Embodied Energy and Design
Making Architecture Between Metrics and Narratives

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Lateral Office, Making Camp (2015). At Lateral Office, my partner Lola Sheppard and I have developed projects that test or imagine these notions of energy and place as designed environments. What if we were to revisit Banham’s site of the campfire and tent with a renewed understanding of thresholds and envelopes? And how might this be inflected by notions of collective life rather than only by the individual? We conceived of a series of prototypes for new campsites in the project Making Camp. These designs capitalized on the specificity of an exterior environment, its interior management for living, and the processes (or rituals) that surround mediation between them. The intent of Making Camp was also to envision possibilities for new forms of collectivity in the wild that integrated energy expenditure and management as celebrated rituals.
Energy Publics: Five Embodied Worlds
Mason White

The irruption of energy in the universe of architecture smashes its crystalline images, shakes its mute silhouette, and gives it a definitive place in the field of processes and life.
—Luis Fernández-Galiano, Fire and Memory

Interest in energy—and its embodied form—has been intermittent over the past half century of architecture. It is an interest that has tended to surface in response to perceived urgency rather than design opportunity, and it has often been unjustly positioned as a dichotomy between architects operating with formal preoccupations or techno-determinism. However, a third way emerges that positions energy as matter within the palette of design—like space, light, or structure—and as a presence able to be sensed, experienced, and interpreted. To understand the relevance of embodied energy in design, it seems critical to consider energy as both a material and a site for design.

Numerous architectural thinkers, historians, and designers have recently exhibited a particular concern with energy, its expenditure, and notions of life cycle in design. This method of energy assessment, before it could even be named as such, demonstrates a radically expanded geographic and temporal understanding of architecture. Embodied energy is the trace of architecture’s reach from its site of construction back out into the sites where its component parts or materials are sourced. It measures the impact of construction in the age of the Anthropocene, and it poses provocations to designers and builders: How might a more cogent understanding of the material matter of architecture’s transformation of the earth alter the very practice, design, and construction of architecture? Or, if a building knew where it came from and the impact of that history, what would it do differently? Legibly associating materials with their origin would create a powerful registration of architecture’s geo-footprint.

This essay is structured in five parts, with a significant protagonist in each part advocating or revealing a vantage point from which to understand environment, energy, and place. Reyner Banham’s campfire, Howard Odum’s energese, Jakob von Uexküll’s umwelt, Buckminster Fuller’s World Game, and Iceland’s Blue Lagoon each offer a different approach and strategy by which to view energy as matter and site for design. All of these unconventional architectural case studies demonstrate architecture’s reach from its site back out into the world, as well as the discipline’s inevitable entanglement with geography, logistics, and energy exchange. In a way, each describes its own energy-conceived world. Through them, we see five embodied worlds suggesting new possibilities for energy publics.

Banham’s Campfire
There is no more fitting place to begin with energy, and its embodiment, than with the campfire. The historian Reyner Banham chose this heated site to

1 While the significant recent publications on energy and design are too numerous to list here, a few contemporary colleagues that have influenced my thinking are Iñaki Abalos, Daniel Barber, David Gissen, Joyce Hwang, Sean Lally, Ariane Laurie Harrison, and Filip Tejchman.
illustrate a parable in which matter and energy are pitted at a crossroads. Banham portrays a tribe that has gathered wood and is now confronted with the dilemma of whether to use the material to make a fire or shelter. Pitting combustion against construction, he presents the versatility of materials to become something over time—no matter how fleeting. This versatility is at the root of embodied energy: gathering the energy expenditure of materials and processes under transformation. Rather than emphasizing one option over the other, Banham celebrates both as architectural acts. Further, Banham believes that rather than make this choice through logic, people (in a tribe or otherwise) choose through custom. Therefore, he offers no bias for either shelter or campfire, though he does note the campfire may offer a more empowering platform for customs or ritual. To enact the (fast or slow) transformation of an embodied energy source is the act of design, or as Luis Fernández-Galiano succinctly puts it, “what is a house but a hearth?” Banham further articulates the campfire and the tent as primal acts of “environmental management.” Both are manufactured things, assembled or produced, that deflect, radiate, and retain a local environment. Banham laments the loss of the campfire—though not often the modern choice, the campfire is representative of a more profound understanding of space, defined by environmental gradients rather than by walls and floors.

Banham’s late-1960s observation was a rallying cry to recognize that environmental management was increasingly on par with the formal design of architecture. In fact, Banham even made a note in The Architecture of the Well-Tempered Environment to advise librarians to shelve the book so that it would be seen by designers rather than exiled to a shelf of technical manuals. Of course there are performative traits of environmental management, but there are cultural and atmospheric aspects as well. Reflecting on Banham’s conjecture today, we could argue that choreography of the circulation of air and moisture is just as essential to the experience of architecture as that of the space itself.

**Odum’s Energese**

Howard T. Odum worked in the field of ecosystem ecology. After an extensive three-year study, funded by the US Atomic Energy Commission, at Puerto Rico’s Luquillo Experimental Forest, Odum published a book on the power and exchange systems within an ecosystem under stress. The research considered the importance of radiant energy in biogeochemical cycles and produced a unique “energy language system.” This language system, which he called “energese,” uses a diagrammatic representation of metabolic energy inputs and outputs to depict energy flows within an ecosystem. To Odum, an ecosystem can be thought of as a program of energy modules in which each category of storage, operation, or species is a group of statements. He illustrated this language system by using generic symbols for flow, storage, consumption, production, and other exchanges to depict a holistic understanding of the transfer and transformation of (metabolic) energy. Odum’s energese offers a program for representing the circuitry connecting a site and the exchanges between its inhabitants. Yet in addition to representing systems and their interactions, it also provides a language with which to modify, intervene, or even redesign the system once it is revealed and understood.

As humans have become more entangled in ecosystems, the scientific undertaking of designing an isolated, closed-circuit system is perhaps not very practical. Instead, energy-responsive design should acknowledge variables, new and declining sources, and methods of anticipation. Buildings, cities, and
How might architecture, technology, landscape systems, and planning collaborate to form an energy ecosystem? How might this ecosystem be inhabited and managed by people and species alike? Water Ecologies/Economies is a dynamic master plan for the recuperation of the failing Salton Sea in southern California. The Salton Sea is an increasingly saline agricultural sump that was once a recreational destination. Our design introduces a series of synthetic islands that float freely in the water, to be used for water-harvesting, energy-harvesting, recreation, or habitat concentration. The islands can be deployed, packed away, or combined to respond to ecological or economic needs and wants. It is a dilatable, systemic, and ecological anti-master plan in which resource production and management is able to comingle with nature and leisure.
constructed landscapes alter existing ecosystems, but they also offer new synthetic (eco)systems. For example, consider the dirt displaced during construction, the land surface area covered, the change in solar exposure from new construction, or the minor alteration of wind patterns. These may seem like low-impact sacrifices for the landowner or developer, but they can still offer clues for synthetic circuits between existing site traits and potentially emergent ones—both of which could be synthesized through architecture. Odum’s energese provides a scalable understanding of systems, and a way to identify the impact that energy-consuming behaviors have on one another. As with embodied energy assessments, it also attempts to represent the reach of a system from its context of origin to a larger territory, in a system dominated by ambitions of closed loops, calibrated backflows, and equilibrium.

Taking the notion of an energy language to architecture and design reveals the potential of recognizing architecture’s reach beyond its site—either charting the origins of its products or the destiny of its by-products. Systems comprehension can also be a form of design. To understand, document, and then intervene in an ecosystem is an inevitable design act, conscious not only of energy expenditure but also of the aesthetics afforded by energy systems. This necessity is not confined to landscape architecture and ecology: architecture and urbanism also affect and generate energy systems, often with even greater reach out into the territory, beyond their sites.

**Von Uexküll’s Umwelt**

Experimental biologist Jakob von Uexküll’s study on species perception led to the introduction of the concept of *umwelt*. The term is loosely defined as “environment-world,” with the intention to distinguish it from the world more generically. *Umwelt* suggests the power of perception, where some objects or traits are of greater interest than others. The notion refers to elements of an environment that a species perceives to be offering greater energy-positive potential. *Umwelt* is the environment filtered by desire and need. Von Uexküll writes that “the space peculiar to each animal, wherever that animal may be, can be compared to a soap bubble which completely surrounds the creature at a greater or lesser distance. The extended soap bubble constitutes the limit of what is finite for the animal, and therewith the limit of its world; what lies beyond that is hidden in infinity.” As these bubbles intersect and overlap, the competition for resources emerges. Layered with Odum’s energese, *umwelt* can show how systems of exchange within and among species intersect and overlap, often in competitive ways.

Von Uexküll illustrates this environmental bias through simplified drawings from the vantage points of different species. In one illustration he compares the bee’s environment-world to the human visual-world of a meadow. This diptych juxtaposes an environment without any bias (in our eyes), and where all elements are equal, with a world where only the most important elements are perceived and others are ignored. Also central to understanding this alternate mode of reading the environment is that senses other than sight—like smell, taste, and hearing—play a critical role. Although von Uexküll does not specifically identify energy within an *umwelt*, perception-worlds rank elements of an environment by their necessity, desirability, or value—and energy, and its conservation, is most certainly a coveted element for all species. While this notion might originate from a biological bias of perception-worlds, it could also extend to an architectural bias. Cities and buildings could be thought to possess bubbles that generate competitive (overlapping) hierarchies of access to materials and energy.

What lessons are there to learn from remote settlement in our globalized, connected age? How might extreme conditions of off-grid living reveal new notions of the local? This proposal for the renewal of the community of Tristan da Cunha—considered to be the “most remote place on Earth”—harnesses the advantages of that remoteness. As an island forced to import so many resources from elsewhere, Tristan da Cunha’s umwelt is extremely legible, making construction (and life itself, for that matter) a question of degrees of importation. The challenge in this “bubble” is how to integrate what is local with what comes from afar. By using primarily local materials born from a volcano, an emergent vernacular supplants the imported generic.
Fuller’s World Game
In collaboration with John McHale, Buckminster Fuller sought to document and represent a generalized inventory of world resources. Fuller intended for the inventory to reveal the impact of energy and resource scarcity at the scale of the planet. He believed that the world—rather than the nation, state, or city—was the necessary unit of analysis to comprehend the availability and distribution of goods and resources. Through a series of seminars and workshops, the inventory further developed into a logistics game, later called the World Game. Fuller inverted the game format to encourage collaboration instead of competition for resources. Identified as a social problem-solving exercise, the World Game offered an alternative goal to “make the world work, for one hundred percent of humanity, in the shortest possible time, through spontaneous cooperation, without ecological offense or the disadvantage of anyone.” While Fuller’s ambition with the World Game was to reveal large-scale geospatial information on elements ranging from grain to iron ore, he was working in an era that preceded the Internet, supercomputing, and big data. The game overlaid a computer simulation on Fuller’s customized Dymaxion map to represent systems such as high-voltage transmission networks or interconnecting electric networks in order to reveal what he called “energy slaves.” An energy slave is a measure that reveals “the man-year equivalents of work being done for man by his inanimate slaves.”

As a broad comprehensive planning tool, the World Game illustrates the potential global impact of resource inequity and imbalance. As a game, it invites players to seek stability and equilibrium for collective survival. As a designer, Fuller implied that this knowledge and awareness was essential to an architect or engineer, and advocated for a model of practice ahead of its time. Is this not what contemporary BIM-based software also aspires to do? To integrate design with economy and material performance all at once? Though Fuller did not have access to such immense real-time data sets, the scope of his work did suggest the political nature of materials and resources being integrally tied to design decisions. The implication is that the extractive site of materials, the impact of that extraction, and the labor to feed it into a global market cannot be entirely divorced from its aesthetic presence within a work of architecture.

Iceland’s Blue Lagoon
In 1976, hot brine from the recently opened Svartsengi Geothermal Power Plant was discharged into an adjacent lava field in Reykjavik. Seeking warmth in a cold climate, people began bathing in the bluish waters of this small lagoon. Since then, this inadvertent by-product of industry has become an international destination and symbol of wellness and leisure: the mineral-rich pool, lined in silica, is believed to heal those suffering from psoriasis. Since 1992, the Blue Lagoon has become more than a body of mineral-rich water; it is now a successful “wellness” company and a producer of skin care products, all powered (accidentally) by geothermal energy. In 2014, it attracted 700,000 visitors—more than double the population of Iceland. This body of water symbolizes a unique partnership between nature and industry. Nature warms up the water that industry then uses for domestic heating and electricity, while the run-off forms a public bath. Typically considered waste, run-off is unceremoniously dumped, and similarly, leisure and industry are typically more isolated than entangled. The Blue Lagoon offers a provocative alternative industrial site that merges energy production with recreational science.
Fig. 7 Lateral Office, Many Norths: Spatial Practice in a Polar Territory (2014–16). How is design affected by extreme climate? And how has adaptation been instrumental to innovation? The Many Norths project was a multiyear study on spatial practice in the Canadian Arctic. The project organized the Arctic into five different agendas of spatial practice — architecture, urbanism, mobility, monitoring, and resources. Each was intended to reveal human ingenuity and innovation when confronted with the unique environment of the Arctic. Like Fuller’s World Game, collaborative living is essential to survival in the north, as is an awareness of the finite nature of materials, resources, and elements.
The Blue Lagoon is a synthetic landscape, equal parts natural and artificial—if one could even draw the line between the two in this case. This landscape of energy broadens the possibility of an energy public, as sites of production are more often far from visible and removed from experience. The potential for sites of industry to go beyond single-program use suggests alternate approaches to design and infrastructure, as well as a possible realignment for cultural understandings of industry landscapes. A transformed mind-set could allow a wider range of design to take place, producing novel public environments for energy, resources, and the public realm.

Five Embodied Worlds

In situating energy-as-design-material, these five case studies illustrate the power of energy thinking to inform design in a new way. From Fuller’s global (logistical) perspective to Uexküll’s microcosmic (biological) vantage point, architects can integrate energy as an experience, a process, and a new conception of site across a series of embedded scales. Considering energy as something to design, embodied energy is not so much a necessity tied to sustainability but more an opportunity to enhance spatial and experiential values. Naturally, metrics for embodied energy assessment are essential to some sort of post-sustainability design, but they are not the only models for thinking. In many ways, energy has always been a material matter in architecture, although only intermittent waves of thinkers and designers have oriented their work toward its potential. New perspectives on energy and its embodiment offer larger conceptions of site and geography and an expanded scope for architecture. An honest question to provoke design thinking within this new perspective is, where does site end and architecture begin?
Fig. 9 Lateral Office and LCLA, Weather Fields (2010). How might sites of renewable energy go beyond utility? Is there a place in our broadening public realm for productive infrastructure, and vice versa? The Weather Fields project is an energy-experience landscape in Abu Dhabi that harnesses the local potential of energy—wind—as an energy source, experience landscape, and urban barometer. The future of energy production is simultaneously the future of the public realm.