Solar Energy: Let's Get Passive!

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Solar energy. Sunlight. Free deliveries every day. Free, that is, if you have the technology to use it. The technology is not free, of course, although the upfront investment costs for some solar energy technologies are less than for others.

When you hear or read the term "solar energy," what technology comes first to your mind? Do you think of photovoltaics, the kinds of solar panels that convert sunlight into electricity? If you do think of photovoltaics, is your next thought something like, "I wonder when, if ever, solar electricity will be able to compete in the market without government support"? I think that depends, in part, on how long we continue to subsidize conventional electric power technologies while we fail to internalize their environmental costs. This article, though, is not about solar electricity.

Rather, this article is about solar thermal energy. Now, when you read the term "solar thermal," what comes to mind? Do you think of roof-mounted solar collectors that produce hot water, for hot showers and washing dishes? For some people, that's what "solar thermal" means. *See, e.g.*, Frederick R. Fucci, *Alternative Energy Options for Buildings: Distributed Generation—Power Generation on or Near Buildings*, *in* The Law of Green Buildings: Regulatory and Legal Issues in Design, Construction, Operations, and Financing 125, 135 (J. Cullen Howe and Michael B. Gerrard, eds., 2010) (describing solar thermal as a technology that "provides heat for hot water"). But that's only one aspect of solar thermal.

When I think ofsolar thermal what comes to mind is space heating, using a range of techniques collectively known as passive solar design. "Passive" solar heating systems generally capture sunlight,store it as heat, and move the heat to where it is needed without mechanical inputs such as pumps and fans. *See generally* Edward Mazria, The Passive Solar Energy Book (Rodale Press, 1979). Passive solar is sometimes distinguished from "active" solar, in which fans and pumps are used, although this distinction may not be not all that significant; "hybrid" solar heating systems use both passive and active features.

Passive solar design features can also be used for cooling and ventilation, and to provide for lighting with sunlight instead of electric lights ("daylighting"). Given that in most regions of this country, space heating is the largest component of energy demand for homes and small commercial buildings, space heating is my focus in this article. Passive solar design techniques can meet a substantial part of the space heating load in most regions. It is puzzling to me why passive design has not been more prominently featured in the green building movement. (I found only a single reference to passive solar in The Law of Green Buildings, in Michael J. Zimmer and Jennifer M. Rohlender, *Green Building Financing*, *id.* at 103, 106 (noting that the installation of active and passive solar technologies is eligible for the energy efficient mortgage program administered by the Federal Housing Administration).)

I am not alone in my concern with the neglect of passive solar. Five years ago, in a commentary in *Solar Today*, the magazine of the American Solar Energy Society, Doug Balcomb observed that, a generation after the first wave of governmental interest in passive solar (1976–1982), "most architects have only vague memories of passive solar. It is generally misunderstood, and only a few designers, many trained 25 years ago, can be found." J. Douglas Balcomb, *Passive Solar Comeback Ahead*, Solar Today (Sept.–Oct. 2006) *available at* www.ases.org. For readers unfamiliar with the work of Doug Balcomb, he is the engineer who, while affiliated with Los Alamos National Laboratory, played a lead role in developing the analytical method for predicting the performance of passive solar in heating buildings (in the era before personal computers). *See, e.g.*, Passive Solar Design Handbook, Vol. 3 (J. Douglas Balcomb, *et al.*, American Solar Energy Society, 1983). Later, while at the National Renewable Energy Laboratory, Dr. Balcomb (Ph.D. from MIT in nuclear engineering) oversaw the project to develop the passive solar design software "Energy 10" (for buildings of 10,000 square feet or less), which is now available from the Sustainable Buildings Industries Council. www.sbicouncil.org/energy-10-software.

The lack of attention to passive solar in the green building movement and, more generally, in our national energy policy (to the extent we might be said to even have a national policy), leads me to ask two basic questions? First, why? Second, what can be done about it? Before offering some observations on those two questions, perhaps I should first provide a little more information on passive solar.

In all passive solar space heating systems, there are two essential elements: aperture (south-facing glass or some other glazing material) to let the sunlight in, and thermal mass (e.g., masonry, concrete) to absorb sunlight and store it as heat. These two elements are relatively easy to incorporate into new construction without adding much to cost, but generally not so easy to do in retrofit. Orientation has to be done correctly from the start—south-facing glass requires a south-facing wall. (And west-facing windows should be kept to a minimum—by adding to cooling loads, they increase the demand for power and can be said to cause power plants.) Similarly, if you don't have enough mass on the inside of a building, adding some later presents a challenge.

Passive solar heating techniques can be classified into three broad categories: "direct" gain, "indirect" gain, and "isolated" gain.A single building can incorporate all three of these kinds of techniques. Direct gain systems feature south-facing windows (and/or clerestories) and thermal mass in the living space (e.g., floors, walls). Overhangs are designed to block sunlight in summer and let it enter in winter. Indirect gain systems place the thermal mass on south facing walls, covered by glass and an air space—the mass captures the heat and gradually radiates it into the living space. This technique is generally called a mass wall (or, if it is used only beneath a window, it might be called a "half-mass" wall); it may be called a "Trombe" wall, after its inventor, Felix Trombe. Isolated gain systems feature sunspaces, atriums, and greenhouses, which are spaces that require little or no auxiliary heat and which provide some heat to the living space.

That's a basic overview of passive solar. In addition to the sources previously cited, the Department of Energy provides information on the web at www.energysavers.gov/your_home/designing_remodeling/index.cfm/mytopic=10250. There are many nuances in passive design. Software such as Energy 10 can be used to analyze and choose among the various options.

Now, back to my two questions. First, why is passive solar being largely ignored? I don't know. After all, it is a mature technology that saves money with little upfront incremental cost (and sometimes a reduction in incremental cost by downsizing, or even eliminating, conventional heating equipment). Passive solar also reduces greenhouse gas emissions by displacing fossil fuels. And it creates living spaces that contribute to an enhanced quality of life. So why isn't passive solar a standard practice in new construction of homes and small commercial buildings? Why is there only one passing reference to passive solar in The Law of Green Buildings?

One factor in the neglect of passive solar may be that the two essential elements – orientation so that a long wall faces south and thermal mass in the living space—are just different from the business-as-usual scenario in new construction. Moreover, orientation for solar design does not seem to be a factor in the layout of subdivisions (which, of course, should be mixed-use, feature bike paths, and be located close to transit nodes to reduce motor vehicle traffic, but that's another subject).

My second question—what can be done to rectify the neglect of passive solar? Maybe we ought to re-tool land use planning laws to facilitate building orientation for solar design.

The other obvious governmental policy tool is building codes. I have an idea about how to incorporate passive solar into building codes, an idea that will require a little set-up before I get to the point. Let's start with Architecture 2030, which is an organization that promotes the goal of making net-zero energy the standard practice for new construction and major renovations by 2030. *See* www.architecture2030.org. To get there by 2030, Architecture 2030 calls for a set of interim targets: all new buildings should be designed to consume 60 percent less fossil fuel energy than the current regional average for that building type. The targets are ratcheted to 70 percent less in 2015, 80 percent less in 2020, 90 percent less in 2025, and carbon neutral by 2030. This basic concept was incorporated into a bill that the House passed in 2009 (which died in the Senate), the American Clean Energy and Security Act, H.R. 2998, § 201 (the Waxman-Markey bill). Cong. Rec. H7505-08 (Daily Ed., June 26, 2009). That bill used the 2006 version of the International Code Council (ICC) Residential Energy Code (REC) as the baseline for homes, with incremental reductions in energy consumption pegged to that baseline, moving toward net-zero energy by 2030. If we are going to make it to net-zero energy, I think passive solar is going to have to be a big part of achieving that goal.

Here's my idea. State, local, and tribal governments could enact a performance-based standard for their building codes that makes incremental targets such as those specified in by Architecture 2030 legal requirements. For each building permit, a similar building that conforms to the ICC REC could be the baseline or reference case. A design tool such as the Energy 10 software could be used to refine the proposed building design, adding passive and other energy saving features, until it achieves the required target for energy consumption. Under this approach, no specific passive techniques would be required; rather, the permit applicant could choose the mix of techniques. A variation on this idea would be for the governmental agency charged with administering the building code to become really adept at using Energy 10 and help applicants for building permits meet the prescribed energy savings increments, in effect, treating code compliance as providing a public service.

But there is a problem. It concerns low emissivity (low-e) glass, which has become a standard component of energy-efficient windows. There are two basic types of low-e glass: soft coat and hard coat. *See* Kenneth Haggard, *et al.*, *Seeing the Invisible: Passive Solar Heating and Window Glass*, Solar Today (May 2010), at 16. Soft coat is best on east, north, and west windows, but its solar heat gain coefficient is too low for south-facing windows in passive solar applications. For that you need the hard coat variety. The problem, as reported by Haggard and his co-authors, is that window manufacturers aren't making hard coat low-e glass anymore. The authors note that the leading green building rating system, Leadership in Energy and Environmental Design (LEED), misses the point that "passive solar architecture can create *energy-producing*, as well as energy-conserving, buildings." *Id.* at 18 (emphasis in original). The authors of the relevant chapter in The Law of Green Buildings also miss this point. Michael J. Baker, et al., *Green Materials and Construction*, *id.*, at 217, 226–27.

Being an Indian lawyer, I will close on an Indian law note. Just this: tribal governments, through the use of their sovereign lawmaking powers, could assume leadership roles in dealing with these issues. Passive solar homes for Indian families through the enactment of tribal building codes. Imagine that.

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