Smart Grid, Intelligent Efficiency, Micro-Grids and Distributed Generation

NASEO 2014 Central and West Regional State Energy Offices Meeting
Sacramento, CA
June 17, 2014

Michael Gravely
Deputy Division Chief
Energy Research and Development Division
California Has Adopted Ambitious Energy Policies

<table>
<thead>
<tr>
<th>Energy Efficiency</th>
<th>Demand Response</th>
<th>Renewable Energy</th>
<th>Smart Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>40,000 GWh/year</td>
<td>Economic DR at 5% of peak</td>
<td>11% penetration</td>
<td>1.325 GW of storage</td>
</tr>
<tr>
<td>63,000 GWh/year</td>
<td>Achieve 100% of economic potential</td>
<td>20% penetration</td>
<td>over 1.5 million zero emissions vehicles</td>
</tr>
<tr>
<td>Zero net energy homes</td>
<td>33% penetration</td>
<td>33% penetration</td>
<td>12 GW DG 8 GW utility-scale</td>
</tr>
<tr>
<td>Zero net energy commercial buildings</td>
<td>11% reduction from current GHG emissions</td>
<td>30% reduction from projected GHG emissions</td>
<td>80% reduction from 1990 GHG emissions</td>
</tr>
</tbody>
</table>
Planned RD&D Investments Will Target Priority Areas and Barriers to Achieving the State’s Energy Goals
Smart Grid—The Merging Two Infrastructures

Electrical Infrastructure

“Intelligence” Infrastructure
These Policies Provide a Vision for the Future Electric Grid
Energy Efficiency Research Program

- Lighting
- HVAC
- Plug Loads
- Food Service
- Commercial Laundry
- Food Processing
- Data Centers
Demand Response Automation by Sector

| Programmable Communicating Thermostat | Demand Response Automation Client | Demand Response Automation Client |

Diagram showing various devices connected through the internet.
What is a Microgrid?

• Small-scale power grid
• Grouping of interconnected loads and distributed energy resources
• Can operate in island mode or grid-connected if desired
• Can connect and disconnect from the grid if desired
• Acts as a single controllable entity to the grid
### UCSD Microgrid Project Summary

**Budget:** $2.4M ($435K UCSD, $2.4M CEC) Leveraged 60M

**Benefits:**
- Provide observability of the operation of the microgrid to the CAISO
- Demonstrate an integrated solution that combines PV and electric energy storage to mitigate the intermittency of renewable generation on a microgrid.

**Goal:** Provide the CAISO the ability to observe its operations since this microgrid affects the surrounding San Diego Gas & Electric grid system.
### SDG&E Borrego Springs Microgrid Project Summary

<table>
<thead>
<tr>
<th>Budget:</th>
<th>$15.2M ($4.1M SDG&amp;E, $7.5M DOE, $2.8M CEC, and $0.8M partners)</th>
</tr>
</thead>
</table>
| Benefits:     | • Reduce the peak load of feeders and enhance system reliability  
               • Accommodate various generation and storage configurations |
| Goal:         | Successfully engage/inform Borrego Springs community           |
Distributed Generation Policy and Program Drivers

- 12,000 MW Governors Goal
- Greenhouse Gas Reduction Targets (AB 32)
- Renewable Portfolio Standard (RPS)
- Net Energy Metering (NEM)
- California Solar Initiative
- New Solar Homes Partnership (NSHP)
- Self Generation Incentive Program (SGIP)
- Renewable Feed-in Tariff Program (FiT) – up to 3 MW
- SB 1122 Bioenergy FiT Program – up to 3 MW
- Renewable Auction Mechanism (RAM) – 3 MW to 20 MW
- Emerging Renewable Program
- Green Tariff Shared Renewables Program
- California ISO Distributed Generation Deliverability
Future development options
Connection vs. Integration

Central control vs. Distributed/Smart control

Capacity

Status quo Future

Today

Central Generation

Transmission networks

Distribution networks

DER

Passive operation

Centralised control

Central Generation

Transmission networks

Distribution networks

DER

Distributed Control

Central Generation

Transmission networks

Distribution Networks
Lorem ipsum dolor sit amet, consetetur sadipscing elitr, sed diam nonumy eirmod tempor invidunt ut labore et dolore magna aliquyam erat, sed diam voluptua. At vero eos et accusam et justo duo dolores et ea rebum.
<table>
<thead>
<tr>
<th>Company Name</th>
<th>Project Title</th>
<th>Type of Technology</th>
<th>Purpose/Application</th>
<th>Rating (MW and MWh)</th>
<th>Projected Ramp Rate</th>
<th>Discharge Time</th>
<th>Status</th>
<th>When Results will be Available</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primus Power Corporation</td>
<td>Wind Firming EnergyFarm (ARRA)</td>
<td>Zn / Halogen Flow Battery</td>
<td>Wind firming</td>
<td>28 MW / 84 MWh</td>
<td>Full power in 5 seconds</td>
<td>3 hrs</td>
<td>Currently lab testing, installation in Summer 2015</td>
<td>Summer 2015</td>
</tr>
<tr>
<td>Pacific Gas and Electric Company</td>
<td>Pacific Gas &amp; Electric Energy Storage Demonstration</td>
<td>Na / S Battery</td>
<td>Grid Support and PV Integration</td>
<td>2 MW / 14 MWh</td>
<td>Full power in 10 seconds</td>
<td>7 hrs</td>
<td>Currently testing</td>
<td>Spring 2015</td>
</tr>
<tr>
<td>Foresight Renewable Solutions, LLC.</td>
<td>Integrated Solar PV, Compressed Air Energy Storage and Microgrid</td>
<td>Compressed Air Technology Project Energy Storage</td>
<td>PV Integration, Peak Shaving, Load Shifting</td>
<td>250-300 kW / 1 MWh</td>
<td>Full power in 30 seconds from idle, 60 seconds from cold start</td>
<td>3-4 hrs</td>
<td>Installation in Summer-Fall 2014</td>
<td>Spring 2015</td>
</tr>
<tr>
<td>EnerVault Corporation</td>
<td>Flow Battery Solution to Smart Grid Renewable Energy Applications (ARRA)</td>
<td>Iron-Chromium Redox Flow Battery</td>
<td>Grid support and Renewable integration</td>
<td>250 kW / 1 MWh</td>
<td>Full power in 5 seconds</td>
<td>4 hrs</td>
<td>Installation completed Spring 2014</td>
<td>Spring 2015</td>
</tr>
<tr>
<td>Transportation Power, Inc.</td>
<td>Grid-Saver Fast Energy Storage Demonstration</td>
<td>Li-ion Battery</td>
<td>Grid support</td>
<td>150 kW / 300 kWh</td>
<td>Full power in &lt; 5 seconds</td>
<td>2 hrs</td>
<td>Building and testing modules</td>
<td>Spring 2015</td>
</tr>
<tr>
<td>Amber Kinetics, Inc</td>
<td>Utility-Scale Flywheel Energy Storage Demonstration (ARRA) Flywheel</td>
<td>Flywheel</td>
<td>Peak shaving</td>
<td>10 kW / 40 kWh</td>
<td>Full Power in &lt; 5 seconds</td>
<td>4 hrs</td>
<td>Fabricating rotors</td>
<td>Spring 2015</td>
</tr>
<tr>
<td>Seeo Inc.</td>
<td>Solid State Batteries for Grid-Scale Energy Storage (ARRA)</td>
<td>Li-ion Battery</td>
<td>Peak shaving and PV integration</td>
<td>5 kW / 10-15 kWh</td>
<td>Full power in &lt; 5 seconds</td>
<td>2 - 3 hrs</td>
<td>Testing completed Spring 2014</td>
<td>Fall 2014</td>
</tr>
</tbody>
</table>
Electrification of the Transportation Sector
Open Discussion

Michael Gravely

Mike.Gravely@energy.ca.gov

(916) 327-1370