Rebound Effects in Sustainable HCI

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Abstract
Much sustainable HCI design research hopes to achieve net reductions in greenhouse gas emissions via persuasive or more efficient technologies. This research has shown promising results. However, the proxies generally used in evaluation (e.g. less energy or water consumption) may be poor indicators of such systems' effect on emissions because of effects outside the scope of analysis; in particular, direct and indirect rebound effects as described in the economic literature. We suggest sustainable HCI might mitigate these problems by requiring designs to affect market options asymmetrically.

Keywords
Sustainability, design, economics, evaluation, methods, persuasive technology

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI)

Problem

The field of sustainable HCI (SHCI) has rapidly grown to represent a variety of approaches by technologists toward achieving "sustainability." For a majority of researchers in SHCI, this means work on slowing or even reversing the growth of greenhouse gas emissions that are leading to climate change. Much SHCI, then, is **activist research**, by which we mean a form of research with specific goals in the economic, political, social, or cultural spheres that does not derive its primary goals from within the research community. SHCI's goal is not, for instance, merely the accumulation of knowledge about the development of a sustainable society. Nevertheless, sustainable HCI has been characterized by little reflective discourse surrounding, among other things, strategy [4].

The strategy implied in much current SHCI research, especially the majority consisting of persuasive, awareness-enhancing, or energy efficiency technology [4], is:

1. SHCI researchers make information systems (devices, phone applications, web applications, etc.).
2. Many people use these systems.
3. The systems help, encourage, and/or persuade their users to adopt less carbon-intensive consumption behaviors.
4. Wide adoption of the systems leads to net reduction in carbon emissions.

This strategy must contend with two problems. Both of these problems are *rebound effects*, which describe situations wherein increased efficiency lowers the price of a good or service, thereby increasing demand for that good or service or another and offsetting the efficiency's benefit. (For clarity, we will standardize on the nomenclature used by [6].)

In particular, rebound may manifest directly as an *income effect*. That is, the increased efficiency of a particular device may drive down the cost of achieving some utility from that device, encouraging the user to use it more. For example, an innovation in energy efficient hybrid vehicles may encourage more driving. (And in fact, a recent study by an insurance company found this to be the case [3].) Or an increase in refrigerator efficiency, while unlikely to increase the utilization of the refrigerator, may lead to a increase in the number of refrigerators or their size [2].

Especially problematic for persuasive technologies, rebound may also manifest indirectly as a *secondary effect*: increased household consumption of other goods and services as a result of increased real income or purchasing power [10, 8]. For example, by increasing a household's awareness of energy consumption, one will save the household money. That money may then be used to make purchases which themselves induce greenhouse gas emissions.

The authors are not aware of studies examining the degree to which the effects of sustainable HCI technologies rebound. Due to the difficulty involved in quantifying rebound effects, especially economy-wide or indirect effects, the economic literature varies widely in its estimates both within and between services. Nevertheless, that existing models of economy-wide rebound (that is, direct and indirect rebound) regularly exceed 50% economy-wide and sometimes exceed 100% ("backfire") rebound should concern designers of efficiency improvements (for reviews, see [7, 2]; for theoretical discussion, see [1, 9]).

Strategy

We propose an alternative approach which, we believe, can help designers avoid the aforementioned pitfalls. Like all strategies, our approach exhibits a particular model of the world. It assumes that: (a) the best predictor of both consumers' and private firms' consumption behavior is fiscal rationality at a high discount rate, and (b) the discount rate is high enough to result in negligible concern for climate change in purchasing behavior.

From this perspective, we suggest that the SHCI community may find value in justifying projects as work toward upsetting the *relative* cost of options for consumers, and human-computer interaction is historically good at reducing cost. Improvements in the ease with which the community solar projects can be deployed lowers the cost of deployment, the expected result of which is that more communities will adopt solar power sooner.

However, contextualizing sustainable HCI work in this way demands a careful case for the *asymmetry* of effects, which requires a broader scope of analysis than is typically required by experimental designs in SHCI. Studies that use only very simple proxies for "sustainability," such as the number of miles driven or amount of water consumed per day, are insufficient [11]. Projects which ease the burden of solar deployment do not contribute to the goals of the SHCI community if they can be trivially repurposed to ease the deployment of coal plants.

Much of the work then lies in making cases for particular options. This is non-trivial and entails nothing less than taking, as a designer, a stance on the value of that option, be it a policy objective, purchasing choice among a set of substitutable goods, or adopting one mode of transport over another. Interdisciplinarity is a strength of HCI research, and so we suggest that designers look to the economics or public policy literatures for guidance in particular interventions.

Caveats

In the foregoing, we have avoided the task of interpreting "sustainability" precisely. We agree with Tainter [12] that the question of what is to be sustained is largely a matter of human values. Thus to the extent that doing sustainable HCI research is a cultural practice in the same way that making art or writing newspaper op-eds are cultural practices, sustainable HCI is a terrain in which a variety of participants argue about values, contest implicit objectives, and make technologies which suggest a great variety of possible futures. To the extent that sustainable HCI research is a disciplinary or technical practice, disciplined technicians with agreed-upon goals will pursue those goals with technical means. In the foregoing we have acted as technicians, narrowing our scope of analysis by presuming that reducing carbon emissions is a fairly unproblematically accepted goal. We admit that "reducing carbon emissions" may be neither necessary nor sufficient to achieve "sustainability," but it seems difficult to argue that reducing GHG emissions is a bad goal without making unusual ethical claims.

Also, the aforementioned strategy, by adopting commitments from rational choice theory, does not address the important roles of persons acting in political or cultural contexts. Some promising previous work does consider this, such as Dourish in [5].

Finally, our attempt at problematizing more efficient, persuasive, or awareness-promoting technologies is not to say that these technologies are useless. Resource efficiency makes goods better or more accessible and improves human well-being. Enabling consumers to make better choices about whether and when to consume energy or goods improves their lives. But if a major goal of sustainable HCI is the reduction of carbon emissions, these technologies may contribute less than expected.

Conclusions

Kentaro Toyama, speaking about ICTD, has recently argued that technology functions largely to amplify the preexisting intents and capacities of its users [13]. A similar argument can be made in the context of SHCI—if a user intends to reduce his or her carbon emissions, efficiency improvements can help. But if, like most of us, her consumption is proportional to her income, improving the efficiency of her tools without changing her intent may lead to increases in consumption and emissions. We suggest an emissions reduction strategy less dependent on user intent. Developing technologies to upset the relative costs of consumer options is one such strategy.

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