CASE Update: Programmable Communicating Thermostats (PCT's)

PIER Buildings Program
SCE Codes & Standards Program
CEC 2008 Title 24 Workshop
October 24, 2005

pier
PUBLIC INTEREST ENERGY RESEARCH
"Research Powers the Future"

SOUTHERN CALIFORNIA EDISON
An EDISON INTERNATIONAL™ Company

Codes & Standards Enhancement Project

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 0.21kW/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

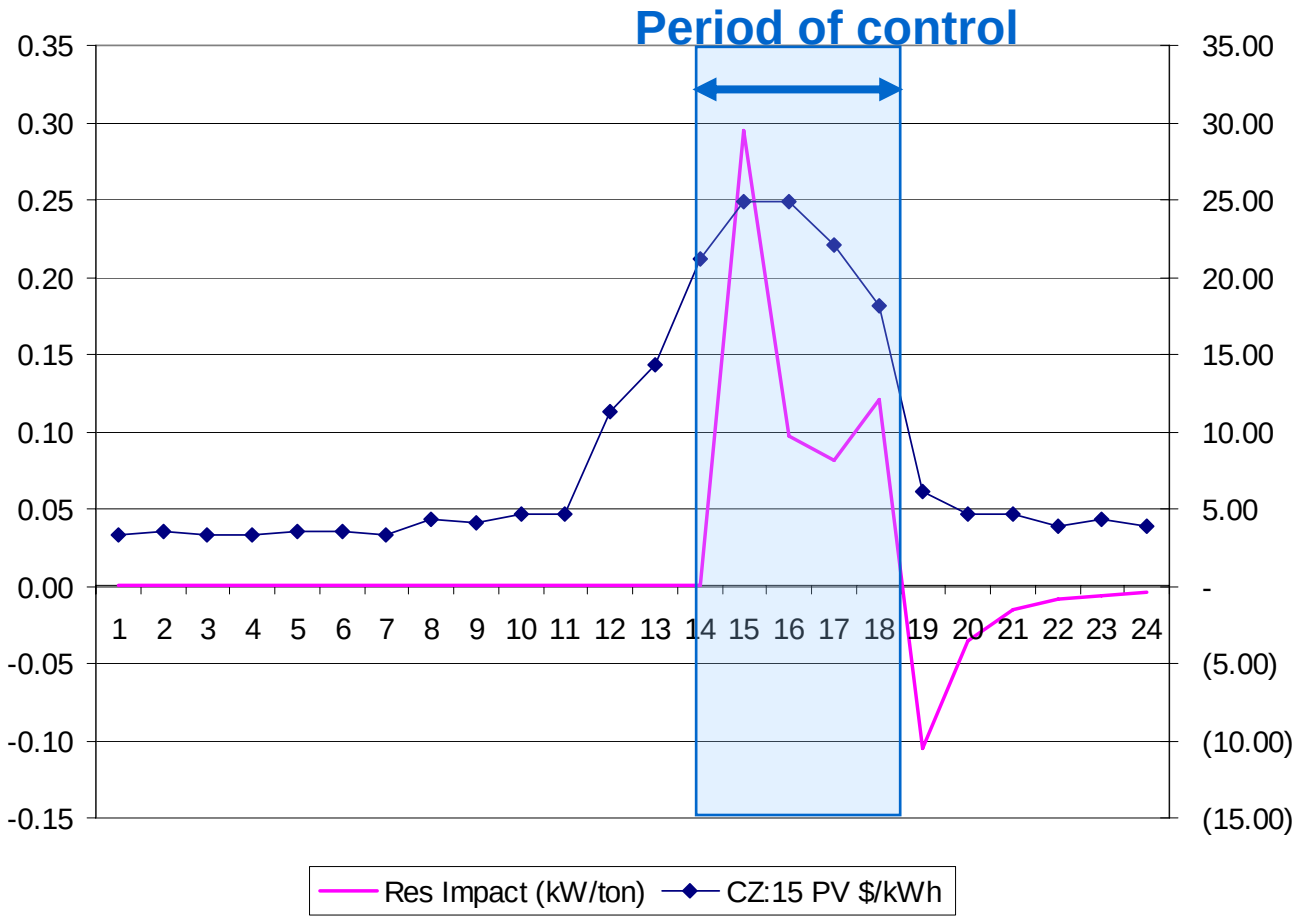
- Comfort impact
- Productivity impact
  - Work output, people leaving work early
  - Less retail sales
- Reliability impacts
  - Calculated only for systems that are not participating in voluntary curtailment

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, Aug23)



Results for 20 Day Program

Ranking	Lifecycle $/ton-day	Day	Date	Days	Cumulative Value ($/ton)
1	$ 12.84	235	Fri, Aug 23	1	$ 12.84
2	$ 11.69	196	Mon, Jul 15	2	$ 24.54
3	$ 10.32	197	Tue, Jul 16	3	$ 34.86
4	$ 9.34	234	Thu, Aug 22	4	$ 44.20
5	$ 9.21	198	Wed, Jul 17	5	$ 53.40
6	$ 8.08	184	Wed, Jul 03	6	$ 61.49
7	$ 7.98	240	Wed, Aug 28	7	$ 69.46
8	$ 7.71	239	Tue, Aug 27	8	$ 77.17
9	$ 7.62	178	Thu, Jun 27	9	$ 84.79
10	$ 7.48	218	Tue, Aug 06	10	$ 92.27
11	$ 6.94	183	Tue, Jul 02	11	$ 99.21
12	$ 5.93	238	Mon, Aug 26	12	$ 105.14
13	$ 5.02	219	Wed, Aug 07	13	$ 110.16
14	$ 4.92	269	Thu, Sep 26	14	$ 115.08
15	$ 4.80	182	Mon, Jul 01	15	$ 119.88
16	$ 4.60	190	Tue, Jul 09	16	$ 124.48
17	$ 4.58	252	Mon, Sep 09	17	$ 129.05
18	$ 4.48	179	Fri, Jun 28	18	$ 133.54
19	$ 4.37	211	Tue, Jul 30	19	$ 137.90
20	$ 4.33	228	Fri, Aug 16	20	$ 142.23

Residential Climate Zone 15 Voluntary Program Impact

Voluntary Impact			
Percentage of AC that is on	90%		
Percentage that receive and can act upon the signal	97%		
Percentage that do not override	80%		
Overall fraction of technical potential	**70%**		
Percentage w/ PCT participating in program	50%		
Overall fraction of potential including participation	**35%**		
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

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

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

	1 way PCT's		2 way PCT's	
Annual Volume	Retail	Wholesale	Retail	Wholesale
50,000	$195 to $300	$175 to $260	$240 to $725	$230 to $615
100,000	$180 to $270	$160 to $235	$240 to $695	$227 to $590
250,000	$160 to $225	$145 to $200	$230 to $650	$216 to $555

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

- http://www.title24dr.com/
- 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
  - Nancy Jenkins
- SCE Codes & Standards Program
  - Carlos Haiad
- E3 Energy and Environmental Economics
  - Snuller Price & Brian Horii
- HMG Heschong Mahone Group
  - Douglas Mahone, Jon McHugh, Matt Tyler & Mudit Saxena
- E-Source/Platts
  - Rachael Reiss