CASE Update: Programmable Communicating Thermostats (PCT’s)

PIER Buildings Program
SCE Codes & Standards Program
CEC 2008 Title 24 Workshop
October 24, 2005
Programmable Communicating Thermostats (PCT’s)

- **Programmable**
  - Existing programmable schedules
  - New feature – set-up based on outside signal,
    - Mandatory emergency signal or voluntary price signal

- **Communicating**
  - One-way – receive load shed or price signal
  - Two-way – verify signal received, on/off status, temperature

- **Thermostat – limit placed on discomfort**
  - Control based on temperature (closed loop)
  - Not duty cycling (open loop)
PCT’s – Minimum Capabilities

- Thermostat receives load shed signal and increases setpoint 4°F
- Temporary reduction in AC consumption
  - Most reduction first hour, less following hours
- Can be controlled by location
  - Useful for local capacity shortage
- Indicates status – normal vs load shed
- Emergency response vs Price Response
  - Emergency – no override of set-up
  - Price Response – voluntary set-up to save $
Communication infrastructure

- **Dispatch**
  - send emergency or real time price signal

- **Communication mode**
  - radio frequency, satellite, paging, powerline carrier, broadband over powerline, one-way vs two-way communication

- **Metering & Verification**
  - critical peak pricing, data processing, signal verification
PCT’s additional capabilities

- **Two way communication**
  - Verify receipt of signal
  - Verify system status, temperature etc.
- **Display of cost information savings etc.**
- **Internet accessible**
  - Change settings remotely, more market price information
- **Gateway to other devices**
Demand Savings in CA PCT Pilots

- **SDG&E (CTZ 10) residential**
  - 0.44 kW/home (low relative to other studies)
  - 0.11/ton (55% realization rate)
  - 10% malfunction, 17% A/C not on,
  - 9% to 42% overridden

- **SCE nonresidential**
  - 0.8 kW/thermostat (125% realization rate)
  - 0.27 kW/ton
    - 1st hour 0.33 kW/ton, 2nd hour 0.21 kW/ton
  - 8% non-participation, 7% no signal
Environmental impact

- Reduced energy consumption at peak
- Increased consumption immediately after peak
- Increased consumption before peak for pre-cooling if warning signal given
- Time Varying Emissions Factors used to calculate net emissions impacts
  - Related to resource mix at different times
Non-energy impacts

- **Comfort impact**
  - Work output, people leaving work early
  - Less retail sales

- **Productivity impact**

- **Reliability impacts**
  - Calculated only for systems that are not participating in voluntary curtailment
PCT Program Features

- **Voluntary Program**
  - 4 degree setup (for this example)
  - User has option of overriding set-up
  - Dispatch 2pm to 6pm, 20 days per year

- **Emergency Program**
  - Mandatory curtailment / no override
  - Only used to prevent rotating blackouts
  - Dispatch, on average 2.4 hours per year
Example Dispatch on Top Day

- Load Impact and TDV on Top Day (Fri, Aug 23)

![Graph showing load impact and TDV on Top Day](image)

- Period of control

- Res Impact (kW/ton) - CZ:15 PV $/kWh
## Results for 20 Day Program

<table>
<thead>
<tr>
<th>Ranking</th>
<th>Lifecycle $/ton-day</th>
<th>Day</th>
<th>Date</th>
<th>Days</th>
<th>Cumulative Value ($/ton)</th>
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<tbody>
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<td>$4.33</td>
<td>228</td>
<td>Fri, Aug 16</td>
<td>20</td>
<td>$142.23</td>
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</table>
Residential Climate Zone 15 Voluntary Program Impact

Voluntary Impact

<table>
<thead>
<tr>
<th>Percentage of AC that is on</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage that receive and can act upon the signal</td>
<td>97%</td>
</tr>
<tr>
<td>Percentage that do not override</td>
<td>80%</td>
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<tr>
<td>Overall fraction of technical potential</td>
<td>70%</td>
</tr>
<tr>
<td>Percentage w/ PCT participating in program</td>
<td>50%</td>
</tr>
<tr>
<td>Overall fraction of potential including participation</td>
<td>35%</td>
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</tbody>
</table>

Avoided Cost Value

- Avoided Cost Value (PV$/ton) $142.23
- AC tons per thermostat 5.8
- Value per thermostat (PV$/tstat) $288.07

Comfort and productivity loss

- Comfort loss as a percentage of avoided cost 50%
- Comfort loss ($PV/tstat) $(144.04)
# Residential Climate Zone 15

## Emergency Impact

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
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<tbody>
<tr>
<td>Class Weighted Average VOS ($/kWh)</td>
<td>$42.02</td>
</tr>
<tr>
<td>Comfort and Productivity Loss ($/kWh)</td>
<td>$2.50</td>
</tr>
<tr>
<td>Net Gain of reduced outages costs ($/kWh)</td>
<td>$39.52</td>
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<tr>
<td>Expected Outage Hours (hours per year)</td>
<td>2.4</td>
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<tr>
<td>Reduced Outage Cost $/kW-yr</td>
<td>$94.86</td>
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<tr>
<td>Present Value Factor</td>
<td>19.60</td>
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<tr>
<td>Real Discount Rate</td>
<td>3%</td>
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<tr>
<td>Number of Years</td>
<td>30</td>
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<tr>
<td>Reduced Outage Cost ($PV/kW)</td>
<td>$1,859.29</td>
</tr>
<tr>
<td>Percentage of air conditioners that are on</td>
<td>50%</td>
</tr>
<tr>
<td>Percentage that receive and can act upon the signal</td>
<td>97%</td>
</tr>
<tr>
<td>Percentage participating in program</td>
<td>100%</td>
</tr>
<tr>
<td>Percentage that overrode non-emergency signal</td>
<td>20%</td>
</tr>
<tr>
<td>Overall fraction of potential including participation</td>
<td>10%</td>
</tr>
<tr>
<td>Average reduction per t-stat (kW/t-stat)</td>
<td>0.08</td>
</tr>
<tr>
<td>Reduced Outage Cost ($/t-stat)</td>
<td>$155.75</td>
</tr>
</tbody>
</table>
Results per Thermostat

- Climate Zone 15 Example Residential Results

  Non-emergency Impact $144.04
  Emergency Impact $155.75
  Total $299.78

- These are interim values to be verified
- PCT CASE report is still process
# PCT estimated installed costs

**E-Source survey**

<table>
<thead>
<tr>
<th>Annual Volume</th>
<th>1 way PCT’s</th>
<th>2 way PCT’s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retail</td>
<td>Wholesale</td>
<td>Retail</td>
</tr>
<tr>
<td>50,000</td>
<td>$195 to $300</td>
<td>$175 to $260</td>
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<tr>
<td>100,000</td>
<td>$180 to $270</td>
<td>$160 to $235</td>
</tr>
<tr>
<td>250,000</td>
<td>$160 to $225</td>
<td>$145 to $200</td>
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</table>
Incremental cost conclusions

- Incremental cost for one-way communicating PCTs < $150
- Incremental costs for two-way communicating PCT’s > $250
- Additional infrastructure cost for two-way communications
- 2-way: verify customer received signal
Code Proposal

- Standards - Mandatory requirement
- Nonresidential - Section 122(c) Shut-off, Reset and Demand Response Controls for Space-conditioning Systems
- Residential - Section 150(i) Setback and Demand Responsive Thermostats
Control Capabilities

- be capable and installed to set up the cooling setpoint by 4°F and …
- if controlling a heat pump be capable and installed to turn off supplementary resistance heating …
- during emergency or voluntary demand response period
- Not capable of being overridden during emergency demand response period
- Exceptions: zones that must have constant temperatures for patient health or to prevent degradation of: materials, a process, or plants or animals
Other considerations

- Who creates PCT specification?
  - Each utility
  - Statewide specification in Title 24 (§112)

- Should cost of communications infrastructure be included?

- Demand response required for ECMS systems?
For more information

- Minutes and presentations of PCT stakeholder meetings
- Coming soon…
  - PCT cost-savings spreadsheet after validation
  - Revised TDV files including DR valuation
  - Preliminary draft PCT CASE report
Acknowledgements

- CEC PIER Buildings Program
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