Renewable and Sustainable Energy Transition 4 (2023) 100066

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Transition

journal homepage: www.journals.elsevier.com/renewable-and-sustainable-energy-transition

Solar architecture and the sufficiency imperative

Daniel A. Barber

University of Technology Sydney - City Campus Sydney, Australia

ARTICLE INFO

Keywords:
Solar energy
Architecture
Renewable energy
Design method
Energy policy

ABSTRACT

It is hard to assess the pace and prospects of the solar revolution and the just energy transition. In architecture solar energy continues to be seen as a salve, a convenient and effective response to the forces – social, regulatory, economic – pushing for more and more efficient energy use in buildings. Photovoltaics solve everyone's problem: the building's form and program do not change dramatically, the renewable industry is furthered in its boom, savings in energy bills follow. Occupancy of the building goes on more or less as before.

Yet the application of solar panels to a building, not to mention the prospect for more and more expansive solar farms, reproduces the extractive model of fossil fuels. Rare earth materials need to be mined and shipped. The manufacturing process is toxic. The beneficiaries tend to be those who can already afford to save and conserve. The clean are getting cleaner, while those struggling with energy supply are less frequently benefited. The panels need to be replaced relatively frequently, yoking economies to resource dependencies sure to be exacerbated as electricity demand swells. Amidst the broad discourse around the just energy transition, photovoltaic solar energy is itself most likely transitional, contingent and conditional.

The analysis of architecture provides a few windows on to the nuances and challenges of this next phase of the just energy transition – on how we can collectively think differently around resources and their provision in our buildings, as a site for both collectivization and social transformation.

It can be difficult to assess the pace and prospects of the solar revolution, and the just energy transition in general. In architecture solar energy continues to be seen as something of a salve, a convenient and effective response to the forces – social, regulatory, economic – pushing for more efficient energy use in buildings. Photovoltaics in particular seem to solve everyone's problem: the building's form and program do not change dramatically, the renewable industry is furthered in its boom, savings in energy bills follow. Occupancy of the building goes on more or less as before.

Yet, as many have noted, the application of solar panels to a building, not to mention the prospect for more and more expansive solar farms, reproduces the extractive structural model of fossil fuels. Rare earth materials need to be mined and shipped. The manufacturing process is glaringly toxic. The beneficiaries tend to be those – individually, and in terms of national economies – who can already afford to save and conserve. The clean are getting cleaner, while those struggling with energy supply are less obviously and less frequently benefited. The panels need to be replaced relatively frequently, yoking economies to resource dependencies sure to be exacerbated as electricity demand swells. Amidst the broad discourse around the just energy transition, photovoltaic solar energy is itself most likely transitional, contingent and conditional, however ascendant and inevitable it may seem today.

Yet the analysis of architecture provides a few windows on to some of the nuances and challenges of this next phase of the just energy transition – on how we can collectively think differently around resources and their provision in our buildings, as a site for social transformation. These windows are especially clear when considering the intensification of solar opportunities within financial constraints.

First window: the doctrine of *efficiency* is losing its social value and technical applicability. In the April 2022 *Mitigation Report* from the Intergovernmental Panel on Climate Change, in the chapter on the building industry, this shift away from an efficiency imperative was made clear. Over the past four decades, since the emergence of so-called sustainable or green architecture, efficiency has been the focus: how can architects provide a building more or less recognizable in form and function, but do so while demanding less operational energy? Complex façade panels – made of layers of glass and inert gasses to increase insulation – have been one prominent aspect; solar panels another, alongside natural ventilation, updated HVAC systems, as well as thermally-active materials, low energy elevators and other systems. Architects frequently collaborate closely with engineers and specialized consultants to optimize the energy efficiency potential of a given project.

E-mail address: daniel.barber@uts.edu.au.

https://doi.org/10.1016/j.rset.2023.100066
Received 26 April 2023; Received in revised form 13 September 2023; Accepted 14 September 2023
Available online 18 September 2023

The same product, with more efficient operating costs.

The challenge to efficiency comes from increasing awareness around embodied energy and life cycle analysis. The amount of carbon involved in the construction of the building – the materials used, their delivery to the site, their eventual dismantling or destruction are all taken into account in assessing the embodied energy of a building project. Efficiency has relied almost exclusively on savings in operational or maintenance energy – how much it costs, in carbon and dollars, to run the building, regardless of the conditions of its construction. This led to a model that involves investing heavily in upfront costs (again, in carbon and dollars) in order to elicit savings in the ongoing costs of, for example, heating and air conditioning. Taking the life cycle of the project into account, the high embodied energy of glass, steel, and concrete often overwhelms the proposed eco-logic of many sustainable projects. Widening the boundaries of a building's analysis to include embodied energy, as well as the vagaries of occupancy and use, offers a different trajectory for the social value of the sustainability movement in architecture since its emergence in the late 1980s.

These new terms and expanded scope of a building or urban analysis opens up opportunities for rethinking the methods and practices of sustainable design. Per the IPCC *Mitigation Report* from April 2022, "in most regions, historical improvements in efficiency have been approximately matched by growth in floor area per capita (*high confidence*)." Buildings are more efficient, but they are also bigger, and more numerous. The skyline of most urban centres, especially in over-industrialized economies, are even now punctured by cranes, promising more 'green' development when in many cases we simply might need less. "*Sufficiency*," the report notes, with an implicit patina of hope, "differs from *efficiency*. *Sufficiency* is about long-term actions driven by non-technological solutions, which consume less energy in absolute terms. *Efficiency*, in contrast is about continuous short-term marginal technological improvements" [1].

One non-technological solution that has arisen with great interest in these same overdeveloped economies is that of reuse and retrofit – "never demolish" the Pritzker prize winning firm Lacaton and Vassal have adapted as their mantra; "Europe has already been built" others intone, while still others call for a moratorium – again, in the over-industrialized economies – on new building construction, suggesting that housing needs and other growth pressures can be filled be reimagining and redistributing existing building stock. Lacaton and Vassal and many others have decidedly proven that the creative, technological, and programmatic interventions endemic to architectural thinking are appropriate to the context of adaptive reuse. Reuse presents a challenge to the status quo of development and economic growth that is also a creative opportunity for savvy design researchers and practitioners, implicitly restructuring the social role for architecture. A new set of constraints in which to demonstrate a collective ingenuity. That these constraints are also often about financial considerations suggests an even wider horizon for the consideration of solar energy as part of reuse projects.

The most sustainable building is the one that already exists, available for selective programmatic reuse, energy retrofit, and reimagination of its role in the urban fabric. Reuse pursues the sufficiency imperative. The specter of reuse allows us to recognize even when a new building attains the highest performance rating – so many are still being built it is still what the IPCC, again, refers to as a "lock-in" building: locking in more carbon, locking in more atmospheric instability, locking in more death, violence, and destruction of homes and habitats. Every building, no matter how efficient, is a small fossil fuel energy generation system, due to be decommissioned. Every existing building is available to redesigned according to the sufficiency imperative.

A second window: this sufficiency imperative has a history, a slightly beguiling one, emergent at another moment, in the relatively recent past, when concern about financial constraints and energy resources were very much on the table. In the late 1940s and early 1950s, in the booming post-war American economy, there was some anxiety about where energy for economic growth would come from. It seems anomalous, largely because by the mid 1950s such anxieties had been quelled by diplomatic and military aggression into the Middle East and Venezuela, a sort of corporate capture of robust petroleum reserves that shifted the logic towards a global fossil fuel regime. But for a brief few years, before the extent of these reserves were known or rendered available to American and European consumers, other sources were on the table – solar, wind, shale, and nuclear energy were all the subject of debate from the end of World War II until about 1955.

The solar house was an essential aspect of this discussion, relative to the expansion into the suburbs in the United States in particular, and also relative to the parallel formation of economic aid and technological assistance programs increasingly popular as a means of managing the global resource condition and of affirming the distinction between East and West. A memo drafted in Eisenhower's Interior Department, just after the relative collapse of the Atoms for Peace program, proposed a "World Solar Energy Project" that envisioned American engineers disseminating solar energy knowledge to so-called developing economies as a means to improve their quality of life while also securing those economies as trading partners, safe from Soviet influence [2]The economic constraints of these developing countries was, to these engineers and bureacrats, an opportunity for a sort of solar diplomacy.

The World Solar Energy Project, proposed in 1954, was not about photovoltaics; it was not focused on the transfer of technological objects (solar panels) so much as technological expertise, and on design knowledge in which the premise of sufficiency was deeply embedded. It was at the same time a transfer of knowledge from two social and political contexts, finally constrained in different ways. It was one of many such technical assistance and knowledge transfer programs in the period, an important aspect of the soft power essential to elaborating cold war divides. While US policy makers were eager to establish a robust economic system based on their own industrial drivers, as well as promoting a culture of consumption, others saw a new way of life emergent after the war: one that relied on a different relationship to needs and desires, based on a different relationship to the sun. Solar power was here a catalyst for considering how demand management could raise quality of life even in the context of financial constraints.

In 1953, for example, *Fortune* editor Erik Hodgins imagined a "not-so-utopian house" premised "on the assumption that the day is coming when population [growth] will make wheat fields and cattle ranges luxuries of the dear dead past" [3]. This small house for a family of four displayed what were by then well-developed principles in passive solar design: south facing, a carefully designed eave to block the summer sun and let the winter sun in, and a principle of sufficient living in terms of the programming of the interior. Hodgins' commissioned drawing also shows a roof covered with algae, "a steady stream about two inches thick of a deep green algal suspension would be pumped over the roof" powered by the burning of trash in the garage. "The reporter of the future" Hodgins concluded, "will certainly hail it as a great achievement when our crowded great grandchildren shall subsist contentedly on hydrolyzed sawdust and vitaminized algae" [4]. Not so utopian indeed. Hodgins' proto-*Population Bomb* panic about "population" – even in the 50 s something of a racist dog whistle (albeit more regional than global) – clarifies some related arguments, later in the 1980s, about the implicit politics of solar energy [5]. Hodgins' project was implicitly nationalistic and xenophobic; as a result it relied on a "massive government funds, on just such a scale as went in to producing the nuclear bomb, applied to every aspect of research to improve solar-energy utilization" [6] Again, the roots of neoliberalism emerging as part of the opportunity of living with the sun.

Around the same time, at the Museum of Modern Art in New York, the housing advocate and curator Elizabeth Mock developed an exhibition and pamphlet intended for the returning servicemen after the war, and their small but likely growing families, to use in envisioning their homes in the suburbs. The exhibition *Tomorrow's Small House* presented scale models of suburban houses – they had originally been published in *Ladies Home Journal* as photographs of the models placed into careful landscape arrangements, a rendering of a possible future. *Journal* editor Richard Pratt called them "small but 'really adequate' houses which would dramatize the benefits of modern planning and building techniques." The 17 houses explored the passive solar principle, modular construction, and an approach to programming that embraced a principle of sufficiency [7].

A final example: In 1959, by which time the flow of oil had flooded and overwhelmed much of this early energy anxiety, sufficient solar houses were nonetheless still being designed and proposed. A design competition for a solar house, organized by the Association for Applied Solar Energy (now the International Solar Energy Society) laid out in its brief that the envisioned occupants where "adventuresome enough" to adjust their lives according to the vicissitudes of passive solar heating: willing not only to live in a smaller house but one that demanded engagement with shades and curtains, or seasonal occupation of some spaces over others [8]. A good life, or at least enough of one.

The IPCC's *Mitigation Report* also uses the terms "demand management" to clarify the prospects for the sufficiency imperative. What one needs, or desires, is part of what is at stake in reconsidering the energy mix of the present and near future. This is less a call for austerity than for creativity, and the flowering of a new kind of imaginary – how can one live comfortably in a world with less oil? In part through replacing means of energy provision with renewable sources – solar, wind, and geothermal covering some of the demand that fossil fuels now meet. But also becoming comfortable with less comfort – cultivating new desires and aspirations that are not for something inherently *less*, but that recognize a different kind of adventure is here and on the horizon – one that offers opportunities for collectivity and sufficiency, in the context of economic and other constraints, and that not only saves energy but improves global public health and quality of life.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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