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Active Passive: Heat Storage and the Solar Imaginary

There is no such thing as *the* house, or the house as such, there are only historically and culturally contingent cultural techniques of shielding oneself and processing the distinction between inside and outside.
–Bernhard Siegert, *Cultural Techniques: Grids, Filters, Doors, and other Articulations of the Real* (2015)

In what follows, I aim to justify an inversion or least a productive complication of the familiar nomenclature of active and passive solar energy, as it pertains to architectural design methods and to solarity more generally: that is, to changes in economies, cultures, and ways of living in the present and future. In the received active/passive distinction, *active* denotes a solar energy system that requires a mechanical device of some sort, usually photovoltaics that convert solar radiation into electricity. Such systems aim to replace fossil-based forms of electricity generation and heat provision. Think, for example, of Tesla's Solar Roof: photovoltaic shingles that can be attached to virtually any roof design and plugged into the house system (often accompanied by a Tesla Powerwall battery). Over the past few decades, research into solar energy in the architectural context has tended to focus on just such technology-intensive approaches

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towards solar and insulative efficiency. Passive systems, by contrast, rely on design rather than technological innovation. They involve attention to orientation and site, thermal properties of materials, seasonal shading devices, and other means to selectively absorb and optimize the heat or light directly from the sun. Generally speaking, passive systems don't require additional resource input, or minimize it–perhaps just a fan to distribute sensible heat. Though passive on these terms, such houses often require the inhabitant to engage with them in an elaborate fashion, by drawing insulating curtains at night, focusing time in one part of the house or another according to season or time of day, and modifying expectations of the thermal interior so that consistency is less important than efficiency.

Active solar, in this received framework, has no, or very few, design implications. Because of this, much of the professional and popular discussion of solar energy, in the context of buildings, involves efficiency, placement, and material options for active, photovoltaic systems. Passive solar, by contrast, is all design: the house, the patterns of the inhabitant, and often a range of thermally induced social practices are solicited by and through such projects, adjusting existing habits and ways of living in interior spaces, in order to allow for a new kind of social interaction with the sun. The house, its capacity to absorb and store heat, in concert with activities of the inhabitant, articulate the system: solar energy, in this framework, is an interactive medium, reliant on participation, articulating a social relationship to fuels appropriate for a given condition.

At stake in reconsidering this distinction is an attempt to understand how we simultaneously experience the resource conditions of our thermal interiors and the transformations of global climatic patterns. Which is to say, to reconsider active and passive in solar architecture (with heat storage, as will become clear below, as the hinge) is also to reimagine the role of buildings in the production of the carbon zero future—less, at least relatively, as spaces of technological innovation, and more as spaces of social and species evolution. An *active passive* solar architecture aspires to lifestyles, habits, and expectations coming into line with the massive geophysical transformation of climate instability. The house becomes a medium for this epochal social change. In addition to exploring photovoltaic-induced technical efficiencies and allegiance to the parameters of performance software, sensor data, and adaptive comfort (that is, broadly construed, the technical fix of the ecomodernists), *active passive* solar architecture also opens up a space for exploring radical changes to means of global inhabitation (interior and exterior). Architecture in this fashion can be framed as a medium for the Anthropocenic transformations solicited by climate instability.

At stake as well is reconsidering the basic economic model for energy systems that encourage specific ways of living on the planet. Unlike buried fossil fuel reserves, which are subject to analysis relative to cost of extraction and time to exhaustion, passive solar technologies are evaluated for their relative efficiency of radiation collection and storage, and subject to increases in that efficiency as technology improves. As Eugene Ayres, a Gulf Oil executive sympathetic to a solar energy transition, put it in 1948:

> The most important factor is not the size of a reserve, but the rate at which it can be procured. When the rate-based measurement is applied to a process that is essentially unrenewable, such as the combustion of fossil fuels . . . the answer is related to the number of years during which that source could be relied upon. On the contrary, if the source is relatively continuous . . . the answer is the rate at which power might be obtained for the almost indefinite future. The two kinds of figures are not comparable. (Ayres and Scarlott 1952: 12)

This economic incompatibility of solar energy and fossil fuels can be emphasized and celebrated as an opportunity for new forms of collective energy management, in addition to being a spur towards specific kinds of design and lifestyle innovation. Solar-engaged architecture is an effective means towards facilitating novel and regionally appropriate socio-economic arrangements. Again, new frameworks for design have been essential to these articulations, as have explorations of heat storage, activating the inhabitant as an agent in increasing the "rate at which power might be obtained" through often straightforward habits and practices.

Along with the solar panel, insulation, and the volumetric disposition of the interior, heat storage is an essential element in the design of the solar house. "The problem of solar energy," as Maria Telkes (1947: 12), one of the pioneering engineers in solar energy, clarified, "is largely a problem of heat storage." It is relatively easy to design a house to absorb the sun, but much more difficult to enact a storage regime that allows solar energy to heat a house through the night, or for days without sunlight. Of the elements of solar house design, heat storage emphasizes practice and process—not just a determinant of the design itself, but of how the design proposes new ways of life in the interior. Whereas solar energy may invoke a sense of abundance and abstract value, storage is the operand of limitation. It holds solarity in check.

If the house (or residence more generally) is one of the primary media through which social bodies articulate a relationship to fuels (i.e., articulate a concept of 'energy' in its most basic sense), then heat storage is the medium that allows a solar house to produce a new sort of subject, a solarized inhabi-

Figure 1. George O. Löf and James Hunter, Löf House, Denver, Colorado, USA, 1957.

tant, ready and able to adjust patterns, lifestyles, and aspirations through meticulous engagement with solarity (Daggett 2019: 3).

Histories of heat storage in this sense premediate the built interior as a dynamic space of social contestation: of the connection, now seemingly inevitable, between the mechanical (fossil-fueled) conditioning of the interior and the emissive (fossil-fueled) conditioning of the atmosphere. In order to play out the premise of the *active passive* solar house, I will explore and contextualize three significant entries in the history of residential heat storage. Geographically, these examples focus on North America in the context of broader global trends; historically, they are bracketed by World War II on one end, and the search for oil and other resources that the end of the war instigated, and the end of the second oil crisis in the 1970s (c. 1978) at the other end, a moment when the initial excitement about renewables in general and the solar house in particular began to wane. In each of these case studies, I aim to clarify the historical value of these buildings and also their promise, both materially and symbolically, for opening up new avenues for building, thinking, and living in solarity.

Löf House, Denver, CO, 1957

The George O. Löf House was built in Denver, Colorado, completed in 1957 (Figure 1). Löf was an engineer and collaborated with the Boulder-based

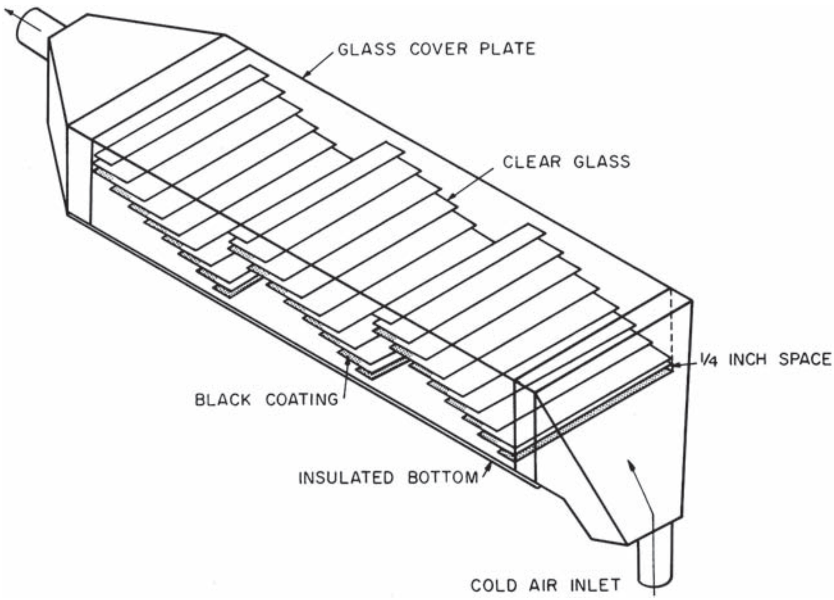


Figure 2. George O. Löf, overlapped plate collector, c. 1947.

architect James Hunter on the design of the house. The low, narrow building reflected what was, by then, a well understood set of principles in designing for solar heating: an open, glazed southern exposure, ideally of double-paned glass panels to allow for some insulation; a carefully determined roof extension that shaded the interior or let the sun it in according to seasonal patterns; and a narrow, compact design that allowed for most of the living spaces to be subject to these seasonal adjustments.

The Löf House was a living experiment in solar heating. The roof was flat, with solar collectors placed atop a plinth. The collectors were independent from the flat roof and angled for optimal absorption of radiation. Air circulated through these collectors (as opposed to water or another medium), and this heated air was then drawn by fans into the storage system. Löf deployed what he called the "overlapped plate collector": layered, overlapping glass plates, selectively painted with a black coating to maximize solar absorption, and encased in a sealed and insulated panel. These collectors generated relatively high heat conditions in relationship to the air outside (Figure 2).

Once heated, the air was circulated by fans to "heat storage beds" filled with river pebbles. These "beds" took the form of columns extending down the middle of the house's central stairway: as the heated air entered the columns, the pebbles would warm up and store the heat; as the air in the house (around the columns) cooled, the pebbles would release their heat and it would radiate into the house. There was also a mechanism to move this heated air through the building by means of forced air vents, familiar to other forms of furnace-based hot air heating systems (and complicating the passive denotation—some additional energy input was required to optimize the system).

The heat storage beds followed on a range of ongoing experiments in heat storage in the years immediately following World War II, which saw extensive experimentation in the design and technology of solar heating (before photovoltaics) (Barber 2016: 63ff). The most common medium of heat storage was water—circulated through solar collectors, the water would be heated and stored in an insulated tank. When house heat was needed, air could be blown over the warmed water and into the house. Löf's first such experiment, in a small house in Boulder, Colorado built in the 1910s (i.e., not designed as a solar house but retrofit) also used an overlapped plate collector and stored the heat in a pile of pebbles in the basement; the heat could be drawn into the interior as needed, as an adjunct to the house's existing furnace.

At Löf's Denver house, the columns were intended to be "worked into the decorative scheme of the house" and thus an essential aspect of the design—revealing rather than hiding the energy infrastructure (Figure 3). In order to make the house work, an elaborate regime was proposed, "a new living pattern," as Hunter, Löf's architect, put it: the occupants (the Löf family, dedicated to the promise of solar living), would be "happy to draw insulating curtains, adjust controlling louvers, and assist the sun in performing the tasks we have assigned to it" (Hunter 1956: 205). Around the same time, Hunter was the architectural consultant for an international competition to design a solar house. In the brief distributed to interested designers, he spoke of the potential occupants of the house as having "great respect for the sun and its influence on their way . . . they are adventuresome enough to commit themselves to this form of energy" (Hunter 1958: ii).

The Löf House was, technically, a hybrid system, relying both on the radiation of heat from surfaces and on the use of electrical fans and other adjuncts. It was similar to a number of experimental houses built by the Chemical Engineering Department at the Massachusetts Institute of Technology between the late 1930s and the early 1970s—Löf worked on the first of those houses while a student in the department. Like many of his colleagues, he was disappointed with the results and sought to innovate in both collector efficiency and storage possibilities. Maria Telkes, a researcher in the department in this period, quoted above, developed a method of heat storage using the phase-change capacity of chemical solutions, which would

Figure 3. Columns filled with heat-storing river pebbles, in the Löf House. Photograph courtesy Anthony Denzer.

solidify as they absorbed heat received from a panel, and then, as the air around them cooled, these chemical solutions would liquefy and radiate heat to the interior. Telkes used what she termed "heat bins," an analogue of Löf's heat beds: material insertions into the design of the house that stored collected heat for distribution as needed. Her system didn't work very well, though it initiated a research trajectory that has since borne significant fruit in the elaboration of phase-change materials (PCMs): standard building materials, such as sheetrock, in which such chemicals are embedded in order to give the material some capacity to store and later radiate heat.

At the Löf House, the equation was this: in order to articulate a viable solar heating system, one needed not only a carefully designed house, an effective solar panel, and an integrated storage system, but also a willing participant. Indeed, the role of the inhabitant was essential to activating the possibilities of solarity, in large part though managing various elements to optimize heat storage capacity. Importantly, especially for houses in cooler climates, this also implied a willingness to adjust one's expectations: to wear a sweater, for example, or focus time in warmer rooms. Solar energy for house heating required the willing participation of the inhabitant: it required activity.

Kelbaugh House, Princeton, NJ, 1974–75

The Kelbaugh House was designed and built by Douglass Kelbaugh in Princeton, New Jersey in 1974, after he graduated from the Princeton School

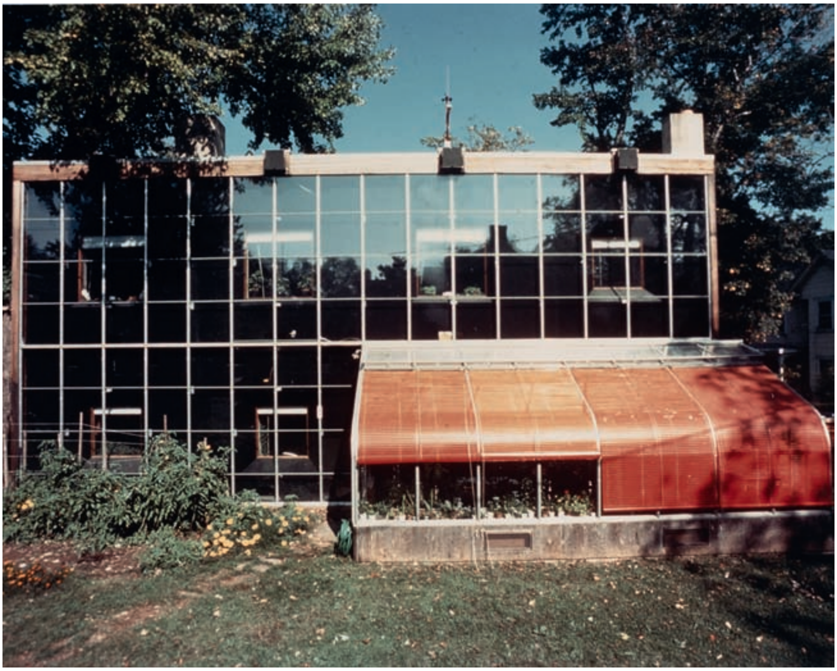


Figure 4. Douglass Kelbaugh, architect. Exterior view of Kelbaugh House, Princeton, New Jersey, USA, ca. 1975. Chromogenic color print, 20.5 x 24.5 cm, ARCH254206 Douglas Kelbaugh Fonds, Canadian Center for Architecture. Gift of Douglas Kelbaugh.

of Architecture in 1972 (Figure 4). It used what had become known as a Trombe Wall, alongside a range of insulation and ventilation techniques and living habits, to keep the house warm in the frigid Northeastern winter and to maintain comfort in the hot, humid summer.

The Trombe Wall, as a concept and a practice, was by this time well known. It follows a basic principle somewhat at odds with the open living of the house described above: in most post-war passive solar houses, the sun-exposed façade was filled with glass, both to bring the sun into the house and celebrate the solar lifestyle. The Trombe Wall instead takes advantage of solar radiation to maximize potentials of thermal mass: the sun-exposed wall has no (or few) windows, and consists of a thick membrane of a thermally dynamic material (usually concrete or masonry) that absorbs the radiation during the day, and distributes it to the interior at night. The principle is named after the French engineer Félix Trombe who, working with the architect Patrick Michel, designed a small experimental house in the Pyrenees with a wall of thick concrete in 1967 (Figure 5).

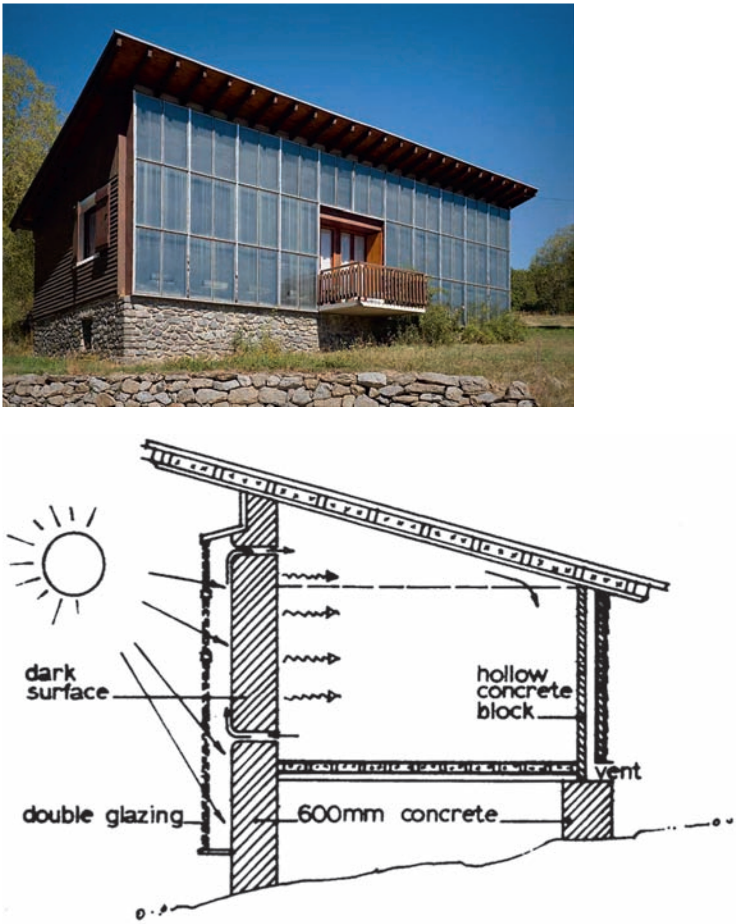


Figure 5. Felix Trombe and Patric Michel, Trombe House, near Odeillo, France, 1967. Photograph and sectional diagram.

The south façade at the Kelbaugh House is a 15-inch-thick concrete wall, set directly behind two panes of "double-strength window glass"; the wall was painted in a black "that absorbs more energy than it emits back." The concrete wall absorbs radiation, the double-paned glass sandwich holds that radiation in, and a series of flues, vents, and interior openings distribute the heated air around the house as needed. The sectional drawing uses the graphic strategy of arrows of varying thickness and trajectories to suggest the dynamism of the system (Figure 6). As Kelbaugh described it, "The warm wall and glass heat up the air which then rises up the slot"; the heated air can

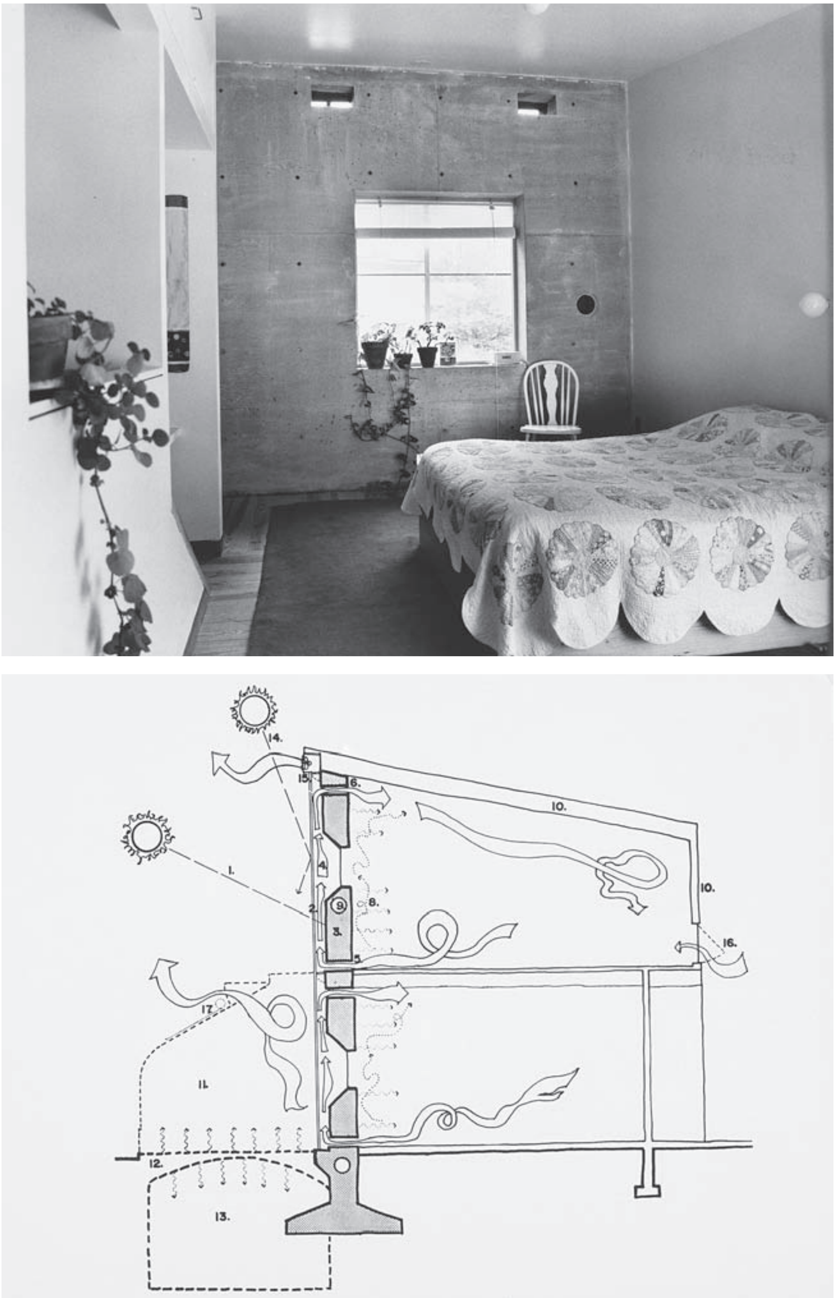


Figure 6. Douglas Kelbaugh, architect, Interior view of the Kelbaugh House, Princeton, New Jersey, USA, ca. 1975. Gelatin silver print, 20.5 x 25.5 cm, ARCH283920 Douglas Kelbaugh Fonds, Canadian Center for Architecture. Gift of Douglas Kelbaugh; and section showing the circulation by thermosphere for the Kelbaugh House, Princeton, New Jersey, USA, ca. 1975. Electrophotographic print on paper, 21.6 x 28.1 cm, ARCH254191 Douglas Kelbaugh Fonds, Canadian Center for Architecture. Gift of Douglas Kelbaugh, ©Douglas Kelbaugh.

be ventilated in the summer; in the winter, it is drawn into the house and heats the rooms—first the spaces closer to the wall and then the northern side of the house. The rising, heated air also pulls up more cold air into the system, allowing the process to continue. The house was heavily insulated so that a relatively small amount of radiation could keep it warm at most times of the year; there was also a small backup furnace system. The heating system also involved the greenhouse and the small cellar as heat storage.

The Kelbaugh house was but one example of the dynamic proliferation of the Trombe Wall and numerous other means of "passive" heat storage in the 1970s. Indeed, in the midst of that decade's oil scares, experiments proliferated. Alongside the Kelbaugh House, the best known is likely Steve Baer's house near Corrales, New Mexico, built in 1971 (Figure 7). The sun-exposed wall consisted of a gridded scaffold populated with ten-gallon drums filled with water. This scaffold sat barely inside the house, behind a protective, insulated metal-framed wall on a hinge: in the day time, the wall would sit flat in the front of the house, allowing solar radiation to heat the water in the drums; in the evening, the wall would be cranked up to seal the house, thereby providing a thick insulative membrane. The heat stored in the drums would radiate into the interior as the air around them cooled. Another example: the Aspen Airport Terminal designed by Copland, Sinholm, Hagman, Yaw Architects in 1975, in Aspen, Colorado, used a "Bead Wall" system (Figure 8). The south façade consisted of two thick layers of glass with an air cavity between. During the day, solar energy could flow into the interior; at night, the air cavity would be filled with Styrofoam beads in order to insulate the building and store the collected heat. As the sun rose, a vacuum would draw the beads back out, opening the building to radiation once more.

The period provided a number of opportunities for elaborations on and adjustments to formal and technological standards in the built environment, as a means towards maximizing energy efficiency. These practices were documented initially in journals, and very soon afterwards—still in the mid-1970s—in a number of government, university, and industry sponsored manuals. In 1975, a collaboration of firms in Harrisville, New Hampshire, under the name of Total Environmental Action produced the book *Solar Energy Housing Design in Four Climates* for the Research Corporation of the American Institute of Architects, under a grant funded by the National Bureau of Statistics. It was filled with schematic descriptions of different solar building types, lengthy indexes outlining recommendations for ideal diversion from a due south building orientation, as well as an index of precise tilt-angles, according to latitude and elevation, to maximize efficiency of solar collectors. A number of solar heating systems were described with

Figure 7. Steve Baer, Baer House, near Corrales, New Mexico, USA, 1971.

technical diagrams, more charts showing the precise relationship of the solar collector area to the cubic volume to be heated, and with plan drawings showing the most amenable distribution of interior rooms and programs according to solar conditions. Site plans and general climatic analyses (i.e., also including wind, precipitation, humidity) also accompanied these drawings, intending to provide a comprehensive approach for other sites and design challenges (Total Environmental Action 1975: 23). The catalogue was developed out of another book produced by the group in 1973 on "solar shelters;" Total Environmental Action also published a guide to "natural thermal heat storage" with the Department of Energy in 1979.

A collaboration between the AIA Research Corporation and the College of Architecture at Arizona State University (ASU) was one of the first attempts to comprehensively map the solar types appropriate to different solar regions, through documenting and analyzing built projects in each region. The Project Director, John I. Yellott, had been the Executive Director of the Association for Applied Solar Energy, headquartered at ASU, when it ran an international competition for a solar house in 1958 (the competition for which Löf's architect James Hunter was a consultant). In addition to general technical and design parameters, according to region, the book mostly consisted of examples laid out in identical format with an information sheet and a hand drawn perspective (Figure 9). Dates and location, participating designers and engineers, general climatic data, building size, and materials framed a precise discussion of collection area, heat storage system, and auxiliary systems. Relevant publications or notes from research team visits were

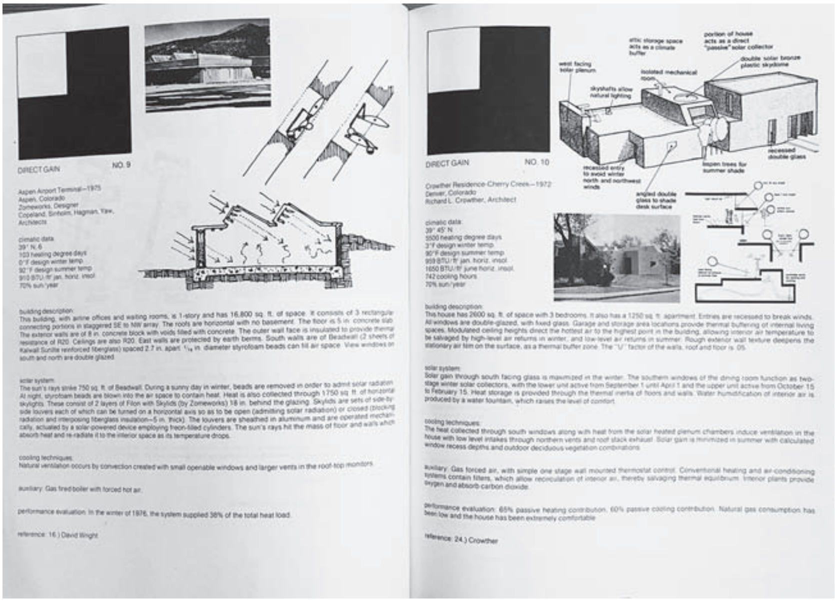


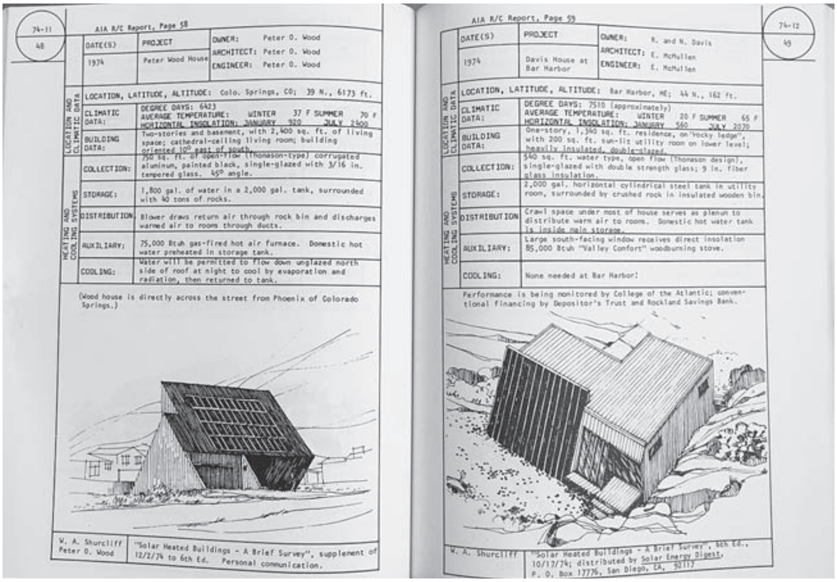
Figure 8. Copland, Sinholm, Hagman, Yaw Architects, Aspen Airport Terminal. Aspen, Colorado, USA, 1975.

also included. A final section of the book analyzed selected projects in more detail and proposed a rubric for best practices (Yellott 1975: 56ff).

A similar publication came out in 1979 from the AIA Research Group, the Office of Policy Development and Research and the Division of Energy, Building Technology, and Standards of the US Department of Housing and Urban Development, and the US Department of Energy. *A Survey of Passive Solar Buildings* was, again, organized according to both type and region; the book used photographs instead of axonometric drawings and focused its evaluation of the buildings it catalogued according to their performance since being built. Directly reflecting Telkes's 1947 intervention, the projects were indexed according to heat storage system, according to the following categories: Sunspace, Direct Gain, Roof Pond, Trombe Wall, Water Trombe Wall, and others (AIA Research Corporation 1978: 21ff) (Figure 10).

Saskatchewan Conservation House, 1977

A third house shifts the discussion. Designed by a committee of researchers led by Harold Orr and built in 1977 as part of the research efforts of the



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DATE(S)	1974
PROJECT	Peter Wood House
OWNER:	Peter O. Wood
ARCHITECT:	Peter O. Wood
ENGINEER:	Peter O. Wood
LOCATION, LATITUDE, ALTITUDE:	Colo. Springs, CO; 39 N., 6173 ft.
CLIMATIC DATA:	DEGREE DAYS: 6423 AVERAGE TEMPERATURE: WINTER 37 F SUMMER 70 F HORIZONTAL INSOLATION: JANUARY 920 JULY 2400
BUILDING DATA:	Two-stories and basement, with 2,400 sq. ft. of living space; cathedral-ceiling living room; building oriented 10° east of south.
COLLECTION:	750 sq. ft. of open-flow (Thomason-type) corrugated aluminum, painted black, single-glazed with 3/16 in. tempered glass. 45° angle.
STORAGE:	1,800 gal. of water in a 2,000 gal. tank, surrounded with 40 tons of rocks.
DISTRIBUTION	Blower draws return air through rock bin and discharges warmed air to rooms through ducts.
AUXILIARY:	75,000 Btuh gas-fired hot air furnace. Domestic hot water preheated in storage tank.
COOLING:	Water will be permitted to flow down unglazed north side of roof at night to cool by evaporation and radiation, then returned to tank.

LOCATION AND CLIMATIC DATA / HEATING AND COOLING SYSTEMS

(Wood house is directly across the street from Phoenix of Colorado Springs.)

W. A. Shurcliff Peter O. Wood — "Solar Heated Buildings - A Brief Survey", supplement of 12/2/74 to 6th Ed. Personal communication.

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DATE(S)	1974
PROJECT	Davis House at Bar Harbor
OWNER:	R. and N. Davis
ARCHITECT:	E. McMullen
ENGINEER:	E. McMullen
LOCATION, LATITUDE, ALTITUDE:	Bar Harbor, ME; 44 N., 162 ft.
CLIMATIC DATA:	DEGREE DAYS: 7510 (approximately) AVERAGE TEMPERATURE: WINTER 20 F SUMMER 65 F HORIZONTAL INSOLATION: JANUARY 560 JULY 2070
BUILDING DATA:	One-story, 1,340 sq. ft. residence, on "rocky ledge", with 200 sq. ft. sun-lit utility room on lower level; heavily insulated, double-glazed.
COLLECTION:	540 sq. ft. water type, open flow (Thomason design), single-glazed with double strength glass; 9 in. fiber glass insulation.
STORAGE:	2,000 gal. horizontal cylindrical steel tank in utility room, surrounded by crushed rock in insulated wooden bin.
DISTRIBUTION	Crawl space under most of house serves as plenum to distribute warm air to rooms. Domestic hot water tank is inside main storage.
AUXILIARY:	Large south-facing window receives direct insolation 85,000 Btuh "Valley Comfort" woodburning stove.
COOLING:	None needed at Bar Harbor!

LOCATION AND CLIMATIC DATA / HEATING AND COOLING SYSTEMS

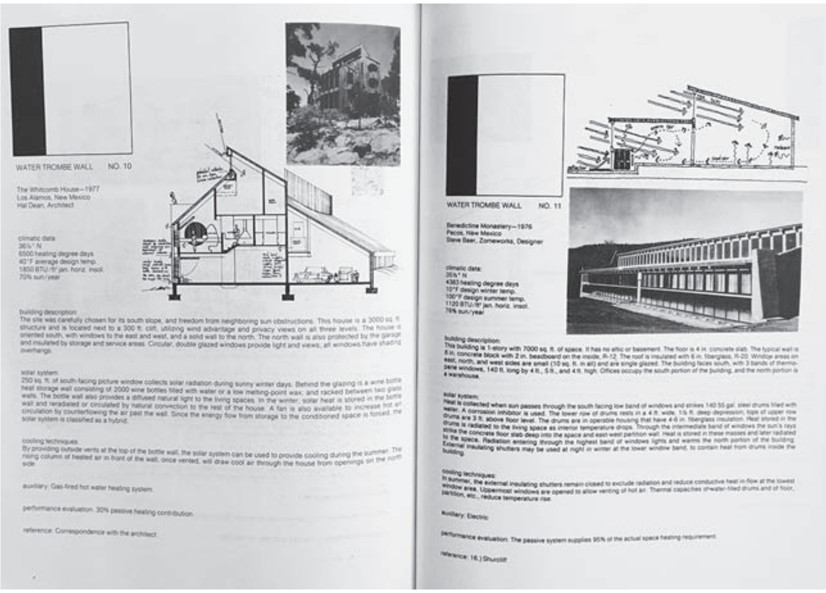
Performance is being monitored by College of the Atlantic; conventional financing by Depositor's Trust and Rockland Savings Bank.

W. A. Shurcliff — "Solar Heated Buildings - A Brief Survey", 6th Ed., 10/17/74; distributed by Solar Energy Digest, P. O. Box 17776, San Diego, CA, 92117

Figure 9. Spread from John I. Yellott, *Solar Oriented Architecture: 1975 Research Report*.

University of Saskatchewan, the Saskatchewan Conservation House relies less on precise methods of heat storage and more on the house itself as a super-insulated storage system. Insulation for the house was six to ten times that of typical construction in the period (Orr 2015) (Figure 11). The research team, having determined that the frigid northern winters did not justify solar heating, looked instead, as the "conservation" appellation suggest, at means of holding in the relatively small amount of radiation that was absorbed.

The nuclear physicist and solar housing advocate William Shurcliff celebrated the house's "thick, clever, and thorough insulation," as he began to advocate for insulation as the key factor to a successful renewable-energy based building in the late 1970s. In his 1981 book *Super Insulated Houses and Double Envelope Houses: A Survey of Principles and Practices*, he argued for the promise of a house that "is so well insulated, and is so airtight, that, throughout the winter, it is kept warm solely by (a) the modest amount of solar energy received through windows and (b) miscellaneous within-house heat sources;" the latter he lists as: "stoves for cooking, domestic hot water systems, clothes dryers, electric lights, clothes washing machines, dishwashing machines, human bodies, TV and radio sets, refrigerators, etc." (Shurcliff 1981: 44).



WATER TROMBE WALL NO. 10

The Whitcomb House—1977
Los Alamos, New Mexico
Hal Dean, Architect

climatic data:
36½° N
6500 heating degree days
40°F average design temp.
1850 BTU/ft² jan. horiz. insol.
70% sun/year

building description:
The site was carefully chosen for its south slope, and freedom from neighboring sun obstructions. This house is a 3000 sq. ft. structure and is located next to a 300 ft. cliff, utilizing wind advantage and privacy views on all three levels. The house is oriented south, with windows to the east and west, and a solid wall to the north. The north wall is also protected by the garage and insulated by storage and service areas. Circular, double glazed windows provide light and views; all windows have shading overhangs.

solar system:
250 sq. ft. of south-facing picture window collects solar radiation during sunny winter days. Behind the glazing is a wine bottle heat storage wall consisting of 2000 wine bottles filled with water or a low melting-point wax; and racked between two glass walls. The bottle wall also provides a diffused natural light to the living spaces. In the winter, solar heat is stored in the bottle wall and reradiated or circulated by natural convection to the rest of the house. A fan is also available to increase hot air circulation by counterflowing the air past the wall. Since the energy flow from storage to the conditioned space is forced, the solar system is classified as a hybrid.

cooling techniques:
By providing outside vents at the top of the bottle wall, the solar system can be used to provide cooling during the summer. The rising column of heated air in front of the wall, once vented, will draw cool air through the house from openings on the north side.

auxiliary: Gas-fired hot water heating system.

performance evaluation: 30% passive heating contribution.

reference: Correspondence with the architect.

WATER TROMBE WALL NO. 11

Benedictine Monastery—1976
Pecos, New Mexico
Steve Baer, Zomeworks, Designer

climatic data:
35½° N
4383 heating degree days
10°F design winter temp.
100°F design summer temp.
1120 BTU/ft² jan. horiz. insol.
76% sun/year

building description:
This building is 1-story with 7000 sq. ft. of space. It has no attic or basement. The floor is 4 in. concrete slab. The typical wall is 8 in. concrete block with 2 in. beadboard on the inside, R-12. The roof is insulated with 6 in. fiberglass, R-20. Window areas on east, north, and west sides are small (10 sq. ft. in all) and are single glazed. The building faces south, with 3 bands of thermopane windows, 140 ft. long by 4 ft., 5 ft., and 4 ft. high. Offices occupy the south portion of the building, and the north portion is a warehouse.

solar system:
Heat is collected when sun passes through the south facing low band of windows and strikes 140 55-gal. steel drums filled with water. A corrosion inhibitor is used. The lower row of drums rests in a 4 ft. wide, 1½ ft. deep depression; tops of upper row drums are 3 ft. above floor level. The drums are in operable housing that have 4-6 in. fiberglass insulation. Heat stored in the drums is radiated to the living space as interior temperature drops. Through the intermediate band of windows the sun's rays strike the concrete floor slab deep into the space and east-west partition wall. Heat is stored in these masses and later radiated to the space. Radiation entering through the highest band of windows lights and warms the north portion of the building. External insulating shutters may be used at night in winter at the lower window band, to contain heat from drums inside the building.

cooling techniques:
In summer, the external insulating shutters remain closed to exclude radiation and reduce conductive heat in-flow at the lowest window area. Uppermost windows are opened to allow venting of hot air. Thermal capacities of water-filled drums and of floor, partition, etc., reduce temperature rise.

auxiliary: Electric

performance evaluation: The passive system supplies 95% of the actual space heating requirement.

reference: 16.) Shurcliff

Figure 10. Spread from *A Survey of Passive Solar Buildings*, 1979.

Shurcliff was dismissive of much of the solar house activity of the 1970s glossed above; in a number of publications, such as *Solar Heated Buildings of North America: 120 Outstanding Examples*, he documented, analyzed, and critiqued what he saw as scattershot attempts to refine solar technologies (Shurcliff 1978: 13). He later told the *New York Times* that he published the book because trying to promote solar design "was infuriating . . . [in any given example] half the information was missing, and systems were vaguely described as 'ingenious' without explaining how they were ingenious or how well they worked. Sense had to be made of it" (Shurcliff 1980b). Rather than regulation, information could circulate, he proposed, as a means to improve methods and techniques.

The basic premise of super-insulation was later developed through experiments then ongoing in a number of departments of the emerging field of architectural science—in Saskatchewan, also at the University of Delaware, the University of Sydney, the Technical University of Denmark, and through a government funded research consortium in Aachen, Germany. In 1990, the German physicist Wolfgang Feist codified some of the knowledge and principles gained from these experiments in the form of the now well-known *Passivhaus* system (Feist et al. 2005).

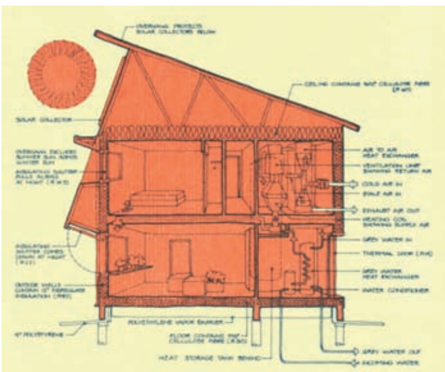


Figure 11. Saskatchewan Conservation House, near Regina, Saskatchewan, 1977; photograph of house and sectional diagram.

The emergence of super-insulation opens up two seemingly contradictory trajectories. On the one hand, the design guidelines that surround the passive house system suggest, indeed, a sort of passive engagement that eschews the active habitation that the previous two houses elicit. Once well designed, the implicit narrative goes, a passive house will not require extensive quotidian engagement from the occupant—in this regard, it follows the familiar path of other heating and cooling strategies. Tightly sealed against the elements, it relies on technical efficiencies rather than social practices to maximize its energy saving potential.

Yet, returning to Shurcliff in the late 1970s, a political position was embedded in this super insulative approach. Shurcliff's extensive review of solar house design ideas over the decade, while at times dismissive, other times celebrated the variety and creativity exhibited by the range of approaches. Shurcliff's 1976 article "The Case against Government Standards for the Solar Industry" aimed to substantiate the need for the *unregulated* elaboration of solar energy technologies, in the face of increasing governmental attempts to manage the solar energy market. In the US, the 1974 Solar Heating and Cooling Demonstration Act and the Solar Energy Research, Development and Demonstration Act regulated solar research and required the certification of solar energy systems. These were seen as intrusions on the free experimentation that was crucial to the solar design process; as Shurcliff (1980a: 26) put it, "mandatory criteria [established by the government] would tend to inhibit invention." Shurcliff's frustration reframes the active passive dynamic, suggesting a tether between the activities of the solar heated interior and broader political conditions and constellations.

Contingency and Solarity

The built world is contingent—every structure we inhabit was built according to a set of principles and priorities; every structure can be retrofit, or built again. Beyond the practicalities of solar living, the contingency of the built environment reflects back on a more general interrogation of the historical necessity of contemporary ways of life. As Andreas Malm (2016: 13), in his history of fossil capital, suggests with a potent building metaphor:

> Agents must have created [the fossil economy] through events amounting to a moment of construction, much as, once erected, a building's structure is now an enduring feature in the world; entrenched in the environment, it conditions the movements of the people inside. Eventually it appears indistinguishable from life itself: business as usual. But the fossil economy was once constructed and has since been reproduced and enlarged, and anything built over time can potentially be torn down (or escaped).

The history of solar house design is thus a past that has potent resonance with the future—for the future of architecture, to be sure, and also for how, on more general terms, we imagine, speculate upon, and design for life amidst increasing climate instability. *Active* systems are from this perspective *passive*: they assume a technological fix, with no demands on and little change to the social body—again, the solar roof tile simply replaces previous roof tiles, with no adjustments to the life going on in the house. *Passive* systems, on the other hand, require novel material engagements and focused attention to solar patterns, geophysical systems, and future possibilities relative to climatic and other conditions. They insist on the importance of individual and collective agency. In the *active passive* house, the epistemological framework is less one of the performance of technical efficiencies, and more one of how the habits, practices, and social values performed on the interior simultaneously reflect and induce new possibilities of zero carbon living.

This inversion has compelling resonance across the broader socio-political challenges of solarity. Solar energy has long been seen as a technology imbued with inherently democratic potentials: as Langdon Winner famously noted in 1980, advocates of the 1970s saw solar as desirable "not only for its economic and environmental benefits, but also for the salutary institutions it is likely to permit in other areas of public life" (21). Active solar energy, in the form of roof tiles indistinguishable from any other roof tile, seems to resist this general political premise; that is, the application of photovoltaics is more of a continuation of status quo patterns of extraction politics, corporate energy management, and the eco-modernist technical fix than it is a reimagining of social institutions towards new ways of life. Although the single-family houses described here fall far short of any political program or model for alternative activities, they nonetheless gesture, at the least, towards a novel disposition. Towards, in other words, eliciting a solarity that frames cultural transformation—active engagement with the production of new ways of life, often through design—as the site for exploration and research into the solar future.

References

AIA Research Corporation. 1978. *A Survey of Passive Solar Buildings*. Washington, DC: American Institute of Architects Research Corporation.

Ayres, Eugene, and Charles A. Scarlott. 1952. *Energy Sources: The Wealth of the World*. New York: McGraw Hill.

Barber, Daniel A. 2016. *A House in the Sun: Modern Architecture and Solar Energy in the Cold War*. New York: Oxford University Press.

Dagget, Care New. 2019. *The Birth of Energy: Fossil Fuels, Thermodynamics, and the Politics of Work*. Durham, NC: Duke University Press.

Feist, Wolfgang, Jürgen Schnieders, Viktor Dorer, and Anne Haas. 2005. "Re-Inventing Air Heating: Convenience and Comfort within the Frame of the Passive House Concept." *Energy and Buildings* 37, no. 11: 1186–1203.

Hunter, James. 1956. "The Architectural Problem." In *Proceedings of the World Symposium on Applied Solar Energy*. Menlo Park, CA: Stanford Research Institute.

Hunter, James. 1958. "Preface." In *Living with the Sun: Volume I: Sixty Plans Selected from the Entries in the 1957 International Architectural Competition to Design a Solar-Heated Residence*. Phoenix: Association for Applied Solar Energy.

Malm, Andreas. 2016. *Fossil Capital: The Rise of Steam Power and the Roots of Global Warming*. New York: Verso.

Orr, Harold. 2015. "Saskatchewan Conservation House." *Passipedia: The Passive Hosue Resource*, March 12. passipedia.org/basics/the_passive_house_-_historical_review/poineer_award/saskatchewan_conservation_house.

Shurcliff, William. 1978. *Solar Heated Buildings of North America: 120 Outstanding Examples*. Baltimore, MD: Brick House.

Shurcliff, William. 1980a. "The Case against Government Standards for the Solar Industry." In *Notes from the Energy Underground* edited by Malcolm Wells, 26–28. New York: Van Nostrand Reinhold.

Shurcliff, William. 1980b. "A Pioneer Inventor Recalls the Dawn." *New York Times*, December 4. timesmachine.nytimes.com/timesmachine/1980/12/04/111320946.pdf?pdf_redirect=true&ip=0.

Shurcliff, William. 1981. *Super Insulated Houses and Double-Envelope Houses*. Baltimore, MD: Brick House.

Telkes, Maria. 1947. "Solar House Heating: A Problem of Heat Storage." *Heating and Ventilating* 44, no. 5: 12–17.

Total Environmental Action. 1975. *Solar Energy Housing Design in Four Climates*. Harrisville, New Hampshire: Total Environmental Action.

Winner, Langdon. 1980. "Do Artifacts Have Politics?" *Daedalus* 109, no. 1: 121–36.

Yellott, John I. 1975. *Solar Oriented Architecture: 1975 Research Report*. Tempe, AZ: Arizona State University.