review

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Richard P. Larrick, Jack B. Soll, & Ralph L. Keeney

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Consumers are often poorly informed about the energy consumed by different technologies and products. Traditionally, consumers have been provided with limited and flawed energy metrics, such as *miles per gallon,* to quantify energy use. We propose four principles for designing better energy metrics. Better measurements would describe the amount of energy *consumed* by a device or activity, not its energy efficiency; relate that information to important *objectives*, such as reducing costs or environmental impacts; use *relative* comparisons to put energy consumption in context; and provide information on *expanded* scales. We review insights from psychology underlying the recommendations and the empirical evidence supporting their effectiveness. These interventions should be attractive to a broad political spectrum because they are low cost and designed to improve consumer decisionmaking.

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Consider a family that owns two vehicles. Both are driven the same distance over the course of a year. The family wants to trade in one vehicle for a more efficient one. Which option would save the most gas?

A. Trading in a very inefficient SUV that gets 10 miles per gallon (MPG) for a minivan that gets 20 MPG.
B. Trading in an inefficient sedan that gets 20 MPG for a hybrid that gets 50 MPG.

Most people assume option B is better because the difference in MPG is bigger (30 MPG vs. 10 MPG), as is the percentage of improvement (150% vs. 100%). But to decipher gas use and gas savings, one must convert MPG, a common efficiency metric, to actual consumption. Dividing 100 miles by the MPG values given above, our family can see that option A reduces gas consumption from 10 gallons to 5 every hundred miles, whereas option B reduces gas consumption from 5 gallons to 2 over that distance.

Making rates of energy consumption clear is more important than ever given the urgent need to reduce fossil fuel use globally. People around the world are dependent on fossil fuels, such as coal and oil. But emissions from burning fossil fuels are modifying Earth's climates in risky ways, from raising average temperatures to transforming habitats on land and in the oceans. Although individual consumer decisions have a large effect on emissions—passenger vehicles

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and residential electricity use account for nearly half of the greenhouse gas emissions in the United States—consumers remain poorly informed about how much energy they consume.[1–3] Behavioral research offers many insights on how to inform people about their energy consumption and how to motivate them to reduce it.[4] One arena in which this research could be immediately useful is on product labels, where energy requirements could be made clearer for consumers faced with an abundance of choices.

The current U.S. fuel economy label for automobiles (revised in 2013) includes a number of metrics associated with energy. The familiar MPG metric is most prominent, but one can also see gallons per 100 miles (GPHM), annual fuel cost, a rating of greenhouse gas emissions, and a five-year relative cost or savings figure compared with what one would spend with an average vehicle (see Figure 1). The original label introduced in the 1970s contained two MPG figures (see Figure 2). As the label was being redesigned for 2013, there was praise for including new information and criticism for providing too much information.[5–7] The new fuel economy label raises two general questions that apply to many settings in which consumers are informed about energy use, such as on appliance labels, smart meter feedback, and home energy ratings:

- What energy information should be given to consumers?
- How much is the right amount?

How information is presented always matters. More often than not, people pay attention to what they see and fail to think further about what they really want to know. In his best-selling book *Thinking, Fast and Slow,* Nobel prize–winning psychologist Daniel Kahneman reviewed decades of research on biases in decision-making and found a common underpinning: "What you see is all there is."[8] Too often, people lack the awareness, knowledge, and motivation to consider relevant information beyond what is presented to them. This can produce problems. In the case of judging energy use, incomplete or misleading metrics leave consumers trapped with a poor understanding of the true consequences of their decisions. But this important communication can be improved.

A CORE Approach to Better Decisionmaking

How people learn and how they make decisions is less of a mystery than ever before. Insights from psychology, specifically, are now used to help consumers make better decisions for themselves and for society.[9,10] In this context, we have created four research-based principles, which we abbreviate as CORE, that could be employed to better educate people about energy use and better prepare them to make informed decisions in that domain. They include:

- CONSUMPTION: Provide consumption rather than efficiency information.
- OBJECTIVES: Link energy-related information to objectives that people value.
- RELATIVE: Express information relative to meaningful comparisons.
- EXPAND: Provide information on expanded scales.

Figure 1. Revised fuel economy label (2013)

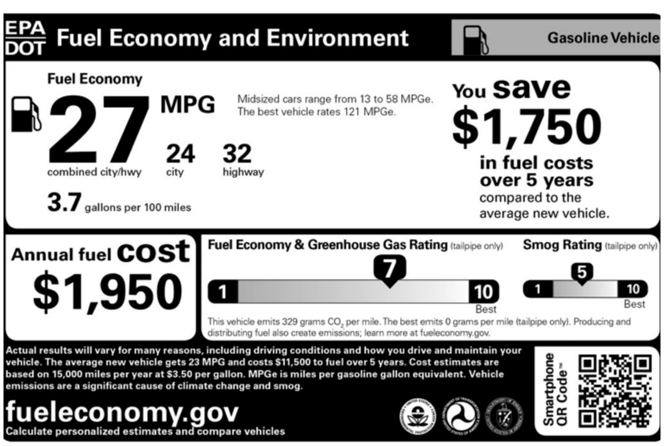
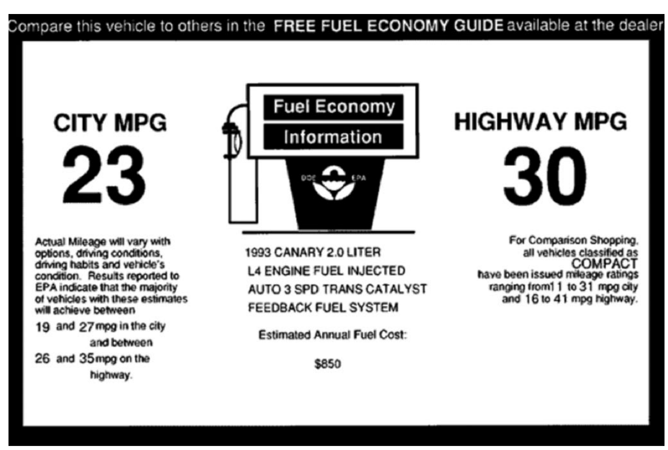


Figure 2. Original fuel economy label (from 1993)



Consumption: An Alternative to Efficiency Information

Our first principle is to express energy use in consumption terms, not efficiency terms. It is common practice in the United States to express the energy use of many products as an efficiency metric. For example, just as cars are rated on MPG, air conditioners are given a seasonal energy efficiency rating (SEER), which measures BTUs of cooling divided by watt-hours of electricity. Efficiency metrics put the energy unit, such as gallons or watts, in the denominator of a ratio. Unfortunately, efficiency metrics such as MPG and SEER produce false impressions because consumers use inappropriate math when reasoning about efficiency.

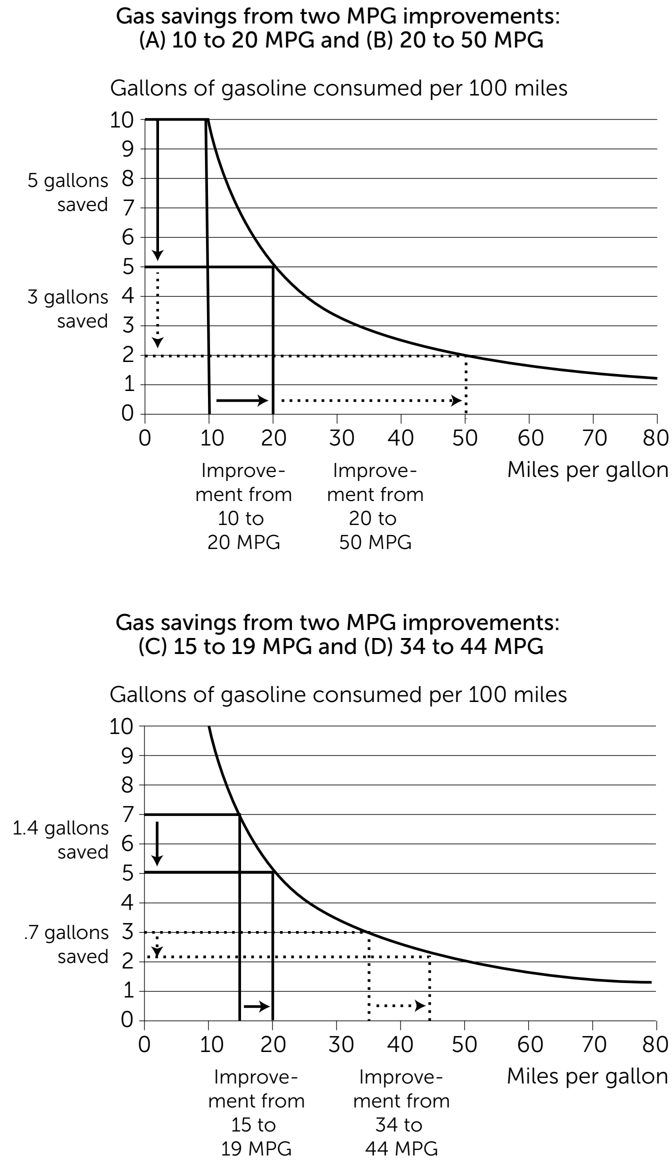
At the most basic level, efficiency metrics such as MPG do convey some crystal clear information: Higher is better. However, as our opening example showed, the metrics create a number of problems when people try to use them to make comparisons between energy-consuming devices. Consider a town that owns an equal number of two types of vehicles that differ in their fuel efficiency. All of the vehicles are driven the same distance each year. The town is deciding which set of vehicles to upgrade to a hybrid version:

C. Should it upgrade the fleet of 15-MPG vehicles to hybrids that get 19 MPG?
D. Or should it upgrade the fleet of 34-MPG vehicles to hybrids that get 44 MPG?

Larrick and Soll presented these options to an online sample of adults.[11] Seventy-five percent incorrectly picked option D over option C. In fact, option C saves nearly twice as much as gas as option D does. Figure 3 plots the highly curvilinear relationship between MPG and gas consumption. The top panel shows the gas savings from the upgrades described in the opening example. The bottom panel shows the gas savings from each of the upgrades described in C and D. Larrick and Soll called the tendency to underestimate the benefits of MPG improvements on inefficient vehicles (and to overestimate them on efficient vehicles) the "MPG illusion."[11]

The confusion caused by MPG is avoided, however, when the energy unit is put in the numerator of a ratio. When the same decision also included a GPHM number, people could see clearly that replacing the

Figure 3. Gas consumed per 100 miles of driving as a function of miles per gallon (MPG)



15-MPG (6.67-GPHM) vehicles with 19-MPG (5.26-GPHM) hybrids saved twice as much gas as replacing the 34-MPG (3.00-GPHM) vehicles with 44-MPG (2.27-GPHM) hybrids.[11]

Consumption metrics are more helpful than efficiency metrics because they not only convey what direction is better (lower) but also provide clear insights about the size of improvements. A consumption perspective (see Table 1) reveals that replacing a 10-MPG car with an 11-MPG car saves about as much gas as replacing a 34-MPG car with a 50-MPG car (1 gallon per 100 miles). A cash-for-clunkers program in

Table 1. Converting miles per gallon (MPG) to gas consumption metrics

MPG	Gallons per 100 miles	Gallons per 100,000 miles
10	10	10,000
11	9	9,000
12.5	8	8,000
14	7	7,000
16.5	6	6,000
20	5	5,000
25	4	4,000
33	3	3,000
50	2	2,000
100	1	1,000

the United States in 2009 was ridiculed for seeming to reward small changes[12]—such as trade-ins of 14-MPG vehicles that were replaced by 20-MPG vehicles—but a consumption perspective reveals that this is actually a substantial improvement of 2 gallons every 100 miles. Moving consumers from cars with MPGs in the teens into cars with MPGs in the high 20s is where most of society's energy savings will be achieved.

Although consumption measures may be unfamiliar in the consumer market, they are common in other settings. For example, U.S. government agencies transform MPG to gallons per mile to calculate fleet MPG ratings. Europe and Canada use a gas consumption measure (liters per 100 kilometers). Recently, the National Research Council argued that policymakers need to evaluate efficiency improvements in transportation using a consumption metric.[13,14] The MPG illusion motivated the addition of the GPHM metric to the revised fuel economy label (see Figure 1).

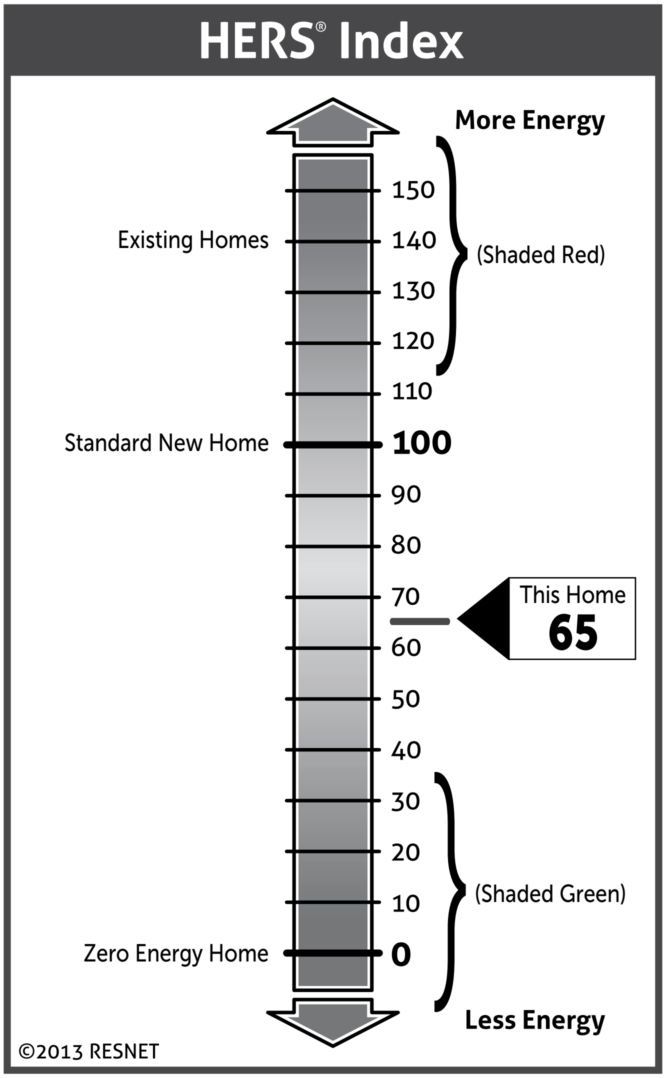
MPG is a well-known energy measure with the wrong number on top, but it is not the only metric that needs improvement. Several important energy ratings similarly place performance on top of energy use, including those for air-conditioning, home insulation, and IT server ratings.[15] These efficiency ratings also distort people's perceptions. Older homes may have air-conditioning units that are rated at 8 SEER (a measure of cooling per watt-hour of electricity) and the most efficient (and expensive) new units have SEER ratings above 20. For a given space and outdoor-temperature difference, energy consumption is once again an inverse: 1/SEER. Trading in an outdated 10-SEER air conditioner for a 13-SEER air conditioner yields large energy savings—more than the trade-in of a 14-SEER unit for a 20-SEER unit for the same space and conditions.

There is no name for the metric 1/SEER, and, unlike GPHM, the basic units in SEER (watts and BTUs) are unfamiliar to most people. Still, it is possible to be clearer. For air conditioners, the consumption metric might need to be an index, expressed as percentage of savings from an initial baseline measure (e.g., 8 SEER). As an example, consider the consumption index created by the Residential Energy Services Network called the *Home Energy Rating System* (HERS) index. A standard home is set at a unit of 100; homes that consume more energy have a higher score and are shaded in red in visual depictions of the index; homes that consume less energy have a lower score and are shaded in green (see Figure 4). A home rated at 80 uses 20% less energy than a home comparable in size and location. The HERS label, therefore, needs to be adapted to specific circumstances. Those circumstances can be explored at http://www.resnet.com. By comparison, a similar label for air conditioners actually could be more general.

Although a large home in Florida uses more air-conditioning than a small home in Minnesota does, the same consumption index can provide an accurate picture of relative energy savings possible from a more efficient air-conditioning unit. For example, Floridians know that their monthly electricity bill is high in the summer and roughly by what amount (perhaps $200 per month). A consumption index would allow them to quantify the savings available from greater efficiency (a 20% reduction in my $200 electricity bill is $40 per month). Minnesotans, on the other hand, have a smaller air-conditioning bill and would recognize that a 20% reduction yields smaller benefits. More precise cost savings could be provided at the point of purchase on the basis of additional information about effects from local electricity costs, home size, and climate, including the number of days when air-conditioning is likely needed in different regions.

In sum, the problem with MPG, SEER, and other efficiency metrics is that one cannot compare the energy savings between products without first inverting the numbers and then finding the difference. The main benefit of a consumption metric is that it does the math for people. There is no loss of information, and consumption measures help people get an accurate

Figure 4. Home Energy Rating System label



picture of the amount of energy use and savings.

Objectives: Make Cost and Environmental Impact Clear

Our second principle is to translate energy information into terms that show how energy use aligns with personal goals, such as minimizing cost or reducing the environmental impact of consumption. Theoretically, people would not require such a translation because both cost and environmental impact are often directly related to energy use. In the case of driving, for instance, as gas consumption goes up, gasoline costs and carbon dioxide (CO_2) emissions rise at exactly the same rate. Realistically, however, people may not know that these relationships are so closely aligned or stop to think about how energy usage affects the goals they care about. For example, burning 100 gallons of gas emits roughly one ton of CO_2. That outcome is invisible when people stop at "what you see is all there is."

Some consumers may care about MPG as an end in itself, but the measure is more often a proxy for other concerns, such as the cost of driving a car, its impact on the environment, or its impact on national security. Keeney argued that decisionmakers need to distinguish "means objectives" such as MPG from "fundamental objectives" such as environmental impact so that they can see how their choices match or do not match their values.[16] Providing consumers with cost and environmental translations directs their attention to these end objectives and helps them see how a means objective—energy use—affects those ends.

There is a tension, however, between offering translations and overwhelming people with information. In the redesign process for the fuel economy label, expert marketers counseled the Environmental Protection Agency (EPA) to "keep it simple."[5] However, the new EPA label for automobiles (see Figure 1) provides a number of highly related attributes, including MPG, GPHM, annual fuel costs, and a greenhouse gas rating. Is this too much information?

Ungemach and colleagues have argued that multiple translations are critical in helping consumers recognize and apply their end objectives when making choices among consumer products such as cars or air conditioners.[17] Translations have two effects. The first is what is called a *counting effect,* meaning that preferences grow stronger for choices that look favorable in more than one category.[18] For instance, multiple translations of fuel efficiency increase preference for more efficient vehicles because consumers see that the more efficient car seems to be better on three dimensions: It gets more MPG, has lower fuel costs, and is more helpful to the environment. But MPG is a not a distinct dimension from fuel costs and environmental impact, so the effect of translation is partly attributable to a double counting.

In addition, Ungemach and colleagues have found that translations have a *signpost* effect by reminding people of an objective they care about and directing them on how to reach it.[17] In one study, Ungemach and fellow researchers measured participants' attitudes toward the environment and willingness to engage in behaviors that protect the environment.[17] Participants

Table 2. Examples of choice options

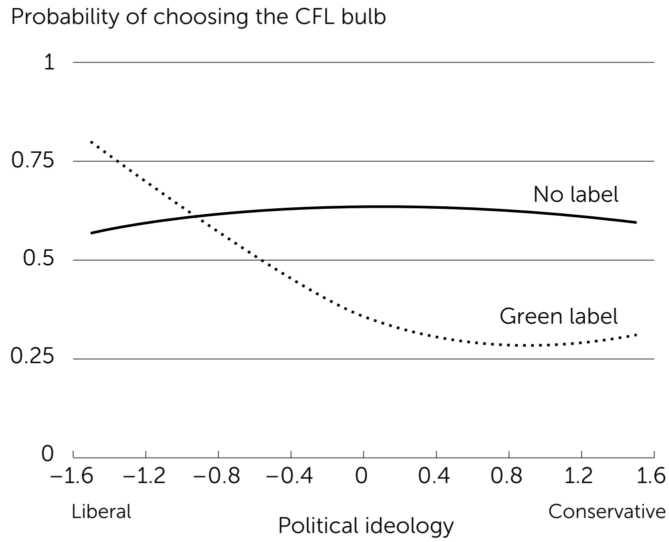
Options	Annual fuel cost	Gallons per 100 miles	Price of car
Car A	$3,964	7	$29,999
Car B	$2,775	5	$33,699

Options	Annual fuel cost	Greenhouse gas ratings (out of 10 = best)	Price of car
Car A′	$3,964	5	$29,999
Car B′	$2,775	7	$33,699

had to choose between two cars: one that was a more efficient and more expensive car and one that was a less efficient and less expensive car (see Table 2). When vehicles were described in terms of both annual fuel costs and greenhouse gas ratings, environmental attitudes strongly predicted preference for the more efficient option. However, when vehicles were described in terms of annual fuel costs and gas consumption, environmental attitudes were not correlated with preference for the more efficient option. Although both annual fuel cost and gas consumption are perfect proxies for greenhouse gas emissions, they were inadequate as signposts for environmental concerns. They neither reminded people of something they cared about nor helped them act on those concerns. The explicit translation to greenhouse gas ratings was necessary to enable people to act on their values. Additional studies demonstrated signpost effects for choices regarding air conditioners[17] by varying whether the energy metric was labeled *BTUs per watt, Seasonal Energy Efficiency Rating,* or *Environmental Rating.* Only *Environmental Rating* evoked choices in line with subjects' attitudes toward the environment.

One problem with translating energy measures into end objectives is that some consumers may be hostile to the promoted goals.[19] For example, in the United States, political conservatives and liberals alike believe that reducing personal costs and increasing national security are valid reasons to favor energy-efficient products. But conservatives find the goal of diminishing climate change to be less persuasive than do liberals.[20] As a result, emphasizing the environmental benefits of energy-efficient products may backfire with some people. Gromet and colleagues found a backlash effect

Figure 5. Probability of buying a more expensive compact fluorescent light (CFL) bulb when it has a green label ("protect the environment") or not as a function of political ideology



in a laboratory experiment in which 200 participants were given $2 to spend on either a standard incandescent light bulb or a more efficient compact fluorescent light (CFL) bulb.[20] All participants were informed about the cost savings of using a CFL. In one condition, the CFL came with a "protect the environment" label. Compared with participants in a control condition with no label, liberals showed a slightly higher rate of CFL purchase, but the purchase rate for independents and conservatives dropped significantly (see Figure 5). With no label, the economic case was equally persuasive to conservatives and liberals. The presence of the label forced conservatives to trade off a desired economic outcome with an undesired political expression.

Thus, there is a potential tension when using multiple translated attributes—they may align with a consumer's concerns but may also increase the chances of triggering a consumer's vexation. One option for navigating this tension is to target translations to specific market segments. Environmental information can be emphasized in more liberal communities and omitted in more conservative ones. Another option is to provide environmental information along a continuum rather than as an either–or choice. The environmental label described above backed consumers into a corner. People were forced to choose between a product that seemed to endorse environmentalism and one that did not. In contrast, the greenhouse gas rating on the new EPA label is continuous (for example, 6 vs. 8 on a 10-point scale) and is less likely to appear as an endorsement of a political view.

Relative: Provide Information with Meaningful Comparisons

Our third principle is to express energy-related information in a way that allows consumers to compare their own energy use with meaningful benchmarks, such as other consumers or other products. This principle is illustrated nicely in a series of large-scale behavioral interventions conducted by the company OPower across many areas of the United States. The company applied social psychological research on descriptive norms to reduce energy consumption.[21] In field studies, OPower presented residential electricity consumers with feedback on how their energy use compared with the energy use of similar neighbors (thereby largely holding constant housing age, size, and local weather conditions). Consumers who see that they are using more energy than those in comparable homes are motivated to reduce their energy use. To offset complacency in homes performing better than average, OPower couples neighbor feedback with a positive message, such as a smiley face, to encourage sustained performance. Feedback about neighbors alone—in the absence of any changes in price or incentives—reduces energy consumption by about 2%, which is roughly the reduction one would expect if prices were increased through a 20% tax increase.[22] Other studies have shown that feedback about neighbors can produce small but enduring savings for natural gas[23]and water consumption.[24,25] Moreover, there is no evidence that consumers ignore or tire of feedback over time.[26] Although many OPower interventions combine neighbor feedback with helpful advice on how to reduce energy use, research suggests that norm information alone is effective in motivating change.[27]

The benefits of comparative information are often attributed to people's intrinsic competitiveness. Homeowners want to "keep up with the Joneses" in everything, including their energy conservation. Competition plays an important part, but we believe that the neighbor feedback effect demonstrates a more basic psychological point. Energy consumption (for example, kilowatts or ergs) and even energy costs (for example, $73.39) are difficult to evaluate on their own. Is $73.39 a lot of money or a little? Feedback about neighbors' energy consumption provides a reference point that helps people judge the magnitude of the outcomes of their actions, as when they learn that they spend $40 more per month on natural gas than their neighbors do. Providing information so that it can be seen as relatively better or worse than a salient comparison measure, such as neighborhood norms, the numbered scale for HERS (see Figure 4), or the greenhouse gas ratings on the EPA label (see Figure 1), helps consumers better understand an otherwise abstract energy measure.[28,29]

Reference points also have a second effect, which is to increase motivation. Decades of research have shown that people strongly dislike the feelings of loss, failure, and disappointment. Further, the motivation to eliminate negative outcomes is substantially stronger than the motivation to achieve similar positive outcomes.[30,31] Because reference points allow people to judge whether outcomes are good or bad, they strongly motivate those who are coming up short to close the gap: Being worse than the neighbors or ending up "in the red" (see Figure 4) leads people to work to avoid those outcomes.

Of course, about half of the people in an OPower study would be given the positive feedback that they are better than average, which can lead to complacency. An alternative is to have people focus on stretch goals instead of the average neighbor.[32] Carrico and Riemer studied the energy use in 24 buildings on a college campus.[33] The occupants of half of the buildings were randomly assigned to meet a goal of a 15% reduction in energy use and received monthly feedback in graphic form. Occupants of the remaining buildings received the same goal but no feedback on their performance. There were no financial incentives tied to meeting the goal, and none of the occupants personally bore any of the energy costs. Nevertheless, those who received feedback on whether they met the goal achieved a 7% reduction in energy use; those who received no feedback showed no reduction in energy use.

OPower uses a similar logic when it lists the energy consumption of the 10% most efficient homes in a neighborhood, in addition to the energy consumption of the average home. This challenging reference point introduces a goal and gives residents with better than average energy consumption habits a target that they currently fall short of and can aim for.

Research on self-set goals has also found beneficial effects. In a study of 2,500 Northern Illinois homes, Harding and Hsiaw found that homeowners who set realistic goals for reducing their electricity use (goals up to 15%) reduced their consumption about 11% on average, which is substantially more than the reductions achieved by homeowners who set no goals or who set unrealistically ambitious goals and abandoned them.[34]

Of the many possible reference points that could be used, which ones best help reduce energy consumption? Focusing on typical numbers (such as neighbor averages) helps consumers know where they stand; deviating from the typical may motivate consumers to explore why they are inferior or superior to others. As we have noted, however, superiority can also lead to complacency. If continued energy reduction is desired, policymakers or business owners should identify a realistic reference point that casts current levels of consumption as falling short. Both realistic goals, say a 10% reduction, and social comparisons to the best performers, such as the 10% of neighbors who use the least energy, create motivation for those already performing better than average.

The most extreme form of relative comparison is when all energy information is converted to a few ranked categories, such as with a binary certification system (for example, Energy Star certified or not) or using a limited number of colors and letter grades (e.g., European Union energy efficiency labels).[5,29,35] If used alone, these simple rankings are likely to be effective at changing behavior,[29] but they may generate some undesirable consequences. For example, ranked categories exaggerate the perceived difference between two similar products that happen to fall on either side of a threshold (for example, B vs. C or green vs. yellow) and thereby distort consumer choice.[29,35] Other challenges arise when there are multiple product categories, such as SUVs and compact vehicles—should an efficient SUV be graded against all vehicles (and score poorly) or against other SUVs (and score highly)? We recommend that simple categories not be used alone but rather be combined with richer information on cost and energy consumption so that consumers can make a decision that best fits their personal goals and preferences.

Expand: Provide Information on Larger Scales

Our fourth principle is to express energy-related information on expanded scales, which allows the impact of a change to be seen over longer periods of time or over greater use. For example, the cost of using an appliance could be expressed as 30 cents per day, $109.50 per year, or $1,095 over 10 years. Fundamentally, these expressions are identical. However, a growing body of research shows that people pay more attention to otherwise identical information if it is expressed on expanded scales (such as cost over 10 years) rather than contracted scales (cost per day). As a result, they are more likely to choose options that look favorable on the expanded dimensions.[36–39] When people compare two window air-conditioning units that differ in their energy use, small scales such as cost per hour make the differences look trivial—savings are within pennies of each other (for example, 30 cents vs. 40 cents per hour). Large scales such as cost per year, however, reveal costs in the hundreds of dollars (e.g., $540 vs. $720 per year). The problem of trivial costs raises questions about the benefits of smart meters. If real-time energy and cost feedback are expressed in terms of hourly consumption, for example, all energy use can seem inconsequential.

A number of studies have shown that providing cost information over an extended period of time, such as the cost of energy over the expected lifetime operation of a product, increases preferences for more expensive but more efficient products.[37,38] Camilleri and Larrick tested the benefits of scale expansion directly by giving people (*n* = 424) hypothetical choices between six pairs of cars in which a more efficient car cost more than a less efficient car.[40] Participants saw vehicle gas consumption stated for one of three distances: 100 miles, which is the distance used to express consumption on the EPA car label; 15,000 miles, which is the distance used to express annual fuel costs on the EPA car label; or 100,000 miles, which is roughly equivalent to a car's lifetime driving distance (see Table 3).

The researchers presented some participants with a gas-consumption metric and others with a cost metric. Participants were most likely to choose the efficient car when they were given cost information (an end objective) and when it was scaled over 100,000 miles. In a second study, when the gas savings from the efficient car did not cover the difference in upfront price (over

Table 3. Three examples from Camilleri and Larrick (2014) of expanding gas costs over different distances (100 miles, 15,000 miles, 100,000 miles)

Options	Cost of gas per 100 miles of driving	Price of car
Car A	$20	$18,000
Car B	$16	$21,000

Options	Cost of gas per 15,000 miles of driving	Price of car
Car A′	$3,000	$18,000
Car B′	$2,400	$21,000

Options	Cost of gas per 100,000 miles of driving	Price of car
Car A″	$20,000	$18,000
Car B″	$16,000	$21,000

100,000 miles of driving), interest in the efficient car naturally dropped, but it remained highest when cost was expressed on the 100,000 miles scale.

Hardisty and colleagues presented people with varied cost information for three time scales—one year, five years, and 10 years—for light bulbs, TV sets, furnaces, and vacuum cleaners.[37] Control subjects received no cost information. Providing cost information increased people's choice of the more expensive, energy-efficient product. The tendency to choose the more efficient product increased as the time scale increased. However, results varied according to the product. This suggests the importance of testing design changes,[41] even in hypothetical studies, to uncover context-specific psychological effects.

A major benefit of expressing energy consumption and energy costs over larger time spans is that it counteracts people's tendency to be focused on the present in their decisionmaking. A large body of research in psychology finds that people heavily discount the future; for instance, they focus more on immediate out-of-pocket costs and do not consider delayed savings.[42] Expanded scales help people to consider the future more clearly by doing the math for them.[43] However, costs that are delayed long into the future may need to be expressed in terms of current dollars to take into account the time value of money.

What is the best time frame to use? Although the results suggest that larger numbers have more psychological impact, there are several reasons to strive for large but reasonable numbers. The magnitude of gas savings appears even larger if scaled to 300,000 miles of driving, but that is not a realistic number of miles that one vehicle will accumulate. Consumers might see it as manipulative. Also, at some point, numbers become so large that they become difficult to relate to (try considering thousands of pennies per year). All of these factors suggest a basic design principle, which is that scale expansion best informs choice if the expansion is set to a large but meaningful number, such as the expected lifetime of an appliance.

Combining CORE Principles

We have largely discussed the effectiveness of the four proposed CORE principles when applied separately. But how do they work in combination? Multiple principles often are being used at once in labeling. The revised EPA label (see Figure 1), for instance, includes a new metric that combines three principles. The label contains a five-year (75,000-mile) figure that displays a vehicle's gas costs or savings compared with an average vehicle. For an SUV that gets 14 MPG, this figure is quite large: It is roughly $10,000 in extra costs to own the vehicle. This new metric combines scale expansion (75,000 miles), translation to an end objective (cost), and a relative comparison (to an average vehicle) that makes good and bad outcomes more salient. On the basis of our research, there is reason to believe that combining principles in this way should better inform car buyers, but the benefits of the combination approach have not been empirically tested. Existing field research on the use of descriptive norms and of energy savings goals finds reductions between 2% and 10%.[22–27] Empirical tests are needed to assess whether different combinations of the four principles could increase energy savings further.

One challenge in redesigning the EPA label was the need to create a common metric that allows the comparison of traditional vehicles that run on gasoline and newer vehicles that run on electricity. The solution was to report a metric called *MPGe,* which stands for *MPG equivalent.* Equivalence is achieved by calculating the amount of electricity equal to the amount of energy produced by burning a gallon of gasoline and then calculating the miles an electric vehicle can drive on that amount of electricity. On the basis of the principles we have proposed, this metric is a poor one. First, it inherits all of the problems of MPG—it leads people to underestimate the benefits of improving inefficient vehicles and to overestimate the benefits of improving efficient vehicles. Second, it completely obscures both the cost and the environmental implications of the energy source, which are buried in the denominator. A better approach would be to express the cost and environmental implications of the energy source over a given distance of driving. This is not a trivial undertaking because the cost and environmental implications of electricity vary widely across the United States depending on regulation and the relative reliance on coal, natural gas, hydropower, or other renewables to produce electricity (to address this challenge, the U.S. Department of Energy provides a zip code–based cost and carbon calculator for all vehicles: http://www.afdc.energy.gov/calc/). Despite the challenges, this information would be more useful to consumers than the confusing MPGe metric.

Although we have proposed the CORE principles in the context of energy consumption information, the same principles may be useful when providing information about a wide range of consumer choices. For example, the federal Affordable Care Act requires chain restaurants to provide calorie information about their menu items by the end of 2015. Although some studies have found that calorie labeling reduces calorie consumption,[44] the results across studies have been a mix of beneficial and neutral effects.[45,46] The provision of calorie information has a larger effect, however, if a relative comparison is offered, such as when there is a list of alternatives from high to low calorie;[47] when calorie counts are compared with recommended daily calorie intake;[48] or when calorie levels are expressed using traffic light colors of green, yellow, and red.[49] There is also limited evidence that translating calories to another objective, the amount of exercise required to burn an equivalent number of calories, also reduces consumption.[50,51] Although we know of no existing studies testing it, the expansion principle might also be of use in the food domain. For example, phone apps that count calories consumed and burned in a given day could provide estimates of weight loss or weight gain if those same behaviors occurred over a month. Dieters might be motivated by seeing a small number scaled up to something relevant to an objective as important as expected weight loss. Research exploring how the principles influence choices in disparate domains, such as energy consumption and obesity-reduction projects, might be useful to both areas.

CORE can also be applied to more consumer domains if the *C* is broadened from *consumption* to include *calculations* of many kinds. MPG is a misleading measure because its relationship to gas consumption is highly nonlinear. A GPHM metric is helpful because it does the math for consumers. There are other nonlinear relationships that consumers face for which calculations would be helpful. Consumers systematically underestimate the beneficial effects of compounding on retirement savings[52] and the detrimental effects of compounding on unpaid credit card debt.[53] Explicitly providing these calculations is helpful in both cases. A familiar product, sunscreen, also has a misleading curvilinear relationship. Sunscreen is measured using a *sun-protection-factor* (SPF) score that might range in value from 15 to 100, which captures the number of minutes a consumer could stay in the sun to achieve the same level of sunburn that results from one minute of unprotected exposure. A more meaningful number, however, is the percentage of radiation blocked by the sunscreen. This is calculated by subtracting 1/SPF from 1 and reveals the similarity of all sunscreens above 30 SPF. A 30-SPF sunscreen blocks 97% of UV radiation, and a 50-SPF sunscreen blocks 98% of UV radiation. Dermatologists consider any further differentiation above 50-SPF pointless,[54] and regulators in Japan, Canada, and Europe cap SPF values at 50.[55]

When one is trying to make the most of the CORE principles described above, it is important to consider how much as well as what kind of information to provide to help people choose. Too much information can be overwhelming. Consider food nutrition labels. They contain dozens of pieces of information that are hard to evaluate and hard to directly translate to end objectives such as minimizing weight gain or protecting heart health. Thus, we believe that *simplicity* is also an important principle when providing information (and can be added as the first letter in a modified acronym, *SCORE*). Simplicity is at odds with multiple translations. To reconcile this conflict, we propose the idea of *minimal coverage:* striving to cover diverse end objectives with a minimum of information. The revised EPA label succeeds here. It is not too cluttered and conveys a minimal set of distinct information (energy, costs, and greenhouse gas impacts) to allow consumers with different values to recognize and act on objectives they care about. Of course, a focus on one primary thing—energy use—requires only a few possible translations.

Feasibility and Acceptability

Thanks to the best-selling 2008 book *Nudge: Improving Decisions About Health, Wealth, and Happiness* by Thaler and Sunstein,[10] behavioral interventions to help consumers are often termed *nudges* because they encourage a change in behavior without restricting choice. However, there has been recent debate over both the ethics and the political feasibility of implementing nudges to influence consumer behavior. We believe it is useful to evaluate nudges in terms of how they operate psychologically. Some nudges steer behavior by tapping known psychological tendencies that people have but are not aware of. Others try to guide decisionmakers by improving their decision processes. Perhaps the best known steering nudge is the use of default options to influence choice. Decisionmakers who are required to start with one choice alternative, such as being enrolled in a company retirement plan[56] or being registered as an organ donor,[57] tend to stick with the first alternative—the default—when given the option to opt out. Consequently, those who must opt out end up selecting the default option at a much higher rate than those who must actively opt in to get the same alternative. Defaults tap a number of known psychological tendencies such as a bias for the status quo and inertia, which people exhibit without being aware they are doing so.[58] Guiding nudges, on the other hand, tend to offer information that consumers care about and make it easy to use—examples include informing credit card users that paying the minimum each month will trap them in debt for 15 years and double their total interest costs compared with paying an amount that would allow them to pay off the debt in three years.[53]

Two of the CORE principles we propose are guiding nudges. Both consumption metrics and expanded scales improve information processing by delivering relevant, useful math. The two remaining principles, however, both guide and steer. Translating energy to costs and environmental impacts improves the decisionmaking process by calling people's attention to objectives they care about and providing a signpost for achieving them. The practice also taps into a basic psychological tendency, counting, that makes efficient options more attractive. The revised EPA label, for instance, may encourage counting when it displays multiple related benefits of efficient vehicles. Similarly, relative comparisons improve information processing by providing a frame of reference for evaluating otherwise murky energy information. However, comparison also taps into a powerful psychological tendency: the desire to achieve good outcomes and the even stronger desire to avoid bad ones. As we have explained, there are many possible comparisons, such as the energy used by an average neighbor or an energy reduction goal, and no comparison is obviously the right one to use.

We emphasize that although the CORE principles we advance are designed to make energy information more usable, they may not always yield stronger preferences for energy reduction. For example, consumption metrics make clear that improvements on inefficient technologies can yield large reductions in consumption (and in costs and environmental impact). They also make clear that large efficiency gains on already efficient technologies, such as trading in a 50-MPG hybrid for a 100-MPGe plug-in or a 16-SEER air-conditioning unit for a 24-SEER air-conditioning unit, will be very expensive but yield only small absolute savings in energy and cost. If some car buyers who would have bought a 16-MPG vehicle now see the benefits of choosing a 20-MPG vehicle, other buyers may no longer trade in their 30-MPG sedan for a 50-MPG hybrid.[59] An interesting empirical question is whether other motivations, such as a strong interest in the environment, will keep the already efficiency-minded segment pushing toward the most efficient technologies for intrinsic reasons. Alternatively, consumers who value environmental conservation may choose to shift their attention from one technology to another (from automobiles to household energy use, for instance) once it is apparent they have achieved a low level of energy consumption in the first technology.[60]

We recognize that better energy metrics can have only limited impact. Better metrics can improve and inform decisions and remind people of what they value, but they may do little to change people's attitudes about energy or the environment. There is a growing literature on political differences in environmental attitudes and the motivations that lead people to be open to or resist energy efficiency as a solution to climate change.[19,20,61,62] An understanding of what motivates people to be concerned with energy use complements this article's focus on how best to provide information. In addition, better energy metrics will not influence behavior as powerfully as policy levers such as raising the Corporate Average Fuel Economy standards to 54.5 MPG, for example, or raising fossil fuel prices to reflect their environmental costs. However, designing better energy metrics is politically attractive because they represent a low-cost intervention that focuses primarily on informing consumers while preserving their freedom to choose.

Even though the benefit of any given behavioral intervention may be modest,[22] pursuing and achieving benefits from multiple interventions can have a large impact as larger political and technological solutions are pursued.[4,63] Moreover, better energy metrics can make future political and technological developments more powerful. If cultural shifts produce greater concern for the environment, or political shifts lead to mechanisms that raise the cost of fossil fuels to reflect their environmental impacts, a clear understanding of energy consumption and its impacts would empower consumers to respond more effectively to such policy changes.

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