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REVIEW AND ASSESSMENT OF ENERGY EFFICIENCY PROGRAMS AND METHODS OF MEASUREMENT & VERIFICATION WITH REGARD TO RESIDENTIAL BUILDINGS

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Abstract

Energy efficiency organizations utilize energy efficiency programs (EEPs) focused on behavioral, structural or technical modifications to reduce energy use. Savings from EEPs are estimated using various Measurement & Verification (M&V) methods, which measure and interpret program results. While existing research has focused on larger energy users, our research focuses on smaller, residential users.

i) Literature review of M&Vs & research relevant to residential energy usage.

ii) Correlation analysis of effects of several factors relevant to energy consumption from a survey of residential energy users

This literature review has revealed that a method to quantify the impact of behavioral EEPs must be developed, disparity is present between the number of behavioral EEPs and the variety and number of methods of analysis, and multifaceted M&V methods must be developed. If EEP administrators record initial attitudes of participants, results of that data can predict EEP outcomes. Correlation analysis performed on 301 survey responses regarding factors relevant to EEPs. The results provide quantitative perspective on optimal standards for efficiency and weight of specific factors on household energy use.

Keywords: Energy Efficiency Programs, measurement and verification, behavioral, structural, technical

1. Introduction

Motivating factors for energy efficiency are social, environmental, political, and financial in nature. As more organizations and governments adopt EEPs, more specialized and functional formation methods, analysis techniques, and running processes will need to be cultivated [11]. As more renewable energy sources are introduced, new locations and sources of electricity appear (e.g. solar panels on buildings, smaller scale hydroelectric power), so city electric systems will continue to become more complicated [16]. Electricity demand will continue to rise as electric cars are added to the city electric grid, as populations climb, and as more electronics are created and procured. In addition, on a broader scale, prices and usage of energy will continue to rise [16]. The purpose of the literature review portion of this project is to determine what methods of M&V are established, determine what further development needs to occur and to generally understand what research has been conducted in the field so as to determine the most effective recommendations and practices.

The data analysis portion of this project works to contribute to developments in determining and facilitating the efficiency of residential buildings. Correlation analysis is performed on data from a survey detailing 301 responses from residents to questions regarding factors in their households relevant to residential energy efficiency. The results of the analysis on specific factors from the survey provide a quantitative perspective on the optimal standards for efficiency and the weight of specific factors on the energy usage of a household

An energy efficiency firm, also referred to as an energy service company (ESCO), is a business that provides energy saving solutions. Administrators of energy efficiency firms generally comprise either government-funded research laboratories or independent energy efficiency consulting firms. Firms generally plan, design, and carry out energy

efficiency programs (EEPs) through any variety of methods [2]. Firms are also generally involved in the measurement & verification of the amount of energy saved, as well as the results and financial loss or gain for the program [1]. The process of estimating the savings of a program is called Measurement & Verification (M&V). This research project has involved investigating the field and relevant literature with regard to residential buildings. This project also uses data collected from residential buildings and the tenants to further the process of correlation analysis for individual characteristics and overall efficiency. The introductory section of the literature review defines terms, classifications, and methods utilized in this paper and the corresponding research.

2. Methods of Measurement and Verification

In order to develop the most functional energy efficiency programs, there are standardized analysis and evaluation methods [3]. The three larger categorizations of evaluations include impact evaluations, process evaluations, and market evaluation. Impact evaluations weight the cost and benefit of an efficiency program. Each impact evaluation specifies different aspects of the program and the program's connected system to consider. Market evaluations involve actions that document the behavior of a market in relation to efficiency [4]. Process evaluations document the process and actions in the program, systematically determining and recommending possible improvements. The Societal Cost Test (SCT) evaluates whether the utility, state, or nation that is involved in the program is better off as a whole as a result of the program or not. Results include the effect on all members of related society, including the program administrator, customers, non-participants, employees of the utility, and so forth. Costs are calculated for the program administrator and participants. Benefits include lower costs for all customers, as well as any nonfinancial benefits experienced by any related group (e.g. health benefits, environmental improvements). Externalities are included in both costs and benefits. The Total Resource Cost Test (TRC) evaluates whether total costs of energy in the utility service territory decrease, and the extent to which they do. Results include the effect on all customers of the utility, both participants and non-participants. Costs include those for the program administrator and participants. Benefits include lower costs for all customers, as well as any nonfinancial benefits experienced by any related group (e.g. health benefits, environmental improvements). In contrast to the SCT (see above) externalities are not considered.

The Ratepayer Impact Measure Test (RIM) evaluates whether utility rates will increase temporarily as a result of the program, and the extent to which they will. Results include the effect on utility rates, including both participants and non-participants. Costs include those for the program administrator and the loss of profit for the utility supplying electricity. Benefits include avoided utility costs. The Program Administrator Cost Test (PACT) evaluates whether utility bills will increase as a result of the program, and the extent to which they will. Results include the effect on, and the work by, the program administrator. Costs include those for the program administrator. Benefits include avoided utility costs, avoided capacity costs, avoided transmission and distribution costs, and any other costs previously incurred by the utility to provide electric services. Participant Cost Test (PCT) evaluates whether participants benefit from the program over the span of the program. Results consider the effect on and by participants in the program. Costs include the direct expenses of the customer to purchase, install, and operate any aspect of the program that is necessary, as well as any other costs or effects on the customer as a result of the program. Benefits include utility savings for participant customers as well as any benefit the participant receives for their involvement in the program (e.g. financial encouragement by administrator).

3. Energy Efficiency Programs

The three classifications of energy efficiency programs used in this project are technical, behavioral, and structural. Technical programs rely upon changes in the efficiency and usage of technology, structural programs rely on changes in the function, usage, construction, or general efficiency of buildings, and behavioral programs

rely upon changes in opinions, awareness, and energy usage, including usage of technology and attitudes changes regarding the other two categories.

3.1 Technical

Previous research regarding technical EEPs includes inquiry into air conditioner efficiency and related theories about future developments and efficiency changes [15], the usage of household and regional electricity supplier data for investigation into return on energy-efficient investments [6], research into the large-scale market impacts of more efficient air-conditioners and other newly efficient appliances [17]. In addition, a report regarding procedure for subsidiaries and/or tax breaks for the purchase or usage of electric vehicles is available [18].

3.2 Behavioral

Examples of behavioral EEP research include an investigation into the results of how the sexes interact with individual chores and encouragement to be efficient [5] (e.g. showering instead of taking a bath), reactive Demand Response (DR) and financial reward for load reduction [7], governmental opinion and public policy necessities [12]. Due to the fact that efficiency and conservation promotions exist in unmeasured quantities with great variation between regions and individuals, the results of the literature that concerns itself with the effects of environmentalist advertising can only be paralleled to, and thus included in, social factors, if at all. The subjection of an individual or a group to advertising, for example, is difficult to measure without much more in-depth information.

3.3 Structural

Research relating to or utilizing structural EEPs includes the investigation of overall financial results of installation of insulation in a home [17], the study of correspondence between a building's social function and its layout and flow-through [10], and standards for the efficiency of new commercial or industrial buildings [12]. In addition, a report is available regarding tax breaks for the purchase of energy efficient homes currently on the market [11]. Table 1 shows the Energy Efficiency Programs Categorizations of Literature Review Papers. Several of the documents reviewed used data from, made recommendations regarding, or analyzed energy efficiency programs. Table 1 identifies the document and any efficiency program that it utilizes in the process of research.

Table 1: Energy Efficiency Programs Categorizations of Literature Review Papers

Paper / Report/ Document [Author/year)	Structural	Technical	Behavioral
Barley, D. *et al*. 2005	x		x
Deru, M. *et al*. 2005	x	x	
Lang S. 2004	x	x	x
Greening, L.A. *et al*. 2000	x	x	x
Hirst, E. *et al*. 1985	x		
Lutzenhiser, L. *et al*. 2009		x	x
Metcalf, G.E. *et al*. 1999	x	x	
Newsham G.R. *et al*. 2011		x	
Rhodes, J. *et al*. 2011		x	
Hiller, B. *et al*. 1984	x		
Eissa, M.M. 2011			x
Giraudet, L.G. *et al*. 2011		x	x
Fouqet, R. *et al*. 2006		x	x
Carlsson-Kanyamaa *et al*. 2007	x		

Table 2 lists the topics relevant to this investigation into residential energy efficiency research with which the papers reviewed are involved. Every paper has a primary topic of relevance, while most have one or more secondary relevant relations. The pertinent topics are also listed in each of the summaries that are present in the literature review section.

Table 2. Topical categorizations of Literature Review Papers

Document	Building-based impacts	Residential Economics / Pricing	Policy	Technology	Social & psychological Determinants	Market Behavior	Energy Efficiency Evaluations
Barley, D. *et al*. 2005	x		x	x			x
Deru, M. *et al*. 2005	x						x
Lang, S. 2004	x	x	x	x		x	x
Greening, L.A. *et al*. 2000		x	x		x	x	
Hirst, E. *et al*. 1985		x	x	x		x	x
Moezzi, M. *et al*. 2010	x	x		x	x	x	x
Lutzenhiser, L. *et al*. 2009	x	x			x	x	x
Metcalf, G.E. *et al*. 1999		x		x		x	x
Newsham, G. R. *et al*. 2011		x	x	x		x	x
Rhodes, J. *et al*. 2011		x	x	x			x
Hillier, B. *et al*. 1984	x				x		
Eissa, M.M. 2011			x			x	x
Giraudet, L.G. *et al*. 2011	x	x	x		x	x	
Fouquet, R. *et al*. 2006		x		x			x
Carlsson-Kanyamaa *et al*. 2007	x	x	x	x	x		
Ruderman *et al*. 1987		x	x	x		x	

4. Literature Discussion

Giraudet et al, 2011 [9] recognize a problem with the system of models that are utilized by the building sector for energy conservation and CO2 emission extenuation. The models commonly utilized have been standard bottom-up and top-down models, and this paper introduces a model constructed with an interdisciplinary approach in

mind to be utilized to predict household energy demand in France. The new model, known as Res-IRF, was created to address the need for models able to account for economic and technological factors related to the forecast of household energy demand. The model differentiates between investment in energy efficiency and changes in large appliance or machine usage, which allows the electricity rebound effect to be considered. The model allows for the consideration of the not directly calculable results of energy efficiency implementation- heterogenous consumer actions, limitations and other factors. In the results of the implementation, it is demonstrated that compared to a 37% reduction by 2050 under non-changing regulation limits, an additional reduction of 21% could be made if efficiency and sufficiency are adequately achieved. While Giraudet's paper is primarily in the building-based impacts category, it also fits into the residential economics, pricing, policy, market behavior, and energy efficiency evaluation categories.

[Greening et al. 2000] [9] address an observed market phenomenon regarding energy efficient technology, decreased energy usage, and consumer demand. A large variety of energy efficiency programs exist and are in place, with growing numbers. Programs include insulation promotions with financial backing coming from subsidiaries and tax breaks provided by government, cultural and resultant financial encouragement to conserve electricity and oil usage, and government tax breaks and subsidies for purchases of energy-efficient products. When energy efficiency increases in prevalence in a market, electricity usage overall decreases. As a result, energy services have a tendency to become less expensive (through either demand-response programs or human-controlled supply and demand theory). Due to the lowered costliness of electricity utilization, the demand jumps up. That increase in demand is referred to as "the rebound effect". A review of relevant literature, aims to provide definitions & provide sources for information and data regarding the "rebound", as well as actuate investigation into, and analysis of, the phenomenon for the purpose of providing organizations, researchers and businesses the information necessary to be prepared. The paper has multiple conclusions. Firstly, the rebound is between very small and moderate relative to the size of the decrease in electricity usage. In addition, the size of any given rebound is primarily dependent on consumer awareness during consumption, including awareness of energy prices, the non-financial cost of electricity usage, and the relative remuneration resulting from any efficiency programs. While for the purposes of the current research project Greening's research is primarily categorized as being relevant to market behavior, the residential economics, policy, and social & psychological determinants categories also apply.

[Lutzenhiser et al. 2009] [8] works to clarify, point out, define, and at times provide solutions to "sticky points", difficult, incomplete or nonspecific aspects of the methodology by which Household Energy Consumption is modeled. It attempts to improve methodologies and strategies within the discipline as a whole. Among the "sticky points" addressed are the results of variability in electricity consumption with regard to households, both over time in specific households and across different buildings. Data quality issues and purportedly common beliefs about causality of perceived trends are addressed. Conflicts among various modeling approaches are addressed, and recurrent recommendations relating to implementation of interdisciplinary models are made. Lutzenhizer's research assists this research project in the clarification and standardization of models and terms utilized. While it is primarily categorized as Residential Economics and Pricing, the paper is also relevant to building-based impacts, social and psychological determinants, market behavior, and energy efficiency evaluation.

[Hillier et al. 1984] [13] attempts to lay out an objective methodology for determining the function of a building and utilizing that information in a layout plan capacity. The methodology requires consideration of primarily two aspects of each building: the building's social purpose (e.g. to store nonperishable shipments in large packages for long periods of time) and the correspondence to structural and spatial layout. The paper argues, using standard building layouts, travel paths, fluid boundaries, and boundary standards, that structural and spatial layout correspond to the social function of a building. The paper also argues that the

determinations of the sizes of various parts of buildings should correspond to the social purpose, and that the action of correspondence is more feasible using the "spatial form" in building design. The number & locations of different connections should be planned as such. The audience of this paper contains primarily theoretical academics, who will in turn teach future profession architects and floor planners.

[Carlsson-Kanyamaa et al. 2007] [10] presents findings from interviews conducted with thirty households in Sweden that participated in an energy efficiency program in an effort to reduce the energy use of their homes. The paper investigates how households divide up chores between the sexes and opinions regarding the chores. The overall impression among households that were under direct billing was that the ability to quickly access information about the effects of labor on the energy bill is a powerful factor in behavior regarding efficiency. For the case of the more difficult, less user-friendly new technologies that were implanted in homes, there was little difference in the use and enthusiasm related to the technologies with regards to the sexes. In general, women and girls were less willing to compromise with shorter showers or showering rather than using the bathtub than men were, while men were somewhat less willing to learn to operate technology that is new that works toward increasing efficiency. This paper appears to be written for practical academics. While relevant to building-based impacts, residential economics and pricing, policy, and technology, the research by Carlsson-Kanyamaa and company is primarily relevant to social and psychological determinants.

[Ruderman et al. 1987] [5] analyzes the market behavior in response to trends of efficiency in residential appliances and technologies. The goal of this research is to use quantitative data and analysis to assist in the prediction of residential energy use. The paper defines “residential appliances” as technologies that residents interact with that are used within a home. For example, toasters, microwaves, and air-conditioning machinery would all be considered residential appliances. Implications include demonstration of the factors that contribute to the delay or neglect of efficiency investment and determination of future specifications for government efficiency regulations. Implications for regulations are relevant both to regulations on the production and design of products as well as the consumption and sale. The research concludes that government intervention is positive, and recommends some level of governmental regulation to promote efficiency in household appliances. The results of Ruderman’s paper are relevant to residential economics/pricing, policy and technology. The category of primary relevance to the paper is market behavior.

[Eissa 2011] [18] uses data from large energy consumers and producers' interactions with electric grids, as well as those utilizing it for production in the industrial and commercial sectors. Two methods of Demand Response (DR) are presented by the paper: incentive program DR, and, varying retail tariff DR. Utilizing tendencies and factors of each method, the paper theorizes that varying retail tariff is the less efficient method, and proves that incentive program is the more efficient demand response method for the Saudi Electricity Company (referred to also as the Electricity Saudi Company). The paper utilizes the fact that many peak usage ratio (PR) values (calculated from the ratio of day peak hours electricity usage during a period to day non-peak hours usage in said period) decrease with incentive-based DR, while nighttime usage ratio (NR) (calculated from the ratio of night hours electricity usage during a period to day non-peak hours usage in said period) can increase as evidence of this. It also concludes that the incentives can be explicit bill credits or payments for pre-determined or measured decreases in electricity use (i.e., "load reductions"), and that the ESC should utilize load management programs centered around incentive response and penalty during peak demand times. For the purposes of this project, this research provides recommendations for weightage of data in future decisions regarding demand response based on the variability and the level of energy usage. Predictions of energy usage could be used to justify methods of demand response even before areas have been established, thus allowing for more precise planning. Eissa’s paper belongs primarily in the policy category, but is also relevant to the market behavior and energy efficiency evaluation categories.

[Lang 2004] [7] describes energy efficiency standards established for residential buildings in China, presents issues and future prospects for development in the sector, provides energy inspection and renovation specifics, and suggests improvements. The data utilized in the analysis includes statistics of construction in China, the categories of research conducted by energy efficiency advocates, and energy use statistics in China in terms of both application and demand. In conclusions and recommendations, the paper focuses on the perceived need for government action. Recommendations involve greater regulation, knowledge of efficiency by public officials, further refinement and development of energy efficiency laws and codes. It is also suggested that building efficiency promotion programs should be integrated with wall construction quality improvement plans, heating energy efficiency programs should be provided, an administrative organization should be established to direct energy efficiency, and a certification system should be established for energy-efficient technology. While primarily accessible to theoretical and practical academics, the paper and the opinions it provides are somewhat pointed towards policymakers. This disparity suggests the promotion of pressuring of policymakers by academics by the author.

Rhodes et al. 2011 [12] describes its method of quantifying the impact of air conditions' poor situation as an analysis of outdoor condenser/compressor and observance of peak power usage data. The condenser/compressor utilizes 80-85% of the power supplied to an air conditioner. Peak power usage data from the city of Austin, Texas between January 2009 and December 2010 was compared to the average power usage of air conditioners over the corresponding time period. The average power usage value of homes from Austin that was utilized in the comparison was scaled 10% negatively to account for the condition that Austin has a hotter peak temperature than the peak air conditioner standard running process temperature. The paper, using the data, predicts that if all the homes were switched to 12 EER AC (min energy star approval efficiency) & 14 EER (the highest efficiency of air-conditioning available on the market as of July 2011) AC, respectively, that Austin could reduce peak demand by approximately 5% and 8%, respectively. The data utilized was 4971 energy audits that occurred when single-family residential structures were placed on the market between January 2009-December 2010. The vast majority of the structures that were able to avoid audits were utilized utility-sponsored energy efficiency programs, condos, manufactured homes, or those that were under foreclosure rather than for sale. The research process of this project and the paper provide an example of the implementation and utilization of technical energy-efficiency programs. The paper fits primarily in the residential economics/pricing category but is also relevant to policy, energy efficiency evaluation, and technology.

Newsham et al. 2011 [17] discuss various methods to evaluate the effect of a utility residential air-conditioner load control program on peak electricity use. The paper uses the minimum, maximum, & average electricity usage in three time periods: the total, the summer usage, and the winter usage. The paper analyzes the sets of data, applies various analysis methods and observes general trends and specific cases dictating what provides the best or most conclusive results as to what load control program is best suited. The paper concludes that researchers, practical academics, and possibly professionals should use more complex time-series methods of analysis to determine which load control program works best. The document also concludes that it is wise to consider more than one analysis method, and that time-series methods generally are more accurate.

Metcalf et al. 1999 [14] works to test whether realized returns of investments in proposed energy efficiency for individuals and small entities fall short of returns promised by engineers, product manufacturers and designers. In addition, the paper investigates the observed perception that the introduction of consumers to a previously secluded or hypothetically simulated marketplace relates to unreasonably high hurdle rates for the commencement of energy saving and efficiency-focused investments. The main source of data is the United States Department of Energy's residential energy conservation survey (RECS), which includes information about the social structure and demographic information of houses. Data also

includes information from households, energy suppliers, and other utilities for the years 1984, 1987 and 1990. An example of the analysis process is the regression of the average daily heat consumption per month to estimate that of a group. The paper concludes that the assumption of equal financial means between individuals that do and those that do not spend money on energy saving investments is very false.

5. Energy data variables

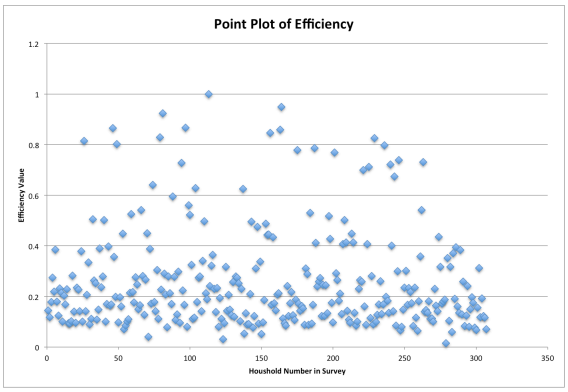

Figure 1: A point plot of the 301 efficiency values in the survey data set.

5.1 Energy Efficiency Program Variable-Efficiency Comparison

In the survey (plotted in Figure 1), there are distinct variables for each residence. Because there are many energy efficiency programs already in place, it is being assumed that every individual surveyed is subject to efficiency programs in all three categories. For example, because subsidiaries exist on electric cars in the state of CA [15], advertisements are present to curb energy and water usage and tax breaks and other incentives are offered to those purchasing and installing new insulations and building energy efficient buildings, an individual living in CA is subject to behavioral, technical and structural EEPs. Because the individual levels of exposure to these programs are not currently quantifiable, the assumption is being made that over a large sample size, there is generally an even distribution of program awareness.

Many of the values of the variables from survey respondents correspond either wholly or partially to one category of energy efficiency program. For example, if one of the survey questions were to ask a participant to rate their energy consciousness, that variable would be considered behavioral because it would be tied to the results of behavioral energy efficiency programs; that behavior is in part a result of the behavioral programs that the individual has been subject to and their response to it based on preconceived notions and opinions. If one of the questions asked the number of air conditioning units in an individual's residence, while part of the causes of the value of that number might be connected to behavioral programs (the individual might be less inclined to purchase additional air conditioners if they were sufficiently energy conscious), because that result corresponds most to the technical specifications of the air conditioners in terms of energy usage, that variable would be considered to correspond to technical EEPs. If a question asked for the year that the residence was built, that variable would be considered to correspond to structural programs because its tie to energy use relates to the structural nature and planning of the home.

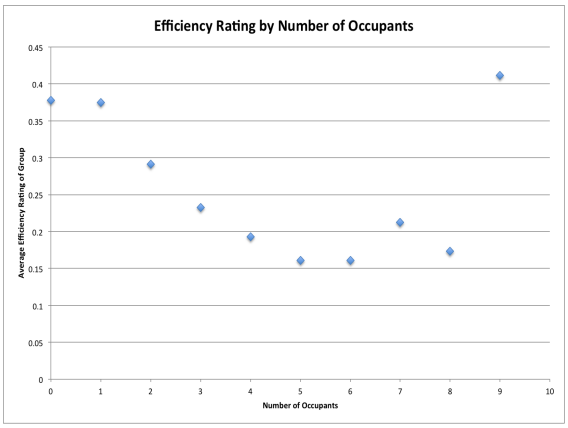

Figure 2: The efficiency ratings of households correlated to the number of occupants in the household. *It should be noted that only one data point was present in the data set each for 0 occupants and 9 occupants.

In the earlier values (0-6), a clear downward trend is visible in the efficiency ratings as occupancy increases. This is understandable as the efficiency rating is not on a per-person basis, but rather regarding the whole residence. The implications of this data center on the facts that, as the data

progresses, the gaps decrease and the figurative trend line curves up. The shape of the trendline indicates that the efficiency per person of residences increases drastically as the number of occupants increases. This is illustrated in Figure 2.

6. Conclusions

A large number of measurable and immeasurable behavioral efficiency programs exist in the form of advertisements, environmental education, social and media promotion of conservation, demand response programs, and administrator-funded efficiency financial reward programs. However, perhaps due to the less directly and immediately quantifiable nature of behavioral changes and the factors that affect those changes, the amount of research conducted on behavioral efficiency programs is less than proportional to the amount of actual programs. More research into the impact of cultural and social influences (likely corresponding to area of residence, level of schooling, and other social characteristics) is recommended.

Reasonable research has been conducted and is being conducted with, as well as on, technical energy efficiency programs made feasible by government tax breaks and subsidies for energy efficient products or their manufacturers, research administrator funded upgrades to more efficient technology, and government regulations (both local and federal) regarding the efficiency of appliances and buildings. As increasing numbers of energy efficient appliances are purchased, research and development of efficiency programs (and measurement technologies) will have to continue, as the load will change accordingly. The contrast between population growth and energy efficient technologies will determine whether energy usage will decrease or increase overall.

Somewhat substantial research has been conducted on and with structural energy efficiency programs. Due to local and federal government regulation, new buildings must be above the specified levels of efficiency. In addition, in certain areas (for example Austin Texas) energy efficient homes for sale are provided advantages like not being required to have or to pay for an energy inspection.

For future projects, behavioral EEP administrators could ask individuals about attitudes regarding energy efficiency, conservation, energy prices etc., compare the attitudes to the behavior of the individuals over a longer period of time, and study the correlation (on a larger scale) between initial attitude and work input into efficiency. That correlation could be used for later predictions of reactions to energy efficiency programs.

Recommendations: More multifaceted analysis methods should be developed- to be able to develop efficiency predictions and recommendations on a case-by-case basis, efficiency programs will have to take into account more information than just isolated market behaviors, costs and benefits, and the process of the program.

7. Future Research

Future research in this project will involve the correlation of other variables involved in the efficiency rating process. Determining the correlation between specific variables, as well as specific values of the variables, and efficiency would provide further information in fields as diverse as advertising, city planning, energy policymaking, and tax lawmaking.

8. References

[1] Kavousian, A., R. Rajagopal, R. and M. Fischer, “Determinants of residential electricity consumption: Using smart meter data to examine the effect of climate, building characteristics, appliance stock, and occupants' behavior”, Energy, Volume 55, 15 June 2013, pp. 184-194

[2] Arimura, T., S. Li, R. G., Newell and K. Palmer, “Cost-Effectiveness of Electricity Energy Efficiency Programs”, NBER Working Paper No. 17556, October 2011. doi:10.3386/w17556

[3] Vine, E. and J. Sathaye, “Guidelines for the Monitoring, Evaluation, Reporting, Verification, and Certification of Energy-Efficiency Projects for Climate Change Mitigation”, LBNL-41543, Berkeley, CA: Lawrence Berkeley National Laboratory, 1999

[4] Bitar, E. Y., R. Rajagopal, P. P., Khargonekar and K. Poolla, “Bringing Wind Energy to Market”, IEEE PES Transactions on Power Systems, August 2012, Volume 27, Issue 3, pp. 1225-1235

[5] Carlsson-Kanyamaa, A. and A. L., Lindén, “Energy efficiency in residences—Challenges for

women and men in the North", Energy Policy, 2007, Volume 35, Issue 4, pp. 2163–2172

[6] Donatos, G. S. and G. J., Mergos, "Residential demand for electricity: The case of Greece", Energy Economics, 1991, Volume 13, Issue 1, pp. 41–47. doi:10.1016/0140-9883(91)90054-4

[7] Eissa, M. M., "Demand side management program evaluation based on industrial and commercial field data", Energy Policy, 2011, Volume 39, Issue (10), pp. 5961–5969. doi:10.1016/j.enpol.2011.06.057

[8] Greening, L. A., D. L., Greene and C. Difiglio, "Energy efficiency and consumption - the rebound effect - a survey", Energy Policy, 2000, Volume 28, pp. 389–401. Retrieved from http://www.sciencedirect.com/science/article/pii/S0301421500000215

[9] Giraudet, L., C., Guivarch, and P., Quirion. "Exploring the Potential for Energy Conservation in French Households through Hybrid Modeling", Energy Economics, 2011, Volume 34, Issue 2, pp. 426-445. Print

[10] Hillier, B., J., Hanson and J., Peponis, "What Do We Mean By Building Function?", Proceedings of the First Meeting of the Environmental Design Research Association, 1984, pp. 61–72. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/cbdv.200490137/abstract

[11] Internal Revenue Service, "Energy Incentives for Individuals in the American Recovery and Reinvestment Act", 2013. Retrieved from http://www.irs.gov/uac/Energy-Incentives-for-Individuals-in-the-American-Recovery-and-Reinvestment-Act

[12] Lang, S., "Progress in energy-efficiency standards for residential buildings in China", Energy and Buildings, 2004, Volume 36, Issue 12, pp. 1191–1196. doi:10.1016/j.enbuild.2003.09.014

[13] Lutzenhiser, L., M., Moezzi, D., Hungerford, C. E., Commission, R., Friedmann, P., Gas and E., Company, "Sticky Points in Modeling Household Energy Consumption Defining the Problem", 2010 ACEEE Summer Study on Energy Efficiency in Buildings, 2010, pp. 167–182

[14] Metcalf G.E. and K. A., Hassett, "Measuring the Energy Savings from Home Improvement Investments: Evidence from Monthly Billing Data", Review of Economics and Statistics, 1999, Volume 81, Issue 3, pp. 516-528

[15] Newsham, G. R., B. J., Birt and I. H., Rowlands, "A comparison of four methods to evaluate the effect of a utility residential air-conditioner load control programs on peak electricity use", Energy Policy, 2011, Volume 39, Issue 10, pp. 6376–6389. doi:10.1016/j.enpol.2011.07.038

[16] Saad, W., Z., Han, H. V., Poor and T. Basar, "Game-Theoretic Methods for the Smart Grid: An Overview of Microgrid Systems, Demand-Side Management, and Smart Grid Communications", Signal Processing Magazine, IEEE, 2011, Volume 29, Issue 5, pp. 86–105

[17] Rhodes, J. D., B., Stephens, and M. E., Webber, "Using energy audits to investigate the impacts of common air-conditioning design and installation issues on peak power demand and energy consumption in Austin, Texas", Energy and Buildings, 2011, Volume 43, Issue 11, pp. 3271–3278. doi:10.1016/j.enbuild.2011.08.032

[18] Ruderman, H., M. D., Levine, & J. E., McMahon, "The Behavior of the Market for Energy Efficiency in Residential Appliances Including Heating and Cooling Equipment" The Energy Journal, 1987, Volume 8, Issue 1, pp. 101–124

[19] US Department of Energy, "One Million Electric Vehicles By 2015", February 2011 Status Report, 2011, pp. 1–11