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Summary and Keywords

Public opinion plays a central role in determining the feasibility of efforts to transform energy systems in the coming years, yet scholarship on communication effects and public opinion about clean energy and energy efficiency seems to have expanded only relatively recently. There is a growing body of work that explores how targeted and strategically framed messages affect individuals' beliefs and motivations to act on matters affecting household energy choices as well as energy policies. One must attend particularly to the principal communication-based factors that shape the public's understanding of clean energy sources and promote efficiencies in energy use. To better understand the communication vehicles for improving both household energy efficiency and conservation, two research foci are most relevant: (1) field experiments that primarily assess how household energy consumption shifts after receiving energy consumption reports and (2) surveys/laboratory experiments that focus on the nuances of energy-related communications, paying particular attention to the role of politics and ideology. This bimodal classification of clean energy and efficiency communication research genres is not exhaustive but can be synthesized into two major contributions. First, providing households with information about specific benefits that would result from a greater reliance on clean energy may increase support for its development and move individuals toward energy efficiency outcomes; however, exposure to counter-messages that emphasize costs associated with clean energy and the associated policies can negate the effects of pro-clean energy messages. Second, there is still no reprieve from the politicization of energy, and thus the role of partisanship and motivated reasoning must be accounted for when assessing how individuals modify their decision-making processes regarding energy efficiency.

Keywords: clean energy, household energy, field experiments, framing experiments, motivated reasoning

Introduction

"The history of informational programs for residential energy conservation . . . shows clearly that the most typical result of simply presenting people with information on the benefits of pro-environmental behaviors is that the behavior does not change" (Stern, 1999, p. 467); yet, information communication "can, if carefully designed and delivered, change certain kinds of environmentally significant consumer behaviors to a modest extent" (Stern, 1999, p. 468). This article serves to clarify precisely which communications meet this standard by addressing the primary themes among field experiments, framing experiments, as well as any correlated factors such as media effects and individual-level effects. Reiss and White (2008) claim that "electricity is considered the most inelastically demanded form of energy" (p. 638), a pattern representative across the OECD countries (Krishnamurthy & Kristrom, 2015). This, however, is an overstatement as household electricity demand may be relatively inelastic, but it is also a function of how information about household consumption, norm-based messages, and politics are synthesized for the individual and the household.

In the following pages, we highlight the two primary dimensions of the most relevant studies covering communication-based research: field experiments that build from existing energy conservation programs and policies; and survey and framing experiments that delve deeper into these findings to provide and address more nuanced causal claims.[1] We expect that this breakdown of the research into two general categories will remain relatively fixed in the near term as they are robust in their methodologies; complementary in their conclusions; and, frankly, equally remarkable in their discoveries regarding the effects of communications about clean energy and energy efficiency.

Field and Framing Experiments on Energy-Related Behavior

An Overview of Energy Efficiency and Energy Curtailment

Individual-level laboratory experiments tend to focus on support for various technologies or intentions to take future action, but the voluminous literature on field experiments conducted in this area typically focuses on energy efficiency or curtailment behaviors. In this context, energy efficiency refers to taking actions that will make a household's energy usage more efficient, such as insulating one's home or installing solar panels while not actually changing the day-to-day energy consumption-related behaviors of individual residents. These are usually "one-shot" behaviors as they involve a purchase or installation to affect energy consumption changes (Abrahamse, Steg, Vlek, &

Rothengatter, 2005, p. 274). Energy curtailment, in contrast, refers to a reduction in household energy consumption, such as turning down the thermostat, turning down the temperature on the water heater, turning up the refrigerator thermostat, line drying clothing, and watching less television per day (Gardner & Stern, 2008). Research has shown that improving efficiency is more effective at saving energy and in turn reduces carbon emissions more than curtailment of the use of older, more inefficient appliances (Gardner & Stern, 2008). That is, driving a fuel-efficient vehicle and replacing inefficient appliances save far more energy than commensurate curtailment actions such as carpooling. On the other hand, efficiency behaviors often require high upfront costs, making them less appealing to consumers (Gardner & Stern, 2008). In the developing world, though, energy efficient technology adoption is a function of access to capital. This was found to be the case not only for more affluent Indians considering solar technology adoption at the household level but for even poor villages based in sunshine-prone areas (Aklin, Chen, & Urpelainen, 2018A). Overall, though, field research in this area has tended to focus on curtailment as it is often easier to induce in the field than efficiency behaviors, while efficiency behaviors tend to be studied in laboratory settings.

The progression of the literature that examines energy efficiency and curtailment has paralleled broader trends in the social sciences, namely the assumption that individuals make decisions about energy usage as rational economic actors to maximize their own interests (Aronson & Stern, 1984). Based on this assumption, many of the early field experiments in the area of energy curtailment behaviors focused on the effects of predictors such as the following: monetary incentives, information on how to save energy, feedback on current and past usage, making a commitment or setting a goal to reduce energy usage, home energy audits, and mass media campaigns (Abrahamse et al., 2005; Gardner & Stern, 2008). Researchers have eventually begun to account for social motivations as well, particularly peer comparisons and normative appeals.

Energy Curtailment Communications

Pecuniary and Feedback Messages

Many early research attempts on energy curtailment were based on the assumption that monetary incentives were a straightforward way to motivate individuals to conserve energy (Battalio, Kagel, Winkler, & Winett, 1979; Winett & Nietzel, 1975; Slavin et al., 1981). Battalio et al. (1979), for example, explored the effect of monetary incentives in the form of cash rebates on household energy consumption. The following five treatments were examined specifically: a high price rebate group, a low price rebate group, a feedback group, an information group, and a control group. In the high price (and low price) rebate group, participants received 30 cents (or 1.3 cents) per 1% reduction in kilowatt-hours per week compared to the same week's usage in the previous year. Participants could earn up to $15 per week (in 1979 dollars) in rebates in addition to a $10 bonus (or a $2 bonus) payment if their household reduced energy usage at least half as much as all other households in this treatment group.[2] Further, households in this

treatment group received instructions for reading their meters and computing their electricity bills as well as a government-prepared booklet of energy saving tips. Finally, these households also received feedback in the forms of a weekly meter reading, a comparison of current usage to usage in the same time period of the previous year, and the amount of the rebate they had earned to date (Battalio et al., 1979). The feedback group received the same feedback and information as the high and low price rebate groups but received no pecuniary incentive, while the information group received only the government-prepared booklet and information about how to calculate their electric bill. As expected, the authors found an 11–12% reduction in energy usage by the rebate groups in comparison to the information group. Surprisingly, the researchers found that the information group and the feedback group had increased usage compared to the control condition.[3] It appears that many participants had been overestimating how much certain energy behaviors cost. Thus, when presented with information and/or feedback without an appeal to curtail usage, participants actually increased energy usage, highlighting the fact that individuals are generally unaware of how much energy costs as well as how much energy is being used for individual activities.

Reductions in household energy usage are confounded by a problem known as double invisibility: Energy cannot be seen nor can it be easily connected to day-to-day activities (Burgess & Nye, 2008). Researchers often assume that eliminating information deficiencies will lead to lowered energy consumption, but the results have been mixed (Brandon & Lewis, 1999; Ueno et al., 2006).[4] In the early 21st century, feedback to households is conveyed primarily through energy management tools that communicate to electricity consumers the exact nature of their consumption on their bill, a webpage to access further details and graphics, media-based advertising about how to save energy, and news coverage about this "advanced metering infrastructure." In their analysis of this information campaign for nearly 500,000 customers of two Maryland-based electricity providers, Faruqui, Arritt, and Sergici (2017) show that, as a result of these types of energy management tools, consumption dropped at a range of 1.55–1.73% for energy program participants.

Hargreaves, Nye, and Burgess (2013), however, found evidence to the contrary while exploring the role that Smart Energy Monitors (SEMs) play in household energy usage over time. SEMs come in a variety of forms, ranging from devices that can simply monitor real-time usage of electricity to devices that can additionally monitor up to 100 individual appliances and show comparisons of usage to historical usage rates. In this study, the researchers found that members of households initially appreciate the novelty of these devices, checking them often. That is, upon purchase of a SEM, people often identify sources of large energy consumption and make efficiency changes, such as replacing a large inefficient appliance; however, after the novelty wears off and people learn what level of usage is "normal" for their household, they often simply maintain the norm. The authors conclude that "simply making energy visible, and even managing to keep it visible, is not enough . . . [E]nergy consumption in households involves multiple

rationalities and logics, performed by multiple householders, often in complex and dynamic negotiations with one another, and in ways that change over time in response to different contextual forces" (pp. 132–133).

Pro-Behavioral Norm Messages

Beyond monetary incentives and feedback, social aspects of household energy use and conservation must be addressed, particularly peer comparisons and prosocial messages. Marketing campaigns seeking to transform socially undesirable behaviors in the population often do so by invoking a descriptive norm of how often the socially undesirable behavior is actually occurring (Schultz, Nolan, Cialdini, Goldstein, & Griskevicius, 2007). Previous work has shown that individuals do not like to stray too far from a particular norm and will often assume more people are participating in a negative behavior in which they themselves participate (Kunda, 1999). Thus, by correcting this misperception, individuals correct their own behavior to more closely approximate their perceptions of the descriptive norm (Kunda, 1999; Schultz et al., 2007). However, this can also cause people who are exceeding the normative goal (i.e., falling below the rate of the descriptive norm) to self-correct in a normatively undesirable manner, known as a boomerang effect (Schultz et al., 2007). Reno, Cialdini, and Kallgren (1993) argue that one way to overcome a boomerang effect is to add an injunctive norm to the descriptive norm, conveying what is socially or culturally acceptable in addition to what is actually done. Thus, individuals who are already behaving in a more normatively desirable manner will receive positive reinforcement that deters them from merely conforming to the descriptive norm.

This theory of pro-behavioral norms has been applied to household energy usage in Schultz et al. (2007), a study in which households were informed about both their own energy usage for the previous week as well as the average household in the neighborhood's usage. It was hypothesized that when only this descriptive norm regarding average household consumption was provided, individuals who exceeded the average neighborhood energy usage (reported in kilowatt-hours per day) would conform and reduce their household usage. However, households that already used less than the amount reported were hypothesized to increase their energy usage, exhibiting the above-described boomerang effect. The findings confirmed these hypotheses and led to a follow-up prediction that an injunctive message, in the form of a drawing of a smiling emoticon for households below the average neighborhood usage, and a frowning emoticon for households who consumed more than the neighborhood average usage amount, would eliminate this boomerang effect. As expected, this simple injunctive gesture effectively prevented low usage households from regressing to the mean.

Schultz et al.'s (2007) work, in conjunction with other research, directly influenced an energy conservation program run by the company, OPOWER.[5] OPOWER works with multiple utility companies across the United States to reduce household energy usage, and its Home Energy Reports (HER), received regularly by households, contain social comparison information and energy saving tips to denote whether a household is "Great," "Good," or "Below Average" based on their neighbor comparison group (Allcott, 2011). "Great" households use less than the 20th percentile of similar neighbor households; "Good" households use energy equivalent to or more than the 20th percentile but still less than the mean; "Below Average" indicates that the household uses more than the

mean. Based on an analysis of data from 600,000 households, Allcott (2011) found that receiving a HER decreases household energy usage by an average of 2%, a finding comparable to similar efforts by the Sacramento Municipal Utility District and Puget Sound Energy (Ashby et al., 2012). For the Indian case, comparisons with neighboring households led to 8% reductions in electricity consumption (Rathi & Chunekar, 2015). Similar research by Agarwal et al. (2017), which focused on the Project Carbon Zero campaign in Singapore, reveals that these impactful messages can also be conveyed from schoolchildren to their families and neighbors. Allcott (2011) also found no evidence of a boomerang effect nor evidence that injunctive norms played a role, looking only those households whose usage rates were clustered together on either side of the cutoff points for "Great," "Good," or "Below Average." Thus, the lack of a boomerang effect could be attributed to a combination of injunctive norms that affected all households equally (Allcott, 2011).

In light of the aforementioned contrasting results, we turn to Nolan et al.'s (2008) focus on whether or not social norms are a conscious influence on individual's actions. Looking specifically at the expressed motives behind an individual's energy conservation behavior, it was found that the majority of people claimed that "environmental protection" was the reason for engaging in energy conservation more than any other reason, followed by "benefits to society," "monetary savings," and, last of all, the fact that "other people were doing it" (Nolan et al., 2008). The authors discovered that the belief that other people were conserving energy (a descriptive norm) was both the least motivating factor as well as the strongest predictor of energy conservation. The authors theorize that people enjoy telling themselves self-serving causal explanations, that is, that they conserve energy out of a love for the environment, instead of acknowledging that their belief that others are conserving energy actually motivates them (Nolan et al., 2008; see Kunda, 1987). Testing this claim, a second study was conducted during which households were provided with, via information conveyed on a doorhanger, information that would appeal to one of the above-cited four reasons for conserving energy. Using a measure of actual household energy consumption as their dependent variable, the researchers further hypothesized that people would conserve the most energy when they received the descriptive norm message. They found evidence to support this hypothesis as well as evidence that, in a follow-up survey, which helps establish the durability of these communicative effects, individuals were still rating the descriptive norm treatment as the least motivational.

Recently, scholars have begun to question the comparative effectiveness of various messages on household energy curtailment. Delmas, Fischlein, and Asensio's (2013) meta-analysis of 156 relevant field experiments from 1975 to 2012 found an average reduction of energy usage of 7.4% across the entirety of the studies examined. However, within these results they find heterogeneity between the various strategies that may be employed: Energy saving tips and usage feedback—both individual and compared other users—do not necessarily trigger energy conservation over monitored time periods more than real-time feedback (e.g., in-home monitors, etc.) and home energy audits result; and,

contrary to expectations, pecuniary incentives sometimes increased energy usage. Informational strategies are effective, but more rigorous studies must be conducted to parse out actual effects of each type of information both individually and comparatively (Delmas et al., 2013).

Issue-Framing Effects and Energy Opinions and Behaviors

A growing literature has begun to evaluate how variations in strategically framed messages affect individuals' support for the usage of clean energy sources, the actions people are willing to take in their own lives to reduce energy consumption, and the extent to which individuals support clean energy policies. Much of this scholarship has been conducted in laboratory and survey experiments that focus on "issue framing," which refers to "situations where, by emphasizing a subset of potentially relevant considerations, a speaker leads individuals to focus on these considerations when constructing their opinions" (Druckman, 2004, p. 672). Thus, supporters of the development of a clean energy technology might emphasize its environmental benefits, prompting others to increase their support and willingness to adopt the technology, ceteris paribus. However, opponents might highlight the economic costs of, for example, subsidies to promote the same technology, leading individuals to decrease their support for its adoption and usage. In the real world, people are often simultaneously exposed to considerations about both the costs and benefits of an emergent energy technology's adoption. In such cases, equally strong frames and arguments that appear in the same message can cancel out the impact of each other, even if the frames are impactful and shift opinions about a target object when they appear in isolation (Aklin & Urpelainen, 2013; Chong & Druckman, 2007). Whatever the case, these individual-level framing effects occur when exposure to a frame in a communication shifts the weight that individuals give to that consideration when forming an overall evaluation toward any attitude object in a particular setting.

Media Framing of Clean Energy and Efficiency Policies

Many of the frames of interest are rooted in media-based messages. Media—in all its forms—serve to inform the citizenry about complex issues, connecting experts, politicians, and the public regarding environmental issues (Boykoff, 2009), and media communications have long been held as a key resource in impacting household consumption levels (Curtis, Simpson-Housley, & Drever, 1984). Several key studies examine the factors that give rise to specific frames in news discourse over time toward clean energy sources and efficiency in personal and household energy use. Gamson and Modigliani (1989) analyzed the evolution of frames in media discourse specifically toward nuclear power and found that key events play a key role in altering media discourse. In particular, the Three Mile Island accident led to nuclear power repeatedly being described in the media as "a technology out of control" (Gamson & Modigliani, 1989, p. 33). Broadening this focus, Bolsen (2011) explores of the impact of world events and the emergence and prominence in news media of distinct frames toward personal energy

conservation. Three eras of action are identified: an era of crisis from 1973 to 1981; an era of production from 1982 to 1999; and a second era of crisis from 2000 to 2007.[6] Media content correspondingly shifted over time where, initially, and as a result of OPEC's contributions to the 1970s crisis, 21% of media-based reports tied U.S. energy problems to foreign nations. Connections in the media between the environment and energy conservation in general were not made during the initial crisis period; yet, such connections increased steadily over the following two periods, prompted at times by events such as the California electricity crisis and the Katrina and Rita hurricanes.

Beyond key events, one may focus on the favorability of clean energy and renewable energy technologies as they are reported by the media. For example, carbon capture and storage and biomass technologies are highlighted in the U.S. news media in relatively positive ways (Feldpausch-Parker, Burnham, Melnik, Callaghan, & Selfa, 2015), and Langheim et al.'s (2014) study of 231 articles from 1998 to 2013 from the *Wall Street Journal*, *USA Today*, and the *New York Times* shows that smart-grid-related content is generally focused on its beneficial aspects more than its negative aspects. Based on patterns of bioenergy use in Sweden, where it is prominent, and Norway, where it is marginal, Skjolsvold (2012) expected media reporting to target controversy, namely "where authorities and industry are adversaries . . . , picking up on and communicating local resistance . . . , [or amplifying] arguments about social and environmental risks . . ." (p. 515). However, in Norway, there is economic and technological ambivalence, while there is technological optimism and a focus on the positive aspects of "green consumption" in Swedish media reports.

The favorability of media reports about renewable energy has changed as a result of the attendant technologies being viewed increasingly more cautiously. Sengers, Raven, and Van Venrooij (2010) discourse analysis of biofuel technologies in The Netherlands media over the 2000–2008 period shows that the frequency of articles has increased and that biofuels are no longer framed as economic and technological boons but as potential detriments to the environment, particularly for the developing world. Similarly, media reporting has shifted over time regarding smart grid coverage in the Canadian media, moving from a focus on the technology's positive aspects to its negative aspects (Mallett, Jenger, Reiber, & Rosenbloom, 2018). In the U.S. media, Delshad and Raymond's (2013) content analysis of 600 *New York Times* and *Washington Post* articles over a 10-year period shows that content about biofuels became 24% more negative during the 2004–2008 period relative to the 1999–2003 period. These negative frames primarily focused on the economic costs of biofuels for consumers, which "did not appear in a single media article through 2003, but is featured in 27% of articles from 2004–2008 (and over 40% of articles in 2008)" (p. 200). In Spain, Heras-Saizarbitoria, Cilleruelo, and Zamanillo (2011) conducted interviews with local authorities, photovoltaic firms, investors, activist citizens, and analyzed media content from five Spanish national and regional daily newspapers from 2004–2010 and found that a decline in growth of the PV installed capacity in Spain corresponded with a media-based debate about the benefits of PV. Namely, "[t]he

predominant discourse regarding PV energy in recent years has tended to focus on the markedly conservative and non-reformist standpoint, which is . . . opposed to the development of renewable energies" (p. 4694).

In the context of competing frames (see Aklin & Urpelainen, 2013), descriptions of renewable energy appearing in the media also operate in competition with each other. A content analysis of 432 *New York Times* articles from 2006 to mid-2008—a period during which biofuels coverage appeared with greater frequency in the popular press—shows that economic development content dominated, followed by frames regarding the environment and national security (Wright & Reid, 2011). Rather than helping foster the legitimacy of biofuels among the public, these competing frames ultimately diminished the persuasive nature of biofuels as well as the tendency to catalyze consensus for policy change. Similar impacts may be occurring elsewhere as the media conveys a multifaceted description of renewable energy utilization. For example, the German media describe wind energy opportunities both positively and threateningly, particularly when detailing precisely where these wind turbines will be installed (Weiss, 2017). A content analysis of 1,025 relevant articles over the 2009–2010 period from the two most influential publications in Wisconsin, *Milwaukee Journal Sentinel* and *Wisconsin State Journal*, confirms that employment and economics content (present 48.6 and 55.9% of the time, respectively) dominate the news over environment frames (present 29.1% of the time) (Zukas, 2017).[7] In a comparative analysis of 678 articles covering wind technology from 1990 through 2007 in Texas (*Houston Chronicle*); Minnesota (*Minneapolis Star Tribune*); and Massachusetts (*Boston Globe*); Stephens, Rand, and Melnick (2009) found that, among the three regions, the risks were highlighted much more for the Massachusetts case. This could be attributed to the fact that wind energy was already much more developed in Texas and Minnesota, while the controversial Cape Wind project in Massachusetts presented both environmental and social concerns given its description as "an industrial eyesore when seen from the pristine shores of Cape Cod" (Stephens et al., 2009, p. 182).[8] As a final example, Romanach, Carr-Cornish, and Muriuki's (2015) content analysis of 451 Australian news articles from mid-2011 to mid-2012 focused on geothermal energy technology's industrial impacts, its economic feasibility, and general uncertainty about the technology. The study found that "economic feasibility and uncertainty about the technology were the most mentioned risks" (p. 1146), although the benefits of geothermal technology were also frequently mentioned. Overall, media content is effectively providing greater weight for the economic costs of clean energy relative to its environmental benefits.

Willingness to Engage in Personal Energy Conservation

In light of these and other media-based statements about clean energy and energy conservation, Bolsen (2013) conducted an experiment to test the impact of exposing individuals to an editorial in a local news outlet discussing energy conservation on opinions and behavioral intentions in this domain (e.g., adjusting the temperature in one's home to save energy, switching to energy efficient light bulbs) and capital investments in energy efficiency (e.g., purchasing a vehicle with better fuel efficiency, insulating or

weatherizing one's home). Participants in the study were randomly assigned to read one of two versions of the editorial, where one version highlighted the importance of consumers taking actions to conserve energy, while the other version highlighted the importance of government action to address the problem and the relatively small impact consumer's decisions have on the nation's energy supply. The experiment also varied the content of an additional "press release" to accentuate a local behavioral, injunctive norm —that is, the press release informed participants that most local residents support taking such actions to conserve energy. Before completing the study, participants were required to make a purchase with cash provided for participation (each participant was given $20 cash [in 2013 dollars] upon arrival for the study), and each participant had to choose between a traditional package of light bulbs for $1 or a package of energy efficient (CFL) light bulbs for $5 at the very end of the study. Participants kept all remaining cash and the chosen light bulb package as remuneration for participation. As an accuracy motivation, participants in the "pro-norm" condition were informed that they would have to "justify and explain" their opinions and purchasing decision to others in a group discussion at the end of each experimental session. Ultimately, the combination of the pro-conservation editorial and pro-behavioral norm manipulation produced both the highest levels of intentions to conserve energy and purchases of CFLs. This can be attributed to increased beliefs about the importance and efficacy of these actions, particularly among those in the pro-norm condition who believed they would have to justify and explain their answers and purchasing decisions. Ultimately, when in competition, the pro-norm manipulation overpowered the "anti-conservation" editorial focusing on government's responsibility for action.

A separate study in Bolsen, Druckman, and Cook (2014A) explored how different frames related to energy conservation influence related behavioral intentions, employing a large nationally representative online survey that varied information about (1) the personal costs or benefits of engaging in energy conservation, and (2) who is attributed primary responsibility for dealing with the nation's energy supply—that is, individuals versus government. Based on a content analysis of news articles about energy conservation appearing in the *New York Times* and *USA Today* from June 2008 through June 2009, frames highlighting the environmental benefits associated with energy conservation were the most prominent aspect associated with such action; however, the second most prominent frame identified in the content analysis emphasized the additional upfront costs of energy curtailment and efficiency investments. Bolsen et al. thus test the hypotheses that individuals will be more likely to engage in energy conservation following exposure to a frame that emphasizes the responsibility of the individual as opposed to that of the government in contributing to collective outcomes. For instance, some participants read, "*The ultimate success of our nation's energy policy depends largely on individuals' choices about energy consumption . . . Individuals need to step up to the plate—something they have done throughout American history without having to rely on the government,*" while others read, "*The ultimate success of our nation's energy policy depends largely on governmental decisions about the energy supply . . . Government needs to step up to the plate—something they often do when individuals alone cannot*

resolve a problem." The authors further hypothesized that frames emphasizing the personal benefits (costs) of energy conservation will increase (decrease) individuals' intentions to engage in energy curtailment and investment behaviors. Additionally, they explored how messages that included combinations of these distinct frames shaped intentions to conserve energy. Following exposure to the experimental treatments, participants were asked how likely they would (1) invest in insulation for their home or apartment (an investment behavior) and (2) adjust their home thermostat to save energy (a curtailment behavior). Respondents were also asked if they would like to receive additional information about how to conserve energy and reported the maximum amount they were willing to pay (up to $500, in 2014 dollars) to weatherize their home or apartment to conserve energy. The results showed that the individual attribution of responsibility frame in isolation had no impact on intentions to conserve energy, information-seeking behavior, or willingness to pay for energy conservation relative to a pure control group. Yet, a government attribution of responsibility frame significantly decreased intentions to conserve energy, interest in receiving an email with information about how to conserve energy, and willingness to pay to conserve home energy. Similarly, emphasizing the environmental benefits of energy conservation in isolation had no effect on behaviors, but the combination of exposure to an individual attribution of responsibility frame and a frame emphasizing the personal benefits of engaging in energy conservation significantly increased intentions to conserve energy for both curtailment and investment actions. The presence of a frame that highlights the personal economic costs of energy conservation significantly decreases support for these behaviors, as does the government attribution of a responsibility frame when coupled with the personal benefits frame. Demobilization thus appears to be easier than mobilization with respect to the effects of these targeted frames on energy efficiency investments and conservation decisions.

Research on issue-framing effects has also begun to explore how frames in the form of both text and visual imagery can shape behavioral intentions related to energy conservation. Hart and Feldman (2016) conducted an experiment in the context of a large survey experiment that recruited a nationally representative sample in the United States comparing the effects of climate change imagery showing solar panels, floods, a climate march, or smoke rising from a smokestack—in isolation and in conjunction with textual messages about the efficacy of taking action—on the willingness of individuals to engage in personal energy conservation. Only images of solar panels were found to increase individuals' sense of efficacy related to climate change action, thus increasing individuals' willingness to engage in energy conservation.

Frames can also serve to induce a status or reputation effect in individuals. Citing a *New York Times* article (see Maynard, 2007), in which it was reported that Prius owners often say they chose to purchase that particular car because it conveys a particular message about the owner, Griskevicius, Tybur, and Van den Bergh (2010) conducted a study that sought to determine the effectiveness of conveying status as a way to promote pro-environmental behavior. In this study, the researchers primed one group of participants to think about status by reading a vignette designed to elicit a status motivation and then

compared this group with a control group that read a similar vignette designed not to elicit any particular motivation, as well as a second control group that received no vignette. The participants were then asked to choose between a green product option and a superior non-green option among a car, a household cleaner, and a dishwasher. The authors found that the individuals who were primed to think about status were more likely to say they would purchase a green product as opposed to a non-green product. Ultimately, ostentatious and costly displays of pro-environmental altruism thus serve to build up an individual's prosocial reputation.

Support for Clean Energy Sources and Efficiency Policies

Frames in communication can shape individuals' beliefs about energy efficiency and conservation, which, in turn, impact public support for clean energy policies. Nisbet (2009) explains that successful efforts to shift public policy have depended on "generating widespread public support and mobilization while effectively countering the communication efforts of opponents . . ." (p. 14). Along these lines, Chen, Cheng, and Urpelainen (2016) conducted an online survey experiment of the Chinese public to determine which frames affected public support for the promotion of renewable energy. They found that only those respondents subject to an energy security frame significantly increased support for renewables; however, these effects were countered to some extent in the presence of an economic cost frame (i.e., "experts say that renewable energy is too expensive for China's economic development as a nation" [Chen et al., 2016, p. 3753]). Elsewhere, Aklin and Urpelainen (2013) implemented a nationally representative survey experiment in the United States that focused on issue-framing effects related to support for clean energy policies to combat climate change. The experiment focused specifically on the effect of clean energy policy frames in conjunction with economy-oriented frames, national security-oriented frames, or a combination of both (i.e., competitively). The pro-clean energy/economy frame emphasized how a clean energy policy would create new jobs, while an anti-clean energy/economy frame highlighted the effect of the policy on increased energy prices. In terms of national security, pro- and anti-clean energy policy frames were matched with their corresponding effects on either reducing dependence on the Middle East or hindering the ability of the United States to develop oil and coal resources domestically. Based on a random assignment of respondents to read an article emphasizing one positive and one negative frame related to federal clean energy policies, the results demonstrated that exposure to competing frames regarding support for the development of wind and solar energy negates each frame's isolated effects (see Chong & Druckman, 2010). In a follow-up study, the authors further discovered that exposure to a single positive frame increased support for the development of these renewable energies. In other words, frame competition in the political information environment can limit the ability of a particular frame—even a frame that is effective in isolation—to influence support for public policies in different contexts due to counter-framing efforts.

Just as energy sources and options have shifted from coal to CFLs to solar, it is crucial to assess communication-related outcomes surrounding the uncertain nature of clean energy technologies. To this end, Druckman and Bolsen (2011) explored issue-framing

effects in the context of an experiment that focused on how different messages shape support for the adoption of an emergent technology that increases the efficiency of converting sunlight to electricity. Their study explored (1) the impact of providing factual information on opinions relative to other factors—including individuals' values and trust in science, (2) how newly presented facts affect opinions when they appear simultaneously with frames or arguments that lack factual content, and (3) how individuals process factual information at a later time after they have formed an opinion about the emergent technology.[9] To investigate these questions, the authors conducted an experiment in the context of an Election Day exit poll with 20 teams of student pollsters randomly stationed throughout northern Cook County, Illinois.[10] The main dependent variable was the extent to which each participant opposed or supported using carbon nanotubes (CNTs), based on their exposure to a frame associated with the implications of the technology either on energy costs/availability (pro) or potential health risks (con). The results from the initial experiment showed that exposure to a pro-frame, fact, or frame-fact combination significantly increased support for CNTs relative to a baseline control group, whereas the con conditions do the opposite. Additionally, frames with facts do not overpower frames sans facts in competition—that is, they canceled one another out—and frames with facts do not add to the impact of a similar frame that lack factual information when it comes to support for the energy technology.[11]

The way in which energy policies are framed can thus influence individuals' support for various energy sources as well as their beliefs about the efficacy of government-sponsored energy programs (Dharshing, Hille, & Wustenhagen, 2017). At times, these effects are connected to individual-level characteristics. For instance, when the mechanism to promote energy conservation (i.e., home energy retrofits) in Switzerland was labeled as a "tax rebate" rather than a "tax subsidy," individuals with right-leaning ideological and partisan orientations were more supportive of the policy than when it was characterized as a rebate (Dharshing et al., 2017). In a follow-up study, the authors explored how varying the presence of an economic frame (i.e., mentioning the economic benefits of energy saving home improvements) or an environmental frame (i.e., highlighting the ecological advantages of energy conservation) influence evaluations of a policy targeting residential energy conservation. Although the frames did not influence support for the policy for the overall sample, relative to a control group, exposure to a frame highlighting the economic benefits of the policy increased support for individuals that were also supportive of free-market liberalism.

Framing, Motivated Reasoning, and the Politicization of Science

Framing Effects and Connections to Political Polarization

Scholars have further developed research on issue-framing effects in recent years to assess how identity-based motivations (e.g., partisan motivated reasoning, Kahan (2017)) can influence the way that individuals interpret and process new information when forming beliefs about energy-related policies (Bolsen, Druckman, & Cook, 2014B;

Druckman, Peterson, & Slothuus, 2013). Partisan and ideological motivations are important to account for in research on targeted messaging effects focused on energy efficiency and conservation behaviors (Costa & Kahn, 2013). For example, Gromet, Kunreuther, and Larrick's (2013) experiment involved participants making a decision about whether to buy an energy efficient light bulb or a traditional one of equivalent wattage. In one condition, the bulbs were equally priced at 50 cents (in 2013 dollars); in a second condition, the energy efficient bulbs were more expensive, reflecting their greater initial costs. The experimenters also manipulated the presence of a sticker on the energy efficient bulbs in some conditions that reminded participants to "protect the environment." Although Republicans/conservatives in the control group were just as likely to purchase energy efficient bulbs over traditional bulbs when the cost was identical, in the treatment condition where the pro-environmental message was affixed to the energy efficient bulbs, Republicans/conservatives were significantly less likely to purchase the energy efficient bulbs relative to Republicans/conservatives in the control condition. Targeted messaging efforts to promote energy conservation and other environmentally beneficial actions can thus backfire when a motivation to protect one's partisan or ideological identity governs information processing and opinion formation (Hart & Nisbet, 2012; Nyhan & Reifler, 2010).

Bolsen et al. (2014B) conducted a nationally representative survey experiment in the United States to assess how partisan endorsements for the *2007 Energy Independence Act* influenced partisans' support for the law.[12] Relative to partisans in a pure control group who evaluated parts of the Act without any partisan endorsement (i.e., opinions were formed strictly on the basis of the policy's content), partisans who were informed that "*The Energy Act overall, was widely supported by [Democratic / Republican] representatives . . .*" shifted their opinion about the Act in a direction consistent with their partisan identity. In other words, Democrats (Republicans) became significantly more supportive of the Act when they received an in-party endorsement, and significantly less supportive of the Act when they received an out-party endorsement, relative to Democrats (Republicans) in the control group. Partisan motivated reasoning was even more prevalent when participants were induced to engage in "directional" motivated reasoning by reminding them to "*consider the bill was passed during a period of divided government where fellow partisans voted together nearly 90% of the time . . .*" Further, the directional manipulation required participants to report their party identification and why they affiliate with that party. In this context where partisan identity is made salient, partisan identity driven evaluations of the Act were even more pronounced in leading partisans to evaluate the law based on its perceived sponsor as opposed to its content. Yet, partisans who received an accuracy motivation were told "*to try to view the policy in an evenhanded way and from various perspectives . . .*" Further, they were informed that they would later be asked to justify the reasons for their judgment of the Act and why its content was more or less appealing. The results indicate that this form of "accuracy inducement" caused partisans to base their opinions of the Energy Act on the basis of its content rather than the perceived sponsor, with opinions similar to those in the baseline condition where no partisan endorsement was provided. In short, although partisans

clearly engaged in motivated reasoning when evaluating the 2007 Energy Independence Act, there are contexts in which individuals set aside identity-protective motivations and evaluate messages in a more even-handed fashion with the goal of forming and holding a correct belief (Druckman, 2012).

Partisan motivated reasoning presents significant challenges to communicators who seek to build consensus for policy action on energy policy. This identity-protective motivation can color the evaluation of new information, and this tendency increases in contexts where polarization exists (Druckman, Peterson, & Slothuus, 2013). Indeed, polarization has been a defining feature of energy and environmental policy debates in the United States for decades (Rosenbaum, 2014; Shipan & Lowry, 2001). Druckman et al. (2013) conducted an experiment that manipulated the presence of elite polarization in the context of providing stronger and weaker versions of arguments (frames) in support for or opposition against allowing drilling for oil and gas off the Atlantic Coast and in the eastern Gulf of Mexico. Respondents in some experimental conditions did not receive a partisan endorsement or a polarization prime; however, in other conditions, partisan endorsements and polarization were present when participants formed an opinion about whether they supported or opposed the energy proposal.[13] In all conditions, respondents received a combination of one frame in support of and one frame in opposition to the energy proposal. The results showed that, in the absence of party cues, both Democrats and Republicans formed their opinion about whether to allow additional drilling based on the merits of the arguments in the absence of polarization and partisan endorsements; that is, frames of equal strength canceled one another out in competition, and stronger frames overpowered weaker frames in competition for both Democrats and Republicans. However, when party cues were provided, partisans shifted their opinion toward their in-party's position (and away from their out-party's position) in conditions where frames of equal strength were in competition. Further, when party cues and polarization were primed, the strength of the frames did not matter and partisans shifted their opinions significantly toward their party's position regardless of the strength or weakness of the arguments that were provided. Druckman et al. (2013) found that overall opinions about the energy proposal shifted in polarized contexts where partisan endorsements were present because polarization influenced the perceived effectiveness of the arguments in different contexts. Elite partisan polarization can thus cause people to perceive the same arguments as weaker (or stronger) than they would in contexts where such factors are not present. Partisans in polarized contexts also became significantly more certain about their opinion relative to those who formed opinions in a non-polarized setting. People are thus gaining confidence in an opinion that is based less on the substance of the argument and communication and more on the party with whom one identifies and their position given the information at hand.

Politicized Science and Support for Emergent Energy Technologies

Partisan motivated reasoning in the evaluation of frames and arguments related to energy efficiency and conservation is not the only challenge facing communicators who seek to build consensus for a fundamental transformation of energy systems as a means of

addressing global climate change. The politicization of science can undermine what are otherwise credible scientific arguments and communications in support of an emergent energy technology. Research on politicized science in the developing world—India specifically—highlights how frames highlighting the role of the private sector as well as frames highlighting urban-rural energy-related inequalities increase support for extensions of off-grid solar power (Aklin et al., 2018B; Urpelainen, 2016).[14] For the U.S. case, Bolsen, Druckman, and Cook (2014C) implemented an experiment in the context of a web-based survey that looked at how politicization can undermine frames that otherwise increase support for the development of nuclear power to generate electricity. Specifically, Bolsen et al. (2014C) found that highlighting the relatively positive environmental impacts of nuclear power compared to other energy sources, alongside consensus scientific evidence about safe storage and disposal of nuclear waste, increased support for its use to generate electricity. However, when politicization was introduced— by highlighting the fact that politicians and others selectively use scientific work to advocate for their own favored agendas—the positive impact of the environmental frame with evidence disappeared. Exposure to politicization also increased anxiety and the belief that politics typically shapes how scientific evidence is portrayed. These effects were most pronounced among individuals with the least trust in science. In the end, politicization generated a bias toward the status quo energy policy.

Bolsen and Druckman (2015) extended experimental research on the effects of politicization by conducting distinct survey experiments on nationally representative samples in the United States that focused on how exposure to politicization affects support for two emergent energy technologies, CNTs or hydraulic fracturing (fracking). The authors also explored ways to counteract politicization through messages that warned individuals about an impending threat (i.e., that they will be exposed to a message that is inauthentic) and provided a refutation of the politicization claim. Across both studies, exposure to positive frames that highlighted the benefits of the novel technologies by citing credible scientific consensus evidence increased support for each technology's use. Similar to the results from the aforementioned study on support for nuclear power, the presence of politicization caused individuals to dismiss what was otherwise seen as credible and impactful information in both experiments.[15] However, counteractive communicative efforts in the form of providing a "warning" prior to exposing individuals to politicization resuscitated the impact of the consensus scientific evidence, increasing individuals' support for each energy technology. In addition, providing corrective information after one has already been exposed to politicization claims can also have a counteractive effect when people are motivated to form an accurate opinion.

Conclusion: Looking to the Future

Although individuals' opinions and energy consumption decisions will play a central role in determining the feasibility of efforts to transform energy systems in the coming years, scholarship on communication about clean energy and energy efficiency is moving increasingly away from "an infancy phase" (Druckman, 2012, p. 617) to a combination of methodological and theoretical constructs that account for some of the most elusive aspects of energy communication. We now bear witness to a host of research projects that assess the moving targets of energy policy, political dynamics, and reflections on social norms. We also recognize the growing importance of the developing world in terms of this area of scholarship and expect increased focus on China and India, which will ultimately yield lessons for countries trailing further behind in terms of economic growth. Most crucial is the role of democratic institutions, and there are parallels between politicization of energy technology in the developed world with varying degrees of trust in the government in the developing world.

Effective communication to the public about clean energy is being made increasingly complex because of the role of social media-based sources of information. Social media is increasingly used to supplement and/or replace original news sources. In terms of general energy-based information, we need to only consider the fact that social media-based reporting after the Deep Water Horizon oil spill in 2010 largely paralleled that of the traditional media in terms of environmental and energy content (Watson, 2016). As well, social media provides a rich source of public opinion data. Consider, for example, the fact that, among the more than 20,000 messages in traditional and social media content relating to solar panels, the general public is largely positive or at least neutral regarding solar energy (Nuortimo et al., 2017). Social media, however, is more importantly a utility for both field and survey experiments on the subject of clean energy and energy efficiency and can thus be tapped for future research efforts in line with the literature cited above. Social media-based communications can, for example, enable comparisons with others regarding smart meter systems and smartphone applications that assess home energy usage through household monitors: One-third of smart meter systems users logged in online to receive updates, among which 79% changed their consumption behavior with a 3.7% reduction relative to a baseline (Pearson et al., 2016). There are thus significant promises for future field experiments that utilize the Internet as the primary communication vehicle. To this end, certain features of new media are not only likely to surpass the function of traditional media in informing the public but will also likely surpass the marketing and messaging campaigns of the energy providers themselves.

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Notes:

(1.) This does not preclude alternative ways in which one could categorize the literature. For example, the economics literature focuses on the consumer while the political science literature focuses on voters. As well, there is a possible division of the literature into research on individual behavior and energy policy.

(2.) The differences between the high and low rebate groups were insignificant and they were thus aggregated.

(3.) In a follow-up study, where the interventions were switched while using the same groups, the results were mixed. For a full discussion, see Battalio et al. (1979).

(4.) Eliminating the information deficiency would certainly lead to more confident residence buying and renting decisions, and such a plan is in the works across at least 15 American cities (as well as many areas in Europe) where it is required that building owners report and benchmark energy use of their building. It has yet to be determined whether these types of laws lead to increases or decreases in energy efficiency (Palmer & Walls, 2017).

(5.) See Allcott (2011) for a summary.

(6.) During energy crises, the impact of mass media campaigns is challenging to assess (IEA, 2005). Bender et al.'s (2004) analysis of interviews with energy campaigners, media tracking data, and telephone surveys matched to more than 1,800 Californian households, confirmed that half of those exposed to the media campaign messages could recall the content of the advertisements up to the end of the energy crisis. Energy crises also increase consumption of energy-saving technologies, such as CFLs and Energy Star appliances. In particular, CFLs sales as a fraction of total medium screw-based lamps increased from 1 to 8% during California's Flex Your Power Program, and then dropped back to 4% after the conclusion of the energy crisis, representing a sustained transformation of the market (IEA, 2005).

(7.) The extent to which these attributes appear in the media is at times a function of geography.

(8.) This might be the result of media reports failing to invoke nontechnical discussions and thus ignoring the expertise of scientists and researchers with regard to the Cape Wind proposal (Thompson, 2005).

(9.) A fact is defined as "something that verifiably exists and has some objective reality . . . Facts come in a wide variety of forms and, on most issues, are ever-present . . . we focus on facts in the guise of 'scientific evidence' that report a verified observation (e.g., an experimental outcome)" (Druckman and Bolsen, 2011, p. 661).

(10.) Every third voter to exit the polling location was paid $5 (in 2011 dollars), for participating in the study, and participants also provided their email addresses so that they could be contacted for a follow-up survey 10 days later. Individuals that received fact-based frames initially were, in the follow-up survey, more certain about their opinion and more willing to use the technology.

(11.) Interestingly, however, Druckman and Bolsen (2011) report that facts do have an additional impact (i.e., beyond frames) in shaping the certainty of one's attitude/opinion about whether or not it is safe to use CNTs—that is, exposure to a frame with a fact increases an attitude certainty about using the technology relative to the same frame sans a fact.

(12.) They informed all participants that the Act included the three main provisions that would: (1) require U.S. automakers to increase gas mileage for all passenger cars by 2020, (2) increase funds for research and development of renewable energy, and (3) provide loans to small businesses for energy efficiency improvements (Bolsen et al., 2014b, p. 243).

(13.) On this issue, Republicans were consistently portrayed as supporting the proposal and Democrats were consistently opposed to it.

(14.) This stands in stark contrast to the Chinese case, where the government was viewed as the most credible source of information regarding nuclear safety (Wu, 2017).

(15.) The politicization of science is defined as occurring "when an actor emphasizes the inherent uncertainty of science to cast doubt on the existence of scientific consensus" (Bolsen & Druckman, 2015, p. 745).

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