Residential Thermostat and Water Heater Field Test

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About SkyCentrics

- Leader in open standards IoT communication: CTA-2045, OADR, Volttron
- Certified OADR 2.0b cloud VEN to AO Smith water heaters and Ecobee tstats
- Pentair pool pumps and controllers coming under our OADR cloud next month
- Large appliance ecosystem for CTA-2045
  - AO Smith – Water Heaters
  - Pentair – Pool Pumps and controllers
  - Mitsubishi – Mini-Splits
  - Siemens – EVSE
  - Emerson thermostats
- SkySnap IoT sensor & control gateway with OADR & Volttron
Project RAIN: Resource Aggregation and Integration Network
Tucson Electric Power - EPRI – AO Smith - Ecobee

- Examine and evaluate technologies for coordinating distributed energy resources (DER) using a mix of OADR, CTA-2045, and Modbus

- Role of DERMS
  - Translate commands among languages used by DER
  - Aggregate DER into smaller units to meet grid operator needs
  - Simplify instruction set to most meaningful for system operations
  - Optimize command distribution for fairness and efficiency
Architecture Overview 2
This is a single-screen interface that allows TEP/EPRI to monitor devices of different types and manage their resource IDs that are used to target individual assets from the VTN via OpenADR.
# Mapping of OADR levels 0-3 to CTA-2045

<table>
<thead>
<tr>
<th>DEVICE</th>
<th>‘LOAD-UP’ (‘0’)</th>
<th>‘SHED’ (‘1’)</th>
<th>‘CRITICAL SHED’ (‘2’)</th>
<th>‘GRID EMERGENCY’ (‘3’)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WATER HEATER</td>
<td>Heat water to max temp.</td>
<td>Avoid heating, maintain lower water temp</td>
<td>Avoid heating, maintain minimum water temp</td>
<td>Turn off WH for length of event</td>
</tr>
<tr>
<td>HVAC</td>
<td>Lower setpoint 6°F (Load-up)†</td>
<td>Relax setpoint 3°F</td>
<td>Relax setpoint 6°F</td>
<td>Turn off HVAC for length of event</td>
</tr>
<tr>
<td>EV CHARGER</td>
<td>Charge normally</td>
<td>Limit charge rate to 60%</td>
<td>Limit charge rate to 30%</td>
<td>Stop charging (0%)</td>
</tr>
<tr>
<td>PV</td>
<td>Curtail PV to 0 kW, 60% VAR absorption‡</td>
<td>100% kW, 30% VAR injection‡</td>
<td>100% kW, 60% VAR injection‡</td>
<td>100% kW, 100% VAR injection‡</td>
</tr>
<tr>
<td>BATTERY</td>
<td>Charge at 60% rated power</td>
<td>Discharge at 30% rated power</td>
<td>Discharge at 60% rated power</td>
<td>Discharge at 100% rated power</td>
</tr>
</tbody>
</table>

† Assumes a cooling mode; in the event of cooler ambient temperatures, setpoint would be raised
‡ Percentages are of max reactive power capability (typically 50% of kVA rating)

* Tuckson Electric Power Project RAIN – October 2018 Update
Principal Conclusions: Phase 1

- DERMS & DER integration are not ‘Plug & Play’
- DERMS targeted on single resource
- Systems focus on sending commands – optimization ‘primitive’

Next Stage of Field Testing
- Controller functionality
- Device capabilities
- Multi-technology/device grouping and basic optimization
Adding ‘default behavior’ to DERMS*

<table>
<thead>
<tr>
<th>Default Behavior</th>
<th>Load Up</th>
<th>Load Shed</th>
</tr>
</thead>
<tbody>
<tr>
<td>PV</td>
<td>Power limit</td>
<td>MPPT</td>
</tr>
<tr>
<td>Batteries</td>
<td>Charge</td>
<td>Discharge</td>
</tr>
<tr>
<td>EV Chargers</td>
<td>Unrestricted charging</td>
<td>Limit charge rate</td>
</tr>
<tr>
<td>HVAC</td>
<td>Pre-heat/pre-cool</td>
<td>Setpoint offset</td>
</tr>
<tr>
<td>Water Heater</td>
<td>Increase water temp</td>
<td>Avoid heating</td>
</tr>
</tbody>
</table>

* Tuckson Electric Power Project RAIN – February 2019 Update
Principal Conclusions: Phase 2

- Consistent communication with customer devices is possible
- PV and battery systems behaving as expected
- Customer behavior will play a significant role
- DERMS logic different between types of load, especially in ‘default’ mode
- Open standards help but DER and management systems are not ‘Plug & Play’
- Batteries difficult without reliable control and State of Charge (SOC) data
The value of grid connected water heaters: Lots of storage and no negative impacts to customers

Flexible, reliable Demand Response
Open Standards: OADR & CTA-2045 play well together

- Designed for grid control
- Avoids vendor lock-in and stranded assets
- Customer choice of devices
- Consistent integration and management experience
- Easy investment decision for OEM
- Additional up-front cost balanced by flexibility for lower lifetime cost
- Adoption & Regulation: AHRI 1380, Energy Star, CA Title 24 JA13, WA SB 1551
CTA-2045 – Open Standard for Smart Grid

- Open Standard: single connector, multiple appliances
- Factory installed or retrofit kit
- Built for customer control
- Built for utility demand response
- Swappable Plug & Play hardware
- Flexible communications
- Ecosystem of category leading brands
- Adopted by major utilities
Questions and Contact Information

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