What’s Up in Hawaii?

Pacific Northwest Demand Response Project
February 25, 2015
Hawaii Electric Systems
4 electric utilities; 6 separate grids

Kauai Island Utility Cooperative
27 MW PV (24 MW in development)
System Peak: 78 MW
Customers: 32,700

Maui Electric
Maui: 60MW PV / 72MW Wind
System Peak: Maui 200 MW
Lana’i: 1MW PV
System Peak: Lana’i: 5 MW
Moloka’i: 1.2 MW PV
System Peak: Moloka’i: 5.5 MW
Customers: 68,000

Hawaiian Electric
221 MW PV / 100 MW Wind / 69 MW WTE
System Peak: 1,100 MW
Customers: 300,000

Hawaii Electric Light
39 MW PV / 30 MW Wind / 38 MW Geothermal / 16 MW Hydro
System Peak: 190 MW
Customers: 81,000

Source: Hawaii Natural Energy Institute
A Tiny Bit of History

• Oahu: centralized power since 1891
• Other islands originally sugar mill based systems; island-wide after WWII.
• IRP process and EE Funding created 1992
  – Cost Recovery, LRAM, Shareholder Incentive; Gamed by HECO from 1994 to 2006
• Decoupling plus third-party EE in 2011.
1996-1998 Big Island Crisis

- Puna CT failed; 2 years to reconstruct
- Negative reserve margin
- Consumer Advocate engaged me
  - Hotel, water, sewer standby generators
  - Install diesels at wind projects
  - Replace all light bulbs and shower heads
Hawaii Clean Energy Initiative
USDOE / Hawaii MOU 2008

• High oil costs devastating to state economy.
• 35% state solar tax credit.
• 40% RPS by 2030.
• Step up of EE

Energy solutions for a changing world
Cost Drivers In Hawaii

Highest rates and bills in USA

$.35 - $.40/kWh; $200/month

vs: $.125/kWh; $100/month

30% Federal + 35% State Tax Credit
Grid Parity in Hawaii: We’re A Little Past That Point!
Residential Solar PV

• Currently 11% saturation
  – ~20% in Single Family
• IEEE Limits Long Passed
  – 85% of Min Load
  – 100% of Min Daytime Load
  – 120% of Min Daytime Load
• Proposed: 250% of Min Daytime Load
  – With smart inverters
Ramping Issues Becoming Severe
April 30, 2014: Four Orders of the Apocalypse

- Renewable Standards Working Group
- DSM Program Review
- MECO Rate Case - Decoupling
The Commission has not observed an “acceptable course correction” and there is not sufficient evidence, at this time, of progress by the HECO Companies towards developing and implementing a sustainable business model. By contrast, the Commission does note that the state’s other electric utility has clearly articulated a strategic vision and made substantial progress in achieving their goals over the same time period.

- Creating a 21st Century Power System
- Creating Modern T&D Grids
- Policy and Regulatory Reforms
- Focus on Performance Incentive Measures
- Revise rate design to address PV issues
Demand Response Direction

• Can benefit company and customers, by enabling capital avoidance and lower cost
• Develop detailed estimates for 5, 10, 20 yrs
• Evaluate third-party implementation
• Wide range of benefits: peak reduction, load shifting, frequency management, spinning reserves, ramping.
Existing Demand Response Programs

• Residential (RDLC):
  – 32,350 water heaters
  – 3,750 AC units
  – 15 MW

• Commercial
  – Large C&I with Generators
  – Small C&I water heat and AC
  – 13 MW
Existing DR Programs (cont’d)

- Fast DR (Oahu and Maui)
  - 38 / 4 customers
  - 6 MW

<table>
<thead>
<tr>
<th>Program</th>
<th>Participating Load (customer level impact)¹ (MW)</th>
<th>2013 Load Impact Estimate (MW)</th>
<th>2013 number of events and tests</th>
<th>2013 Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>RDLC</td>
<td>14.8²</td>
<td>7.2³⁴</td>
<td>58 events + 19 tests</td>
<td>75 hr 30 min</td>
</tr>
<tr>
<td>CIDLC</td>
<td>12.8</td>
<td>12.3³</td>
<td>3 events + 2 tests</td>
<td>1 hr 13 min</td>
</tr>
<tr>
<td>Fast DR (Hawaiian Electric)</td>
<td>6.1</td>
<td>0.7³</td>
<td>54 tests</td>
<td>33 hr 15 min</td>
</tr>
<tr>
<td>Fast DR (Maui Electric)</td>
<td>0.2</td>
<td>0.15⁵</td>
<td>29 tests</td>
<td>19 hr 30 min</td>
</tr>
</tbody>
</table>
Maui Wind

- 200 MW peak demand
- Night load ~80 MW
- 72 MW wind
- Minimum thermal load
- Spilling ~15%

DR Report:
6,200 water heaters
## What Needs Can DR Provide?

<table>
<thead>
<tr>
<th>Grid Service Requirements</th>
<th>Response Speed* (Mainland)</th>
<th>Response Speed** (Hawaii)</th>
<th>Response Duration</th>
<th>Potential for DR?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capacity</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Used to meet demand plus reserve margin; supplied by on-line and off-line resources, including interruptible load</td>
<td>Minutes</td>
<td>scheduled in advance by system operator</td>
<td>If called, must be available for at least 3 hours</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Ancillary Services</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contingency Reserve**</td>
<td>Seconds to &lt;10 min</td>
<td>Within 7 cycles of contingency event</td>
<td>Up to 2 hours</td>
<td>✓</td>
</tr>
<tr>
<td>Reserves to replace the sudden loss of the single largest on-line generator; supplied from online generation, storage or DR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Regulating Reserve</td>
<td>&lt;1 min</td>
<td>2 seconds, controllable within a resolution of 0.1 MW</td>
<td>Up to 30 min</td>
<td>✓</td>
</tr>
<tr>
<td>Maintain system frequency; supplied from on-line capacity that is not loaded</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Spinning Reserve</td>
<td>10-30 min</td>
<td>&lt;30 min</td>
<td>2 hours</td>
<td>✓</td>
</tr>
<tr>
<td>Used to restore regulating reserves and contingency reserves; supplied by off-line fast start resources or DR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-AGC Ramping</td>
<td>N/A</td>
<td>&lt;2 min</td>
<td>Up to 2 hours</td>
<td>✓</td>
</tr>
<tr>
<td>Resources that can be available prior to quick start generation and can add to system ramping capability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black Start Capability</td>
<td>N/A</td>
<td>&lt;10 min</td>
<td>Duration of system restoration time</td>
<td>❌</td>
</tr>
<tr>
<td>The ability of a generating unit to start without system support</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inertial Response</td>
<td>N/A</td>
<td>2-3 seconds</td>
<td>2-3 seconds</td>
<td>❌</td>
</tr>
<tr>
<td>Local (i.e. at a generator) response to a change in frequency, supplied by rotational mass of generators, or power electronics of inverter-based resources</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Accelerated Energy Delivery***</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>✓</td>
</tr>
<tr>
<td>Shifting the demand for energy from high demand evening peak periods to lower demand midday periods, or higher demand morning periods to lower demand overnight periods</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
# What Services From Which Programs

<table>
<thead>
<tr>
<th>Grid Service Requirements</th>
<th>Current Demand Response Programs</th>
<th>RDLC</th>
<th>CIDLC</th>
<th>Fast DR (Hawaiian Electric)</th>
<th>Fast DR (Maui Electric)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capacity</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Regulating Reserve</td>
<td></td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Contingency Reserve*</td>
<td></td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Non-Spinning Reserve</td>
<td></td>
<td>✓</td>
<td>×</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Non-AGC Ramping</td>
<td></td>
<td>✓</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
<tr>
<td>Accelerated Energy Delivery</td>
<td></td>
<td>×</td>
<td>×</td>
<td></td>
<td>×</td>
</tr>
</tbody>
</table>

* Under-frequency response provided by RDLC and CIDLC can provide system protection but is not fast enough to be substituted for spinning reserves under the Companies’ contingency reserve requirement.
# Alternative Communication Networks

<table>
<thead>
<tr>
<th>Function</th>
<th>Paging</th>
<th>AMI</th>
<th>Gateway</th>
<th>Cellular</th>
<th>Wi-Fi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effective Throughput Speed</td>
<td>High*</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Network Availability</td>
<td>Always on</td>
<td>Always on</td>
<td>Dependent on customer</td>
<td>Always on</td>
<td>Dependent on customer</td>
</tr>
<tr>
<td>Endpoint Online Status</td>
<td>None</td>
<td>Post-event analysis</td>
<td>15 minutes</td>
<td>15 minutes</td>
<td>Immediate</td>
</tr>
<tr>
<td>Load Control</td>
<td>Immediate</td>
<td>Scheduled</td>
<td>Immediate or scheduled</td>
<td>Immediate or scheduled</td>
<td>Immediate or scheduled</td>
</tr>
<tr>
<td>Acknowledgement</td>
<td>None</td>
<td>Next meter read</td>
<td>15 minutes</td>
<td>Immediate</td>
<td>Immediate</td>
</tr>
<tr>
<td>Commissioning</td>
<td>Simple</td>
<td>Complex</td>
<td>Complex</td>
<td>Plug and play</td>
<td>Low</td>
</tr>
<tr>
<td>Consumption Display</td>
<td>None</td>
<td>Local real-time</td>
<td>From meter read</td>
<td>From meter read</td>
<td>From meter read</td>
</tr>
<tr>
<td>Remote Device Telemetry</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Remote Device Configuration</td>
<td>Some</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>
# Proposed Future Programs

<table>
<thead>
<tr>
<th>Program</th>
<th>Grid Service Requirement</th>
<th>Resource</th>
</tr>
</thead>
<tbody>
<tr>
<td>RBDLC</td>
<td>Capacity</td>
<td>Water Heaters, central A/C</td>
</tr>
<tr>
<td></td>
<td>Non-AGC Ramping</td>
<td>Water Heaters, central A/C</td>
</tr>
<tr>
<td></td>
<td>Non Spinning Reserve</td>
<td>Water Heaters, central A/C</td>
</tr>
<tr>
<td>R&amp;B Flexible</td>
<td>Regulating Reserve</td>
<td>GIWH, central A/C</td>
</tr>
<tr>
<td></td>
<td>Accelerated Energy Delivery</td>
<td>GIWH</td>
</tr>
<tr>
<td>CIDLC</td>
<td>Capacity</td>
<td>C&amp;I Curtailable</td>
</tr>
<tr>
<td>C&amp;I Flexible</td>
<td>Regulating Reserve</td>
<td>Central A/C, Ventilation, Refrigeration</td>
</tr>
<tr>
<td></td>
<td>Non-AGC Ramping</td>
<td>Central A/C, Ventilation, Refrigeration, Lighting</td>
</tr>
<tr>
<td>Water Pumping</td>
<td>Regulating Reserve</td>
<td>Pumps</td>
</tr>
<tr>
<td></td>
<td>Non-AGC Ramping</td>
<td>Pumps</td>
</tr>
<tr>
<td>Customer Firm Generation</td>
<td>Capacity</td>
<td>Generators</td>
</tr>
<tr>
<td>Dynamic and Critical Peak Pricing</td>
<td>Capacity</td>
<td>Unspecified Customer Load</td>
</tr>
<tr>
<td></td>
<td>Accelerated Energy Delivery</td>
<td>Unspecified Customer Load</td>
</tr>
</tbody>
</table>
Pilot Programs

• Grid Integrated Water Heating
  – Two technologies deployed
• EV Charging TOU Pilot
Power Supply Improvement Plan

Retire Old Steam

Build Marine Diesels
Some Things NOT Happening

- Full deployment of GIWH
- Water Pumping Controls: Not accepted by water agencies.
- Deployment of Air Conditioning thermal storage
- TOU pricing
Potential for GIWH

- ~150,000 electric water heaters; 70% in multi-family
- ~600 MW of potentially dispatchable load (40%)
- ~75 MW of potential peak load reduction (6%)
- Incremental cost < $100/kW if integrated at manufacturing.
It’s Easy To Spot a Water Heater
Water Pumping Uses
~5% of Hawaii kWh

$0.20/kWh when power is “cheap”
$0.50/kWh when power is “expensive”
AC Storage

Simple technology; great peak relief.
No programs to deploy

Energy solutions
for a changing world
Current Rate Design Options

- **No AMI;** all require special metering
- **Rider I:** Interruptible 4 custs; 3 MW
- **Rider M:** 2 Hours Curtailable >10 MW
- **Rider T:** 2-Period TOU Rate
  - +3 cents on-peak; -2 cents off peak
- **Schedule U:** 3-Period TOU Rate
  - 5 – 9 PM Priority Peak

- **EV Charging TOU Pilot**
Residential Rate Design

<table>
<thead>
<tr>
<th>Current HECO Residential Rate</th>
<th>Principles-based Residential Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer Charge</td>
<td>Customer Charge</td>
</tr>
<tr>
<td>$9.00/month</td>
<td>$9.00/month</td>
</tr>
<tr>
<td>First 350 kWh</td>
<td>Off-Peak</td>
</tr>
<tr>
<td>$0.34</td>
<td>$0.10</td>
</tr>
<tr>
<td>Next 850 kWh</td>
<td>On-Peak</td>
</tr>
<tr>
<td>$0.35</td>
<td>$0.30</td>
</tr>
<tr>
<td>Over 1,200 kWh</td>
<td>Power</td>
</tr>
<tr>
<td>$0.37</td>
<td>$0.05</td>
</tr>
</tbody>
</table>

ONLY the “Power” rate credited for power fed to the grid.
Large Commercial Rate Design

Current:

Customer: $60/mo
Demand: $11.69/kW
Energy: $.216/kWh

Alternative

Customer: $60/mo
Demand:
  NCP: $2.00/kW
  4 – 8 PM: $9.00/kW
Energy:
  Off-Peak: $.12/kWh
  On-Peak: $.25/kWh
  Critical: $.75/kWh
Current Chaos

• Dockets Underway:
  – Decoupling
  – Renewable Interconnection / Net Metering
  – HECO Rate Case
• New Chairman
• Acquisition of HEI by NextEra
• Longstanding tension between energy future scenarios
Big Wind and Solar

NextEra Merger

Biofuels

Decentralized
Will Hawaii Ride The Wave of Change?

Or Wipe-Out?

Energy solutions for a changing world
About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

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