

Karen Herter, Ph.D.

EXPERIENCE SUMMARY

Karen Herter has worked in the energy industry for over fifteen years, in academic, governmental, and private institutions, conducting primary research, statistical analysis, and reporting on a broad range of topics including utility-scale wind energy potential, energy efficiency, dynamic pricing, demand response, utility-customer communications, consumer behavior, and home automation.

PROFESSIONAL BACKGROUND

2009 – present President, Herter Energy Research Solutions, Inc.

Owner of an energy research and consulting firm, specializing in mass-market smart grid technologies, energy efficiency, demand response, dynamic pricing, and customer feedback. Designed, implemented, and evaluated the Residential Summer Solutions Study to test the effectiveness of TOU-CPP rates, communicating thermostats, precooling, real-time energy information and enhanced customer services. Oversaw the evaluation of hourly demand data to estimate the energy efficiency, peak load shifting, and demand response impacts for multiple research pilots. Created Excel-based models using regression coefficients to allow forecasts of loads and impacts under user-chosen scenarios.

2006 – 2009 Associate Director, Heschong Mahone Group, Inc.

General responsibilities included writing proposals, acquiring funding, and managing projects involving demand response technologies, programs, and hourly load impact evaluation. Designed and managed the Small Business Summer Solutions Research Pilot, which characterized the load potential and behavioral issues related to an integrated energy-efficiency and demand-response program in the small commercial sector. Led a team to develop a model to predict peak load reduction by California forecast climate zone, utility program, building type and end-use. Facilitated collaboration between the U.S. Environmental Protection Agency, over 20 California energy utilities, and over 30 State departments to fulfill the state benchmarking requirements of Executive Order S-20-04.

2001 – 2006 Advisor to Commissioner Rosenfeld, California Energy Commission

Provided advice on technical and policy issues related to advanced metering infrastructure, electric demand response and dynamic pricing. Collaborated with state agencies, utilities, and industry at meetings, conferences, seminars, and trade shows. Organized, analyzed and summarized large databases, authored peer-reviewed papers and presentations, and developed new research concepts and related proposals. Contributed to the California Public Utilities Commission's Demand Response Rulemaking and Statewide Pricing Pilot with the Energy Commission and investor-owned utilities. Contributed to the development of a statistical methodology for determining hourly residential baselines for demand response evaluation.

1998 – 2006 Principal Research Associate, Lawrence Berkeley National Laboratory

Performed a major component of research projects in LBNL's Environmental Energy Technologies Division. Investigated technologies and methods for improving energy efficiency in consumer electronics. Evaluated the efficacy of existing energy-efficiency policies and the feasibility and expected effects of proposed energy efficiency policies. Organized, analyzed and summarized large databases and authored peer-reviewed papers and presentations. Investigated national electricity consumption of consumer electronics for the U.S. Department of Energy, participated in the International Energy Agency Taskforce on Standby Power Use in Electrical Equipment, and contributed to the development of technical specifications for the U.S. Environmental Protection Agency's Energy Star Program.



EDUCATIONAL BACKGROUND

Ph.D. Energy and Resources, University of California, Berkeley (2006)
M.S. Environmental Studies, San Jose State University (1998)
B.A. Mathematics, University of Rochester (1991)
B.A. Psychology, University of Rochester (1991)

SOFTWARE EXPERIENCE

Expert knowledge of Microsoft Excel, Word, and PowerPoint.

Limited knowledge of SAS, Java, C++, HTML, and MS Access.

SELECTED PUBLICATIONS

- *SMUD's Load Impact Calculator (SLIC) for Smart Grid Cross-Pilot Evaluation*. Prepared for the Sacramento Municipal Utility District. November 2014.
- *SMUD's Low Income Weatherization & Energy Management Pilot – Load Impact Evaluation*. Prepared for the Sacramento Municipal Utility District. November 2014.
- *SMUD's IHD Checkout Pilot – Load Impact Evaluation*. Prepared for the Sacramento Municipal Utility District. September 2014.
- *SMUD's Smart Thermostat Pilot – Load Impact Evaluation*. Prepared for the Sacramento Municipal Utility District. 2014. August 2014.
- *SMUD's EV Innovators Pilot – Load Impact Evaluation*. Prepared for the Sacramento Municipal Utility District. July 2014.
- *SMUD's 2013 PowerStat and Pricing Study – Load Impact Evaluation*. Prepared for the Sacramento Municipal Utility District. March 2014.
- *SMUD's Communicating Thermostat Usability Study: A simultaneous, multi-user, paired comparison test of communicating thermostats for task efficiency, preference, and perceived usefulness of advanced features*. Prepared for the Sacramento Municipal Utility District. February 2014.
- *SMUD's Residential Summer Solutions Study: 2011-2012*. Prepared for the Sacramento Municipal Utility District. January 2014.
- "The Effects of Combining Dynamic Pricing, AC Load Control, and Real-time Energy Feedback: SMUD's 2011 Residential Summer Solutions Study" with V. Wood and S. Blozis. *Energy Efficiency* 6(4): pp 641-653. June 2013.
- *SMUD's 2012 Residential Precooling Study Load Impact Evaluation: Hourly load impacts resulting from residential precooling followed by peak temperature offset*. Prepared for the Sacramento Municipal Utility District. June 2013.
- *Evaluation Framework for Smart Grid Deployment Plans: A Systematic Approach for Assessing Plans to Benefit Customers and the Environment*. Prepared for the Environmental Defense Fund. July 2011.
- *Residential Information and Controls Pilot: Technology Review Memo*. Prepared for the Demand Response Research Center and the Sacramento Municipal Utility District. February 2010.
- "Residential Response to Critical Peak Pricing of Electricity: California Evidence" with S. Wayland. *Energy*, 2010. 35(4): pp 1561-1567.
- *Behavioral Experimentation with Residential Energy Feedback through Simulation Gaming*, with S. Wayland. 2009.



- *Development and Demonstration of the OpenADR Standard for the Residential Sector*, with J. Rasin and T. Perry. LBNL-6531E , August 2009.
- *Small Business Demand Response with Communicating Thermostats: SMUD's Summer Solutions Research Pilot*, with S. Wayland, and J. Rasin. LBNL-2742E, September 2009.
- *A Successful Case Study of Small Business Energy Efficiency and Demand Response with Communicating Thermostats*. International Energy Program Evaluation Conference, August 2009.
- *Universal Energy Benchmarking for Commercial Buildings - Making It a Reality in California*, with D. Mahone, M. Langley, and T. Narel. ACEEE Summer Study, August 2008.
- *Technology Evaluation of Programmable Communicating Thermostats with Radio Broadcast Data System Communications*, with S. Wayland. Prepared for the California Energy Commission, PIER Energy Systems Integration Program, 2008.
- "Residential Implementation of Critical-Peak Pricing of Electricity." *Energy Policy*, 2007. **35**(4): pp 2121-30.
- "An exploratory analysis of California residential customer response to critical peak pricing of electricity" with P. McAuliffe and A. Rosenfeld. *Energy*, 2007. **32**(1): pp 25-34.
- *Effects of Critical Peak Pricing on Residential Electricity Use in California*. Ph.D. Dissertation, University of California, Berkeley. November 2006.
- *Residential Demand Response Evaluation: A Scoping Study*, with C.K. Woo. LBNL-61090. June 2006.
- "Introduction to Web-Based Energy Information & Control Systems for Energy Management & Demand Response in Commercial Buildings" with N. Motegi, M.A. Piette, and S. Kinney. In *Information Technology for Energy Managers*, B. Capehart, ed. Fairmont Press: Lilburn, GA. 2004.
- *Unlocking the Potential for Efficiency and Demand Response through Advanced Metering*, with R. Levy and J. Wilson. LBNL-55673. ACEEE Summer Study, August 2004.
- *Feasibility of Implementing Dynamic Pricing in California*, with California Energy Commission Demand Response Committee, October 2003.
- *Rates and Technologies for Mass Market Demand Response*, with R. Levy, J. Wilson, and A. Rosenfeld. LBNL-50626. ACEEE Summer Study on Energy Efficiency in Buildings, August 2002.
- *Things That Go Blip in the Night: Standby Power and How to Limit It*, International Energy Agency, Paris, 2001.
- *Energy Consumption of Set-top Boxes and Telephony Products in the U.S.*, with A. Meier. LBNL-45305. Report to the U.S. Department of Energy, Jun. 2001.
- *Energy Use of U.S. Consumer Electronics at the end of the 20th Century*, with A. Meier. LBNL-46212. Proceedings 2nd International Conference on Energy Efficiency in Household Appliances and Lighting and Assoc. of Italian Energy Economics, September 2000.
- "Power Measurements and National Energy Consumption of Televisions and Video Cassette Recorders in the USA" with A.K. Meier. *Energy*, 2000. **25**(3): p. 219-232.
- *Energy Use of Home Audio Products in the U.S.*, with A.K. Meier. LBNL-43468. Report to the U.S. Department of Energy, December 1999.
- "Wind Energy Potential of Coastal Eritrea: an Analysis of Sparse Wind Data" with R. VanBuskirk and K. Garbesi. *Solar Energy*, 1999. **66**(3): p. 201-213.

EXPERIENCE DETAIL

Experimental Design and Evaluation

U.S. DOE Smart Grid Investment Grant Consumer Behavior Studies (2010-present)

Role: Technical Advisory Group Coordinator

The Smart Grid Investment Grant (SGIG) program, authorized by Title XIII of the Energy Independence and Security Act of 2007 (EISA) and later modified by the American Recovery and Reinvestment Act of 2009, provided the U.S. Department of Energy (DOE) with funding to conduct statistically rigorous studies of consumer response to smart grid related technologies and programs, including applications of AMI, dynamic pricing, and enabling technologies. To each of the dozen or so Consumer Behavior Studies funded by the SGIG, the DOE has appointed a Technical Advisory Group (TAG) made up of a team of 3 or 4 industry experts. The purpose of the Technical Advisory Group is to provide guidance on the study design and the corresponding elements of the Consumer Behavior Study Plan, ensuring that it is methodologically sound and pursues objectives that are consistent with the recipient utilities' interests. The TAG Coordinator leads the team in this effort and coordinates ongoing interaction between the TAG and the recipient utility team. The TAG Coordinator is also responsible for engaging the DOE's project manager at Lawrence Berkeley National Laboratory and the DOE's Technical Project Officer (TPO) to make sure they are aware of (a) meetings and documents passed between the recipient and the TAG, (b) the improvements the TAG and recipients are proposing, and (c) the progress made in finalizing the Consumer Behavior Study Plan.

Related publications:

- See *Consumer Behavior Study Guidance Documents* at http://www.smartgrid.gov/recovery_act/reporting_resources

SMUD's SGIG Consumer Behavior Study (2010-2011)

Role: Consultant

In 2009, the U.S. Department of Energy awarded the Sacramento Municipal Utility District (SMUD) a Smart Grid Investment Grant for the SmartSacramento® project - a \$308M project involving system-wide deployment of distribution automation, advanced metering, and customer systems installed to improve the reliability and efficiency of grid operations, optimize the use of assets, and enable more informed participation by customers. A portion of this funding was earmarked for a Consumer Behavior Study intended to test customer response to new smart-grid enabled pricing and technology options. In the early development of the District's Smart Grid Investment Grant funded Consumer Behavior Study, Dr. Herter assisted SMUD staff with the sample design and statistical power calculations needed to meet the experimental rigor required by the Department of Energy's Technical Advisory Group.

Related publications:

- See http://www.smartgrid.gov/project/sacramento_municipal_utility_district



California Statewide Pricing Pilot (2003-2004)

Role: Contributor to Experimental Design and Load Impact Evaluation

A collaborative project supervised by the California Public Utilities Commission and the California Energy Commission, and implemented by the three investor-owned electric utilities: Pacific Gas and Electric, Southern California Edison, and San Diego Gas and Electric. The pilot involved placing roughly two thousand residential customers and five hundred small commercial customers on experimental time of use and critical peak pricing rate structures. Results indicated significant response to critical peak events.

Residential customers with no enabling technologies provided up to 13% peak load drop for 5-hour events, while participants equipped with programmable communicating thermostats dropped 25% during 5-hour events and 41% during 2-hour events. Significant response rates were also found in the commercial sector: 6-9% peak load drop for commercial customers with no enabling technologies, and 14% peak load drop for commercial customers with communicating thermostats. Results for time of use rates were inconclusive. An analysis of response to two different event price levels (50 cents per kWh and 68 cents per kWh) showed no statistical difference between the two.

A demographic analysis indicated that high-use customers respond significantly more in kW reduction than do low-use customers, while low-use customers save significantly more in percentage reduction of annual electricity bills than do high-use customers—results that challenge the strategy of targeting only high-use customers for CPP tariffs. Across income levels, average load and bill changes were statistically indistinguishable, as were satisfaction rates—results that are compatible with a strategy of full-scale implementation of CPP rates in the residential sector. Finally, the high-use customers earning less than \$50,000 annually were the most likely of the groups to see bill increases—about 5% saw bill increases of 10% or more—suggesting that any residential CPP implementation might consider targeting this customer group for increased energy efficiency efforts.

Related Publications:

- *Residential Response to Critical Peak Pricing of Electricity: California Evidence*, with S. Wayland. *Energy*, 2010. **35**(4): p. 1561-1567.
- *Residential Implementation of Critical-Peak Pricing of Electricity*. *Energy Policy*, 2007. **35**(4): p. 2121-30.
- *An exploratory analysis of California residential customer response to critical peak pricing of electricity*, with P. McAuliffe and A. Rosenfeld. *Energy*, 2007. **32**(1): p. 25-34.
- *Effects of Critical Peak Pricing on Residential Electricity Use in California*. Ph.D. Dissertation, University of California, Berkeley. November 2006.

Residential DR Evaluation Methodology (2006)

Role: Coauthor

The primary goals of this scoping study were to (1) summarize existing methods for estimating demand response, (2) evaluate these methods' abilities to accurately estimate residential demand response for the purpose of program evaluation, (3) recommend a preferred approach, and (4) outline any remaining knowledge gaps. This study was motivated by the CPUC directive (D.05-11-009) to develop measurement and evaluation protocols for demand response. The evaluation considers both day matching and regression techniques, outlining the following alternative methods: (1) prior-day averaging, (2) weather-matching techniques, (3) regression-based load profile comparison, and (4) econometric demand analysis. Based on a review of these methods for evaluating demand response, we find that customer-specific regression analysis is likely to give accurate, transparent and intuitive results. Depending on program requirements, this method can be modified to estimate hourly demand response before, during and after events, providing hourly kW response results and load profiles. Beyond basic demand response estimation, several

issues need to be addressed before a practical method for residential demand response program evaluation can be determined. Among them are the ability to evaluate multiple events on consecutive days, an understanding of how advance notification affects demand response, and incorporation of considerations affecting the extrapolation of results from a voluntary pilot to a large-scale program.

Related Publications:

- Woo, C.K. and K. Herter. *Residential Demand Response Evaluation: A Scoping Study*. LBNL-61090. June 2006.

Program and Pilot Implementation

Small Commercial EEDR: SMUD's Small Business Summer Solutions Research Pilot (2008)

Role: Principal Investigator

A field study of 78 small commercial customers in the Sacramento Municipal Utility District service territory who volunteered for an integrated energy efficiency and demand response (EEDR) program in the summer of 2008. The original objective for the pilot was to provide a better understanding of demand response issues in the small commercial sector. Early findings justified a focus on offering small businesses (1) help with the energy efficiency of their buildings in exchange for occasional load shed, and (2) a portfolio of options to meet the needs of a diverse customer sector. To meet these expressed needs, the research pilot provided on site energy efficiency advice and offered participants several program options, including the choice of either a dynamic rate or monthly payment for air conditioning setpoint control.

An analysis of hourly load data indicates that the offices and retail stores in our sample provided significant demand response, while the restaurants did not. Thermostat data provides further evidence that restaurants attempted to pre-cool and reduce AC service during event hours, but were unable to because their air conditioning units were undersized. On a 100°F reference day, load impacts of all participants during events averaged 14%, while load impacts of office and retail buildings (excluding restaurants) reached 20%. Overall, pilot participants (including restaurants) had summer energy savings of 20% and summer bill savings of 25%. About 80% of participants said that the program met or surpassed their expectations, and three quarters said they would probably or definitely participate again without the \$120 participation incentive. These results provide evidence that energy efficiency programs, dynamic rates and load control programs can be used concurrently and effectively in the small business sector, and that communicating thermostats are a reliable tool for providing air conditioning load shed and enhancing the ability of customers on dynamic rates to respond to intermittent price events.

Related Publications:

- Herter, K., S. Wayland, and J. Rasin. *Small Business Demand Response with Communicating Thermostats: SMUD's Summer Solutions Research Pilot*. LBNL-2742E, September 2009.
- Herter, K., S. Wayland, and J. Rasin. *A Successful Case Study of Small Business Energy Efficiency and Demand Response with Communicating Thermostats*. International Energy Program Evaluation Conference, August 2009.
- Herter, K. *SMUD Small Commercial Focus Groups: October 25-26, 2007*. November 2007.

Residential Information & Controls Pilot: SMUD's Residential Summer Solutions Study (2011)

Role: Principal Investigator

An integrated energy efficiency and demand response (EEDR) research pilot implemented in the Sacramento Municipal Utility District in the summer of 2011. Three groups of residential customers were randomly selected for installation of three different versions of a real-time information and automation system. Group A received the base system: an Internet connected gateway that provided local OpenADR event signals to communicating thermostats. Group B received the base system plus the ability to view real-time whole-house electricity use on their thermostat and personal computer. Group C received the base system plus the ability to view real-time electricity of their home and up to three appliances on their thermostat and personal computer. All participants were offered a free in-home energy assessment and two non-mutually-exclusive program options: (1) a dynamic rate (Critical Peak Pricing) and (2) payment for remote thermostat control. An analysis of load impacts, participant behavior, and customer satisfaction is to be published in December of 2011.

Related Publications:

- Herter, K. *Residential Information and Controls Pilot: Research Plan*. Prepared for the Demand Response Research Center and the Sacramento Municipal Utility District. January 2011.
- Herter, K. *Residential Information and Controls Pilot: Bill survey and final rate design*. Prepared for the Demand Response Research Center and the Sacramento Municipal Utility District. January 2011.
- Herter, K. *Residential Information and Controls Pilot: Focus Groups*. Prepared for the Demand Response Research Center and the Sacramento Municipal Utility District. June 2010.
- Herter, K. *Residential Information and Controls Pilot: Technology Review Memo*. Prepared for the Demand Response Research Center and the Sacramento Municipal Utility District. February 2010.

Technology Research, Development and Demonstration

Residential Energy Information and Automation Technology (2010)

In preparation for the Residential Information and Controls Pilot to be conducted in Sacramento, California, conducted an extensive review of the market and published a summary of 48 residential energy information and automation companies and their products as of February 2010. For each device, the summary provides a graphic, and briefly describes the information displayed, user interface, and the method of communicating with the meter, utility and controlled devices.

- Herter, K. *Residential Information and Controls Pilot: Technology Review Memo*. Prepared for the Demand Response Research Center and the Sacramento Municipal Utility District. Feb 2010.

Residential OpenADR (2009)

Role: Principal Investigator

The goal of this study was to demonstrate a demand response system that can signal nearly every customer in all sectors through the integration of two widely available and non-proprietary communications technologies—Open Automated Demand Response (OpenADR) over Internet protocol, and Utility Messaging Channel (UMC) over FM radio. The outcomes of this project were as follows: (1) a software bridge to allow translation of pricing signals from OpenADR to UMC; and (2) a portable demonstration unit with an Internet-connected notebook computer, a portfolio of DR-enabling technologies, and a model home. The demonstration unit provides visitors the opportunity to send electricity-pricing information over the Internet through OpenADR and UMC, and then watch as the model appliances and lighting respond to the signals. The integration of OpenADR and UMC completed and demonstrated in this study enables utilities to send hourly or sub-hourly electricity pricing information simultaneously to the residential, commercial and industrial sectors.

- Herter, K., J. Rasin and T. Perry. *Development and Demonstration of the OpenADR Standard for the Residential Sector*. December 2009.

FM Radio Broadcast for DR Programs (2008)

Role: Principal Investigator

This study investigated the technical feasibility of using FM broadcast Radio Data System (RDS) signals to communicate with thermostats for electric utility demand response programs. Based on a probability analysis, broadcasts from 2 of the 17 existing RDS-enabled FM radio stations in Sacramento would reach all 40 sites tested for this study greater than 95 percent of the time. Further reliability could be built into the system by increasing the number of radio stations or signal repeats. The communicating thermostat tested for this study was a fully functional multi-zone thermostat modified to receive and respond to demand response signals via RDS. The thermostat responded to both price and emergency events within seconds of sending an RDS signal from a local FM station.

- Herter, K. and S. Wayland. *Technology Evaluation of Programmable Communicating Thermostats with Radio Broadcast Data System Communications*. California Energy Commission, PIER Energy Systems Integration Program, 2008.

Consulting Services

Environmental Defense Fund – Smart Grid Deployment Plan Scorecard (2011)

Role: Principal Investigator

Worked with the Environmental Defense Fund (EDF) to document the predicted consumer and environmental benefits associated with smart grid deployment – including those identified in the Energy Independence and Security Act of 2007 and California Senate Bill 17 (2009) – to create a scorecard and to apply it in grading California Investor-Owned Utility Smart Grid Deployment Plans submitted to the California Public Utilities Commission in July 2011. Scorecards and grades based on the framework are to be submitted as part of EDF’s comments under Rulemaking 08-12-009 in August 2011.

- Herter, K. *Evaluation Framework for Smart Grid Deployment Plans: A Systematic Approach for Assessing Plans to Benefit Customers and the Environment*. Prepared for the Environmental Defense Fund. July 2011.

Tennessee Valley Authority – Five-Year Energy Efficiency and Demand Response Plan (2011)

Role: Lead Consultant for the 5-Year Demand Response Plan

The Tennessee Valley Authority (TVA), the largest publicly owned electric utility in the country, provides electric energy for 158 distribution customers and 58 direct-served industrial customers within a seven-state service area. In 2007, the TVA Board of Directors released its Strategic Plan stating a commitment to becoming a regional leader in energy efficiency. Since the Plan’s release, TVA has engaged in an Integrated Resource Plan development process, which resulted in goals of 3.5% energy reduction and 1,400 MW peak demand reduction by 2015. To address these goals, TVA initiated the development of a comprehensive 5-year Energy Efficiency and Demand Response Plan, to be completed in 2011. As part of the team involved in drafting this document, Dr. Herter provided best practices and recommendations for the 5-Year Demand Response Plan.

