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TURNING SOLAR CONSUMERS INTO SOLAR CITIZENS: STRATEGIES FOR WISE ENERGY USE

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ABSTRACT

Adding photovoltaics should be the final step in a coordinated strategy to reduce building demand. If new solar installations are not *always* tied to decreases in energy use, however, are we are solving our existing energy problem or creating a new one? This paper compares and contrasts two different ways of moving toward a solar-oriented future. It uses examples from government-sponsored solar housing demonstration programs (e.g., the U.S. Department of Energy's Zero Energy Home program) and private solar initiatives (e.g., owner retrofits) to consider whether we are pursuing a path that leads us to consume more solar rather than one that helps us use energy wisely. The paper argues that foregrounding more solar and backgrounding how energy is used could lead to lower levels of overall environmental improvement than an approach that integrates solar and wise use. This paper concludes with examples of a particular form of wise use: direct feedback systems to convey resource use in real time to residents.

1. IS MORE SOLAR ALWAYS BETTER?

Grid-connected solar is the fastest growing power generation technology in the world, with cumulative installed capacity growing 55% in 2004-05 alone.[1] But is more solar always better? Solar advocates know that the best way to get to zero energy use in the building sector is by adding solar photovoltaics as the last step in a coordinated strategy to reduce demand. If new solar installations are not necessarily tied to decreases in energy use, however, are we are solving our existing energy problem or creating a new one? This paper compares and contrasts two different ways of moving toward a solar-oriented future. It uses examples from government-sponsored solar housing demonstration programs (e.g., the U.S. Department of Energy's Zero Energy Home program and the Solar Decathlon) and private solar initiatives (e.g., owner retrofits) to consider whether we are pursuing a path that leads us to consume more solar rather than one that helps us use energy wisely.

2. MORE IS NOT ALWAYS BETTER

Government-sponsored solar demonstration programs play an explicit role in shaping social and professional expectations of solar technologies and advances in building design. For example, such programs promote technical change by showcasing solar houses instead of non-solar houses. They also implicitly promote certain lifestyles and social arrangements either by holding housing size and function relatively constant, or by concentrating on homes that are at particular places (usually the high end) of the size and quality spectrum.

2.1. Size Matters

Since the 1970s, the U.S. economy has become more efficient in its use of resources. Better use of resources is not in itself a sustainable path, however, as it is possible to use ever greater levels of resources in relatively more efficient and "green" ways. For example, a large new house may use energy efficiently and be constructed with healthy materials, but it will often consume more energy and resources than a smaller "inefficient" home. The general trend in American building has been to consume more and more energy and resources in the name of making life

better. In 1970, two-thirds of new homeowners kept their cool without central air-conditioning; today, central A/C is a standard feature in 90% of new homes, even in temperate climates. In the past three decades, the size of the average new American home has climbed 57%, to say nothing of the proliferation of 2 and 3-car garages.[2]

Where energy is concerned, bigger is not necessarily better. An EnergySTAR Homes calendar from the 1990's portrayed a 9,999 square foot home as a model of efficiency (see Figure 1).

Fig. 1: 9999 square foot EnergySTAR Home

Although federally supported solar homes are not always as large as the home pictured above, some municipalities, such as Marin County, CA, are considering or in the process of implementing legislation that requires large houses (e.g., those greater than 7,000 sqft) to install PV arrays.

PV arrays on large homes may not just be a good idea in the eyes of local government. Figure 2 shows a couple in Santa Cruz, CA who built themselves a 2,880 square foot PV array (larger than many homes) to offset their energy consumptive hobbies.

Fig. 2: The Adelmans and their 30.5 kW array. (Source: **www.solarwarrior.com**)

On the one hand, when large consumers install PV, it helps build the market for this important technology. On the other, it may help justify further over-consumption, on the grounds that this energy is "green" and free after the point of purchase.

2.2. Cost Matters

Cost is one area where most people would agree that more is not necessarily better. It stands to reason that larger homes usually cost more than smaller ones. But do solar homes need to cost more than non-solar homes? Many entities are working on reducing the cost of solar homes, but the price tag is still high because PVs are still expensive. *Professional Builder* recently ran a story about the first zero energy home that cost less than $200,000.[3]

At the 2005 Solar Decathlon, cost was one of the areas that the public most wanted information about.[4] Although costs are obviously important to the public, there was no requirement for decathlon teams to discuss this information publicly. Teams in 2005 were required to report their costs to the event organizers, but the rules and regulations declared that the teams were not to be judged on them [5]. In 2007, there is a new requirement that the teams show whole-house, levelized energy cost has been reduced to $.10/kWh by 2015 [6].

2.3. Use Matters

In addition to the size and cost of a home, the way that it is used matters if carbon reductions are the goal. Figures 3 and 4 show a ZEH housing development near Sacramento. Unlike the houses mentioned in the previous sections, size and costs aren't the issue with these houses. Although these are designed to be "zero energy" houses, their size, shape, and spatial arrangement are typical of many new developments. Interestingly, their energy use distribution is also typical.

Fig. 3: Bird's eye view of Premier Gardens (Source: Keesee, M. 2005. "Setting A New Standard - The Zero Energy Home Experience In California" ISES 2005 Proceedings).

Figure 4 shows that the PV arrays and energy efficiency measures are effective: there is an across the board decrease in bills in the ZEH development compared to a neighboring development. However, the distribution of energy use across the studied homes has not changed: the energy use patterns in the ZEH development exactly mimic those of their neighbors, rather than reflecting the near "zero energy" design intent.

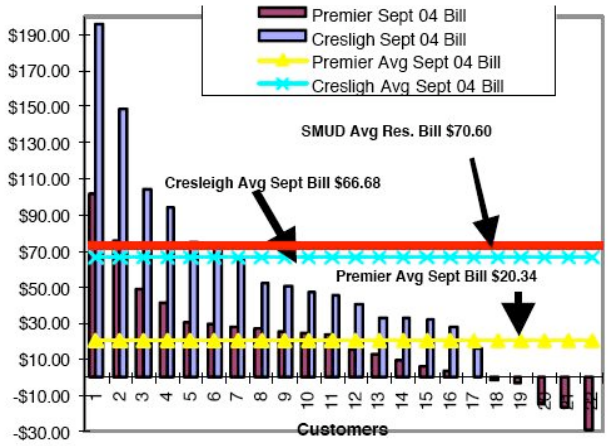

Fig. 4: Sept. 2004 Electricity Bills for Premier Gardens vs. Cresleigh Rosewood (Source: Keesee, M. 2005. "Setting A New Standard - The Zero Energy Home Experience In California" ISES 2005 Proceedings).

3. CITIZENS VS. CONSUMERS

The examples in the previous section point to the need for "sufficiency"—the ability to break the spiral of material saturation that currently signifies affluence and well-being in our society. In contrast to "efficiency," Thomas Princen argues that sufficiency is a term that could help Americans develop a notion of "enoughness."[7] The following section builds on this idea, associating sufficiency with citizenship in contrast to business as usual consumption patterns.

3.1. Business as Usual

Relative to people in other parts of the world, Americans tend to over-consume goods, services, and energy. Our identity as consumers is easy to recognize: a Google search reveals that Americans are twice as likely to be called "consumers" as "citizens."[8]

If a picture is worth a thousand words, reviewing Microsoft's online clip art is a quick way to garner a great deal of information about citizens vs. consumers. On Microsoft's website, one can find 21 images labelled "consumer", most of which involve a lone woman and her shopping cart (see center column image in Table 1). In contrast, Microsoft only indexes three images for the term "citizen." All of these images contain an American flag (see right column image in Table 1), and all three portray groups rather than individuals. Although these small points are insufficient for a detailed semiotic analysis, they serve as useful and widely available indicators of what each of these terms infer.

In addition to the frequency with which Americans are classified and pictured as consumers or citizens, it is important to further delineate the meanings and connotations of both terms. These definitions are sketched in Table 1, Row 2, titled "Business as Usual." Consumption is generally considered to contain a set of economic rights and social opportunities. Social theorists tell us we have a consumer culture, and there are ways in which buying has become its own form of right action. Just after 9/11, for instance, President Bush urged Americans to go shopping to support the economy and show that our will had not been broken by terrorist activities.

Citizenship, on the other hand, is generally construed as a set of political rights, opportunities, and in some cases, responsibilities.[9] Influential work in the citizenship literature focuses mainly on the issues of voting and earning as individual entitlement.[10] Relative to these two major foci, the notion of citizenship as a community responsibility is present but not currently a major emphasis in the field. Nevertheless, it is precisely this concept of responsible action that might be useful in considering the transition from today's business as usual practice to a solar future. This paper argues that the increasing identification of Americans as self-interested economic actors rather than public citizens has implications for how we implement solar PV in both our public and private ventures.

TABLE 1: PRESENT AND POSSIBLE FUTURE QUALITIES OF CONSUMPTION AND CITIZENSHIP

	Consumer 	**Citizen** 
Business as Usual	Economic Rights (& Social Opportunities) • more is better	Political Rights • voting • earning • responsibilities
Solar Scenario	Buy more solar => Smart houses + dumb users (?)	Wise use & sufficiency => Smart houses + smart users

3.2. Solar Scenario

If Americans continue to be categorized as consumers, then the "buy more solar" message is a good fit for a likely solar future (see Table 1, Row 3). While buying more solar is necessary, the question remains: is it sufficient? Will a PV system on every roof and a Prius in every driveway solve our environmental problems? Or is there a way in which these technologies might have unintended consequences? The answer depends, of course, on how these technologies are used. If the Prius is driven more frequently because it is more efficient and the A/C is used more often because the electricity is "free", buying more PVs or hybrid cars may increase rather than diminish energy consumption. As Andrew Rudin pointed out in his analysis of 45 years of U.S. energy consumption, "When we were less efficient we used less energy."[11, p. 8.331] Since the 1970s, efficiency gains have been outpaced by increases in the size, number, features, and use of energy-consuming equipment.[12] It is worth considering whether buying more solar without providing additional guidance about what the solar is *for* might ironically result in increased energy use rather than in lower emissions.

This problem is compounded by the fact that most Americans do not understand energy issues. A recent survey by the National Environmental Education and Training Foundation showed that only 12% of the general population can pass a basic energy quiz.[13] These results beg the question of whether Americans are uninterested, incapable, or simply ill-equipped to handle the challenges presented by the eventual need to reduce energy consumption. As we make smarter houses, are we concurrently assuming that users are irreparably dumb? The next section suggests that the houses we build could actually invite their owners to better understand and participate in their performance.

4. WISE USE: A SOCIAL STRATEGY

The paper argues that foregrounding more solar and backgrounding human dynamics of how solar is used will lead to lower levels of overall environmental improvement than an integrated approach would. An integrated approach would demonstrate both the best available technologies *and* illustrate methods for wise energy use. This paper concludes with examples of a particular form of wise use: direct feedback systems to convey resource use in real time to residents.

For most existing homes, attempts to understand energy use has been aptly compared to shopping at a grocery store without any prices on individual items.[14] In the absence of information, residents asked to reduce their consumption have a hard time estimating the costs and benefits of their actions. Research conducted in different contexts over the past 25 years shows that providing direct feedback on resource use can help bridge the gap in this information loop and reduce consumption by 10-20%.[15] In the case of PV systems, real time feedback invites residents to see their homes as a site of both production and consumption. Figure 5 shows one such system installed in the kitchen of a house

with a 1.2 kW array in Oberlin, OH.

Fig. 5: Direct real time feedback of PV production and electricity consumption in Oberlin, OH. PV production is shown on the top, electricity consumption is portrayed on the bottom.

Although providing feedback on electricity production and consumption to homeowners is not a panacea, it does alter the landscape of possible solutions. Conceptually, it offers the opportunity for smart houses to have smart users. It also promotes an important change in the assumed identity of the occupant: from blind consumer to educated citizen. Some policy options that would support this shift are discussed below.

5. POLICY OPTIONS: BUILDING IN SOCIAL STRATEGIES

Pursuing an integrated approach to solar homes could impact policy by broadening existing educational and outreach efforts to include the critical role that building users play in the built environment. While we are fairly comfortable with the notion of better buildings and becoming more comfortable with the notion of better management, we have yet to consider whether and how to encourage a role for better occupants. "Better" occupants might be those who are responsible for their own energy, responsive to the built environment around them, and prepared to adapt to the different qualities of comfort and convenience that low-energy buildings offer. This broader context is important to explore, but for brevity's sake this paper focuses mainly on feedback.

There are several different policy options for increasing the provision and use of feedback in residential settings, some more politically palatable than others. Our current system is almost entirely voluntary: feedback is usually provided at only at the behest of the resident, who can do with it as s/he chooses.

5.1. Mandatory Feedback, Voluntary Action

In effect, our current standards and labels for appliances are a form of mandatory feedback on performance. For the most part, however, citizens may choose to pay attention to or ignore EnergyGuide and EnergySTAR labels.

California has recently required that a performance meter be installed on all new PV systems, but the meter is for verifying system performance to the California Energy Commission (CEC). Some systems are designed to bypass the owner and send their performance data directly to a consultant or to the CEC. Such a bypass may limit the utility of the performance metering to the resident. However, it sets in place the beginnings of a technical infrastructure that monitors performance. Inviting the resident into this information loop as an voluntary participant would be the next step.

5.2. Mandatory feedback, mandatory action

In the current political climate, it is difficult to discuss rationing in the US. In other countries, however, carbon limits are under discussion. Providing real time feedback along with any mandatory targets would enable residents to better meet the targets by knowing more about their energy use profiles than monthly utility bills currently allow.

6. CONCLUSIONS

For the solar homes of the future to reach their full environmental potential, the role of the user should be considered more thoroughly. Data from "zero energy home" developments confirms that different management strategies in the same neighborhood can turn zero energy homes into net consumers or net producers.[16] User participation in the social shaping of housing is a critical part of making sustainable buildings work in practice. Rohracher [17] reminds us that the success of low energy ventilation systems and smart home technologies depends not only on good design, but on appropriate use. This paper has argued that there are ways of changing the sociotechnical system of housing to produce smarter buildings *and* smarter users. Providing real time feedback and changing our nomenclature could help transform the market from one based on energy consumption to one that supports solar citizenship.

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