Using Bounded Rationality and Nudge Theories to Motivate Household and Business Energy and Environmental Sustainability at the ZIP-Level: A Public Service Application

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Summary

Bounded rationality is a theory of decision making where individuals apply "satisficing" behavior resulting in an acceptable outcome rather than an optimal outcome. This theory, now widely accepted, was advanced by Herbert Simon in 1956 as a way to explain human decision making in the face of limited or imperfect information, complicated problems, uncertainty and human cognitive limitations. Satisficing decisions criteria are referred to as cognitive heuristics which are mental shortcuts used to make decisions under these circumstances.

Nudge theory was introduced by Richard Thaler and Cass Sunstein in their 2008 book: Nudge – Improving Decisions about Health, Wealth and Happiness. The theory suggests that poor decision outcomes can be improved by acknowledging and using biases, habits and other behavioral and social factors to modify the decision-making process.

This paper presents evidence of poor energy efficiency & sustainability decision-making in the US, discusses the application of both of these concepts to address this issue and provides a framework designed to improve that process. This new framework is used to develop a US ZIP-detailed free online public service App demonstrated with screen shots in a later section of this paper.

The free, public service App can be called as a popup window on any organization's Web site by including several lines of script. Access to the tool is also available at: https://maisyenergyapps.com/sustainability_tool.htm .

Evidence of Poor Energy Efficiency/Sustainability Outcomes

Energy analysts have long recognized and discussed the so-called "energy-efficiency gap "which is the difference between current energy use and energy use if all cost-effective energy-efficiency investments and behavior were to occur. While a variety of government and utility programs beginning in the late 1970's have reduced the gap's size, a consensus estimate of the current efficiency gap is probably around 20 percent. McKinsey & Co. estimated this gap at about 23 percent in its 2009 report, "Unlocking Energy Efficiency in the U.S. Economy."

A variety of factors are blamed for this gap; the most important and relevant for this analysis are limited, imperfect and or an overwhelming amount of information, uncertainty over actual outcomes, and analysis complexity. This description perfectly fits conditions for observing Simon's satisficing behavior.

Satisficing criteria typically focus on short-term benefits so promoting detailed financial analysis or long-term sustainability impacts is likely to have little or even a negative impact on promoting energy efficiency investments. Short-term energy cost savings and annual emissions reductions resonate with households while businesses often opt for simple payback calculations as opposed to more

sophisticated financial analysis like internal rate of return. (See Energy Budgets at Risk, Chapter 4, and Capital Budgeting: Theory and Practice, in the References section for an overview of business satisficing behavior.)

Applying Bounded Rationality to Improve the Decision Process

These observation suggests that the energy efficiency decision process should be framed to:

1. simplify input information to focus on the most relevant facts (addresses the information problem)
2. apply a credible, simplified, intuitive analysis process (reduces complexity and outcome uncertainty), and
3. present outcome options consistent with satisficing behavior

This framework reduces but doesn't eliminate outcome uncertainty. Satisficing criteria may include a rule-of-thumb like requiring savings to be greater than some threshold but invariably include cognitive heuristic criteria such as feeling certain that savings will exceed the threshold. The greater the level of uncertainty, the less likely the satisficing decision criteria will be met for any individual decision-maker. Consequently, any remaining uncertainty in the decision process creates an additional barrier to a more desirable sustainability outcome.

Other behavioral decision biases like loss aversion (i.e., potential for losses is weighted more heavily than the potential for gains), sunk cost bias (e.g., reluctance to replace existing less efficient light bulbs with more efficient bulbs even though savings over the remaining lifetime of existing bulbs would pay for the new light bulbs) and other behavioral factors also impede decisions to reduce energy use and emissions for households and businesses. (See "Household energy use: Applying behavioral economics to understand consumer decision-making and behavior," in the References section for more detail on these behavioral factors).

Using Nudge Theory to Overcome Uncertainty and Decision Biases

Nudges can be used to motivate behavior beyond what can be achieved by accommodating the satisficing decision framework outlined above. Nudges engage decision-makers by appealing to behavioral and social factors beyond those of the framework described above.

Studies of motivational behavior reveal that indirect competition, where people are encouraged to gauge performance against an objective measure or standard, provides a strong motivation to excel. Indirect competition increases what behavioral psychologists call intrinsic motivation – that is motivation resulting from the inherent satisfaction that an activity brings to the individual. An example of indirect competition and intrinsic motivation is the golfer who strives to beat a personal best score. Other examples, relevant to this application, are actions that an individual might take to reduce emissions or to reduce future energy costs below last year's costs. Reducing emissions provides a positive feeling by meeting an altruistic goal while reducing energy cost provides the satisfaction of achieving a personal goal.

An Online Energy-Sustainability Framework

An online framework that is successful in nudging behavior in the direction of improved sustainability

also requires attention to online customer experience (CX). Principles discussed above are used along with CX considerations to identify seven objectives designed to maximize indirect competition and intrinsic motivation in pursuit of improved energy-related sustainability:

1. **Promote intrinsic motivations using a sustainability score along with details on energy cost and emissions percentiles.** Using a top-line focus on a sustainability score focuses attention on improving one's overall score while information on emissions and energy cost percentile targets appeal to both altruistic and personal goal achievements.

2. **Provide relevant objective comparisons**. Research shows that motivation based on assessing performance and personal targets is greater when comparisons are perceived as more relevant. In this case, comparisons with households or businesses with similar characteristics in the same ZIP as opposed to compared to comparisons with "typical" nationwide consumers.

3. **Provide a meaningful measure of benefits associated with emissions**.
   Pounds of CO2 emissions and reductions have little meaning to most of us. Showing the reduction in equivalent miles driven or equivalent of how may trees would have to be planted for a specific energy use reduction is a much more meaningful and motivational metric. Similarly, providing an actual cost savings estimate associated with meeting a percentile target is much more likely to motivate behavior.

4. **Make it easy and fast**. Households and businesses should be able to access a Web site and enter information that is readily available (i.e., without looking up/downloading utility billing), provide inputs in a single screen, and get results within 1 minute.

5. **Encourage improvements by tapping into indirect competition and intrinsic motivation**.
   Challenge users to achieve a better sustainability score or energy cost percentile. How much cost savings and emissions reduction can be achieved? This information provides the "call-to-action" to motivate users to achieve lower emissions, costs and better sustainability scores.

6. **Show limited immediate low-cost, low-effort actions to achieve a new score**
   Provide information on the most relevant action items for households – things that can be accomplished without professional help and at most a short trip to Home Depot or Lowes. For commercial customers, identify options that can be dovetailed with annual HVAC or other maintenance options. Keep the lists short with the most relevant and likely to be undertaken tasks. Too much information impedes the decision process potentially resulting in no action being taken.

7. **Make the process anonymous**. In this age where everyone is reluctant to provide personal information, make the sustainability process email and contact-free.

A Free Public Service Application: The Energy Cost and Sustainability Assessment Tool

The conceptual framework and principle presented above were applied to develop and make available a

free, non-commercial, public service Energy Cost & Sustainability Assessment Tool that can be accessed on the Web and/or as a popup App that can be installed on any organization's Web site with a few lines of script.

The Online Sustainability Assessment Tool takes about 1 minute to complete and requires only information at hand without looking up utility bills or other information. The tool can be accessed at https://www.maisyenergyapps.com/sustainability_tool.htm

The Tool:

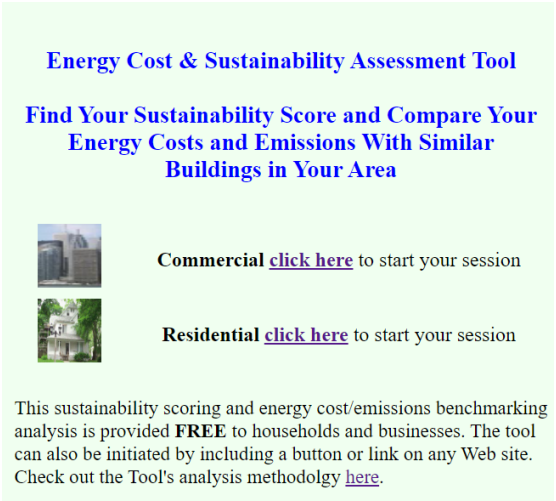
1. Is a free, non-commercial, public service App providing analysis for all ZIP code tabulation areas in the continental US for residences and businesses
2. Can be accessed online, linked to, or installed as a pop-up App on any organization's Web site (utility, private company, municipality, etc.)
3. Requires only easily-provided user data delivering results in about 1 minute.
4. Compares user cost and emissions to similar households/businesses within the same ZIP code using the industry-standard MAISY Utility Customer Databases consisting of more than 7 million US utility customers and geographically-detailed US EPA emissions data.
5. Provides potential cost and emissions reductions based on self-identified percentile targets
6. Provides easily-applied, low-cost suggestions for energy cost and sustainability reductions

Overview: Public-Service App Screen Shots

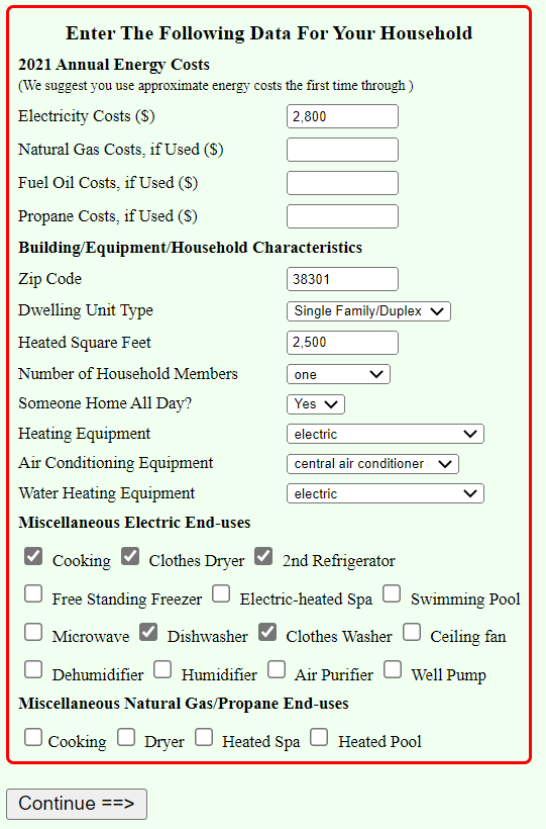
Residential Sustainability Assessment Tool screen shots and descriptions are shown below (similar screens are available for 42 US business types). Commercial building applications are similar.

Organizations can, at no cost, include several lines of script on their Web site to provide user access to the following screens in a small popup window that displays in front of their calling page.

Screen Shot 1. Select a building type. A link to the analysis methodology and data sources is also included at the bottom of the screen.



Screen Shot 2. Enter information on your home (estimated costs are fine).



Enter The Following Data For Your Household

2021 Annual Energy Costs

(We suggest you use approximate energy costs the first time through)

Electricity Costs ($)	2,800
Natural Gas Costs, if Used ($)	
Fuel Oil Costs, if Used ($)	
Propane Costs, if Used ($)	

Building/Equipment/Household Characteristics

Zip Code	38301
Dwelling Unit Type	Single Family/Duplex
Heated Square Feet	2,500
Number of Household Members	one
Someone Home All Day?	Yes
Heating Equipment	electric
Air Conditioning Equipment	central air conditioner
Water Heating Equipment	electric

Miscellaneous Electric End-uses

☑ Cooking ☑ Clothes Dryer ☑ 2nd Refrigerator

☐ Free Standing Freezer ☐ Electric-heated Spa ☐ Swimming Pool

☐ Microwave ☑ Dishwasher ☑ Clothes Washer ☐ Ceiling fan

☐ Dehumidifier ☐ Humidifier ☐ Air Purifier ☐ Well Pump

Miscellaneous Natural Gas/Propane End-uses

☐ Cooking ☐ Dryer ☐ Heated Spa ☐ Heated Pool

Continue ==>

Screen Shot 3. View current sustainability score based on energy costs and emissions relative to similar households in the same ZIP code. View the "cleanliness" of generated electricity in the ZIP code. Select an efficiency target to determine energy cost and sustainability savings with a better percentile ranking

Your Sustainability Score is 38 Out of 100

(Enter a target % at the bottom of the page to see the impacts of improving your energy efficiency.)

Your Energy Cost

$2,800

▼

Annual Energy Costs for Comparable Households in Your Area

Smallest cost (5%)	Median	Largest cost (5%)
$1,048	$2,167	$6,495

Your Annual Sustainability Impacts

14,558 Pounds of annual greenhouse gas emission

Electric generation GHG emissions/kWh in your state are 27 percent less than the US average. However, reducing your electric use by just 10 percent will still reduce your annual emissions by 1,456 pounds. See analysis methodology detail here.

Now See How Much You Can Reduce Your Energy Costs and Sustainability Impacts

Target % lowest 10 % of comparable households CALCULATE

- OR-

REVISE BUILDING DATA

1. your sustainability score

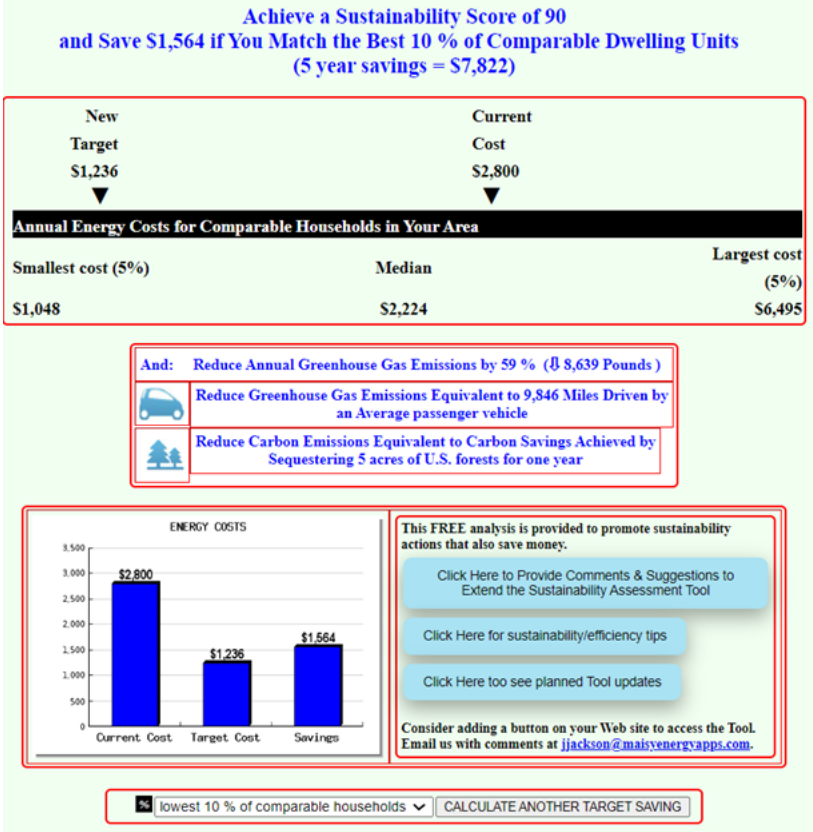
2. your energy cost compared to similar households in your ZIP

3. your annual greenhouse gas emissions

4. Info on "cleanliness" of electric generation

5. Select a new energy cost & sustainability target & recalculate

Screen Shot 4. View annual and five-year energy costs savings and annual emissions reductions associated with a new percentile target. Emissions reduction equivalents include number of vehicle miles driven and the acres of annual forest sequestrations.



1. your new sustainability score, annual and 5-year cost savings

2. your new energy cost compared to similar households in your ZIP

3. your annual greenhouse gas emissions reduction and equivalents

4. Chart comparison of old and new target energy costs

5. Links to comment section, and energy savings tips

6. Calculate savings with other target values

A Note on the Sustainability Tool Data Sources

This Tool matches user household and business inputs to provide ZIP-level comparisons to motivate sustainability actions. These ZIP-level comparisons are based on comparisons using data from the 7+ million MAISY Utility Customers Database that have been an industry standard source for more than 30 years. These data have been used to develop US Department of Energy efficiency standards, to develop electric utility and state energy efficiency programs and to support energy equipment manufacturer product development and marketing strategies and to support other energy-related organizations (see clients). Geographic-specific emission data are derived from US EPA and Department of Energy sources.

Accessing the Energy Cost and Sustainability Assessment Tool

This free, public service App can be included as a popup on any Web site by including several lines of script. Contact the author for instructions. The App can be accessed directly at: https://maisyenergyapps.com/sustainability_tool.htm .

References

1. Simon, Herbert A. (1956). "Rational Choice and the Structure of the Environment" . Psychological Review. 63 (2): 129–138. Available at https://uk.sagepub.com/sites/default/files/upm-binaries/25239_Chater~Vol_1~Ch_03.pdf
2. Thaler, Richard H.; Sunstein, Cass R. (2008). Nudge: Improving Decisions about Health, Wealth, and Happiness. Yale University Press. ISBN 978-0-14-311526-7. OCLC 791403664.
3. Granade, Hannah Choi, et. al. Unlocking Energy Efficiency in the U.S. Economy, McKinsey and Company, Inc. July, 2009. http://www.mckinsey.com/~/media/mckinsey/dotcom/ client_ service /epng/pdfs/unlocking%20energy%20efficiency/us_energy_efficiency_exc_summary.ashx
4. Jackson, Jerry, Energy Budgets at Risk (EBaR): A Risk Management Approach to Energy Purchase and Efficiency Choices (2008), Wiley Finance, ISBN: 978-0-470-28021-8
5. Frederiks,Elisha R. , Stenner, Karen, Hobman, Elizabeth V (2015). "Household energy use: Applying behavioral economics to understand consumer decision-making and behavior," Renewable and Sustainable Energy Reviews, Volume 41, January 2015, Pages 1385-1394 available at https://www.sciencedirect.com/science/article/pii/S1364032114007990
6. Lee, T. , "Competition and Motivation" (2016). This is a brief Web note introducing motivational theories that includes links to supporting information. Available at Competition and Motivation.pdf (nie.edu.sg)

About the Author

Jerry Jackson is a Ph.D. economist who has worked on sustainability and energy-efficiency issues for more than 35 years. He has analyzed/authored energy efficiency program strategies for the Department of energy, and many state governments. He has held positions as economist at Oak Ridge National Laboratory, Chief of the Applied Research Division at Georgia Tech, Assistant Professor of Economics at the University of Central Florida and Signature Professor at Texas A&M, and as president of Jackson Associates has served more than 200 clients including federal and state government agencies, utilities, equipment manufactures, and many other energy-related organizations. (see clients). His patented business intelligence software has been licensed to nearly every major business intelligence software company including Microsoft, Oracle, SAP, SAS, and other companies.