NATIONAL ENERGY TECHNOLOGY LABORATORY

Military and Government Microgrids Summit

Results from DOE's Smart Grid ARRA
Microgrid Projects

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Presentation Outline

Introduction

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Introduction

DOE-OE ARRA Primary Microgrid Field Projects

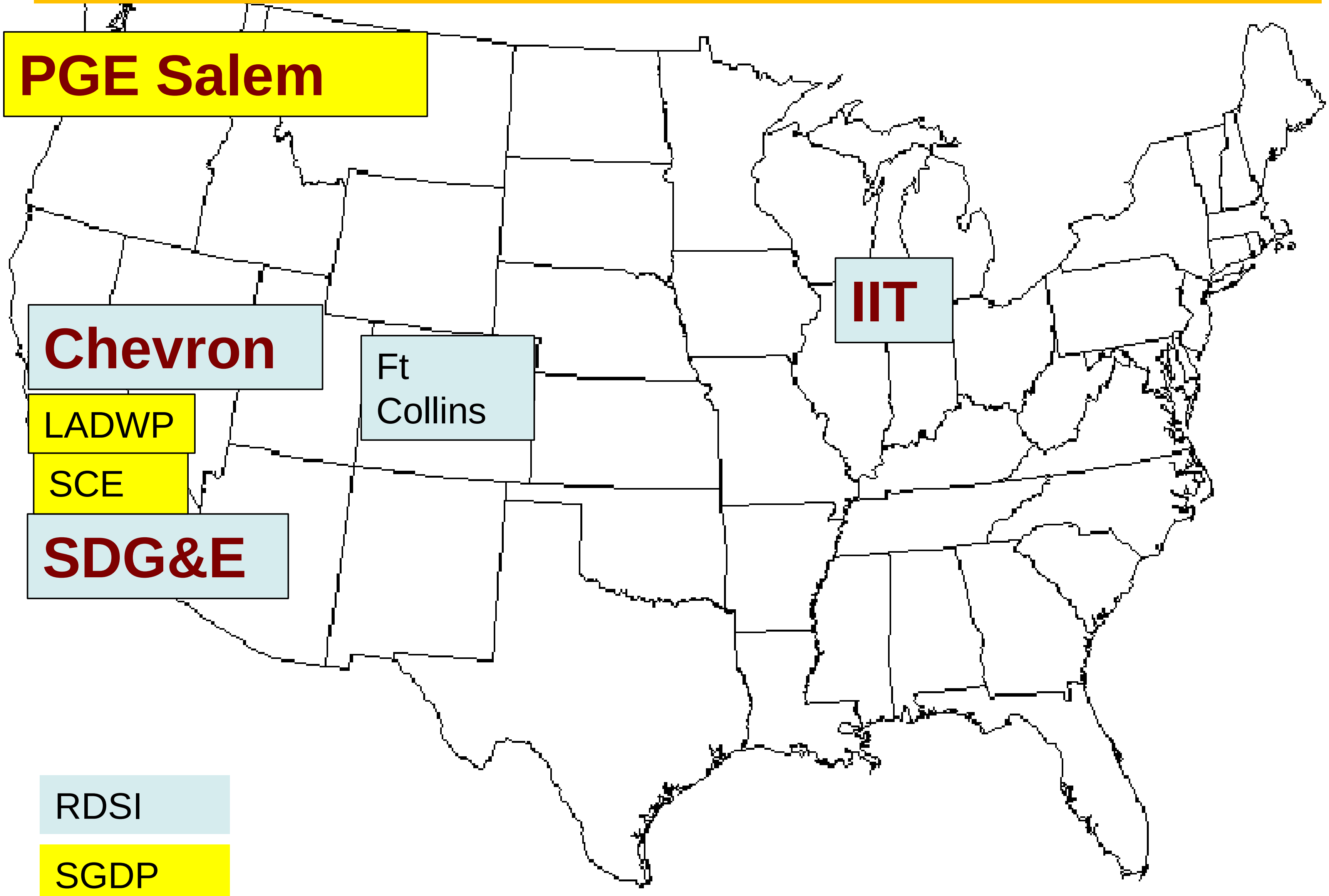
RDSI Projects

- Chevron Energy Solutions — Santa Rita Jail
- Illinois Institute of Technology — Perfect Power
- San Diego Gas & Electric — Borrego Springs Microgrid

SGDP Project

- PGE Salem Microgrid (part of Battelle–Pacific Northwest Smart Grid Demonstration)

DOE OE ARRA Primary Microgrid Project Locations



Common Areas Evaluated

Design Features

Performance Features

- Reduce peak load
- Improve reliability
- Enable integration of renewables
- Enhance security and resiliency
- Increase consumer engagement
- Improve system efficiencies
- Create economic value

Results of Individual Projects

Chevron Energy Solutions — Santa Rita Jail
A Consumer-based Microgrid

Santa Rita Jail Resource Portfolio

Resource	Capacity MW
Fuel cell (existing)	1
Photovoltaic system (existing)	1.2
Two 1.2 MW back-up diesel generators (existing)	2.4
CERTS-compliant power conversion system (2.5 MVA) with Lithium iron phosphate (LiFePO4) battery (4 MWh)	2
Five wind turbine generators (existing)	11.5 kW
Capacitor bank (900 kVAr)	
Total Capacity	6.6

Santa Rita Jail Results

Objective	Results
Reduce Peak Load	95% (facility) 15% (feeder)
Improve Reliability	0 outages since commissioning
Enable Integration of Renewables	✓
Enhance Security and Resiliency	✓
Increase Consumer Engagement	✓
Improve System Efficiencies	Not quantified
Create Economic Value	$110,000 (annual) BCR < 1 (estimated)

San Diego Gas & Electric - Borrego Springs
A Utility Distribution Microgrid

Borrego Springs Resource Portfolio

Resource	Capacity MW
Two 1,800 kW Diesel Generators (existing)	3.6
1.5 MWh lithium ion energy storage system	.5
Interface with Price Driven Load Management (Potential Demand Response)	
Total Capacity	4.1

Borrego Springs Results

Objective	Results
Reduce Peak Load	>15% of peak load
Improve Reliability	✓
Enable Integration of Renewables	✓
Enhance Security and Resiliency	✓
Increase Consumer Engagement	✓
Improve System Efficiencies	Not quantified
Create Economic Value	None identified BCR < 1 (estimated)

IIT Perfect Power
A Consumer-based Microgrid

IIT Resource Portfolio

Resource	Capacity MW
Two 4 MW Rolls Royce gas-turbines (existing)	8
Photovoltaic system	.3
11 Building Back-up Generators	4
500 kWh Flow Battery Storage System	.25
Wind turbine generator	8 kW
Total Capacity	12.6

IIT Results

Objective	Results
Reduce Peak Load	60 % of peak load
Improve Reliability	✓
Enable Integration of Renewables	✓
Enhance Security and Resiliency	✓
Increase Consumer Engagement	✓
Improve System Efficiencies	6.6%
Create Economic Value (NPV)	+4.6 Million BCR 1.38

Portland General Electric — Salem
A Utility Distribution Microgrid

Salem Resource Portfolio

Resource	Capacity MW
Two 1,250 kW Diesel Generators (existing)	2.5
Four 800 kW Diesel Generators (existing)	3.2
1.25 MWh Lithium Ion energy storage system	5
Total Capacity	**10.7**

Salem Results

Objective	Results
Reduce Peak Load	Not demonstrated
Improve Reliability	Not demonstrated
Enable Integration of Renewables	✓
Enhance Security and Resiliency	✓
Increase Consumer Engagement	✓
Improve System Efficiencies	Not demonstrated
Create Economic Value	None identified BCR < 1 (estimated)

Summary of Results

Comparison of Design Features

Feature	Chevron	SDGE	IIT	PGE
Type	CBM	UDM	CBM	UDM
Diesel Gen Capacity (MW)	2.4	3.6	4	5.7
AES Capacity (MW / MWh)	2 / 4	.5 / 1.5	.25 / .5	5 / 1.25
Renewables Capacity (MW)	1.2	0	.308	0
Other Capacity (MW)	1 (fuel cell)	0	8 (natural gas)	0
Total Capacity (MW)	6.6	4.1	12.6	10.7
Peak Load (MW)	2	4.6	12	5
Local control (island mode)	Droop	Isochronous	Droop	Isochronous
Supervisory control (MMC)	DERMS	Manual	MMC	Manual
Transactive (grid connected)	Yes	Yes	Yes	Yes
Primary Focus	Reliability, Econ	Reliability	Reliability, Econ, Environ	Reliability

Preliminary Conclusions

Microgrids Work

The technical viability of microgrids was demonstrated

All four projects demonstrated by operating in islanding mode that a microgrid can deliver substantial value in terms of reliability and security to the customers within the microgrid footprint. In general, the operation of the CBMs was more sophisticated than the operation of the UDMs as they optimized operations economically and environmentally in addition to improving reliability and resiliency.

CBM =Customer Based Microgrids

UBM = Utility Distributed Microgrids

Storage Systems are Complex

The nascent nature of advanced energy storage systems requires extra attention

The continued evolution of energy storage systems requires extra effort on the part of microgrid developers to ensure they have a complete understanding during the design, procurement, installation, commissioning and operational phases for these systems. Often the vendors for battery systems and inverter systems are different creating potential issues at the interface of the two systems.

Negawatts are Helpful

Load shedding capability is an important microgrid resource

The ability to shed load rapidly (noncritical loads) or using direct load control is a valuable resource when transitioning to and operating in island mode. Load shedding provides rapid response during transients, particularly during an unplanned separation from the main grid.

The use of customer incentive based DR for load shedding was not shown to be reliable enough to act as a load shedding resource.

Need “Someone in Charge”

[A supervisory level controller (MMC) is essential for supporting microgrid operation]

Real time response to load changes and transients is best done locally at the microgrid resource. A higher level control system is needed to re-dispatch the microgrid resources periodically to ensure their optimal participation. The need for a supervisory level of control is essential for CBMs that actively operate 24/7 to optimize performance.

Need an "Off the Shelf MMC"

The limited availability of a commercial MMC is a barrier to future microgrid development

The development of standardized MMC technologies that support interoperability with the many possible microgrid resources and legacy systems is needed. In addition, an architecture that enables microgrid developers and operators to easily program microgrid-specific algorithms is needed.

Check the Regulations

Regulations impacting the installation and operation of microgrid resources should be fully researched early in the planning and design phase

Changing regulations can impact the operation of microgrid resources in ways that may limit their value as a resource. For example, restrictions on when diesel generators may operate may prevent them from responding to economic dispatch signals. Other limitations may exist for wind turbine generators and power electronics.

Are Microgrids a Good Deal?

Microgrids do not have a positive business case except in special cases

The following conditions may be needed to give microgrids the potential for achieving a positive business case:

- Large portion of DER portfolio requirements are pre-existing
- Opportunity exists to defer large capital investments
- Cost of utility supplied energy is very high
- Significant production tax credits or investment tax credits exist that apply to the DER portfolio
- A method is created for valuing (monetizing) increased resiliency and reliability

What is Resiliency Worth?

A mechanism for monetizing the value of resiliency and improved reliability is needed to support microgrid business cases

The greatest value provided by microgrids is resiliency and improved reliability. But standard methods do not exist for monetizing these benefits which often results in a non-compelling business case for many microgrids. The inability to monetize these substantial benefits is a barrier for future microgrid development.

The Key Ingredients

Energy storage systems and the MMC are microgrid differentiators

The application of energy storage and a supervisory level of control can convert diverse DER portfolios into a microgrid. Energy storage is needed to assist in transient response and transitioning to island mode of operation. The MMC is needed to coordinate and dispatch the microgrid DER portfolio to meet microgrid objectives

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Key Microgrid Resources:
DOE OE www.oe.energy.gov
Smart Grid www.smartgrid.gov