Who Will Control Your Customers' Thermostats and What are the Implications for Your Rates?

Selected Results from a Smart Grid Research Consortium (SGRC) Study of Programmable Communicating Thermostat Programs

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Summary

Coops and public utilities can potentially reap large savings with new programmable communicating thermostat (PCT) programs -- while ignoring PCT opportunities exposes customer relationships to third-party providers whose initiatives may result in increased customer rates.

It's time to reevaluate residential programmable communicating thermostat (PCT) programs, even if a program is already in place. Big changes have taken place recently in PCT technologies and programs. Compared to several years ago:

- PCT costs have dropped dramatically with PCTs that provide basic control functionality available for less than $100
- PCT functionality has increased including capabilities such as HVAC maintenance diagnostics, and voice recognition,
- Control strategies have become more sophisticated and can provide individual dwelling unit strategies, address "bounce-back" impacts and address other program issues, and
- Many PCTs do not require an AMI infrastructure.

Nearly all utilities can develop PCT programs that provide utility and customer value and many utilities and their customers can potentially reap large savings with these technologies.

These PCT advances also define a huge mass market potential for third-party PCT program providers as evidenced by the growing number of companies in this space.

While utility/third-party PCT provider relationships can provide net benefits to a utility and its customers as described later in this paper, utilities face a risk that independent third-party relationships with utility customers will increase customer rates. Impacts differ by utility depending on power cost characteristics, customer rate structures and customer characteristics; however, customer rates will increase if participating customer bill savings are greater than utility avoided power costs. In this case, participating customers will see bill reductions and third-party providers will share in savings while overall rates will increase to cover revenue short-falls.

On the other hand, third-party providers of PCT services working with utilities can potentially provide more value for participating customers and the utility than can be provided by the utility's own program

– and still make a profit. The costs and benefits of in-house versus utility/third-party partnerships depends on a variety of factors discussed in a later section.

The remainder of this paper includes a brief overview of newer PCT technologies and control strategies along with an evaluation of several of the factors that impact utility PCT program potential using the Consortium's Smart Grid Investment Model. PCT business case analysis, utility-provided versus utility/third-party PCT program considerations, and a conclusion section complete the paper.

New Generation PCT Technologies/Programs

Newer Technologies. Programmable Communicating Thermostats (PCTs) with quoted costs of as much as $750/unit several years ago (one potential vendor quote was $1,000) are now available for less than $100. In addition to reduced costs, accompanying software can read, record and develop optimal strategies that maximize peak period impacts recognizing heat gains/losses, peak period times and "bounce-back" impacts that occur after the peak load event. In addition, these technologies can operate outside AMI systems with direct cellular communications or internet access.

Providing customers control over the most volatile part of their electric bill along with incentive payments can significantly improve customer satisfaction. In addition to providing customers with utility-provided incentives to reduce power during peak events, control strategies offer customers off-peak savings through better control of HVAC functions including savings in natural gas space heating.

While utility avoided costs (demand charges or excess power sales on the wholesale market for self-generators) are still primary drivers of the utility business case, even utilities with some of the lowest avoided costs are likely to find newer PCT programs attractive depending on utility and customer characteristics.

Newer PCT technology includes internet and/or wireless communication. A basic, low-end PCT, The "Homewerks Radio Thermostat CT-30-H-K2 Wireless Thermostat with Wi-Fi Module," provides Wi-Fi access for an Amazon price of $115. Several other low-end PCTs retail for less than $100.

Additional features are available in more expensive models including extended programing, diagnostic maintenance and voice recognition functions. Honeywell recently introduced the " RTH9590WF1003/U Wi-Fi Smart Thermostat with Voice Control" that, according to its advertisement recognizes commands such as "make it four degrees warmer" or "make it much cooler." The current Amazon retail price for this technology is $349. While more expensive, the voice recognition feature on this unit may finally break through the "customer interface" barrier that limits program participation, especially among certain utility customer segments.

Of course, utility bulk pricing is lower than the Amazon quotes so, even with installation costs a utility program can expect to see per unit costs south of $250 for even more advanced hardware.

Newer Strategies. Earth Networks(SM) uses the Homewerks Radio Thermostat mentioned above (along with several other PCTs) with hourly weather data from 10,000 stations, smart meter electricity data and thermodynamic models to determine air conditioning and space heating weather sensitive relationships for each individual customer. Through a combination of pre-cooling, pre-heating and thermostat changes peak period loads are reduced. A Houston area demonstration conducted for Centerpoint Energy achieved 1.2 kW savings during peak hour events. For 24 percent of the more than 1000 dwelling units, precooling was sufficient to require no air conditioning at all during the peak hour. For these customers, dwelling unit savings ranged from 2.0 kW to 6.33 kW and resulted in no more than a 2 degree Fahrenheit internal temperature increase. Average kW savings in more efficient homes were 52 percent greater than those of less efficient homes. Earth Networks' strategy is to limit internal temperature increases to no more than several degrees and to use its algorithms and household preferences to reduce energy bills beyond peak periods. Earth Networks provides free service to households and charges utilities for the demand response impacts. (see http://www.earthnetworks.com/MediaCenter/PressRelease/tabid/118/newsid513/486/Default.aspx).

One can imagine even more sophisticated monitoring and control algorithms that can reduce peak demand beyond what Earth Networks achieves. For example, monitoring dwelling unit energy use in high load periods can provide evidence of when the dwelling unit is unoccupied and adjust thermostat setting accordingly, saving the utility customer money (especially if it is on time of use rates) and reducing peak period system loads.

EcoFactor is another firm that applies heat-load relationships on an individual customer basis with similarly encouraging results from its pilot program with NV Energy. EnergyHub is included in a growing number of firms participating in this market space.

Other benefits. In addition to reducing peak period utility costs and customer electricity bills, these more sophisticated PCT technologies and programs provide significant customer value to a number of utility customer segments through greater control of their air conditioning and heating energy use, reductions in generation emissions and so on. The ability of newer control strategies that focus on reducing total electricity use along with the ability to reduce natural gas and other non-electric fuels can provide customers with significant savings. Iphone and IPad apps enhance customer control and feedback while building stronger customer-utility relationships.

Evaluating the PCT Business Case

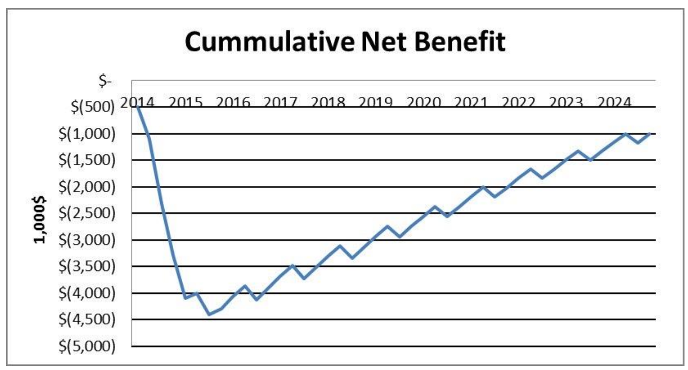
Every utility presents a unique business case depending on the distribution of dwelling unit sizes, types, and ages, end-use loads, customer income and demographics, peak period power costs, length of peak period events, customer participation, incentive programs, current metering and communications systems, power cost characteristics, and other factors.

The quantitative analysis in this section applies the Consortium's Smart Grid Investment Model (SGIM) to a representative utility to explore the impacts of some of these variables in the business case evaluation. The utility reflects residential load shapes consistent with a moderately hot and humid climate. The utility has 50,000 residential customers with an average customer peak of 5.4 kW. Seventy-five percent of residential customers have central air conditioning amenable to PCT control. The utility purchases its power and faces a peak demand charge of $8.00/kW with a ratchet that applies the previous year's average 4-month summer peak to each month of the current year.

The PCT program is paired with a critical peak pricing program (CPP) that pays $1.00 for each kW saved. With an average of 64 peak events in the four months, the average participating customer earns annual CPP payments of about $100 for the average air conditioner reduction of 1.4 kW. Program participation is assumed to be 20 percent, which reflects a reasonable estimate based on existing programs. First-year overhead costs (excluding customer incentive payments) are specified as $135,000 including program development, recruitment costs, software and other IT costs.

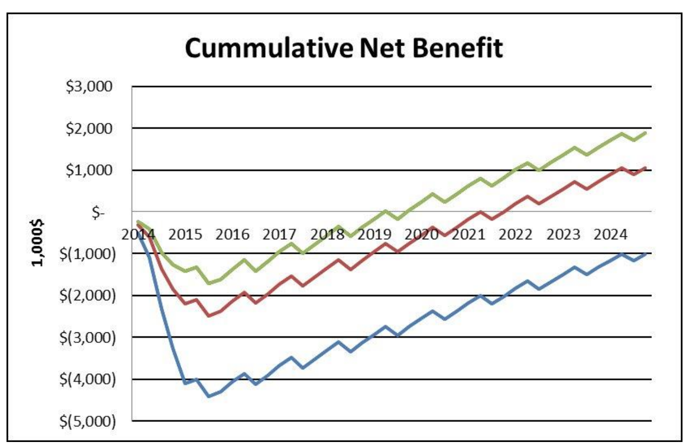
This analysis considers only impacts on peak period power costs; however, full business case analysis would include impacts on energy use and avoided costs in off-peak hours.

Older PCT Costs. Using a PCT cost estimate of $500/unit (including $50 for installation) provided to SGRC by a vendor several years ago provides a program that does not break even in 10 years as shown below in the cumulative net benefit chart.



The cumulative net benefit chart shows the discounted total of all benefits minus the discounted costs for each quarter through 2024 reflecting a ten-year program lifetime after the first year ramp up in 2014. The point where the curve crosses the X-axis is the breakeven-quarter and the vertical distance from the X-axis to the right end-point of each line is the total discounted financial benefit net of costs. In this case the breakeven period is beyond 10 years and there is a negative net value at the end of the 10 year evaluation period.

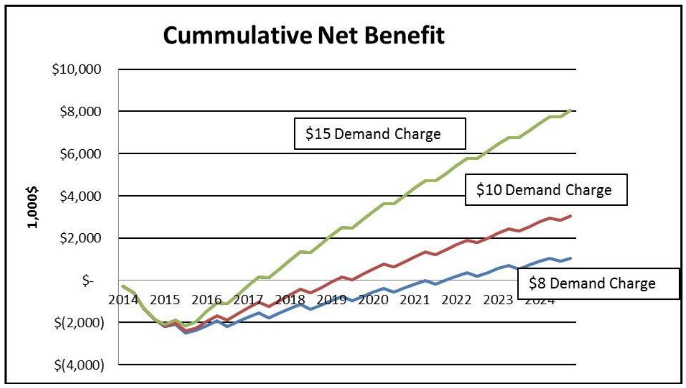
Current PCT Costs. Reduced costs associated with newer PCTs dramatically change the business case. The chart on the right and table below show results for the old $500 unit and for newer $250 and $150 units ($50 installation is included in each).



Even at $250 per unit, PCT programs pay for this particular utility providing $1 million in net benefits over the ten year analysis period. At the current low-end market cost of $150 ($100 PCT and $50 installation), net present value increases to almost $2 million with a 22.7 internal rate of return and a simple payback of 5 years.

	PCT Cost	
	$250.00	**$150.00**
Net Present Value (NPV, 1,000$)	1,041	1,855
Internal Rate of Return (IRR)	12.6%	22.7%
Undiscounted Breakeven Period	6.5	5
Discounted Breakeven Period	7.75	5.5

Of course, every utility is different and program results differ as a result. The hypothetical utility faces relatively low $8/kW peak demand charges. The following chart and table show business case evaluations for two additional peak demand rates using a $250 per unit PCT cost with all specifications the same as described above.



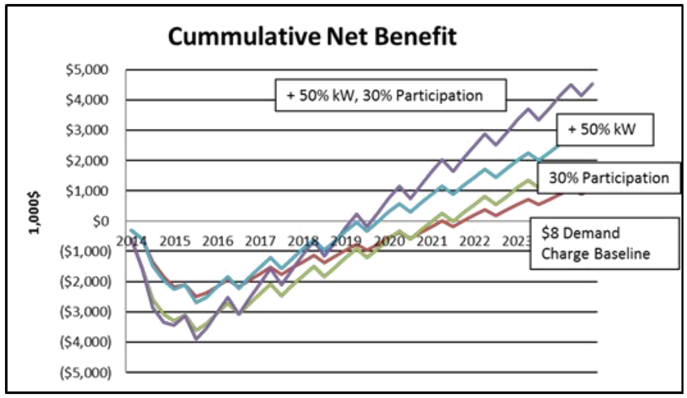
With a $15 demand charge, the PCT program saves nearly $8 million over the ten year period and provides a 50 percent internal rate of return with a 3.25 year breakeven. Even the $10 demand charge shows attractive investment returns with 24.7 IRR, a 5 year breakeven and net savings of $3 million.

	Avoided Demand Cost ($/kW)		
	$8.00	**$10.00**	**$15.00**
Net Present Value (NPV, 1,000$)	1,041	3,017	7,957
Internal Rate of Return (IRR)	12.6%	24.7%	50.0%
Undiscounted Breakeven Period	6.5	5.00	3.25
Discounted Breakeven Period	7.75	5.25	3.25

Finally, we consider a utility with an $8 demand charge and evaluate (1) an increase in program participation from 20 percent to 30 percent and/or (2) optimizing individual customer weather-based demand response to increase average customer response by 50% to 2.1 kW per participating customer (rather than 1.4 kW). Both of these program improvements are consistent with observed variations in program parameters and would represent reasonable targets for a PCT program with 20 percent participation and 1.4 kW savings per customer.

This comparison is interesting because it differentiates between marketing efficacy (i.e., increasing participation) and control efficacy (i.e., optimizing per customer impact with pre-cooling, and so on).

As the cumulative net benefit chart illustrates visually, increasing participation increases total program benefits (vertical distance from the X axis in 2024), but does not significantly reduce the payback period (point where line crosses the X axis) nor does it achieve the kind program return associated with increased customer demand reductions.



Overhead costs associated with the PCT program guarantee that increasing participation will improve the business case and net benefits; however, investment returns are nearly the same ($13.9% versus 12.6% for the baseline) as are breakeven periods. Increasing the per-customer demand impact increases the internal rate of return to 21.9 % (versus 12.6% baseline) and reduces the simple payback (undiscounted breakeven period) to 5 years.

These results indicate that while increasing participation improves total value of the program, improving control strategies is likely to provide greater improvements to the business case.

	Avoided Demand Cost ($/kW)			
	$8.00 Dmd	**+30% par**	**+2kw**	**+30% par+2.1kw**
Net Present Value (NPV, 1,000$)	1,041	1,848	2,753	4,471
Internal Rate of Return (IRR)	12.6%	13.9%	21.9%	23.2%
Undiscounted Breakeven Period	6.5	6.50	5	5
Discounted Breakeven Period	7.75	7.50	6	5.5

The examples shown above reflect only a small number of issues related to PCT program evaluations under one wholesale power cost structure. Alternative incentive strategies, target marketing, energy efficiency initiatives and many other factors can be explored with different wholesale power cost and other avoided cost structures. Future avoided distribution capital investments and savings from improved asset management programs should also be included in the business case analysis.

Should Your Utility Consider (Update) a PCT Program?

Falling PCT technology and communications costs, increased functionality, improved control strategies, and rising avoided costs are increasing PCT program benefits and reducing program costs to the extent that most utilities should consider the business case for a PCT program.

Utilities that already have a PCT program underway should consider updating their programs to take advantage of newer technologies and program strategies.

A PCT program business case analysis identifies utility and customer benefits for alternative PCT program designs. Every utility presents a unique business case depending on:

1. Utility characteristics (peak period power costs, number and length of peak period events, current metering and communications systems, power costs characteristics and so on), and
2. Program characteristics (customer participation, incentive programs and other factors), and
3. Utility customer characteristics (distribution of dwelling unit sizes, types, and ages, air conditioning and heating loads, customer income and demographics, and so on).

Data on utility characteristics are provided by the utility while data on program characteristics impacts reflect actual technology and program experience. Utility customer data are available from a variety of sources (e.g., the Consortium applies utility-specific customer data from www.maisy.com and other sources) and are typically provided as part of the business case analysis.

A quantitative model, like the Smart Grid Investment Model illustrated in a previous section, should be applied to reflect heating and air conditioning load impacts and other customer characteristics, to evaluate alternative PCT technologies, program parameters and options and to provide "what-if" scenarios that support risk analysis. The analysis in the previous section considered only impacts on peak period power costs; however, full business case analysis would include impacts on energy use and avoided costs in off-peak hours.

Utilities that find a positive business case for PCT programs can use business case analysis results to consider three options for implementing (or updating) a PCT strategy.

Utility PCT Program Development Options

Electric Cooperatives, municipal and other public utilities have three basic PCT program development options:

1. Develop in-house programs that manage program design, promotion and recruitment
2. Use full partnership turnkey operations with PCT program vendors, or
3. Pursue some combination of in-house (#1) and turnkey (#2) options.

#1. In-house programs. Depending on utility staff expertise and availability and current metering, IT and other infrastructure characteristics, some utilities may prefer to have primary control of PCT program development, recruitment, and management. This approach is typically pursued by larger investor-owned utilities; the primary constraint for coops and public utilities is staff availability and customer program experience. Most utilities that develop their own in-house programs will want to utilize specialized billing and PCT management software available from their current or alternative IT vendors. A business case analysis will identify potential costs and benefits of in-house program development, recruitment and administration relative to the following two options.

#2. Partnership turnkey program development. Partnership turnkey program development and application will make sense for utilities that are short on staff and do not have the resources to develop programs in-house. The program can be utility-branded with the vendor essentially providing outsourced program development, recruitment and management. A shared savings approach can remove utility program risk; however, shared savings formulas should be consistent with utility avoided costs and should attempt to reward firms for providing net benefits that are greater than what the utility could provide on its own if it were to pursue an in-house development strategy. In other words, utilities should carefully evaluate fees required to outsource their PCT programs.

#3. Many utilities will find it economical to combine in-house resources with resources from firms that specialize in this space to ensure the most efficient, cost-effective program. These outside resource contributions should be evaluated as part of the business case analysis.

Business case analysis of the three options described above and utility management preferences will identify a preferred development strategy.

Conclusion

Utilities can potentially reap large savings and reduce customer electric rates with new programmable communicating thermostat (PCT) programs that take advantage of reduced PCT costs, increased functionality and optimized control strategies applied to individual customers.

Ignoring this program opportunity can potentially expose utility/customer relationships to third party independent PCT providers. The impact of third party independent PCT programs may benefit the utility and its customers or it may end up requiring increases in utility rates to meet utility revenue requirements.

Every utility should consider undertaking a business case analysis of PCT programs. Utilities with existing programs should evaluate the expanded functionality and individual customer control strategies applied with newer programs. A business case analysis of PCT programs will identify potential utility and customer benefits and options for implementing up-to-date programs for utilities with a positive business case.

Every utility presents a unique PCT business case depending on the distribution of dwelling unit sizes, types, and ages, end-use loads, customer income and demographics, peak period power costs, length of peak period events, customer participation, incentive programs, current metering and communications systems, power costs characteristics and other factors. While PCT programs were initially applied primarily as demand response options, modern programs can provide significant reductions in heating and air conditioning energy use throughout the year; consequently, business case analysis should include both avoided peak period and energy costs. Alternative program design options including incentive specifications (critical peak pricing, time of use pricing and so on), target marketing and other factors should be considered.

The examples in this paper, which were drawn from a larger Smart Grid Consortium study, illustrate the impacts of just a few of these factors on PCT program savings. Results of the original study indicate that most utilities can reduce costs and customer rates by implementing modern PCT programs customized to meet utility and customer characteristics.

About the Consortium and Author

The Smart Grid Research Consortium (SGRC) (www.smartgridresearchconsortium.org) is an independent, objective research and consulting firm with headquarters in Orlando, Florida. The SGRC was established in 2010 and is currently completing its twentieth smart grid investment analysis project.

The SGRC is managed and its research is led by Dr. Jackson, an energy economist with more than thirty years' experience in new energy technology market analysis, financial model development, utility program development and project management. He was previously a professor at Texas A&M University, chief of the Applied Research Division at Georgia Tech Research Institute, and president of a consulting firm where he has worked with utilities, state regulatory agencies, equipment manufactures and others in addressing energy industry issues. Dr. Jackson can be reached at Smart Grid Research Consortium, 37 N Orange Ave, Suite 500, Orlando, FL 32801, 979-204-7821 or by email at jjackson@smargridresearchconsortium.org .