on multiple distribution feeders
- Increase the penetration of renewables
- Deliver improved efficiency and reliability to the grid and resource asset owners

Project Partners

- Fort Collins Utilities
- Colorado State University
- Advanced Energy
- Brendle Group
- Eaton Corporation
- InteGrid Laboratory
- New Belgium Brewing
- Spirae, Inc.
- Woodward Governor Company

Project Location

- Fort Collins, Colorado

Project Funding and Cost Share

- 3 years
- $3.9M Federal Funds
- $7.2M Industry Funds/non-Federal

City of Fort Collins
Project Technologies

Site	Description	kW
New Belgium Brewing	PV Array	200
	CHP Systems	942
	Thermal Storage	135
	Load Shedding	160
InteGrid Laboratory	Conventional Generators	460
	Microturbines	160
	Wind Turbine Simulator	100
	Fuel Cells	10
City of Fort Collins Facilities	Conventional Generator	500
	Thermal Storage	92
	PV Array	5
	PHEVs	10
	HVAC and VFD DSM	62
Larimer County	PV Array	10
	Water Fountain Control	1.5
CSU	Thermal Storage	80
	Variable Speed Drives	80
	Water fountain pumps and hot water controls	25.2
	Load Shedding	6
	Conventional Gen sets	950

City of Fort Collins Schedule and Status

Activity	Deliverables	Duration
Project Mgmt and Reporting	Plan, Schedule, resource alloc, reports	Ongoing
Requirements Specifications	Site, Utility, and Sys Performance req	Now – Q2 '09
Detailed Design	Design specs, drawings, materials list	Q1 '09 – Q2 '09
Development and Lab Testing	Operational system, Lab test results	Q1 '09 – Q2 '10
Procure, Install, Commission, Test	Operational system, Field test reports	Q1 '09 – Q2 '10
Research and Development	Technical reports	Q1 '09 – Q2 '11
Demonstration	Demo and Data Collection	Q1 '11 – Q4 '11

San Diego Gas & Electric

Utility Integration of Distributed Generation

Project Objective

- Conduct a pilot scale "proof-of-concept" test in San Diego, CA of how information-based technologies and DER may increase Utility asset utilization and reliability.

Project Partners

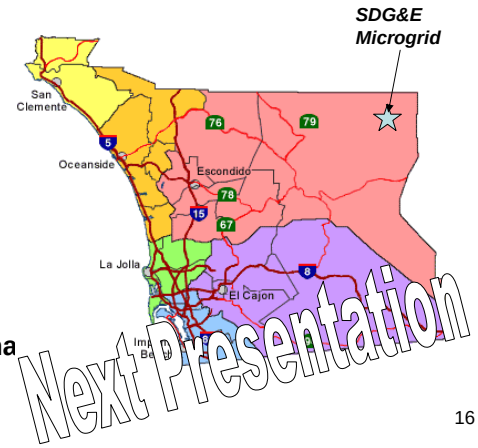
- SDG&E – Prime Contractor
- IBM - PMO
- Horizon Energy Group – Solution Architect
- Motorola
- Pacific Northwest National Labs
- Oracle
- Advanced Energy Storage
- University of San Diego
- Lockheed Martin

Project Location

- San Diego, California
- Borrego Springs Substation

Project Funding and Cost Sha

- 3 years
- $6.9M Federal Funds
- $4M Industry Funds/non-Federal



Next Presentation

San Diego Gas & Electric Product Technologies

Integrate the 5 following technologies:

- ***DER and VAr***
- ***Feeder Automation System Technologies (FAST)***
- ***Advanced Energy Storage (AES)***
- ***OMS/DMS system***
- ***Price Driven Load Mgmt (PDLM)***

San Diego Gas & Electric Schedule

Phase 1: Baseline and Key Developments
- Develop project management plan
- Site Selection
- Analyze Advanced Energy Storage Solutions
- Negotiate AES Pricing and Obtain Costs
- Install Initial Field Hardware
- Pilot Network Analysis and Baselining
- Establish functional Specifications and Test Programs

Phase 2: Integration and Operational Testing

Phase 3: Data Collection and Analysis

University of Nevada

Dramatic Residential Demand Reduction in the Desert Southwest

Project Objective

- Decrease the peak electrical demand for a new housing development by as much as 65% compared to a similar development that is built conventionally (i.e., to code).

Project Partners

- University of Nevada, Las Vegas, Center for Energy Research
- Pulte Homes
- NV Energy

Project Location

- Las Vegas, Nevada
- Villa Trieste Community

Project Funding and Cost Share

- 5 years
- $7M Federal Funds
- $13.9M Industry Funds/non-Federal

University of Nevada Product Technologies

Energy Efficient Homes

- •Sensus Icon residential meters
- •In2 Networks
- •Energy Star Appliances
- •Low-E Windows
- •Tankless Water Heater

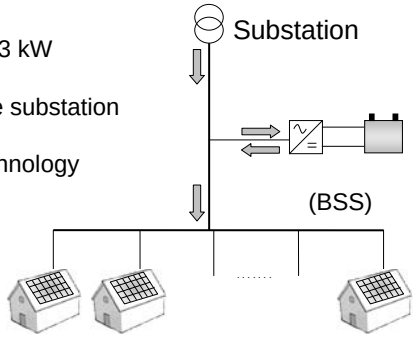
•Roof Integrated PV Systems 1.76-2.43 kW

•Battery Energy Storage System at the substation

•Advanced wireless mesh network technology

•Advanced Meter Infrastructure

- •HVAC thermostat control



University of Nevada
Schedule Status

- Several model homes have been built.
- Pulte will continue with home construction.
- UNLV/NV Energy to select the type of battery storage and power conversion unit. Purchase, install and test the system.
- NV Energy to continue installation and test of AMI, meshed network, and related hardware for the Demand Response program.

University of Hawaii

Managing Distribution System Resources for
Improved Service Quality and Reliability, Transmission Congestion Relief, and Grid Support Functions

Project Objective

- Develop and demonstrate a distribution automation solution that integrates dispatch of distribution assets and bulk power assets to achieve system-level benefits.

Project Partners

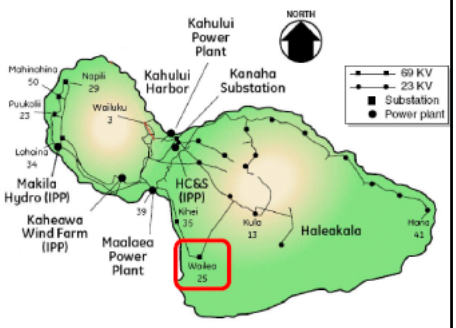
- Hawaii Natural Energy Institute, University of Hawaii
- Maui Electric Company
- GE Global Research
- Sentech, Inc.
- Hawaiian Electric Company
- GE Energy

Project Location

- Maui, Hawaii
- Wailea Substation

Project Funding and Cost Share

- 3 years
- $7M Federal Funds
- $8M Industry Funds/non-Federal



University of Hawaii Technologies

- **Integrated Volt/VAr Control - Minimize Losses and Control Voltage Profile**
  - GE ENMAC DMS, MECO cap banks, PV inverters
- **Demand Management** - Optimize consumption and enable direct load control
  - GE Smart Meters, GE Home Energy Manager/Smart Appliances, HECO Load Control "Energy Scout" equipment, GE ENMAC DMS
- **Distributed Energy Resources (DER) Management** - Provide MECO greater visibility in dist-level resources
  - GE Smart Meters, PV inverters, Wind forecast module

University of Hawaii Project Status

Planning Stage-Nearing Finish

- Selecting functions, feeders, substations, customer premises, communications
- Choosing equipment and integration/interconnection points

Design Stage-in Progress

- Smart Grid architecture and control hierarchy
- Information flows and communication links
- Functional specification of the demonstration
- Incorporating MECO and HECO demand response, AMI, AGC, etc. functions

Product Development-Starting

- Adapting existing equipment, applications (e.g., ENMAC, IVVC)
- Developing and validating feeder models
- Beginning development of one of the residential responsive load options – GE Residential Energy Management optimizer with smart appliances

Allegheny Power

West Virginia Supercircuit Project

Project Objective

- To demonstrate improved electricity distribution system performance, reliability, and security of electricity delivery through the integration of distributed resources and advanced technologies.

Project Partners

- Allegheny Power
- Science Applications International Corporation
- West Virginia University
- WVU Advanced Power and Electricity Research Center
- North Carolina State University
- Augusta Systems, Inc.
- Tollgrade Communicatons

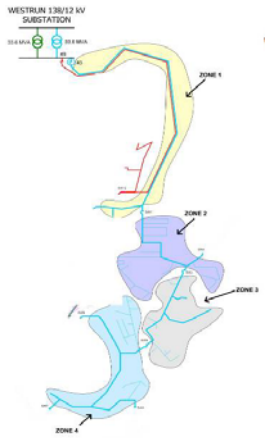
Project Location

- Morgantown, West Virginia

Project Funding and Cost Share

- 4 ½ years
- $4M Federal Funds
- $5.4M Industry Funds/non-Federal

*Negotiations between NETL/Allegheny Power. Expected project kick-off October, 2009



Allegheny Power
Project Technologies

- Distributed Energy Resources
  - 1.2 MW (3x400 kW) Biodiesel Internal Combustion Engines (ICE)
  - 250 kW Micro-turbine
  - 100 kW Solar Photovoltaic (PV) System
  - 500 kW (2x250 kW), 8 hrs Energy Storage
- Multi-Agent Grid Management (MGM) System
- Demand Response and Automated Load Control
- Low-Cost Distribution Sensors
- Fault Location & Prediction
- Dynamic Feeder Reconfiguration

Allegheny Power Technical Challenges

- Microgrid Operation Challenges
  - Seamless transition
  - Stability issues
- Optimal Placement and Sizing of DERs
  - Loss minimization
  - Recloser-fuse coordination
- Protective System Challenges
  - Bi-directional currents
  - Limited fault current magnitudes due to Power-Electronics
- Interoperability
- Cyber Security
- Wireless Communication Network Challenges
- Personnel Safety

The Santa Rita Jail

CERTS Microgrid Demonstration With Large-Scale Energy Storage and Renewables at Santa Rita Jail

Project Objective

- Demonstrate the first commercial implementation of CERTS microgrid technology combined with large-scale energy storage and renewable energy sources.

Project Partners

- Chevron Energy Solutions
- Alameda County, California
- Satcon Power Systems
- Pacific Gas & Electric Company

Project Location

- Alameda County California
- Santa Rita Jail

Project Funding and Cost Share

- 3 years
- $6M Federal Funds
- $6M Industry Funds/non-Federal

The Santa Rita Jail Project Technologies

- Existing features
  - 1 MW fuel cell
  - 1.2 MW solar photovoltaic system
  - Two 1.2 MW emergency diesel generators
- New technologies
  - CERTS Microgrid control logic
    - Fast Static Disconnect Switch (for islanding)
    - Plug and play control
  - 2 MW Sodium Sulfur battery
    - For demand offset and time-of-use pricing
  - 2 kW wind turbines

Next Steps

- Complete design and development phase
- Model validation
- Equipment installation and testing
- Conduct demonstrations
- Collect and analyze data
- Cost-benefit analysis
- Commercialization

Questions?