Tomorrow's House: Solar Energy and the Suburban Territorial Project, 1938-1947

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As the imperative for sustainable design preoccupies the discourse of architecture today, the push to reconceive the place of architectural design amidst the global energy metabolism allows for many new points for interdisciplinary intervention, and also for new historical narratives. One of the most compelling elements of these emerging challenges revolves around the reconsideration of energy in its territorial context - as in the "Map of Eneropa," developed in April 2010 by AMO as part of the Roadmap 2050 project of the European Climate Foundation [figure 1].¹ The map redraws the boundaries of Europe to postulate the need for re-conceived boundary conditions - national, professional, disciplinary - in order to expand on the promise of possible infrastructural adjustments. Of further interest here is the conflation of these political and infrastructural transformations with changes in lifestyle - the air balloon, floating over the hydro-electric power installation, celebrates new habits and ways of living in this vision of a post-carbon Europe, and is as important to the image as the projected rate of kilowatt production.

In what follows, I want to reflect on this imagined imbrication of infrastructural innovation and lifestyle expansion by describing an earlier episode when the relationship between design and the territorial organization of energy production was on the minds of architects. In the period surrounding World War II, experimentation in solar house heating was seen, briefly, as a necessary component to managing the demographic and economic expansion into suburbia. Developed through familiar design tropes of architectural modernism – including the expansive use of glass, the open plan and façade, and the



Figure 1a. OMA/AMO, Map of Eneropa, 2010.



Figure 1b. OMA/AMO, *Map of Eneropa*, 2010: a scene from "Central Hydropia"

flexible roof line – solar radiation for passive heating was an important site for technological innovation characteristic of American developments of Modern Architecture in the period; it also allows us to expand on the relationship between the suburban house, its infrastructure, and the attendant geopolitical complications of energy provision. At stake is not only the excavation of a compelling historical precedent for architects exploring the global problematics of energy and the environment, but even more so the spatial and territorial implications of cultural practices.

1: "THE PROVEN MERITS OF THE SOLAR HOUSE"

In order to arrive at the solar house and its infrastructural implications, we start with brief reference to a familiar episode: the Case Study House program, organized by the journal *Arts and Architecture* from 1945-1963. Widely considered "one of the landmark chapters in post-World War II architecture," the Case Study houses are also seen by many as the moment when the international architectural discourse shifted its attention from Europe to the United States.² In a 1989 appreciation of the program, Esther McCoy, who had chronicled the Case Study Houses from the early 50s, wrote as follows:

The most innovative of the early projects was Ralph Rapson's #4, of 1945, which he called a 'greenbelt house'. It describes well the yearnings of mid 1940s. Rapson's rendering of the house showed a helicopter hovering over the flat roof, as if the owner was coming home to the suburbs from his day at the office. His wife is waving to him. Where is she? Hanging out diapers in the drying yard. Rapson's money was on the wrong machine.³

Already, then, a trace of the contested social implications of technological innovations [figure 2]. While the clothes dryer soon replaced the drying yard as part of the post-war consumer boom in domestic appliances, Rapson's gamble on the helicopter not only prefigures AMO's air balloon but also registers a persistent hope, in the architectural discourse, for how the industrial war machine would be repurposed for peacetime uses - the domestic helicopter was a frequent image in wartime advertising as an "anticipatory tease" for the flowering of applied technology once atrocities, and the industrial engine that conditioned them, subsided.⁴ In this sense, aerial commutation was, like the solar house, a vision of the promise of modernity.

More than the indication of the poor judgment of the youthful architect, then, the "Greenbelt House" drawing is symptomatic of the heated debates over the ramifications of energy infrastructure that preoccupied politicians, technologists, and even some architects during World War II; we will return to it at some length below. Rapson, part of the generation of architects trained in modern design strategies by European émigrés in the late 30s was, like many of his colleagues, enmeshed in discussions of technological possibility. For our purposes today, Rapson operates as an effective guide to the expanded technological disposition of the modern house during the war - a disposition that, on the one hand, included the solar house as an important experimental component and that, on the other hand, directly connected technological experimentation in architecture to wartime debates over the infrastructure of energy and the need for new forms of living in the post-war future.



Figure 2. Ralph Rapson, *Case Study House #4: the Greenbelt House*, 1945.

Rapson trained at Cranbrook under Eliel Saarinen, graduating in 1939. He joined Saarinen's office to work on *Demountable Space*, one of the more prominent pre-war attempts at designing a prefabricated building system. In 1941 Rapson left for Chicago, and entered the office of Keck and Keck Architects while also, as we will see below, working on a number of speculative projects. Rapson arrived in Chicago just as George Fred Keck, the lead designer of the firm, was becoming involved in a multi-faceted inquiry into the possibilities of solar house heating.⁵

Keck's interest in solar housing was initiated through a decidedly non-solar project - but one that nonetheless reflects the technological and cultural aspirations of the American architectural discourse of the period: his House of Tomorrow, built for the Chicago "Century of Progress" World's Fair in 1933. A dodecagonal structure filled with the latest in lighting technology, appliances, and air conditioning, and completely glazed, floor-toceiling, on all twelve facades of the second and third floors, the House of Tomorrow was visited by thousands and became an iconic representation of the modern house in America.⁶ While important as a symbol of modernity, the single-paned all glass façade was detrimental to the house's climatic performance. Keck documented his experience of the unbearable heat in the house on a hot summer day as central to his interest in integrating shading systems in house design, while the frigid interior in the winter encouraged the glass company Libbey-Owens-Ford, the house's corporate sponsor, in its attempts to develop an insulating glass panel.7

Of course, the basic principle of managing seasonal heat gains and losses through shading devices and south-facing windows has been an element of house design for centuries. The designed relationship to the sun was also the subject of some interest in the modern architectural discourse of the 1930s; indeed, while it is beyond the scope of the present discussion, one could connect many prominent examples of inter-war European architecture by virtue of a dual interest in the planametric implications of solar orientation and technological innovation in glass production. In two iconic examples, the jardins suspendu of Le Corbusier's Villa Savoye (1928) were intended, as Le Corbusier wrote, to bring the "sun into the very heart of the house" for light, heat, and health.8 Mies van der Rohe's plate glass wall in the Tugendhat House (1930) was mechanized to sink into the floor below, opening the living space onto the terrace; combined with a conservatory that operated as both a greenhouse and a thermal buffer, the house exhibited, as Colin Porteous has recently written, "a remarkable ability to opportunistically take advantage of fine weather."9

Such opportunism was not directed towards house heating. However, contemporaneous developments extended this interest towards research on the dynamic between site orientation, disposition of the open plan and the roof overhang, and innovations in the thermal qualities of glass. In 1931, as an attempt to encourage cost-effective means of building in an English countryside still in the throes of the Great Depression, the Royal Institute of British Architects sponsored and published an analysis into the radiation properties of the sun's seasonal path and introduced the term 'insolation' - the absorption of solar radiation - into the architectural vocabulary.¹⁰ Maxwell Fry's 1935 Sun House, in London, was planned according to the RIBA diagrams, as was Serge Chermayeff's House at Sussex of 1938, with a fully glazed south facade and precise roof overhangs for summer shading - perhaps the first indication of a proper history of the modern solar house.¹¹

Here again, however, the poor insulation of the all glass facade compromised the performance of these houses. Soon after a 1932 article in Architectural Forum presented the RIBA research to the American architectural discourse, and following his experience with the House of Tomorrow, Keck became interested in combining the design principles of maximizing solar insolation and the technological properties of multi-paned glass that could maximize insulation, thereby retaining solar radiation for space heating purposes.¹² In order to do so he collaborated with Libbey Owens Ford - the company that had sponsored the House of Tomorrow – to refine an insulated glass panel. By 1937 this collaboration led to "Thermopane," a sealed panel in which two panes of glass surround an air cavity, though delicate, it provided significant insulative properties.13

Beginning with Keck's *Sloan House* in 1939, the planametric and material template for a 'solar house' emerged [figure 3]. These long, narrow houses had a south-facing façade, almost fully glazed, on which all of the living spaces were placed. The delicacy of Thermopane meant that many of the glass panels were fixed in place, often alternating with operable windows or surrounded with ventilating panels. Keck's early experiments, following the RIBA and other analyses described above, also led to a precisely tuned design process of correlating the roof projection to seasonal solar angles, which allowed for complete shading in the summer and the penetration of sunlight and heat deep into the interior in the winter. In concert with Thermopane, these houses thus maximized both insolation and insulation in the winter: again, this dual maximization was the distinction of the modern solar house, as a fully glazed *and* insulated southern façade deployed the formal and material tropes of modern architecture as an auxiliary heating system.

By the time Rapson joined the firm in 1941, Keck was in the midst of a solar building boom across the northern mid-west, with variations on this basic template. Numerous other architects were also pursuing solar design strategies, and the "solar house" was well received in both the popular and professional press.¹⁴ Many were published in a "Portfolio of Modern Houses" in *Architectural Forum* in September 1942; a *Reader's Digest* article in December 1943 referred to Keck's 1941 *Duncan House* as "the most exciting architectural news in decades."¹⁵ By 1945 the solar house was seen, as *Architectural Forum* editor's George Nelson and Henry Wright wrote in their book *Tomorrow's House: How to Plan Your Postwar House Now*, as



Figure 3. George Fred Keck, *Howard Sloan House*, outside Chicago, 1939.

"typical of the very best developments in modern house design."¹⁶ And typical they were -with

wide expanses of glass, radiant floor heating, experimental use of new materials, open plans with flexible room partitions, and careful site orientation, these houses are readily placed in the context of numerous contemporaneous experiments in residential design.¹⁷ As the solar house became emblematic of the cultural expansiveness and costefficient pragmatism of American modernism, it came to be seen by many as a necessary component of suburban expansion after the war.¹⁸

The conflation of the modern and the solar house was further reiterated in a compendium organized by Libby Owens Ford in 1944, though not published until after the war, called Your Solar House: A Book of Practical Homes for all Parts of the Country, by 49 of America's Leading Architects, Containing 49 Sets of Plans and Drawings, Together with Many Suggestions for the Home Builder, in which the glass company commissioned a number of prominent architects to propose solar house designs, organized by state.¹⁹ While the modern pedigree is clear both in the names of the architect's associated with the project and in the designs presented - aside from the arrow pointing north, away from a facade presumably glazed with Thermopane, one is hard pressed to distinguish the solar aspect of many of these houses from their contemporaries. Which, in the end, was part of Libbey Owens Ford's point, and one that we will return to below.

At the same time, the precise maximization of both the insolative and insulative properties of the solar house instrumentalized modern design principles on new and different terms. As the writers of Tomorrow's House continued, "from here on, anyone who plans a house without giving serious consideration to the operation of the solar house principle is missing a wonderful chance to get a better house, a more interesting house, and house that is cheaper to run." 20 This last point was paramount. When the U.S. fully committed to the war in late 1941 the price of heating oil increased dramaticaly. Keck's solar houses were also featured in an Architectural Forum article of September 1943 entitled, "Does Modern Architecture Pay?" in which the client of the Sloan House, a developer, boasted of his documented 60% savings in heating costs as an effective marketing tool for the subdivision of "Solar Park" which he had built with Keck at the end of 1942. As Sloan wrote in Forum, "[Solar Park] was born in trying times. Hitler was fast overrunning Europe, prospective customers were becoming jittery, prices were going up. In spite of these difficulties, solar houses... sold faster than we could build them."²¹

Sloan's comments blithely connect the distinction of the solar house to an array of wartime complications - concerns over energy foremost among them. In December 1943, Harold Ickes, the U.S. Secretary of the Interior and, since 1941, head of the Petroleum Administration for War, published an article provocatively titled "We're Running out of Oil!;" indicating that "we no longer deserve to be listed with Russia and the British Empire as one of the 'Have' nations of the world. We should be listed instead with the 'have-nots,' such as Germany and Japan." 22 Such concerns were directly legible in the architectural press, as a November 1944 editorial in Arts and Architecture, for example, bemoaned the "the effect of shrinking oil reserves on home heating" and "the inevitability that we shall have to depend on oil fields as far away as Russia, Iraq, Iran, Egypt and Romania."23 The technological disposition of the modern solar house is thus a potent indication of the impact of wartime anxiety on broader transformations to the American architectural discourse in this period - transformations also characterized by interest in prefabrication, flexible programming, and the use of new materials; as well as newly conceived in relationship to financing structures, insurance regimes, and regional planning - in which design strategies were seen to coalesce a wide array of practices and policies and to mitigate the unpredictability of both geopolitical and geophysical forces as 'Tomorrow's House' was becoming today's.

2: "WHAT IS A HOUSE?"

These multivalent engagements of the modern solar house provide an opportunity to expand our discussion to the broader speculative trends of American architectural practices during the war, concerned with both technological innovation and the challenges of suburban expansion, and also to suggest a more general emergence by which developments on the cultural sphere became tightly connected – across a discursive and multivalent web of infrastructural, institutional, and subjective relations – with policy imperatives.²⁴ To do so, we return to the developing context for Rapson's *Case Study House #4: the Greenbelt House*. When

introducing the Case Study House program in January 1945, *Arts and Architecture* editor John Entenza wrote: "That building is likely to begin again where it left off is something we frankly do not believe. Not only in very practical changes of materials and techniques but in the distribution and financing of these materials lie factors that are likely to expand considerably the definition of what we mean when we now say the word 'house'."²⁵ During World War II, the entire system of home building, from its economic position to its political complications to its vast potential for technological innovation, was under analysis.

It is important, in this context, to distinguish between the seeming inevitability of the suburban disposition of the post-war housing boom, which didn't begin in earnest until after the Housing Act of 1949, and the visions of the post-war future proposed by planners, economists, and architects during the war. That the war involved a massive technological, cultural, and infrastructural reconfiguration is well documented; less evident is the fact that, at the time, this reconfiguration was seen to have the potential for many different possible futures.²⁶ On the one hand, suburban patterns were embedded in wartime economic expansion: the rapid growth of wartime factory production facilities relied on a vastly expanded road network, the beginnings of an air transportation system, and new methods in the production of housing – though much of it in multi-family apartment blocks.27 On the other hand, much of this expansion, especially as regards housing, was seen as temporary: it was not clear, in the midst of the process, how such growth would persist after the war, even as the need for housing returning veterans and their anticipated families became increasingly urgent.²⁸ More than attempting to consolidate suburban patterns, the important question for architects and planners during the war was how innovations and interventions in home design could accommodate this uncertainty, and how technology could mediate the adaptation to new, and as yet undefined, living conditions. In other words, even though a suburban infrastructure was growing rapidly during the war, the disposition of this growth on terms of energy, economics, and cultural change was less clear.

This uncertainty was both reflected in the wartime speculative work of architects and taken as a literal theme for exploration. The September 1942 issue of

Architectural Forum exemplified the trend. Published less than a year after the U.S. fully committed to the war - and a month after Forum's first feature article on solar houses - the issue contained an 87-page spread on "the New House 194x;" it was an explicit attempt to read the possibilities for post-war living inherent in the industrial, economic, and political uncertainties of wartime production. Architects, as the editors made clear, were on the front lines: "It is everywhere recognized that the end of the war will bring about vast changes in our everyday lives. These changes will affect habits of consumption and methods of production, and inevitably will be reflected in the physical form of the world in which we live - and which it is the business of designers to mold."29 The editors further summarized the issue as evidence of a broad transformation to the conception of the house, in which its productive and infrastructural parameters were transformed by new industrial possibilities, and reflected in a dramatic programmatic shift. Their directions to the architects were organized around descriptions of rooms - "kitchen-work-center," "bathroom," "storage," and "living room" - and the changing role of these categories in the physical and social construction of domestic space. "The functions of the living room," for example, as the editors wrote, "are exceedingly complicated... and there is always the possibility that these room designations, and the compromises they represent, will give way to some more functional subdivision of the house."³⁰

Rapson's "194x" proposal, in collaboration with his Cranbrook colleague David Runnels, was for a "Fabric House," a light steel frame covered with a hybrid wall-element that operated as cladding, insulation, and water protection, and which could not only accommodate numerous design configurations but could also be changed by the user at will: "since all walls and roof are fabric, with one-inch light metal telescopic pipe integrated with the [fabric] rolls, maximum freedom of planning results."31 As the architects continued, "the postwar individual, long weary of wartime regulations and restrictions, will demand the freedom for which he fought... since every family has ever changing requirements, shelter must have one major characteristic - flexibility." 32 If Rapson and Runnels' conflation of the flexible house with political and economic liberation is perhaps overly simplistic, it is nonetheless symptomatic of the hope embedded in many architectural proposals of the period: the premise of programmatic indeterminacy was a pervasive component of the pronounced tendency of many architectural proposals that saw the wartime re-tooling of the American industrial infrastructure as an opportunity to produce visions of the how such large-scale reconfigurations could be redeployed towards new forms of living in the post-war future.

In "194x" the trope of flexibility was everywhere. The simple title of "flexible space" headed entries from Skidmore, Owings and Merrill and also one by William W. Wurster. The SOM proposal included modular furniture and wall units to allow for changes in the family home as the family itself grew or shrunk. John Porter Clark and Albert Frey show their recent vacation house in Palm Springs as an example of manipulating "New Architectural Elements" in which the five components of the floor slab, wall unit, glass unit, roof unit, and composition can accommodate any variety of needs and desires. Gardner Dailey and Joseph Esherick's "House DE-2, Magic Carpet Series," included an identifying number on its roof, like an airplane or the license plate of a car, to allow for the family to maintain a bureaucratic and social identity in the midst of demographic and territorial flux. They also read these tropes back onto the question of energy; the mobile unit had a "mechanical nurse" that carried its own fuel and contained all of "equipment needed to supply the functions of the house's chemical and mechanical core" [figure 4].33



Figure 4. Dailey and Esherick, "Magic Carpet Series DE-2" from "194x."

The July 1944 issue of *Arts and Architecture* further articulated the flexible imperative of post-war

growth and its anticipated effects on the future. Entitled "What is a House?," the 18-page spread contained photo-collages by Ray Eames and Herbert Matter and graphically aggressive text to explain the potentials and pitfalls of the "urgent housing problem" that was expected when the war ended, and identified the architect as a key figure in the negotiation of the economic, infrastructural and industrial metabolism of the production system of the post-war house.³⁴ Symbolically interpollating this system into changes in the human condition, in the opening spread Matter illustrated the relationship between the natural systems of the human body and the mechanics of industrialized civilization, connecting drawings of atomic nuclei, an electronic switchboard, and the structure of elements to human nerve and organ systems on the right-hand page, and on the left, to a visually interconnected system of gears, pulleys, hydraulics, and other mechanical systems - industrial and human metabolisms graphically intertwined.³⁵

While the entries to "194x" operated as a survey of adaptive strategies, "What is a House?" was a more aggressive editorial push for architects to take a leading role in the anticipated transformations of post-war industrial development. The war effort, the issue proposed, had produced ideal conditions for architectural interventions in the "modernization" of the housing industry, though this term was variously defined.³⁶ The centerpiece of "What is a House?" was a process diagram in which the architect, figured as "the student of human behavior ... the scientist ... the economist ... [and] the industrial engineer," was the thread by which the post-war house would be organized according to a new set of inputs.³⁷ On one side: "AN UNDERSTANDING OF FAMILY BEHAVIOR, free from any preconceived ideas and based on the most complete study of every facet of family life... interpreted in terms of needs spatial, chemical, psychological, social, and environmental;" on the other: "A VOCABULARY OF MATERIALS AND TECHNIQUES, drawn from all our experience as a nation organized for war production and from all related scientific development." These two factors were then "correlated through a logical approach to economics," and fed through a coordinated system of mass production and regional distribution [figure 5]. This deployment of an expanded field of architectural strategies focused on benefits to the family, drawn at the bottom of the diagram in an inverted heart, "whose burden will be further lightened" by rationalized financing and service systems.³⁸ Seemingly intended as a direct response to the question "What is a House?," the diagram indicated that the hoped-for post-war house would be both the shelter for family – the center of social life – and, perhaps more consequentially, a central node of the post-war political and economic network, the organizing principle of the expanding industrial condition.³⁹

infrastructural network - of materials An distribution, energy provision, and communication, but also of political support and economic possibility - thus emerged in the wartime architectural discourse in which the technological and cultural disposition of the modern house occupied a prominent and multifaceted position. This network was seen to be legible in - and perhaps only in the new forms of living that would be shepherded through architectural interpretations of its multiple ramifications. Energy, though often implicit, continued to be paramount; in "What is a House?," for example, the editors expanded the logic of energy efficiency from the design of the house to the multivalent infrastructure that conditioned it; "the value of the house," as they summarized, "will be measured by the degree to which it serves for the amount of energy it costs."40 The architect claimed an important position amidst the multivalent forces of infrastructural change.

Rapson's Case Study House #4: the Greenbelt House, proposed in 1945, again serves as potent indication. The most striking feature of the house was a covered, planted courtyard bisecting the house - the green belt - which separated the public spaces of the kitchen, living, and dining from the private sleeping areas and also provided a space for recreation and reflection. "The open plan," Rapson wrote, "will have been achieved" - not just planametrically, with his facile integration of interior and exterior spaces, but on the terms of lifestyle adaptation: for Rapson, "The most important aspect of the greenbelt lies in its personality the personality each family will give it... Here, the individual might grow."41 Thus while the adaptation of the infrastructure of wartime production to that of postwar suburban expansion was a possibility quickly embraced by policy makers, industry, architects, and others, as we will see below, it was on terms of the multiple possibilities inherent in

these transformations; on the terms of the general possibility, as Kenneth Frampton has noted in a related context, "to render the American suburb as a place of culture."⁴² The persistent trope of flexibility and infrastructural indeterminacy evident in these discussion can be read in the relation to the energy concerns informing solar house production: both are symptomatic of the anxiety of wartime demographic upheaval, and, even more, both are indicative of ambitions to expand on the possibilities inherent in the chaos of war to produce new patterns of living – to use the intellectual and technological tools of modern architecture, in other words, to render geopolitical threats as lifestyle improvements.

3: "A HOUSE IN THE SUN"

This architectural-managerial regime was read directly onto the solar house in a monthly feature in the Ladies Home Journal from January 1944 to August 1946. Here, as the war was drawing to a close, the anticipated changes described in both "194x" and "What is A House?" were developed in tandem with the possibilities of solar house heating to help re-conceive infrastructural priorities. Richard Pratt, the architecture and gardens editor at the Journal, enlisted "outstanding architects... to design small but 'really adequate' houses which would dramatize the advantages of modern planning and building techniques."43 Pratt not only commissioned designs but also hired a modeling firm to build detailed miniature versions of the houses, including "tiny bentwood chairs, workable four inch lawnmowers and real greenery."44 He then photographed the models himself to produce a seductive vignette, a clear vision of a well coordinated future at one-inch scale. From May to September of 1945, the models were shown at the Museum of Modern Art in the exhibition "Tomorrow's Small House,"



Figure 5. Hugh Stubbins, Jr. and Richard Pratt, "Easy to Live In" in *Ladies Home Journal* (January 1945).

Pratt's editorial commentary offers a sophisticated analysis of the multivalent complications to resource, production, and economic systems that the post-war house, considered in the midst of wartime anxiety, had come to represent. Rather than speculate as to the future possibilities of industrial transformation, Pratt was interested in outlining the specifics and promoting the mechanisms for a new structure for home production in the present, so that the building industry, architects, and homebuyers would be ready once materials became available and war bonds returned savings to the public. There were, in sum, three major themes to his intervention: first, that "such houses will not be in the reach of average Americans until we revitalize our homebuilding industry through the kind of coordination and research which is winning the war;" second, "to accomplish these objectives, there must be a well-informed and widespread demand on the part of the home-buying public;" and third, that "such a house depends on the highest standard of design... in terms of security, attractiveness, comfort, convenience, and economy;" architects would mediate between the desires of individuals and the possibilities inherent in industrialization.45 These themes were reiterated, with little variation, in the descriptions accompanying each monthly entry.

Most of the houses presented in the Journal embodied a formal and material simplicity characteristic of the wartime architectural discourse - one that we have already seen in Rapson's and Keck's houses described above. Indeed, on general terms the solar house was an implicit model: as the co-curator of the exhibition Elizabeth Mock noted in the MoMA catalogue: "Despite marked differences in architectural expression, many of the houses are so similar in basic conception as to suggest that the long, single story, precisely outlined rectangle, open to the south and closed to the north, will emerge as the dominant post-war plan type."46 Hugh Stubbins, Jr.'s house of January 1945 was one of the most straightforward: a rectangular building with living, kitchen, and master bedroom on the south façade, and kid's rooms and services on the north, the house was topped with a mildly sloping v-shaped roof to allow for shading and drainage. As built and photographed in the model, the house appeared light filled and open to the spacious yard, with modern furniture both inside and out, and surrounded by trees. Other models, such as the one designed by A. Lawrence Kocher

for the November 1944 issue, emphasized the capacity for modular houses to expand and contract according to family needs. In Plan-Tech's house of April 1945, the ease of construction is emphasized, with model views showing the house being built in a day from factory fabricated panels and other elements. The June 1945 house by "the world's most distinguished architect," Frank Lloyd Wright, did much to give credence to the *Journal*'s program while also indicating the resonance between Pratt's agenda and that of Wright's Usonian houses, also gaining some popularity as the war was ending. Aside from a small service area, Wright's model was almost completely sheathed in glass, with thin wood columns elegantly supporting an extended roof.⁴⁷

Mock also indicated, in a section of the MoMA catalogue on "what to look for in the exhibition," that "the most remarkable thing about the group [of houses] as a whole is the quantity of glass, and its there for a better reason than the personal whimsy of the architects."48 Indeed, the benefits of glass were a prominent component - amongst discussion of "one-piece combination kitchen units" reminiscent of "194x," government-supported systems of financing reflecting the diagrams in "What is a House?," and other proposed technological and organizational innovations – as they were a simple way of "making the house easier to heat" with "winter warmth in daytime provided free of charge by the sun."49 Keck's July 1944 contribution, "Water on the Roof," for example, not only reproduced the premise of his contemporaneous designs, but also elaborated on this solar logic by providing an insulating membrane of water on the roof for summer heat deflection. John Funk's "House in the Sun" of August 1945, much like Wright's house described above, had a southern façade consisting of a simple a series of wood framed glass panes.50 The designed provision of solar heating was a central element in the complicated placement of the house amidst the multivalent networks of energy, economy, and desire in the anticipation of post-war living.

Beyond creative and targeted design solutions, innovation in government financing and an increase in industry coordination were the central components of Pratt's strategy. "Federal legislation" to "stimulate public and private research into materials, methods, industrial coordination, financing and community planning" was necessary, he proposed, to rationalize home-building and take advantage of the emergent possibilities of technological innovation. "If half a billion dollars worth of research for military aviation has given us air supremacy in war," Pratt wrote, "just think what a fraction of that would do for home improvement in peace."51 These issues, frequently reiterated, were also moral and political: Pratt was insistent that "unless our American standard of living is an idle boast, every family should be able to have a really adequate house... American resources can provide such a house... but they can do it only if industry, labor, finance, and Government all make up their minds to work together as never before."52 Significantly, the architect, whimsical or not, is not on this list; while the architect had an important role in producing models for social transformatin, for Pratt the architect is an absent presence, almost magically resolving the anticipated "vast changes in our everyday lives" through the considered deployment of design and technology; as in the hopeful headline for Philip Johnson's July 1945 entry, "As Simple as That."53

Instead, the interested reader was the activated subject; as Pratt wrote, directly to this reader, "This is where you come in; the more you like houses that are made this way, the sooner you will have them."54 When shown at MoMA, the models were hung at eye level, encouraging the viewer to, "imagine yourself five or six inches tall and walk about each house until you feel quite at home."55 There were numerous appeals to "urge your congressmen to get behind federal legislation," and indications that "the hope for houses like this, at prices you can afford, is within your power to realize."56 This proposed empowerment of individual desire was a significant distinction to Pratt's program, especially as it was an early identification of the housewife - the reader of Ladies Home Journal - as the decision maker in many of the economic decisions that impacted post-war growth.57 In the context of anticipated scarcity of energy and material resources, the allocation of means towards various ends was an important way for consumers to produce their own satisfaction.58 Even more, the proposal inherent in Pratt's campaign for a modern, solar suburb was that the desire of individuals could impact infrastructural organization, and lead not only to a new kind of architecture but to a new form of community life and national perspective on consumption and economic growth. The principles of modern design, assumed by Pratt and others, were an integral element of this alternative vision of suburbia – as both a cultural indication of new ways of living, and a designed intervention to make that living easier, more accessible, and more affordable.

When suburban growth began in earnest in the late 1940s, this possibilities developed in Pratt's program - and its reflection of the solar house and the technological facility of "194x" - were not considered; or at least not as he, or Keck or Rapson, might have hoped. The Housing Act of 1949 did provide significant improvements in financing structures, and strengthened the G.I. Bill in this regard, but it also imposed design and siting restrictions on mortgage approval that was heavily biased towards non-modern design.59 The coordination and industrialization of the building industry certainly took place, but according to a lowest common denominator of design and materials, best represented by the assembly line production in the well-known example of Levittown.60

The project of the solar house, amidst these and other impediments, persisted as an image of possible alternative futures. At the Massachusetts Institute of Technology, for example, active strategies successfully used solar energy for space heating by absorbing sunlight in water or air, before transferring it to a traditional heating system. These systems were effective, but expensive, and never developed into marketable applications. The architectural condition of the solar house also continued to be significant: in an international competition for a solar heated house in 1958, run by the Association for Applied Solar Energy, (the precursor to the International Solar Energy Society and arguably the first international environmental non-governmental organization), intended to develop an "off-theshelf" solar heating system that could be built and then improved through industry investment. The competition was won by a student of Rapson's, who was by then dean of the school of Architecture at the University of Minnesota. The house was built, but its complex solar heating system never worked. Other houses, from South Africa to India to Princeton, New Jersey, attempted similar strategies and harbored similar infrastructural ambitions.61 Though never quite successful, a lineage of solar houses can be traced from the 40s to the 70s, where popular attention was again focused on energy infrastructure after the oil crises. The solar project persisted in large part because of its attempts to use modern architectural strategies as a method to articulate a lifestyle that could accommodate different infrastructural conditions.

There is significant formal resonance between Lee's plan and Rapson's Greenbelt House. I conclude with this not to indicate the banalities of architectural influence, but rather to complicate the relationship between cultural and technological innovation.62 How does culture change? Levittown is symptomatic of a broader post-war trend defined by David Smiley as "Modified Modern," in which the benefits of technological modernity "could be enjoyed in a traditional-looking or in a modern-looking house;" in other words, as Smiley continued, by the late 1940s "a modernism emerged that formalized a separation of exterior appearances from interior performance."63 The Levittown houses were made in the image of traditional buildings, but inside they were filled with modern amenities: the same, but different. Returning to AMO's proposal in the Roadmap 2050 as an indication, this structure is reflected, perhaps surprisingly, in the current discourse on sustainability in architecture. Despite the redrawn boundaries of Eneropa, as AMO partner Reinier de Graaf said, introducing the project, "The most shocking part of [the Roadmap] is how incredibly unshocking it is. Everything that moves is the same and still moves. Only the things that make the things move have all completely changed. It's a situation where everything changes and at the same time nothing changes."64 Similarly, design practices attempt to facilitate the continuation of present ways of life, only with different consequences.

The various proposal's for "tomorrow's house" during the war, and their intended impact on territorial and geopolitical conditions, were of a different sort: the transformation of architectural technologies and design principles was seen to be instrumental to changing external conditions, difference producing difference. The solar house was only the most concentrated example of this model: its performative benefits relied on "exterior appearances" and formal disposition - it necessitated difference, and as a proposal in the midst of the chaos of war, these houses opened up an opportunity, however briefly, to extend beyond immediate solutions for energy management to the production of new lifestyles, with new social formations and new relationships to the imperative for environmental change.

ENDNOTES

1 Architecture Metropolitan Office is the research component of Rem Koolhaas' architectural firm, OMA (Office of Metropolitan Architecture). See http://www. oma.eu/index.php?option=com_content&task=view&id= 237&Itemid=25

Elizabeth A. T. Smith, "Introduction" in Elizabeth A. T. Smith, ed., Blueprints for Modern Living: The History and Legacy of the Case Study Houses (Los Angeles, CA: The Museum of Contemporary Art, 1989), 11-14; see also Thomas S. Hines, Architecture of the Sun: Los Angeles Architecture 1900-1970 (New York: Rizzoli, 2010). The Case Study House program ran from 1945 to 1963; 30 designs were developed and the majority were built. These houses, such as Charles and Ray Eames Case Study House #8: The Eames House and multiple houses by Craig Ellwood and Pierre Koenig, guickly became icons of mid-century design and were an important element of global interest in American modernism after the war. They also developed important innovations in using industrial materials, such as structural steel, in hosue construction. See Reyner Banham, "Klarheit, Ehrlichkeit, Einfachkeit... and Wit too!: The Case Study Houses in the World's Eyes," in Smith, Blueprints for Modern Living, 183-196. Beatriz Colomina has analyzed the importance of the program to the development of mediatic strategies in architectural practices, see for example her Domesticity at War (Cambridge, MA: MIT Press, 2007).

Esther McCoy, "Arts and Architecture Case Study Houses," in Smith, Blueprints for Modern Living, 15-29. Smith reiterated McCoy's observation in her description of Rapson's plan in the general catalogue. Andrew Shanken, 194X: Architecture, Planning and Consumer Culture on the Home Front (Cambridge, MA: MIT Press, 2009), 69. For specifics on the expanded market for consumer appliances in the 1940s and 50, see John Ullman, ed., The Suburban Economic Network: Economic Activity, Resource Use, and the Great Sprawl (New York: Praeger, 1977).

Both Keck and Rapson also taught at the Institute of Design, also known as the New Bauhaus. Keck was the head of architecture there until 1942 and appointed Rapson as his successor; Rapson stayed until 1945 at which point he went to teach at MIT. See Robert Boyce, Keck and Keck (Princeton Architectural Press, 1993), 9-12; and Peder Anker on the "Bauhaus of Nature" and "New Bauhaus of Nature" in his From Bauhaus to Ecohouse: A History of Ecological Design (Baton Rouge: Louisiana State University Press, 2010). As Ford and Ford note, "the early experimental use of glass is associated in the public mind with the 'modern homes' of the Century of Progress and other world's fairs," which were better known and more popular than "the white boxes and cylinders" of the International Style show at MoMA in 1932. James Ford and Katherine Morrow Ford, The Modern House in America (New York: Architectural Book Publishing Company, 1940), 132. Mallgrave refers to the Ford's book as "one of the first books to chronicle modern architecture in the United States;" see Harry Francis Mallgrave, Modern Architectural Theory: A Historical Survey, 1673-1968 (New York: Cambridge University Press, 2005), 327.

7 Lisa D. Schrenck, *Building a Century of Progress: The Architecture of Chicago's* 1933-34 World's *Fair* (Minneapolis: University of Minnesota Press, 2007), 218. See also See also Narciso Menocal, *Keck and Keck, Architects* (Madison, WI: Elvehjem Museum of Art, University of Wisconsin-Madison, 1980).

8 Le Corbusier, *Precisions: On the Present State of Architecture and City Planning: with an American Prologue, a Brazilian Corollary Followed by The Temperature of Paris and The Atmosphere of Moscow* (Cambridge, MA: MIT Press, 1991 [originally published in 1930]), 132. See also Paul Overy, *Light, Air and Openness: Modern Architecture Between the Wars* (London: Thames and Hudson, 2007). Overy summarizes: "A preoccupation with cleanliness, health, hygiene, sunlight, fresh air, and openness characterized modern architecture in the years between the two world wars," 9.

9 Colin Porteous, *The New Eco-Architecture: Alternatives From the Modern Movement* (New York: Spon Press, 2002), 51.

10 H.E. Beckett, "Orientation of Buildings" in Journal of the Royal Institute of British Architects v. 40 (1933), 61-65, and P.J. Waldram, "Universal Diagrams" in Journal of the Royal Institute of British Architects v. 40 (1933), 50-55.

11 'House in Hampstead: Maxwell Fry, architect" Architects' Journal, v. 84, no. 8 (Aug. 1936): 210-14; "House near Halland, Sussex: Serge Chermayeff, architect" The Architectural Review, v. 85, no. 2 (Feb. 1939): 63-78. See also Colin Porteous, The New Eco-Architecture, 37-42. Chermayeff came to the US in 1936 and began to teach with Keck at Institute of Design, which may have served as another point of Keck's interest in solar housing. However, Chermayeff designed little after his move to the US, instead focusing on architectural pedagogy and the notion of 'design science.' See Richard Plunz, ed., Design and the Public Good: Selected Writings of Serge Chermayeff (Cambridge, MA: MIT Press, 1982) and Serge Chermayeff and Christopher Alexander, Community and Privacy: Towards a New Architecture of Humanism (Garden City, NY: Doubleday, 1962).

Howard T. Fisher, "A Rapid Method for 12 Determining Sunlight on Buildings," Architectural Record 70 (December, 1931), 445-454. Fisher's article was also based on an article by Waclaw Turner-Szymanowski, "A Rapid Method for Predicting the Distribution of Daylight in Buildings" University of Michigan Engineering Research Bulletin no. 17 (January, 1931) and referenced the "rational site-planning" imperative discussed at the third CIAM conference in Brussels in 1930, where Gropius and others developed "light and air" diagrams for multi-family dwellings. See Walter Gropius, "Houses, Walk-ups or High-Rise Apartment Blocks?" (1931) in The Scope of Total Architecture: A New Way of Life (New York: Harper and Row, 1943), 119-135, and CIAM, Rationelle Bebauungsweisen: Ergebnisse des 3. Internationalen Kongresses für Neues Bauen (Stuttgart: J. Hoffman, 1931). A number of the relevant texts were translated into English through the New York Housing Study Guild (Lewis Mumford, Henry Wright, and Carol Arnovici) as Abstract of Papers at the Third International Congress at Brussels of the International Committee for the Solution of the Problems of Modern Architecture

(New York, 1935). See Eric Mumford, *The CIAM Discourse on Urbanism, 1928-1960* (Cambridge, MA: MIT Press, 2002), 59-65 and n.130, 287.

13 Libbey-Owens-Ford, Glass as an Architectural Medium in Nine Small Modern Houses at A Century of Progress, 1933-1934 (Toledo, OH: Libbey-Owens-Ford, 1934), n.p. See also Earl Aiken, "Glass in Future Building Construction" in Paul Zucker, editor, New Architecture and City Planning, (New York: Philosophical Library, 1944), 230-234. Note that this is also the symposium where Giedion and others began the important post-war discussion of monumentality in architecture. The main technological challenge in developing Thermopane was the seal: it needed to be a hard seal to prevent leakage of air and subsequent decline in insulating capacity, but the metals that could provide a hard seal tended to shrink and expand with temperature variations, leading to leaks and even breakage. Eventually, an alloy of aluminum, titanium, and copper allowed for a workable compromise: the alloy's resistance to expansion and contraction in extreme temperatures made it ideal for insulating purposes, however, it was still physically delicate and not conducive to repeated opening - most installations of Thermopane, solar or otherwise, invovled fixed rather than operable windows. See Charles Haven "Notes on Thermopane" in Libbey-Owens-Ford Collection, The Ward M. Canady Center for Special Collections, The University of Toledo Libraries.

14 The term 'solar house,' according to a 1943 article in Architectural Forum, was first used in a Chicago Tribune report on Keck designs for 'Solar Park', described below, in 1942; see "Does Modern Architecture Pay?" in Architectural Forum, vol. 32 no. 9 (September, 1943): 69-76, 73. The appellation was used by the popular press rather loosely: in one example, a 1949 story in The New York Times on Frank Lloyd Wright's planning of the Usonian compound in Pleasantville, the subtitle reads: "New Kind of Home Rising in the Suburbs: Solar Houses on Round Lots, Minus Attics, Cellars, Mark Big Westchester Project." In the article, the solar nature of the houses is not elaborated upon beyond the use of "large expanses of glass." See Merrill Folsom, "A New Cooperative Housing Development Underway in Westchester County" in The New York Times, Tuesday, May 17, 1949, A7. 15 "A Portfolio of Modern Houses: George Fred Keck" in Architectural Forum vol. 82, no. 9 (September, 1942), 67-82; 75-79; Ralph Wallace, "The Proven Merits of a Solar Home" in Reader's Digest (January, 1944), 101-104. The article was originally published in The Baltimore Sun, December 13, 1943. Keck's solar houses were first published in late 1942, featured in "What houses will be like after the war: George Fred Keck' House Beautiful vol. 84 (Jul-Aug 1942): 30, 72; other articles discussing solar houses included "Solar Heating - survey proves large windows, properly oriented, save fuel costs even in rigorous climates," in Architectural *Forum* vol. 76 no. 8 (Aug 1943): 6-9,114; see also "Solar house for a sunny hilltop," in *Architectural Record* vol. 95 no. 3 (Mar 1944): 58-63; and "How to Heat Your House" in Fortune (September, 1942), 45-49. See also both Keck's house and a "solar house" by Carl Koch in

"Seven Postwar Houses" in *Architectural Forum*, vol. 87, no. 9 (September, 1947): 77-124, and collected quotes

in Libbey-Owens-Ford, "The Solar House: A Surefire Promotion Made-to-Order for Your Newspaper," 1945. Libbey-Owens-Ford Collection, The Ward M. Canady Center for Special Collections, The University of Toledo Libraries.

16 George Nelson and Henry Wright, *Tomorrow's House: How to Build Your Postwar House Now* (New York: Simon and Schuster, 1945), 178-179. We should note that *Architectural Forum* and *Fortune* were selfconsciously promoting modern architecture in the U.S. from the mid-30s; see Dolores Hayden, *Building Suburbia: Green Fields and Urban Growth*, *1820-2000* (New York: Vintage Books, 2003), 133.

17 In-floor radiant heating was a parallel technological innovation that exaggerated and refined the effects of the solar house principle, and pointed again to the place of solar house heating amidst a more general set of relevant concerns in the period. Keck developed and marketed the "RadianTile" system with the Clay Products Association; in most of the *Architectural Forum* publications of Keck's houses, a diagram of the heating system was included. It also served as the pretext for a number of discussions between Keck and Frank Lloyd Wright. See Menocal, *Keck and Keck*, 57ff.

18 There was also a pervasive notion that the solar house was better for your health. Keck's first solar client, Howard Sloan, was featured in a number of articles on the solar house and was adamant that the solar house had improved his wife's vision to the point of making glasses no longer necessary. The point was reiterated in Reader's Digest: "In the [Keck designed] Chicago home of John Bennett... every member of the family had noticed a lessening in eye strain. In fact, young Johnny complains how dark his school seems after leaving home in the morning... it is no exaggeration to say that solar architecture restores the conditions for which the human eye was originally designed." Wallace, "The Proven Merits of a Solar Home," 104. See also Hugh Duncan in George Fred Keck, "Design and Construction of Solar Houses" in Richard W. Hamilton, ed. Space Heating with Solar Energy: Proceedings of a Course-Symposium held at the Massachusetts Institute of Technology, August 21-26, 1950. (Cambridge, MA: Massachusetts Institute of Technology/Bemis Foundation, 1954), 89.

19 Maron J. Simon, editor, *Your Solar House: A* Book of Practical Homes for all Parts of the Country, by 49 of America's Leading Architects, Containing 49 Sets of Plans and Drawings, Together with Many Suggestions for the Home Builder (New York: Simon and Schuster, 1947), 19-23.

20 Nelson and Wright, *Tomorrow's House*, 178-179; The *Reader's Digest* article also emphasized the promise of "fat savings in fuel bills."

²¹ "Does Modern Architecture Pay?" 73. See also Howard Sloan, "Insolation" in *Pencil Points* vol. 25, no. 2 (February, 1944), 80.

22 Harold İckes, "We're Running Out of Oil!," American Magazine (Dec 1943), 37-43; 38. Ickes had been Secretary of the Interior since 1933, and was an important architect of the New Deal. See Jeanne Nienaber Clark, *Roosevelt's Warrior: Harold Ickes and the New Deal* (Baltimore: Johns Hopkins University Press, 1996); Harold Ickes, *Fightin' Oil* (New York: Alfred A. Knopf, 1943).

23 Rex Nicholson, "New Developments: The West Cannot Reconvert, It Must Expand," *Arts and Architecture*, v. 61, no. 11 (November 1944), 34-36; see also Jakob I. Zietlin, "Double Talk," *Arts and Architecture* v. 61, no. 5 (May 1944), 10.

24 This wider transformation has been described by Michel Foucault as the process of 'governmentalization," through which architecture can be articulated as an "art of governance" - not government per se, but a managerial disposition to the care of the population, coextensive with practices and principles in the cultural sphere. These new techniques for the administration of life developed on the one hand by expanding the mechanisms of bureaucracy, and, on the other hand, by extending those mechanisms into the heart of the family and of subjective experience a distributed and dynamic infrastructure of both bureaucracy and self-care, forming "a sort of complex," as Foucault wrote, "of men and things... men in their relations, their links to wealth, resources, climate, customs, famine, epidemics, and so on;" a complex that is managed according to liabilities and assets, real and potential risks, and as a territorial matrix optimized for economic growth and political security. See Michel Foucault, Birth of Biopolitics: Lectures at the College de France, 1978-79 (New York: Palgrave Macmillan, 2008), 217-226.

25 "The Case Study House Program," in *Arts and Architecture*, v. 62, no. 1 (January 1945): 39.

In May 1940, President Roosevelt received \$1 26 Billion from Congress for war preparation, and in the period from 1940-1945 industrial capacity doubled. See Arnold L. Silverman, "Defense and Deconcentration: Defense Industrialization during World War II and the Development of Contemporary American Suburbs" in Barbara M. Kelley, ed., Suburbia Reexamined (Westport, CT: Greenwood Press, 1989), 157-165; see also Robert A. Beauregard, When America Became Suburban (Minneapolis, MN: University of Minnesota Press, 2006). 27 See Alan Rabinowitz, Urban Economics and Land Use in America: the Transformation of Cities in the 20th Century (Armonk, NY: M.E. Sharpe, 2004), 129; as Rabinowitz summarized, "Wartime production had required new facilities. The government had decided that all of them should be outside of the old cities, partly as a defense measure against attack by enemy bombers... new highways to these suburban plants had been mapped in the 1930s by the WPA. The plants required new housing nearby;" see also Peter Galison, "War Against the Center" in Grey Room v. 4 (2001).

28 For details on the demographics of post-war growth, see Robert C. Wood, "Rethinking the Suburbs," in Kelley, *Suburbia Reexamined*, 75. Indications of the Roosevelt and Truman administrations lack of clarity over how to make these temporary adjustments permanent can be found in Silverman, cited above.

29 "The New House 194x" in Architectural Forum v. 82 no. 9 (September, 1942), 65. The editors included Ruth Goodhue, John Beinert, Doris Grumbach, George Nelson, and Henry Wright. While prefabrication and the more general transformation of industrial building techniques were recognized as an important development in this context, some of the other elements indicated – "new and higher standards of illumination, thermal comfort, atmospheric composition and so on" – were played out directly on the terms of the solar house. On prefabrication see, for example, Barry Bergdoll and Peter Christensen, *Home Delivery: Fabricating the Modern Dwelling* (New York: The Museum of Modern Art, 2008); Herbert, *The Dream of a Factory Made House*, cited above; Colin Davies, *The Prefabricated Home* (London: Reaktion Books, 2005). Contemporaneous accounts include a comprehensive survey of relevant activity in the immediate post-war period in, Burnham Kelly, *The Prefabrication of Houses: A Study by the Albert Farwell Bemis Industry of the Prefabrication Industry in the United States* (Cambridge, MA: MIT Press, 1951).

30 Ibid., 69.

31 The quote is taken from a later entry of the Fabric House into a competition organized by California Arts and Architecture (which became Arts and Architecture in February 1944). The Fabric House was not premiated, but was nonetheless shown in Forum when they published the results. See "Prize Winners in California Arts and Architecture's 'Designs for Postwar Living' Competition" in Architectural Forum, vol. 83, no. 9 (September 1943): 88-93; 93. As Forum reported: "according to juror Charles Eames, the design was 'killed' for suggesting that the owner act as his own architect" in determining the organization of rooms, spaces, and amenities within a given framework. 32 Ibid., 87.

33 Ibid., 100-101; 118-119; 140-142; 114-115. Keck also participated, with an entry on "Housing Standards" that emphasized the capacity of industrial development to meet "MAXIMUM HOUSING STANDARDS," as Keck put it, rather than the "minimum dwelling" discussions that had developed in Europe before the war. A subsequent issue of Forum, in May 1943, explored school, office buildings and other institutional and commercial buildings types in "New Building 194x," with more varied levels of explicitly experimental practices; later that year, in "Street and Highway Lighting for 194x," there is a marked emphasis on energy infrastructure, though the experimental parameters are less dramatic. "The New Building 194x" in Architectural Forum, v. 83, no. 5 (May, 1943): 65-174; "Street and Highway Lighting for 194x" in Architectural Forum, v. 83, no. 10 (October, 1943): 55-84.

³⁴ "What is a House?" *Arts and Architecture*, v. 61, no. 7 (July, 1944): 21-39, 22.

35 Ibid., 21-22. Other collages showed the industrial components of house production and illustrated the new found efficiency in the production range of automobile manufacture as impetus to the industrialization of the housing industry (see "What is a House?," 25,31). The issue was also another example of the influence of R. Buckminster Fuller on a broad architectural audience, as he was frequently quoted in offset text.

36 Ibid., 23. "NOW is the time in the world when all the necessary circumstances and conditions exist in such relationship to one another that we can attack, on an inclusive, all-over scale, the problem of mass-housing with a better than good chance of success." Again, prefabrication, or 'mass production' as the article put it, was the explicit emphasis, though a broader imperative for technological and cultural transformation through the figure of the single-family house can readily be discerned.

37 Ibid., 33.

38 Ibid., 31.

39 Though less articulate in their specifics than "194x" or "What is a House?," a number of articles, special issues, and competitions further placed the house in this charged infrastructural condition. Revere Copper and Brass held a competition in 1942; Arts and Architecture's "Design for Post-war Living" competition in 1943 has already been mentioned; Pittsburgh Plate Glass' "Design of a House for Cheerful Living" in 1945; the Plywood Corporation's competition of 1944, also published in California Arts and Architecture; House and Garden's "Blueprint's for Tomorrow," held in late 1944 - and in which Rapson's "aggressively modern" Lopez House won first place; the characterization of Rapson's entry is from Elizabeth A.T. Smith, "Chronology of Related Events" in Smith, Blueprints for Modern Living, 240. Though innovative products were often featured, few of these were explicitly engaged in energy concerns; nonetheless they stand as evidence of the breadth and depth of the speculative condition of the architectural discourse, in terms of both material regimes and of new forms of living, that proliferated during the war. For further discussion of these competitions, see, for example, David Smiley, "Modified Modern" in Brendan Moran and Annmarie Brennan, eds., Perspecta 32: Resurfacing Modernism (2001): 39-54; and Colomina, Domesticity at War, 33.

40 "What is a House?," 33.

"Case Study House 4" in Arts and Architecture 41 v. 62, no. 4 (April 1945), 32-36; 33. See also "Case Study House 4: Interiors," in Arts and Architecture v. 62, no. 8 (August 1945). Emphasizing this potential, an earlier proposal had verticalized the programmatic distribution, placing two blocks of living space cantilevered off a supporting wall, itself tethered by cables, and leaving the lot for personal expression. While in built form the house would take definitive shape, Rapson stressed again that the possible combinations inherent in the design were multiple; the early project was rejected by Entenza because, as he wrote to Rapson afterwards, "this whole job has to be done without scaring the wits out of the dopesJohn Entenza, Letter to Rapson, April 10, 1945, guoted in Jane King Hession, Rip Rapson, and Bruce N. Wright, Ralph Rapson: Sixty Years of Modern Design (Afton, Minnesota: Afton Historical Society Press, 1999), 35.

42 Kenneth Frampton, "Foreword," in Lisa Germany, *Harwell Hamilton Harris* (Austin, TX: University of Texas Press, 1991), xi; see also Ullman, ed., *The Suburban Economic Network*.

43 Pratt germinated the idea with "The First Victory House" in *Ladies Home Journal*, v. 59, no. 4 (April, 1942), and also referred to the later series (before the exhibition was developed with MoMA as "Tomorrow's Small House") as "Houses Planned for Peace;" see "The House Planned for Peace," *Ladies Home Journal*, v. 61, no. 1 (January, 1944), 54.

44 Museum of Modern Art (Elizabeth Mock and Richard Pratt), *Tomorrow's Small House: Models and Plans* (New York: Museum of Modern Art, 1945), 5. 45 Ibid., 4. 46 Ibid., 6.

47 Hugh Stubbins, Jr.'s house was published as "Easy to Live In" in *Ladies Home Journal*, vol. 62, no. 1 (January, 1945): 116; A. Lawrence Kocher's as "Most House for the Least Money" in *Ladies Home Journal*, vol. 61, no 11 (November 1944): 130; Plan-Tech's as "House in a Day" in *Ladies Home Journal*, vol. 62 no. 4 (April 1945): 166-67; Frank Lloyd Wright's as "Opus 497" in *Ladies Home Journal*, vol. 62, no. 6 (June 1945): 138-39.

Pratt and Mock, *Tomorrow's Small House*, 7.
Richard Pratt, "Easy to Live In" in *Ladies Home Journal*, vol. 62, no. 1 (January, 1945), 116.
Richard Pratt, "Water on the Roof" in *Ladies Home Journal*, vol. 61, no. 7, (July 1944): 125; Richard

Pratt, "House in the Sun" in *Ladies Home Journal*, vol. 62, no. 8, (August 1945): 118. Funk's project was added to the MoMA show towards the end of its run.

51 Richard Pratt, "As Simple as That" in Ladies
Home Journal, vol. 62, no. 7 (July 1945), 118.
52 Richard Pratt, "Every Family's Right" in Ladies

Home Journal, vol. 61 no. 9 (September, 1944), 134-135. As Robert Beauregard wrote recently regarding the international impact of the suburban dream after the war, "the power of America's message was derived from a conflation of freedom and democracy with consumption and lifestyles," a point well expressed here by Pratt. See Robert A. Beauregard, *When American Became Suburban* (Minneapolis, MN: University of Minnesota Press, 2006), 144.

Richard Pratt, "As Simple as That" in Ladies
Home Journal, vol. 62, no. 7 (July 1945), 118.
Richard Pratt, "Easy to Live In" in Ladies Home
Journal, vol. 62, no. 1 (January, 1945), 116.
Museum of Modern Art (Elizabeth Mock and
Richard Pratt), Tomorrow's Small House: Models and
Plans (New York: Museum of Modern Art, 1945), 5.
Both quotes are from Pratt, "House in the
Sun," 130, but were repeated in slightly different ways in
most entries.

57 See Ullman, "Introduction," in *The Suburban Economic Network*, 15; and Colomina, *Domesticity at War*, 32-35.

58 The instrumentalization of consumer desire was a prominent them of economic analysis of the 1970s in the United States, and was also an important element of Foucault's theorization of regimes of selfcare. Placing this question of competing ends in the center of the economic debates of the post-war period, Foucault read the emergence of American neo-liberalism as ascribing political power to the growth of consumptive behaviors, here summarizing the economist Gary Becker's analyses of the 1950s, written in the early 70s: "We should not think at all that consumption simply consists in being someone in a process of exchange... the man of consumption, insofar as he consumes, is a producer. What does he produce? Well, guite simply he produces his own satisfaction. And we should think of consumption as an enterprise activity by which the individual, precisely on the basis of the capital he has at his disposal, will produce his own satisfaction;" Foucault, Birth of Biopolitics, ed. Michel Senellart (Basingstoke [England]; New York: Palgrave Macmillan, 2008), 222-226. Foucault is summarizing Becker's "On the New Theory of Consumer Behavior" from 1973, reprinted in

Gary Becker, *The Economic Approach to Human Behavior* (Chicago: University of Chicago Press, 1976); see also Gary Becker, *Human Capital: A Theoretical and Empirical Analysis* (New York: National Bureau of Economic Research, 1964). Becker was a University of Chicago trained economist who taught at Columbia and Chicago, he was awarded the Nobel Peace Prize in 1992. 59 Gwendolyn Wright, *Building the American Dream*: A Social History in America (Cambridge, Mass.: MIT Press, 1983). The Housing Act was also heavily biased towards the suburbs; though it made provisions for Urban public housing they were ignored until the 1960s.

60 Making housing affordable was only one piece of the complex puzzle of decentralizing the city. Though seemingly a model of efficient production and affordable housing provision, Levittown's infrastructural condition was seriously flawed, here indicated less by energy provision than by waste extraction: each house was built with a cess pool to "manage" sewage, a system that was quickly overwhelmed and led to increased county and state taxes and eventually federal assistance to nearby towns to expand their sewer system to accommodate the poor planning. Similar, though less dramatic, developments occurred relative to schools, hospitals, road maintenance, and other basic systems. See Hayden, Building Suburbia, 139. See also Adam Rome, The Bulldozer in the Countryside (New York: Cambridge University Press, 2001) for a description of the sewage problem in the suburbs through the 1960s. Levittown was an extreme example, though many early suburban developments used buried septic tanks, which were poorly built, poorly maintained, and usually had to be replaced by sewers at enormous cost.

61 One should note here that a number of contemporaneous practices similarly placed themselves between infrastructure and subjectivity, and often, as in the numerous climatic architectures of the period, on the terms of relationships to geophysical conditions – one thinks of the codification of Tropical Architecture at the Architectural Association in the mid-50s, and the methodological work of Victor and Aladar Olgyay in the same period; other projects and practices could be mentioned, from Candilis-Josic and Woods projects for nuclear power installations, to Doxiadis and Fuller's global mapping, to the flexibility inherent to Metabolist practices in Japan.

62 Rapson left Chicago in 1946 for Cambridge, MA to teach at MIT; leading to further, although more circumstantial, connections to solar house developments. In 1948, he was hired to design embassies and support buildings for the U.S. Foreign Buildings Office, reflecting a different disposition to a political reading of modern architectural gestures. He returned to MIT in 1952, but soon went to the University of Minnesota where he assumed the position of Head of the School of Architecture and Landscape Architecture in 1954 and stayed in that position for thirty years. See Hession, et. al., *Ralph Rapson...*, 224.

63 David Smiley, "Making the Modified Modern" in Brendan Moran and Annmarie Brennan, editors, *Perspecta 32: Resurfacing Modernism* (2001): 39-54. 64 http://www.oma.eu/index.php?option=com_co ntent&task=view&id=237&Itemid=25