CHAPTER 8

Conclusion

This final chapter discusses the policy insights and implications derived from the Energy Atlas and the research projects it has enabled, as well as directions for future research that are supportive of a just energy transition. The Energy Atlas was created in response to the urgent need for cities to curb their consumption of energy and GHG emissions to achieve greater sustainability, and, increasingly, to become more resilient in the face of climate change impacts. At the same time, the transformation of the energy system and climate adaptation must also be managed in such a way as to increase energy equity and democracy, so that everyone is able to thrive.

Supporting Local Government Progress on the Energy Transition

Local governments have been at the forefront of policy implementation in the realm of energy use reduction, climate mitigation, and adaptation. Increasingly, there is a need for quantitative analyses, including greenhouse gas emissions inventories, depictions of business as usual, measurement and documentation of energy use reductions, commercial building energy disclosures, etc., to support policy development and implementation. This has put pressure on localities to find sufficiently granular data. Providing that data is service that the Atlas is uniquely
qualified to deliver. Whereas the state of California restricts the provision of energy data to local governments to the zip code level only, the Atlas provides much-needed data by a number of relevant building and sociodemographic attributes, thereby supporting policy implementation and quantitative analyses.

**Regulatory Impediments**

The Energy Atlas demonstrates that in the world of big data, information—even information essential for the pursuit of the public good—can be scarce. Electricity and natural gas billing data can make possible the tracing and quantification of energy flows, either fossil fuel-based or renewable. This is valuable information; all sources of energy have different environmental impacts and social tradeoffs: combusting fossil fuels creates greenhouse gas emissions and dangerous co-pollutants that are now found in the air, in soil, in water, and in the bodies of nearly all living beings, both animal and human. Sun and wind technologies, while vastly more benign by comparison, still depend on rare Earth minerals that are often mined in places with weak environmental protections. They are also—especially in the case of solar—space intensive. Wind generation causes bird deaths and noise. No energy technologies are impact free, but renewables create fewer toxic byproducts, and fewer GHGs. Thus understanding the consumption of energy—quantities, types, and demands—can help better shape the direction of public policy. Information about building energy use, coupled with additional data on material flows, life cycle costs, and social life cycle analysis can yield insights into the tradeoffs between various energy system investments and transformation pathways. It can also help connect issues such as affluence and consumption levels to Earth systems impacts, such as those of rare Earth mineral extraction for smart systems, air pollution and GHG emissions impacts of fossil fuel energy, and more. The Energy Atlas, we hope, provides an additional set of empirical data to help understand how cities work and their impacts on both people and planetary resources.

Yet, at the same time, the utilities’ grip on account-level energy data creates substantial obstacles to shifting toward a more benign energy regime. Relatively little is known about patterns of energy consumption, such as the relationships between consumption and urban morphology, the built environment, income, and sociodemographic factors. Furthermore, the effects of regulation are poorly understood. Though California
state policy calls for the expansion of renewable generation and better building performance, the data needed for the successful implementation of the policies pursuant to those goals is currently inaccessible.

Our efforts to provide necessary information in this complex and interconnected realm have been impeded at every step. Resistance to our efforts is due primarily to a state regulatory regime that is seemingly ignorant of the need for actual ground-up data, and that regime’s relationship with the state’s utilities. The regulatory regime is made up of state agencies, legislation, rules and regulations, and interactions between the regulated industries and the public. The current system is mostly a product of the back-and-forth between regulatory agencies, including the CPUC and others, and the utilities—with continued, but minor, input from the state legislature and the public. The long-standing relationships with the utilities—nearly a century of collaboration to establish the current system, as agonistic as it has been at times—make it difficult for CPUC to radically alter its rules governing the sharing of and access to utility data for “outsiders” to use (including local governments, other agencies in state government, academia, or other stakeholders). As of this writing, there is no indication that the CPUC or state legislature is willing to challenge the idea that the data utilities collect in the course of their operations is proprietary and subject to strict rules relating to its access and use.

Although granular building energy data was made available to universities through an administrative judge’s ruling in 2014, this process was highly contested and the outcome of a particular moment in time, as well as leadership by the Jerry Brown administration. After the decision there was a loss of momentum; the EDAC process did not yield a clearly defined set of rules for the fulfillment of data requests. Instead, utilities fulfill university data requests according to their own criteria which are not subject regulatory oversight. Our research has suffered from the utilities’ capriciousness, as they can choose to deny a data request if the project does not have an identifiable funding source, if they consider the study’s geographical area too large, or if they determine that the cost to produce the data is too high. Each utility can also require its own data security reviews, even if the requester has already passed a security review for another similar utility, and so forth. These interactions are time consuming and satisfying the conditions set by the utilities
may cause projects to stretch beyond their funding windows, potentially causing researchers to lose a grant or to be unable to fulfill their deliverables.

Any changes to the State’s utility data privacy rules that might be warranted based on the experiences of universities requesting data from utilities would entail a highly complex legal procedure, and require policymakers at the top to initiate it. It is not at all obvious how university researchers could set such changes in motion. After the departure of Governor Brown, the interest and commitment to greater data transparency seems to have waned; other issues have taken the forefront, including now, as of this writing, the Coronavirus pandemic, and just recently, the imminent bankruptcy of PG&E.

And yet, the regulatory and fiscal requirements to which local governments are subject have not changed. Local governments are increasingly desperate to accurately report their GHG emissions under mandates to do so, and must rely on aggregated data from utilities. This data has not been subjected to third-party review or verification, and is simply too aggregated to be much use for GHG emissions accounting. State agencies or other third parties do not have the capacity and/or authority to verify the accuracy of utility data, and universities remain the only parties who can request address-level billing data and extract meaningful information from it. A data-driven approach requires information about which sectors to target with what interventions. Without this, the goal of cutting building energy by half, mandated by state law, will remain a chimera, an unrealizable dream. In the absence of better data, local governments will inevitably resort to using extrapolations from aggregated data, modeling potential savings, and claiming success without ground truthing or validation. It doesn’t have to be this way. The Energy Atlas demonstrates that it is possible to take utility billing data and extract valuable insights from it, even while complying with current privacy rules. And we anticipate that one day, the weaponized version of “privacy” advanced by the utilities will lose to compelling public interest.

**Insights from Data-Driven Research**

Despite attempts to constrain the project, the back-end data of the Energy Atlas has allowed researchers to ask questions about the energy system and dynamics of energy consumption heretofore rarely addressed.
Most energy data have been used to estimate possible savings through various mechanisms, such as energy efficiency investments, or pricing, but issues of equity impact have been of less prominent concern. Having the ability to probe data with the addition of place-specific layers (our thick description attributes), creates the opportunities to ask new questions and develop important findings.

**Time-of-Use Pricing**

The state and utilities hope to reduce energy use at peak times by shifting it to other times of the day via time-of-use pricing. Time-of-use pricing is intended to reduce the need for ramping up inefficient, gas fired “peaker” power plants. These plants are currently needed because of the steep changes in demand between mid-day, with high levels of solar generation, and the early evening hours, when solar generation drops off concurrent with increasing demand by households (this is known as the “Duck Curve”). However, important energy justice issues must be evaluated and addressed as part of this implementation of time-of-use rate schedules. To what extent do households, especially in under-resourced communities, have the capacity to shift their loads? How will this impact household electricity bills? And, more broadly, how much energy is being used per capita in under-resourced households, and how does this compare to wealthier communities? Should load shifting requirements apply equally to all households? Moreover, what are the trade-offs between natural gas peaker power plants and the installation of batteries for the storage of surplus renewable solar electricity generated during the day, to be discharged during times of peak demand? These cost/benefit, environmental impact and generation vs demand studies seem to be missing. Yet state regulators have continued to approve new gas-fired peaker power plants while hoping to curb demand through time-of-use pricing.

The implementation of time-of-use tariffs involves charging higher rates at peak hours in order to reduce energy use and shift it to earlier or later times of the day, and has potential significant disproportional equity impacts. The least affluent have fewer options for shifting their energy use, such as the purchasing programmable appliances or installing energy storage. Aside from cost considerations, they are also often renters, using equipment provided by landlords, which may or may not be energy efficient. Considering the thermal characteristics of their buildings, their lack of access to distributed renewable energy resources, and their sensitivity
to energy price increases, lower income communities are more likely than relatively affluent communities to be severely impacted by time-of-use pricing. Their appliances, as we have observed in our community-based research, are much older, and their housing stock is often in poorer condition. Higher peak use prices will mean difficult choices for these communities. Households lucky enough to have air conditioning (and these are often inefficient window units) will have to decide whether to turn it on upon coming home from work or school, suffer in the heat, have very high electricity bills, or perhaps find a local air-conditioned space, like a mall or library. It is important to remember that many under-resourced households already forgo consumption of energy in order to save on utility bills; are these the families that should now be responsible for solving the “Duck Curve” problem? Time-of-Use pricing shifts the burden to households, in contrast to an aggressive mandate for battery storage. It is possible to imagine an alternative where utilities prioritize battery storage to avoid TOU charges for under-resourced neighborhoods, but this would require a fundamental shift in utility business model.

**Interconnection of Distributed Generation**

To mitigate potential detrimental consequences of distributed solar generation on electric grid operations, California utilities can impose limits on the size of solar generation capacity, as well as the numbers of installations on a circuit (Rule 21), per the Public Utilities Commission. By coupling data on solar rooftop potential, consumption, income characteristics, and grid information, we found that under-resourced communities may potentially be disproportionately impacted by these interconnect policies.

In nearly 20% of communities in Los Angeles County, current interconnection policies reduce the potential of net rooftop solar generation. This is due to limits on the size of arrays that can be installed. Utilities limit the size of the photovoltaic arrays so that they meet 150% of historical consumption of the building on which they are installed, as they are obliged to pay a feed in tariff for the power produced by rooftop systems, and do not wish to undermine their own power purchases by having their customers becoming distributed power providers. Urban rooftop capacity might generate more than is utilized by the building currently, but the
potential of such installations to contribute to energy supply is limited due to concern about grid capacity and utility power purchase preferences.

We found that under-resourced communities in Los Angeles generally have greater potential to contribute peak solar generation exports to the electric grid, along with greater excess capacity in local circuits to accept solar from sources other than rooftops (Porse et al. 2020). This means that solar capacity potential is underutilized in situ, pushing purchases of solar to off-site solar arrays, taking up lands that could be used for other purposes. Our findings imply that current interconnection rules aren’t consonant with the goal of a 100% renewable transition; utility interconnection policies forestall maximum generation in the urbanized region, and foreclose on maximum solar generation from rooftops due to inadequate grid configurations. These findings are important, as they suggest how states can develop policy instruments and interconnection rules to increase solar generation in the existing built environment, mitigating possible environmental impact of extensive solar power plants outside of the urban areas.

**Building Energy Use**

Comparative analyses using the Atlas data have also revealed substantial shortcomings in California’s attempts to reduce building energy use. Beginning in 1978, the state developed building energy codes to make buildings more energy efficient. These codes have been revised regularly over time, reflecting new building technologies and materials. We found that despite increasingly stringent building codes, energy use per capita has been rising over time, driven by the construction of larger and larger homes. This building trend significantly undermines the state’s sustainability regulations and goals relating to energy use. Our analysis revealed that historical energy savings within Los Angeles County, attributable to state-mandated building codes, could have been equivalently achieved by constraining growth in the size of new homes. Put another way, the growth in home size reduced the potential energy savings from building codes by more than half. This is a classic illustration of the Jevons Paradox (Sorrell 2009) which seems entirely unknown to energy policymakers.

Nineteenth-century economist William Stanley Jevons observed that increasing the efficiencies of coal burning machines such as locomotives resulted in more of them being built and used, thus increasing the total consumption of energy. This is the case in California, where the
actual amount of consumption is not the subject of regulation. What is regulated instead is the efficiency of consumption. The promulgation of mere efficiency measures like insulation and double-paned windows, without caps or goals for absolute energy use reductions, means that buildings can become more efficient per square foot while total energy use keeps increasing. Such trends raise fundamental ethical questions. We must consider: how much energy is sufficient for a decent life? Is there a level of consumption above which the externalities of consumption, such as greenhouse gas emissions from peaker power plants or natural gas appliances, and the embedded GHGs in materials required to build new construction, outweigh the benefits of those that enjoy them (Fournier et al. 2020).

In addition to the effects of increasing building size and efficiency on total energy consumption, we have also found that energy efficiency incentives (for example, utility rebates for efficient washing machines or home weatherization) are disproportionately taken up by affluent residents who live in newer, more energy efficient homes (per square foot). This cohort can afford to shoulder the cost of the upgrades or new devices and receive partial repayment over time, while the less wealthy, in most cases, cannot (Chuang et al. 2018). It is important to realize that energy efficiency measures merely serve to modify existing conditions, but do not take into consideration structural circumstances that drive energy use, such as the power grid, grid supplier, prices charged, neighborhood context, weather, the proliferation of electronic appliances, and the building itself (Lutzenhiser 2014). Additionally, energy efficiency incentives of the type discussed here assume that individuals privilege energy savings above all else. Such programs implicitly assume that people prioritize financial savings that result from greater efficiencies. Generally speaking, such programs do not recognize that people have many household priorities, including, for example, caring for the sick who may need very warm, or cold environments, or other factors.

Another important factor to consider in building energy use is the impact of anticipated increased heat days and higher temperatures. Southern California is anticipated to experience 1–4 °C in the region, resulting in higher summertime peak electricity demand. With the data from the Energy Atlas, we were able to ascertain what the possible impacts increased heat load would have on the grid. Since there may be up to 1 million additional persons living in parts of the Los Angeles region that will be experiencing the hottest days, according to state population
projections, understanding the possible risk to those populations is important. We estimated that generators, substations, and transmission lines could lose up to 20% of safe operating capacities, as discussed in the case study chapter, and that 4–32% of additional capacity, distributed energy resources, and/or peak load shifting would be necessary by 2060 (Burillo et al. 2019).

By utilizing consumption data from the Atlas for the regions most susceptible to extreme higher temperatures, matched to the grid network generation capacity and housing types, such projections are possible—and are empirically based. The work shows the importance of Atlas type data in planning where future urban growth may put people at greater heat risk. In Los Angeles County, temperature increases will vary significantly from the coast to the high desert, reflecting the regional climate’s heterogeneity. Energy system impacts analysis should be used to guide future land use planning and where urban growth should be minimized. The analysis further showed, based on existing energy use, that common wall buildings—such as apartments or row houses—are less energy intensive than isolated single-family dwellings. This too is an important finding for planning into the future with the likelihood of more and higher heat days.

**Summary**

California has adopted aggressive electric utility renewable portfolio requirements, GHG emissions reductions targets, building energy performance standards, and other measures intended to reduce GHG emissions and energy consumption. However, the fact is that existing buildings, their energy use and their users, remain largely mysterious. They are the objects of modeling exercises and suppositions that are based on rarely examined assumptions, yielding policy mandates that are impossible to implement or evaluate. State energy policy is a kind of house of mirrors; to find our way forward we glance carefully at highly distorted images of empirical reality, wandering at times indeterminately and occasionally bumping into obstacles.

Current policies emerge from epistemologies of knowledge based, in part, on the belief that increasing the efficiency of end uses of energy will lead to energy savings—a belief which is supported by some modeled and experimental evidence. While an exhaustive description of these epistemologies (and the beliefs that undergird them) is beyond the scope of this book, it is important to note that the pursuit of efficiency is at the
core of the policy tool kit that is becoming universalized as a set of “best practices.” This tool kit is being adopted by localities and states across the globe that aspire to carbon neutrality. The creators of this tool kit evince a kind of Promethean techno-utopianism which fails to account for the life cycle impacts of technological fixes, such as smart meters and controllers, and are mostly satisfied with simplistic assumptions about individuals being essentially utilitarian or “economically rational.” Calculations of savings are uniformly modeled, reflecting assumptions about efficiency and that savings can be compared across types, technologies, and implementation.

We have argued that granular building energy data—thickly contextualized—is indispensable to a parsimonious and just energy transition away from fossil energy. We are in an era of feverish measurement and quantification, one which seems qualitatively and ideologically distinct from the past, one in which we discuss the inevitability of “smart” cities, “networked” cities, “sensored” cities. These terms imply the integration of information gathering into the fiber/infrastructure of the city itself, measuring and gathering information second by second, minute by minute. More and newer technology, so we are told, will solve previously intractable problems: smart roadways and distributed traffic monitoring systems will decrease congestion, lowering emissions, and supporting thriving neighborhoods. Verizon, for example, is marketing a new smart approach to urban infrastructure, offering cities sensor technology that they can use to more efficiently direct people to empty parking spots by enabling drivers to use their phones to access the information. The smart city evangelists, however, fail to mention or account for the many tons of GHG emissions the new technologies and their deployment will create, along with the rare Earth minerals and other life cycle costs, and the energy costs of collecting, transmitting, and storing the data. Theirs is a truncated view of sustainability which does not adequately address the climate impacts of their approach. They seem to exist independent of their materiality.

The technologies in which smart city technophiles place their faith are essentially one-offs, developed for specific applications (like the management of parking) that are being commodified by a handful of firms—Siemens, AECOM, ABB—as part of competing data collection programs, dashboard, sensors, and implementation strategies. The data collection and analysis platforms marketed by these firms and others are
not alternatives to an integrated, holistic, and interactive set of strategies for dealing with urban sustainability issues and climate change. The creators and boosters of such technology are, at best, agnostic about the underlying causes of environmental problems, and have a tendency to reduce them to engineering problems. This kind of strictly technological approach falls short because it does not involve understanding of city specificities and possibilities inherent in a particular place. Cities are different, conditions will always vary, but locally appropriate problem-solving and solutions are potentially foreclosed upon by “sustainability experts” who wield one-size-fits-all metrics and models. Taking local variation into account means—for example—understanding the potential for local energy generation, and what measures might improve building energy performance, such as openable windows that take advantage of cooling breezes. Instead, technophilic solutions tend toward hermetically sealed buildings that control their internal temperatures automatically, “efficiently,” and are nearly identical to all other smart buildings, even those in very different climates. Their construction is not accompanied by an accounting of the life cycle costs or the impacts of their sensor and control systems, nor is it informed by notions of human comfort outside of the set temperatures included in the building’s control software. These totalizing technical solutions flatten geographies of difference and suppress local potentialities.

The Energy Atlas serves as a window, allowing us to see and appreciate the importance of granular accounting of energy use embedded in the context in which that energy use occurs: the age and size of buildings, the sociodemographic characteristics of inhabitants, weather, urban morphology, and more. From a lens of “thick description” that couples building energy use with urban history (such as patterns of urban development and housing types over time), sociological characteristics (income, ethnicity, renter/owner), policy mandates (Title 24 building standards, renewable portfolios, building energy use reduction), technologies (smart meters, photovoltaics, battery storage, inverters), such data can enable a thicker reading of the urban landscape from an energy and infrastructure perspective. Pursuing urban sustainability requires addressing energy use by cities, and developing analytical methods that can assess patterns and relationships that might lead to the prevailing energy use.

Only with a fine-toothed approach can we begin to “understand” building energy use and the potential for change. The Energy Atlas creates an opening for thinking about the existing built environment and what
that means for sustainability. If the goal is to create more sustainable cities, and to mitigate climate change, buildings, and urban morphology become a critical part of the agenda. The ubiquitous lack of transparency about building energy use needs to be addressed. Without granular data, successful mitigation of the most intensive energy users in cities will be hit and miss, wasteful and will potentially lead to greater energy inequality.

Finally, building energy use is nested in a set of larger questions about the energy and the sustainability future of urban areas, how they are built, rebuilt, and powered. If resources like sand, lithium, and rare Earth minerals, are becoming scarcer, and the energy required for mining, processing, manufacturing, and transportation to construct and maintain the urban environment is taken into account, it becomes increasingly obvious that our current approach to the built environment cannot be sustained. There needs to be a serious reconsideration of the value of the existing stock of buildings and infrastructure. These are sunken/fixed Earth materials whose extraction, processing, transportation, and transformation into urban morphology has produced greenhouse gases and untold amounts of pollution. They are also materials that may not be replaceable at as high a quality or low a cost.

We should begin to look at the entire urban fabric as representing embedded energy and materials and to treat it as an investment of expended GHGs and stocks of Earth materials. It therefore needs to be thought of and treated as durable and lasting, if reconfigurable. New large-scale construction that replaces the old simply increases the burden of GHGs and impacts Earth resources. Existing building stocks can be used more effectively and efficiently. Densities need to be increased in both new development and in the existing built environment. Increasing density makes better use of the existing water, sewer, and other fixed infrastructures in areas already built up, and any urban areas should maximize solar generation by utilizing all available rooftops and open built spaces. The generation should be routinely coupled with different scaled storage technologies that would be available for quick peak time demand, to longer consistent demand. And all of this intensification of use should be accompanied by building energy data to determine how buildings are performing and to make the buildings perform better over the long term. The understanding of planetary limits and the ways in which cities must start to think differently changes how energy efficiency and renewables are integrated into the existing urban fabric. If buildings are expected to endure 100 or 200 years, what retrofits make sense? If we are indeed to
reduce GHGs and pollution emitted from fossil energy, how do we integrate renewables in the built environment, and perhaps more importantly, how do we configure daily life to use less energy overall? These are the questions of the day. Hoarding building energy data to protect the status quo will not get us there. Rather, understanding building energy use and its context through thick description mapping is a foundational step to launch into these larger and connected issues facing us today.

The UCLA Energy Atlas provides an important window in constructing a different energy future that is based on data, data that reflects people, place, and buildings. Data constructed to help understand the condition of the most disadvantaged in order to be able to create an equitable energy transition. It enables understanding of context and how regulations shape energy type and provision. It helps think through how and which changes need to take place to ensure a just energy transition for the future.

**BIBLIOGRAPHY**

Burillo, D., Chester, M. V., Pincetl, S., & Fournier, E. (2019). Electricity Infrastructure Vulnerabilities Due to Long-Term Growth and Extreme Heat from Climate Change in Los Angeles County. *Energy Policy, 128*, 943–953.

Chuang, Y., Delmas, M., Federico, F., Fournier, F., & Pincetl, P. (2018). *UCLA AEC Project, Energy Efficiency Program Effectiveness Analysis* (Final Report). https://ucla.app.box.com/s/xp0dkev4qiu9l3qyzokmbvm5mg2ms8d6.

Fournier, E., Federico, F., Porse, E., & Pincetl, S. (2019). Effects of Building Size Growth on Residential Energy Efficiency and Conservation in California. *Applied Energy*. https://doi.org/10.1016/j.apenergy.2019.02.072.

Fournier, E. D., Cudd, R., Federico, F., & Pincetl, S. (2020). On Energy Sufficiency and the Need for New Policies to Combat Growing Inequities in the Residential Energy Sector. *Elem Sci Anth, 8*(1).

Lutzenhiser, L. (2014). Through the Energy-Efficiency Looking Glass. *Energy Research and Social Science., 1*, 141–151.

Porse, E., Fournier, E. D., Cheng, D., Hirashiki, C., Gustafson, H., Federico, F., et al. (2020). Net Solar Generation Potential from Urban Rooftops in Los Angeles. *Energy Policy*. https://doi.org/10.1016/j.enpol.2020.111461.

Sorrell, S. (2009). Jevons’ Paradox Revisited: The Evidence for Backfire from Improved Energy Efficiency. *Energy Policy, 37*(4), 1456–1469.