RESEARCH REPORT

Americans' Perceived and Actual Understanding of Energy

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Abstract

Addressing individual and household energy consumption behavior will require that we assess public understanding of energy. Despite this logic, there is scant social science evidence regarding current public understanding of energy in the United States. We began to address this deficit with a web-based survey to assess Americans' perceived and actual knowledge related to energy. We interviewed a nationally representative sample of respondents ($N = 816$) from Knowledge Networks' KnowledgePanel in fall 2011. Rather than attempting to assess a single, all-encompassing indicator, we pursued a constellation of specific measures that reflect the range of energy information interpretation tasks people engage in on a daily basis. This decision reflects our claim that public understanding of energy is multifaceted and might be operationalized in several ways that will not perfectly co-vary. Specifically, we measured three concepts: perceived understanding of energy, demonstrated energy knowledge, and the ability to interpret an energy bill. Results suggest that public understanding of energy is multifaceted; perceived understanding is not directly equivalent to actual understanding in many cases. Moreover, a range of factors predicted each of our outcome variables. Results of our work have implications for future policy and intervention.

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Introduction

In a presentation at Columbia University at the dawn of the present century, Nobel prize–winning scientist Richard Smalley (2003) concluded that the most important issue and greatest challenge facing humanity is energy. There are myriad reasons for this conclusion, not the least of which is the centrality of energy availability to contemporary living standards. Rather than assuming the topic of energy to constitute a single issue, though, we can view the topic as multifaceted, encompassing dimensions as diverse as production technology, efficiency improvement trends, and human behavior, all of which currently pose concerns for researchers and policymakers. Scientific and technological questions related to energy supply, distribution, and storage are undoubtedly critical, and academic literature related to energy has focused substantially on those issues (e.g., Davis, 2011). Nonetheless, we also need to know more about individual and household-level energy demand. Citizen behavior and support for energy policy initiatives will affect how and to what extent the United States and other countries are able to address energy challenges (Hegedus & Temple, 2011).

Understanding citizen energy consumption behavior requires that we assess *public understanding* of energy. We know that individual behavior likely is a function, at least in part, of human cognition regarding energy; behavioral scientists tend to agree that volitional behavior is a function of intention, which itself is affected by ideas about the behavior in question (see Fishbein & Ajzen, 2010, for discussion). Moreover, insofar as democracies rely on informed decision making by citizens, public understanding of energy also constrains possibilities for policymaking. In other words, public conceptualization of energy-related issues likely will be vital into the foreseeable future both as a political force and as a factor affecting actual consumption patterns. Despite this logic, we have scant social science evidence regarding current public understanding of energy in the United States.

We do know that, objectively measured, Americans' understanding of science in general has not been particularly robust in recent decades. Miller (2004), for example, reviewed respondent performance on science understanding questions in the National Science Board's Science and Engineering Indicators studies across a 40-year span. While the ability to describe what it means to study something scientifically (in response to an open-ended question) improved modestly from the late 1950s through the late 1990s, at best only roughly a fifth of respondents appeared to have a clear understanding of the importance of experiments or other rigorous study design methods to the scientific approach. Knowledge of common scientific constructs is also far from universal in the US. As recently as the late 1990s, Miller notes, less than 15 percent of respondents to National Science Board studies could correctly explain what a molecule is.

What much of the available public understanding of science work does not do, however, is offer extensive, nationally representative insight as to Americans' specific understanding of *energy* per se. Studies that attempt to link science knowledge to other constructs, such as predictions of science perceptions or explanations as a function of educational attainment, often rely on broad knowledge indices that span various domains. Nisbet and colleagues (2002), for example, employed a 14-item science knowledge measure that included a diverse array of National Science Board questions about how lasers work, the relative size of electrons and atoms, the efficacy of antibiotics to kill viruses and bacteria, and whether the Earth goes around the Sun or vice versa, among other topics. We lack substantial empirical evidence of the extent of Americans' understanding of energy science.

Certainly, researchers have produced social science evidence relevant to energy. Some public opinion work, for example, has focused on specific policy issues or political controversies such as new power plant construction (Ansolabehere & Konisky 2009; Bolsen & Cook, 2008). Other survey efforts, such as the Residential Energy Consumption Survey conducted by the Energy Information Administration of the US Department of Energy, have focused on describing actual consumption patterns. What these peer-reviewed studies typically have not done, however, is to assess US consumers' comprehension of energy facts or their ability to engage and interpret utility bill information, areas of citizen knowledge related to what some have labeled "energy literacy" (e.g., DeWaters & Powers, 2011; Sovacool, 2011). (Aside from peer-reviewed literature, some past nonprofit foundation reports have begun to look at public understanding of energy, e.g., National Environmental Education & Training Foundation and RoperASW, 2002, and we build on that work here.)

The exact importance of specific knowledge and understanding from a public policy perspective is subject to debate. People are clearly capable of forming opinions about various scientific topics in the absence of substantial factual knowledge; Scheufele and Lewenstein's (2005) work, for example, illustrates how people make sense of emerging technologies such as nanotechnology by relying on existing and available mental heuristics to make judgments about novel information. Much recent work, e.g., Krosnick, Holbrook, Lowe, and Visser, (2006), has focused on popular beliefs about the political importance of climate change that are not necessarily equivalent with knowledge of scientific research on the topic. Insofar as popular support for scientific research matters politically, survey research to measure such dimensions of public opinion is logical. What such research often does not do is assess the nature, complexity, and adequacy of citizens' grasp of specific scientific constructs in a way that might offer insights for future public education and intervention.

In light of these gaps in existing literature, we sought both to assess current consumer knowledge regarding energy and to understand how that knowledge corresponds to *perceived* understanding of energy among a sample of US residents. Building on past research on energy knowledge with high school students (DeWaters & Powers, 2011), we developed an 11-item energy knowledge index and administered that measure to a nationally representative sample of US householders. We also assessed the extent to which Americans could interpret and use information presented on a prototypical household energy bill to answer questions about energy consumption. We then compared patterns in demonstrated knowledge against respondents' own reported assessment of their ability to understand the topic of energy. Lastly, we predicted various knowledge outcomes as a function of demographic variables.

Methods

Procedure

We developed a 30-minute survey instrument using original and existing items related to energy consumption, knowledge, attitudes, and behaviors, an instrument called the Energy Behavior, Knowledge, and Opinions Survey (Murphy et al., 2011). The survey assessed a wide array of household energy behaviors, energy perceptions, and beliefs about energy; the key outcomes and predictors relevant to this paper are outlined in the Key Measures section below.

To assess potential problems that respondents might face in completing the questionnaire, we utilized RTI International's Question Appraisal System (QAS). The QAS is an instrument review methodology that assists in evaluating problems that often plague items within an instrument, such as vague reference periods, incomplete instructions on how to answer a question, and the use of technical terms that a respondent may not understand (Willis & Lessler, 1999).

After the QAS review, we held cognitive interviews with homeowners and renters, mirroring procedures that would be followed when the survey was fielded. Participants logged into a test site and answered the survey questions on the web, and the interviewer stopped the participant on occasion to discuss the questions and probe further to understand how he or she interpreted the question or came up with that answer. The interviews assessed the cognitive burden of questions, detected questions that were unclear to respondents, and measured overall impressions and reactions to the survey instrument. Findings from the cognitive interviews led to further revisions to the instrument.

The target population for the survey consisted of noninstitutionalized adults age 18 or older residing in the United States. Knowledge Networks sampled households from its KnowledgePanel, a probability-based web panel designed to be representative of the United States. Staff administered the survey via the web from September 28, 2011, to October 13, 2011.

The final sample (N = 816) included participants from 49 states plus the District of Columbia, which helped to ensure that results were not unduly affected by state variability in tiered pricing or other billing norms. (Rhode Island did not contribute a survey participant, but the statistical chance of such contribution from the panel was close to zero given that the state contributes less than 1 percent of the national population.)

Only those who first consented to complete the energy survey participated. Also, only those who deemed themselves to be the most knowledgeable in their household about energy were invited to participate. Participants received incentive credits (not redeemable for cash, but equivalent to $5 in value from participating vendors) for their participation.

To combat potential bias effects of nonresponse among those invited to participate, Knowledge Networks sent three rounds of e-mail reminders to those not responding (all during the field period). Response to survey invitation was reasonably high. Knowledge Networks obtained a completion rate of 59.1 percent, meaning that about 6 in 10 from their sample completed the survey screener. Of those who completed the screener, 80.7 percent were eligible for the survey. Among eligibles, 94.6 percent, or 816, consented and completed the survey. (Further documentation regarding general KnowledgePanel sampling, data collection procedures, and weighting is available at http://www.knowledgenetworks.com/knpanel/index.html.)

Key Measures

Rather than attempting to assess a single, all-encompassing indicator, we pursued an array of specific measures that reflect the range of energy information interpretation tasks in which people engage in on a daily basis. This decision reflects our claim that public understanding of energy is multifaceted and might be operationalized in several ways that will not perfectly co-vary. Specifically, we measured three concepts: perceived understanding of energy, demonstrated energy knowledge, and the ability to interpret an energy bill. All questions were closed-ended with multiple choice responses.

Perceived Understanding of Energy

Prior to asking about factual knowledge and the ability to interpret numbers presented on a bill, we asked respondents for a summary judgment of the extent to which people similar to them can understand the general topic of energy. We adapted a measure from previous work on public understanding of science by Southwell and Torres (2006) to assess perceived understanding of energy. Using a five-point scale, we asked respondents the extent to which they agreed or disagreed with the following statement: "Energy is a topic that people like me can understand." Responses ranged from "strongly agree" to "strongly disagree."

Energy Knowledge

To assess actual energy knowledge, we developed an index using items drawn and adapted from a bank of 38 energy knowledge items constructed by DeWaters and Powers (2011). We consulted with a range of academic energy experts as well as officials at the US Department of Energy and incorporated expert feedback into the questions. Using 2008–2009 survey data from 1,211 New York high school students made available by DeWaters and Powers, we also assessed the short (11-item) and full (38-item) indices in terms of their shared linear relationship and found Pearson $r = .84$ ($p < .001$) for the two index versions.

Table 1 summarizes the final set of knowledge index items and the percentage selecting the correct answer to each question. Appendix A shows examples of complete wording used for questions in the online survey.

Table 1. Respondent performance on individual knowledge items

Knowledge item (*n* responding)	Correct answer	% respondents (weighted) answering correctly
The original source of energy for almost all living things is … (*n* = 807)	The sun	85
The amount of energy consumed by an electrical appliance is equal to the power rating of the appliance (watts or kilowatts) … (*n* = 772)	Multiplied by the time it's used	47
What does it mean if an electric power plant is 35% efficient? (*n* = 768)	For every 100 units of energy that go into the plant, 35 units are converted into electrical energy	67
It is impossible to … (*n* = 780)	Build a machine that produces more energy than it uses	51
The term "renewable energy resources" means … (*n* = 799)	Resources that can be replenished by nature in a short period of time	65
Which of the following energy resources is not renewable? (*n* = 797)	Coal	67
Most of the renewable electrical energy used in the United States comes from … (*n* = 793)	Water (hydro) power	41
Which of the following choices always saves energy? (*n* = 782)	Turning off the car engine when the car is stopped for 15 seconds or more	31
Which uses the most energy in the average American home in one year? (*n* = 805)	Heating and cooling rooms	66
Which typically uses the least energy in the average American home in one year? (*n* = 805)	Lighting the home	38
Which of the following sources provides the most electricity in the United States? (*n* = 795)	Burning coal	38

Energy Bill Interpretation Ability

In light of the importance of consumer understanding of household bill information (Payne, 2000), we included three tasks related to interpretation of a hypothetical energy bill formatted to appear as a typical bill and displayed as a graphic figure in the questionnaire. See Figure 1 on the following page for a depiction of the bill.

For example, we asked, "Using this month's energy usage total, if the average rate was $0.12/KWH, what would the month's charges be (before taxes or the renewable energy rider)?" and offered a series of multiple choice responses (including the correct response). We also computed an index (ranging from zero to three) of total correct responses across the three questions. Table 2 provides the questions asked, the correct answers, and the percentage responding correctly.

Table 2. Respondent performance on bill interpretation items

Bill interpretation item (*n* responding)	Correct answer	% respondents (weighted) answering correctly
Using this month's energy usage total, if the average rate was $0.12/KWH, what would the month's charges be (before taxes or the renewable energy rider)? (*n* = 765)	$257.52	70
If the occupant had decreased power usage by 300 KWH in the billing month, how much money would he/she have saved (before taxes or the renewable energy rider)? (*n* = 751)	$27.33	39
If next month's meter reading is 94627, how many KWHs did the residence use in the billing month? (*n* = 755)	1,865	63

KWH = kilowatt-hour.

Figure 1. Hypothetical energy bill used in the questionnaire

Energy Company

John Q. Doe
112 Main St, Anytown, USA

Account Number	1234567890
Verification Code	8
Bill Date	6/14/2011
Current Charges Past Due After	7/11/2011

Service From: MAY 11 to JUN 11 Your next meter reading is between JUL 13 and JUL 18

PREVIOUS BILL AMOUNT	PAYMENTS (-)	NEW CHARGES (+)	ADJUSTMENTS (+ OR -)	AMOUNT DUE (=)
$119.78	$119.78	$194.34	$0.00	$194.34

METER NUMBER	METER READINGS PREVIOUS, PRESENT		TOTAL USAGE	RATE SCHEDULE DESCRIPTION	AMOUNT
123456	90616	92762	2, 146 KWH	Residential Service	188.44
				Renewable Energy Rider	0.24
				Sales Tax	5.66
				Amount Due	194.34

BASIC CHARGE RATES		
FIRST 10		$17.40
NEXT 500	X $0.0440	$22.00
NEXT 1636	X $0.0911	$149.04
ENERGY (KWH)	2146 X $0.0878	$188.44

Electricity Usage	This Month
Total KWH	2,146
Days	31
AVG KWH per Day	69
AVG Cost per Day	$6.08

Our records indicate your telephone number is XXX-XXX-XXXX. If this is incorrect, please follow the instructions on the back.

A late payment charge of XX% will be added to any past due utility balance not paid within 25 days of the bill date.

RETURN THIS PORTION WITH YOUR PAYMENT TO THE ADDRESS BELOW. THANK YOU.

For Correspondence: PO BOX 70516
Anytown, USA
ENERGY PHONE: 800-777-7777 www.energycompany.com

9123438783509042245000400019434000143566000088 0 66 0

John Q. Doe
112 Main St.
Anytown, USA

Account Number	1234567890
Verification Code	8
Amount Due	$194.34
Current Charges Past Due After	7/11/2011

Energy Company PO BOX 70516
Anytown, USA

Total Amount Enclosed $

KWH=kilowatt-hour.

Analysis

In our Results section, we report frequencies and multivariate relationships to address the following research questions:

- Do Americans believe energy is a topic they can understand? What characteristics are associated with a higher level of perceived understanding?
- How well do Americans fare on a test of energy knowledge? What characteristics are associated with higher scores, and how does knowledge relate to performance?

All results reflect use of a post-stratification weighting variable developed post hoc by Knowledge Networks to adjust for potential response bias relative to a national adult population. Demographics included in the multivariate models include educational attainment, income, age, US geographic region, sex, housing type, home ownership, and whether the respondent lives in a metropolitan statistical area (MSA).

For prediction of perceived understanding, we used logistic regression to predict the agreement that a respondent could understand energy as a topic (using a 3 or higher on the 5-point scale as an affirmative response) as a function of demographic variables (including education, income, age, sex, residential ownership, and metropolitan statistical area status). For the model used to predict the energy knowledge score, we included perceived understanding as a predictor, along with demographic variables, and used ordinary least squares (OLS) regression. For the model predicting the energy bill interpretation score, we included both perceived understanding and the energy knowledge index score as predictors, along with demographic variables, in an OLS regression model. The final models employed backward selection; only predictors significant at the $p < .05$ level were retained. (For example, sex was included as initial predictor in analysis for all models but was dropped from the final model predicting bill interpretation as it did not garner a significant coefficient.)

Results

Perceived Understanding

Most respondents reported that people like them can understand energy. Approximately 79 percent either agree or strongly agree that energy is a topic that "people like me" can understand. Controlling for other factors in a multivariate logistic regression model predicting agreement with the perceived understanding statement, educational attainment (ranging from less than high school to a bachelor's degree or more) predicted perception of understanding, ranging from a low of 70 percent for those with less than a high school degree to 87 percent for those with a bachelor's degree or higher. (All categories of respondents differed in perceived understanding in comparison with those with a bachelor's degree or more, $p < .05$.) This suggests those with more formal education are more likely to think that energy is topically accessible for people like themselves. In addition, those whose household income was between $50,000 and $99,999 were significantly less likely to agree that people like them understand energy than were those with a household income of $100,000 or more (76 percent vs. 90 percent, $p = .0074$). Males were more likely to report that people like them can understand energy than females (86 percent vs. 74 percent, $p < .0001$). Table 3 provides the full model results.

Table 3. Perceived understanding of energy: frequencies and logistic regression model results

Characteristics	*N* (unweighted)	% who agree energy is something "people like me" can understand (weighted)	Odds ratio	Standard error	*p*-value
Intercept	—	—	—	0.22	<.0001
Education					
Less than high school	76	70	0.31	0.33	0.0003
High school	224	76	0.53	0.26	0.0155
Some college	244	79	0.59	0.26	0.0438
Bachelor's or higher	268	87	—	—	—
Household income					
<$25,000	138	77	0.75	0.30	0.3463
$25,000–$49,999	150	79	0.64	0.31	0.1419
$50,000–$99,999	281	76	0.50	0.26	0.0074
$100,000+	203	90	—	—	—
Sex					
Male	434	86	2.27	0.18	<.0001
Female	378	74	—	—	—

— = Not applicable or not statistically significant.

Note: Analysis used backward selection; only variables garnering a significant coefficient in a full model are included here.

Energy Knowledge

Actual performance on the energy knowledge assessment reflected a different view of the extent to which respondents understand energy. Most respondents answered *less than 60 percent* of the knowledge items correctly. In other words, when tested regarding their energy knowledge, more than half of all respondents essentially failed the test. The median score on the 11-item energy knowledge index was 6 (with mean = 5.80 and SD = 2.48), meaning half of all respondents scored less than 55 percent on the test. (Scores ranged from 0 correct to 11 correct among respondents and were normal in their distribution.)

At the level of individual knowledge items, as shown in Table 1, performance ranged considerably. A high of 85 percent correctly identified the sun as "the original source of energy for almost all living things," whereas a low of 31 percent correctly identified "turning off the car engine when the car is stopped for 15 seconds or more" as the action that always saves energy.

Accurate knowledge varied considerably across respondents as well. In a multivariate ordinary least squares regression model predicting the energy knowledge index score, educational attainment, household income, and sex were significant predictors (as with perceived understanding). Scores on the index also increased significantly by age, ranging from 5.3 for 18- to 29-year-olds to 6.1 for those 60 or older. Homeowners fared better than those who did not own their home (6.2 vs. 5.0, $p = .0003$), and those outside of metropolitan areas fared better than those within MSAs (6.2 vs. 5.7, $p = .0046$). Perceived understanding was also significantly associated with the energy knowledge index score, with those believing energy is something people like them can understand faring better on the knowledge test (6.1 vs. 4.7, $p < .0001$). Table 4 provides the full model results.

Table 4. Energy knowledge: frequencies and ordinary least squares regression model results

	N (unweighted)	Mean energy knowledge index score (weighted, max = 11)	Unstandardized regression coefficient	Standard error	*p*-value
Intercept	—	—	5.96	0.36	<.0001
Education					
Less than high school	76	3.9	-2.55	0.29	<.0001
High school	224	5.2	-1.30	0.21	<.0001
Some college	244	6.2	-0.38	0.20	0.0619
Bachelor's or higher	268	6.7	—	—	—
Household income					
<$25,000	138	4.7	-0.75	0.25	0.0028
$25,000–$49,999	150	5.7	-0.36	0.24	0.1343
$50,000–$99,999	281	5.9	-0.39	0.20	0.0500
$100,000+	203	6.8	—	—	—
Age					
18–29	106	5.3	-0.80	0.24	0.0010
30–44	197	5.7	-0.64	0.21	0.0024
45–59	247	5.8	-0.51	0.20	0.0119
60+	262	6.1	—	—	—
Sex					
Male	434	6.4	1.14	0.15	<.0001
Female	378	5.2			
Household ownership status					
Owned	609	6.2	0.64	0.18	0.0003
Rented or occupied	203	5.0	—	—	—
MSA status					
Metro	673	5.7	-0.61	0.21	0.0046
Non-metro	139	6.2	—	—	—
Perceived understanding					
Yes	654	6.1	0.88	0.19	<.0001
No	150	4.7	—	—	—

— = Not applicable or not statistically significant. MSA = metropolitan statistical area.

Note: Analysis used backward selection; only variables garnering a significant coefficient in a full model are included here.

Energy Bill Interpretation Ability

Although a relatively high percentage of respondents (81 percent) successfully completed at least one of the three bill interpretation tasks, only 27 percent of respondents completed all three tasks correctly. Scores on the bill interpretation task index ranged from zero to three (with a mean score of 1.67, median = 2, and SD = 1.07). Roughly 70 percent of respondents correctly completed one of the tasks involving computation of a month's charges using a different rate than was posted on the hypothetical bill depicted in the survey (Table 2), whereas only 39 percent and 63 percent, respectively, completed the other two tasks accurately.

The multivariate model suggests that the ability to interpret an energy bill also appears to be associated with educational attainment and, to a lesser extent, income. Those living in a single-family home were more likely than others to score higher on bill interpretation (1.8 vs. 1.3, $p < .0001$). A higher score on the energy knowledge index also predicted the ability to interpret an energy bill, with an average bill interpretation score ranging from 0.8 for those with an energy knowledge index score between 0 and 2 (inclusive), to 2.3 for those scoring between 9 and 11. Table 5 provides the full model results.

Discussion

A substantial proportion of survey respondents agreed that energy as a topic is generally accessible for people like themselves. What our results also suggest, however, is that there is a gap between perception and the reality of energy knowledge. Our results suggest that many people do not know key facts about energy use and consumption. That is particularly true at lower levels of formal education. Moreover, while many respondents demonstrated at least some

Table 5. Bill interpretation: frequencies and ordinary least squares regression model results

	N (unweighted)	Mean bill interpretation score (weighted, max = 3)	Unstandardized regression coefficient	Standard error	*p*-value
Intercept	—	—	0.68	0.14	<.0001
Education					
Less than high school	72	1.0	-0.33	0.13	0.0136
High school	210	1.5	-0.14	0.10	0.1489
Some college	232	1.8	-0.02	0.09	0.8453
Bachelor's or higher	261	1.9	—	—	—
Household income					
<$25,000	103	1.5	-0.30	0.11	0.0083
$25,000–$49,999	189	1.7	0.02	0.11	0.8612
$50,000–$99,999	238	1.7	-0.11	0.09	0.2203
$100,000+	245	1.7	—	—	—
Housing type					
Single-family home	634	1.8	0.36	0.08	<.0001
Apartment or other	141	1.3			
Energy knowledge index score			0.15	0.01	<.0001
0–2	60	0.8	—	—	—
3–5	241	1.3	—	—	—
6–8	321	1.9	—	—	—
9–11	152	2.3	—	—	—

— = Not applicable or not statistically significant.

Note: Analysis used backward selection; only variables garnering a significant coefficient in a full model are included here.

capacity to interpret energy bill information, most people were not able to accurately complete all three of the tasks we posed.

What these results suggest is that we have available at least three distinct constructs related to public understanding of energy: perceived topical understanding, knowledge of energy facts, and the ability to interpret practical energy utility information such as household energy bills. While some of these constructs co-vary, the three variables clearly do not vary in lockstep. Perceived understanding of energy and overall energy bill interpretation ability, for example, did not demonstrate a statistically significant relationship, when controlling for other factors.

Investigating the extent to which any of these constructs is a useful predictor of energy *behavior* would be a justifiable task for future research. It might be the case that one or more of these variables matters in predicting and explaining energy-related behavior, despite the lack of strong relationships between the three variables themselves. Moreover, we need to know more about the genesis of each variable. Formal education, for example, appears to have been more predictive of factual knowledge and bill interpretation than is the case for perceived understanding, suggesting that factors other than formal education can bolster US residents' perceptions of their own knowledge and understanding.

Our results are constrained by measurement factors, such as the exact questions employed for the knowledge index and bill interpretation tasks, and sampling factors. For example, while we developed the energy knowledge index through a rigorous process that included analysis of existing data, consultation with US Department of Energy officials and academic experts, and internal question wording assessment, the index included a limited set of energy concept items. Many of the items focused on household electricity usage, for example, and the questions likely varied in difficulty (as evidenced by item-level variation in aggregate respondent success).

Future research might focus on even more specific subcategories of energy; such specific topical focus could represent an important next step in assessing what people know and do not know about energy.

As for variation in item difficulty, that variation is not a major concern because the measure is an *index* of energy knowledge items that are added together (and not a scale in which all items are assumed to be interchangeable alternative measures that can be averaged). As a result, variability in item difficulty is reasonable, much as it would be on an academic test. Lastly, because we asked to speak with the most knowledgeable noninstitutionalized adult in a household with regard to energy, our descriptive results may be an overestimate of the perceived energy knowledge of all Americans generally, but they do offer at least a snapshot of what those making decisions about household energy use appear to know. Despite these limitations, our results appear to offer a coherent and useful picture of Americans' general energy knowledge and a foundation for future inquiry.

In sum, these survey results respond to those who have called for work on energy literacy and provide empirical evidence of areas for improvement in energy understanding among US residents. They also offer a nuanced picture of the possibilities for measuring energy understanding. It appears there is a demonstrable gap between perceived understanding and factual knowledge (as well as utility bill interpretation). This pattern suggests that abstract notions such as energy literacy are likely best conceptualized as multifaceted ideas that can be operationalized in multiple ways in future public opinion research depending on the primary research focus of interest.

Our results should generate more than idle methodological pondering, as they hold direct implications for academic, nonprofit, and government action with regard to household energy behavior. Future research and investment intended to improve public understanding of energy will likely succeed or fail in part as a result of tracking (and better understanding the exact roles of) perceived understanding, factual knowledge, and practical skills such as utility bill interpretation. Usefully answering questions about how well Americans understand energy will depend on the theoretical and methodological choices we make regarding what counts as knowledge that matters.

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Appendix A

Example Knowledge Index Items

Example question 1:

Which of the following energy resources is not renewable?

a. Solar
b. Biomass (wood, waste, plants, alcohol fuels)
c. Coal
d. Water (hydro) power
e. Geothermal

Example question 2:

Which of the following choices always saves energy?

a. Using portable electric heaters for added space in oil or gas heated homes
b. Buying a more fuel-efficient car and driving that instead of riding the bus
c. Leaving fluorescent lights on instead of turning off for a short period when not in use
d. Using your computer's screen saver in between use
e. Turning off the car engine when the car is stopped for 15 seconds or more

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