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Features

editors' note

This issue of *Behavioral Science & Policy* focuses on the defining issue of our time: humankind's far-reaching effects on the planet. These effects are so vast that scientists say the earth has now entered the Anthropocene epoch, in which human behavior has become the dominant influence on the environment that supports all life on earth. In this reality, environmental challenges are behavioral challenges—and opportunities. The articles in this issue illuminate these connections across the spectrum of behavioral science through empirical studies of interventions that reduce individuals' energy use, comparisons of discrete behaviors and policies, reviews of how insights from behavioral science can be woven into environmental policies, and macro-level policy proposals to transform institutional structures themselves.

Four empirical articles report evidence from policy-relevant field studies designed to change individual behaviors.

Kelly Peters, David R. Thomson, and Nathaniel Barr provide evidence from tests of several interventions intended to augment the effectiveness of "time-of-use pricing," which involves charging higher prices for energy consumption during periods of high demand. Their evidence suggests that using prices to discourage electricity consumption at peak hours is most effective when price differentials between high-demand and low-demand periods are large and when these differentials are communicated in simple and salient ways on people's electricity bills. As an example, they show that peak hours are recalled more when displayed in linear rather than circular graphics. The team also notes that what they call a "nudge report" (complete with personalized benchmarks, conservation tips, and an energy-reduction pledge) reduced energy usage even when price differences were too small to significantly influence behavior.

David A. Comerford, Mirko Moro, Rodolfo Sejas-Portillo, and Till Stowasser demonstrate that labeling and grading the energy efficiency of homes can increase people's willingness to retrofit their dwellings—that is, to replace outdated infrastructure with more efficient alternatives. In particular, they highlight the importance of discrete and familiar grades (in their studies, the letter grades A through F) and the use of color-coded categories (with green representing the most desirable levels of energy efficiency). They close with four lessons for most effectively leveraging labels to reduce energy consumption: (a) mandating that a standardized label depicting energy audit results accompanies property listings, (b) making labels easy to accurately evaluate, (c) making deliberate use of salient thresholds, and (d) prompting people to retrofit when the hassle costs of retrofitting are low and attention to energy efficiency is high.

Ashley Whillans, Joseph Sherlock, Jessica Roberts, Shibeal O'Flaherty, Lyndsay Gavin, Holly Dykstra, and Michael Daly discuss ways to nudge people toward using more sustainable modes of transportation. They differentiate between structural interventions (such as economic incentives and modifications to the physical environment) and behavioral interventions (such as changing psychological factors that relate to transportation choices) and show that behavioral interventions have been comparatively neglected in transportation research. To address this gap, they first review psychological barriers to considering and adopting new transportation modes. Next, they provide a six-step process for testing behavioral interventions, starting with partnering with mission-aligned organizations and ending with conducting field studies. Finally, they review data from their own campaigns to increase carpooling and the use of public transportation.

Tatiana Homonoff, Rebecca L. C. Taylor, Lee-Sien Kao, and Doug Palmer also home in on a specific behavior—namely, reducing the use of disposable shopping bags—and compare evidence on the most effective ways to elicit this desirable behavior. They first compare and contrast market-based incentives (such as bag taxes) with "command-and-control" policies (such as bag bans). Their analysis yields three lessons: (a) disposable bag taxes work better than offering a bonus for bringing reusable bags, (b) a bag tax does not have to be large to be effective, and (c) plastic bag bans can have unintended negative consequences (for instance, companies may replace banned thin plastic bags with thicker ones that are worse for the environment).

The authors of the next article compare a range of behaviors that can affect the environment, trying to determine which to prioritize for intervention. Kate Heller, Michael Berger, Antonius Gagern, Abdurakhim Rakhimov, John Thomas, and Erik Thulin point out that behavioral scientists will be most effective in reducing collective carbon emissions if

they prioritize changing the behaviors that produce the highest emissions. In the work described in their article, they first generated a list of 55 possible behaviors. Then, through literature reviews and discussions with subject matter experts, they evaluated each behavior's emissions-reduction potential and relevance to the U.S. context (the setting for their research), which informed their ultimate selection of the six most impactful behaviors for reducing carbon emissions: purchasing an electric vehicle, reducing air travel, reducing meat consumption, purchasing carbon offsets (which fund projects that reduce emissions), reducing food waste, and purchasing green energy. The researchers close by illustrating behavioral insights specific to each of the six emissions-reducing behaviors.

The next three articles discuss how specific insights from psychology may inform environmental policies.

Asaf Mazar, Geoffrey Tomaino, Ziv Carmon, and Wendy Wood explain that cultivating eco-friendly habits may reduce the gap between people's widespread pro-environmental attitudes and their relatively weaker rates of pro-environmental behavior. They identify three principles to follow when working to achieve this goal: reducing friction (the perceived difficulty of performing a behavior), enabling action cues (environmental triggers of behaviors), and using psychologically informed incentives and disincentives. For each principle, they also provide examples of various tactics that rely on the principle, how the tactics may be applied to a desired behavior change, and who is best suited to implement the tactics. One common thread is that tying the three principles to specific and actionable behaviors will build the strongest cue–response associations that characterize habits. The researchers close by explaining how initially unpopular policies that nudge behavior change can gain acceptance as the desired behaviors become more familiar and habitual.

Ben R. Newell and Jeremy Moss make the case that policies focusing on environment-relevant behavior need to go beyond making pro-environmental behavior easier to enact and must emphasize why action is necessary. Newell and Moss lead with moral arguments, such as fairness, that may motivate pro-environmental behavior. They review arguments and framings that increase the likelihood that individuals will change their behavior (such as by highlighting the effect of an individual's behavior by aggregating its effects across time), as well as evidence suggesting the effectiveness of these tactics. Finally, the authors link these insights to policy design by highlighting implicit and explicit ways in which moral arguments can be communicated to the general public and the importance of tailoring moral messages to specific audiences.

Kaitlin T. Raimi's piece addresses the concern that interventions intended to change individuals' environmental behavior may inadvertently "crowd out" the public's support for regulations and policies that would have much greater effect. Raimi describes an evidence-based approach for avoiding this undesirable crowding-out effect. That is, interventions should (a) push for specific high-impact behaviors, (b) accurately convey the behaviors' effectiveness, (c) promote behaviors that are clearly related to desirable policies, and (d) frame the desired behaviors as steps toward a higher goal—in this case, climate-change mitigation.

In the closing article, Andrew J. Hoffman, P. Devereaux Jennings, and Nicholas A. Poggioli draw on institutional theory to argue that protecting the planet will require shifting society from being guided by the logics, or worldviews, of market capitalism and techno-optimism (faith that technology can solve all problems) to a logic that views nature and society as interdependent. Hoffman and his colleagues propose five categories of policies that can drive these shifts: establishing eco-sensitive corporate governance, reducing consumption, elevating the role of science, extending corporate time horizons, and making society more resilient. They emphasize specific policies within each of these categories that are relatively well-suited for incremental, transitional, and transformational change.

We believe that the collection of articles in this special issue can serve a dual purpose: paving the way for concrete policy changes that will protect the planet and inspiring future research on interventions that will increase pro-environmental behaviors.

Izzy Gainsburg, Julia Lee Cunningham, Leidy Klotz, & Rick Larrick
Spotlight Editors

review

Improving the effectiveness of time-of-use pricing to make household electricity consumption more sustainable

Kelly Peters, David R. Thomson, & Nathaniel Barr

abstract

To increase efficiencies and reduce greenhouse gas emissions, policymakers and electric utility providers are increasingly adopting time-of-use (TOU) pricing policies, which charge the most for electricity consumption during *on-peak* hours, the times when the demand for electricity is greatest. TOU policies aim to disincentivize on-peak electricity use in favor of use during usually low-demand, *off-peak* periods to reduce the suppliers' need to augment electricity generated by low- or nonemitting sources (such as hydro-electric and nuclear power) with electricity generated by high-emitting sources (such as coal- or gas-fired power plants). Researchers and policymakers are attempting to apply behavioral science tactics to enhance the effectiveness of TOU pricing by making behavioral science–based changes to electricity bills or delivering personalized information about electricity use and pricing, or doing both. In this article, we describe several studies we conducted in Ontario, Canada, in which we examined customer responses to various bill designs and communications. Simplifying bills and emphasizing the high cost of on-peak use (that is, making on-peak pricing more salient) were effective at shifting behavior, as was the delivery of *nudge reports*, which compared a household's electricity use with its past consumption, offered conservation tips, and asked customers to make a pledge to reduce consumption. These studies demonstrate that incorporating behavioral tactics into existing consumer-facing communications can be an effective, low-cost, and scalable way to induce customers to increase off-peak electricity use and thus limit greenhouse gas emissions.

Peters, K., Thomson, D. R., & Barr, N. (2021). Improving the effectiveness of time-of-use pricing to make household electricity consumption more sustainable. *Behavioral Science & Policy*, *7*(2), 1–15.

Core Findings

What is the issue?

Encouraging people to reduce their energy consumption is an important way to reduce greenhouse gas emissions and address climate change. Increasingly, governments and utility providers have begun adopting *time-of-use* (TOU) pricing that incentivizes energy use at times when demand is typically lower. For this intervention to be more effective, however, stakeholders should leverage behavioral insights into preexisting customer communications about electricity use and TOU pricing.

How can you act?

Selected recommendations include:
1) Highlighting TOU pricing in simple bills that make the high cost of on-peak energy salient
2) Delivering *nudge* reports to consumers, which compare a household's electricity use with its past consumption, offer conservation tips, and ask customers to make a pledge to reduce consumption

Who should take the lead?

Researchers, policymakers, and utility providers in energy

Electricity production is a major contributor to the release of carbon dioxide and other greenhouse gases at the root of human-caused climate change. It is the second largest contributor to greenhouse gas emissions in the United States (26.9% in 2018),[1] and electricity and heat generation are the primary sources of emissions globally (31% in 2017).[2] Advancements in energy technology are critical to the success of interventions aimed at reducing these emissions and their effects on climate. But policymakers and utility providers are increasingly recognizing that inducing citizens to alter their electricity use in their homes can also help.

The proportion of energy consumption attributable to the residential sector varies significantly by country, but the global impact is large: By one estimate, it accounts for 27% of global energy consumption and 17% of carbon dioxide emissions.[3] What is more, the recent pandemic-driven shift to remote work, which many organizations are considering making permanent, may increase residential energy consumption dramatically.

One way to lower emissions from household energy consumption is to spur people to invest in eco-friendly infrastructure, such as more energy-efficient appliances or windows. Consumers considering such investments face high costs, however, both economically and in terms of hassle. Another option, which requires less expense and effort for consumers, is for utilities to establish load-shifting, or *demand management*, policies. These policies encourage people to shift electricity consumption from *on-peak* to *off-peak* hours—from the times when demand for electricity is generally highest to times when it is typically lowest—and can be an important strategy for lowering emissions.[4]

One might well wonder how shifting the timing of electricity use could reduce emissions, given that the net energy consumption would not necessarily change much. Yet the approach makes sense: Normally, power plants designed for continuous use (such as nuclear generators and hydroelectric stations) supply most of the energy consumers use during off-peak times. During on-peak times, energy suppliers must often meet the higher demand by also obtaining electricity from power plants that are less energy efficient and can emit large amounts of greenhouse gases (such as natural gas–fired plants), a maneuver that is not only more costly but also worse for the environment. Further, as on-peak demand increases, so does the need to expand the system's capacity through the construction of new power sources.[5,6,7] Although inducing people to consume a greater share of their electricity during off-peak times is challenging, achieving this shift is probably more feasible, more cost effective, and better for the environment than is a massive switch to energy-efficient home appliances or increasing on-peak capacity and energy supply.

Recognizing the benefits that demand management can bring to the grid—and the planet—many jurisdictions in North America, Europe, and Australia have implemented *time-of-use* (TOU) pricing models, in which on-peak electricity prices for residential consumers are significantly higher than off-peak prices. The approach is gaining popularity thanks to the increasing use of smart metering technology,[8] which precisely records household electricity consumption by the hour. In addition to enabling TOU pricing, smart meters allow consumers to see how their energy-consumption patterns affect their costs. In theory, this insight should lead consumers to use less energy during on-peak hours and perhaps even drive them to reduce energy consumption overall. The use of TOU pricing and smart meters relies on traditional economic-incentive-based approaches to behavior change and typically combines the incentive with the delivery of information to citizens that explains the pricing scheme and its economic and environmental benefits.

Although TOU pricing has intuitive appeal, it also has limits for inducing behavior change. First, some consumers may not be aware of or comprehend the TOU pricing models, and others may experience *present bias*, placing higher value on the convenience of their current behavior over the prospect of saving money in the future.[9] In addition, given that electricity is generally viewed as an essential

service, electricity pricing is often regulated, as is the case in the province of Ontario, Canada.[10] This regulation means that only relatively minor changes to pricing may be permissible. Further, people generally lack awareness of how much electricity they are consuming, particularly relative to the electricity consumption of others.[11]

TOU pricing can also have drawbacks for those who institute it. From a financial perspective, the cost of investing in TOU pricing models may not always be justified by the size of the effect on peak electricity demand. For example, Ontario made a considerable investment to retrofit millions of households with smart meters. The auditor general of Ontario reported that the investment in smart meters, which enabled TOU pricing, added up to over U.S. $1 billion,[12] yet one study assessing the impact of TOU pricing on residential electricity customers in the province found only a 2.8% average reduction in on-peak energy consumption over the course of a year.[13] Another study showed that by 2014, two years after the full-scale rollout of TOU pricing, on-peak energy use had been reduced only 1.18%.[14]

The inherent limitations and relatively low impact of TOU pricing on load shifting raises a question: What can be done to improve the effectiveness of TOU pricing in encouraging individuals to shift their electricity consumption to off-peak hours and, in turn, lead to more sustainable electricity consumption in homes? In a series of investigations carried out with Canadian utility providers in Ontario, we have shown that interventions based on insights from behavioral science research can increase this effectiveness—such as the insight that how information is framed and highlighted can make a huge difference in whether people act on it. This locale gave us a unique opportunity to assess such approaches because Ontario was the first region in the world to require all low-usage customers (including all households and most small businesses) to use smart meters[15] and because TOU pricing was rolled out almost universally through Ontario's regulated price plan, which was introduced in 2005. By 2014, approximately 96% of the province's residential and commercial customers were on TOU pricing.

In this article, we present key findings from research in which we initially used information-framing techniques drawn from behavioral science to try to improve bill payers' understanding of TOU pricing and their awareness of their own electricity consumption. On the basis of the results, we then created new electricity bills and communications that aimed to alter real-world electricity consumption. The work we describe, which we carried out between 2014 and 2020, involved a variety of measurement approaches, including surveys, panel experiments (in which different groups, or *panels*, of participants were asked questions about different versions of electric bills), and field experiments (which measured consumer behavior in response to actual bills delivered to their homes). Taken together, the findings converge with other evidence indicating that policymakers should augment existing strategies for altering energy consumption patterns with strategies based on behavioral science.[16] Our findings also provide evidence-based guidance on how best to integrate behavioral science–based methods into existing strategies.

Study Series 1: Assessing TOU Pricing Comprehension & Intentions to Conserve

In light of the relatively low impact of TOU pricing alone on electricity consumption, the Ontario Energy Board engaged BEworks (a consulting firm that specializes in applying behavioral science research to real-world problems) to uncover barriers that impede the shifting of electricity consumption in response to TOU pricing and to identify ways to increase the effect of TOU pricing on these shifts. This work is described in detail in a publicly available report, *Analyzing and Nudging Energy Conservation and Demand Shifting Through Time of Use Compliance*.[17]

An online consumer survey of 666 electric-bill payers revealed that most Ontarians were aware of TOU pricing (85%), but less than three-quarters (73%) knew the names of the three TOU

27%

Global energy consumption attributable to the residential sector

17%

Global carbon dioxide emissions attributable to the residential sector

31%

Global emissions attributable to electricity and heat generation in 2017

"people could well experience *information overload*"

periods that were used (*on-peak*, *mid-peak*, and *off-peak*), and less than half (44%) could define the unit of electricity (kilowatt hour) for which they were being charged. Hassle costs were cited as the primary reason for not shifting behavior; that is, participants strongly agreed with the statement "It is difficult for me to schedule electricity consuming activities during off-peak hours" (the mean level of agreement was 61 on a 100-point scale). Those who had shifted their consumption patterns in response to TOU pricing cited finances as the main reason, agreeing most strongly with the statement that "saving money on monthly electricity bills" was a motivating factor (the mean level of agreement was 90 on a 100-point scale). Finally, most Ontarians in the study underestimated their relative electricity consumption, with 83% thinking they consumed about the same amount as or less than their peers.

Next, we examined two electricity bills used by Ontario's largest local distribution companies, looking for ways the bills might impede consumers' compliance with TOU pricing. We noted that by displaying the financial benefits that would be seen on a future bill, the existing bills could encourage *temporal discounting,* a psychological process in which people devalue financial benefits that do not accrue until long after an action is taken (in this case, several weeks). Further, because the bills included a multitude of line items, people could well experience *information overload,* confronting too much detail to be able to parse the most important information related to their electricity consumption. In addition, the bills lacked *social normative messaging*: They provided no frame of reference that allowed bill payers to judge whether their household's electricity consumption was higher or lower than that of other households during on-peak hours.

We then conducted a study to unearth further insights for forming hypotheses about how best to redesign bills. We asked 175 Ontario bill payers to view an electricity bill (one of the two bills we had examined earlier) on a computer and instructed them to click on areas they would look at if it were their own bill. Seeking to identify areas of the bill that were most salient, overlooked, or misunderstood, we recorded participants' viewing time as well as the sequence and location of mouse clicks. Unsurprisingly, the amount due and payment due date received the most clicks. In addition, graphical depictions of electricity consumption were more likely to be clicked than tabular depictions of that same information—an indication that graphs may be more visually salient or more interesting (or both) than tables and may, as a result, receive more attention.

A subsequent test assessing recall of key billing information (such as the timing and pricing schedules for the three TOU periods—on-peak, off-peak, and mid-peak) revealed that, overall, recall was poor for both bills tested, with participants answering less than 30% of recall questions correctly, on average. However, each 10% increase in the total seconds spent reviewing the bill was found to increase the overall recall score by 9.3% ($p < .001$). See note A for a discussion of the statistics used in this article.

We concluded from our audit of the bills, the click study data, and the recall data that key billing information related to on-peak electricity consumption should be placed near highly attended information, such as the amount due and payment due date, and that it should be depicted in graphs rather than tables. Further, we expected that making the most important information visually prominent and therefore salient would capture attention and thus increase bill viewing times, which would lead to higher recall of the information most important for convincing consumers to use less on-peak electricity.

To isolate interventions that could enhance comprehension and recall of electricity usage and increase intent to adjust consumption, we conducted 10 randomized controlled online panel experiments that manipulated specific elements of a typical electricity bill in different ways. (Randomized controlled trials, which assign participants to experimental and control

conditions randomly, are the gold standard of trial designs because of their ability to limit bias and reveal cause–effect relationships rather than merely correlational effects.) These experiments showed that a number of actions are beneficial for driving intent to shift electricity consumption to off-peak periods in response to reading electric bills, such as increasing the ease of processing the bill's information, reducing ambiguity, comparing an individual household's electricity usage with the usage of others (that is, *benchmarking*), and including calls to shift electricity consumption to off-peak times of day. Specific key findings from these online trials include the following:

- Displaying on-peak prices in cents, as opposed to dollars, decreased the mean margin of error in price recall from 32.5 cents to 13.5 cents.

- Price-focused TOU period names (such as *most expensive* and *least expensive*) were recalled better than were more typical naming conventions (*on-peak, mid-peak,* and *off-peak*), with the former yielding a 60% correct recall rate and the latter a 17% rate.

- Showing the TOU periods using linear visuals led to correct recall of off-peak times of day in a greater percentage of participants (86%) than did using circular pie chart format visuals (80%), as is typical. (See Figure 1 for examples of linear and pie chart presentations. Print readers: All figures can be seen in color in the online version of this article at https://behavioralpolicy.org/publications/.)

- Displaying consumption visuals that focused on only one TOU period (such as on-peak) were rated as being easier to understand and resulted in respondents reporting 12% higher intentions to reduce consumption than did visuals that, as is typical, depicted consumption for all TOU periods.

Guided by our findings, we constructed seven bills we thought would be optimized for producing the greatest shift to off-peak use, designing the bills to include top-performing elements (in terms of comprehension, recall,

Figure 1. Example stimuli (circular versus linear TOU visuals) from the panel experiments in Study Series 1

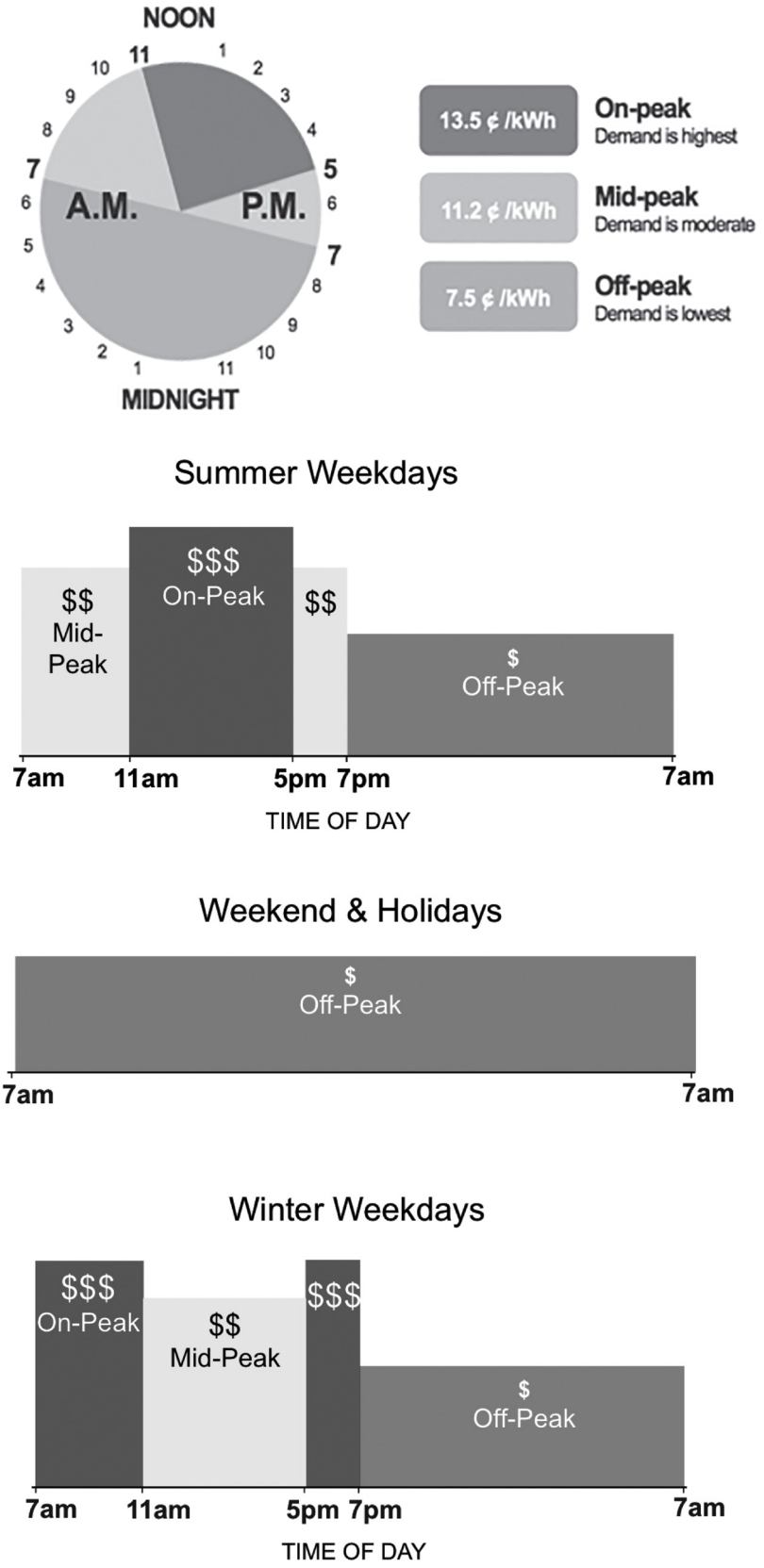
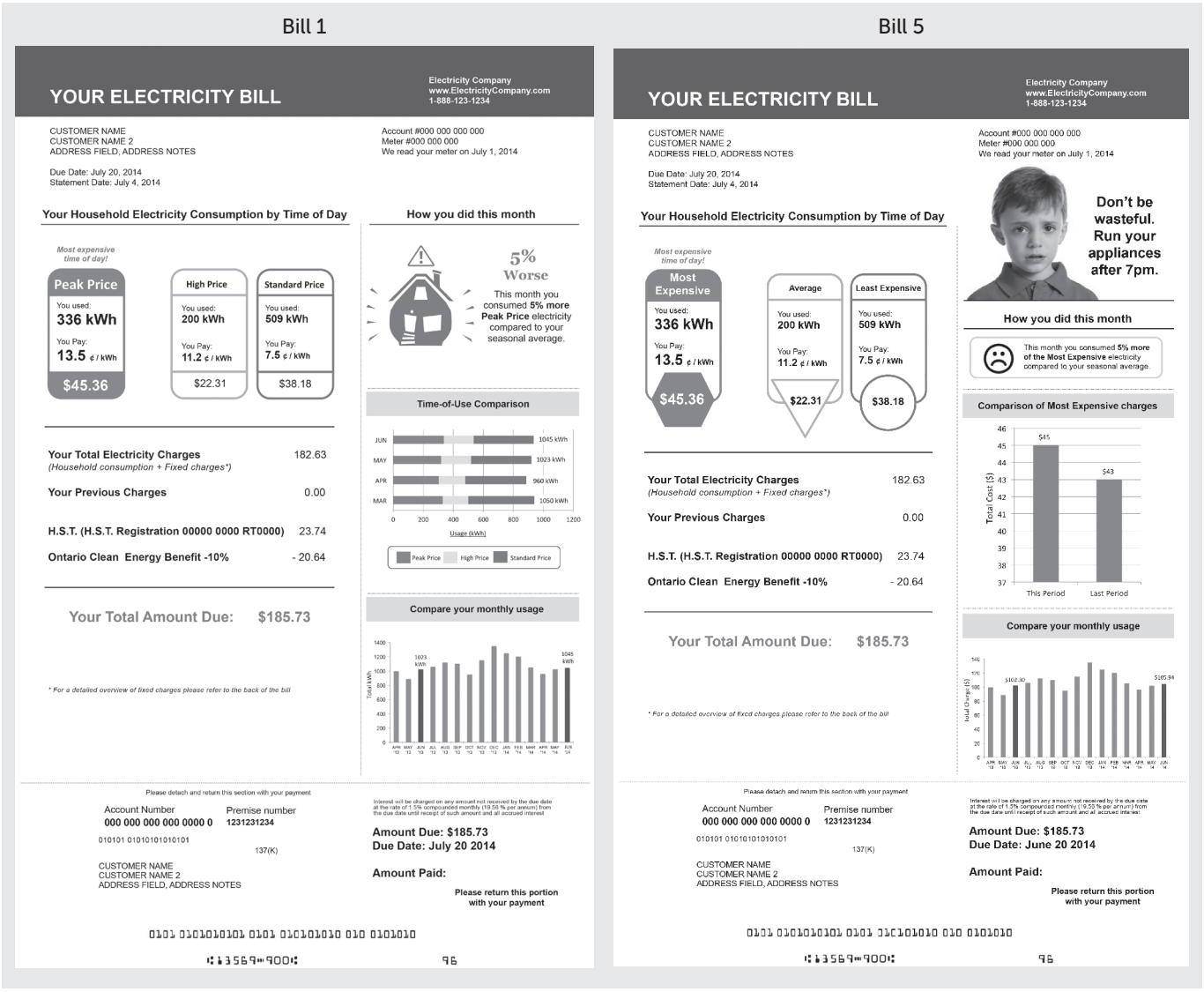


Figure 2. The best-performing treatment bills from the online panel experiments in Study Series 1



and intentions to shift behavior). Two of these bills were variations on the control: The content and layout were the same as in the control bill, except that the energy consumption bar graphs in the control were replaced with different graphs that had been shown to be more effective. The remaining five bills each incorporated top-performing elements, and all five included elements targeting price clarity, consumption benchmarks, and pledges, among other factors. Different bills had different ways to manifest these elements. For instance, in Bills 1–3, the pledge had an informational message, whereas in Bills 4 and 5, the pledge had a social message.

We assessed these optimized bills in an online randomized controlled trial with 935 residential electricity consumers. Using what is called a *between-subjects randomized design*, we divided the participants randomly into nine groups. Seven treatment groups saw one of the optimized experimental bills, and two control groups saw bills in formats already in use. Two of the experimental bills—Bill 1 and Bill 5—emerged as clear winners (see Figure 2), in that they outperformed the standard bills on a suite of key metrics to a statistically significant degree.

Both winners featured colorful visuals to draw attention to TOU-period consumption, placing bright shapes—colored red, yellow, and green, as with traffic lights—around the on-peak, mid-peak, and off-peak prices, respectively. They also displayed TOU-period consumption graphically rather than in a tabular format and listed prices in cents rather than dollars. Bill 1 also incorporated a linear comparison of the household's energy consumption during the different TOU periods.

The metrics we used to deem the two bills winners included the following:

- *Attention* (measured by mouse clicks on key consumption information). The average number of clicks on TOU-period visuals was 115% higher for Bill 1 than for the standard bills (0.43 versus 0.20 clicks, respectively), and the average number of clicks on TOU-consumption visuals was 10.2% higher for Bill 5 than for the standard bills (1.08 versus 0.98).

- *Recall.* Bill 1 reduced the margin of error associated with recall of absolute prices by 36.8% relative to the standard bills. (The mean margin of error was 45.7 cents for the experimental bill and 28.9 cents for the standard bills.) In the case of Bill 5, the proportion of respondents correctly identifying on-peak prices was greater than for respondents who saw the standard bills (a mean of 47% versus a mean of 20% for the control groups.)

- *Perceived ease of understanding.* Participants answered the question, "How easy is it for you to understand the information on this bill?" on a 7-point scale, ranging from 1 = *not at all easy* to 7 = *very easy*. Mean ratings for Bill 1 and Bill 5 (5.30 and 5.40, respectively) were higher than for the standard bills (5.10) to a statistically significant degree.

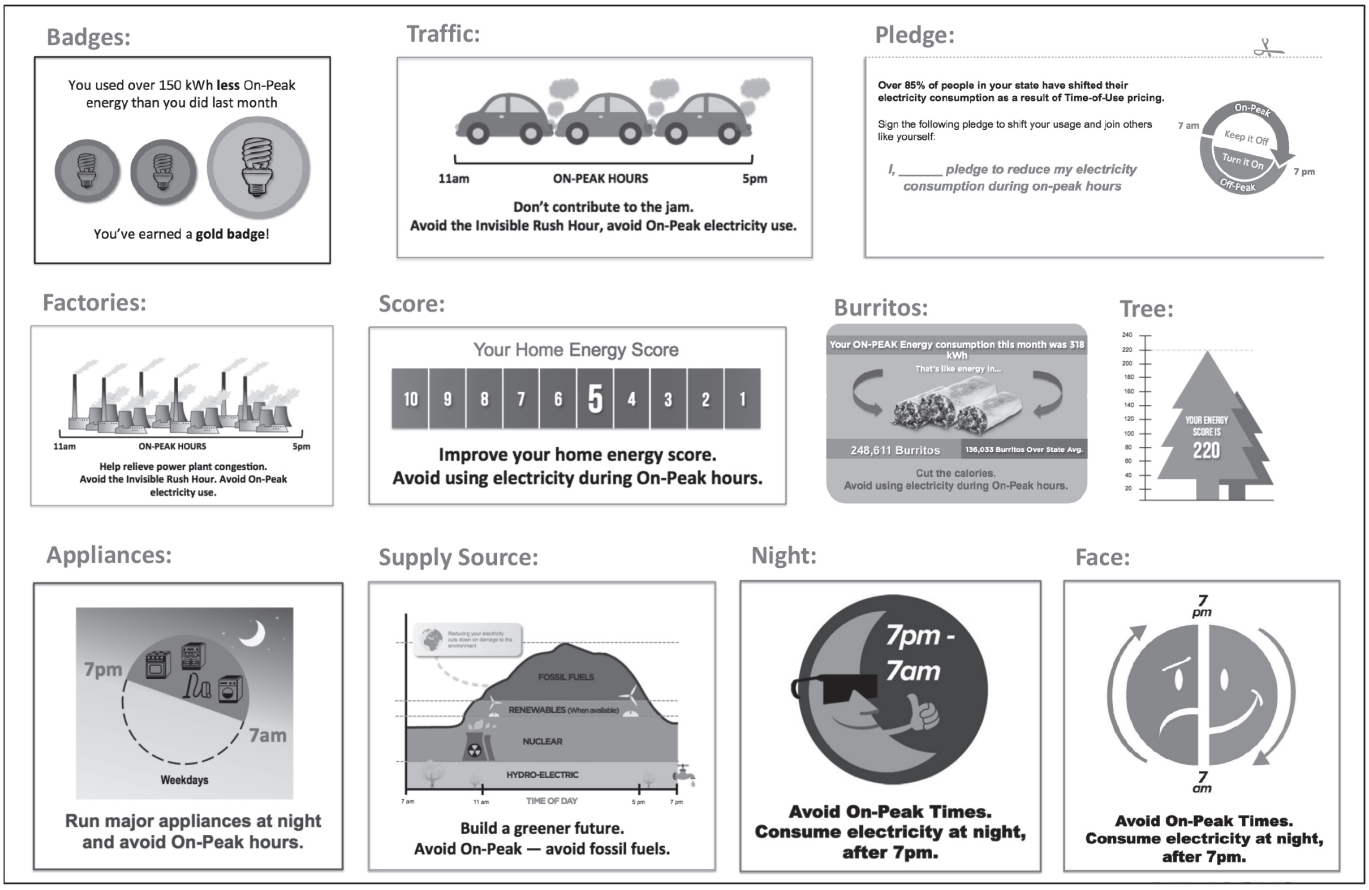
This series of studies revealed that the information consumers were receiving about TOU pricing was suboptimal for helping them recognize their electricity-consumption patterns and the higher costs they were paying during on-peak and mid-peak periods. The work also demonstrated that reengineering existing consumer-facing communications using evidence-backed behavioral insights could increase comprehension and recall of TOU pricing effectively. The next question was whether these improvements could drive real-world behavior change and lead people to conserve electricity by shifting electricity use to off-peak hours or otherwise reducing electricity consumption.

Study Series 2: Testing Behaviorally Informed Bills in the Field

To build on our work with the Ontario Energy Board and assess revised bills in the field, we partnered with the Independent Electricity System Operator in Ontario. The Independent Electricity System Operator manages supply and demand, promotes energy efficiency, and plays a central role in planning for the future energy needs of the province. It was a logical partner because it has a conservation fund for conducting pilot projects and the capacity to facilitate testing with residential and commercial customers in the region it serves. Before conducting a large randomized controlled field trial assessing the ability of behaviorally informed bills to drive load shifting and conservation, we ran another series of studies examining specific elements that could be incorporated into the bills. A detailed analysis of this work is in the publicly available report *Driving Conservation and Demand Management Objectives Through Bill Redesign: A Behavioural Economics Approach*.[18]

The first phase consisted of a panel experiment that varied multiple bill elements in isolation, such as the terminology used to describe on-peak versus off-peak hours, the visuals that provide feedback about past electricity usage and benchmarks, the visuals used to convey TOU information, and the clarity of pricing information. This work replicated key findings of the Ontario Energy Board research we described earlier; for example, it confirmed that showing the price per kilowatt-hour in cents rather than dollars results in better recollection. The panel experiment also extended the earlier research,

Figure 3. Example stimuli used in Study Series 2 to communicate environmental costs & social undesirability of overconsumption in peak times



such as by testing novel bill content meant to motivate customers to conserve on-peak electricity and take other eco-friendly actions. We tried a number of tactics to make the environmental costs and social undesirability of overconsumption both salient and concrete, including showing images of pollution-emitting cars and factories, comparing the amount of electricity consumed with the amount of energy available in tangible terms (such as speaking about how a household's energy usage translated to the energy in food—as in, "Your on-peak energy consumption this month was 318 kWh, which is like the energy in 248,611 burritos"), and showing via simple graphics that consuming electricity after dark is better for the environment. See Figure 3 for example stimuli.

We measured the stimuli's effects by having participants indicate their agreement with various statements and their recall of TOU pricing. Several of the visuals proved superior on measures of motivation to shift the timing of electricity consumption, comprehensibility, whether people felt positive toward the visual, and recall of pricing schemes. In particular, the visuals we named Appliances, Night, and Faces generated the best overall scores, and so we integrated aspects of those visuals into the design of new experimental bills in the next phase of testing. For instance, all three of those stimuli used a simple circular icon of some sort to highlight that nighttime (after 7 p.m.) is the desirable off-peak period for electricity consumption.

In this next phase, we tested three experimental bills (Bill 1, Bill 2, and Bill 3) against a control bill (an existing bill already in circulation) in a large-scale randomized control trial involving 24,687

households in Ontario randomly assigned to receive one of the four bill layouts monthly from June 2017 to May 2018. (Figure 4 depicts selected pages from the bills.) Bill 1 included a simple circular visual showing that off-peak times of day run from 7 p.m. to 7 a.m. on weekdays (as in the Appliances stimulus) and provided customers with a salient linear depiction of TOU periods. Bill 2 gave prominent feedback highlighting the household's on-peak consumption and whether it was higher than average for the neighborhood; it also provided a salient linear depiction of TOU periods that showed the relative differences between on-peak and off-peak pricing. (This bill accompanied the on-peak consumption data with a frowning face similar to that in the Faces stimulus.) Bill 3 was the simplest, providing much less information and devoting a significant portion of the bill's real estate to reporting on the household's on-peak consumption and flagging whether the customer's electricity consumption was higher than average. (This bill also included the frowning face with on-peak data and showed the Night visual next to a tip advising people to run appliances at night.)

We analyzed each household's hourly electricity consumption during each TOU period (on-peak, mid-peak, and off-peak) using what statisticians call a "difference-in-difference" approach. In other words, for each TOU period, we measured each group's change in electricity consumption during the treatment year (when households received the experimental bill) relative to their baseline for the year before. Then we compared the average hourly consumption change of each experimental group against the consumption change by the control group. It is important to note that seasonal variation in temperature and other factors can influence year-to-year usage, which means that some differences from one year to the next are not necessarily meaningful. The most meaningful comparison is between the treatment and control groups.

Despite the promising results from our experiments with individual stimuli, Bill 1 and Bill 2 did not produce statistically significant differences in customers' time of electricity consumption. Bill 3, however, did yield statistically significant

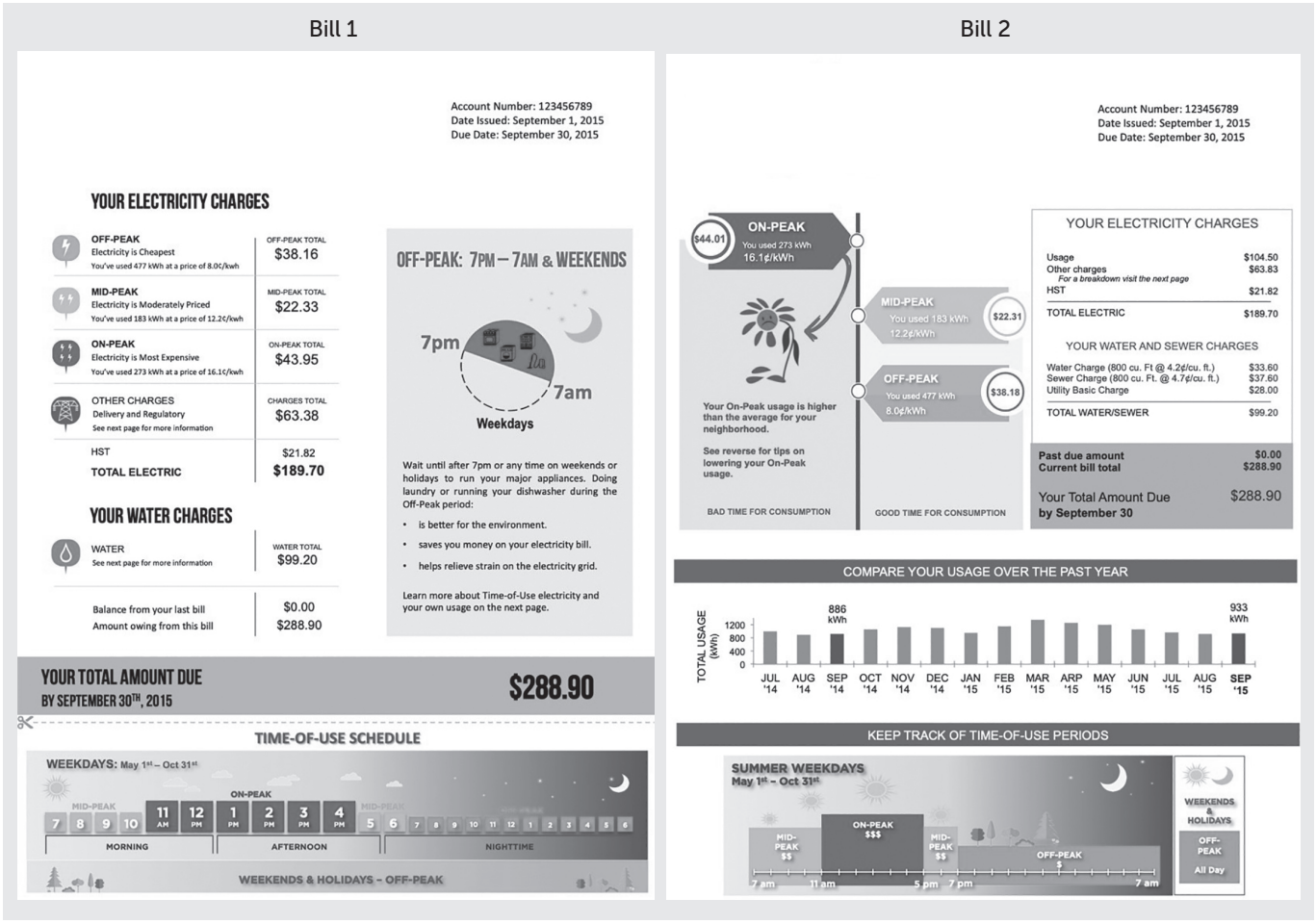
"there was a 1% greater reduction in average electricity consumption"

($p < .05$) consumption reductions relative to the electricity consumption of the control group on a number of key metrics. Some of the key observations include the following:

- There was a 1% greater reduction in average electricity consumption from pretreatment to treatment periods during on-peak times of day in the winter months.
- There was a 0.8% greater reduction in average hourly on-peak consumption from pretreatment to treatment periods across the entire 12-month duration of the study.
- There was a 0.6% greater reduction in average hourly mid-peak consumption from pretreatment to treatment periods across the entire 12-month duration of the study.
- The highest reductions in average hourly TOU consumption ratios (the amount of on-peak consumption relative to the amount of off-peak consumption) occurred in August and May (1.8% and 1.95%, respectively).

To better understand why Bill 3 alone was effective, we need to do further testing, but it seems plausible that its simplicity may have made it the easiest to absorb and remember. In the final month of the 12-month trial, we sent an online survey to all participating households, ending up with 2,007 surveys completed. This survey, which probed recall and opinions of the bills, revealed that, relative to households that received the control bill, those that received Bill 3 were more likely to correctly answer a set of three comprehension questions related to TOU pricing. For example, 6.3% more Bill 3 households could correctly identify the on-peak electricity price. Recipients of Bill 3 also held more positive opinions of their bill (when asked about satisfaction with the bill and whether the layout should be continued) than did recipients

Figure 4. Experimental bills & a control bill used in the large field study in Study Series 2



of the control bill (with mean scores of 5.1 and 4.4 out of 7 for Bill 3 and the control bill, respectively).

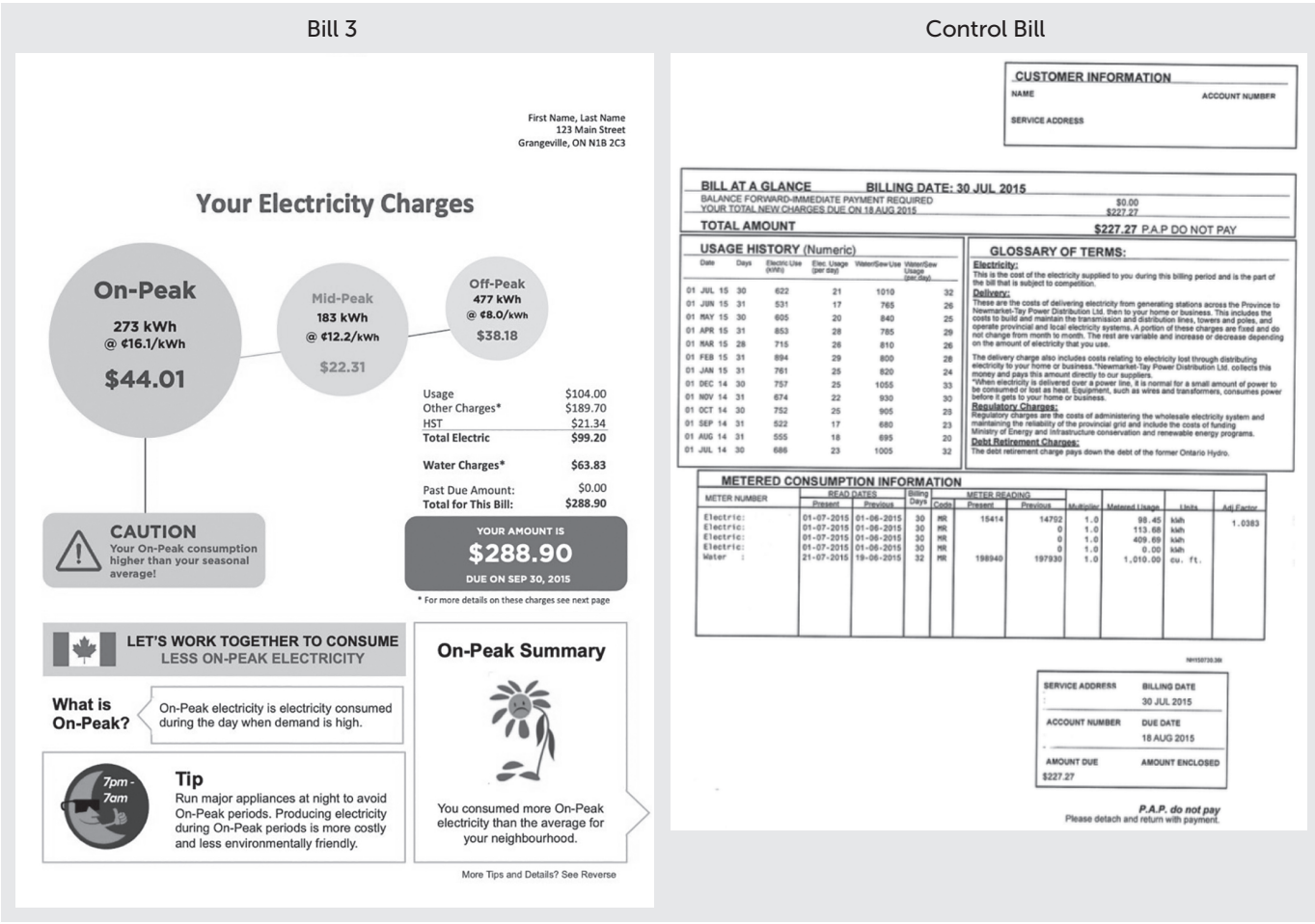
Overall, our results indicate that applying behavioral insights to preexisting customer-facing communications about electricity use and TOU pricing can be an effective and scalable option for augmenting existing initiatives to shift time of electricity use. Although our best intervention did not change behavior dramatically—key consumption metrics changed by just 1% to 2%—such reductions are similar to the effects on on-peak consumption that occurred in response to TOU pricing alone when the scheme was first introduced in Ontario.

It is interesting that the field data did not support several hypotheses that were suggested by past behavioral research. For example, although numerous other studies have found that comparing people's actions with those of others can promote behavior change, the comparisons used in our field study had little effect. (See reference 19 for a study demonstrating effective comparisons.) Our results serve as a reminder that launching full-scale rollouts in the absence of empirical validation in the field could lead to the misallocation of public funds to initiatives that then will not meet their goals for sustaining the environment.

Study 3: Testing Behaviorally Informed Bills & Pricing Interventions in the Field

To understand how financial and behavioral interventions could work together, we

Figure 4. Experimental bills & a control bill used in the large field study in Study Series 2 (*continued*)

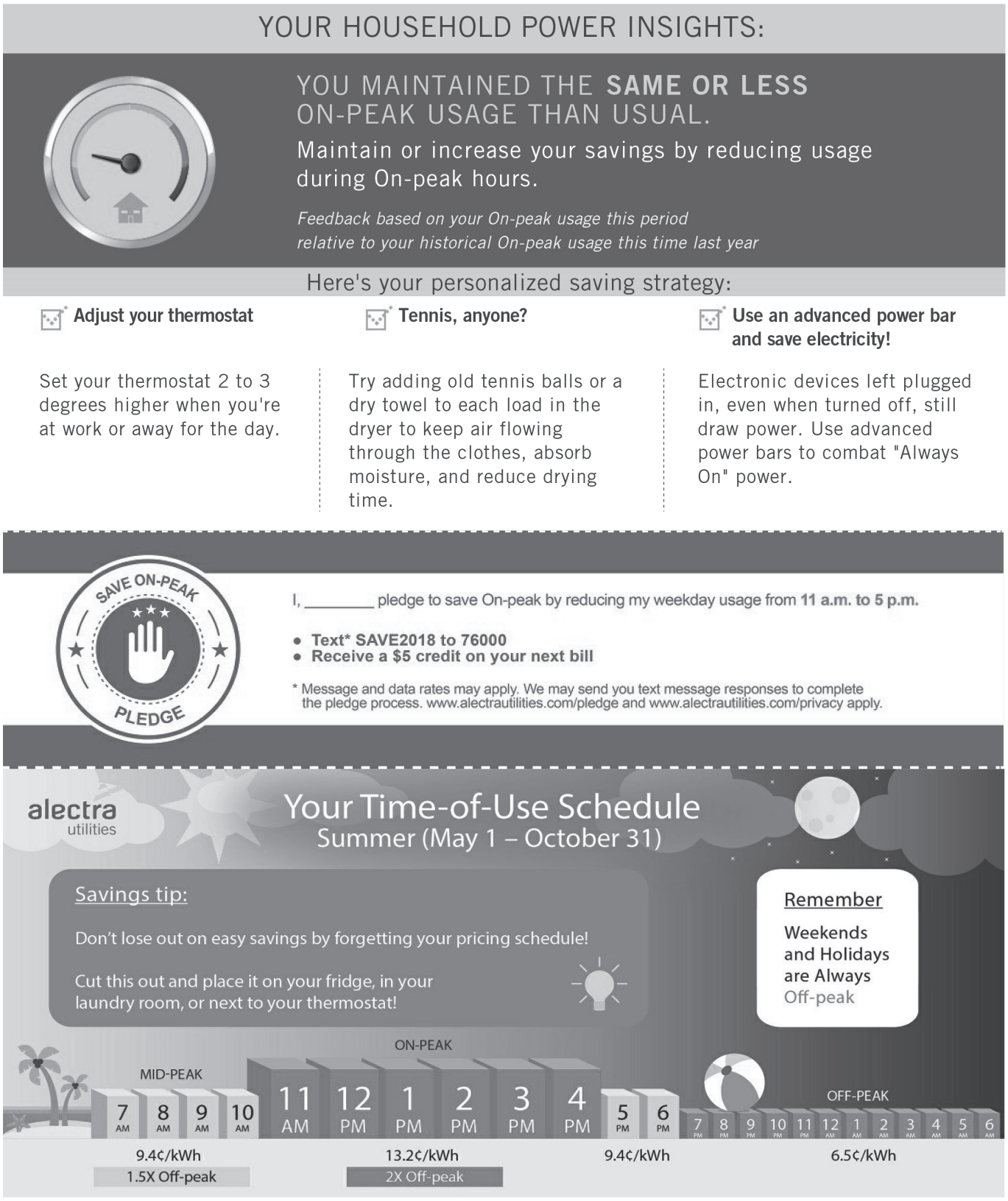


Note. The bills were double sided. Only the first page of each bill is displayed here.

undertook an additional study, this time with the Ontario Energy Board and a large regional electricity provider in Ontario's Golden Horseshoe area, Canada's most populous region. This was a large-scale field study—involving 19,276 households—that tested the effects of various pricing interventions as well as a nonfinancial intervention on conservation, load shifting, and reductions in on-peak electricity consumption among residential customers. A detailed analysis of this work is reported in the publicly available interim report[20] titled *Alectra Utilities Regulated Price Plan Pilot—Interim Report*.

Specifically, we tested three novel TOU pricing schemes that varied with respect to the ratio of on-peak to off-peak prices; these three schemes had progressively higher on-peak and lower off-peak prices relative to status quo TOU pricing. The nonprice intervention consisted of what we called *nudge reports*: monthly communications that were informed by behavioral science research and by insights gleaned from the extensive online and in-field experimentation we conducted in the two sets of studies described earlier. (See Figure 5 for a sample nudge report. *Nudges* are gentle prods that do not interfere with people's freedom of choice). The nudge reports included personalized benchmarking (they compared current on-peak consumption with use during previous billing periods), actionable advice for how to reduce on-peak consumption, and an offer for bill payers to earn credit on their next bill by signing a pledge to lower on-peak electricity use.

Figure 5. A sample nudge report distributed to randomly selected households each month over the 12-month duration of Study 3



Study 3 relied on a mixture of methodologies, including randomized controlled trials and matched controlled trials (wherein a treatment group and a control group are matched on historical consumption behaviors to create an appropriate comparison). We assigned participants randomly to one of three experimental groups (in which they received bills that used one of the three pricing schemes) or to control groups for each of those conditions; participants in control groups received a bill already in use and in line with current TOU pricing. We also sent a monthly nudge report to half of the participants in each experimental and control group for each pricing scheme, which enabled us to examine the effect of behaviorally informed nonfinancial interventions. The full experiment took place over 12 months, during which we monitored hourly electricity consumption. Our first analyses, part of a prescheduled preliminary report, focused on the summer months (May through October) and measured the electricity consumption of a given experimental group relative to that of its control group.

Regarding the pricing interventions, the scheme with the highest on-peak to off-peak price differential (approximately 8:1) was most effective in driving reductions in on-peak electricity consumption. We estimate that in the summer months, the experimental group consumed 13% less electricity than the matched control group used during on-peak times of day.

Critically from a behavioral science perspective, one of the experimental pricing schemes (the one that had the smallest difference between on-peak to off-peak pricing while still charging about 50% more for on-peak electricity use than is standard) yielded no statistically significant effect on electricity consumption relative to that seen in the control group, whereas the nudge reports sent to these participants resulted in statistically significant (albeit relatively small) on-peak consumption reductions of about 1.1%. These findings demonstrate the potential for behavioral interventions to drive environmentally beneficial behavior by citizens when financial levers are ineffective, not desired, or simply not available. Put differently, the findings suggest that in some contexts, delivering nudges aimed at changing behavior may sometimes function as an alternative and not merely a complement to pulling pricing levers.

> "the experimental group consumed 13% less electricity"

Key Insights

In our research with various partners, we have found that behavioral interventions are promising tools for improving the effectiveness of policies designed to sustainably reduce greenhouse gas emissions from electricity consumption. Although the effects of our interventions on electricity consumption were statistically significant, they were not massive and were much smaller than those of the pricing interventions, but they were comparable to the effects of TOU pricing itself. That is, the behaviorally informed approaches complemented traditional economic approaches like TOU, could be scaffolded on existing channels

Takeaways for Policymakers

Foster public–private partnerships between regulators, utility providers, and behavioral scientists. Innovation is not possible within the energy sector without regulatory willingness to facilitate experimentation. To make it possible to try something new, policymakers must be willing to allow exemptions to existing policies.

Behavioral insights can augment existing policy approaches based on economics. For instance, the higher cost of on-peak pricing over off-peak pricing can motivate consumers to shift electricity use to off-peak times, but enhancing the salience of the price difference, such as by highlighting it on bills, can further increase the motivation to shift electricity use to off-peak times—and potentially bridge the gap between intentions and action.

Do not assume that household consumers understand time-of-use pricing. Of those who do understand the scheme, many will not know which behaviors contribute to meaningful shifts in energy consumption. Behavior change strategies are necessary to overcome both the say–do gap and the limits of the educational information provided by standard electrical bills.

Embrace the scientific method. Although behavioral strategies have great promise for shifting the time of electricity use and reducing household energy consumption, policymakers will need to pretest interventions to ensure that they are likely to have the desired effects on target populations. The costs of pretesting and experimentation are far lower than the expense of an ineffective strategy deployed at scale.

of communication with consumers, were less cumbersome for policymakers in terms of regulatory burden, and were relatively low in cost to implement.

An array of useful insights emerged over the course of our experiments. For instance, we saw that although consumers in Ontario had broad awareness that TOU pricing was in effect, relatively few solidly understood how it worked, and many pointed to hassle costs as precluding changes in their electricity consumption patterns. These barriers to behavior change suggest that simplifying and clarifying the information provided to consumers about TOU pricing could be beneficial. We found support for this notion in the greatest success of the simplest bill in our second series of studies, which gave a lot of space to the cost of TOU pricing and made the high cost of on-peak pricing salient. Not only did this simple bill lead to a tangible reduction in electricity consumption during on-peak times in a field study, it was also associated with higher comprehension of TOU pricing, according to the results of a subsequent survey of households receiving this type of bill.

Study 3 showcased the effect that very significant differentials between on-peak and off-peak pricing can have on consumption, with the most extreme difference yielding the greatest degree of behavior change. However, when the price differential was reduced so much that it had no effect on consumption, the use of a behavioral intervention (in the form of nudge reports) yielded statistically significant electricity use reductions. Thus, although large peak price differentials can certainly drive change powerfully, behavioral approaches can be used to augment more modest pricing schemes when large peak price differentials are not an option.

In terms of broader insights from our work, arguably the most important is that behavioral science approaches should feature prominently in policies relating to electricity consumption because of their efficacy and their ability to be easily integrated with other strategies for sustaining the health of the environment. (See the sidebar Takeaways for Policymakers.) Moreover, sustainability strategies in general—and for reducing household energy consumption in particular—could benefit from the early involvement of behavioral scientists and cross-disciplinary collaborations with designers, architects, and engineers,[21] because such collaborations can ensure that policies are attuned to the realities of human behavior and will thereby increase the policies' effectiveness. We support Richard Thaler's call for more "projects where behavioral scientists can be involved at the very start, helping to create the blueprints of a program before ground has ever been broken."[22] The successes of behavioral science–based interventions to date warrant further investments to help society reach its sustainability goals more efficiently in the future.

end note

A. Editors' note to nonscientists: For any given data set, the statistical test used—such as the chi-square (χ^2), the *t* test, or the *F* test—depends on the number of data points and the kinds of variables being considered, such as proportions or means. The *p* value of a statistical test is the probability of obtaining a result equal to or more extreme than would be observed merely by chance, assuming there are no true differences between the groups under study (this assumption is referred to as the *null hypothesis*). Researchers traditionally view $p < .05$ as the threshold of statistical significance, with lower values indicating a stronger basis for rejecting the null hypothesis.

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microwave
Washing Machine
Air Conditioner

proposal

Leveraging the motivational effects of labels: Lessons from retrofitting

David A. Comerford, Mirko Moro, Rodolfo Sejas-Portillo, & Till Stowasser

abstract

Retrofitting—replacing obsolete home infrastructure with more energy-efficient substitutes—will be essential to reducing energy use and carbon emissions in the future. Yet European and American households have proved reluctant to undertake these changes. Evidence has shown that a home energy audit can motivate people to retrofit their homes. In this article, we show that including the EU energy label—which displays the property's energy-efficiency rating—in energy audit reports is a simple way to enhance the audit's effectiveness: When energy labels are required as part of the process of selling a property, home sellers become motivated to retrofit if doing so boosts their property into a higher efficiency category on the label. Drawing on insights from the behavioral science literature, we offer suggestions for how policymakers can leverage this motivation to expand household investments in retrofitting. Although our proposals focus on retrofitting, some of them could also encourage other actions that would reduce energy consumption.

Comerford, D. A., Moro, M., Sejas-Portillo, R., & Stowasser, T. (2021). Leveraging the motivational effects of labels: Lessons from retrofitting. *Behavioral Science & Policy*, *7*(2), 17–25.

Core Findings

What is the issue?
Despite global imperatives to reduce energy consumption and the financial incentives of doing so, homeowners have been reluctant to *retrofit*—replace obsolete home infrastructure with more energy-efficient substitutes. However, mandating energy audits of residential properties and including the display of results in the form of a regulatory-approved and dynamic scoring label shows promise as an effective intervention to induce retrofitting.

How can you act?
Selected recommendations include:
1) Mandating a standardized label depicting accurate energy audits be presented in literature describing a property
2) Making it easy for home buyers to accurately evaluate labels—using colors and letters, for example

Who should take the lead?
Policymakers, researchers, and regulatory agency leaders in energy

A decade ago, an article in *Science* called on the behavioral science community to deliver low-cost and scalable interventions to reduce energy consumption.[1] For consumers, replacing inefficient appliances with more energy-efficient ones results in bigger reductions in household energy consumption than does curtailing or modifying the use of existing energy-draining equipment.[2] An open question is how to induce homeowners to take this step.

In this article, we summarize findings on tested interventions that encourage *retrofitting*, or replacing obsolete home infrastructure with more energy-efficient substitutes. We then offer advice, based on behavioral science research, for ways to improve the effectiveness of one of the most successful interventions: the home energy audit.

Failed Interventions

Surprisingly, even when the financial returns are high, homeowners are reluctant to install energy-saving technologies. Data on this point come from a randomized controlled trial by the North American energy provider OPower.[3] OPower offered all its customers rebates ranging from $50 on an energy-efficient washing machine up to $5,000 on home insulation to encourage them to take steps to retrofit their homes to save energy. One group of randomly chosen customers—the treatment group—additionally received tailored recommendations on retrofits that would deliver cost savings (for instance, they were told that a new air-conditioning unit would save the household a specific amount of money). But the messages did little good: Only 4.8% of the treatment group compared with 4.4% of the other participants—the control group—claimed rebates on energy-efficient purchases. It is striking that this intervention produced such modest effects, because the treatment group (a) had the requisite information to retrofit, (b) had a financial incentive to act, and (c) received an intervention that heightened their motivation to reduce energy consumption.[3,4]

A second resource-intensive and behaviorally informed randomized controlled trial also yielded discouraging results.[5] In this experiment, thousands of low-income households in Michigan received an in-person visit by a field worker from their community who explained the benefits of replacing inefficient heating and cooling systems and offered to help the members of the household complete the paperwork for free retrofitting. The campaign increased retrofitting by the treatment group relative to a control group, but only 6% of eligible households undertook retrofits, and the administrative price of the intervention was high: Using field workers cost more than $1,000 per household.

Motivating Consumers to Retrofit: The Success of Energy Audits

There is good news, however. Although many interventions have failed, requirements that home sellers deliver information about energy performance to prospective owners have succeeded in getting some sellers to retrofit their homes. Sellers of certain houses in Texas were required to provide buyers with audits of home energy performance. This requirement caused home buyers to place greater value on energy performance and motivated sellers to invest in the energy efficiency of their properties.[6]

Additionally, how audit results are presented can affect how influential the energy-performance information is. An American study found that, relative to presenting cost information alone or displaying the U.S. Energy Star label, using an energy-efficiency label similar to the current iteration of the European Union's energy label seemed to especially motivate investment in retrofitting.[7]

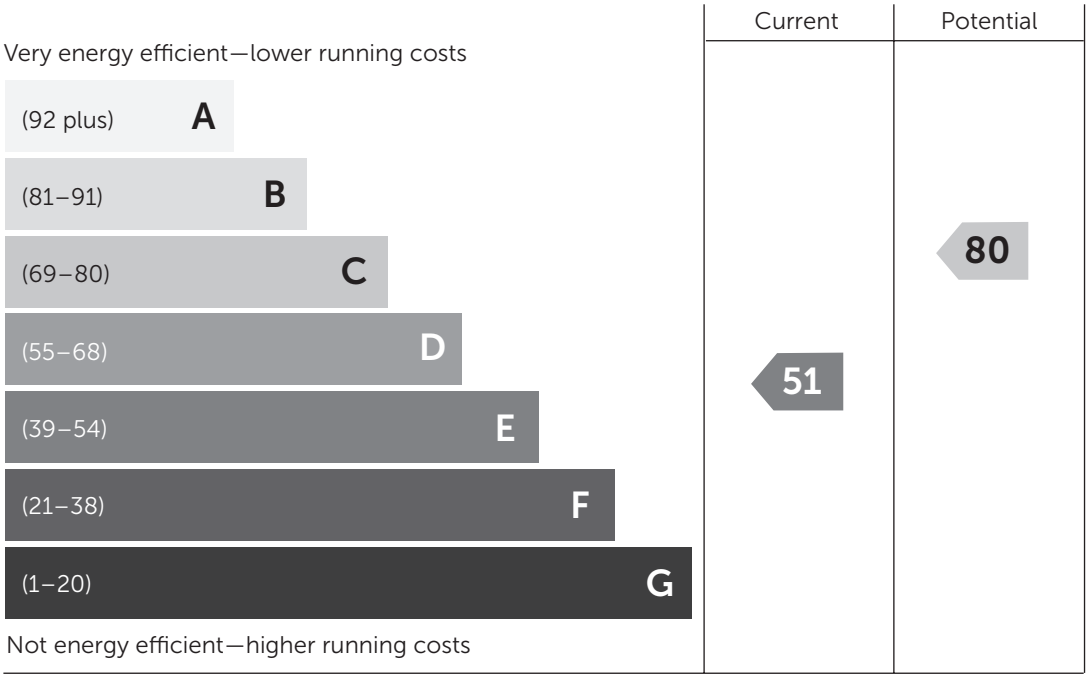
The EU energy label displays the energy-efficiency ratings of buildings and certain appliances. These ratings are given on a seven-level scale, in which each level is represented by a combination of colors and letters. The level corresponding to the most efficient rating, at the top of the scale, is colored green and

labeled *A*, and the least efficient level is colored red and labeled *G*; the in-between levels have various colors and are labeled with sequential letters. Any good label makes important information salient and easy to evaluate. The EU energy label has been praised on this basis[7]: If there is one thing everyone learns at school, it is that an A is better than an F. And indeed, other things being equal, a home rated A is likely to sell for a higher price than a house rated B. Additionally, consumers are responsive to the label's color coding: In experiments that hold the letter constant, products are more sought after when their category is colored green.[8] Although the thresholds on the EU energy label are arbitrary, data from Ireland,[9] published in 2016, and England,[10] published in 2018, suggest that sellers will invest to boost their property into a higher energy-efficiency category.

Further evidence of the power of the energy audit and the motivating effect of well-designed energy-efficiency labels comes from the 2018 English study, in which researchers looked at changes in the distribution of energy ratings for a representative sample of homes before and after the United Kingdom adopted its own version of the EU energy label.[10] That version combines the color–letter categories of the EU energy label with numerical indications of efficiency at each of the levels (see Figure 1).

The United Kingdom adopted the label after the British Parliament passed a law in 2004 that required an energy audit of any residential property on the market and the display of the audit's results on the EU energy label. The audit is conducted by an independent engineer, who inputs various measures of the fabric and fittings of the building into an algorithm to deliver a standard assessment procedure (SAP)

Figure 1. The U.K. version of the EU energy label



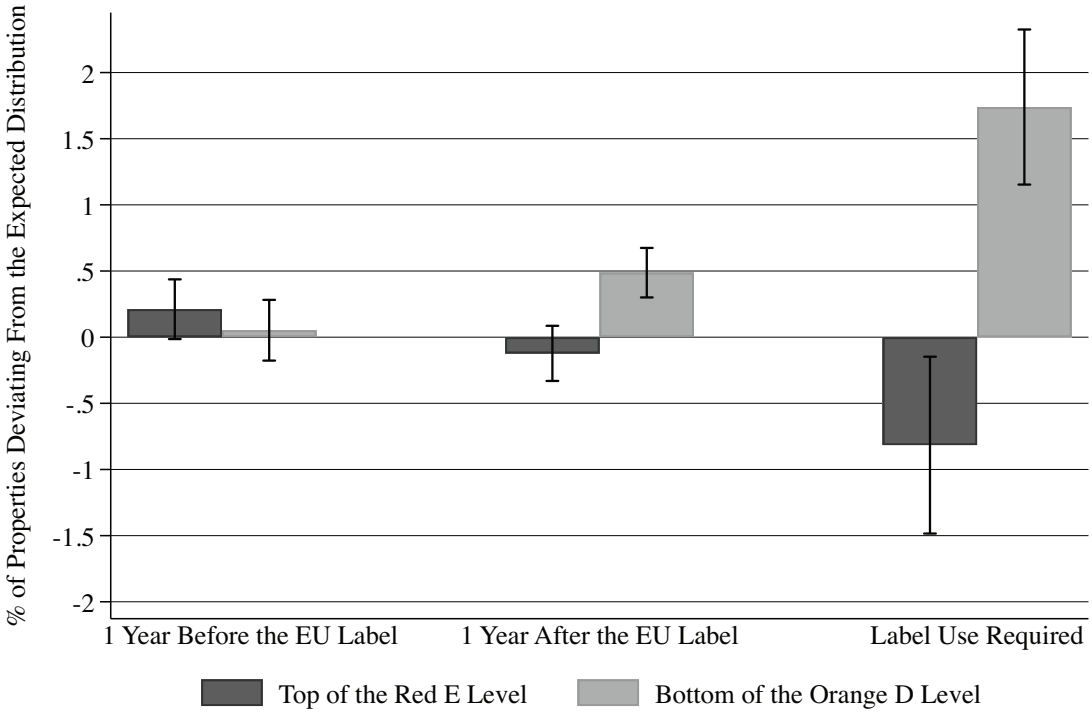
Note. The EU energy label rates energy efficiency using a color and letter scale and differs slightly from country to country. The U.K. version reports a standard assessment procedure (SAP) score, which is a numerical rating of energy efficiency determined via an energy audit, in addition to the letter grade; the SAP score ranges from 1 to 100. In the United Kingdom, the graph is included in an energy audit document that recommends ways to improve energy efficiency; the Potential column indicates the level that could be reached if the recommendations were implemented. See Table 1 for a fuller definition of SAP. (Readers of the print article: A color version of this figure may be seen in the online version.)

score. The SAP score goes from 1 (*least efficient*) to 100 (*most efficient*) and is a measure of "how much energy a dwelling will consume, when delivering a defined level of comfort and service provision," according to the U.K. Department for Business, Energy & Industrial Strategy.[11] Although the SAP existed prior to the 2004 legislation, few property owners or buyers would have encountered it because owners were not required to have properties audited for energy efficiency.

As is shown in Figure 2, the 2018 study found that before the label went into use, the proportion of homes in the highest part of the E level (54 points) was about the same as the proportion of homes just across the threshold at the D level (55 points). (This E–D threshold was studied because of the sample size—a majority of homes in the data set were rated either E or D; see Figure 4 in Reference 10.) A year after the label's introduction, however, a statistically significant number of homes had shifted up to the bottom of the D category. Among homes that were identified in the data set as having been sold in the year prior to data collection—which were required to have an energy label—researchers found a dramatic increase in the number of homes at the 55-point level of the D category and a dramatic decrease in the number of homes at the top of the E category.

The results tell this story: Properties that, with modifications (such as those listed in Table 1), could jump the threshold into a higher color–letter category were indeed modified by their sellers so that they would move to a new category. We confirmed this narrative in a recent working paper. We found that when their property was on the market, 4% of sellers in

Figure 2. Effect of the introduction of the EU energy label in the United Kingdom on homeowners' motivation to increase the energy efficiency of their properties



Note. Before the EU energy label was introduced into the United Kingdom (left bars), an equal number of properties fell on either side of one threshold (at the top of the E level and at the bottom of the D level). After the label had been in use for a year, a significant cluster had emerged at the lowest point in the D category (central bars), implying that many homeowners made improvements that helped them move into a better energy level. When the analysis is restricted to properties for which energy labels were mandated (right bars), the movement in categories was even more striking. Error bars represent 95% confidence intervals. (A 95% confidence interval for a given metric indicates that in 95% of random samples from a given population, the measured value will fall within the stated interval.)

England from 2012 to 2019 invested in retrofitting and applied for an updated energy label.[12] Our analysis identified two predictors of filing for a new label: (a) the initial label showed the current energy-efficiency score to be close to a threshold, and (b) the second audit brought the property into a higher color–letter category.[12]

One mechanism that might contribute to these results is that, as in Table 1, English energy labels display the expected costs of replacing or installing an energy-efficient technology as well as the number of points the property would be expected to gain from these investments. The energy label made it easy for sellers to calculate whether their investment would enable a property to cross the threshold to a new energy-efficiency category. We estimate in the working paper that sellers gain thousands of pounds in the selling price from boosting a property across a threshold.[12]

In short, energy audits can induce retrofitting. It is important to note that the effects of retrofitting can be large, as the 2018 study found.[10] Estimates indicate that the reduction in energy use that resulted when sellers retrofitted their homes to squeak into the D level from the E level was equivalent to the total annual electricity consumed by 11,542 English households (27,702 people),[13,14] which is approximately the current population of Shakespeare's hometown,

Table 1. Estimated gains & costs of various retrofits

Improvement	Gain in energy efficiency[a] (measured on 1–100 SAP scale)	Total up-front cost	Cost per SAP point gained[b]	Estimated energy-use reduction[c] over a 12-month period (kWh/m^2)
Add insulation to empty loft	8–15 points	£350	£44	72–123K
Install insulation in wall cavities	5–10 points	£300	£60	54–86K
Replace existing room heaters with central heating with A-rated boilers	60 points	£3,000–£4,000	£67	506K
Draft-proof existing doors and windows	1–2 points	£50–£80	£80	29–36K
Use dual rather than single immersion for water heating	8–10 points	£750	£94	72–86K
Replace an old gas or oil boiler with a new A-rated condensing boiler	20 points	£2,000–£3,000	£150	164K
Install efficient LED lighting	1–2 points	£3–£15 per bulb	£150	29–36K
Replace an electric boiler with a new A-rated condensing boiler	30–40 points	£4,500–£5,500	£183	237–342K
Install a full heating-controls package (including radiator valves and zone controls)	3–10 points	£500–£600	£200	43–86K
Add new double glazing to single glazing on windows	3–4 points	£250 per square meter window area	—	43–50K
Install solid wall insulation	10–20 points	£55–£90 per square meter wall area	—	86–164K

Note. The improvements are ordered according to the cost per SAP point gained, from the least to the most expensive. Estimates of standard assessment procedure (SAP) score gains and financial cost are the authors' calculations based on data from the UK Green Building Council (https://www.ukgbc.org/about-us/) and The Green Age (https://www.thegreenage.co.uk/top-10-tips-improving-domestic-epc-rating/). Dashes indicate that information is not available.

[a] The U.K. Department for Business, Energy & Industrial Strategy (2014) defines SAP points as a measure of "how much energy a dwelling will consume, when delivering a defined level of comfort and service provision" (How SAP Works section, para. 1).

[b] Lower numbers indicate more energy saved per pound spent. Further, the values in this column are conservative estimates, derived from the upper bound on cost and the lower bound on SAP gain.

[c] The SAP-to-kWh/m^2 conversions are derived from the results of home energy audits on the sample of English properties analyzed in Sejas-Portillo et al. (2020).

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"energy labels succeeded in significantly cutting energy use"

Stratford-Upon-Avon (27,445 people).[15] In other words, the energy labels succeeded in significantly cutting energy use in buildings for sale in the United Kingdom.

We now suggest additional ways to use homes' energy-efficiency labels to spur reductions in energy consumption. We base these recommendations on lessons gleaned from behavioral science research.

Ways to Further Leverage Energy Efficiency Labels

Recommendation 1: Mandate That a Standardized Label Depicting Accurate Energy Audits Be Presented in Literature Describing a Property

Recommendation 1 has three dimensions: observability, standardization, and timing. Each contributes to the effectiveness of the EU energy label. Energy audits provide information on a building's energy performance that is otherwise unobservable or obscure. Publishing these results leads consumers to place greater value on energy efficiency and sellers to make investments in improving energy efficiency.[6] This information will weigh more heavily in home buyers' decisions if it can be easily compared across properties, hence the need for standardization. If the government mandates that the result of an audit be included in any literature or listings describing the property, this information would allow potential home buyers to make side-by-side comparisons of the energy performance of alternative sites at a time when they are selecting properties to visit. We return to the importance of timing in Recommendation 4.

Although we emphasize the benefits of mandating information disclosure and labeling, we note that there are costs as well. A mandate imposes administrative expenses on the agencies that bear the burden of policing compliance. Additionally, the audit is another expense home sellers will incur. Last, there are political barriers to mandates. Some politicians and voters might perceive compulsory audits and labels as regulatory overreach.

Recommendation 2: Make It Easy for Home Buyers to Accurately Evaluate Labels

The color–letter categories displayed on the EU energy label are easy for consumers to interpret, even by Americans who are unfamiliar with the rating system.[7] If this exact label is not used, policymakers should ensure that the labels they design are straightforward and highlight the most important information.[16]

We should note, though, that it is possible that the EU energy label sacrifices accurate evaluation for ease of interpretation. The label depicts energy efficiency per unit area rather than total energy consumption, and so some larger, more energy-consuming homes appear to outperform smaller homes. In theory, this depiction could bias choice toward high-capacity rather than low-consumption options. In fact, a field experiment found that the introduction of the EU energy label caused consumers to purchase higher-capacity freezers than they otherwise would have.[17] It is possible that such distortions in energy-efficiency ratings affect purchasing decisions among home buyers, too. Although one may argue that home buyers usually have set ideas about the target size of the properties they would consider, the presence of such distortions cannot be completely ruled out as an influence. This constitutes an important policy trade-off for optimal label design.

Recommendation 3: Label Designers Should Take Perceptions of Thresholds Into Account & Consider Setting Dynamic Thresholds

Any scale, by accident or design, will manifest thresholds. Even a continuous scale such as an odometer that runs from 0 to 999,999.9 miles contains certain salient numbers that act as reference points and evoke heightened responses. For example, research shows that the mile that pushes a car from 9,999 miles to 10,000 miles is especially costly to resale value.[18] Because the perception of thresholds is unavoidable, the question becomes,

How can policymakers deploy thresholds to nudge behavior in a desired direction? (A *nudge* encourages a behavior without interfering with freedom of choice.)

Answering this question requires some understanding of the potential downsides of thresholds, one of which is that they can discourage changes. People who find that their property is far from a threshold might view retrofitting as a poor investment if the home will end up staying in the same energy-efficiency category even after improvements are made. Sure enough, a data set of residential property sales in England and Wales revealed that the properties least likely to receive investments in energy efficiency while on the market were those with initial audits placing them far from a threshold in the U.K. version of the EU energy label.[12]

A related drain on motivation is complacency: People quit their efforts once they have successfully crossed a threshold. In the study with results depicted in Figure 2, homes that were boosted into the bottom of the D category by the retrofitting investments made by home sellers then stayed where they landed.

These demotivating effects can be reduced by making the thresholds *dynamic* or relative. Instead of fixing the seven color–letter categories at arbitrary absolute levels of energy efficiency, the categories could represent septiles. As the housing stock becomes more energy efficient, thresholds would move up. If thresholds shift over time, properties that are currently distant from a threshold might eventually become close to moving up a category or, more important, down a category. Because people are loss averse[19] and concerned with rank position,[20] we expect the prospect of dropping into a lower category to be especially motivating.

An important objection to a dynamic labeling approach is that updates might cause labels to lose credibility or interpretability or cause consumers to disengage from an apparently unwinnable game. These objections are testable hypotheses. Some relevant data already exist: For a time, energy labels on appliances in Europe were updated to go beyond the letter "A" and include the categories A+, A++, and A+++. Consumers adapted and the labels continued to be effective in nudging their behavior.[8] Of course, one should be cautious when extrapolating from appliance markets to property markets. For this reason, we recommend extensive testing prior to implementing our proposal.

"people quit their efforts once they have successfully crossed a threshold"

Recommendation 4: Provide the Label When Hassle Costs of Retrofitting Are Low & Attention Paid to Energy Efficiency Is High

Why did the EU energy label succeed in inducing retrofitting when more resource-intensive, targeted interventions failed? One potential reason is that the energy-label requirement caught people at an opportune moment.

Hassle is a major deterrent to retrofitting. This is evidenced by a field study in London to promote loft insulation.[21] In two treatment conditions, loft owners were offered the opportunity to hire workers (at market rates or at cost) who would clear out the loft for the owners so the loft insulation work could be done. These treatments resulted in greater uptake of the loft insulation upgrade than occurred in a control condition that left it to owners to arrange for their lofts to be cleared in advance of the work.

The EU energy label comes into play at a time when people are already involved in selling their homes, moving, or building additions, so arranging for energy-efficiency retrofitting adds relatively little to the hassle they are already experiencing. This low added-hassle cost may help to explain why researchers conducting the study of residential property sales in England and Wales found that 4% of sellers retrofitted their property and applied for a new energy-efficiency label while their property was on the market.[12]

Prompts to attend to the potential energy savings from retrofitting could be especially persuasive when delivered at crucial moments. For instance, institutions could offer people who are seeking mortgages or home-improvement loans additional credit that is earmarked for retrofitting investment. Engineering models suggest that these investments will pay for themselves via reduced energy bills.[2]

It is worth noting that people who boost their properties into a higher energy-efficiency category shortly before selling do not get to enjoy the greater comfort and savings their investments delivered. Had they made the same investment when they first moved to a property, they would have enjoyed the same selling price premium as well as the consumption benefits of a more energy-efficient home.[12] Thus, providing information and prompts when buyers are moving into a home, a time when they are formulating plans for the future, might be especially effective. If so, it might be useful to have energy labels do more than merely present information. For instance, labels could be designed as decision aids that guide the new homeowner through the process of reaching a property's energy potential, such as by offering a table resembling Table 1 in this article; listing the contact information for various local tradespeople; and even including if–then prompts in which new homeowners articulate concrete behaviors they will enact under certain conditions (for instance, "If I am getting someone out here to fix an appliance, then I will also have them replace the boiler.")[22]

$1K

Using field workers to visit homes and motivate for retrofitting costs $1000 per household.

4%

Property sellers in England who retrofitted and south an updated energy lable from 2012-2019

11 542 households

Equivalent total energy savings in the UK when sellers moved from an E label to D

Conclusions

In this article, we have explored the implications of various strands of empirical research for the design and delivery of home energy-efficiency labels. Our recommendations were crafted with the goal of promoting retrofitting investment, but they also apply more generally. Recommendation 2, that a label be easy to evaluate, speaks to the core function of any information label. Recommendation 3, to take perceptions of thresholds into account, applies to any label in any context. As we have noted, the perception of thresholds is an unavoidable effect of any label that involves a scale. Further, it is well-established that thresholds influence decisions, including high-stakes ones,[12,18] yet little research deliberately tweaks the placement of thresholds to test effects on behavior. Our suggestion that the A–G categories depict septiles of the distribution rather than absolute levels also has a broader implication: We hypothesize that dynamic labels will generally outperform absolute labels in motivating investment, whether the investment involves money (as in retirement savings), time (as in educational contexts), or effort (as when people engage in exercise).

Recommendation 4, which essentially says to provide energy labels when people are likely to be most receptive to them, can be restated as a general principle: If your goal is to motivate a certain behavior, then be selective regarding when you prompt people to engage in that behavior. The time when individuals perceive the benefits of engaging in a behavior to be unusually high relative to the perceived costs is the moment for a prompt. Our discussion of prompts, dynamic labels, and the accuracy of energy labels suggests questions for future empirical research. We look forward to developments in this field.

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review

Nudging the commute: Using behaviorally informed interventions to promote sustainable transportation

Ashley Whillans, Joseph Sherlock, Jessica Roberts, Shibeal O'Flaherty, Lyndsay Gavin, Holly Dykstra, & Michael Daly

abstract

One way to limit the emissions from fossil fuel combustion that underlie global climate change and air pollution is to nudge people away from commuting alone in their vehicles—that is, to gently encourage people (without limiting their freedom of choice) to replace single-occupancy-vehicle commutes with environmentally friendlier options. Abundant research has focused on the influence of external factors—for example, urban design, the availability of roadways and bicycle lanes, and the costs of using one's chosen means of transportation—on commuters' transportation decisions. Much less is known about the psychological factors that influence which commuting modes people use. The field of behavioral science is therefore overdue to focus on transportation. In this article, we—a multidisciplinary team consisting of academics, applied researchers, and a transportation-management consultant—present a framework for designing and testing interventions informed by behavioral theory. We hope that this framework will help policymakers in government and the private sector identify nudges that can encourage commuters to adopt eco-friendlier modes of transportation. We also describe several studies we have designed on the basis of this framework and present the results collected so far.

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Core Findings

What is the issue?

Single-occupancy-vehicle (SOV) commutes are a significant contributor to global emissions. While *structural* interventions focus on reducing SOV commutes by changing economic incentives or modifying the physical environment, less is known about relevant *behavioral* factors. Knowing the psychological levers for shifting people's commuting mode choices has the potential to result in more effective interventions.

How can you act?

Selected recommendations include:
1) Highlighting the easily hidden costs of driving and the often-hidden benefits of alternative commuting modes
2) Ensuring that making the switch from SOV commutes to using alternative commuting modes seems easy and attractive
3) Delivering psychologically informed interventions in combination with structural interventions

Who should take the lead?

Transportation managers, government policymakers, and business leaders

To avoid the most expensive and catastrophic effects of global climate change and air pollution, humanity must dramatically reduce the emissions associated with fossil fuel combustion. Researchers predict that if emissions of greenhouse gases, such as carbon dioxide, continue at their current pace, global temperatures could rise to 8°F above preindustrial levels by the year 2100.[1] This warming will cost about $400 billion each year in the United States alone, which is 1.25 times the amount currently spent on heart disease, the leading cause of death.[1] The temperature increase is also projected to cause calamitous human suffering and ecological collapse. More than a million plant and animal species are at risk of extinction.[2] In 2017, a large collaboration of scientists warned that the world could endure "widespread misery" resulting from climate change.[3] People are already suffering because of the emissions responsible for air pollution, as is highlighted by the COVID-19 pandemic: Individuals who live in areas with high levels of air pollution are more likely to die when exposed to the virus.[4]

Recent estimates suggest that the transportation modes people use significantly affect emission levels.[5] In a 2019 report, the U.S. Environmental Protection Agency (EPA) noted that driving and air travel were responsible for about 27% of greenhouse gas emissions in the United States each year.[6] The EPA also reported that motor vehicles accounted for 75% of carbon monoxide pollution and one third of the air pollutants that produce smog.[7] In a typical prepandemic workweek, about 128 million people in the United States—86% of workers—commuted to their jobs by car, and over three quarters of this group drove solo. In the transportation industry, driver-only trips are known as single-occupancy vehicle (SOV) commutes.[8,9]

To slow global climate change over the next 20 years, massive numbers of people must change their commuting behavior to reduce SOV commutes and to increase the use of other commuting modes. With 15% of U.S. carbon emissions and 24% of global carbon emissions stemming from car use,[10] it is difficult to imagine a successful climate change mitigation strategy that does not include encouraging commuters to increase their use of eco-friendly modes of travel.

Reduced driving could also have financial benefits for municipalities and individuals. Each of the 4.18 million miles of road in the United States costs governments about $24,000 per year to preserve.[11] For the typical American, the average vehicle costs about $9,500 per year to own and operate.[12]

Given the potential benefits of shifting away from SOV commutes, how can transportation managers, government policymakers, and business leaders encourage individuals to adopt more environmentally sustainable commuting modes? In this article, we describe standard approaches to the problem, explain why we believe that adding strategies informed by behavioral science research could increase the adoption of greener commuting modes, and present a framework for identifying behaviorally informed interventions that are likely to be effective. Our views are based on theory as well as experiments we have conducted.

In another article recently published by *Behavioral Science & Policy,* Christine Kormos and her colleagues similarly argued that behavioral science research has untapped potential for reducing SOV commutes.[13] Their article provides a broad overview of previously conducted behavioral science research related to three kinds of interventions: communication-based approaches, bias-busting approaches, and technology-based approaches. In our article, we delve more deeply into the identification of behavioral barriers that prevent people from changing their daily commuting modes. On the basis of our experiences, we also provide a how-to guide for forming partnerships between behavioral scientists and transportation management professionals, present our own experimental results, and offer tactical tips for policymakers who want to implement behavioral science–based strategies to reduce SOV commutes.

Past Strategies & New Opportunities for Changing Mode Choice

Researchers and policymakers have developed an approach known as *transportation demand management* (TDM) to encourage sustainable commuting and minimize SOV traffic. *Sustainable commuting* usually refers to using environmentally friendly commuting modes, such as taking public transportation (bus, subway, light rail, tram), walking, cycling, or carpooling. Designers of TDM strategies aim to increase the use of sustainable commuting modes by enacting policies, programs, and pricing that make these modes more appealing, convenient, and accessible.[15]

Over the past 30 years, researchers and policymakers have tested various TDM methods to promote sustainable commutes. These methods generally fall into two categories.[15] *Structural* interventions focus on changing economic incentives or modifying the physical environment, such as by closing roads and replacing them with bicycle lanes. *Behavioral* interventions focus on psychology, such as by changing attitudes, beliefs, values, and the perceptions of norms that relate to transportation choices.

Most researchers have focused on structural interventions and examined the effects of land use,[16] the availability of public transit and parking infrastructure,[17–19] parking pricing,[20] congestion pricing,[21,22] and trip length,[23] among other variables, on commuting behavior. (For a comprehensive review, see reference 24.) This research is certainly valuable. Yet studies demonstrating the effectiveness of behavioral interventions could provide powerful tools for increasing the public's adoption of sustainable commuting modes. After all, such interventions have had far-reaching success in other domains, such as public health and education.[25,26]

Unfortunately, researchers are not yet sure whether applying behavioral interventions can encourage commuters to shift from SOV commutes to other commuting modes.[27] Most research on mode shifts has been published by transportation researchers, not psychologists.[28] Moreover, behavioral scientists have historically overlooked the topic, aside from examining how consumers decide to purchase fuel-efficient vehicles.[26,29] Relatively little research has addressed questions such as how people determine whether to drive to work or take public transportation. (For similar arguments on the need for more research into behavioral interventions, see reference 27.)

Research into the effects of various psychological levers for shifting people's commuting mode choices is growing but still nascent. Much of this work has relied on correlational data as opposed to evidence from experiments, which can establish cause and effect more convincingly.[30–32] Notably, in a meta-analysis published in 2020 that combined data from 2,920 studies and explored the effects of psychologically informed interventions on commuting modes,[28] only 30 of the included studies used randomized controlled trials (RCTs). RCTs randomly assign participants to experimental and control groups and are considered the gold standard for determining whether an intervention has had the desired effect. What is more, only two of the studies in this meta-analysis relied on objective measures, such as GPS data, to assess the effect of the interventions on commuting behavior. Other meta-analyses of studies on this topic describe a similar lack of causal evidence and overreliance on self-reported data.[33,34]

Because of the successes that behavioral interventions have achieved in other domains, these practices have drawn the interest of policymakers who want people to switch from SOV commutes to other commuting modes.[25,26] To better understand the efficacy of behavioral interventions[28] and overcome the limitations of correlational and self-report studies,[35] we decided to collaborate with multiple businesses and city agencies to conduct an array of mostly RCTs aimed at influencing commuting mode choices.

We are a multidisciplinary team consisting of academics, applied researchers, and a consultant who works with cities and organizations to implement TDM methods. Our multidisciplinary,

collaborative approach fits with an emerging focus in behavioral science on understanding how to use psychologically informed interventions to effectively change behavior at scale.[36] The effective application of behavioral interventions requires both an understanding of behavioral science principles and knowledge of the practical aspects of program design.

Preliminary Research Planning

To carry out our research, we first needed to find organizations that would partner with us to study the effect of behavioral science interventions on their constituents' commuting modes. One of the authors, Jessica Roberts, is a principal at Alta Planning + Design, a consulting firm that advises public agencies and organizations on TDM programs and research. With her organization's assistance, we invited public agencies and private companies in the United States to submit a brief statement of interest if they wanted to collaborate with us on behavioral research exploring ways to encourage people to shift from SOV commutes to using sustainable commuting modes. We specifically asked about their interest in encouraging carpooling, because we knew that some of our prospective partners would have technology that could provide objective data on carpooling before and after an intervention was introduced. To be clear, by *carpooling*, we mean having riders who are traveling between the same two locations ride in the same vehicle; usually carpooling involves people commuting to work, but newer technology is also enabling more spontaneous carpooling for one-off trips. We were also open to studying other commuting mode shifts. Our recruitment materials may be found at the Open Science Framework (https://osf.io/ufcht/).

This call to action yielded 36 interested parties. We were able to work with five parties that represented organizations and institutions running transportation initiatives and technology platforms that had developed carpooling tools.

We were also able to work with 12 partners through a collaboration with the Center for Advanced Hindsight at Duke University.

Because we were working with partners that needed to control their costs, we concentrated the research on behavioral interventions that did not involve monetary rewards. We do not mean to imply that financial incentives are ineffective. Case studies from jurisdictions across the United States show that cash and cash-like rewards such as lottery entries can motivate commuting mode shifts. See Table 1 for examples of studies using such rewards.

Although many people claim that they want to commute less by car, they often have difficulty following through on these intentions, especially when trying to change the way they habitually commute.[27,37] Thus, even before we put out the call to potential research partners, we conducted a review of behavioral science research to identify the psychological barriers likely to prevent individuals from relinquishing their SOV commutes in favor of other commuting modes. We later required all partners to study interventions meant to overcome one or more of the barriers listed next.

Behavioral Barriers to More Sustainable Commutes

Some of the barriers we describe in this section are similar to and can exacerbate one another. We address them separately because overcoming them can sometimes require different intervention strategies.

Barriers to Considering a Change in Mode

Availability Bias. People tend to think that examples that easily come to mind are more representative of a situation than they actually are.[38] Because the popular media glorifies driving, the most easily accessible images of driving depict prestige and freedom.[39] In contrast, alternative forms of transportation, such as riding the bus, are frequently portrayed as being difficult, dirty, and unsafe.[40] Exposure to glorified images of driving and negative portrayals of other options can bias people against biking to work or using mass transit.[41] In another manifestation of availability bias, people often overestimate the occurrence of rare events such as childcare emergencies because

Table 1. Examples of past U.S.-based studies of incentives for shifting commuting modes

Study	Study type[a]	Desired behavior change	Intervention	Results
			Financial[b]	
BART Perks (San Francisco County Transportation Authority, 2018)	Longitudinal, correlational	Reduced peak congestion	The San Francisco Bay Area Rapid Transit (BART) system implemented a rewards program to encourage riders not to use transit during the most popular commuter window. Participants earned points they could use to obtain cash or gift cards during the study.	In the first phase of the study, when participants could earn cash, there was a 9.6% reduction in transit trips during the busiest commuter window. In the second phase of the study, when people could earn points to redeem for gift cards by altering their travel time, taking surveys, or using BART in the evenings or to travel to the airport, people were willing to alter their typical commute behavior by 6%–20%.
CAPRI program (Zhu et al., 2015)	Longitudinal, correlational	Reduced peak congestion	The Congestion and Parking Relief Incentives (CAPRI) program provided points and prizes for commuters to avoid peak hours. Commuters chose to receive either cash or random rewards (90% chose random rewards).	People enrolled in this program were 21.2% less likely to commute during morning peak hours and 13.1% less likely to commute during evening peak hours as compared with commuters who were not enrolled in the program. These effects were stronger when participants knew someone who had won a prize: Commuters with friends who recently won a prize traveled around 1.5 minutes earlier than their normal travel time.
Chicago Transit Authority Cubs game congestion study (ideas42, 2017)	Longitudinal, experimental	Reduced peak congestion	The Chicago Transit Authority (CTA) wanted to reduce congestion after Chicago Cubs games. To encourage commuters to avoid the Red Line between 5 p.m. and 6 p.m., participants: (a) were sent an alert reminding them of a baseball game, (b) were sent a message encouraging them to use the Red Line outside of the 5 p.m.–6 p.m. window, (c) received a $2.25 travel rebate when they avoided this window, or (d) received a note pledging to make a $5 contribution to charity when they avoided the 5 p.m.–6 p.m. window.	The study found a 17.5% reduction in Red Line commuters between 5 p.m. and 6 p.m. when the CTA offered the $2.25 travel rebate. The most effective incentive was presenting commuters with a $2.25 rebate for avoiding peak times.
Seattle's One Less Car Challenge (Bauer et al., 2018, pp. 31–32)	Longitudinal, correlational	Reduced SOV commutes	Families in Seattle with more than one car opted in to commit not to use their additional car for six to eight weeks during the study. In total, 86 households participated. Study organizers gave each household $80 for participating.	Across participating households, the number of miles families commuted per week by SOV dropped 27%, bicycle miles increased 38%, mass transit commuting miles increased 25%, carpooling increased 23%, and walking miles increased 30%. In total, 26% of households got rid of their additional car once the study ended.
Florida DOT incentive study (Lee et al., 2013)	Longitudinal, experimental	Reduced driving miles	Participants were given $5 each time they lowered their total mileage by 20 miles. In one condition, people received the reward after lowering their mileage. In another condition, people received the reward before saving mileage.	Regardless of the reward received, around 50% of members in both conditions reduced their mileage at some point during the study.

(continued)

Table 1. Examples of past U.S.-based studies of incentives for shifting commuting modes (*continued*)

Study	Study type[a]	Desired behavior change	Intervention	Results
			Prize incentives[c]	
Metropia application (Bauer et al., 2018, pp. 7–9)	Longitudinal, correlational	Reduced peak congestion	Metropia is a phone app used to alter commuters' travel habits by providing rewards for traveling during off-peak travel times. Metropia can also deliver personalized nudges and incentives and offers carpool matching. By traveling at 8:30 a.m. (instead of 7:30 a.m.) and 5:15 p.m. (instead of 4:15 p.m.), commuters earned 100 points per trip compared with only 10 points given to those who continued to travel during peak hours.	Participants who were given points were 13% less likely to take a trip during the morning rush hour and 7% more likely to commute during an alternative time in the morning. (The points could be exchanged for discounts, offers, or other goods or services offered by Metropia.)
			Employee & public benefits[d]	
Travel benefits and mode choice, New York and New Jersey (Bueno et al., 2017)	Cross-sectional, correlational	Changed commute mode	This study looked at the commuting mode used by nearly 20,000 households in New York and New Jersey. Researchers tracked the efficacy of employer-provided commuter benefits.	Employees who were given transportation benefits by their employers were 9 times more likely to use transit rather than driving alone. Employees with bike-related benefits were 50 times more likely to commute by bike compared with employees with non-bike-related benefits. Parking benefits undermined employees' willingness to commute by transit, bike, or walking.
Access MIT (Massachusetts Institute of Technology Office of Sustainability, n.d.)	Longitudinal, correlational	Reduced parking pass purchase; reduced parking lot usage	This ongoing study aims to reduce faculty and staff use of campus parking. As part of this program, MIT implemented changes to parking policies that included offering free transit passes, higher subsidies for commuter rail trip costs, and paying half of the cost of parking at public transit facilities.	Since the initiative started, there has been a 15% drop in year-round parking permits and a 10% drop in parking transactions at campus parking lots relative to baseline.
Atlanta Regional Household Travel Survey (Ghimire & Lancelin, 2019)	Cross-sectional, correlational	Increased self-reported transit use	The study examined data from the Atlanta Regional Household Travel Survey and looked at the role of transit passes on transit use among employees.	Employees who received a free or subsidized transit pass from their employer were 156% more likely to use transit. Similarly, when employers had access to free or subsidized parking, self-reported transit use fell 71%.
ECO Pass Initiative (Regional Transportation District, n.d.)	Longitudinal, correlational	Reduced self-reported SOV use	Denver residents were able to register for the ECO Pass initiative, which enabled citizens to access transit for as little as $100–$200 a year. The city studied how eligibility for these passes shaped transit use.	The City of Denver reported a 7.7% drop in SOV use between 1990 and 2015 as compared with national trends of transportation use. These data provide suggestive evidence that the pass reduced SOV use.

Study	Study type[a]	Desired behavior change	Intervention	Results
			Other incentives[e]	
FlexPass at the University of California, Berkeley (Tang et al., 2016)	Experimental, longitudinal	Reduced parking on campus	UC Berkeley launched the FlexPass program, which gave students and faculty the ability to report whether they used the campus parking lot or an alternative transportation option. In exchange for their reports, participants could receive rebates as rewards to cover the cost of their campus parking permit.	In this study, there was a 4.2% drop in parking demand among people who were assigned to the treatment group (the group offered rebates) as compared with a control group that was not offered rebates.
Intrinsic interest in a driving reduction challenge (Kent de Grey et al., 2018)	Experimental, longitudinal	Increased self-reported motivation to reduce SOV commutes; reduced self-reported SOV commuting	In one study, participants were assigned to one of three conditions during a citywide drive-alone reduction challenge. These messages were designed to encourage intrinsic motivation to sustain non-SOV commutes during a challenge period. Participants were assigned to receive messages based on one of three theories about motivation: cognitive elaboration, cognitive dissonance, or social marketing.	Although there were no differences in non-SOV commutes by condition, this study suggested that motivations for participating in the study influenced self-reported commuting behavior and self-reported motivations for SOV commutes.

Note. SOV = Single-occupancy vehicle.

[a] *Longitudinal studies* follow people over time. In doing so, they provide a more accurate snapshot of long-term behavior change than other approaches do. These are chosen when it is possible to track people's behavior and when there is a need to examine a sustained change on behavior. *Correlational studies* examine the relationship between two or more variables and often examine associations over time. Correlational studies cannot establish causality and thus provide only tentative evidence for a causal relationship. *Experimental studies* assign study participants to groups randomly and can reveal whether an intervention or interventions cause any changes in the desired outcome. This method is selected when it is necessary to demonstrate causality and when it is possible to randomize and track participants.

[b] Financial incentives such as cash rewards can be used to motivate people to alter the way they commute and are often provided to employees to reduce SOV use or shift employees' behavior from commuting during peak hours to commuting during off-peak hours.

[c] Cash-like incentives such as lottery prizes are often provided with the same aims as financial incentives.

[d] Employers often incentivize employees to use non-SOV commute modes by offering free or discounted passes, bikeshare memberships, or vanpool subsidies. Sometimes transit authorities offer discounts for individuals who join special programs to increase ridership.

[e] Other incentives that do not fall squarely into the categories of cash or noncash incentives have been designed to shift commuter behaviors.

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"people often overestimate the occurrence of rare events"

these events are more memorable. As a result, they may place more value than is warranted on having the flexibility that driving their own car to work allows.

Commute Impedance. People often suffer psychological distress when efforts to reach a goal are thwarted. Anything that reduces the ease of a commuter's trip—like traffic on the way to a destination—can be thought of as *commute impedance*. According to a theory known as the *commute impedance model*,[42] drivers often take a dim view of alternatives to single-occupancy commutes because they fear that these commuting modes will be more unpredictable and that they will have less control over the speed, comfort, and other features of the trip.[43] Research suggests that alternative modes of transportation are, indeed, often seen as less desirable than driving one's own car because they are perceived to offer less control and less freedom and are seen as reflecting lower status.[40,44]

Loss Aversion. People dislike losses more than they like equivalent gains, and this *loss aversion* means that people are more likely to avoid risk than to take a potentially beneficial action. Thus, they will often continue with a current behavior unless the threat of a loss motivates them to change.[45] Likewise, when an individual is deciding which mode of transportation to use, the anticipated downsides, or *losses*, of selecting alternative modes could loom larger than the potential benefits in the individual's mind. For example, the anticipated stress of lost independence or having to wait an unpredictable amount of time for a bus may outweigh the anticipated pleasure of being able to relax on a bus instead of sitting behind the wheel in traffic.

Opportunity Cost Neglect. When making decisions, people fail to consider the opportunity costs—the sacrifices they are making by selecting one choice over another.[46–48] With respect to driving, each trip has costs that often go unnoticed, such as tolls collected electronically or parking fees deducted from a paycheck. When people forget about the costs of SOV commutes, this neglect can prevent behavior change.

Present Bias. People tend to minimize the value of future events and outcomes and prioritize the present.[49] Driving is more convenient and familiar than other commuting modes, and the health and environmental benefits of sustainable commuting modes can take years to observe. Hence, even though the ultimate benefits may greatly outweigh the value of immediate convenience, present bias can be a substantial barrier to adopting sustainable modes of transportation.[50]

Status Quo Bias. People are reluctant to change their behavior from an established reference point and therefore need to have strong motivation to overcome their inertia.[45] When it comes to commuting, status quo bias is exacerbated by daily travel routines that have become deeply ingrained habits. Most people drive to work and do it automatically, with little thought. If they are prodded to alter this habitual behavior, they may resist in part because they are likely to mainly consider the downsides of changing their commute.[51]

Sunk Cost Bias. Individuals feel particularly committed to actions in which they have already invested time, money, and effort.[52] Most car owners have already made an up-front investment to purchase their vehicle or pay for an annual parking permit—sunk costs that encourage them to drive even when they could plausibly commute via other modes.[53]

Together, these barriers suggest that to encourage people to consider shifting away from SOV commutes, behaviorally informed interventions need to (a) highlight the easily hidden costs of driving and the often-hidden benefits of alternative commuting modes and (b) ensure that making the switch from SOV commutes to using alternative commuting modes seems easy and attractive. For example, to increase the attractiveness of carpooling or public transportation for people who overestimate how much

they will be inconvenienced by rare events, employers could offer free Uber rides when emergencies arise to provide these people with a sense of a safety net.

Barriers to Actually Adopting a New Transportation Mode

We also observed several psychological mechanisms that could influence whether people follow through on intentions to shift their commuting behaviors. These barriers are especially important for policymakers to consider because commuters often claim that they are interested in taking the bus, walking, or biking to work, yet very few follow through on these intentions[27]—a disconnect often called the *intention–action gap*.

Default Bias. People tend to stick with options that are preset as defaults. For instance, if a company offers free or subsidized parking as a default benefit and requires employees to complete paperwork to obtain a rebate for public transportation, the employees are likely to take the default option and drive to work. In this context, employees are more likely to drive because it is easier: There are no concerns about finding a spot, and driving feels free.

Friction Costs. People tend to avoid difficult decisions and do whatever requires the least amount of effort—that is, whatever presents the least *friction*.[54] Unless people clearly see the benefits of sustainable transportation, they may be deterred by the aspects that make it seem difficult, such as weather or unpredictability.[55]

Overconfidence. People believe in their abilities more than past performance would warrant.[56] They also think that they will have more time to change their behavior than they do in reality and underestimate the amount of effort needed to follow through.[57] This overconfidence can prevent people from commuting in sustainable ways. If individuals say they are going to commute by bike but do not think through the barriers that could prevent this action, like rain, they are likely to quit when they encounter any difficulty.[58] Even if individuals do commit to changing their behavior, they might indefinitely delay acting on the decision.[59]

"overconfidence can prevent people from commuting in sustainable ways"

Social Norms. Actions are influenced by people's beliefs about what other people do (*descriptive norms*) or their beliefs about what others think they should do (*injunctive norms*). Most Americans believe that other people travel to work by SOV commutes, which is based on a descriptive norm that is true in most of the United States.[60] Many cities lack pro-environmental norms that could prompt sustainable behavior.[61] Additionally, stigma is attached to alternative transportation modes, which the public associates with a social status lower than that associated with driving.[62]

These barriers suggest that to encourage follow through on peoples' intentions to change their commuting modes, program designers need to cultivate positive norms around sustainable transportation. Norm shifts might be achieved by increasing the visibility of people's use of these modes and decreasing the visibility of driving. Program designers also need to help people to easily overcome possible obstacles such as rain and service outages.

Although we focus on psychological barriers in this article, we do not mean to imply that structural and practical barriers are unimportant deterrents to the widespread use of alternative commuting modes. For example, lack of knowledge about the existence and benefits of such alternatives can be a deterrent, as can lack of knowledge about the financial and health benefits of alternative commuting modes.[59]

An often-cited barrier against the use of alternative commuting modes is the lack of quality infrastructure. Thus, prior to committing to a partnership with an organization willing to take part in our experiments, we also considered both the availability and the quality of infrastructure at the organization and in the surrounding region.[63]

A Framework for Selecting Organizations & Testing Behavioral Interventions

We used a multistep process for designing and assessing potential interventions. For a summary and fleshed-out example, see Table 2.

Step 1: Partner With Motivated & Mission-Aligned Organizations

In selecting partners from the respondents who initially reached out to us, we prioritized organizations with leaders who expressed a strong interest in our approach, used data-oriented decision-making, and demonstrated an openness to new ideas. We also required potential

Table 2. A framework for designing & testing behavioral interventions

Basic steps in the strategy	Substep	Example of the strategy in action
1. Partner with motivated and mission-aligned organizations.	• Identify an organization interested in the same research problem that interests you. • Form a collaborative working relationship.	We worked with a large public university that wanted to decrease car use in and near campus.
2. Identify and define the unique challenge the organization is facing.	• Conduct kickoff meetings with key stakeholders, including members of senior leadership. • Agree on the specific objectives of the project and timeline. • Figure out exactly what behavior you want participants to change.	Goal: Increase use of buses by students commuting to and from classes by 10% relative to baseline levels.
3. Explore the context and map the psychological barriers to the desired behavior.	• Talk to your research partners and to members of the participant population to identify the individual steps involved in the desired behavior. • List the steps in sequence. • List barriers to each step in the sequence.	After speaking with our partners about the bus routes students might use, we held focus groups with commuter students about the steps and perceived challenges involved in using the bus. We then listed the steps in a diagram along with the barriers that were revealed in the discussions.
4. Design an intervention.	• Guided by the collected findings, design an intervention that seems most likely to overcome the barriers that were identified in the previous step.	Because many students intended to take the bus, ride a bike, or carpool but were not consistent in following through on this intention, we tried to help them follow through by giving them personalized travel plans that demonstrated all the ways they could use these commuting modes. This personalized travel plan tool showed them exactly what route they should take depending on their starting and ending location and exactly how long the commute would take.
5. Pilot test the prototype intervention.	• Try to enact the proposed process yourself. • Watch a small number of people trying to enact the process you are hoping to change. • Revise the plan as needed.	We conducted interviews with transportation and behavioral science experts who critiqued our proposal. We also tried it out ourselves and enlisted 17 students to test out the personalized travel plan tool and provide feedback about which features worked well and which ones did not. In response to the feedback, we made several key changes—for instance, by simplifying the language; reducing the number of travel options; and emphasizing benefits in terms of health, time used, and money saved.
6. Conduct the field study.	• After you have piloted the approach, you can conduct a large-scale field study. • Ideally, you will track objective behavior, such as actual bus commutes taken in relation to the intervention.	We enlisted participants and randomly assigned half of them to the treatment condition. They received the personal planning tool, and we tracked their bus and other commuter mode use. Control participants did not receive the tool. We still tracked the bus use of control participants through a link to their student ID cards; other mode use was tracked using surveys.

partner organizations to have the capacity and willingness to conduct a RCT and to provide behavioral data on the outcomes of the interventions tested. Guided by statistical best practices, we targeted organizations that could provide at least 500 potential participants.[64] To ensure that potential partner organizations demonstrated these qualities, we asked them to answer application questions during an initial phone call. The application questions may be seen at the Open Science Framework (https://osf.io/ufcht/).

Step 2: Identify & Define the Unique Challenge the Organization Is Facing

After this initial phone screening identified an eligible and interested organization, we reviewed the organization's application and entered into a verbal agreement to establish a formal partnership. We then signed a data-sharing agreement with the partner organization and started to collaborate with them to design behavioral interventions. As part of this collaboration, our group conducted kickoff meetings with key stakeholders, including members of senior leadership, and we worked with the partner organization to establish the specific objectives of the project and timeline, including the actions they wanted their constituents to take.

Each partner organization faced different challenges for promoting sustainable commuting modes. At one organization, new employees did not receive clear information about alternative commuting modes. At another organization, parking was free, transit passes cost hundreds of dollars each month, and the organization did not highlight the often-hidden costs of driving. Given these differences, we worked to identify which psychological barrier identified in our literature review was most relevant to each partner organization.

Step 3: Explore the Context & Map the Psychological Barriers to the Desired Behavior

As an aid to identifying relevant interventions for each organization, we built a *behavioral map*, which (a) visually encapsulates the steps leading up to and enabling a particular behavior and (b) outlines the relevant pain points and psychological barriers that could prevent people from adopting the mapped behaviors. (See a sample map related to carpooling at https://tinyurl.com/yne7rury.) To gather the needed input for these behavioral maps, we tried to observe the experience of mode switching from the commuters' perspectives. To this end, we worked with organizations to conduct open-ended interviews and asked commuters to fill out surveys on the topic. We also analyzed existing data, such as the responses from past surveys that had been conducted by these organizations.

Step 4: Design the Intervention

After designing the behavioral map and considering the psychological processes that posed the greatest barriers to commuters' adopting an organization's desired behaviors, we suggested one or more interventions that would best address those obstacles.

Step 5: Pilot Test the Prototype Interventions

We then worked with our partner organizations to develop prototypes for the chosen interventions. We first piloted the solutions to determine whether the interventions were likely to operate as intended when implemented at scale. For example, when collaborating with a southern U.S. university and developing a prototype for an intervention that provided personalized route planning for public transportation and other alternative commuting modes like biking, we ran a series of group interview sessions to gain insight into the user experience when interacting with the intervention. In an iterative way, we were able to improve the intervention using insights from the literature and user feedback. Although we tried to craft ideal interventions based on organizational barriers, we also took feasibility into consideration (see reference 35 for an example of an approach to conducting a feasibility analysis).

Step 6: Conduct the Field Study

When steps 1–5 were complete, we launched the studies at scale. Where possible, we designed the studies to be RCTs with objective behavioral outcomes.[35]

86%
US workers who usually commute via car

15%
Car use's share of total US emissions

$100.32b
Total cost to relevant governments for preserving US roads

A Sampling of Our Studies

About half the studies we designed were attempts to increase carpooling. The others focused on increasing public transportation use. Six were completed or are ongoing, but as we write this article, the rest are on hiatus because of the COVID pandemic. See Table 3 for a comprehensive summary of all completed and ongoing projects, and visit the Open Science Framework (https://osf.io/ufcht/) for up-to-date study materials and interim results. On the basis of the findings so far, we are considering ways to improve the effectiveness of the interventions we have tested, apply the interventions to other organizations, and disseminate the results of our ongoing research. Next, we provide a brief overview of the kinds of research we have undertaken.

Carpooling Projects

Several of our behaviorally informed studies rely on messaging to encourage participants to sign up for and use carpooling programs. These messages call attention to typically unrecognized benefits of carpooling. One of our partner organizations had provided little information to new employees about carpooling benefits, so the study we designed with this organization highlighted these benefits, such as opportunities to socialize. In another study, messaging from an organizational leader promoted the (often hidden) benefits of the program for financial savings, physical health (via reduced stress), and environmental sustainability (a core organizational priority). In a subset of these studies, we also formed a joint partnership with ride-matching platforms that allowed us to track actual carpooling behavior.

Among the field experiment studies on hiatus because of the COVID pandemic are projects involving Western Washington University (N = 3,500 employees) and the City of Santa Monica (N = 2,800 employees). While waiting for carpooling projects sidelined by COVID to resume, our team conducted a lab experiment to improve the efficacy of the messages we had designed.

In this online study (N = 642), we instructed participants to imagine that their workplace was starting a carpooling program. Participants in the control group simply read about the program. Participants in the experimental groups were told that the program could provide a benefit, which differed depending on their assigned condition: The program would help them to either get to know their colleagues (the *social* condition), have quiet time (the *personal* condition), save money (the *economic gain* condition), or avoid losing money from driving (the *economic loss* condition). Participants in the economic gain condition expressed the greatest interest in signing up for the carpooling program. In contrast, participants in the social condition showed the least interest in the program. We plan to design and test new interventions in the field as a result of this initial online study.

Projects Promoting the Use of Public Transportation

In two of our completed studies, we aimed to increase transit ridership by providing personalized route plans; one of those studies also tested the impact of a weekly cash prize drawing—that is, a lottery—in addition to the personalized route plans. As described in Table 3, in both experiments, the personalized route plans increased bus use and reduced SOV commutes during the study, according to self-reports. In the lottery study, the effect of personalized route plans was similar to or greater than that of the lottery incentive. This last finding suggests that behavioral interventions alone, without the addition of cash or cash-like incentives, can meaningfully shape commuting behaviors, especially when these interventions make it easy to use alternative transportation modes.

Discussion: Future Directions

In the past few years, we have engaged in countless discussions with policymakers in government and industry, TDM practitioners, and behavioral scientists about how to shift commuting behaviors to reduce SOV commutes, and we have collaborated on designing and implementing field experiments with 17 diverse partners that include city governments, universities, technology companies, and private corporations. The number of

Table 3. Solutions we have tested or plan to test through our team's ongoing partnerships with cities, transportation initiatives, & organizations to promote sustainable commutes

Partner	Study description	Population	Psychological barriers addressed	Hypotheses	Outcome measured	Results
			Randomized controlled trials			
A midsized southern U.S. university	Encourage alternative modes of transportation by using a personalized route tool coupled with follow-up reminder emails.	*N* = 3,797 individuals living in and around the university	Intention–action gap Overconfidence Opportunity cost neglect Loss aversion	The personalized route tool makes alternative transportation feel easier than usual. The personalized route tool highlights the benefits of sustainable transportation for money saved, calories burned, and emissions not released, thus making alternative commuting modes more attractive.	Self-reported transportation behavior Actual bus ridership	The personalized route tool did not lead to a statistically significant reduction in self-reported single-occupancy vehicle (SOV) commutes. The personalized route tool plus follow-up emails did lead to a statistically significant reduction in self-reported SOV commutes of 7.2% during the 3-month study. This result was statistically significant. There was no significant difference between study conditions in the number of bus trips taken.
City of Austin, Texas	Encourage alternative modes of transportation by using a personalized route tool and a commuter commitment contract.	≈*N* = 1,000 individuals living around Austin	Intention–action gap Overconfidence Opportunity cost neglect Loss aversion	The personalized route tool and commitment contract will make alternative transportation modes feel easier than usual. The personalized route tool highlights the benefits of sustainable modes of transportation for money saved, calories burned, and emissions not released, thus making alternative commuting modes more attractive. Asking people to commit to behavior change and reminding them of these commitments will increase the salience of the desired behavior and encourage follow-through.	Self-reported transportation behavior Actual bus ridership Actual parking data	Results are in progress. This study is on hiatus—stopped after one week—due to COVID.

(continued)

Table 3. Solutions we have tested or plan to test through our team's ongoing partnerships with cities, transportation initiatives, & organizations to promote sustainable commutes (*continued*)

Partner	Study description	Population	Psychological barriers addressed	Hypotheses	Outcome measured	Results
City of Durham, North Carolina	Encourage alternative modes of transportation by using a personalized route tool or the personalized tool plus lottery-based incentives.	*N* = 1,496 people living in and around Durham	Intention–action gap Friction costs associated with figuring out how to commute in a different way. Present bias	The personalized route tool will make using alternative transportation easier than it usually is. Furthermore, the personalized route tool highlights the benefits of sustainable modes of transportation for money saved, calories burned, and emissions not released. The lottery incentive capitalizes on the fact that people overweight small probabilities. Together, the personalized route plans and lottery incentive should increase the attractiveness of using sustainable transportation.	Self-reported transportation behavior Actual bus ridership data	The personalized route tool alone led to a statistically significant reduction in self-reported SOV commutes (9% reduction over the first five weeks of the study). The addition of the lottery did not lead to a further decrease in SOV commutes. Bus ridership data also showed increases in ridership because of the personalized tool; however, these results were based on fewer participants and were less reliable.
Portland, Oregon, Bureau of Transportation (BIKETOWN)	Incentives, described in two different randomly assigned emails, encourage users to refer other people to use a new bikeshare program	*N* = 45,947 members of Portland's bikeshare program	Friction costs associated with referring friends Default of not speaking to friends about commuting	By offering benefits for making a referral, this approach will ease the perceived cost of referring friends and help users overcome the status quo default of not communicating transportation choices.	Referral to the bikeshare program	People were 3 times more likely to refer a friend when they had the chance to receive an incentive ($5 credit for BIKETOWN) than when they could donate the $5 incentive to charity (0.78% versus 0.26%). This result was statistically significant.
Oregon Department of Transportation (ODOT)	Encourage users to switch from one carpool matching tool to a new tool through the use of autoenrollment or by sending a targeted email. Increase the usage of the new carpooling tool.	*N* = 65,910 Of those, 25,790 are active users of the tool, and 40,120 are inactive users.	Friction costs associated with registering for the new program	By increasing the ease of sign-ups for the new tool (that is, having the account already set up versus needing to take new action to set up the account), autoenrollment should encourage sign-ups and use of the new tool.	Sign-up for carpooling tool Subsequent app use	In the autoenrollment condition, 5.9% logged into to the new tool as compared with 3.9% in the control condition. This result was statistically significant. People who had to take action to create a new account were more likely to use the app six months later (67% compared with 54%). This result was statistically significant. Long-term analyses are ongoing.

Partner	Study description	Population	Psychological barriers addressed	Hypotheses	Outcome measured	Results
San Francisco Municipal Transportation Agency (SFMTA)	Encourage employees to sign up for public transportation benefits by sending targeted messages.	*N* = 5,926 SFMTA benefits-eligible employees	Opportunity cost neglect	Overcome opportunity cost neglect by highlighting the often underrecognized benefits of public transportation and thus increasing enrollment in transportation benefits by SFMTA employees.	Sign-up for benefits program (WageWorks)	Employees who received a postcard emphasizing the benefits of public transportation (that is, financial savings, time savings, or increased control over one's time) were 23% more likely to enroll in the benefits program compared with a control group who received no message about the benefits (7.4% versus 6.0%). This result was statistically significant. There was no difference in enrollment across treatment groups. Regardless of condition, people were more likely to enroll if they were (a) young, (b) women, (c) working a regular shift, (d) living close to transit, and (e) living further from work.
Santa Monica, California	Encourage employees to sign up for an existing carpooling program by sending targeted messages.	≈*N* = 2,800	Opportunity cost neglect Friction costs associated with finding a carpooling match	Overcome opportunity cost neglect by highlighting the underrecognized benefits of carpooling and thus increasing employee enrollment in the carpooling program. Overcome friction costs by using a technology platform to automatically match individuals from the same organization with one another.	Sign-up for the carpooling matching service Ridership data	This study is on hiatus—stopped at the design phase—due to COVID.
Technology platform	Encourage existing users of the platform's carpooling app to refer new users.	Varies; available by request	Friction costs associated with referring their friend Loss aversion	Highlighting that referring friends could give them $20 in credit for the service or for a charity of their choice could make the referral more attractive and encourage friend referrals.	Referrals made Ridership data	This study is on hiatus—stopped at the design phase—due to COVID.

(continued)

Table 3. Solutions we have tested or plan to test through our team's ongoing partnerships with cities, transportation initiatives, & organizations to promote sustainable commutes (*continued*)

Partner	Study description	Population	Psychological barriers addressed	Hypotheses	Outcome measured	Results
Technology company	Encourage new employees to uptake carpooling benefits by sending targeted messages using dynamic social norms (that is, conveying the fact that carpool use and sustainable commuting are emerging trends).	*N* = 15,000 new employees over five months	Status quo bias	Overcome inertia and status quo bias by encouraging new employees to adopt new habits during a critical moment of change (such as when they are transitioning to a new workplace).	Carpooling use Parking data	This study is on hiatus—stopped at the implementation phase—due to COVID.
Western Washington University in Bellingham, Washington	Encourage employees to sign up for a new carpooling program by sending targeted messages and reminders.	≈*N* = 3,500 faculty, staff, and students	Opportunity cost neglect Availability bias	Highlighting the underrecognized benefits of carpooling could increase enrollment in carpooling benefits among employees. Having these messages come from the university leader and feature members of the university could help change perceptions of sustainable transportation activities.	Sign-up for the carpooling matching service Ridership data	This study is on hiatus—stopped at the implementation phase—due to COVID.
			Studies in partnership with private companies			
Biotechnology company in San Francisco, California	Via e-mail, encourage new employees to sign up to carpool. Test incentives (in partnership with Scoop). Explore well-being before and after carpool uptake.	15,000 employees				This study is on hiatus due to COVID.

Partner	Study description	Population	Psychological barriers addressed	Hypotheses	Outcome measured	Results
Large software company in Mountain View, California	Encourage the reduction of SOV commutes and employee uptake of long-distance shuttles from San Francisco to the office (the area lacks a strong public transit option). Test incentives and framing of incentives (in partnership with Waze).	2,500 employees				This study is on hiatus due to COVID.
Large software company in the Bay Area of California	Test incentives and framing of incentives (in partnership with Waze).	1,600 employees				This study is on hiatus due to COVID.
			Commuting platform technology partners			
RideAmigos, an online commute planning platform for organizations	Encourage carpool sign-up. Encourage existing users to carpool more.	Varies				This work is on hiatus due to COVID.
Scoop, a carpool- and rideshare-matching app	Encourage carpool sign-up. Explore well-being before and after carpool uptake.	Varies				This work is on hiatus due to COVID.
Luum, integrated parking software that enables organizations to manage and administer their parking facilities	Test different ways to structure parking pricing: pay daily, pay monthly, pay annually, and pay incrementally (the price increases or decreases with use).	Varies				This work is on hiatus due to COVID.
Waze, a carpool- and rideshare-matching app	Encourage carpooling by existing users. Determine how best to frame messages. Determine how best to frame incentives.	Varies				This work is on hiatus due to COVID.

Note. See https://osf.io/ufcht/ for study materials and interim results for all studies. See the main text for definitions of the psychological barriers.

participants in these experiments ranges from 1,000 to 60,000. Although people working in the TDM field have great interest in increasing the sustainable use of public transportation by applying behavioral interventions, more research is needed to reveal how best to apply behavioral insights and scale interventions to encourage commuters to choose sustainable transportation options. Progress is being slowed by the lack of a reliable funding pipeline to support this work.

So far, the results of our experiments indicate that behavioral interventions can be helpful but are not yet as effective as they could be. Across the studies listed in Table 3, no behavioral intervention resulted in more than a 9% change in how frequently commuters used an alternative to SOV commutes. Additionally, in a recent study involving 60,000 employees in the United Kingdom who lived near public transportation and said they wanted to commute in more sustainable ways, we found no evidence that behaviorally informed interventions reduced SOV commutes.[27] In many circumstances, such as when SOV commutes are the easiest and cheapest commuting option, behavioral interventions alone are unlikely to provide enough of a nudge to spur increased use of more sustainable commuting modes.

To encourage commuting mode shifts, policymakers and employers will need to deliver psychologically informed interventions in combination with structural interventions, such as offering financial incentives as well as imposing higher costs for parking and SOV commute tolls during rush hour. When considering how best to proceed, researchers and program designers need to consider the entire decision-making context, ensuring that existing policies and programs—such as subsidies for commuting expenses, pricing for parking, and congestion pricing schemes—are aligned with the goal of increasing the use of sustainable transportation. In our experience, such alignment is essential for a behaviorally informed intervention to have a chance of working.

Building on this insight, we are currently exploring how employers might restructure the way they charge for parking at the office. In one behaviorally informed financial intervention, we are separating bundled payments. Employees are being asked to pay each time that they park rather than paying up front at monthly, quarterly, or yearly intervals. This change should encourage people to evaluate whether driving is the best option for them each day and could reduce the inertia associated with up-front payment.[65] We are also planning to study *incremental parking pricing*, an arrangement in which people have to pay more to park more, which may help break the driving habit.[66]

Research on loss aversion suggests that turning parking payments into a per-trip rather than a per-month amount could shift behavior so long as the fee is not perceived as negligible or does not round to zero. Concretely, organizations could ask their employees to pay for parking as a lump sum at the start of the year, with the understanding that rebates will be given at the end of the year for the amount not used. The employer could frame the approach in behaviorally informed ways, such as by emphasizing that, by not parking, employees can enjoy a "growing amount of rebate earned," or that, by parking, they "permanently lose a percentage of the parking cost for the year." This example illustrates the benefit of moving away from studying structural and behavioral interventions in isolation and applying behavioral insights to the design of fines and incentives.

In light of increasing income inequality and ongoing economic volatility, more research should focus on the efficacy of interventions that highlight the financial benefits of using commuting modes other than SOV commutes. Our initial studies and prior research suggest that messages that promote the cost savings of pro-environmental behavior are especially effective when people are worried about their finances.[47] Thus, people who are seeking financial independence or are concerned with their finances may be most motivated to change their mode of commuting if messaging about the new mode frames it as a financially beneficial activity, such as by emphasizing the cash saved on car insurance and parking.

Relatedly, behavioral interventions instituted to promote the use of public transport or carpooling will work only if people can realistically engage in an alternative commuting mode without incurring significant penalties in safety, convenience, or cost. Data from the studies described in Table 3 show that interventions were more effective when people lived near the public transportation routes advertised in our communications. Some strategies that cities could apply to reduce SOV commutes include introducing high-quality bicycle facilities and dedicated bus lanes, requiring major employers to submit a TDM plan and to track its progress, and creating and analyzing reduced-fare programs for low-income residents. (See references 67, 68, and 69 for recent examples of such programs.) Organizations and city governments could consider signing a joint public commitment to limit the number of business trips required of employees.

Future research could also explore other factors that prevent people from switching commuting modes, such as the perceived personal benefits of driving. People consistently report disliking car commutes, yet the "ideal" car commute length for most people is not zero.[70] In one study, people reported that their average desired commute length—regardless of mode—was 16 minutes.[70] Another study of over 400 car commuters found (after investigators controlled for the time variability caused by traffic congestion) that people with longer car commutes enjoyed them more.[71]

Such findings suggest that commuting by car can serve an important psychological function by providing uninterrupted time to plan the day and transition between personal and professional responsibilities. A potentially generative area of research would be to explore the psychological benefits of SOV commutes to better understand how alternative options might provide similar psychological rewards.[72,73] Another worthwhile effort would be to further examine the existence of—and ways to mitigate—*rebound effects*, in which people who drive less fly more because they feel that their relatively low daily carbon footprint gives them license to do so. A similar pattern has been found in relation to energy consumption; for instance, people who start taking public transportation often spend more on gas, heat, and electricity.[74]

"People consistently report disliking car commutes"

Research into the best way to increase the use of sustainable commuting modes would also benefit from the ability to easily collect smartphone, bus ridership, and parking data. When researchers measure objective behavior passively and continuously, their studies are less intrusive and easier to run, can more easily assess behavioral changes that unfold over time, and can avoid the reporting biases associated with self-reports. Lasting partnerships between researchers, employers, and owners of technologies that can readily collect ridership or parking data are needed to obtain these data and expand the scope of research on behavioral interventions.

As a result of our experiences establishing such partnerships, we believe that researchers should develop a proactive research agenda of foundational commuting questions up front and work toward these broad goals over time. Our ongoing interventions may have been more successful had we begun by outlining a specific set of research questions that we wanted to address (relating to the barriers we identified) instead of choosing to work with interested organizations to test the most feasible or convenient research questions available to us at the time. We hope that this article inspires researchers and practitioners to develop their own pipeline of behaviorally informed projects.

To further advance this work, existing government TDM grant funding sources should start to require high-quality evaluation as a condition for funding. Existing foundation and government grant programs that are focused on environmental goals should also start to acknowledge the importance of behavioral science–related approaches in their ongoing work.

Our partnerships have revealed the interest of the TDM community in applying behavioral science principles to achieving shifts in the transport modes used by commuters as well as the challenges of conducting research in this area, such as the difficulty of accurate measurement. We hope this article will serve as a springboard for sustained collaborations between researchers and practitioners of TDM and provide a framework for encouraging these partnerships. Joint partnerships between academics, cities, TDM practitioners, and technology platforms will best enable the future design and implementation of effective behaviorally informed interventions.

author note

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review

Harnessing behavioral science to design disposable shopping bag regulations

Tatiana Homonoff, Rebecca L. C. Taylor, Lee-Sien Kao, & Doug Palmer

abstract

Policies to curb the use of disposable shopping bags take two main forms: (a) They provide *market-based incentives,* imposing fees or taxes on disposable shopping bags or offering rewards for bringing reusable bags from home, or (b) they impose *command-and-control policies*, which ban certain types of disposable shopping bags altogether. In this article, we review evidence on the effectiveness of these policy design choices through a behavioral economics lens and highlight best practices for policymakers considering similar legislation.

Homonoff, T., Taylor, R. L. C., Kao, L.-S., & Palmer, D. (2021). Harnessing behavioral science to design disposable shopping bag regulations. *Behavioral Science & Policy, 7*(2), 51–61.

Core Findings

What is the issue?
Reducing environmental waste means encouraging consumers to curb their use of disposable shopping bags. Two types of interventions targeted at doing so are *market-based strategies*, which give consumers a financial incentive to change their behavior, and *command-and-control approaches*, which regulate consumer behavior directly. Leveraging insights from behavioral science is key to ensuring that these interventions can be effective.

How can you act?
Selected recommendations include:
1) Levying taxes on disposable shopping bags to capitalize on people's loss aversion
2) Imposing hybrid bans that combine bans on thin plastic bags with fees for alternative disposable bags

In the United States alone, more than 400 laws aim to curb the use of disposable (single-use) shopping bags, particularly those made of plastic. Policies implemented by governments or retailers typically impose fees for disposable shopping bags, give rewards for bringing reusable bags, or ban stores from supplying certain types of disposable shopping bags. In this article, we review research on these policies and apply insights from behavioral economics to suggest strategies for enhancing their success. Behavioral economics can be helpful in this situation because, unlike standard economics (which assumes that consumers make decisions by carefully tallying the costs and benefits of their options), it reveals ways that psychological factors, such as the salience of a fee or the awareness of social norms, can influence how people respond to regulatory interventions.[1]

Why Regulate Disposable Shopping Bags?

Each year, Americans consume 100 billion disposable plastic shopping bags.[2,3] When the bags are not accumulating in landfills, they clog storm drains, seep into waterways, and hang on trees, costing local governments an estimated $3 to $8 billion per year in aggregate to clean up.[4] Beyond imposing cleanup costs, plastic bags create environmental costs that can extend beyond jurisdictional borders. For example, one team of researchers calculates that 2%–5% of plastic waste ends up in the ocean.[5] There, plastic items do not degrade but instead break into ever smaller pieces, which can harm sea animals that mistake plastic for food.[6]

Paper shopping bags might initially seem to be a better alternative because they are biodegradable, but they have their own drawbacks. They are more environmentally costly to transport because they are heavier, and their cycle of production, use, and disposal leaves a larger carbon footprint—that is, the cycle results in higher emissions of carbon dioxide and other greenhouse gases. The United Kingdom's Environment Agency estimates that paper bags' carbon footprint is 4 times as large as that of typical plastic shopping bags.[7] Typical plastic shopping bags are thin and lightweight, measuring less than 2.25 mils (2.25 thousandths of an inch) thick and weighing about 6 grams. This means they require less material to produce and transport—and consequently have a lower carbon footprint—than thicker types of bags.

The economic case for governmental regulation of disposable bags is based largely on the existence of what economists call *environmental externalities*: environmental consequences of producing a product or service that are not considered when prices are set. The presence of environmental externalities means the producers and users of disposable shopping bags do not pay the costs that the bags impose on the environment. For example, most plastic shopping bags cost U.S. retailers an average of 3 cents each,[4] while cities spend up to 8 cents per bag on litter control.[8] Regulations are also needed because the way in which most stores charge for the bags encourages unrestrained use. Specifically, retailers usually roll the cost of the bags into the overall price of groceries—as they do with the cost of the store's air conditioning or the cashiers' salaries—rather than directly charging for the bags. Thus, instead of calculating the cost of each bag when deciding how many to use, customers perceive the bags to be free, which leads them to use more than they would if they paid for each bag individually.[9] They may go home with still more bags than they need if cashiers who help with bagging prioritize time efficiency over minimizing bag use.

In economic terms, the damages disposable shopping bags impose on the environment, marine ecosystems in particular, as well as the high cleanup costs they impose on governments represent a failure of the free-market system (that is, where governments impose few regulations on individuals and businesses) to meet society's needs efficiently. Economic principles indicate that such failure requires governmental intervention. The question is, Which interventions are most likely to be successful? This is where behavioral economic insights into consumer behavior have much to offer. Behavioral economics studies the effects

of psychological, emotional, and social factors on economic decisionmaking. In this article, we bring together principles from standard economics and behavioral science to assess recent regulations on the use of disposable bags.

Existing Policies in Brief

Governments around the world have implemented a variety of policies to regulate the use of disposable shopping bags and thereby limit their costs to the environment and to government budgets. Although varied, these policies can be divided into two main approaches: (a) *market-based* strategies, which give consumers a financial incentive to change their behavior, and (b) *command-and-control* approaches, which regulate consumer behavior directly, such as by banning certain activities. Policies classify disposable shopping bags into three types: thin plastic shopping bags (under 2.25 mils thick), thick plastic shopping bags (over 2.25 mils thick, roughly the thickness of a commercial garbage bag), and paper shopping bags. Some bag policies regulate only thin plastic shopping bags, while others address disposable shopping bags more broadly without singling out thin plastic versions. Table 1 summarizes the most commonly used governmental and retailer policies for limiting the use of disposable shopping bags.

"customers perceive the bags to be free"

Market-Based Strategies

Market-based incentives to discourage disposable bag use typically take the form of a small tax or fee charged for each such bag used by a customer at the checkout. A well-known example is the Irish "Plastax," a €0.15 fee for every plastic shopping bag.[10] In 2010, Washington, DC, became the first city in the United States to adopt a similar policy, which placed a 5-cent tax on all plastic or paper disposable shopping bags provided by grocery retailers.[11] Additionally, many retailers have proactively adopted their own policies. One common approach offers customers a bonus—usually between 3 and 5 cents—for each reusable bag a customer uses. Some of the largest grocery chains in the United States have tried this approach, including Kroger, Safeway, Giant, Target, and Whole Foods.

Command-and-Control Approaches

Command-and-control policies set standards for allowable products or actions, banning those that do not meet the standards. In the case of disposable bags, these policies typically ban thin plastic shopping bags. In 2002, Bangladesh became the first country to impose such

Table 1. Types of policies to limit use of disposable shopping bags

Market-based incentives		Command-and-control policies	
Disposable bag taxes	Reusable bag bonus	Stand-alone bans	Hybrid bans
Small tax or fee per disposable shopping bag used by customers; issued at point of sale	Small bonus given to customers by retailers for using reusable shopping bags at checkout	Prohibits use of plastic shopping bags under a certain thickness (generally 2.25 mils thick) at checkout	Prohibits use of plastic shopping bags under a certain thickness and requires a fee (usually small) for all remaining types of shopping bags
• Denmark (1994) • Ireland (2002) • South Africa (2004) • Washington, DC (2010) • Boulder, CO (2013) • Israel (2017) • Spain (2018) • Peru (2019)	• Kroger • Safeway • Giant • Target • Whole Foods • Trader Joe's • Ralphs	• Bangladesh (2002) • San Francisco, CA (2007; replaced with hybrid ban in 2012) • Chicago, IL (2015; replaced with tax in 2017) • Kenya (2017) • New York (2020; hybrid ban opt-in)	• Seattle, WA (2012) • California (2016) • Boston, MA (2017) • Minneapolis, MN (2017) • Oregon (2020) • Vermont (2020)

a ban. Five years later, San Francisco became the first jurisdiction in the United States to pass a similar law, prohibiting stores from providing thin plastic shopping bags.

Currently, bans on thin plastic bags constitute the most common type of disposable bag regulation worldwide.[12] In the United States, more than 90% of state and local ordinances that regulate the provision of disposable bags incorporate a ban on thin plastic bags.[13] The bans take one of two forms. *Stand-alone bans* restrict the use of traditional thin plastic shopping bags, often using a thickness cutoff similar to the one used in San Francisco while leaving other types of disposable shopping bags—such as paper bags or thicker plastic bags—unregulated. *Hybrid bans* pair bans on thin plastic bags with a minimum required fee for paper bags and reusable bags (usually between 5 and 10 cents), although stores can choose to sell paper and reusable shopping bags for more than the mandatory minimum.

Policy Recommendations

In this section, we provide several policy design recommendations, founded in both standard and behavioral economics, for governments and other policymakers interested in implementing disposable bag regulations. In each case, we summarize the theoretical rationale for the recommendation and review recent relevant evidence. We focus on research that used a *difference-in-differences* methodology, in which investigators compare bag use in a selected area before and after a policy change against bag use in similar places where no such policy change occurred. (Note A explains our rationale for focusing our discussion on studies that use this methodology.)

Lesson 1: Disposable Shopping Bag Taxes Are More Effective Than Reusable Bag Bonuses (That Is, Use Sticks, Not Carrots)

Standard economic theory suggests that the choice between the two common market-based policy designs—levying taxes on disposable shopping bags (that is, "sticks") or offering bonuses for bringing one's own bag (that is, "carrots")—should not matter as long as the taxes and bonuses have the same monetary value. Behavioral economics, however, teaches that people are loss averse, meaning they dislike losses more than they appreciate similar-sized gains.[14] If customers are loss averse, a tax would be expected to be more effective than a bonus of the same magnitude. Empirical evidence of loss aversion has been documented in the field in several contexts, including among stock market investors,[15] taxi drivers, [16] and professional golfers.[17] In this section, we describe recent work that indicates disposable bag taxes are effective tools for reducing disposable shopping bag use, whereas reusable bag bonuses are not.

One of the first evaluations of disposable bag taxes in the United States examined the effect of a 5-cent tax on disposable shopping bags in Montgomery County, Maryland.[11] This study used observational data on disposable and reusable bag use in the months just before and just after the tax was implemented at stores in Maryland (which experienced a policy change); Washington, DC (which had a 5-cent tax throughout the study period); and Virginia (which had proposed a tax but never passed one). The study found that prior to the tax, just over 80% of customers in Maryland used at least one disposable shopping bag, and that the tax decreased the proportion of customers using a disposable shopping bag by 42 percentage points. Studies that apply a similar methodology but use different data or evaluate policies in different cities find comparable results. For example, Taylor obtained similar results using scanner data from a large supermarket chain,[18] and Homonoff et al. documented a comparable response to a 7-cent tax in Chicago—a 33 percentage point decrease in disposable shopping bag use.[13]

Similar evaluations of disposable bag charges have been conducted in several other countries. Using observational customer data, a team of researchers found that the implementation of a 2.5-cent to 4-cent tax on disposable shopping bags in the city of Buenos Aires led to an increase in the proportion of customers using

at least one reusable bag relative to the proportion doing so in Greater Buenos Aires (which was not subject to the tax), with the magnitude of the increase similar to that reported in U.S. studies.[19] Cabrera et al. used administrative data on disposable bag use from retailers during a staggered rollout of a 7–10 cent tax in Uruguay, finding a roughly 80% decrease in the number of bags provided after the tax went into effect.[20]

Elsewhere, two separate research teams turned to survey data to evaluate the effect on reusable bag use of a 5-cent single-use carrier bag levy in Toronto[21] and a 5-pence charge in Wales.[22] Both studies found statistically significant increases in reusable bag use; however, the magnitudes of these estimates are considerably smaller than those estimated in the U.S. and Latin American evaluations, possibly because of different baseline levels of reusable bag use, different data sources (observational data versus self-reported surveys), or other regional differences.

One interpretation of the large change in consumer behavior after the implementation of relatively small taxes is that many customers are just on the margin of bringing a reusable bag instead of taking a disposable shopping bag at the checkout. In other words, the cost a customer associates with bringing a reusable bag is no more than 5 cents per bag—otherwise, customers would continue to take disposable bags at the same rate that they always had. If a strictly financial calculus fully explained the results, a similar-sized bonus for supplying one's own reusable bags would be expected to be as effective as the tax. On the other hand, if loss aversion, rather than the size of the financial incentive, accounted for the findings, one would predict that a bonus would not be as effective as a tax at decreasing the use of disposable bags: People who would be moved by the pain of paying any tax but who did not otherwise care whether their wealth changed by pennies per bag would be unlikely to be swayed by even a 10-cent bonus.

In addition to estimating the effect of the 5-cent tax in Washington, DC, Homonoff looked at the effect of offering rewards for bringing reusable bags to stores.[11] When she compared disposable shopping bag use at retailers in the DC area that offered a 5-cent reusable bag bonus with the use of disposable shopping bags at retailers that offered no bonus, she found no differences. This finding is supported by anecdotal evidence from retailers that reusable bag credits had little effect on reusable bag use, resulting in many retailers rolling back these incentives.[23] This asymmetry in customer responses to the two types of policies—a large change in behavior with a 5-cent tax, but no change in behavior with a 5-cent bonus—is consistent with a behavioral model of loss aversion and suggests that policymakers who are considering market-based incentives to discourage disposable bag use should choose to use sticks rather than carrots.

> "many customers are just on the margin of bringing a reusable bag"

Lesson 2: A Disposable Shopping Bag Tax Does Not Have to Be Large to Be Effective

Proponents of disposable bag taxes have hotly debated the ideal size of the tax. Early failed legislation in California suggested charging a 2-cent fee per bag on all disposable plastic shopping bags as part of the Litter and Marine Debris Reduction and Recycling Act of 2003.[24] Two years later, San Francisco proposed a 17-cent fee on both plastic and paper bags, but the proposal was met with public opposition, causing policymakers to consider lower fees.[25] In 2008, Seattle became the first city in the United States to pass a disposable bag fee—20 cents on both plastic and paper bags—but before the fee was implemented, the policy was placed on a citywide ballot and voted down. Three years later, however, the city successfully implemented a policy that banned thin plastic shopping bags and charged a 5-cent fee for paper shopping bags. These battles suggest that policymakers face a trade-off when choosing the size of the bag fee: Higher fees may generate larger reductions in waste but are less likely to receive enough political support to be implemented.

$1K

Using field workers to visit homes and motivate for retrofitting costs $1000 per household.

4%

Property sellers in England who retrofitted and south an updated energy lable from 2012-2019

11 542 households

Equivalent total energy savings in the UK when sellers moved from an E label to D

To date, only limited evidence speaks to the optimal fee size, primarily because the majority of disposable bag fees in the United States are about the same amount—between 5 and 10 cents—although a few jurisdictions levy fees as high as 25 cents per bag. Nevertheless, the evidence described in the previous section suggests that even very small taxes on disposable bags can lead to large changes in behavior across a wide range of countries. Standard economics could explain this effect if shoppers perceive the cost of bringing their own bags as negligible. Results from Shampanier et al.'s work, however, imply that individuals do not apply standard cost–benefit rules when choosing between two goods if one of the goods is free.[9] The researchers suggest that receiving a good for free not only makes the price attractive but also increases the good's perceived benefits; that is, people really like getting things for free. Hence, even a very small fee—say, 1 or 2 cents per bag—may lead to large decreases in disposable bag use because any price on a bag means it is no longer free.

Behavioral science also suggests that, as we elaborate on next, small taxes on disposable bags can be effective despite their small size if they (a) make salient that each bag has a cost, (b) help to break the habit of using disposable bags and to form new bring-your-own habits, and (c) signal that using reusable bags is the new social norm.

Salience. A growing literature on tax salience demonstrates that if a tax is out of sight—that is, hidden in some way due to the placement of the tax, the payment method, or the complexity of the tax—then it is also out of mind when individuals make economic decisions relating to the taxed item. Conversely, if attention is drawn to the tax, its salience will lead people to keep the tax in mind when making decisions. For example, specifying the sales tax on the posted price of a good (rather than adding the tax in at the register as is usual) decreases sales of that good.[26] Similarly, reducing the salience of road tolls through the introduction of EZ-Pass reduced the responsiveness of drivers to changes in the toll.[27]

Conversely, several examples in the field of environmental economics suggest that taxes are actually more salient than are traditional price changes. For example, one study showed that customers responded more to an increase in a gasoline tax than to a similarly sized increase in gas prices driven by oil price changes, citing the media coverage of the tax as what made it more salient.[28] Similarly, the introduction of a carbon tax in Canada led to a significantly larger change in the demand for gasoline than did an equivalent price change.[29] Consistent with these findings, Homonoff found near-perfect awareness of the DC area's disposable bag taxes, which suggests that salience may have contributed to the policy's effectiveness.[11]

Habits. Customers may use disposable bags in part because they are simply in the habit of doing so; this habit is easy to maintain when stores provide the bags as a default. In other words, the decision to use a disposable shopping bag may not be a deliberate choice: At the register, consumers likely are not actively weighing the costs and benefits of each bag for each purchase but rather are acting on autopilot and making decisions based on the choices they have made in the past. When a disposable bag tax is introduced, the tax cues customers to make an active decision as to whether to pay for a disposable bag.[30] This choice, when repeated over time, can then serve as the foundation for a new habit. Taylor found evidence of habit formation after both disposable bag taxes and hybrid bans were imposed in supermarkets. The share of customers paying for disposable bags fluctuated only in the first two weeks after the policies were implemented and then remained constant for the rest of the one- to two-year sample period.[18]

Social Norms. Behavioral science research has shown that social comparison can be a powerful policy tool, especially in the area of environmental conservation.[31,32] Because bringing one's own shopping bags is a highly visible behavior, even if a small tax initially prods just a few people to abandon disposable bags, this visible change in behavior can inspire many other shoppers to follow suit. In other words, the small tax can generate large effects through what is called a

social multiplier effect.[33] Research also suggests that policies may be particularly effective when they are government regulations rather than store policies because of the "expressive function of law"—the presumed ability of the passing of a law to signal a change in social norms.[34]

Before turning to our next recommendation, it is worth pointing out that the change in consumer behavior in response to disposable bag taxes is much larger than responses to similar-sized taxes on other products, like sugar-sweetened beverages.[35,36] This fact may simply suggest that the demand for disposable bags is more elastic. However, elements of the decisionmaking environment we have described that are unique to the case of disposable bags—the salience of the tax, habit formation, the visibility of the behavior, and the fact that disposable bags were originally considered free—may contribute to the particular effectiveness of disposable bag taxes.

Lesson 3: Avoid the Cobra Effect—Anticipate & Avoid Unintended Consequences

Certain policy design decisions may lead to unintended consequences—outcomes that are not anticipated and may run counter to the policy's stated goal. When a policy decision exacerbates the problem it is meant to solve, the negative outcome is often called the *cobra effect*, in reference to a cautionary tale in which a policy that aimed to reduce the number of cobras in India by offering a reward for each captured snake led instead to an increase in the number of cobra breeders.[37] In the context of disposable bag regulation, the design and scope of the regulation will affect not only the use of the regulated bags but also the use of substitutes for those bags. Depending on the substitute, the policy could potentially do more environmental harm, undermining the intention of the policy.

In the case of stand-alone bans—the most common disposable shopping bag regulation—research suggests that the cure may be worse than the disease. Homonoff, Kao, Selman, and Seybolt evaluated the effect of a stand-alone thin plastic bag ban that was implemented in Chicago in 2015 and then repealed in 2017.[13]

"the cure may be worse than the disease"

Like the San Francisco policy mentioned earlier in this article, the ban applied to thin plastic shopping bags (less than 2.25 mils thick). In response to the Chicago ban and counter to the policy's goal, retailers circumvented the regulation by offering customers free thick plastic bags, which were roughly five times the thickness of the standard plastic shopping bags that were on offer prior to the ban. The investigators observed customers in Chicago (which was covered by the ban) and in surrounding suburbs (which had no disposable bag regulations) and found that the proportion of Chicago shoppers using disposable bags did not change after the ban's repeal. Additionally, when the ban was in place, over 40% of Chicago customers used a newly provided thick plastic bag. In other words, the ban failed to reduce the overall number of customers using disposable bags and, in fact, increased the environmental costs associated with disposable bag use by shifting customers toward more environmentally harmful disposable bags. (See note B for examples of similar responses to stand-alone bans in other cities.)

Hybrid bans may be preferable to stand-alone bans because they restrict the use of thin plastic shopping bags while leaving fewer disposable substitutes unregulated. In a 2016 study, Taylor and Villas-Boas evaluated the effect of such a policy in Richmond, California, which combined a ban on thin plastic bags with a 5-cent minimum fee for all other bags.[4] Using observational data and comparing bag use before and after a policy change in regulated versus unregulated cities, the researchers found that, unlike the stand-alone ban in Chicago, the hybrid ban led to a substantial (roughly 35 percentage point) reduction in the use of disposable shopping bags. (See note C for more detail.)

In addition to increasing the use of thicker disposable bags at checkouts, policies that ban the use of thin plastic shopping bags can potentially have a different unintended consequence: the increased purchase of plastic trash

bags. This increase could occur, for instance, if consumers normally reuse plastic shopping bags as waste bin liners. The environmental benefits of restraining the use of plastic bags at checkout could then be reduced by the increased consumption of other kinds of plastic bags. In a 2019 study, Taylor measured the effects of various hybrid bans as they rolled out in different parts of California.[38] She found a large increase in sales of plastic trash bags, including a 120% increase in sales of small trash bags (the closest substitute for thin plastic shopping bags). The study showed that over a quarter of the reduction in plastic associated with the hybrid bans was offset by the increase in purchases of plastic trash bags. Understanding this unintended consequence allows policymakers to more accurately quantify the effects of disposable bag bans on bag use for their cost–benefit calculations.

Discussion

In this article, we have laid out several recommendations for designing disposable bag regulations that are based on behavioral science theory and supported by empirical evidence. Many of the studies we discussed evaluated policies implemented in economically developed countries, because that is where most of the studies that met our methodological criterion were conducted. However, we believe that the lessons we highlight would apply to many locales. In support of this view, a large number of studies using simple-difference designs (see note A) in a variety of countries have produced findings similar to the ones reported in this article: They demonstrate large decreases in disposable bag use in response to small fees and show minimal effects of stand-alone plastic bag bans.[12,21]

Two common regulation designs adhere to our policy recommendations: levying taxes on disposable shopping bags and imposing hybrid bans that combine bans on thin plastic bags with fees for alternative disposable bags. Both policies have been shown to yield large decreases in disposable bag use. In contrast, the most common policy in the United States—the stand-alone ban on thin plastic bags, with no regulations on other disposable bags, such as paper bags—may simply change the type of disposable bag a customer uses without decreasing overall use, and they may even cause retailers to offer free thicker plastic bags that are worse for the environment. When Homonoff et al. directly compared the environmental costs associated with disposable bag use across the life cycle of the bags (from production to cleanup) during a stand-alone ban in Chicago and during the imposition of a tax on all disposable shopping bags, they found that customers used the life-cycle cost equivalent of over six additional lightweight plastic bags per shopping trip during the ban relative to during the tax.[13]

It is important to note that the research we have discussed in this article also indicates that even small taxes on disposable bags can lead to major changes in consumer behavior. Hence, policymakers who want to decrease disposable bag use but worry about the economic burden that fees would place on consumers—especially low-income shoppers—may want to consider a very small tax. A small tax could still shift behavior to help the environment and would be more effective than no tax at all.

end notes

A. A large body of empirical research evaluates the effectiveness of disposable bag regulations using a *simple-difference* approach, which compares consumer behavior before and after a policy change. Rivers et al. review a number of these studies in a 2017 article, but they point out that the simple-difference approach may lead to biased estimates, because it does not account for confounding events that may occur simultaneously with the policy change.[21] (An example would be a hypothetical shortage of the material needed to produce the bags.) Randomized controlled trials (RCTs) are the gold standard for determining cause and effect because they assign participants randomly into either a group that receives an intervention or a control group that does not; however, to our knowledge, no RCTs have been conducted in this policy area. In their absence, the difference-in-differences research design provides the most credible causal identification strategy for determining the effectiveness of disposable bag regulations. By comparing the

behavior of a community that is subject to a bag policy not only before and after a policy is established but also with a similar community that was not subject to the policy, the analysis controls for the influence of potentially confounding events.

B. Anecdotal evidence indicates that in 2015, retailers in Honolulu County, Hawaii, behaved much the way Chicago retailers did after the implementation of a stand-alone ban on thin plastic bags, providing thicker plastic bags in lieu of thin plastic bags.[39] After San Francisco implemented a stand-alone ban in 2007, paper bag use increased more than fourfold,[40] which ultimately motivated a shift to a hybrid ban (one accompanied by a fee on other disposable bags) in 2012.

C. In the study conducted in Richmond, California, Taylor and Villas-Boas also found that after the hybrid ban was instituted, the plurality of customers purchased 10-cent paper bags at the checkout, although customers shopping at a grocery chain that additionally sold thick plastic bags for 15 cents chose those bags and paper bags in roughly equal proportions.[4]

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report

Six behaviors policymakers should promote to mitigate climate change

Kate Heller, Michael Berger, Antonius Gagern, Abdurakhim Rakhimov, John Thomas, & Erik Thulin

abstract

Policymakers have a crucial role to play in averting climate catastrophe. Policies that rely on behavioral science principles to encourage individuals to reduce emissions of carbon dioxide and other greenhouse gases can be an effective complement to broader top-down policies, such as charging for carbon emissions—provided that the behavior-based policies focus on actions with the highest potential to reduce emissions. We conducted an analysis to identify behaviors that have the greatest practical potential to reduce emissions in the United States and modeled the effects of their uptake. Our analysis identified six behaviors to prioritize: If adopted by 5%–10% of the U.S. population, these actions can collectively lower current national emissions by 464 million metric tons of carbon dioxide equivalent per year, or 7% overall annually. We identify behavioral mechanisms that can inform policy design for promoting each of these behaviors.

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Core Findings

What is the issue?
Policymakers face political gridlock when introducing interventions designed to address climate change. However, interventions that use behavioral science principles to encourage individual action while preserving choice have been shown to be effective. Six behaviors to prioritize include (a) purchasing an electric vehicle, (b) reducing air travel, (c) eating a plant-rich diet, (d) purchasing carbon offsets, (e) reducing food waste, and (f) purchasing green energy.

How can you act?
Selected recommendations include:
1) Invest in testing behavioral policies prompting these high impact behaviors
2) Adopt effective behavioral policies, such as assigning utility customers to a green energy provider unless they opt out

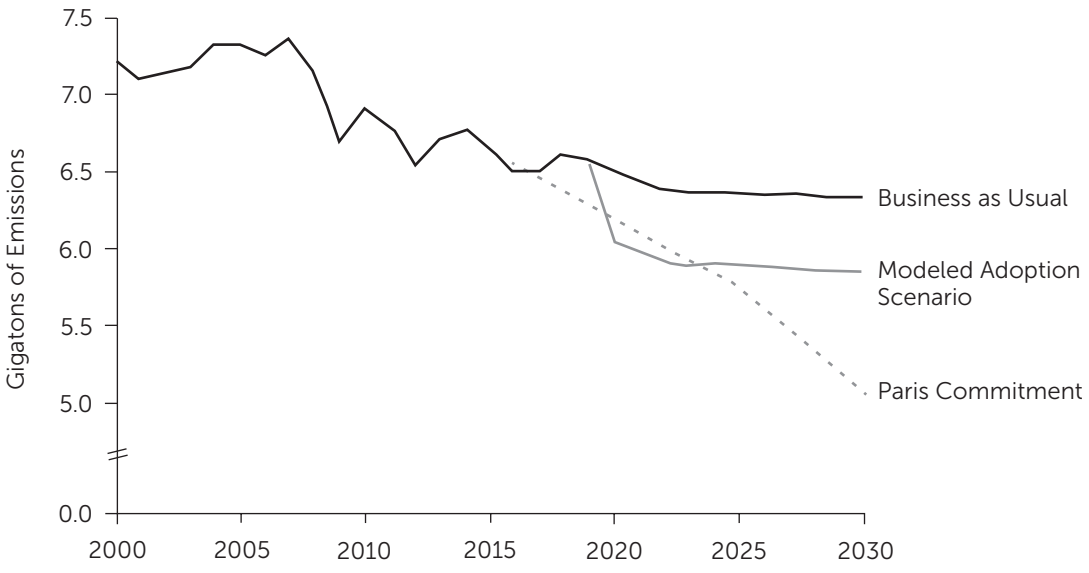
Who should take the lead?
Policymakers, regulators, and business leaders

Climate change is projected to cause crop failures, extreme weather, rising seas, and heat-driven mortality.[1] Policies that promote reducing or eliminating emissions of carbon dioxide and other greenhouse gases are crucial for mitigating these effects. In the United States, broad policies that would have a substantial impact, such as placing a price on carbon emissions, currently face significant political opposition, making them unlikely to have the near-term effects on emissions needed to prevent the worst consequences of inaction. Policies that use behavioral science principles to encourage individual action while preserving choice have been shown to be effective for shifting behavior and present a complementary path for policymakers.[2,3] However, before developing policies that will encourage individuals to modify their behaviors, it is critical that policymakers identify—and prioritize—the behaviors that have the most potential for reducing emissions.[4]

To that end, we conducted an analysis that identified a short list of six individual and household behaviors that have the greatest practical potential to reduce emissions in the United States. Our analysis, based on computer modeling, indicates that if these six behaviors were adopted by 5% or 10% (depending on the behavior) of their respective addressable markets in the United States, they could collectively lower current national emissions by an estimated 464 million metric tons of carbon dioxide equivalent ($MtCO_2e$) per year, or 7% overall annually—an amount that would bring the United States about three-quarters of the way to meeting the 2025 emissions-reduction target set in the 2015 Paris Agreement (see Figure 1). Considering that U.S. emissions are projected to remain relatively flat through 2030, a 7% reduction through individual and household behaviors alone represents a nontrivial decrease.[5] An *addressable market* is the individuals or households that are in a position to adopt a certain behavior but have not yet done so. *Carbon dioxide equivalent* is a measure of the global warming potential of a gas, represented in terms of how much carbon dioxide would be needed to generate the same amount of warming.

In addition to identifying the target behaviors that policymakers should prioritize and quantifying their potential effects on global warming, we share examples of behavioral mechanisms

Figure 1. U.S. emissions reductions achieved by the adoption of six recommended behaviors



Note. The modeled adoption scenario assumes all behaviors listed in Table 1 are adopted as described in the main text of this article.

that the research literature indicates could inform successful policy design, and we offer examples of interventions that could target those mechanisms. Understanding these mechanisms should be a first step in policy development.

"We ended with six behaviors that are highly relevant in the context of the United States"

Method

Developing a Short List

We reviewed several publications that estimated the carbon emissions impact of various climate friendly actions to generate a list of 55 behaviors for potential intervention.[6–8] (See the Supplemental Material for a full list of sources.) Recognizing that many of the recommendations identified in the literature were appropriate only for specific locations, we focused on those that would be applicable to the United States. We concentrated on the United States for a couple of reasons. First, it is the second highest carbon-emitting country in the world, as well as one of the highest per capita emitters. Second, behaviorally informed policies could well enable the United States to make progress toward climate-change goals even though the current political gridlock means that national mandates intended to mitigate climate change are likely to meet great resistance.

We used two criteria to identify priority behaviors to target in the United States. We first ranked each behavior's emissions-reduction potential as high, medium, or low. These rankings corresponded to annual reductions of greater than 500 million $MtCO_2e$, 100–500 million $MtCO_2e$, or less than 100 million $MtCO_2e$, respectively. We then conducted an initial literature review for the behaviors to understand the relevance of each in the United States. We assessed relevance on the basis of whether the behavior was (a) culturally feasible, (b) ecologically applicable, and (c) not disincentivized by existing regulatory frameworks or infrastructure. (Rankings are available in the Supplemental Material.) We considered a behavior culturally infeasible if we found it conflicted with the prevailing values and social mores of the majority of U.S. residents. To be ecologically applicable, the behavior had to pertain to U.S. habitats; certain habitats, such as tropical forests, do not exist in the United States and therefore could not be considered for intervention. Finally, the behavior was excluded if current laws or regulations would actively undermine its promotion. We filtered for behaviors with medium or high emissions impact that met all three criteria for U.S. relevance, and we arrived at a list of eight possible interventions to consider further.

Next, we assessed the underlying social and psychological mechanisms driving those behaviors and the applicability of various behavior-change techniques. We examined these aspects by conducting a behavior-specific literature review and interviewing 20 subject matter experts selected for their expertise in the eight short-listed behaviors. Our research indicated that the three behaviors in our short list related to energy use at home involved similar actions and effects on emissions, so we bundled and modeled them as a single behavior. Thus, we ended with six behaviors that are highly relevant in the context of the United States and that have high or moderately high emissions-reduction potential. These should be at the top of policymakers' agendas (see Table 1). We list them below and describe them more fully later in the article.

- Purchase an electric vehicle (EV).
- Reduce air travel.
- Eat a plant-rich diet.
- Purchase carbon offsets.
- Reduce food waste.
- Purchase green energy.

Modeling the Behaviors of Interest

To estimate the annual effect on greenhouse gas emissions of change in each of the listed behaviors, we built a model that compares business-as-usual trajectories with behavior-change scenarios. Business-as-usual scenarios are based on linear extrapolations of historic trends (such as from 1990 to 2018), and

Table 1. Six priority behaviors to target

Behavior	Illustrative policy	Behavioral principle
	Commute and travel	
Purchase an electric vehicle.	Provide discounts at the point of sale or that expire within a set time.	Leverage *hyperbolic discounting,* a cognitive process that undervalues costs or savings in the future relative to those incurred today.
Reduce air travel.	Require airlines to highlight the environmental consequences of air travel through labeling, such as by informing ticket buyers of the environmental effects of their flights.	Increasing the *salience* of the effects of one's decisions can prompt active consideration of a factor that might otherwise have been ignored.
	Lifestyle	
Eat a plant-rich diet.	Mandate adding emissions information to food labels.	*Information provision* can influence behavior when it contradicts preconceived beliefs and is consistent with existing values.
Purchase carbon offsets.	Require emitters to have customers explicitly choose whether to pay for carbon offsets.	When people are required to make an *active choice*—to explicitly decide on something rather than absentmindedly continue with the status quo—they are more likely to shift from the status quo.
	Waste reduction and management	
Reduce food waste.	Regulate expiration dates on food labels, which are currently set by manufacturers and result in the unnecessary disposal of still-edible foods.	*Information provision* can influence behavior when it allows people to more effectively express their already established preferences.
	Residential energy use	
Purchase green energy.	Default utility customers to a green energy provider.	People often go along with the default option presented to them rather than giving the choice active consideration.

behavior-change scenarios assume immediate adoption of carbon-footprint-reducing activities. Because we made assumptions and because the model does not account for any potential indirect effects of adopting climate friendly behaviors, our results are best interpreted as indicative rather than predictive.

We modeled adoption levels (that is, the number of individuals who change their behavior) with a two-step approach. First, we estimated the addressable market for each behavior. (See the Supplemental Material for more details on addressable markets.) Second, we assumed that a given percentage of this addressable market would adopt the behavior. Past meta-analyses, which combine data from multiple studies, have found that behavioral science–based interventions vary in effectiveness, yielding behavior-change levels ranging from 1.4% for minimal, nudge-style interventions (which modify the decision context without changing incentives); to 18.1% for broad social marketing campaigns and to 27.2% for interventions that change the default consequence of inaction.[9–11]

For five of the six desired behaviors, we assumed a 10% adoption rate. For purchasing carbon offsets, we assumed a 5% adoption rate, because offset markets are not yet mature enough to absorb the demand that would result from a 10% adoption rate. As is indicated by the wide range of adoption rates found in the meta-analyses, the ultimate adoption rate of

any behavior will depend on the specific intervention chosen. Therefore, the adoption rates we selected should be considered illustrative. If a designer has a particular estimated adoption rate for a given intervention and context, the designer can use our model to estimate its impact by linearly adjusting our estimated emissions impact of adopting that behavior. We modeled each behavior using the assumptions described next.

Purchase an EV. We calculated the vehicle miles traveled in EVs when the share of passenger vehicular travel completed in EVs increased by 10%. For modeling purposes, we projected that the efficiency of electricity production by the U.S. electricity grid would increase linearly after 2017 based on a 10-year average, although future technology and policy shifts may significantly alter this trajectory. This linear assumption makes modeling easier to interpret and acknowledges that the grid's efficiency (and thus its rate of emissions) is likely to change over time, but future researchers may refine these projections to account for more nuanced projections of grid efficiency. Emissions released in the course of producing gasoline and running gasoline-using vehicles (that is, from "wells to wheels") were assumed to remain static, although we also assumed that the fuel efficiency of passenger vehicles would increase. We based our fuel economy projections on data from the U.S. Energy Information Administration's *Annual Energy Outlook* and the Bureau of Transportation Statistics.[12,13]

Reduce Air Travel. We defined *frequent fliers* as U.S. residents who take round-trip flights five or more times per year (13% of Americans)[14] and assumed that these individuals took one fewer round-trip transnational or transatlantic flight per year than usual. (That is, we deducted 0.9 $MtCO_2e$ from their annual travel, roughly the amount of their share of emissions from one round-trip transatlantic flight).[15] Our business-as-usual scenario assumed an industrywide increase in fuel efficiency.

Eat a Plant-Rich Diet. Meat production generates higher emissions than vegetable production does.[16] We split U.S. residents into five quintiles of increasing levels of meat consumption, with people in the fifth quintile consuming the most meat and thus being responsible for the most greenhouse gas emissions. We assumed that 10% of people across all but the first quintile switched to the diet of the next lower meat-consumption quintile. To calculate greenhouse gas emissions reductions, we used the midpoint emissions level of each quintile.

> "For five of the six desired behaviors, we assumed a 10% adoption rate"

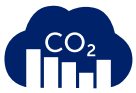
Purchase Carbon Offsets. Our model assumed that purchasing certified offsets, which fund projects that have been verified to reduce carbon emissions by a set amount, is equivalent to eliminating emissions (see note A). It also assumed that individuals who buy offsets would opt to offset their entire annual carbon footprint and that their footprint was the U.S. average emission level of 16 $MtCO_2e$ (a value that is based on data from the World Bank).[17] As stated earlier, we assumed that only 5% of U.S. residents offset their emissions.

Reduce Food Waste. Evidence suggests that interventions such as shrinking plate sizes can reduce food waste by approximately 20%.[18] We therefore modeled emissions reductions associated with a 20% reduction in per-person household food waste in 10% of U.S. households. We further assumed that the change in consumption would create a change in demand, such that emissions are reduced throughout the food supply chain (encompassing production, transport, storage, and so on).

Purchase Green Energy. We assumed that 10% of U.S. households consumed fully carbon-neutral energy by installing rooftop solar panels, buying green energy (such as that generated by wind turbines) from their utility for the rest of their energy needs, and meeting all water-heating needs with solar power. Our model assumed that the decision to install

The reported range of effectiveness across behavioral science intervention types is 1.4% – 27.2%

13% of Americans are frequent fliers



The average emission level in the US is 16MtCO2e

rooftop solar panels was made independently of the decision to buy green energy—that is, the people who adopted rooftop solar installations were not presumed to be more likely than others to buy renewable energy from their utility. We calculated residential emissions on the basis of energy consumed for space heating and cooling, lighting, water heating, cooking, and appliance use. Our business-as-usual scenario assumed normal improved efficiency of residential energy use, in accordance with the International Energy Conservation Code for new buildings. Our model held constant (through 2040) the share of buildings eligible for rooftop solar installations (75%) and the proportion of per-household energy consumption that each solar installation displaces.

The model's source data are mainly drawn from studies that observed peoples' behavior or from administrative records. However, we derived information about diet composition, flying, and green energy purchases from nationally representative surveys, which should be interpreted with the understanding that these self-reports can be biased. See the Supplemental Material for the data sources and calculations used in our modeling.

Results & Policy Opportunities for Accelerating Behavior Change

Our model indicates that a 5% increase in certified carbon offset purchases and a 10% increase in each of the other five recommended behaviors in their respective addressable markets would together reduce U.S. emissions by 464 million $MtCO_2e$ annually and thereby meet 76% of the emissions reduction that the United States targeted for 2025 in the Paris Agreement. Having this size of an impact on emissions at the national level through individual and household behavior changes alone would be a great achievement, and behaviorally informed policies have a key role to play in enabling those shifts.

As has been recognized by the more than 100 governments and institutions that have commissioned behavioral insights teams, behaviorally informed policy has incredible potential to efficiently drive behavior adoption.[19,20] In the following sections, for each of the behaviors we have identified as a priority, we provide the potential for emissions mitigation according to our modeled adoption rate, the cost society avoids with that emissions reduction, and examples of the ways that specific behavioral principles could inform the design of policies meant to achieve adoption of that behavior.[2] See note B for details on how we calculated the avoided costs to society, a monetary figure reflecting the mitigation's societal value, such as the savings realized by paying out less than currently anticipated for property damage resulting from climate change. Of course, the rate of adoption of a given policy in practice will depend on its design and implementation.

Behavior: Purchase an EV

Change modeled: 10% of new car purchases are EVs

Emissions mitigation impact: 65 million $MtCO_2e$ annually

Avoided cost to society: $2.9 to $33.4 billion per year[21,22]

Illustrative applications of behavioral principles to policy:

Because people tend to overvalue the present relative to the future—a phenomenon known as hyperbolic discounting[23]*—provide discounts at the point of sale or set them to expire within a set time.* Many current policies intended to increase EV adoption rely on tax credits, which do not deliver a benefit to the buyer until after taxes are filed. Hyperbolic discounting would render incentives delivered at the time of purchase more effective than tax breaks—even if the cash value of the incentives were lower than the tax credit would ultimately be. One intervention that might avoid hyperbolic discounting while supporting EV markets would be providing vouchers that would have to be used within one to two years to subsidize a consumer's purchase or lease of an EV.

People are more likely to complete simple processes than complex ones, so simplify EV purchases. Having to deal with complexity requires cognitive resources; that is, it adds

to the cognitive costs of making a decision or enrolling in a program. Simplifying enrollment processes can increase interest and participation in voluntary programs.[24] Yet taking advantage of incentives for buying EVs is often difficult, with offers varying depending on multiple factors, like consumer income or engine size.[25] This complexity allows policymakers to target incentives to specific audiences, but it also taxes the cognitive energy of dealers and potential purchasers. Simpler schemes would remove the friction created by such calculations for both dealers and buyers and therefore would likely increase EV purchases. For example, providing a single standardized incentive for all EVs rather than one that depends on the properties of a particular car would reduce the cognitive costs involved in both purchasing and selling EVs.

Behavior: Reduce Air Travel

Change modeled: 10% of frequent fliers drop one long-haul round-trip flight per year
Emissions mitigation impact: 4 million $MtCO_2e$ annually
Avoided cost to society: $0.2 to $2.1 billion per year
Illustrative application of behavioral principles to policy:
Given that people tend to place particular weight on factors that are most salient—that draw their attention most[26]*—highlight the environmental consequences of air travel.* The environmental consequences of air travel are rarely salient when an individual decides to fly. Government policymakers can prompt that salience by, for instance, mandating that airlines include emotionally compelling labeling at the point of purchase informing fliers about flying's effects on pollution (similar to the cigarette labeling that has successfully reduced smoking) or establishing the peer norms around decreased flying.[27] A different tack is suggested by the U.S. government's requirement that all federally funded travel be on a U.S. airline, which demonstrates the government's willingness to direct flying behavior. To try to reduce air travel, federal and state governments could require people who pay for flights using federal or state funds to justify for their supervisor's approval why an alternative such as video conferencing is an inadequate substitute for the trip and why less carbon-intensive travel modes such as rail are infeasible. Requiring justification does not prohibit flying, but it prompts consideration of alternatives, likely increasing their uptake.

> "our analysis suggests a way to focus interventions so that behavior change reduces U.S. emissions as efficiently as possible"

Behavior: Eat a Plant-Rich Diet

Change modeled: 10% of meat eaters drop down one consumption quintile
Emissions mitigation impact: 25 million $MtCO_2e$ annually
Avoided cost to society: $1.1 to $12.7 billion per year
Illustrative application of behavioral principles to policy:
Because providing information that contradicts people's preconceived beliefs but is consistent with their existing values can shift behavior,[28] *mandate the addition of emissions information to food labels*. Consumers have been shown to substantially underestimate the effects that their food choices, particularly the decision to consume meat, have on the climate.[29] Although U.S. policymakers exert significant power over food labeling, they have used this power primarily to provide health-related information. This is a missed opportunity: When other countries have added labels conveying foods' emissions impact, the labels have driven a reduction in the purchase of foods associated with high emissions.[30] Mandating the inclusion of such labels would help consumers make more informed decisions while reducing meat consumption. This strategy has already been incorporated into Denmark's plan to become carbon neutral by 2050.[31]

Behavior: Offset Carbon

Change modeled: 5% of U.S. residents offset their emissions

Emissions mitigation impact: 276 million $MtCO_2e$ annually

Avoided cost to society: $12.4 to $142.6 billion per year

Illustrative application of behavioral principles to policy:

People tend to absentmindedly stick with the status quo or accept a preset default,[11] *but requiring them to make an active choice increases their likelihood of shifting away from the original condition,*[32] *so mandate that companies selling products that cause large emissions have their customers explicitly choose whether to pay for carbon offsets.* Presently, purchasing carbon offsets is generally an opt-in decision: To buy offsets, consumers must actively seek them out. A policy that required consumer-facing emitters, such as airlines, to have customers say yes or no to purchasing carbon offsets would let customers know the choice exists and would prompt active consideration of the climate friendly option. For example, policy could mandate the inclusion of a step in the online checkout process that says, "Your portion of this flight is responsible for X tons of carbon dioxide pollution. Do you authorize paying Y dollars to offset this impact?" and then requires the customer to click *Yes* or *No.* Alternatively, a policy could go one step beyond active choice by mandating that offsets be a default charge and requiring consumers to choose to opt out if they want to avoid the charge—an approach that has been shown to increase offset purchasing while still preserving choice.[33]

Behavior: Reduce Food Waste

Change modeled: 10% of households reduce food waste by 20%

Emissions mitigation impact: 13 million $MtCO_2e$ annually

Avoided cost to society: $0.6 to $5.3 billion per year

Illustrative application of behavioral principles to policy:

Inform consumers of the true expiration dates of food by regulating the expiration dates that food sellers place on their products. People's beliefs, particularly concerning their health and safety, can substantially influence their choices.[34] Providing information can inform these beliefs and, by extension, their behavior. Consumers report that concern over foodborne illness is their primary reason for discarding food.[35] Ninety-one percent of Americans say they pay attention to date labels (which use language such as "best by," "use by," and "sell by"), yet a majority do not realize that these labels are not federally regulated—a misperception that could lead to overreliance on the accuracy and relevance of the labels.[36] Whether or not labels are deliberately designed to misinform consumers, the present labeling regime creates much unnecessary food waste. Recognizing that consumers pay close attention to date labels gives policymakers an opportunity to provide guidance for and regulation of such labels, rather than relying on food suppliers, who have mixed incentives, to provide accurate information.[37]

Behavior: Purchase Green Energy

Change modeled: A 10% increase in households using 100% green energy from a combination of rooftop solar panels, green energy bought from a utility, and solar water heating

Emissions mitigation impact: 82 million $MtCO_2e$ annually

Avoided cost to society: $4 to $42 billion per year

Illustrative applications of behavioral principles to policy:

Simplify the purchase of green energy. Because adding complexity to a decision increases its cognitive cost, consumers often simply prefer to make no choice at all.[38] In the case of rooftop solar panels, choosing not to choose effectively preserves the status quo of relying on grid-based energy. A major barrier to purchasing rooftop solar panels is complexity, much of which stems from policies relating to permits, inspection, and interconnection to put energy back into the grid.[39] Policy reform could lessen this friction through various streamlining tactics, such as providing access to a web-based permitting system.

Leverage the power of defaults by assigning utility customers to a green energy provider unless they opt out. Changing the default option is particularly effective when people are not paying significant attention to their options,

such as when consumers select an energy provider from a utility. Policy that defaults utility customers to a green energy provider and requires them to actively opt out if they want a non–green energy provider has been successful at switching customers into green energy, driving adoption rates as high as 94%.[40]

The Path Forward

Policymakers who want to help constituents reduce emissions have a host of potential target behaviors to choose from and limited time to act. By identifying the six behaviors likely to have the greatest effect in the United States, our analysis suggests a way to focus interventions so that behavior change reduces U.S. emissions as efficiently as possible. It is important to recognize that the varied interests and capacities of different U.S. populations may make certain behaviors less or more for a given group. We encourage policymakers to view these behaviors and the illustrative behavioral insights we have provided as starting points from which to conduct analyses specific to their own contexts. Such analysis would typically include a combination of qualitative and quantitative research to identify which of the behaviors may be most suitable for that population and what behaviorally informed policies might most effectively motivate adoption. This design process should involve dialogue among multiple stakeholders and include active participation by community members as well as behavioral and policy experts. Behaviorally informed policies targeting high-impact behaviors could provide a much-needed boost to the adoption of emissions-reducing activities by individuals and households and could be key to achieving critical near-term emission reductions that will mitigate global climate change.

end notes

A. Although certified carbon offsets are verified by third parties as having a stated additional reduction in emissions over what would have happened without the funds provided by the offsets, it is possible that not all offsets make their stated impact. Further, whether the emissions reductions we project are truly equivalent to actual greenhouse gas reductions can be debated for different interventions. If someone applying this model wishes to assume a different level of effectiveness, they can adjust our estimates by multiplying the impact by project-specific expected effectiveness.

B. We calculated avoided cost to society using estimates of the social cost of carbon from the Environmental Protection Agency[21] for the low end and from Ricke et al.[22] for the high end.

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author note

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supplemental material

- https://behavioralpolicy.org/publications/
- Method & Analysis

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review

Habits to save our habitat: Using the psychology of habits to promote sustainability

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abstract

Public awareness and concern about climate and environmental issues have grown dramatically in the United States and around the world. Yet this shift in attitudes has not been accompanied by similar increases in eco-friendly behaviors. We propose that this attitude–behavior gap is partly driven by the difficulty of changing unsustainable habits. Governments and businesses can reduce this gap through interventions that draw on insights from research into the psychology of habits and behavioral economics. First, they can reduce or add *friction*, making it easier for people to engage in eco-friendly actions and making it harder to continue environmentally damaging practices. Second, they can set up *action cues*—prompts that trigger pro-environment actions—and deliver these cues where and when they will have the biggest impact. Finally, they can provide *psychologically informed incentives and disincentives* that steer people toward environmentally beneficial actions. We also describe how even initially unpopular policies can become accepted through habitual repetition. In these ways, habit psychology represents a promising addition to the policymaker's toolbox.

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Core Findings

What is the issue?
Solving climate and environmental issues requires interventions that address the gap between people's attitudes and their actual behavior. Failing to do so means that people will not adopt eco-friendly behavior despite an awareness of ecological problems. A crucial way in which interventions can address this gap is at the level of *habit formation*.

How can you act?
Selected recommendations include:
(1) Increasing friction on environmentally unsound options while reducing friction on desirable choices
(2) Adding, removing, or replacing action cues that drive specific behaviors
(3) Deploying psychologically informed financial incentives and disincentives

Who should take the lead?
Policymakers, organization leaders, and researchers on environmental issues

The 2006 film *An Inconvenient Truth* made an eloquent and impassioned call for immediate climate action, combining heart-wrenching storytelling with statistics to highlight the grave state of the environment.[1] It earned two Academy Awards and became one of the highest grossing documentaries of all time.[2] In 2007, the film's creator, Al Gore, even received the Nobel Peace Prize.[3] This recognition is likely due to the dramatic effect the movie had on viewers' attitudes. When polled in 2007, 66% of respondents indicated that the film had changed their attitudes toward global warming.[4] In another survey, filmgoers reported that it had strengthened their intentions to engage in pro-environment behaviors, such as contacting their senator or contributing to an environmental organization.[5]

Since then, concern about climate change has continued to grow globally. In a 2018 survey across 26 nations, climate change was ranked the most important global threat, above issues such as terrorism, nuclear weapons, or economic concerns.[6] About 67% of survey respondents rated climate change as a major threat—a substantial increase from the 56% of respondents who did so just five years earlier. Clearly, people in both the developed and the developing world recognize climate change as a crucial priority.

Yet changed attitudes have not been accompanied by changed behavior. A recent synthesis of 196 studies and polls found that eco-friendly attitudes and intentions were only modestly associated with eco-friendly behavior.[7] And back in 2007, when researchers followed up a month later with the same filmgoers who had expressed intentions to take action after seeing Gore's film, adherence to those plans was dismal. For example, none had contacted their senator, and only one had contributed to an environmental organization.[5] Another study showed that even when the film prompted immediate action, the effect faded quickly, completely dissipating within two months of the movie's release.[8]

Interventions that change minds often do not change behaviors. It seems that people fail to act to protect the environment not because they lack concern but rather despite their concern—often because they keep reverting to old, habitual behaviors. In this article, we suggest solutions to such inaction that are based on research into habit psychology and behavioral economics, which examine the psychological factors that cause people to stray from rational behavior. We show how policies can leverage proven behavior-change principles to break environmentally unsustainable habits and form new, eco-friendly ones in their place.

New approaches are needed because public policies too often fail to address the gap between attitude and behavior.[9] The U.S. government spends approximately $1.5 billion annually on public relations and advertising, with much of this money going toward public awareness campaigns aimed at changing attitudes.[10] In the environmental policy sphere, such information, much like Gore's film, has been found to have only minimal effects on behaviors such as household energy use.[11] And yet many governments continue to produce attitude-change campaigns rather than turning to more forceful, top-down approaches such as legislation, perhaps because of the broad public acceptance of information-based approaches that maintain individual freedom of choice.[12,13]

Why Altering Habits Is Critical to Environmental Protection

An understanding of habits is key to understanding why people do not align their behavior with pro-environmental attitudes. A habit is a tendency to act automatically that reflects a mental association between a situation and a response. People learn these associations by repeating a behavior in a given situation. With repetition, reward-sensitive brain regions come to associate the situation with actions that worked in the past. Eventually, just being in a familiar situation brings the habitual action to mind.[14] For example, when you get into a car (a familiar situation), you might put on a seat belt automatically (a habitual action). Once you have

formed a seat belt habit, you do not need to consciously decide to buckle up every time you enter a car—the action comes to mind without much thought.[15] Thus, habits reflect mental shortcuts that automate frequently performed actions so that people can repeat them without deliberation.

People's everyday activities generate a sizable proportion of anthropogenic (human-activity-related) greenhouse gas emissions. Many people consume foods rich in animal products, which typically require intensive use of land, fossil fuels, water, and chemicals to produce and distribute; travel by air and automobile; and use excessive energy at home.[16] These activities are largely habitual: People repeatedly eat familiar foods at set times,[17] travel similar routes at similar times of day using the same travel modes,[18,19] and mindlessly consume energy while at home.[20]

Interventions that counter undesirable habits and simultaneously foster the formation of new habits are key to effective change. Although people can be convinced to act in new ways for short periods of time, they tend to revert to old habits when stressed, tired, or distracted.[21,22] That is, they fall back into practiced actions rather than maintaining behaviors that are more consistent with new attitudes or social norms.[23,24] For example, in one study, households were given feedback that compared their energy consumption with their neighbors'.[25] The intervention initially reduced households' energy use for a few days, with consumption quickly rebounding to baseline as households reverted to their habitual consumption patterns. The energy use decrease was maintained only with repeated feedback. These results show how strong habits can act as barriers to otherwise successful interventions.[26]

Fortunately, policies can harness habits to power environmentally sustainable choices. Once habits are created, they persist even when people are not thinking about the environmental impact of their behavior. For instance, once people form the habit of regularly commuting by bike, they stick with cycling even when trips become complex and involve multiple stops.[27] Demonstrating the role of habits in maintaining both sustainable and unsustainable behaviors, habitual drivers and bicyclists seem to be bound to their usual travel mode and show little interest in other options.[28,29]

In our view, changing environmental behavior for the long term requires structural changes: creating circumstances that encourage the repetition of desirable actions and discourage the habitual performance of undesired ones. These changes can take the form of setting new defaults, which determine what happens unless people actively select a different option. At a Danish academic conference in 2019, for instance, some attendees received a registration form in which the default meal choice included meat. Most people prefer meat, so it was not surprising that only 10% of conference goers asked to switch to the vegetarian option. However, when other attendees were given a registration form with a vegetarian meal default, 80% of them stuck with that choice.[30]

The impact of defaults can extend beyond immediate choices. A similar study conducted in Swedish restaurants found that placing a vegetarian meal at the top of the menu increased the number of vegetarian meals chosen, an effect that largely persisted months after the original menu order was restored.[31] The order of the menu provided what behavioral economists call a *nudge*: a change that encourages a certain behavior without limiting individual choice. The restaurant's nudge may have helped form habits that persisted even after the nudge was removed. The success of such interventions has inspired structural changes such as those advocated by the organization DefaultVeg, which successfully convinced several U.K. food providers to switch to vegetarian-default menus.[32]

The resetting of menu defaults provides a simple example of how structuring situations to guide eco-friendly habits can lead to dramatic behavior changes without shifting attitudes or requiring monetary incentives. There are many more.

How to Help People Create New, Better Habits

Research points to three broad principles for designing interventions that promote repetition of environmentally desirable behaviors: modifying *friction*, adding or removing *action cues*, and leveraging *psychologically informed incentives* (see Table 1). As we show next, these principles can guide structural changes so that individuals form desirable habits and break existing undesirable ones.

Principle 1: Modify Friction

The first principle involves modulating friction—the perceived difficulty of performing a behavior. Interventions that modify friction alter situations to make desirable behaviors seem easier, undesirable behaviors seem more difficult, or both. Even minor increases or decreases in friction—ones that would not initially be expected to have much impact on behavior—can induce change. Although it is a truism that people choose the path of least resistance, friction interventions are rarely put to good use.

As the earlier seat belt example suggests, repetition reduces friction. When a behavior that is difficult is repeated so much that it becomes a habit, repetition can make the once-difficult action feel familiar, safe, and easy.[33] The power

Table 1. Core principles for designing sustainable policies, examples, & potential implementers

Principle	Tactic	Desired behavior	Example	Who should implement?
Modify friction	Reduce friction on desirable behavior	Waste recycling	Place recycling bins in accessible locations, next to conventional trash cans	Government officials at the local and national levels; school administrators; business leaders and business regulation agencies
		Public transit use	Integrate apps and ticket services for a seamless public transit experience	Government officials at the local and national levels; business leaders and business regulation agencies
	Increase friction on undesirable behavior	Reduced meat consumption	Make default menu choices vegetarian	School administrators; restaurants
		Reduced single-occupancy vehicle use	Use traffic-free zones and speed limits to make driving more effortful	Government officials, particularly at the local level
		Reduced energy consumption	Set low winter and high summer thermostat temperature defaults	Business leaders
Leverage action cues	Provide actions cues	Waste recycling	Provide large desk-side recycling bins and small trash bins	Government officials at the local and national levels; business leaders
			Provide simple visual signage on dining hall trash cans	School administrators
	Disrupt old cues	Eco-friendly behavior in new environments	Focus environmental interventions on people who moved recently	Government officials; nongovernmental organizations
Use psychologically informed incentives and disincentives	Design incentives and disincentives to be immediate, salient, and tied to a specific action	Encourage pro-environmental purchasing	Impose minor charges on single-use plastics; require cash for less-green purchases	Government officials, particularly at the national level
		Reduce traffic congestion	Provide real-time in-vehicle auditory and visual displays of congestion charges	Government officials at the local and national levels
		Reduce household energy use	Provide in-home smart energy meter displays showing real-time costs	Government officials at the local and national levels; business leaders and business regulation agencies

of habits must be taken into account when trying to use friction to change behavior.

An instructive example comes from Calgary, Canada, where residents were encouraged to *grasscycle*: that is, let grass clippings naturally decompose on the lawn instead of collecting and disposing of them after mowing.[34] Adoption rates for grasscycling were lower than expected. Even though grasscycling objectively requires less effort, the deviation from routine may have made it feel difficult.

Reduce Friction to Encourage Eco-Friendly Behavior. Even slightly reducing the friction on desired behaviors can go a long way toward encouraging new, better habits. In one study, recycling uptake in an office setting doubled after recycling bins were placed right next to trash bins instead of a short distance—only 4 meters (roughly 13 feet)—away.[35] In another study, placing a personal recycling bin next to each desk in an office decreased the amount of paper waste sent to a landfill.[36] And when recycling receptacles on a university campus were moved inside classrooms, the rate of aluminum can recycling doubled.[37]

The experiment in which a personal recycling bin was placed at each desk is noteworthy because a similar recycling bin was already sitting at the center of the office space.[36] The intervention simply removed the need to get up and walk a few steps to recycle, illustrating the strength of spatial distance as a form of friction. The office workers had maintained their elevated recycling rates when revisited two months postintervention, suggesting that they had formed recycling habits.

Interventions that reduce friction can be used to encourage travelers to use modes of transportation that reduce pollution and save energy. For example, transit systems can provide travelers with real-time service information about their wait times, mitigating the aversive uncertainty of irregular bus and train schedules.[38] Econometric studies indicate that large U.S. cities that instituted real-time service information increased bus and train ridership by 2%.[39]

"people choose the path of least resistance"

Interventions can also reduce friction by simplifying behavior, such as by decreasing the number of steps or the amount of decisionmaking required. Strategies that simplify behavior can also hasten habit formation, because simple behaviors consolidate into habits faster than more complex ones.[40,41]

By making multimode travel simple and frictionless, policymakers can build a clear runway for pro-environment transit habits. The use of smartphones for navigation, for example, is associated with greater use of multiple modes of transportation.[42] Mobility apps such as Google Maps or Apple Maps can promote sustainable transportation habits by making it easier to combine bus and train rides. Individuals using these apps might make decisions that are even better for the environment if low-emission modes such as walking and biking are set as defaults, reducing friction on those choices.

Transit apps are evolving in a friction-reducing direction, becoming MaaS (mobility-as-a-service) applications that integrate multiple transportation service providers. MaaS apps have the potential to facilitate eco-friendly transit behaviors by reducing search and time costs across a variety of transit modes.[43] The potential of multimode travel is evident in Germany, where regional transit organizations coordinate public transit—for example, by integrating bus and rail subscriptions and by building cycling facilities next to transit stations.[44]

The design of the built environment can also harness friction by making some transportation modes easier to use. An analysis of 13 U.S. metropolitan areas showed that residents are more likely to cycle when provided with bike lanes protected from motor traffic.[45] Similarly, in residential neighborhoods with well-connected sidewalks and access to shops, people walk more and drive less.[46] The practical utility of bike lanes is further underscored by their extremely low price: The city of Portland,

Oregon, estimated that the cost of just one mile of freeway can fund 240 miles of the city's extensive bike-friendly boulevards.[47] Furthermore, such structural changes exert broad effects, not limited to those who are already inclined to walk and cycle. Even residents who prefer driving end up walking more when they live in walkable neighborhoods.[48]

Increase Friction to Discourage Undesirable Actions. Just as reducing friction promotes desirable behaviors, increasing friction can decrease undesirable ones. One effective way of increasing friction is to impose time delays. Even brief delays can cause notable shifts in behavior. In one study, a 16-second delay in closing elevator doors at a university reduced elevator trips, cutting energy use by a third.[49] In comparison, signs posted to encourage people to save energy by taking the stairs had no effect. Remarkably, the energy savings continued even after the delay was removed, suggesting that people had formed long-term stair-climbing habits while the delay was in effect.

Even imperceptible structural changes that slightly increase friction can have far-reaching consequences. For example, some German households were offered a standard energy contract—that is, one using power generated from conventional sources—as their default choice but were given the option to switch to a green contract.[50] Fewer than 8% chose the green alternative. When other households were offered the green energy contract as the default choice, almost 70% adopted the green option—a near-tenfold increase.

Similarly, defaults can be applied to habitual behaviors that determine everyday energy use.[51] For instance, in a study conducted in a virtual office environment, participants tended to stick with the default light setting, so setting the default to natural light resulted in energy savings.[52]

Another study examined the effect removing trays had on food waste in a university dining hall.[53] Just as a slow elevator door added friction to the habit of taking the elevator, removing trays added friction to patrons' tendency to pile on excess food, reducing food waste by approximately 18%.

In yet another example, researchers partnered with a luxury hotel chain to reduce guests' water use. The hotels installed dual showerheads in their bathrooms, with one of the heads, the full-pressure one, turned off as a default. After this change, fewer than 20% of the guests used the full-pressure showerhead.[54]

To promote environmental sustainability, urban planners should increase friction on environmentally unsound options while reducing friction on desirable choices. *Traffic calming*, for example, involves designing streets to reduce traffic speed, using such measures as speed bumps. Although traffic-calming measures were created with safety in mind, they also reduce car use through the friction that they impose on driving. Living streets (*woonerf*) originated in the Netherlands as zones in which pedestrians and cyclists took precedence over cars. The Tempo-30 zones that are now common in European cities limit traffic speed to 30 kilometers per hour (approximately 19 miles per hour). In addition, German city centers often include one-way streets, car-free zones, and other features intentionally introduced to discourage car use.[44] Such features—having to drive slowly, via circuitous routes, while sharing the road with pedestrians and cyclists—can disrupt the habit of driving by making car use effortful and deliberate. Indeed, traffic-calming measures reduce congestion while increasing safety for drivers, cyclists, and pedestrians.[55]

Principle 2: Leverage Action Cues

Another approach to increasing eco-friendly behavior is to add, remove, or replace action cues. Examples of such interventions include providing recycling containers, which signal by their presence ways to dispose of waste; giving households immediate, concrete feedback on energy use; and fitting showers with visible clocks to reduce water waste.

Recurring cues are especially important for habit formation. As habits form, cues become associated in memory with an action, eventually causing the perception of the cue to

automatically trigger the action.[56] Similar to friction, cues can be leveraged both to encourage the formation of desirable habits and to discourage undesirable ones.

To be most effective, action cues should be specific and prompt straightforward, concrete actions. Simple, unambiguous cues may be especially suitable for reinforcing the automatic cue–response associations that characterize habits.[56] For example, signs are more effective at getting people to recycle (and to do so correctly) when they use visuals rather than words[57] and when verbal instructions are limited to a few words in large, easy-to-read fonts.[58] Another simple cue for waste disposal is what other people are doing, as indicated by the amount of litter already in a setting. People are less likely to litter in a clean setting than in one that is strewn with trash.[59]

Cues are also most powerful at the point of action. If presented too early, they might fade from memory by the time they are needed; if presented too late, they might arrive after people have already initiated old, undesirable habits. In one instance, a recycling initiative in a university dining hall foundered when students were given recycling instructions as they entered the cafeteria, long before they had to dispose of their dishes.[58] Once simple, actionable signs were placed on the dining hall trash cans where students disposed of their waste, recycling levels tripled, and food contamination of recycled material decreased. Messages that highlight a building's LEED certification—verifying that the building complies with the green building requirements of the Leadership in Energy and Environmental Design program—can similarly serve as cues to increase recycling and to reduce energy use when people are in such buildings.[60]

Recycling at Work, a 2014 research project commissioned by Keep America Beautiful, provides another creative example of visual cues.[61] In most offices, a typical waste disposal station has equal-size bins for waste and recycling (and sometimes smaller sizes for the latter). In place of the same-size bins, this intervention provided office workers with large recycling bins paired with much smaller trash bins (see a similar design in Figure 1). The bin sizes provided a clear, simple visual cue that encouraged recycling right at the location where workers had habitually tossed waste in the trash bin. Indeed, this minor adjustment reduced the amount of recycled materials wrongly discarded in the trash bin by 25%.

Cues for everyday actions are naturally disrupted when people move to a new place or start a new job.[62,63] By removing the familiar cues that activated old habits—such as the stores and streets of one's prior community—life changes can force people to make new decisions. In one sustainability intervention, U.K. households were provided with an in-person consultation, a bag of eco-friendly products, and brochures.[62] Households that had moved in the prior three months were most influenced by the intervention, adopting changes such as using less water and walking or cycling for short trips. Presumably these recent movers had not yet had a chance to develop strong habits in their new residence, and their behavior was still malleable. The intervention had no effect, however, on long-term residents, whose habits were already in place. Thus, interventions might prove most effective when they target people after major

Figure 1. A recycling-promoting waste bin configuration consisting of a large recycling bin beside a smaller trash bin

Note. This multiple-disposal-bin configuration provides a salient visual cue for recycling while minimizing the cue for waste bin use. When office workers in several locations across the United States were given bins in a similar configuration, recycling increased by 30% compared with locations using equal-sized bins. Photo credit: Bellevue College Office of Sustainability. Reprinted with permission.

"The pain of paying with cash affects what people purchase"

life changes, when they are not yet hampered by cues for undesirable habits.

Principle 3: Use Psychologically Informed Incentives & Disincentives

Incentives and disincentives can be structured to achieve environmental policy goals effectively. Some policies, however, overlook evidence that such measures can be made more effective by drawing on key robust psychological principles. By designing incentives and disincentives to be immediate, salient, and tied to a specific behavior, policymakers can amplify the habit-forming potential of those interventions without increasing financial costs.

Disincentives are policies that impose actual or perceived costs on undesirable behavior. Research shows that increasing the salience of such costs increases their effectiveness. For instance, an intervention that increases the pain of paying—the aversive experience of letting go of one's money—can maximize the effect of a surcharge without increasing its monetary cost.[64] The concrete, visceral experience of parting with cash is more aversive than the innocuous-seeming swipe of a credit card.

Figure 2. Electronic Road Pricing in-vehicle display unit

Note. Units like this one must be mounted on the dashboards of vehicles in Singapore. When a toll is charged, the unit's displayed balance decreases, and the unit emits an audible sound. The dashboard device makes payment convenient yet maintains the salience of being charged via immediate visual and auditory feedback.

The pain of paying with cash affects what people purchase. Shoppers who used cash instead of a credit or debit card were less likely to make impulsive and unhealthy grocery store purchases, according to an analysis of the shopping trips of 1,000 U.S. households over a six-month period.[65] These results imply that asking consumers to pay cash for less eco-friendly purchases and accepting credit cards or electronic payments for greener purchases—an approach that also leverages friction in environments where cash is rarely used—might make the cost of the less desirable option seem higher without an actual pricing change.

Even when using cash is impractical, payment can be made more painful by increasing its salience. In 1998, Singapore introduced Electronic Road Pricing, a tolling system that bills vehicles automatically as they pass through toll gates during peak traffic hours. When vehicles are charged through this system, an in-vehicle device (see Figure 2) emits a noticeable noise and displays a clearly visible decrease in the driver's remaining balance. This system has been widely successful at reducing congestion: A mere $1 increase in tolls in 2013 increased public transit usage from 12% to 20% during morning commute hours.[66] This example suggests that pairing a disincentive with a concrete, salient cue can influence even long-entrenched habits.

Other cases demonstrate the importance of pairing incentives with salient feedback. For example, real-time feedback has been shown to induce sizable, lasting behavioral changes in household energy use that would have otherwise required much more costly incentives.

Economists have long argued for nonlinear energy-use pricing schemes—ones in which energy prices increase the more a household consumes or during times of peak energy use. However, behavior change in response to such pricing schemes has been minimal,[67] a fact that makes sense from a psychological perspective:

The disincentive (a higher energy bill) usually arrives weeks after the action that caused it, and consumers do not know which specific actions caused the inflated bill. Although more than half of U.S. households have smart energy meters that could provide such actionable information, relatively few have in-home displays.[68]

One field trial in Connecticut compared the effects of a conventional nonlinear pricing scheme with an augmented treatment in which some households were provided with a smart in-home energy display.[69] Households in the pricing-scheme-only condition did not reduce energy use, but households that received in-home displays reduced energy use by an impressive 11% to 14%. A similar trial in Japan found a 16% reduction in energy use that persisted even at the three-month follow-up after the nonlinear pricing scheme was removed.[70] Participants reported that they used appliances in more energy-efficient ways, suggesting that these households formed energy-saving habits rather than making one-time changes such as buying more efficient appliances.

Designers of disincentives can take advantage of another psychological insight: People value access to free products disproportionately more than they value access to products that are so cheap as to be virtually free.[71] This means that small charges on undesirable behaviors can exert disproportionately strong effects. Disincentivizing the use of single-use plastic bags by charging for them (usually a negligible amount) has reduced their use in countries from Botswana to Ireland.[72,73] Notably, these disincentives have succeeded where heart-wrenching visuals depicting strangled marine life have failed. This provides another example of a structural, psychologically informed intervention succeeding where attitude-based ones have failed. The trivial size of the surcharge demonstrates again that effective incentives and disincentives need not be costly for governments or individuals.

Studies of parking provide further evidence of how small charges can have large effects. Parking spaces consume large quantities of funds and land, precluding other uses. The United States, for one, devotes more space to parking than to housing.[74] Rescinding free parking is one of the strongest tools available for reducing car use. A review of workplace policies found that when employers stopped offering free parking as a benefit, the share of solo-driving commuters dropped by 41%.[75] This effect held even for employers in Southern California, where most workers commute via single-occupancy vehicles.[76]

In some cases, financial incentives or disincentives need not be permanent, just kept in place long enough to establish new habits, especially if forming the habits involves relatively easy behavior changes. For example, a 10-week free pass to travel on the Singapore subway prior to the crowded morning peak prompted a 6% increase in prepeak commutes, relieving congestion that made transit less convenient and efficient.[77] More important, the early morning commute became a habit for many riders that persisted after the intervention ended. A transit incentive tried in Copenhagen was less successful.[78] In this trial, a free travel pass was offered for a shorter duration (four weeks) and required a major switch in transit modes (car to public transit). Commuting by public transit fell back to baseline levels after the Copenhagen promotion ended. As these cases exemplify, temporary incentives may be effective if they are repeated long enough to form habits and if the behavior change is relatively easy to accomplish.

Habits Can Help Build Public Support Over Time

Although the public is highly supportive of information-based policies to encourage pro-environment behaviors, attitudes about more effective behavioral interventions, such as nudges and incentives, are mixed.[12] Effective interventions can achieve widespread acceptance, but this acceptance often materializes only after repeated exposure. These policies thus may need to be enacted before gaining public acceptance, and resistance to change may subside only after new behaviors become habits.

$1.5b
US government spending on pubic relations and advertising

80%
People who chose the vegetarian option when it was presented as the default in a 2019 study

16sec
Timed delay in closing elevator doors yielding a third reduction in energy use per a 1981 study

"familiarity breeds liking"

In Los Angeles, for example, people who do not ride the Metro report safety concerns as a chief reason for avoiding the rails.[79] To address this, the Metro partnered with law enforcement in a crime-reduction effort that successfully decreased their already low onboard crime rates by 7%.[80] However, increased safety was not accompanied by increased ridership—annual Metro rides actually decreased by about 27 million rides (a 6% reduction) between 2017 and 2019.[81] Notably, habitual Metro riders routinely rate it as safer than do nonriders.[79] Repeated Metro use apparently reduces riders' fears as they experience minimal crime and no longer perceive riding as unfamiliar and thus risky.[82]

Indeed, familiarity breeds liking.[83] Simply practicing a behavior can increase people's liking and support for it. For example, reducing meat consumption is one of the most effective actions individuals can take to reduce their impact on the climate, but change in this domain is hampered by preferences for meat products over foods like fruits and vegetables.[84] Instead of intervening to change people's attitudes toward sustainable foods, an alternative approach involves just providing regular opportunities for people to sample fruits and vegetables.[85] Such repetition-based approaches can increase both liking and everyday consumption of these more eco-friendly choices,[86] which in turn can reduce meat consumption.[87]

Similarly, many pro-environment policies quickly gain acceptance once implemented. For instance, when Champaign, Illinois, instituted curbside recycling in 1987, public support for recycling increased markedly, and this upward trend continued over the next year.[88] Acceptance of wind power turbines has followed a similar pattern: Although people may express initial doubts about turbines' effects, their opinions turn favorable over time.[89]

Even environmental policies that impose surcharges—one of the least-liked policy types[13]—can enjoy increased support once implemented. For example, after the 2015 enactment of a minimal 5-pence charge for single-use plastic bags in England, shoppers reported stronger support for the charge than before it was implemented.[90] Furthermore, this shift had spillover effects, increasing support for charging for other types of plastic waste.

Congestion pricing, a policy designed to reduce traffic by charging drivers at peak driving periods, also attracts after-the-fact public support. Despite imposing a cost on individual drivers, congestion pricing schemes typically become popular once implemented. In Durham, England, support for congestion pricing rose from 49% at the time of implementation to 70% afterward.[91] Similar congestion pricing policies in Europe saw upticks in acceptance once they were put in place.[92] Such postimplementation shifts in attitudes might be driven by positive outcomes—in the case of congestion pricing, people come to appreciate reduced congestion, easier parking, and lower pollution levels[93]—but they are also driven simply by acceptance of the status quo.[92]

Policymakers should not be deterred by mixed public support for some of the initiative types outlined in this article. Given the overall favorable public attitudes toward environmentally friendly policies, apparent resistance to specific interventions will likely dissipate over time as people come to support repeated actions, especially once their benefits become apparent. For instance, when the city of Pasadena, California, introduced parking meters, the meters generated $1.2 million in revenue that helped revive the once-dilapidated city center. The visible improvements to the area helped shore up public support for this policy, despite Pasadena being a heavily car-dependent suburb.[94] In short, rather than hoping to change behavior by first changing attitudes, public and private leaders can expect that attitude change will accompany behavior change when interventions are successful.

Conclusion

Public recognition of climate change has increased dramatically in the past two decades. However, people who believe it is important

to reduce climate change do not always act accordingly. Actions by government and industry are key to bridging this gap. We hope this article will guide policymakers in enacting structural changes that empower the public to form habits that can mitigate climate change. The policy checklist included with this article (see the sidebar Checklist of Guiding Principles for Designing Effective Sustainability Interventions) may help by describing examples of specific psychological tools that policies can use for leveraging friction, cues, and incentives.

Many structural changes have the benefit of being cost effective and straightforward to implement. For instance, merely setting thermostats to a lower default temperature in the winter can reduce energy use by imposing the slight friction of having to actively turn on the heat.[95] Action cues can be similarly easy to implement: Just painting footsteps leading toward recycling bins has been shown to reduce littering.[96] Finally, psychologically informed incentives, such as a negligible surcharge on single-use plastics, can drive lasting behavior change while earning broad acceptance.[72]

Enduring behavior change requires structural change informed by lessons drawn from the psychology of habits. Achieving measurable progress in the fight against climate change is challenging, but the size of this task is dwarfed by its importance. Climate change is ultimately caused by physical and social structures that foster unsustainable habits. The solution must similarly come from reimagining those structures and creating new ones that instead foster sustainability.

Checklist of Guiding Principles for Designing Effective Sustainability Interventions

- ❑ Reduce (or increase) friction for (un)sustainable behaviors
  - ✓ Minimize (or maximize) delay
  - ✓ Eliminate (or add) steps
  - ✓ Reduce (or increase) thinking required
- ❑ Leverage action cues
  - ✓ Make cues salient
  - ✓ Suggest simple, concrete actions
  - ✓ Place cues close to actions
- ❑ Leverage psychologically informed incentives
  - ✓ Set up immediate feedback
  - ✓ Tie feedback to specific actions
  - ✓ Maximize psychological pain of disincentives

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proposal

Making it easier to take environmental actions is not enough: Policymakers must also emphasize why action is necessary

Ben R. Newell & Jeremy Moss

abstract

A complete policy response to climate change, habitat destruction, plastic pollution, and other Anthropocene challenges requires action by governments, industries, nongovernmental organizations, and individuals. In this article, we focus on ways to persuade individuals to take action, whether that entails making decisions to reduce their own carbon emissions, lobbying for new laws, or providing leadership in their sphere of influence. We argue that interventions will be most effective if they not only make it easier for people to act (as behavioral science suggests) but also highlight moral reasons for taking action and assure people that their actions make a difference. Such steps should increase humanity's chances of surviving and thriving in the Anthropocene.

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Core Findings

What is the issue?
Behavioral interventions often target the ease with which an individual or group can adopt a desirable action. But to address the potentially catastrophic environmental and ecological challenges brought about by the Anthropocene, these interventions should take the moral dimension into account as well so that they can be even more effective.

How can you act?
Selected recommendations include:
(1) Setting the default choice to be the option that most benefits the environment
2) Emphasizing the public good of a behavioral change and combining this with initiatives that require people to publicly commit to changing their behavior

Who should take the lead?
Policymakers, organization leaders, and researchers on environmental issues

During the Southern Hemisphere summer of 2019–2020, the world looked on in horror as Australia burned. Bushfires of unprecedented ferocity wreaked havoc across large swaths of the country. Australia's largest-ever bushfire burned an estimated 20% or more of Australia's forests, leading to the loss of 34 lives, 5,900 buildings, and over 1 billion animals.[1] If ever there was a signature event to represent the negative consequences of the Anthropocene, surely this was it.

The Anthropocene is a proposed geologic time period that has already begun and is marked by human activities' significant effects on Earth's systems.[2] Climate change, wildfires, habitat destruction, plastic pollution, and widespread extinctions are examples of these effects. Accepting that human actions have such negative consequences is uncomfortable for many people, in part because such an acknowledgement leads to the obvious follow-up question of whether such contributions generate any responsibility to address these problems.

Although governments and industry have major roles to play in mitigating these effects, part of the overall response will require persuading individuals to change behaviors that affect the environment. In this article, we argue that those attempting to drive this change must anticipate and answer such questions as "Why should I bother altering my behavior? And if I do change, will my actions make a difference?" We also contend that people will be most motivated to act in pro-environmental ways when the answer to the first question is grounded in firm moral arguments and the answer to second question is a clear "yes."[3,4]

At the most basic level, moral arguments concern how people judge whether an action is right or wrong. Emphasizing the moral aspects of actions is important for two reasons. First, moral arguments can persuade people that they bear some responsibility for problems in the world and that the behavioral changes being asked of them are fair. Second, people are more likely to comply with policies requiring behavior change if they perceive that the policies align with robust moral justifications for making the change. For example, learning of the harms that might be caused to others by not isolating during a pandemic—and the importance of avoiding those harms—is likely to increase compliance.

We should stress that articulating a moral framework for action does not guarantee that individuals will always act in accordance with that framework. But being aware of the right course of action often bolsters the motivation to take that action and avoid immoral ones.

In the first section of this article, we unpack the moral case for taking individual action to protect the planet, emphasizing that the obligations of not causing harm and of doing one's fair share are crucial for motivating people to take pro-environmental actions. In the second section, we discuss ways that messaging can emphasize the efficacy of individual actions and ways to help people determine what constitutes their fair share. In the final section, we propose some ways policymakers can incorporate these ideas into more effective policies and communications about those policies.

The Moral Case for Individual Action

Moral philosophers often speak of people having two kinds of ethical duties. *Positive duties* are actions that people ought to do because they can assist others. *Negative duties* are actions that people can and ought to avoid so as to do no harm. The obligation to do one's fair share is less discussed as a moral imperative but is also a component of morality.

Positive Duties

The notion of positive duty implies having the ability to act. In the case of climate change, the duty required of wealthy individuals might be to provide others with assistance by bearing a greater share of the costs of adaptation (such as building flood barriers or growing heat-resistant crops) and transition (such as installing renewable energy infrastructure). The broader literature on global justice refers to numerous

positive duties—among them, duties based on human rights[5] and duties of beneficence (acting for the benefit of others).[6] In the article "Famine, Affluence, and Morality," Peter Singer claimed that "if it is in our power to prevent something very bad from happening, without thereby sacrificing anything morally significant, we ought, morally, to do it."[7] Singer's is a classic statement of a positive duty argument in that it attempts to motivate action not on the basis of whether one has caused the harm in question but on the basis of whether one can do something about it.

Negative Duties

Negative duty arguments assert that people should avoid violating others' interests in a significant way. In other words, it is not acceptable to cause harm to others in pursuit of individual goals, especially if the harm can be avoided; if people do cause harm to others, they are plausibly liable for the consequences. Dumping toxic waste on another person's property is not justified even when it is greatly beneficial to the person doing the dumping. According to the same argument, activities that result in emissions of carbon dioxide and other greenhouse gases cause harm to others by contributing to climate change.

Whatever the disagreements over whether people have a positive duty to aid, many will agree that people have a duty not to harm. The injunction to avoid causing harm should influence people's actions more strongly than the motivation to do good does. Therefore, in this article, we focus more on negative duty than on positive duty.

Doing One's Fair Share

Beyond the duty to help and not harm others as they are able, people concerned about morality might also be motivated by the responsibility to do their fair share. One way to motivate action is to convince people that they are being unfair if they do not join in with others to make a difference.

Consider the example of taxation. People may ask themselves, "What is wrong with my not paying my taxes? They are just a tiny portion of the overall taxes paid in one country." But they may be moved to pay taxes if they realize it is unfair to avoid making any sacrifices to pay for all the social goods that taxes provide while everyone else has to do their share. Tax avoidance is wrong because a member of a group that has agreed to take action to provide something worthwhile does not participate in that action while others do.[6]

"people have a duty not to harm"

The same kind of argument can be made in relation to climate change. When people are reminded that many other individuals have collectively agreed to take action to reduce emissions because of the harms emissions can cause, they ought to be motivated to do their part to ensure emissions are reduced. Not doing so is a kind of moral free riding. *Free riding* typically means receiving a benefit from a collective good but failing to contribute, such as when someone rides the bus but fails to buy a ticket. In the climate case, the duty to contribute does not depend on gaining a direct personal benefit but merely on being a member of some group that has agreed to sacrifice to fix a problem.

Ways to Demonstrate That Individual Actions Are Effective

Even if moral arguments convince people that they need to take action, they may be deterred by the belief that any action they take would be too insignificant to make a difference. In one sense, they would be right: The emissions produced by the average individual are only a very tiny fraction of the world's annual emissions. The average citizen of the United States emits 16.24 metric tons of carbon dioxide annually, whereas the world's annual emissions were around 26 billion tons in 2017.[8]

Or take the example of polluting the oceans with plastic waste. The Great Pacific Garbage Patch, made up of millions of tons of plastic

waste, covers an area larger than Texas.[9] Surely throwing a single bag into the sea will make only an insignificant difference to the problem?[10]

But thinking about preventing emissions or plastic pollution in this way is incomplete, because small contributions add up. Yet if people do not believe that their actions are effective, they are less likely to be persuaded to act.[11] Therefore, efforts to alter behavior should demonstrate that the requested action truly makes a difference.

1 billion animals were lost in Australia's 2019–2020 bushfire season

Global carbon dioxide emissions in 2017 totaled 26 billion metric tons

The average US citizen is responsible for 16.24 metric tons of carbon dioxide emissions annully

Demonstrate Effectiveness by Aggregating Actions Across Time

People's individual emissions become more troubling to them when they consider those emissions over the course of their lives. For instance, John Broome has estimated that the average person born in 1950 will emit around 800 tons of carbon dioxide in their lifetime.[12] Broome combined these figures with the World Health Organization's estimates of the number of deaths caused by climate change, and found that the average person in the United States is responsible for the destruction of around six months of healthy life.[12–14]

These calculations assume that the harm resulting from climate change increases linearly as emissions increase, which may not be the case. But in general, these calculations demonstrate that the harm posed by an individual's emissions—whatever their exact quantity—is real.

If people accept the argument that each individual's emissions are contributing to harm, then they should also accept that each individual can do good by engaging in a mitigating action, even if that action feels like a mere drop in the bucket at the time.

Demonstrate Effectiveness by Aggregating Actions Across Groups

Another way to highlight effectiveness is to encourage people to consider the collective effect of many individuals' actions. For example, participants in one study were more effectively persuaded to reduce their TV watching when told that 1,000 people can prevent the emission of 1,190 pounds of carbon dioxide by watching 20% less TV for a week than when told that one individual can save 1.19 pounds of carbon dioxide emissions the same way. The two statements are, of course, mathematically equivalent, but the aggregated number has greater psychological impact.[15]

It is interesting that the aggregation effect appears to work better when the aggregation occurs across people rather than time, even though one person taking the same action every day for 1,000 days achieves the same impact as 1,000 people taking action on one day. It seems that people's tendency to discount the effects of actions that occur in the future (such as 1,000 days hence)[16] reduces the persuasiveness of a message that aggregates data across days as compared with a message that aggregates data across people.

Furthermore, there is evidence that people are more likely to act if they know they are part of a large group of people taking the same action, because they perceive group effort to be more effective.[17] Specifically, when pro-environmental outcomes are described as deriving from the effort of many people rather than just one, participants are more likely to believe that their own actions and those of others would be effective at achieving a collective goal, such as addressing the threat of climate change.[15]

Help People Define Their Fair Share

Once people are convinced that they need to take an action, they may need guidance in deciding what their fair share entails. Does taking one kind of pro-environmental action give a person moral license to engage in other behaviors that are less environmentally friendly? For example, does giving up the family car make it OK to fly more, or does saving water allow the use of more electricity?[18] Several lines of research suggest that people engage in this form of moral calculus, which can reduce the overall effectiveness of efforts to encourage the public to engage in a set of behaviors having related goals.[19] For example, because a household is reducing water use, its members may feel entitled to not reduce or even increase electricity use.

David Hagmann and his colleagues are among those who make the case that such calculations can reduce the effectiveness of interventions aimed at inducing pro-environmental behavior.[20] They argue that people who respond to simple, low-cost actions might get the impression that they are doing enough and thereby neglect to take more efficacious actions or to support green policies.

To explore this idea, the researchers ran a set of experiments using hypothetical scenarios in which different groups of participants were asked to indicate their support for actions to reduce societal carbon emissions. The key comparison was between a tax on carbon use and a plan in which electricity that powered residents' homes would be generated by renewable energy sources unless residents took the trouble to opt out of the program (the "default-renewables option"). One group of participants (the "single-implementation" group) was asked whether they supported a carbon tax. A second group (the "joint-implementation" group) was told about both the tax and the default-renewables option and asked whether they supported the tax, the default, both, or neither. The team found that support for the tax was higher in the single-implementation group (70% of participants supported it) than in the joint-implementation group (55%). This was similar to the result in another experimental variation in which the researchers manipulated the order in which details about the tax and the default-renewables option were presented to participants. When the tax information came first, 60% of respondents supported it, but when the default-renewables option information was presented first, support for the tax dropped to 40%.[20] This pattern of results implies that the default-renewables option provides false hope of a solution that does not require resorting to costly interventions like taxes, which would be much more effective at reducing emissions.

Hagmann and his colleagues found that nonexpert participants rated the default-renewables option as being at least as effective as the tax in reducing carbon emissions. Perhaps even more worrisome, so did a subgroup of participants who were graduates of the Heinz College of Public Policy at Carnegie Mellon University, half of whom had professional roles shaping public policy. Whether this belief was driven by skepticism in the ability of a government to actually implement a carbon tax or a genuine misconception about the effectiveness of the two approaches is unclear. However, only when a heavy-handed intervention was used to explain the relative ineffectiveness of the default-renewables option did support for the tax rise to the level seen when it was presented as single option.[20]

"does saving water allow the use of more electricity?"

A further aspect of assessing one's fair share concerns the actions that best meet an individual's duty to contribute to collective action against climate change. A fair share could mean simply reducing one's personal emissions. Although this action is important, it is not the only way or even the most effective way an individual could contribute. If carbon taxes or other policies are the most effective ways of reducing emissions, then policymakers need to make this effectiveness clear, and individuals ought to work to put such policies in place. Indeed,

Arguments That Encourage Individual Action

Moral Arguments
• Positive duty: If individuals can take an action to help others, they should do so. • Negative duty: If individuals can take an action to cease harming others, they should do so. • Fair share: To tackle problems that require collective effort, each person should do their fair share.[a]
Arguments Indicating That Individual Actions Matter
• Aggregating data on the effects of actions across a lifetime can make it easier for people to appreciate the significance of small daily actions. • Aggregating data on the effects of the actions of a large group of individuals can make it easier for people to appreciate the significance of those actions.

[a] In invoking the need to do one's fair share, be cognizant of potential unintended consequences: When people do their fair share in one arena (such as water conservation), they tend to do less than their fair share in another arena (such as energy conservation).

"implicit social interactions play a role"

if collective measures are necessary to achieve lasting and effective emissions reductions, then acting to influence the political process is likely to be more effective than reducing one's personal emissions. Individuals might take action to push political change by voting, campaigning, lobbying, persuading others, or donating to political parties. (See the sidebar Arguments That Encourage Individual Action for a summary of effective strategies.)

Implications for Policy Design

Policymakers and practitioners can highlight in at least two ways moral concerns that motivate people to act responsibly toward the environment: They can use behavioral science–based interventions that implicitly convey the message that the actions are the ethical thing to do, and they can incorporate explicit moral components into communications. In the first case, a policy could set the default choice to be the option that most benefits the environment. Even if an individual does nothing, the most desirable environmental outcome is realized.[21] Such techniques are effective,[22] and they implicitly communicate the moral motivation because individuals infer that the default option is the right thing to do for the environment.[23,24]

Implicit moral recommendations can also be embedded in other types of policies. For example, evidence suggests that charging for plastic bags in shops reduces usage more effectively than does providing an equal discount for shoppers who bring their own bags.[25] One factor contributing to the efficacy of this policy might be social sensemaking—inferring what policies say about the intentions of the policy setter.[24] In this case, shoppers might infer that the surcharge implies that the policy setter (the government in this case) thinks most shoppers already bring their own bags and this is what shoppers ought to be doing. In this way, the policy aligns the use of reusable bags with social norms that are both descriptive (what other people do) and injunctive (what people ought to do), indirectly appealing to the moral need for everyone to do their bit for the environment. Naturally, other factors might also contribute to the success of such policies, such as the fact that people dislike additional costs, but a growing body of evidence suggests that implicit social interactions between policy-setters and the public play a role in the success of interventions.[24,26]

Turning to more explicit methods, we note that moral arguments can be directly incorporated into policy communication. For instance, Omar Asensio and his colleagues found that explicitly framing the benefits of an energy conservation scheme in terms of reducing harm to public health and the environment improved rates of energy savings,[27] perhaps because such explanations engaged individuals' sense of being part of a collective with a responsibility not to harm other members of the collective. This framing is a different and plausibly more effective alternative to explaining how an action may affect someone individually.

Approaches that explicitly emphasize the public good can be combined with initiatives that require people to publicly commit to changing their behavior (for example, to reduce plastic bag usage). Commitments can markedly increase the likelihood that people will engage in a behavior.[28] They also can potentially overcome the perception that individuals' actions are too small to make a difference by demonstrating that a large number of people are taking the action, essentially aggregating action across groups, as described earlier in this article. In turn, these records help to establish a descriptive social norm for the desired behavior. If the targeted behavior is, in fact, uncommon, practitioners could motivate people to participate by emphasizing the large effect that would result from 1,000 people adopting the desired behavior.[15]

Different sectors of the population are sometimes motivated by different moral arguments. For example, evidence suggests that conservatives are more effectively persuaded to begin recycling when a sense of authority and civic

duty are emphasized, whereas liberals respond more readily to arguments highlighting the need to care for others and reduce harm to the environment.[29] Similarly, if a sector of the population values economic growth and low energy prices, it can be effective to explain that rapid emissions reduction is not necessarily at odds with those concerns. Evidence that some renewable energy sources have already reached parity with fossil fuels could be particularly convincing for this audience.[30,31] More research is needed to explore whether individuals view pro-environmental behaviors as moral obligations and how best to match moral messaging to the attitudes of different populations.[11] (See the sidebar Ways to Improve Policies & Policy Communications for a summary of tips for effective messaging.)

Conclusion

Although moral arguments alone are not sufficient to alter behavior, they may add important motivation for individuals to change their behavior. Our analysis provides pointers to the kinds of moral arguments that future research should address. However people come to act in moral ways, the warm glow that results from doing the right thing may provide motivation for maintaining a long-term commitment to pro-environmental behavior that is more powerful than what externally imposed rewards and penalties can achieve.[3,4,32,33] It is only through such intrinsically motivated commitment that humankind will not just survive but thrive in the Anthropocene.

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Ways to Improve Policies & Policy Communications

Implement Policies That Provide Implicit and Explicit Moral Motivations

- Use policies in which the default option is the desired option. Defaults convey the implicit message that the default option is morally right.
- Use policies that impose fees for undesired actions. These convey the implicit message that the undesired behavior is wrong and that most people do the desired action.
- Use messaging that gives explicit moral explanations for policies. Explicit messaging can improve participation rates.

Tailor Moral Arguments to the Audience

- Evidence shows conservative audiences are more receptive to messages that refer to authority, civic duty, and a considerate society.
- Liberal audiences are more receptive to messages that refer to taking care of others and protecting the environment.

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proposal

How to encourage pro-environmental behaviors without crowding out public support for climate policies

Kaitlin T. Raimi

abstract

Utilities, governmental agencies, and nonprofit organizations all use interventions meant to spur the public to act in ways that reduce greenhouse gas emissions, such as by turning down the heat in the winter and limiting beef consumption. Yet critics contend that these interventions promote relatively trivial behaviors while reducing the perceived need to support regulations that would have much more of an effect but might require, say, increased taxes or effort. In other words, promoting behavioral interventions can crowd out the public's support for climate policies. But this undesirable consequence is avoidable. In this article, I propose evidence-based guidelines, which I collectively call the *SESH formula*, for implementing climate-related behavioral interventions that avoid crowding out support for effective policies. They hold that interventions should (a) push for *specific* high-impact behaviors, (b) accurately convey the behaviors' *effectiveness,* (c) promote behaviors that are *similar* to (that is, are clearly related to) desirable policies, and (d) frame the desired behaviors as steps toward a *higher* goal—in this case, climate-change mitigation. I review the evidence for each SESH guideline and identify areas for future research into behavioral interventions that will complement, rather than undermine, climate-change policies.

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Core Findings

What is the issue?
Interventions aimed at encouraging pro-environmental behaviors can sometimes have unintended consequences. Crowding out will occur when an intervention diverts people's attention away, in part or in full, from more effective, traditional climate change policies. The problem is particularly acute when the behavioral intervention is relatively low effort yet much less effective, while the traditional policy is high effort—such as requiring taxation—and effective.

How can you act?
Selected recommendations include:
1) Breaking down abstract instructions for people into specific, concrete recommendations
2) Accurately conveying the magnitude of a behavior's impact
3) Increasing the perceived similarity between target behaviors and key policies
4) Emphasizing that target behaviors are part of a larger goal

Who should take the lead?
Policymakers, organization leaders, and researchers on environmental issues

People who are concerned about climate change may be prompted to adopt climate friendly behaviors if they are given a *nudge* in that direction—a slight push that does not limit their freedom of choice. For instance, receiving household utility bills that indicate how the household's energy use compares with that of the neighbors may motivate homeowners to turn their heat down during the winter, which will reduce the burning of fossil fuels and thus the emission of carbon dioxide and other climate-warming gases. Or seeing emissions ratings on new-car labels might prod a buyer to select a more fuel-efficient vehicle. Behavior-based climate interventions such as these have been touted as cost-effective ways to reduce greenhouse gas emissions and circumvent the political gridlock that has prevented the adoption of large-scale policies.[1] Not surprisingly, then, government policymakers, utilities, and nonprofit organizations increasingly rely on these approaches. But the efforts have critics as well as supporters.

Even the most effective behavioral interventions can achieve only a fraction of what might be accomplished by a classic climate policy—such as the imposition of a tax on the carbon in fossil fuels or the regulation of greenhouse gas emissions from power plants.[2,31] Further, efforts to expand such traditional climate policies have stalled in the United States, and critics fear that adopting simpler behavioral interventions may divert attention from and even crowd out public support for climate policies.[4,5] *Crowding out* (sometimes called *negative spillover*) is a well-studied phenomenon in which motivation to take one action diverts attention from and diminishes interest in another action.[6–8]

Crowding-out effects are often small.[92] Even so, they are best avoided given the dire risks of climate change. Fortunately, crowding out is not inevitable. *Interveners*—my word for anyone conducting an intervention, whether they be researchers, policymakers, or others—[1]can use several tactics to avoid it. These tactics include being selective about which behaviors to pursue and strategically communicating their merits to a target audience. In this article, I introduce the *SESH formula*. This acronym represents the recommendation that interventions should (a) push for *specific* high-impact behaviors, (b) accurately convey the behaviors' *effectiveness*, (c) promote behaviors *similar* (that is, related) to desirable policies, and (d) frame desired behaviors as steps toward a *higher* goal. I then define these four guidelines of the formula, describe the evidence behind them, and highlight opportunities for future research.

Many researchers have demonstrated that behavioral climate interventions can crowd out policy support. This is the first article to propose evidence-based, practical guidelines for avoiding this crowding-out phenomenon. (See Table 1.)

Push for Specific High-Impact Behaviors

People who want to reduce their carbon footprint face a dilemma. They will find plenty of suggestions about actions they can take, but they will not receive much guidance on which ones have the greatest impact. Given this quandary, people tend to choose behaviors that seem either easy or important.[10] They may end up acting in a way that does little to mitigate climate change, such as turning off lights whenever they leave a room, and they may overestimate the impact of that activity.[11–15] Interveners cannot simply nudge people toward climate-friendly behaviors and assume that they will try them all or that they will choose the most effective options. Worse, people taking an action may be less likely to support policies that would have a greater effect on the climate, which means these individual behaviors could result in a net increase in emissions.

Instead, interveners must select target behaviors carefully, choosing ones that have as high an impact as possible. One factor in impact calculation is the extent to which greenhouse gas emissions might be reduced by adopting a particular behavior, such as reducing beef consumption.[16,17] (The beef-production process results in large emissions of climate-warming gases into the atmosphere.) Interventions must

Table 1. SESH cheat sheet: Avoid crowding out climate policy support with behavioral interventions

Initial	What to do	How to do it
S	Push for **specific** high-impact behaviors.	• Pick a small number of target behaviors. • Choose target behaviors that are likely to have the most impact and are most likely to be adopted. • Be specific in telling the audience what behaviors to perform.
E	Accurately convey the behaviors' **effectiveness**.	• Inform the audience that behavior interventions cannot solve climate change on their own. • Tell the audience how a target behavior's effectiveness compares with that of other approaches.
S	Promote behaviors **similar** to desirable policies.	• Choose target behaviors that self-evidently relate to key policies (for example, both help to reduce energy consumption). • Pretest to see whether the audience perceives these behaviors as being related to policies. • Spell out how these behaviors are related to policies.
H	Frame desired behaviors as steps toward a **higher** goal.	• Draw attention to an audience's successes at changing behavior, which will enhance people's confidence in their ability to take actions to protect the climate. • Communicate to the audience that target behaviors and policy support both serve the higher order goal of climate-change mitigation.

also target behaviors that people are able or willing to adopt. For example, carpooling can potentially save a lot of fuel, but getting people to do it has proved extremely difficult.[2] Fortunately, researchers have identified behaviors that have a high impact and that people are also willing to do.[2,18,19] These include driving fuel-efficient vehicles, weatherproofing homes, and installing energy-efficient heating and cooling equipment. However, similar research has not been done on interventions that might alter other behaviors that have a substantial effect on the climate, such as flying.[18]

Targeting high-impact behaviors is not sufficient by itself, though. Interveners must also be specific about what they want people to do and communicate this information clearly. For example, instead of telling people to save energy by weatherproofing their home (a vague admonition that could be interpreted in a number of ways), interveners should instruct people to install insulation having a rating of R-38 or higher in their attics. By breaking down abstract instructions into concrete recommendations, interveners can avoid confusion and increase the likelihood that their target audiences will believe themselves capable of acting on the recommendations.[20]

"people tend to choose behaviors that seem either easy or important"

By focusing efforts on a select group of meaningful behaviors and clearly communicating the exact behaviors being recommended, interveners can maximize the climate-mitigation impact of behavioral interventions. Even if behavioral nudges toward the desired actions crowd out policy considerations for some people, focusing on high-impact behaviors helps ensure that those actions will still have a beneficial effect on the climate.

Accurately Convey the Behaviors' Effectiveness

People motivated to change their behavior because of climate change often overestimate

"geoengineering alone cannot solve climate change"

the impact of small behaviors. Even policymakers sometimes believe that relatively low-impact behavioral interventions, such as changing the default option so that households automatically receive electricity from renewable sources, are as effective as high-impact policies, such as carbon taxes.[6] Such misconceptions can crowd out support for effective policies by leading people to conclude that the behaviors are so effective that they obviate the need to support large-scale policies.

Recent experiments demonstrate this phenomenon. In an online experiment, participants who were told about a behavioral intervention that linked utility customers to renewable energy sources reduced their support for a carbon tax.[6] Yet when researchers explicitly told participants that their switch to a renewable energy source would reduce carbon emissions only a small amount, this crowding-out effect was erased. Similarly, another experiment found that crowding-out effects were strongest when people thought voluntary energy savings made sufficient progress toward climate goals.[8]

These findings clearly indicate that to minimize crowding out, interveners must accurately convey the magnitude of a behavior's impact. Imagine, for instance, an infographic showing that insulating attics saves more energy than turning off lights but also that a carbon tax would be more effective than either of these voluntary approaches.

Behavioral interventions are not the only actions that can crowd out support for important climate policies. Scientists worry that when people learn about *geoengineering*—the deliberate manipulation of the climate to lessen the consequences of climate change (such as by injecting cooling particles into the atmosphere)—their support for more traditional emissions-reducing policies will be undermined. As with behavioral interventions, this geoengineering crowding-out effect can be reduced or eliminated simply by telling people that geoengineering alone cannot solve climate change.[21]

One cautionary note: Because people are more likely to support and adopt behavioral interventions if they think those interventions are effective,[22,23] informing people about the relative ineffectiveness of behavioral actions could theoretically undermine people's willingness to undertake them. However, research shows that, at least with climate change, providing information about the small impact of a behavioral nudge does not appear to weaken public support for it.[6] Thus, telling people these interventions are not as effective as traditional climate policies appears to prevent the crowding-out effect on policy support without undercutting support for behavioral approaches.

Researchers still need a better understanding of the most effective ways to convey magnitude information to audiences. It would be useful, for instance, to test whether people are more convinced by messages that provide concrete numbers about impacts or by qualitative messages that speak of relative impacts. Whichever method interveners choose, they should be careful to convey to audiences the reality that behavioral interventions are a step in the right direction toward climate goals but cannot replace large-scale policies.

Promote Behaviors That Are Similar to Desirable Policies

Crowding out is less likely to occur when two actions seem similar or are closely related along some dimension. A recent meta-analysis (a study that combines data from multiple studies) found that when people were asked to do one pro-environmental behavior, their intentions to do a second action increased greatly when the two behaviors were very similar (for example, buying energy-efficient light bulbs and buying energy-efficient appliances).[9] Other researchers have confirmed that the more similar two environmentally friendly behaviors are, the more likely it is that someone who does one will also do the other.[24–26] This pattern may hold true for behaviors and policies as well, such that behavioral interventions that seem to be aligned with

an environmental policy effort could actually increase support for that policy. For instance, people motivated to buy a fuel-efficient car may be more likely to support government fuel efficiency mandates on the automobile industry. The converse relationship also appears to hold true: Researchers have shown that promoting behavioral interventions that were dissimilar in some way to a policy crowded out support for that policy (for example, promoting plastic recycling among college students undermined their support for a campus nature-preserve fund).[7,9]

Studies like these tend to rely on researchers' concepts of similarity, but perhaps the target audience's perception of similarity is even more important.[27] This distinction is key, because experts and nonexperts perceive climate-related behaviors differently. Experts often categorize climate-related behaviors by their effectiveness or frequency of use; however, laypeople tend to categorize them in terms of their health effects or even by the room of the house in which they occur.[14,15] Further, laypeople may judge similarity on factors such as how difficult actions are to carry out or by their categories—for example, transportation, energy consumption, or purchasing.[28,29] In short, interveners should not assume that their audience will share their perceptions of similarity. Researchers can aid in efforts to match the goals of interventions with the goals of policy by gaining more insights into which behaviors laypeople see as similar to key policies: Most existing work focuses on the similarity among behaviors but not between behaviors and policies.

In any case, interveners can help their audience appreciate the similarity between recommended behaviors and policies by highlighting the shared attributes of both (such as when both reduce greenhouse gas emissions or conserve energy) and thus the ways that recommended behaviors and larger policies support the audience's underlying values.[30] In addition, highlighting the shared attributes of behaviors and policies may help to clarify the effectiveness of the behaviors, as the previous guideline recommends.

Interveners can take a number of actions to increase the perceived similarity between target behaviors and key policies. First, they can choose behaviors that they think audiences will most readily perceive as being similar to key policies. For instance, if a carbon tax is the desired policy, then interventions can target related behaviors, such as voluntary purchases of low-carbon electricity sources. Second, interveners should run pilot studies to test which behaviors their particular audience sees as being most similar to key policies. Finally, interveners can explicitly tell audiences how these behaviors and policies are connected. For example, if a carbon tax is the highest priority policy, then household energy efficiency should be described in terms of the carbon saved.

Thus, by targeting behaviors that audiences perceive as being similar to key policies and also highlighting that similarity to the audience, interveners can prevent behavioral interventions from crowding out support for those policies. Beyond reducing crowding-out effects, this approach might, in some cases, even help elevate policy support above baseline levels.

Frame Desired Behaviors as Steps Toward a Higher Goal

When people see the achievement of small goals as a way to advance toward a higher goal, they are more likely to treat these smaller actions as complements to one another rather than as substitutes.[31,32] In addition, viewing small goals in terms of higher order values can help motivate further actions and prevent backsliding.[33] Thus, when people perceive two behaviors as working together toward a higher, valued goal, they are more likely to follow through on both.

Moreover, converging evidence suggests that the framing of goals matters with regard to crowding-out effects. Interventions that use environmental appeals to change household behavior (such as those that encourage buying energy-saving appliances) can lead people to support environmental policies even more than they otherwise would, whereas appeals that emphasize monetary savings (such as via reduced energy bills) can end up crowding out

Nudge

A slight behavioral push that does not limit people's freedom of choice

Crowding out

When motivation to take one action diverts attention from and diminishes interest in another action

Gengineering

The deliberate manipulation of the climate to stave off the consequences of climate change

of policy support[34] or at least failing to boost climate policy support.[35] This pattern may occur because people can easily understand that a behavior done for environmental reasons serves the same goal as environmental policies, but they have a harder time seeing how an economic choice relates to environmental policies.

Research thus indicates that interveners can prevent crowding out of policy support by emphasizing that target behaviors are part of a larger goal. By all means, interveners should celebrate what people are doing right: Drawing attention to accomplishments can increase people's beliefs that they are capable of performing climate-mitigation behaviors, which can in turn lead to more action.[28,36] But interveners should also convey that these little victories are part of a bigger push for climate-change mitigation.

It is important to be explicit. Interveners should not assume that members of their audience, by themselves, will recognize that recommended behaviors and government policies fulfill the same greater goal. Instead, interveners need to spell out for their audience that target behaviors and policies serve the same higher order goal of mitigating climate change. For example, interveners should frame household energy savings as combating climate change in the same way a carbon tax does. Interveners, particularly those in the United States, sometimes avoid mentioning climate change for fear that members of their audience may reject climate science.[37] But the proportion of the U.S. population that is deeply worried about climate change has grown,[38] which makes it increasingly reasonable to explicitly highlight this goal.

Conclusion

Any behavioral intervention related to climate mitigation, no matter how well designed, has the potential to crowd out support for climate policies. Therefore, researchers should continue to evaluate whether interventions cause this effect, to ensure that interventions do not cause more harm than good. Meanwhile, by applying the SESH formula—targeting specific high-impact behaviors, conveying their effectiveness, and communicating that behaviors are similar to and serve the same higher climate goals as policies—interveners can minimize the risk that crowding out will occur and can thereby maximize their interventions' beneficial effects on climate change.

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review

Institutional policies for a healthy Anthropocene society

Andrew J. Hoffman, P. Devereaux Jennings, & Nicholas A. Poggioli

abstract

The *Anthropocene epoch* refers to the geological epoch, now underway, that is defined by monumental, human-caused geophysical changes in planetary ecosystems. Human society is also changing, marked by an equally profound shift in attitudes, beliefs, and practices. In this article, we apply research on social change in institutions—that is, in the enduring belief systems, ideas, and practices that guide organizations and society—to propose policies that could prepare Anthropocene society to change in ways that would ensure healthier ecosystems. These policies would alter the institutions driving corporate governance, patterns of consumption, the role of science in business and society, and the time horizons used by governments and organizations to plan, and they would help society adapt to unpredictable changes in the climate and in ecosystems. Ultimately, the policies would shift long-standing institutional structures, or *logics*, that support market capitalism and the belief in technology's ability to solve all problems to help create a more enlightened culture and more stable ecosystems on a rapidly changing planet.

Hoffman, A. J., Jennings, P. D., & Poggioli, N. A. (2021). Institutional policies for a healthy Anthropocene society. *Behavioral Science & Policy, 7*(2), 111–127.

We have become, by the power of a glorious evolutionary accident called intelligence, the stewards of life's continuity on earth. We did not ask for this role, but we cannot abjure it. We may not be suited to it, but here we are.

—Stephen Jay Gould[1]

Core Findings

What is the issue?
Humans in the Anthropocene have crossed four of nine planetary boundaries beyond which natural ecosystems and human societies will tend toward collapse. To avoid this, a shift needs to occur in the two dominant types of logic that underlie much of present-day Western society: market capitalism and technological optimism. *Institutional theory* provides guidance on how to design effective policies that target regulations, norms, and implicit beliefs and agreement, driving requisite incremental, transitional, and transformational change.

How can you act?
Selected recommendations include:
1) Developing policies for eco-sensitive corporate governance
2) Prioritizing policies that reduce resource consumption

Who should take the lead?
Researchers, organizational leaders, and public policymakers

From the end of the last ice age more than 11,000 years ago until the latter part of the 19th century, humanity was blessed with a relatively stable climate. The stability of this period, which scientists named the *Holocene epoch*, was unlike the climate upheavals the Earth has experienced in its more distant geological past, and it allowed humanity to develop crops, plant farms, and build cities, nations, and civilizations. But the earth is quickly changing, and humans are the reason. In 2005, the United Nations concluded that "over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history."[2] Since then, the pace of change has not slowed.

In fact, scientists now believe that humanity has transformed earth's climate and its ecosystems so dramatically that the Holocene epoch has ended and a new geological epoch has begun. And because human activity is driving this planetary makeover, scientists have named our current era the *Anthropocene epoch*, after the Latin word for "human."

To deal with these global environmental changes, scientists first need to understand them. The old paradigms that held true during the Holocene epoch no longer apply, so scientists have developed new ones. Among the most useful is the *planetary boundary paradigm*.[3] (See Figure 1.)

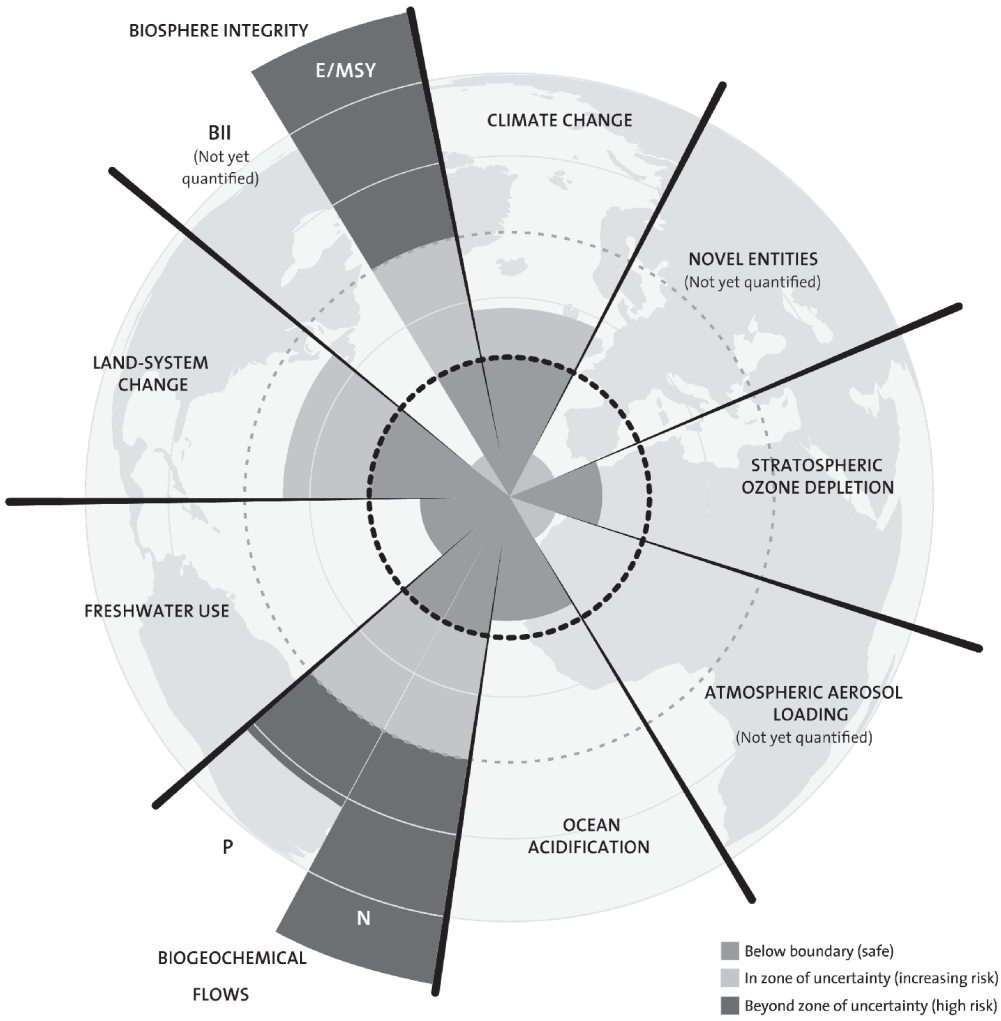
This paradigm defines nine different ways that people are altering the planet. It includes thresholds for each "beyond which the stability of planetary-scale systems cannot be relied upon," as Michael Gillings and Elizabeth Hagen-Lawson have put it.[4] In essence, planetary boundaries provide a fence that defines the space within which humanity can live safely.

Humanity has crossed four of these nine boundaries. Climate change is the best known, but boundaries have also been crossed for biosphere integrity (in the form of species extinction); nitrogen and phosphorus pollution of land, freshwater, and oceans; and changes to land use and land cover, such as deforestation.[5] One of the nine boundaries—stratospheric ozone depletion—is on the mend, but boundaries for freshwater use and ocean acidification are being watched with concern, while data are still being collected for atmospheric aerosols, novel entities, and biodiversity intactness. Meanwhile, the human population is projected to grow from 7.5 billion people in 2021 to 10 billion by 2050, and global gross domestic product is projected to grow from $80 trillion to $135 trillion over the same time period, with lifestyles becoming increasingly resource and energy intensive. Although planetary boundaries are incompletely understood, scientists believe that if humanity continues on its current trajectory, more of these boundaries will be breached, pushing natural ecosystems and human societies toward collapse.

But the planetary boundaries paradigm also offers encouraging news. Because outmoded industrial-age policies were largely what drove society to push beyond planetary boundaries, new policies could reverse these trends and pull humanity back to safety.[6] The best efforts so far at fashioning policy responses have come from discrete interventions designed to change the products and services people create and consume. These include replacing ozone-depleting chlorofluorocarbons with safer alternatives to reduce ozone depletion, putting a price on carbon, electrifying mobility, and switching to renewable energy sources to reduce greenhouse gas emissions.

These interventions have been essential, but they have not been enough to stop humanity

Figure 1. The planetary boundaries of the Anthropocene



Note. The dark dashed circle represents the planetary boundary for the global change represented by each wedge; in wedges that exceed the boundary, human influence threatens humans and other life forms. In the Biogeochemical Flows wedge, N and P refer to the global nitrogen and phosphorus cycles, respectively. In the Biosphere Integrity wedge, BII stands for Biodiversity Intactness Index, a measure of how land use pressures have diminished wild species abundance since premodern times (Scholes & Biggs, 2005), and E/MSY stands for extinctions per million species per year (Pimm et al., 2006). We encourage readers to visit the Stockholm Resilience Centre's website (https://www.stockholmresilience.org/) for updates on and discussions about this figure. Credit: J. Lokrantz/Azote based on Steffen et al. (2015).

Pimm, S., Raven, P., Peterson, A., Şekercioğlu, C. H., & Ehrlich, P. R. (2006). Human impacts on the rates of recent, present, and future bird extinctions. *Proceedings of the National Academy of Sciences, USA, 103*(29), 10941–10946. https://doi.org/10.1073/pnas.0604181103

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Steffen W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., de Vries, W., de Wit, C. A., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B., & Sörlin, S. (2015). Planetary boundaries: Guiding human development on a changing planet. *Science, 347*(6223), Article 1259855. https://doi.org/10.1126/science.1259855

from pushing out of the zone of safety. That is because they do not address the root causes of human-driven environmental destruction. Changing humanity's trajectory will require policies that drive deep and systemic social, economic, and political change—change that, in turn, shifts the way humans live in, engage with, and perceive their relationship to the natural world. And deriving those policies requires a clear understanding of what actually motivates societal transformations.

"society must transform both its culture and its practices"

Fortunately, researchers in a branch of social science called *organizational studies* have been investigating this question for decades. In this article, we first present a brief overview of Anthropocene society through the lens of one of the field's more encompassing theories, called *institutional theory*, and then offer five sets of policy suggestions to prevent or reverse humanity's dangerous overshoot of planetary boundaries.

Why Societies Get Stuck

Institutional theory explains how formal organizational structures, including policies and practices, are adopted and how they spread. In applying it to the Anthropocene epoch, we begin with the premise that all aspects of the Anthropocene, including the science that has been used to identify it, are socially constructed—that is, people understand them only through a lens of culture and language.[6] The emphasis in this discipline is on institutions. By *institutions*, we refer not to organizations, like a university or a legislative body, but instead to the enduring belief systems and practices that guide organizations and society, as in the institution of marriage.[7] Because the beliefs and practices they embody are enduring, institutions tend to be stable, and this stability impedes change—even positive and necessary change.

Institutions can be sorted into three types: (a) government or other regulations and enforcement (*regulative institutions*); (b) norms, such as occupational standards and educational curricula (*normative institutions*); and (c) implicit beliefs and agreements about what confers legitimacy and authority (*cognitive institutions*).[8] All types of institutions force stability, but they can also be levers for driving change.

The ultimate objective of that change is to alter the dominant *logic*, a term that comprises all three types of institutions. In institutional theory, a logic denotes an overarching outlook on the world that translates beliefs into action. For example, religious logic favors collecting money from wealthier members of a congregation and leads to expectations that people should give alms for the good of the poor. Other types of logic include the logic of the state, the logic of the community, and the logic of the military.[9]

Two dominant types of logic underlie much of present-day Western society: market capitalism and technological optimism.[6] By the logic of market capitalism, it takes a free market, property ownership, shareholder rights, limited regulation, and unlimited economic growth to produce socially optimal outcomes such as economic prosperity or a clean environment. By the logic of technological optimism, it takes human ingenuity and industrial innovation to solve the most pressing problems of our day. Both of these types of logic prioritize economic and technological progress. Both tend to devalue nature by viewing it as a mere source of raw material or a place to dump waste.

More than one type of logic can operate simultaneously, and one type can reinforce another. In a classic study, for example, German sociologist Max Weber, one of the founders of modern social science, argued that a Protestant religious logic—the Protestant work ethic—coexisted with a market logic and helped drive the emergence of modern capitalism.[10] Today, market capitalism and technological optimism seem locked in place, and they are reinforcing each other and making planetary boundary problems worse.

How Societies Get Unstuck

To remain safely within planetary boundaries, society must transform both its culture and its practices. Institutional theory offers clues on how to proceed. For the past 20 years, much of the research in this field has focused on overcoming the ways institutions create barriers to change.[11] The work led to an important idea: Catalyzing the necessary change will require a new type of logic.

History shows that one type of logic can compete with another or even displace it, driving societal change. Such displacement

happened in Europe before and during the Enlightenment. Prior to this period, most Europeans viewed nature as unknowable, animated by mystical forces that could best be understood through a religious logic, primarily that of the Catholic Church. But beginning early in the 16th century, the Protestant Reformation undermined this logic, challenging it with a logic that offered laypeople the opportunity to read and interpret the scriptures themselves to understand the world, rather than rely solely on the interpretation of religious authorities. The Reformation cleared the way for the European scientific revolution, which promoted a scientific logic that demystified and cataloged nature through rational scientific inquiry. This shift set the stage for the Enlightenment, which lasted from the late 17th century into the early 19th century. The Enlightenment fostered a logic of rationality, exalting humans' ability to understand and control the world around them.

Over time, however, rationality morphed into a mechanistic worldview that sanctioned the exploitation of nature through unrestrained technological and commercial expansion.[12] In this way, the logic of the market and the logic of technological optimism led society—and the planet—directly into the Anthropocene. Those types of logic dominate Western society today but are not up to the task of addressing humanity's newfound level of impact on the natural world.

Recall that a logic—whether it is religious, nature based, market dominated, or about technological progress—guides thought into action.[9] As humanity moves further into the Anthropocene epoch, a new type of logic is needed that incorporates emerging realities and accepts humanity's newfound role as steward of "life's continuity on earth," as Stephen Jay Gould put it.[1] This new type of logic would replace the belief that society dominates nature with the view that nature and society are inseparable and interdependent.

Shifting the logic of a culture can take a long time, as the historical examples described above show. Happily, there are other ways to overcome resistance and catalyze meaningful societal change in a shorter time frame. Researchers in institutional theory have identified three approaches.

The first does not challenge existing institutions or the logic that they support. Instead, innovators pioneer new solutions that fit within the dominant logic. For example, the logic of market capitalism holds that environmental protection creates a drag on economic progress. Through that lens, any effort to address climate change threatens to eliminate jobs or hamper gross domestic product growth. But policymakers who promote technological solutions such as electric cars, offshore wind farms, or rooftop solar panels do not challenge the logic of either market capitalism or technological optimism. Instead, they can safely advocate for these technologies by framing them as market solutions to climate change that exhibit human ingenuity, create jobs, and improve the economy.

The second approach to overcoming resistance is to challenge institutions that support the existing logic. One way to do that is to shift norms. For example, within the logic of market capitalism, orthodox economists have followed Nobel laureate Milton Friedman in arguing that a corporation's only responsibility in a free-enterprise system is to maximize returns for its shareholders: it has no social responsibility to the public or society. But more recently, researchers who study how businesses can contribute to environmental sustainability have argued that companies should pursue not just profit but also environmental and social goals. Pursuing this "triple bottom line" of people, planet, and profit alters one institution supporting the logic of market capitalism to achieve more responsible outcomes.

Another way to challenge an institution is to change how an industry is regulated. For example, over time, regulations have established new norms that have increased corporations' obligations to protect others from health and environmental damage. New regulations that make polluters pay for the harm their pollution causes—through mandating cleanup costs, cutting subsidies, or imposing taxes or fees on polluters—could further reduce harm

10b

Projected human population by 2050

The estimated global GDP by 2050 is $136 trillion

99%

Reduction of cost of solar photovoltaic powers from 1980 to 2012

from pollution without challenging the logic of market capitalism.

The third approach to overcoming resistance is more dramatic. It involves seizing the day after major crises and disruptions—such as terrorist attacks, environmental catastrophes, or hostile takeovers—because such events make a system amenable to rapid social change. As Winston Churchill is reputed to have said, "Never let a good crisis go to waste."

Such a flip occurred after the terrorist attacks of September 11, 2001. Within months, President Bush had signed the Patriot Act into law, creating the Transportation Security Agency, which imposed travel restrictions, and the Department of Homeland Security, which changed social norms around privacy, freedom, and government control in ways that people never would have considered possible on September 10. In similar ways, the Santa Barbara oil spill of 1969, the Bhopal gas leak disaster of 1984, the discovery of the Antarctic ozone hole in 1985, and the Chernobyl nuclear disaster in 1986 rapidly flipped the logic by which people understood pollution, technological risk, and corporate responsibility. The COVID-19 pandemic is having a similar effect at the time of this writing.

To achieve change in society, it is important to match the approach to the circumstances. When resistance to change is high, incremental change is more feasible than rapid change, and therefore it is best to fit an intervention within the existing logic. For example, electric cars are catching on in part because they do not challenge people's freedom of independent mobility, and they even improve on traits considered desirable, like styling and acceleration. Similarly, Beyond Burgers and other plant-based meats are gaining acceptance partly because they taste like real meat.

When the need for change is apparent, solutions are readily available, and resistance to change is moderate, changes in regulation can be successful. For example, plastic bag taxes or bans work best when the community sees plastic bag waste as a problem and solutions (in terms of alternatives and implementation mechanisms) are readily available.

Both of the approaches just mentioned allow for careful policy prescriptions that do not rock the boat too much. Leveraging crises, in contrast, is potentially transformative, but it relies on unpredictable events and is less controllable. For example, the sudden discovery in 1978 that an abandoned hazardous waste dump in Love Canal, a neighborhood in Niagara Falls, New York, was causing birth defects, miscarriages, and leukemia in nearby residents led to the enactment of the federal Superfund cleanup law in 1980. This new law overhauled the norms of corporate financial liability for harms caused by dumping hazardous waste.[13]

However, leveraging crises can result in unexpected outcomes and an accompanying backlash that then impedes change. The Superfund law triggered a forceful corporate pushback that lasted for years. More recently, efforts to impose mask or vaccine mandates to protect people from COVID-19 have run into a buzz saw of opposition.

New Policies for the Anthropocene Epoch

To create a more enlightened Anthropocene society and healthier ecosystems, humanity needs to change its institutions, meaning the ideas and practices that guide organizations and society. But because institutions resist meaningful change, policies to shift them need to be chosen consciously and on the basis of the best available evidence of what will be effective. To that end, we have developed five categories of research-based policies that will shift society toward environmental sustainability in the Anthropocene epoch. These policies, which are summarized in Table 1, drive change by targeting one of the three types of institutions: regulations, norms, or implicit beliefs and agreements. Each set of proposals contains a mix of policies that drive incremental, transitional, and transformational change. Ultimately, the goal of all these policies is the same: to shift the two types of logic that underpin today's global economy—market capitalism and technological optimism.

Table 1. Five sets of policies for shifting Anthropocene society

Category	Change mechanism	Policies	Policy examples
Policies for eco-sensitive corporate governance	Rethink the predominate focus on shareholders in corporate governance.	• Create new types of corporate governance that elevate considerations of the planet and people alongside profit outcomes. • Recognize natural systems as subjects with legal rights, as corporations are, rather than as property over which humans have ownership. • Base executive compensation on progress toward social and environmental objectives, not only share price. • Require transparency in corporate political activities. • Mandate economic metrics that assess broad social and environmental well-being.	• BlackRock (Fink, 2019), the World Economic Forum (Schwab, 2020), and the Business Roundtable (Gelles & Yaffe-Bellany) challenging the idea that corporate governance should focus exclusively on maximizing shareholder value • Ecuador giving nature legal rights of personhood (Gleeson-White, 2018), and a panel of international lawyers proposing the criminalization of ecocide (Bowcott, 2020) • New Zealand's economic metrics that shift the country's focus to broad social and environmental outcomes (New Zealand Treasury, 2019)
Policies that reduce consumption	Promote sustainable consumption and reimagine success in non-material-based ways.	• Create environmentally sustainable supply chains and circular-economy production models. • Promote norms of sufficiency, restraint, repair, and philanthropy as measures of success. • Develop new forms of urban infrastructure that do not focus on shopping and reduce material and energy consumption. • Make consumption and distribution more equitable.	• Circular-economy policies, such as those promoted by the Ellen MacArthur Foundation (n.d.), Dell, Adidas, Method, and Dow, as well as the Right to Repair movement (The Repair Association, n.d.) • New urbanism (Congress for the New Urbanism, 1996) • Patagonia's Common Threads (Patagonia, n.d.-a) and Worn Wear (Patagonia, n.d.-b) initiatives • The degrowth movement (Roulet & Bothello, 2020) • Increasing self-sufficiency in local economies, as described by the Schumacher Center (Witt, 2014)
Policies to elevate the role of physical and social sciences in business and society	Reestablish science's legitimacy in public and private decisionmaking.	• Fund and promote basic and applied science to achieve sustainability objectives. • Speak out publicly in support of science's legitimacy. • Train and reward scientists for public engagement. • Integrate lessons on the scientific method into public education.	• Science-based targets in corporate planning (Science Based Targets, 2020) • Letter from 75 CEOs, alongside union leaders, urging the United States to maintain its commitment to the Paris Agreement (Appelbaum et al., 2019) • Changes in K–12, college, and public science literacy programs (National Science Board, 2004)
Policies that extend corporate time horizons	Extend time horizons in corporate and public planning.	• Use longer (40- to 60-year) time horizons for planning. • Amend standard discounted cash flow methods and reduce discount rates to appropriately value long-term impacts on the natural environment. • Develop global standards and audit procedures for longer financial horizons (Task Force on Climate-Related Financial Disclosures, 2018).	• Unilever's elimination of quarterly financial reports (James, 2018) • The Long-Term Stock Exchange's efforts to extend time horizons for return on investment (Delaney, 2016) • The Production Tax Credit, applying longer time horizons to public policies that promote sustainable technology investments (Nelson & Pierpont, 2013) • The Long Now Foundation's (n.d.) Organizational Continuity Project, which seeks to create long-lasting institutions that can address multigenerational challenges
Policies that make society more adaptable and resilient	Embrace the new normal, which includes a less stable environment that is more prone to sudden shifts.	• Adopt new risk models that account for the new normal, such as those being adopted by the insurance sector (Hope & Friedman, 2018). • Develop new programs and infrastructure to address multiple challenges simultaneously, such as an economic stimulus, as well as low-carbon energy, energy efficiency, pollution abatement, and materials recycling.	• The Federal Emergency Management Agency policy change to relocate people rather than rebuild storm-damaged properties (Sack & Schwartz, 2018) • Insurance policy shifts after the California wildfires to avoid rebuilding in risky areas (Kasler, 2020) • Building standards that incorporate climate resilience (Hill & Zaidi, 2016) • Planning and zoning laws that promote climate resilience (National Oceanic and Atmospheric Administration, n.d.) • COVID-19 green recovery policies that include the removal of fossil fuel subsidies and the taxation of carbon (Barbier, 2020)

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Policies for Eco-Sensitive Corporate Governance

Many people today still believe, as Friedman did, that the corporation's sole social purpose is to maximize shareholder profits. This view is embedded in many norms and regulations that reinforce the logic of market capitalism. It has also accelerated resource extraction and pollution, which has, in turn, caused environmental crises such as habitat destruction, ozone depletion, and excess greenhouse gas pollution.

Nevertheless, the market can be a powerful and constructive force. It has provided food, drugs, shelter, and mobility, raising the standard of living and increasing the life span for millions of people over the past century. What is more, corporations have tremendous power to leverage market forces to solve environmental problems. For example, companies have helped reduce greenhouse gas emissions by developing better wind and solar technology. These advances have lowered the average installed cost of wind power from 7 cents per kWh in 2009 to below 2 cents in 2019,[14] and it has lowered the cost of solar photovoltaic power by 99% between 1980 and 2012.[15]

For corporations to solve environmental problems, they have to prioritize such outcomes, which will require their moving away from Friedman's single-minded focus on profit and instead making all three elements of the triple bottom line—people, planet, and profit—important priorities. As Klaus Schwab, founder and executive chairman of the influential World Economic Forum, has argued, corporations should generate value for their employees, customers, suppliers, local communities, and society at large and should act as "a steward of the environmental and material universe for future generations."[16]

Fortunately, norms that govern corporate behavior are shifting. In the private sector, powerful market actors like the Business Roundtable, a consortium of CEOs from major U.S. corporations,[17] and BlackRock, a multinational investment management company,[18] have begun to challenge the idea that corporations exist solely to maximize profits for shareholders.

Innovative public policies can also drive change in the private sector. Policies to help protect the environment could include giving nature legally enforceable rights, as Ecuador did in 2008 by amending its constitution,[19] or granting specific ecosystems the legal status of personhood, as has been done in New Zealand, Canada, Pennsylvania, and Florida.[20] Policies can also be more ambitious. For example, a group of international lawyers is drafting legislation that criminalizes the destruction of the world's ecosystems.[21] In each of these cases, the goal is to shift institutions that guide humanity's view of nature so that people regard it as a subject under the law rather than as property.[22]

Policies could also require corporations to be more transparent about their political activities and influence,[23] which would cut down on *corporate greenwashing*, the practice of publicly supporting sustainability while privately working to thwart the actions that promote it. ExxonMobil, for example, states on its website that "we are committed to positive action on climate change."[24] Meanwhile, it spent over $40 million in 2018 to lobby against policies that address climate change[25] and has supported

"norms that govern corporate behavior are shifting"

trade groups like the American Legislative Exchange Council and the American Petroleum Institute that have also lobbied against such policies. This position precipitated a proxy fight among ExxonMobil shareholders that resulted in two climate friendly directors gaining seats on the company's board.[26]

Other policies could address the disconnect between one common type of economic metric—stock market indices—and economic, social, and environmental well-being. For example, the Dow Jones Industrial Average grew steadily in the summer of 2020, even though the world was mired in the COVID-19 crisis,[27] the economy posted its worst drop on record,[28] and unemployment reached historic highs.[29]

This disconnect suggests that stock market indices reflect only the narrow economic interests of shareholders rather than the broader interests of employees, the community, and the natural environment. As corporate attorney James Gamble wrote in 2019, many economic metrics compel corporate executives "to act like sociopaths,"[30] each running their company as "a textbook case of antisocial personality disorder [that] is obligated to care only about itself and to define what is good as what makes it more money."[31] To compensate for such antisocial tendencies, some companies are reconfiguring executive compensation to reward progress toward social and environmental objectives, and many companies are searching for ways to profit more while reducing their environmental impact by consuming less energy and fewer raw materials.

Nations can assess their progress toward social and environmental well-being by shifting their economic metrics and priorities. These are being developed and, in some locations, implemented. In 2019, New Zealand began basing its budget decisions on effects on overall well-being rather than economic outcomes.[32] These

and all the examples above show how public and private policies can shift the logic of market capitalism.

Policies That Reduce Consumption

Today's global marketplace can fulfill a vast range of human desires and still provide clean air, water, and food.[33] Nevertheless, to remain within planetary boundaries, society must reduce its collective consumption of goods and resources. The World Business Council for Sustainable Development has already recognized that need, proposing the development of new models of what they call "sustainable consumption."[34]

New private and public policies can help. Recycling offers a good start, and companies and communities are making strong efforts to get more people to recycle, both by designing more products that may be recycled and by creating the infrastructure to collect and process more recyclables.

But recycling is just a start, and the *circular economy* picks up where recycling leaves off. This approach involves designing products so they can be reclaimed at the end of their useful life, their parts and materials then refurbished and reused to keep them in circulation as long as possible.[35] Promoted by the Ellen MacArthur Foundation[36] and implemented by companies like Dell, Adidas, Method, and Dow,[37] among others, the circular economy can reduce demand for virgin natural resources, which can help keep humanity within planetary boundaries.

Advocates of the right-to-repair movement[38] are supporting this shift by pushing for legislation that compels companies to make it easier to repair their products. A Massachusetts law requires car manufacturers to provide independent mechanics with access to the same diagnostic tools used in dealerships, for example, and Montana is considering a similar law that covers both agricultural equipment and consumer technology.[39]

The design of cities and their infrastructure can also slash the use of materials and fuels used in transportation. Although some older cities, such as Boston and New York, remain walkable, most modern American cities are designed primarily as habitats for cars, with roads and parking dominating the cities' layouts. In cities such as Houston, Indianapolis, and Los Angeles and in suburbs nationwide, people drive to work and rely on cars for most of their transportation needs. This was by design. In the 1920s, the leaders of big oil and auto companies, along with the car-loving elites, "enforced dependency on the automobile," as Greg Shill wrote recently in *The Atlantic*.[40]

Today, cities have begun implementing urban planning, zoning, and development policies that prioritize people and livability. *New urbanism*, a popular urban-planning movement, advocates for the renovation of downtown areas and the infill of unused space over suburban expansion, which can decrease suburbanization, road building, and the environmental impacts that follow.[41] Some cities that closed off streets to create pedestrian malls for social distancing in response to the COVID-19 pandemic have maintained those driving restrictions as businesses have reopened. Other cities have developed new forms of cultural infrastructure that focus on the outdoors and forms of social engagement rather than shopping, such as the High Line in New York City, a 1.45-mile-long elevated linear park, greenway, and rail trail created on a former New York Central Railroad spur.

Reducing consumption also means taking a hard look at the disproportionate use of goods and services by the affluent few. Ultimately, society will need to make consumption more equitable and not base social status on material possessions. National policies can set the tone by no longer demanding continuous economic and material growth, which is pushing humanity past planetary boundaries, and instead emphasize consuming only what is needed.

A new social movement has begun calling for *degrowth*, which means to shrink rather than grow economies to levels more in line with the carrying capacity of the planet. Efforts to promote self-sufficient local economies can

help cities, towns, and regions become more resilient to the effects of climate change. Such efforts reduce the consumption of products and materials that have been shipped long distances, which reduces greenhouse gas pollution and can promote the protection of vulnerable ecosystems.[43]

Meanwhile, some corporations have begun striving to eliminate planned obsolescence and are placing less emphasis on the satisfaction of immediate desires.[44] Patagonia is one company that is already doing this: Its Common Threads and Worn Wear initiatives encourage people to extend product lifespans by buying used clothing or repairing damaged items.[45]

Policies to Elevate the Role of Physical & Social Sciences in Business & Society

Public trust in academic institutions, scientific agencies, and other sources of scientific information is rapidly eroding.[46] The public and even government leaders challenge science as mere opinion. But science is essential in the Anthropocene as ecosystems and the climate transform, and people need to trust scientific findings. To assess and adapt to rapid change and remain within planetary boundaries, society must bolster scientific literacy as an institution.

In the private sector, companies could change how they use science. Today, it is used primarily for product and process innovation and to assess customers and potential customers for marketing purposes. But companies could also use science to pursue social and environmental goals. For example, some companies are adopting science-based carbon emissions reduction policies in concert with the Science Based Targets initiative, which helps companies reduce or eliminate their carbon footprint.[47]

Other companies pursue research that balances the quest for basic scientific understanding with considerations for applications and use.[48] For example, social science perspectives on network analysis have proved valuable for navigating the interpretation and application of big data sets in medicine (where they can be used to assess patterns of disease spread and treatment response in large populations of patients)

"science is essential in the Anthropocene"

and in responses to climate change (where they help in the assessment of emissions and shifts in weather patterns). In addition, many companies have spoken out to reinforce scientific conclusions on issues such as climate change, particularly in the face of opposition that attempts to cast doubt on the validity of the science. For example, 75 CEOs signed a letter in 2019, alongside union leaders, to urge the United States to maintain its commitment to the Paris Agreement.[49]

Another way to elevate science is to encourage scientists and scholars to become more engaged in public and political discourse, bringing their work to the communities that most need it. In so doing, they could help people grasp what scientists do, how they do it, what their findings mean, and why their research is important. For this to happen, the norms of academic science and success must shift to empowering, training, and rewarding scientists for public engagement.[50] In this way, scientists could help increase public understanding of planetary boundaries and how society is overshooting them.

Grasping the concept of planetary boundaries requires people to understand science differently. In the past, scientists relied on direct observations, or they used methods and instruments that enabled individuals to observe the previously unobservable. These approaches were intuitive and easy enough for educated people to follow. Today, understanding science often requires that people trust and accept the results of computational models whose workings are too complex to intuit.[51] For example, people rarely observe climate change directly and instead are asked to trust the projections of complex computational models of the earth's climate. Similarly, many have not directly observed the devastating effects COVID-19 can have on the human body and thus have dismissed or diminished the urgency of addressing it. The inability to observe and

experience science directly has led many people to regard it as being more politicized, uncertain, and open to challenge and interpretation than it is. Restoring trust in science will take efforts on several fronts. Because many people do not understand the scientific method or how it works, educational policies should require that children be instructed from an early age on the processes and outcomes of scientific research and that adults have opportunities to learn through science literacy initiatives.[53]

Policies That Extend Corporate Time Horizons

People conceive of time as linear and continuous, and they often think short term. For example, business leaders tend to focus on quarterly or annual time frames, and policymakers think in terms of business and election cycles that last a few years. But planetary heating, sea level rise, and carbon cycles occur over decades, centuries, and millennia and can cause abrupt changes. The greenhouse gases emitted today will elevate temperatures and acidify the oceans for centuries, not quarters. In Anthropocene society, these long time scales must be considered.

The short-term thinking that dominates business institutions and business education today percolates into the larger world of business and economics. Most large multinational corporations, for example, use valuation techniques such as discounted cash flows, which are anchored in ideas that "favor short term gains at the expense of future generations," as Arturo Cifuentes and David Spinoza have argued.[54]

But pioneers in business are beginning to think long term. Unilever stopped issuing quarterly financial reports in 2018 to encourage managers to think less about the company's short-term profits and more about its long-term health.[55] And to keep the shareholders of public companies focused on long-term rather than short-term thinking, Silicon Valley entrepreneur Eric Ries created an SEC-registered stock exchange to promote long-term investing. The Long-Term Stock Exchange (LTSE) uses several policies to promote the use of extended time horizons. In contrast to the typical focus of corporate boards on quarterly and annual results, companies listed on the LTSE count a long-term shareholder's vote more than a short-term shareholder's vote, and they link executive compensation to long-term business performance. The LTSE also allows companies to know who their long-term shareholders are, which helps them understand which sources of capital are likely to remain stable.[56] Another initiative promoting long-term thinking, the Long Now Foundation's Organizational Continuity Project, tracks organizations that have managed to stay stable over many centuries, even a millennium, to learn how to build long-lived organizations that can better address the multigenerational challenges facing humanity.[57]

Some economists are also focusing on the long term, although not without pushback from conservatives in their ranks. Nicholas Stern stirred controversy in a landmark 2007 study on the economics of climate change.[58] Stern argued that the costs of stabilizing the climate were manageable, but delay would be dangerous and far more costly. His calculations were strongly influenced by his chosen *discount rate*, a measure economists use to estimate the value of an investment today based on projections of how much money it will generate in the future. Most economists use a discount rate of 5%–10%, which assumes that nothing in the present will have much value after 10 or 20 years. When analyzing the cost of climate change mitigation and adaptation, Stern instead used a rate of 1.4%, which added value to reducing harm to the environment. This same logic could apply to a wide array of global standards and audit procedures that can be used to promote long financial horizons, such as investment planning tools, financial disclosures, and financial pressure tests.[59]

Public policies, too, should have long time horizons, and policymakers should consider a broader array of outcomes than monetary costs and benefits. Today, U.S. energy policy gets whipsawed from one election cycle to the next, making long-term planning difficult, if not impossible. For example, federal tax credits that subsidize the development of solar or wind farm installations are renewed on short annual cycles,

thereby discouraging long-term planning.[60] Energy policy should instead be developed with a 40- to 60-year time horizon, as promoted under the Paris Agreement and in the European Union climate agreements. Instead of asking what they want their company's energy mix to be in a few years, policymakers should ask what it should be in half a century and what steps need to be taken to get there.

Policies That Make Society More Adaptable & Resilient

Most people still see nature as being relatively static, as has been the case since the Enlightenment, with change happening slowly and continuously. This view squares with the logic of market capitalism and the logic of technological optimism, both of which view the world as being on a relatively continuous, upward path of progress.[61]

But science has shown clearly that the world has fundamentally changed. Sea levels are rising and drowning coastlines, and storms, droughts, and wildfires have become more frequent and severe. Earth's oceans, climate, and ecosystems now interact and behave in unpredictable ways. The environment is less stable and more prone to sudden shifts than it has been in the past.

Policies must be revised to adapt—and some already are being changed. Insurance companies, realizing that past is not prologue, are discarding outdated weather data that they once used in actuarial calculations and are instead hiring teams of in-house climatologists, computer scientists, and statisticians to redesign risk models to reflect today's climate and weather instability.[62] In the wake of major California wildfires that burdened insurers with high payouts, the companies adjusted their policies to reduce their liability in wildfire zones and made it more difficult for customers to obtain coverage that would allow them to rebuild should disaster strike.[63] Now that 100-year storms occur far more often than they used to, localities are finding their insurance coverage being reduced or deemed nonrenewable. As a result, some are adjusting their planning and zoning laws[64] and building standards[65] to prepare for more frequent storm disasters and guide rebuilding efforts. Such shifts can be seen in areas where weather-related impacts are greatest, notably near the coasts.

In the new normal, public policies must be adjusted as well to enhance resilience by planning for both climate and financial disruptions. Government agencies like the United States Federal Emergency Management Agency must shift flood response plans away from rebuilding to relocation, acknowledging that damaging weather events will recur and intensify.[66] Communities must focus on building resilience in the face of weather-related disruption and disaster.

To rebuild economically after the COVID-19 pandemic, the World Economic Forum has called for a "green recovery" that addresses multiple challenges simultaneously. Stimulus money could fund new programs and infrastructure that promote economic benefits while also furthering measures that promote climate resilience, such as low-carbon energy, energy efficiency, pollution abatement, and materials recycling.[67]

The Resistance Ahead

Creating a healthy Anthropocene society requires that these proposed policies be implemented, each fitted to a particular condition and desired outcome, such as incremental, transitional, or transformational change. However, virtually all of these policies threaten closely held cultural, ideological, and religious beliefs that many now hold or benefit from. The policies challenge the logic that market forces, human ingenuity, and technological innovation inevitably lead to positive ends.[68] They stir fears of centrally planned socialist or communist economies and concerns that no good economic alternative to a free-market economy is available. They raise anxiety that people will lose freedom and stop taking personal responsibility. And they spark resistance from those who distrust scientists and cast them as liberal elites who elevate reason over faith and the rational over the intuitive or spiritual.[69]

Such tensions already drive ideological resistance to policies that ban plastic straws and incandescent light bulbs or mandate low-flow toilets, as well as resistance to acknowledging and addressing climate change. They also have driven people to resist wearing masks or get vaccinated during the COVID-19 pandemic. In the future, similar fears could create ideological resistance to phasing out fossil fuels, reducing meat consumption, and other constructive moves that would help keep the world within planetary boundaries. Divisiveness, polarization, and misinformation are and will continue to be substantial barriers to transition and change.

For these reasons, planning for a healthy Anthropocene society must be inclusive in a new way, drawing in people who have not been consulted in the past. For example, the debate over climate change, which once might have been restricted to scientific agencies and political leaders, now includes religious leaders, meteorologists, media personalities, movie stars, sports figures, and the Pope. Such inclusivity and engagement should continue and even expand.

Conclusion

Research investigating mechanisms that alter institutions can inform and guide some incremental or transitional changes that can help keep the earth within safe planetary boundaries. And given the new normal caused by the Anthropocene (and COVID-19), policymakers will have plenty of opportunities to push for more rapid and transformational change when sudden, disruptive events compel a reexamination of the institutions and types of logic in society. Only by shifting the dominant logics of market capitalism and technological optimism will society be able to keep the planet within its livable boundaries–and thereby fulfill humans' long-abjured role as the planet's stewards.

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authors' note

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- Reviews (≤ 5,000 words) survey and synthesize the key findings and policy implications of research in a specific disciplinary area or on a specific policy topic. This could take the form of describing a general-purpose behavioral tool for policy makers or a set of behaviorally grounded insights for addressing a particular policy challenge.
- Other Published Materials. BSP will sometimes solicit or accept *Essays* (≤ 5,000 words) that present a unique perspective on behavioral policy; *Letters* (≤ 500 words) that provide a forum for responses from readers and contributors, including policy makers and public figures; and *Invitations* (≤ 1,000 words with links to online Supplemental Material), which are requests from policy makers for contributions from the behavioral science community on a particular policy issue. For example, if a particular agency is facing a specific challenge and seeks input from the behavioral science community, we would welcome posting of such solicitations.

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On submission, the manuscript author is asked to indicate the most relevant disciplinary area and policy area addressed by his/her manuscript. (In the case of some papers, a "general" policy category designation may be appropriate.) The relevant Senior Disciplinary Editor and the Senior Policy Editor provide an initial screening of the manuscripts. After initial screening, an appropriate Associate Policy Editor and Associate Disciplinary Editor serve as the stewards of each manuscript as it moves through the editorial process. The manuscript author will receive an email within approximately two weeks of submission, indicating whether the article has been sent to outside referees for further consideration. External review of the manuscript entails evaluation by at least two outside referees. In most cases, Authors will receive a response from BSP within approximately 60 days of submission. With rare exception, we will submit manuscripts to no more than two rounds of full external review. We generally do not accept re-submissions of material without an explicit invitation from an editor. Professional editors trained in the BSP style will collaborate with the author of any manuscript recommended for publication to enhance the accessibility and appeal of the material to a general audience (i.e., a broad range of behavioral scientists, public- and private-sector policy makers, and educated lay public). We anticipate no more than two rounds of feedback from the professional editors.

Standards for Novelty

BSP seeks to bring new policy recommendations and/or new evidence to the attention of public and private sector policy makers that are supported by rigorous behavioral and/or social science research. Our emphasis is on novelty of the policy application and the strength of the supporting evidence for that recommendation. We encourage submission of work based on new studies, especially field studies (for Findings and Proposals) and novel syntheses of previously published work that have a strong empirical foundation (for Reviews).

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In our checklist for authors we ask for a brief statement that explicitly details how the present work differs from previously published work (or work under review elsewhere). When in doubt, we ask that authors include with their submission copies of related papers. Note that any text, data, or figures excerpted or paraphrased from other previously published material must clearly indicate the original source with quotation and citations as appropriate.

Authorship

Authorship implies substantial participation in research and/or composition of a manuscript. All authors must agree to the order of author listing and must have read and approved submission of the final manuscript. All authors are responsible for the accuracy and integrity of the work, and the senior author is required to have examined raw data from any studies on which the paper relies that the authors have collected.

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BSP requires authors of accepted empirical papers to submit all relevant raw data (and, where relevant, algorithms or code for analyzing those data) and stimulus materials for publication on the journal web site so that other investigators or policymakers can verify and draw on the analysis contained in the work. In some cases, these data may be redacted slightly to protect subject anonymity and/or comply with legal restrictions. In cases where a proprietary data set is owned by a third party, a waiver to this requirement may be granted. Likewise, a waiver may be granted if a dataset is particularly complex, so that it would be impractical to post it in a sufficiently annotated form (e.g. as is sometimes the case for brain imaging data). Other waivers will be considered where appropriate. Inquiries can be directed to the BSP office.

Statement of Data Collection Procedures

BSP strongly encourages submission of empirical work that is based on multiple studies and/or a meta-analysis of several datasets. In order to protect against false positive results, we ask that authors of empirical work fully disclose relevant details concerning their data collection practices (if not in the main text then in the supplemental online materials). In particular, we ask that authors report how they determined their sample size, all data exclusions (if any), all manipulations, and all measures in the studies presented. (A template for these disclosures is included in our checklist for authors, though in some cases may be most appropriate for presentation online as Supplemental Material; for more information, see Simmons, Nelson, & Simonsohn, 2011, *Psychological Science, 22, 1359–1366*).

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While the basic elements of study design and analysis should be described in the main text, authors are invited to submit Supplemental Material for online publication that helps elaborate on details of research methodology and analysis of their data, as well as links to related material available online elsewhere. Supplemental material should be included to the extent that it helps readers evaluate the credibility of the contribution, elaborate on the findings presented in the paper, or provide useful guidance to policy makers wishing to act on the policy recommendations advanced in the paper. This material should be presented in as concise a manner as possible.

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To foster and connect a growing community of interdisciplinary practitioners, providing thoughtful application of rigorous behavioral science research for the public and private sectors, with a simple goal in mind: addressing social change for the benefit of all.

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