A Tale Of Two Motivations

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In 2006, when I began working in the area of sustainability, it was still a blip on the radar at conferences like CHI. Since then, it has been the topic of numerous well-received papers workshops and special interest groups. And following this success have come the first questions about what we are doing, most notably in Dourish's article on HCI and Environmental Sustainabiltiy: The Politics of Design and the Design of Politics (2010). Thanks to that article, and many other readings, I've been feeling an inkling of discomfort with the standard motivation for some of the work we do on the StepGreen project. I've seen the same concern in various forms crop up in reviews and on thesis committees I've been privy to — the question of how much impact a project really has, what the costs of the project are, and so on. Sort of like privacy in Ubiquitous Computing work, the issue is often avoided or handled in a cursory fashion. But I want to investigate this issue in more depth today.

The cart leads the horse

The standard motivation for much of the work in sustainability in the HCI community (and I've used this myself) goes something like this (I choose energy here as an example, but similar motivations can be constructed for other sustainability issues as well): "Using too much energy is bad (list of reasons). But look, energy is used by people for everyday activities (percentage given), and daily activities are a big percentage of this (more percentages). These things are within our control, and because they involve human choice, they are an area that human computer interaction has something to say about. Not only that, but technology has advanced and … " I'll stop here, because of course there's some divergence (are we looking and individuals? At businesses? At campuses? What technology have we advanced in what way? What study did we do? These things vary from project to project).

On the positive side, this motivation is exciting, encouraging, and easy to connect to human computer interaction work such as technologies for behavior change. "Feel-good" motivation has played a role in many impactful areas in our field, including health and education research. This seems especially valuable when an area is just starting out and needs to be

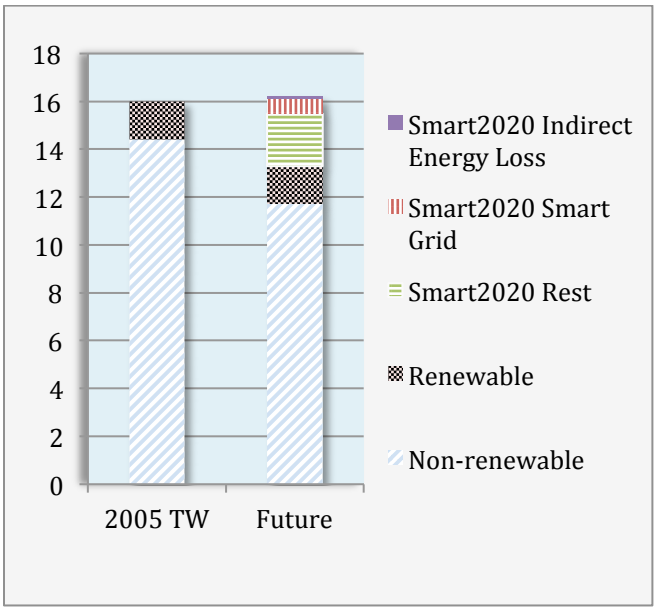

Figure 1: Projected global emissions vs Smart2020 decreases

nurtured, but must eventually be supplanted by work that has as much scientific as social value. On the negative side, as others before me have argued (*e.g.*, Dourish, 2010) it is utopian, ungrounded, and difficult to measure.

As a thought exercise, I would like to explore a different ways of motivating sustainability work. I choose this motivation for its focus on impact, regardless of how well it might sell our work. We will work from raw facts down to specific potential impact number. Such a motivation might start from the same place (Using too much energy is bad), but the ending is quite different. Globally, we used 16 Terawatts (TW) of energy in 2005, 90% non-renewable (gas, coal, oil, nuclear) (Griffith, 2008). About 7.8 gigatons of CO_2 ($GtCO_2$) emissions can be removed by information technology advances (Climate Group). This is about 2.7 TW by my calculations[1], assuming that the source is coal (about 17% of 2005 emissions). Of the categories of IT work proposed in Smart2020, the largest impact category is the smart grid category (2.03 $GtCO_2$). More than half of the energy generated each year is wasted in the grid ("directly") or is wasted because it is unnecessary to spend ("indirectly"). The indirect component adds up to about .28 $GtCO_2$ (Climate Group). This is a very small portion of global

[1] I will not repeat the entire calculation here, but calculated a conversion factor of .036 I using the following data sources to help http://www.nezhadpmd.com/worldenergyscenarios.pdf; http://en.wikipedia.org/wiki/World_energy_consumption; http://205.254.135.24/forecasts/ieo/more_highlights.cfm#world

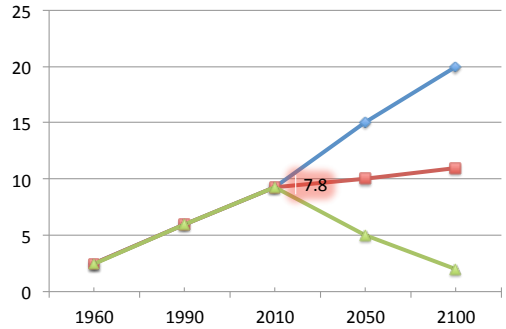

Figure 2: Global carbon emissions from fossil fuel use, 1960-2010 and for the IIASA-WEC scenarios to 2100 (In $GtCO_2e$, data from http://www.iiasa.ac.at/cgi-bin/ecs/book_dyn/bookcnt.py). Blue line shows the maximum of the top range. The potential savings (7.8 $GtCO_2e$) from all information technologies work, as estimated by the Smart2020 group, is shown as well.

energy emissions (.6%), as shown in Figure 1 under the label "Smart2020 Indirect Energy Loss". Human behavior change to reduce energy use (such as home heating and cooling) falls into this category. By this reasoning, the maximum impact we can have is .6% of global energy emissions, assuming that we had a systemic impact on all energy wasted post grid (not just home heating and cooling in a few households in one or two developed countries).

On the positive side, this motivation is measurable, can be used to set real goals, and is based on real data. On the negative side, it is discouraging and it highlights how much we don't know. Over what time period is Smart2020 technology expected to have its effect? What are the current global emissions, and how much are they likely to rise? The 7.8 $GtCO_2$ saved by the Smart2020 projects pales in comparison to possible projections of global increases, as shown at right. Would such work actually replace or reduce coal plant emissions, or just enable increased energy use globally? What percentage, really, would even global adoption of any of our projects create? Is any of the work we do appropriately designed for a global context? And on and on…. To make matters worse, projecting impact requires projecting future trends, something I would argue requires more formal methods, as humans are notoriously bad at doing this intuitively in the face of exponentially increasing change (Mankoff, et al., In Submission).

It seems that neither of the two most obvious motivations for doing sustainable HCI work seems to justify the time we are putting in. Is there an alternative?

A new path forward

Moving forward requires putting our work in a new context, and viewing it in a new way, and that may affect how we must proceed. Before describing that motivation, we need to explore a broader theory of how we might globally address sustainability. Many opinions exist about how one might do this. Most of them come from other fields than Human Computer Interaction. While there is not space to discuss them all here, I have chosen two exemplars, again focused on energy use. The first is an article by Pacala and Socolow (2004) discussing "wedges" (made famous in the 2006 film "An Inconvenient Truth") that can together create a global reduction in emission sufficient to bring CO_2 emissions back to a zero net level (*i.e.*, no more CO_2 emitted than is naturally absorbed). The second is a book written by a young Al. Gore in 1992 describing a policy-maker's perspective on how to achieve worldwide changes in energy consumption. While two decades old now, its recommendations represent a much broader perspective than is typical of many treatises on the topic. If we combine the recommendations of Pacala & Socolow and Gore, we can see that the list of ways to reduce carbon emissions is both broader than either of the motivations provided above can encompass, and amenable to research at the intersection of technology and people.

Here is a partial list. At left are direct ways of reducing carbon emissions, at right are indirect ways of reducing carbon emissions.

Opportunities for Direct Reductions	**Opportunities for Indirect Reductions**
Efficiency (new technologies, new patterns of use, better buildings, etc.)	Population control
Carbon capture & storage	Economic controls (e.g., taxes)
Alternate sources of energy	Cross-cultural solutions (expanding solutions in either category to work in multiple global contexts)
Carbon sinks (e.g., reforestation)	Improved energy grid
	Education
	Governmental buy in (local laws, world treaties, etc.)
	Advances in science

While many of these things are far removed from the HCI research (such as the basic science necessary to explore carbon capture and storage), there may be ways we can contribute

to the science, politics, education, and mobilization necessary to achieve them. Indeed, interactive systems may have already contributed in subtle ways to some of these topics. For example, eBay might be credited with increasing the market for re-use of durable goods, a form of improved efficiency, while twitter and SMS may have had an impact on group mobilization and communication.

The category "alternate sources of energy" requires special attention as most people underestimate exactly what is involved in making a significant change in how we produce energy. According to Griffith, to replace 14 (of 16) TW of global energy use with alternative sources (which be sufficient to reduce CO2 emissions to a manageable level), we would need, for the next 25 years, to build: One 1250m^2 pool of algae per second; One 100m^2 solar cell per second; One 50m^2 thermal mirror per second; 12 wind turbines per hour; 3 geothermal turbines per day; and 1 nuclear plant per week. This paints a daunting picture of how big the effort required is to truly solve the problems we face.

Projects about individual behavior also fit within the list above (under efficiency), but I would argue that the list of indirect ways of reducing emissions are potentially much more impactful. In fact, we must engage with this broader list, or we risk, as Dourish states (2010) that "framing sustainability solely in terms of personal moral choice in a marketplace of consumption options may obscure the broader political and regulatory questions that attend significant change. (p. 10)"

Making work accountable

So where do we go from here? What is the "right" motivation for sustainable Human Computer Interaction work? I would like to argue for a new checklist for impact. Projects must be explicit about the potential for both direct and indirect impact, measurable, and (ideally) scalable. They should consider major growth trends, multiple cultural contexts, and address energy production as well as use. Here is a partial checklist of issues to consider.

- ✓ What is the core goal?
    - How does the research directly contribute to *and* take away from it? For example, with respect to energy, how much energy is produced, and how much is needed for the project.
    - How does the research indirectly contribute to *and* take away from it?

- Externalities (what are the other potential negative and positive impacts? For example, what waste is generated? What are the economic and societal benefits and costs?)

✓ Metrics & Measures
- At what level of detail can the impacts of the project be described? What are the right units and measures?
- What are the uncertainties here?

✓ Scale (and scalability) of impact
- At what scale must this be deployed to have impact?
  - One person at a time? (*e.g.,* landlords, tenants, homeowners, managers)
  - Institutional? (*e.g.*, corporations, cities, campuses)
  - Cultural/National? (*e.g.*, social movements; governments; science)
  - International? *(e.g.*, countries, corporations, advocacy groups)
- How could that be achieved? (is there a feasible plan for scaling up to the point where impact is possible, or is it improbable that the technology will scale?)
- What are the limitations (*e.g.*, certain cultural contexts or economic groups?)
- How much impact / cost does it have at scale?

This is just a partial list of things that we might consider when choosing a project. Many of these may also be difficult to make progress on. For example, how do we address population control in ways that are sensitive to individual rights and cultural differences? Is this even a domain for computer science? However, I would argue that when we accept the importance of things like scale, internationalization, and indirect options for reducing energy use, a new focus for sustainable CHI emerges. This focus requires locally grounded, socially focused solutions. It attempts to decentralize, increase sharing, and encourage environmentality (Agarwal, 2004). We must measure waste (of all sorts) so that it can be regulated and taxed, monitor resource use, model it, and inform governments as well as individuals about what we discover. And all of this must be made relevant across sectors and scale up to cities, nations, or more.

Feel-good motivations are no longer enough. The crisis we face is too big for that. Luckily, it turns out that indirect influences on energy use are as important as direct. If we think about IT for sustainability more broadly, perhaps we can begin to have the impact that is needed. IT has changed so much in the world. It's worth believing (and trying) to do this as well.

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