ENERGIZING THE SPACES OF EVERYDAY LIFE

Learning from the Past for a Sustainable Future

Edited by

Vanessa Taylor
Heather Chappells

Transformations in Environment and Society

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Introduction

New energy forms have transformed the patterns and spaces of everyday life over the past two centuries. These transitions from one energy pathway to another have been uneven, unpredictable, and often perplexing for energy users. Promises about the societal and environmental improvements that new energies would bring—such as citizen empowerment, greater equity, and cleaner air—have materialized only selectively. No single energy pathway has proved a panacea to solve all societal problems; nor is one likely to emerge that will completely eradicate reliance on fossil fuels.

The think pieces in this volume were inspired by two core questions.[1] What can a retrospective look at how the spaces of everyday life have been energized in the past tell us about how to navigate the social and material uncertainties of lower carbon futures? And what can this historical focus tell us about energy users as variable agents of change? Together, these contributions address spatial transitions at local interfaces where new material energy arrangements have met very diverse forms of social life. All consider the role of users in energizing spaces, but they each present a unique view of users' roles and relative powers as agents of change.

The collection as a whole is designed to provoke debate about the character of energy spaces from a user-oriented perspective. Beyond this shared focus, there are different understandings of user agency at the intersection of energy, society, and space. Energized spaces are variously conceived as sociomaterial landscapes structured by the regional or global politics of provision; as sites of local contestation, consumer resistance, and negotiation; and as culturally defined "energyscapes" where power to effect change evolves slowly from within communities. Energy transitions appear in some cases as a single fuel change for a specific group of users; in others, we see how multiple energy systems have coevolved to serve complex household needs.

1 These articles arose from the Transitions in Energy Landscapes and Everyday Life in the Nineteenth and Twentieth Centuries workshop held at the Deutsches Museum, 27–29 April 2017. The event was organized by Vanessa Taylor, Heather Chappells, and Frank Trentmann (Material Cultures of Energy Project) in collaboration with Christof Mauch (Rachel Carson Center) and Helmuth Trischler (Deutsches Museum). Sponsorship and funding for the event came from the Arts and Humanities Research Council (UK), Rachel Carson Center, and the Deutsches Museum. The editors would like to thank all the organizers and contributors for helping to enrich understandings of users' experiences of energy transitions. We would also like to thank the editorial team at RCC Perspectives, especially Katie Ritson and Samantha Rothbart.

The articles in this volume offer important insights into the spatial, material, and social dimensions of transition that promise to enrich our understanding of how everyday environments came to be energized. Attention to how the varied spatial organization of energy influenced transition is one shared theme for the collection. The dominant image of "the modern energy landscape" in the twentieth century is of large-scale grids with pylons and wires bringing power to the waiting urban, and later rural, masses. Such macroscale landscapes of energy evolution represent only one piece of the jigsaw. Contributors to this volume also deal with what emerging energy modernity looked like off the grid and how it appeared within the micro settings of urban and rural life. Some of the spaces featured are by now familiar research settings for the exploration of energy transitions—including niche eco-communities (Strauss and Eggleston), climatically sensitive buildings (Barber), cities or rural communities (Melsted, Carlson), and "the home" (Sandwell, Taylor and Chappells)—but there is still much to learn about how these spaces are politicized, diversified, and culturally nuanced. Other featured spaces—such as domestic fuel storage (Adams) or areas designated as "wastelands" (Baka)—are less familiar as the site of transitions but they can be pivotal to unlocking or blocking energy futures.

Materiality is the second major dimension that connects all of the featured stories of energy evolution. As authors explore the convoluted transition pathways of wood, coal, gas, oil, biofuels, and electricity in the past, they bring to the fore the tangible or intangible qualities of these different energy sources and the ways in which they each distinctively define the spaces they inhabit. It matters that coal is dirty, hard to handle, and bulky, just as it matters that electricity is invisible, cannot be handled, and is useless without conversion. Means of accommodating physical properties are hardwired into the infrastructure of homes and communities, and they structure daily routines and habits. In the past, households organized their lives around the materiality of wood—which required sourcing, chopping, and storing—and of coal, which required stockpiling in advance of the cold winter months (see, for example, Sandwell, Adams). Fragile distribution networks and inadequate domestic storage could thwart people's capacity to access energy and handle disruptions effectively. Attention to these different material requirements, and to supporting infrastructures, has proved vital in the past to people's capacity for transition.

Material energies have other sensory qualities that permeate local environments, community relations, and patterns of daily life. These can produce experiences that are positive—like the warmth and comfort of an open fire—or negative, as in the historical experience of noisy wind turbines or noxious air pollution.[2] Such sensory dimensions are in the foreground of Jennifer Carlson's account of contemporary energy transitions in rural Germany. Intensified biogas production to support the country's *Energiewende* (renewable energy turn) intrudes upon the lives of rural inhabitants through an overwhelming stench of slurry, while simultaneously resurrecting old frictions between social classes. Materiality, and its sensory manifestation within communities, is central to forging positive social attachments to energy but it can also provoke reactions and resistance that are rooted in the past.

Shifting environmental sensibilities have influenced the ways in which people perceive the materiality of different energies over time, but they have rarely been considered in isolation from social and political concerns. Anthracite coal was valued in the late nineteenth century, as Sean Adams shows, both for its high carbon content and its lack of impurities, producing intense heat with little soot or smoke pollution. But its successful penetration of North American energy markets was also its weakness as cities came to a standstill during regular strikes, prompting calls for transition to alternatives such as gas and electricity. Odinn Melsted offers a different perspective on how environmental concerns have been constructed around material qualities, showing how coal was "rebranded" from an essential household resource to a problem. In order to convince domestic consumers to embrace a "clean" geothermal future in 1930s Reykjavík, coal first needed to be discredited as "dirty." Competition between fuels characterized some transitions but others supported complementarity, with a range of energy options meeting different local or household needs. The balance between single- or multi-fuel arrangements has been shaped partly by users' cultural preferences, partly by local resource availabilities, or by wider political ambitions. And optionality in fuel choice has varied greatly across energy landscapes because of the social and material constraints of everyday life.

In addition to the intrinsic material qualities of energy forms, associated technologies embody specific discourses of environmental and social resilience that can determine

2 See also complaints about noise and wind turbines: Noise Abatement Society (UK, established 1959), http://noiseabatementsociety.com/campaigns/wind-turbines/, accessed 10 July, 2018.

people's future relationships with energy. In the context of building materials, modern constructions of glass and metal are characteristically environments sealed off from nature, requiring energy-intensive mechanical systems to make them comfortable for inhabitants. But Daniel Barber's piece explores alternative visions of modernity in architectural projects in Brazil from the 1930s and 1940s that embraced rather than excluded climate. This architecture, attentive to cultural desire as well as offering a different kind of functionality, embodied a counter-ideology to carbon dependency. Barber urges us to think about how to make buildings exhilarating through innovative features—such as the "irresistible staircase"—that can prove a compelling material aid to sustainable habits. Elsewhere in this volume we are encouraged to consider what *inhabitants value* within domestic spaces, and how accommodating user-defined notions of comfort or functionality in the past has supported energy innovation (Sandwell, Strauss and Eggleston, Taylor and Chappells).

A third dimension of common interest across this collection is the social variance that characterized experiences of energy transitions. Modern urbanites differed greatly from rural farm users in how they were able to access energy and its associated technologies, as did pioneers and later adopters. But there were also deeper social demarcations and divisions. Several authors address these tensions, suggesting how unevenness in the spatial development of energy has been matched by *social asymmetries* in access to resources. Income and class have directly determined experiences of energy, through the ability or inability to buy fuel (as articulated in the pieces by Sandwell and Adams). Housing and tenure arrangements have also limited the kinds of energy devices and service options available to different users, as seen in our own contribution. Official policies, such as those tackling rural depopulation, have likewise influenced what and who is prioritized in energy services. Energy spaces evolve in the context of these differentiated societal structures and variable cultural norms that specify what is essential or peripheral to domestic comfort or convenience. This tends to produce unequal, variegated, and "hybrid" configurations of space. While there have been persistent calls for equalization of services and practical efforts to iron out differences over time, differentiation remains a normal feature of everyday energy arrangements. An important question to ask when planning energy futures is whether entrenched structural inequalities will prevent some citizens from achieving sustainable living arrangements.

Accounts of the physical realignment of space to support modern energy infrastructures are often juxtaposed with stories of power struggles between regional network developers and local actors. This was true of early twentieth-century energy ideals—with disputes over hydropower development and indigenous land dispossession in Canada—and it continues to be a feature of evolving energyscapes. Jennifer Baka's contribution explores how India's fuelwood crisis in the 1970s was a catalyst for social forestry programs on newly designated "wastelands" that transformed local subsidence economies. The more recent shift from biomass to biofuel production on these "wastelands" severs local bonds with the land and access to its fuel and food materials; distant urban elites form the main beneficiaries of this version of green modernity. A contrasting late twentieth-century development in India, the eco-enclave of Auroville, highlights the evolutionary character of this modern "energyscape"—not as a finished space but as a continually shifting canvas for new ideas and innovations. Sarah Strauss and Carrick Eggleston describe an organic, fluid, and experimental process of sustainable adaptation where community solar and wind installations have partly given way over time to more resilient connections, where the community now supports the development of externally sited wind turbines feeding the regional electrical grid to reduce intermittency. These cases from India, along with Carlson's experiences of transition in rural Germany, illustrate how different interpretations of social and environmental resilience generate selective improvements, with unequal benefits.

In highlighting the spatial, material, and social dimensions that defined experiences of energy in the past, this collection opens up new lines of debate about the nature of energy transitions in the context of variable everyday lives. Importantly, the perspectives combined here do not lead us to a grand narrative of unified transformation in homes or communities, or towards a universal ideal of modern energized life. Notably, transition has more commonly been a slow, laborious, and continual process than an abrupt change, as new energy systems have met existing sites of consumption. Ruth Sandwell demonstrates these temporal rhythms of transition in recounting the slow progression to a mineral regime in Canada, where rural people still relied heavily on locally available, organic energies into the 1950s. Conversely, Odinn Melsted highlights the ongoing effort needed to construct demand for local geothermal heating in order to lure people away from their dependence on imported coal. The continuous effort involved in energizing the spaces of everyday life is often overlooked when things appear to have temporarily stabilized—as in today's prevalent carbon dependency and the normality of connections to centralized grids. But historical hindsight offers a realistic view of how change happens, and it can help explain the circumstances under which resistance to a promised future may surface.

Stories of material and cultural entrenchment within energy spaces are striking here. Affluence and fuel availability have partly dictated the pace of energy conversions, but people have not automatically switched from embedded infrastructures or existing practices even when faced with a cleaner, cheaper, more technologically advanced or convenient modern alternative. Several explanations are offered for this persistence of older energy formations and they point to the centrality of energy users as agents of change. Rural users in Canada did not wholeheartedly embrace new gas or electric cooking appliances, largely because older stoves enabled multitasking and contributed to “all-round” value; these advantages were especially appreciated during times of thrift and economy. The people of Reykjavík were not easily seduced by the idea of an energy source literally beneath their feet, but this was not simply because of concerns about cost; the geothermal option also had to match coal’s quality of heat that could be controlled on demand. No energy future was guaranteed if it did not provide for the complex elements householders valued in what they already had. What we take from such examples is that resistance to change appears when elements of new energyscapes are out of sync with existing values, or when they revitalize existing tensions within communities. Those planning postcarbon energy landscapes should note the importance of such existing values, recognizing also that users have rarely all shared the same “sustainable” values when appraising new energy options.

Transitions have proved enduringly uneven processes, generating “hybrid” material arrangements and social disparities that are seldom ironed out. There *have* been huge changes in the energized spaces of everyday life over time, of course, and this provides hope for a more sustainable future. But people’s energy needs today, geographically adapted and culturally specialized as they are, continue to be met through multiple systems, and to varying extents. In highlighting diversity in the energized spaces of everyday life, this collection aims to stimulate debate about what will be valued in the sustainable energyscapes of the future, and to put all users at the center of such dialogue.

Vanessa Taylor and Heather Chappells

What Do Consumers in the Past Tell Us about Future Energyscapes?

As significant players in rising carbon levels, today's domestic energy users face increasing pressure to adopt more sustainable practices and technologies. This is not the first time people have been asked to switch energy sources, accommodate new technologies, or modify their behavior. Transitions from wood to coal, and later from solid fuels to gas and electricity, also meant changes in homes and everyday routines. But domestic energy transitions across the twentieth century show that consumer compliance with providers' and policymakers' visions has rarely been a smooth or predictable process. Here, in order to ask how consumers will feature in the evolution of energy futures, we review their roles in shaping transitions in the past. Offering insights from our historical investigation of changing material cultures of energy in Britain and Canada, we reflect on a central focus of this volume: the spatially differentiated character of energy modernization and the role of consumer agency in forging new energy spaces. We consider how the past can inform current debates about the transition to sustainable consumption.

"Energyscape" is used here to encapsulate shifting connections between energy consumption and production activities across multiple spatial scales: from homes and local communities to regional and national contexts. We draw here on the meaning articulated by Strauss et al: that energy exists at different spatial levels, "shifting its cultural, social, economic, and technological values as it flows from one domain to the next."[1] As fluid entities across space and time, energyscapes encompass both changing expectations of energy use at a broad societal level, and shifting local geopolitical and cultural contexts. Developers' visions of national or regional energy futures may have a strong bearing on how energyscapes evolve locally but they have rarely determined community or household practices in precise terms. Energyscapes reflect patterns of consumer resistance and negotiation, as well as cooperation.

The home within changing twentieth-century energyscapes was like Dorothy's house caught in the twister in *The Wizard of Oz*, spinning through space and time at the

1 Sarah Strauss, Stephanie Rupp, and Thomas Love, eds., *Cultures of Energy: Power, Practices, Technologies* (Walnut Creek, CA: Left Coast Press, 2013).

mercy of complex and unpredictable forces. These forces were generated outside and inside the home. They involved large-scale shifts in the global politics of energy, changing regional fuel availabilities, and local transformations in urban, suburban, and rural spaces. Affecting the finer details of household energy choices were variable income levels, housing regulations, new housing types, generational preferences, and diverse land-tenure and living arrangements. Practices within the home were also influenced by social patterns of work, leisure, and mobility beyond its walls.

To make sense of some of these complex, dynamic forces we consider three past patterns of household-grid interaction that typify the contested evolution of energyscapes. The first interaction highlights tensions between consumers as imagined in developers' visions of the future and consumers' actual behaviors as grids expanded across urban and rural space. Next, we reflect on the material and cultural hybridity of emergent domestic energy spaces that suggests persistent differentiation in users' experiences of energy over time. The third interaction is characterized by the resistance of energy users, who mobilized because of conflicts over tariffs, service contracts, quality of service, and questions of fairness perpetuated by uneven energyscapes. In exploring these key tensions around the household-grid interface in the past and their persistence in the present, we reflect on the challenges they may create in projections for a sustainable energy future.

Modifying Visions of Electrified Life

Electricity was often represented by early twentieth-century suppliers as a transformative, modernizing force that would unite society. Sebastian de Ferranti's statement on Britain's electric future was typically all encompassing: "Wherever coal, gas, or power are now used, everything . . . will be better done when electricity is the medium of application."[2] Consumers were passive beneficiaries in such visions: a captive audience eagerly awaiting the arrival of the grid and its modern conveniences (Figure 1). Behind the scenes, suppliers struggled to understand the behavior of their target audiences; they also struggled with technical and commercial concerns about how to expand their networks and construct the diversified demand they needed to balance system loads. These difficul-

2 Sebastian Z. de Ferranti, "Inaugural Address," *Journal of the Institution of Electrical Engineers* 46, no. 205 (1911): 15.

ties shaped the nature of electrical development. Private providers often chose to serve lucrative industrial users first, adding domestic connections only when beneficial, to supplement off-peak loads. Public providers promised more inclusive landscapes of connectivity. Adam Beck, chair of the Hydro Electric Power Commission of Ontario (founded 1906), advocated "Power for All" citizens at low cost in the first decade of the twentieth century, but this promise was frequently reinterpreted as the physical and economic difficulties of rural extension became evident. The equalizing public-service ethos belied great unevenness in grid connections. By 1921, only half of Ontario homes had electric lighting, and electricity did not reach many urban homes until the early 1940s. Well over half of rural homes had no electrical services at this time.[3] Customers struggled to understand the rationale behind this differentiation, with advocates for Ontario's rural users often challenging the fairness of service extension priorities and seemingly arbitrary pricing policies that divided neighboring districts.[4]

Figure 1:
Energy users were often portrayed as awaiting electrification rather than being actively involved in modernization. Virtual Museum Canada, 1942. Used with permission from Manitoba Electrical Museum Inc.

The envisaged mass of new consumers did not simply materialize, either in urban or rural settings. Many were neither convinced by an electric future nor in a position to choose one, with its new equipment, complex rates, often-unreliable service, and upheavals in everyday routines. By 1948, almost 25 percent of UK households were still without electricity, the majority being tenants in poor urban housing, and rural in-

3 Ruth W. Sandwell, "Pedagogies of the Unimpressed: Re-Educating Ontario Women for the Mineral Economy, 1900–1940," *Ontario History* 107, no. 1 (2015): 36–59.
4 *The Globe* (Toronto), "Advocate Flat Rate for Hydro Power in Rural Ontario," 17 December 1926, 11; "Hydro Meters," 1 March 1935, 4.

Are you having baking problems?

TEN CHANCES TO ONE IT IS NOT YOUR RANGE.

USING THE OVEN CORRECTLY

1. Heat the oven to within 50 degrees of the temperature required with both top and bottom oven elements. Turn off the top element and continue heating the oven for the last 50 degrees with the bottom element only.
2. Bake with the bottom element only.
3. Place rack one-third way up in the oven. Always place baking pans on racks, never directly on baffle sheet.
4. Baking pans must not touch each other or the sides or the back of the oven.
5. If two racks are used to bake four layers of cake or four pies, the tins should be staggered diagonally on two racks so that each will receive as much top and bottom heat as possible.
6. If two sheets of cookies are baked at the same time, the pan on the top rack should be changed with the pan on the bottom rack the last quarter of the baking period.
7. Give the oven a fair chance by not peeking.

ECONOMY POINTS

1. Plan oven dinners, cooking meat or fish, vegetables and dessert in oven.
2. Plan baking days and bake several foods when the oven is hot.
3. Use stored heat to bake a custard or a custard type of pudding; the last pan of cookies; a meringue on a pie or some melba toast.

Figure 2: "Are you having baking problems . . . ten chances to one it is not your range." BC Hydro Home Service Centre, pamphlet, ca. 1960s, Box 2 File 3, Beatrice Millar Home Economics Ephemera Collection, University of British Columbia Library, Rare Books and Special Collections. Used with permission from University of British Columbia Library.

habitants.[5] Britain's nationalized energy sector, created that year, aimed to smooth out spatial and social inequalities in grid access and services. Aided by postwar urban housing programs, this figure was reduced to less than 10 percent by 1958. But even within wired households, UK consumers proved highly selective in their electrical applications, frustrating providers' efforts to "build the load." A national survey in 1953 found one-fifth of farmers to be using electricity only for domestic purposes, despite intensive "electricity on the farm" campaigns designed to boost agricultural uses.[6]

Energy users were significant in defining the terms of energy use and were often seen as impediments to progress. Providers frequently expressed frustration with those who failed to appreciate the benefits of new services or to use appliances as intended (Figure 2). "Don't Blame the Appliance," a 1968 article published by the BC Hydro Home Service Centre,[7] highlighted an enduring perception of customer misuse, claiming that almost half of service calls could be eliminated if homemakers would simply follow the instruction booklet. In reality, there were many complex practical and cultural reasons why consumers did not fully embrace electric cooking, heating, or laundering.

5 L. Needleman, "The Demand for Domestic Appliances," *National Institute Economic Review* 12, no. 1 (November 1960): 39–40.

6 Anthony Hurd MP, "Electricity Supplies (Rural Areas)," Hansard Parliamentary Debates, Commons, 5th series, volume 516, column 1355 (19 June 1953), available at http://hansard.millbanksystems.com/commons/1953/jun/19/electricity-supplies-rural-areas.

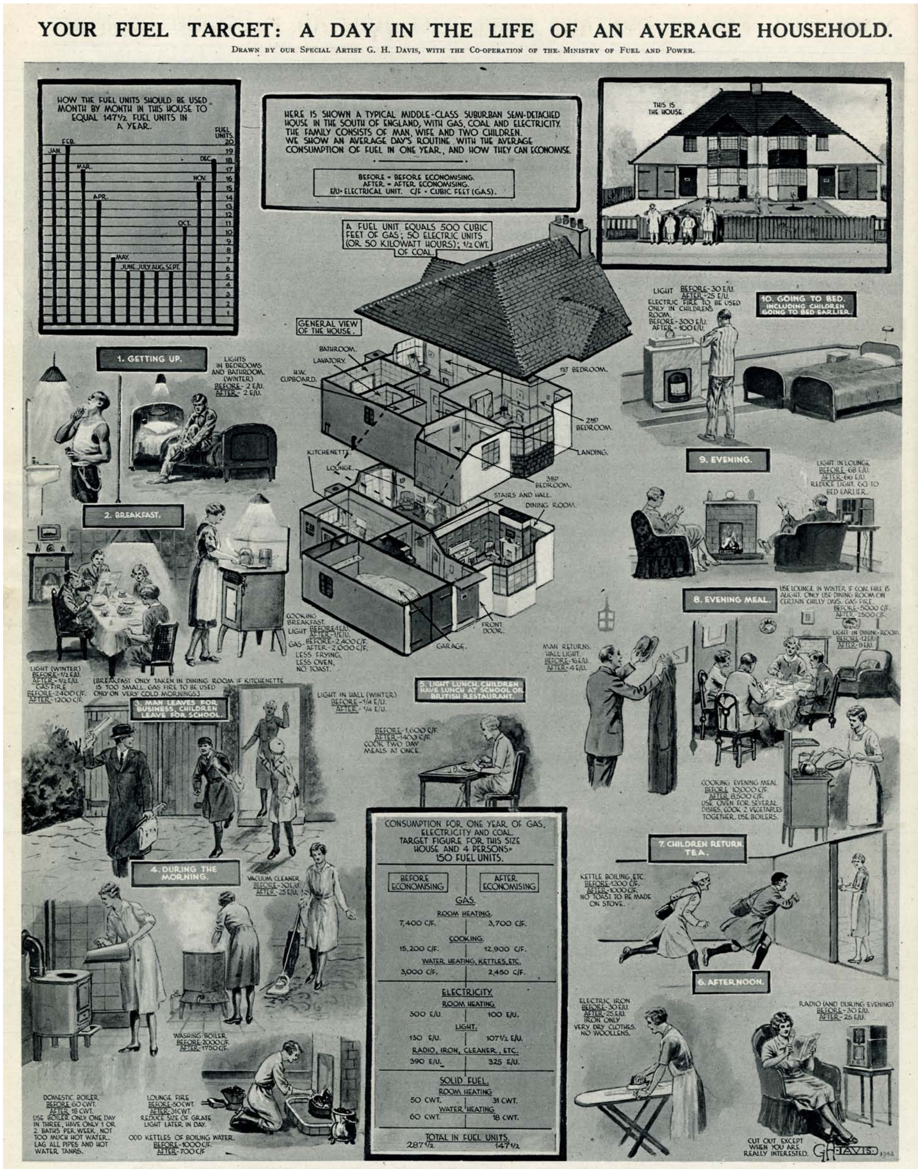
7 BC Hydro Home Service Centre, "Don't Blame the Appliance," *The Tie-In*, Aug–Sept 1968, B. Millar and BC Hydro Home Service Centre Collection, UBC Rare and Special Collections, Vancouver.

Hybrid Energyscapes across Time

Figure 3:
A 1930s cartoon shows a "knock-out" fight between gas and electricity, with the cook egging on the traditional gas cooker. Government "subsidies" (the wire trailing from the electric cooker) helped electricity move into some rural areas at this time. Gas Progress: *The Annual Bulletin of the Bedford District Gas Company and Co-Partners' Journal* 1, no. 8 (Dec 1932). © Bedfordshire Archives & Records Service.

A common way of looking at energy developments in the past was as a series of zero-sum conflicts between competing fuels resulting in a single-source transition. The 1932 cartoon in Figure 3 portrays this, with its "knock-out" fight between a gas and an electric cooker. "Needless to say, we cannot both have the heating and cooking business," claimed the Bedford gas company. In fact, households relying on a single energy source were a rarity for most of the twentieth century. The persistence of both coal and wood in postwar rural Canada, for instance, has been well documented (see Sandwell in this volume). Regional availability of fuels, the cost of electrical service extensions, and versatility of traditional appliances all influenced household energy decision making. Fuel substitutability and competition also lingered in Britain. Early domestic electricity was often used only for lighting a single room, alongside gas or oil lighting in other rooms, for complex reasons relating to cost, technical capacity, and preferences for comfort. Such diversity is captured in a 1942 depiction of the "average British household" in Figure 4, with heat and power matched to different practical and affective purposes, including electrical appliances, a gas cooker, and an open fire for relaxing after dark. Electricity's domestic role expanded significantly in the postwar years, but most households remained stubbornly entangled in multiple energy networks. In a 1951 social survey of British households, 66 percent used both gas and electricity; 98 percent still used a coal fire in their living room. A 1963 British government report on *Domestic Fuel Policy* noted the continued widespread use of solid-fuel fires and paraffin heaters, as well as electric heaters and gas fires, attributing differences in household transitions to prices, available fuels, local habits, and the influence of local authorities and suppliers.[8]

8 Leslie T. Wilkins, *Domestic Utilization of Heating Appliances and Expenditures on Fuels in 1948/49*, Government Social Survey Publications NS, 130 (c) (London: Central Office of Information, 1951); Ministry of Power, *Domestic Fuel Supplies and the Clean Air Policy*, Cmnd. 2231 (London: HMSO, 1963).



ECONOMIES THAT WOULD HAVE TO BE PRACTISED IN ORDER TO KEEP WITHIN THE LIMITS SET BY THE MINISTRY.

Drastic economy will have to be practised in most households if they are to keep within the limits of fuel consumption laid down by the Ministry of Fuel. On this page we show how an average household, comprising a man and his wife and two children, can achieve their target by means of many small economies which, in the aggregate, amount to a great saving. Coal *must* be available for the war factories and transport, and unless a saving is made in gas and electricity (both of them produced by coal) the country will be short of a war essential. The most drastic cut suggested in the programme outlined by our artist is a reduction from 60 cwt. to 18 cwt. in the domestic boiler. Instead of keeping this going night and day, it is suggested that it should be lit only once in three days. Lagging of pipes and tanks will minimise the danger of a frozen supply. On our final fuel page, opposite, we give simplified instructions for checking actual consumption of fuel week by week.

Figure 4: An average day in "a typical middle-class suburban semi-detached house in the south of England." G. H. Davis, "Your Fuel Target: A Day in the Life of an Average Household," *Illustrated London News*, 2 October 1942. © Mary Evans Picture Library.

Some important regional variations arose where fuels were not easily substituted. In such cases, complementarity shaped the transition. Despite their misleading names, the British Columbia Electric Railway Company (established in 1897) and its successor BC Hydro (created 1961) saw electricity and gas in complementary terms, supporting both options for customers (Figure 5). Home modernization campaigns from the 1930s encouraged consumers in the main urban centers to exercise their preference for a gas or electric water heater, refrigerator, or range. As an example of more extreme diversification, the North of Scotland Hydro-Electric Board (established in 1943) served the remote highlands and islands through diesel generation, Calor gas, and experimental wind power, as well as hydroelectricity (Figure 6). Oil and portable liquid petroleum gas today remain central to the UK's rural heating provision.

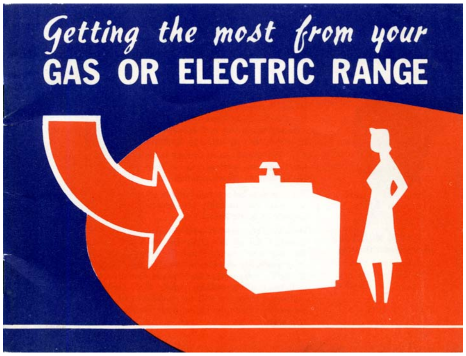


Figure 5: "Getting the most from your gas or electric range." BC Hydro Home Service Centre, illustrated booklet, ca.1960s, Box 2 File 3, Beatrice Millar Home Economics Ephemera Collection, University of British Columbia Library, Rare Books and Special Collections. Used with permission from University of British Columbia Library.

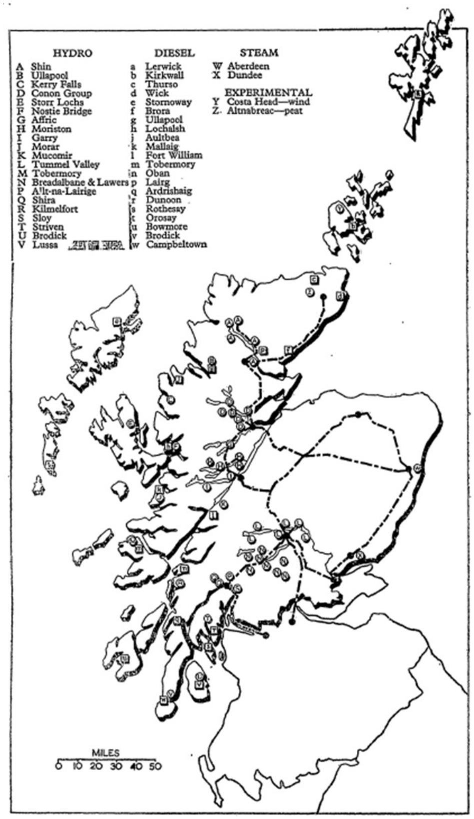


Figure 6: Hydro, diesel, steam, and (experimental) wind and peat electricity generation in the Highlands and Islands. North of Scotland Hydro-Electric Board, Annual Report and Statement of Accounts, 1 January 1953 to 31 December 1953. © SSE.

Contested Energyscapes

Cost has always been a potential source of conflict and one reason for ongoing reliance on multiple fuels. Householders who were disillusioned with the prices they were paying for limited electrical capacity sometimes returned to older energy systems. One disgruntled Toronto resident reverted to the coal range for the winter to avoid paying the higher service cost of adding an additional electrical wire to their home.[9] There were also frequent reports of resistance to costly centralized provision where cheap local resources were available. South Wales collier families who received subsidized coal frustrated electricity suppliers' aims to increase household demand in the region.[10] Conflicts over fair rates arose when urban users were asked to subsidize rural users. And people were often unhappy with the tariff and service differentiations they saw in their own localities. One urban Victoria resident complained to BC Electric in 1930 that his friend living only a short distance away in the city of Vancouver paid lower rates for comparable electrical equipment and usage.[11] But these were not simply rational consumers intent on the best price. Perceptions of material benefit and comfort have been contradictory. In late 1960s Britain, a Norfolk resident complained to the electricity board that after installing seven storage heaters, her house was still cold. But when advised of the draught from her "large Elizabethan type open fire place," she chose to keep using it.[12]

People's capacity to shape their domestic energyscapes was highly variable and affected by structural constraints within and beyond the home. In Britain, housing tenure was particularly influential in this regard. Local councils here held much power as "proxy consumers" of services and appliances, being responsible for almost a third of homes by 1970. Gas and electricity providers competed for services and appliances in new public housing from the 1930s onwards in the name of council tenants' "freedom to choose."[13] Residents were not entirely locked into given energy pathways, turning at times to collective protest. Tenants' rent strikes show how issues such as inadequate heating could become politicized, but their frequent defeats also indicate the odds stacked against tenants with limited legal rights.[14]

Even when electrified homes became normal for the majority, some struggled to get the service they wanted. Some consumers demanded electrical services but were held back

9 The Globe, "Hydro Meters," 1935.
10 House of Commons Parliamentary Papers, South Wales Electricity Board, Fifth Report and Statement of Accounts, Including Report of Electricity Consultative Council, for the Year ended 31 March, 1953.
11 J. Forman, "Letter to A T Goward, Manager BC Electric Railway Company," 12 February 1930, BCER Collection MS-0004, RBC Archives, Victoria.
12 Eastern Electricity Consultative Council, GC473/5/14: Norfolk Local Committee, 9 April 1969, Suffolk Record Office.
13 Frank Trentmann and Anna Carlsson-Hyslop, "The Evolution of Energy Demand in Britain: Politics, Daily Life and Public Housing 1920–1970," *The Historical Journal* 61, no. 3 (September 2018): 1–33; Central Office of Information, *Housing in Britain: Reference Pamphlet 41* (London: HMSO, 1970).
14 Mass Observation Archive, Ref. SxMOA1/2/1/1/F/1, "Housing Conditions and Rent Strikes, 1939–40," The Keep, University of Sussex.

by infrastructural constraints, such as the inadequacy of wiring. As late as the 1960s, residents in remote parts of Ontario rewired their homes in anticipation of Hydro grid connections, only to be told that service was not yet economically or technically feasible in their area. In areas that were especially slow to electrify, rural users were enrolled as voluntary labor to speed up connections or offset costs. Farmers in Alberta's Rural Electricity Associations in the 1950s–60s cooperated both by helping to construct their local power lines and by educating their neighbors on how to live safely with electricity. Such experiences of becoming electrified contrast strikingly with earlier visions of consumers as passive recipients of convenient modern energy forms.

What Can the Past Tell Us about Future Energyscapes?

Returning to our image of Dorothy's spinning house, the home—though increasingly grounded within large-scale integrated networks—has not really stabilized over time. We see a variety of household energy transitions in the twentieth century. But within these changing domestic energy arrangements, there are three broad, persistent patterns that we believe are crucial in considering future transitions.

Firstly, totalizing visions of transformation have rarely materialized. There is no single model for transitions in everyday life: these evolve in myriad ways as new spatial formations meet preexisting material cultures of energy. Despite convergence over time around electrified ways of life, households have remained entangled in multiple energy systems that have worked for them, even where these systems have not been the most rational solution from a provider perspective. Hybrid modes of domestic energy transition are normal—even crucial—in the evolution of energyscapes. This is unlikely to change. Emergent systems today, such as microgrids, must also intersect with existing centralized networks and other entrenched domestic arrangements that people may be reluctant to change. As the experience of blackouts in the past suggests, this hybrid complexity can often support resilience during grid disruptions.

Secondly, domestic users have co-created energy transitions—from their decisions about appliance purchases and fuel mixes, to complaints about service conditions, or direct action in the building of rural networks. Transitions are unpredictable, but it is certain that households will continue to modify energy policies, though on uneven playing fields in terms of their agency. While domestic consumers are being asked to assist in developing current plans for lower carbon societies, it is not clear that the complexity of domestic energy behavior is fully understood. Much emphasis is placed on green values as a determinant of household energy demand, but not all visions for sustainable living or household arrangements are the same. Nor will all those with green values have similar access to lower-carbon lifestyles. As social equalization in future energy services is far from guaranteed, there is likely to be both accommodation of change in domestic provision and hardwired resistance to change.

Finally, the combination of receptivity, adaptability, and entrenched practices that characterizes past domestic transitions—reflecting rational decision making, affective values, and material constraints—points to an infinite variety of flexible service arrangements in future energyscapes. The complexity of decision making we see in households of the past is an important signal for policymakers and providers currently considering how transitions will evolve to attend to both the internal and external politics of household energy demand. Though electricity networks have expanded and connection rates soared since the mid-twentieth century, people's experience of electrified life is still highly variable. Instead of a common end point, we see ongoing negotiations to mediate the gap between people's expectations and the variable conditions of their energy services. This history suggests that grand transformative visions that ignore spatial unevenness and sociomaterial diversity will not materialize. Diversified energy services aligned to people's everyday ambitions for better lives offer more realistic prospects for sustainable transitions.

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Ruth W. Sandwell

How Households Shape Energy Transitions: Canada's Great Transformation

The crisis of climate change has prompted concerned citizens around the world to consider the impact of fossil fuels on the planet's environment and on society. Many individuals are struggling to understand how their own personal patterns of transportation, heating, cooling, entertainment, and eating might be contributing to the crisis, and they worry about what changes might be required in the near future. Climate change is also changing the way that researchers, including those in the social sciences and humanities, think about the world—past, present, and future. Following the pioneering work of E. A. Wrigley,[1] historians worldwide are now arguing that new forms of energy were at the heart of the transformations associated with industrialization. Societies were previously completely reliant on the organic, and usually quite limited, energy available from wood, wind, water, and muscle power, sources that were, however, typically renewable and sustainable. With the shift to the industrial energy of the "mineral energy regime" of coal, oil, gas, and electricity, energy became massively abundant, highly potent, easily transportable, and much cheaper than ever before. The new energy regime transformed just about every aspect of society, economics, and culture in the nineteenth and twentieth centuries. Unfortunately, as we now realize, its use is unsustainable. If, as now seems possible, the twentieth century emerges in the historical record as the first *and last* Age of Abundant Energy, historians and others will be reevaluating the sustainability not only of the mineral economy, but of the progress and modernity ushered in by those "new" fuels.

The concept of energy transitions has provided a way for scholars to engage intellectually with the enormity of change wrought by fossil fuels. This approach does little, however, to explain (to scholars or anyone else) how the transition was experienced within the contours of everyday life. But understanding the *experience* of energy transitions is arguably just the kind of knowledge people need today as they contemplate the challenges presented by climate change, and the need to transition to a postcarbon future. The emphasis on experience is important, because one of the defining characteristics of having cheap, convenient, and abundant energy at our fingertips is that

1 E. A. Wrigley, *The Path to Sustained Growth: England's Transition from an Organic Economy to an Industrial Revolution* (Cambridge: Cambridge University Press, 2016).

most of us do not actually experience energy, as such. The energy-harvesting practices that have made up so much of the social, material, and cultural fabric of human history—finding food and then cooking or preserving it, caring for animals, generating heat or light, making and building things, and almost all other forms of physical labor—are seldom initiated or enacted exclusively in local environments today. They have retreated into the background of modern lives in industrial society. We all eat food harvested from the ground, for example, but the labor (energy) involved in planting, tending, harvesting, and transporting the food—and in many cases processing, preserving, and even cooking it—is done elsewhere, in places and in ways that are invisible to us. The relationships between the energy we consume and the environments that support us have been obscured by technology and distance; as a result, we know little about where energy comes from, how it is delivered, or what the full effects of its extraction, processing, transportation, and consumption are. But modern urbanites around the world nevertheless remain deeply linked to the environment through their energy use, as the crisis of climate change and a host of other environmental problems confirm.

To phrase this in a slightly different way, the energy a society uses significantly determines its relationship to the environment. Arguably, it will only be when people have a deeper understanding of the relationship between energy and society, including the intended and unintended consequences of each on the other, that they are going to be willing and able to make the society-wide changes required to address urgent problems of climate change and global pollution.

A study of the household through time, I would suggest, provides a welcome window on people's energy-related experiences, allowing a view of the ways in which people were directly, and viscerally, linked to their environments through their daily energy-related practices in earlier times. As Elizabeth Shove has argued, the way people use energy is deeply entwined with social as well as material practices; understanding what energy is *for* in people's lives tells us a lot about its uses and significance, at both the personal and the social level. Situating energy use firmly within the household and the contexts of everyday life, and "conceptualizing energy as an ingredient of specific social practices" sheds considerable light on what energy means, and therefore offers considerable insight into why people made changes to their energy-related behaviors.[2] This approach challenges earlier, and simpler, triumphalist narratives suggesting a "natural" or painless progress to modernity. For, notwithstanding the big picture of the transition from the organic to the mineral regime, a close look at patterns of everyday energy use demonstrates that energy transitions have been highly variable, intermittent, overlapping and, in some cases, strongly resisted. A focus on households, therefore, moves beyond concepts of inevitable monolithic, homogeneous, and one-directional change. These are particularly unhelpful for people who are either trying to understand energy transitions generally, or looking for examples from the past to illuminate the way forward into the next energy transition to sustainable energy.

Canada's Great Energy Transition: The Big Picture

Canada is a great place to study the history of energy and everyday life. Canadians have long been among the highest per capita consumers of energy. On par with Americans, they have consumed more than twice as much energy as Europeans since before the early nineteenth century, a trend that continues to the present. And the society-changing shift from the organic to the mineral (or modern energy) regime occurred so recently that it is still within living memory for many Canadians, providing a wonderful range of sources and perspectives about changing energy use from which the historian of energy and everyday life can draw. Canada's huge energy consumption is generally explained by the country's long, cold winters, low population density, the great distances that separate people and markets, and an abundance of organic and mineral energy resources that have been increasingly exploited for personal use and for profit. The superabundant supplies of biomass fuel (wood) and the ease with which wood was transported via waterways have been used to explain the slow transition to the mineral regime: it was only in 1906 that Canadians obtained more energy from fossil fuels than trees, a benchmark that England and Wales had reached by 1800, and the United States by the 1880s. It was not until 1955 that Canada reached the 90 percent level of fossil fuel versus traditional energy use that Britain had attained by 1845.[3]

2 Elizabeth Shove and Gordon Walker, "What is Energy for? Social Practice and Energy Demand," *Theory, Culture & Society* 31 (2014): 41–58, 51.
3 Richard W. Unger and John Thistle, *Energy Consumption in Canada in the 19th and 20th Centuries* (Napoli: Consiglio Nazionale delle Ricerche, 2013).

Rural Households and the Energy Supply Problem

Understanding the role and nature of Canadian households and the practices of everyday life within them provides a scale of analysis that is particularly fruitful in explaining Canadians' long reliance on organic energy. Rural populations thrived in Canada and remained a majority of the population until the Second World War. The great distances separating individual homesteads militated, however, against the rapid spread of the newly emerging network services for gas or electricity, which relied on small distances and high population densities to be economically viable. The vast majority of rural Canadians never had access to gaslight, and even as late as 1941, only 20 percent of farm homes had central grid electricity. The relative deprivation of rural households compared to urban homes attracted growing attention from a wide variety of reformers in the early twentieth century. In the 1920s and '30s, electrical companies began publishing special pamphlets to encourage rural populations to "sign up for the hydro," including *Boosting Egg Production*, and *Ten Uses for Electricity on the Farm*. Other articles championed the health and well-being that would naturally follow with increased electrical consumption—"Summer Showers Chase Fatigue," "Optometrists Talk about Home Lighting," and "Electricity Will Lighten Washday Work." Others, like "Does Mother Do the Pumping on Your Farm?" and "Poor Mommy!" had a somewhat darker message directed at those who stubbornly continued to "put up with a lot of needless bother and inconvenience" from old-fashioned ways of working in the home, when the "cool, calm and collected . . . [m]odern girls don't go in for red faces."[4]

Rural Households: Understanding the Rural Energy Landscape

While it was rural deprivation—manifested most emblematically in the absence of a grid delivery system of electricity—that attracted the most attention from urban observers by the 1920s, the energy situation of rural Canadians looked a little different from the vantage point of rural dwellers themselves. The millions seeking independence on their own rural lands in nineteenth- and early twentieth-century Canada were well aware that, even if rural households were only marginally suited for commercial agriculture and

4 BC Electric, "Home Service News," June 1932, October 1933. For an overview of Canada's energy history, see Ruth W. Sandwell, ed., *Powering Up Canada: A History of Power, Fuel and Energy from 1600* (Kingston, ON: McGill-Queen's University Press, 2016).

remained unconnected to the electrical grid, the land would still provide a wealth of food and fuel opportunities to support a family: either indirectly through commodity sales, or directly through home consumption (self-provisioning). A third pillar of economic support in rural areas was gained from wages: most rural men worked part of the year in the rural resource industries including logging and fishing, and in infrastructure projects including the construction and maintenance of roads, power plants, transmission lines, and later, oilfields. Wood, waterpower, and the muscle power of people and their animals dominated families' economic support on and off the farm until the 1940s, when gasoline-powered tractors began to displace horses for the first time, and bulldozers, chain saws, and gasoline-powered engines first made their appearance.

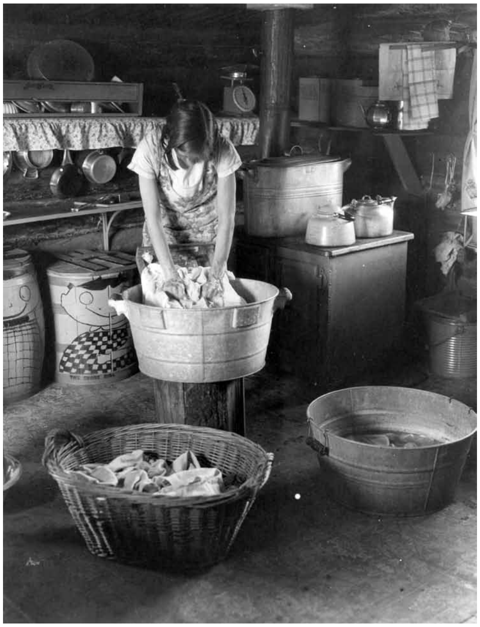

Figure 1:
Mary Tidd doing laundry in her Ross River home. A woodstove, wicker basket, two water barrels and two laundry tubs are all visible, ca. 1930. Photo by C. Tidd ©. Used with permission from the Yukon Archives, Claude and Mary Tidd fonds, 77/19, #8533.

Energy practices of the organic regime can also be clearly seen inside the home. Throughout rural Canada (and in parts of small-town urban Canada as well), most women continued to grow, cook, and preserve foods that they had gathered, grown, or tended on their own and nearby lands, well into the 1950s. Many kept livestock and sold eggs, milk, and cream. Horses provided transportation; wood provided the energy needed for cooking and heating, and for washing clothes, which the wind dried. Women preserved food through processes like smoking, as well as heating and canning; Canada's cold climate anticipated indoor freezing technologies of the post-1930s era, and ice, another link to the organic economy and local environments, continued to be used for food preservation by urban and rural women alike throughout the 1930s and '40s in many areas. Water was pumped or carried using human muscle power, as few rural houses had running water until the mid-twentieth century.

Rural Households and the Energy-Demand Problem

Figure 2: Two women baking bread in a woodstove, ca. 1940s. Note the electric light in the ceiling. Many homes took advantage of electricity for lighting but remained committed to using their multifunctional wood stoves for heating and cooking. Courtesy of Library and Archives Canada/National Film Board of Canada fonds/ PA-108032.

With thanks to the Museum of Science and Technology, Ottawa, and their *Life, Love and Laundry Collection*, which first brought these images to my attention.

Rural men and women would eventually demand the same modern amenities as their urban brothers and sisters, but there was a long half-century or more when demand for such modern innovations was as limited as the supply. Patterns of household labor, and not just distance, continued to limit the appeal of electrical power. While many would have welcomed electric lighting at a price they considered affordable and fair, rural households balked at the high-priced inefficiency of electricity. Electrical power was, however, most cost-effective when in heavy and steady use, as in a factory. Most of the farm work that could be "lightened" by electricity, such as winnowing or grinding, was highly seasonal and relied on bursts of power for short durations. As well as being poorly adapted to many rural uses, where it did exist, rural electrical infrastructure was not only expensive but worked erratically, subject to frequent power failures and planned outages, often failing when it was needed the most. Farm men and women, like their urban counterparts, complained about the difficulties of retrofitting wiring into older houses, the high cost of installing the specialized wiring needed for stoves and heaters, and incomprehensible billing practices. All of this limited demand, providing influential vernacular counternarratives to the ongoing propaganda from the electrical utility companies about the benefits of rural electrification. For the most part, rural households continued to rely on energy carriers such as wood and draft animals that provided energy consistently, in ways that were cost-effective and which furthermore fit into familiar patterns of daily life.

The Hybrid Energy Transition in Rural Canada

Coal oil lamps and wood stoves are two cases in point. Coal oil (also known as kerosene and paraffin) was the first petroleum product to be used widely across Canada. Although it was technically a "modern" fossil fuel, it was nevertheless delivered through the same transportation systems as people and other goods—trains, and in large barrels by horse and wagon—rather than through a specialized grid system. Portable and inexpensive, the coal oil lamp was the artificial lighting of choice in almost all rural homes between the 1880s and 1950s. In daily use, it closely resembled the familiar oil lamp, though with the advantages of being brighter and less smoky.

Cast iron wood stoves were used by more than 80 percent of rural homes in Canada from their appearance in the 1880s and into the mid-twentieth century. They were created by the new smelting, forging, and transportation methods of the mineral energy regime of coal and steel. Their use in most rural homes, however, relied on familiar patterns of household labor, where men, women, and children first needed to find and process the fuelwood. And unlike the electric or gas stove, which could only provide one function (cooking), the wood stove provided a multiplicity of functions. As Harriett Beecher Stowe summarized in *The American Woman's Home*, read widely throughout Canada, with sufficient fuel the stove would "keep seventeen gallons of water hot at all hours, bake pies and puddings in the warm closet, heat flat-irons under the back cover, boil tea-kettle and one pot under the front cover, bake bread in the oven and cook a turkey in the tin roaster in front."[5] And in Canada, it had the advantages of keeping a house warmer than other sources of heat, and drying snow-coated clothing. The new wood stoves (which were also capable of burning coal in wood-starved areas) were transformed into "the first consumer durable with near-universal market penetration" because they were "affordable, versatile and reliable," and in large part also because they fell within established practices of everyday life.[6]

5 Catharine Beecher and Harriett Beecher Stowe, *The American Woman's Home* (New York: J.B. Ford and Company, 1869), 130.
6 Howell John Harris, "Conquering Winter: US Consumers and the Cast-Iron Stove," in "Comfort in a Lower Carbon Society," ed. Elizabeth Shove, Heather Chappells, Loren Lutzenhiser, and Bruce Hackett, special issue, *Building Research and Information* 36, no. 4 (2008): 337–50.

Conclusions

The low-energy practices so characteristic of the organic regime—decentralized, non-commodified, locally sourced, household based, and vernacular—continued to dominate rural Canadians' engagement with energy within the domestic sphere, helping to explain Canada's long reliance on organic energy. New energy practices in the home were adopted between 1850 and 1950, and in ways that increasingly linked households with the emerging industrial energy networks of production, transportation, and waste. But most characteristic of the energy transitions slowly occurring in rural areas was the adoption of hybrid patterns of change, where elements of the emerging fossil fuel regime could coexist (sometimes for generations) with older patterns and technologies that resembled those of the organic energy regime, and even alongside growing modern specialist networks of oil and electricity. The development of these hybrid energy carriers is an apt reminder that while rural people lived out their lives within the contours of the organic economy and were frequently criticized for being backward or recalcitrant, they made decisions based on what worked within their own political economy and patterns of everyday life. A focus on the household reveals that Canada's rural majority had a complex, varied, and intimate relationship with the world outside their door. It was a relationship forged by their reliance on the organic energy regime, which lasted longer than in other industrializing countries, even as new fuels slowly began to impact the country's environment and society.

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Odinn Melsted

Who Generates Demand for Sustainable Energy Transitions? Geothermal Heating in Reykjavík[1]

Looking around Iceland's capital today, one might think that it was only a matter of time before the inhabitants of Reykjavík would tap the geothermal resources under the city. Virtually all houses are connected to the city's geothermal district heating utility, supplying abundant hot water for residential heating, swimming pools, and snow melting. But Reykjavík has not always been this way. Before the geothermal utility was constructed between 1930 and 1944, the inhabitants relied on imported coal for heating, and shifting to geothermal heating was not easy. How can this sustainable transition be explained? Starting with a brief overview of the geothermal utility's history, I argue that its breakthrough depended not only on the availability of sufficient resources and the application of suitable technologies, but also—above all—on the creation of a new societal demand.

Reykjavík's Transition

Geothermal heating started out as an experiment in the early 1930s. Several large public buildings, initially an elementary school, a hospital, and an indoor swimming pool, were supplied with hot water from local boreholes. The experiment was a success: the water sufficed both in temperature and quantity and could be pumped into existing central heating systems. Given how much it cost to heat the same spaces with coal, the city's geothermal investment seemed worthwhile and was extended to 50 or so residential houses in the vicinity between 1933 and 1938. The rest of the city's 3,000 buildings, however, remained heated with coal.[2]

Motivated by this success, the municipal government planned a citywide geothermal utility. This was a massive undertaking, with the heavy infrastructure costs exceeding

1 Odinn Melsted is the recipient of a DOC Fellowship of the Austrian Academy of the Sciences at the Institute of History & European Ethnology, University of Innsbruck. This publication was also aided by research grants of the Landsvirkjun Energy Research Fund (Orkurannsóknasjóður) and the European Society for Environmental History (ESEH).

2 Reykjavík Municipal Archives, Málasafn borgarstjóra 965, Report on the Laugar Utility, 16 July 1937.

what the city government could afford. And it meant that geothermal heating would have to replace coal as the primary form of heating. Construction began in 1939, when the city partnered with a Copenhagen contractor and secured a Danish bank loan, but was delayed by the outbreak of the Second World War. The utility was ultimately completed in 1943–1944, years later than planned and three times over budget. With all the houses connected to geothermal sources, however, coal heating had been eliminated.[3]

How did Reykjavík succeed in transitioning from coal to geothermal heating? The geographical and societal circumstances certainly helped. Reykjavík is situated atop an extinct volcano that still radiates heat into the bedrock, providing a relatively high geothermal energy potential. And, of course, Reykjavík is situated at the edge of the Arctic, which means there is a high demand for indoor heating. In addition, the construction of the utility coincided with a period of urban growth. New public buildings and (public and private) housing favored innovation in the heating sector. There was also an increase in engineering know-how, as Icelanders trained abroad, returned, and became influential public and private engineers. But those were only preconditions. The breakthrough in geothermal heating depended on overcoming three central challenges: sufficient resources had to be made available, suitable technologies had to be applied, and societal demand for the geothermal alternative had to be created.

Harnessing the Earth's Power

Reykjavík is named after the steam from the hot springs at Laugarnes, which the first settlers saw when they entered the bay in the ninth century (Reykja- = steam/smoke, -vík = bay). The hot-water springs in their natural state could be used only for laundry and swimming. Harnessing greater quantities required drilling into the earth and tapping hot water reservoirs. And because the demand for heating was highest during winter, the utility's potential supply needed to be much higher than average demand. The early geothermal experiment of the 1930s drew water from the hot springs at Laugarnes. For the citywide project, the hot water needed to be transported from the farm of Reykir, 15 kilometers outside the city, where much more geothermal energy

3 For an overview, see: Lýður Björnsson, *Saga Hitaveitu Reykjavíkur* (Reykjavík: Orkuveita Reykjavíkur, 2007); Sveinn Þórðarson, *Auður úr iðrum jarðar: saga hitaveitna og jarðhitanýtingar á Íslandi* (Reykjavík: Hið íslenska bókmenntafélag, 1998).

could be harnessed. (Even in Iceland, geothermal energy is not always found where it is needed.) As with other energy carriers, transportation from the center of production to the center of consumption made citywide geothermal heating a costly project.

The infrastructure was crucial. The geothermal utility required boreholes to tap the hot water, basins to collect it, pumps to regulate its flow, insulated pipelines for transportation, storage tanks, an insulated grid under the surface to distribute the water, house connections with regulators and measuring devices, indoor central-heating systems, and a means of discharging the water into the sewage system. To build such a system, the engineers mainly needed to adapt existing technologies. The drilling technology was essentially the same as that used to search for cold water, minerals, or oil. The transportation technology could be borrowed from district heating systems, which had already been established in cities such as Copenhagen. But the technology needed to be adapted to cope with mineral-rich, near-boiling water. This required extensive experimentation to find suitable materials for pipes, joints, and sealing rings. To limit heat loss during transportation, the 15-kilometer-long pipeline was covered with pieces of cheap, locally available turf, while the underground pipes in the city were placed in a bed of cinder (porous lava rock).[4]

The technology for geothermal indoor heating was almost completely taken from central heating. While older homes in Reykjavík still used indoor coal ovens for heating and cooking, new houses were equipped with updated technologies. From the 1920s, the city's hydroelectric plant supplied most homes with power for lighting and cooking; hydroelectric power had replaced the need for coal ovens for cooking and "town gas" for lighting. By the late 1930s, most houses were also equipped with water-based central heating systems. Instead of burning coal in the kitchen or living room, the fuel was stored down in the basement and shoveled into a burner to heat up water, which was circulated through the house's radiators. The spread of central heating systems—to almost 80 percent of the houses by 1938—facilitated the transition to geothermal heating; the existing pipes could simply be connected to the hot-water grid in the street.[5]

4 Helgi Sigurðsson, "Hitaveita Reykjavíkur," *Tímarit* VFÍ 32, no. 2 (1947): 26–39.
5 Reykjavík Municipal Archives, Málasafn borgarstjóra 965, Comment on Central Heating Systems, 16 September 1938.

The Creation of Demand

Recent studies in energy history, such as Christopher Jones's *Routes of Power*,[6] have shown that the creation of user demand is a key factor in transitions from one energy carrier to another. Actors involved in the building and operation of new energy infrastructures cannot rely on preexisting demand but have to help create new demand. This was also the case in Reykjavík. The geothermal project's success depended on prospective users for a return on investments. They needed to be willing to abandon coal and switch to geothermal heating.

Before the twentieth century, geothermal resources were little valued by Icelanders. While hot springs were used for bathing, laundry, and cooking, the springs also lowered the value of land, as they could be hazardous to people and animals and make freshwater unpotable.[7] Perceptions changed in the early twentieth century. Icelanders first considered geothermal heating a feasible alternative to solid fuels in cities upon learning about the geothermal district heating utility in Boise, Idaho, in 1910. But the initial excitement about becoming another Boise soon faded, as the construction of a new harbor, a freshwater utility, as well as a hydroelectric and manufactured "town gas" plant were prioritized.[8] Outside of Reykjavík, however, around 20 small heating systems were set up in the years that followed, mostly for houses close to hot springs. These pioneering projects, and the early 1930s experiments in Reykjavík, were an important factor in convincing people of the feasibility of geothermal heating. The first experiences in Reykjavík were not solely positive, however. Users complained about the price scheme, which required them to pay a fixed rate per month even though they used little hot water during the summer. They also objected to the fact that the centralized geothermal utility could not be controlled as coal heating could. During the coldest days of the year, the system repeatedly failed to provide enough hot water, and the radiators remained cold. With coal, on the other hand, consumers could simply burn more fuel if they wanted to increase the heat.[9]

6 Christopher Jones, *Routes of Power: Energy and Modern America* (Cambridge, MA: Harvard University Press, 2014).
7 Árni Magnússon and Páll Vídalín, *Jardabók Árna Magnússonar og Páls Vídalíns* III (Copenhagen: Hið Íslenska fræðafjelag, 1923), 318.
8 A. G. Johnson, "Er mögulegt að hita Reykjavík upp með Laugunum?" *Þjóðviljinn* 24, no. 23–24 (1910): 90–91.
9 Jón Þorkelsson, "Haglegur hitakútur," *Morgunblaðið*, 22 July 1943, 6.

When the citywide geothermal utility was being planned during the 1930s, many of the inhabitants were still not fully convinced. They had heard users' earlier complaints. By the time the project was launched in 1939, however, it had widespread support. How was this demand eventually created? Two groups were involved in this transition: builders (city government actors and engineers), who actively promoted geothermal heating, and users (the inhabitants as prospective consumers of hot water), who embraced the builders' promotions and ultimately constructed the demand. Through a broad newspaper campaign for geothermal heating during the late 1930s, the builders managed to communicate the feasibility and the advantages of geothermal heating. Yet it was not enough just to praise the geothermal option. Coal was more than a prehistory to geothermal heating; when imported coal became readily available in the early 1900s, it was considered a godsend. For centuries, Icelanders had struggled to heat their homes with peat, animal dung, or whatever bushes could be gathered on this largely deforested island. Coal was valued for the reliable indoor heating it provided, which created a culture of temperate comfort (for those who could afford it). By targeting the disadvantages of coal and systematically reinforcing negative views of the fuel, builders were able to brand geothermal heating as the better alternative. This can clearly be seen in an advertisement from 1938 (Figure 1).

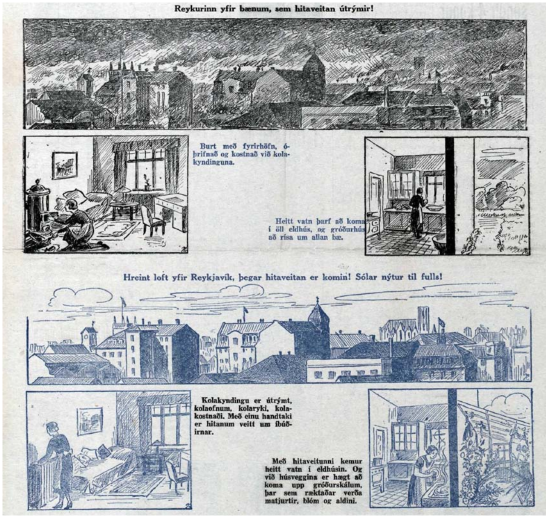

Figure 1: Newspaper advertisement for the planned geothermal heating utility. Source: Icelandic National Library. *Morgunblaðið*, 30 January 1938, 1. Available at: https://bit.ly/2XkuDSV.

In essence, four issues were raised to discredit coal.[10] First, coal was branded as dark and dirty, while geothermal heating was praised as bright and clean. Reykjavík was not plagued by coal smoke as badly as other industrial cities, since there were no heavy industries and there was usually plenty of wind to circulate the air. Yet there were also exceptionally cold and still winter days, when the coal smoke lay over the city like a dark

10 See also Helgi Eiríksson, "Hitaveitan," *Lífið* 4, no. 1 (1939): 458–66; Árni Óla, "Hitaveita Reykjavíkur," *Lesbók Morgunblaðsins* 23 (1936): 177–81.

cloud, dimming the day and polluting the air. Coal was condemned for the soot, dust, and dirt it spread on the streets and inside buildings. The geothermal alternative, it was promised, would clean up houses, streets, and the air.

Second, coal was branded as unhealthy both because of the poisonous smoke it created when it was burned and because it cost so much to heat up homes to what were considered "healthy" room temperatures. Geothermal heating would improve public health by eradicating the coal smoke from the urban environment and by providing more reliable, regular, and above all, affordable heating, which would reduce health risks.

Third, geothermal heating was said to bring comforts that coal simply could not offer. It would end the days of coal shoveling around the house and liberate housewives from this arduous and filthy task. Homes would be warm day and night, as people could simply turn on their radiators. It would even improve one's surroundings, as excess water could be used to heat up sunrooms, where the inhabitants could cultivate exotic flowers and vegetables. And Reykjavík would become prettier: the first chimney-free city in the world. (The chimneys became useless and did gradually disappear from the urban scene.)

Fourth, there was a promise of energy autarky in using domestic resources instead of imported fuels. This was popular following the experience of coal shortages during the First World War and the 1930s, when Icelanders realized how much they depended on fuel imports. The citywide geothermal utility was framed as a prestigious project of utmost national importance. Like hydropower, geothermal energy was portrayed as a "national" energy carrier.

Yet all this changed little if geothermal heating was not cheaper than coal. Price incentives are often considered key drivers of energy transitions. In Reykjavík, the promise of affordable heating via the geothermal grid became quite popular, as the periodically high cost of coal during the 1930s had made heating barely affordable to many. And geothermal heating promised to liberate the inhabitants from their dependency on local coal merchants. The coal merchants were despised for receiving profits from what inhabitants perceived to be unethical price agreements. But how was the price of hot water to be determined? The builders' strategy was to link the hot water price to that of coal, but keep it 10–20 percent below what it would cost to heat the same spaces with coal.[11] That way, geothermal heating could compete with coal and at the same time generate maximum revenue to ensure a return on investments. While this price difference was not as great as many users wanted, the perceived benefits of geothermal heating sufficed to outweigh discontent with prices. The key to popular acceptance of geothermal heating was the construction of user demand during the 1920s and 1930s.

Conclusion: Learning from the Past for the Future

Though it may sound futuristic to suggest that any town on Earth could be heated (or cooled) with geothermal energy, it is available all around the globe. Moreover, while intensity varies, it can be harnessed anywhere with today's technology, be it by drilling for hot water and steam in the depths of the Earth or by transferring ground heat through heat pumps. In the light of current aspirations for sustainable development, geothermal energy has much potential as a renewable, clean, and locally available resource. Like oil and natural gas in many other cities today, coal was the incumbent heating regime that needed to be replaced for geothermal heating to succeed in Reykjavík. This was achieved by making sufficient resources available, applying adequate technologies, and creating societal demand for geothermal heating by promoting it as the better and cheaper alternative.

The case of Reykjavík shows that we cannot assume that humanity will automatically strive towards a sustainable future. We have not always chosen the newest, most effective, or most sustainable energy options, and the availability of renewable resources such as geothermal energy does not predetermine local heating systems. Energy systems are always built into the natural environment, with the help of technology for a complex set of reasons. Reykjavík also shows us that consumers play a central role in energy transitions. As prospective users, the city's inhabitants were as important as the builders were. Even though the users' agency might not seem obvious, it was they who had to provide the demand to fund the geothermal alternative. We cannot assume that if technologies become more efficient and cheaper, this will eventually spur demand and lead to their use worldwide. If today's and tomorrow's engineers, researchers, and policymakers wish to transform energy systems, they will have to put the construction of demand at the core of the transition.

11 Reykjavík Municipal Archives, Málasafn borgarstjóra 965, Comment on Hot Water Prices, 8 December 1939.

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Sean Patrick Adams

Domestic Storage Problems and Transitions: Coal in Nineteenth-Century America

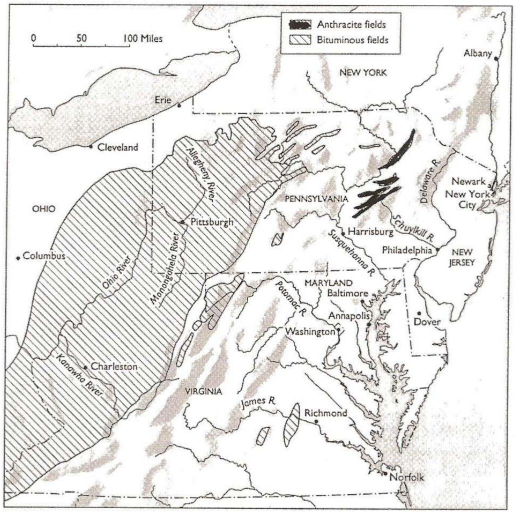

Figure 1:
Map of coalfields in the Eastern US. The dense anthracite fields of Eastern Pennsylvania were in close proximity to the large cities of New York and Philadelphia. Map by author.

Nothing warms a cold, damp room better than anthracite coal. Because of its high carbon content and lack of impurities, anthracite or "stone" coal, as it is sometimes called, produces an intense heat and—as an added bonus for the homeowner—very little soot and smoke. It is no wonder that nineteenth-century Americans in growing cities came to rely on anthracite as an essential heating fuel. Nearly all of the anthracite coal deposits in the United States lay upriver from urban centers such as Philadelphia, and transportation firms, such as the Schuylkill Navigation Company and the Lehigh Coal and Navigation Company, sought to grow markets for mineral coal there in the decades following the War of 1812. As stone coal offered more heat for its weight and better enabled the use of fuel-efficient stoves or fireplace grates, it seemed to be the best solution for the heating-fuel crises that plagued early American cities. Engineers, entrepreneurs, public officials, and even philanthropists enlisted in an effective campaign to promote mineral fuel. Philadelphia served as ground zero for this transformation, but eventually cities such as Boston and New York realized the value of anthracite. By 1860, historian Christopher Jones estimates, about 90 percent of homes in the American North used stoves for heating, and an overwhelming number of those stoves burned anthracite coal for heat.[1]

1 Christopher Jones, *Routes of Power: Energy and Modern America* (Cambridge, MA: Harvard University Press, 2014), 62.

An Uneven Transition

This transition, however, was far from instantaneous and it depended a great deal on the consumer's ability to invest in it. Affluence also dictated the pace and effectiveness of the conversion from organic to mineral heating fuel for the home. Philadelphia's households of means had the luxury of testing various systems: perhaps installing a fireplace grate in one room, buying a coal stove for another, while retaining a traditional fireplace for burning firewood in yet another. This "hybridization" of home heating sources was common for large urban households, many of which preferred open fireplaces (with their aesthetically pleasing roaring wood fires) in common rooms, while warming functional areas with more efficient coal stoves.[2]

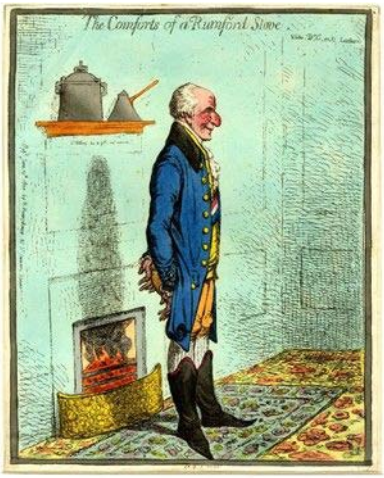

Figure 2: "The Comforts of a Rumford Stove" by James Gillray (1800). Wealthy households retained open fireplaces like this Rumford Stove for aesthetic purposes, but used coal furnaces and stoves to heat their homes more efficiently. Courtesy of the British Museum (CC BY-NC-SA 4.0).

But the vast majority of Philadelphia's working poor could not repeat this pattern of fuel consumption. Comfort was not the main concern; keeping warm during the winter was more an issue of survival for them. Whereas wealthy Philadelphians might measure their weekly consumption of heating fuel in dollars, one contemporary estimated that the average seamstress in Philadelphia budgeted only about 15 cents a week in 1833. More importantly, less affluent consumers often lacked the cash and storage space to "lay up" their fuel, so they tended to purchase it in small amounts: by the half-bushel or even less. "If poor people could only realize what an advantage it would be to purchase coal in the summer, and their summer goods in winter, availing themselves of the seasons when they are selling cheap," one 1856 proscriptive short story opined, "they certainly would, I think, make greater efforts to do so."[3] But all the realization in the world could not provide space in which to store coal over a long winter season; nor could it provide the ready cash to purchase four or five tons of coal at one time. Both economic and

2 Frederick M. Binder, "Anthracite Enters the American Home," *Pennsylvania Magazine of History and Biography* 82 (1958): 82–99.

3 Emma Carra, "Laying in the Winter's Coal," *Ballou's Dollar Monthly Magazine*, 4 July 1956.

spatial restrictions therefore delayed the implementation of mineral fuels in all urban hearths, even as coal clearly represented the future of home heating by the time of the Civil War.[4]

The Challenge of Providing Heat on Demand

Coal-storage methods in America's anthracite-burning cities remained imperfect. Some urban residents dug "coal holes" in the street for storage. In 1855, however, city officials in Boston considered coal holes a nuisance, as they tended to collect pedestrians as well as mineral fuel. An 1863 ordinance in Boston required them to be covered "with a 'substantial iron plate,'" and the legislated maximum depth of 11 feet suggests this was no idle threat to passers-by. Other methods made coal holes look sophisticated. In 1877 New York's *Saward's Coal Trade Journal* criticized "the ordinary custom of dumping the coal upon the sidewalk" as a "most unhandy and unclean arrangement."[5] In order to remedy this problem, the editors recommended that coal be delivered in two-hundred-pound bags (of which ten would make a ton), which they said would be cleaner. In London, coal was already being delivered in one-hundred-pound bags to poorer customers. Spatial concerns about the storage of mineral fuel reinforced the division between affluent and poor consumers; the former could still afford roomy coal cellars or coal holes in which they stored fuel, while the latter depended upon smaller purchases, usually secured on unfavorable terms.[6]

Spatial constraints frustrated the equitable use of anthracite coal in American cities. An 1870 study of working-class households found that an average Boston model tenement house had 20 compartments for wood or coal fuel in the basement, but that most other buildings lacked adequate space for their renters to store heating fuel. Inspectors from the Massachusetts Bureau of Labor Statistics reported that coal was kept in closets, cupboards, or under the stairs—all of these locations suggest that only a small amount of coal could be stored. One worker told inspectors that only "one in ten can

4 Mathew Carey, *An Appeal to the Wealthy of the Land, Ladies as Well as Gentlemen, on the Character, Conduct, Situation, and Prospects of Those Whose Sole Dependence for Subsistence Is on the Labour of their Hands* (Philadelphia, PA: L. Johnson, 1833); Carra, "Laying in the Winter's Coal," 21.

5 *Saward's Coal Trade Journal* 13, no. 2, (January 1877).

6 City of Boston, *Ordered That the Chief of Police Be Directed to Notify All Owners or Occupants of Coal Holes* (Boston, MA: 1855), n.p.; City of Boston, *Rules and Regulations in Relation to Coal-Holes, Vaults, &c. Under the Sidewalks* (Boston, MA: 1863) n.p.; *Saward's Trade Journal.*

put in a winter's [worth of] coal"[7] ahead of the season. Moreover, once Boston's harbor froze up, dealers demanded payment in advance. Poor consumers there bought coal by the "peck," an informal measure of about 20 pounds. Unlike the more economical practice of purchasing coal by the ton once per season, small-scale purchase drove the price up for those who could least afford it. A Massachusetts survey of 1870 estimated that coal secured in this fashion cost about 18 dollars a ton—about a fourfold increase in the price charged for larger purchases. Despite moves to reform urban housing in postwar decades, the improvement of heating systems found only rare mention. More often than not, renters were left to decide whether to use a stove, grate, or fireplace, and where they could purchase and store their fuel. As late as 1889, Boston's city code ruled that every tenement building "shall have adequate chimneys running through every floor, with an open fireplace or grate, or place for a stove," along with the facilities to collect noncombustible waste.[8]

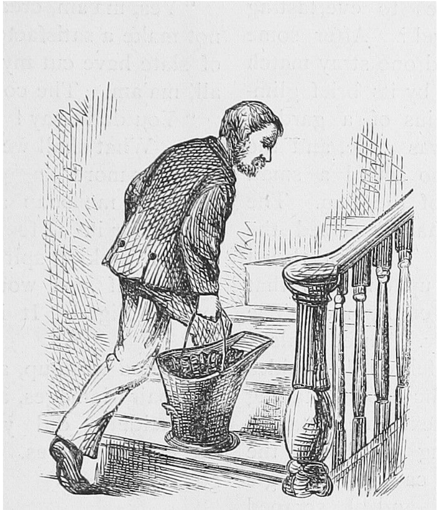

Figure 3: Affluent households could lay in a season's supply of coal in a basement and then use coal hods to provide fuel. Poorer residents stored their fuel wherever they could, or used it at the same time as purchase. Source: Charles Barnard, "From Hod to Mine. In Seven Lifts," *American Homes Magazine*, 1874.

As has always been true of heating homes with coal, the solution to negotiating the system was spatial: large stores of coal purchased cheaply in warm summer months could last throughout the winter. This might seem obvious—of course the wealthy were able to negotiate consumer markets with more ease—but consider the ways in which home-heating markets were shaped by these spatial limitations. Although coal dealers suffered the immediate brunt of consumer anger, they really only represented one component of an immensely complex energy delivery system that linked far-flung mining communities via rail and canal to urban distribution centers. Any disruption in this network could have dire effects on millions of Americans, many of whom lacked the capacity to store energy for more than a few days at a time. This "just in time" en-

7 *Report of the Massachusetts Bureau of Statistics of Labor* (Boston, MA: Wright & Potter, 1870).

8 *Massachusetts Bureau of Statistics*, 173, 176, 179, 246, 272; Associated Charities of Boston, *Laws Applying to Tenements in the City of Boston* (Boston, MA: Associated Charities of Boston, 1889), 9.

ergy flow kept wholesale prices low and discouraged oligopolistic positions in energy markets by creating a national system of energy production; if one coal region went "offline," another could make up the difference in supply. But this network could not adapt when fuel consumption swelled at the same time that labor troubles simultaneously hit the bituminous and anthracite fields. Pennsylvania alone witnessed more than eight hundred strikes in its coal fields from 1881 to 1886.[9]

Famines, Strikes, and Energy Flows

The rise of a particularly urban phenomenon in the era of labor unrest in the coalfields—the "coal famine"—reflected the vulnerabilities of this national network of fuel production in serving urban populations. In February 1871, a series of labor disputes panicked New Yorkers; 1.5 million residents had an estimated two-week supply of coal on hand in their city. "At the very season of the year when Winter sheds it icy coat, and the chill, damp winds and mists of Spring succeed—just when we need the artificial heat to temper the unfriendly atmosphere of wind and storm," *The New York Times* reported, "we are threatened with this kind of famine." When more labor troubles threatened the flow of coal in April 1875, panicked consumers rushed to the "bucket and scuttle" trade of the "small-fry groceries." In the process, they paid outrageously high prices for small parcels of coal, or simply did without. These occurrences played out across Gilded-Age America, and although most strikes were short lived, the dreadful prospects of an energy crisis never quite abated.[10]

The problem of how to provide heat on demand was not really solved until the gradual implementation of electric and gas heaters over the half century following the Second World War. There were problems, of course, with this new system of burning fossil fuels for heat; but generally, the networked city of the twentieth century solved the nineteenth-century issue of coal storage, at least in areas where natural gas or electricity could replace stoves. These networks grew in both size and scale, slowly replacing the need for coal cellars and regular fuel deliveries in the decades following the First

9 Andrew Arnold, *Fueling the Gilded Age: Railroads, Miners, and Disorder in the Pennsylvania Coal Country* (New York: New York University Press, 2014), 87; Sam H. Schurr and Bruce C. Netschert, *Energy in the American Economy, 1850–1975: An Economic Study of Its History and Prospects* (Baltimore, MD: Johns Hopkins University Press, 1960), 36–37.

10 *The New York Times*, 25 February 1871; The New York Times, 1 May 1875.

World War. Although early adopters of natural-gas heating drew upon local reserves, the completion of interstate pipelines such as the Second World War's Big Inch and Little Big Inch—each stretching over one thousand miles to link the gas fields of Texas and Oklahoma to the East Coast—mirrored the expanded, national system of coal distribution, even as natural gas or heating oil offered a more cost-effective solution to home heating. In fact, Philadelphia, the same city that benefited the most from the production and consumption of anthracite coal in the nineteenth century, became dependent upon natural gas piped in from the American Southwest in order to heat its homes in the 1950s.[11]

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Why is the story of nineteenth-century energy storage significant? It forces us to think about the wider implications of an energy transition and provides an object lesson for how a small-scale problem—the spatial limitations of urban housing—could create vulnerabilities in a national system of energy distribution. Today's home-heating networks provoke different anxieties. Now, we worry more about the impacts of burning coal on global climate change, the environmental impact of natural-gas pipelines, and the continued reliance upon fossil fuels in keeping us warm during the winter. Just as in the original transition to mineral fuel, making the break to a new regime will prove difficult. In 2015, for example, Tesla's CEO Elon Musk promoted one potential solution with a system of wall-mounted lithium-ion batteries, called the Tesla Powerwall, to take individual homes off the grid and allow them to be self-sufficient providers of energy. Like the "boosters" of anthracite coal in the Early American Republic, Musk engaged in some criticism of the current energy regime. "It sucks, exactly," Musk has said of fossil fuel emissions and climate change. "I think we, collectively, should do something about this," he added, "for us and a lot of other creatures." Rebilling itself as an "energy innovation company" rather than an automotive one, Tesla hopes to replace the networked home with an energy-independent one.[12]

11 Nicholas Wainwright, *History of the Philadelphia Electric Company* (Philadelphia, PA: Philadelphia Electric Company, 1961), 320.

12 Benjamin Hulac, "Tesla's Elon Musk Unveils Solar Batteries for Homes and Small Businesses," *ClimateWire*, 1 May 2015, https://www.scientificamerican.com/article/tesla-s-elon-musk-unveils-solar-batteries-for-homes-and-small-businesses/.

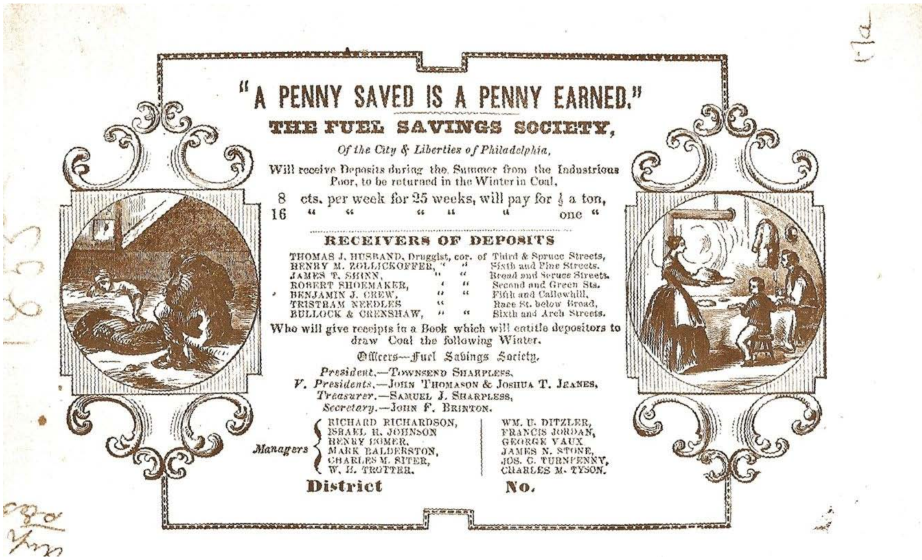

Figure 4: Philadelphians attempted to remedy fuel disparities through charitable institutions. This frontispiece of the 1855 Annual Report of the Fuel Savings Society highlights the gap in home heating between poor and affluent households. Courtesy of the Library Company of Philadelphia.

If the historical experience of home heating teaches us anything, though, it is that energy transitions among consumers is a sticky, uneven process. Cultural preferences for open fireplaces, imperfect knowledge about anthracite coal ignition, and early disruptions in the trade all delayed the implementation of a coal-stove regime in early American cities. Once anthracite was king in home-heating markets, the challenges of fuel storage ensured that its reign benefited only wealthy consumers. Put simply, the process of replacing one household technological system with another—even with the straightforward task of warming air—can take decades to accomplish. And once in place, there is no guarantee that the new system will not bring unique problems of its own. What will be the lithium battery's version of ash and soot, storage space problems, or "coal famines"? Only time will tell.

Even today, the difficulties of household energy transitions are apparent. A crisis in Australia offers an example of this, where political and economic factors have complicated that nation's plan to wean itself off coal-fired electric plants. One might think that this is the moment for Tesla to demonstrate the value of its battery-powered substitute. But while batteries offer a fast solution to the immediate problem, coal is still cheaper in Australia than either natural gas or renewable energy forms, such as wind or solar power. Consumer resistance to higher utility bills, as well as the politician's allergic reaction to promoting them, have derailed Tesla's plan to provoke revolutionary change. "Forging enough common ground with the various stakeholders will be the main obstacle," columnist Clyde Russell argued of Tesla's plan, "but more than anything else, Australia is showing how difficult it is to end the age of coal." The story of the United States over the course of the nineteenth century demonstrates not only how difficult it was to usher in that age, but also the unintended consequences of its arrival.[13]

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Jennifer D. Carlson

Renewable Energy and Class Struggles: Slurry and Stratification in Germany's Energy Transition

Sensing the Energiewende

"When I was a girl they didn't use those synthetic chemicals. That's why it doesn't smell right—why it smells so strong." Pouring us both another cup of tea, 60-year-old Hanne[1] shook her head at the stench of fertilizer blanketing the village beyond her kitchen window. "It's an outrage how they stink up the countryside with that stuff." Having spent many months in Dobbe, Hanne's village, I could also attest that I had never smelled anything like it in the area before. It was July 2007 and I had returned to the East Frisian Peninsula to research everyday life in the *Energiewende*, Germany's renewable "energy turn," which has transformed the Lower Saxon countryside into an alternative energy landscape. The Energiewende is an experiment in "energy democracy"; by decentralizing the grid and incentivizing people to produce their own power from wind, solar rays, and biomass, the transition's planners aimed to bring everyday citizens into energy governance. The East Frisian Peninsula has been home to a number of early test sites for alternative energy. By 2007, the energy transition was in full swing: wind turbines covered the countryside, and solar panels were beginning to spread across rooftops in the area.

The pungent scent of fertilizer on the breeze was part of Germany's biofuel boom, spurred by federal subsidies for biofuel crop cultivation in a series of pro-renewable laws passed from 1990 to 2016. Much of the land here and elsewhere in Germany was planted with fuel crops such as corn, rapeseed, and sugar beets as farmers shifted gears to make the most of the biofuel boom. Amid this *Rausch* or "craze" for renewables, ordinary statements such as Hanne's illuminated how non-farming rural dwellers—that is to say, the majority of the region's population—made sense of these dramatic changes.

1 The names of individuals and my field site have been changed to preserve the anonymity of those with whom I worked.

Figure 1: Hanne's house is surrounded on three sides by tracts owned by an absentee landowner and cultivated by tenant farmers. Farming intensified in the area during the last century, when reclamation works raised the low-lying meadowlands above the flood plain. When this photograph was taken (2011), crops planted around Hanne's house included biofuel crops and hay. In the early years of Germany's Energiewende, generous subsidies for biofuel compelled many farmers to plant corn, rapeseed, and other crops to be used in biogas digestion, further intensifying cultivation on former grazing lands.

Despite Hanne's suspicions, the substance that farmers were spreading that afternoon probably came from a "natural" source: liquid manure from farm animals, widely embraced as a more sustainable fertilizer than synthetics. The difference in scent that Hanne noticed was not necessarily a transformation in the fertilizer's chemical makeup, but rather an increase in the scale of its use. Once known for its dairy farming and animal husbandry, Dobbe's farmland had metamorphosed into a bioenergy landscape, with intensive cultivation and increased applications of fertilizer.

But Hanne's description of the stench on the breeze was no less significant for being incorrect. In rural northern Germany, such speculation not only informs how non-farmers perceive the farmers in their midst; it also shapes how they imagine their own possibilities for taking part in infrastructure projects such as the Energiewende. As I explain here, northern Germans' widespread sense that farmers control local politics—and, by extension, local energy governance—stems from historical legacies of stratification that are reproduced anew as landowning farmers become partners in the energy transition. In what follows, I unpack how real and imagined divisions between farmers and non-farmers take shape in everyday northern Germany, and the consequences these have for energy democracy.

Who are Germany's Energy "Citizens"?

A trend:research study from 2013 suggests that nearly half of Germany's renewable energy installations are citizen owned.[2] This sounds like good news for German energy democracy, but in actuality this much-cited statistic does not qualify who counts as "citizens." Are they landowners who buy wind turbines, citizens who cooperatively share profits from a biogas-processing plant, or single-family homeowners who install solar panels on their roofs? It's difficult to gauge the Energiewende's social impact because there are as many energy transitions in Germany as there are places using renewable energy. The transition was designed to allow communities to make use of resources afforded by their physical surroundings—whether hydropower, solar energy, wind, bioenergy, or some combination of these. Yet the Energiewende unfolds differently in different places, not simply because each landscape has unique natural features but also because each landscape is constituted through unique social relations. These social relations have consequences both for the people who occupy a given landscape, and for how nature is articulated through cultural activity and appropriated for human ends. Examining the Energiewende, where participation in and profit from renewable energy development hinges largely on investment (of money, rooftops and/or land), it is necessary to examine how class distinctions shape people's access to energy democracy, as well as their inclination to take part in it.

On the East Frisian Peninsula, for example, many people spoke of rural dwellers as belonging to one of two social classes: namely, farmers and non-farmers. Here farmers (*Bauer*) are generally understood as coming from families that have long worked the same lands, with a more patrician status in the community where they farm. Those who do not farm recall the region's historical working class, whose livelihood once consisted of seasonal farm labor, peat cutting in moor colonies, or fishing in the marshes that covered the peninsula before much of the land was raised above the flood plain. The words once used to describe these classes in local dialect reflect their hierarchical placement in rural social imaginaries: farmers were *Buren*, a relative of *Bauer*; non-farmers were *Lüttje Lüü*, which can be literally translated as "little people." Even though these class distinctions no longer correlate to income level, they

2 trend:research, "Definition und Marktanalyse von Bürgerenergie in Deutschland" (Lüneburg: Leuphana Universität, 2013), https://bit.ly/2FZ8m7c.

continue to shape economic life in northern Germany as well as its energy transition. When Hanne or others refer to an abstract "they" fertilizing fuel crops on the outskirts of town, they invoke the figure of the Buren. When people express ugly feelings about the massive windfalls that farmers earn from leasing their land to the nearby wind park, it is this image of the farmer to which they react. And when landowning farmers exclusively contact other landowning farmers about investment opportunities in new development projects, it is this class distinction that they ultimately perpetuate.

Inequality's Afterlife in Citizen Energy

It may seem odd that arcane class distinctions could exert such force in contemporary Germany, particularly in a place so greatly altered since the beginning of the twentieth century. Over the century, vast areas of the East Frisian Peninsula were reclaimed from the North Sea coast, producing land for cultivation and development. In the 1950s, Volkswagen built a factory at the nearby port of Emden, one of multiple manufacturers now offering factory jobs and other positions to which rural dwellers could commute on newly paved roads. Single-family homes sprang up around the peninsula as the availability of jobs enabled many to stay who might otherwise have left to find work. And newer arrivals to the peninsula—whether from other areas of Germany, as refugees from Central Europe (and, more recently, Africa, Asia, and the Middle East), or guest workers from Turkey—have likewise participated in the industries reshaping the East Frisian countryside. Because postwar generations experienced unprecedented levels of social mobility, many descendants of the Lüttje Lüü now earn higher incomes than do descendants of the Bauer. Yet despite these changes, and despite the fact that it had been years since many East Frisians had worked in farming, older residents still remembered farm labor or knew someone who worked on a farm. Hence Hanne's sense that she could speak with authority about farming practices that had changed since her youth, and her sense that farmers and landowners belonged to the same social class.

With the rise of Enercon—a multinational wind turbine manufacturer—and other alternative energy firms in the area, large numbers of young adults from villages such as Dobbe were able to find production and tech-industry jobs closer to home rather than moving to larger cities to the south and east. These still-forming livelihoods attest to

Figure 2:
Prior to the land reclamation works that raised this area in the mid-twentieth century, farmers had to drain their lands using small windmills, like the one pictured here (in 2017). Farmers could plant only on a small scale, making their living through animal husbandry and growing hardy feed crops for livestock. After the land was raised, area landowners rapidly consolidated and cultivated it, or leased it for farming. The area became a test site for biofuel crops planted on an industrial scale during the Energiewende.

the importance of industrial work and the knowledge economy in the Energiewende, now Germany's largest postwar infrastructure project. Additionally, solar panels on residential rooftops show how the transition has "greened" middle-class aspiration since the mid-century economic boom, when single-family homeownership became a benchmark of the good life. The Energiewende's effects on Germany's non-landed middle class are evident, if less frequently discussed in terms of local politics.

Local understandings of farmers as elites may seem counterintuitive given that Germany's small farms have long been in crisis from falling milk prices, public health scares over toxins in agriculture, and the bundling of tracts for high-paying industrial farm leases. Renewables are often portrayed as a way for farmers to stay afloat without having to scale up their operations to compete in a Europeanized agricultural market. By installing a wind turbine, solar panels, or a biogas plant, the story goes, farmers can remain productive members of society. Indeed, many farmers have found these installations helpful in meeting costs. But not all farmers are equally able or inclined

Figure 3: As farmers intensified cultivation to reap the rewards of federal incentives for biofuel crop production, farmlands were treated with increased amounts of organic fertilizer—particularly manure and liquid slurry harvested from livestock. In this image (2017), clumps of mud and manure are left behind on a farm road from a tractor trailer carrying fertilizer to a nearby farm.

to take part in the initiatives happening in their regions. Even as many Germans imagine farmers owning the land they work, the most recent EU Farm Structure Survey[3] reveals that 59.8 percent of Germany's agricultural land is actually worked by tenant farmers, and that number is growing as small tracts of land are bought and bundled into leases by large landowners. In some cases, the Energiewende has posed new challenges for many tenant farmers, such as the dairy and sheep farmers who have lost longstanding leases to biofuel crop cultivators willing to pay rent at a premium.

Yet, beyond a boom in residential solar panels, farmers remain the most commonly identified actors in the Energiewende. Germany's biofuel economy is predicated on agriculture, and the majority of its biogas plants are owned and operated by farmers using fuel crops and agricultural waste materials to generate thermal energy. Landowning farmers are also visible beneficiaries of the solar boom, with large arrays spanning their barns' rooftops. In some communities, landowners from longtime farming families are majority shareholders in limited liability companies (in Germany, *Gesellschaften mit beschränker Haftung*, or GmbH) formed to administer wind parks. One example is Dobbe's "Citizens' Wind Park," which is sometimes mistaken for a cooperative endeavor, though it is privately held. "When they first started the wind park [in 1999], the people who started it offered a share of the profits to anyone in the community who was willing to pay two thousand marks [ca. 1000 euros]," one Dobbener explained to me in 2017. But who knew then what it would become? Today, when new turbines are planned, he continued, "they're not so forthcoming with investment opportunities." Many residents learn about these installations only when requests for permits are filed, triggering the process by which authorities are required to notify people living within a certain radius of the proposed site.

3 Eurostat, "Agricultural Census in Germany," *Eurostat Statistics Explained*, last modified 28 August 2018, http://ec.europa.eu/eurostat/statistics-explained/index.php/Agricultural_census_in_Germany#Further_Eurostat_information.

Figure 4: Even as German policymakers move to curb subsidies to mitigate the adverse effects of intensive fuel-crop cultivation, as well as fluctuations in bioenergy markets, farmers in many areas of Germany continue to plant crops to sell to biogas digesters. This image (2017) depicts a canal bisecting two tracts planted with fuel crops located a few hundred meters from a residential neighborhood. Area residents, aware that nearby farmers had been cited for dumping excessive amounts of slurry on their lands, pointed to swirls of manure-like matter on the once-smooth surface of the canal—evidence that dangerous quantities of nitrates were seeping into area groundwater.

Many communities across Germany have implemented civic power generation in more equitable ways, with equal opportunities for participation and shareholding. Today, many wind parks and biogas installations are more cooperatively owned and managed. But the fact that more exclusive wind parks could be billed as civic energy projects speaks to widespread confusion—and sometimes equivocation—as to the *social* sustainability of clean energy initiatives. The Bundestag worked to mitigate this in 2006 when it changed the law to promote renewable energy cooperatives rather than GmbHs. But as Energiewende analysts Craig Morris and Arne Jungjohann note, "[t]he lack of a clear definition [of community energy] means that the German government cannot have a specific goal for the share of citizen ownership."[4] Amid these murky waters, it is necessary to sound the submerged histories of class that shape renewable energy development in order to better understand who is able to participate in energy governance and who is left on the sidelines.

4 Craig Morris and Arne Jungjohann, *Energy Democracy: Germany's* Energiewende *to Renewables* (New York: Palgrave, 2016).

Figure 5: In this part of Lower Saxony, popular unease about industrial farming is voiced in terms of class resentment, referring to historical legacies of inequality between landowners and workers. Today, farmers are often considered to be the inheritors of the prior landowning class, even though most lease the lands they work, and some farmers are contracted out by larger corporations. Yet legacies of inequality persist, as absentee landowners and landowning farmers disproportionately influence local farming practices, energy governance, and politics. In this picture of an East Frisian churchyard (2007), this legacy of inequality takes on spatial form, with the ornate graves of landowning farmers placed above the flood plain, and, working class graves situated beneath them.

The Force of Speculation in Germany's Energy Future

People who are sidelined from energy governance may not care or even notice that they've been excluded from it, but they are nonetheless part of the energy development projects taking shape in their midst. Living on the outskirts of Dobbe from 2010 to 2011, I watched as most of its remaining dairy pastures were plowed up, planted with corn and then, eventually, fertilized. The smell of slurry became commonplace, like a climatological force to which we adapted. For the majority of villagers, there was no telling when exactly the farmers would fertilize their crops. But when the tractor pulling the slurry drum appeared on the horizon, we sprang into action, removing laundry from clotheslines and summoning children to play indoors.

Elsewhere in northern Germany, people protested against plans for local biogas plants, citing the ecological effects of fuel monocultures and slurry stockpiling, as well as the potential devaluation of their own property. In the nearby village of Holtrop, a few hundred concerned citizens petitioned the county to block a farmer's permit for a biogas plant across the road from their neighborhood of tract homes. (After going back and forth in the courts, the farmer prevailed, perhaps because he made a case that biogas would allow him to afford to maintain his dairy farm, and that he would sell the heat generated at his plant to the village school at a reduced price.)[5] But Dobbe's two biogas plants were located at a distance from residential neighborhoods, and Dobbeners' everyday conversations never connected the cornfields to the plants. Such things were the business of farmers, not villagers. Villagers complained about the slurry and, like Hanne, speculated as to what "they" were doing, but there was no move to critique the cultivation in our midst, nor did anyone verbally link what was happening around us to the biofuel industry. While these activities affected the health of the community (and led to nitrate runoff in its groundwater and algal blooms in nearby lakes), Dobbeners' annoyance with them failed to translate into formal calls for reform or increased representation in energy governance.

Reacting to biofuel's sensory incursions, Dobbeners drew upon a broader history of inequality as they speculated about farmers' activities and control of the countryside. Their speculations elided the complex realities that farmers continue to face, as well as the role that capital has played in determining which farmers have influence over the transition. But these speculations also point to the fact that much renewable energy development in Germany has relied upon capital investment promoted through existing social networks between landowners. In this way, the Energiewende has limited the participation of the would-be "energy citizens" it was intended to enfranchise. And the ways in which non-farmers link existing forms of inequality to prior forms of inequality communicates a sense that exclusion is part of the order of things. In this way, capital and quiescence conspire to discourage non-landowners from staking claims in energy governance, making landowners' domination of development projects a social fact.

As federal support for civic power generation wanes, it is even more crucial to consider how energy governance intersects with localized forms of social stratification, and with the cultural frameworks through which these inequalities are expressed. In

5 Daniela Schröder, "Ärger um Biogasanlage: Kalter Krieg in Ostfriesland," *Spiegel Online* (Last modified 8 January, 2010), http://www.spiegel.de/wirtschaft/unternehmen/aerger-um-biogasanlage-kalter-krieg-in-ostfriesland-a-664487.html.

2016, the Bundestag moved to end subsidies for local power generation in favor of offshore, corporate-owned wind parks, making it harder for citizens without start-up capital to invest in onshore development projects. Yet the Energiewende is still young. Market research indicates that many Germans are interested in participating in community energy, particularly as volunteers. It is necessary to diversify avenues for citizen participation not only to generate support for new projects, but also to bring equity to already existing ones. Many rural dwellers who have been sidelined from the Energiewende have cultivated sustainable practices apart from the cutting-edge technology of the transition. Their perspective offers new insights into Energiewende democracy, as it currently exists. But more fundamentally, such a perspective reminds us that vibrant, vernacular forms of environmental politics arise from everyday life, like a blast of slurry on a breeze.

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Jennifer Baka

Do Wastelands Exist? Perspectives on "Productive" Land Use in India's Rural Energyscapes

Introduction

Since the 1970s, the Government of India (GOI) has sought to cultivate energy on so-called "wastelands," an official government classification for marginal or degraded lands. The policies enabling this strategy have framed wasteland development as a mechanism for addressing interlinked rural-development, energy-security, and environmental challenges. This paper evaluates two such development programs—the 1970s Social Forestry Programme and the 2003 National Mission on Biodiesel—and reflects on the implications of these energy transitions for rural energy users. Each program presented similar optimistic visions for the potential of India's wastelands to generate energy and revitalize rural communities. However, they have both largely failed to meet the various "improvement" goals motivating the programs. In what follows, I compare their objectives and argue that an incomplete understanding of the significance of wastelands to rural livelihoods helps to explain the adverse social outcomes that have resulted. Without developing a more holistic conceptualization of the significance of wastelands, India's future wasteland development schemes are likely to continue the decades-long trend of exacerbating, rather than improving, rural energy security.

Wasteland Discourses and "Improvement"

John Locke coined the term "wasteland" in the seventeenth century to refer to any lands not privately owned: lands that are frequently referred to as common property lands. Arguing that there is little incentive to maximize returns from common property lands, Locke advocated privatizing them. Privatizing the commons, he argued, would improve the value of nature lying in waste.[1] During India's colonial era, the term "wastelands" was used in land-classification processes to refer to marginal or degrad-

1 John Locke, *Second Treatise of Government* (Hollywood, FL: Simon & Brown, 2011 [1680]).

ed lands unsuitable for agricultural production. In practice, the category forged class divisions between indigenous communities and colonial settlers. Indigenous people, who often occupied wastelands, were deemed "backward" and incapable of putting wastelands to productive (revenue-generating) use. As a result, the colonial government often redistributed the lands to British settlers and others who were considered more capable of cultivating the lands for profit. Wasteland classification and "improvement" schemes extended beyond the colonial era in India but took a distinct twist when they were linked to the country's energy-security and environmental goals.

In the 1970s, the GOI initiated strategies to improve the productivity of the country's natural resource base. One such strategy focused on addressing the "other energy crisis" of the decade: the forecast shortage of fuelwood supplies in developing countries. The Social Forestry Programme was a prominent part of this strategy. It established fuelwood lots on wastelands throughout the country in order to provide biomass energy for rural households and to alleviate land-use pressures in India's high-value forests. This strategy aimed to secure household energy supplies but also to create new jobs for rural communities. Although highly criticized for promoting industrial forestry over household fuelwood needs, the Social Forestry Programme introduced one tree species, *Prosopis juliflora* (hereafter Prosopis), that has helped alleviate rural fuelwood shortages in certain regions of the country. Yet, unbeknownst to policy planners, Prosopis became a menace to landowners because it rapidly spread throughout the dryland regions of India, becoming an invasive species. Officials began classifying Prosopis lands as wastelands, despite the tree's significance to fuelwood users.

Another shift in wasteland development policy at the turn of the twenty-first century responded to the interlinked crises of climate change and energy security. The GOI initiated a National Mission on Biodiesel (2003) in hopes of cultivating a domestic biofuel industry by growing *Jatropha curcas* (hereafter Jatropha) biofuels on wastelands. Jatropha is a tree capable of growing in degraded environments. The tree yields nonedible oilseeds that can be used to manufacture biodiesel, a substitute for diesel fuel. Because the tree would not, in theory, compete with food production on agricultural land, the Biodiesel Mission attempted to establish Jatropha plantations on 17.4 million hectares (mha) of wasteland throughout the country—about three percent of India's total geographic area. In order to make space for Jatropha plantations, the government began uprooting Prosopis lands, which represented a sizeable portion of the wastelands targeted for the Biodiesel Mission (Figure 1).

Figure 1: Jatropha tree (left) in front of Prosopis trees (right) on wastelands, Tamil Nadu. Photo by author.

In practice, the Social Forestry Programme in India and analogous community forestry projects throughout the world have been criticized for their regressive effects. Scholars have argued that conceptualizing the fuelwood "crisis" as nothing more than a supply shortage overlooked the broader economic and political processes facilitating deforestation. Further, many of the tree species promoted under these projects, such as eucalyptus and teak, were better suited as feedstocks for emerging pulp and paper industries than as household fuelwood. These disconnections between policy and practice motivated community protests, including the famed *Chipko* movement in India, in which rural women created human chains around trees in protest against deforestation. The Jatropha Mission is today widely considered a failure for technological, economic, and political reasons, and has been linked to public-private land grabs within the country. Making space for Jatropha has also exacerbated rural energy shortages, as Jatropha is not a substitute for Prosopis.

Wasteland Development: Getting the Numbers "Right"

Defining and classifying wastelands was a key component of India's postcolonial development schemes. Such definitions, however, focused on the ecological and economic conditions of lands, rather than their social significance. In the 1980s, India initiated the *Wasteland Atlas of India*, a classification project that uses remote sensing to identify degraded lands, and categorizes wastelands by type and severity. According to the most recent version of the *Atlas*, nearly 15 percent of India's total geographic area is currently classified as wasteland (47.2 mha). These definitions serve to construct wastelands as empty, unused lands that are available for improvement projects. However, wastelands, and common property lands more generally, are often used by landless communities for gathering fuelwood and fodder. These dimensions are not included in India's current wasteland classifications. This is because of official assumptions as to what constitutes "productive" land use and "modern" energy services. Scholars have argued that the GOI's conceptualization of "wasteland" has become so malleable a term that it is difficult to discern what types of lands could be converted to Jatropha plantations; recent shifts in classifications, they assert, are aimed at facilitating land transfers to industry.[2] As I have argued elsewhere, wasteland development acts as a metaphor for the entrenched struggle between government conceptions of land-use "improvement" and existing local land-use practices.[3]

The Transition from Prosopis to Jatropha

The interlinkages between the Social Forestry Programme and the National Mission on Biodiesel are starkly illustrated by the transition from Prosopis to Jatropha in rural India. To better examine this transition, I conducted a comparative energy-flow analysis of the Prosopis and Jatropha energy economies in Sattur Taluk, Tamil Nadu, India (Figure 2). The objective of such an analysis was to evaluate the mobilization, transformation, use, and disposal of energy within society.[4]

The energy-flow analysis revealed that the existing Prosopis economy currently provides three to 10 times more useful energy than India's proposed Jatropha economy. Despite this, neither the central nor state government biofuel policies mention the Prosopis economy. The study also compared the types of energy services provided by the Prosopis and Jatropha systems in order to evaluate the distribution of costs and benefits resulting from India's efforts to replace one with the other. Prosopis is primarily used as fuelwood by local households and small-scale industries, and as a feedstock for energy provision. For many decades, it was used to manufacture charcoal but in recent years, as numerous small-scale biomass power plants have opened throughout Tamil Nadu, it has been used as a feedstock for electricity generation.

2 Pere Ariza-Montobbio, Sharachchandra Lele, Giorgos Kallis, and Joan Martinez-Alier, "The Political Ecology of Jatropha Plantations for Biodiesel in Tamil Nadu, India," *Journal of Peasant Studies* 37 (2010): 875–97.

3 Jennifer Baka, "The Political Construction of Wasteland: Governmentality, Land Acquisition and Social Inequality in South India," *Development and Change* 44 (2013): 409–28.

4 Jennifer Baka and Robert Bailis, "Wasteland Energy-Scapes: A Comparative Energy Flow Analysis of India's Biofuel and Biomass Economies," *Ecological Economics* 108 (2014): 8–17.

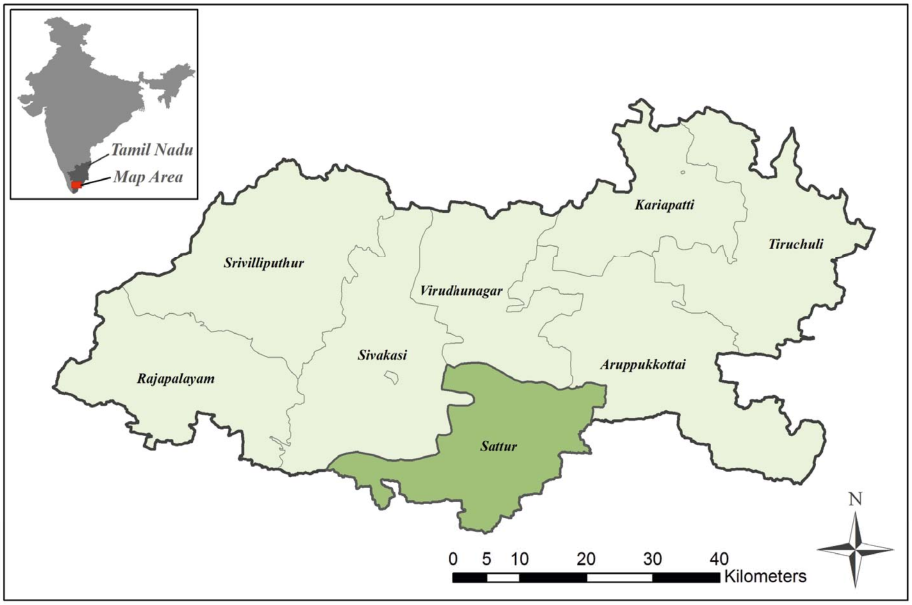

Figure 2: Map showing Sattur Taluk, Tamil Nadu. Map by author.

While some of the energy services provided by Prosopis are exported from Sattur, most of the energy is consumed locally. In contrast, Jatropha is used to manufacture a liquid transportation fuel, an energy service not currently provided by Prosopis. Although some of the by-products from the manufacture of Jatropha biofuel could, in theory, be used as substitutes for Prosopis, they are insufficient to match the quantity of energy that the Prosopis energy system presently provides.

Because of both the differences in the quantity of energy and incommensurate types of energy services provided by these two economies, replacing Prosopis with Jatropha in Sattur has engendered a rural energy deficit, exacerbating rural energy poverty and contributing to what geographers refer to as "uneven development." Further, landless rural communities are disproportionately bearing the costs of India's efforts to develop an environmentally friendly domestic renewable-energy economy. The benefits of this energy economy flow instead to the country's rapidly urbanizing vehicle-owning, bio-diesel-consuming households, as well as to industrial elites who have profited from the land transfers and economic subsidies implemented by the GOI to establish Jatropha plantations. Lastly, the energy flow analysis supports environmental-justice activist

Vandana Shiva's assertion that Jatropha fuels cars while impoverishing rural communities.[5] Elsewhere I have termed this process "energy dispossession."[6]

Hidden Livelihoods: Land Grabs and Surplus Populations

The process of energy dispossession was also enabled by GOI efforts to privatize and enclose wastelands. Specifically, the GOI extended land leases, lines of credit, and subsidies to biofuel companies who were willing to establish Jatropha plantations on wastelands. In a rush for wastelands, land brokers throughout Sattur started to amass contiguous plots of wastelands in order to establish Jatropha plantations. Land grabs ensued, as land brokers began bribing government officials for land records rather than attempting to purchase these plots. Once land brokers had acquired the land, landless communities could no longer use it for animal grazing and fuelwood harvesting.

Further, the energy transition from Prosopis to Jatropha translated into net job losses in rural Sattur. Landless laborers had frequently worked on Prosopis cutting crews, a job that provided about nine months of steady employment (Figure 3). In contrast, Jatropha plantations in the Sattur region provided about two weeks of steady employment, and only once the trees had reached maturity after three to four years (Figure 4).

As a result of energy dispossession, affected land users have been migrating to urban areas in search of wage labor in paper and firework factories. However, the availability of low-skilled industrial work has been in decline in recent years because of the expansion of high-tech Special Economic Zones (SEZs) into the region. Tamil Nadu's Prosopis land users are therefore at risk of becoming what Marxist political-economy scholars call a "surplus population."

These findings are not unique to Sattur. Prosopis is being uprooted in many states to make space for Jatropha. The GOI has been actively establishing SEZs on "vacant" lands throughout the country, further exacerbating processes of dispossession. In particular, SEZ projects in the north of India have been linked to widespread protests over

5 Vandana Shiva, *Soil not Oil: Environmental Justice in a Time of Climate Crisis* (New York: South End Press, 2008).

6 Jennifer Baka, "Making Space for Energy: Wasteland Development, Enclosures, and Energy Dispossessions," *Antipode* 49, no. 4 (2017): 977–96.

the loss of land-access rights.

Figure 3: Landless laborers cutting Prosopis in rural Tamil Nadu. Photo by author.

Figure 4: Female laborer harvesting Jatropha, Tamil Nadu. Photo by author.

Conclusion

This paper illustrated the objectives and social impacts of India's transition from biomass to biofuel. A problematic conceptualization of wastelands has been central to the outcomes of this process. Rather than acknowledging the significance of wastelands to livelihoods, the GOI has focused efforts on getting wasteland estimates "right" in order to locate rural development schemes. These conceptualizations of wastelands have dispossessed rural wasteland users, creating rural energy shortages and job losses. Yet, the impacts on agrarian livelihoods have been obscured in policy discussions because of the government's shifting perceptions of what constitutes "modern" energy and "productive" land-use practices.

It is likely that future land-use improvement schemes will continue to center on wastelands. To avoid repeating the outcomes of the Social Forestry Programme and the National Mission on Biodiesel, it is imperative to acknowledge the livelihood significance of wastelands in policy debates and to challenge the idea of wasteland users as "backward." When I asked interviewees to define wastelands, I was repeatedly informed that there are no such things as wastelands, since all lands are currently in use.

In other words, wastelands are already “improved” because the lands are providing important energy services to rural communities. Policymakers would do well to incorporate this perception into their energy policy planning.

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Sarah Strauss and Carrick Eggleston

Experimenting with Energyscapes: Growing up with Solar and Wind in Auroville and Beyond

The path to sustainable energy systems is never singular. Energy transitions are inherently experimental, requiring flexibility and recognition of the limits of site and scale. For Auroville in South India, overcoming limitations on the scale of renewable energy required moving development off-site and involved local, regional, and even national policy shifts. Such transformation includes not only technological novelty, but also new ways of thinking about what is possible. Each community, each nation, must take stock of its own resources, values, and opportunities to make effective choices for foreseeable futures that are, themselves, moving targets. The notion that such energy systems, whether at the household level or on a wider scale, would be developed once and then left alone is also unrealistic; instead, we must understand that living communities will grow and change, just as their technologies, resources, and systems must.

"The City the Earth Needs": Auroville, Sustainability, and the Anthropocene

Auroville, "the city the earth needs," is an intentional community founded in 1968. From a few dozen members at the start, the Auroville community grew to 2,700 members in 2017, representing 53 nationalities.[1] Auroville's energyscape (pace Appadurai)[2] transformed along with the landscape. The notion of energyscapes allows us to consider "the problem of energy in motion across social and physical spaces, shifting its cultural, social, economic, and technological values as it flows from one domain to the next."[3] The energyscape of the Auroville bioregion (encompassing parts of the state of Tamil Nadu as well as the Union Territory of Pondicherry) is significant because it illuminates critical aspects of energy production and distribution in relation not only to scale, but also to siting and context. All energy is not equal, and access to (or impacts

1 "Census September 2018—Auroville Population," Auroville: The City of Dawn, last updated 7 September 2018, http://www.auroville.org/contents/3329.
2 Arjun Appadurai, *The Future as Cultural Fact: Essays on the Global Condition* (London: Verso, 2013).
3 Sarah Strauss, Stephanie Rupp, and Thomas Love, eds. *Cultures of Energy: Power, Practices, Technologies* (Walnut Creek, CA: Left Coast Press, 2013), 11.

from) the same resources can vary widely depending on location and interaction with other resources or activities.[4]

In Auroville, new generations of solar and wind technologies emerged as the trees grew and began to shade the original installations. This required new towers to be built, and connections between shade and sun, heat and light, energy and opportunity had to be reimagined. Auroville today provides an unusual window into a world where solar and wind power have been used continuously for 50 years. Along the way, Auroville's residents have developed new technologies and energy policies that affect people throughout India. Every phase of solar and wind innovation has been represented in this small community. These gradual transitions across the realm of renewables highlight not only the intersection of technologies—for example, from battery storage to grid-tied solar electric systems—but also a shift from basic subsistence to the panoply of consumer luxuries that abundant electrical power allows.

Auroville's experiences in navigating such complex and ever-changing cultural and sociotechnical terrain provide both templates and cautionary tales for rural and urban transformations across India and the world. The negotiation of power in all of its senses is an ongoing challenge for Auroville: it is a highly contested space, comprising over one hundred enclaves within the community and several villages at the margins. The transformation of the Auroville bioregion over the past two hundred years of colonial and postcolonial history is central to the story of Auroville's emergence, as the constraints and opportunities that engaged both the material context and the meanings of this social-ecological system have continued to feed each other. The "capacity to aspire"[5] for both local villagers and newcomer Aurovilians has been shaped by changes in the economic, environmental, and energy landscapes over time, especially with regard to forest and water resources.

4 Robert McC Netting, *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture* (Stanford, CA: Stanford University Press, 2013).
5 Appadurai, *The Future as Cultural Fact*, 187.

The Past: Deforestation in South India

In 1750 a local king hunted for elephants and tigers in the nearby forest, in what would become known as the Auroville bioregion in the twenty-first century. Forests were later cleared to remove the tiger threat. The last two-thousand-year-old neem trees were cut down in the 1950s to build boats. Blanchflower notes that at present, the only surviving forest is in sacred groves around temples.[6] By the 1960s, the Auroville bioregion was a desertified plateau with little agriculture and an impoverished population. Reforestation was a primary initial goal of Auroville's founders. The lack of shade in the searingly hot climate was a key motivator—not just for comfort, but to protect food plants, soil moisture, and water resources. Both food production and reforestation required immediate attention to water management with the specific goal of "net-zero" runoff. Water was trapped and allowed to infiltrate the ground to support crops as well as the regional water table. "Bunds"—dirt ridges built around fields—were built to prevent rainwater runoff and to increase water infiltration and retention. Today, we still see active bunds and infiltration ditches to collect runoff and reduce evaporation, maintaining groundwater at sustainable levels.

Into this Martianesque landscape (Figure 1a), The Mother[7] imagined a central structure that would be a focal point for the new community, and so began the Herculean task of making this part of her dream—what became the Matrimandir—a reality. The Matrimandir is an impressive construction by any standard, standing about 30 meters above the surrounding plains; in Figure 1b you can see it in the distance from the roof of the Auroville Foundation building next to City Hall, itself the site of one of the first grid-tied solar arrays in the state of Tamil Nadu. Begun in 1970, the Matrimandir was completed in 2008. Well before its completion, the Matrimandir's electrical needs were met by what was at the time India's largest photovoltaic array, commissioned in 1997. At the end of the twentieth century, Auroville accounted for about 15 percent of all installed photovoltaics in India. Renewable energy has been crucial to water

6 In Eliza Kent, *Sacred Groves and Local Gods: Religion and Environmentalism in South India* (Oxford: Oxford University Press, 2013).

7 The Mother is the common name for Sri Aurobindo's soulmate, a French-Lebanese woman named Mira Alfassa, who dreamt of the founding of Auroville in the plains north of Pondicherry, where she and Aurobindo lived and taught in the first part of the twentieth century. According to the Mother, Auroville, the City of Dawn, would "belong to nobody in particular . . . [but] to humanity as a whole." ("The Auroville Charter: A New Vision of Power and Promise for People Choosing Another Way of Life," Auroville: The City of Dawn, last updated 21 November 2018, http://www.auroville.org/contents/1).

Figure 1A: Eroded landscape of Auroville ca. 1968. Photo of original by Sarah Strauss.

1B: The 30m tall Matrimandir as viewed from atop the three-story Auroville Foundation building (foreground) that supports one of the first grid-tied photovoltaic arrays in Tamil Nadu, emphasizing the reforestation of the barren landscape upon which Auroville was founded in 1968. Photo by Carrick Eggleston.

management and irrigation from Auroville's early days, in which first wind turbines and later photovoltaics were used to pump water out of wells. Today, some wind but predominantly photovoltaics remain the backbone of water management in Auroville. Photovoltaics power water-well, irrigation, and fountain pumps on the Matrimandir grounds just as they do around much of Auroville.[8]

Auroville's Energyscape

Solar photovoltaics, very expensive in the 1980s and 1990s, were installed on a house-by-house basis in small arrays for pump systems and lighting. Auroville's reforestation efforts could not proceed indefinitely without affecting these installations; the dynamics of this social-ecological system continued to evolve. The shifting landscape, with its deliberate afforestation, gradually impinged upon renewable energy systems. Trees began to block the sun (Figure 2) and likewise the wind, making wind-driven water pumping less viable. More recent photovoltaic installations were placed on new buildings in Auroville, sitting above much of the forest canopy or in sufficiently large clearings. But the changes have been in fits and starts. While the Matrimandir and larger Auroville construction projects have been carefully designed and executed, much of

8 Sandra Loret, Samuel Martin, and Deoyani Sarkhot, "Sustainable Energy in Auroville: The Vision and the Reality," *Report to the Municipality of Auroville* (Auroville: Technology and Sustainable Development, École Polytechnique Federale de Lausanne, Switzerland, and IIT Madras, India, 2002), http://research.auroville.org/system/papers/attachments/000/000/627/original/Sustainable_Energy_in_Auroville_Sandra_Loret_Samuel_Martin_Deoyani_Sarkhot_2002.pdf.

Figure 2:
Various photovoltaic installations in Auroville, each affected by forest shading. Note that some installations are far more recent than others and that reasons for shading are complex. In some cases, new arrays were installed with the acceptance of shading to avoid loss of forest; in others, panels were taken down from tall mounts to protect them from storms, and never put back up because the storm damaged the stand. Also, salt corrosion has increased the incentive to keep panels closer to the ground where they can be worked on more easily. Photo by authors.

the rest of the community simply "grew up," with shifting residences and residents; changing environmental conditions created by storms or floods; and an assortment of technical problems and misalignments caused by differing timelines for the replacement of system elements (such as solar panels or batteries), or simply by shifting plans and priorities.

Individuals and small enclaves make independent decisions about household- to hamlet-scale options, although they also contribute to decision making at the wider community level. Experimentation is ongoing. Auroville is a complex entity; it is managed by consensus, with a Residents' Assembly and several working groups, and committees for day-to-day affairs and longer-term planning. The governance strategy means that, in theory, every Aurovilian has the ability to affect all decisions made for the group, but in practice only a small number participates in any given action. There are also a variety of enterprises that develop and produce new technologies, as well as think tanks and other organizations that consult with outside entities on a wide variety of topics, including renewable energy, organic farming, and reforestation. Such enterprises draw on both the prior experiences of Aurovilians and the experiments that they have conducted at Auroville itself. Very little at Auroville is obligated, except a requirement for individuals who would like to become newcomers or residents to adhere to the yoga of Sri Aurobindo and the Dream of the Mother,[9] but these are interpreted quite broadly within the context of understanding that Auroville is meant to be a place "where human relationships, which are normally based almost exclusively on competition and strife, would be replaced by relationships of emulation in doing well, of collaboration and real brotherhood."[10] Many different ways of being in the world, and of problem solving, have thus emerged. One person's vision of a "solar village" might be realized very differently from one enclave to another; down the road, one might find an elite community filled with Bollywood screen royalty or, across the field, a community living in thatched huts in the traditional local style. There is no single Auroville, just a set of ideals inscribed by Aurobindo and The Mother that might support progress toward human unity as they defined it.

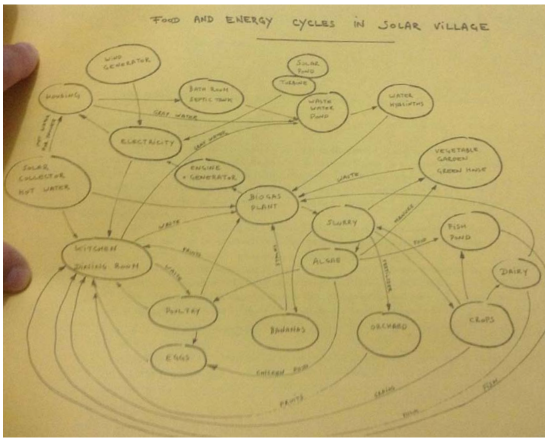

Figure 3:
A food and energy flowchart for a proposed solar village in Auroville, 1980. Note that the technology considered viable in the South Indian context at the time was the use of biomass to create biofuels to run a generator for electricity. Photo by Sarah Strauss, with permission from Auroville Archive.

The vision of a self-sufficient community supported by renewable energy has developed over time in Auroville in ways that are closely connected to both available materials and a changing landscape. As an example, Figure 3 shows a flowchart for a proposed "Solar Village" in Auroville. This 1980 concept of a solar village uses solar collectors as a way to heat water. The connection of solar to electricity is indirect, through the medium of biogas. Indeed, the main form of solar energy in this solar village concept is biological photosynthesis—a vegetable garden, banana trees, an orchard—to provide both biomass (food and nonfood) and waste for

9 "Auroville Entry Policy 2017," Auroville: The City of Dawn, last updated 17 December 2018, https://auroville.org/contents/4450.

10 "A Dream: Envisioning an Ideal Society," Auroville: The City of Dawn, last updated 5 November 2018, https://auroville.org/contents/197.

a biogas plant that would supply fuel to run a generator and produce electricity. These systems were seen not just as sustainable, but sustainable in rural South India given the limits of village life, rather than an expensive renewable technology beyond the reach of the majority of the population. Context matters.

Power Intermittency and Energy Storage

Issues of energy storage have come to the forefront of global energy development as intermittent wind and solar energy sources reach a global scale and affect entire electrical grids. But Auroville's relationship with electricity was defined by intermittency long before photovoltaics were installed in relatively large quantities. Grid power was not available for much of each day, giving the advantage to photovoltaics in the minds of many Aurovilians. Grid intermittency led to relatively large local investments in infrastructure and to the widespread development of alternatives regionally, not just in Auroville. The community's municipal planners ("L'Avenir d'Auroville") pursued long-term solutions to grid intermittency that took advantage of new technologies at a different scale. Locally, many people purchased diesel generators to meet their needs when the grid power was off. However, generators and diesel fuel are expensive, and within Auroville their noise and exhaust were unwelcome.[11] Generators also do not start instantly, and power outages meant costly and unacceptable interruptions, especially with computers running and commercial transactions being conducted. Many locations around Auroville, including households, guesthouses and municipal offices, and businesses within Auroville therefore invested in battery-inverter systems to store energy from the grid to be used during power cuts.

Some consumers realized that, with existing investments in batteries and inverters, photovoltaics would be a relatively modest added expense. These small-scale solutions, implemented locally in the twentieth century, have analogs today at the global and grid scale. Massive wind and solar installations worldwide are being coupled to fossil-fuel-driven and nuclear-driven power systems not originally designed for intermittency. The problem of power intermittency in South India is not purely the result of greater demand for electricity than can be supplied. Intermittency is connected to policy. Choices must be made about who will lose power most frequently. Grid power

11 Loret, Martin, and Sarkhot, "Sustainable Energy in Auroville."

is provided for free to farmers to extract water from wells and irrigate fields, but the farmers are the first to lose power since priority for continuous power is given to the university and large industrial users. Auroville was previously not classified as a major power user and so experienced frequent power interruptions. By actively using more grid power, Auroville could achieve a new status that allowed for more reliable access. In a municipal power report,[12] it was also suggested that Auroville could invest in grid-scale wind turbines elsewhere in India, feed power to the grid, and be eligible for better terms from the power company. In late 2014, the Varuna project became reality: several grid-scale wind turbines (4.3 megawatts capacity), built elsewhere by Auroville, supplied power to the Tamil Nadu grid. Auroville then achieved a different status as a power consumer. Fewer power interruptions, improved reliability, and decreased prices all affected Auroville's power use; electricity was now perceived to be "free."

The expense and difficulty of renewable energy in Auroville initially limited power usage. One cannot just install solar panels, but must also face an array of "balance of system" costs and complexities including a racking system for the panels, batteries, battery maintenance, charge controllers, inverters, wiring—often with the help of a paid installer or technician and often without a reliable supply chain for specific products. However, removal of the expense was sufficient to permit some quick changes. On our return to Auroville in 2015, we found that our former guesthouse now had a toaster, microwave oven, electric water kettle, and an electric espresso machine, none of which were possible in 2013 when we first arrived there. In addition, new air conditioners and water heaters had changed the level of comfort available in the rooms and the ability to manage it. There was also a new entertainment system, and a small electric car. The incentive to avoid excessive electricity use was removed.

While overall energy use by the guesthouse increased, the uptick is smaller than one might at first assume. The electric water kettle and espresso machine for guests supplanted an earlier system in which two large urns, one with coffee and one with tea, were supplied to guests each morning. The propane required to heat the water for these urns on a stovetop used more primary energy than electric water-heating systems do. Electrification for tea and coffee is therefore more energy efficient. The new air-conditioning and water-heater systems for guest rooms do increase overall energy usage, but this increase is modest

12 "Auroville Municipal Energy Plan," Auroville: A Universal City in the Making, last modified 23 May 2012, https://www.auroville.info/ACUR/documents/municipal_energy_plan.pdf.

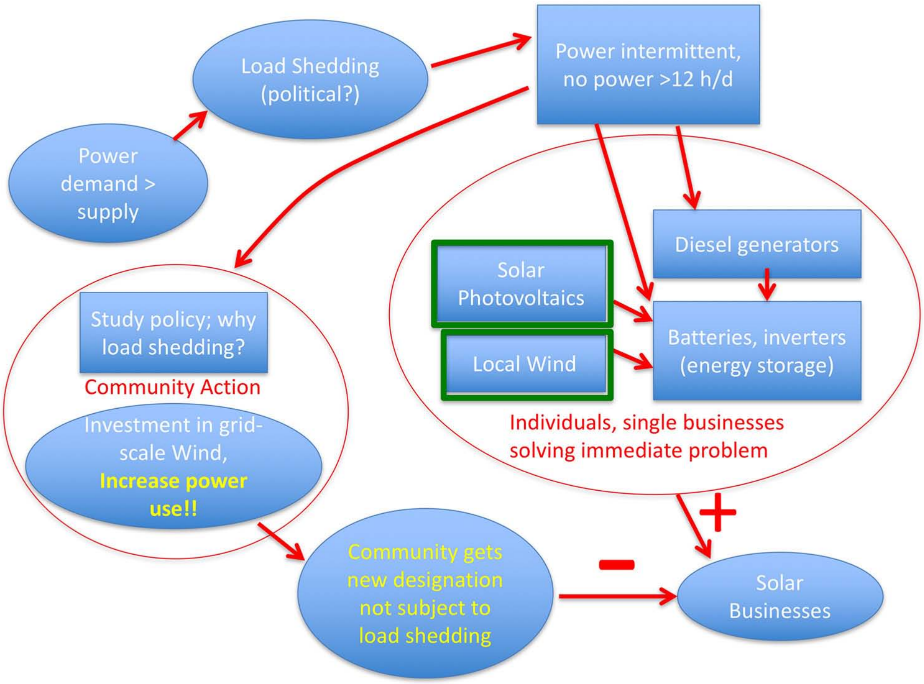

Figure 4: Flow diagram showing parallel individual (short-term) and municipal (long-term) responses to power intermittency. Individual solutions supported a local renewable power industry (symbolized by the "+" in lower right), but the municipal approach—while providing renewable power—resulted in lost support for the local renewable power industry (symbolized by the "-" at lower right). Diagram by Carrick Eggleston.

and the source is now renewable, rather than fossil-fuel, energy. One unanticipated result of the change to wind-powered, grid-tied electricity in Auroville was that there was no longer an incentive to install photovoltaics (Figure 4). The city was now being powered by renewable energy to a greater extent than ever before, but where previously the renewable energy infrastructure was highly varied (solar cooking, solar hot water, mechanical wind-driven water pumps, biogas, photovoltaics) and local (small individual installations), now it is mostly externalized.

Hopeful Signs: Implications for the Future of Renewable Energy

In many ways, Auroville pointed the way toward renewable energy in India and provided real-world experiential knowledge that supported implementation on a wider scale. Auroville goes somewhat beyond the typical "niche" described by Geels[13] and others, for

13 Frank Geels, "The Multilevel Perspective on Sustainability Transitions: Responses to Seven Criticisms," *Environmental Innovation and Societal Transitions* 1, no. 1 (June 2011): 24–40.

two reasons. Firstly, there are multiple simultaneous, but independent, efforts to move towards a sustainable energy system, from the household level to private enterprise and the wider community. This is not just a singular R&D site. Secondly, because of the privileged space Auroville occupies within the Indian government (at national and state levels), its consultants have disproportionate influence in designing policies and suggesting practices. Auroville therefore affects both regime and landscape levels. One example of this is the development of grid-tied net-metering systems for rooftop solar in the state of Tamil Nadu. Auroville was the initial test/demonstration site for this initiative, using a system designed there between 2012 and 2013. Later that year, the first statewide policy was issued, with specific implementation instructions following the Auroville model.[14] In Auroville, and in India more generally, the shift to grid-scale renewable energy has increased overall energy use. This can be viewed as a limitation on the ability of renewable energy development to displace carbon emissions from (for example) coal-fired power plants. While renewable energy is rarely implemented for reasons of climate change mitigation, the result is in fact often mitigation of climate change drivers, but this is not always the case. Each new system transformation must be evaluated in context, and no "silver bullets" for carbon reduction can be assumed.

What Does It Mean to Be Modern? Evolution of Energy and Consciousness in Auroville

This experiment in community has created the tools to allow Aurovilians to dwell in a degraded landscape, highlighting how renewable energy and water systems can be integrated to provide an alternative to the fossil fuels that enabled notions of "Progress" in the production of "Modernization" as embodied in development projects. "Energy" is no more a modernizing force than is iron or water or fire or air; all can be put to technological uses that increase efficiencies and mask the costs, economic or environmental, of such resource use. Fossil fuels, in their limited time as the dominant source of energy as the West rose in power, have certainly created a shortcut, a way of moving and acting that seems to speed up and extend our capacities as humans, per Marx, to act upon

14 Tamil Nadu Generation and Distribution Corporation Ltd (TANGEDCO), "Memo. No.CE/Comml/EE/R&C/AEE1/F.Solar NM/D. 023/14, dt.17.02.2014," 17 February 2014, http://www.teda.in/pdf/TANGEDCO_dt_17_02_14.pdf.

nature and society. But in conversations about this,[15] reasonable questions emerge as to the symbolic and metaphorical values that fossil fuels have for modernity as a way of engaging the world. The changing energyscape of Auroville has coevolved with its diverse range of community members, who have not only converted a "ruined"[16] landscape back into one that supports life in all its forms, but created a built environment that offers different ways to imagine community, prosperity, and sustainability. The Aurovilians responded to their unique conditions, and continue to act on the land and its resources as experimentalists—agents who are not just consumers or citizens, but also producers of the energyscape as it plays out on many scales that change over time.

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16 Anna Tsing, *The Mushroom at the End of the World: On the Possibility of Life in Capitalist Ruins* (Princeton, NJ: Princeton University Press, 2015).

Daniel A. Barber

Climate-Sensitive Architecture as a Blueprint: Habits, Shades, and the Irresistible Staircase

Patterns of Desire

The relationship of climate to the built environment has been of increasing interest over the past decade. As is generally known, the production and operation of buildings contributes between 40 percent and 60 percent of the carbon emissions produced by the industrialized world. For this reason, buildings have become a site for the making of efficient energy systems—or at least of attempts to do so—through innovations in everything from thin solar panels to design that maximizes nonmechanical heating or cooling potentials. Architecture, as a profession, a cultural realm, and a discursive space, is entangled with ambitions for energy transitions. Indeed, it is difficult to imagine, not to mention enact, a low-carbon future without a substantive transformation in the ways that buildings are designed, built, and inhabited.

If architecture is, in this sense, a locus for contemporary energy debates, it is so in a fashion that demonstrates the complexity of these discussions, even their seeming intractability. This is true in terms not only of technology, policy, and regulation relative to carbon emissions, but also of the cultural dynamics through which architecture is developed and refined. In other words, across this nexus of architecture, climate, and energy, two important considerations emerge. To what extent can innovation produce apparent solutions? And is it possible for design to encourage different kinds of cultural aspirations and to build, or possibly renovate, the conditions that would allow low-energy ways of living to proliferate? Recent historical scholarship and design research, by Nerea Calvillo, Jiat-Hwee Chang, Lydia Kallipolitti, Kiel Moe, and many others,[1] have intensified this discussion.

1 Jiat-Hwee Chang, *A Genealogy of Tropical Architecture: Colonial Networks, Nature, and Technoscience* (New York: Routledge, 2016); Lydia Kallipolitti, *History of Ecological Design*, Oxford Research Encyclopedias Online, April 2018, http://environmentalscience.oxfordre.com/view/10.1093/acrefore/9780199389414.001.0001/acrefore-9780199389414-e-144; Kiel Moe, *Insulating Modernism: Isolated and Non-isolated Thermodynamics in Architecture* (Basel: Birkhauser, 2014).

Furthermore, numerous critics outside the field have illuminated the intensity with which buildings—as cultural and technological objects—have come to be seen as both obstacles and opportunities in a collective ambition to reconsider ways of life amidst climatic instability. Amitav Ghosh, in his landmark text *The Great Derangement: Climate Change and the Unthinkable*,[2] is interested in clarifying the extent to which the climate challenge is rooted in culture as much as technology. He identifies the importance of buildings early on, in two seminal passages: "Culture generates desires," Ghosh writes, "for vehicles and appliances, for certain kinds of gardens and dwellings—that are among the principal drivers of the carbon economy." A seemingly simple causal imperative, locating design intention as essential to broad social transformations. Focusing even more closely on the cultural dimensions of design and its reception, Ghosh continues, "[I]f contemporary trends in architecture, even in this period of accelerating carbon emissions, favor shiny, glass-and-metal-plated towers, do we not have to ask, What are the patterns of desire that are fed by these gestures?"[3] At stake, for Ghosh, is how new buildings, new narratives, and new cultural practices can adjust such patterns and foster new desires.

Perhaps even more significant than the embodied energy of the glass and metal plates Ghosh refers to are the thermal conditions such façades produce: the shiny towers of late capitalism are, in general, fully sealed systems, reliant on mechanical conditioning. These buildings reflect how cultural desire, enacted in a range of social and geographic contexts, has produced interior spaces with a consistent temperature and humidity, all generated through fossil-fueled air-conditioning and heating systems. In the brief excursus below, I want to outline a historical moment when such desires, and the technologies that facilitated them, were still in development, and when other ideas and processes regarding everyday life inside buildings were still seen as viable and available—that is, before a diffuse yet seemingly definitive shift towards mechanical conditioning took over. I will focus on a series of experiments in 1940s Brazil that sought to condition interiors by architectural, rather than mechanical, means, and will outline the kind of politics involved. What emerges is a nuanced historical relationship to a past that is also resonant across a possible future, as cultural desires are, slowly, opening towards other frameworks for inhabiting the built environment, and the planet, on differ-

2 Amitav Ghosh, *The Great Derangement: Climate Change and the Unthinkable* (Chicago, IL: University of Chicago Press, 2016).
3 Ghosh, *The Great Derangement*, 9–10, 11.

ent carbon terms. What emerges as well is an emphasis on the potential for habits—the rote manifestation of patterns of desire—to enact (albeit slowly and through a logic of accumulation) different lifestyles and different consequences for planetary futures.

Evidence

I want to play this out through a few buildings, to focus on a moment when new kinds of individual and collective habits were seen to be central to the modernization process—almost as an energy system itself. Or, put differently, I am focused on the articulation of an architecture that operated in concert with repetitive gestures as a sort of geophysiological conditioning—the production of a relationship between bodies, buildings, thermal interiors, and climatic instabilities. Such patterns and habits can be framed as a supplement to existing energy conditions, as a politically driven and architecturally activated means to draw the population into modernity. Habit, following Wendy Hui Kyong Chun,[4] is here posed as a means of analyzing historical change. It offers a different set of causal relationships, whereby the aggregation of small gestures is seen as a counter-practice to the accumulation of carbon: an epochal change built on patterns of desire.

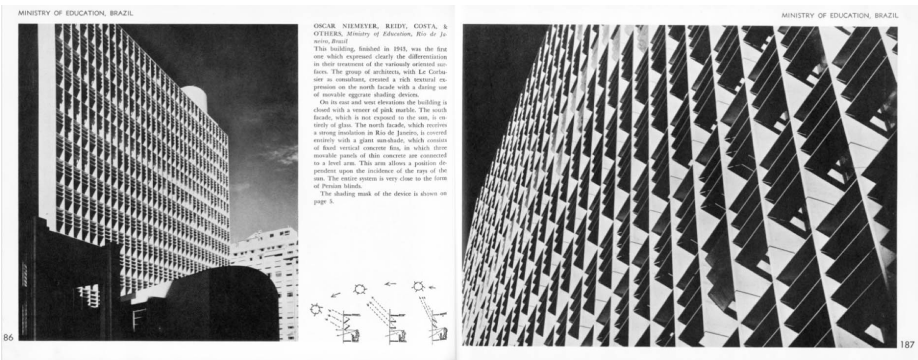

Figure 1:
Lúcio Costa, Oscar Niemeyer, Carlos Leão, Affonso Eduardo Reidy, Ernani Vasconcelos, et al., Ministerio da Educação e da Saúde (MES), Rio de Janeiro, 1936–1943. Source: Victor and Aladar Olgyay, *Solar Control and Shading Devices* (New York: Reinhold, 1957).

The architecturally induced habits I am interested in are well captured in the Ministry of Education and Health (Ministério da Educação e Sáúde—MES) in Rio de Janeiro. The building was designed by Lúcio Costa and a team of Brazilian architects and built between 1936 and 1943. It is a tall, narrow structure with a more amorphous form—an audito-

4 Wendy Hui Kyong Chun, "On Hypo-Real Models or Global Climate Change: A Challenge for the Humanities," *Critical Inquiry* 41, no. 3 (Spring 2015): 675–703.

rium—intersecting at the base. This established a template for an early phase of modern towers, more or less repeated in the UN Headquarters in New York and in many US embassies around the world, among other buildings built in this same period. Predating, by a decade or so, the proliferation of the shiny glass and metal towers that Ghosh refers to, the Ministry building deploys a second skin to cover the glass-curtain wall and to modulate the effects of the sun on the interior. The north, sun-facing exposure thus protects the interior from overheating through banks of operable louvers nested in an egg-crate façade; the south façade is all glass. The shading devices hold the façade together as a visual field, while the variation in each module is both formally dynamic and effective as a device to engage with the microclimate. As the diagram at the bottom of Figure 1 indicates, the inhabitants could adjust the conditions of the interior according to the path of the sun and their desired interior temperature.

The shaded façade was, as I have argued at length elsewhere, the primary site for creative architectural production in the period.[5] In this specific case, and as part of a cycle of global architectural development, it was deeply enmeshed in the *Estado Novo*: the modernizing, authoritarian-democratic regime of Getúlio Vargas. The building was essential to, and is emblematic of, the social and economic processes of modernization as they came to play out in Brazil. The ministry itself (that is, the government agency, not the building) was focused on improving the education and health of the Brazilian population, deep into the hinterland. The maintenance of the body and the mind were seen as essential to a complex governmental project of transforming the population, relative to a global political economy of globalization, neoliberalization, and the collective optimization of resources. This reflected, in fact quite closely, Michel Foucault's well-known triumvirate of security, territory, and population in his discussion of new governmental regimes, and also clarified the terms by which the public was newly imagined as subject to management and optimization.

A few other examples help to clarify how climate, design, and governance were entangled. The Rio-based firm MMM Roberto (run by brothers Mauricio, Milton, and Marcelo) rose to some prominence in this period through their expertise in carefully shaded buildings for modernizing programs. A number of government commissions—a press agency, airport facilities, technical training institutes—established the

5 Daniel A. Barber, *Climatic Effects: Architecture, Media, and the Great Acceleration* (Princeton, NJ: Princeton University Press, forthcoming 2020).

brothers' reputation relative to both shading mechanisms and political priorities. Of especial interest is their design and construction of the headquarters of the Brazilian Reinsurance Institute (IRB), also completed in 1942. It is compelling both for its façade and for the significance of the activities that went on inside: the IRB housed a government fund intended to assure foreign capital that investments in Brazil would be safe. The Roberto brothers' later factory, warehouse, and offices for the Caterpillar corporation offer a general indication of how modern architecture became essential to Brazil's economic and social development.

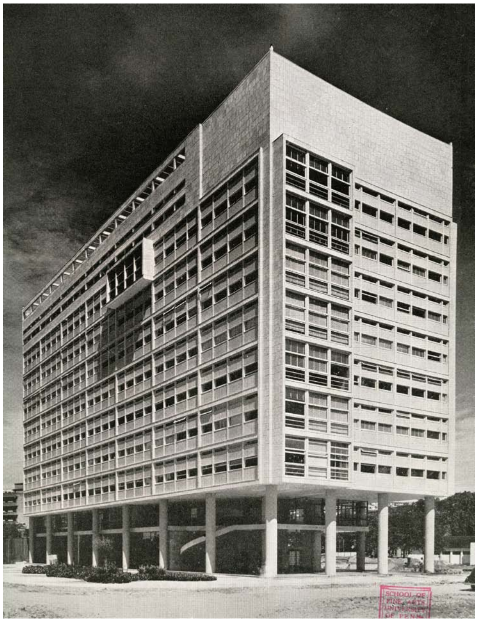

Figure 2: MMM Roberto, Associação Brasileira de Imprensa (ABI), Rio de Janeiro, 1936. Source: *The Architectural Forum*, August 1944.

The Roberto brothers were prolific along these lines, creating climate-sensitive buildings that reflected the complexity of these socioeconomic transitions. One such example is the Edificio Seguradoras, a speculative office building for the property insurance industry built in 1949; on its sun-facing façade, there were at least four different means of adjusting the conditions of the interior according to the seasonal and diurnal patterns of solar radiation. A weekend retreat for workers at the IRB, commissioned by the Vargas administration, provides an elegant contrasting example in the formal organization of the building—it had a fixed, integrated shading screen rather than one allowing multiple forms of manipulation. The example of the IRB retreat also supports my assembly of these buildings around evident biopolitical notions of self-care: a reinsurance agency that seeks preemptively, it seems, to support the health and happiness of its employees, and a means of using architecture (and the design of the façade in particular) to reflect cultural desire and enact it towards a more open physiological future. At the Marques do Herval, a speculative office building in Rio's center, the brothers were given license to further explore how the inhabitants could control their interior conditions through dynamic interaction with the façade, both through

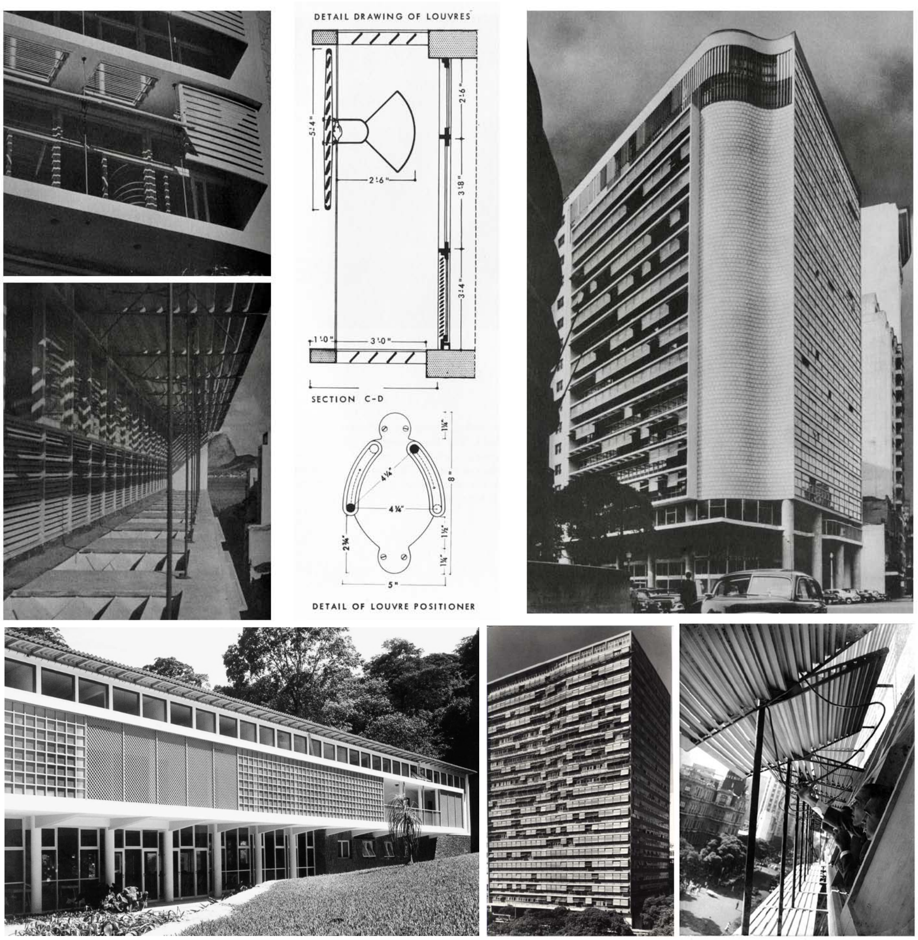

Figure 3: (top) MMM Roberto, Edifício Seguradoras, Rio de Janeiro, 1949; (bottom left) MMM Roberto, Colonia de Ferias do Instituto de Resseguros do Brasil (IRB), 1947; (bottom right) MMM Roberto, Marques do Herval, Rio de Janeiro, 1952. Source: Victor and Aladar Olgyay, *Solar Control and Shading Devices* (New York: Reinhold, 1957).

an attuned engagement with the climatic membrane and as an *active* physiological integration between the body and the conditioning of the interior; ultimately, between *habit* and *climate*.

A final example: The Edificio Mamae was built by the Roberto brothers in 1945, one of the first modern buildings in Copacabana, as an apartment building that could house their entire extended family. Each of the brothers had at least one floor, and their mother, by then widowed, occupied the seventh story, which was protected by a ter-

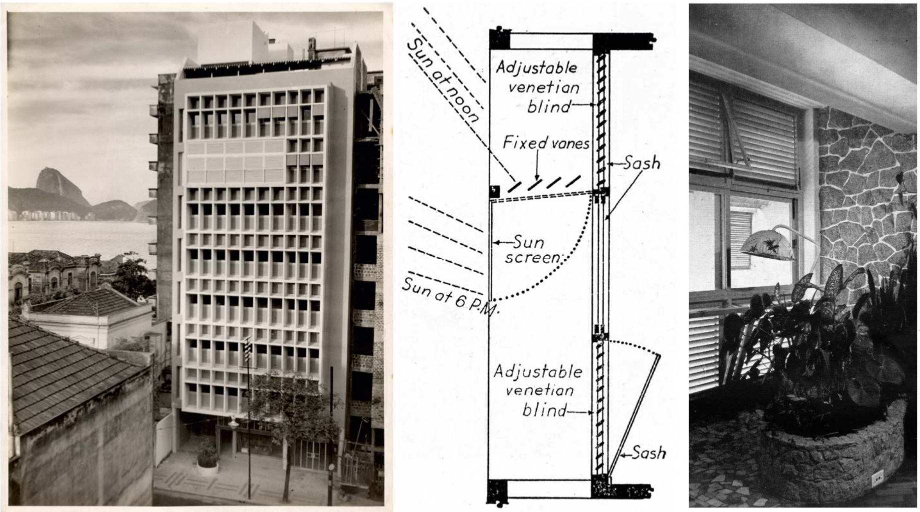

Figure 4: MMM Roberto, Edifício Mamae, Rio de Janeiro, 1945. Source: *The Architectural Review*, November 1947.

tiary shading screen. The dynamism of the Edificio Mamae façade was such that it demanded elaborate attention from the inhabitant, with a number of adjustable and fixed elements, as seen in the section drawing in Figure 4. The emphasis is on the façade system as a designed membrane that draws the inhabitant into engagement with climatic patterns. The inhabitants—the family—attended to its needs through these interactions. Though, significantly, in the case of the Roberto family interaction with the façade was likely to have been performed by domestic servants rather than the family members themselves: a substantive complication of the political economy of habit that I cannot fully address here, but which nonetheless begins to indicate a yawning gap between the diagrammed possibilities of interactive, climate-sensitive design and the lived experience of these interiors.

Habit

Awash in these contingencies, these buildings are best seen as events in the history of a future yet to come: liminal moments of engaging bodies directly in regimes of modernization that seem less like a past, which has since been overcome by the forces of progress and economic growth, and more like a future, a scenario for a new approach to cultural and climatic contingencies. That is to say, as the built environment has since been overwhelmed by mechanical air conditioning, and as the environment more generally has absorbed the carbon emissions that have resulted from such mechanical proliferation, the way that we think about buildings and about how to inhabit them is undergoing stark transformation. Although, perhaps, not stark enough.

The space of the thermal interior, in both domestic and commercial environments, is thus enacted and emphasized in order to reimagine an embodied relationship to climate—a politics of the everyday. The question becomes: Can we induce habits—in ourselves, our friends and colleagues, our children and grandchildren—that activate a different relationship to fossil fuels? If so, the goal of such architecture, and related scholarship, is to provide a framework in which such patterns of desire can be enacted and emphasized. As Chun puts it, "Habit occurs when understanding becomes so strong that it is no longer reflected, when an action is so free that it anticipates and escapes will or consciousness, or when a being's repeated actions assuage its own needs."[6] Habit occurs, in other words, at least in some instances, when it becomes architectural.

Can a building make us act differently? Can it induce new habits? Stated differently: Is the "normalized" thermal condition of the built interior imposed or desired? Much recent work in architectural engineering has focused on adaptive comfort as a means to encourage regional and cultural specificity in the experience of the interior. One built example, more direct perhaps, concerns a staircase. The Bullitt Center, an office building in Seattle designed by the Miller Hull Partnership, has been both excoriated for its awkward solar roof and celebrated as an example of the "Living Building Challenge": a set of imperatives for design and construction focused on a principle of carbon negativity; that is, on using buildings to produce renewable energy rather than burn fossil fuels. One way the designers sought to reduce the building's energy load was through the specification of what they called an "irresistible staircase," a lush wooden arrangement placed "right at the front entrance." The elevators are tucked in behind, available to those who need them but harder to access. "This stairway has near-magical powers: people can't seem to resist going up." Per the building's website, "the irresistible stair helps the Bullitt Center conserve energy and encourages the tenants to maintain a healthy lifestyle."[7] Thus, an imperative to make climate-sensitive habits irresistible.

6 Chun, "On Hypo-real Models," 702.
7 Bullitt Center website, http://www.bullittcenter.org/building/building-features/active-design/. On the Living Building Challenge, see Living Future website, https://living-future.org/. Both accessed 12 January 2018.

It is, no doubt, too simple a political program to imagine that new and exhilarating architectural interventions can transform the carbon economy. It is also too simple to rely on individual predilections to aggregate towards a global sociopolitical shift that embraces carbon negativity. Yet, the conditioned interior and the staircase become sociopolitical objects available for manipulation on these terms. They are cultural objects that not only propose to generate new desires, but that also open up new spaces of contestation, available for elaboration as a different kind of lived environment in the future.

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Britain and the British Empire, 1850–1960 (2018). She edited *Powering Up Canada: A History of Fuel, Power, and Energy from 1600* (McGill-Queen's University Press), and published *Canada's Rural Majority, 1870–1940: Households, Environments, Economies* (University of Toronto Press), both in 2016.

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This volume of *Perspectives* offers case studies of energy transitions within everyday environments over the last two centuries, from Europe to South Asia, to North and Latin America. Together, the contributions in this issue address the spatial, material, and social dimensions of energy transitions and foreground energy users as meaningful agents of change. But energy transitions have typically proved to be a slow and uneven process, often fraught with contention, and there is still much to learn about how "energyscapes" are politicized and culturally nuanced. This volume proposes that an understanding of domestic energy transitions of the past will better equip us to navigate the uncertainties of a lower-carbon future.

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