COMPARATIVE ANALYSIS OF THE RESIDENTIAL ENERGY EFFICIENCY POLICIES OF SIX MIDWESTERN STATES OF THE U.S.

Suchismita Bhattacharjee, Nichlas Emmons, Tarek Mahfouz and James Jones, Ball State University

Abstract

This study looked at the need for energy conservation and the use of renewable sources of energy, energy efficiency and renewable energy policies implemented by state governments in order to accelerate the development and deployment of energy efficient and renewable energy technologies. This research task represents an initial step in a line of research projects aimed at developing an automated methodology for decision support in the field of energy efficiency policy development and evaluation. As a first step, a solid point of departure for this research line should be established through a literature review and a comprehensive understanding of the current standing of energy efficiency policies in the United States. Consequently, the current research task focuses on residential energy efficiency policies in six Midwestern states, namely Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin, due to their proximity and familiarity to the authors.

This study employed a cross-sectional analysis to understand the components of energy efficiency policies in the aforementioned six Midwestern states in the U.S. Policy priorities were identified and predictions put forward about possible future directions of energy efficiency policy in these states. To that end, the Database of State Incentives for Renewables & Efficiency (DSIRE) has been used for data collection. The database provided detailed information about each policy, both at the state and municipal levels. The study provides the groundwork for more specific research targeted toward individual policies implemented across the states, identifying possible trends and conducting policy analyses to test policy efficiency.

Introduction

Energy conservation and the use of renewable sources of energy have gained increasing importance subsequent to the oil crisis of the 1970s. In recent years, the world has been faced with a serious shortage of energy which has heightened the need for energy efficiency. "Governors, state legislators, regulators, and citizens are increasingly recognizing that energy efficiency—the kilowatt-hours and gallons of gasoline we don't use as a result of improved technologies and practices—is the cheapest, cleanest, and quickest energy resource to deploy" [1]. As a result, energy efficiency policies are targeted towards creating necessary conditions to speed up the development and the deployment of energy-efficient equipment. These policies encourage people to use energy more efficiently; that is, get the maximum output from a minimum input of energy.

In the U.S., various energy efficiency policies have been developed and implemented at the federal level as well as at the state level. Usually, following the policies implemented at the federal level, each individual U.S. state implements its own set of policies, which are guided by the broader aspects of the federal policies. Some states such as California (ranked first among the 50 states in 2010 and second in 2011), Massachusetts (ranked first in 2011) and New York (ranked third in 2011) are more advanced compared to others with respect to the type and the number of energy efficiency policies implemented [1]. The world is undergoing vast changes that create unique challenges for development and implementation of efficient energy policies. In 2010, a total of $5.5 billion was allocated to support electricity and natural gas efficiency programs in the U.S. [1]. These challenges and their manifestations in societies are often very complex in nature and require integrated approaches to solve them.

Although energy efficiency policies represent a pressing demand for our communities, the literature does not include a lot of comparative or explanatory analysis to the ones currently in place. In one of the most recently developed reports, the American Council for Energy Efficient Economy (ACEEE) ranked the 50 states in relation to energy policies with respect to six areas: 1) utility and public benefits programs and policies; 2) transportation policies; 3) building energy codes; 4) combined heat and power; 5) state government initiatives; and 6) appliance efficiency standards [1]. To that end, this study presents a focused comparative analysis of the energy efficiency policies implemented at the six Midwestern U.S. States surrounding the Great Lakes. This research represents a point of departure for a research line aimed at developing a comprehensive decision support methodology for energy policy portfolio analysis.

Background

Over the past 30 years, several energy efficiency policies have been implemented in the U.S., which were guided mainly by three drivers [2]. The first major driver was the economic concern that evolved during the oil embargo of the 1970s. The second factor was the environmental movement that started in the early 1970s in response to urban smog and acid rain, and more recently to climate change. The third driver was the increasing energy cost for the consumer [2]. According to the 2011 ACEEE report, nearly every state implements a kind of energy efficiency program nowadays. "Driven by effective regulation from state utility commissions, utilities and third-party program administrators in some states have been delivering energy efficiency programs for decades, and offer various efficiency services for residential, commercial, industrial, and low-income customers." [1]. Policy-makers responded to the aforementioned market drivers by formulating two types of policies: (a) supply-push policies and (b) demand-pull policies [3]. Supply-push policies encouraged technological innovations while demand-pull policies created a market for emerging energy efficient technologies. Supply-push policies were mostly in the form of mandatory regulations, economic incentives and financial help for industries to promote energy efficiency or energy efficient products. Demand-pull policies were, for example, environmental regulations, regulations related to utilities, information and awareness programs, and subsidies for specific energy saving technologies.

Research Goals

The goal of this study was to perform a comparative analysis of the energy efficiency policies implemented in the six Midwestern states of Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin. Content analysis was used to comprehend and arrange large volumes of data collected from the Database of State Incentives for Renewables & Efficiency (DSIRE). The outcome of the analysis would assist in understanding the dynamics of currently implemented policies.

Rationale

The need for this study was justified by the following reasons. First, a majority of the existing literature in this area was survey-based. Therefore, this study focused on policy content and available socioeconomic information in order to gain an in-depth understanding of how instituted policies directly relate to state and local constituents [4-7]. Second, an analysis of energy efficiency policies implemented at the state level was an uncommon phenomenon. Several studies analyzed the effectiveness of energy efficiency policies at the national or international level [8-12]. Third, this study provided information to social scientists, such as political scientists and sociologists, to better understand the requirements of the efficiency policies. Finally, much of the available research was conducted at larger and advanced states, like California and New York, but never on the Midwestern states [13-15].

Methodology

This section provides a description of the adopted research methodology illustrated in Figure 1. To that end, the study included only the states in the Midwest region of U.S. surrounding the Great Lakes, namely Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin.

The method employed for this study was content analysis, which was used to analyze the explicitly mentioned components of each policy. Content analysis permitted the authors to develop a better understanding of energy efficiency policy portfolios of these six Midwestern states. To that end, 341 municipal energy efficiency policies listed under the six Midwestern states in the DSIRE database were first collected. Next, the authors went through the descriptions of all of the policies and shortlisted a total of 274 policies which focused only on the residential sector.

Content Analysis

Content analysis is a useful technique used to sort qualitative data and categorize them into a more methodological and systematic manner [16-18]. The study adhered to the rigorous process of content analysis as outlined by Robson [19]. After identifying the research questions, the sampling strategy was chosen, followed by identification of the recording unit. Subsequently, the analysis was conducted using the recording units.

The specific steps described here were performed in conducting the content analysis in order to analyze the residential energy efficiency policies in the states of Illinois, Indiana, Minnesota, Michigan, Ohio and Wisconsin. Each of these steps is described below, providing a detailed representation of how the data for this study were collected.

Research Question

The primary research question for the analysis was: What are the common components of energy efficiency policies in these six Midwestern states? A number of initiatives have
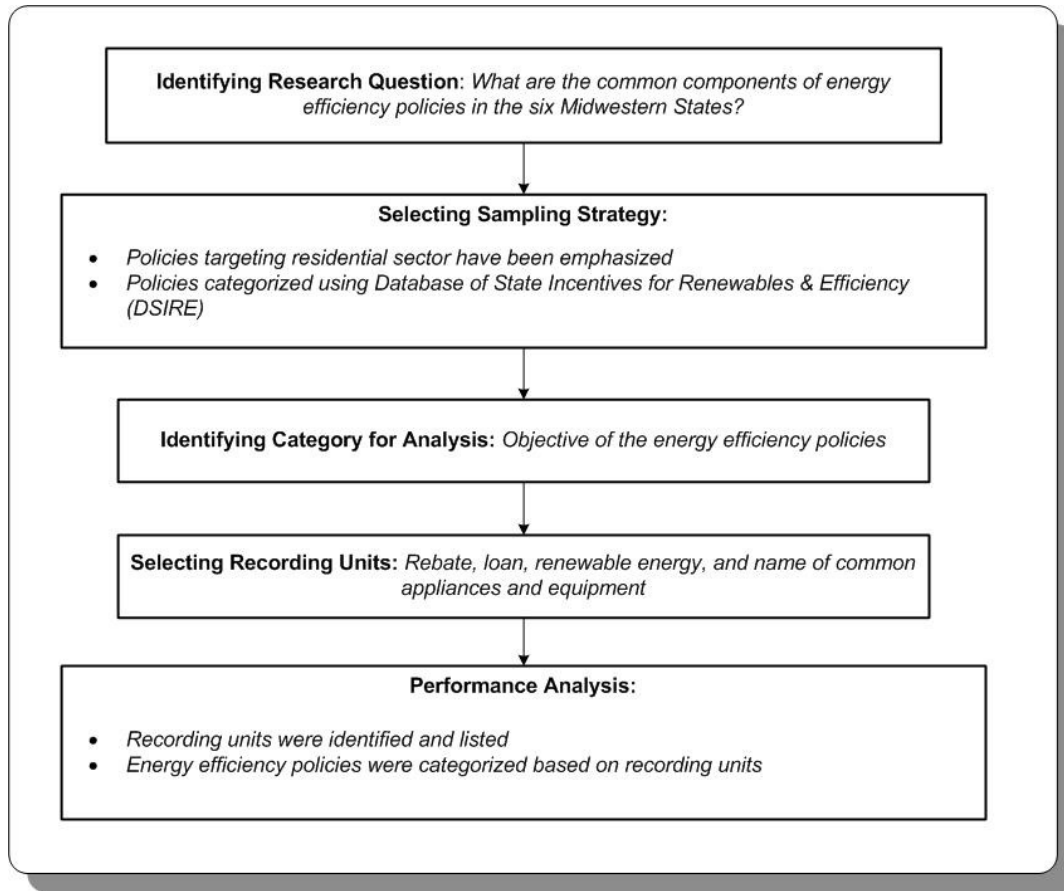
Figure 1. Research Methodology

been implemented at the state and local levels with the aim of increasing energy efficiency in the residential sector. This study evaluated these components in order to develop a better understanding of the incentives that are offered along with the types of appliances that are targeted by the policies.

Sampling Strategy

Energy efficiency policies targeting both residential and commercial sectors, and energy efficiency policies targeting only residential sectors, have been included. Based on the target sector, categorization of policies was performed using an energy efficiency policy online database, the Database of State Incentives for Renewables & Efficiency (DSIRE). DSIRE, a comprehensive source of information on state, local, utility and federal incentives and policies that encourages renewable energy and energy efficiency, was used for this study [20].

Category Analysis

The categories for analysis were based on the research questions. According to Holsti [21], there are several types of categories: subject matter, direction, values, goals, methods, traits, actors, authority, location, conflict and ending. For this study, the category for analysis was the objective of the energy efficiency policies. The categories were exhaustive and mutually exclusive.

The primary objective of residential energy efficiency policies is to generate the required conditions that can expedite both advancement and deployment of market efficient equipment through the following means: (a) knowledge for and interaction with the end users, (b) potential threat shared with both distributor and producer, (c) research, development and diffusion of the skill inherent in energy efficiency sectors, (d) operation of particular mechanisms pertaining to finance, and (e) parameters for the consumers and/or of equipment used [22].

Recording Unit

Apart from defining the categories to be used, another important task was to select the recording unit. Individual words were used as the recording unit for this study. Each time a particular word occurred, it was counted as one, and counts of these occurrences were made and compared. Due to the simplicity of the approach, authors could distinguish between words with multiple meanings and code phrases that constituted a semantic unit. For this study, units of interest were "incentive", "rebate", "loan", "renewable energy", and names of particular appliances or equipment.

Analysis

The analysis of the information followed three steps. Consistency was considered to be the key for this study, so the standards were strictly met. The three-step process of analysis was:

    a. Each policy description was studied once to find the recording units. Generally, exact words or phrases were not found; instead, the understood meaning was considered. Brief notes were made when something containing relevant information appeared.

    b. The policy descriptions were studied again and a list of all of the identified recording units was finalized.

    c. Finally, the energy efficiency policies were categorized based on the recording units.

Results

The four analyses that were conducted for this study were: (a) type of policies (residential alone and residential with other audiences), (b) the types of appliances that were included in the policies, (c) the policies that have either an energy efficiency or renewable energy focus, and (d) the types of incentives offered. The background of policy content and purpose provided by the analyses would act as a foundation for subsequent investigations.

In an attempt to validate the forthcoming outcomes of the adopted research methodology, an investigation of the underlying probability distribution of the addressed populations (six Midwestern states) was performed. To that end, a one-way ANOVA and a correlation analysis were performed on data gathered from these states. The aforementioned analyses were performed using 20 factors:

Median household income
Median age of people
% Male
% Female
Population
% White
% African American
% American Indian
% Native Hawaiian
% of two or more races
% Hispanic or Latino
% White, not Hispanic or Latino
Number of households
Number of industries
% HS Diploma
% Bachelor's
Per Capita Energy Consumption -- Million Btu
Number of heating degree days
Energy Price -- per million Btu

Table 1 includes the outcomes of the correlation analysis, while Table 2 identifies the results of the ANOVA analysis. A closer look at these outcomes shows that there is a strong correlation between the six states. The values ranged between a maximum of 0.999987 to a minimum of 0.999613. Furthermore, the achieved an F value of 0.246 compared to a critical F value of 2.29 illustrates that there is an overlap between the underlying sampled populations. This was expected due to the fact that the analyzed states operate under one major governmental policy that supports the development and implementation of efficient energy policies at the state level. As defined by Elizabeth Doris, Jaquelin Cochran, and Martin Vorum in the Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government report [23], the efficient energy policies in the U.S. aims at lowering energy bills, improving air quality, reducing greenhouse gases, increasing energy security and deferring the need to invest in new infrastructure. This finding is further supported by the notion that the analyzed states are Midwestern ones, which mandates similarities of the underlying distributions.

Table 1. Correlation Analysis of the 6 States

	IL	IN	MI	MN	OH	WI
IL	1					
IN	0.999945	1				
MI	0.999757	0.999876	1			
MN	0.999933	0.999858	0.999757	1		
OH	0.999626	0.999802	0.999983	0.999613	1	
WI	0.999905	0.999987	0.999931	0.999861	0.999872	1

Within the first analysis (Figure 2), it was found that Michigan had the highest percentage (96.8%) of programs targeting residential audiences only, with nearly every policy aimed at energy efficiency of residential users. Indiana

had the highest percentage (47.4%) of programs targeting both residential and other audiences, including businesses and schools. Illinois and Ohio had an equal distribution in both categories, whereas two-thirds of programs implemented in Wisconsin were aimed at residential audiences.

Table 2. Outcomes of ANOVA Analysis of the 6 States

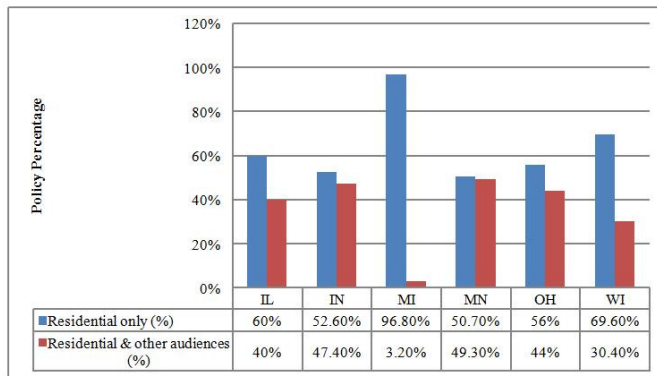| Source of	SS	df	MS	F	P-	F crit.
Between	5.59E+12	5	1.12E+12	0.246	0.94	2.29
Within	5.19E+14	114	4.55E+12			
Total	5.25E+14	119				

Figure 2. Policies in the Six States Targeting Residential Audiences

The second analysis explored the types of appliances that were targeted by the energy efficiency polices of all the six states (Table 3). A majority of the energy efficiency policies of Indiana, Ohio, Minnesota and Wisconsin targeted heat pumps and water heaters, whereas the policies of Illinois focused on water heaters and furnaces. The primary focus of the policies of Michigan was clothes washers. In all of the six states, central air conditioners were targeted by approximately 48% of the policies. Overall, Indiana and Michigan had the greatest number of policies targeting appliances, whereas Illinois had the lowest number of policies.

The third analysis examined whether the policies had an energy efficiency or a renewable energy focus (Figure 3 and Table 4). Table 4 explains various types of policies that were in demand. There was an overlap in some cases where both energy efficiency and renewable energy were focused within the same policy. However, the vast majority (85.6%) of all programs focus on energy efficiency and more than half (59.8%) also featured incentives for renewable energy technologies. Michigan had the highest percentage (93.5%) of energy efficiency programs; however, a little more than one in ten (12.9%) of those focused on renewable energy. Indiana was most likely to support the use of renewable

energy policies with more than three-fourths of the programs encouraging their use.

Table 3. Percentage of the Policies Implemented in the Six States Targeting the Different Residential Appliances

Appliances	IL %	IN %	MI %	MN	OH %	WI %
Water heater	75.0	75.0	37.0	55.7	63.2	72.2
Space heater	25.0	3.1	0.0	3.8	15.8	16.7
Heat pump	50.0	84.4	11.1	68.9	68.4	57.9
Pool heater	8.3	3.1	0.0	1.6	0.0	16.7
Refrigerator	25.0	3.1	29.6	63.9	21.0	33.3
Freezer	0.0	0.0	0.0	0.0	0.0	5.5
Dehumidifier	8.3	0.0	14.8	44.3	5.3	11.1
Ceiling fan	8.3	0.0	7.4	29.5	15.8	0.0
Furnace	58.3	15.6	44.4	31.1	47.4	50.0
Central air condi-	41.7	43.8	63.0	67.2	36.8	50.0
Room air condi-	16.7	0.0	14.8	36.1	5.3	5.5
Clothes washer	8.3	15.6	70.4	62.2	5.3	16.7
Clothes dryer	0.0	0.0	3.7	0.0	0.0	0.0
Boiler	33.3	9.8	18.5	24.6	21.1	50.0
DE super heater	8.3	0.0	0.0	0.0	0.0	0.0
Back-up genera-	0.0	3.1	0.0	0.0	0.0	0.0
Dishwasher	0.0	0.0	7.4	55.7	5.3	16.7
Total number of	12.0	32.0	27.0	61.0	19.0	18.0

Table 4. Percentage of the Policies Targeting Renewable Energy

State	Renewable (%)
IL	53.3
IN	76.3
MI	12.9
MN	56.3
OH	48.0
WI	60.9
Total	59.8

To gain further insight into the topic, a comparison of the types of incentives that were offered within the policies was performed (Table 5). The majority (76.5%) of residential energy efficiency programs were rebates for using energy efficient or renewable technologies. Loans were the least popular (9.1%), except in Wisconsin (21.7%) and Ohio (20%). Michigan dominated the rebate category (93.5%) and offered no residential loans. Other forms of incentives were present in all states. Those that were not rebates or loans accounted for a relatively small portion (14.4%) of overall energy efficiency policies.
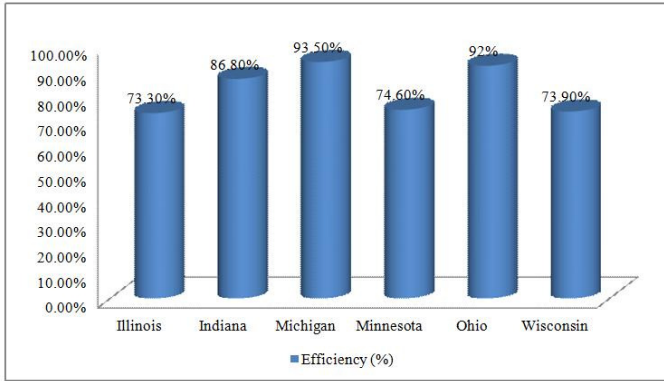
Figure 3. Percentage of the Policies Implemented in the Six States Targeting Energy Efficiency

Table 5. Percentage of the Policies Implemented in the Six States that are Either Rebates, Loans or Other Types

State	Rebate	Loan (%)	Other (%)
IL	66.7	6.7	26.7
IN	86.8	2.6	10.5
MI	93.5	0.0	6.5
MN	77.5	14.1	8.5
OH	68.0	20.0	12.0
WI	52.2	21.7	26.1
Total	76.5	9.1	14.4

Discussion

The aforementioned findings are encouraging because of the potential implication. This means that the Midwestern states recognized the need to offer financial incentives to constituent homeowners. Large areas of rural communities could be the reason for the greater number of policies targeting appliances in Michigan and Ohio compared to Illinois; the larger the influence of rural communities, where homeownership is higher, the more relevant the need for financial assistance for energy efficient appliances. Indiana and Michigan have larger areas of land that is mostly rural, whereas the influence of Chicago often sways decision-making in Illinois. Indiana's support to increase the use of renewable energy is most likely a result of the movement within the state to harness ethanol-based fuels. Additionally, it is encouraging to notice that a high proportion of the policies implemented in the six Midwestern states focus on renewable energy and energy efficiency. At the same time, the policies should continue increasing their focus on renewable technologies.

Although these outcomes might not fully comply with the outcomes of the 2011 ACEEE report in regards to the rank-

ing of states, this fact contributes to the focus of the current research. As mentioned earlier, the ACEEE report considers six area of energy efficiency, namely Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin. On the other hand, this study provides a more focused look at policies targeting residential construction and energy saving appliances.

This study helped to identify the possible methods to enhance energy efficiency policy at the local and state levels, in addition to serving as a model for the development of federal energy policy. Beyond the environmental benefits gained from enhanced energy efficiency policies, human health and well-being will likely improve as a result of better financial incentives built into energy efficiency policies and the shift from conventional energies to renewable technologies.

Conclusion

The purpose of this study was to create a preliminary understanding of the focus of energy efficiency policies implemented in six Midwestern states. This study can possibly serve as a model in the study of energy policies at the local, state and federal levels. The analyses identified the types of financial incentives for residential users and found that an overwhelming majority of these incentives was in the form of rebates. It would be interesting to analyze the evolution of these types of policies to better understand how incentives have changed. In addition to the rebate programs in these six states, the economic market for loan programs is still alive.

Directions for future research would include further analysis of environmental and energy policies in the United States. There also exists the opportunity to compare domestic residential energy efficiency policies with international energy efficiency policies. Studies reflecting on the evolution of energy policy in the United States—at the federal and state levels—will assist in developing a broader concept of projected trends for the future. Finally, it would be of special interest to stakeholders to look at how climate change affects the incentives and incentive types of these policies.

The results of this study should be considered carefully due to possible limitations. First, this was a cross-sectional analysis of a convenience sample of six states only, posing a threat to external validity. The results cannot be generalized to the entire United States policy scenario. Second, researchers could have made errors in interpretation of policy content. However, this was controlled by assessment of all policies by two independent researchers. The study was

delimited to the DSIRE database, which may not be up-to-date, resulting in some missing elements of policies. Finally, due to a small number of states considered in this study, in-depth quantitative analyses could not be conducted. There may be more insights that can be revealed with a larger sample that would allow for a detailed quantitative analysis in addition to content analysis.

References

[1] American Council for an Energy-Efficient Economy. (2011, October). *The 2011 State Energy Efficiency Scorecard*. (Report No. E115). Washington, D.C.

[2] Norberg-Bohm V. (2000). Creating incentives for environmentally enhancing technological change: lessons from 30 years of U.S. Energy technology policy. *Technological Forecasting and Social Change*, 65:125-48.

[3] Resource for the future. (2004, July). *Retrospective examination of demand side energy efficiency policies.* Washington, DC.

[4] Austin, C. M., Pande, A., & Mahone, D. (2009). *A study of international appliance standards enforcement strategies*. Paper presented at the 2009 International Energy Program Evaluation Conference, Portland, Oregon, U.S.

[5] Wiser, R., Porter, K., & Grace, R. (2005). Evaluating Experience with Renewables Portfolio Standards in the United States. *Mitigation and Adaptation Strategies for Global Change*, 10(2), 237-63.

[6] Frondel, M., & Schmidt, C. M. (2005). Evaluating Environmental Programs: the Perspective of Modern Evaluation Research. *Ecological Economics*, 55(4), 515-26.

[7] Lee, W. L., & Yik, F. (2004). Regulatory and Voluntary Approaches for Enhancing Building Energy Efficiency. *Progress in Energy and Combustion Science*, 30(5), 477-99.

[8] Sutherland, R. J. (2003). The High Costs of Federal Energy Efficiency Standards for Residential Appliances. *Cato Policy Analysis*, No 504.

[9] Schiellerup, P. (2002). An Examination of the Effectiveness of the EU Minimum Standard on Cold Appliances: The British Case. *Energy Policy*, 30(4), 327-32.

[10] Mahlia, T., Masjuki, H., Saidur, R., & Amalina, M. (2004). Cost-Benefit Analysis of Implementing Minimum Energy Efficiency Standards for Household Refrigerator-Freezers in Malaysia. *Energy Policy*, 32(16), 1819-24.

[11] Alberini, A., & Segerson, K. (2002). Assessing voluntary programs to improve environmental quality. *Environmental and Resource Economics*, 22(1-2), 157-184.

[12] Banerjee, A., & Solomon, B. D. (2003). Eco-labeling for Energy Efficiency and Sustainability: A Meta-Evaluation of U.S. Programs. *Energy Policy*, 31(2), 109-23.

[13] Margaret, T. (2008). Beyond Technology-Push and Demand-Pull: Lessons from California's Solar Policy. *Energy Economics*, 30(6), 2829-54.

[14] Orans, R., Price, S., Williams, J., Woo, C. K., & Moore, J. A. (2007). Northern California–British Columbia Partnership for Renewable Energy. *Energy Policy*, 35(8), 3979-83.

[15] Wiser, R., Pickle, S., & Goldman, C. (1998). Renewable Energy Policy And Electricity Restructuring: A California Case Study. *Energy Policy*, 26(6), 465-75.

[16] Berelson, B. (1952). *Content analysis in communication research.* New York, The free Press.

[17] Stemler, S. (2001). An overview of content analysis. *Practical Assessment, Research & Evaluation*, 7(7).

[18] Weber, R. P. (1985). *Basic content analysis*. Beverly Hills, California, U.S.: Sage Publications.

[19] Robson, C. (2002). *Real world research*. Malden, Massachusetts, U.S.: Blackwell Publishing.

[20] DSIRE. (2009). *Database of State Incentives for Renewable & Efficiency Raleigh*. North Carolina, U.S.; NC State University.

[21] Holsti, O. R. (1969). *Content Analysis for the Social Sciences and Humanities Reading*. Massachusetts, U.S. Addison Wesley.

[22] World Energy Council. (2008). *Energy Efficiency Policies around the World: Review and Evaluation.* London, UK.

[23] National Renewable Energy Laboratory. (2009, December). *Energy Efficiency Policy in the United States: Overview of Trends at Different Levels of Government*. (Report No NREL/TP-6A2-46532). Golden, Colorado, USA.

Biographies

SUCHISMITA BHATTACHARJEE is Assistant Professor of Construction Management at the Department of Technology, Ball State University. She earned her Bachelor of Architecture (2005) from Jadavpur University (India), MS (Construction Management, 2007) from Michigan State University, and a Doctoral degree (Building Construction, 2010) from Virginia Polytechnic Institute & State University. Dr. Bhattacharjee's main research interests are in the areas of renewable energy policies, decision support for energy decision making, building information modeling, and building diagnostics. She is an ATMAE member. Dr. Bhattacharjee may be reached at sbhattacharj@bs.edu

NICHLAS EMMONS is a graduate student at the Department of Natural Resources & Env. Manage., Ball State University. Nichlas may be reached at ndemmons@bsu.edu

TAREK MAHFOUZ is Assistant Professor of Construction Management at the Department of Technology, Ball State University. He earned his B.Sc. (Construction Engineering, 2000) from the American University in Cairo (AUC), MS (Construction Engineering, 2005) from the American University in Cairo (AUC), and a Doctoral degree (Civil Engineering with specialization in Construction Engineering and Management, 2009) from Iowa State University. Dr. Mahfouz's main research interests are in the use of information technology, machine learning, and statistical modeling for knowledge management and decision support in the construction industry. He is a ASCE associate member, Construction Research Congress (CRC) committee member, ASCE Data Sensing and analysis (DSA) committee member, and ASCE Technical Council for Computing and Information Technology (TCCIT) committee member. Dr. Mahfouz may be reached at tmahfouz@bsu.edu

JAMES JONES is Associate Professor of Construction Management at the Department of Technology, Ball State University. He earned his B.Sc. (Civil Engineering, 1992) from Purdue University, M. Eng. (Engineering Management, 2000) from the University of Idaho, M.A. (Adult and Community Education, 2004) from Ball State University, and Ed.D. (Adult, Community, and Higher Education Cognate: Executive Development for Public Service, 2008) from Ball State University. Dr. Jones may be reached at jwjones@bsu.edu