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# Thinking critically about smart city experimentation

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**Abstract**
The proliferation of smart technologies, big data, and analytics is being increasingly used to address urban socio-environmental problems such as climate change mitigation and carbon control. Electricity systems in particular are being reconfigured with smart technologies to help integrate renewable generation, enhance energy efficiency, implement new forms of pricing, increase control and automation, and improve reliability. Many of these interventions are experimental, requiring real-world testing before wider diffusion. This testing often takes place in "urban living labs," integrating urban residents as key actors in experimentation with goals for broader sustainability transitions. In this paper, I investigate one such urban living lab focused on smart grid research and demonstration in a residential neighborhood in Austin, Texas. I develop a framework based in governmentality studies to critically interrogate urban experimentation. Findings suggest that the focus of experimentation devolves urban imperatives into individual responsibilities for socio-environmental change. Managing carbon emissions through energy efficiency, renewable energy, and conservation is promoted as a form of self-management, wherein households reconfigure everyday activities and/or adopt new technologies. At the same, sociotechnical interventions are shaped by technology companies, researchers, and policy-makers marking a central feature of contemporary urban entrepreneurialism. This skews the potential of active co-production, and instead relies on the delegation of responsibility for action to a constrained assemblage of smart technologies and smart users.

Keywords: urban living lab, smart grid, governmentality, experimentation, entrepreneurialism

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## 1. Introduction

Cities across the planet have increasingly experimented with various socio-technical and policy interventions in order to respond to calls for sustainability and climate mitigation (Castán Broto & Bulkeley, 2013a). New technological interventions ranging from smart homes to urban control rooms have been marketed as solutions to help address these environmental challenges. More broadly, "smart cities" technologies have been positioned as opportunities to improve urban environments and stimulate economic development (Höjer & Wangel, 2015; IBM, 2015).

However, these overlapping urban imperatives do not come without problematics and complications. As numerous scholars have noted, the entrepreneurial, economic-growth agendas of sustainable and smart cities approaches often undercut the ecological promises of urban experiments resulting in a gap between visions and reality (Buck & While, 2015; Colding & Barthel, 2017; Cugurullo, 2017; Rosol, Béal, & Mössner, 2017). A parallel area of critical scholarship has shown how climate change and sustainability interventions, especially facilitated by new smart technologies, tends to reduce questions of responsibility for solving environmental problems down to individual's choices and behaviors (Brand, 2007; Braun, 2014; Gabrys, 2014; Moloney & Strengers, 2014; Peattie, 2010; Soneryd & Uggla, 2015; Vanolo, 2013; Wakefield & Braun, 2014). This paper contributes to these debates by arguing for closer attention to the connections between these two literatures—entrepreneurialism and responsibilization, respectively—in order to critically study smart and sustainable city experiments. My central argument is three-fold: (1) urban experimentation offers opportunities for entrepreneurial forms of governance, at the scale of the individual and the city, to take hold through smart and sustainable cities agendas; (2) the transformative potential of smart and sustainable cities agendas is undercut by a focus on governing individual consumption instead of systemic change; and (3) these techno-fix agendas often produce inequities that are overshadowed in public discourse by the spectacle of sustainability and smartness.

This argument is supported through a case study of the development of a smart and sustainable neighborhood in Austin, Texas. I frame this development project in Austin's Mueller neighborhood as a particular form of urban experimentation, what scholars have called "urban living laboratories" (Bulkeley, Castan Broto, & Maassen, 2013; Caprotti & Cowley, 2016; Cardullo, Kitchin, & Di Feliciantonio, 2017; Evans, Jones, Karvonen, Millard, & Wendler, 2015; Evans, Karvonen, & Raven, 2016; Karvonen & van Heur, 2014; Voytenko, McCormick, Evans, & Schliwa, 2016). The concept behind this urban living lab (ULL) was the integration of smart home and smart grid technologies to test their performance (defined variously as efficiency, economic benefits, or lower environmental impacts), and to understand how households utilized these technologies and responded to a variety of experimental interventions.

"Smart grid" is a broad descriptor for information and communication technologies integrated into the electric grid (from generation to transmission and distribution to the end-use consumption). These technologies offer greater control, two-way communication, and more frequent data collection promising a variety of benefits including better grid reliability and resiliency, and potentially, a variety of end-user (or household) benefits (Buchholz & Styczynski, 2014). Similarly, smart homes is a descriptor for a variety of household technologies that include remote electronic control and management of smart appliances (ranging from refrigerators to washing machines) that take advantage of real-time data collection and communication (Balta-Ozkan, Davidson, Bicket, & Whitmarsh, 2013). Much like many cases of urban experimentation (James Evans & Karvonen, 2014; Moloney & Horne, 2015; Voytenko et al., 2016), Austin's ULL focused on the promises of smart technologies for realizing low-carbon transitions and sustainable water management. The ULL project was a collaboration between the

City of Austin, a large development company, a non-profit research organization, a large non-profit environmental organization, and the University of Texas (UT) with goals to test and demonstrate smart grid infrastructure coupled with smart home technologies and renewable energy generation in "real-world" settings. While the promises of this mode of urban experimentation are considerable, the politics shaping Austin's ULL resulted in a project fueled by interests in economic growth over radical sustainability.

The data used to construct this case study was collected between March 2014 and May 2016. Primary sources of data included 26 semi-structured, in-depth interviews with government officials, researchers, and representatives of non-profit groups and development companies involved in the project, and observation at various technology showcases, public meetings, and conferences in Austin. Secondary data, including plans and policy documents, news and media, and archival materials, were analyzed through content and discourse analysis. All sources of data were inductively coded to produce themes, then interpreted with theoretical concepts based in governmentality studies and urban governance literatures. While case-studies have intrinsic limitations, the purpose of this paper is to elaborate a conceptual framework that can be expanded, refuted, or supported in further studies of sustainable and smart urban development. This single case study is representative of a broader, diverse and situated phenomenon at the convergence of smart and sustainable cities agendas that I utilize to provide a way of "thinking critically" about urban experimentation.

In the next section, I lay out the theoretical framing for "thinking critically" about urban experimentation which builds from Foucauldian governmentality theory together with geographers work on neoliberal urban governance. I provide a critical view of urban experimentation in order to reclaim a socially just and environmentally sustainable formulation. Then, I turn to the case of Austin, Texas, and show how these logics manifest in a smart and sustainable city project. The case shows how local and state government strategies for economic growth leverage urban experiments to attract technology firms and capital while simultaneously enacting a version of entrepreneurial urbanism that poses as panacea for social and ecological problems. At the same time, the case shows how urban experiments involve socio-technical changes that co-produce norms of conduct for resource consumption enrolled in larger shifts in urban governance, but do not evolve from input from the community itself. In the conclusion, I further elaborate on the possibilities and pitfalls of smart and sustainable urban experimentation for more ecologically and socially just futures.

## 2. "Thinking critically" about urban experiments

As cities seek to test-out new smart city and sustainability policies, scholars have conceptualized this phenomenon as a mode of governance, a mode of knowledge production and learning, and a form of strategic urban development broadly called *urban experimentation* (Bulkeley, Castán Broto, & Edwards, 2014; Caprotti & Cowley, 2016; Evans et al., 2016; Evans, 2016). The logic of experimentation is, quite simply put, to test-out new urban technologies (including smart grids

and autonomous vehicles), policies, and partnerships between industry, government, non-profits, and universities (Castán Broto & Bulkeley, 2013a; Karvonen & van Heur, 2014; A. McLean, Bulkeley, & Crang, 2015). The potential of experimentation is that it will enable learning from interventions in specific urban contexts that enable control and observation of changes over time (Evans, 2011; Evans & Karvonen, 2014). Knowledge production and diffusion regarding innovative urban policies and accompanying economic stimulus is a central motivation.

While urban experiments are incremental and fragmented projects (although often framed by holistic master plans that suggest controlled and systematic development), they shape local policy and the urban environment itself (Caprotti & Cowley, 2016; Cugurullo, 2017; Joshua Evans, 2016). Experiments, more generally, are "purposive and strategic but explicitly seek to capture new forms of learning or experience... they are interventions to try out new ideas and methods in the context of future uncertainties serving to understand how interventions work in practice, in new contexts where they are thought of as innovative" (Castán Broto & Bulkeley, 2013: 93). They offer the "means through which discourses and visions concerning the future of cities are rendered practical, and governable" (Bulkeley and Castan Broto, 2013b: 367). Experiments, thus, are also public engagements that aim to persuade audiences, in this case, as to how effective or worthwhile a smart and sustainable city agenda may be. Following this argument, urban experiments are essential elements in constructing political power behind smart and sustainable city projects. While powerful opportunities to introduce alternative logics and models for sustainable urban development, smart and sustainable city experiments too often focus on economic growth and individual responsibility, benefitting well-off households and technology companies that seek profits without concern for social outcomes.

Adding to this existing literature on urban experimentation, this paper presents a critical framework for analyzing urban experiments through a Foucauldian lens of governmentality. The framework asks three questions: (1) What are the dominant motivations for urban experimentation and who stands to benefit? (2) How does urban experimentation shape approaches to sustainability and justice? (3) How do urban experiments engage communities/citizens, and with what implications?

These three questions offer an opportunity for critique and reflexivity in urban experimentation. As experiments grow as a defining feature of urban (environmental) governance, they translate ideas and visions into reality through projects and policies that shape how urban development is conducted. Under neoliberal regimes of urban governance, however, ideas of sustainability become associated with technological fixes often in the form of calculative devices for managing individual resource consumption (such as real-time energy and water monitoring, carbon audits, etc.) that promise to facilitate ecologically sound urban development (Braun, 2014). Furthermore, the power of experimentation comes not only from the experience of a single place. Experiments shape the perception of possible urban futures and future action. Experiments can thus be understood as places wherein knowledge claims are deemed credible and authoritative, having broader impacts on agendas for governing cities.

This framework employs a governmentality lens to answer the three questions posed above, responding to three interconnected elements of governmentality analyses: (1) rationalities, (2) techniques, and (3) subjectivities. Governmental rationalities are systems of thinking about the practice of government (who can govern, what governing itself is, and what or who is governed) as a way of making that activity itself practicable (Gordon, 1991; Lemke, 2001, 2002). Rationalities are formed around problematizations. Foucault was specifically concerned with the problematization of population, for example, and how population created a political necessity and possibility for governmental thought: how to manage and govern populations within a certain territory (Foucault, 2009). In the case of smart and sustainable city experimentation, the city and citizens are problematized as unsustainable, inefficient, and in need of economic development. Here, a critical approach asks: What are the dominant motivations for urban experimentation and who stands to benefit?

Techniques refer to the "how" of governing. For Foucault, this included disciplinary techniques, "techniques of power," or power/knowledge "designed to observe, monitor, shape and control the behavior of individuals" in a variety of institutions (Foucault, 1977; Gordon, 1991, p. 3). In his later lectures on neoliberalism, Foucault argued that power also operated through forms of "freedom" in neoliberal governmentality that shaped the conduct of individuals through entrepreneurial and competitive mandates (Barry & Osborne, 1996; Foucault, 2010; Rose, 1999). In other words, freedom was conscribed to "self-management" and introduced a new form of "self-regulation" always in relation to a broader set of norms that one either tried to distance themselves from or collapse onto (i.e. self-improvement or responsibility). In smart and sustainable city experimentation, techniques are broad and range from land use planning (Leffers & Ballamingie, 2013) to digital maps that produce urban territories (Luque-Ayala & Neves Maia, 2018) to urban dashboards that position particular (often contestable) metrics as essential monitors of urban sustainability (Kitchin, Lauriault, & McArdle, 2015; Kitchin et al., 2015; Kitchin, Maalsen, & McArdle, 2016). Here, a critical approach asks: How does urban experimentation shape approaches to sustainability and justice?

Subjectivities are central to governmental power. For example, Foucault (2008) worked through the political rationality of liberalism and neoliberalism in his lectures, *The Birth of Biopolitics*, explicating the ways in which neoliberal rationality was entwined with market activities and the proliferation of enterprise into the social body, working on and through a particular subject, *homo economicus.* That is, Foucault's interest in power was related to the ways in which it shaped subjects and "proper" conduct. In smart and sustainable city experimentation, we must question how disciplinary power, norms, and other power/knowledge technologies conscribe subject positions as sustainable or not (Gabrys, 2014; Sadowski & Pasquale, 2015; Vanolo, 2013). Here, a critical approach asks: How do urban experiments engage communities/citizens, and with what implications?

Utilizing this framework, I argue that smart and sustainable urban experiments as currently developed tend to deepen neoliberal regimes of government marked by tenets of entrepreneurialism and responsibilization. This argument is based on critical readings of the

political rationalities of neoliberalism which argue that neoliberalism extends economization into all aspects of life (Brown, 2015). Governmental rationalities are deeply intertwined with the production of subjects. The neoliberal subject, *homo economicus*, is shaped in relation to the "idea and practice of responsibilization—forcing the subject to become a responsible self-investor and self-provider—which reconfigures the correct comportment of the subject from one naturally driven by satisfying interests to one forced to engage in a particular form of self-sustenance that meshes with the morality of the state and the health of the economy" (Brown 2015, 84). In neoliberal versions of urban experimentation, subjectivity is associated with responsibilization for environmental sustainability and economic productivity.

Strategies of neoliberal subjectification are deeply integrated into regimes of urban entrepreneurialism. Urban policy and development in an era marked by a roll-back of state funding has turned towards private capital to fund everyday city services, development projects, and provide "public" goods (Hackworth, 2008; Keil, 2009). Harvey (1989) described this transition from managerialism (under welfare-state conditions) to entrepreneurialism (under neoliberalism) as a defining feature of urban governance. Here, cities have to brand and market their place in order to attract companies, often leading to lob-sided public-private partnerships, and new forms of real estate speculation (Hall & Hubbard, 1996). Cities also utilize development projects to market themselves as sustainable, resilient, or smart in order to further attract investment (Hollands, 2008; Long, 2016; While, Jonas, & Gibbs, 2004) and particular kinds of urban subjects recognized as creative "talent" (Jensen, 2007; H. McLean, 2014). Here the focus of smart and sustainable city experimentation takes on an exclusionary logic, as the city becomes marketed as a place for large technology companies to test their products and services, and as some groups of people are privileged over others. This is precisely why a critical framework is necessary for analyses of urban experimentation: it asks critical questions that open smart and sustainable city experimentation up for critical inquiry and reconceptualization.

The next section works through the case of Austin's urban smart grid experimentation described in the Introduction. I demonstrate how this framework for "thinking critically" about urban experimentation can uncover the neoliberal logics and rationalities of an ostensibly sustainable and socially responsible project. The case illustrates how the focus on economic growth, demonstration of technological efficiency, and individual consumption habits limits the power of experimentation for transformative change.

## 3. Austin's Living Laboratory for Smart Technologies

The transition of urban electricity systems towards more sustainable and resilient forms is a vital ingredient in combating climate change. Urban experiments, and urban living labs (ULLs) in particular, have been positioned to address this challenge, often by utilizing smart technologies including the "smart grid." The smart grid carries with it the promises of decarbonization and increased reliability, economic efficiency and new business models, and the ability to harness innovations such as electric vehicles and energy storage through the integration and application

of information and communications technologies (ICTs). The smart grid is a sociotechnical intervention that includes more than technologies, but also knowledge networks, user practices, and new business models for energy utilities, data analytics, and grid operations (Luque-Ayala, 2014, p. 160). Thus, the smart grid carries opportunities for sociotechnical innovations, new relations of production and consumption, and is a tool for generating greater investment and public acceptance for smart city projects.

Austin's ULL for the smart grid, known locally as the Pecan Street Project (PSP), has its roots in the idea of the "technopolis." The technopolis was developed in the thought of Austin's tech "godfather" George Kozmetsky, who helped develop a University of Texas (UT) startup incubator called the Austin Technology Incubator (ATI) in 1989 (Butler, 2011). ATI was seen as a way to "future proof" Austin, setting it up to be a leader in the high-tech economy (Butler, 2011). ATI has been promoted as an economic engine for the City, propelling startups and spinoff companies while attracting venture capital and talented researchers and workers (Calnan, 2014). Partnering with the ATI, City of Austin, Austin Energy, UT researchers, tech companies, and the Environmental Defense Fund, a non-profit research organization called the Pecan Street Project—later Pecan Street, Inc.—was developed in 2009 to foster, test, and pilot smart grid innovations related to advanced technology, business models, and customer behavior.

The PSP began as conversation about the "electric internet" between some of Austin government elites, including most prominently several former city council members, UT professors, and a previous mayor pro-tem. Initially described as an "energy internet demonstration project," PSP served to test various socio-technical interventions including electric vehicles and distributed solar, smart home technologies, and advanced smart grid infrastructure in real-world settings. The project aimed to engage environmentally concerned and technologically savvy residents of the newly built Mueller neighbourhood (where the PSP is located) with incentives to adopt electric vehicles, solar panels, home energy management systems (HEMS) and numerous other smart technologies, which then allowed Pecan Street to get considerable participation, conduct research and field trials, and gain access to fine-grained data on energy usage of consumers.

The PSP is located in the Mueller neighborhood, itself a private-public redevelopment project that commenced in 2004 on a nearly 700-acre defunct airport base just three miles northeast of downtown Austin and the University of Texas. The "greenfield" type development of Mueller enabled construction of smart grid infrastructure from the ground up, which included the development of Austin Energy's smart grid platform (Carvallo & Cooper, 2015), new green-built homes, and Pecan Street's own information and communications technologies and smart grid network. Coupled with the various industry or federally supplied smart home technologies, the neighborhood became a "testbed" for smart technologies and related platforms (Levenda 2018).

### 3.1. Rationalities and Techniques of Smart Grid Experimentation

ULLs test out visions of urban futures that align various actors through reconfigurations of urban infrastructures (Bulkeley, Castan Broto, & Maassen, 2013), and at the same time, they provide opportunities to address environmental problems with "testable" solutions in particular places (Bulkeley & Castán Broto, 2012; Castán Broto & Bulkeley, 2013a). But what are the dominant motivations for Austin's urban experimentation and who stands to benefit? How does this kind of experimentation shape approaches to sustainability and justice? Austin's Pecan Street Project and Mueller redevelopment highlight two salient points about the role of living labs in neoliberal urban politics: the confluence of entrepreneurial and environmental ideals in shaping urban governance (While, Jonas, & Gibbs, 2010), and secondly, the mobilization of these ideas via channels of "fast policy". In the Mueller neighborhood, demonstration and leadership is centered on the ability to demonstrate a reproducible model, best practices, policy recommendations, or other forms of knowledge that attract attention from other cities and companies. The Mueller neighborhood is, as a representative of the development company explained:

> A model of urban development, that's part of our vision. We actually learned from Stapleton, and other folks are now learning from us. The other thing that this has done for the City of Austin is that it has become a living lab. (Development Company Representative, Interview, November 2015)

Mueller had to push the threshold of what was prescribed for Austin development projects, and by doing so offered defined spaces wherein new city ordinances could be tested for evaluation and possible future use and adoption in the greater Austin area. The public-private partnership documentation – the Master Development Agreement between the City and developer – gave developers freedom to change the urban form to "new urbanist" styles of development. Yet, this sort of development is indicative of the type of "private over public" partnerships that have become commonplace under neoliberal urbanism, benefiting developers and wealthy Austinites over the people most in need of housing (Weber, 2002, 2010). Similarly, these sorts of experimental developments are part and parcel of the acceleration of neoliberal urban policy learning and mobility as cities become more extrospective in search of tools, best practices, reference cases, and knowledge transfer opportunities that will entice private capital (McCann & Ward, 2011; Peck & Theodore, 2015).

The PSP focused on demonstration of smart grid and smart home technologies as a way to meet federal and local smart grid program goals, but also as a way to place Austin as the forefront of high-tech, smart city innovations. As a partner, the Environmental Defense Fund (2014) ardently promoted the project:

> The Mueller neighborhood, the locus of Pecan Street, is a laboratory of ideas and technologies that will move the nation's $1.3 trillion electricity market toward a future in which energy is cheap, abundant and clean. If Pecan Street is successful, every neighborhood in America will look like it in 20 years.

EDF mobilized the notion of the laboratory to position the city as a testbed for learning about sociotechnical innovations that meet the discursive mandate of triple-bottom-line urban sustainability (Davidson, 2010; Gunder & Hillier, 2009). Environmental sustainability is leveraged as a marketable idea, one that enhances Austin's competitive advantage. Entrepreneurial urban strategies and policies have utilized sustainability as a discursive move, often with some positive impacts for carbon reduction, and a central focus in order to secure new spaces for development and to neutralize political opposition (While, Jonas, and Gibbs 2004; Davidson and Gleeson 2014). The so-called "new environmental politics of urban development," makes carbon reduction strategies, like the implementation of smart grid interventions and new infrastructures, key to interurban competition and the practices of local governance and planning (Jonas, Gibbs, and While 2011; While, Jonas, and Gibbs 2010).

Furthermore, Austin's Chamber of Commerce, a board member of Pecan Street, has developed strategies to attract startups with potential to receive venture capital for growing their companies. They aim to attract startups working in the spaces of clean energy, creative industries, digital media, and data management, in line with Austin's (highly uneven) creative culture and high-tech economy (Long, 2010). The Chamber boasts Austin Energy's commitment to renewable power, the Pecan Street's research potential, and ERCOT's willingness to integrate clean energy companies into their electric grid as key factors for attracting energy companies.[1] Similarly, the University of Texas Clean Energy Incubator, the Clean TX cluster development organization, and the already large clean tech industry located in Austin are supportive of the growth of the cluster. These technical and economic considerations are only part of the attraction. As one Chamber of Commerce representative explained:

> Clean energy was supported as a recruitment target starting over 10 years ago, supported by Austin Energy. […] But, we have a very educated population. […] Obviously quality of life too. We're a blue dot in a red state. (Chamber of Commerce Representative, Interview, November 2015)

The convergence of cultural and economic innovation are positioned as central to the growth of Austin's economy. Austin's brand of urban entrepreneurialism leverages clean energy and clean tech, positioning the local economy as supportive of progressive environmental politics.

This context explains the motivations behind Austin's PSP ULL, and highlights the way ULLs are positioned to promote ecological modernization. It also shows the importance of ULLs becoming an exemplary "model" that entrepreneurial city leaders can advertise. As former City Council member and Pecan Street President explained, "We intend to make the Mueller neighborhood an example of what modern neighborhoods can accomplish, with smarter energy management, clean energy generation, and advanced system integration [...] the most self-sufficient and energy efficient neighborhood development in the country" (King, 2009). The focus on demonstration and leadership has garnered attention from other cities around the world

[1] Please see: https://www.austinchamber.com/economic-development/key-industries/clean-energy-power.

looking to understand how to effectively integrate smart technologies. Austin's Mayor Steve Adler remarked in his 2016 State of the City Address that, "Cities from all over our country and the rest of the world send entire delegations here to troop through our offices in hopes of finding the magic formula written on a white board somewhere. These leaders from other cities ask me what makes Austin so special. I tell them about Barton Springs and how our commitment to our environment became perhaps our most important asset." He continued to explain that what makes Austin special is a commitment to innovation: "We have 7 percent of the state's population but 30 percent of the new patents. Austin ranks 8th in the country in venture capital investments. A year ago Forbes put us on a list of five cities poised to be the next Silicon Valley Tech Hub. Whether it's Google's driver-less cars, the Pecan Street Project implementing energy-use technology out at Mueller, or our community's seemingly limitless innovations in the field of breakfast tacos, Austin has become a city where good ideas become real" (Goudreau, 2016). The Mayor's speech centered cultural and economic "innovation" as a primary force behind Austin's growth, and noted the Pecan Street ULL as one exceptional case in order to demonstrate the city's leading position.

Pecan Street has been a vital resource for Austin in this regard, serving as the basis of an "innovation cluster" on smart energy systems (Chamber of Commerce Representative Interview, November 2015). Pecan Street's Dataport offers the world's largest database on customer energy use to university researchers (for free) and technology companies (for a fee). As one Pecan Street representative explained:

> I talk to cities; I talk to for-profit companies. We meet with them and they say, what have you learned, and I'll be happy to tell the for-profit company that is trying to build a product that this is what we've learned, this is what's failed, and this is what's succeeded. [...] We're happy to show off our work […] My job is to make sure we can get as much data as possible to give to people so they can utilize it and learn from it. (Pecan Street representative, Interview, October 2015)

In this way, living labs, such as Pecan Street's smart grid project can be viewed not only as a place for research and learning, but also as a "theatre of proof" (Simakova, 2010; Smith, 2009) for ways of configuring smart technologies in urban space to achieve sustainable, low-carbon outcomes. Akin to contemporary practices of the product "launch" in high-tech industries, the "theatre of proof" is described as a situation where an organization "offers a 'novel' product to 'the market'" (Simakova 2010: 549), and this case that means data about households energy and water consumption, preferences for certain technologies over others, and the efficiency of grid integrated products like electric vehicles and energy storage systems. Here the rationality of experimentation in ULLs is to learn about tech-company-driven agendas for smart technologies, and to gain broader recognition for the city as an innovative space for testing various smart city technologies.

In Austin, for example, having a large public-private redevelopment project provided the opportunity for the PSP to flourish in a community of so-called "early adopters": largely upper-

middle class residents that are motivated to save energy or participate in research (Pecan Street representative, Interview, October 2015). Smart grid experimentation in ULLs certainly might yield worthwhile research on the technical limits of the smart grid (such as studies that find how many electric vehicles can be charging in one location without stressing distribution infrastructure), but this approach contributes to the lock-in of particular pathways for smart infrastructure development without broader consideration of the concerns of citizens or the structural limitations to managing energy consumption and production.

Furthermore, while these forms of experimentation may provide some insight into policy pathways for smart and sustainable infrastructures, it also is dominated by the need to attract private capital. Fitting with the dominant form of neoliberal urban governance, governing through experiment aligns with the entrepreneurial role of local governments (K. Davidson & Gleeson, 2014; Hall & Hubbard, 1996; MacLeod, 2002). As Harvey (1989: 5) argued, with the turn from managerialism to entrepreneurialism in urban governance, "investment increasingly takes the form of a negotiation between international finance capital and local powers doing the best they can to maximize the attractiveness of the local site as a lure for capitalist development." Opening up the city as a test-bed and a demonstration site for new smart technologies provides an opportunity to attract highly mobile capital. However, this may have "splintering" impacts in the city (Graham and Marvin 2001) that create spaces of high-value while simultaneously excluding and marginalizing other spaces and communities. Therefore, attention to the rationalities of experimentation are central to understanding their impacts and to understanding who controls and who benefits from these projects.

### 3.2. Smart Consumers

Within the scholarship on ULLs and sustainability transitions, the conception of governing by experiment has been used in a variety of cases to understand the urban governance of sustainability (Berkhout et al., 2010; Bickerstaff, Hinton, & Bulkeley, 2016; Blok & Tschötschel, 2015; Harriet Bulkeley & Castán Broto, 2012; Harriet Bulkeley, Castán Broto, & Edwards, 2014; Caprotti & Cowley, 2016). In ULLs, citizens often become experimental subjects or research participants, such as in the PSP. People are often made to be the object of engagement – the engaged customer, active participant, technology adopter. But how do experiments such as the PSP engage communities/citizens, and with what implications?

More than technological interventions aimed at increasing renewable integration or grid reliability, smart grid experiments attempt to orchestrate and govern energy demand according to particular political-economic rationalities. Smart grid demonstration projects have increasingly used the vocabulary of customer engagement and empowerment (Gangale, Mengolini, & Onyeji, 2013). The customer moves beyond the role as a passive consumer and becomes an active participant in the electricity grid with new responsibilities, choices, and opportunities (Naus, van Vliet, & Hendriksen, 2015). The growth in attention to demand response, time-of-use pricing, and other "customer side" interventions have been celebrated by utilities and electricity providers as potential opportunities to shave or shift peak demand while increasing customer awareness

and engagement. Yet, these opportunities rely on significant changes in energy consumption activities that have not yet been realized (Hargreaves, Nye, & Burgess, 2013). Underlying much of these programs is a conceptualization of the end-user as a rational economic actor, or what Strengers (2013: 51) calls "resource man" – "a data-driven, information-hungry, technology-savvy home energy manager." These depicted smart end-users are neoliberalized subjects, conscribed by social norms, expected to perform the scripted uses for smart technologies, with the encouragement to act rationally both economically and environmentally.

Tied to the entrepreneurial forms of governance pushed by the policy elite, parallel ideas of entrepreneurialism circulate in discourse to constrain and shape the contours of citizen-consumer subjectivity. In neoliberal urban governance regimes, the emphasis on entrepreneurship shapes expected citizen subject positions. This resonates with Foucault's notion that the role of homo economicus – the consumer subject – is not so much a consumer as a person of "enterprise and production" (Foucault, 2008). Lois McNay (2009: 56) explains how neoliberal governmentality is expressed through the concept of "self as enterprise" where individuals are encouraged to view their lives and identities as an enterprise, "understood as a relation to the self based ultimately on a notion of incontestable economic interest." Foucault's investigation into American neoliberalism explains the proliferation of enterprise, entrepreneurship, and policies empowering individuals into the social fabric, and reveals its central importance as a reinforcement of neoliberal subjectivity. Citizens manage themselves and their households according to the dictates of the economy, maximizing efficiency over satisfying desires or interests. Instead, efficiency and economic production replace other forms of self-interest to become dominant, aligned with social norms.

The promise of smart grid projects like the PSP relies, in one part, on behavioral changes of users. Here, the expectation is that "smart users" become active participants in the smart grid, performing their part as solar pioneers, eco-energy misers, or flexible energy users adjusting consumption to the dynamics of a time-of-use rate structure. In this sense, smart grid experiments "success" presupposes (rational and individual) market actors who manage their everyday practices in a careful, calculative, and reflexive way. But as the experience in some of the households in Austin's smart grid experiment show, people do not necessarily act "rationally." A Pecan Street representative explained this point directly with a story of a multi-family tenant and research participant whose data profile showed his oven was always on:

> The [resident] goes, 'yeah, my oven is on,' and our technician was like, 'no no no, we *show* that your oven is on' and the [resident] says, 'yeah, my oven's on.' And it turns out this guy just left his oven on all the time. [...] We said, it costs a lot of money to you. And the guy had no clue. (Pecan Street Representative, Interview, October 2015).

Similarly, a representative from the Environmental Defense Fund explained that from his research in relation to the smart grid experiment in Austin, people just don't think or care about energy enough to change their behavior or their practices:

> There is a statistic that is widely quoted that people think about their energy bills and electricity six minutes a year. For most people it's not something that you choose to focus on. One barrier for scaling up demand response and smart technology and that sort of thing is just generating interest. [...] Even if they don't think about it that much, they think about ways to save money, if something is a no-brainer, then you make that choice. (EDF Representative, Interview, October 2015)

As energy researchers engage with smart grid users, they often seem to get dismayed by the irrationality of human behavior. As the quote above illustrates, the researchers involved with smart grid experiments understand that end-users don't necessarily think about energy very often, but they still feel they can be persuaded economically. This logic is changing the nature of smart grid implementation. Lessons learned from early studies on energy efficiency impacts of smart meters and in-home displays suggest little evidence of sustained behavior change (Hargreaves, Nye, & Burgess, 2010; Hargreaves et al., 2013). Studies on voluntary demand response and time of use pricing have indicated that these options may work (Dyson, Borgeson, Tabone, & Callaway, 2014; Muratori, Schuelke-Leech, & Rizzoni, 2014), but automating decision-making to maximize energy and economic efficiency now is the dominant trend. As one EDF representative explained:

> Using machines and technology doesn't have the human error element, or the human-interest level, so you have these items programmed to be more efficient, and at scale, that will take a lot of the human element of being more efficient with energy out of the equation. It just makes it easier for humans to act with the environment in mind. (EDF Representative, Interview, October 2015)

While automation may provide energy and cost savings for end-users, it also rationalizes and normalizes the deep integration of smart technologies in everyday life without deliberation over end-users concerns or values (Strengers, 2013). This concretizes a technological fix for the seeming inflexibility of energy demand and the irrationality of human behavior, essentially framing energy problems as purely technical ones. But, these problems are more than technical. Energy demand is structured by the rhythms and patterns of everyday life (Walker, 2014). Consumption is not for the sake of consumption, but rather for aiding in everyday activities shaped by social norms, habits, economic demands, and other conventions (Shove, Pantzar, & Watson, 2012; Shove & Walker, 2014). The limitations of the techno-economic approach exemplified by the forms of experimentation discussed in this paper is that the design and implementation of ULLs –whether for smart grid experiments or other purposes – needs to be questioned along axes of social and political concern. And centrally, it should consider how these technological systems lock-in expectations, or technological scripts (Akrich, 1995; Gjøen & Hård, 2002), that assume particular subject positions and desires without addressing what communities consider important or needed.

## 4. Experimentation, Governance, and Smart Urban Futures

In this paper, I have shown how urban entrepreneurialism and neoliberal governmentality are shaping the design and influencing the proliferation of governance experiments for smart infrastructures in Austin, Texas. I have highlighted how a specific ULL—the Pecan Street smart grid experiment at the Mueller neighborhood—was constructed materially and discursively as a place of demonstration for public approval and a test-bed for smart technologies. The entrepreneurial push to locate such a project in Austin was spurred by the City's legacy as a technopolis—an economic development strategy that aspires to attract high-tech companies and creative class workers through leveraging the University of Texas and other public resources. Although there are certainly positive pathways for urban experimentation, this case has shown that the role of citizens in determining or influencing the pathways to a smart urban future are limited to very narrow realms of participation through consumption, and it has further shown how these projects seem to only apply to a particular segment of the population—"early adopters" and those with enough wealth to afford to live in places like the Mueller neighborhood. As such, this paper demonstrates the need for thinking critically about smart and sustainable city experiments along three dimensions: the motivations of experimentation, how experimentation shapes action for sustainability and justice, and the ways communities and citizens are engaged.

With the ever greater entrenchment of smart technologies in the urban environment, greater amounts of data being collected and analyzed, and new programs for managing and governing urban infrastructures, the smart city creates opportunities for the deepening of surveillance in everyday life (F. R. Klauser & Albrechtslund, 2014) and provides new avenues for "corporate storytelling" (Söderström, Paasche, & Klauser, 2014) to influence entrepreneurial urban governance. This paper has raised several additional critical issues for future scholarship on urban governance at the convergence of smart and sustainable city projects. First, although ULLs or other forms of experimentation promise ways to test-out solutions for urban sustainability, they are largely shaped by existing governance regimes with political economic interests and goals. This may contribute to creating exclusive sustainable enclaves in the city where only small portions of the population benefit. Second, as demonstrations, ULLs are significant opportunities to enroll public support for addressing urban sustainability. Yet, these approaches seem to have a limited approach due to the ways in which citizens can participate in these projects. The Austin case study demonstrates that techno-economic approaches seek to regulate the conduct of individuals through economic incentives, but this approach limits more democratic citizen-led alternatives. This points to the need to reinvigorate governance experimentation with a radically democratic agenda, and that we should take seriously the role that seemingly one-off experiments have for possible co-production of more sustainable and just urban futures.

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